

New, emerging, re-emerging tropical infectious and non-communicable diseases persistent to the climate, landscape, and environmental changes on the grounds of the urbanizations, industrializations, and globalisation: Review article

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**Abstract:** Historical records evidenced of urban landscape changes, and environmental transitions brought by the improper growths and urban development's of the urbanisation and industrialization in the developing countries, especially in India, significantly chaotic urban sprawl and industrial growths, and the development of its allied activities for the recent decades, invites new, emerging, re-emerging, and triggers the tropical infectious diseases including vector borne diseases (VBD) as well non-communicable diseases. Urban sprawl has a multiplier effect of growth of unplanned a crowded housing, and industrialization has an impact on the urban landscape with commercial and market development, and roads over large expanses of urban land while little concern for appropriate urban planning. The union government of India is launching to promote 100 mega smart city projects / metropolitan / urban agglomeration across the nation for betterment of the standard of living infrastructure facilities by 2030. The large scale urban landscape architectural changes, land use / land cover changes, environmental transitions, and micro climatic changes in the heart of the urban landscape, and its fringe areas on the consequence of built-up structures, construction of roads transport networks, drainages, commercial buildings, human dwellings, educational buildings, legal and medical health services, income tax professionals, small scale to large scale industries, etc., The census of India, reports highlighted that people mass movements / migration from rural to the urban, and small towns to mega cities are notably accelerating trends for the recent decades mainly for the purposes of occupation, education, trade and commerce, and professional services, generally reasons for male migration, and marriage is the absolute reason for female adults migration. The spatial and temporal aspects of malaria and dengue has been declining trends in rural settings, however, it has been accelerating trends in the urban settings due to the urban buoyant migrants. Urbanization and industrialization effect on urban landscape environment leads to breakdown of sanitations, water-borne diseases associated with inadequate and unsafe drinking water supply, tendency to use metal, plastic, and mud pots water storage containers, discarded domestic waste misshapen to vector breeding habitats containers, urban heat island, garbage waste disposal, liquid waste from dwellings, and industries, air pollution (dust, pollen and spores suspended as particles, Sulphur Dioxide-SO<sub>2</sub>, nitrogen oxides-NO, Carbonate-CO<sub>3</sub>, depletion of Oxygen O<sub>2</sub>, Ozone-O<sub>3</sub>, Methane Gas- CH<sub>4</sub>, Lead- Pb, Mercury- Hg etc.), exonerated by the industries and urban transport emissions, modern transport / shipping goods and services, and collectively hazard to human health through erratic infectious diseases and vector borne diseases immediately.

**Key words:** urban migration, landscape environment changes, industrials pollution, vector ecology, vector breeding habitats, host-pathogen interactions, tropical infectious diseases

**Introduction:** Historically, the occurrences of new, emerging, re-emerging tropical infectious and non-communicable diseases have been influenced on the consequences of spatial and temporal dynamics of urbanisation, industrialisation, and globalizations, mainly, in the developing nations. Remarkably, in India, rapid changes in the urban landscape architectures, socio-economic changes influenced by industrialization, and globalisation of the modern technology. Landscape architectural changes by the influences of high raised buildings, transport networks, increase of retail shopping business, bus stands, markets, railway networks, recreational centres, amusements, and IT parks, increase of tertiary activities / professional services, educational institutions, legal services, markets, trade & commerce, health and medical services. However, on the other hand, it has brought out the human ill health and socio-economic imbalance, and has highly influenced the people's society. Human ill health diseases are classified into; i) communicable / infectious diseases, and ii) non-communicable diseases, are being caused by parasites, vectors, pathogens, virus, bacteria, fungus, protozoa, and helminths, are persistent with the long term ecological, climate and landscape changes (Fig.1). These processes are mainly due to the urbanisation (urban growth, urban migration, urban development, urban sprawl, urban agglomeration) (Fig.2a-2c). Industrialization(industrial growth, development, trade and commerce, transport networks development, skilled professional farms etc.), and globalization (export and imports of goods, food processing and preservation for global extent, fashion of new trending, global trade and markets, diffusion of past food culture, science and technology, the spatial extend of modernisation, spread of new innovations and technology, pressure on changes in socio-economic and culture, accumulation of huge people movements at the global conferences, migration of skilled and unskilled workers, global markets, continental trade and commerce, etc. The United Nations reports 2021, shows that approximately, 500 International Airports are operating airline transport services across the globe, about, 5million people, i.e. 2.8 million people are travelling within the nations and 2million people are travelling to other nations every day with an average increase of 5% Air-bus passengers in a year, since 1990, as a result, can spread infectious disease across the globe within an hour. These major three components are stimulating new infection or increase of communicable diseases. Communicable diseases mainly caused by bacteria, fungus, pathogen, virus, and transmit through vectors, and non-communicable diseases (mental health, cancer, diabetics, obesity, cardiovascular diseases, breathing difficulties, lung disorder, behavioural mental strength, fecundity disorders), are mainly due to occupation, socio-economic pressure, standard of living, and change in food and habitual behaviour.

