# Human Environment (EMT 421)

Lecture Notes

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## Course Synopsis:

Conceptualization of Environment

Constituents of Human Environment

Perception and mental map in human decision making

Superstructures created by man in the environment

Outcomes of the interaction between physical and human environment

Cases of human misuse of the environment

Theories of human impacts on the environment(e.g. ecological, sustainability models)

Strategies for minimizing human impact on the environment

# *Conceptualization of Environment*

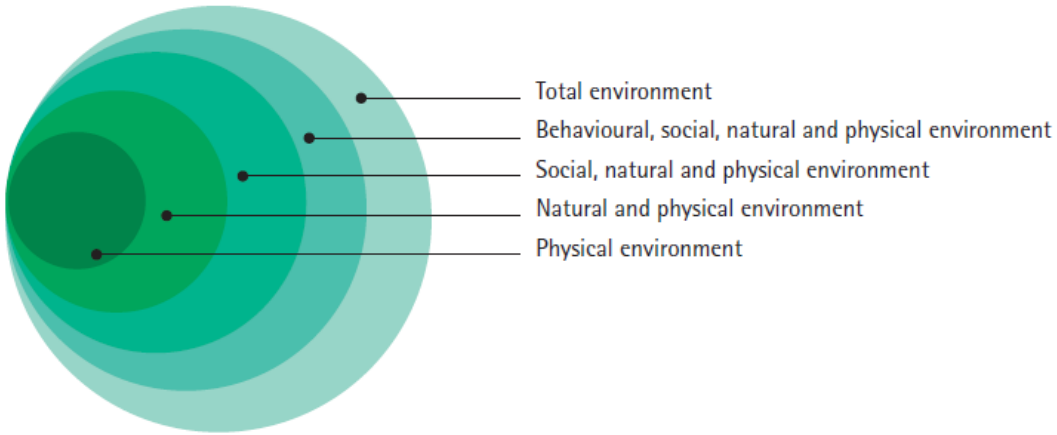
## Human Environment

The natural environment is contrasted with the human or built environment, which comprises the areas and components that are strongly influenced by humans. The human environment describes the evolution of humans, biologically and culturally. The term *environment* became specialized beginning in about the 1960s to designate the context of human and animal groups, with a special emphasis on the natural world and its physical and vegetal components. Environment can be described as the natural world of land , water, air, plants and animals that exist around us. It forms the basis of our existence and development. The dictionary meaning of the word 'environment' is " the external conditions influencing development or growth of people, animals or plants,; living or working conditions etc. It is therefore refer to as the sum total of conditions, which surround man at a given point in time.

Within this framework, the word took on an even more limited meaning and in the early twenty-first century refers primarily to the interaction between human and animal activity on the one hand and to humans and the natural world on the other, principally the impact of the former on the latter. In this context, "environment" is often linked with notions of habitat deterioration and species endangerment, and with appropriate responses to these threats, such as species recording and protection and natural-resource and habitat conservation. In a broader sense, however, *environment* refers to all elements (physical, biological, psychological, social, and cultural) that constitute the context in which life (vegetal, animal, and human) has evolved and continues to evolve. Four major components of this complex notion are taken into consideration here for their particular historical relevance and importance in Western culture: the notion of animism; materialist conceptualizations of environment (including diseases, medicines, and astrology); theological understandings; and contemporary approaches to the environment and environmental issues.

The comprehension of human agency in natural environment evolution can be chosen as the main criterion of examination of human-nature interaction. Three main directions of environmental thought development can be distinguished in contemporary humanitarian and scientific thought. One of them, known as geographical determinism, concentrates on the environmental impact on human history. The second, concerning human agency in nature development, became popular alongside global reconsideration of the human role in the universe, which took place at the time of the scientific revolution. Proponents of the third direction tend to interpret human-environment interaction as an integrated system, all elements of which are of equal importance and are engaged in complicated reciprocal influence.

FIGURE 1 DEFINITION OF THE ENVIRONMENT [a]




[a] (Adapted from Smith, Corvalàn and Kjellström, 1999)

Human societies respond to environmental (e.g., climate) signals through multiple pathways including collapse or failure, migration and creative invention through discovery. Extreme drought, for instance, has triggered both social collapse and ingenious management of water through irrigation. Human responses to change may in turn alter feedbacks between climate, ecological, and social systems, producing a complex web of multidirectional connections in time and space. Ensuring appropriate future responses and feedbacks within the human-environment system will depend on our understanding of this past web and how to adapt to future surprises. To develop that understanding, we need to look at multiple time and space scales.

Rapid technological change, global environmental concerns, and other dramatic ecological and societal changes are rendering previous conceptualizations of environments, and the relationships between environment and behaviour, inadequate. Dramatic, rapid changes in communication technology and organizational structures; the emergence of multi-locational options for work, family and leisure pursuits; sudden national reorganizations and cultural upheaval; and increasing awareness of and information about global environmental concerns are some of the factors rendering more static conceptualizations of environments inadequate (Stokols, 1995).

## ***Built Environment***

The term built environment refers to the human-made surroundings that provide the setting for human activity, ranging in scale from personal shelter and buildings to neighbourhoods and cities that can often include their supporting infrastructure, such as water supply or networks. The built environment is a material, spatial and cultural product of human labor that combines physical elements and energy in forms necessary for living, working and playing.

In practice, the term is typically used to describe the interdisciplinary field which addresses the design, construction, management and use of these man-made surroundings as an interrelated whole as well as their relationship to human activities over time (rather than a particular element in isolation or at a single moment in time). The field is generally not regarded as a traditional profession or academic discipline in its own right, instead drawing upon areas such as economics, law, public policy, management, design, technology, and environmental sustainability. In landscape architecture, the built environment is identified as man-made landscapes as opposed to the natural environment. For example, Central Park in New York City may have the look, feel and quality of natural surroundings, but is completely man-made and 'built'.

## ***Geographical determinism***

Geographical determinism comes from the "man as sufferer" paradigm in the adaptation concept. Interpretation of a human being as a passive sufferer originated in ancient natural philosophy. In the earliest period of human habitation of the earth, they were regarded as a creature deeply dependent on its natural habitat. As early as at the middle of 4th century B.C.E., geographic determinism had been designed as a specific direction of philosophic thought with at least two extreme schools: one of climatic psychology and another of climatic ethnology. Later climatic astrology also originated. The Enlightenment ideology reconsidered these ideas about total human dependence on nature and elaborated the wide circle of geographically and climatically deterministic theories (C. Montesquieu, L. Mechnikov, E. Semple, E. Huntington, E. Reclus). At the second half of the 20th century, this idea was treated in the framework of the adaptation concept, which is interpreted by representatives of "new" (L. Binford) and behavioral (B. Schiffer) archaeology, environmental psychology (A. Bell), and phenomenological (T. Ingold) and actional (E. Markaryan) approaches to culture studies as phenomena inherent for an active and creative human being. In Soviet science, most attention was paid to the biological aspects of adaptation, with an emphasis on the human capacity to fit the requirements of natural environment. At the end of 20th century, adaptive reaction has become the subject of special attention. As a result, general theory of stresses and ecological stress concept were elaborated (P. Bell). To identify the possible character of human beings and human society in response to natural environmental changes, the concept of social and ecological resilience was introduced (A. Neil). Thus, the idea of humans as nature modifiers and creators came to be. Roots of the idea of human domination over nature are traced as early as the Enlightenment times, when the human ability to solve rationally all his or her vital tasks was declared for the first time (T. Hobbes, C. Linney).

## ***Ecological Crisis***

At the beginning of industrial development and the origin of first ecological crisis at the middle of 19th century, scientists began to study the results of a transforming impact from human activity on the natural environment. More recently during the 20th century, the idea of humans as nature-creators was conceptualized in the context theories of cultural landscape, and the notion of landscape as series of sequent occupancies. In frameworks of postmodern methodology, this idea is conceptualized in the idea of landscape as artefact, based on two ideas (T. Darvill, P. Criado Boado). One of them is that landscape should be interpreted as a mental image, which could not exst without human beings who elaborate it. At the same time, humans consciously and purposefully form their geographical environment, and their decisions about living space ordering are deeply motivated by their vital needs. Consequent application of these postulates inevitably results in partial or total negation of the natural landscape existence. This idea has become the starting point for the theory of human eco-dynamics, which concerns the analysis of changes made by humans in the landscape in a long-lasting perspective. In spite of principal differences in theoretical backgrounds of the "human as nature-creator" concept, they incorrectly tend to date the beginning of the human impact on nature with the origin of agriculture and farming. Thus, the possibility of hunters and gatherers substantially reshaping their landscape is practically excluded or regarded as a minimal and non-permanent one, displayed only in connection with so-called secondary landscape components. There is also the idea of mutual creativity in human-environment interaction. The process of formation of so-called integral direction of man-environment interpretation is long and ambiguous. These ideas, originating for the first time in ancient natural philosophy, obtained theoretical scientific background during the second half of the 19th century (J. Raskin, K. Ritter). The fundamental theoretical background for this idea was elaborated during the late 19th and early 20th centuries in the framework of anthropogeography (F. Ratzel) and biosphere theory (V. Vernadsky). The traditional variant of anthropogeography envisages attention to all spheres of human culture and to humanity itself, taken as social and biological creature (F. Ratzel, A. Hettner, A. Grigorev, A. Borzov). At the same time, some researchers proposed to limit their subject field by the phenomena, which directly and materially display themselves in the landscape (O. Schluter, O. Brun) or by the human being as an organic form of life (W. Davis).

