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Human-Environment Interface And Effective Management Of Resources For Sustainable Development

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Abstract

Societal foundations to environmental sustainability, areas of human-environment interface and resource management effectiveness have great significance in sustainable development parameters. Accordingly, the discourses of this research paper include the views of natural and social scientists, tools and languages used in environmental sustainable parlance for assessing on multidisciplinary types of work undertaken as of now. Environmental sustainability is concerned with bio-ecological sciences needs integrative framework, human-environment interface for effective utilization of resources to peace, progress and prosperity of mankind. Developmental activities need strategic way of dealing with the things to control the man-made elements through judicious monitoring as well as sequential simulation of the environmental issues with time bound scientific plans, realistic programs, and appropriate targets. All these are illuminated in sparkling manner to cope up with the man-made causes of environmental degradation for healthy human living tendencies and protection of our future generations. The study provides important findings on different evidential reviews to understand the global changes and to meet the challenges of time with scientific visions, adequate policy formulations by the national governments. Also, some measures are suggested for sustainable development and mitigating environmental problems. At the end, adequate recommendations are given for scientific developmental goals in terms of utilizing the earth's resources as an urgent need. It further provides guidelines on the basis of empirical research evidences to alarming changes in global environment, and concludes on making appropriate decisions for harmonious development with nurturing environmental resources for better future, prospective growth of human civilization and peaceful social progress to achieve sustainable development goals (SDGs).

Key Words: Agricultural Innovation, Environmental Justice, Human Civilization, Integrative Modeling, Multidimensional Scale, Pollution Levels, Tropical Deforestation.

Conceptual Framework

Environment has great relevance to development studies, and therefore, managing environmental resources needs effective human-environment interface. This study is expected to deal with human-environment interface from the view points of societal foundations. In synthesizing the societal foundations, it has been considered that the emergence of a new cross-disciplinary enterprise has given birth to empirical research findings with different visions for environmental sustainability and development paradigms. As a matter of fact, many scholars at the present day studies have attempted for development notions from the view points of environmental social science approach, and so, it is also true to be mentioned here that human-environment interface has wide interactions in empirical research studies. Development is thus essential part of managing effectively environmental resources with relevance to the societal aspects coupled with human natural existence[1]. The conceptual framework of societal foundations to environmental sustainability, areas of human-environment interface and resource management effectiveness have significance in sustainable development parameters. It is therefore essential to mention here that societal foundations are important from the view points of international environmental regulatory regimes (environmental treaties), environmental policy formation, and public environmental concern. Accordingly, we would like to have fruitful discourses including the views of both natural and social scientists, and the tools and languages that are being used in environmental sustainable parlance for assessing more about the conceptual framework of the subject matter through the multidisciplinary type of work undertaken as of now. It will thus reflect on the collaborative work across the natural and social sciences[2] in facilitating to understand the view points of environmental sustainable concepts with reference to developmental paradigms in scientific temper of thought. Thus, it will help for finding solutions to environmental sustainability in utilizing environmental resources. Hence, this research paper will suggest how to use resources effectively for development of society and mitigate environmental problems to bridge the divide between the social and natural sciences under different discourses. With this notion in mind, we have lamented the potential developmental issues with environmental sustainability to assist those who wish to work across these boundaries to have a broad understanding on the underlying assumptions and theories[3], which have been found to be productive in the past as well as in current researches demand. Accordingly, the reminiscent of some of the earlier researches should also be covered under the conceptual framework of the societal foundations of sustainable development. To leverage it, our whole efforts have been concentrated as a compendium of the past experiences of environmental studies, as it applies to how to facilitate the interaction of social and bio-ecological scientists. Thus, as a fillip to continuing challenge on human-environment interface,

various discussions will provide scientific guidelines to members of the community in the present day world who work for sustainability of environmental resources to facilitate a valid as well as scientific conversation, and formulation of basic questions for that are integrative in nature, and to result in better collaboration between scientists for protecting the precious Mother Earth for the future generations[4] as well as for present day living of human beings in harmonious manner.

In nutshell, this research topic covers a wide range of environmental parameters and components, like: (a) environmental anthropology, (b) environmental geography, (c) environmental history, (d) environmental sociology, (e) environmental and ecological economics, (f) environmental psychology and so on. Over and above, the subject matter of environmental sustainability is further concerned with the bio-ecological sciences[5]. Thus, the societal foundations of environmental sustainability pertain to the integrative framework for this research area, and introduce both social and natural scientists to the tasks that we must undertake to make these types of complex systems approaches to move forward. It is thereby presumed from all these facts that the conceptual framework will be very much useful for environmental lovers to enter into the subject matter of sociological issues[6] of environmental sustainable means with profitable opportunity to review things with shared knowledge in participative manner with vast experiences in such cross-disciplinary area. Global environmental issues will be addressed in terms of societal foundations of environmental sustainable developmental paradigms, and therefore, it will be highly beneficial from human peaceful living dimensions in harmonious manner for better future in this Earth. The diverse components of environmental sustainable issues are reflected in various discourses with rational thoughts to understand clearly human-environment interface for attaining the goals of sustainable development in terms of effective utilization of environmental resources for peace, progress and prosperity of mankind.

Objectives of the Study

The study covers wide range of discourses on effective use of environmental resources with protective measures to utilitarian developmental goals. It enumerates reasons to scan productive resources for socio-economic activities to human better living pursuits in modern world. Consequently, the primary and secondary objectives consonance with sustainable development goals (SDGs) accentuates provisions for effective management of environmental resources. Primary objectives relate to empirical evidences supporting sustainable development contained in bio-ecological, natural, and social sciences, Intergovernmental Panel on Climate Change (IPCC), multidisciplinary types of work undertaken so far for assessing issues pertaining to scientific use of environmental resources, vulnerability of modern world, hazardous degeneration of life support systems, fundamental safety consciousness, quality of work life (QWL) etc.; whereas, secondary objectives deal with environmental scanning with scientific tools and

techniques to achieve resource management goals for conservation and protection of the Earth systems with inventive creativity, global dynamicity to cope up with environmental change with unified efforts and integrating biophysical and social sciences. Both these objectives illuminate visions, missions and strategies of holistic sustainable development processes with relativity approach, collaborative system and government policy formulations to promote safety measures for protecting future generations in terms of conserving environmental resources with scientific development notions and appropriate guidelines, to mitigate the challenges of human-environment interface with controllable measures to minimize environmental risks and maximize social progress.

Scope of the Study

This empirical research endeavors to suggest measures for environmental sustainability with effective resource management norms and guidelines. It perpetuates level playing role model to protect precious environment in promoting civil living initiatives with valuable means. To ensure nurturing scarce resources of nature with justice driven principles of work in equanimity concept and emancipation of human beings from severe societal sufferings to a stage of liberal living autonomy with SDGs as well as cementing effective public relationships, the study furnishes long-run perspective of dynamic social progress. Findings and conclusion of such theoretical research effort will provide opportunities to policymakers, administrators, researchers, social thinkers, environmentalists, reformers, academicians, entrepreneurs, jurists and others to frame models of SDGs in future. The study has immense scope of embracing holistic development thought, inclusive growth perspective and forward looking tendencies with resource management utility and framing scientific decisions to progressive agenda as well as implementing policies for environmental sustainability with stakeholders' confidence. Altogether, the study strengthens the pyramid of global society in performing socio-economic activities with integrated approach for peace, progress and prosperity of human civilization in terms of environmental safety measures.

Methodology

The study is mainly concentrated on theoretical research practices, and therefore, secondary sources are utilized for historical analysis of things. Essential facts are reflected in terms of government reports, reports of international institutions, agencies and organizations. Policy decisions of government, international organizations and agencies are attentively observed with path-goal relational approach. Again, information technology and internet services, books, journals, periodicals, reviews and some other important sources well warrant the methodology of discussions for covering wide issues of effective resource management initiatives, environmental sustainability and human social progress in equipoise

nature of doing things to profess, promote and practice the sustainability science in terms of SDGs. Thus, the entire study demarcates areas of human deprivation and societal injustices for healthy living pursuits with environmental protective measures. All these are accentuated scientifically, discussed chronologically and lamented for healthy exercises with relativity aspects for objective conceptualization purposes to adopting resource management policies, programs and procedures. As a whole, the secondary sources strengthen pillars of human society in terms of academic discourses for developing models of social progress, implementing policies for dynamic growth and framing strategies for realistic journey of life with civil liberties to existential autonomy of human life bringing processes. Hence, the secondary sources adopted under the study for scientific explanations of things have enriched the whole spectrum of resource management activities for environmental sustainability in holistic and all-comprehensive manner, to work as a rejoinder as complement to prepare the road map of SDGs.

