A Study of "Air Pollution and Climate Change and its impacts on Human Health with Special focus on Visakhapatnam City" Andhra Pradesh

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Abstract-**Climate records kept worldwide clearly show that ongoing changes are happening in our eco-systems. Such climate changes include temperature, precipitation, or sea level, all of which are expected to keep changing well into the future, thereby affecting human health, the environment, and the economy. Air pollutants such as Tropospheric ozone and black carbon (soot) also contribute to the greenhouse effect. Black carbon is thought to be the second or third most important anthropogenic contributor to global warming, while Tropospheric ozone is the fourth most important. Both are also major components of indoor and outdoor air pollution. This paper reviews the existing literature of the health, economic, and climatic impacts of Tropospheric ozone and black carbon emissions, together with mitigation options. The local nature of many of the impacts, combined with their short atmospheric lifetime and the existence of cost-effective abatement technologies that are already widely deployed in developed countries means reducing these emissions provides a highly climatically effective mitigation option that is also appropriate to the development strategy of industrializing countries.**

The natural causes by themselves are not able to describe these changes, so to understand these, scientists are using a combination of state-of-the-science measurements and models. Human activities are a major contributor due to the release of different air contaminants through various activities. Air pollution is one case-in-point, a human-made factor that contributes to climate change by affecting the amount of incoming sunlight that is either reflected or absorbed by the atmosphere. The discussion includes the role of air pollution levels affecting the climate. Emerging topics such as black carbon (BC), fine particulate matters (PMs), role of cook stove, and risk assessment are also covered.

Key words - Climate Change, Air Pollution, Air Quality Monitoring, Health Effects etc.

I. INTRODUCTION

Air pollution is responsible for an estimated 7 million deaths annually, or one in eight premature deaths every year. This makes it the world's largest environmental health risk, and among the largest global health risks – comparable with "traditional" health risks such as smoking, high cholesterol, high blood sugar and obesity. Some 4.3 million air pollution-related deaths are due to household air pollution and 3.7 million deaths are due to outdoor air pollution. Most air pollution-related deaths are from heart disease and stroke, followed by chronic obstructive pulmonary disease, acute and chronic respiratory conditions and cancers. The air pollutant linked most closely to excess death and disease is PM2.5 (particulate matter less than 2.5 micrometers' in diameter), heavily emitted by both diesel vehicles and the combustion of biomass, coal and kerosene. Ozone is another pollutant that causes significant respiratory illness, including chronic asthma. There is growing evidence that oxides of nitrogen (NOx), a major contributor to ozone and heavily emitted by diesel vehicles, is also linked to significant health risks.
[1]

Air and climate pollutants have their greatest health impacts among the poor – but the poor are not the only victims of air pollution. Reducing household pollution risks from smoky biomass and coal cookstoves, in particular, can help alleviate the burden of poverty-related diseases. Urban air pollution levels also tend to be higher in many low and middle-income cities and in poor neighbor hoods of high-income cities. This means reductions in SLCPs can have particularly large health benefits for lower income groups as well as for children, elderly, and women. Climate change is fast becoming one of the most significant challenges of the 21st century. While there may be uncertainty surrounding the scale, scope and of Climate change, one thing is clear – cities and towns everywhere will be exposed to Significant climate change-driven impacts. All of us will need to play a role in helping to adapt to these changes. It is also widely accepted that cities are major producers of the greenhouse gas emissions that contribute to climate change. Hence, cities need to play their part in both reducing greenhouse gas emissions and increasing their resilience to climate-driven impacts. While climate change is a global issue, communities in low and middle income countries where the challenges are unique and the human stakes of planning for climate change are particularly high.

After the past few decades after independence India is few decades back India backward economic development, employment, food and others are back in few decades ago, but after independence developed industrialization, and developing the economic activity, increasing the urban people and urbanization, employment and employment opportunities,

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increasing the pollution, people improving quality of life, economic prosperity, transportation, and environmental sustainability. Climate change is projected to have severe adverse impacts on India's population, natural eco-systems, and socio-economic parameters. India's vulnerability to climate change impacts is profound since around 650 million Indians are dependent on rain-fed agriculture for their livelihoods; around 250 million Indians live along a 7500 km of coastline that is at high risk due to sea level rise and extreme weather events; many of the 10,000-odd Indian glaciers are receding at a rapid rate; and deforestation is happening. India is concerned about climate change impacts.

