

Vulnerabilities of Urban Poor Children and Urban/Peri-urban Ecosystem Based Resilience



ABSTRACT

World is witnessing unprecedented urban sprawl, with high pace in the Asia Pacific. It is likely that half of the Indian population shift to cities and towns in the coming two decades, and the already prevailing challenges of urban poor will manifest itself as a major challenge if not addressed proactively and prudently. Climate change and ecological degradation are major impediments, in the backdrop of inadequate civil infrastructure and services of water, sanitation and health. Children and more particularly urban poor children bear and would continue bearing the brunt of their as well as their family's sufferings. The ever growing migratory population dwelling in slums, urban villages, fringes and peri-urban areas include significant portions of rural ecological refugees affected by prolonged climatic stresses, agricultural setbacks, natural hazards or socio-cultural challenges, in addition to job and amenities aspirations. Children

are differentially vulnerable to climatic stresses, related disasters and health risks. In order to understand the vulnerability of urban poor children to climatic risks and issues pertaining to peri-urban ecosystems in resilience building, a study has been undertaken in five cities of India, viz. Shimla (Himachal Pradesh), Indore (Madhya Pradesh), Gorakhpur (Uttar Pradesh), Panjim (Goa) and Guwahati (Assam). Of late, the role of ecosystems and particularly those constituting of peri-urban areas on which many of city's services and interests depend have come to some recognition in the discourse of resilience as well of sustainable cities. However, urban and rural planning still has no mechanism to harness peri-urban potential and, thus, degradation of peri-urban ecosystems continue posing even greater threat to urban poor and particularly to children. The context of Sustainable Development Goals (SDGs) and other resilience related

policy paradigm pertaining to underlying factors contributing to urban poor children's vulnerability has been discussed in the light of the study results. So, has the role of urban and peri-urban ecosystems which offer significant part in urban resilience building.

Key words: Climate resilience, Urban poor children, Peri-urban ecosystems.

(1) URBANIZATION, POOR CHILDREN AND GREEN GROWTH SOLUTIONS

2008 was a historic year as for the first time, more than half of world's population was deemed to be living in urban areas. This shift is the result of both "pull" and "push" factors. On the one hand, people are attracted to economic resources, employment opportunities, social mobility and government services there in urban areas; and on the other, migrants flock to cities due to social insecurity, environmental vulnerability, and as a graduated shift away from rural agriculture as their main occupation. Global warming is a dominant factor in moves from rural to urban regions in most developing countries. Around 45 per cent of the urban population in developing countries live in slums and informal settlements, defined as 'a group of individuals living under the same roof lacking one or more of the following conditions: access to improved water, access to improved sanitation facilities, sufficient living area that is not overcrowded, safe structural quality and durability of dwellings, and security of tenure' (UN Habitat, 2014).

Such conditions violate several of the rights of children as enshrined in the UN Convention on the Rights of the Child (UNCRC), such as: the right of every child to a standard of living adequate for his or her physical, mental, spiritual, moral and social development (Article 27); the right of every child to reach the highest attainable level of health not only through access to healthcare but also through healthful living environments (Article 24); the child's right to play, recreation, rest and leisure through allocation of leisure time and provision of safe and appropriate spaces for play and recreation (Article 31); and so on. As attention to improve living environments of children in urban poverty has been inadequate in relation to the scale of the problem, millions of children across the world and particularly in low-income countries live in 'life and health threatening' housing conditions

(Hardoy et al., 1990). This poses great risks to their life and well-being.

Urban India is projected to have half of the country's total population by 2040–50. Urban share in India's GDP is to grow to 75 per cent by 2030. Given the ongoing trend, 600 million people are expected to reside in urban areas by 2030 as compared to 377 million in 2011 (Forgotten Voices, STC, 2015). Urban poor often represent socio-economic and physical vulnerability of cities and towns. Indian cities are overcrowded; over 53 million + cities account for 13 per cent of the population but occupy just 0.2 per cent of the land. Around half of the urban migrants are among the poorest in terms of consumption expenditure. Environmental degradation, natural resource conflicts and socio-economic disparities are considered among major drivers of migration from rural and countryside to urban areas. Acute agro-climatic distress was observed to be a frequent aspect of push from their homelands. In fact many of them are ecological refugees (Mitra and Singh, 2011).

A large proportion of the population in Asia comprises of infants, children and adolescents. They are in a stage of rapid development and are less equipped on many fronts to deal with deprivation and stress. Children's still evolving development makes them physiologically and metabolically less able than adults to cope with high exposure to hazards (Akachi et al., 2009; Costello et al., 2009). Their exposure to various climatic stresses is also more likely to have long-term repercussions than of the adults. Furthermore, such exposure also threatens all other aspects of their well-being including their psychological health, education, safety and protection, and recreation. Urban children are generally better off than their rural counterparts, but this is untrue for those hundreds of millions living in urban poverty. The 'urban advantage' does not come into play in terms of health, education and respectful growth opportunities for most of those living in urban poverty.

Besides a resilient urban development which helps in mitigating the impacts of climate change, it is also important that mitigation measures are adopted to address the causes of such hazards and environmental factors. 'Green growth strategies' calls for urban governance facilitating wetland restoration, mangrove plantation and protection, maintenance of green spaces and commons, green energy, ecological and soil



Figure 1. Water and Sanitation in SDGs and Role of Ecosystems (6.6) and Communities (6.b)

conservation, plantation, green roofs, water harvesting, and other such GHG emission mitigation measures, which at the same time also reduces vulnerabilities to the ill effects of sewerage and contamination, pollution, solid waste, health risks and other environmental emergencies.

(2) CALL OF SDGs: SAFE, SUSTAINABLE AND RESILIENT

The design of Sustainable Development Goals (SDGs) is drawn on learning from the Millennium Development Goals (MDGs). Goal 7 of the MDGs, which is aimed at ensuring environmental sustainability and addressing the challenges of access to water and sanitation services, has led to tremendous improvements in access to water worldwide. According to the Joint Monitoring Report Update 2017 (WHO-UNICEF Report), 6.5 billion people (89 per cent of the global population) have access to at least a basic service to obtain drinking water and 4.6 billion (71 per cent of the global population) have access to a safe source of drinking water; however, 844 million (7.5 per cent) have no access to even a basic drinking-water service. Of the 5.0 billion (68 per cent) that have access to at least a basic sanitation service, nearly 2 billion (39 per cent) have access to safe sanitation services. By 2015, 154 countries had achieved at least a basic level of sanitation (JMP, 2017).

Despite the overall development of urban infrastructure in many cities, especially roads, flyovers and so on, children from disadvantaged sections - slum as well as street children, orphans, and people with disabilities are susceptible to scenarios such as ill-health, poor access to water and sanitation, insufficient education, urban disasters and child protection and safety concerns. Climate change and disasters exacerbate these conditions. Keeping children and urban poor children in particular exposed to climatic stresses and extremes, undermines not only their health – well-being and rights of development (Right to Life, Article 21 of Indian Constitution, in reference) but also undermines their contribution to national and local development process as responsible and gentle future citizens.

Despite dedicated programmes on sanitation, India still has the largest number of population (47 crores) practicing open defecation. Consideration portion is from cities and towns – particularly poor dwellers of urban fringes, peripheries, urban villages, slums and those living beneath bridges, flyovers, trees and in temporary camps. Making slums and similar areas (where majority of the city's poor people inhabit) inclusive, equal, integrative and green, demands fresh communitarian narratives (TU, 2017).

Of the 17 SDGs, Goal-6 “Ensure access to water and sanitation for all” is central (TU, 2017) to urban-poor children, which in fact stands on six other Goals, viz.:

- poverty eradication (SDG 1),
- ending hunger by improved nutrition (SDG 2),
- ensuring healthy lives and promoting well-being (SDG 3),
- education (SDG 4), gender equality (SDG 5), and
- inclusive cities (SDG 11).