Challenging Phases of Human-Environment Interface

Human beings have been facing great challenges mostly during the last two-three decades in this world of living due to environmental changes, which have caused for the rapid development of researches on human side of harmonious living dimensions. The challenges have been evidenced in front of all of us which are caused due to climate change[7], loss of biodiversity, rapid deforestation in the tropical areas of the world and so on. Again, it is also observed that there has been an impending crisis in availability of potable water, unseasonal heavy rains in some parts of the earth, lack of adequate rainfall where it is needed, loss of crop harvesting, high temperature, severe floods, draught, etc. have made scholars and policy makers aware of the need to address the causes and consequences of these global processes. Moreover, it is widely recognized that these cumulative processes vary in their severity from region to region, and from place to place. In order to understand these processes, researches in the past decades have supported the breakdown of traditional disciplinary boundaries in order to study more systematic way the complexities of the present human problems, and for the edifice of a good interface between human living and environment factors[8]. While interdisciplinary research is nothing new, there has been considerable progress in identifying some of the dimensions that speak to these contemporary environmental problems. As such, environmental challenges to human living parameters begin with the examination of the mounting evidences for the cumulative nature of global environmental change, and the requirements to begin to scientifically understand it with the proximity of environmental consequences related to better living of human beings. Scientists working on all such issues have come to a nearly unanimous conclusion that we cannot begin to understand global environmental change without a

concerted and unified effort that integrates both biophysical and social sciences (NRC: 1997; NSF: 2003). Accordingly, it is true to say that human agency (actions of individuals) is implicated in most of our current dilemmas, and must play role in solving them. However, integrating the social and natural sciences has not been easy, nor has the cacophony of competing theories and paradigms helped to promote collaboration between the social sciences and the natural sciences. Hence, the challenges in front of modern human beings as well as for future generations regarding safe environment[9] have become a major concern for all thinkers in this world. So, we would like to deal with different evidential reviews under the whole study for the nature of the global changes from time-to-time observed frequently, and therefore, it is considered here that coping with challenges in time with scientific visions as well as adequate policy formulations by the national governments will lead to the path for achieving SDG by overcoming the problems of environment resources utilization in healthy manner. As a matter of fact, it is asserted equivocally that the understanding of all these complex issues in bio-geophysical and social processes will provide appropriate guidelines to mitigate the challenges of human-environment interface judiciously for assessing on the issues of more sustainable impact of environmental healthy elements[10] for survival benefits of all human beings. In short, the historical perspective of the development issues in environmentally sustainable means require positive analysis of the interdisciplinary areas, the study of which will be immensely helpful for knowing exactly about the global environmental changes. Thus, the challenges of human-environment interface can be monitored effectively by taking decisions at right time, preparing and implementing strategic as well as standing plans and adopting human controllable measures to minimize environmental risks for better future[11], greater progress and prosperous life with means of SDGs.

Utilization of Resources and Global Environmental Changes

The present condition of our planet is very much serious and worrisome to those who pay close attention to the evidences of the scientific studies. At present, over the world at large, more and more species are becoming endangered or going to be extinct forever. Wetlands are disappearing at a rapid rate, endangering the migration routes of birds, and the maintenance of local and even intercontinental biodiversity[12]. Unprecedented levels of CO2 threaten our climate system, coral reefs, the Greenland areas and the Antarctic ice sheets. Pollution levels in a growing number of cities can only be called toxic for human health and habitation purposes. Such vicious stories are going on for many years in the world and all these provide us the major causes for environmental degradation. There has been considerable alarm, being given by the environmental and natural scientists for long; but still such panic situations are being

continued by enormous rate of industrial growth unscientifically and without having adequate planning measures by the national governments throughout the world at large. There is very little evidence that governments are succeeding in implementing concrete strategic policies which ensure a sustainable earth system[13]. Everyone these days talks about sustainable development, but fails to implement measures to reduce our downward spiral, and also we have failed even to define the actual meaning of sustainability, or even how we can mitigate environmental problems for beginning to get on the path of sustainability in terms of scientific development goals. What is not widely recognized is that we have in the past 60 years changed nearly every aspect of our relationship with the environment. This fact cannot be ignored by anyone else in the world. We know that the Industrial Revolution began at about 300 years back from now, and since then, the impact and the pace of our impacts on the earth have been gradually increasing (Turner et al.: 1990). Yet, the impact in the past 300 years pales by comparison with our impact in the past 60 years. We have no equivalent experience in our entire history or prehistory as a species[14]. Burning fossil fuels results in emissions of vast amounts of carbon dioxide and other earth-warming gases that are changing the atmosphere, the productivity of terrestrial vegetation and these consequences are at the highest levels known over the past 400 millennia. It is also observed that more amount of nitrogen fertilizer is applied in agriculture than is fixed naturally in all terrestrial ecosystems (Crutzen: 2002). Again, it can be mentioned here without any doubt in mind that fishing fleets have depleted the stock of many species, and removing more than 25% of the primary production in upwelling ocean regions (Crutzen: 2002). As a result of environmental changes, the catches are collapsing very speedily day-by-day. Another notable fact is that irrigation and other alterations of surface and underground water are increasing the vulnerability of hydrologic systems[15]. It has been causing detrimentally to the people that depend on these precious water sources (Crutzen: 2002). Unplanned agricultural activities have resulted in massive deforestation and alteration of land cover at huge scales. The amount of land devoted to agriculture has increased almost five-fold over the past three centuries (Lambin and Geist: 2006). Briefly speaking, human developmental activities have been going on in this world with pervasive nature
which has made all such above situations for environmental changes, and it has made human beings fully capable of altering the earth system in ways that could change the viability of the very processes upon which human and nonhuman species depend[16]. The pictures illuminated here on the basis of empirical research findings, and both the data as well as information at global scale are now abundant in the researches made on environmental degradation and its impact on the Earth. Global environmental changes have therefore been unleashed for putting fingers in our eyes to the facts of alerting reasons with higher magnitude and seriousness to the man-made processes that have been observed so far. All such evidences tell us the stories of exponential increase in carbon dioxide, exponential rates of ozone depletion and

nitrous oxide concentrations in the atmosphere, rapid losses in tropical rainforests, and increases in the frequency of natural disasters and in the rate of species extinctions[17]. Accordingly, we can mention some other man-made reasons of environmental degradation, such as: (a) unplanned fertilizer consumption in agricultural fields, (b) damming of rivers, (c) unscientific water use for agricultural and other purposes, (d) huge paper consumption activities, (e) increasing number of people living in cities, and (f) the increasing number of motor vehicles (Steffen et al.: 2003) used by human beings, among others. There has also been a steady increase in the last 60 years in the incidence of armed conflict worldwide (Kates and Parris: 2003). As for example, it can be cited here that only in 1992, one third of the world's countries were involved in such conflicts[18]. Moreover, in that particular year 40 million refugees and displaced persons were affected by armed conflicts (Ibid, p. 8062). These figures do not include the growing globalization of both terror and crime beyond state borders. Some have described this growing conflict in terms of "the coming anarchy" and as a "clash of civilizations" (Ibid.).

If we turn our eyes to the historical perspective of development in the human civilization, then it becomes easily understandable that all such man-made incidences have increased several-fold during so long years in the Earth. However, we may say that the exponential increase in all these measurable phenomena is tied to the increase in the human population and to our consumption habits[19]. The repercussions of enormous growth of population in the world is that one Euro-American citizen consumes 25 times the resources that one average citizen from India, Guatemala, or other less developed countries does (Redclift: 1996; Wernick: 1997). As such, it is observed that the birth rates have steadily declined to replacement level or even below in developed countries, and these populations continue to impact the earth's resources far more than the larger populations in developing countries. Both developed countries and developing countries have a huge impact on the environment, the former through consumption, and the latter through population increases. In this way, it is found from empirical research evidences that there has been alarming changes in the global environment[20].

