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RISK MANAGEMENT IN GLOBAL WARMING

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Abstract: It is recognized that the Earth's climate is undergoing changes in response to natural variability, which include an increase in the concentrations of greenhouse gases and aerosols, as well as variability in solar radiation. Climate change is largely originated from anthropogenic activities and poses significant risks to human and natural systems. Global warming and climate change refer to statistically significant variation either in the mean state of the climate or in its variability, which may persist for an extended period of time of the order of decades or even longer. Indeed, the World Meteorological Organization defines climate variability as variations in the mean state and other statistic metrics, such as variations, the occurrence of extremes or frequency, of the climate on all temporal and spatial scales beyond isolated episodes or extreme events. There is scientific progress associated with extended literature on climate adaptation and risk management, which can provide valuable solutions to some of the challenges facing societies and natural systems.

Keywords: Risk Management, Global Warming, Climate Change, Climate Variability, Climate Adaptation

1. INTRODUCTION

The basis of global climate change lies on scientific observations and analyses summarized in Intergovernmental Panel on Climate Change's ([8], [11], [12]): the Earth is warming. Indeed, a linear trend of globally averaged land and ocean surface temperature shows a warming of 0.85°C (0.65 to 1.06 °C) from 1880 to 2012; under the high emission scenario (A2), it is projected to increase by 4.6'"C by the 2090s as compared to measures from the 2000s. Specifically, the upper 75m layer of the ocean has warmed by 0.11°C (0.09 to 0.13°C) per decade from 1971 to 2010. Permafrost temperatures have increased in most regions since the early 1980s in response to increased surface temperature. Other changes related to global warming are of great concern, such as the following: increase in the frequency of intense rainfall over the mid-latitude land areas of the Northern Hemisphere; decreases in Northern Hemisphere of spring snow cover and the average thickness and extent of Arctic sea ice; the shrinkage of glaciers worldwide; the 26% increase in ocean acidity. Moreover, it is expected that the sea level will continue to rise by an additional 0.18 to 0.59 m by 2100. A recent study found that if GHG emissions continue unabated, Antarctica has the potential to contribute more than 1 m of sea-level rise by 2100 and more than 15 m by 2500 [6].

Natural processes produce substantial seasonal, annual, and even decadal variations that are superimposed on the long-term warming trend, but it is very unlikely that natural variations could have given rise to the observed levels of global warming, especially over the last several decades. Anthropogenic forces emerging in the mid-20th century have contributed to surface temperature increases, to increased surface melting of the Greenland ice sheet, to the melting of glaciers, to the enhancement of global upper ocean heat content (up to 700 m) and the global mean sea level rise observed during the last 3-4 decades, and have affected the global water cycle during the last 2-5 decades. Most of the warming over the last several decades can be attributed to human activities that release carbon dioxide (CO_2) and other heat-trapping greenhouse gases (GHGs) into the atmosphere. The major portion of anthropogenic emissions of green-house gases is emitted from the burning of fossil fuels-coal, oil, and natural gas—for the production of energy. Humans emit about 30 billion tones of CO_2 each year through energy consumption. However, changes in agricultural and livestock farming practices, deforestation, land use changes, such as replacing forests with cropland, and certain industrial activities also had significant effects. Transport and cement production are also large emitters of GHGs. Human activities have also increased aerosols emissions. Aerosols have a wide range of environmental effects, but on average they increase the amount of sunlight that is reflected back to space, a cooling effect that offsets some of the warming induced by increasing GHGs. Human-induced climate change and its impact will continue during this century and beyond. Individually and collectively, and in combination with the effects of other human activities, these changes pose risks for a wide range of human and environmental systems, including freshwater resources, coastal environments, ecosystems, agriculture, fisheries, human health, and international security, among others.

2. GLOBAL WARMING

Global Warming **(**GW) is the increase in the average temperature of the Earth's near-surface air and oceans since the mid-20th century and its projected continuation. Global surface temperature increased 0.74 ± 0.18 °C during the last century. Climate model projections summarized in the latest Intergovernmental Panel on Climate Change (IPCC) report indicate that the global surface temperature will probably rise a further 1.1 to 6.4 °C during the twenty-first century. The uncertainty in this estimate arises from the use of models with differing sensitivity to greenhouse gas concentrations and the use of differing estimates of future greenhouse gas emissions. Some other uncertainties include how warming and related changes will vary from region to region around the globe [19]. However, warming is expected to continue beyond 2100 even if emissions stop, because of the large heat capacity of the oceans and the long lifetime of carbon dioxide in the atmosphere [8].