However, it is interestingly relevant to look at urban poor children's vulnerability and their resilience through 'second paradigm shift in disaster risk reduction' and 'ecosystem services' based approaches. This is central to the new global policy regime of SDGs, Paris Climate Agreement and Sendai Framework for DRR (2015-30), which collaborate to promote and utilize green growth opportunities more particularly for urban resilience.

(3) CLIMATIC RISKS: STRESSES, DISASTERS AND EMERGENCIES

Rapidly expanding cities, towns and the upcoming ones in the developing world are and will continue to face increasing risks as a result of climate change. Urban vulnerability builds up with a combination of population density and infrastructural degradation. Additionally, with nearly 65 per cent large cities located on coasts, many are at a significant risk of flooding, cyclone, tsunami and other environmental risks. In populous areas with dense infrastructure, "heat island effect" raises temperatures around the city and heightens the wind and rain intensity of storms. Poor wetlands preservation exacerbates the danger of flooding, while the deforestation of hillsides heightens

Box 1: Children's Vulnerability to Environmental Risks

Exposure to environmental risks differs between adults and children. The environment in which foetal and childhood development occurs is critically important. Generally speaking, the presence of an environmental hazard (e.g. a pathogen, pollutant or physical hazard) does not necessarily mean that it will do harm.

Many factors influence the risk of health effects from exposure to hazards, including the degree of susceptibility or vulnerability. Children are more likely to suffer from adverse reactions and long-term health effects than adults, since they are subject to greater exposure and are more vulnerable to environmental hazards, especially to contaminants.

- Children need more food, water and air per kilogram of body weight compared to adults. In the first months of life, for example, babies drink seven times more water than an adult, and in their first five years they eat three to four times more than an adult, compared to their body weight.
- A child's immune system and other key physical defence mechanisms are not fully developed, leading to greater risk from exposure to contaminants in the outdoor and indoor air, water and soil.
- According to recent research, exposure to certain chemicals of concern begins at a very early stage of development (including exposure in the uterus).
- Children breathe more rapidly than adults, taking in four to six times more air for their body weight. They also have a larger lung surface area in relation to their body weight, which increases exposure to air pollutants.
- The way in which they breathe, combined with the incomplete development of their respiratory tract, makes them more vulnerable to infections that may be triggered by an inflammatory response to air pollutants.
- Children have thinner skin than adults, which makes them more susceptible to the absorption of substances. They also have a proportionately larger body surface area than adults, which increases the area of exposure to skin contact and the absorption of toxic substances through the skin.
- Children's cells grow in number more rapidly than adults', causing increased vulnerability to the effects of radiation.
- Children's limited diet in the first year of life may lead to increased exposure to food-specific contaminants (e.g. mercury in fish).
- Children have immature blood-brain barriers, thus the brain tissue is more vulnerable to the intrusion of toxic pollutants from the blood stream.
- Children's immature immune systems may increase their susceptibility to infections and allergic reactions.

Last but not least, very young children are unaware of risks. They are unable to protect themselves from hazards and their typical behaviour (crawling, playing on the ground, putting their hands and objects in their mouths) facilitates the ingestion, skin contact and absorption of pollutants in dust and dirt.

Source: Regional Environmental Center for Central and Eastern Europe. Italian Ministry for the Environment, Land and Sea. <http://airpack.rec.org/>

the likelihood of landslide in the event of earthquake. For many cities, this risk is pressing; more than half of the large cities are located in areas with a high risk of earthquake, each with a population ranging from 2-15 million. Living in cities can present further hazards for those children with poverty, and in precarious situations with respect to housing, land, basic water and waste management systems, healthcare and emergency services (Dodman et al., 2013).

Talking specifically of developing countries; the climatic changes are significantly altering health of humans and natural ecosystems. Increasing temperatures and projected changes in hydrological cycle are to lead to an increase in temperature-related illnesses, vector-borne diseases, impacts related to extreme weather events (particularly floods and droughts), and health effects due to food insecurity. Increase in coastal water temperatures and subsequent drinking water contamination is posing a serious disease threat. The phase of rapid and uncertain natural disasters has already begun (with India facing one of the hardest droughts in the past 83 years) (Sharma, n.d.). Climate change impacts will lead to an increased frequency of hot days, heat waves, droughts (declining water tables, crop failures, etc.) and natural disasters.

Indian cities, especially the secondary cities, and urban villages, slums, and peripheral parts of cities, are more at risk of climatic disasters and health consequences due to their high population density, constrained basic services, expansive informal settlements and urban expansion onto risky sites. In any urban context, gains in child health and well-being are undermined and vulnerabilities of urban poor are exacerbated by climate change impacts in developing countries, unless the core issues of inadequate living environments are addressed in policy and practice. More than 700 million children below the age of 15 years comprising 40 per cent or more of the population live in the 20 countries deemed at 'extreme risk' from climate change, mainly in the belt around and immediately north of the equator (Maplecroft, 2014).

Urban poor children are highly prone to the effects of climatic disasters, extremes and environmental emergencies. Climatic hazards affecting urban poor children commonly include flooding, windstorms, water scarcity, urban heat, smoke and/or fog, etc. Complex emergencies resulting from reaction of

climatic incidences with non-climatic stressors such as chemicals, hazardous and infectious wastes, drainage and sewerage failure, pollution, accidents, fire, sick buildings, unsafe schools, etc., are a growing concern.

Urban children living in poverty face multiple deprivations rendering them vulnerable in fast Indian urbanizing cities. The dangers severely restrict children's independent mobility and opportunities for play and recreation while increasing their exposure to hazards, violence and unintentional injuries. The cumulative effect of such risks severely undermines the adaptive capacities of children to climate change. Understanding these risks is important, as policies aimed to lessen pressures on resources, manage environmental threats and increase the welfare of the poorest members of society can simultaneously advance to sustainable development goals through enhanced adaptive capacity and reduction of vulnerability to climate change and other risks.

(4) ENVIRONMENTAL BASIS OF VULNERABILITY

The Hyogo Framework of Action (2005-15) in its priority 4 referred to underlying causes of vulnerability, which forms the basis of Priority 1 of Sendai Framework for DRR, i.e. Understanding Disaster Risk. This is connected to the hypothesis that disasters are caused when hazards meet vulnerability and such vulnerabilities are often generated or exist in human-made settings. Inextricable linkages between environment and human development is more clearly visible in urban settings and, thereby, understanding of nexus of climatic risks, urban poverty, children and ecosystems is critically important as one exerts significant influence on others.

Urban poverty including deprivation of health, resources and infrastructure are aggravated by climate change impacts and inadequate environmental management. Failure to address climate change and build resilience against it will lead to increased risks that undermine children's development. Environmental changes: climate change, land-use changes and natural resources degradation, coupled with other anthropogenic pressures aggravate people's vulnerability to disasters, health risks and (frequent or prolonged) low-order stresses. Urban poor children are frequently exposed to physical hazards, such as polluted water; open sewer systems; inadequate public

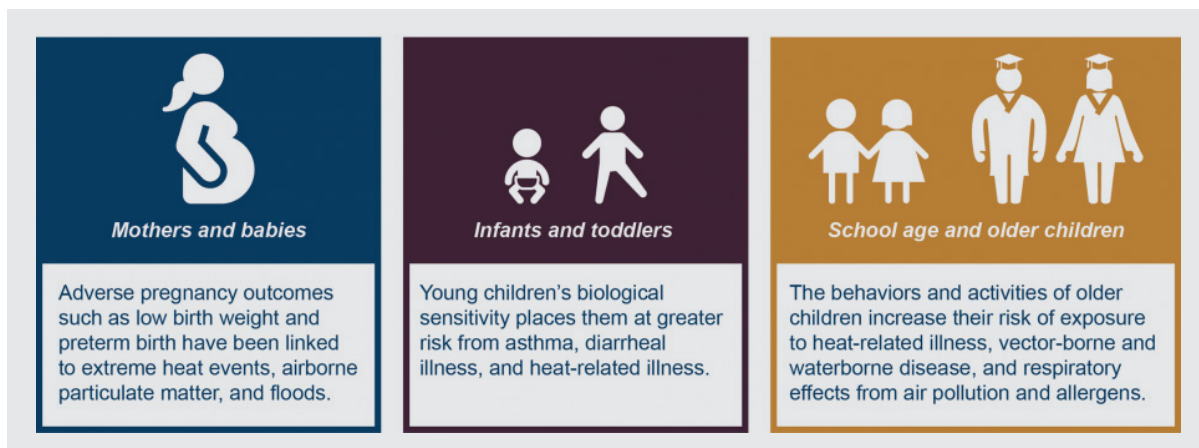


Figure 2. Vulnerability to the Health Impacts of Climate Change at Different Life Stages

transport; lack of local safe play areas or cultural facilities; toxic local environments; and overcrowding.