India occupies 2.4% of the global land area, supports 17% of the global population and contributes less than 4% of global greenhouse gas emissions. Sustainable development is at the core of Indian planning process and India has been making huge efforts for enhancing the quality of life of her people including sustained poverty alleviation efforts. The number of people below poverty line has declined from 469 million to about 388 million during 2005 to 2010. Even then roughly three fourths of Indian population lives below a daily income of US$ 2 (PPP). This also highlights the extent of number of people who are vulnerable to adverse impacts of a changing climate.

II. Review of Literature

- Climate change usually refers to change over time in variables such as temperature, precipitation and wind with increases in temperature being a particular focus (Parry et al., 2007). Climate change is typically considered in terms of having a negative impact on biodiversity, although a range of other responses are also reported, albeit less considered (Delpla et al., 2006). The assessment of vulnerability to climate change is needed to set up relevant adaptation policies. Adaptation to climate change in coastal areas is especially important because many metropolitan cities are located along the coast and the existing problems due to high exploitation of resources in coastal areas may be exacerbated by climate change risks.

- Changes in mean sea level as measured by coastal tide gauges are called relative sea-level changes (Church and Gregory, 2001). Sea-level rise can be a product of global warming through two main processes: thermal expansion of seawater and widespread melting of land ice. Global warming is predicted to cause significant rises in sea level over the course of the twenty-first century. Among this other associated natural calamities like storm surges, tsunamis etc cause sudden increase in sea level for a period which may cause extreme damage to law laying areas. Thus it becomes necessary to study the effect of sea-level rise on the coastal areas. From the coastal vulnerability point of view, coast subjected to a high rate of sea-level rise is considered as a high vulnerable area and vice versa (Church and Gregory, 2001).

- Tushaar Shah (2009) studied the climate change impact on groundwater in India. He investigated the opportunities for mitigation and adaptation. Karen et al. (2004) have taken climate change and globalization for mapping vulnerability to multiple stressors in India.

- Rajawat et al. (2006) delineated the hazard line along the Indian coast using data on coastline displacement, tide, waves, and elevation.

- Urban conditions are very different from city to city, and the quality of life as well as the impacts produced on the environment depend on a variety of local factors of environmental, economic, and cultural nature, and every action must cope with such local conditions, traditions, and attitudes. In a world of cities, it is becoming more and more clear that sustainable urban development is a crucial challenge (Girardet, 2003) and is maybe the most significant current and future environmental issue (McDonald and Patterson, 2007).

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III. Objectives

The main Objectives of the study are:-

- To study the present status of urban environment in Visakhapatnam.
- To study the role of city administration in urban environment management.
- To identify local risks and vulnerabilities in Visakhapatnam city.
- To conduct study on climate change, air pollution and to suggest proactive measures for the urban environmental sustainability, resilience and livability in Visakhapatnam city.
- To the study the impacts of Air pollution and climate change impacts on Human Health.
- To identify the influence of air pollution on city climate of Visakhapatnam city.
- To suggest proactive measures for urban air pollution control, protection of urban ecosystem, mitigate climate change and its associated disasters.

IV. Importance of the Study

- The study will help in better understanding of the present status of urbanization and its management by city administration.
- This study is focused on identification of options to develop city as a sustainable, resilient and livable habitat.

Factors Affecting Urban Health

The past 100 years trend showing a horizontally growth of cities in a radial manner with submerging of peri- urban areas. Cities growth has direct implications for the efficiency of urban services, including delivery of water and sanitation, provision of urban public transport, provision of industrial zone, affordable education, food and health services. Health inequalities in urban area are the result of a complex interaction of various determinants of health, including inadequate health delivery mechanism, planned urban infrastructure, necessary coordination between different stakeholders.

Followings are key factors affecting the outcomes of urban health:

- Rapid migration,
- Governance and convergence,
- Real time data collection and monitoring & evaluation,
- Industrial growth and associated hazards & risks,
- Climate change,
- Socioeconomic conditions,
- Accessibility and affordability of health services,
- Living conditions of houses,
- Changing lifestyle,
- Health Inequality

