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Climate Change Risk Reduction: Decision-making in Uncertainty

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Climate change risks have been increasing over the past twentieth century. One of the most significant indicators has been the rise of global average temperatures by 0.6°C. Greenhouse gas concentrations are higher now than in the past 450,000 years and are projected to keep rising. It is no surprise that the jargon such as 'climate', 'climate change', 'climate risk' and 'climate risk management' has dominated the literature in research and developmental spheres. The rise of this kind of 'climate awareness' could be related to rise in awareness on various aspects of environment, pollution, environmental quality and environmental degradation in the late 1960s and years thereafter. No doubt, the debate after Malthus proposed population theory,[1] the explosive and radical concept of Limits to Growth as proposed by the MIT graduates,[2] and subsequent report of the Brundtland Commission (formerly the World Commission on Environment and Development) has brought the attention of global community to environment and sustainability.[3] The UN Conference on the Human Environment (popularly known as Stockholm convention, UNCHE), held in 1972, came out with what is famously called as Stockholm Declaration on Human Environment. The declaration has been clearly one of the significant achievements of UN in specific and global community in general as it brought out the environment from the scientific realm to the developmental realm. The achievement was also significant because the environment was brought into international agenda for the first time. Since then, environmental issues have had a decisive role to play in the way the world looks at development. Since then, countries continue to pursue what is called environmental sustainability and sustainable development. The concept was so well-defined that it became highly impossible to divide and differentiate the environment from the sustainability, the concept that was also put forward with a significant impact in the Brundtland report.

The United Nations Conference on Environment and Development (UNCED) which met at

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Rio de Janeiro from 3–14 June 1992 proclaimed that 'in order to achieve sustainable development, environmental protection shall constitute an integral part of the development process and cannot be considered in isolation from it'. The concept of sustainable development first emerged in the World Conservation Strategy of 1980, published by the International Union for Conservation of Nature and Natural Resources (IUCN-NR). However, the definition put forward by the Brundtland Commission Report is worth mentioning here as it has identified sustainable development as a new path for the humanity. In the words of the Commission:[4]

> ...many present development trends leave increasing numbers of people poor and vulnerable, while at the same time degrading the environment. How can such development serve next century's world of twice as many people relying on the same environment? This realization broadened our view of development. We came to see it not in its restricted context of economic growth in developing countries. We came to see that a new development path was required, one that sustained human progress not just in few places for a few years, but for the entire planet into the distant future.

This new development path was termed as sustainable development which was defined as 'development which meets the needs of the present without compromising the ability of future generations to meet their own needs.' Since its advent, sustainable development became the centre stage of development discourse across the globe. The term was well-debated and dissected apart in every major forum on development and has become a mother's prescription for all the ills the humanity is facing today. The concept of sustainable development was also seemingly easy for the policy makers and development personnel to preach.

The world has not made a significant progress beyond UNCHE and UNED. Environmental problems continue to plague human development and sustainable development seems to be a distant reality. Many threats were identified for realizing the sustainable development. Some of them include climate, biodiversity, forests, savannas, deserts and semi-arid areas, fresh waters and oceans, toxic and nuclear waste, energy, new technologies, communication, poverty, urban and rural disparities and violence, racism, militarization, population growth, foreign debt, debilitating diseases such as malaria and HIV AIDS.[5] It seems that the list is endless. The three pillars of sustainable development—environmental, economic and social dimensions—seem to stand alone while the problems have diversified beyond these dimensions. Today's problems of sustainable development are so intricately interwoven that the three pillars of sustainable development need to be propped up.

Since we argue that there is a long-drawn debate over environment and sustainable development, one may ask about what is the new threat that climate change is posing? A recent survey of more than 250 experts and practitioners from 71 countries rated climate change as the second most important issue (after poverty eradication) in terms of achieving sustainable development.[6] Hence, any discourse on sustainable development will inevitably lead to the climate and its change for the same reason that the sustainable development and environmental sustainability are inseparable. The similarity between climate change and any other environmental problem is that they can drastically undermine sustainable development, are interwoven and comparable in magnitude. In addition, climate change deserves attention due to its ability to question the global future. Hence, climate change needed a global action which was made possible through United Nations Convention on Climate Change (UNFCCC).

An outcome of the Conference on Environment and Development (UNCED), famously called the Earth Summit that debated the overarching impacts of global environmental

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degradation, the climate convention aims at stabilizing the greenhouse gases at a safer level and prescribes precautionary measures to achieve the targetted reduction in greenhouse gases.[7] One of the major achievements of the Convention has been that it could set targets to return the carbon dioxide emissions to 1990 levels by 2000. The subsequently constituted Intergovernmental Panel on Climate Change (IPCC), established by the World Meteorological Organization (WMO) and United Nations Environment Program (UNEP), was mandated to assess the available scientific and socioeconomic evidence on climate change and its impacts and on the options of mitigating climate change and adapting it, and to provide, on request, scientific/technical/socioeconomic advice to the Conference of Parties to the United Nations Framework Convention on Climate Change (UNFCCC). Since its inception, IPCC has brought out four comprehensive assessment reports on the status of climate change and its impacts. All the reports to date have brought out the evidence that the climate change is emerging as a significant problem to the human development.