Re-conceptualizing the Earth System for Development

To protect the Earth from inhuman and unscientific man-made activities, it is necessary to chalk out a global plan of action (GPA) and common agenda for human activities (CAHA) in the world very urgently. Only replacement of population will not be enough at the present situation, though some developing countries have now succeeded in reducing the growth of population[21]. As for example, it can be said that Brazil is now at, or below, replacement. In all societies one sees conflicting cultural values. Europe has similar traditions to the USA in a number of regards, e.g. democratic institutions, capitalism, etc. But it does not value individualism above the common good. This has made it possible for Europe to accept more quickly than the US the proposed reduction of carbon dioxide in the atmosphere to 1992

levels and thus to support the Kyoto Protocol on the emission of greenhouse gases. A profound rift between the more advanced nations of Western Europe and the USA has developed over the willingness of the former to set limits on carbon dioxide emissions[22], and the unwillingness of the US to do so. Nevertheless, we must remember that even West European countries have had difficulty meeting the Kyoto greenhouse gas emission targets. Again, the use and misuse of the earth's resources is at the very center of international negotiations, the global political economy and the fate of nations. These negotiations require an understanding of both environmental science and social science. Thus, there is urgent need for integrative science that can address the biophysical and the social dimensions of 'human-environment' interactions judiciously. On the other hand, it is observed that the Cartesian dichotomy between humans and nature is a peculiar notion in Western society. Most peoples in the world see humans as very much a part of nature[23]. In its more extreme forms, it takes the form of ideologies where we are reincarnated in forms other than human, i.e. plant, animal and vice versa. Mythologies across the globe have always pointed out the close connections in between the both about their origin, and also about the continuity between animals in nature and us; between the plants in the landscape and our spiritual and material lives

(Pretty, 2002: 13). Australian Aborigines' Dreamtime embodies these beliefs, for example, in how the land came to be, how closely they are still connected to these ancestors and why the land must be respected in the way that it belongs to no one else, but that it belongs to everyone[24]. Again, in modern times we even know that we are closely tied to our primate ancestors, with over 90 percent of our DNA shared with them, yet we insist in our philosophical stances and behavior to act as if, we hold a place above the rules that govern the rest of the species on the planet. Hence, one of the challenges we must face in these days is rethinking how we view the environment. Dichotomous thinking led us to think of people as apart from nature, and charged with controlling nature for human purposes[25]. Thus, it is a matter of distinct thought for knowing about the reasons of our differences crucially, which are seemed to be as distinct from the inherent dynamics of the earth system itself. Accordingly, from this error has come the lot of our post-World War II spiral towards self-destruction which is obviously visible to the earth.

As a matter of fact, we must re-conceptualize the working of the Earth system in a way to know what happens to the air we breathe, the water we drink and the land upon which we depend for our food. All these aspects concern us about the Earth system, and therefore it matters to explain the phenomena for protective measures to bring in greater sustainability. If we take care of all these situations, it will help us to nurture the system of the Earth[26], and if we damage its capacity to provide us with sustainable goods and services and the comfort of aesthetic beauty, we will put ourselves at risk. We cannot do propagate this conception alone, but rather there must be a partnership and participative concept for preserving and

conserving the Earth's system which needs trust and confidence among the whole human communities bound by covenants that favor life over material accumulation and is beneficial to all. Also, it must favor dignity for members of the community as a whole, the pleasures of taking care of each other and nature as the highest well-being for all living beings. We therefore need to re-conceptualize our relations with each other and with nature[27]. We should think piously about ourselves as human agents and as organic parts of nature (Moran: 2006). With such notion, the Vedanta approach of environmental sustainability is dealt with by Rishis, Munis, Seers and Sages long back in historical perspective in the past in human civilization. So, the Vedic hymns pronounced by them all as with the unity in diversity in equivocal manner: "Vasudhaiva Kutumbakam" is the exclaiming demand of the day for maintaining the scale of sustainable environment and to abide by the original system of work in human living nature on this Earth[28]. This principle of environmental thought still holds good in these days of scientific envisagement in the world.

Environmental Change Elements and Sustainable Development Parameters

It has been observed in the realm of human living elements that various processes of human living variables rise to a number of concerns in issues pertaining to environmental sustainable development parameters. Population has been increasing rapidly since 1750, but it has gone exponential since 1950, and thereby it shows a very little sign of leveling off in the next 30 to 40 years[29]. In the past 60 years we have gone from 2.5 billion to 6 billion people. In less than 30 years the human population will be in excess of 10 billion. Further, the total Gross Domestic Product (GDP), foreign direct investment (FDI), damming of rivers, water use, fertilizer consumption, urban population, paper consumption and the number of motor vehicles have all jumped exponentially since 1950, and accordingly, there has been no evidences regarding the turnaround in this upward increase of population increase[30]. This increase would be enough evidence for substituting our views to explain on the sustainable development parameters in reflecting the various issues pertaining to environmental sustainability in realistic sense of the terms. Again, the rate of increase in several spheres of human activities for the past 300 years such as: (a) population (US Census Bureau: 2000), (b) world economic GDP (Nordhaus: 1997), (c) motor vehicles (UNEP: 2000), (d) energy consumption (Klein Goldwijk and Battjes: 1997); among others have furnished a well picture about the environmental degradation, and therefore, it is reasonably believed that the cause of concern for it, if it were happening in one or two of these measurable areas should be taken care of for all such happenings in simultaneously to the development paradigms. As if this were not enough reason for concern, and therefore, similar synchronous events are being observed to be happened to the biophysical side of the whole picture[31]. Of the different change elements in the environmental issues, the CO2 concentrations, N2O concentrations, CH4 concentrations (all the three of them are earth-warming

gases), ozone depletion, Northern Hemisphere average surface temperatures, the number of natural disasters, the rate of loss of fisheries, the increase in nitrogen fluxes in coastal zones, the rapid loss of tropical rain forests and woodlands and the number of species gone extinct have all gone exponential since 1950. While some other might argue this fact that there is enough evidence that CO2 concentrations are actually beneficial to many plants and can result in enhanced productivity, the experimental studies have shown that the increases in productivity when CO2 concentrations are up to a certain level (e.g. 56 pa) can take place but that these gains are lost when concentrations go higher (e.g. to 70 pa), at which time there is a steady decline in productivity (Granados and Korner: 2002). There are also notable differences in how different species and types of forest vegetation respond to CO2 enrichment (Norby et al.: 2002). There is very little positive light that can be found in these measures going exponential. So, there is a question naturally arises in mind of all judicious thinkers: "Are thresholds about to be crossed from which systemic collapses can ensue?" Hence, it can be said without any doubt in mind that one of the most troubling changes in the planet has been observed for the human alteration of the global nitrogen cycle[32]. We know with a high degree of certainty based on available scientific evidences the following repercussions: (a) that we have doubled the rate of nitrogen input into the terrestrial nitrogen cycle and that these rates are still increasing; (b) that increased concentrations of the greenhouse gas N2O globally and other oxides of nitrogen drive the formation of photochemical smog; (c) that this nitrogen increase has caused losses of calcium and potassium from soils essential for soil fertility have all contributed to the acidification of soils[33], streams and lakes; increased the quantity of organic carbon stored in terrestrial ecosystems and accelerated losses of biodiversity, particularly plants adapted to efficient use of nitrogen (Vitousek et al.: 1997).

