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GREEN AND CLEAN CITY: CONNECTING PEOPLE WITH NATURE

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***Abstract*:** *Growing urbanization is posing serious environmental concerns in India in terms of changing land use pattern, increasing carbon emissions, solid waste generation and disposal, air and water pollution and poor sanitation amenities. A large segment of urban population in India resides in slums, squatters and informal settlement. These settlements are often located in low laying areas prone to direct and indirect risks due to environmental degradation including changes in the climate and lack of basic urban services. An urban environment is complex primarily because of rapidly changing variables such as socio- economic and demographic indicators, land-use patterns, resource demand and utilization patterns, lifestyle changes etc. In the light of climate change, a new layer of uncertainty is added in terms of changes in precipitation, temperature and occurrence of extreme events. Furthermore, there are scale mismatches; in terms of the timescales over which policymakers and urban planners operate, and scales over which projected impacts of environmental decisions, degradation, climate variability and change will manifest. Against this backdrop, present paper purports to review the urban environment in the context of green and clean city development.*

INTRODUCTION

India has witnessed remarkable progress in human and economic development since Independence, however, the path of economic development and growth has been challenging. The concept of sustainable development is buzz word now-a-days which has emerged due to increasing problems of environment and ecology. The inter-related issues emerged from economic growth; environment and ecology are affecting the human population. The human activities are adversely affecting the environment and

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ecology while the global issues like ozone layer depletion, greenhouse gases affect, global warming, climatic change, etc. cause concern. There is degradation of natural resources due to over exploitation, unsustainable economic and commercial activities as well as poor governance of environmental regulations, policies and enforcement of environmental legislations. Environmental pollution is one of the major challenges of the present day. A greater attention is being paid to global environmental change, biodiversity conservation, environmental toxics, ecological restoration, and sustainable development with particularly emphasis on human well-being. Most of the global environmental problems fall within the gambit of ecological studies and require a thorough understanding of ecological principles for resolution. The understanding of ecological principles is important for sustainable use of resources and to evolve strategies for mitigation of environmental problems at local, regional and global regions. The ecologists are required to interpret the human induced environmental changes and postulate varied scenarios for alternative policy options for legislative and implementable administrative decisions. Thus, ecology has grown by internalizing different disciplines of natural and social sciences.-

Increasing urbanization, expansion of habitat into unsuitable vulnerable areas, higher population density, higher housing density, vulnerable housing and buildings construction, non engineered unsafe construction, and aging buildings and other infrastructure are some of the factors that have increased the vulnerability of hazards and disasters in urban areas. Growing urbanization is posing serious environmental concerns in India in terms of changing land use pattern, increasing carbon emissions, solid waste generation and its disposal, air and water pollution and poor sanitation amenities. Major challenge for cities in the face of rapid population growth is to maintain sustainability within the social, economic and environmental dimensions. The accelerated and uncontrolled urban growth has contributed to the ecological transformation of the cities and their immediate surroundings resulting in flash floods and water scarcity. Furthermore other factors depending on the local circumstances contribute to the urban vulnerability, hazards and risks.

Cities may be viewed as hubs of the intensive resource demand, environmental degradation and greenhouse gas emissions. However, cities may play a critical role in promoting low carbon development through use of renewable energy, energy efficiency, green buildings and mitigating emissions from urban transport. The immediate problems of states' cities relate to inadequate institutional arrangements for solid waste management, drainage, sewage treatment and disposal and sanitation services. Thus, it is imperative to improve the municipal services, particularly sanitation services and urban local governments adopt the integrated urban planning for climate resilience and addressing the environmental problems.Cities are the engines of growth. Besides, they have widespread implications on environment and human society. There is large scale incidence of urban poverty and slums in cities. This has resulted in mismatch between infrastructure, resources and population, leading to degraded and unsustainable urban environment. The footprints of urbanization, concretization and land use conversion are visible in the form of urban heat island formation that poses threat to human health and wellbeing. The vegetation cover is imperative for balanced atmospheric temperature and sustenance of Life. Water bodies are crucial for sustainable urban eco-hydrology. The land surface temperature is a critical indicator of urban environment. It is a phenomenon, whereby city experiences elevated temperature in comparison to the surrounding hinterland due to trapping of insulation by atmospheric gases, high rise buildings and concrete surfaces of asphalt, metal, tiles and bricks. It causes heat waves in summers and leads to heat stress and mortality. It changes the micro climate, hence, changes in transmission and life cycle of many diseases (McGeehin & Mirabelli, 2001). The satellite data is widely used for understanding urban micro-climatology and urban heat islands (Singh & Grover, 2014). The land surface temperature, in October, range between 23 to 46°C with lowest value for water bodies and highest for fallow land (Mallick, Kant & Bharath, 2008) and urban heat islands was intense in dense commercial areas (Mohan, Kikegawa, Gurjar, Bhati & Kolli, 2013). There are seasonal and diurnal variations in land surface temperature and urban heat islands (Singh, Grover & Zhan, 2014).

It is less intense on summer owing to aerosol distribution and presence of water bodies. The higher temperatures are associated with fallow agricultural land, industrial and concrete surfaces. There is formation of urban heat belts corresponding to high density areas across the city. Increased land surface temperature coupled with atmospheric pollutants is menace to human health. The modifications in atmospheric composition, surface geometry and characteristics, urban heat islands creation, increased pollution, land use alterations have global impacts as the scale of urbanization is widespread in the developing countries. The changing city environment has implications on ecology, human morbidity and mortality. There is wide array of problems faced by urban centers. Therefore, there is need for creating efficient sustainable plans to overcome the challenges. There is encouragement on public private partnership like for river cleaning and Swachh Bharat Abhiyan. Further, green buildings and eco-roofs along with wall gardens need to be promoted. The improvements in living conditions like improved transportation, sanitation, clean drinking water, improved sewage and solid waste management and well-managed infrastructure lead to preventive measures.

