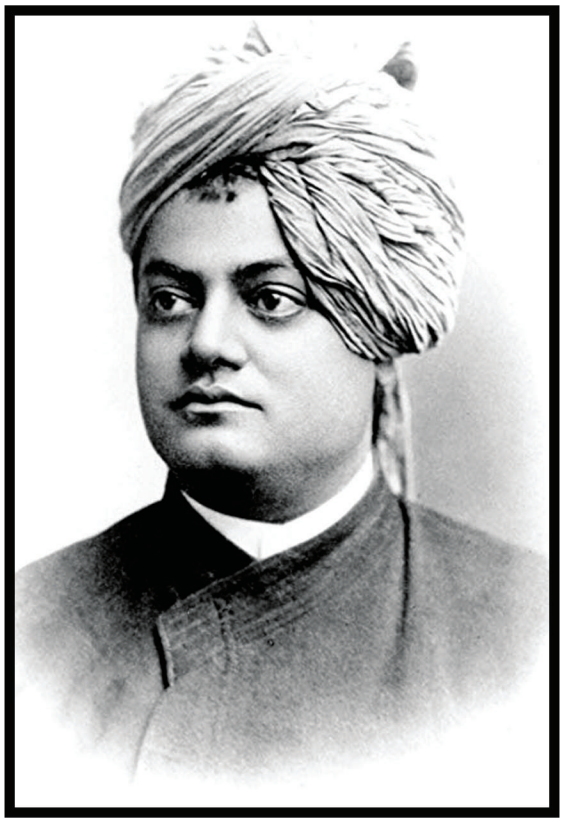
ENVIRONMENT AND HEALTH

Scopes and Challanges

SCHOOL OF ENVIRONMENT AND DISASTER MANAGEMENT
RKMVERI



We must have life-building, man-making and character-making assimilation of ideas.

Preface

The staff, research scholars, and students of the School of Environment and Disaster Management express their heartfelt gratitude to the honorable Vice-chancellor of the university, the Secretary of Ramakrishna Mission Ashrama and Administrative Head of IRDM Faculty Centre, Narendrapur, and other senior monks and members of the university for the unflagging encouragement and the relentless support extended to the school, since its inception. This has enabled the progressive emanation of the school from it's nascent state.

We put on record the contribution of the European Commission ERASMUS PLUS program, apropos of the inclusion of the university in the list of its partner institutions, which notably also includes several premier universities across Europe and Central Asia. The school is indebted to Prof. Claudio Colosio of the University of Milan for trusting us with some of the noteworthy proceedings of the program.

The comprehensive compendium of scientific accounts documented herein includes humble contributions by the staff, research scholars, and the students of the school on the eclectic elements of environment and disaster management.

2020

RAMAKRISHNA MISSION VIVEKANANDA EDUCATIONAL AND RESEARCH INSTITUTE

The Ramakrishna Mission Vivekananda Educational and Research Institute (RKMVERI) is a humble initiative of the Ramakrishna Math and Ramakrishna Mission, Over a century ago, Swami Vivekananda, the prophet of modern India and apostle of Vedanta in the West, emphasized the importance of broadening the scope of education from being merely a book-learning exercise to becoming a more comprehensive man-making and character-building assimilation of life-giving ideas. For an effective system of education, he suggested combining the best elements of ancient spiritual traditions of the East with modern scientific traditions of the West.

In 1939, the Ramakrishna Mission took a small step towards actualizing this vision by starting Ramakrishna Mission Vidyamandira, an institution of higher education near Belur Math. A couple of decades later, during Swami Vivekananda's birth centenary year (1963), a proposal was muted for starting the Vivekananda University. Finally, a deemed university under University Grants Commission (UGC) was established, under Ramakrishna Mission's auspices in 2005.

A UNIVERSITY WITH A DIFFERENCE

The university places emphasis on academic areas and research that are of importance and social relevance, but are under-represented in the Indian educational framework, such as the study of Indian heritage, fundamental sciences, rural and tribal development, disability management, disaster management, and the like.

The study areas are so chosen that provide students an environment conducive for the growth of well-rounded personalities harmonizing diverse but complementary ideals.

The university operates through four campuses - Belur Math near Kolkata (headquarters), Coimbatore, Ranchi, Narendrapur (Kolkata).

The Faculty Centre of 'Integrated Rural Development and Management' (IRDM) located at Ramakrishna Mission Ashrama, Narendrapur, Kolkata 700103 is an 'off-campus' centre of Ramakrishna Mission Vivekananda Educational and Research Institute (RKMVERI), PO Belur Math, Dist. Howrah, West Bengal and is approved by UGC, and MHRD, Govt. of India.

School of Environment & Disaster Management

The programmes offered by the School of Environment & Disaster Management at the IRDM Faculty Centre include:
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- MSc (2 year course) in Environment and Disaster Management

- PhD in Environment and Disaster Management

The burgeoning deleterious impacts of environmental pollution on human health are a major cause of concern for scientists and environmentalists across the globe. In particular, environmental degradation is exacerbated by serious environmental issues, including climate variability, air pollutiion, and global warming, which pose serious environmental threat to global environmental sustainability.

As such, the School of Environment & Disaster Management (EDM) at IRDM Faculty Centre, RKMVERI, is presently working on the various aspects of environmental quality in an effort to gain a comprehensive insight into environmental pollution and unravel pragmatic means to mitigate the inadvertent environmental repercussions on human health.

These scientific investigations have provided the principal underpinning for the compendium of scientific accounts contributed by the staff, research scholars, and students of the school.

Contents


Heavy Metal Pollution
22
Disaster Management
51
Geo informatics
32
Bioclimate - Rural housing
47
ICD - code
17
Natural Disaster
12
Climate Modelling
36
Environ-mental Impact Assessment
8
Environ-mental Acts & Rules
1
Artificial Neural Network
41
Climate change
29
Risk Assessment
54
Thermal image processing
39

ENVIRONMENTAL ACTS IN INDIA

Components of the environment gradually become polluted due to rapid population growth, urbanization, unplanned industrialization, burning the fossil fuel, agricultural activity, discharge of industrial effluents in water and soil. Other environmental issues that are critical encompass constraints of safe potable water, food, fodder, fuel, and energy supply. Rivers are polluted due to industrialization, wastewater from urban areas and others. The quality of the river water is fast deteriorating and raising alarm of health concerns to human beings, animals and aquatic plants. There are problems like soil erosion, soil deterioration, causing depletion of forests and other land areas.

The situation with regards to freshwater lakes is particularly bad due to sewage disposal, cultural activities. The pollution of freshwater lakes and rivers is not limited to organic effluents alone. An enormous amount of water bodies receive toxic effluents with heavy mater borne diseases account for 2/3rd of illness in India. The deteriorating air quality of our metropolitan cities and industrial towns demands urgent remedial action to safeguard health and well being. Stockholm Conference on Human environment (1992) was a turning point in the environmental history of many countries including India.

Prior to 1972, environmental aspects in India was looked after by multiple departments and ministries. National Committee on Environmental Planning and Coordination, set up in 1972 under the Department of Science and Technology, as an apex body to examine issues of environmental protection in India for a long time. Tiwari committee (1980) recommended the requirement of the legislative measures and administrative machinery and the creation of the Department of Environment.

India has adopted several Acts, Rules, Amendments, and Guidelines and issued by the state and central governments. Prominent among them being the Water (prevention and control of pollution) Act, 1974, and the Air (prevention and control of pollution) Act, 1986. Environmental audit of industries has been made compulsory since 1992, and guidelines for hazardous waste management and handling of hazardous substances have been issued.

Environmental Impact Assessment Guidelines have also been issued, and procedures for environmental clearance have been streamlined. A considerable change in the environmental scenario has taken place after the new industrial policy of 1991.

Environmental Acts, Rules, Notifications and Guidelines

Purpose	Acts, Rules, Notification	
Water Pollution	Act	The Water (Prevention and control of pollution) Act, 1974 (article 6); The Water (Prevention and Control of Pollution) Cess Act, 1977 (article 36); The water (Prevention and Control of Pollution) Cess (Amendment) Act, 2003 (article 19).
	Rules	Central Board for Prevention and control of water pollution (procedure for Transaction of Business) Rules, 1995 amended 1976. G.S.R. 58(E): The water(prevention and control of pollution) Rules, 1975; G.S.R. 378(E): The water (Prevention and Control of Pollution) Cess Rules, 1978.
	Notification	S.O. 498(E): Date on which the Water(Prevention and Control of Pollution) Cess (Amendment) Act, 2003 (19 Of 2003) come into force; S.O. 499(E): Rate of cess Notified Under the Water (Prevention And Control of Pollution) cess (Amendment) Act, 1977 (36 Of 1977); S.O.862 (E): Central Pollution Control Board constituted the Pollution Control Committee in the UT of Daman, Diu, Dadra, and Nagar Haveli.
Air Pollution	Act	The Air (Prevention and Control of Pollution)Act 1981, Amended 1987 (article 14 of 1981);
	Rules	G.S.R. 712(E): The Air(Prevention And Control Of Pollution) Rules, 1982 G.S.R. 6(E): The Air(Prevention and Control of Pollution) (Union Territories) Rules,1983
	Notification	S.O. 935(E): Ambient Air Quality standard For Ammonia; S.O. 389(E): CPCB re-established labs in Delhi, Calcutta, Vadodara, and Kanpur. S.O. 1032(E): Constitution of the Appellate authority for the Union Territories;

Purpose	Acts, Rules, Notification	
Environment Protection	Acts	The Environment(Protection) Act, 1986
	Rules	The Environment(Protection) Rules, 1986
	Notification	The Environmental Impact Assessment Notification, 1994
National Environment Appellate Authority	Acts	The National Environmental Appellate Authority Act, 1997 (article 22);
National Environment Tribunal	Acts	The National Environment Tribunal Act, 1995 (article 27);
Indian Forest Service	Rules	No. 17011/03/200-IFS- II: Rules for a competitive Examination to be held by UPSC For IFS.
Biodiversity	Acts	The Biological Diversity Act, 2002 (article 18)
	Rules	Draft Biological Diversity Rules,2003 S.O. 497(E): dated April 15, 2004 G.S.R. 261(E) dated April 15, 2004
Forest Conservation	Acts	The Indian Forest Act, 1927; Forest (Conservation) Act, 1980. Amended 1988; State /UT Minor Forest produce (Ownership Rights of Forest Dependent Community)Act, 2005
	Rules	G.S.R. 23(E): Forest Conservation Rules, 2003 G.S.R. 719: Forest conservation Rules, 1981.,Amended 1992
	Guidelines	Guidelines for diversion of forest lands for a non-forest purpose under the Forest (Conservation) Act, 1980 (article 5-5/86-FC)

Purpose	Acts, Rules, Notification	
Wildlife	Acts	The Wildlife (Protection) Act, 1972, Amended, 2003 (article 53 of 1972); The wildlife (Protection) Amended Act, 2002 (article 16 of 2003
	Rules	S.O. 1092(E): The National Board of Wildlife Rules, 2003; S.O.445(E): The declaration of wildlife stock rules,2003; G.S.R. 350 (E): The wildlife(Specified plant stock Declaration) central rules, 1995; G.S.R. 348 (E): The Wildlife Protection Rules, 1995; Recognition of Zoo Rules, 1992; G.S.R.328 (E): The Wildlife(Protection) Licencing(Additional Matters for Consideration) Rules, 1983; G.S.R 29(E): The Wildlife (Stock Declaration) Central Rules, 1973; G.S.R. 198(E): The Wildlife(Transaction and Taxidermy) Rules, 1973
	Notification	S.O. 1093 (E): Constitution of the National Board for Wildlife S.O. 1091(E): Coming into force of section 6 of the Wild Life (Protection) Amendment Act, 2002 (article 16 Of 2003)
Waste /Biomedical waste Management	Rules	Hazardous Wastes(Management and Handling) Rules, 1989 (amended 2000); The manufacture, storage, and import of hazardous chemicals Rules/ Amendment, 1989/1994/2000 Municipal Solid Waste(Management and Handling)Rules, 2000; The Biomedical Waste(Management And Handling) Rules, 1998

Purpose	Acts, Rules, Notification	
Chemical Hazardous	Rules	Chemical accident(Emergency Planning, preparedness, and Response) Rules, 1996; A guide to Manufacture, Storage, and Import of Hazardous Chemical Rules, 1989; Manual on Emergency Preparedness for Chemical hazardous, 1992

Aim and objectives

Act/Rules	Description
The Wildlife (Protection) Act, 1972	According to section 1 of this act, the objectives of wildlife (Protection) act, 1972 are (a) to maintain essential ecological processes and life-supporting systems, (b) to preserve biodiversity and to ensure continuous use of species, i.e., protection and conservation of wildlife. Applicability - Central or state governments also used to prevent the hunting of wild animals and protect wild animals.
The Water (Prevention And Control of Pollution) Act, 1974; The water (Prevention And Control Of Pollution) Rules, 1975	Prevention and control of water pollution and maintaining or restoring wholesomeness of water and establishment of boards for prevention and control of water pollution. Applicability - Establishment, and operation of any industries having a source of discharge either sewage or trade effluent into a stream or well or sewer or on land
The water (Prevention and Control of Pollution) Cess Act, 1977; The water (Prevention And Control of Pollution) Cess Rules, 1978	To provide for the levy and collection of a cess on water consumed by the person carrying on certain industries and by local authorities with a view to augment the resources of the Central and State PCBs. Under Schedule II, Rates of water cess are prescribed for specified purposes.

Act/Rules	Description
The Air(Prevention and Control of Pollution) Act, 1981; The Air(Prevention And Control Of Pollution) Rules	Prevention, control, and abatement of air pollution and the establishment of state PCBs for the purpose. Applicability -any industries having a source of emission in an air pollution control area. Many states have declared the entire state as an air pollution control area. General environmental standards are included in Appendix II.
The Environment (Protection) Act, 1986; The Environment (Protection) Rules, 1986; The Environmental Impact Assessment Notification, 1994; The environmental statement, 1992/93; Amendments –Public Hearing, 1994; Environmental standard, 1998; Coal beneficiation, 1997; The direction of fly ash and fly ash-based product, 1999	The environment includes water, air, land, and the interrelationship, which exists among and between water, air, and land, human being, other living creatures, plants, microorganisms, and property. The purpose of this act is to protect and improvement of the different components of the environment.
Hazardous Wastes (Management and Handling) Rules, 1989 (amended 2000)	To regulate the management and handling of hazardous wastes (collection, reception, treatment, storage, and disposal). Hazardous wastes are those falling under Schedule I, II, and III.
The manufacture, storage, and import of hazardous chemicals Rules/Amendment, 1989/1994 /2000	To regulate the manufacture, storage, and import of hazardous chemicals. This rule covers several issues, including notification of an accident, new industrial activity, notification of sites, safety guidelines, onsite and off-site emergency plans, discloser of information, containment of hazardous chemicals, etc.