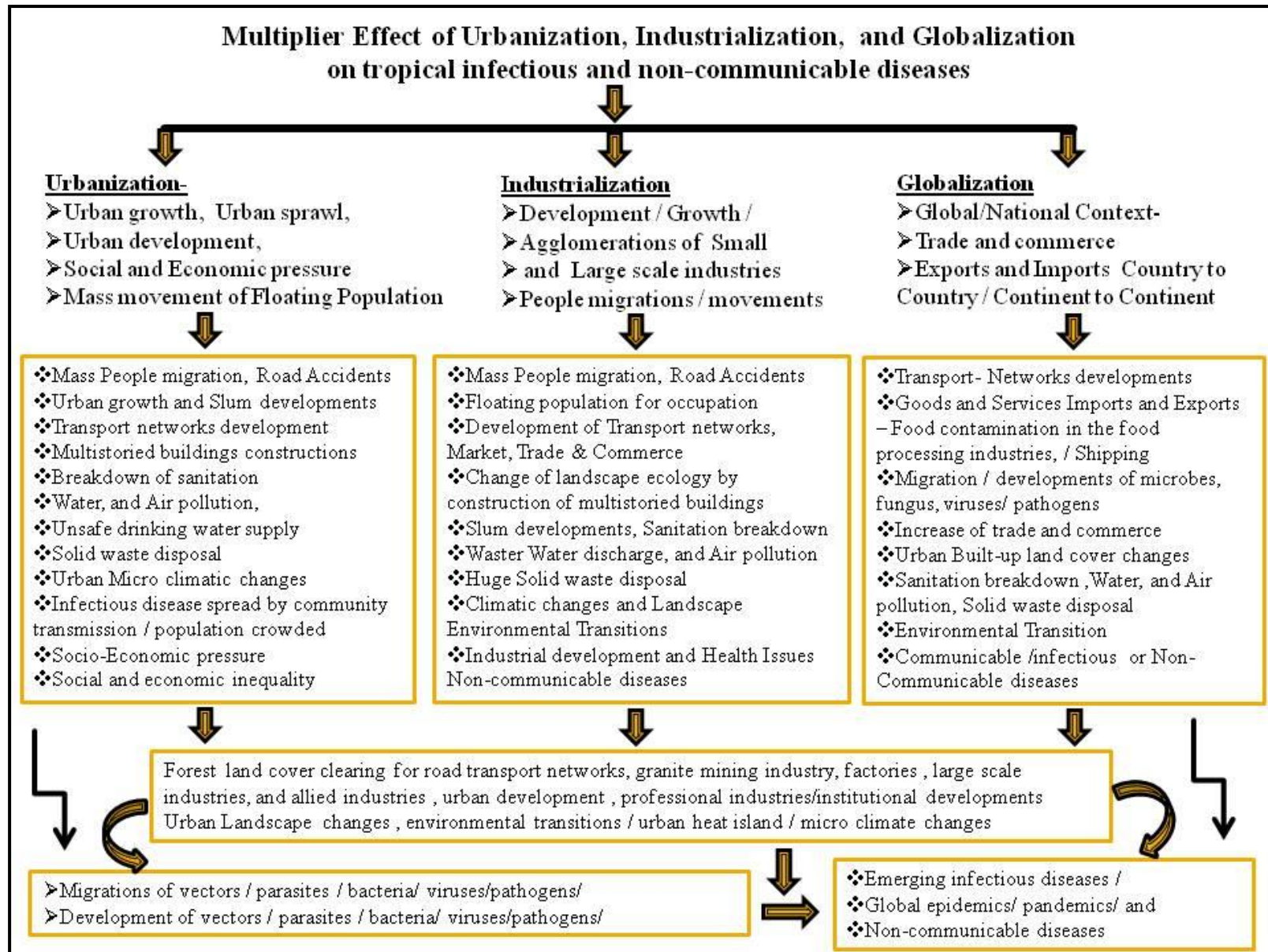


Fig.1. The impact of Urbanization, Industrialization, and Globalization on tropical infectious and non-communicable diseases

**Urbanisation and Health Issues:** Evidenced from throughout the historical records, rapid urbanisation in the developing nations has a multiplier effect on the urban landscape environmental transitions, particularly, unplanned built-up structures, slum development, sanitations breakdown, insufficient water/ lack of safe drinking water supply, forest clearing for urban dwelling, and road network constructions, absences of drainage facilities, unacceptable solid waste disposal grounds, increase of air pollutions, are all collectively fuelled to persuade on underpinning to communicable and non-communicable diseases (Fig.3). Worldwide, 884 million people do not have access to an adequate domestic and safe drinking water supply, and about 3 times that number lack basic sanitation services (1,2). Diarrheal epidemics are most common in the urban or semi urban agglomeration of the developing nations (1-4), approximately, 2 million people die every year because of the unsafe drinking water supplies, and 90 % of those who die from diarrheal diseases, predominantly, young children below 15 years (1,3). In India, researchers emphasised the spatial autocorrelation associated with variables, viz; the dense population settlements / or slums, lack of drainage facilities, inadequate and unsafe drinking water supply, low income, low standard of living, lack of ventilations/windows, and GIS based map results illustrate that the studies the risk of diarrheal infection dense populated wards in the metropolitan limits (5-7), overcrowded towns , and slum neighbourhoods located on the outskirts of major cities in the developing world, lack of access to clean water and improper sanitation services lead to spread of diarrheal and dysentery diseases. similarly, risk of vector borne diseases, dengue and chikungunya, ticks and mites borne diseases, scrub typhus, urban malaria, rabies, in the urban settlements highly associated with the urban type of dwellings, urban hotspots, manmade landscape environmental changes including deforestation (4,8), urban climate change, crowded settlements, drinking water supply, domestic discarded containers in the peripherals, (9-14). The spatial extension of dengue spreads in the newer regions in the Europe, Asia, Middle Asia, North America, mainly because of the climate change caused by increase of air pollution from the industrial and transport emission, and globalisation of trade and commerce, development of tourism industries, increase of tourists / international travellers cross the borders with asymptomatic signs in the recent years (15,16). In India, the effect of rapid development of urban agglomeration had been brought the crowded unplanned settlements with a complex of risk factors simultaneously (11,12), and causing huge magnitude of tropical infectious diseases as well as non-communicable diseases recorded from the socially, and economically vulnerable poor community in the crowded urban

environments, and has been affected at higher degree and has challenge to the local health authority, and the national sustainable health promotions .