Thus, it appears from the above discourses that surface temperatures over the Northern Hemisphere at present are warmer than at any other time over the past millennium, and the rate of warming has been especially high in the past 60 years (Hurrell et al., 2001:603). Further it is observed that agricultural yields, water management and fish inventories are affected by such warming reasons, which could be assessed scientifically, and therefore, there is prone consequences of these effects which must be having phenomenal impact on the sustainable development issues of environmental surroundings, as it does in its origin to an upward trend in the North Atlantic Oscillation[34], and dictating thereby the climate variability from the eastern seaboard of the US to Siberia and also from the Arctic to the subtropical Atlantic regions. Accordingly, it can be predicted that changes in the North Atlantic Oscillation, in turn, affect the strength and character of the Atlantic Thermohaline Circulation (THC). In this way, it is evident that the climate changes can have profound effects on society as suggested by recent research studies. As a result, the suggesting guidelines are a kind of warning to all of us that the lowland Maya collapse was associated

with an increase in droughts in Yucatan which is resulting to a severe warning for future generations at the most viable causes of environmental degradation[35]. These are but, altogether the changing phenomenon of the world of human living tendencies with enormous rate of depleting the situations of the Earth, and therefore, be required to be taken into consideration for protection of our future generations with scientific planning, realistic developmental activities and strategic way of dealing with the things for controlling the man-made elements through judicious monitoring as well as sequential simulation of the environmental issues with time bound plans and programs[36]. Thus, the various change elements: (a) nitrogen fixation (Vitousek: 1994), (b) species extinction (Smith: 2002), (c) northern hemisphere surface temperature (Mann, Bradley and Hughes: 1999) and (d) atmosphere CO2 concentrations (Keeling and Whorf: 2000); among others, have increased environmental risks on the spheres of the earth system due to man-made agents, which are required to be managed with scientific controllable measures very immediately.

Necessity of Sustaining Resources with Climate Change Studies for Developmental Needs

From the bicentennial oscillations in precipitation (Hodell et al.: 2001), it has been known that the environmental situations are going to be decay more seriously in coming days. The Maya were dependent on rainfall and small water reservoirs for the sustainability of their agriculture, and these multi-decadal and multi-century oscillations in precipitation probably exacerbated other challenges faced by the Classic Maya (Demarest: 2004). One of the conclusions of recent climate change studies is not that it will be warmer everywhere; but rather, that we will see more extreme events more frequently in the near future, such as the occurrence of El Niño events with drought in some places and flood in others (Caviedes: 2001). Again, in Brazilian Amazonia there is already serious concern with the increased frequency of devastating fires entering into Amazonian forests as a result of El Niño. Moreover, in 1997 climate scientists and ecologists were in agreement that the droughts associated with that El Niño were responsible for a fire that consumed 13,000 square kilometers of forest in just one location[37]. We could also know of similar vast fires during the period 1982–83 in El Niño over Borneo (Prance, 1986: 75–102) and of devastating fires in the Amazon at about 250–400 years ago (Sanford et al.: 1985). As such, it is well known to us that climate change will increase the severity of population and species declines, especially for generalist pathogens infecting multiple host species. The most detectable effects relate to geographic expansion of pathogens, such as Rift Valley fever, dengue fever and Eastern oyster disease. Whereas, it is observed that some more factors are surely implicated, such as land-use change, among others[38]. There is also very little doubt in the end that warming trends will affect crop and human diseases (e.g. potato late blight; rice blast; cholera and Rift Valley fever) (Harvell et al.: 2002). Climate warming is also expected to alter seasonal biological phenomena, such as plant growth, flowering and animal

migration (Penuelas and Filella: 2001). Some Canadian tree species (e.g. Populous tremulous) show a 26th day shift to earlier blooming over the last century. Further, the biological spring in Europe is about 8th days earlier from data for the period 1969–98 (Ibid.). In the Mediterranean, leaves of deciduous plant species now unfold 16th days earlier and fall on average 13th days later than they did 60 years ago (Ibid.). In short, the simultaneous and interconnected nature of these changes in human and in environmental conditions since 1950 suggest that human activities could inadvertently trigger abrupt changes in the earth system with consequences that we can only faintly imagine. The most troubling of all is, of course, triggering a disruption in the "oceanic conveyor belt," as it is called, which regulates world climate (Broecker: 1991). The increases in greenhouse gases can trigger changes in the North Atlantic circulation and computer simulation results have most of the scenarios resulting in rather dramatic collapses[39]. It is a well known fact that already the Atlantic Thermohaline Circulation (THC) can have multiple-equilibrium and multiple thresholds, and that THC reorganization can be triggered by changes in surface heat and in freshwater fluxes. Thus, the crossing thresholds can result in irreversible way**.** To the contrary, it is better to mention here that the Vostock Ice Core provides the best current record of carbon dioxide changes for the past 420,000 years (Petit, Jouzel and Raynaud: 1999). Again, the changes of ocean circulation (Rahmstorf and Stocker: 2003) have been more prone to affect environmental sustainability. Our current situation with regards to CO2 alone, not to mention all the other earth warming gases being emitted exponentially[40], and is well above the experience of the past 420,000 years as recorded in the Vostock Ice Core. The evidences for the seriousness of climate change have been affirmed at a meeting of members of 63 national academies of science from all parts of the world, which is stressed by affirming support for the work of the Intergovernmental Panel on Climate Change (IPCC) and thereby assuredly contended by pointing figure that it is at least 90 percent certain temperatures will continue to rise by at least 5.8 degrees Celsius above 1990 levels by 2100. Thus, important suggestions are put forward by urging for prompt action to reduce emission of greenhouse gases (IPCC: 2000). In their joint statement, the representatives of the 63 national academies of science concluded thus: "The balance of the scientific evidence demands effective steps now to avert damaging changes to Earth's climate." (Inter-academies: 2000). The past 60 years have been devastating to the earth system's functions[41].

These changes have been of sufficient magnitude to rival climate change in both environmental and social terms (Vitousek et al.: 1997; NRC: 1999, 1999). During the first 50 years of the twenty-first century, demand for food and other commodities by a wealthier and larger global population will be a major driver of global environmental change (particularly from the BRIC countries, Brazil, Russia, India and China). While some of this change may come from more intensive and efficient agricultural production, and much of it will come from converting further land areas and natural ecosystems into agricultural fields[42]. This

will result, at least, in a 2.5 fold increase in the amount of nitrogen and phosphorus making its way into terrestrial freshwater and near-shore marine ecosystems resulting in unprecedented eutrophication and habitat destruction (Tilman: 2001). Much of the nitrogen and phosphorus from fertilizers and animal wastes enters surface and groundwater untreated and unimpeded to any significant extent (Tilman et al.: 2001). The result is eutrophication of estuaries and coastal seas, loss of biodiversity, changes in species composition, groundwater pollution and troposphere smog and ozone depletion. The projected conversion of up to 1,000,000,000 hectares of natural habitat to meet our expected demand for food is viewed as conservative. For most of the 400 generations that we have been farming, production and consumption of food has been intimately linked to social and cultural systems[43], to systems of beliefs and respect for the environment. Foods were given special meaning and were surrounded with ritual. First crops harvested were treated with deference and gratefulness. We still see some of these practices in some ethnic rural populations and even in an industrial superpower, such as Japan; particularly in relation to traditions regarding rice. Japan's rice paddy fields are carefully maintained, even by those who hold other employment as their main means of support, and all special occasions include rice dishes as ways of connecting people to this basic staple and giving it importance. Rivers and mountains embodied the divine and the forces of creative and destructive nature that were respected[44]. Over the past three generations we have changed this respect for the environment in too many places. Industrial agriculture has steadily replaced family farms worldwide and, while this seems to produce a lot more food in absolute terms, it does so at huge cost in terms of loss of soils, damage to biodiversity, pollution of the air and water, and negative impacts on human health through heavy use of chemicals (Pretty, 2002:
xii). Industrial agriculture, in an age of cheap fossil fuels was able to ship produce across large distances and drive local producers out of business. In a future world, where fossil fuel will be increasingly dear, we will need to redesign whole systems of food production[45], and more directly linking those who grow food to those who consume it, and also will be using methods that have a lighter impact on the environment, and in which the land takes on, will once again, find the nurturing value that it had for most of human history. In the past 35 years, we were able to double food production but we did so with a six-fold increase in nitrogen fertilization, a threefold increase in phosphorus fertilization and a substantial increase in the area under cultivation (Tilman: 1999). Another doubling of food production would result in a threefold increase in nitrogen and phosphorus fertilization and an increase of 18 percent in cropland cultivated. These increases will further entropy fresh and marine ecosystems, leading to biodiversity losses, shifts in the structure of the food chains and impairment of fisheries (Tilman: 1999).