Act/Rules	Description
Municipal Solid Waste (Management and Handling) Rules, 2000	The municipal authority shall be responsible for the implementation of the provisions of the rules, e.g., infrastructure development for collection, storage, segregation, transportation, processing and disposal of municipal solid wastes.
The Bio-Medical Waste (Management and Handling) Rules, 1998	To regulate the management and handling of biomedical wastes. Applicability - all hospitals, nursing home, clinic, veterinary institution, animal house, pathological laboratory, blood bank.
Ozone Depleting Substances (Regulation and Control) Rules, 2000	To regulate the production and consumption of ozone-depleting substances. This has been notified by the Ministry of Environment and Forest, issued on 19th July 2000.
The Noise Pollution (Regulation and Control) Rules, 2000	To control and regulate ambient noise level at public places.
The National Environmental Tribunal Act, 1995 Chemical accident (Emergency Planning, preparedness, and Response) Rules, 1996; A guide to Manufacture, Storage, and import of Hazardous Chemical Rules, 1989; Manual on Emergency Preparedness for Chemical hazardous, 1992	As notified by the central government, the purpose of the Act is to provide for strict liability for damage arising out of any accident occurring while handling any hazardous substances and for establishment of a National Environment tribunal for expeditious disposal of cases arising from such accident, with a view to giving relief and compensation for damages to persons, property and the environment and for matters connected therewith. To regulate emergency planning, preparedness and response for the chemical accident. For the guidance purpose only i.e., to facilitate a better understanding of related rules, among the implementing agencies, industries, experts, and ensures compliance. For guidance purposes only, the ministry of Environment and forest manual describes the state of readiness to face the adverse effects of accidents caused by a hazardous substance.

ENVIRONMENTAL IMPACT ASSESSMENT

Environmental Impact Assessment (EIA) is a process of evaluating the likely environmental impacts of a proposed project or development. The first comprehensive environmental legislation in the United States came into force in 1970 in the form of the National Environmental Policy Act. In 1994, the Ministry of Environment and Forests, Govt of India issued Notification making EIA statutory for 29 specified activities, covering industries, mining, irrigation, power and transport. The objectives of EIA are mentioned as:

1. Identify, predict and evaluate the economic, environmental and social impact of development activities;
2. Provide information on the environmental consequences for decision making;
3. To promote environmentally sound and sustainable development through the identification of appropriate alternatives and mitigation measures.

EIA Methodology:

1st step: Determine whether the project under consideration follows the jurisdiction of the relevant acts and regulations.

2nd step: An EIA is undertaken and the environmental impact statement (EIS) is prepared, if the 1st step is satisfied

3rd step: EIS is open to public scrutiny and is reviewed at public hearings.

4th step: A political decision is taken whether, the development project may be accepted/ accepted with amendments/ an alternative proposal is accepted or rejected.

The students of the School of environment and disaster Management acquire the skill to carry out EIA in specific areas of application in and around Kolkata city of the state of West Bengal. Some examples of EIA reports prepared by the students are highlighted below:

Construction Projects:

Kolkata is the main business, commercial & financial hub of eastern India and the north-eastern states. The relative antiquity of Kolkata and unplanned growth has further exacerbated the problems of

Guiding principles of EIA

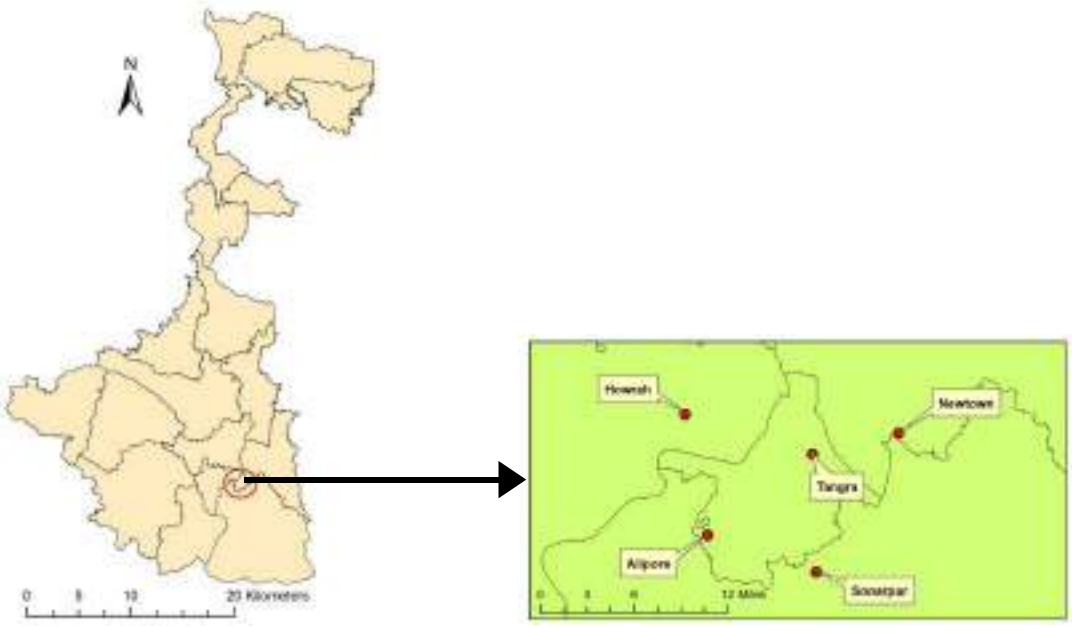
inadequate civic amenities in the city. Realizing the magnitude of this problem, the government is keen to put into place modern infrastructure and a number of agencies are working towards that goal. A preparatory attempt has been made to prepare EIA reports from different perspectives.

Metro stations:

EIA is required for development projects. Construction of metro stations is a huge project and requires large scale of land and high level of expertise. The extent the metro project in Kolkata (from Howrah Maidan to Saltlake Sector-V) therefore, need EIA. A modest endeavour has been made to prepare a draft report on metro railway mentioning the applicable rules, regulation following the proposed methodology, suggested by MOEFC (Ministry of Environment, Forest and Climate change).

Road construction:

Road development enhances mobility and is critical to the economic growth of a community and a country as a whole. The common impacts of road development include damage to natural landscape, habitat and biodiversity, destruction of the cultural and social structure of affected communities, creation of air and water pollution, and generation of noise and vibration. To minimize adverse environmental and socio-economic impacts, road infrastructure must be built to a high quality and maintained to a high standard. This can be achieved by integrating environmental considerations into road development planning, design, and construction. An EIA report documents the environmental issues of Sursuna-Raipur road section in West Bengal.



Locations selected for EIA study

Bridge:
The industrial and agricultural developments in the city, as well as the suburban area of Kolkata, have led to higher transport demand. As a result of the aforesaid growth, new infrastructure development projects has been planned. The Govt. of West Bengal takes the needful action through West Bengal Highway Development Corporation Limited (WBSRDCL), which proposed the need of a road bridge over Ganges connecting Howrah and Kolkata. Based on the feasibility, a new six-lane suspension type bridge about 10.5 kms has been proposed across Ganges River from Howrah (Belur) to Baghbazar. The student EIA report elaborates on the potential impacts and mitigation measures of the suggested area.

Food processing industry:
The Scheme of Mega Food Park aims at providing a mechanism to link agricultural production to the market by bringing together farmers, processors, and retailers so as to ensure maximizing value addition, and minimizing wastage. Emphasis has been placed on an EIA study on the sector to minimize the adverse impact of such industries on the environment in terms of different kinds of pollution. The common effluent treatment plant is proposed at Addirabad village near Sonarpur. The area is well served by communication lines, both by all-weather motorable roads and by the railway and airport connectivity. A modest attempt has been made to prepare an EIA draft over this region.

Tannery industry:
Tannery industry is a prominent industrial sector and has been identified as an area of extreme focus. Such industries have adverse impact over environment as well as on human health. It creates ecotoxicity like water pollution, solid waste generations. Before the establishment of such industry EIA report is an essential requirement. A preparatory

Potential Impacts	Mitigation
• Soil erosion • Contamination of ground and surface water • Air pollution due to dust generation and vehicular exhaust gases • Damage to ecosystem • Noise pollution • Increase the spill of toxic substance • The exploitation of groundwater resources • Deforestation and loss of biodiversity • Fire hazards	• Install erosion control measures such as bales, berms, fabric barriers. • Minimize disturbance of native flora and fauna. • Sprinkles water on the surface during construction. • Prevent the dumping of hazardous materials and their spill. • Trees allowed growing up to a height maintaining adequate clearance between the top of the tree and the conductor as per the regulations. • Re-plantation with removed plants and storage of topsoil for re-spreading. • Maintenance of engine and road surface in good condition.

EIA study was carried out at Tangra, Kolkata to focus on the evaluation of pollution areas and also aimed at optimum utilization of resources in particular areas.

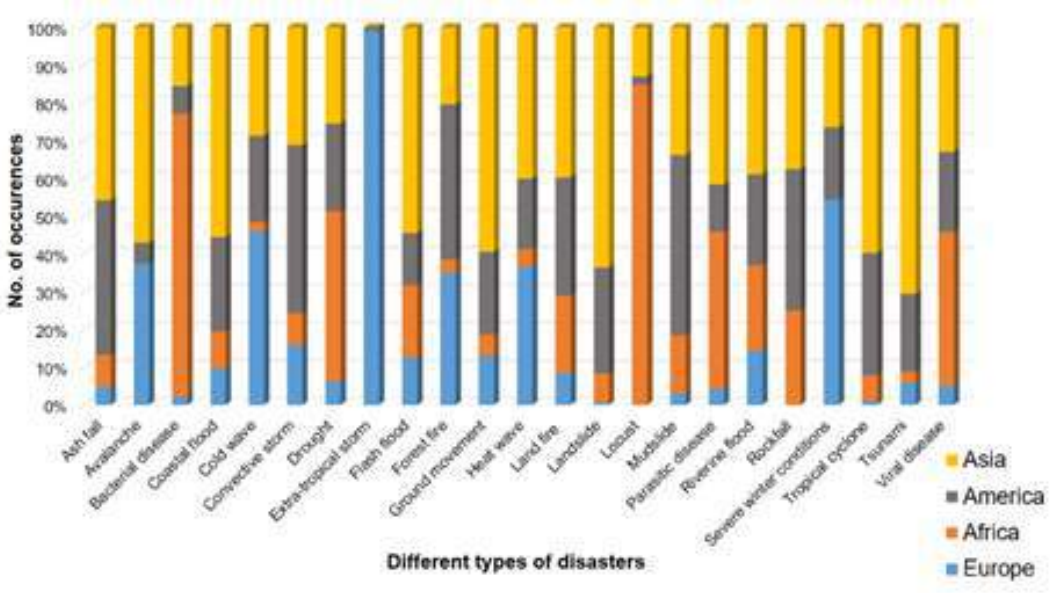
Substation:
The increasing economic growth demands a rise in current and future demand for electric power supply. A substation is a part of the locality an electricity delivery system, with the high-voltage capacity and can be used to control the apparatus, generators and electrical circuits. An EIA report was drafted for a substation at Newtown-Rajarhat areato ensure stable and quality power supply and meet the increasing power demand on that area.

Residential Housing Complex:
To provide housing and utilize the available land, there is a mushrooming of housing projects of multi-storied buildings. To meet the increasing housing demand for the urban population in Newtown area, such projects are in high number, ignoring the basic environmental and bioclimatic requirements. To evaluate the overall potential impacts and mitigation measures of such projects, a preparatory EIA report covered Category B1 projects that require Environmental Clearance, where the Built-up area was greater than 1,50,000 m2.

NATURAL DISASTER

A natural disaster is a calamity that seriously disrupts the functioning of a community or society and causes human, material, and economic and environmental losses that exceed the community's or society's ability to cope using its own resources. It causes widespread human, material, economic or environmental loss. Developing countries suffer the greatest costs when a disaster hits – more than 95% of all deaths caused by hazards occur in the developing countries, and also losses due to natural hazards are 20 times greater than in industrial countries.

The global scenario depicts that since 1960, the number of occurrences of different types of disasters in Asia is quite manifold higher than the other continents. More than 50% of the tsunami, tropical cyclone, landslide, mass movements and floods were taken place in Asia over the last 50 years. Europe is largely affected by coldwave, heatwave, extra-tropical storm and forest fire. Different types of bacterial and viral diseases, drought occurrences were taken place in Africa. America is disaster-prone for the ashfall, convective storm, forest fire, and mudslide.



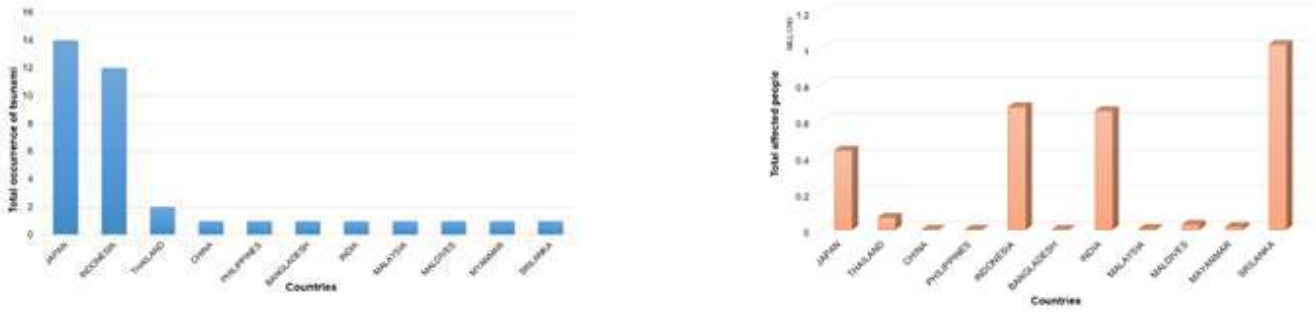
Disaster scenario from 1960 to 2019

Natural disasters in India

Disaster Group	Disaster Sub-Group	Disaster Main Type	India 1960-2019
Geophysical	Earthquake	Ground movement	26
		Tsunami	1
	Mass Movement (dry)	Landslide	1
Meteorological	Extreme Temperature	Cold wave	29
		Heatwave	25
		Severe winter conditions	2
	Storm	Tropical storm	93
		Convective Storm	41
Hydrological	Flood	Coastal flood	4
		Riverine flood	143
		Flash flood	26
	Landslide	Avalanche (snow, debris, mudflow)	45
Climatological	Drought		13
	Wildfire	Forest Fire	3
Biological	Epidemic	Viral Disease	32
		Bacterial Disease	20
		Parasitic Disease	5
	Insect infestation	Locust	1

Tsunamis

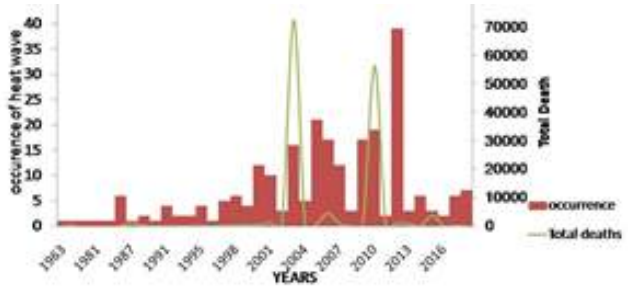
Tsunami- the "seismic sea waves", can be generated by mechanisms other than earthquakes. Tsunami is a very long-wavelength wave of water that is generated by sudden displacement of the seafloor or disruption of any body of standing water. The southeastern part of Asia is mainly prone to tsunami. The occurrences are high in Japan and Indonesia in comparison to the continents like Thailand, China,Philippines, Bangladesh, India, Malaysia, Maldives, Myanmar, Sri Lanka in the last few decades. Although, due to the early warning system and advanced management, Japan seems to be less affected by this gigantic wave. India evidences only one tsunami in the year 2004 although, the loss of life and property was quite high due to the lack of awareness.