Spatially, a significant association was existed between population movements and infectious disease transmission (17). The mass movement of people interstate urban migration has been a greater extent from Bihar, Uttar Pradesh, Jharkhand, and Assam. These major urban migration has been arisen to Mumbai metropolitan (Maharashtra) pursued by New Delhi, Kolkata (West Bengal), Chennai (Tamil Nadu), Bangalore (Karnataka), Jaipur (Rajasthan), Nagpur (Maharashtra), Bhopal (Madhya Pradesh), Hyderabad (Telangana) and Sri Nagar (Jammu & Kashmir). The second major migration from Assam to West Bengal, Bihar and Uttar Pradesh; third level of migration from Andhra Pradesh, Telangana, Bihar, Uttar Pradesh, Jharkhand, Chhattisgarh, and Rajasthan to Chennai (Tamil Nadu), Bangalore, Mumbai, and New Delhi, and fourth level of major migration from Uttar Pradesh, Jharkhand, Haryana, Uttarakhand, Himachal Pradesh, Jammu & Kashmir to Chandigarh, New Delhi, and Mumbai, during 1972-1982 ((Fig.2a-2c), and then it has been gradually reduced till 2002, and subsequently stabilized. Migration, whether within the state, interstate, within the country, or cross the nations (international level), has forever and a day been acted as the principal forces stand-in background of the growth of urbanization and increase of commerce and trade markets bringing major job opportunities to the skilled, semi-skilled, and unskilled workers, economic infrastructural developments, educational institutes. On the other hand, it has been challenging health issues, predominantly, people who migrates from Bihar, Jharkhand, Odisha, Chhattisgarh, and Madhya Pradesh, Uttar Pradesh, and West Bengal (18) are carrying *Plasmodium vivax*, and *Plasmodium falciparum* malaria parasites during the mass movements to Kolkata (West Bengal) for living, and hence, major metropolitan floating population in West Bengal, considered as potential hot spot hosts for malarial parasites in the state, Despite, the municipality authority of Kolkata has operated department to setup a public health clinic and entomological division to vector mosquito control towards the urban malaria parasite transmission control through *Anopheles stephensi* genus mosquitoes urban malaria vector control, the disease has been persisting in Kolkata, and has become challenging health issue in the corporation area in the state. Whereas, 40 % of the urban dwellers and migrants who have been living in the metropolitan, are having positive with infectious diseases, viz; tuberculosis, human immunodeficiency virus infection- HIV transmission (19), and acquired immune deficiency syndrome (AIDS), sexually transmitted virus (STD), cancer, cardiovascular disease (CVD), gastrointestinal diseases, scrub typhus,

hepatitis-B, respiratory, gastrointestinal, meningeal, gene disorders, and skin infections, and vector borne diseases becoming common in a crowded urban environment (1,3).

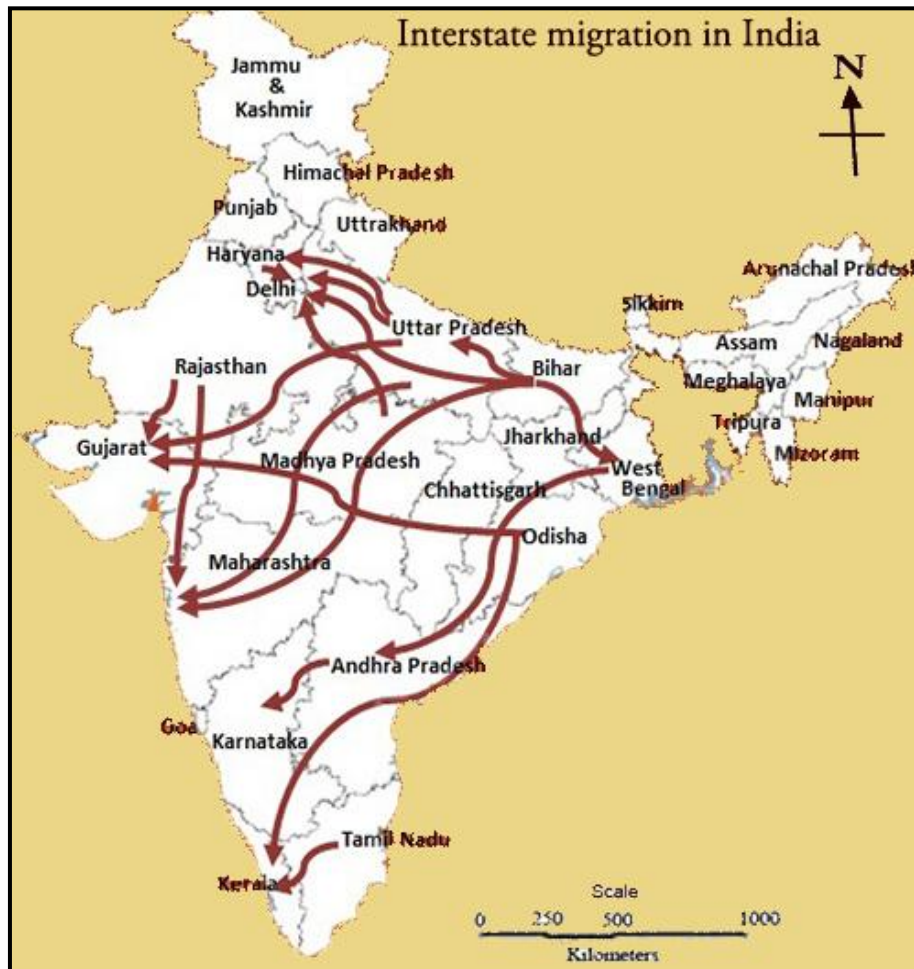


Fig.2a: Mass movement of people interstate migration towards the metropolitan in India (Source: Indian Institute of Population Studies-IIPS, Mumbai)