URBAN GREEN SPACE

Urban green belts are considered the lungs of the cities as they act as a sink for some of the harmful gases released by vehicles and industries operating in the city area. Whether sprawling over a large area or a small belt, these green belts are found in all cities and play a very important role. Today, urban areas in India are faced with excessive population along with the pressure of unplanned economic development, industrialization, and vehicular emissions. This has led to considerable rise in urban pollution, affecting air, water, and land. Air pollution has increased rapidly in many cities and metropolises, especially due to vehicular traffic and industrial emissions. Over the years rising population has led to a decrease in open spaces and green belts in the cities. These green belts serve as lungs for cities and towns. They serve as a sink for pollutants, check the flow of dust and bring down noise pollution level. Plants provide innumerable environmental benefits and considering the steady

increase in air pollution it has become imperative to increase the green belts in and around the cities.

Urban green spaces and parks are integral components of urban ecosystems, contributing to enhanced environmental quality and sustainable development and provide significant ecosystem services. Role of parks and gardens has enhanced in view of growing population of cities and increasing pollution. Tangible and intangible benefits provided by green spaces and parks are often taken for granted by the public and municipal authorities. In order to squarely address the challenges of urbanization, the Government of India has launched a number of new initiatives. The Atal Mission for Rejuvenation and Urban Transformation (AMRUT) for 500 cities target the provision of drinking water, sewerage, storm water drainage, development of green spaces and parks, and creation on infrastructure for non- motorized transportation at least the established benchmark levels. Urban forestry is an important contributory factor in the cities for environmental enhancement, control of air and noise pollution, microclimatic modification and recreational purposes of the urban population. Before the city expands further a proper plan for greening in the city especially with respect to land availability in the form of parks and gardens, forest patches and road side plantation should be in place. In addition to avoid illegal diversion of green cover of the city for taking up developmental works or otherwise a legal framework should be in place. And therefore plan for urban forestry should be integrated into overall planning of the urban areas in advance otherwise greening of the urbanized area becomes more difficult once the settlement takes place especially in identifying the land for the same and in greening the same. It is to be noted that as per Desertification and Land Degradation Atlas of India, 2016 by ISRO, 26 out of 29 Indian states have reported an increase in the area undergoing desertification in the past 10 years. It was reported high in Delhi, Tripura, Nagaland, Mizoram, Assam, Himachal Pradesh and Jammu and Kashmir.

Broadly speaking, urban forestry is the art, science and technology of managing trees and forest resources in and around urban community ecosystems for physiological, sociological,

economic and aesthetic benefits trees provide for society (Miller, 1997). Urban parks, gardens and natural landscapes provide several non-market or intangible benefits for urban population. A literature survey reveals an earliest research paper containing details of various experimental studies related to functions and impacts of urban planted areas, effect of plants on climatic characteristics of a city, climatic impacts of private planted areas around buildings, impact of green spaces on air pollution and social functions of urban parks/gardens (Givoni, 1991).

Green spaces and parks are critical component of urban and peri-urban environment, which moderate microclimate, enable ground water recharge, provide shade and conserve local biodiversity, improve quality of life for city dwellers by pro viding recreational avenues. Urban centres need public space for better social cohesion, significant health benefits, aesthetics as well as mitigating climate change. Presently the responsibility for development, protection and management of green spaces and parks in urban areas lies with number of agencies like local bodies, Development Authorities and Forest Departments etc. From a legal perspective also, green space is covered under various Acts and Rules like the Municipal Acts, Indian Forests Act, Master Plans and Bye Laws etc. In addition there are Country and Town Planning guidelines governing allocation of space for green areas while laying out of town plans. Most of these green areas are Neighborhood Parks, District and Regional Parks, and other green areas. The extent of areas that are to be set out as greens under these town planning rules and guide lines have mostly followed however, empirical guidelines are not based on scientific findings and requirements. As a result these guidelines have most often fallen short in demarcating adequate land cover under greens resulting in sub-optimal benefits to environmental, health and other related issues. The regulatory authorities entrusted with protection of trees do not have a proactive role to play in planning of green areas in urban landscapes. Multiplicity of agency has proved to be more of an obstruction than help in protecting and conserving tree cover and urban greens. The absence of long term planning resulting in frequent changes in land use is also an important factor. Land

covered with trees is viewed as loss of opportunity cost when compared to the land put to commercial and infrastructural uses. There is tremendous pressure on green areas/ trees for competing land uses especially for expanding infrastructure. Thus, there is need for uniform policy framework for integration of existing green spaces and parks in the Master Plans of cities. Green spaces resource assessment should be undertaken in urban and peri-urban areas by the concerned landowning agencies in coordination with respective Departments. There is an urgent need to have common guidelines for maintaining and enhancing tree cover based on sound scientific principles. Necessary facilities should be developed for training and capacity building, transfer of technical knowhow, and awareness raising and information dissemination among citizens for promoting tree growth in urban areas. Urban greening is different from normal plantation/ afforestation activity, requiring appropriate cost norms for plantation & maintenance. Maintaining green spaces and parks is important which require regular care and maintenance. There is a need for dedicated funding for improving green cover in urban areas from Central, State Governments and Municipal Bodies which can be augmented with fees, cess or other such sources by the respective authorities. It is essential to explore funding from all possible sources to support urban greening.

BIODIVERSITY RESOURCES

Biodiversity, encompassing variety and variability of all life on Earth, is the product of evolutionary history. Biodiversity benefits human societies in myriad of ways by providing wide range of ecological, economic, social, cultural, educational, scientific and aesthetic services. Extensive anthropogenic interventions and climatic change in the natural eco-systems have been resulting in loss of biodiversity. South Asia is endowed with an exceptional array of biodiversity. The region's biodiversity is reflected in varied biomass and the wide range of habitats within its ecosystems. The rich ecological landscape has been integral to the lives, wellbeing and livelihoods of the millions of people. Climate change will increase the threat the ecosystems and biodiversity. It will also affect the vegetation, productivity and biodiversity. In India, climate

change is projected to lead the severe loss to the vegetation cover in various ecosystems. Fresh water and inland wetlands will be affected by the likely impacts of sea level rise, glacial melt and extreme weather events.