Human-Environment Dimensions of Environmental Studies for Sustainable Development

The study of global environmental changes was carried out largely until 1998 by the earth science disciplines, such as meteorology, atmospheric chemistry, atmospheric sciences and geology. So, the main focus of this work under the aegis of the International Geosphere-Biosphere Program (IGBP) has been devoted towards the documentation of the extent of biosphere change and projecting at global scale the likely consequences of changing atmospheric conditions on the earth[46]. Accordingly, environment related modeling, particularly global circulation models (GCMs) were heavily used in that during those periods given the absence of many important data points and the ambition of understanding the global environment. As result, it is observed that scientists were busy then identifying and lobbying for research activities in areas needed to better run the GCMs. Among the many achievements of this effort, for example, was the creation of a vast network of buoys in the earth's oceans to measure changing temperatures. Over time they led to the current ability of atmospheric and marine scientists to forecast El Niño and La Niña events many months in advance of human populations feeling their terrestrial impact. Scientists accurately predicted the onset of the 2002–2003 El Niño Southern Oscillation almost a year in advance and farmers in many locations further modified their planting behavior, and thereby reducing economic losses and human misery[47]. This is done by observing the warming or cooling of the waters over the northern Pacific and following its circulation around the globe. But something was missing. The coarse spatial scale of these early GCMs did not allow for any meaningful role for what human behavior does within the earth system, which ran at very coarse spatial (several degrees of latitude) and temporal (decades to centuries) scales with broad assumptions like, what might happen if all tropical forest cover were removed and replaced by pasture. While the results of such models were informative and so, they rarely included adaptive behavior on the part of humans, who are likely to desist from the total elimination of tropical forest cover by information, dissemination and feedback processes[48]. At the request of scientists associated with the IGBP, the International Social Science Council (ISSC) was asked to consider assembling a working group to develop a human dimensions (social and economic sciences) agenda to parallel the ongoing work of atmospheric and climate scientists working on global environmental change. The ISSC met and recommended that it would be desirable to begin to create national panels to undertake such a discussion and write up research plans that would articulate well with the IGBP research. It had led to the creation of a group parallel to the IGBP, named as Human Dimensions Program (HDP). Moreover, in the USA, both the National Research Council (NRC) and the Social Science Research Council (SSRC) created expert panels of scientists to discuss research priorities for the human dimensions as well. The obvious changes in our global environment led first to the creation of a network of scientists to address these globally scaled processes. The IGBP was started in 1987

because of the need for an international collaborative research endeavor on the phenomenon of global change. A Special Committee was appointed to guide the planning and initial implementation of the program. The planning phase ran from 1987 to 1990 and involved about 500 scientists worldwide. This community of climate and atmospheric scientists, in turn, turned to the social sciences in 1988 and asked them to join in an effort to understand the human dimensions of global environmental change (NRC: 1999, 1999). This agenda began to be formulated in 1992 with the National Research Council's book, Global Environmental Change:

Understanding the Human Dimensions (NRC: 1992), which set the early agenda for research in this area. The early research on global change had focused on: (a) climate change, (b) biodiversity, (c) pollution and (d) international environmental agreements driven by a growing awareness of global impacts, such as accumulation of earth-warming gases, the appearance of an ozone hole changing the amount of ultraviolet (UV) radiation people receive and documentation of glacier meltdowns[49].

Current trends are expected to continue to have cumulative effects on the atmosphere and climate change (NRC: 1998b; Hunter: 1999 and Potter: 1999). In short, human dimensions research addresses the workings of social systems that manage environmental resources, such as: (i) markets, (ii) property rights regimes, (iii) treaties, legal and informal norms; among others[50]. The potentials of these are required to be through institutions in terms of policy resolutions. Thus, to mitigate global change or increase adaptive capability (NRC, 1999: 5) some issues were identified in 1992 for drawing urgent attention and research priority. These were: (1) understanding land-use and land-cover changes; (2) understanding the decision-making processes; (3) designing policy instruments and institutions to address energy-related problems; (4) assessing impacts, vulnerability and adaptation to global changes; and (5) understanding population-environment interactions[51]. In this way, a great deal was accomplished in the years that followed, focusing on the causes, consequences and responses of human populations to global environmental change (NRC: 1999). Advances were particularly notable in the study of land-use and land-cover change which had been defined as the topic that the research community was mostly ready to undertake. Hence, some of the issues of environmental studies are synthesized and reproduced in the works of Gutman et al. (2004); Moran and Ostrom (2005); NRC (2005) to understand human responses to climate related events.

Environmental Socio-Ecological Dynamics of Sustainable Development

As a species we have relied on our capacity for sociality and communication in order to surpass our physical limitations (Richerson: 1977). Our success as a species in spreading and colonizing the planet was through operating as relatively small groups of hunter-gatherers (HG). HGs' advantages were their behavioral flexibility, based on small-group, trust and reciprocity, in response to opportunities and their

highly mobile strategy of resource harvesting[52]. This strategy served our species well for most of our time on the planet. However, as we grew in population size this strategy began to demonstrate its limitations in providing for an ever larger population. Hunter-gatherers knew about plant reproduction and carried out light management of plants of interest to them long before they began to sedentary and turn into farmers (Smith: 1989). This first major transformation in socio-ecological systems, from hunter-gathering to farming was a result of population increase, growing confrontation of HG bands over resources and of rising costs and risks of moving into marginal environments. It took a couple of millennia for the transformation from a mostly HG landscape to one increasingly occupied by farming groups i.e., in North America (Smith: 1989). Whether famine played a role is not clear from the archeological record. Like many other transformations in social ecological systems, it probably had the shape of the diffusion of innovations (Rogers: 1969) with a few adopting the change early, followed by a very slow adoption by others, and finally substantive adoption when the benefits were absolutely clear to most and the price of no adoption was dear[53]. The greater density of farming communities allowed them to occupy preferred territories and HGs increasingly were pushed into marginal areas which could not be cultivated. The keystone features of this new farming mode of production were: (a) the evolution of community institutions; (b) shifts in the scope of reciprocity and trust; (c) domestication of plants and animals; and (d) sedentary. The shift in reciprocity and trust led to features of social cooperation being associated at first with the settlement and as settlements grew in size to kin-based groupings, such as lineages, clans and moieties. This reduced flexibility in HG systems since the common form of descent was bilateral, meaning thereby that individuals traced their descent from either the paternal or maternal sides and band membership was highly flexible. In settled farming communities, control over land through inheritance grew over the years. In order to ensure control over the better land and eventually over investments, such as irrigation, homes, lineal descent, etc.; the topic “People and Nature” (Moran: 2006) is expected to illuminate the whole pictures which will not be discussed here for our purpose. However, either through father, or mother it came into play important role in order to provide clear forms of inheritance, along with the development of rules of preferred marriage, and even endogamy, to ensure control over resources. Whereas, exogamy had been preferred before, and indeed it is a preferable evolutionary strategy[54] from a biological perspective with the growing importance of land and accumulated wealth, and interest in keeping wealth intact among those already well-off favored intermarriage among favored families. This resulted in extreme cases in caste endogamy and class consciousness in marriage choice. The deleterious biological impact of this strategy is well known in the genetic aberrations found in some European royal families in the past.