Urban Health Challenges in India

- Shortage of Urban Infrastructure – India is currently facing an unprecedented growth of urbanization without adequate urban infrastructure and delivery system.
- Accessible and Affordable health service delivery model – Health indicators of urban poor are worst compare to rural area. A large number of urban poor often live in unlisted slums/settlements which prohibits them for accessibility of health services. Irregular employment, migration and socio-economic conditions are the key challenges for health service affordability.
- Urban Health governance – Urban health policy in Informative phase so dedicated urban health governance is very essential to address health issues of most vulnerable sections living in urban area.
- Need-based unique model – Each city has unique requirements in terms of urban health due the complexity of health determinants, so dedicated projects in addition to state and national health program could improve specific urban health challenge.
- Convergence and coordinated mechanism – A number of public health programs are being implemented by various departments under the state and national projects/program but effective convergence and coordinated mechanism is lacking to reduce the duplication of work.
- Climatic variable and its impact on Urban Health – Climate change has major environmental health impacts in urban area. Key vulnerability factors including coastal or geographic location, river side area and extreme weather condition (urban health Ireland) could increase the vector or water borne diseases on a greater extend. State and national intervention are still lacking the climate change focused interventions due unavailability of evidence based research and documentation.
- Community Participation- Currently community participation is lacking in project/program planning, implementation and policy recommendation which ultimately affects the outcomes of urban health program.
- Urban Health Management skills.
- Dual System of health care (Public and Private) - is currently lacking.

V. METHODOLOGY

- Collection of secondary data: Data collected from city administration, technical organizations reports on the city or on urban planning.
- Field visits: Visited various areas in the city covering hazard risk areas, vulnerable areas, critical infrastructures, old towns, satellite towns, developing areas, etc.
- Interviews: Conducted interviews with city administration officials, urban development officials, administrators, planners, engineers, NGOs, academicians, scientists and other stakeholders.
- Literature review: Gone through the published papers in journals, reports etc.
- Brainstorming: Conducted group discussions and brainstorming sessions to analyze the data and to identify best options for the city developments.

VI. STUDY AREA

i. **Visakhapatnam**

Visakhapatnam city is located at latitude $17^{o}43'$ N and $83^{o}17'$E in North eastern coast of Andhra Pradesh with a topography like a spoon shaped basin surrounded by hill ranges on three sides and sea on the other side and is often called as bowl area for assessment of environmental related issues. The hill ranges causes inversion conditions particularly in winter season. Visakhapatnam also harbors a naturally built port and bowl area extends over an area of 266 Km^2. Visakhapatnam has a tropical wet and dry climate (Koppen Aw). The manual mean temperatures ranges between 24.7-30.6^{o}c (76-87^{o}F), with the maximum in the

month of May and minimum in January; the minimum temperatures ranges between 20-27°c (68-81°F). The highest maximum temperature ever recorded was 42.0°c in 1978, and the lowest was 20.0°c (68°F) in 1904. It receives rainfall from the southwest and North-east monsoons and the average annual rainfall recorded is 1,118.8 mm (44.05 in). As of 2011 census of India, Visakhapatnam had a population of 1,728,128, of which males were 873,599 and females were 854,529, - a sex ration of females per 100 males. The review enables to have a clear picture of what had been done in the particular field in the recent years and also facilitates clear view of what should be done in the field. The concept of ambient air quality in atmosphere and induced change of climate change due to industrial and traffic air pollution which have attracted the attention of the experts in the field of air pollution. Visakhapatnam is presently witnessing a boom in industrialization and a consequent explosion in population. The establishment of industries like Hindustan shipyard, HPCL, Steel Plant, Hindustan Polymers, Coromondal Fertilizers, and Hindustan Zinc, APIIC Industrial park, BHPV etc.., over the years there has been a tremendous increase in human population, road transports, vehicular traffic and industries in Visakhapatnam region, has lead to increases in the concentration of gaseous and particulates pollutants in the ambient Air.

ii. **Physical and environmental aspects of city**

Physiographically, the city's area extent can be divided into four physiographic divisions

- Hill ranges
- Hill slopes
- Central Plain area
- Coastal Zone

The Kailasa Hill range on the north extends east west with a length of 14.5 kms and has heights ranging 425m to 504 m above mean sea level (MSL). The Yarada Hill range (Dolphin Nose) on the south extends about 8 kms, almost parallel to the Kailasa hill range and has heights of about 355 m above MSL. There are a few detached hillocks along the foothills of these ranges towards the central part of the area. Narava hill range on the western side of the area extends north south for a length of 6.5 kms. It reaches heights of about 320 m above MSL. The southern hill slope of Kailasa hill range is flanked by a series of piedmont fans whereas the northern hill slope of the Yarada hill range has only one piedmont fan.