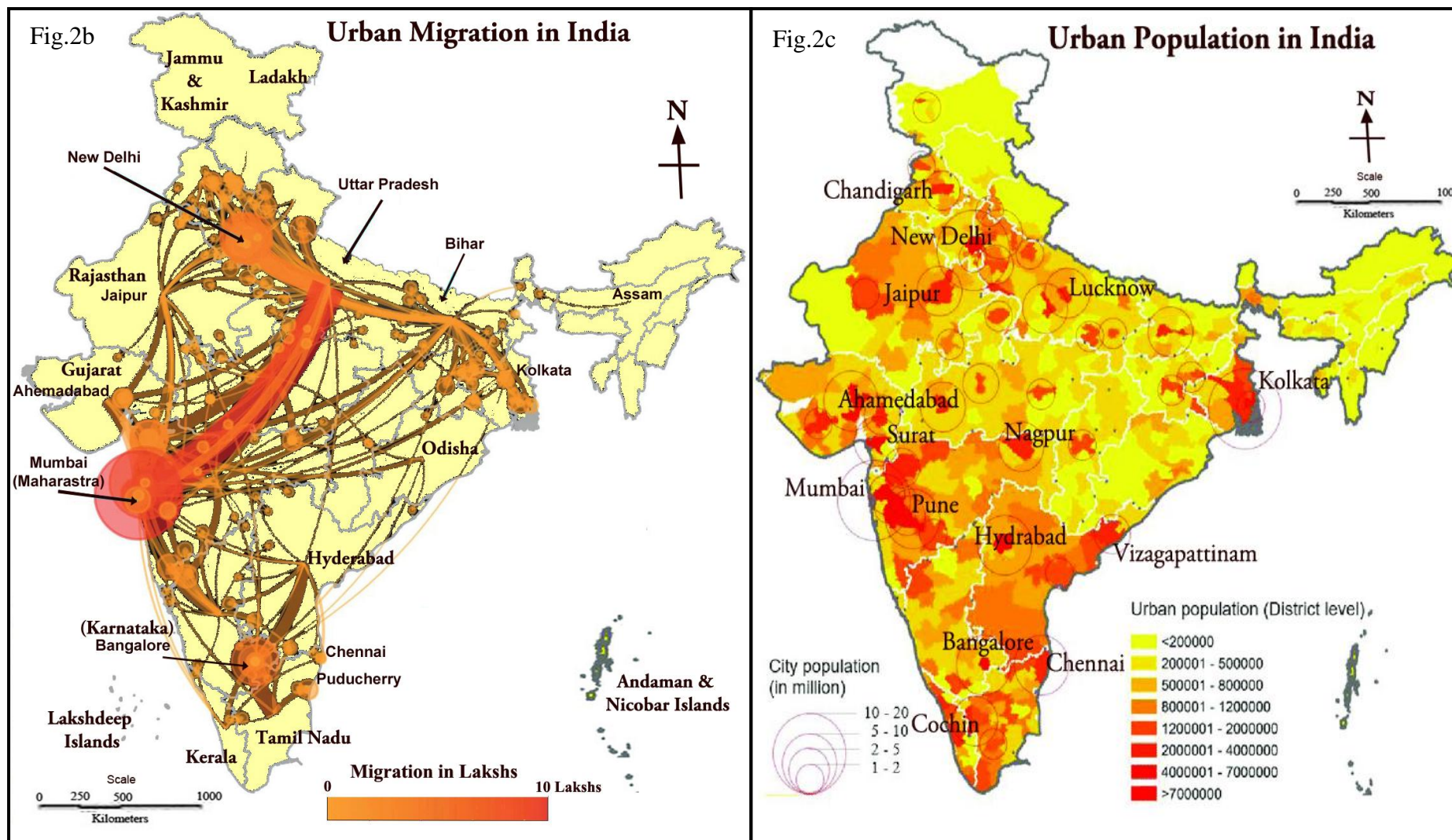


Fig.2b and 2c: Map illustrates the interstate people migration to mega cities, and urban population in India respectively (Source: Census of India, Data on People Migration 2011, Ministry of Home Affairs, Government of India, and IIPS, Mumbai)

Urban agglomeration become immense challenges to municipalities, public health departments, electricity board, law and order, civil supply departments, metropolis authorities, government civic authorities as well as newly migrants, therefore, the government personnel playing important role in taking care of the migrants, and managing migrated people by included migrants in the urban planning for providing high-quality sanitation, safe and adequate drinking water supply, legal services, civil administrative services, civil supplies, road networks, electricity supply, drainage facilities, public health care services centres, education, recreation and amusement parks, vehicle parking areas, shopping bazaars, public transport facilities, etc., similarly, other metropolitan in India, viz; Mumbai (Maharashtra), Delhi, Bangalore (Karnataka), Chennai (Tamil Nadu), Ahmedabad and Surat (Gujarat), Chandigarh (Punjab), Jaipur (Rajasthan), Raipur (Madhya Pradesh), Hyderabad (Telangana), Bhopal (Madhya Pradesh), and Gurgaon (Haryana) are facing the analogous community health issues, mainly due to a less significant of socio-economic conditions, low education level, and lack awareness among the people who has been moving over the period from rural to the urban permanently, whereas, in Noida (Uttar Pradesh), comparatively environmental health issues are under control, because it is emerged as a well planned urban landscape architecture, integrated multidisciplinary approach, and modern industrial city.