India is rich in biodiversity resources. It represents large bio-geographic zones ranging from Himalayan region to the coastal areas. India ranks 7th in mammals, 9th in birds, and 5th in reptiles. India has 23.39 per cent of its geographical area under forests and tree cover. Of the 34 globally identified biodiversity hot spots, India harbors 4 hot spots i.e. Himalaya, Indo-Burma, Western Ghats, and Sri Lanka and Sunderland. The global estimates as per IUCN Red List, 2008 suggest that 10 per cent of the vertebrate and 0.2 per cent of invertebrate described fauna is threatened. Out of 1296 species, 648 species were recorded as threatened. In terms of plant diversity, India ranks 10th in the world and 4th in Asia. With over 45500 plant species, India represents nearly 11 per cent world's known floral diversity (MoEF, 2009). India has significant share in the plant species of the globe however; a larger proportion of the plant species in India are endemic. India has 246 globally threatened floral species which constitute approximately 2.9 per cent of the world's total number of threatened floral species.

India has 1.8 per cent of the global forest area with per capita forests of 0.0.8 hectare. The total forest and tree cover of the country is estimated to be 23.41 per cent of the geographical area. Protected areas are the corner stone's of biodiversity conservation efforts. India has created a network of protected areas and other conservation areas which include a total of 661 units, besides identifying a number of wet lands under NWCP for conservation interventions. The area covered under protected areas and other conservation sites accounts for around 9 per cent of the total geographical area of the country. Out of 27 biogeography provinces, 19 are adequately represented in the protected areas network. Besides, National Parks and Wildlife Sanctuaries, 15 biosphere reserves have been created in India which represent many states and serve the purpose of biodiversity conservation. India has a long history of legislation relevant to biodiversity conservation. The Constitution of India contains specific provisions for environmental conservation. Numerous legislations

(Acts, Rules, Circular and Orders), related to environmental protection as well as specific laws relating to forests, wildlife and biodiversity have been passed taking into account governmental and civil society concerns.

MANAGEMENT OF URBAN LAKES

Lakes are important part of urban ecosystem. Lakes perform significant environmental, social and economic functions as source of drinking water, recharging groundwater, controlling floods, supporting biodiversity and providing livelihoods. At present, lakes and wetlands are in extremely bad shape and are in varying degrees of environmental degradation. Despite knowing their environmental, social and economic significance, these water bodies haven neglected and destroyed (CSE, 2014). Today, these water bodies are encroached, full of sewage and garbage. Due to unplanned urbanization, much of the landscape around the lakes has been covered by impervious surfaces. As a result, instead of rainwater, it is the sewage and effluents that are filling up urban water bodies. Once the sponges of urban area, today urban lakes have turned into hazards. It is the disappearance of these sponges of the city which has exacerbated floods and sharpened the pain of droughts (CSE, 2012).

For the last two decades, urban water bodies have been a victim to unplanned urbanization in India, because of which they face several threats. These are pollution, encroachment, illegal mining activities, ungoverned tourist activities and cultural misuse. There has been an explosive increase in the urban population without corresponding expansion of civic facilities such as adequate infrastructure for the disposal of waste and are used for disposing untreated local sewage and solid waste, and in many cases the water bodies have been ultimately turned into landfills. Encroachment is another major threat to water bodies particularly in urban areas. As more people are migrating to cities, the availability of land is getting scarce. Today, even a small piece of land in urban areas has a high economic value. Hence, these urban water bodies are no more acknowledged for their ecosystem services but as real estate. Illegal mining for building material such as sand and stones both on the

catchment and on the bed of the lake also have extremely damaging impact on the water body and one the reasons behind the destruction of many water bodies in India . Unplanned tourism activities without systematic planning and regulation proved to be another major threat to urban water bodies. Disturbance of wildlife, pollution, changes in local lifestyles and loss of cultural heritage are some of the impacts of tourism on the local environment.

Water Bodies play multi functional role in urban area. It can be the source of water for supply, landscaping, irrigation, fishing and eco tourism, which add values to social benefits. They can also be used to prevent heat island effects and to improve the micro climate in cities. For conserving the same, it is necessary to analyze the hydrological system with reference to catchment basins for the water bodies. Ministry of Environment and Forests has prepared 'Advisory Report for Conservation and Restoration of Water Bodies in Urban Areas' which recommends State and ULBs to take initiatives in order to conserve water bodies. While formulating Development Plan at city levels, steps suggested by Ministry of Urban Development & Ministry of Environment and Forests in the above mentioned report could be adopted to conserve and restore the water bodies in cities. One of the finest examples of restoration of lakes in the fast growing urban environment is the Kankaria Lake in Ahmadabad. Ministry of Environment and Forests has also suggested to integrate identified projects on water bodies with Programmes such as National Lake Conservation Programme and National Wetland Conservation Programme, JnNURM/ UIDSSMT, Ministry of Water Resources programme for Repair, Renovation & Restoration (RRR) of Water Bodies with Domestic/External Assistance which are undertaken by Government of India. For conserving rivers, MoEF has taken up the initiative and formed National River Conservation Directorate (NRCD). Initiatives have been taken through various River Action Plans such as Ganga Action Plan and Yamuna Action Plan.

Wetlands, natural and manmade, freshwater or brackish, provide numerous ecological services. They provide habitat to aquatic flora and fauna, as well as numerous species of birds, including migratory species. Several wetlands have sufficiently

unique ecological character as to merit international recognition as Ramsar Sites. Wetlands also provide freshwater for agriculture, animal husbandry, and domestic use, drainage services, and provide livelihoods to fisher folk. Larger wetlands may also comprise an important resource for sustainable tourism and recreation. Wetlands are under threat from drainage and conversion for agriculture and human settlements, besides pollution. This happens because public authorities or individuals having jurisdiction over wetlands derive little revenues from them, while the alternative use may result into financial gains to them. A holistic view of wetlands is necessary, which looks at each identified wetland in terms of its causal linkages with other natural entities, human needs, and its own attributes. In December, 2010, The Ministry of Environment, Forests and Climate Change published exclusive rules for wetlands management, regulated under one authority. However, not a single state has compiled the data or created nodal agency, as per rules.