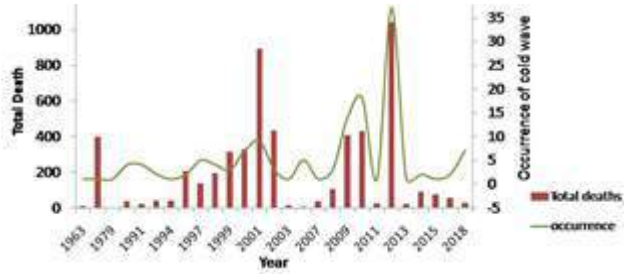
Tsunami in Asia (1960 – 2018)

Extreme temperature

Over the world, extreme temperature generally indicates the changes in mean temperature. Extremes temperatures have a significant effect on human health and mortality, ecological systems, infrastructure and agriculture. This generally refers to the prolonged period of excessively hot and sometimes also humid weather relative to normal climate patterns of a certain region. The European meteorological departments declared hazard conditions when the temperature approaches towards 40˚C. Whereas, coldwave can be both a prolonged period of excessively cold weather and the sudden invasion of very cold air over a large area. The European Meteorological departments declared the cold hazard when the temperature approach -13˚C to -25˚C. However, this range is different over the region.



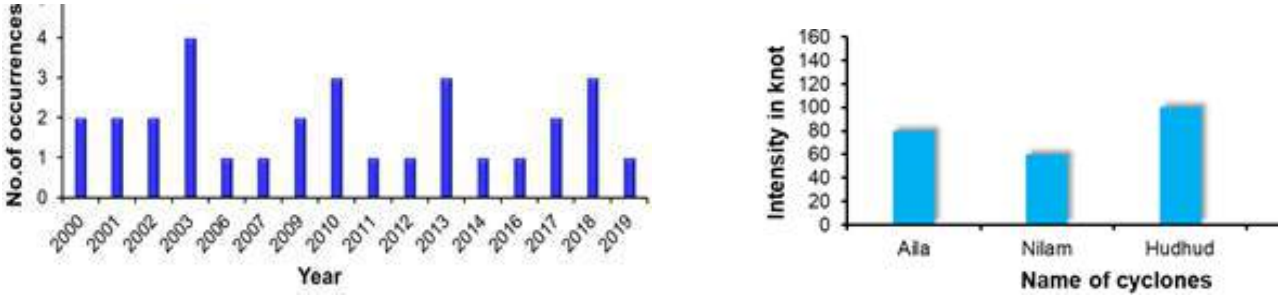
Heat wave in Europe (1960 – 2018)



Cold wave in Europe (1960-2018)

Tropical Cyclone

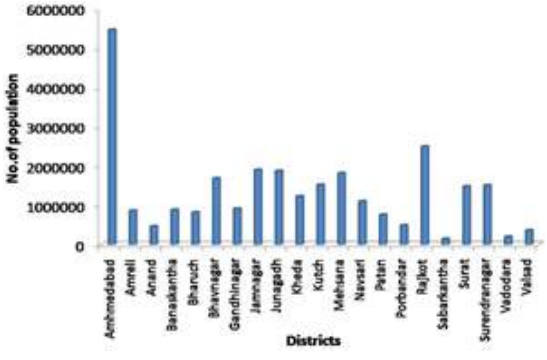
A tropical cyclone, an intense circular storm with a rotating system of cloud and thunderstorms having a low-pressure center. It originates over warm tropical oceans and is characterized by low atmospheric pressure, high winds and heavy rain. A tropical cyclone generates winds that exceed 119 km per hour. Such a combination of high winds and water makes cyclones a serious hazard for coastal areas in tropical and subtropical areas of the world. The Indian subcontinent is one of the worst cyclone-affected areas of the world.The subcontinent is exposed to nearly 10% of the world's tropical cyclones. The majority of cyclones in India have their genesis over the Bay of Bengal. The eastern coast of India is significantly more prone to cyclones as compared to the western coast. The states of Andhra Pradesh, Tamil Nadu, Odisha and West Bengal on the east coast of India are vulnerable towards tropical cyclones.



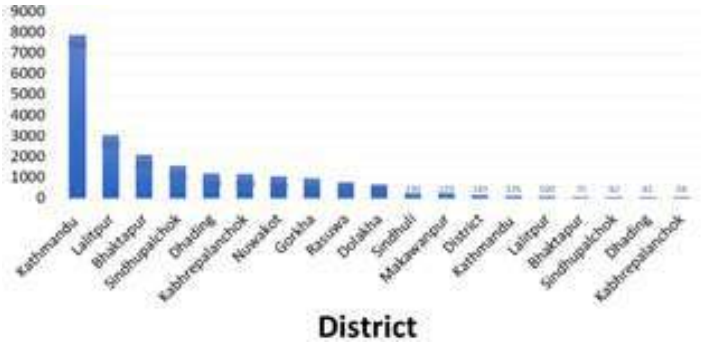
Occurrence of cyclone in east coast of India

Earthquake

An earthquake is the shaking of the Earth's surface, resulting in the sudden release of energy in the Earth's lithosphere that creates seismic waves. India is prone to an earthquake with varying intensities. The entire Himalayan belt is more susceptible to earthquakes than the other regions of India. Almost 26 earthquakes were taken place in India since 1960. Among them, two major and recent earthquakes occur in Gujarat and Nepal in the year of 2001 and 2015 respectively. The magnitude of the Gujarat earthquake was 6.9 and Nepal was 7.8 in the Richter scale. Millions of people died and injured in these earthquakes.



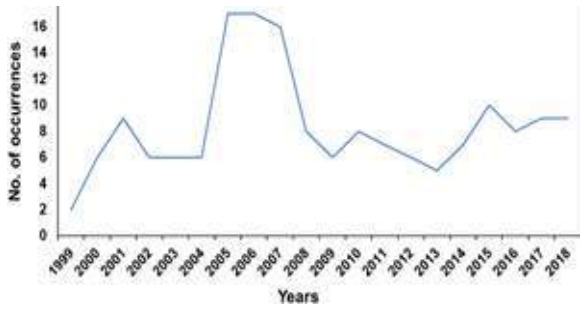
People affected in the earthquake of Gujarat



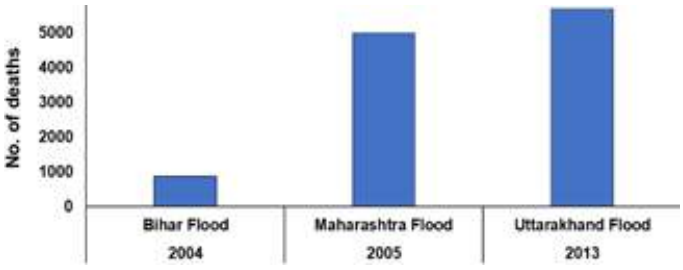
People affected in the earthquake of Nepal

Flood

Flood simply means the inundation of extensive land area with water for several days in continuation. Floods are the most recurring widespread and disastrous natural hazard in India. Floods can cause damage at local as well as national levels. The effects include death or distress to a large number of people, failure of the city drainage and other support systems like water bodies, sewage systems. In a global context as well as in the Indian context, river flood plains and coastal areas are most susceptible to flood. The most flood-prone region of India is the Brahmaputra valleys, North Bihar (Kosi river and north Gangetic plain) and lower West Bengal. The occurrence of the flood was highest in the years 2005-06 in the Indian subcontinent. In 2004, almost 885 people died in Bihar flood. In 2005 and 2013 over 5000 people died in Maharashtra and Uttarakhand flood claimed 5700 lives.



Occurrence of flood over India



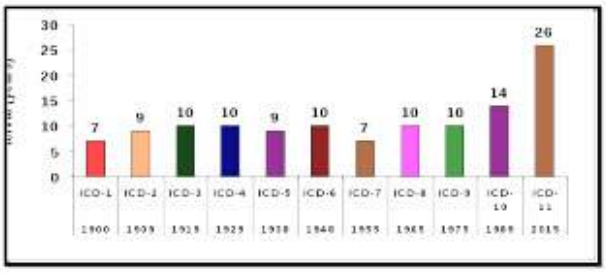
Death due to flood in different states of India

ICD CODES OF ENVIRONMENTAL DISEASES AND DISORDERS

An Overview

The International Classification of Diseases and Related Health Problems (ICD) is a tool for recording, reporting and grouping conditions and factors that relate health conditions, categories of diseases, and external causes of illness or death. The ICD has evolved over the past 150 years from an International List of Causes of Death to a comprehensive classification system for use in mortality, morbidity, quality measurement and patient safety.

The first recorded international classification, known as the International List of Causes of Death, was adopted in 1893, based on the Bertillon Classification of Causes of Death, and that was ultimately named as the ICD. The ICD is used to translate diagnoses of diseases and other health problems into an alphanumeric code, which allows storage, retrieval, and analysis of the data.

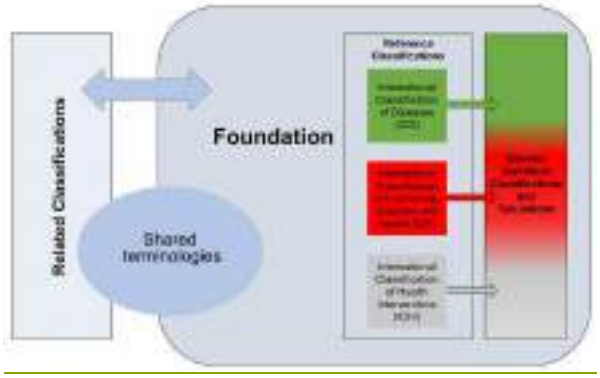


It has become the international standard of diagnostic classification for general epidemiological and many health management purposes. Users of the ICD include physicians, nurses, other health care providers, researchers, health information management professionals, coders, health information technology workers, analysts, policy-makers, insurers, patient organisations, and many more.

The WHO Nomenclature Regulations, adopted in 1967, stipulated that Member States use the current ICD revision for mortality and morbidity statistics. ICD-10 was endorsed in May 1990 by the 43rd World Health Assembly, and in the formative stage of ICD -11, for use around the world.

WHO Family of International Classifications (WHO-FIC)

The purpose of the WHO-FIC is to build a reliable statistical systems for application at local, national, and international levels, focusing on the multi-dimensional aspects of health. The WHO-FIC provides standardised building blocks for health information systems and consists of three broad groups: Reference classifications, Derived classifications, and Related classifications. The Reference and the Derived classifications



WHO Family of International Classifications and shared terminologies

are based on the Foundation Component, which is a large collection of terms and their relationships,

that describe health and health related domains. Terms related to diseases and health related problems are organised into the ICD, those pertaining to functioning into the CF (International Classification of Functioning, Disability and Health), and those related to interventions into ICHI (International Classification of Health Interventions).

General features of ICD-11

ICD-11 Term	Explanation
Foundation Component	Underlying database content that holds necessary information to generate the tabular list and the alphabetical index, as well as additional information for speciality linearizations of ICD-11 and country specific modifications.
Stem code	Stem codes are found in the tabular list of ICD-11 for Mortality and Morbidity Statistics. The design of stem codes makes sure that in use cases that require only one code per case, a meaningful minimum of information is collected.
Extension code	Extension codes are designed to standardize the way additional information is added to a stem code when users and settings are interested in reporting more detail than is included in a stem code. Extension codes can never be used without a stem code and can never appear in the first position in a cluster.
Precoordination	Stem codes may contain pertinent information about a clinical concept in a pre-combined fashion. This is referred to as 'precoordination'.
Postcoordination	Postcoordination refers to linking (through cluster coding) multiple codes (i.e. stem codes and/or extension codes) together, to fully describe a documented clinical concept.
Cluster coding	Cluster coding refers to a convention used (either forward slash (/) or ampersand (&)) to show more than one code used together (e.g. stem code/stem code(s) & extension code(s)) to describe a documented clinical concept.
Primary and secondary parents	The hierarchy of ICD-11 is defined the same as it was in previous versions of ICD. The possibility to connect specific diseases and concepts within the classification to another parent code was introduced to enable specific extracts of the Tabular list for medical specialties or for specific use cases.

ICD-11 Revision Process

External review in 2015

Phase 1: until 2015:
extensive clinical inputs from TAGs and methodological work to meet the many uses

Phase 2: from April 2015 to present: focus on mortality and morbidity statistics (MMS)

Phase 3: from now until May 2019: preparations for implementation version

Phase 4: thereafter: Maintenance

Examples of problems solved with ICD-11

Antimicrobial resistance - essentially missing in ICD-10

HIV subdivisions - outdated detail in ICD-10

Simplified Diabetes coding

Skin cancer - melanoma types missing – basalioma missingin ICD-10

Valve diseases - outdated structure, need by valve, less rheumatic

Postprocedural conditions - clarify when use 19 and when not for postprocedural

Cancers with histopathology – ICD-O for cancer registries embedded

External causes – better coding traffic accidents

Code structure

The codes of ICD–11 are alphanumeric and cover the range from 1A00.00 to ZZ9Z.ZZ. Codes starting with 'X' indicate an extension code. The inclusion of a forced number at the 3rd character position prevents spelling 'undesirable words'.

The letters 'O' and 'I' are omitted to prevent confusion with the numbers '0' and '1'. Technically, the coding scheme would be described as below:

ED1E.EE

- E corresponds to a 'base 34 number' (0-9 and A-Z; excluding O, I);
- D corresponds to 'base 24 number' (A-Z; excluding O, I); and
- 1 corresponds to the 'base 10 integers' (0-9)
- The first E starts with '1' and is allocated for the chapter.
- (i.e. 1 is for the first chapter, 2: chapter 2, … A chapter 10, etc.)

The terminal letter Y is reserved for the residual category 'other specified' and the terminal letter 'Z' is reserved for the residual category 'unspecified'. For the chapters that have more than 240 blocks, 'F' ('other specified') and 'G' ('unspecified') are also used to indicate residual categories (due to problems with the coding space).

Chapters are indicated by the first character. For example, 1A00 is a code in chapter 1, and BA00 is a code in chapter 11.

Inclusions - Within the coded categories there are typically other optional diagnostic terms. These are known as 'inclusion terms' and are given, in addition to the title, as examples of the diagnostic statements to be classified to that category. They may refer to different conditions or be synonyms. They are not a sub-classification of the category.

Exclusions - Certain categories contain lists of conditions preceded by the word 'Exclusions'. These are terms which are classified elsewhere. An example of this is 5A60 Hyperfunction of pituitary gland which excludes Cushing syndrome.

Process of agreeing and adopting ICD-11

Step 1 was the formulation of ICD-11 over the past several years, with input from international working groups with more than 300 specialists from over 270 institutions in 55 countries of all regions.

Step 2 invited comments from Member States, technical consultations in regions and field trials. (added another 40 countries to the process)

Step 3 the release of the version for implementation in June 2018.

Step 4 a summary report submitted to the EB 144, January 2019.