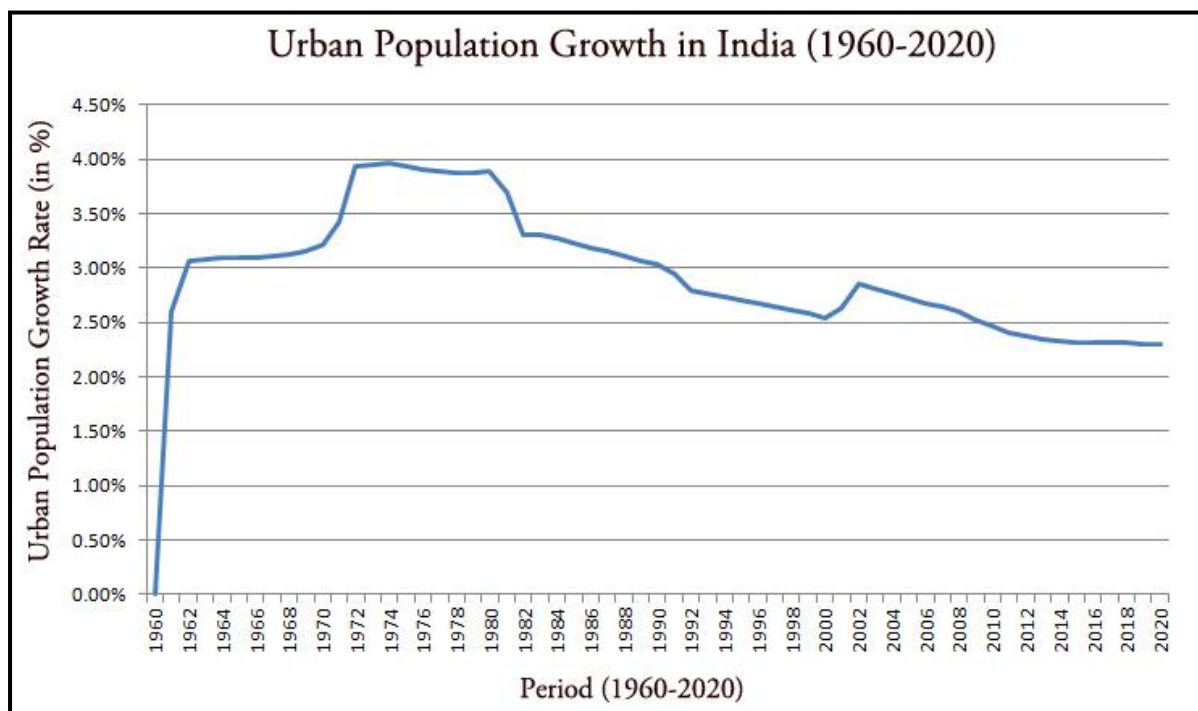


Fig.3: Urban population growth in India (1960-2020), shows the trend of urban population (rate in %.)  
 Source: World Bank population estimates and the United Nations World Urbanization Prospects, 2020



**Industrialization and Health Issues:** In India, large scale and allied small scale industrial developments were accelerated for the past 7 decades, and attracted occupation, throughout the historical records, people mass movements for their living from rural to the urban and small town to metropolitans, or new towns near to industrial estates. On the other hand, public health diseases created by the industrial pollution (liquid, solid, and air pollution), has increased both in the spatial and temporal aspects. Industrial pollution causes lung breathing difficulties, and cardiovascular disease, stroke, lung cancer, chronic obstructive pulmonary diseases, diarrheal, and gastrointestinal diseases, meningial, skin infections, tuberculosis, and respiratory infections. Approximately, 2.4 million people have died due to air pollution, and 90 % of the urban residents in India breaths lower than the global standard of Air quality, and approximately, 2million casualty in a year due to unsafe drinking water supplies, and 1.5million people do not have basic sanitation services lead to diarrheal /dysentery diseases, as a result, 90 % of the children mortality, particularly, in the developing nations, including India. According to the United Nations 2018, about 900 million people do not have access to safe drinking water / an adequate water supply for domestic purposes. A recent study has revealed that the spatial association between mining activities and cholera outbreaks, mostly affected in the age group of < 15 years young children and the senior citizens > 60 years, p-value <0.05, and >40 % of the infected patients were migrated from other places as host and has fuelled by breakdown of sanitation (20), it is a serious public health problem in 42 developing nations (21, 22). In India, Cholera is most possibly associated with breakdown of sanitation, poverty, and lack of clean drinking water supply in the clustered settlements in the mining activities, and industrial estates (15, 18, 23-25).

Cardiovascular diseases (Acute myocardial infarction (AMI), stroke, and atrial fibrillation (AF) are associated with similar geographical patterns caused by Development of CVD is associated with behavioural risk factors, such as; impetuous lifestyle changes and health care behaviour with smoking, unhealthy diet, obesity and physical inactivity (26). In India, about 63% of total deaths have been recorded due to non-communicable diseases, of which 27% deaths have been recorded due to cardiovascular disease, mainly in the middle age group of 40-69. Throughout the past records, sexually transmitted infections (STD), zoonotic diseases, bacterial infections, viral fever, and vector borne diseases are high in the urban settings associated with urban and industrial developments. In India, the spatial distribution pattern of STD, HIV/AIDS are highly associated with metropolitans, industrial estates, distribution of goods and truck / lorry transport services, and trade and market networks, and

the increase of production demand on mobile phone networks among the urban settings (27). The adult prevalence of HIV/AIDS was identified in Chennai city in Tamil Nadu, and the burden of whole state is 7% of the nation, over the period of 2 decades, and the spatial-temporal trends of the infection found constant in the western districts where the industrial growth, trade and commerce, urban agglomerations are growing rapidly and steadily (29). The overcrowded urban agglomeration due to the huge population movements towards the industrial growth and development sites have been brought the flourishing economic development as well urbanization, have led to lifestyle changes, on the other hand, it has a pressure on migrants, superfluous economic differences, socio-economic inequality, and the metropolis society imbalance has a disquiet on the nuclear family, day today life style, standard of living, diminishing learning capacity, and the level of education squalid to behavioural changes accumulate impact on the deteriorated environment of the individual lead to serious mental illness, consequently, diverted to unhealthy diets and lack of physical activity causes obesity and overweight (2,21), particularly, affects the young children <15 years, and 0.8 million people die by suicide every year due to mental melancholy, predominantly, in the age group of 15-29 years (21,29).