WATER RESOURCES

India is experiencing rapid urbanization and consequently water demand in urban areas is escalating. Due to shortage of surface water sources in many urban centers, ground water is now increasingly tapped for water supplies. As a result, there is lot of pressure on underlying aquifers for fulfilling the domestic water demand. Inadequate access to improved water has been a persistent challenge for many Indian cities. Urban water resources are overstressed due to increase in urban population, pollution and unplanned as well as un -sustainable urban growth. Moreover, over exploitation of ground water resources in urban centers for quenching the thirst of increasing urban population, changing lifestyle, and water uses for various purposes is cause of concern. Due to unregulated housing and building construction, lack of proper drainage and sewer network and also ineffective functioning of sewerage system, urban centers are at high risks .The blockage and choking in drainage sever system leads to water logging and flash flood in urban centers. Increasing urbanization, expansion of habitat into unsuitable vulnerable areas, higher population density, higher housing density, vulnerable housing and buildings construction, non engineered

unsafe construction, and aging buildings and other infrastructure are some of the factors that have increased the vulnerability of hazards and disasters in urban areas. The accelerated and uncontrolled urban growth has contributed to the ecological transformation of the cities and their immediate surroundings resulting in flash floods and water scarcity.

As of April 2015, the water resource potential or annual water availability of the country in terms of natural runoff (flow) in rivers is about 1,869 Billion Cubic Meter (BCM)/year (Central Water Commission, 2015). However, the usable water resources of the country have been estimated as 1,123 BCM/year. This is due to constraints of topography and uneven distribution of the resource in various river basins, which makes it difficult to extract the entire available 1,869 BCM/year. Out of the 1,123 BCM/year, the share of surface water and ground water is 690 BCM/year and 433 BCM/year respectively. Setting aside 35 BCM for natural discharge, the net annual ground water availability for the entire country is 398 BCM (Central Water Board, 2015). The overall contribution of rainfall to the country's annual ground water resource is 68 percent and the share of other resources, such as canal seepage, return flow from irrigation, recharge from tanks, ponds and water conservation structures taken together is 32 percent. Due to the increasing population in the country, the national per capita annual availability of water has reduced from 1,816 cubic metre in 2001 to 1,544 cubic metre in 2011. The level of ground water development is very high in the states of Delhi, Haryana, Punjab and Rajasthan, where ground water development is more than 100 percent. This implies that in these states, the annual ground water consumption is more than annual ground water recharge. In the states of Himachal Pradesh, Tamil Nadu and Uttar Pradesh and the Union Territory of Puducherry, the level of ground water development is 70 percent and above. In rest of the states, the level of ground water development is below 70 percent. Over the years, usage of ground water has increased in areas where the resource was readily available. This has resulted in an increase in overall ground water development from 58 percent in 2004 to 62 percent in 2011.

Groundwater is one of the most precious natural resource and has played a significant role in maintenance of India's economy, environment and standard of living. Besides being the primary source of water supply for domestic and many industrial usages, it is the single largest and most productive source of irrigation water. India is a very vast country having diversified geological climatologically and topographic setup, giving rise to divergent groundwater situation in different parts of the country.

The CGWB has categorized 62.2 percent of the total assessment units of 6,600 blocks, mandals and taluks as over exploited. The report also said that 276 districts have high levels of fluoride, 387 report nitrates above safe levels and 86 districts have high levels of arsenic. According to Government excessive withdrawal of ground water were responsible for decline in ground water levels and in many areas groundwater recharge was reduced due to varied and erratic rainfall pattern as well as change in land use. In Out of 75 districts of Uttar Pradesh, exploited or groundwater on the basis of 2011 assessment report. According to report, Shamli and Pratapgarh districts top the list, with groundwater exploitation rate exceeding 140 percent followed by Saharanpur, Firozabad and Agra. State capital Lucknow along with Aligarh, Allahabad, G B Nagar, Ghaziabad, Kanpur city, Kasganj, Kaushambi, Mathura, Meerut, and Varanasi are over exploited district among others. According to Jal Nigam, Agra is losing 700,000 litres of groundwater reserves daily because of indiscriminate extraction. In Agra, the situation is grim as the groundwater level continues to deplete at an alarming rate due to unregulated and excessive extraction and relentless concretization of green zones. According to officials, out of the 15 blocks in the districts under Agra division, 10 are in over exploited category while one block has been listed as critical. A recent survey has also found that industrial units are consuming excessive quantity of groundwater. On a daily basis, they are taking 18 times more water than the total water requirement of the entire human population of the district. It is to be noted that more than half of the world's major aquifers which store ground water are depleting faster than they can be replenished (Down to Earth, March, 16-31, 2017). Only three percent of the world's water is freshwater, about 30

percent of which comes from aquifers. Ganga-Brahmaputra basin in India has the faster rate of depletion in the world. Mountain glaciers provide the resource base upon which social and economic development in mountain regions is dependent. Seasonal melting of frozen water stores, such as glaciers and snow packs, smoothes the effect of highly variable summer rainfall, and glaciers play a crucial role in supporting ecological, social and economic systems in mountains and down streams. With the increasing level of global warming and climatic change, glaciers are melting which will lead to short term increase glacial runoff and in long term eventually lead to decreased summer runoff. This will reduce water security (Down to Earth, May1-15, 2017).

Environmental problems including water quality degradation from agro-chemicals, industrial and domestic pollution, ground water depletion, water logging, soil Stalinization, siltation, degradation of wastelands, eco system impacts and various health related problems have caused concern to policy makers and administrators. Thus, management of water resources is imperative rather than development of the resources. Water borne diseases of a wide spectrum and are caused by direct transmission though water containing a variety of pathogens such as viruses, parasites or bacteria. These diseases are most commonly manifested as acute diarrhea, dysentery, dengue, malaria, hepatitis, typhoid and cholera. Water gets contaminated either at source or while passing through poorly laid and maintained water pipes or in the homes when it is not stored properly. A major contributing factor for the incidence of water borne diseases is lack of hygiene such as the absence of the habit of washing hands with soap after going to the toilet. Water quality can be affected by naturally occurring factors and by externally introduced pollutants. Natural water contains inorganic and organic matter, which may get dissolved in the water or remain as suspended particles. Inorganic matter is derived from the rocks and soils through which water percolate or over which it flows. Organic matter is derived from the breakdown of plant material or from algae and other micro organism that grow in the water or on sediments in the water. Natural pollutants are mainly arsenic, fluoride, iron, etc. while external pollutants include

dumping of sewage, domestic waste, industrial effluents, nitrogen, pesticides and other chemicals into the water bodies. Thus, changes in water policy and evolving strategies for water management are imperative. Similarly, legal framework for coping with climate change is also to be amended. There is more need on institutional building to enhance capacity of the state governments and stake-holding agencies to cope up with climate change and also to regulate the water use for various purposes. More decentralized mechanism for water development and management will be required.