Water, sanitation, wastes, climatic hazards and environmental emergencies coupled with ecological decline and poor governance, are known to compromise not only children's health, safety and protection but also multiply and complicate their future vulnerability to such or other risks. Several slums are located along the edges of sanitation corridors on untenable lands. Servicing slums on ecologically fragile lands, besides being additionally complex, is also fraught with legal problems (TU, 2017). Underlying contributors of vulnerability were at the core of Hyogo Framework of Action (Priority 4), which was rated as most inadequately achieved during 2005-15 and hence rated to Priority 1 (Understanding Risk) in the Sendai Framework for DRR, as voiced clearly in the Special Report on Extreme Events and Disasters (SREX, IPCC 2012).

Children's vulnerability to climate change results from distinct exposures, biological sensitivities (developing bodies and immune systems), and limitations to adaptive capacity (dependency on caregivers) at different life stages (figure 1). Children's health is primarily determined by the socio-economic and physical conditions of the environment in which they live and are nurtured. In the context of climate change, the situation of these children residing in the fragile fringes of the city with poor basic facilities which gets aggravated in times of extreme weather events becomes even more precarious. Health is closely inter-linked with livelihoods and income, nutrition, and water and sanitation facilities. In 2011, only 70.6 per cent urban households had access to tap water and only 60.6 per

cent had access to tap water from treated sources (Bhat et al., 2013). Sewerage, toilets, sanitation, drainage, electricity and transport are severely deficient for the poor. During the study, these aspects were closely studied in order to understand the issues of health amongst children living in different situations.

Many of India's 14 crore children in primary school are the first in their family to go to school. Damage or losses due to climatic hazard's and related environmental emergencies on physical structure, access or functioning of the schools are further deleterious to children's development. Such implications of climate change and environmental



Figure 3. Map of India showing the five case study cities

emergencies were seldom considered in conventional programmes of school safety, DRR or adaptive development. In the wake of changing weather patterns, education is influenced by declining livelihood opportunities, migration, inaccessibility to schools, health, etc. Children living in slums grow up in a volatile environment where safety is always in question. During extreme temperatures and rainfall, physical safety becomes a problem for the children. These slum children and also those living on the streets face extreme vulnerability and deprivation of basic entitlements. Climate change and disasters cause large scale dislocation of poor people from rural to urban areas or even within the urban areas.

(5) CASE STUDIES AND LESSONS

A study on urban climate resilience in the context of children and in different geo-climatic and hazard situations has been undertaken. Vulnerability analysis has been done in the context of poor children's

exposure to climatic hazards, related disasters and health consequences, and role of urban and peri-urban ecosystems in resilience building, through city case studies. Five Indian cities (figure 2), viz, Shimla (Himachal Pradesh), Indore (Madhya Pradesh), Gorakhpur (Uttar Pradesh), Panjim (Goa) and Guwahati (Assam), represent India's agro-climatic, geographic and cultural diversity, and varying state of urban pace and infrastructure growth. Diversity of climatic settings – past trends as experienced and/or reported and projected changes in climatic regime and patterns are given in the table 1. This also shows the environmental basis of selection of these cities. Shimla and Guwahati are part of Himalayan states whereas Panjim is a coastal city. Gorakhpur is chronically flood prone and the city of Indore represents recent changes in climatic patterns.

It is evident from table 1 that change in patterns of rainfall, temperature and extreme events has become a serious concern for a city's sustainability and safety. The projections are also surrounded with uncertainties

Table 1. Climatic and Risk profile of the cities

City	Shimla	Indore	Gorakhpur	Panjim	Guwahati
Height (m) above MSL	2206	553	84	60	60
Past climate	Maximum temperature shown fluctuating trend, varied 14.9 to 21.0°C. Min. temperature. Declined in the range of 0.5 to 1.2°C. Average annual rainfall increased - low variability with exceptions.	Transitional climate: tropical wet & dry to humid sub-tropical. Hot summers – more in Apr-May, extended, very low humidity. Decline in cool evening breeze. Sudden downpours.	Pleasant, rapid alteration and uncertainties in recent past. Average temp. 25.68°C, average maximum temp. 31.95°C, average lowest 19.57°C. City receives annual rainfall above 119.2 cm.	Coastal climate – West coast/ Arabian sea. Temperature and rainfall changed significantly in 36 years (1964-2000). Data gap – a challenge.	Rainfall through the year, majority monsoons. Min. and max. temperatures show increasing trend. Extreme temperature (high as 40°C & low 6.4°C).
Projected climate	Increase in average rainfall, more in June-Sept. and moderate in Jan-Feb. Rise in average annual temp. by 1.7-2.2°C, but Oct-Dec to be cooler (2.6°C).	Increase in min. and max. temp., more in winters, min. in monsoons. Shift in rainy season – prolonged starting May, increased rain.	Rise in max. temp. in all seasons, with more summer & winter oscillation. High uncertainty in rainfall, increase/ decrease.	Ave. annual rainfall rise - high probable, range 69-109 mm. more in June-Aug., decline in Jan-Feb., a bit in Mar-May. Rise in ave. ann. temp. 1.5-2.2°C, more in June-Sept.	Decreasing trend of seasonal and annual rainfall. Slight decrease in rainy days in June-Sept. Extreme rainfall events.
Climatic - disaster and health risks	Landslides. Water/ food borne diseases.	Waterlogging, flooding. Water and vector borne diseases. Heat wave.	Water risks, Water/vector borne diseases. Flood/ waterlogging.	Waterlogging/ flooding, Heat wave, water/ waste borne risks.	Ecological degradation. Urban floods/ waterlogging, diseases.

(Source: Information extracted from Wajih and Mani, 2016, and other public as well as web sources).

Table 2. Vulnerability assessment of cities: Major factors of concern, with reference to climate change and resilience

City	Major concerns
Shimla	Water supply, Transport, Tourism, Ecosystems
Indore	Waterlogging and floods, Water scarcity, Discomfort and health risks, Loss of livelihoods
Gorakhpur	Waterlogging, Drainage and Sewerage, Solid waste, Household based traditional livelihoods, Drinking water, Urban planning
Panjim	Salt water intrusion, Formation of beaches, Loss of mangroves, Land reclamation, High water table, Loss of sand dunes, Lack of sewerage network, Siltation of storm water drains
Guwahati	Water Supply (gaps in network, inefficiency, water quality), Sewerage, Drainage (capacity of drains, natural drainage topographical and pattern, encroachments of swamps and natural reservoirs), Lack of robust drainage schemes

and coupled with recent experiences from the past expresses concern on water and climatic disasters, and associated environmental health challenges. These often cause damage and undue pressure on infrastructure and operability of environmental services of water, sanitation, storm water, sewerage, waste management, in addition to effect of increased in-migration and floating populations, pollution, transport, housing, etc.