Step 5 submission of ICD-11 through the EB to the World Health Assembly in May 2019 to come into effect on 1 January 2022

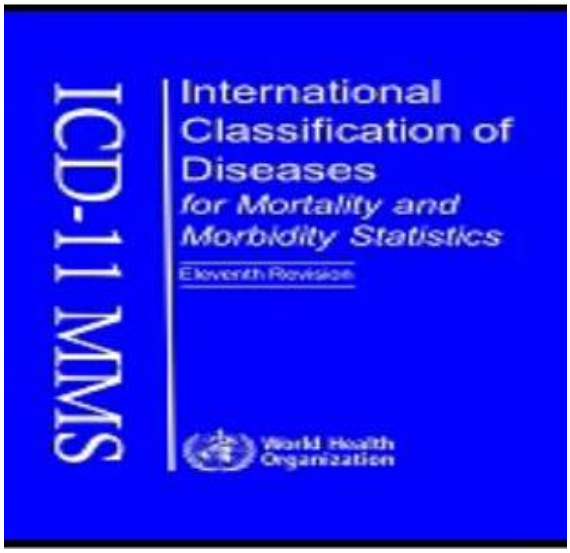
ICD-11-MMS

- MMS = Mortality and Morbidity Statistics
- It is derived from the foundation component
- Incorporating advances in science and medicine
- Has structural consistency with ICD-10 – where possible

Chapter Structure of the ICD-11 MMS

The international core reference linearisation is the ICD-11 for Mortality and Morbidity Statistics (ICD-11MMS). It is used for coding and reporting illnesses or causes of death for international comparison. The naming of this linearisation highlights its two main use cases.

This core linearisation is divided into 27 chapters, of which 25 refer to health conditions similar to past ICD versions, while one serves to identify external causes of morbidity and mortality, and another includes concepts of traditional medicine.



ICD-11 MMS

The following is an overview of the 27 chapters included in ICD-11 MMS:

Chapter 01 – Certain infectious or parasitic diseases

Chapter 02 – Neoplasms

Chapter 03 – Diseases of the blood or blood-forming organs

Chapter 04 – Diseases of the immune system

Chapter 05 – Endocrine, nutritional or metabolic diseases

Chapter 06 – Mental, behavioural or neurodevelopmental disorders

Chapter 07 – Sleep–wake disorders

Chapter 08 – Diseases of the nervous system

Chapter 09 – Diseases of the visual system

Chapter 10 - Diseases of the ear or mastoid process

Chapter 11 – Diseases of the circulatory system

Chapter 12 – Diseases of the respiratory system

Chapter 13 – Diseases of the digestive system

Chapter 14 – Diseases of the skin

Chapter 15 – Diseases of the musculoskeletal system or connective tissue

Chapter 16 – Diseases of the genitourinary system

Chapter 17 – Conditions related to sexual health

Chapter 18 – Pregnancy, childbirth or the puerperium

Chapter 19 – Certain conditions originating in the perinatal period

Chapter 20 – Developmental anomalies

Chapter 21 – Symptoms, signs or clinical findings, not elsewhere classified

Chapter 22 – Injury, poisoning or certain other consequences of external causes;

Chapter 23 – External causes of morbidity or mortality

Chapter 24 – Factors influencing health status or contact with health services

Chapter 25 – Codes for Special purposes

Chapter 26 - Supplementary Chapter Traditional Medicine Conditions

Section X - Extension Codes

In ICD-11 MMS chapter 03, 04, 07, 17, 26 and Section X have been freshly included for better specification of cases

ICD-11 Drafts/Phases

The final version of ICD-11 will be released in June 2018.

ENVIRONMENTAL RISK DUE TO HEAVY METALS

Heavy metals are generally defined as metals with relatively high densities, atomic weights, or atomic numbers. Heavy metals are metallic, naturally occurring compounds that have a very high density compared to other metals--at least five times the density of water.Heavy metals are toxic to humans. Even small doses can have serious consequences.The presence of heavy metals in aqueous streams, air, soil, and food has become a problem due to their harmful effects on human health even at low concentration in the environment. According to the World Health Organization, the metals of most immediate concern are aluminum, chromium, manganese, iron, cobalt, copper, zinc, cadmium, mercury and lead. Classification of elements according to toxicity and availability.

Non-critical Accessible	Al, Br, C, Ca, Cl, F, Fe, H, K, Li, Mg, N, Na, O, P, Rb, S, Sr, Si
Toxic but rare	Ba, Cs, Ga, Hf, Ir, La, Nb, Re, Rh, Ru, Ta, Ti, Zr, W
Very toxic	Ag, As, Au, Be, Bi, Cd, Co, Cu, Hg, Ni, Pb, Pd, Pt, Sb, Se, Ti, Te, Zn

As a fact, metals are elements and they have been an intrinsic component of the environment to which humans and animals are adapted.Therefore,"natural" exposure to all metals may thus be harmless to a human being. Many "trace metals" are even fundamental for growth and metabolism at low concentrations as they serve a As a fact, metals are elements and they have been an intrinsic component of the environment to which humans and animals are adapted.Therefore, "natural" exposure to all metals may thus be harmless to a human being. Many "trace metals" are even fundamental for growth and metabolism at low concentrations as they serve a biological function.Heavy metals only exert their harmful effects when exposure is excessive. The United States Environment Protection Agency (EPA, 1987) has recommended the maximum permissible concentrations of some toxic metals for the protection of human health as given in the table.

The maximum permissible concentration of various metals in natural water for the protection of human health (based on EPA, 1987).

Metals	Maximum level (µmol/m³)	Permissible level mg/m³
Mercury	0.14	1.72
Lead	5	24
Cadmium	10	89
Selenium	10	127
Thallium	13	64
Nickel	13.4	228
Silver	50	464
Manganese	50	910
Chromium	50	962
Iron	300	5327
Barium	1000	7281

A few examples of heavy metals:

Mercury(ICD Code: T56.1):

Mercury (symbol Hg; atomic number 80) is the element with atomic number 80 of the Periodic System of the Elements and is classified in Group 17 (II-B; Transition Metals). Mercury is poly-isotopic with natural isotopes between 196 Hg and 204 Hg (the most abundant, at 30% is 202 Hg), and its mean atomic mass is 200.56u. Under ambient temperature and pressure conditions, Mercury is the only metallic element that is a liquid with a high specific gravity (13.59 at 20˚C) and which vaporizes slowly even at ambient temperature and boils at 356.73 ˚C. Liquid Mercury is silver-grey, shiny and mobile and has a high surface tension (which leads to the formation of tiny droplets) and a high expansion coefficient with temperature. In the elemental state, it is sparingly soluble in water and in oily solvents and forms inter-metallic alloys (amalgams) with several other pure elements, among which several are of technological importance.

CHARACTERISTICS:

It does not react with oxygen in the air very readily. It reacts with some acids when they are hot, but not with most cold acids.

1. It is the only liquid metal.
2. It has high density and low vapor pressure.
3. Mercury is silver white,slowly tarnishes in moist air, and freezes into a soft solid like tin or lead.
4. It alloys with copper, tin, zinc to form amalgams or liquid alloys.
5. It is a good conductor of electricity and it is useful in sealed electrical switches and relays. But it is a poor conductor of heat if compared with other metals.
6. It is naturally occurring elements that are found in air, water, and soil. It can travel a long distance in the air.
7. Exposure to mercury – even a small amount may cause a serious health problems. It may cause irritation and dermatitis.

metal	Source	Acute exposure	Chronic exposure
Mercury	Pesticides Batteries Paper industries	Diarrhea Fever vomiting	stomatitis Nausea tremor Nephrotic syndrome Parageusia

Disease name	ICD-10
Mercury Poisoning (Acute, Chronic)	(T56.1,)
Gastrointestinal toxicity	K52.1+T56.1
Acute Stomatitis	K12.1
Acute Gingivitis	K05.0

Arsenic(ICD Code: C34, C44, C43, C22.3):

Arsenic is a chemical element with the symbol As and atomic number 33. Arsenic occurs in many minerals, usually in combination with sulfur and metals, but also as a pure elemental crystal. Arsenic is a metalloid. It has various allotropes, but only the gray form, which has a metallic appearance, is important to the industry.

metal	Source	Acute exposure	Chronic exposure
Arsenic	Pesticides Fungicides Metal smelter	Nausea Vomiting Diarrhea Arrhythmia painful neuropathy	Cancer: lung, bladder, Skin, Encephalopathy

Disease name	ICD-10
Lung Cancer	C34
Skin Cancer	C44, C43
Liver Angiosarcoma	C22.3
Bladder Cancer	C67
Kidney Cancer	C64

Nickel (ICD Code C30.0, C31, C34)

Nickel compounds include nickel oxide, nickel hydroxide, nickel subsulphide, nickel sulfate, nickel chloride, nickel carbonyl. nickel (II) oxide (NiO, nickel monoxide, nickelous oxide, (powder)], CAS N° 1313-99-1 is a green to blaCK crystalline powder. Nickel sulfide (heazlewoodite, nickel subsulphide, trinickel disulfide) CAS N° 12035-72-2 Ni3S2, pale yellowish bronze lumps with metallic lustre; it decomposes on heating to high temperatures producing sulfur oxides.

metal	Source	Acute exposure	Chronic exposure
Nickel	•Atmospheric nickel includes dust from volcanic emission and the weathering of rocks and soil. • Stainless steel product • Food processing industries, • Catalysts and pigments	• Dermatitis • Nickel carbonyl • Myocarditis • Encephalopathy	• Pulmonary fibrosis • Nasopharyngeal Tumors, • Reduced sperm count

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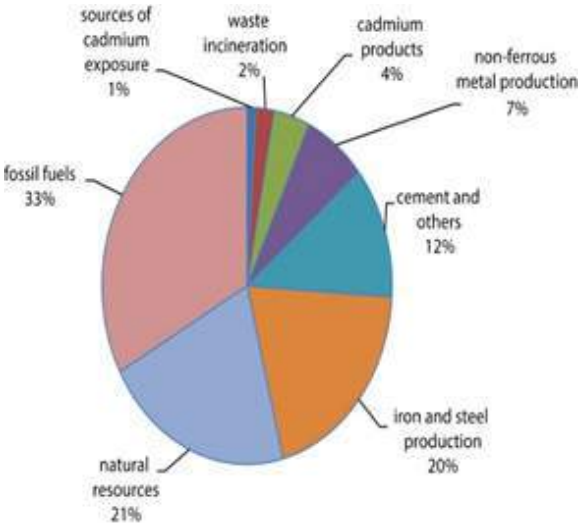
Disease name	ICD-10
Nasal cavity Cancer	C30.0
Paranasal sinuses Cancer	C31
Bronchus and Lung Cancer	C34

Chromium (ICD Code T56.2):

Chromium is a steel grey, lustrous, hard metal extracted from chromite ores. Chromium is a chemical element withsymbol Cr and atomic number 24. It is the first element in group 6. It is a steely grey, lustrous, hard and brittle metal that takes a high polish, resists tarnishing, and has a high melting point. The name of the element is derived from the Greek word χρῶμα, chrōma, meaning color, because many chromium compounds are intensely colored high corrosion resistance and very hard.

metal	Source	Acute exposure	Chronic exposure
Chromium	· Plating for car and bicycles · Catalyst Pigment	GI hemo-rrhage Hemol-ysis Acute renal failure	Pulmona ry fibrosis lung cancer

Disease name	ICD-10
(Acute/ Chronic/ Longterm) effects of exposure to chromium or its compounds	T56.2
Respiratory Irritation	J68+T56.2
Chemical Bronchitis and Pneumonitis	J68.0
Upper Respiratory Tract Inflammation	J68.2
Chemical Pulmonary Oedema	J68.1



Cadmium (ICD Code T56.3):

Cadmium is the element with atomic no. 48 of the periodic system of the Elements has several stable isotopes between 106Cd, 114Cd, 116Cd, and 112Cd being the most abundant and its mean atomic mass is 112.4 u. Cadmium is classified as number ii. Cadmium is a silver-white, low-melting (327°C) malleable metal which is highly resistant to corrosion, although its standard reduction potential is at -0.40 V, due to the protection afforded by the superficial oxide layer. Cadmium (Cd) is a soft, malleable, bluish-white metal found in zinc ores, and to a much lesser extent, in the cadmium mineral greenockite.

metal	Source	Acute exposure	Chronic exposure
Cadmium	batteries and pigments, electro-plating baths fungicide photograp hic films	Pneumo-nitis	Lung cancer Osteoma lacia Proteinu ria

Disease name	ICD-10
(Acute/ Chronic/ Long term) effects of cadmium or its compounds	T56.3
Metal fume fever	T56.3
Acute Chemical Bronch-itis and pneumonitis	J68.0+T56.3
RADS(reactive airway syndrome)	J68.3+T56.3

Lead (ICD Code T56.0):

Lead (Pb, Plumbum, CAS No. 7439-92-1) is the element with atomic number 82 of the Periodic System of the Elements. Lead is classified in Group VII (7-B; Transition Metals) and features the oxidation numbers II and IV, the former being that stable in water solutions, the latter being a mild oxidizer. Lead is poly-isotopic (206Pb, 207Pb, and 208Pb in approx. 1:1:2 proportion being the most abundant ones), since it is the stable terminal nuclide of the radioactive decay of the natural actinide elements Thorium and Uranium. The isotopic composition of lead changes with the source of lead minerals and its measurement can be employed to trace the source of the mineral. The mean atomic mass of Lead is 207.2. Lead is a high density (10.66 g/cm3), low-melting (melting point 327.4˚C) metal, appreciably volatile at temperature greater than 500˚C, of a typical silvery-grey color and dull bluish shine, ductile and resistant to corrosion by some acids such as carbon dioxide and sulphuric acid due to the formation of protective insoluble oxide and salt layers. However, its negative oxidoreductase potential in water makes lead reactive with strong inorganic (hydrochloric and nitric) acids, with some organic acids (especiallyacetic acid) and with oxidants.

metal	Source	Acute exposure	Chronic exposure
lead	· Ship building · Batteries · Cable sheaths · Light industry Pigments	·Encephal opathy ·Nausea Vomiting	·Anemia ·Encephal opathy ·Foot drop nephropat hy

Disease name	ICD-10
Acute and subacute and chronic Inorganic lead poisoning	T56.0
Gastrointestinal Toxicity (Organic and Inorganic), (Acute and Chronic)	K52.1+T56.0
Hypertension	I10
Acute Lead Nephropathy	N14.3
Fanconi-like syndrome	E72.0

Manganese (ICD Code T57.2):

Manganese (Mn) is the element with atomic number 25 of the Periodic System of the Elements, which is essentially mono-isotopic and its atomic mass is 54.9 u. Manganese is classified in Group VII (7-B; Transition Metals) and features most oxidation numbers between 0 (elemental) and VII (permanganate), with Mn(II) being that stable in aqueous solution over the entire range of acidity. Manganese is ubiquitously in rocks, soil, water, and food, as the twelfth most abundant element in the Earth's crust (about 0.1%), yet it seldom occurs as a free metal, if not in cosmogenic iron meteorites. Elemental manganese is whitish-grey in color, very hard but brittle.

metal	Source	Acute exposure	Chronic exposure
Manganese	· Welding · Fuel addition Ferrom-anganese producti on	Acute mangane se or its compoun ds poiso-ning MetaL Fume Fever	Mangan-ism Allergic occupatio-nal asthma

Disease name	ICD-10
(Acute/ Chronic) Manganese or its compounds Poisoning	T57.2, X49, Y19
Mucous membrane irritation	J68
Bronchitis and Pneumonitis	J68.0
Burns and corrosions of the respiratory tract	T27

Mitigation:

The following measures can be employed to mitigate the adverse effects of heavy metals on human health:

1. Promotion of the use of clean energy sources that do not burn coal.
2. Elimination of heavy metal mining, and use in gold extraction and other industrial processes.
3. Health care facilities, including hospitals and dental offices, should phase out heavy metal-containing products in favor of safer alternatives.
4. Manufacturers of compact fluorescent light bulbs should find alternatives to the heavy metal contained in those bulbs Government agencies should expand programs to remove, collect, and safely store heavy

CLIMATE CHANGE: EMERGING VIEWS

Gradual changes in all the interconnected weather elements on our planet. In other word it refers to significant changes in global temperature, precipitation, wind patterns and other measures of climate
that occur over several decades or longer. Climate change is the long-term alteration of temperature and typical weather patterns in a place. Climate change could refer to a particular location or the planet as a whole. Climate change may cause weather patterns to be less predictable. These unexpected weather patterns can make it difficult to maintain and grow crops in regions that rely on farming because expected temperature and rainfall levels can no longer be relied on. Climate change has also been connected with other damaging weather events such as more frequent
and more intense hurricanes, floods, downpours, and winter storms.