Intensive deepening of our knowledge about climate, relief, flora, and fauna and their chronological and spatial distribution, which took place at the middle of the 20th century thanks to active development of environmental archaeology, geoarchaeology, and paleogeography, has created an empiric background for theoretical conceptualization of the "man in nature" idea in Western European and American archaeology, prehistory, and paleogeography. In Soviet science, such ideas were reflected in research activity of proponents of the socalled paleoenvironmental approach to prehistoric studies (S. Bibikov). As a result, at the beginning of the 21st century, one can trace the gradual growth of popularity of the idea of mutual and interdependent evolution of nature and society. A specific form of its interpretation is proposed by representatives of mainly postmodern directions of contemporary geography, scholars who have introduced a wide spectrum of variants of landscape understanding.

# CONSTITUENTS OF HUMAN ENVIRONMENT

Human beings are one of the most important components of the environment. Humans play integral role in earth ecosystem. They are known to frequently change their environment according to the changes in their way of life. They use the natural resources in a very unplanned way, often without thinking about the future effects while using the natural resources.

## *Chemical & Biological Constituents in the Environment*

# *Perception and mental map in human decision making*

***Cognitive Maps***

Cognitive or 'mental' maps are cognitive representations of an area which include representations of such features as landmarks, nodes, routes, edges (boundaries), and districts (Lynch, 1960; Golledge, 1993). Landmarks are significant features of an environment such as distinctive or large buildings or sites (in Lynch's original work he was concerned principally with urban environments). Routes are such things as roads, footpaths, railway lines, etc. which facilitate travel between parts of the environment. Nodes are spaces in which people converge and include road intersections as well as features such as town squares. Edges typically refer to geographical features that act as boundaries around particular environments or parts of an environment. Rivers, coastlines, city walls, mountain ranges, etc. are typical examples. Finally, districts are distinct areas within the environment. Within urban environments this might include such aspects as the central business district, residential districts and industrial zones.

A cognitive map, therefore, is an inherently subjective representation of the geography of a site and has been found to include systematic distortions (distance, orientation, relative location, etc.). Such maps are known to be elaborated during experience at a site with knowledge typically progressing from 'landmark' knowledge (awareness of significant landmarks but no real appreciation of relative location, etc.) through 'route' knowledge (understanding sequential routes and nodes between places within the site) and, finally, to 'configurational' or 'survey' knowledge (elaborate understandings of the relative locations of landmarks, nodes and districts and a sophisticated appreciation of connecting routes) (McDonald and Peregrino, 1993). The underlying assumption is that cognitive maps are mental representations, not necessarily in the form of visual images, which may incorporate information from several senses "as well as semantic and affective [feelings, emotional reactions] information" (McDonald and Pellegrino, 1993). Thus, the spatial aspect cannot be straightforwardly separated from other aspects of the mental representation.

The way in which these representations are formed can vary, depending on the type of learning involved. Simply, primary learning involves direct experience of an environment while secondary learning is indirect experience (e.g., from maps) (McDonald and Peregrino, 1993). The estimation of relative locations, for example, can in some situations be superior when it results from secondary learning, while route distances may be best estimated when they result from primary learning. Sketch maps have been criticised for several reasons, including their reliance on a certain degree of drawing skill - that is, they are physical representations of mental representations of physical environments and distortions can therefore occur at both representational levels. Nevertheless, they do provide an overall summary of a cognitive map as opposed to a fragmented analysis of parts of that mental representation.

It is a common sense notion that environmental events can give rise to subjective experiences, but also reverse, that intuition or thinking has an impact on or control behavior, as the saying goes 'matter influences the mind' and the 'mind influences the body'. From the view of 'matter-mind influencing', (stored) environmental objects/subjects, having an impact on experience is generally hold. For this mental state of subjectivity, the person is dependent on properties of objects/subjects. On the other hand, the notion of 'mind-matter-influencing' holds that the person himself, through his thinking, is making behavioural choices, to adapt to and change his environment. Though real or imagined events are presupposed in subjective experience, the person in his behavioural repertoire is also an active and creative human being to construct and organize his surroundings, in which he lives. Thus, it is a general hold that the human being in relation with the physical-social environment shows an attitude/behavior of *passivity* and *activity*.

Example
In making decision about tourism in the environment the visitors decision making is understood to subsume the formation and development of destination perceptions (as an aspect of the decision making process). This discussion highlights the main features of the decision making process including the role of information, destination images (perceptions), decision rules, group processes in decision making and the affective component of decisions.

In a useful model of the overall process from motivation to the particular act of travel, Mansfeld (1992) emphasises the role of motivation as providing an impetus to travel, but notes that there is, as yet, little understanding of how such an impetus gives rise to particular travel decisions. In this sense, motivational theories of travel provide little help, he suggests, in predicting tourist flows. It is partly for this reason that increasing emphasis is being placed on identifying the specific cognitive processes involved in the travel decision event. A major factor influencing such basic cognitive processes is the availability, accuracy and comprehensiveness of information about destinations (Chon, 1990; 1992; Mansfeld, 1992). This information produces, in the individual, an image of the destination. The images of destinations held by prospective travellers can be either ‘organic’ or ‘induced’ (Gunn, 1989). The former refers to images principally dependent upon general life experiences and general knowledge, while the latter are largely the product of deliberate efforts at marketing and promotion. Both types of image result from the different information sources available to any particular traveller at any point in time. Mansfeld (1992) notes that the information search process also has the potential to affect motivation (as well as the reverse) and will tend to become more specific to particular destinations over time.

Van Raaij and Francken (1984) emphasise that decision making often occurs within a group and/or family context. Within the group, different people will have greater or lesser control over the different decisions involved from the ‘generic decision’ to travel, to the specific decisions related to destination selection, transport and accommodation used and specific attractions visited. These dynamics will alter from one type of group (e.g., family) to another (e.g., friends). That decision making often occurs in group contexts represents a caution for any study that examines decision making using a survey instrument administered to individuals, as is the case

in this study. It can be argued, however, that individuals are still able to report on this process and the predominant reasons for the (group) decision.

The information search and decision making processes have sometimes usefully been modelled using 'choice set theory' (e.g., Crompton, 1992). The basic principle underlying this approach is that, during the decision making process, the prospective traveller carries out a winnowing of all possible destinations, gradually eliminating different 'sets' of destinations according to one or other attribute or, less rationally, according to the 'clarity', 'availability', etc. of particular destinations. So, for example, some destinations may 'drop out' of the process because of a lack of sufficient information about them for the decision maker to come to any clear understanding of what they have to offer (they thus are bundled into the 'fuzzy set' and sidelined from the remaining decision process). Ultimately, a single destination or sequence of destinations is left and it is to this end that remaining informational efforts and practical steps are taken (including contacting a travel agent, if this has not already been done).

# SUPERSTRUCTURES CREATED BY MAN IN THE ENVIRONMENT

## Superstructures: Introduction

A superstructure is a building, structure, construction, elevation, frame, framework built or erected by man in his environment for his convenience or make life better for him. They include dams, bridges, nuclear power plant, roads and highway, airport, ships and other ocean going vessel to transport cargoes and people, skyscrapers in the megacities, dykes and polders, massive residential and commercial buildings etc. They are also called Mega structure.s Mega Structures focuses on constructions that are extreme; in the sense that they are the biggest, tallest, longest, or deepest in the world. Alternatively, a project may appear if it had an element of novelty or are a world first (such as Dubai's Palm Islands). This type of project is known as a Megaproject.

. Early cultures used substances occurring in their environment and invented the tools, skills, and technologies to exploit a variety of materials, creating a legacy that continues to inform more industrialized methods. Building with stones or bricks is called masonry. The elements cohere through sheer gravity or the use of mortar, first composed of lime and sand. The Romans found a natural cement that, combined with inert substances, produced concrete. They usually faced this with materials that would give a better finish. In the early 19th century a truly waterproof cement was developed, the key ingredient of modern concrete.

In the 19th century also, steel suddenly became abundant; rolling mills turned out shapes that could make structural frames stronger than the traditional wooden frames. Moreover, steel rods could be positioned in wet concrete so as to greatly improve the versatility of that material, giving impetus early in the 20th century to new forms facilitated by reinforced concrete construction. The subsequent profusion of aluminium and its anodized coatings provided cladding (surfacing) material that was lightweight and virtually maintenance free. Glass was known in prehistory and is celebrated for its contributions to Gothic architecture. Its quality and availability have been enormously enhanced by industrial processing, which has revolutionized the exploitation of natural light and transparency.

Urbanization increased on a large scale, brought about by the needs and desires of many groups, including the church and its monasteries, the nobles and kings, the craft guilds, and the merchants and bankers. The planning patterns that developed are quite different from the arbitrary geometry of Roman cities or of Renaissance theorists. Throughout northern Europe, where hardwood remained available until the Industrial Revolution, timber frame construction flourished. The Industrial Revolution, which began in England about 1760, led to radical changes at every level of civilization throughout the world. The growth of heavy industry brought a flood of new building materials—such as cast iron, steel, and glass—with which architects and engineers devised structures hitherto undreamed of in function, size, and form.

*Tall buildings and the Environment*

Tall buildings are an inevitable building form and part of the contemporary landscape. Given the limitations of available land, there is a growing tendency for tall buildings to be developed. New design ideas are becoming common currency among progressive architects and developers. "Bioclimatic skyscrapers" and well-designed tall buildings can be energy efficient and closely relate to their site. New buildings are increasingly user-friendly, offering a comfortable occupant-controlled environment all year. The creation of internal green "sky gardens" within buildings contributes to the natural environment. The primary design concern for many tall buildings is their operational efficiency rather than their environmental impact. A new balance needs to be struck between these two factors. Inefficient energy use is a particular concern. Speculative office developers have less interest in their buildings' environmental performance than do the companies that lease their offices. Almost three quarters of London's energy consumption is in buildings. The most intensive use of energy usually results from the heating or cooling of spaces. Lifts use about 10 per cent of a tall building's energy while lighting can make up about 20 per cent. Careful services design can minimise the need for heating and cooling throughout the year. Automatic light control can make significant energy savings. Access to opening windows provides a stimulus to occupants and increases the use of daylight and natural ventilation. Fire safety engineering is an ever-more important issue in the design of tall buildings, especially in light of recent events in New York

*Tall Buildings and Transport Provision*

The clustering of buildings in densely built-up spaces is widely regarded to be very efficient in transport terms. Studies have illustrated that cities such as Hong Kong and Singapore, where the clustering of tall buildings is the norm, are among the world's most transport-efficient.