**Arsenic:** Arsenic is caused by both nature and man-made; nature (volcano, forest fire, folds, faults, landslides, earthquake, heavy rain and floods), and man-made (anthropogenic activities- industrial pollution, urban waste effluents, intensive and extensive herbicides, agriculture and medical entomological pesticides, smoke emission from coal thermal power plants, etc.), it is affecting mainly in the landscape soil topography, and groundwater. The arsenic effects are mostly caused by anthropogenic activities, and lead to the human standard of living environmental conditions deteriorated. Habitual contaminated drinking water causes skin cancer, bladder infection, urinary tract infection (UTI), kidney damage, lung diseases, and affects blood vessels in the bottom of legs and feet, destruction of nerve tissues, and second hand smoke affects the pregnant women and unborn baby (30), and spraying toxic chemicals for pesticides resulted stillbirth (a typical example, Kasaragod district in Kerala) (30,31). In India, huge records of neurological disorders, deformed limbs and still birth was recorded in the Kasaragod district of North Kerala due to ground water pollution by the Endosulfan pesticide widely used for agricultural crops, including cashew, tea plantation, fruits orchards, and extensive paddy field in the upper basin for more than 2 decades (31). It has also affected and vanished many of the animals, birds, and insects' biodiversity, in Kerala (31). West Bengal, Jharkhand, Bihar, Uttar Pradesh, Assam, Manipur and Chhattisgarh are

reported to be most affected by arsenic contamination of groundwater above the permissible level. Recent clinical evidence indicates that significant association between drinking contaminated water and diabetes, hypertension, reproductive turmoil, hyperkeratosis, gastrointestinal symptoms, disturbances of cardiovascular disease, and nervous system disorders, and in due course leads to serious or mortality. In survivors, bone marrow depression, haemolysis, hepatomegaly, melanosis, polyneuropathy, encephalopathy, and pigmentation are recorded, as well as emerging evidence of significant health concerns. In India, the states of Kerala, West Bengal, Jharkhand, Bihar, Uttar Pradesh, Odisha, Assam, Manipur, Madhya Pradesh, and Chhattisgarh are reported with high arsenic contamination of groundwater above the permissible level 5µg/litre. The implementation of rain water harvesting, check dam constructions, watershed management, and mega water resource projects could be reducing the arsenic level for ensuring the permissible water quality.

**Globalisation and Health Issues:** Speedy travels by the development of aircraft technology reducing travel time for making the global networks, and has marvellous effect on fashion of trade and commerce, particularly, in the developing nations, simultaneously, it has impact on challenging accelerating infectious diseases (24,32,33). Evidenced of that the exploitation, obliteration of the local /native culture, change in pressure on socio-economics, and especially, modify the native culture fetched through the globalisation of past foods culture, preserved readymade foods, persevered fruits, vegetables, animal meats, eggs, shellfish (aquatic invertebrates animal foods-*crustaceans, molluscs, and echinoderms*), and processed foods and groceries. Fresh fruits and vegetables become infected if they are washed with water contaminated or irrigated in the field adding animal manure or human sewage in the farming land. Raw foods of animal origin are the most likely to be contaminated, raw meat and poultry, raw eggs, unpasteurized milk, poultry, unpasteurized milk, and raw shellfish are causing *Salmonella bacteria, and Calicivirus* (33). New, emerging, and re-emerging infectious diseases have been brought all the way through the contamination of foods during harvesting, processing, storage, and transport, and engross long times before it reaches cities in the inlands as well overseas international markets (for typical example, a fungus *Cryptococcus gattii* emerged as new infectious disease among the human and animals in the Vancouver Island, British Columbia province, Canada, during 1999), the fungus, which causes harmful infections of the lung and brain, is causing a spreading epidemic infections and somewhat, ultimate deaths, it has spread to the spatial extend of Pacific North-Western United States of America(USA), and it had previously been known only in the tropical and /

or subtropical climatic regions of the Africa, Australia, Southeast Asia, and the South Pacific (33). The fungus might have been introduced through the import of contaminated trees, shoes, wooden pallets / shipping crates (33). Similarly, during 1999, mosquito-borne infection-West Nile virus-suddenly began targeting New York dwellers, it was a new experience, and before that it had had been restricted to the spatial spread in Africa, West Asia, and the Middle East Asia, currently, the infection caused by West Nile virus has spread in North America, and Latin America, and the appearance of Legionnaires disease/ pneumonia , toxic shock syndrome (33), and HIV/AIDS during the mid 1970s and early 1980s, HIV/AIDS, and the spatial extent of tuberculosis (1,51), respiratory and emerging intestinal infections, intestinal worms, Chagas, Pneumonia, diarrhoea, dengue, malaria, West Nile virus, and Lyme disease, and SARS virus (3,33,51) mainly through the extensive continental travellers including tourists, sports personals, researchers /scientists, and business executives who are from distinctive geographical regions, different immunisation, and host for many infectious diseases, and also disease infectious agents migrate through the global trade and commerce (33), The migrants are growing multiple level during past 20 years, and the accounted annual migration growth was double the world annual population growth of 1.2% (34). The infectious diseases claim huge deaths in the developing world, particularly in the age group of children below the age of 5years (1-4, 35-37). Economic developments has been brought the strong changes in the developing nations through the course of industrialisation, modernisation, and globalization (38-40), unfortunately, anti-social and anti-national elements are making ways to bioterrorism is the deliberate release of viruses, bacteria, toxins, or other agents to cause illness or death in people, animals, or plants, and diffuse passing through contaminated food materials, ruined water, or air (for a typical example, bioterrorism became a reality occurrence when letters containing powdered *Bacillus anthracis*, the U.S. Postal Service was used to spread this *bacterium* spores in October 2001, similarly, the *botulinum* toxin is the highly harmful lethal compound, a nerve toxin produced by the bacterium *Clostridium botulinum*, a gram of aerosolized *botox* could be killed more than 1.5million people (33).