Ongoing climatic changes are being monitored by networks of sensors in space, on the land surface, and both on and below the surface of the world's oceans. Climatic changes of the past 200–300 years, especially since the early 1900s, are documented by instrumental records and other archives. These written documents and records provide information about climate change in some locations for the past few hundred years. Some very rare records date back over 1,000 years. Researchers studying climatic changes predating the instrumental record rely increasingly on natural archives, which are biological or geologic processes that record some aspect of past climate. These natural archives, often referred to as proxy evidence, are extraordinarily diverse; they include, but are not limited to, fossil records of past plant and animal distributions, sedimentary and geochemical indicators of former conditions of oceans and continents, and land surface features characteristic of past climates.

Paleoclimatologists study these natural archives by collecting cores, or cylindrical samples, of sediments from lakes, bogs, and oceans; by studying surface features and geological strata; by examining tree ring patterns from cores or sections of living and dead trees; by drilling into marine corals and cave stalagmites; by drilling into the ice sheets of Antarctica and Greenland and the high-elevation glaciers of the Plateau of Tibet, the Andes, and other montane regions; and by a wide variety of other means. Techniques for extracting paleoclimatic information are continually being developed and new kinds of natural archives are being recognized.

Timeline: Climate Change Impacts

1896- Svante Arthenius constructs the first climate model of the influence of atmospheric carbon dioxide (CO_2).

1920-25- Era of large –scale petroleum development begins with the opening of texas and Persian Gulf oil fields.

1930s- Milutin Milankovitch publishes "Mathematical Climatology and the Astronomical Theory of Climatic Changes" to explain the causes of Earth's ice ages.

1957- Roger Revelle and Hans E. Suess write that "human beings are now carrying out a large scale geophysical experiment" in a paper examining CO_2 uptake by the oceans.

1960- Curve developed by American climate scientist Charles David Keeling beings to track atmospheric CO_2 concentrations. CO_2 concentration in 1960= 315 parts per million (ppm).

1973- First oil shock

1974- First evidence of chlorine chemicals being involved in ozone depletion is published.

1979- Second oil shock

1980- Keeling Curve: CO_2 concentration in 1980=337 ppm

1990- First Intergovernmental Panel on Climate Change (IPCC) report notes pattern of past warming while signaling that future warning is likely.

1992- United Nations conference in Rio de Janerio creates the UN Framework Convention on Climate change.

1997- Kyoto Protocol is created with the intent to limit greenhouse gas (GHG) emissions from industrialized countries. The U.S., the largest GHG emitter at the time, does not sign on.

2000- Keeling Curve: CO_2 concentration in 2000= 367 ppm.

2001- Third IPCC report note that warming resulting from GHG emissions has become very likely.

2005- Kyoto Protocol goes into effect. All major industrialized countries sign on except the U.S.

2006- China becomes the world's largest GHG emitter.

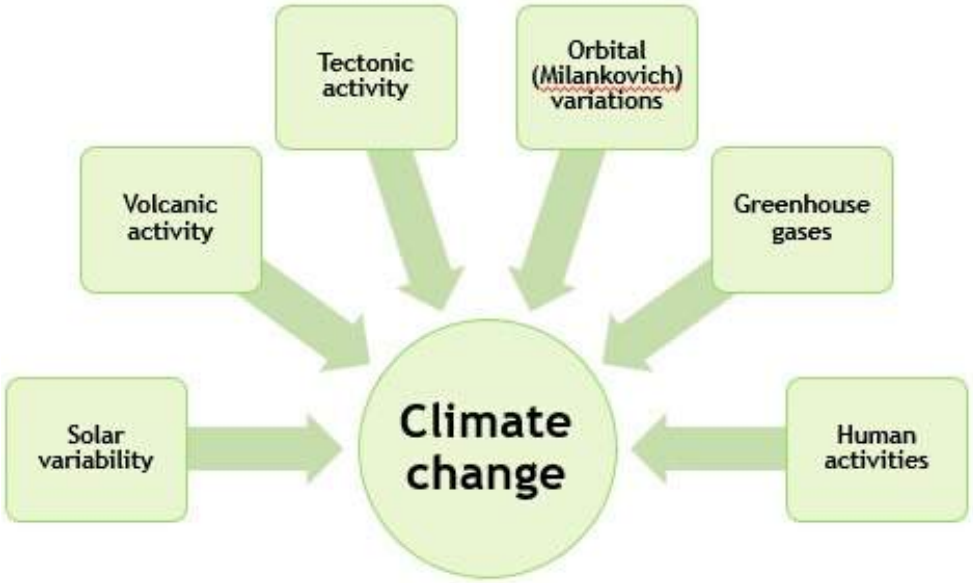
2007- Fourth IPCC report notes that effects of global warming are occurring.

2011- Canada withdraws from the Kyoto Protocol.

2013- Keeling Curve: CO_2 Concentration in 2013=400 ppm.

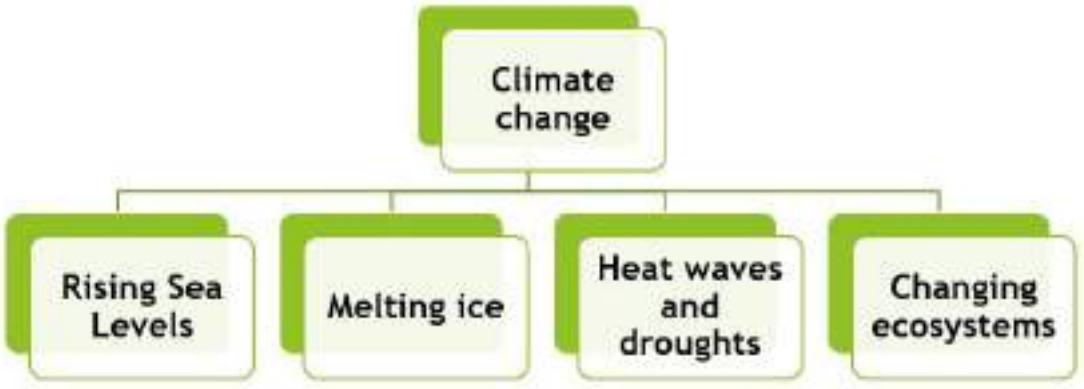
2015- Paris Agreement (Which replaces the Kyoto Protocol) is adopted by nearly 200 countries, including the U.S.

2016- Paris Agreement goes into effect.



Causes of Climate Change

It is much easier to document the evidence of climate variability and past climate change than it is to determine their underlying mechanisms. Climate is influenced by a multitude of factors that operate at timescales ranging from hours to hundreds of millions of years. Many of the causes of climate change are external to the Earth system. Others are part of the Earth system but external to the atmosphere. Still others involve interactions between the atmosphere and other components of the Earth system and are collectively described as feedback within the Earth system. Feedback are among the most recently discovered and challenging causal factors to study. Nevertheless, these factors are increasingly recognized as playing fundamental roles in climate variation. The most important mechanisms are manifested below.



APPLYING GEOINFORMATICS IN ENVIRONMENTAL VISUALIZATION

Geoinformatics broadly deals with the use of information technology. This technology helps to address complex information challenges through data collection, analysis, storage, retrieval, representation and dissemination of information about the Earth system and other environmental applications.

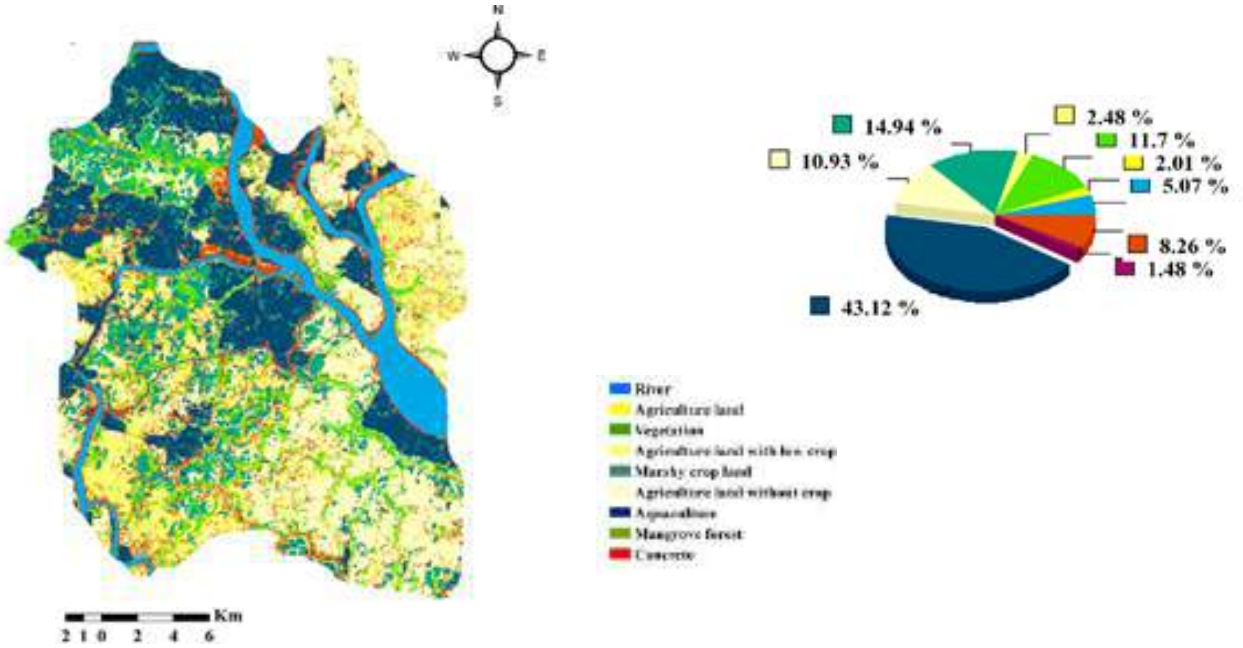
Remote sensing is integral to geoinformatics, as the science and art of obtaining information about an object, area, or phenomenon. Remote sensing is the non-contacting recording of information from the ultraviolet, visible, infrared and microwave region of the electromagnetic spectrum. It acquires multi spectral-spatial and temporal data through space borne remote sensors. It analyses the acquired information by means of visual and digital image processing. It helps in analyzing the dynamic changes associated with the earth's resources.

GIS

The geographic information system (GIS) is an information tool to introduce interdisciplinary spatial and statistical data. The system is used to store, retrieve, manipulate, analyze and output the geospatial data. The application of GIS is manifold, e.g., planning and management of land use, natural resources, environment, transportation, urban facilities and so on

Land Information System

To obtain the landuse/landcover information from a satellite image classification technique has generally been applied. The pixels are assigned according to their spectral reflectance values in different classes such as water body, vegetation, agricultural land, settlement and so on. Image classification technique can be used either in a supervised or unsupervised way applying different algorithms like maximum likelihood, parallelepiped classifier (for supervised classification) and ISO cluster, K-means (for unsupervise classification) etc. Image classification technique helps to retrieve land information of any area based on the satellite images. Such classification may be useful for development planning and may use as a land bank information

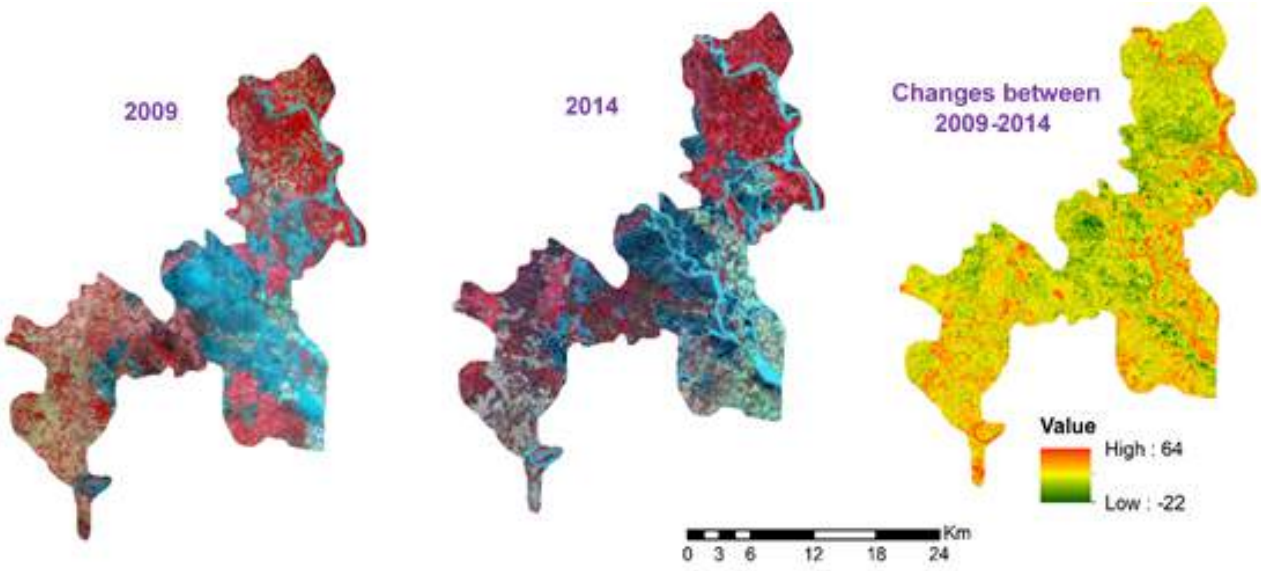


Change Detection

Terrestrial changes over the period can also be detected and analyzed by the geoinformatics. Such a technique helps in defining the changes associated with land use and land cover with reference to multi-temporal remote sensing data. The reflectance values over a different time period are considered. Change detection may be useful in many applications such as land-use changes, rates of deforestation, coastal change, urban expansion, and other cumulative changes.