*Eco-design*

Leading-edge design ideas such as these are helping to advance the concept of sustainable tall buildings. The Malaysian architect Ken Yeang has pioneered the bio-climatic skyscraper which has been highly influential in architectural design since the 1980s. He recognises that, due to the cultural and economic environment, tall buildings are an inevitable building form and part of the contemporary urban landscape, and he has focused on researching and developing energy-efficient and climatically-adapted buildings. Most contemporary skyscrapers are designed so that the internal environment is completely enclosed and disengaged from the climatic conditions of the site. They are 100% reliant on mechanical air conditioning for the comfort of their occupants. The bio-climatic skyscraper, in contrast, responds to the ambient climate of its location. Through this acknowledgement of site considerations the building achieves, through passive means, a comfortable environment for its users all year round. Passive low energy techniques that relate to the site's climate and meteorological data are key to the design, and lead to a tall building that is environmentally interactive, and low energy in embodiment and operations while being high quality in performance and comfort levels.

Another feature of several new eco-towers is landscaping and planting in buildings. Yeang's aims include recreating the conditions of the ground on the building, and creating a new eco-habitat to enhance bio-diversity. Continuous ramps of vegetation around a building and sky gardens built into internal spaces can bring positive benefits to local ecology rather than attempting to minimise impacts. There are many important aspects to the bio-climatic skyscraper. Most of Yeang's buildings were designed for tropical conditions. In temperate locations such as in London, adjustable openings in the building's skin are added to filter and control the entry and emission of heat, glare and drafts as necessary. Such features are incorporated in the design for a tower proposed for the Elephant and Castle redevelopment.

Wind can be utilised as a free tool available to the designer and occupant rather than being shut out of the building. By allowing air in and through the internal spaces of the building, as appropriate, natural air conditioning can be achieved. As well as being energy efficient, fresh air can create a healthier internal environment and raise the comfort level of occupants. Building occupants get the opportunity to regulate fresh air coming into the building, helping them to adjust the airflow as required.

*Liveability, Sustainability and Productivity*

The potential for creating sustainable tall buildings has developed since the highly publicised mistakes of the 1960s. Improvements in construction techniques and advances in building services have contributed to the potential to make greener and more people-friendly high-rise buildings. However, tall buildings can never be viewed in isolation. Their contribution to the growth of a city, their impact on the cityscape, their relationship with neighbouring buildings and their effects upon the people who use them are the ultimate test.

**Climate Change and Adaptation**

Rising fossil fuel burning and land use changes have emitted, and are continuing to emit, increasing quantities of greenhouse gases into the Earth's atmosphere. These greenhouse gases include carbon dioxide ($CO_2$), methane ($CH_4$) and nitrogen dioxide ($N_2O$), and a rise in these gases has caused a rise in the amount of heat from the sun withheld in the Earth's atmosphere, heat that would normally be radiated back into space. This increase in heat has led to the greenhouse effect, resulting in climate change. The main characteristics of climate change are increases in average global temperature (global warming); changes in cloud cover and precipitation particularly over land; melting of ice caps and glaciers and reduced snow cover; and increases in ocean temperatures and ocean acidity – due to seawater absorbing heat and carbon dioxide from the atmosphere It is now clear that global warming is mostly due to man-made emissions of greenhouse gases (mostly CO2).

Over the last century, atmospheric concentrations of carbon dioxide increased from a pre-industrial value of 278 parts per million to 379 parts per million in 2005, and the average global temperature rose by 0.74° C. According to scientists, this is the largest and fastest warming trend that they have been able to discern in the history of the Earth. An increasing rate of warming has particularly taken place over the last 25 years, and 11 of the 12 warmest years on record have occurred in the past 12 years. The IPCC Report gives detailed projections for the 21st century and these show that global warming will continue and accelerate. The best estimates indicate that

the Earth could warm by 3° C by 2100. Even if countries reduce their greenhouse gas emissions, the Earth will continue to warm.

***The need for adaptation***

The major impacts and threats of global warming are widespread. Increasing ocean temperatures cause thermal expansion of the oceans and in combination with meltwater from land-based ice this is causing sea level rise. Sea levels rose during the 20th century by 0.17 metres. By 2100, sea level is expected to rise between 0.18 and 0.59 metres. There are uncertainties in this estimate mostly due to uncertainty about how much water will be lost from ice sheets (Bindoff *et al*. 2007), for example Greenland is showing rising loss of mass in recent years (UNEP 2007). Increased melting of sea ice and freshwater influx from melting glaciers and ice sheets also has the potential to influence global patterns of ocean circulation. As a result of global warming, the type, frequency and intensity of extreme events, such as tropical cyclones (including hurricanes and typhoons), floods, droughts and heavy precipitation events, are expected to rise even with relatively small average temperature increases.

Changes in some types of extreme events have already been observed, for example, increases in the frequency and intensity of heat waves and heavy precipitation events (Meehl *et al*. 2007). Climate change will have wide-ranging effects on the environment, and on socio-economic and related sectors, including water resources, agriculture and food security, human health, terrestrial ecosystems and biodiversity and coastal zones. Changes in rainfall pattern are likely to lead to severe water shortages and/or flooding. Melting of glaciers can cause flooding and soil erosion. Rising temperatures will cause shifts in crop growing seasons which affects food security and changes in the distribution of disease vectors putting more people at risk from diseases such as malaria and dengue fever. Temperature increases will potentially severely increase rates of extinction for many habitats and species (up to 30 per cent with a 2° C rise in temperature).

Adaptation is a process through which societies make themselves better able to cope with an uncertain future. Adapting to climate change entails taking the right measures to reduce the negative effects of climate change (or exploit the positive ones) by making the appropriate adjustments and changes. There are many options and opportunities to adapt. These range from technological options such as increased sea defences or flood-proof houses on stilts, to behaviour change at the individual level, such as reducing water use in times of drought and using insecticide-sprayed mosquito nets. Other strategies include early warning systems for extreme events, better water management, improved risk management, various insurance options and biodiversity conservation. Because of the speed at which change is happening due to global temperature rise, it is urgent that the vulnerability of developing countries to climate change is reduced and their capacity to adapt is increased and national adaptation plans are implemented. Future vulnerability depends not only on climate change but also on the type of development path that is pursued. Thus adaptation should be implemented in the context of national and global sustainable development efforts. The international community is identifying resources, tools and approaches to support this effort.

## *Outcomes of the interaction between physical and human environment*

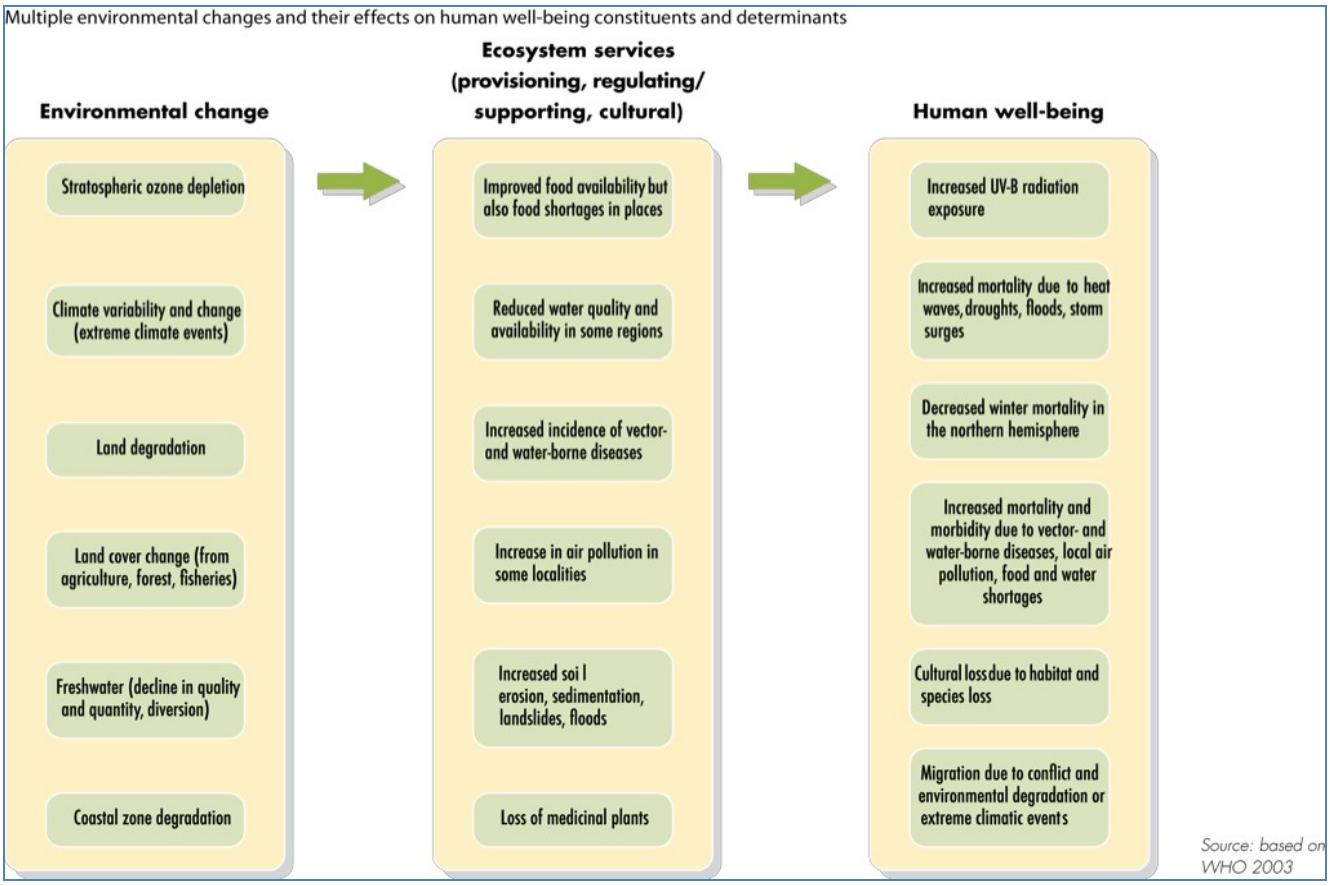
***Introduction***

From the past, we know there are circumstances in which a society is resilient to perturbations (e.g., climate change) and there are circumstances in which a society is so vulnerable to perturbations that it will be unable to cope. The evolutionary biologist and biogeographer Jared Diamond identifies what he considered to be the 12 most serious environmental problems facing past and future societies—problems that often have led to the collapse of historical societies:

- Loss of habitat and ecosystem services;
- Overfishing;
- Loss of biodiversity;
- Soil erosion and degradation;
- Energy limits;
- Freshwater limits;
- Photosynthetic capacity limits;
- Toxic chemicals;
- Alien species introductions;
- Climate change;
- Population growth; and
- Human consumption levels.