**Vector Borne Diseases:** Malaria, Chikungunya, Dengue, Japanese encephalitis, Zika Virus, Nipah virus, Kala-azar, Lymphatic filariasis, Scrub Typhus fever, Kyasanur Forest Disease, Schistosomiasis, Flea-borne (murine) typhus (caused by a bacteria called *Rickettsia typhi*), West Nile virus, yellow fever, and Lyme disease are most common vector borne diseases (3, 35) in the developing and the third world nations. Globalization is making way for vector

borne diseases spread in the newer regions, and vectors and infected asymptomatic patients are migrated within the nation or crossing the international border through flights, cargo ships, as well goods and services, parcels, trade and commerce (16,33,36,41). The vectors, namely; mosquitoes, fleas, mites, ticks, rats, snails, sand flies, and dogs are transmitting vector borne diseases (3). The global incidence of dengue has been increased 30 - 40 % every year, especially, for the past two decades about 45% of the people living in the 142 countries estimated approximately 450 million people at risk of infection, and 500,000 cases of severe dengue or dengue haemorrhagic fever (DHF) with 25,000 deaths annually reported worldwide, approximately, half the world's population is currently infected with a vector-borne disease (3,16,42-44). The first epidemic cases of dengue was reported in Afghanistan during 2019, and 16 Nations many of the developing and low income countries have experienced with increase of dengue epidemic records during the year 2020, namely, Bangladesh, Brazil, Cook Islands, Ecuador, India, Indonesia, Maldives, Malaysia, Mauritania, Mayotte (France), Nepal, Philippines, Singapore, Sri Lanka, Sudan, Thailand, Timor-Leste and Yemen, and Vietnam. The spatial extents of dengue epidemic cases are geographically extended to the new areas in Europe during the recent years. Climatic factors, and land use/ land cover categories are playing important role in the increase or decrease of vector mosquitoes as well as VBD epidemics (3,13,16,41-45). In India, the both geographical and historical sequential aspects of vector borne disease epidemics have increasingly been reported across the nation for several decades, and it has been found generally everywhere across the nation, however, the frequency of outbreaks in urban settlements province has clustered and accelerated trends relatively higher than rural settings, similarly, it has been occurred in the global nations perhaps boosted by the transitory migrants who are infected asymptomatic host (16,40,45).

The combined effect of feeding plant nutrient with blood meal has impact on the results of the boosting longest survivals >30 days, and highest fecundity rate was obtained in the *Aedes aegypti* dengue vector mosquitoes (p-value < 0.001) (46). As the result shows that wherever the vegetation land covers thickly great quantities in and around the human living areas, support the *aegypti* vector mosquito's profusion, and thus, dengue, chikungunya, and zika virus fever transmission may perhaps have occurred decidedly high. It means that the rural setting has high risk of dengue epidemics than the urban setting. In contradiction to this statements, throughout the historical records in the global nations, dengue epidemics was highly recorded in the metropolitan region than the rural settings, because of the urban

environmental determinants together with large quantity of discarded manmade containers and limited vegetation land cover supports *Aedes* genus mosquitoes fecundity and density (42-45,47). Malaria is a serious disease transmitted by malaria parasites (*P. vivax*, *P. falciparum*, *P. Malariae*, and *P. ovale*) into the human body by the infected female *Anopheles* genus mosquitoes. In India, it has been drastically reduced and the National Vector Borne Disease Control (43,45,47) authority has made health plan to eliminate malaria by 2050, however, the trend of urban malaria is persistently reported over the space and time, and the problem is challenging issues to the public health programmers due to the floating migrant people who are living in the urban (45), the national malaria surveillance system shows the declining trend of malaria in the rural settings, but it has been accelerated trends in the urban settings, particularly, in the developing nations (40,43,45) .

**Global Pandemic Disease Risks, Impacts, and Mitigation:** Pandemic diseases are huge epidemics at the large scale geographical regions, and it has been extended to the neighbouring regions, or the entire nation, or the whole world (3,24,33). The epidemics of Diarrhoeal disease, Cholera, Tuberculosis, Avian influenza, Yellow fever, Ebola, Plague, Meningitis, MERS, Influenza, West Nile Fever, Zika virus, Rift Valley Fever, Lassa fever, Leptospirosis, HIV/ AIDS, Malaria, dengue, Hepatitis-B, and Covid-19 are the major pandemic diseases (37,38,48,49,51). People mass movements at the international / inter-continental level has responsible for large scale spread of diverse infectious diseases, including STD, HIV/AIDS, malaria, dengue, Influenza, etc., has effect on the infertility, a serious long term reproductive health consequences including still birth, newborn mortality, etc., than the instantaneous impact of the disease. 1.4 million People who have died with Tuberculosis (TB) infection in 2019, among those 0.2 million have co-infection of HIV/AIDS (3,36,51). Tuberculosis is alone responsible for the huge deaths in the world top 10 infectious diseases. Approximately, 10 million people have been infected with tuberculosis (TB) across the globe, and have 5.6 million men, 3.2 million women and 1.2 million children, and estimated 95% of deaths have occurred in the developing countries (1,3). Diarrhoeal diseases / Dysentery / Cholera disease caused huge deaths (3,22), and followed by TB, second leading cause of deaths, and followed by diarrhoea kills around 525, 000 children below five years and above 70 years old in every year, it claims highest mortality in Sub-Saharan Africa and South Asia. Malaria is the third serious burden of mosquito vector borne infectious disease, it has been recorded 229 million cases worldwide, and deaths toll is 409 000 during 2019 (3). In India, 162.5 million people (i.e. about 12% of the total population of