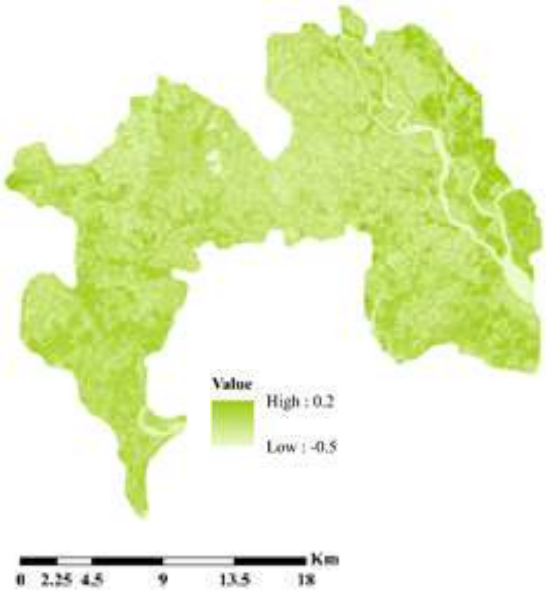
Indices

The images generally emphasize a specific phenomenon. Image indices are computed from multiband images emphasizing specific factors like minerals, vegetation, built-up area based on a different algorithm. Different indices are available in the field of GIS, such as., Soil-Adjusted Vegetation Index (SAVI), Normalized Difference Moisture Index (NDMI), Normalized Difference Vegetation Index (NDVI), geological indices, Normalized Difference Built-up Index (NDBI). Suppose, NDVI is based on the vegetation spectral reflectance



value based on the principle that the healthier green vegetation has higher near-infrared surface reflectance and lower red surface reflectance (has a value between 1.0 indicates healthier vegetation and -1.0 indicate the reverse). It is calculated as the following:

NDVI = (NIR – red) / (NIR + red)

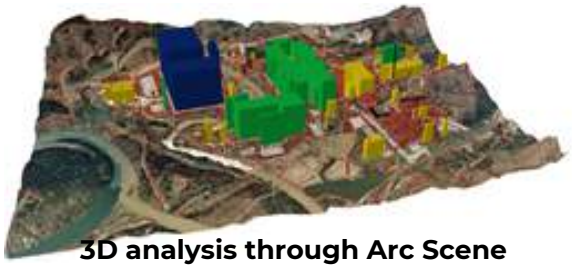


Cartographic analysis

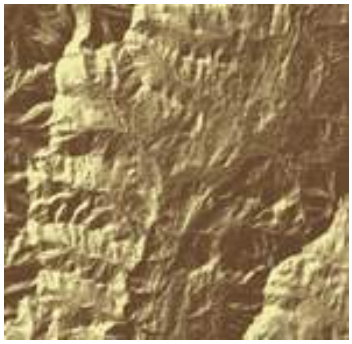
Cartography is the art of mapmaking and map use. Cartography is generally been practiced in GIS and also in mapping sciences like Remote Sensing, Photogrammetry, Geodesy, and Surveying. Cartographic techniques display/ present graphic information with an added role of data input under the GIS system. The major association between cartography and GIS is that cartography is concerned with representation while GIS is concerned with the analysis of spatial relationships.

3D analysis

GIS technology is helpful in visualizing data in 3-dimension. Various type of surface modeling like DEM (Digital Eevation Model), TIN (Triangulated Integrated network), slope analysis can be performed. Such analytic tools has applicability in regional planning with inclusion of multiple parameter. This technique is also useful in satisfying the visual sense of depth of the earth in 3D.



3D analysis through Arc Scene



Digital Elevation Model(DEM)

Network Analysis

Network Analysis techniques are emerging as methodological advances that helps to identify optimum distance and locations for services to be provided.

CLIMATE PROJECTION AND IMPACTS OF CLIMATE CHANGE ON HUMAN HEALTH

Global climate patterns are continuously changing and they certainly have impacts on living and working environments. The average temperature is rising every year and it is projected to rise between 1.8–4.0oC by 2100.

The extent of climate change in a region depends upon geographical and local meteorological conditions. On both local and regional scale, the variations in the land cover may worsen greenhouse gas emissions and influence global warming. Increasing urbanization is an additive factor towards the increment of local temperatures. The urban heat islands are distinctively hotter urban areas compared to their rural counterparts. There are various reasons to the generation of such urban heat islands, e.g., dark-coloured roads and buildings absorb more heat compared to rural areas, thermal and surface radiation properties of the materials used for the construction of building roofs like asphalt and concrete invigorate the heat absorption and retention compared to those materials used in rural areas. Such factors significantly alter the energy budget of an urban area and make them warmer compared to the surrounding rural areas. Increment in the local ambient temperature at a place makes the population of the area more exposed and susceptible to the harmful effects of a hot climate. During the summer season, the hotter parts of the world become unhealthy for the normal population and even more severe for the people who do not have enough resources and mitigation measures to counter the increasing heat. Both extreme hot and cold weather contribute to increased morbidity and mortality in the exposed population, in comparison to the areas where the temperature is in an intermediate range. The mortality rate due to heat follows a J-type temperature curve whose slope becomes steeper at a higher temperature, i.e., higher the temperature faster the increase in mortality rate. WHO projected the morbidity and mortality until 2030 by using the Hadley Centre Global Climate Model (HAGCM) for predicting different types of climate dimensions for different greenhouse gas emission scenarios. Estimated that the risk of different kinds of health-related issues due to climate change may become more than double by the year 2030. Now problem with this analysis is that the Global Climate Model which was used for climatic variable prediction provides us the data on a much larger resolution or on a much larger scale than what will be required for making correct predictions of climate change related health issues on a local level. Although the GCM simulations used for preparing the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report were much better than its previous reports but still it was not possible to make the resolution or grid size finer than 250 km 2 .

If we shall talk about the climate on a regional or local scale than its variability depends on a number of factors like topographical variations, presence of large water bodies, coastlines, any other kind of geographical feature etc. These kinds of variations can’t be incorporated in a Global Climate Model and so the predictions made by using GCM can be

very much erroneous depending upon above mentioned variations. So, if we want to incorporate these variations in climatic projection and want to make our resolution finer and more on a regional scale then we can take help of 'downscaling' techniques which will help us in observing the effect of local variations on the climate change. There are two different type of downscaling techniques which are:

1.Dynamical Downscaling
2. Statistical Downscaling

The table below explains the major differences between the two kind of downscaling techniques-

Type of Downscaling	Benefits	Drawbacks	Applications
Dynamical Downscaling	Makes a simulation of climatic mechanisms.	Requires more monetary support in terms of computing equipment and skilled professionals.	Effect of health risks associated with extreme climate scenarios and trend of the variability.
	There are no assumptions about any kind of relation between present and future climate.	Results can be erroneous because of any uncertain parameters.	In the areas where much data is not available.
	'State of Science' Tools.	Any errors in the GCM (from where we take boundary conditions for or regional climate model) can changes results on local level also.	Establishing a relation between the results given by the model and climate processes.
	Technological advances and more computing power are making regional climate model simulations faster and economical.	Output obtained from the model may not be ready to be used by health scientists without further data processing	For incorporating the impact of land-use on climate or human health outcomes.
	Motivate alliances between health and climate researchers.		
Statistical Downscaling	It's much economic as less computing power is required and can be done on a normal desktop computer with free softwares.	Believes that the relation between local and large- scale climate always stay constant.	For finding climate data means and their variability to some extent.
	Requires experience in statistical techniques which are more familiar to health scientists.	Isn't able to apprehend climate mechanisms.	In the regions where a lot of data is readily available like mid latitudes in Northern Hemisphere.
	Any errors in GCM may be corrected in this method.	Not the suitable method to understand variability and extreme events.	Comparison between the current climate with the future projected climate.
	It makes possible the estimation of climate results over a wider spectrum of GCMs and emission scenarios.		For testing a wide spectrum of inputs.
			Variables are scaled down to individual measurement areas.

So, there are two main impacts of change in climate on human health which are direct heat related deaths and risk of getting ill due to change in climate. Death related to heat are controlled by the difference in the temperature extremes and the mean temperature values mainly in the beginning of summer when people have not already adjusted to sudden rise in temperature and are more accustomed with gradual increase. Projections of future climate hint that increment in temperature extremes compared with mean temperature values will be more in mid latitudes compared with other regions of the world. In addition, the heatwave effect will be even more in urban areas due to urban heat island effect and greater population of cities which is also increasing at a much greater rate compared to rural areas. Land use and change in land use, as discussed earlier are also some significant factors which have an influence on how climate change will affect a particular area. So, while going for the future projections of climate understanding and incorporation of the impact of these two factors is also very important which every climate scientist should consider and implement.

THERMAL IMAGE PROCESSING OF HUMAN SKIN TEMPERATURE PROFILE

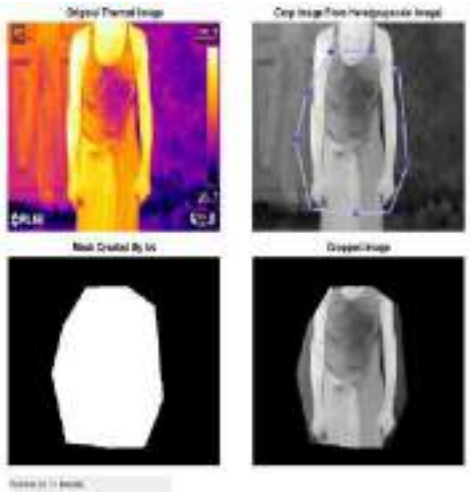
This contribution discusses about various techniques and tips which we can use for processing and extracting information from a thermal image.

A thermal image is special kind of picture which is captured with the help of a device known as thermal camera or thermal imager. The basic idea is that all objects emit infrared energy(heat) as a function of their temperature i.e. higher the temperature more will be the emitted energy. A thermal camera is sensor or device which can capture this infrared energy with a significant sensitivity. It is capable of sensing even very tiny differences in temperature. After collecting this infrared radiation from the objects thermal camera prepares an electronic image based on the collected temperature data. This electronic image is known as thermal image whose each pixel contains a temperature value corresponding to that part of the picture.

In the present study, the various techniques and tips ordinarily used to process and extract information from a thermal image have been discussed.

The camera used in the study is a FLIR T420BX Infrared Thermal Imaging Camera. After capturing thermal images using the camera, the temperature information is extracted from each image with the help of FLIR Tools, which is an extraction software provided by FLIR. The temperature data of each image are saved individually as '.csv' excel files. Each file contains the temperature value of each and every pixel in an image. It is noteworthy in this regard that certain parts of a thermal image delineate the covered regions of the human body. The difficulty in extracting temperature data from these parts of the image is apparently a major drawback of FLIR Tools. This mandates the application of alternative techniques to extract the relevant temperature information which is very critical to the comparative study of various portions of the human body. This disadvantage can be overcome with the help of MATLAB's image processing toolbox which enables the extraction of the required information. The basic steps for processing of the image are listed here:

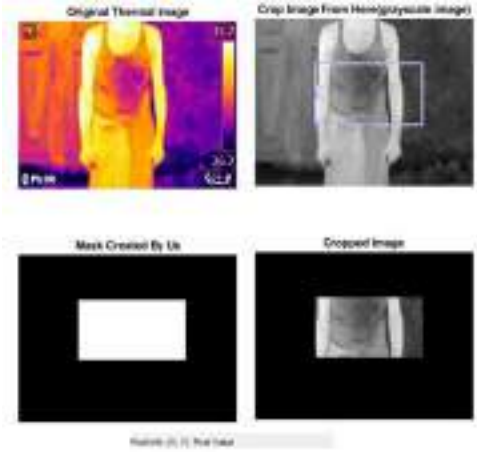
- Reading image data from the original thermal image file using the 'imread' function of MATLAB.
- Displaying the thermal image from already read image data using 'imshow' function of MATLAB.
- Reading the temperature '.csv' file made by FLIR Tools of the same thermal image using 'dlmread' function of MATLAB.
- Displaying the thermal image in grayscale* using the '.csv' file using 'imshow' function with minimum and maximum temperature values.
- Providing user with an interactive polygon tool using 'impoly' function of MATLAB so that user can draw an area over the thermal image of which temperature data is required.
- Creation of a mask which is logical matrix having values zero everywhere apart from the polygon covered region. This is done using 'createmask()' function of 'impoly' object.
- Displaying the mask created by us in the previous step again by using the 'imshow' function of MATLAB.



Final image generated after cropping and masking the thermal image.

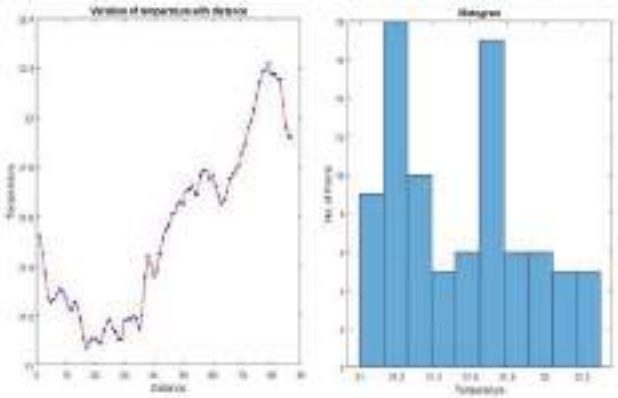
- Application of the mask by Linear Indexing on grayscale image (or on temperature values) so that only the polygon covered portion temperature values are left and all other values become zero.
- Displaying the final grayscale image where only the masked (polygon covered) portion image is visible.
- Sizes of all the displayed images were adjusted by saving the handles of all the subplots made and then using the properties of subplot class.
- Enabling the user to see the pixel information as well as temperature values of each pixel in the displayed final image using MATLAB function 'impixelinfo ()'.
- Saving the extracted image data in an excel file using 'xlswrite' function of MATLAB.
- Calculation of the mean temperature of the polygon covered portion temperature values using basic 'sum' and 'length functions of MATLAB.
- Everything was kept in a loop using 'for' loop of MATLAB so that anybody can process more than one file continuously without interruption.

Following the extraction of this primary information, the code is further developed and other utilities are added into it. The different selection tools, namely, the line selection tool and the rectangle selection tool and their associated functionalities are incorporated into the code using 'imline' and 'imrect' objects of MATLAB. The line selection tool enables the user to draw any number of lines on the thermal image and then find the average temperature values of the corresponding pixels comprising those lines. The same averaging functionality is added



Final image generated after cropping and masking the thermal image using box selection.

In the case of the rectangle selection tool. Finally, for obtaining a better perspective and understanding of the data, an option for plotting the gradient and histogram of averaged corresponding pixel values are also added apropos of the rectangle selection tool.



ARTIFICIAL NEURAL NETWORK-BASED PREDICTIVE STRATEGY FOR CLIMATE-INDUCED THERMOREGULATORY RESPONSES

Given the burgeoning impacts of climatic variability on human health, suitable computational paradigms are used to explore the subsequent ergonomic repercussions. The artificial neural network (ANN), in particular, exhibits near-accurate input-output mapping. However, the employment of ANN to trace the inter-dependencies between the climatic and human. thermoregulatory parameters in real world fuzzy problem landscapes is relatively inadequate. In the present study, the ANN models examined the relationships between the climatic, behavioral, and intrinsic input factors and the thermoregulatory outputs, namely sweating and the evaporative heat transfer at the skin surface (Esk).