In order to understand various attributes of vulnerabilities of urban poor children in the context of climate change, key context of children’s development, i.e., health, education and physical safety and protection were taken as thematic aspects. Detailed vulnerability assessment for the cities, separately, has

been carried out using the tool called Shared Learning Dialogue (SLD), and city vulnerability reports have been developed. Key concerns of city vulnerability to climate change and for its resilience to related shocks and stresses, are identified from the exercise, and given in table 2. Interestingly water supply, waterlogging, flooding, waste management, sanitation and health risks emerged commonly through varying terminologies.

Some of the issues captured in the vulnerability analysis are critical. For example, in the city of Shimla, the increased precipitation and/or frozen water in pipelines may disrupt infrastructure. This affects drinking water, sewerage management and sanitation. In the situation, people opt for consumption

Table 3. Identified vulnerability attributes in five study cities

City	Shimla	Indore	Gorakhpur	Panjim	Guwahati
Identified Vulnerabilities of children	Health, Education, Child Labour, Child Beggars, Illegal practices (drinking alcohol, intoxications, etc.)	Health, Education, Child Labour, Child Beggars, Illegal practices (intoxication), Child sexual abuse	Vector borne diseases, Snake bites, Health problems due to contaminated water, Lack of or / disrupted access to school, Child labour, Trafficking	Health, Education, Sex Abuse, Child Labour, Child Begging	Housing, Health, Education, Child Labour, Illegal practices (child sexual abuse, substance abuse, etc.)
Special categories of affected children	Children in slum areas, Children in low-income settlements, Floating population of children, Children residing in unsafe localities	Children in slum areas, Children in low-income settlements, Migrants, Trafficked children	Children in slum areas, Children living in fringes of city, peri-urban areas and flood plains, Children in low lying and waterlogged areas, Addicted children	Children in ‘Slum like’ areas, Children in localities at fringe of city/low lying areas, Begging Children (October-March), Floating Children (migratory)	Children in slum areas, Children in low-income settlements, Children residing in unsafe localities

City	Shimla	Indore	Gorakhpur	Panjim	Guwahati
Responsible factors	<ul style="list-style-type: none"> • Fragile, inadequate and unsafe water supply system • Lack of proper sewerage network causing contamination • Improper water quality testing facilities • Lack of solid waste management • Health issues • Education issues • Child labour/child beggars during tourist season/ in-migrants due to agricultural losses 	<ul style="list-style-type: none"> • Water logging and floods • Water scarcity • Lack of sewerage management • Lack of drainage management • Lack of solid waste management • Health issues: No coordination between blood banks • Education issues • Child labour/ child beggars/ child sexual abuse 	<ul style="list-style-type: none"> • Water logging, • Inadequate sewage water disposal, • Groundwater contamination • Non-availability of safe drinking water, • Vulnerable habitat and housing, • Lack of ecosystem management – adding to floods and waterlogging impacts, • Health: Exposure to vector and water borne diseases 	<ul style="list-style-type: none"> • Salt water intrusion • High water table • Lack of adequate sewerage network • Health aspects • Education aspects • Child Abuse/ Labour during tourist influx, in-migrants due to agricultural losses 	<ul style="list-style-type: none"> • No proper housing for slums / low-income settlements • Inadequate supply of safe drinking water forcing people to draw water from extremely unsafe sources which are contaminated

(Source: Data extracted from Wajih and Mani, 2016).

of questionable quality water. It also leads to adverse effect on tourism and economy. Increase in temperature in other areas leads to increased biotic pressure (tourist's inflow) causing stress on urban services. Ecosystems are most adversely affected, with diminished carrying capacity, pollution, and other anthropogenic effects.

The vulnerability assessments of cities were reviewed to identify critical factors contributing to urban poor children's vulnerability to climatic risks and associated disaster and health implications, and summarised in table 3. Results show a range of environmental factors responsible for their social and economic vulnerability attributes.

5.1 Health

Health and environment as a sector comprises multiple and integrative-collaborating and sometimes conflicting factors, viz., those relating with medical treatment, water, sanitation, sewerage, pollution control, waste management, industry, transport, ecosystems – parks, plantations and gardens, agriculture, wetlands, etc. In India, annually 45,000 deaths are reported due to diarrhoea alone. Health outcomes are shaped by environmental attributes comprising not just the biological factors but also the influencing social, economic, cultural and ecological settings. Hence, climate variability and disaster caused

damages and losses enhance vulnerability of children, especially the poor, by contributing to or complicating underlying factors. Deficiencies in water supply and sanitation, poor housing fabric with poor ventilation and density of homes, spread of infectious diseases and respiratory illness are only a few of the environmental challenges aggravated due to changing and extreme climate conditions like rainfall, humidity, temperature, wind, smog, etc. Health of urban children living in spaces waterlogged and low-lying, city peripheries, slums, and dense localities, roadsides and underneath flyovers and bridges, are particularly vulnerable due to exposure to hazards and inadequate health facilities.

In absence of basic water and sanitation facilities, urban poor children often become victims of illnesses like ringworms, scabies, jaundice or diarrhoea. Stunted growth in children has been reported as a result of severe malnutrition. Incidences of skin disease among children are also high. Girl children are even more vulnerable to health issues as they get almost no options for safe sanitation. Unsafe drinking water is a major cause of ill-health especially in climate change induced stresses; and the sudden changes in weather and weather extremes (heat, cold wave) are increasing morbidity. Increased duration of humidity along sewage/polluted water stagnation creates a favourable mix for the breeding of mosquitoes and enhancing vector-borne diseases. Poor public-health

infrastructure in cities and difficult access of poor people in such situations has obvious negative impacts. Since awareness of preventive public health is quite low in poor communities climate change impacts exacerbate vulnerabilities.

5.2 Drinking water

Water is the most important sector responsible for children’s vulnerability with the problems getting worse due to climate change impacts. It is possible to reduce child mortality by 25 per 1000 children by providing for access and use of safe drinking water (STC, 2015). While the challenge of unreliable water supply remains for all city dwellers, it is highly pronounced among low-income households. Coping costs with alternative water supply is also a major concern for urban poor. Safe drinking water emerged as the most serious issue across the studied five cities.

Increased waterlogging due to high intensity or prolonged rainfall coupled with unregulated inhabitation patterns are also causing groundwater contamination that in turn affects the people fetching on shallow borewells (Gorakhpur, Panaji, Guwahati). Gorakhpur is particularly vulnerable to Japanese Encephalitis, claiming sometimes hundreds of lives of children a year due to Acute Encephalitis Syndrome (AES) caused by contaminated water. In Guwahati, drinking water is sourced from the river Brahmaputra

after treatment but water treatment plants are running below their capacities leading to inefficient water supply in the city. Assam, accounts for more than 50 per cent children without access to drinking water facilities in schools (STC, 2015).

City of Shimla reported recurring hepatitis in city claiming several lives during every alternate year starting 2005. An epidemic and closing of schools for some days due to unavailability of water was also reported this year. Salt water ingress and high water table is a major issue in coastal zones (Panjim), which needs check on percolation of sewage and the safe recharge of groundwater. For planning and designing effective drinking water supply, it is important that peri-urban areas are protected and water exploitation is reduced (Shimla, Indore).