WATER POLLUTION

Water is one of the most abundant compounds found in nature, covering approximately three fourths of the surface of the earth. However, potable water availability is limited. Water is distributed in nature in different forms such as rainwater, river water, spring water and natural water. Rain water is in the purest form of naturally occurring water. However, the human activities contribute impurities in the form of industrial and domestic wastes, agricultural chemicals and other contaminations. Water pollution may be defined as the presence of impurities in water in such quantity and of such nature as to impair the use of the water for a purpose. Water pollution may be classified mainly into four categories viz., physical pollution, chemical pollution, biological pollution and physiological pollution. The physical pollution of water brings about changes in water with regard to its colour, order, density, taste, turbidity and thermal properties etc. The chemical pollution of water is due to the presence of inorganic and organic chemicals such as acids, alkalis, toxic inorganic compounds, dissolved inorganic compound and dissolved organic compounds. The biological pollution of water refers to the bacteriological pollution of water due to presence of pathogenic bacteria, certain fungi, pathogenic protozoa, viruses, parasitic worms, etc. The important sources of bacteriological pollution are domestic sewage and industrial waste. Physiological pollution of water is caused by several chemical agents such as chlorine, sulphur dioxide, hydrogen sulphide, merceptions, and phenols quohydroxy benzene.

Water pollution is a phenomenon that is characterized by the deterioration of the quality of land water (rivers, lakes, marches and ground water) or sea water as a result of various human activities. Water pollution is any physical or chemical change in the water that can adversely affect organisms. The major sources of water pollution include (i) sewage and domestic wastes; (ii) industrial effluents; (iii) agricultural discharges; (iv) fertilizers; (v) agro chemicals – pesticides, insecticides, fungicides, etc.; (vi) detergents; (vii) toxic metals; (viii) siltation; (ix) thermal pollutants; (x) radio-active materials. Water pollution can be defined as any unfavourable change in physical, chemical and biological properties of water that makes it harmful to humans and other life forms. Human actions reduce the use of water as a resource. However, the decrease in usefulness is in a relative term. A water source may be fit for navigation and fishing, but not for irrigation, or drinking which requires pure water. Examples of polluted water include, red, lifeless, acid mine drainage water, raw sewage-laden waters that enter the Ganges in Varanasi, or any other city, turbid domestic waters full of detergents containing phosphate, the rust-coloured, opaque water of a lake, full of toxic metals, Microcystis and Escherchia coli or a highly nutrient-rich village pond water, coated with Lemna or Azolla, the heated water from the cooling towers of an electric-generating plant, and of the lake superior contaminated with asbestos fibres. Thus, water pollution is common in all the regions of the world; the magnitude and the type of pollutants may vary.

Sewage invariably goes into streams, ponds, lakes and rivers of the city, polluting the water bodies in urban areas. It is no surprise that surveys of groundwater are finding higher and higher levels of microbiological contamination due to sewage contamination. Currently, we assume that 80 per cent of the water officially supplied by municipalities is returned as sewage. No Indian city is in a position to boast of a complete sewerage system, which can keep up with the sanitation and pollution challenge. Large parts of the modern cities remain unconnected to the sewage system as they live in unauthorized or illegal areas or slums, where the municipal sanitation services do not reach. Moreover, there are also zones

within the growth pockets of a large city where even authorized housing remain unconnected to both water supply and sewage systems.

WASTES DISPOSAL & ENVIRONMENT

Waste generation is associated with human civilization. In India, average per capita waste generation ranges in between 400 to 700 gms. per day. However, the quantity of waste generation depends upon the life style and economic activities. Waste disposal in urban areas is the main responsibility of urban local governments. The wastes may include municipal solid waste, hazardous waste, sewage, sludge, clinical waste, agricultural and industrial waste as well as commercial waste. There has been a significant increase in the generation of municipal solid waste in India over the last decades. India generates more than 48 million tons of solid waste per year. The waste generation has been reported significantly high in the metropolitan and larger cities and low in the small cities. Out of total waste generation in urban areas, about 25 per cent waste is reported to be hazardous. The hazardous waste is mainly generated by high polluting industries, hospitals, medical centres and nursing homes. The quality of waste generation in South Asia has been reported to be poor and thus, it cannot be converted into fuel due to its low calorific value. Most of the waste generated so far may be categorized into biodegradable and non-biodegradable. Most of the studies have highlighted the poor infrastructure and facilities for collection, segregation, transportation, handling and disposal of the waste. There are several technologies for the disposal of the waste, however, landfill is the most important technique for disposal of the waste. However, land filling in India lacks the scientific processing for disposal of the waste. Other technologies include pulverization, baling, compositing, incineration, briquetting, pyrolysis, gasification, and biogas (Singh and Khanna, 2005). When plague spread in Surat City, scientists explored that due to failure of proper handling and management of the solid waste, the problem emerged after a long time. Thus, Government is equally conscious for the proper handling and management of the solid waste. Ministry of Environment & Forest, Government of India has already

formulated Municipal Solid Waste, (Management & Handling) Rules, 2000. These rules are applicable to every municipal authority that is responsible for collection, segregation, storage, transportation, processing and disposal of municipal solid waste. The rules have made provisions that waste will not be incinerated and municipal authorities will make the necessary arrangements for proper handling and management of solid waste including collection, segregation, storage, transportation, processing and disposal. Except in case of bio-medical waste which is supposed to be incinerated, the rest waste is supposed to be safely disposed off by the municipal authorities. The standard norms and practices for the safe disposal of the waste are also being given in the rules.