Input and output variables in ANN models

Input variable		Output variable			
Climatic dimensions	Ta (^{0}C), Twb (^{0}C), Tg (^{0}C), Wind_Vel (m/s)	Model 1	Sweating response (g/min)	Model 2	Esk (W/m2)
Behavioral factor	Rate of metabolism (W h/m2)				
Intrinsic factors	Age (years), Body height (cm), Body weight (kg)				

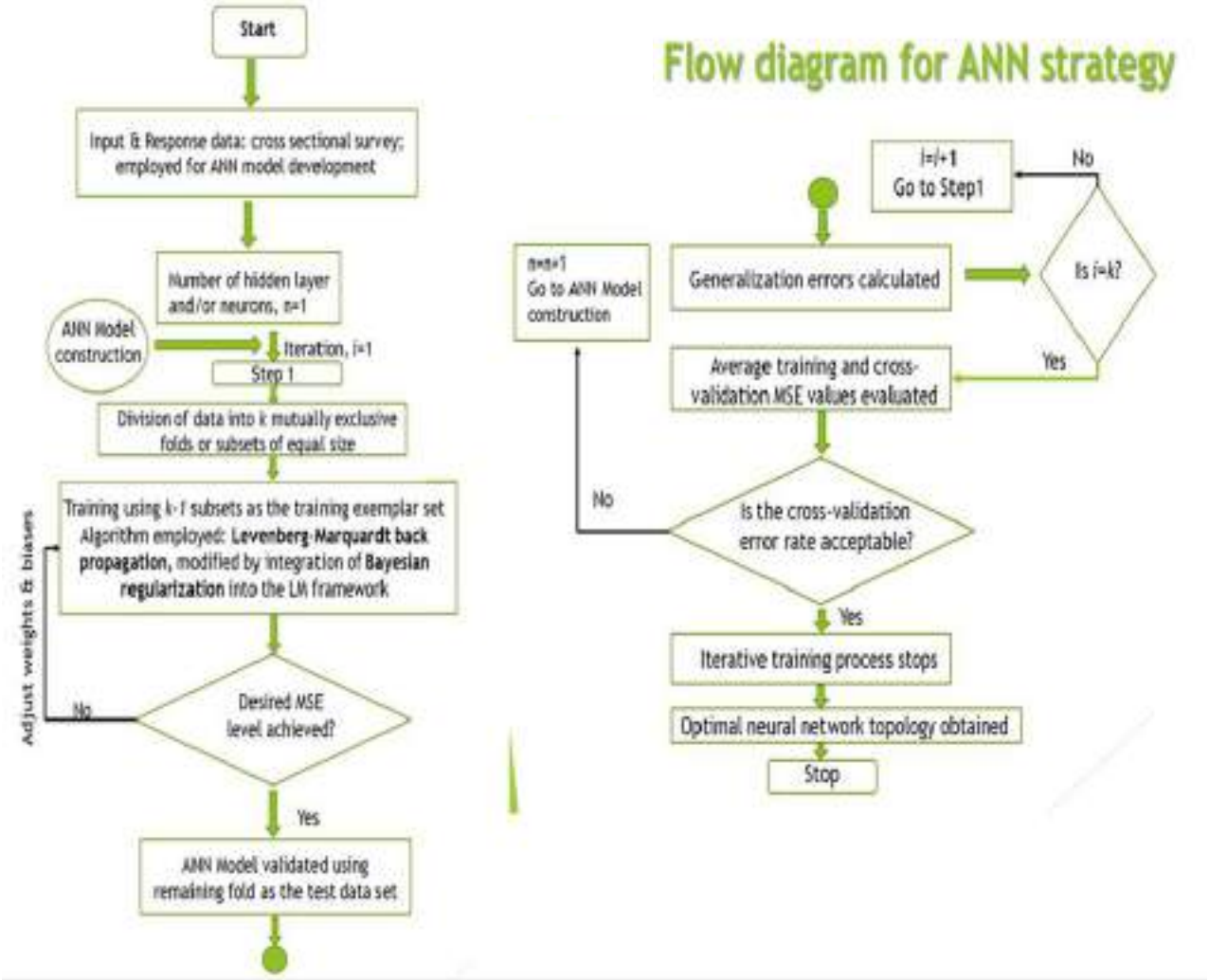
Note: ANN = artificial neural network; Esk = evaporative heat transfer at the surface of the skin; Ta = ambient temperature; Tg = mean radiant temperature; Twb = wet bulb temperature; Wind_Vel = wind speed. The data were obtained from nearly one thousand eight hundred subjects who were exposed to hot and humid climate outdoors. The ANN models were trained using Levenberg-Marquardt (LM) algorithm combined with Bayesian regularization.

Statistical parameters corresponding to the distribution of the climatic input variables and the respective output variables of Models 1 and 2.

Variable		Statistical Parameter		
Input (Climatic)		Skewness	Kurtosis	p
Ta		-0.9905	4.0387	0.0005 ≈ 0.001*
Twb		-0.1279	2.2860	0.0005 ≈ 0.001*
Tg		0.1113	2.4268	0.0006 ≈ 0.001*
Input (Behavioral)		Skewness	Kurtosis	p
Rate of metabolism (W h/m2)		1.2883	5.6573	0.0006 ≈ 0.001*
Output	Model	Skewness	Kurtosis	p
Sweating response (g/min)	Model 1	-0.7562	3.4698	0.0008 ≈ 0.001*
Esk (W/m2)	Model 2	-0.4893	3.1342	0.0006 ≈ 0.001*

*p < 0.001

Note: Esk = evaporative heat transfer at the surface of the skin; Ta = ambient temperature; Tg = mean radiant temperature; Twb = wet bulb temperature; Wind_Vel = wind speed.



The optimal topologies of the developed ANN models.

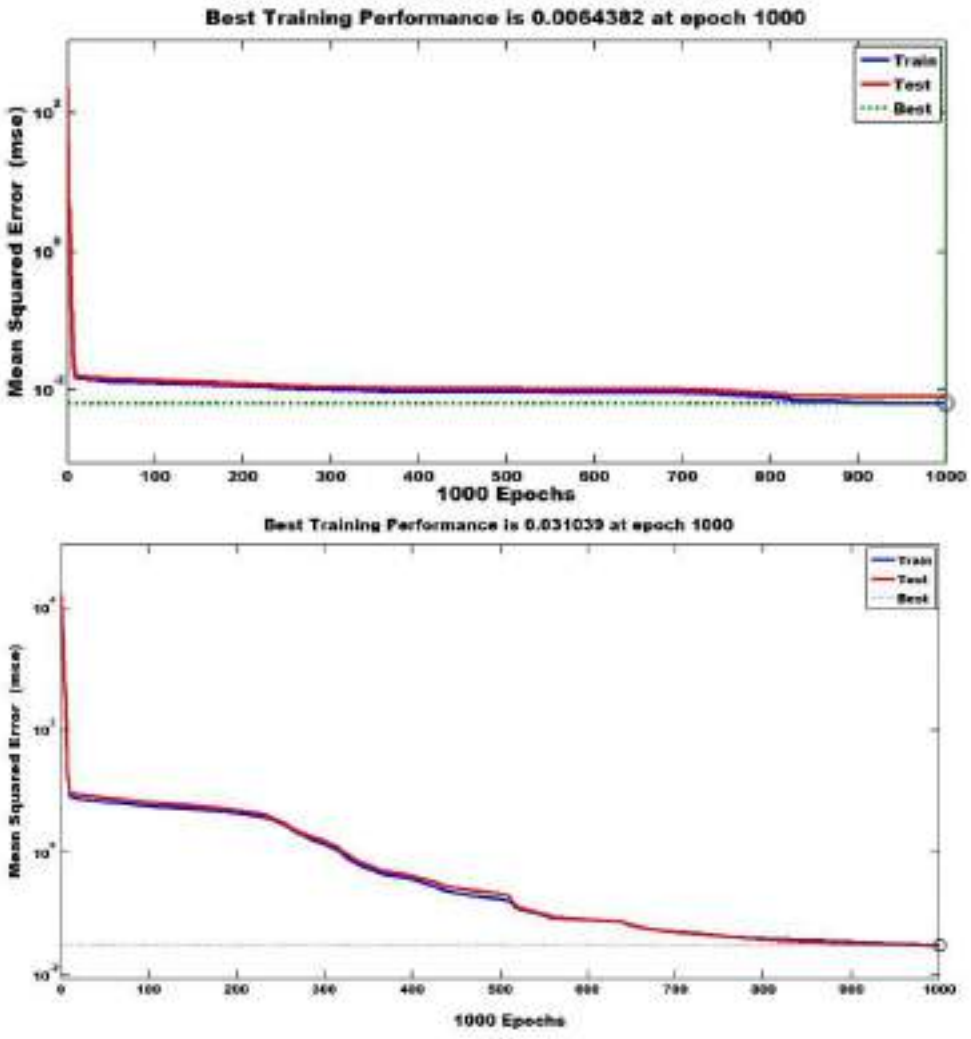
ANN Model	Network Topology
1	8-12-1
2	8-12-8-1

Results:

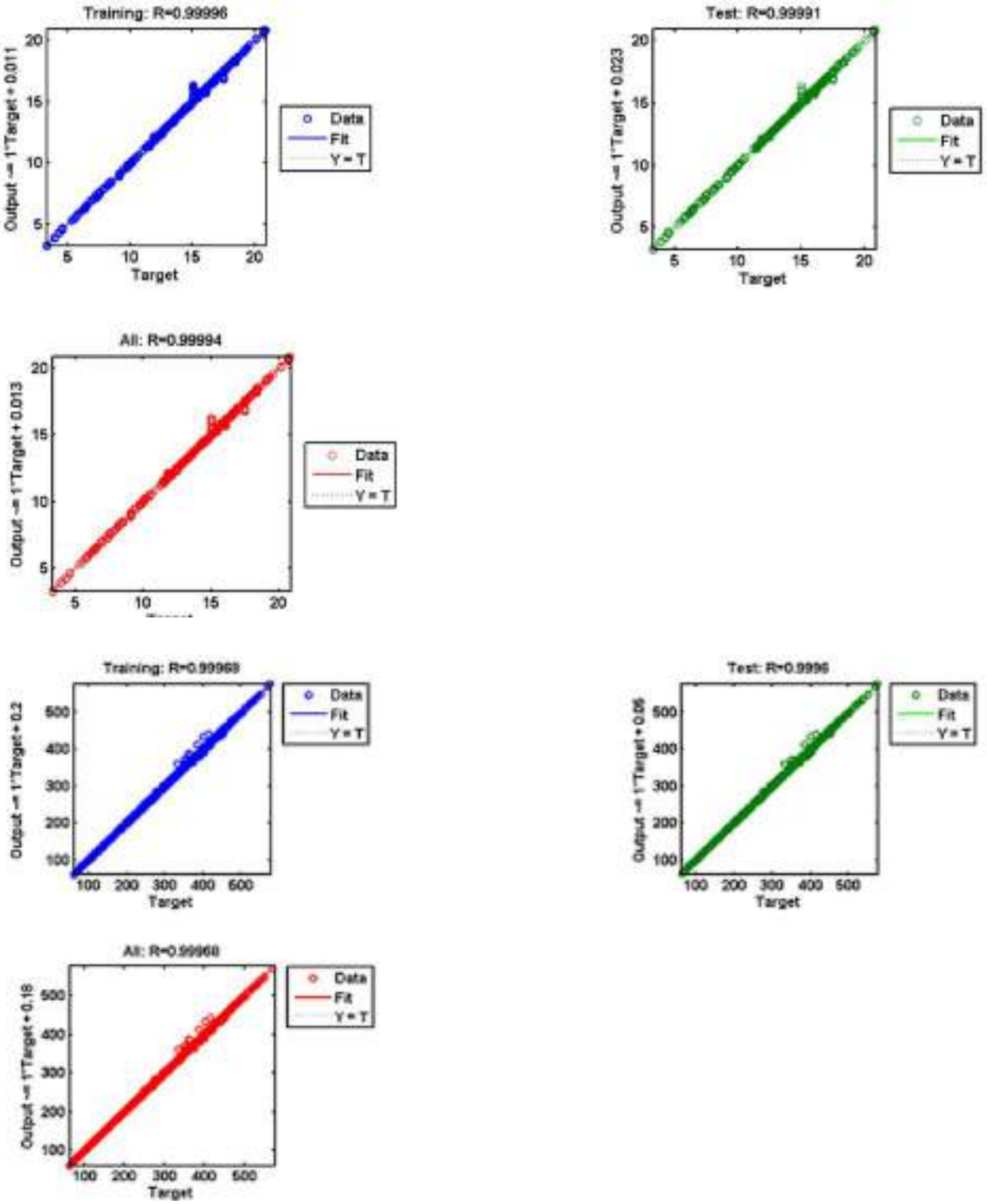
The predictability of the ANN models was statistically substantiated. The clothing insulation factor was not included as an input parameter, given its similar values.

The generalization performances of the ANN models are exhibited below using their respective MSE versus epoch performance plots. Herein, the attainment of significantly low training and cross-validation or testing MSE values reflected

the precision of the response predictions obtained from the ANN models. The prediction accuracy of each of ANN models was further investigated by plotting the model predicted output values against the corresponding observed target values with regard to training cross-validation, and overall datasets, as exhibited herewith.



MSE versus epoch performance plots pertaining to (a) ANN model 1 and (b) ANN model 2.



Predicted versus target plots pertaining to the training, cross-validation, and overall datasets of (a) ANN model 1 and (b) ANN model 2.

In each case, the close clustering of points along the line of regression validated the accuracy of the response predictions engendered by the ANN model. The attached Table enumerates the statistical network performance indices pertaining to the training, cross-validation, and overall exemplars of the developed ANN models. Intriguingly, the ANN results indicated that fabrics with similar thermal resistances could still affect Esk, plausibly owing to the temporal variation in the evaporative resistance of fabrics among individuals.

Values of the statistical parameters used to gauge the performance of the ANN models apropos of training, cross-validation, and overall instances.

ANN Model	MSE		R2			Adjusted R2		
	Cross-validation	Overall	Training	Cross-validation	Overall	Training	Cross-validation	Overall
1	0.0079	0.0072	0.9999	0.9999	0.9999	0.9996	0.9996	0.9996
2	0.0460	0.0385	0.9997	0.9996	0.9997	0.9993	0.9992	0.9993

Note: ANN=artificial neural network.

Conclusion: The reasonably accurate results affirmed the suitability of ANN as a pragmatic technique that could elucidate heat-induced ergonomic challenges.

BIOCLIMATE OF RURAL HOUSING

Nearly 70% of the country's population lives in the rural area (according to the census, 2011). The state of West Bengal is uniquely positioned in terms of its climatic zones, which include the tropical savannah, monsoon, and dry winter. The State exhibits major ecosystems, viz., mountains, hills, forests, the gangetic plain, islands, coastal and marine, semi-arid zones.

The main characteristics of rural housing are (a) the low height of the housing structure and (b) the linear and scattered settlement patterns. From the bioclimatic point of view, These unplanned settlement clusters are practically heat islands, due to (a) trapping of short wave and longwave radiation in and around the households, (b) anthropogenic heat released from the combustion of fuel in rural houses, and (c) reduced evapotranspiration and convective heat removal due to reduced air movement in the small houses.

A major bottleneck of the rural areas is the poor indoor environmental quality of rural or semi-urban building due to different anthropogenic activities in the indoor and outdoor environment i.e. combustion of fuel for cooking purpose, poor sanitation, unplanned building infrastructure, and energy consumption pattern. Undoubtedly, building design and building environments have significant implications on the comprehensiveness of sustainability. That is, the building design process must address energy demand, building form, construction, materials, operation and maintenance, and above all, the long-term needs of the user population, Throughout the life cycle of buildings. The sustainable design aims at maximizing the quality of the built environment and minimizing or eliminating negative impacts on the natural environment.

Bio-climate may be defined as a climate or climatic zone that relationship between climate and living organism and their distribution and its aspects associated with the minimum impact on the environment, attention to human health and maximum comfort in the indoor or outdoor environment, and increase the energy efficiency and minimize the energy consumption.

Bioclimatic Aspects

Bio-climatic aspects may be considered as a scientific aspects towards sustainable building design that is associated with (a) building to be Eco-friendly that have minimal impact on the environment; (b) building focusing on human-friendliness, with attention to human health, comfort, and safety; and (c) making the building energy-friendly to achieve efficiency and conserve energy. Undoubtedly, building design and building environments have significant implications on the comprehensiveness of sustainability. That is, the building design process must address energy demand, building form, construction, materials, operation and maintenance, and above all, the long-term needs of the user population, Throughout the life cycle of buildings. The sustainable design aims at maximizing the quality of the built environment and minimizing or eliminating negative impacts on the natural environment.