5.3 Sewerage and Sanitation

Underserved and un-served areas of cities are inhabited by poor people. Insufficient water supply and sanitation coverage combined with overcrowding maximizes faecal contamination. Absence of sewerage systems and sewage treatment plant in the cities (Guwahati) intensifies the problem. Open defecation in Indian urban areas is still high (Census, 2011). Madhya Pradesh and Uttar Pradesh have higher number of urban households without toilets (25.78 and 16.89 per cent respectively) whereas Goa rates relatively quite

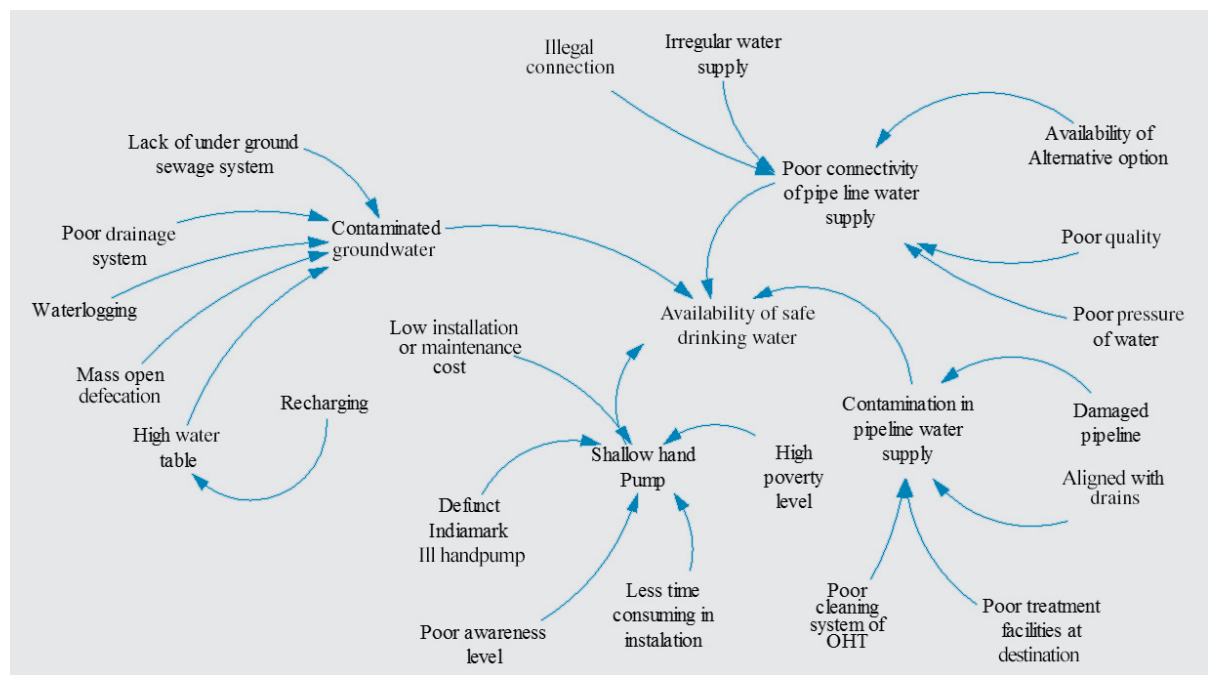


Figure 4. Causal loop diagram on availability of safe drinking water in Gorakhpur

low (14.75 per cent) (STC, 2015). Untreated sewage is one of the main causes for surface and groundwater pollution. Urban poor are particularly vulnerable as their dwellings are generally on or near the sewage dumping location (CRS, Gorakhpur).

Sewage and storm water drainage are critical challenges with increasing/high rainfall and shrinking water bodies. Open, un-paved and wetland areas that help assimilate stormwater and en-route groundwater recharge are disappearing. Hence, water logging is increasing every year. In Gorakhpur, Panjim and Indore the area and duration of waterlogging is increasing after each monsoon. This leads to mixing of sewerage with drinking/domestic water supplies and also causes groundwater contamination. Vector-borne diseases have risen, with urban poor children being affected disproportionately. Guwahati is increasingly facing problems of artificial flood and acute waterlogging due to poor drainage. Children with inadequate clothing cover and living in unhygienic conditions are more vulnerable. Sewerage and sanitation are crucial services that need urgent attention as climate change is aggravating the risks. Lack of proper solid waste collection commonly results in clogging open-drains and further adds to the problem of urban flooding.

5.4 Education, Physical Safety and Protection

Despite the 'children's rights to free and compulsory education' guaranteed by the Right to Education Act 2009, growing vulnerabilities due to effects of disasters and climate change are known to rise affecting their enrolment and retention in schools in India. There is large 'rural to urban migration' due to deceleration in agricultural occupations, increasing climate variability adversely affecting agricultural production and business along with incidences of disasters and escalating input costs in agriculture in all the geo-climatic settings (flood, hills, coastal and drought) covered under the study. Such urban migration is also with families - the children being most vulnerable due to such dislocations and parents getting engaged in earning livelihood. Settlement in slums, low lying and unhygienic areas and urban fringes affects access to education for children. Factors which affect children's education in the context of climate change and the needed coordination issues towards their enrolment and retention were identified as following:

- *Floating Population:* Large number of migrants to cities is temporary for limited duration due to causes like agricultural losses due to climate vulnerability and disasters (2015 is one of the worst in UP in recent memory). In most cases males migrate to cities alone but a large number of families also move to cities with children.
- *Dislocations:* This was particularly seen in Guwahati. Distressed migration in the city from the neighbouring rural areas is huge with an aspiration to earn better livelihoods. People with no houses settle in the fragile areas with no access to schools.
- *Unsafe Settlements:* Urban poor children either have no or rare access to schools, or there are no government schools in such areas. Increasing waterlogging and water stagnation in residential areas, fear in security of children particularly girls in foggy days, schools being on other side of busy roads are a few examples which hinder the access of schools.
- *Disruptions:* Climate change impacts are causing intense weather conditions leading to floods, inundation, fog, heat, cold wave, heavy winds, all of which disrupts schools. Increasing disease incidence in the vulnerable areas also cause schools absenteeism sometimes leading to drop-outs. The recent hepatitis outbreak in Shimla, malaria and Japanese Encephalitis in Gorakhpur, drinking water related illness in peripheral Panjim and Guwahati are some of such examples, which cause negative effect on children's education.

Children in urban areas, those belonging to poor communities, and from the urban fringes, urban villages, also engage in hazardous work environments of manufacturing, chemicals, rag picking and processing (*kabadi*), etc., without physical safety or occupational protection. Poor quality housing and businesses in such locations add to the physical safety risks, besides the risk of climate induced disasters and extremes, like flooding, waterlogging, fire, etc. Many of the children in cities are wards of environmental refugees in areas affected by climatic hazards.

(6) ECOSYSTEM BASED ADAPTATION AND CLIMATIC DRR

Healthy, well-functioning ecosystems enhance natural resilience to the adverse impacts of climate change and reduce the vulnerability of people, especially children to hazards associated with water, weather, sanitation, food and health, etc. The city systems, therefore, are needed to be strengthened at both, built infrastructure and green infrastructure. Ecosystem services comprising the biological systems on earth and underwater, directly pertaining with water, sanitation, and thereby health and well-being, are significantly recognized major facets of sustainable development goals (SDG 3, 6, 14 and 15) as referred in the figure 5.



Figure 5. SDGs for Ecosystem Based Urban Poor Children's Resilience

Table 4. SDGs – Relevant Goals, Targets and their contexts for children's vulnerability

Goal	Theme / Target	Emphasis	Children Contexts
17	Strengthen means of implementation & revitalize global partnership for sustainable development	People-planet-prosperity-peace-partnership.	Children's resilience is important. Children's inclusive development model/sustainability partnership.
6	Target 6.3 Water Quality and Wastewater	Improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally.	Children's health, Child labour/ Occupational hazards, Water & sanitation, Food safety.
	Target 6.3.2	Proportion of bodies of water with good ambient water quality.	Recreation, Food & nutrition, Water, Ecotourism / livelihoods of parents, Cultural benefits.
	Target 6.3.1	Wastewater safely treated: <ul style="list-style-type: none"> Wastewater generated by households (sewage + faecal sludge) Wastewater generated by economic activities. Onsite facilities Hazardous waste industries, Diffuse pollution, e.g. runoff from agriculture (6.3.2 indicator) 	Children's health & safety, Food safety.
	Target 6.3.2	Bodies of water with good ambient water quality: <ul style="list-style-type: none"> Water bodies Ecosystem function and human health Biological indicators 	Water, Ecotourism, Recreation, Livelihood of parents, Biodiversity benefits, Education/awareness.
	Target 6.6 Water-Related Ecosystems	Protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes.	Ecotourism, Recreation/Sports, Water, Livelihood of parents, Food & nutrition, Biodiversity benefits, Traditional knowledge.
	Target 6.6.1	Water-related ecosystems: Vegetated wetlands, lakes/reservoirs, rivers/estuaries. 6.3.2 Optional: Health of ecosystems; Groundwater volume.	Sanitation and wastewater treatment, Children's health, Water sources.