URBAN SANITATION

Providing environmentally safe sanitation to the people of world's second most populous nation is a challenging task. The challenges that urban sanitation sector faces mainly relate to the low priority accorded to it by the municipal governments. This task becomes more intricate in context to the country like India where introduction of new paradigms of plans, policies or projects can challenge people's tradition and belief. Widespread open defecation has major consequences for health and human capital in India. Inadequate sanitation has a great environmental economic and health impacts in India. In order to minimize these impacts, Government of India has under taken several measures including increased investment in urban sanitation, policy initiatives, regulations, and public campaigns to improve sanitary conditions in the country. This has resulted in raising the sanitation status during the last two decades but a marked improvement is yet to be achieved. Individual health and hygiene is largely dependent on adequate availability of drinking water and proper sanitation. There is, therefore, a direct relationship between water, sanitation and health.

With the passing of 74th Constitutional Amendment Act, Metropolitan Planning Committee and District Planning Committee have been formed to take up developmental activities in the concerned region in place of the parastatals (Singh, 2014). The ULB's have also been empowered to take up development functions. States

have responded in diverse manner with regard to the status of parastatal agencies in the post decentralized period. Many state governments like Kerala and Karnataka have recommended the abolition of the parastatals while some have recommended for a change in their functional role like in Tamil Nadu, Uttar Pradesh, Maharashtra, West Bengal and Andhra Pradesh. The parastatal agencies have also been merged with Urban Development Department. The 74th Constitutional Amendment Act has also transferred administrative and financial process and created an enabling environment for the local bodies to undertake planning and development responsibility. Sanitation brings heavy return on investment of any development intervention, however, in India; it has been remained neglected for most of the post independence history. Millions of Indians are subjected to grave ill health, increasing threats to safety, lower spending on education and nutrition, reduced productivity and lower income earning potential resulting into a deepening cycle of poverty due to lack of sanitation facilities (Dasra, 2012). Growing slum population and lack of adequate sanitation force over 50 million persons to defecate in the open every day. The poor bear the worst consequences of inadequate sanitation in the form of ailing children, uneducated girls and unproductive people, making these populations even more vulnerable and costing India 6.4 percent of its GDP (Dasra, 2012). Inadequate sanitation is much more than just an inconvenience. As urban population increases, demand for water and sewage treatment will increase. Census data demonstrate that slum population has tripled in the last three decades, intensifying the strain on insufficient urban resources. Moreover, 7 million people continue to migrate to urban areas every year with most of them finding their way to slums within and on the fringes of cities. Slums are typically overcrowded, lack basic services and facilities, and hence are unhygienic and unsafe.

Until recently, urban local bodies were not mandated to provide non notified slums with any services. Thus, slum localities bear the worst consequences of inadequate sanitation facilities. Sanitation is urban slums is a complex and pressing issue. Existing unhygienic standards, crowed conditions and poor sanitation contribute to

frequent and rapid outbreaks of diseases, lack of access to healthcare facilities compounds health problems. About 18 per cent urban households reported that there is no drainage system in India. This was reported significantly high in the state of Tripura (46.55 per cent) followed by Kerala (45.45 per cent), Assam (43.65 per cent), Odisha (40.95 per cent), Arunachal Pradesh (33.79 per cent) and West Bengal (33.17 per cent). About 2/5th urban households further reported that waste water outlet is connected to closed drainage. This was recorded high in the state of Gujarat (69.44 per cent), Himachal Pradesh (65 per cent), Maharashtra (62.70 per cent), Delhi (60.31 per cent) and Punjab (57.63 per cent). The proportion of households reporting open drainage was recorded high in the state of Nagaland (67.88 per cent), Manipur (64.36 per cent), Meghalaya (62.45 per cent), Mizoram (59.05 per cent) and Chhattisgarh (51.42 per cent). Open defecation is still prevalent in urban areas as about 13 per cent urban households reported that they are defecating in open. This was recorded significantly high in Chhattisgarh (34.44 per cent) followed by Odisha (33.17 per cent), Jharkhand (30.99 per cent) and Bihar (28.88 per cent). Overall, 81.36 per cent urban households reported that they own latrine facility within their housing premises. This was found significantly high in the state of Mizoram (98.52 per cent), Tripura (97.88 per cent), Kerala (97.43 per cent), Meghalaya (95.74 per cent), Manipur (95.77 per cent), Nagaland (94.60 per cent) and Assam (93.71 per cent). Thus, about 19 per cent urban households do not own latrine facility within their housing premises. This was recorded significantly high in the state of Chhattisgarh (39.80 per cent), Odisha (35.22 per cent), Jharkhand (32.83 per cent) and Bihar (31.04 per cent). Overall, about 6 per cent urban households are using public latrine facility. This was recorded significantly high in the state of Maharashtra (21.04 per cent), Tamil Nadu (8.65 per cent), Delhi (7.12 per cent) and Chhattisgarh (5.36 per cent).The accessibility of toilets is found significantly high in the urban areas as compared to slums. Similarly, the proportion of households admitting that they are defecating in open has been recorded high in the slums as compared to urban areas in most of the states. However, the proportion of slum households defecating in open has been reported low where government and other non-

government agencies have ensured the construction and functioning of public toilets. The proportion of households reporting non-existence of drainage was found significantly high in the slum areas as compared to urban areas in most of the states.

Asia accounts for 34 percent open defecation, of which India accounts for 26 percent. In order to achieve the target of Swachh Bharat Mission, 65000 toilets have to be built every day by September 2019. India has spent huge amount on construction of toilets, however, about 40 percent toilets built free or with subsidy, were reported to be not used at all. A major paradigm shift was seen in the early 2000 with the emergence of Community Led Total Sanitation. The need to achieve sustained and collective behavioral change through community involvement was acknowledgement globally. It is to be noted that about India has the capacity to treat only 30 percent of its waste water. Large cities have comparatively higher capacity to treat waste water while in small cities the facility of waste water treatment is lacking. Using septic tanks may not be the perfect solution of urban sanitation as huge quantity of faecal sludge is likely to be released from septic tanks and there is no proper system for collection, transportation and treatment of faecal sludge in most of the urban local bodies in India. Thus, it is imperative to emphasize on septage and faecal sludge management in urban centres. Most of the ULBs do not have skills to construct, operate and maintain septic tanks.