In the interface areas and along the rest of the hill slopes are colluvium. The southern slope of the Kailasa hill slope, it is all colluvium. The southern slope of the Kailasa hill range has steeper gradients than the northern hill slopes of the Yarada hill range. The eastern part of the Narava hill range has a gentle gradient. The width of the piedmont zones along Kailasa and Yarada hill ranges towards the central plain area varies from 0.25 to 0.5 kms. This zone is important from the groundwater point of view. The central plain area is occupied by a marsh. The plain zone is connected to sea through Naravagedda flowing from above till it touches the marshy zone.

iii. **Climate**

The district has differing climatic condition in different parts of it. Near Coast the air is moist and relaxing, but gets warmer towards the interior and cools down in the hilly areas on account of elevation and vegetation. April to June is warmest months. The temperature (at Visakhapatnam airport) gets down with onset of South West Monsoon and by January after which there is reversal trend till the temperature reaches maximum by the end of June.

According to Thronthwait's scheme of climatic classification the city area falls under semi-arid type of climate.

iv. **Rainfall**

- Average Annual : 973.6 mm
- Annual Min : 654.0 mm
- Annual Max : 1308.6 mm
- Maximum recorded in a day : 375.2
- Highest annual : 1,314
- Highest monthly : 606 mm
- Highest daily : 2, 93.3 mm
- Fog Months : December to February

v. Vegetation and landscape

The area around Visakhapatnam is predominantly agriculture in character and hence the landscape is mostly man made. The indigenous plants that grown naturally in this area are Vegetables, Mango, Tamarind, Banana, Neem, Palmyra and King trees.

vi. **Monsoons and Cyclones**

In the Bay of Bengal, depressions are likely to be encountered in all seasons of the year with a gradual fall in pressure. On an average 4 to 5 cyclones per year occur. However, at particular locations the average frequencies may be lower. The Coast is mainly affected by waves generated by Cyclones. The highest waves are experienced in the period April September when the winds are more intense and

consistent. The deep sea waves with the highest and lowest period frequent from the South West quadrant. Waves of over 1.5 mtrs in the height may be expected approximately 14% of the time. The daily record of tidal levels shows two highs and two lows.

vii. **Environmental attributes**

The environmental quality in the study area was multi factorial and mostly influenced by unplanned urbanization, intensive transportation, irresponsible industrialization, location specific conditions, loss in vegetation cover, increase in built-up area, ill planned developmental activities and carbon intensive lifestyles. The environmental quality varies from region to region within the city area depending upon the assimilative capacity of a region, population density and the quantity of pollutants causing social damage, the level of valuation and appreciation of the surrounding environment by people in a region etc. All these factors together accord different values regarding the environmental quality to different region within the city. Environmental policy coupled with regional and zonal planning which is presently underway by the APPCB takes into account the long term as well as short term orientation. Major environmental variables characteristic of the city which are responsible for the degradation of the quality of the environment in the city area are considered for describing the environmental scenario of Visakhapatnam - the point and non-point sources of pollution of air, noise, water, land, soil, regimes as well as coastal and marine sectors have been taken into consideration. The point sources are mostly concentrated in a limited area along the northern flank and in the Steel plant-Parawada area located on the south western flank of the Yarada Hill range. The major industries are concentrated in pockets. The map of the city gives a fair idea of the industrial and residential areas. The other industrial areas are of minor consequence.

vii. **Air pollution**

In winter comparing to summer seasons air pollutants concentration values were high. This is may be due to the meteorological conditions such as atmospheric stability and inversion conditions are more prominent in winters. Vehicular air pollution is growing problem in Visakhapatnam. In winter seasons RSPM, TSPM, SO2, NOx and ammonia concentrations were high compared to summer seasons. Whereas no particular seasonal variations were observed in metal parameters. They were at some locations higher in winters, but at some locations higher in summer may be due to difference in dispersion. Overall air pollutants concentrations in the monitoring locations were seen in increasing trend.

ix. **Climate change**

India, as a whole, has experienced its average annual surface air temperature rise by about 0.5C during the past century as also observed across the continents and globe and thus supporting its attribution to anthropogenic influences on global scale. The rise in surface temperature seems to have accelerated since 1971 and particularly so during the past decade. Past studies reported that surface air temperatures over India are going up at the rate of 0.4^0C per decade, with peaks during the post-monsoon and winter seasons. Summer temperatures over the State of Andhra Pradesh in India are projected to increase by 2.5^0C during 2040s and 3.5^0C during 2080s. Winter temperatures could increase by as much as 3.0^0C during 2040s and 4.5^0C by 2080s. According to a more recent study, south Asian summer temperatures are projected to increase by 3°C to nearly 6°C by the end of 21st Century with the warming most pronounced in the north-western parts of India. By the time 1.5°C warming is reached, heat extremes that are unusual or virtually absent in today's climate in the region are projected to cover 15% of land areas in summer. Some regions are projected to experience unprecedented heat during more than half of the summer months.