Goal	Theme / Target	Emphasis	Children Contexts
Other Goals/Target			
3	Target 3.9	Reduce deaths and illnesses from hazardous chemicals, pollution & contamination.	Children's health & safety, Food safety.
12	Target 12.4	Environmentally sound management of chemicals/wastes, reduce release to minimize impacts on human health & environment.	Children's health & safety, Food safety, Occupational health/safety of parents.
	Target 12.5	Reduce waste generation through prevention, reduction, recycling and reuse.	Children's health, Child labour,

One of the 2nd United Nations Environment Assembly's (UNEA-2) joint themes for the year 2016 was on "delivering the environmental dimension of the Sustainable Development Goals" (SDGs). Ecosystem goods and services refer to many life-sustaining benefits we receive from nature-clean air and water, fertile soil for crop production, pollination, and flood control (USEPA, 2014). Hence, issues of sustainable cities and sustainable communities include efforts of climate change adaptation and mitigation; resilience in the face of climate related disasters and environmental emergencies such as plantation/forest fires, windstorms and cyclone, city flooding, ecological extremes and damages, and storm water management (including combined sewer overflows) etc. Cities and its people may also face human-driven modifications

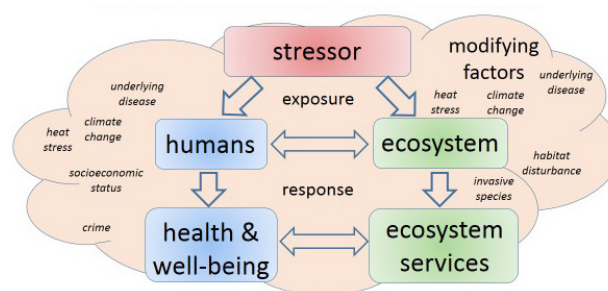


Figure 6. Example concept model: Stressor, ecosystem services and human-health and well-being (Source: USEPA, 2016)

that adversely impact both humans and ecosystems. Reducing environmental hazards and disaster risks is a major component of community resiliency (figure 6).

Box 2: Examples of Services by Urban Green and Blue Infrastructure

Microclimate regulation: Urban parks and vegetation, including green roofs and green walls, reduce the urban heat island effect. A 10 per cent increase in tree canopy cover may result in a 3–4.8°C decrease in ambient temperature and save large amounts of energy used in air conditioning. The cooling effect of trees in cities may contribute significantly to reduce energy needs from fossil fuels and cut carbon emissions.

Water regulation: Interception of rainfall by trees, other vegetation, and permeable soils in urban areas can also be crucial in reducing the pressure on the drainage system and in lowering the risk of surface water flooding. Urban landscapes with 50–90 per cent impervious ground cover can lose 40–83 per cent of incoming rainfall to surface runoff whereas forested landscapes only lose ca. 13 per cent of rainfall input from similar precipitation events.

Pollution reduction and health effects: Urban vegetation is widely reported to improve air quality (context dependent to high spatial and temporal variability). Green area accessibility has been linked to reduced mortality and improved perceived and actual general health. The distribution and accessibility of green space to different socio-economic groups, however, often reveals large asymmetries in cities, contributing to inequity in both physical and mental health among socio-economic groups.

Habitat: An important characteristic of urban areas is their mosaic of habitats and a surprisingly high diversity of plant and animal species.

Cultural services: Many cultural services are associated with urban ecosystems and urban biodiversity plays a positive role in enhancing human well-being. It is found that the psychological benefits of green space increase with biodiversity, whereas a 'green view' from a window increases job satisfaction and reduces job stress. Diverse ecosystems in urban areas may also be important in providing design features that can be utilized in the context of eco-design and bio-mimicry in architecture and urban planning.

(Source: Elmqvist et al., 2015).

Reviews of the natural environment and health literature have tended, at times intentionally, to focus on a limited subset of ecosystem services as well as health benefits stemming from the presence, access and exposure to, green infrastructure. The sweeping influence of green infrastructure on the myriad ecosystem services essential to health has therefore often been under represented (Coutts and Hahn, 2015).

Neighbourhood and national parks, parkways, forests, community gardens, and the myriad other forms of conserved private and public components of natural landscape (greenspaces), taken together and considered as a system, are what constitute a community's green infrastructure. In urban environments, this infrastructure can include not only landscape patches and corridors but also other representations of nature (e.g., green roofs, street trees) that provide health-supporting ecosystem services without requiring the same level of consumption of finite urban land. A widely cited definition of green infrastructure is "an interconnected network of greenspace that conserves natural ecosystem values and functions and provides associated benefits to human populations" (Benefict and McMohan, 2002). Green roofs (roofs with a vegetated surface and substrate) provide ecosystem services in urban areas, including improved storm-water management, better regulation of building temperatures, reduced urban heat-island effects, and increased urban wildlife habitat (Oberndorfer et al., 2007).

Investing in ecological infrastructure in cities, and the ecological restoration and rehabilitation of ecosystems such as rivers, lakes, and woodlands occurring in urban areas, may not only be ecologically and socially desirable, but also quite often, economically advantageous, even based on the most traditional economic approaches (Elmqvist et al., 2015).

(7) URBAN/PERI-URBAN ECOSYSTEMS

Ecosystem-based resilience building need to be encouraged and mainstreamed which uses ecosystem services including landscape, biodiversity, wetlands, rainwater, as part of overall adaptation strategy to help people and their cities become resilient to climatic stresses and shocks. However, city's resilience needs special call on peri-urban ecosystems along urban ones



Ecosystem for Resilience

Figure 7. Role of ecosystems in resilience and adaptation to climate risks.

recognizing their benefits in reducing city's pressure of migrants and worker populations, urban agriculture occupants, assimilating city's pollution and discharges, ecotourism and health services, water resource recharge, etc.

These peri-urban ecosystem rich areas not only enable buffers for city's protection from external eco-climatic risks like river floods, pests, animals, etc., but offering their organized benefits to city dwellers. By protecting and harnessing peri-urban and urban ecosystem services, children-particularly urban poor, are benefitted not only through promotion of health, nutrition, sanitation, livelihood of family, physical safety and protection for city dwellers in general – and for them in particular, but also mainstream them in city's resilience building by developing into aware – responsible citizens.