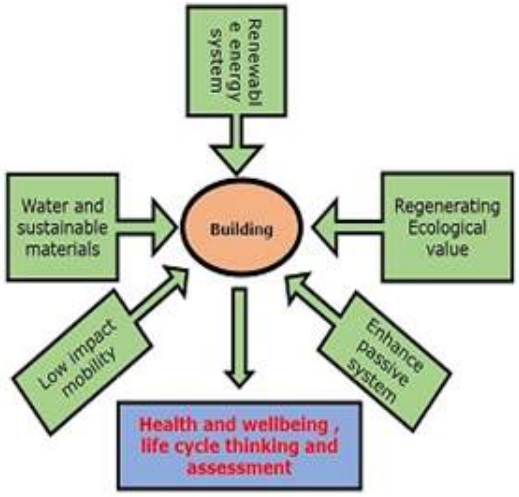
BIOCLIMATIC ASPECTS	DESCRIPTION
ECO-FRIENDLY	This is the important aspect towards minimization of impact on the environment as well as non-renewable resources. The eco-friendly aspects of bioclimate are public transportation, ecological footprint, walking distance from market or school, use of surface water, rainwater harvesting, local building materials, etc.
HUMAN – FRIENDLY	The human-friendly aspect addresses the challenges to human health and increasing human comfort. Human comfort is not just a matter of physical conditions and environment (thermal, auditory, visual, and chemical) but also the intermediaries, such as the architectural features, space design, the physiological, demographic indicators, and the safety features embedded in the design of the building.
ENERGY – FRIENDLY	The energy-friendly aspect is associated with minimum energy consumption and maximum energy efficiency. This aspect is influenced by building arrangement and layout, natural ventilation, landscape pattern (open ground), ecological footprint (watershed, plantation), solar energy use, use of low voltage electronic aids, building materials, etc. The bio-climatic approach adopts the passive building design to create comfortable conditions for occupants. The primary strategies include site design, landscape elements (such as plants, water), building orientation, building form and envelope, openings for ventilation, sun shading and window/façade design.

Bioclimatic design

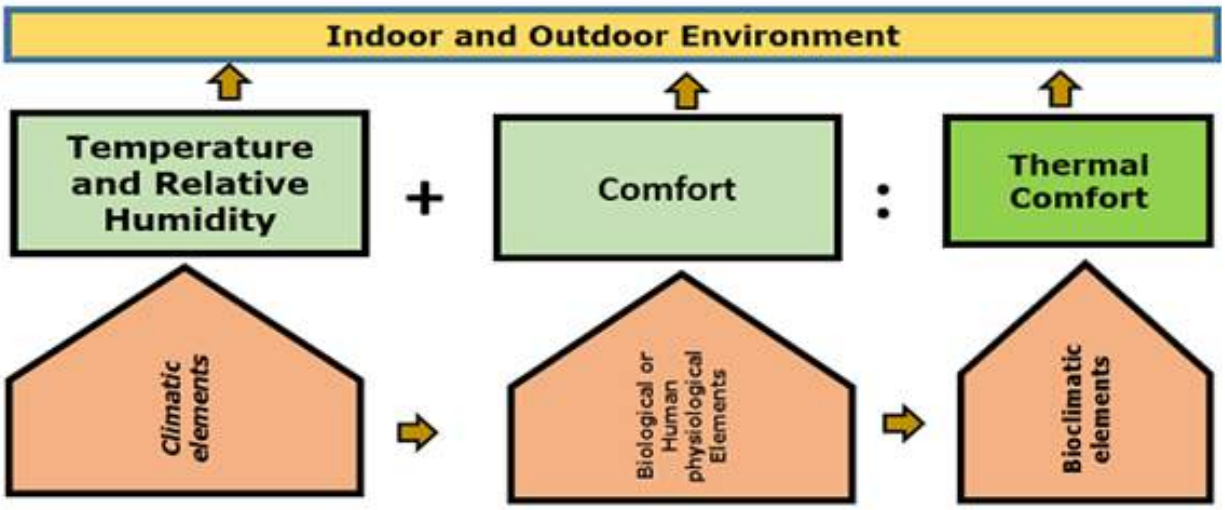
Bio-climatic design comprises the scientific and architectural strategies which attempt to increase the human comfort level and energy efficiency. The relationship between the biological and physical domains depends on:

- The climate types and requirements
- The adaptive thermal comfort
- The vernacular and contextual solution
- The tools and assessment methods
- The microclimate: sun path, wind, and rain
- Working with the elements, such as passive and active system, and
- Development of a responsive form.

In the context of the bio climatic parameters under consideration in the design of rural building include (a) building design (b) site and location (c) energy efficiency (d) health and safety (e) building materials (f) water use (g) innovation.



New parameter for bioclimatic housing



COMMUNITY PARTICIPATION IN DISASTER MANAGEMENT

A community may be defined by parameters, such as geographical proximity, shared language, experience, and culture. In the context of disaster management, a community is a number of people living in a common geographical area and exposed to similar kinds of hazards. A community can socially be diversified, in terms of gender, caste, wealth, ethnicity, religion and other aspects. Therefore, the community might not be homogeneous. The disaster risk management in which communities are actively engaged in the identification, analysis, treatment, monitoring, and evaluation of risks in order to reduce vulnerabilities and enhance their capacities. This means that the people are at the heart of decision making and implementation of an intervention in disaster risk management and protect people from the menace of the hazards. The top-down disaster management approach in many cases failed to address the vulnerabilities, resources and capacities of the community. In some cases it has negatively affected the community by increasing its vulnerabilities due to lack of proper knowledge of the local situation. The local communities need to be involved in the process of identifying and resolving the issues of vulnerability as only they can understand local opportunities and constraints. The community whose survival and well-being are at stake understands the local affairs and requirements. Therefore, there is a need for the generation of information in a manner and language that is understood by the community.

Stakeholders in disaster management

According to the United Nations International Strategy for Disaster Reduction (UN/ISDR), there are several key parties that play major roles in the disaster management process. These include communities, particularly those most vulnerable; local institutions, government, NGOs, private organizations, media and scientific communities. Stakeholders' approaches towards disasters refer to activities such as mitigation, preparedness, response and recovery, which are planned and conducted before, during and after disasters. They represent stakeholders' proactive and reactive intent to manage disasters by employing decision-making mechanisms involving a combination of stakeholders' institutional attributes, socio-economic and the built environment exposures.

Community-based disaster risk management

In the community based disaster risk management process, a detailed assessment of community's risk, vulnerability and exposure to hazard as well its capacities is the basis for activities, projects, and programs to reduce disaster risks. The involvement of the community at step i.e. assessment, planning and implementation is necessary. Community based disaster management also includes efficient management of the concerned stakeholders. The first step is to identify the people, groups, or organizations that could impact or be impacted by the consequences of disasters. The second step is to analyze stakeholders' expectations and their impacts on the environment, society and the built environment.The third step is to develop appropriate disaster mitigation plans for effectively engaging stakeholders in disaster mitigation decisions and executions. The community based disaster management process involves seven sequential stages which can be carried out before the occurrence of disaster, or even after for risk reduction. These stages are related in a way that the previous stage leads to the later. The planning and implementation system is embedded in these sequential stages which can be used to generate a disaster risk management tool.

QUANTITATIVE ENVIRONMENTAL RISK ASSESSMENT

The human civilization has traced a declining trajectory in terms of environmental health, since its inception and what is becoming increasingly clear is that societal decisions must be based on an honest and forthright appraisal of the state-of-the-art knowledge. More often than not, these decisions relate to so-called “wicked” problems to which no easy answers exist. Unfortunately, these decisions almost always become highly politicized.

Over the years, notwithstanding the numerous advantages offered by industrialization, the generation of toxic wastes has emerged as a major cause of concern to scientists and environmentalists across the globe. Many toxic substances are suspected carcinogens; that is, they may cause cancer, and for carcinogens, the usual assumption is that even the smallest exposure creates some risk. These inadvertent repercussions have mandated a comprehensive exploration of environmental risk.

The result has been the emergence of the field of environmental risk assessment. Risk assessment is the gathering of data that are used to relate response to dose. Such dose-response data can then be combined with estimates of likely human exposure to produce overall assessments of risk.

The purpose of risk assessment is to support societal decision making. Risk assessment is the means by which democratic societies attempt to understand the adverse and unintended consequences of technology.

Risk assessment involves the identification, evaluation, and estimation of the levels of risks involved in a situation, their comparison against benchmarks or standards, and determination of an acceptable level of risk.

Identify hazards and risk factors that have the potential to cause harm (hazard identification).

Analyse and evaluate the risk associated with that hazard (risk analysis and risk evaluation).

Determine appropriate ways to eliminate the hazard, or control the risk when the hazard cannot be eliminated (risk control).

Why risk assessment is important?

Risk assessments are very important as they form an integral part of an occupational health and safety management plan. They help to:

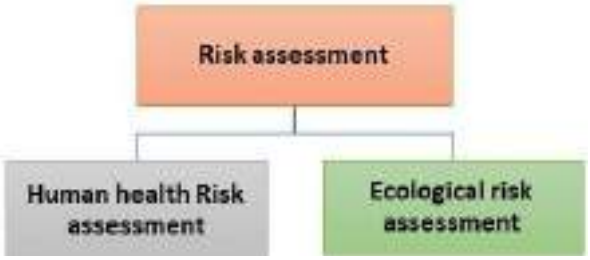
Create awareness of hazards and risk. Identify who may be at risk (employees, cleaners, visitors, contractors and the public).

Determine whether a control program is required for a particular hazard. Determine if existing control measures are adequate or if more should be done.

Prevent injuries or illnesses, especially when done at the design or planning stage.

Prioritize hazards and control measures.

Meet legal requirements where applicable.



Types of Risk assessment

Human Risk assessment is the process to estimate the nature and probability of adverse health effects in humans who may be exposed to chemicals in contaminated environmental media, now or in the future.

Ecological risk Assessment is a process that evaluates the probability that adverse ecological effects will occur as the result of exposure to one or more stressors.

Steps of Risk assessment

Human Risk Assessment

Hazard identification is the process of determining whether exposure to a stressor can cause an increase in the incidence of specific adverse health effects (e.g., cancer, birth defects). It is also whether the adverse health effect is likely to occur in humans. In the case of chemical stressors, the process examines the available scientific data for a given chemical (or group of chemicals), and develops a weight of evidence to characterize the link between the negative effects and the chemical agent. Exposure to a stressor may generate different adverse effects in humans: diseases, formation of tumors, reproductive defects, death, or other effects.

Dose-response assessment refers to the dose-response relationship describes how the likelihood and severity of adverse health effects (the responses) are related to the amount and condition of exposure to an agent (the dose provided). This principle applies to different situations, where the exposure is to a concentration of the agent (e.g., airborne concentration in inhalation exposure), and the resulting information is referred to as the concentration-response relationship.

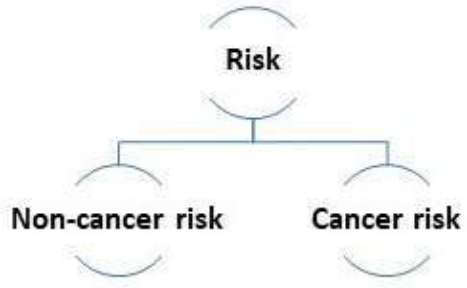
Exposure assessment is the process of measuring or estimating the magnitude, frequency, and duration of human exposure to an agent in the environment, or estimating future exposures for an agent that has not yet been released. An exposure assessment includes discussion of the size, nature, and types of human

populations exposed to the agent, as well as discussion of the uncertainties in the above information. Exposure can be measured directly, but more commonly is estimated indirectly through consideration of measured concentrations in the environment, consideration of models of chemical transport and fate in the environment, and estimates of human intake over time.

Risk characterization conveys the risk assessor's judgment about the nature and presence or absence of risks, along with information on how the risk was assessed, where assumptions and uncertainties still exist, and where policy choices need to be made. Risk characterization takes place in both human health risk assessments and ecological risk assessments.

Ecological Risk assessment

Problem formulation and hazard identification Exposure assessment
Ecological effects/toxicity assessment
Risk characterization.



Non-Cancer Risk

Non -cancer risks are expressed in terms of a hazard quotient (HQ) for a single substance, or hazard index (HI) for multiple substances and/or exposure pathways. Hazard quotient is the ratio of the potential exposure to a substance and the level at which no adverse effects are expected. If the Hazard Quotient is calculated to be less than 1, then no adverse health effects are expected as a result of exposure.

Hazard Quotient (HQ)

$$\frac{Average\ daily\ dose\ during\ exposure\ period\ \left(\frac{mg}{kg}/day\right)}{RfD\left(\frac{\frac{mg}{kg}}{day}\right)}$$

Reference Dose (mg/kg/day)

The reference dose (RfD) is an oral or dermaldose derived from the NOAEL, LOAEL or BMDL by application of generally order-of-magnitude uncertainty factors (VFs).

$$RfD = \frac{NOAEL}{VF_1 \times VF_2 \ldots \times VF_n}$$

The sum of the hazard quotients of different substances or agents is called as the hazard index (HI).

Cancer Risk

If the dose–response curve is assumed to be linear at low doses for a carcinogen, then Incremental
cancer risk = CDI x PF, where
CDI is the chronic daily intake (mg/kg-day).

In c $$CDI = \frac{\text{Average Daily dose } (\frac{mg}{day})}{\text{Body weight(kg)}}$$

in whic $CDI = \frac{C \times IR \times EF \times ED}{BW \times AT}$ tion in water o (mg/l),
IR = Ingestion Rate (l/day),
EF = Exposure Frequency (days/yr),
ED = Exposure Duration (yr),
BW = Body Weight (kg),
AT = Averaging Time (period over which exposure is averaged) (days).

For non-carcinogens: AT = ED x 365 days per year and intake is called Chronic Daily Intake (CDI).

For carcinogens: AT = Lifetime (70 years) x 365 days per year and intake is called Lifetime Average Daily Dose (LADD).

Risk estimates of some non-carcinogenic and carcinogenic substances are tabulated herewith.

Non-carcinogenic agents

Substance	Rfd (mg/kg-day)	Hazard quotient	Risk
Atrazine	0.035	0.16	Acceptable
Chloroform	6.1×10^{-3}	1.4	Non-acceptable
Carbon tetrachloride	1.3	0.0003	Acceptable

Carcinogenic agents

Substance	CDI (mg/kg-day)	PF $(mg/kg\text{-}day)^{-1}$	Risk	Cancer risk
Benzene	0.228	2.9×10^{-2}	663×10^{-6}	$>10^{-6}$ Not Acceptable
Arsenic	2.14×10^{-3}	1.75	375×10^{-6}	$>10^{-6}$ Not Acceptable
Methylene Chloride	8.5×10^{-5}	7.5×10^{-3}	0.6×10^{-6}	$<10^{-6}$ Acceptable
Cadmium	0.01	6.1	697×10^{-6}	$>10^{-6}$ Not Acceptable
DDT	2.14×10^{-3}	0.34	728×10^{-6}	$>10^{-6}$ Not Acceptable
Chrysene	0.057	0.01	571×10^{-6}	$>10^{-6}$ Not Acceptable

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