Increasing global temperature will cause sea levels to rise and will change the amount and pattern of precipitation, probably including expansion of subtropical deserts. The continuing retreat of glaciers, permafrost and sea ice is expected, with the Arctic region being particularly affected. Other likely effects include shrinkage of the Amazon rainforest and Boreal forests, increases in the intensity of extreme weather events, species extinctions and changes in agricultural yields.

Political and public debate continues regarding what actions to take in response to GW. The available options are mitigation to reduce further emissions; adaptation to reduce the damage caused by warming; and, more speculatively, geo-engineering to reverse global warming. Most national governments have signed and ratified the Kyoto Protocol aimed at reducing greenhouse gas emissions.

2.1. Temperature changes

The most commonly cited indication of GW is the trend in globally averaged temperature near the Earth's surface. This global mean temperature has increased by 0.75 °C relative to the period 1860–1900, according to the instrumental temperature record. The urban heat island effect is estimated to account for about 0.002 °C of warming per decade since 1900. Temperatures in the lower troposphere have increased between 0.12 and 0.22 °C per decade since 1979, according to satellite temperature measurements. Temperature is believed to have been relatively stable over the one or two thousand years before 1850, with regionally-varying fluctuations such as the Medieval Warm Period or the Little Ice Age.

Ocean temperatures increase more slowly than land temperatures because of the larger effective heat capacity of the oceans and because the ocean loses more heat by evaporation. Northern Hemisphere warms faster than the Southern Hemisphere because it has more land and because it has extensive areas of seasonal snow and sea-ice cover subject to the ice-albedo feedback. Although more greenhouse gases are emitted in the Northern than Southern Hemisphere this does not contribute to the difference in warming because the major greenhouse gases persist long enough to mix between hemispheres.

The thermal inertia of the oceans and slow responses of other indirect effects mean that climate can take centuries or longer to adjust to changes in forcing. Climate commitment studies indicate that even if greenhouse gases were stabilized at 2000 levels a further warming of about 0.5 °C would still occur [17].

2.2. Lapse rate (LR)

The atmosphere's temperature decreases with height in the troposphere. Since emission of infrared radiation varies with the fourth power of temperature, long wave radiation escaping to space from the relatively cold upper atmosphere is less than that emitted toward the ground from the lower atmosphere. Thus, the strength of the greenhouse effect depends on the atmosphere's rate of temperature decrease with height. Both theory and climate models indicate that GW will reduce the rate of temperature decrease with height, producing a negative LR feedback that weakens the greenhouse effect. Measurements of the rate of temperature change with height are very sensitive to small errors in observations, making it difficult to establish whether the models agree with observations.

2.3. Water vapor feedback

If the atmosphere is warmed the saturation vapor pressure increases, and the amount of water vapor in the atmosphere will tend to increase. Since water vapor is a greenhouse gas the increase in water vapor content makes the atmosphere warm further; this warming causes the atmosphere to hold still more water vapor (a positive feedback), and so on until other processes stop the feedback loop. The result is a much larger greenhouse effect than that due to CO_2 alone. Although this feedback process causes an increase in the absolute moisture content of the air, the relative humidity stays nearly constant or even decreases slightly because the air is warmer.

2.4. Cloud feedback

Warming is expected to change the distribution and type of clouds. Seen from below, clouds emit infrared radiation back to the surface, and so exert a warming effect; seen from above, clouds reflect sunlight and emit infrared radiation to space, and so exert a cooling effect. Whether the net effect is warming or cooling depends on details such as the type and altitude of the cloud, details that are difficult to represent in climate models.

2.5. Ice melting and albedo feedback

When ice melts, land or open water takes its place. Both land and open water are on average less reflective than ice and thus absorb more solar radiation. This causes more warming, which in turn causes more melting, and this cycle continues.

Positioned in the Arctic, the Greenland ice sheet is especially vulnerable to GW. Arctic climate is now rapidly warming and much larger Arctic shrinkage changes are projected. It has experienced record melting in recent years and is likely to contribute substantially to sea level rise as well as to possible changes in ocean circulation in the future. The area of the sheet that experiences melting has increased about 16% during 1979-2002.

2.6. Arctic methane release

Warming is also the triggering variable for the release of methane from sources both on land and on the deep ocean floor, making both of these possible feedback effects. Thawing permafrost, such as the frozen peat bogs in Siberia, creates a positive feedback due to the release of CO_2 and CH_4.