Green infrastructure includes examples like wetlands (lakes, ponds, tanks), gardens and parks, avenue and road plantations, city forests, green roofs, and peri-urban ecosystems. These are primarily non-engineered structures but may also include human-made ecosystems. Urban agriculture is now common in many Indian cities and towns. Climate change exacerbates hazards and further degrades agriculture jeopardizing lives and livelihoods of those living in urban and peri-urban areas. Study inferred that peri-urban and urban ecosystems support engineered infrastructure and,

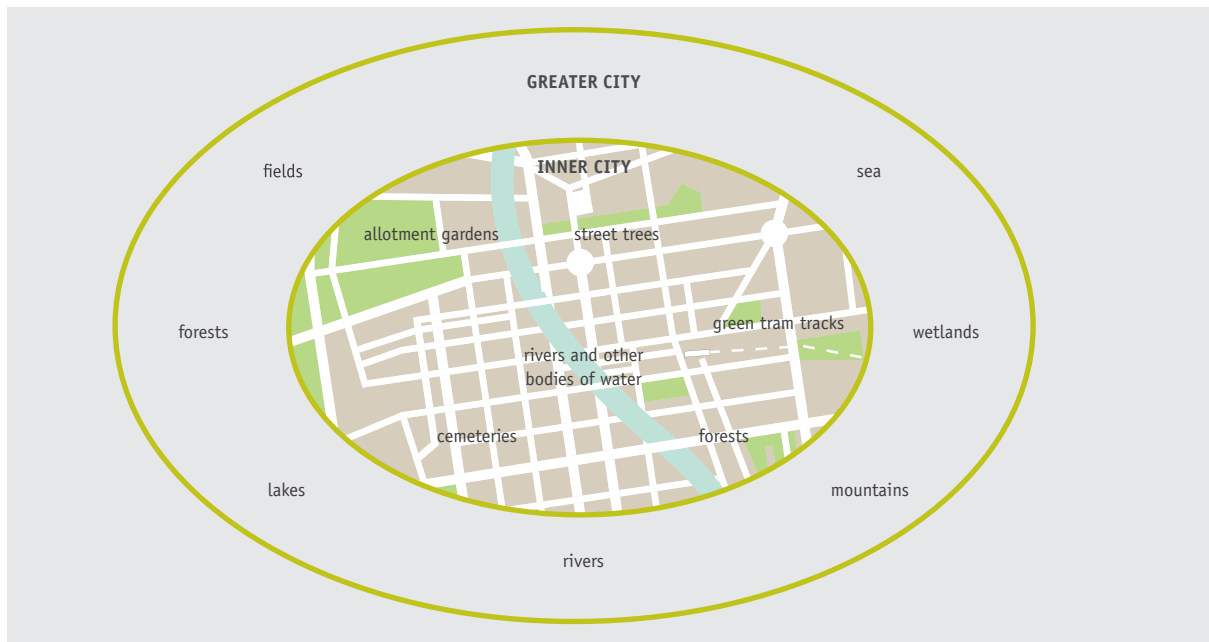


Figure 8. Examples of ecosystems which provide cities with services: all ecosystems (urban and peri-urban) presented in the figure are interrelated and crucial for the quality of life in cities (Source: Kronenberg, 2012).

thereby, reduce poor children’s vulnerability by helping in water conservation, drainage, water infiltration into the soil leading to decreased run-off, keeping the areas flooding free and diversifying food and income sources, and thereby enhancing climate resilience of these vulnerable communities.

Urban resilience cannot be achieved in isolation as the flow of goods and services - including the natural continuous - connect the urban areas with peri-urban areas. Both in water excess and deficient areas these sites provide buffering capacity (Gorakhpur, Indore and Guwahati). In hilly areas (Shimla), the availability of drinking water is largely dependent on upstream peri-urban areas. In coastal zones (Panjim), the peri urban areas play a very important role in checking salt water intrusion and bio-shields for protection of coast.

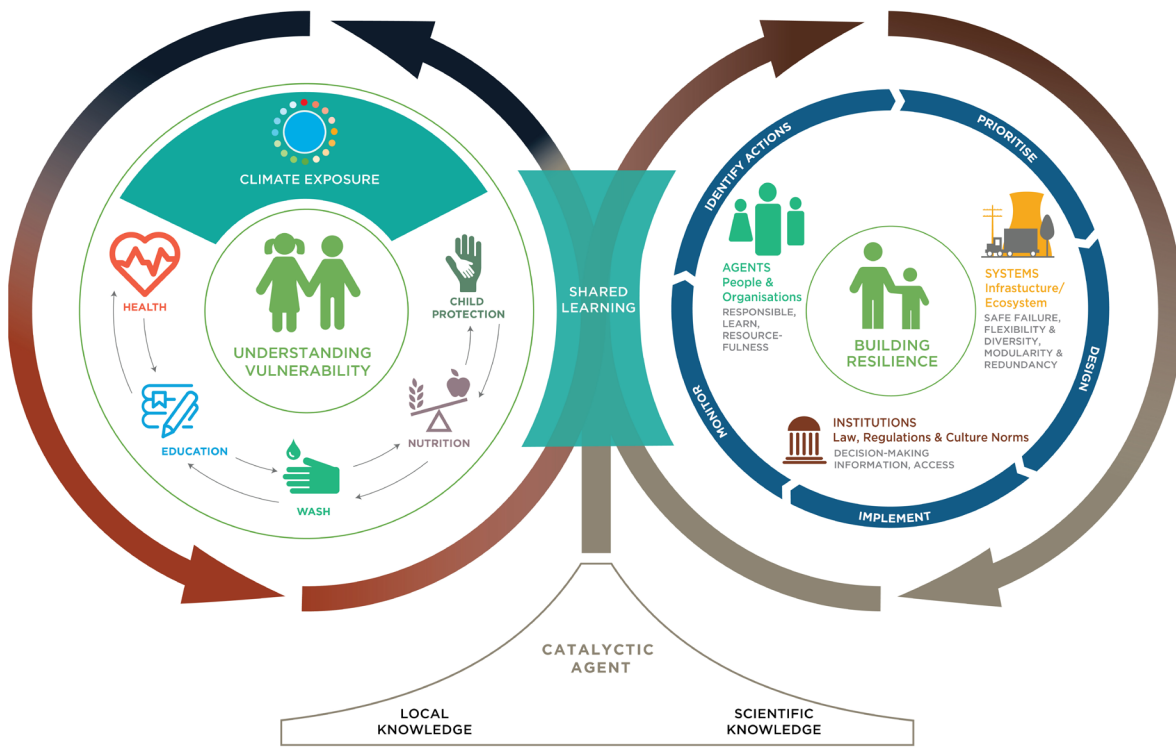
However, urban peripheries are not considered properly in urban planning or governance and, therefore, in urban resilience. Land tenures in peri-urban areas are uncertain. The infrastructure is poor, incomes low and there is no formal recognition of these areas (Prakash, 2012). Typified by mixed agriculture and non-agricultural land use and flows of goods and services between village and urban centres and a perpetually changing heterogeneous social population that lead to specific environmental and natural resources problem beyond the scope of urban and rural governments individually, peri-urban areas

need attention and innovate approaches (Allen, 2003; Narain, 2010; Prakash, 2012; Mitra et al., 2015).

These are also the spaces which provide easy access to the poor migrating from rural areas in search of jobs and livelihoods. The resilience of children in urban and peri-urban areas (especially economically weaker sections) cannot be addressed adequately unless this peri-urban/urban connect and role of ecosystem services are appropriately considered. The safe habitats and health, food, water, fuel, waste decomposition, playing grounds, clean air, etc. are linked to ecosystem services. In all the cities covered in the current study, peri-urban ecosystems are crucial in terms of producing safe food, water, inhabitation and other essential services for climate change resilience. The degeneration of peri-urban ecosystems has caused severe problems especially for the urban children.

The mismanagement of upstream ecosystems in Shimla is one example which caused severe hepatitis outbreak affecting large number of children. Coordinated governance involving citizens and departments like irrigation and public health, Municipal Corporation, agriculture and horticulture would be significant in maintenance of ecosystem services towards sustained urban resilience. Likewise, the contamination of groundwater in Panjim and degeneration of water bodies in Gorakhpur reduces urban resilience. Rapidly expanding Guwahati with

Figure 9. Child-Centred Urban Resilience Framework



Adapted from Climate Resilience Framework, ISET International

concrete infrastructures is already witnessing severe artificial flooding conditions and in fact deteriorating the situation further.