More importantly, Diamond, and several others before him, have emphasized that the interplay of multiple factors is almost always more critical than any single factor. Societies on the edge become brittle and lose resilience (including the ability to adapt social values to new circumstances) making them more susceptible to the impacts of potential perturbations of several kinds, including climate change, political corruption, war, and terrorism. In addition, what happens to any society is an emergent phenomenon, the result of individual decisions and conflicts in combination with environmental factors.

To make further progress, we need to construct a framework to help us understand the full range of human-environment interactions and how they affect societal development and resilience. We now have the capacity to develop this framework in the form of more comprehensive integrated models, combining approaches from geophysical, systems dynamics and agent-based models to implement approaches including simulation games and scenario analysis. Insights from modelling and analysis of the rich array of well-documented integrated historic events can be used to structure, test and further develop these models.




### *Human Environmental Interaction*

Human Environmental Interaction is basically how we affect and are affected by the environment, and also how we disturb the natural environment. The study of human behaviours with respect to his environment is known as human ecology. Human interacts with the environment in a number of ways, which can be observed everywhere there is human presences, from the cities to rural areas.

Examples of Human-Environment Interaction include:

- During travel or migration, historically, people followed trails made by wild animals. In mountain areas, these trails were often along the ridge---meaning, very close to a drop off. Instead of going up and over a mountain, animals went around, using the path of least resistance. But when people moved about to hunt, fish, gather berries, or to migrate from one place to another, these trails were not well-suited to human feet whether bare or in sandals or moccasins. So, as more humans used those pathways, they looked for easier ways to get where they were going. Maybe at first, this just meant that strong men moved a boulder out of the way, to make a path straighter and less distance to travel. But, over time, these muddy paths became roads. Finally, people realized that it would be easier to go through a mountain than to go around it on treacherous paths or roads. So they blasted through the mountain to create tunnels that we have today.

- Water was another "pathway" used by peoples in every country to move from place to place. But a stream or river may have had only one fairly safe crossing through the water. That meant people walked or rode many miles upstream or downstream to get to the safest part. Eventually, people tired of the distance, the difficulties, the hazards. As trade between people or areas increased, people needed easier ways to use the power of water. So they made bridges first so they could cross at the easy places without getting themselves, the animals, or goods all wet. Later, people built locks and dams to control river height so they could raise or lower boats over drops in the river. Boats could be "lifted" or "dropped" many feet, safely, through a lock and dam.

- Dams became very important, not only for control of fast-flowing rivers, but to provide drinking water to increasing populations. People saw for generations how beavers could dam a river; why couldn't people use a similar process. Earthen, wood, and concrete dams and reservoirs quickly became standard in water control and water delivery. Dams such as the Hoover Dam (USA), Kainji Dam (Nigeria), Volta Dam (Ghana) and Kariba Dam (Zimbabwe) are examples. Thousands of men permanently altered an entire area in order to build the dam. Hundreds of men were killed in the process. But like other dry areas, this dam provides water for drinking, irrigation/farming, and other human needs.

- Rivers have literally been "moved" or "tamed" so that humans changed the riverbed! This is amazing--and it also has many problems. Rivers want to flow in their natural beds or pathways. Humans may have "pushed" the water over by some feet, but during heavy rain or floods, the river seeks its original path. So while some river changes have benefited residents, the changes need constant upkeep.

## *Evolution of the human-environment relationship*

A full understanding of the challenges facing humanity requires knowledge of the evolution of the roles of technology, population growth, cultural mores (background), climate, disease and warfare in changing human attitudes and responses through time. This is especially the case if the past is to be used in more sophisticated ways than as a simplistic analogue of projected future conditions. We also know that assessment of the sensitivity or vulnerability of modern landscapes and ecosystems to future human activities and climate can be greatly improved by knowing the rates and directions of past trajectories in key processes such as land cover, soil erosion and flooding, observing how thresholds have been transgressed and deducing the natural or pre-impact patterns of environmental variability. The present nature and complexity of socio-ecological systems are heavily contingent on the past; we cannot fully appreciate the present condition without going back decades, centuries or even millennia. As we are witnessing today with global warming, current societal actions may reverberate, in climatic and many other ways, for centuries into the future. As such, there is the real danger that our visions of the future are becoming unconstrained by knowledge of what has already occurred, at least in part because information about human-environment interactions in the historical past has not been well organized for this purpose or properly utilized.

Knowledge on the inputs to and persistence in the environment of chemical and biological constituents and how their presence may affect public and ecosystem health is of personal to the public. Such information is also needed by regulatory agencies, and private, government, and commercial industries in order to control the use and impact of chemical and biological constituents and minimize or mitigate negative impacts to human health, our ecosystem and quality of life. Multitude adverse impacts to human and ecosystem health at a variety of scales have been documented from exposure to a broad range of chemicals and pathogens (collectively referred here as "agents"). Environmental loadings of these agents to terrestrial, aquatic, and atmospheric compartments are the result of human activities with continued increases in population and advances in technology. Understanding and predicting the linkages, at all scales, among the hydrologic, biogeochemical, and atmospheric processes that control the fate and transport of these agents, and the human and eco-toxicological implications of chronic and acute exposures these agents.

With increasing populations, more land is being converted for intensively managed agriculture, which, in turn, is leading to the increased discharges of fertilizers, pesticides, and other agrochemicals into the air, water and soil. With increasing urbanization, there have been increasing discharges of wastewater and urban runoff. Technologies targeted at increasing our quality of life and meeting the needs of our increased populations and energy needs are concomitantly compromising human and wildlife health, contributing to loss of habitats, and reducing ecosystem biodiversity. Secondary effects include disease vectors in humans and plants that are leading to the production and use of even a larger suite of chemicals.

***What need to be done***

*Air Emission and transport:* Characterizing the emissions of gases such as hydrogen sulfide and ammonia and particulates (with bacteria) into the atmosphere and dispersion from confined animal production facilities.

*Fate:* characterizing how and at what magnitude chemicals interact and persist in soil and water environments from multiple classes (hormones, antibiotics, fluorotelomer compounds, aryl hydrocarbon receptor ligands, chlorinated solvents, arsenic, selenium, pesticides, perchlorate, phosphate, nitrate) as well as pathogens (primarily *e. coli*).

*Remediation/reclamation:* implementing and evaluating various remediation (phytoremediation, chemical flushing, soil amendments) and reclamation strategies at sites impacted by industrial- and military-impacted sites; developing predictive models and decision tools for evaluating the need for active remediation and remediation strategies and success;

*Waste Reuse:* evaluating the occurrence and release of selected constituents of concern in soils amended with waste products (e.g., paper mill residuals, coal combustion products, animal manure, poultry litter).

*Bioavailability and Impact:* assessing the impact of sorption organic contaminants on their bioavailability to bacteria and mammals; the effects of nanomaterials (fullerenes and carbon nanotubes) on biological processes in soil and waste water systems; the role of soil and soil-borne food pathogens in the "farm-to-fork" continuum, the environmental impacts of the biofuel

products (alkanols), and the evolution of phylogenetically diversity and functionality of bacteria in long-term contaminated soils.

# *Cases of human misuse of the environment*

### *Introduction*

Humans have had the ability to change their environment for thousands of years. Today this ability is greater than ever. This is because there are more people living now than ever before and human activity is concentrated in huge cities. Also, science and technology allow us to interfere with natural processes in more direct ways. Years of thoughtless exploitation of nature by man has resulted in the effects staring right in our face now. The truth, that in the bid to improve our lives, we have put our own survival to stake, has finally hit us hard. Now as more and more studies and researches are being carried out to understand how do humans affect the environment, an increasing number of people are awakening to the fact that the well-being of the environment and survival are intricately woven into each other.

## ***Effects of Human Activities on Environment***

### *Climate Change*

Human impact on the environment or anthropogenic impact on the environment includes impacts on biophysical environments, biodiversity and other resources. The term *anthropogenic* designates an effect or object resulting from human activity. Human impact on biodiversity is significant, humans have caused the extinction of many species including the dodo and perhaps even many of the large megafaunal species during the last ice age. Though most experts agree that human beings have accelerated the rate of species extinction, the exact degree of this impact is unknown, perhaps 100 to 1000 times the normal background rate of extinction.

The development path that we have been taking, in the past few centuries, has been ultimately detrimental to the health of our surrounding ecological context. We are consuming an increasing share of the natural resources available to us on this planet, and we are creating sufficiently large amounts of waste and pollution such that the earth can no longer assimilate our wastes and recover from the negative impacts. This is a result of a growing population as well as new technologies which make it easier for us to access natural resources and also require the consumption of more resources.