It is evident from that the maximum day-time surface air temperatures in the city of Visakhapatnam during hot summer months (March – June) is likely to rise on an average by about 1.0°C around the middle of this century while the rise in night-time minimum surface air temperature could exceed 1.15°C by the middle of this century. This illustration further suggests that the diurnal temperature range would become lesser in future in the entire Visakhapatnam district of Andhra Pradesh State. During 2080s, both the maximum day-time and minimum night-time surface air temperatures in the city of Visakhapatnam during hot summer months are expected to rise in excess of 2.2°C. These projections of rise in surface air temperatures during hot summer months (March – June) suggest that the intensity of heat waves in the city of Visakhapatnam during summer months should become stronger with time and record high temperatures could be experienced here more often in future.

x. **Air Pollution Status**

Continuous Ambient Air Quality Monitoring

- Two continuous ambient air quality monitoring stations (CAAQMS) were installed and operated by APPCB near APIIC office, Marripalem and at GVMC office, Asilmetta, Visakhapatnam for continuous monitoring of various pollutants in the ambient air. The online data is disseminated to the public through display boards installed at the respective stations. The data is also available on the official website of APPCB (www.appcb.nic.in).
- The parameters monitored are PM10, PM2.5, SO2, NO2, Benzene, Ammonia, Ozone, CO, etc., and also certain meteorological parameters viz., Wind speed, Wind direction, Temperature, Relaeative Humidity, Rain fall, etc.

VII. IMPACTS OF AIR POLLUTION AND CLIMATE CHANGE

a. **Air Quality and Related Health Effects**

Climate can influence the concentration of air pollutants and promoting the formation of secondary pollutants. Studies

show that ozone irritate the respiratory system, reduce lung function, aggravate asthma and damage lungs cell line which may cause permanent lung damage and aggravate chronic lung diseases. Weather condition and vehicular pollution can influence the transportation of airborne pollution and allergenic pollens leading to respiratory disorders such as asthma, emphysema and chronic bronchitis, and allergy problems. Climate change also cause diseases like chronic obstructive pulmonary disease, pneumothorax, and respiratory infections in children, elderly, ailment person and other. IIPS reported that in India around 6% children suffer from respiratory tract infection and 2% of adults suffer from asthma.

b. **Water and Infectious Diseases**

Water is fundamental for life and scarcity or excess water affect human health which may increase the chance of food and water-borne diseases. Scarcity of water affect agriculture resulting in less production. Heavy rainfall events can transport terrestrial microbiological agents into drinking-water sources resulting in outbreaks of crytosporidiosis, giardiasis, amoebiasis, typhoid, cholera and other infections. In India the burden of water borne diseases is enormous but are unreported due poor surveillance, awareness and minimal data infrastructure. The World Health Organization (WHO) estimates that 900,000 Indians die each year from drinking contaminated water and breathing polluted air and Indian Ministry of Health estimated 1.5 million deaths annually between 0 to 5 year old children. A reduction in the availability of clean water increases the risk of contamination and thus leading to infectious diseases.

c. **Vector-Borne Infectious Diseases**

Change in weather pattern and precipitation further affect the transmission of many infectious vectors diseases, e.g. malaria, plague, dengue fever, chikungunya, Japanese encephalitis, kala-azar, filariasis and diarrheal diseases. Enzley and Barros conducted a household survey in India and found that the morbidity rate of children under five year due to diarrhea is about 1.7. In the year 1994 Surat plague had resulted 59 deaths. Heavy rainfall result in breeding ground for mosquitos. Every year ~2 million cases of malaria cases confirmed in different regions of India i.e., Odisha, Jharkhand, Madhya Pradesh, Chattisgarh, West Bengal, and North East. The World Health Organization in 2008 estimated that in India each year approximately 15,000 die due to malaria. Recently Dhingra et al. estimated that malaria mortality in India is difficult and found that approximately 200,000 deaths per year before 70 years of age and 55,000 in early childhood. Dengue is another important disease occurring in tropical and subtropical regions.