The evolution towards kin-based lineal systems also provided a more rigid form of passing on cultural values, identities, norms and religious preferences. This process took hundreds of years to occur as groups developed their own combination of workable ways of controlling resources as a function of population density, competition and resource availability[55]. In areas with great resource patchiness, where control over favorable patches was key to success, the development of sophisticated forms of kin-based control was more rapid given the stakes; whereas in areas with widely distributed resources and patches it was often easier for resource competitors to just move elsewhere and maintain a more flexible and less restrictive set of community rules. Over time, as agriculture moved from extensive production systems to more intensive systems based on irrigation and eventual mechanization, social stratification, ethnicity, complex rules for resource use; among others, exclusion came into being. In the former extensive systems, it was a value to share accumulated resources with other less fortunate members of the community, and thereby helped in acquiring social-capital and prestige; whereas, in the latter, the amount of shared resources declines, prestige still goes to those capable of concentrating resources but those resources are more sporadically redistributed[56], and thereby there had been observed that it facilitated for increasingly rewarding those who already have more resources and productive capacity or wealth. Thus, control over land becomes the greatest source of wealth and by extension this provides greater control over labor, as more and more people are not able to control access to land; especially in patchy environments, such as semi-arid landscapes. Boserup (1965) and others (Netting: 1968, 1981 and 1993) have shown that the most important driver of the intensification implied by the shift from HG to agriculture has been population growth leading to greater applications of technology to production, in order to stave off famine and meet the basic needs of growing populations. It is associated with greater competition over resources and the growing need to store supplies for times of scarce resources. The need to store provisions[57], rather than move to find them resulted in a shift in how labor was invested and in the settlement pattern of peoples worldwide. As these populations grew more numerous, chronic warfare ensued as groups competed for the best soils and the prime spots along the river or mountain and sought ways to recruit more members to their communities. In a world of hand-to-hand combat, having strong and numerous men to field was the top determinant of success in holding onto territory. Over time, some groups developed from single village communities into networks of communities and chiefdoms emerged thereby which provided some capacity to mobilize larger social units, when any of their member communities was threatened. The evidence is quite substantial that, as human communities grew more successful in production, the temptation was great for other communities[58] to take away their accumulated wealth (often in the form of grain or animals).

As in the shift from HG to extensive cultivation, the shift from extensive cultivation to intensive cultivation appears to have been driven by population growth putting too much pressure on resources (Boserup: 1965 and Netting: 1993). One study showed that a given area of irrigated land could support 14 times as many families as it could under shifting cultivation (Palerm: 1968 and Spooner: 1972). However, another explanation offered by scholars has been that this intensification was forced upon people either by external domination and colonialism (Geertz: 1963) or by internal domination brought about by elites wishing to control land resources for their own political and military objectives (Demarest: 2004). Associated with farming populations[59] one often found pastoralists, occupying land unsuitable for cultivation. In some cases, they represented segments of ethnic farming populations; in other cases they represented other ethnic groups. Pastoralist social organization shows much greater flexibility than other forms of subsistence because of the flexible nature of managing animals. Sometimes it is possible to gather people and animals in areas when rain is abundant and pasture is rich, but for at least half of the year or more, the drying of the savannas results in scattering of people and animals. This scattering would put these populations at risk if it were not for mechanisms, such as seminary lineages, that allow segments of large lineages to call upon others to come to their assistance in times of trouble. Thus, pastoral societies have developed an impressive capacity to field armed men to defend their animals and people[60], and thereafter, to return to a very scattered and apparently disorganized pattern of moving to find the best forage (McCabe: 2004). It is a remarkable example of social self-organization that results in politically sophisticated outcomes. Farmers and pastoralists maintained an uneasy truce and trade relationship over the years, and there are well-documented cases of pastoralists becoming farmers and vice versa under favorable conditions. It was just a matter of time and opportunity, for people to have their growing villages develop into larger and more complex entities that we have come to call cities. Urban areas provided a site for trade, for the exchange of information, for specialists in a large number of skills to meet the needs of a more technologically intensive society[61], and for redefining the nature of social ecological interactions. The rise of urban centers is most commonly associated with irrigation and the rise of complex water control. As these systems grew in size and complexity, breakdown became more common and more costly. In time, when they had grown to paranoiac proportions, the systems could collapse when either information or climate, or both, were beyond the capacity of managers (Butzer: 1976). If the rise of cities and a growing network of linked villages into states proved to be a considerable source of disturbance in socio-ecological interactions, imagine what happened with the rise of that technological wonder that is the industrial revolution[62]. Cities are symptomatic of human transformation of socio-ecological systems: they are creative centers where some of the best and brightest of every society are concentrated to develop the arts, technology, education, science, and commerce. Yet, they are

also often chaotic with erosion of social controls and distant enough from day-to-day realities of environment to ignore environmental feedbacks for a very long time. It is because of such facts that the urban areas have too many layers of information between the environment and the decision managers. They are motivated by many other incentives than just ensuring good environmental management: political pressures, wrong valuation of the resources, self-interest and corruption as narrated in the discussions of 'urban ecology' (Moran, 2007: Chap.10).

Again, the industrial mode of production is accompanied by major technical innovations that also result in a reorganization of the division of labor (Schnaiberg: 1980). The industrial revolution's larger environmental impact is the product of discovering the use of fossil fuels. First, and for a very long time, this involved only the use of coal[63]. Oil and natural gas came much later. In using fossil fuels humans did not have to compete with any other animal species to use the resource, as we had often had to do with the use of plants (herbivores) and animals (carnivores). This would seem to be a 'win-win' situation, and it certainly allowed for an enormous increase in the amount of energy that humans could harness for productive purposes. Unfortunately, the exploitation of the huge amounts of fossil fuel materials stowed away for geologic periods of time in sub-terrestrial sinks and the launching of the by-products from their use into the biosphere, kicked off

biogeochemical changes in the atmosphere that took a couple of centuries to be felt and which now threaten our planet[64]. But these changes were not entirely surprising. Fossil fuels were felt early on: the nineteenth century fogs of industrial cities like London, with serious health consequences for people living in these locations being the most recognized. While the rich could escape to their rural estates to breathe fresh air, the poor in the cities grew sick from the constant exposure to foul air. Social stratification, along with the use of police and power to maintain this mode of production with its high human and environmental costs took place then, and continues into the present, as developing countries industrialize with similar consequences (e.g. the current urban pollution in China's industrial centers). The result has been a growing loss of trust[65] and the virtual extinction of reciprocity except in the bosom of families, growing disparities between people in wealth and access to resources, an increase in the amount of time spent working and a growing emphasis on consumption to support the productive capacity unleashed on the planet. Moran therefore gives a detailed analysis for examining all such issues related to environmental degrading situations (Moran: 2006). In short, over a period of 400 generations, or 10,000 years, the human population has grown from a few million to more than 6 billion. This growth has taken place quickly in recent decades, and has changed the nature of how we deal with each other (Raven: 2002).

To sum up the entire dynamics of environmental socio-ecological perspectives, it can be assessed that the biggest shift has been since World War II and is connected to rising living standards and rising consumption levels[66] for materials and energy. This compounding of population and consumption is recent and without precedent. Human populations do not respond in homogeneous ways to the environment or anything else. Human society and culture is characterized by high diversity, and in the past this has gone along with biological diversity. The number of people who live by hunting-gathering today is shrinking, and most of them are connected to the global economy to some degree. Horticultural populations (i.e. extensive farmers using slash-and-burn methods mostly) still constitute significant populations in rural areas of developing countries and among those in developed countries who seek to return our food production system to more organic methods. The latter is a fast and expanding movement that questions the industrial mode of food production and seeks to return to more organic ways to take care of the land and produce the food we need. Pastoral peoples[67] have been under pressure for decades to abandon their migratory ways, but they still constitute an important component of how grasslands are managed, despite efforts to block the routes of their movements. Intensive farming is growing ever more intensive, now including genetic modification to a degree that has not been seen before. These shifts in the relationship of people to the environment constitute the fundamental questions that drive environmental social science and human-environment interactions research[68]. With the growing recognition of the human dimensions of contemporary global environmental change this area of study has grown rapidly.