Environmentalists have expressed their concerns about the misuse and unsustainable use of earth's natural resources which has great consequences on the survival of man and other living organisms. The phenomena of Global warming which refers to the increase in the temperatures of the earth due to release of greenhouse gases like carbon dioxide and methane from industries and vehicles is one major consequence of unguarded human action in the environment . This phenomenon is causing the glaciers to melt at an alarming rate. The polar ice caps are melting at a faster rate than they can form resulting in increase in the sea level, and it poses a danger of drowning the low lying areas. Some of the areas that may go under the sea if the sea levels kept increasing include Bangladesh, parts of Africa and even major cities like London, Dhaka, Lagos and New York and other areas in Southeast Asia.

Other major consequences of human misuse of the environment are discussed below:

*Depletion of Ozone Layer*

The stratosphere has a layer of ozone that protects us from the harmful ultraviolet (UV) rays of the sun. Exposure to these layers cause skin cancer and cataracts. However, the ozone layer filters out the dangerous UV rays from sunlight as it enters the earth's atmosphere. The cholofluorocarbons (CFCs) that are man-made chemicals are released in the atmosphere through CFC containing aerosols, refrigeration equipment, foam and as by products of certain industrial processes. As these chemicals are released, they rise up into the atmosphere and break down the ozone molecules that form the ozone layer. There is an ozone hole in the Antarctic stratosphere that is causing great concern to environmentalists all over the world. Not only is the depleting ozone layer harmful to human beings, but the UV rays can destroy a certain type of bacteria known are Cyanobacteria that are important for a number economically important crops. Researchers are even predicting that excess level of UV rays could lead to the death of the phytoplanktons, that are an important component of the food web of the oceans.

*Pollution*

Industrialization has been the hallmark of human progress. However, with industries have come a host of toxic gases that are being released into the atmosphere even as I write this article and you read it. The industries release gallons of liquid waste into the seas and rivers. Some of the effluents percolate down to the reach the ground water and pollute it to the extent that it can't be used by human beings for drinking or cooking. Besides adding to air pollution, the innumerable vehicles running on the roads add to noise pollution that has lead to increase in stress, anxiety and problems related to hearing. Pollution of water has led to the decrease in a number of large number aquatic life forms. Migratory birds are known to change their course due to pollution or change in weather. Respiratory diseases in human beings is another price that we are paying for polluting the environment.

*Deforestation*

Expanding population, industrialization and need of land for development of expanding cities has led man to cut down forests selfishly. Not only are the forests home to a large number of animals, trees are also an important component of the water cycle. The roots of plants hold the soil together and prevent soil erosion. The global forest cover has shrunk to half its area in the last 11,000 years. During the period between 1990 and 2000 itself, the yearly loss of natural forests 16 million hectares. Deforestation at such alarming rate has been a cause of constant worry for environmentalists the world over.

*Extinction of Species*

Man has been killing animals right since the time he acquired the skill of hunting. Although in those times hunting was the means for survival, human beings continued to kill animals even after he had learned to cultivate crops. The relentless hunting by human beings, sometimes for the hide of a cheetah or the tusks of the elephants, or simply to cook the tasty shark fin soup, has wiped out the existence a large number of animals in just a century. Besides hunting, human activities like environmental pollution and

deforestation has led to the extinction of a large number of animals and plants due to loss of habitat. Recent studies have shown that in North America, 37 animal species have become extinct in the last 50 years due to human activities. Loss of habitat led to the extinction of the Bali subspecies of tiger in 1937. According to the 2008 annual IUCN report, there were 16,928 animal and plant species that are threatened of extinction and the list keeps increasing every year.

Other cases of human impact on the built environment are briefly stated below:

*Irrigation*

The environmental impact of irrigation includes the changes in quantity and quality of soil and water as a result of irrigation and the ensuing effects on natural and social conditions at the tail-end and downstream of the irrigation scheme. The impacts stem from the changed hydrological conditions owing to the installation and operation of the scheme.

*Electricity generation*

The environmental impact of electricity generation is significant because modern society uses large amounts of electrical power. This power is normally generated at power plants that convert some other kind of energy into electrical power. Each such system has advantages and disadvantages, but many of them pose environmental concerns.

*Reservoirs*

The environmental impact of reservoirs is coming under ever increasing scrutiny as the world demand for water and energy increases and the number and size of reservoirs increases. Dams and the reservoirs can be used to supply drinking water, generate hydroelectric power, increasing the water supply for irrigation, provide recreational opportunities and to improve certain aspects of the environment. However, adverse environmental and sociological impacts have also been identified during and after many reservoir constructions. Whether reservoir projects are ultimately beneficial or detrimental—to both the environment and surrounding human populations— has been debated since the 1960s and probably long before that. In 1960 the construction of Llyn Celyn and the flooding of Capel Celyn provoked political uproar which continues to this day. More recently, the construction of Three Gorges Dam and other similar projects throughout Asia, Africa and Latin America have generated considerable environmental and political debate.

*Mining*

The environmental impact of mining includes erosion, formation of sinkholes, loss of biodiversity, and contamination of soil, groundwater and surface water by chemicals from mining processes. In some cases, additional forest logging is done in the vicinity of mines to increase the available room for the storage of the created debris and soil.[31] Besides creating environmental damage, the contamination resulting from leakage of chemicals also affect the health of the local population.[32] Mining companies in some countries are required to follow environmental and rehabilitation codes, ensuring the area mined is returned to close to its

original state. Some mining methods may have significant environmental and public health effects.

*Transport*

The environmental impact of transport is significant because it is a major user of energy, and burns most of the world's petroleum. This creates air pollution, including nitrous oxides and particulates, and is a significant contributor to global warming through emission of carbon dioxide, for which transport is the fastest-growing emission sector. By subsector, road transport is the largest contributor to global warming.

Environmental regulations in developed countries have reduced the individual vehicles emission; however, this has been offset by an increase in the number of vehicles, and more use of each vehicle. Some pathways to reduced the carbon emissions of road vehicles considerably have been studied. Energy use and emissions vary largely between modes, causing environmentalists to call for a transition from air and road to rail and human-powered transport, and increase transport electrification and energy efficiency. Other environmental impacts of transport systems include traffic congestion and automobile-oriented urban sprawl, which can consume natural habitat and agricultural lands. By reducing transportation emissions globally, it is predicted that there will be significant positive effects on Earth's air quality, acid rain, smog and climate change.

The health impact of transport emissions is also of concern. A recent survey of the studies on the effect of traffic emissions on pregnancy outcomes has linked exposure to emissions to adverse effects on gestational duration and possibly also intrauterine growth.

*Aviation*

The environmental impact of aviation occurs because aircraft engines emit noise, particulates, and gases which contribute to climate change and global dimming. Despite emission reductions from automobiles and more fuel-efficient and less polluting turbofan and turboprop engines, the rapid growth of air travel in recent years contributes to an increase in total pollution attributable to aviation. In the EU, greenhouse gas emissions from aviation increased by 87% between 1990 and 2006. Among other factors leading to this phenomenon are the increasing number of hypermobile travellers and social factors that are making air travel commonplace, such as frequent flyer programs.

There is an ongoing debate about possible taxation of air travel and the inclusion of aviation in an emissions trading scheme, with a view to ensuring that the total external costs of aviation are taken into account.

*Roads*

The environmental impact of roads includes the local effects of highways (public roads) such as on noise, water pollution, habitat destruction/disturbance and local air quality; and the wider

effects including climate change from vehicle emissions. The design, construction and management of roads, parking and other related facilities as well as the design and regulation of vehicles can change the impacts to varying degrees.

*Shipping*

The environmental impact of shipping includes greenhouse gas emissions and oil pollution. Carbon dioxide emissions from shipping is currently estimated at 4 to 5% of the global total, and estimated by the International Maritime Organisation (IMO) to rise by up to 72% by 2020 if no action is taken.

## *Theories of human impacts on the environment(e.g. ecological, sustainability models)*

***Sustainability Model***

A U.S. anthropologist, Margaret Mead (1901 - 1978) in the book titled "The Energy Crisis—Why Our World Will Never Again Be the Same" stated that we are living beyond our means. As a people we have developed a life-style that is draining the earth of its priceless and irreplaceable resources without regard for the future of our children and people all around the world".

The concept of sustainability has grown out of the need to reconcile conflicts between economic development and the conservation of the environment. The 1987 Brundtland Commission on Environment and Development defined sustainable development as 'development that meets the needs of the present, without compromising the ability of future generations to meet their own needs.'

For instance, sustainable farming aims to balance agricultural development with the natural limitations of the environment, while feeding more people and providing many with a better diet. Organic farming, which uses no chemicals, is one form of sustainable development that is slowly being introduced into countries which have alternative sources of food, in case the organic yields decline without the help of artificial fertilizers and pesticides. Others include integrated pest management, which combines the judicious use of strictly timed, narrow-spectrum pesticides with biological and cultural forms of control; and improved methods of irrigation, which deliver measured amounts of water directly to the roots of plants. A key concept of sustainable farming is environmental capacity, determined by assessing how much use a particular environment can withstand before it starts to decline in productivity. The overall aim is for an agriculture that maintains the integrity of agro-ecosystems through a reduced dependence on chemicals, greater care of the soil, and conservation of water. Unfortunately, all these hopeful developments are still a long way from yielding food in the amounts needed to feed the modern world, and they will arrive last in those parts of the world that need them the most.