2.7. Reduced absorption of CO_2 by the oceans

Ocean ecosystems' ability to sequester carbon is expected to decline as the oceans warm. This is because warming reduces the nutrient levels of the meso-pelagic zone (about 200-

1000 m depth), which limits the growth of diatoms in favor of smaller phytoplankton that are poorer biological pumps of carbon.

2.8. Responses to GW

The broad agreement among climate scientists that global temperatures will continue to increase has led some nations, states, corporations and individuals to implement responses. These responses to GW can be divided into mitigation of the causes and effects of GW, adaptation to the changing global environment, and geo-engineering to reverse GW.

2.9. GW Mitigation

Mitigation of GW involves taking actions to reduce greenhouse gas emissions and to enhance sinks aimed at reducing the extent of GW. This is in distinction to adaptation to GW which involves taking action to minimize the effects of GW. Scientific consensus on global warming, together with the precautionary principle and the fear of abrupt climate change is leading to increased effort to develop new technologies and sciences and carefully manage others in an attempt to mitigate GW [11].

The Stern Review identifies several ways of mitigating climate change. These include reducing demand for emissions-intensive goods and services, increasing efficiency gains, increasing use and development of low-carbon technologies, and reducing non-fossil fuel emissions [20].

At the core of most proposals is the reduction of greenhouse gas emissions through reducing energy use and switching to cleaner energy sources. More radical proposals include geo-engineering techniques ranging from carbon sequestration projects such as carbon dioxide air capture, to solar radiation management schemes such as the creation of stratospheric sulfur aerosols. The ever-increasing global population and the planned growth of national GDPs based on current technologies are counter-productive to most of these proposals.

Many environmental groups encourage individual action against GW, as well as community and regional actions. Others have suggested a quota on worldwide fossil fuel production, citing a direct link between fossil fuel production and CO_2 emissions. There has also been business action on climate change, including efforts to improve energy efficiency and limited moves towards use of alternative fuels. In January 2005, the European Union introduced its European Union Emission Trading Scheme, through which companies in conjunction with government agree to cap their emissions or to purchase credits from those below their allowances. Australia announced its Carbon Pollution Reduction Scheme in 2008. United States President Barack Obama has announced plans to introduce an economy wide cap and trade scheme.

The world's primary international agreement on reducing greenhouse gas emissions is the Kyoto Protocol, an amendment to the UNFCCC negotiated in 1997. The Protocol now covers more than 160 countries and over 55% of global greenhouse gas emissions. The IPCC's Working Group III is responsible for crafting reports on mitigation of GW and the costs and benefits of different approaches. The 2007 IPCC Fourth Assessment Report concludes that no one technology or sector can be completely responsible for mitigating future warming. They find there are key practices and technologies in various sectors, such as energy supply, transportation, industry, and agriculture which should be implemented to reduced global emissions. They estimate that stabilization of carbon dioxide equivalent between 445 and 710 ppm by 2030 will result in between a 0.6% increase and three percent decrease in global gross domestic product.

2.10. Adaptation to GW

A wide variety of measures have been suggested for adaptation to GW. These range from the trivial, such as the installation of air-conditioning equipment, up to major infrastructure projects, such as abandonment of settlements threatened by sea level rise. Measures including water conservation, changes to agricultural practices, construction of flood defenses, changes to medical care, and interventions to protect threatened species have all been suggested. A wide ranging study of the possible opportunities for adaptation of infrastructure has been published [10].

2.11. Geo-engineering

Geo-engineering is the deliberate modification of Earth's natural environment on a large scale to suit human needs. An example is greenhouse gas remediation, which removes greenhouse gases from the atmosphere; usually through carbon sequestration techniques such as carbon dioxide air capture. Solar radiation management reduces insulation, such as by the addition of stratospheric sulfur aerosols. No large-scale geo-engineering projects have yet been undertaken.

2.12. Causes of GW

Carbon dioxide and other air pollution that is collecting in the atmosphere like a thickening blanket, trapping the sun's heat and causing the planet to warm up. Coal-burning power plants are the largest U.S. source of carbon dioxide pollution they produce 2.5 billion tons every year. Automobiles, the second largest source, create nearly 1.5 billion tons of CO_2 annually [2]. Technologies exist today to make cars that run cleaner and burn less gas, modernize power plants and generate electricity from nonpolluting sources, and cut our electricity use through energy efficiency. The challenge is to be sure these solutions are put to use.