Accurate and timely information on the status and trends of peri-urban ecosystem has been attracting increasing attention recently (Díaz-Caravantes et al,

2011). Part of the problem lies in defining, identifying and measuring peri-urbanity, and more particularly the ecosystem benefits in terms of physical, social, livelihood and economic resilience of the inhabitant communities. Peri-urban areas are often used to dump the city waste, sullage and sewerage, waste water or locate landfills, impacting adversely the lives and



Figure 10. Discharge of untreated wastewaters in river Rapti at Gorakhpur (Source: Mitra et al., 2017)

livelihoods of the residents, and degrade beneficial ecosystems converting to filthy hazard-hotspots. Children's health is more severely affected in the process (Mitra et al., 2015). Lack of environmental and health services and civic infrastructure mark the peri-urban areas almost in every Indian city including Gorakhpur and Visakhapatnam (Mitra et al., 2017). The people and the landscape interact dynamically with the associated land-uses and livelihoods based on flows of agricultural goods and ecological services both within peri-urban zones and between them and urban core areas (Lerner and Eakin, 2011). The 'extractive' nature of urbanisation places a low premium on preserving the ecosystem, affecting not only the livelihoods of those directly dependent on it but also the city itself.

Decline in the number, spatial extent, ecosystem health and services of wetlands – lakes, ponds and tanks, in most urban centres is the principle cause of growing urban flood incidences and related consequences, which are mostly highly deleterious. Mumbai, Surat, Chennai, Kolkata, Bhopal, Guwahati, Bangalore and Hyderabad are a few examples of urban flood menace. Loss of water bodies affected livelihoods, recreation and aesthetics besides, water, sanitation and health of people who in the past depended on them. Not only in India, this is a common syndrome now in many cities and towns of Asia-Pacific for example Dhaka,

Islamabad, etc. Decline of water bodies significantly affects water and sanitation facilities of the dependent people, exerting demands on already stressed and inadequate civil supply systems. Alongside, it leads to mal-adaptation to unhygienic practise and unsafe sources thereby affecting children the most.

Urban and peri-urban agriculture defined as, "agricultural (including livestock) production, processing, and distribution activities within and around cities and towns, whose main motivation is personal consumption and/or income generation, and which compete for scarce urban resources of land, water, energy, and labour that are in demand for other urban activities" (Gundel, 2006) is central to a system approach to urban resilience. Agroecosystems in and around cities offer buffer in flooding and local climatic processes, heat island effect and ambient heat/ heat waves.

Maintaining the land use pattern beyond the city edge or protection of open space in city's periphery has been tested in adapting to flooding by a range of enterprises from productive greening strategies involving fruit trees, herbal shrubs, high-value vegetables, and on hill slopes and in valleys to increase water infiltration and reduce the time lag for flood occurrence. Peri-urban forests, plantations, estuaries, lakes, dunes and other ecosystems role in moderating cyclones, sea water ingress, tides and surge intensities are scientifically and



Figure 11. Solid waste is being used as landfilling materials in low lying areas of Gorakhpur. The same is situation of peri-urban and under-developed areas in most cities and towns.

also economically well reported.

However, contrary to scientific and policy understanding, peri-urban ecosystems in most Indian cities including the study cities are uncared for. Direct and indirect benefits of ecosystem services to urban poor children through a system dynamics and economic evaluation approach are yet to be studied. Records and community interaction in most of peri-urban parts around Gorakhpur revealed 60-70 per cent population (with children are most susceptible) suffering from gastrointestinal diseases due to intake of polluted and contaminated water. Japanese Encephalitis (JE), AES, jaundice, cholera, colitis, diarrhea, worms, dysentery, and skin diseases have become rampant. Vishakhapatnam has witnessed serious damage to peri-urban forests and open lands with dumping of city and industrial wastes. Degradation of temples tanks in Chennai and lakes in Bangalore along worrisome land use changes and sprawl of concrete jungles at cost of wetlands lead to recurring flood menace (Gupta and Nair, 2011). Delhi NCR's peri-urban settings near Asola lake and Okhla wildlife sanctuary are live examples of such deluge of garbage, plastics and are like a death sentence to ecosystems.

Having known the facts of urban poor children's vulnerability, primarily of water, sanitation, health, and exposure to climatic stresses and extreme events, besides food and nutrition insecurity, damage/losses to schools, maladaptation to unhygienic practise and unsafe sources, aggravated due to loss of peri-urban/urban ecosystems, the policy-planning-practice regime now has none other than the choice of looking at peri-urban ecosystem services for building resilience. This approach is connected with the ground, is people oriented, most economic and viable with additional benefits of cleanliness, livelihood, tourism, educational, biodiversity and other several benefits. However, the mechanism has to be worked out in an integrated manner synergizing with urban, rural and countryside planning, and with harnessing technological advances.

(8) MODELLING INCLUSIVE RESILIENCE

Urbanization has been accompanied by an alarming rise in urban poverty. Around 76 million urban people are estimated to be poor. The Census, 2011 reported 13.7 million slum households in India living without adequate amenities, poor health conditions

and insufficient and uncertain incomes. Over the last four decades, the total headcount of the poor in the share of urban poverty has gone up from 18.7 to 26.8 per cent. While it may be a bit early to call it the 'urbanization of poverty', there is a definite shift that must be acknowledged and addressed in a planned manner in the official discourse (Forgotten Voices, 2015). Moreover, nearly a third of these urbanites (120 million) are children below 18, ten per cent being below six years. More than eight million children below six live in slums. Despite this, the official discourse on children does not distinguish much between rural and urban children nor does it clearly focus on poor urban children and their needs. These children remain invisible, as held in UNICEF's State of the World's Children (2012).

People are integral parts of ecosystems, and are even more important to understand in terms of building resilience of urban poor and their children, which has direct bearing on and from peri-urban ecosystems. A dynamic interaction exists between humans and ecosystems, with the changing human condition driving, both directly and indirectly, changes in ecosystems and thereby causing changes in human wellbeing (MEA, 2005). At the same time, social, economic and cultural factors unrelated to ecosystems alter the human condition, and many natural forces influence ecosystems.

The key outcome of this study is the process framework for vulnerability assessment which is based on combination of the following:

- Scientific and data based understanding of the past and present climatic scenarios, and associated hazards and risks,
- Understanding and assessment of key contributors of vulnerabilities and their sensitivities to the impacts of environmental changes – climate change, natural resource degradation, and land use changes,
- Key sectors governing vulnerability of urban populations – urban poor and more particularly the urban poor children (i.e. health – water, sanitation, sewerage, education, physical safety and protection),
- Opportunity for integration of CCA, DRR and Sustainable Development Goals, from the vulnerability and risk assessment stage itself, as these principles focus on inclusiveness,

- Addressing the challenges of environmental services, and role of green infrastructure – in particular of the peri-urban ecosystem services, and
- Role of policy-practice changes in reference to the 74th amendment in India's constitution empowering urban local bodies.

In addition to the process guidelines establishing key strands of issues and aspects for capturing vulnerability for the purpose of delineating city strategy of climate resilience focussing children, the fundamental hypothesis has been established that: “*vulnerability of urban poor children to the risk of climate change impacts, is determined by the combination of factors governing water – more particularly drinking/domestic water, sanitation, sewerage and waste management, pollution prevention/control, preventive environmental health, and*

climate related natural hazards – affecting their homes, schools and healthy-recreations, and all being facets of environmental risk management – call for and support ecosystem based interventions – recognizing peri-urban and urban ecosystem services, urban-rural connect, and for effective governance and inter-departmental coordination for responsible, participatory, accountable and scientifically sound execution of respective services catering urban populations”.

Climate resilience, thus, needs to be conceptualized and operationalized as holistic, integrated, inclusive, children focused, and comprising of issues related with rural migration check, livelihood security, peri-urban systems, ecosystem services, public health, education, women sensitivities, resilient infrastructure, and socio-cultural factors.

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