Conservation biologists also work with established industries to develop practices that ensure the health and the sustainability of the resources on which they depend. For example, conservation biologists work with fishers to determine how many fish the fishers can harvest without damaging the population and the ecosystem as a whole. The same principles are applied to the harvesting of trees, plants, animals, and other natural resources. Preserving biodiversity also takes place at the molecular level in the conservation of genetic diversity. All around the world efforts are being made to collect and preserve endangered organisms' DNA, the molecule that contains their genes. These collections, or *gene banks*, may consist of frozen samples of blood or tissue, or in some cases, they may consist of live organisms. Biologists use gene banks to broaden the gene pool of a species, increasing the likelihood that it will adapt to meet the environmental challenges that confront it. Many zoos, aquariums, and botanical gardens work together to carefully maintain the genetic diversity in captive populations of endangered animals and plants, such as

the giant panda, the orang-utan, or the rosy periwinkle. Captive animals are bred with wild populations, or occasionally released in hopes that they will breed freely with members of the wild population, thus increasing its genetic diversity. These gene banks are also an essential resource to replenish the genetic diversity of crops, enabling plant breeders and bioengineers to strengthen their stocks against disease and changing climate conditions.

UNEP was designed to be "the environmental conscience of the United Nations," and, in an attempt to allay fears of the developing world, it became the first UN agency to be headquartered in a developing country, with offices in Nairobi, Kenya. In addition to attempting to achieve scientific consensus about major environmental issues, a major focus for UNEP has been the study of ways to encourage *sustainable development*—increasing standards of living without destroying the environment. In 1992 the UN Conference on Environment and Development was held in Rio de Janeiro, Brazil. Popularly known as the Earth Summit, this meeting was the largest gathering of world leaders in history. The conference produced two major treaties. The first was an agreement for nations to voluntarily reduce emission of gases leading to global warming, and the second was a pact on biodiversity requiring countries to develop plans to protect endangered species and habitats. At the insistence of the United States, however, the final version of the global warming treaty was dramatically scaled back.

Environmentalists argue broadly in favor of sustainable development. By this they mean a pattern of living that favours the preservation of habitat, the conservation of non-renewable resources, and the increased use of renewable energy sources so that Earth's ecosystems are not harmed beyond repair. Environmentalists favour the principle that polluters should pay for the right to pollute. Concerning genetic engineering, most environmentalists argue for a precautionary principle that emphasizes careful study before new genetically engineered plants or animals are introduced into ecosystems. Genetically modified plants, according to this principle, should not be introduced unless it is clear that no damage will be done. Some politicians and agribusiness corporations believe such a conservative approach would slow growth unnecessarily, lower living standards, and result in greater costs for businesses and consumers. They favour rules based on proven danger and far quicker introduction of genetically engineered products and processes.

## *Ecological footprint*

The **ecological footprint** is a measure of human demand on the Earth's ecosystems. It is a standardized measure of demand for natural capital that may be contrasted with the planet's ecological capacity to regenerate. It represents the amount of biologically productive land and sea area necessary to supply the resources a human population consumes, and to mitigate associated waste. Using this assessment, it is possible to estimate how much of the Earth (or how many planet Earths) it would take to support humanity if everybody followed a given lifestyle. For 2006, humanity's total ecological footprint was estimated at 1.4 planet Earths – in other words, humanity uses ecological services 1.4 times as fast as Earth can renew them. Every year, this number is recalculated — with a three year lag due to the time it takes for the UN to collect and publish all the underlying statistics.

While the term *ecological footprint* is widely used, methods of calculation vary. However, standards are now emerging to make results more comparable and consistent.

Ecological footprint analysis compares human demand on nature with the biosphere's ability to regenerate resources and provide services. It does this by assessing the biologically productive land and marine area required to produce the resources a population consumes and absorb the corresponding waste, using prevailing technology. Footprint values at the end of a survey are categorized for Carbon, Food, Housing, and Goods and Services as well as the total footprint number of Earths needed to sustain the world's population at that level of consumption. This approach can also be applied to an activity such as the manufacturing of a product or driving of a car. This resource accounting is similar to life cycle analysis wherein the consumption of energy, biomass (food, fiber), building material, water and other resources are converted into a normalized measure of land area called 'global hectares' (*gha*).

Per capita ecological footprint (EF) is a means of comparing consumption and lifestyles, and checking this against nature's ability to provide for this consumption. The tool can inform policy by examining to what extent a nation uses more (or less) than is available within its territory, or to what extent the nation's lifestyle would be replicable worldwide. The footprint can also be a useful tool to educate people about carrying capacity and over-consumption, with the aim of altering personal behavior. Ecological footprints may be used to argue that many current lifestyles are not sustainable. Such a global comparison also clearly shows the inequalities of resource use on this planet at the beginning of the twenty-first century.

In 2006, the average biologically productive area per person worldwide was approximately 1.8 global hectares (gha) per capita. The U.S. footprint per capita was 9.0 gha, and that of Switzerland was 5.6 gha per person, while China's was 1.8 gha per person. The WWF claims that the human footprint has exceeded the biocapacity (the available supply of natural resources) of the planet by 20%. Wackernagel and Rees originally estimated that the available biological capacity for the 6 billion people on Earth at that time was about 1.3 hectares per person, which is smaller than the 1.8 global hectares published for 2006, because the initial studies neither used global hectares nor included bioproductive marine areas.

Ecological footprinting is now widely used around the globe as an indicator of environmental sustainability. It can be used to measure and manage the use of resources throughout the economy. It can be used to explore the sustainability of individual lifestyles, goods and services, organizations, industry sectors, neighborhoods, cities, regions and nations. Since 2006, a first set of ecological footprint standards exist that detail both communication and calculation procedures.

*Methodology*

There have been differences in the methodology used by various ecological footprint studies. Examples include how sea area should be counted, how to account for fossil fuels, how to account for nuclear power (many studies simply consider it to have the same ecological footprint as fossil fuels), which data sources used, when average global numbers or local numbers should

be used when looking at a specific area, how space for biodiversity should be included, and how imports/exports should be accounted for. However, with the new footprint standards, the methods are converging.

The primary advancements in ecological footprinting were to include the entire surface of the Earth in biocapacity estimates, allocate space for other (non-human) species, change the basis of equivalence factors from agricultural land to net primary productivity (NPP), and change the carbon component of the footprint, based on global carbon models. The advancements were peer reviewed and published in several books, and have been well received by teachers, researchers, and advocacy organizations concerned about the ecological implications of humanity's footprint. The UK's average ecological footprint is 5.45 global hectares per capita (gha) with variations between regions ranging from 4.80 gha (Wales) to 5.56 gha (East England).

Calculating the ecological footprint for densely populated areas, such as a city or small country with a comparatively large population — e.g. New York and Singapore respectively — may lead to the perception of these populations as "parasitic". This is because these communities have little intrinsic biocapacity, and instead must rely upon large *hinterlands*. Critics argue that this is a dubious characterization since mechanized rural farmers in developed nations may easily consume more resources than urban inhabitants, due to transportation requirements and the unavailability of economies of scale. Furthermore, such moral conclusions seem to be an argument for autarky. Some even take this train of thought a step further, claiming that the Footprint denies the benefits of trade. Therefore, the critics argue that the Footprint can only be applied globally.

The method seems to reward the replacement of original ecosystems with high-productivity agricultural monocultures by assigning a higher biocapacity to such regions. For example, replacing ancient woodlands or tropical forests with monoculture forests or plantations may improve the ecological footprint. Similarly, if organic farming yields were lower than those of conventional methods, this could result in the former being "penalized" with a larger ecological footprint. If the use of ecological footprints are complemented with other indicators, such as one for biodiversity, the problem could maybe be solved. Indeed, WWF's Living Planet Report complements the biennial Footprint calculations with the Living Planet Index of biodiversity.

### ***Bronfenbrenner's Ecological Theory of Human Development***

The ethological theory focuses on the impact of biology on human behavior, while the ecological theory focuses on the impact that environment plays on the growth and development of an individual. A researcher by the name of Urie Bronfenbrenner theorized that there were five environmental factors that impacted an individual's growth and development; the microsystem, the mesosystem, the exosystem, the macrosystem and the chronosystem.

#### *The Microsystem*

The microsystem refers to the environment in which an individual lives. This system includes family members, peers, religious communities, neighborhoods and others whom the individual

has regular interaction and direct contact with. The microsystem is the system in which an individual encounters the most social interactions. The individual is not simply observing or having things happen to them, but helping to create and construct the experiences they have.

### *The Mesosystem*

The mesosystem is described as the interactions between the microsystems. The mesosystem could include experiences at home related to experiences at school, or experiences at school related to experiences at church. Much like the microsystem, the individual is not simply observing the things happening to them, but are playing an active role in helping create the experiences they have.

### *The Exosystem*

The exosystem is a system in which the individual plays no role in the construction of experiences, but these experiences have a direct impact on the microsystems the individual is part of. An example of an exosystem could include a husband being laid off and this lack of employment having a direct impact on the family's financial state that could affect their day-to-day lifestyle and the stress level in the home.

# STRATEGIES FOR MINIMIZING HUMAN IMPACT ON THE ENVIRONMENT

## *Introduction*

The world has seen spectacular political, social, cultural, economic and scientific progress during this century. But this progress has been monopolized by the chosen few at the unbelievably and indescribably large cost of the majority of mankind. The most disconcerting manifestation of this lop sided progress has been our planet's ravaged ecology. The current pattern of unsustainable, inequitable and unstable asymmetric demographic and economic growth has forced many segments of society to come together in facing a critical challenge: how can societies across the world meet their current basic human needs, aspirations and desires, without compromising the ability of future generations to meet their own needs? At the core of this challenge is the question: how can the human race maintain in perpetuity a healthy, physically attractive and biologically productive environment. This calls for a sustainable development or sustainable utilization of our natural resources. The survival and well-being of a nation depend on sustainable development. It is a process of social and economic betterment that satisfies the needs and values of all interest groups without foreclosing future options.

Despite the indiscriminate exploitation of nature by some people, there are a handful of those that are relentlessly working to reverse the detrimental effects of human activities on the environment. The World Wildlife Fund, European Environment Agency and the National Geographic are some organizations that run programs for the preservation of nature and educate and inspire people to conserve all life forms be it flora or fauna. To this end, we must ensure that the demand on the environment from which we derive our sustenance, does not exceed its carrying capacity for the present as well as future generations.