2.13. Carbon capture and storage

Carbon capture and storage (CCS) is a plan to mitigate climate change by capturing carbon dioxide (CO_2) from large point sources such as power plants and subsequently storing it away safely instead of releasing it into the atmosphere. Technology for capturing of CO_2 is already commercially available for large CO_2 emitters, such as power plants. Storage of CO_2, on the other hand is a relatively untried concept and as yet no power plant operates with a full carbon capture and storage system. When this technique is used with biomass, the technique is known as biomass energy with carbon capture and storage and may be carbon negative [3].

CCS applied to a modern conventional power plant could reduce CO_2 emissions to the atmosphere by approximately 80-90% compared to a plant without CCS. Capturing and compressing CO_2 requires much energy and would increase the energy needs of a plant with CCS by about 10-40%. This and other system costs are estimated to increase the costs of energy from a power plant with CCS by 30-60% depending on the specific circumstances.

2.14. Pollution and GW

Carbon dioxide, while vital for photosynthesis, is sometimes referred to as pollution, because raised levels of the gas in the atmosphere are affecting the Earth's climate. Disruption of the environment can also highlight the connection between areas of pollution that would normally be classified separately, such as those of water and air. Recent studies have investigated the potential for long-term rising levels of atmospheric carbon dioxide to cause slight but critical increases in the acidity of ocean waters, and the possible effects of this on marine ecosystems.

By reducing pollution from vehicles and power plants, GW pollution could be limited. Existing technologies should be put for building cleaner cars and more modern electricity generators into widespread use .Our reliance can be increased on renewable energy sources such as wind, sun and geothermal. Finally, more efficient appliances and conserve energy can be manufactured.

3. RISK MANAGEMENT

Risk can be described as the mixture of the probability of an event and its results. In all types of undertaking, there is the potential for events and results, which constitute chances for benefit (upside) or threats to success (downside).

Risk Management (RM) is, increasingly, recognized as being concerned whit both positive and negative features of risk. Therefore this standard considers risk from both perspectives. It involves transferring the risk to another party, avoiding the risk, reducing the negative effect of the risk, and accepting some or all of the results of a particular risk. In the safety field, it is generally recognized that results and consequences are only negative, so the management of safety risk is centered on prevention and mitigation of harm ([4], [13]).

RM is an activity directed towards the assessing, mitigation and monitoring of risks. In some cases, the acceptable risk may be near zero. Risk can come from accidents, natural causes and disasters as well as deliberate attacks from an adversary.

RM is a central part of any organization's strategic management. It is the process whereby organizations methodically address the risks attaching to their activities with the goal of reaching sustained benefit within each activity and across the portfolio of all activities. On the other hand, financial RM focuses on risks that can be managed using traded financial instruments.

RM, in businesses, entails organized activity to manage uncertainty and threats and includes people following procedures and using tool in order to ensure conformance with RM policies. It also used in the public sector to identify and mitigate risk to critical intra structure.

The strategies Health risk assessments in traditional RM programs are focused on risks stemming from physical or legal causes (e.g. natural disasters, accidents, ergonomics, death and lawsuits).

The focus of good RM can be the identification and treatment of these risks. It is goal is to add maximum sustainable value to all the activities of the organization. It gathers together the understanding of the potential upside and downside of all those factors which can affect the organization. It increases the probability of success, and reduces both the probability of failure and the uncertainty of reaching the organization's overall objectives and goal [6][11].

RM should be a continuous and developing process, which runs throughout the organization's strategy and the implementation of that strategy. It should address methodically all the risks surrounding the organization's activities past, present and in particular, future. It must be integrated into the culture of the organization with an effective policy and a programme led by the most senior management. It must translate the strategy into tactical and operational goals, assigning responsibility throughout the organization with each manager and employee responsible for the management of risk as part of their job definition. It supports accountability, performance measurement and reward so promoting operation efficiency at all levels [14].

3.1. Risk Assessment

Once risks have been recognized, they should be assessed as to their potential severity of loss and to the probability of occurrence. These quantities can be either simple to measure, in the case of the value of a lost building, or impossible to know for sure in the case of an unlikely event occurring. So, it is critical to make the best educated guesses possible in the assessment process in order to prioritize the implementation of the RM plan, properly.

The fundamental difficulty in risk assessment is recognizing the rate of process because statistical information is not available on all kinds of past incidents. Furthermore, it is often quite difficult for immaterial assets, to evaluate the severity of the result.