d. **Impact of Heat Stress**

Heat stress and strain are multifactorial and combination of heat stress, dehydration and physical activity impose challenge for physical adjustment, with potential risk of ensuing heat related injuries and disorders, e.g., heat cramp, heat exhaustion, heat syncope. Prolong exposure to solar radiation may cause a substantial amount of body water lost as sweat, including loss of fluid through respiration, gastrointestinal tract as well as kidney which disturbs the homeostasis of the body, leading to decreased skin blood flow, elevated core body temperature (Tcr), decreased sweat rate, tolerance to work, and increased risks of heat injuries. The National Laboratory, New Delhi predicted heat stress on human health in view of climate change using PRECIS model A1B scenario and showed maximum temperature for three consecutive days in the range of 45–500C in April to June months in the years of 2030, 2050, and 2080 in some districts of Andhra Pradesh, Bihar, Gujarat, Odisha, Rajasthan, Uttar Pradesh, and West Bengal .Increased temperatures are also likely to cause increase in eye diseases (cataract, dry eyes, pterygium) and skin diseases.

e. **Climate change and human health: Indian context**

Climate affects water, food, air quality, diseases, physical comforts and human health. Any change in climatic conditions is likely to affect human health. Relationship between climate and health is an old one as evidenced by increase in the visit of patients to clinics after severe heat, rain and cold. Role of meteorology was also well-understood way back in 1921 when Gill1, developed a method for early warning of malaria in Punjab. Changes in climatic conditions are usually termed as climate variability which varies from month/year-to-year. But the variability of temperature over a period of 100 years in India has been reported as 0.5°C2 . Since 1990, there has been sharp increase in global temperatures3 which explains the greater awareness about the potential impact of climate change on different sectors including human health. The importance of the global phenomenon was realized by the international community as far back as 1988 resulting in the establishment of the Intergovernmental Panel on Climate Change (IPCC) by the United Nations Environmental Programme and the World Meteorological Organization in Geneva which collects, analyzes and documents scientific evidences with the involvement of myriad of scientists from various disciplines looking at the impact of climate change on different sectors. Rise in temperature, changes in rainfall and sea level rise are the major aspects that have been projected by the year 2100. The IPCC in its report of 20074 has projected rise of about 4°C in temperature, increase and decrease in rainfall patterns, and a rise in sea level up to 0.59 metre by the year 2100. Extremes of weather resulting in excessive heat and cold events, and disasters are also projected. Melting of glaciers are likely to result in floods, cyclones and disasters. Thus, climate change is basically climate variability which has become faster in the last two decades.

f. **Impact of heat**

In India, loss of life due to excessive heat occur every year. Recently, Akhtar8 has reviewed the mortality due toheat wave in India and found that heat waves occur in the month of March to June. Maximum deaths (1658) occurred in the year 1998. Andhra Pradesh, Odisha, Punjab, Uttar Pradesh, Rajasthan, Bihar and Madhya Pradesh were the most affected

states. With projected rise in temperatures, mortality is expected to rise due to heat waves.

g. **Air quality-respiratory diseases**

Warmer air temperatures can influence the concentration of regional air pollutants and aeroallergens. Allergenic pollens grow more profusely in a warmer climate leading to respiratory disorders such as asthma, emphysema and chronic bronchitis, and allergy problems. Vehicular pollution, particularly in metropolitan cities experience heavy smog and haze resulting in asthmatic attacks. When combined with smog and other atmospheric pollutants, illness from allergic respiratory diseases, particularly asthma, could increase. Changes in the climate also affect diseases like chronic obstructive pulmonary disease, pneumothorax, and respiratory infections in children. There are also indications of relationship between air pollution and tuberculosis. Further, there is some evidence that dust storm in deserts as well as high altitude areas can lead to respiratory problems15. There is ample scope of establishing a relationship between climate change and exacerbation in respiratory diseases in India. The quality of air is likely to decrease as surface ozone concentrations begin to rise with increasing temperatures. This will lead to an increasing incidence of asthma and other cardiovascular and respiratory diseases. This issue is being addressed by the Govt. of India by introducing compressed natural gas (CNG) for transport and replacement of wood fire for cooking by the liquid petroleum gas (LPG) in villages. It is an excellent example of co-benefits of other sectors to human health.

h. **Disasters**

Excessive floods, cyclones, storms and earthquakes usually cause loss of life, infrastructure and human resources. As per projections of extreme events due to climate change, loss of life and mental stress are expected in vulnerable people. Coastal areas of India, particularly the east coast and Andaman & Nicobar Islands are vulnerable to cyclones and tsunamis. Lessons learnt from the past would serve as guiding principle for formulating preventive measures and combating tools. National Institute of Disaster Management, set up by the Government of India is making headway in imparting training to different sectors and mapping the disaster prone areas in India which should serve as a baseline for development of preparedness plans to meet adverse impacts.