STATUS OF MUNICIPAL SOLID WASTES

The Central Pollution Control Board has reported that 1,33,760 metric tonnes of waste is generated daily in urban areas in the country. There are several deficiencies in the current system and they do vary across states and cities. In general, there is low primary collection at the doorstep; little storage and segregation of recyclables; poor secondary storage , mostly by the road side in open spaces or in derelict concrete of bricked in containment areas; no regular sweeping of streets; transportation of waste in open tractors /trucks; little processing of waste; and unscientific disposal of MSW at dump sites. Uncontrolled dumping of wastes on precious land resource in and around towns and cities has created huge piles of

waste, some running into millions of tonnes and are a source of contamination of ground water and air pollution posing a risk to public health. These dumping yards are breeding grounds for many infectious agents causing diseases like cholera, dysentery, jaundice, typhoid and diarrhea.

In comparison to the levels of the developed world, of 1-2.5 kg capita/day, our per capita average generation of 450 gm/day of MSW is of course, lower. The per capita municipal solid waste generation rate reported for small towns is 200-300 gm/capita, 300-400 gms/capita for medium cities and between 400-600 gms/capita for large cities. The total quantity of waste currently handled each day in the urban areas in the country is estimated to be 1, 70,000 metric tonnes *i.e.* about 62 million tonne per year. As per 2011 census, 31.16 per cent population of India *i.e.* 377 million people live in 7,935 urban areas with 4041 municipal authorities. It is estimated that by 2050, 50 per cent of the population will be living in urban areas. Considering that the volume of waste is expected to increase by 5 per cent per year on account of increase in the population and change in lifestyle of the people. The CPCB report also reveals that only 68 per cent of the MSW generated in the country is collected of which, 28 per cent is treated by the municipal authorities. Thus, merely 19 per cent of the total waste generated is currently treated. The remaining waste is disposed off at dump sites / landfill sites untreated. The enormous quantity of MSW i.e. 62 million tonnes per year, generated will dramatically reduce the potential of disease burden and provide a huge public benefit.

Various components of MSW have an economic value and can be recovered, reused or recycled cost effectively. Currently, the informal sector picks up part of the resources from the streets and bins to earn their living. However, a sizeable portion of organic waste as well as recyclable material goes to landfills untreated. Over 81 per cent of MSW annually is disposed at open dump sites without any treatment. With planned efforts to Reduce, Reuse, Recover , Recycle and Remanufacture and appropriate choice of technology, the country can profitably utilize about 65 per cent of the waste in producing energy and/or compost and another 10 to 15 per cent to promote recycling industry and bring down the quantity of wastes

going to landfills/ dumps under 20 per cent . The percentage of wet biodegradable waste is high in Indian waste and is a source of contamination of soil, water and air, if it is disposed indiscriminately Biodegradable waste has a good potential for generating biogas, which can serve as fuel, can also be converted to energy as well as to compost which can improve soil health and lead to increased agriculture production. This wet waste must therefore be processed either through bio- methanation or composting technology for generating biogas, electricity or compost for use as nutrient and prevent such wastes reaching the landfill. Considering that reusable and recyclable wastes form 20-25 per cent of the actual waste generated (which does not include the wastes collected by the kabadiwalas from source of generation). Plastics, paper and glass constitute 17 per cent of the recyclable wastes. Plastic wastes including composites are high calorific value material and crucial ingredient for MSW based waste to energy plants. This material also needs to be fully recovered and profitably utilized. The next step should be to strengthen segregation of the non-recyclable dry combustible MSW at secondary storage depots/transfer stations and optimally utilize this material in the form of RDF which can be fed to waste to energy plants waste to energy plants power plants and as auxiliary fuel in cement and metallurgical industry. Setting up of small to large plastic waste to liquid fuel plants, thereby utilizing the plastic not picked up by kabadiwalas and rag pickers, also needs to be encouraged.

The 12th schedule of the Constitution (The 74th constitutional amendment of 1992) clearly assigns solid waste management as the primary function of municipal authorities. State laws governing the municipal authorities also stipulate management of solid waste as an obligatory function of the municipal authorities. Despite constitutional and legal mandate no serious efforts have been made, by municipal authorities towards scientific processing and disposal of MSW. It was only after the direction issued by Hon. Supreme Court of India in a public interest litigation, the Municipal Solid Waste (Management and Handling) Rules was finalized by the Ministry of Environment and Forests. These rules define MSW, mandate that all municipal authorities in the country shall manage MSW in a time bound manner and the State Government ensure

implementation of the rules. These rules were followed up by the National Environment Policy in 2006. A set of rules on plastic waste management were notified to regulate littering and manufacturing of plastic carry bags.

CONCLUSION

Cities may be viewed as hubs of the intensive resource demand, environmental degradation and greenhouse gas emissions. However, cities may play a critical role in promoting low carbon development through use of renewable energy, energy efficiency, green buildings and mitigating emissions from urban transport. Mainstreaming climate resilience into urban development is essential because climate risks may only be one of the several factors defining poverty level, well-being, economic growth and development in an urban environment. Strategic urban planning directly supports urban resilience as a tool for sustainable development. Urban local governments must actively coordinate and mainstream mitigation, adaption and resilience into urban planning process to prepare cities to deal with climatic risks and impacts. The Supreme Court of India has played a catalytic role for greening cities in the country. The court identified critically polluted cities and suggested an action plan to reduce the level of pollution in these cities. The immediate problems of India's cities relate to inadequate institutional arrangements for solid waste management, drainage, sewage treatment and disposal and sanitation services. Thus, it is imperative to improve the municipal services, particularly sanitation services and urban local governments adopt the integrated urban planning for climate resilience and addressing the environmental problems. Thus, changes in water policy and evolving strategies for water management are imperative. Similarly, legal framework for coping with climate change is also to be amended. There is more need on institutional building to enhance capacity of the state governments and stake holding agencies to cope up with climate change and also to regulate the water use for various purposes. More decentralized mechanism for water development and management will be required. The governance of urban water sector is non-transparent and unaccountable with no