Human-Environment Interface and Sustainable Development

Human dimensions of global change have become an important priority at the National Science Foundation (NSF), the National Oceanic and Atmospheric Administration (NOAA), the National Aeronautics and Space Administration (NASA) and the Social Science and Population Program at the National Institute for Child Health and Human Development (NICHD). New priorities[69] have been identified that place human-environment research activities even more concerning about sustainable paradigms for enriching the pillars of human living goals for initiating healthy environmental cause, for protecting the norms of human existential autonomy and survival objectivity at the center of researches on global change. One important reason is that there is growing evidences that socio-economic uncertainties are greater than biophysical uncertainties, which have been covered under the study of climate impacts (NRC, 1999: Chap.1). So, the major sources of the environmental changes regarding the global atmosphere which have been illuminated from human activities, such as deforestation and energy consumption are all the reflecting reasons of man-made causes of environmental degradation[70]. Hence, the empirical research studies have shown that the tragedies of the commons are not inevitable, but are

rather the product of how humans organize themselves to respond to perceive threats to their well-being. Thus, it strengthens the case for the importance of human-environment interactions research. Since 1992, the field has evolved and a new set of research priorities have emerged. For the first decade of the twenty-first century several research questions have been identified, and these are: (1) understanding the social determinants of environmentally significant consumption (NRC: 1997 and Moran: 2006); (2) understanding the sources of technological change; (3) making climate predictions more regionally relevant and accurate (NRC: 1999); (4) improving how human populations can better respond to environmental surprises; (5) understanding the conditions favoring institutional success or failure in resource management (Ostrom: 1998 and 2005); (6) linking land-use and land-cover dynamics to population processes, especially the role of human migration (Moran and Ostrom: 2005; NRC: 2005; Lambin and Geist: 2006); (7) improving our understanding about human decision-making (Moran et al.: 2006; Brondizio and Moran: 2008); and (8) advancing capacity to make social science data spatially explicit (NRC: 1998). Interestingly, the SSRC, the NRC and the HDP quickly came to agreement that the research area which would best articulate with the work of IGBP and to which social scientists could make the strongest contributions in the short term would be the study of land-use and land-cover change[71]. The logic was that there was a pre-existing community in the social sciences concerned with cultural ecology, agrarian studies and agricultural and resource economics whose work approximated the likely areas of interest of a land-centric research program. All these led to the creation of the Land-Use and Land-Cover Change core project (LULCC), a joint activity of IGBP and HDP with support from groups, such as SSRC and NRC. A panel of scientists began to work in this line of thinking to meet that is required to be produced over the next several years. Hence, a Science Plan will be the actual idea to guide the work of the international community (Lambin et al.: 1999). The Science Plan has several major science questions that they deemed central to the core project. These were: (a) how has land cover changed over the last 300 years as a result of human activities? (b) What are the major human causes of land-cover change in different geographical and historical contexts? (c) How will changes in land use affect land cover in the next 50 to 100 years? (d) How do immediate human and biophysical dynamics affect the sustainability of specific types of land uses? (e) How might changes in climate and bio-geochemistry affect both land use and land cover? (f) How do land uses and land covers affect the vulnerability of land users in the face of change? (g) How do land-cover changes in turn impinge upon and enhance vulnerability and at-risk regions? Similarly, though varying in some degree questions were put forth for research priorities as defined by the NRC and SSRC. The first major guiding document to appear from these expert panels was the ‘rainbow book’, Global Environmental Change: the Human Dimensions (NRC: 1992). This book defined a broad set of priorities that identified land-use and land-

cover change as the top research priority, but that also listed in detail some other important questions that deserved attention, such as environmental decision making[72], integrative modeling, environmental risk analysis and studies of population and environment. Many of the recommendations of this book served as guidance to funding agencies and have since that time been implemented, such as the creation of human dimensions centers of excellence by the National Science Foundation (NSF); land-use and land-cover change research programs at NASA; human dimensions of global change programs at NOAA; and population and environment programs at NICHD.

From the above discussions, it is highly important to note here that the growing role of coordinating the work of national human dimensions panels has helped creating IHDP-based research groups on the Institutional Dimensions of Global Environmental Change and the Environmental Security and Vulnerability group, and therefore, it is permeably said that the environmental degrading situations[73] are required to be nurtured in healthy living pursuits of human existential survival freedom of life. Thus, the interface between human and environment is a matter of stimulating the syntheses of what we know about LUCC processes, such as tropical deforestation, agricultural intensification and urbanization to provide input to a larger synthesis for earth system science (Steffen et al.: 2003). These efforts at synthesis rely heavily upon the scholarly community working on issues of land-use and land-cover change. Other interesting research areas in the human dimensions of global change agenda include: social dimensions of resource use; perception of environmental change; how people assess environmental changes and environmental risks; the impact of institutions; energy production and consumption; industrial ecology; environmental justice[74] and environmental security, etc. However, in 2001 an expert panel from the NRC came up with eight Grand Challenges in the Environmental Sciences that defined the key priorities which are analyzed for environmental sustainability (NRC: 2001). The eight priorities share one common denominator: they require joint work by biophysical and social scientists. A similar recommendation came from the National Science Board (NSB) which developed similar but not equivalent priorities, and also gave multidisciplinary across the biophysical and social sciences a strong nod. It is therefore permeably said that environmental sustainability is concerned with the mechanisms of scientific studies and researches based on empirical findings, which are immensely valuable for human living paradigms in regard to healthy as well as peaceful living agenda of societal goal of life[75]. In nutshell, interface between human-environment is a matter of judgment and requires a scientific analysis of things, and the researches are undertaken in the activities of NRC, which are immensely potential for understanding human living paradigms as well as goals of healthy living parameters of peaceful existential survival norms. The multidimensional scale of environmental issues apply to the global aspects of human living parameters, in so far as the agenda oriented towards comparative research

diversity of biophysical and social processes (Moran and Ostrom: 2005) to be spatially explicit so as to be able to anchor the work precisely on the earth's surface. Thus, the narratives of environmental sustainable goal is required to be understood from what is specific towards the agenda which is driven by the concept of a concern for changing environmental dynamics[76]. It is therefore human-environment interface requires a dynamic development view for knowing about the natural depth on sustainable environmental issues for historical analysis of the subject matter that is addressed so far for explanations, to the achievement of the goal of human healthy living potential for peaceful co-existential autonomy of life.

Findings

Some of the important findings of the research study are outlined below:

1. Natural sciences are required working balance with scales of operation in industrial and social activities in relation to population increase, demand for new means of livelihood and heritage of human civilization to recapitulate the norms of environmental harmony, future discourse about the ecological balancing sequence with forecasting measures in terms of fundamental research findings.
2. Effective human-environment interactions need the Vedanta philosophy of environmental resource management initiatives, the Vedic norms of equanimity thought of work and eternal principles and values of human life bringing processes as propounded in the Upanishads for performing in equipoise nature with scientific approach to achieve SDGs with path-goal relativity in time and space.
3. Efficient human-environment interface in developmental activities needs better adaptive measures to recall possible norms of global environmental changes from time-to-time with judicious understanding, to incorporating a sequential balance in environment for both the present and future generations for peace, progress and prosperity of humankind.
4. Understanding environmental change and its underlying human dimensions in the early years of the twenty-first century was a major challenge for human beings, as the traditional theories of population-environment relationships posit the simplest models to explain phenomena at a national or international level.
5. Adequate attention is necessary to overcome limitations of the theories in addressing multi-scaled problems to non-social scientists who need knowledge on social sciences dimensions which requires multidisciplinary environmental approaches. Hence, environmental theories should not only be treated as myths, but rather should be applied with empirically supported experiments for all.

6. Diverse vocabularies of separate disciplines make human-environment interactions extremely complicated. Hence, the emerging interdisciplinary field of human-environment interactions must give attention to both spatial and temporal variability to meet urgency often felt by researchers, students, policy makers, and land managers; because the state of the earth calls for immediate action.
7. Due to lack of collective understanding and monitoring of the development programs, human-environment interactions continues to lag severely which create problems for humanity to mitigate the negative consequences of environmental sustainability and to prevent avoidable future problems**.** So, appropriate strategies if adopted can help to integrate all the varying analytical "lenses" used by scholars from a variety of social and physical science disciplines.
8. No single set of theories and methods can address all questions on sustainable development parameters with environmental protective measures encompassing multidisciplinary field. Hence, great challenges are faced by the planners and decision makers in areas of human-environment interactions due to major obstacles in understanding the jargon of the interdisciplinary field.
9. Human-environment interface requires a dynamic development thought for knowing about the natural depth on sustainable environmental issues from historical perspectives.
10. Narratives on environmental sustainability are required to be understood from development-oriented specific agenda driven by the concept of changing environmental dynamics.