i. Diarrhoeal diseases

Excessive floods contaminate drinking water creating conditions for transmission of diarrheal diseases like cholera.

j. **Water scarcity and malnutrition**

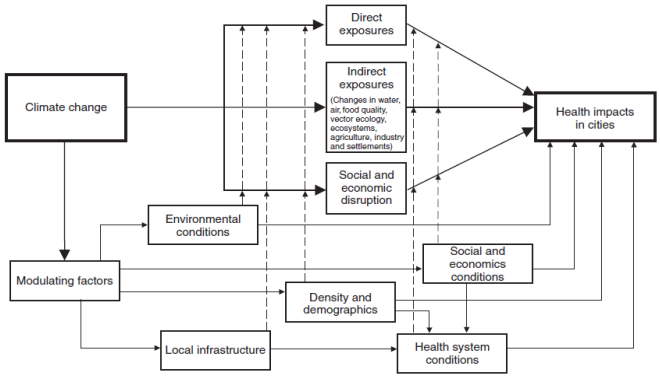
Water is fundamental for life. Scarcity of water or excess water due to floods, cyclones are likely to affect human health. Scarcity of availability of water for crops and high temperatures will affect agriculture resulting in less production. As per World Bank, India ranks at number 2 after Bangladesh where about 47% of children exhibit a degree of malnutrition21. Diseases like diarrhoea, malaria, typhoid and pneumonia further add misery to the problem.

k. **Vector-borne diseases**

Spatial and temporal distribution of vector-borne diseases like malaria, dengue and chikungunya are likely to be affected the most as the mosquitoes which transmit thediseases are cold blooded. Their life cycle and development of pathogen in their body are likely to be affected at varying temperature and relative humidity.

l. **Dengue**

Major issue of concern is urbanization in the context of VBD, particularly dengue and chikungunya. Impact of climate change on dengue also reveals increase in transmission with 2°C rise in temperature in northern India as reviewed in 2010. The thresholds of temperature and relative humidity for indigenous transmission of dengue need to be redefined. Risk factors in terms of water availability, storage practices and life style also need to determined. As adaptation measures, early warning system for preventing outbreaks is need of the hour. In a preliminary study using A1B scenario of PRECIS model, transmission windows for dengue transmission (20–32°C temperature and >55% RH) were projected by the year 2030 which show increase in transmission months open for dengue transmission in northern areas and reduction in western part of southern India.



National Ambient Air Quality Monitoring Programme (NAMP)

Under NAMP, APPCB is monitoring Air Quality at 8 prominent locations in and around Visakhapatnam city for 24 hour duration @ 3 shifts per day on 9 days in a month. As on date, the APPCB is monitoring the parameters viz., Sulphur dioxide, Nitrogen dioxide, PM_{10} and Ammonia.

1. Mindi
2. Autonagar
3. Seethammadhara
4. Police barracks
5. ESI Hospital

6. Gnanapuram
7. Pedagantyada
8. Ramky Pharmacity

TABLE
PM_{10} Values recorded at various locations in the city from 2010 to 2016

Location	Standard*	2010	2011	2012	2013	2014	2015	2016
ESI HOSPITAL	60	59.5	74.5	55.5	48.9	55.7	45.4	76.2
MINDI	60	71.8	92.6	50.1	52.2	54.9	60.2	75.0
SEETHAMMADHARA	60	75.4	81.3	61.8	62.4	61.4	51.5	85.8
GNANAPURAM	60	87.2	119.5	95.1	122.2	84.6	68.7	67.2
POLICE BARRACKS	60	95.9	148.8	104.3	115.1	87.1	86.1	74.2
INDUSTRIAL ESTATE	60	70.0	77.2	69.0	59.3	64.1	59.3	85.9
PEDAGANTYADA	60	65.6	74.4	60.6	49.8	54.3	52.4	75.9
RAMKY	60	43.5	83.6	34.5	31.7	44.8	55.3	73.9

TABLE
SO_2 (Sulphur Dioxide) Values recorded at various locations in the city from 2010 to 2016