## ***Sustainable Development***

During the last few decades, there has been a gratifying resurgence of this good environmental sense in world. The most important aspect of this growing environmental consciousness in this country is its permeation at the establishment as also the people's level. It is imperative that environmental consciousness becomes a pre-occupation with the people as no amount of government intervention can reverse ecological collapse. Sustainable development offers a new way of thinking which reconciles the ubiquitous human drive to improve our quality of life with the limitations imposed on us by our global context. It requires unique solutions for improving our welfare that do not come at the cost of degrading the environment or impinging on the well-being of other people. Although there is no general agreement regarding the precise meaning of sustainability, beyond respect for the quality of life for future generations, most interpretations and definitions of the term "sustainable" refer to the viability of natural resources and ecosystems over time, and to the maintenance of human living standards and economic development (National Science and Technology Council 1994).

Sustainability is a relationship, or balancing act, between many factors (social, environmental and economic realities and constraints) which are constantly changing (see Figure 1). As one expert has defined it “Sustainable development is a process of change in organizing and regulating human endeavours so that humans can meet their needs and exact their aspirations for

current generations without foreclosing the possibilities for future generations to meet their own needs and exact their own aspirations" (Weston 1995). Because sustainability is a dynamic concept rather than a static state, it requires decision makers to be flexible and willing to modify their approaches according to changes in the environment, human needs and desires, or technological advances.

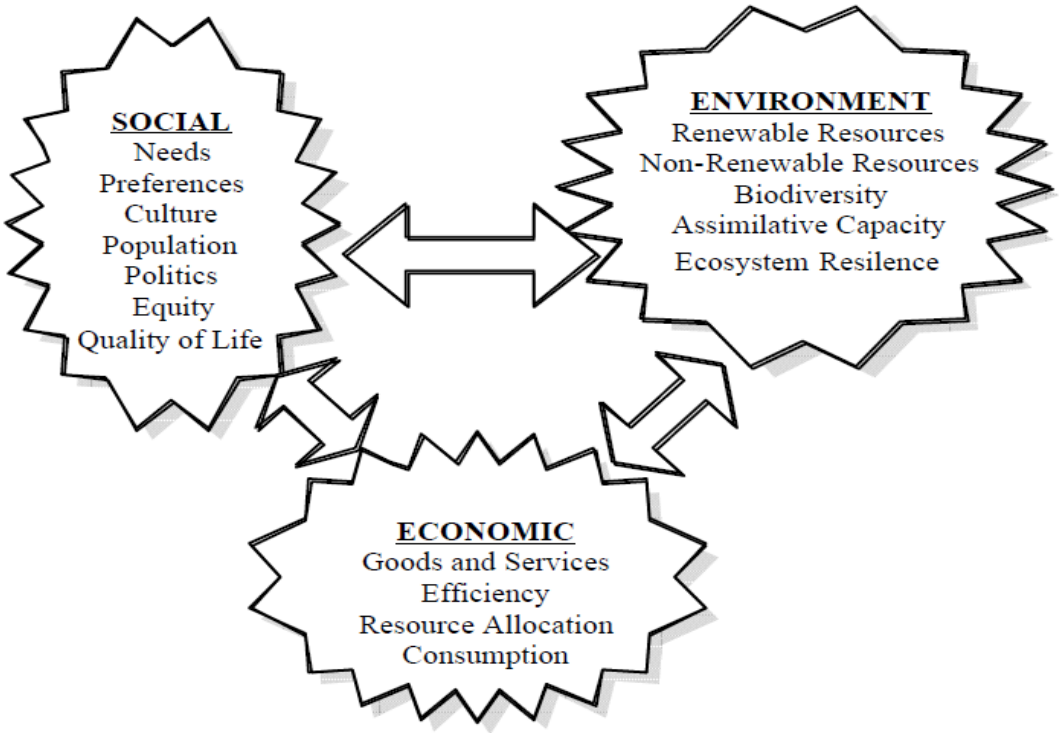



**Figure 1:** The Context of Sustainability. This figure is one representation of the issues which comprise sustainability. Sustainability is at the nexus of sociocultural, environmental, and economic factors. Although useful, this representation is deceptively uncomplicated in its portrayal of the relationships between sustainability issues, because in fact the relationships between these issues are quite complex.

## Social Sustainability

Sustainability is inherently anthropocentric, since it is the welfare of humans with which we are concerned. More than a concern for mere survival, sustainability is a desire to thrive, to have the best life possible. There are many socio-cultural issues which influence sustainability. The most prominent issue is inter-generational equity, in which we must insure that we leave our progeny with the tools and resources they need to survive and enjoy life. As an African proverb says, "We do not own the earth, we are just taking care of our grandchildren's inheritance." In so doing, we should not forsake the quality of life that people today are experiencing. Instead, we must strive to raise the standard of living of those people who *today* lack the most basic requirements such as clean water and adequate food. Other issues in this realm are: environmental justice, population growth, human health, cultural needs, and personal preferences. These elements have a great deal to do with our quality of life and should not be ignored in favour of the more easily measurable economic elements discussed below.

***Environmental Sustainability***

Environmental concerns are also very important for sustainability. The natural environment is the physical context within which we live. Sustainability requires that we recognize the limits of our environment. There are limits to the quantities of natural resources that exist on the planet. Some of these resources, such as trees and wildlife, are renewable so long as we leave enough intact to regenerate. Other resources, such as minerals, are renewed at such slow rates that any use whatsoever depletes the total stock. We need to minimize our consumption of all resources, renewable and depletable. Another key environmental issue is to minimize our impact on global ecosystems: the earth is like an organism and we must maintain it in a healthy state. Natural ecosystems can survive some impacts, but these must be small enough so that the earth can recover. In some cases there are particular resources or elements of an ecosystem which are essential to its health. For example, we might appear to provide enough timber for future generations, but if it is all contained in managed monoculture forests (which fail to duplicate the complexities of ecosystems), our efforts may not be adequate (Norton 1992). Protecting ecosystem health may involve the protection of an endangered species, the preservation of a wetland, or protection of biodiversity in general.

***Economic Sustainability***

Economics, as it pertains to sustainability, does not simply refer to Gross National Product, exchange rates, inflation, profit, etc. Economics is important to sustainability because of its broader meaning as a social science that explains the production, distribution, and consumption of goods and services. The exchange of goods and services has a significant impact on the environment, since the environment serves as the ultimate source of raw material inputs and the repository for discarded goods. Economic gain has been the driver for much of the unsustainable development that has occurred in the past. A shift to sustainability will only occur if it is shown not to be excessively costly and disadvantageous. Part of sustainability is changing the way things are valued to take into consideration the economic losses due to lost or degraded natural resources, and expand our scope of concern from short term to long term impacts. Once this is done sustainable development will be revealed to be a more economically beneficial option than current development patterns.

## *Strategies, Technologies, and Opportunities for Implementing Sustainable Design and Construction*

In the creation of built facilities, there are many opportunities to improve how design and construction are currently done to make them more sustainable. Three general objectives should shape the implementation of sustainable design and construction, while keeping in mind the three categories of sustainability issues discussed above (social, environmental, and economics). These objectives are:

- Minimizing consumption of matter and energy over the whole life cycle of consumption, while
- Satisfying human needs and aspirations with sensitivity to cultural context, and
- Avoiding negative environmental impact.

In the following subsections, we discussed specific strategies for approaching each of the three objectives, along with examples of technologies and opportunities related to each of the strategies.

**Minimizing Consumption**

Consumption of natural resources is at the heart of sustainability. With its large scale use of material and energy and displacement of natural ecosystems, the built environment greatly influences the sustainability of human systems as well as the natural ecosystems of which we are a part. Minimizing consumption of matter and energy is essential to achieve sustainability in creating, operating, and decommissioning built facilities. The following sections highlight several strategies for minimizing consumption of natural resources over the life of built facilities.

***Improving Technological Efficiency: Doing more with less***. One strategy for minimizing consumption in creating the built environment is improving the technological efficiency of our materials and processes. For materials, we need to improve the efficiency with which they meet the needs for which they are used. An example of this is improving the technology of windows to reduce unwanted thermal losses and air leakage in climate-controlled applications. With respect to processes, technological efficiency means reducing the amounts of input matter and energy required to generate the desired outcome of the process. In construction, improving site layout to reduce the travel distance of excavating equipment is an example of improving process efficiency, resulting in fewer equipment hours, less fuel used, and lower maintenance costs.

***Reuse, Rehabilitation, and Retrofitting***. Reusing buildings, materials and equipment is a second strategy for making design and construction more sustainable. By reusing what already exists we save the cost, material, and energy input which would be required to create new facilities "from scratch." The primary reason for disposal of facilities and materials is that those artefacts do not meet the present needs of humans. By using techniques such as adaptive reuse, rehabilitation, or retrofitting, old facilities can be modified or improved to meet new use criteria, at a much lower consumptive cost than building a new facility. An example of adaptively reusing existing facilities are loft apartments developed in the structures formerly used for factories. Materials and equipment can also be reused or rehabilitated to varying degrees. The biggest impediments to this strategy are artefacts which are designed for obsolescence, with short life cycles, or where economic constraints have forced sub-quality construction or manufacturing.

***Creating New Technologies.*** Many opportunities exist to increase the sustainability of human activity by creating new technologies. Consumption of matter and energy can be reduced by developing new technologies which do not rely on traditional types or amounts of materials and energy to meet human needs. Photovoltaic panels, which generate electricity from solar radiation, are one example of such a technology. Instead of using finite reserves of coal or oil to make the electricity used by humans, PV panels use the essentially infinite resource of solar energy. Opportunities for new technologies can be found by observing natural ecosystems: what sources of energy and matter are used by these systems? Particularly promising opportunities exist in the area of waste recovery and reuse. Using waste masonry and concrete from demolished structures as aggregate in new concrete is one example of taking artificially-

generated waste which would otherwise have been disposed in the natural environment, and using it as input back into the building process.