Suggestions and Recommendations

Major suggestions of this research study are enumerated below:

1. Scientific efforts and investment on environmental balancing situations will require searching on future happenings to emulate the advantages of human-environment interactions, so as to bring values to social living processes, human activities and nurturing sustainable means to forward looking tendencies in rolling human civilization.
2. Human participation dimensions need theories of ecology, anthropology, and geography to contribute for human cultural ecology, political ecology with sustainable development means which are necessary ingredients of resource use required for industrial and socio-economic purposes of living pursuits to the ends of life.
3. Effective human participation helps cementing better relationships between productive activities and resource use for global and local scales of work management system, to optimize resource utilization potentials, maximize productivity in industrial and socio-economic activities and minimize wastes to curb environmental crises.
4. Scientific researchers will illuminate the pictures of environmental degradation and guide human beings toward the maximum beneficial means of resources utilization policy, and thereby, fillip

the gaps between environmental crisis and mitigation norms for future safety and security with adequate resource scanning techniques to local and global perspectives.

5. Global environmental changes need robust activities in terms of integrated approaches for practical exposition of things to bringing progress of human civilization in rolling towards forward looking tendencies with continuous growth, ecological balance and harmonizing productive norms for better living purposes.
6. Sustainable agenda requires the 'state-of-the-art' vision, environmental protective mission and global strategy for human peaceful living, progressive growth and prosperous development in terms of contributions of all the stakeholders in multidisciplinary and interdisciplinary field of research, besides international agencies, government institutions and public authorities.
7. Environmental research community should move forward in their collective group efforts in getting benefits by becoming familiar with a common set of theories and methods that are mutually understood across the social and natural sciences.
8. Multidisciplinary studies on environmental sustainability are required to be well documented with respect to spatial and temporal dimensions for formulating appropriate development plans with strategic decision-making processes, to ease case-to-case integration and compatibility which will yield synergistic results to critical research endeavors in progressive manner.
9. Diverse spatial and temporal perspectives will help students and researchers understand how contrasting processes relate to each other. Thus, sustainable development thought is strengthened in terms of case study in a broader context.
10. For robust development with human-environment interface, interdisciplinary and multidisciplinary science should overcome disciplinary biases without losing rigor in theories and methods, as these help addressing specific questions having broader scope and focus on specific scientific challenges, in particular, spatial and temporal scales of analysis. Methods are promised to aid the development in human-environment interactions research.

The most important recommendations of this research paper are as follows:

1. Human-environment interaction needs overcoming problems of global and local environmental crisis in terms of policy researches, and implementation of the plan of action (PoA) on environmental issues, which inform communities about working scales for harmonious and healthy living prospects with societal foundations.
2. Sustainable development skills require scientific study on demography which is provided by Sociology and Economics for integrating with both bio-ecological and spatially explicit approaches. Political science contributes institutional and cross-national approaches for addressing a variety of scales of interactions. Biological scientists and ecologists can bring in

robust theories to evolution by natural selection for knowing about environmental changes that occur at a variety of levels in organization.

3. Satellite images connect healthy link for local environmental differences with scanning land-use patterns associated with socio-economic and cultural processes concerning local populations. Thus, Anthropologists, sociologists, and human geographers can reveal human living reality behind land-cover classes.
4. Dimensions of social sciences like anthropology, geography, history, psychology, political science and sociology provide the foundations for addressing cross-disciplinary issues in global environmental change.
5. Research teams composed of scholars from multiple social and biophysical disciplines can guide through their work about the sustainable development in magnified way. Ecologists, biologists and environmental social scientists provide very high priority to fieldworks and give special emphasis on their advantageous contribution for environmental sustainability through advancing the state of spatially explicit social science for sustainable development purposes.
6. History traditionally places more emphasis on time and less on spatial aspects. Geography, on the other hand, emphasizes the spatial dimensions over the temporal one. Other disciplines, such as geology and ecology, contain a mix of both dimensions. Certain social sciences (e.g. political science, sociology, and anthropology) traditionally emphasize space or time when needed. Again, political scientists do, at times, undertake research that emphasizes the temporal aspects in longitudinal studies. Thus, all these constitute the pyramid of SDGs.
7. By becoming familiar with a baseline set of theories and methods from 'across the aisle,' understanding and dialogue are facilitated with integrative questions having significance on sustainable development.
8. A set of theories and methods pertaining to sustainability science facilitate for a baseline dialogue across the social and natural sciences which well warrant integrative analysis for development agenda with due attention of the environmental issues.
9. Scientific studies and researches based on empirical findings provide mechanisms for environmental safety norms and are immensely valuable for sustainable development to achieve human societal goal of life.
10. Collective actions of world communities linking the biological, physical and social sciences help monitoring the overall system of productive works to conserve, preserve and sustain environmental balancing match.

Conclusion

Population and productivity has direct connection to developmental issues, as the growing population impacts on the phase of productivity as well as managing resources effectively for environmental sustainability. In this context, Malthus theory, also known by the followers as Malthusians[77] or neo-Malthusians has relevance to sustainable development study that provides a direction and reflect on the ability of the environment to produce food (Malthus: 1803). Hence, his theory has great implications in social sciences. Malthus foresaw no limit to the potential expansion of productivity, but he saw a limit to the rate of increase in productivity[78]; which is important for sustaining the environmental resources in these days of population increase. However, Malthus did not include agricultural innovation[79] among the possible reactions to scarcity. Boserup therefore challenged the presumption that either population or technology was the dominant engine of agricultural change[80] and development. But rather, he advocated that increases in population density leading to land scarcity could be seen as a trigger which stimulates agricultural intensification. His argument was that farmers who faced little scarcity were not motivated to search for ways of increasing productivity. So, his work has been applied most successfully in studies at the community level. Again, considerable research has shown that some farming groups have devised intensive agricultural technologies[81] that are dramatically more efficient and less harmful to the environment than extensive technologies (Netting: 1993). Further, many scholars think the level of productivity which is achievable in a particular environmental zone depends on the technology or physical capital available or invented as well as the available human and social capital[82]. Decision makers connote the idea well-being by choosing among the productive options that appear to be available to them or, when necessity calls for it, inventing new options. Moreover, one should expect that the level of deforestation[83] which occurs as a result of agricultural expansion will be directly related to the presence of roads and the transportation costs the farmers face for the crops which they may invest in (Chomitz and Gray: 1996). Nonetheless, demographers describe the typical changes in vital rates of birth, death and growth experienced by population over the course of development as demographic transition theory (Kirk: 1996). It is permeably said as communities, countries and regions developed modern public health programs and modern medicine, death rates began to fall[84], which has substantiated for corresponding economic development and are thus, associated consequently with high rates of urbanization[85]. Recent research also shows that the condition of land cover is affected by land settlement policies, road-building, market forces and characteristics of the biophysical area[86]. These contextual variables interact with each other and affect land-use and other decisions.

Based on all such things, it is observed that future research on sustainable development concept should be pursued in two substantive areas: (a) the study of frontier areas, and (b) that of regions experiencing rapid

urban development. It is therefore noteworthy to mention here that migration into frontiers changes the environment by bringing people with a different pattern of land-use to a new area, and thereby transforming its land-cover, biogeochemical cycles and precipitation patterns. Accordingly, the site-specific studies common in rural areas need particular attention to developmental paradigms, with respect to the decision-making processes of households[87] and the outcomes for the land and the members of the household. Experts in areas of sustainable management have increasingly argued for the need of comparative studies to address the importance of context and to bridge between household processes and political economy. We need therefore scientific instruments and research designs for developmental issues which can explicitly focus on capturing the causes and consequences of migration and other population dynamics[88] to minimize the impact of burden in utilizing environmental resources. These are the different theoretical perspectives of environmental sequential analysis having great relevance to sustainability assumptions to make appropriate decisions for harmonious development with nurturing environmental resources[89] for better future, prospective growth of human civilization and peace initiating pursuits to societal foundations.

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