Locations	Standard*	2010	2011	2012	2013	2014	2015	2016
ESI HOSPITAL	50	6.3	14.3	8.1	12.5	12.3	7.9	7.5
MINDI	50	9.3	20.8	8.8	11.6	12.7	7.6	7.6
SEETHAMMADHARA	50	5.5	10.1	13.0	13.8	12.8	8.0	9.5
GNANAPURAM	50	10.4	24.6	22.3	16.8	16.2	11.0	7.0
POLICE BARRACKS	50	7.2	19.9	22.9	19.8	18.3	11.4	7.1
INDUSTRIAL ESTATE	50	5.4	14.9	11.8	13.0	11.8	7.7	9.8
PEDAGANTYADA	50	4.9	8.7	8.8	10.4	10.5	7.7	7.3
RAMKY	50	4.3	6.7	7.3	9.2	10.9	8.0	8.2

TABLE
NO_2 (Nitrogen Dioxide) Values recorded at various locations in the city from 2010 to 2016

Locations	Standard*	2010	2011	2012	2013	2014	2015	2016
ESI HOSPITAL	40	15.9	20.9	12.1	15.8	18.6	17.0	17.1
MINDI	40	18.6	25.2	11.6	16.1	18.1	16.2	16.6
SEETHAMMADHARA	40	16.1	20.2	15.5	17.0	19.2	17.7	22.3
GNANAPURAM	40	22.8	36.8	17.2	22.8	26.9	24.8	15.2
POLICE BARRACKS	40	20.6	30.3	19.0	24.8	30.9	15.7	15.7
INDUSTRIAL ESTATE	40	14.5	21.2	12.6	17.5	18.2	16.4	24.2
PEDAGANTYADA	40	12.2	15.8	10.9	15.0	15.1	15.7	15.9
RAMKY	40	10.2	13.3	10.0	14.1	16.3	16.6	18.4

VIII. Conclusion

As Visakhapatnam is a coastal industrial city, there is a threat of natural and man-made disasters. The temperatures in the city were in increasing trend and the effects of climatic change are evident. The natural resources and environmental quality are in deteriorating condition. In this situation it is very important to mainstreaming disaster risk reduction, climate change adaptation principles and environmental considerations in urban planning, to develop Visakhapatnam city as a sustainable, resilient and livable habitat.

Ground measurements, computational studies, and satellite measurements, are all pointing towards changing pollution trends in India. Today, India has the unique opportunity to further the air pollution abatement measures, at the urban and the regional scale, but these depend on effective inter-sector and inter-ministerial collaboration. This is primarily due to the fact that all the sources contributing to the air pollution are interlinked. Among the sectors, transportation is the most critical and most connected. Following the review, two challenges have emerged for better air quality in Indian cities (a) the need to secure greater public awareness of the problems and commitment to action at civic, commercial, and political levels (b) to ensure that action to tackle air pollution is seen in the context of wider social and economic development policies. For example, how much can these interventions help reduce the local challenges, like providing safer and reliable public transportation systems; cleaner and efficient waste management; dust free roads; and pollution free industries and power plants.

Recommendations/suggestions to improve the air quality:

1. For the development of the country, establishment of new industrial units can not be downgraded; however, effective control measures of pollution, and proper installation of air pollution control devices and their smooth functioning must be ensured before the establishment of any industry. After the establishment of industry, proper functioning of the installed controlling units must also be ensured.

2. Emission from construction industries / activities can be minimized by adopting best practices such as; use of water sprays for dust suppression, creating ridges to prevent dust, compaction of disturbed soil, prevention of dumping of earth materials along road side *etc*.

3. Restrictions may be imposed over the number of vehicles owned by an/a individual/family.

4. Fines should be imposed for the parking of vehicles on the roads.

5. Provision of parking space in any commercial establishment/shopping mall/parks/residential apartments should be mandatory.
6. There should be strict restrictions on old polluting vehicles and subsidies may be given on the vehicles running on cleaner fuels.

7. There should be strict checking of PUC certificates.

8. There should be uniformity in the fuel quality standards used across the country.

9. There should be more space for pedestrians and two wheeler vehicles on the roads.

10. Up-gradation of public transport is necessary by improving service quality, enhancing the number of buses, and better road management.

11. Improvement in traffic signal co-ordination for continuous traffic flow to reduce traffic jam and idling time can also help to minimize pollution.

12. Corporate firms/ government offices may draw up an action plan to have bus/cab service for their employees with reasonable rates.

13. Idea of working in different shifts for corporate firms / government offices to minimize traffic at peak hours can be introduced.

14. Strict rules should be imposed for proper dumping and disposal of solid waste, since unregulated burning results in pile-up of smoke and particulate matter in concentrated form at one place. Regular functioning of all the installed solid waste treatment facilities must also be ensured.

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