mechanism for the citizens to participate in the governance in a bottom of, direct, legally enabled way. Sewerage treatment has not been a priority for the majority of the utilities across India. The sewerage treatment facilities are grossly inadequate besides low level of sewerage network in India. The sewerage treatment plants are not effective functioning due to several reasons. Cities may be viewed as hubs of the intensive resource demand, environmental degradation and greenhouse gas emissions. However, cities may play a critical role in promoting low carbon development through use of renewable energy, energy efficiency, green buildings and mitigating emissions from urban transport. Mainstreaming climate resilience into urban development is essential because climate risks may only be one of the several factors defining poverty level, well-being, economic growth and development in an urban environment. Strategic urban planning directly supports urban resilience as a tool for sustainable development. Urban local governments must actively coordinate and mainstream mitigation, adaption and resilience into urban planning process to prepare cities to deal with climatic risks and impacts. The Supreme Court of India has played a catalytic role for greening cities in the country. The court identified critically polluted cities and suggested an action plan to reduce the level of pollution in these cities. The immediate problems of India's cities relate to inadequate institutional arrangements for solid waste management, drainage, sewage treatment and disposal and sanitation services. Thus, it is imperative to improve the municipal services, particularly sanitation services and urban local governments adopt the integrated urban planning for climate resilience and addressing the environmental problems.

In order to maintain the resources for use of future generations, strict policy and planning implementation is required. The 3 R's-reuse, recycle, reduce need to be asserted and reflected in all development plans. The initiatives of corporate social responsibility for improvement in urban environment should be promoted. Plastic should be banned with the provision of availability of low cost substitutes of plastic. The general public should be involved in urban sustainable development. The behavioural changes and a sense of belonging to the city need to be inculcated among the potential

development actors. Public transportation should be made more affordable, efficient and safe. Car pooling and training of drivers on air pollution and fuel use may be promoted. Besides, strict policy control measures like polluters pay and firm inspection of vehicles and industries needs stringent implementation. It is important to abolish the burning of garbage and biomass and focus on less-polluting better ventilated kitchens. The indigenous pollutant tolerant tree species like Mango, Peepal, Neem, Babool etc, should be planted (Firdaus, 2010). This will help maintain green cover, control pollution and also lead to health, happiness, wellbeing and sustainable city. Urban sustainable development is a collective concept that underpins within it the individual wellbeing. It is important to meet the needs of present generation, especially poor, keeping in mind the environment's ability to meet the needs of future. Three perspectives of sustainable urban planning viz. resource and consumption, good environment and social capital should be incorporated in planning process. Wellbeing and happiness can be achieved only when the urban environment is socially, ecologically, economically and politically sustainable.

WAY FORWARD

- It is imperative to establish and strengthen ground water monitoring network through construction of observation wells, sanctuary wells for coastal aquifer management and water quality monitoring.
- It is high time to review the National Water Policy with a view to ensure integrated water resource management in the context of climate change challenges in water sector.
- It is imperative to develop inter-ministerial and inter-departmental coordination for vulnerability analysis, mitigation and addressing of climate change challenges both at the state and centre level.
- Promotion of cleaner technologies, strengthening of emission standards, introducing economic incentives and strengthening of monitoring and reporting system is imperative in order to control the industrial pollution.

- It must be made mandatory to install rainwater harvesting systems in both public and private buildings, including industrial and commercial establishments. Buildings having a courtyard should allocate a prescribed proportional area for rainwater harvesting and recharging. The ULBs should make ensure such provisions before approving building plans.
- A long term national programme for supporting public participation in environmental management including climate change adaptation measures aimed at educating and building capacity of all stakeholders is imperative. The most serious attention should be given to building civil society's capacity to understand the environmental issues and linkages to sector activities, to effectively engage in public participation forums; and promoting innovative and more interactive approaches to public participation that increase public ownership of environmental action.
- Water use efficiency programmes including water conservation, water recycling, piped water system, metering and regulation of water use and rationalizing energy supply need to be adopted.
- Capacity building and institutional strengthening for environmental management including climate change adaptation measures is called for. There is need to improve the overall quality of governance, particularly at the state and local levels in order to effectively implement the environmental policies and legislations.
- There is an urgent need to reach out the poor and the marginalized groups for improving the access of water supply and sanitation services. In view of the poor state of sanitary facilities and inadequate hygiene awareness, physical infrastructure and awareness building are equally important.
- Technological intervention is required to enhance effective treatment of waste water. Strengthening of waste water and sewerage/effluent treatment plants should be undertaken on priority basis.
- Enhancing public and private investments for raising plantations for enhancing the cover and the density of forest is called for.

Effectively implementation of Greening India Programme is to be ensured to increase the forest cover and vegetation. In-situ and ex-situ conservation of genetic resources, especially of threatened flora and fauna may be adopted for conserving biodiversity.

- Fostering climate resilient reforms in agriculture and water resource management is imperative to promote agricultural research and extension services for better suited agricultural crops in the context of climate risk and variability.
- Faecal sludge management is important in densely populated urban areas where much of the population is not connected to sewerage network. FSM is generally carried out as a service by urban local governments or the formal or informal private service providers. Faecal sludge collection may be either on a scheduled or on a call-for-service basis. Vacuum pumps or centrifugal style booster pumps are required for effective service. A variety of manual and motorized devices designed to excavate thick and viscous sludge and accumulated trash are also required.
- The collected faecal sludge may be transported to treatment plants via a vacuum truck or even a hand cart. Often, mobile or permanent transfer stations are will be required for improving the efficiency of faecal sludge transportation.
- This material should preferably be processed at dedicated faecal sludge treatment plants, instead of being co-treated with sewage in municipal sewage treatment plants, unless these are able to take the additional load. A variety of mechanized and non-mechanized technologies may be used, including constructed wetlands, anaerobic digestion, and waste stabilization ponds. Collectively, the collection, transport, treatment and reuse of excreta constitute the value chain of faecal sludge management.
- Waste water treatment, recycling and reuse should be ensured though enforcing legislation besides regulation on fresh water use. Wastage of fresh water should be strictly banned in urban centres.

- It is imperative to search appropriate suitable technologies in sanitation that consume less water. Now a day's models for water less toilets and bio toilets are being developed which may be further promoted. There is need to introduce new system of storing waste water from Kitchen and bathroom for use in flush in toilets. Thus, the sewerage system need to be accordingly changed in the houses in urban centres.

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