***Modifying Historical Technologies.*** Technologies have been used over the course of human history to meet the needs of people. Many of these technologies have been forgotten or abandoned as new technologies were developed to replace them. While most of these technologies may appear to be obsolete, some may prove to be useful in and of themselves, or to suggest ideas for new technologies. Traditional construction techniques such as rammed earth have found new applications in structures constructed from waste automobile tires, filled with compacted earth. By combining a knowledge of historical building techniques with consideration of the insidious problem of waste tyre disposal, builders have developed a low-cost system which helps to deal with waste disposal while creating a useful and durable structure.

***Reshaping Human Desires.*** A more fundamental strategy for minimizing consumption is to attempt to change human desires and tastes. While fundamental human needs such as food, shelter, and water are not greatly adaptable, other human wants are often significantly responsive to external influences. The obvious architectural trends in built facilities from decade to decade are an example of how designers can influence consumer demand and thus the consumption of matter and energy. Other mechanisms for changing human consumptive patterns are education and awareness. If people are aware of the impacts of their choices on the ecosystems of which they are a part, they may make more enlightened choices.

**Satisfying Human Needs and Aspirations**

The quality of the facility as a man-made environment for people is determined by how well it meets human needs and aspirations for such things as security, non-toxicity, shelter, aesthetics, and other functional requirements. Other human needs which are indirectly met by built facilities include economic profitability for those who participate in the design and construction of the facility. Since sustainability is meaningless without reference to humans and their continued survival, the second objective of applied sustainability is satisfaction of human needs and aspirations.

***Improving Economic Viability.*** In today's world, economic viability is an important consideration for any building project. Indeed, a facility design which is sustainable but too expensive to construct has little value in and of itself. Thus, increasing cost effectiveness of facilities is a critical strategy for creating sustainable built facilities. Economic viability often follows from achieving the objectives of minimizing cost and negative environmental impacts, since less consumption means less cost, and reduced environmental impact means lower liability and remediation costs. However, tradeoffs usually exist with respect to economic viability. While sustainable choices save money in the long term, they are often more expensive initially, making these choices seem unattractive from a short term perspective. To accurately identify the

economic viability of sustainability choices, we need technologies which assist in cost-benefit analysis, financial forecasting, and long term predictions. In addition, revised economic valuation schemes which assign meaningful values to reserves of natural resources and ecological habitats are essential in assessing the economic viability of construction projects.

***Matching User Needs with Facility Design.*** In creating a facility which is sustainable based on the human satisfaction criteria, the first step must be to identify the needs of the people who will use the facility. These needs shape the basic functional requirements of the facility, and must be met in order for the facility to be considered sustainable. The facility design process has been described by one architect as "establish[ing] a 'fit' between the pattern of needs and use: the patterns of built form, servicing systems, technological factors, and environmental factors" (Yeang 1995).
Opportunities exist in the area of systematic human needs assessment, and adapting those needs as input to the design process. Additionally, technologies such as decision support systems can help designers and project decision makers to match user needs with appropriate building functionalities within the design.

***Creating a Healthy Built Environment.*** In addition to the basic functional requirements of users which must be met by the facility, designers and constructors must also strive to include factors which create a healthy environment both inside and outside the facility. Non-toxic materials are an essential component of a healthy built environment, as well as design features which convey aesthetic or spiritual values conducive to the tasks and activities which occur within the facility. Besides the requirements for creating a healthy indoor environment, sustainable design also requires consideration of the interfaces between the built environment and the natural environment. Non-toxic materials and processes are essential technologies for achieving sustainability throughout the facility life cycle.

***Empowering People to Meet their Own Needs.*** A final strategy for satisfying human needs in the built environment is empowerment. By including users in decision making for the planning and design of facilities, the final facility will be more likely to meet the needs of those users. Allowing user participation at all phases of the facility life cycle creates an awareness among the users of the interfaces of the facility with its environmental context, and a respect for the flows of energy and material through the built system over time. Strategies such as owner/builder programs, where people are taught techniques for constructing their own homes, invite a respect for the final outcome which might not exist for manufactured or contractor-built houses. This respect and understanding can only lead to more sustainable design and construction.

**Avoiding Negative Environmental Impacts**

Built facilities impact the natural environment in many ways over their entire life cycles. Yeang (1995) lists four categories of impacts which built facilities have on the earth's ecological systems and resources:

- Spatial displacement of natural ecosystems, and modification of surrounding ecosystems as a result
- Impacts resulting by human use of the built environment, and the tendency for that use to spur further human development of the surrounding ecosystems
- Depletion of matter and energy resources from natural ecosystems during the construction and use of the facility
- Generation of large amounts of waste output over the whole life cycle of the facility, which is deposited in and must be absorbed by natural ecosystems.

Given their large scale and long life cycles, built facilities have particularly large and long-lasting effects on the environment as a whole. The following strategies are examples of approaches which can be taken to improve the sustainability of built facilities by avoiding negative environmental impacts over their life cycle.

**Recovering Waste: Reduce, Reuse, Recycle.** Various approaches exist to help recover waste from building construction and operation processes. Pollution prevention, for example, is a strategy which advocates anticipating and eliminating pollution before it is produced, and has been used very successfully in factory fabrication applications. Material recycling is also commonly used in prefabrication processes, where careful planning can eliminate waste or enable it to be directly recycled back into the manufacturing process or to other complimentary processes. Construction and demolition (C&D) waste recycling is also becoming increasingly popular, as disposal options become more expensive. Promising applications include recycling C&D waste into new composite materials for construction, such as the concrete aggregate mentioned earlier.

**Reusing Existing Development.** Another way of minimizing impacts on the natural environment is by making better use of sites and facilities which have already been used. Rehabilitation of existing structures for similar or adaptive uses, as well as using retrofitted existing sites rather than greenfield sites for new development, are examples of strategies which reduce negative impacts on the natural environment. By reusing existing sites and/or facilities, we save costs and avoid negative impacts by avoiding the need to "start from scratch". Additionally, peripheral costs such as extending utility and transportation systems to greenfield facilities, as well as travel savings for users are reduced or eliminated. Thus, not only is reuse of existing development more sustainable because of its reduced environmental impact, it can also be economically beneficial. Finally, redeveloping unsavoury components of built systems can lead to improvements in the human system as well, by providing better environments for living and encouraging further development.

**Integrating the Built Environment into Ecological Systems.** Sustainability must occur within the context of natural ecological systems, since it is these systems which provide the resources for all human activity. The built environment can be integrated into the natural environmental context of its site and bioregion by designing material and energy flows into and out of the built system to fit within the yield and assimilative capacities of that context. Greywater systems are an example of a technology which has been successfully used to facilitate the processing and absorption of human waste water back into the natural environment. Rather than collecting the wastewater and using artificial chemical treatment processes to eliminate contaminants, greywater systems take advantage of the naturally purifying processes of ecosystems in their operation. As an added bonus, the greywater relationship is symbiotic, since the plants which purify the wastewater use the contaminants as a nutrient. Thus, integration of built systems into the surrounding ecological context can be mutually beneficial to humans and nature, provided that humans do not exceed the assimilative capacity of natural systems.

## *Other Strategies*

### ***Promote Residential Green***

Buildings in Canada, Mexico, and the United States as a way to positively impact global issues such as pollution, dependence on fossil fuels, resource scarcity, loss of natural habitat and species, and climate change. Green building represents one strategy for reducing human impact on the environment. Green buildings can be generally defined as: high-performance, sustainable structures that more efficiently consume and harvest energy, water, and materials while reducing negative impacts on human health and the environment through a holistic approach to design, site usage, construction, operation, maintenance, and deconstruction at the end of a building's useful life.

### ***The Need for Green Housing***

Two of the greatest challenges currently facing the global population are climate change and social and economic inequality resulting from resource scarcity. Green housing can begin to address these challenges by integrating the key areas of environmental and human health: protection of ecosystems; preservation of natural resources (including water, agricultural land, timber, minerals, ore, quarry products, and fossil fuels); reduction of atmospheric pollutants associated with energy use and materials manufacturing; and creation of safe, non-toxic indoor environments. A 'whole-building' approach to residential design and construction combines sustainable site design, water conservation, energy efficiency, environmentally preferable materials, and superior indoor environmental quality to achieve a green end product that meets basic human needs for shelter without compromising safety, security, and health needs. In addition to reducing carbon emissions, green buildings can reduce a host of social and economic costs. For example, significant increases in chemical sensitivity have been linked to volatile organic compounds (VOCs) found in building materials and consumer products.

Multiple Chemical Sensitivity (MCS) is a syndrome in which a sufferer experiences multiple symptoms upon exposure to minute amounts of everyday chemicals, producing some level of unwellness all the time. Often the chemical concentration that triggers a reaction may be so low that the sufferer can't even smell the substance. Although there are a multitude of triggers for MCS, the products related to the building industry include chemicals emitted by carpets, particleboard, and paints, as well as sealants and adhesives. Healthy, low-emitting alternative materials and superior ventilation are two of the characteristics of green buildings that improve the health of occupants, and in turn lessen the financial burden on families, employers, and insurers.

Globally, more than two billion people are expected to live in countries where it will be difficult or impossible to mobilize sufficient water resources to meet the needs of agriculture, industry and households by 2025. Green buildings use strategies to reduce interior and exterior water consumption by 30 to 70 percent. The examples above illustrate that humans face a range of negative impacts linked to the way buildings are designed, built, and maintained. At the micro level, the need for green housing may be propagated by an individual's health concerns; on the macro level, the need is driven by the climate change crisis facing humanity, and the social unrest and violence resulting from resource scarcity. When integrated with improved transportation and eliminating hunger and drought, green building can become a key component to solving the world's greatest challenges.

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