India, 2021) affected with malaria, particularly North Eastern and Eastern India, it is highest record of the South East Asia regions, at the same time, and it has showed a reduction of malaria cases 49% in 2020 (16,45).

Since November 2019, Covid-19 virus infectious disease and its variants has paralyzed the whole world, and destroyed the total economic conditions (48,49). In India, accumulated infected cases of 32.6 million reported with Covid-19 (Coronavirus disease), death recorded 0.436 million during the last years (Oct-2019-Aug-2021), and Maharashtra is the most affected state, and followed by Kerala, Karnataka, Tamil Nadu, Andhra Pradesh, Uttar Pradesh, West Bengal, Delhi, Chhattisgarh, Odisha, and remaining states are recorded below 1 million cases. In the world, the cumulative record of 214 million infected cases with death recorded 4.46 million as on 25th August 2021 (48,49). Covid-19 virus / coronavirus (2019-nCoV) spread through a Virus laboratory in the Wuhan State in China-During Nov 2019, and a deadly disease rapidly diffuse to Italy in Europe, and immediately to North America, Asia, Africa, South America, Australia, Middle Asia, Caribbean and Pacific Islands, and within a short span of period Covid-19 virus pandemic extended throughout the globe (49). Literature source evidenced that coronavirus (2019-nCoV) virus has become a community transmission across the global nations. The first wave of pandemics has lesser effect than the second wave of coronavirus (2019-nCoV), because, metamorphosis of the Covid-19 virus variants into 3 types, viz., these Covid-19/ SARS-CoV-2 infection is a meticulous pneumonia causing severe damage to cardiac damage, and the geographical distribution of the Covid-19 variants has been attributed with the specific spatial patterns (48,49). There are a complex of phenomenon responsible for the wild spread of pandemics and unexpected huge mortality, among that chiefly, genetically modified SARS-CoV-2 infection, and In India, the second wave of infections are modified Delta variants of COVID-19 strain, and it was spread like wild fire across the nations and claimed huge deaths due to overcrowded floating population movements from urban to rural, and the people have not been exposed to these virus and variants previously, as a result, immunity among the community absolutely zero, however, the government of India has made appreciate right decision to control the pandemic situation through the complete lockdown including the educational institutions, trade and commerce, markets, recreations and amusement parks, cinema theatres, temples, shopping malls, hotels, migrations (inter-districts, interstate, and or outside the country), exports and imports, public transports, family and community functions with limited people, social distance, making awareness to wearing N95 WHO standard face masks, prohibited public gathering, etc., at

present, the pandemic situation is under control, however, the researchers are giving alarming to the world nations for the third wave of SARS-CoV-2 / Covid-19 delta variants, therefore, Covid-19 vaccinations double dose, and personal protective health care measures as per the WHO guidelines/ICMR Government of India guidelines could be saved from the yet another dangerous pandemics in India (37,49, 50).

**Medical waste and health care delivery services:** The improper waste disposal of medical waste, such as; syringes, soiled dressings, damaged/removed human body parts, diagnostic test samples, contaminated blood, used chemical waste, expired / tainted pharmaceuticals, discarded medical devices, and toxic /radioactive materials leads to ill health / infection to health care workers, medical waste cleaners and waste handlers, and thus, probably risk of infection to the entire community who are living in and around the waste disposal. About 34,000 HIV infections, 1.7 million hepatitis-B, and 315 000 hepatitis-C infections were recorded due to the unsafe injections reported in 2010, therefore, WHO has provided the guidelines to safe management of medical wastes, which includes waste minimization and recycling, waste handling, classification, consignment and transportation, and organize to treatment and disposal alternatives, and training (50). In India, The Ministry of Health and Family Welfare, Union Government of India, has various health plans to organizing the health infrastructures, deploying the health personnel, managing the epidemic situation, and given much more attention for health care delivery services to the weaker section and the people who are living in the remote locality, highly vulnerable socio-economic weaker groups in the urban migrants/ the urban poor, tribes, and minority groups. A map based environmental health and the spatial epidemiological approaches for assessing the probability of risk of infectious and non-infectious diseases, conserve the spatial relationships between the each of its mechanism (52), and based on the final map products the health officials and programmers could deliver health care services to all and render justice a head towards sustainable health.

**Conclusion:** The infectious and non communicable diseases are most probably associated with urbanisation, industrial developments, and globalisation. Remote Sensing and GIS have been used for mapping multiple diseases including communicable and Non-communicable diseases for the recent decades. The thematic mapping of diseases provides insights to identifying the spatial and temporal patterns for a long period. A clear illustration of the disease at a glance may perhaps provide a better understanding of disease ecology, and risk



factors, insights of the infections as well as facilitate targeted towards control, health information, management, prevention and allocation of health care resources. Mapping the multiple infectious diseases and non-communicable illness could provide a way lead to better understanding of the spatial patterns of disease epidemics over a time periods, similarities and dissimilarities of the one or multiple diseases could be revealed disease-specific determinants, and public health programme managers joint hands with multidisciplinary experts enable plan for prevention and control in advance.

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