The main point that is necessary to be addressed is asset valuation. So, the primary sources of information are best-educated ideas and available statistics. Nevertheless, risk assessment should produce such information to manage the organization which primary risks are easy to understand and that the RM decisions may be prioritized. So, there have been several theories and attempts to quantify risks. Although numerous different risk formulae exist, but perhaps the most widely accepted formula for risk quantification is: "Rate of occurrence multiplied by the impact of the event equals risk" .Later research has shown that the financial benefits of risks management are less dependent on the formula used but are more dependent on the frequency and how risk assessment is performed.

It is imperative, in business, to be able to present the findings of risk assessment in financial terms. Robert Courtney Jr. from IBM in 1970 proposed a formula to present risks in financial terms. The Courtney formula, as the official risk analysis method was accepted for the US government agencies. This formula proposes calculation of ALE (annualized loss expectancy) and compares the loss value which is expected to the security control implementation costs (C/B: cost/benefit) [1].

Risk assessment includes an objective evaluation of risk in which assumption and uncertainties are considered and presented. Measurement of both of the quantities in which risk assessment is concerned–potential loss and probability of occurrence–can be very difficult to measure, is part of the difficulty of RM. The chance of error the measurement of these two concepts is large. A risk with a large potential loss and a low probability of occurring is often treated differently from one with a low potential loss and a high likelihood of occurring. In theory, both are of nearly equal priority in dealing with first, but it can be very difficult in practice to manage when conduct the RM process. Expressed mathematically:

$$R_i = L_i P(L_i) \qquad\qquad R_{total} = \sum_i L_i P(L_i)$$

Decisions which are financial, such as insurance, describe loss in terms of dollar amounts. Loss can be quantified in a common metric, such as a country's currency, or some numerical measure of a location's quality of life, when risk assessment is used for public health and environmental decisions, loss is simply a verbal definition of the outcome, such as increased cancer incidence or incidence of birth defects. In that case, the "risk" is expressed as: $R_i = P(L_i)$

It is termed a "population risk" and is units of expected increased cases per a time period, if the risk estimate takes into account information on the number of individuals exposed. If the risk estimate does not take into account the number of individuals exposed, it is termed an "individual risk" and is in units of incidence rate per a time period. Population risks are of more use for analysis of C/B; individual risks are of more use for evaluating whether risks to individuals are "acceptable".

3.2. Enterprise RM

A risk, in enterprise RM, is defined as a possible event or circumstance which can have negative influences on the enterprise in question. Its impacts can be the resources (human and capital), the products and services, or the customers of the enterprise, as well as external effects and impacts on society, markets, or the environment. Enterprise RM, in a financial institution, is normally thought of as the mixture of credit risk, interest rate or asset liability management, market risk, and operational risk.

Every probable risk, in the moral general case, can have a pre–formulated plan to deal with its possible results. As a result from the information above and the average cost per employee over time, or cost accrual ratio, a manager of the project can separately estimate the probable increase in time and cost related to a risk.

3.3. Risk Evaluation

It is necessary to compare the estimated risks against risk criteria that the organization has established when the risk analysis process has been completed. The risk criteria may involve related costs and benefits, legal needs, socio–economic and environment factors, concerns of stakeholders, etc. Risk evaluation therefore, is used to make decisions about the significance of risks to the organization and whether each specific risk should be accepted or treated.

3.4. Risk Treatment

Risk treatment is the process of selecting and implementing measures to recognize the risk. It involves as its major element, risk control/mitigation, but extends further to, for example, risk avoidance, transferring risk, risk financing, etc.

By recognizing the risks which need attention by management of those risk analysis processes assist the effective and efficient operation of the organization. They will need to prioritize risk control actions in terms of their potential to benefit the organization. Effectiveness of internal control can be the degree to which the risk will either be eliminated or decreased by the proposed control measures.

Cost effectiveness of internal control associates to the cost of implementing the control compared to the risk benefits expected which decrease. The proposed controls need to be measured in terms of potential economic effect if no action is taken versus the cost of the proposed action(s) and invariably require more detailed information and assumptions than are immediately available. An organization must understand the applicable laws and must use a system of controls to reach compliance. There is only occasionally some flexibility where the cost of reducing a risk may be totally disproportionate to that risk.

One method to obtain financial protection against the impact of risks is risk financing that involves insurance. So, it should be established that some losses or elements of a loss will be uninsurable [7].

3.5. Flood RM and Mitigation

The best way of reducing the risk to people and property is production of flood risk maps. In the developed world, most countries have produced maps which show areas to flooding events of known return periods. In the UK, the Environment Agency made maps, which show areas at risk, this map has been plotted for the city of York, the predicted flood plain for a 1 in 100 year flood and low lying areas which need flood defenses,

Flood mitigation is managing the effects of flooding, instead preventing it. It is management of people, by measures such as evaluation and properties for example dry/wet proofing. The prevention of flooding can be studied on a number of levels, individual properties, small communities and whole towns or cities. When more people and property are protected, the costs of protection increase ([5], [16]).

3.6. Earthquake Preparedness

It refers to a variety of measures designed to help individuals, businesses, and local and state governments in earthquake prone areas to be ready for significant earthquakes. These measures are part of the emergency management cycle, and can be refined thorough the use of an Earthquake scenario, such as the Great Southern California ShakeOut. Awareness of historical events such as those which document the New Madrid Seismic Zone are useful in anticipating effects of future events that are possible.

3.7. Hurricane Mitigation and Preparedness

Hurricane or Tropical Cyclone Mitigation affects measures and products designed to lower the likelihood of damage from hurricanes and tropical storms. All buildings, whether residential or commercial, are harmed from storms. The internal contents of the structures can be damaged as result of exposure to water if the building envelope is breached, usually as a result of the strong winds joined to hurricanes and tropical storms. Although the negative pressure caused by high velocity wind flowing over a building roof can cause failing the roof, breaking windows which allow raising the air pressure in a building, creating an even greater pressure difference, and raising the likelihood of roof failure.

Hurricane preparedness involves actions taken before a tropical cyclone strikes to mitigate the personal danger and damage, which storms can cause. Personal preparedness includes actions individuals can take, anywhere from hours to months before a storm may strike, which minimizes the damage a cyclone can do to their possessions and improves their opportunities of coming through the storm safety. Hurricane mitigation makes buildings and other property more resistant to the effects of tropical cyclones, using policy adherence and enforcement.

For people who live in a hurricane–prone area, the major decision that must be made when a hurricane approaches is whether to stay or go. Regardless of that decision, so, it is in their best interest to have the home prepared to the maximum extent possible, well in advance of the annual hurricane season. So, the whole idea is to increase the interesting of having a home to come back to after the storm. The most important decision is to locate the building outside of range from the coast that is exposed to storm surge, because regardless of protection from the effects of wind, a building can be flooded or destroyed by storm surge.

3.8. Landslide Mitigation

Landslides can be triggered by many often concomitant causes. In addition to shallow erosion or reduction of shear strength caused by seasonal rainfall, causes triggered by anthropic activities such as adding extreme weight above the slope, digging at mid–slope or at the foot of the slope, can also be included [18]. So, often individual phenomena join together to generate instability, also after some time has passed, which, other than in well–instrumented limited areas, do not permit a reconstruction of the evolution of the occurred landslide. However, it is pointless, for the purpose of planning landslide hazard mitigation measures, to classify the work as a function of the phenomenon or of more important phenomena, renouncing attempt to exactly define all the causes or the conditions which, at different times, help to the occurrence of the landslide. So, slope stabilization methods in rock or in earth, can be collocated into three types of measure, namely Geometric, Hydrogeological and Chemical and mechanical methods.

4. SUMMARY

Global warming and climate change can have adverse effects on human and natural ecosystems, currently and in the near future. Nevertheless, there is an uneven distribution of the severity of impacts in the nature and within the society. Indeed, it is the level of exposure and vulnerability of a system to global warming or to an extreme climate event that determines whether an impact is severe or extreme. Vulnerability is influenced by a wide range of factors, such as anthropogenic, climate change and socioeconomic development, among others. There is scientific progress associated with extended literature on climate adaptation and risk management, which can provide valuable solutions to some of the challenges facing societies and natural systems. Vulnerable areas and groups, as well as institutionally less-diversified groups, must be the primary focus of national development plans and adaptation strategies. However, the challenge remains on the implementation and sustainability of the resulting transformations. Needless to say, the programs and actions, which aim to reduce disaster risk and enhance resilience, e.g. multi-hazardous management, should be multidisciplinary. There is a need to re-conceptualize the role people can play in the determination of extreme impacts in order to generate sustainable behaviour. Indeed, natural sciences should be merged with behavioural science, sociology, economics, public policy management, and communication. It is strongly recognized that the emphasis should be on collaboration, where through these sciences the necessary mechanisms can be identified and implemented in order to have individuals and societies as active participants of change rather than pathetic observers.

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