CLIMATE AND CLIMATE CHANGE

Climate change can be well understood by decomposing the concept of climate. Global climate system consists of totality of atmosphere, hydrosphere, biosphere, and geosphere and their interactions. The atmospheric component of climate system well characterizes the climate. Climate is defined as average weather conditions of a particular region measured over a period of time usually 30 years or longer. Here, the duration is an important distinguishing factor between weather and climate. The UNFCCC has defined the climate change as "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods.[8] The keywords to be noted in this definition are change in climate, direct or indirect influence of human activity over and above the natural variability and comparable time periods.

According to IPCC, 'climate change' refers to a change in the state of the climate that can be identified (e.g., using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer.[9] However, it should be noted that climate change and weather are intertwined and that climate change has significant impact on the short-term weather. Hence, a change in the climate can obviously impact the weather which is a day-to-day phenomenon.

There is burgeoning literature characterizing the climate change. The IPCC Working Group I in its fourth assessment report suggests the following:[10]

- Global atmospheric concentrations of carbon dioxide, methane and nitrous oxide have increased markedly as a result of human activities since 1750 and now far exceed pre-industrial values determined from ice cores spanning many thousands of years.
- The understanding of anthropogenic warming and cooling influences on climate has improved since the Third Assessment Report (TAR), leading to very high confidence that the global average net effect of human activities since 1750 has been one of warming.
- Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level.
- At continental, regional and ocean basin scales, numerous long-term changes in climate have been observed. These include

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changes in arctic temperatures and ice, widespread changes in precipitation amounts, ocean salinity, wind patterns and aspects of extreme weather including droughts, heavy precipitation, heat waves and the intensity of tropical cyclones.

- Some aspects of climate have not been observed to change.
- Paleoclimatic information supports the interpretation that the warmth of the last half century is unusual in at least the previous 1,300 years.
- Most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations.
- For the next two decades, a warming of about 0.2°C per decade is projected for a range of emission scenarios. Even if the concentrations of all greenhouse gases and aerosols had been kept constant at year 2000 levels, a further warming of about 0.1°C per decade would be expected.
- There is now higher confidence in projected patterns of warming and other regional-scale features, including changes in wind patterns, precipitation and some aspects of extremes and of ice.
- Anthropogenic warming and sea level rise would continue for centuries due to the time scales associated with climate processes and feedbacks, even if greenhouse gas concentrations were to be stabilized.'

The above assertions clearly state that there is an apparent change in the state of climate that could potentially undermine the prosperity of human, biological and environmental systems thus endangering the sustainable development. Though the future projections are not yet that dependable, it is clear to a major extent that the anthropogenic warming and sea level rise would continue for centuries in future. However, some skeptics may question the credibility of these assertions. It has been a famous dilemma that how one can project climate so distant into the future when we are barely able to forecast the weather beyond a week's time. Though it is well understood that we are yet to gain major understanding on weather and climate system, it is much easier to project the impact of increasing carbon dioxide on earth temperature than projecting weather pattern beyond an extended period of time due to the dynamic property of the atmospheric system.

What is Climate Risk?

The concept of risk is worth elaborating here before we arrive at full understanding of what constitutes climate risk. In disaster management terminology, risk is defined as the probability that a hazard will turn into a disaster. Einstein (1988) defined risk as the probability of an event multiplied by the consequences if the event occurs.[11] Chapman (1994) defined risk as a function of the probability of the specified natural hazard event and vulnerability of cultural entities.[12] In all these definitions, it is apparent that the risk involves the probability factor and the loss factor. The probability factor denotes the chances of the loss to occur for a given intensity of the natural hazard. Natural hazard here is defined as those elements of the physical environment, harmful to man and caused by forces extraneous to him.[13] The definition of disaster is subjected to a large debate in the literature. However, according to WHO, disaster is an occurrence disrupting the normal conditions of existence and causing a level of suffering that exceeds the capacity of adjustment of the affected community.[14] Disaster can also be defined as an event, natural or man-made, sudden or progressive, which impacts with such severity that the affected community has to respond by taking exceptional measures.[15] In both the definitions, it is apparent that a natural event turns into a

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Getting hold of climate risk

Since it is difficult to visualize what constitutes climate risk, it is worthwhile to provide some illustrative examples. The following list should be read and interpreted in sequence.

- Climate risk constitutes the probability of a drought or flood to happen and the result in terms of impacts such as loss of agricultural production, damage to infrastructure, animal and human loss.
- Climate change risk constitutes the change in the intensity and magnitude of climate-related hazards such as droughts, floods, typhoons, and high temperature hazards and their impacts over the time period longer than 50 years or so.
- Since climate is changing and since such changes cannot be anticipated with the current level of understanding of climate system, the uncertainty involved in such changes could lead to anticipatory adaptations which may turn out to be maladaptation. This in itself is a risk posed by the changing climate. For example, if farmers anticipated that the rainfall will continue to decline and adapted to grow upland crops with less production potential, and if such changed do not happen, the decision of selecting upland cropping systems could be considered as a maladaptation. The risk is the area and extent of income loss occurred due to such adaptation practice.

disaster when the impacts far exceed the coping capacity of local communities requiring an external assistance.

It can be said that the climate risk constitutes sum of all the risk posed by the climatic change in a given region at a given point of time. However, it is clear that the risk still exists in a non-changing climate because climate inherently has instability that could still give rise to extreme events such as hurricanes and extreme rainfall events. In the context of climate change, climate risk constitutes enhanced risk due to the climate change in addition to the inherent risk posing nature of the climate.

Characteristics of climate risk

The risk posed by the climate and its change is unique. The most distinguishing characteristics of climate risk are:

- They span across long periods of time beyond the scales that human systems use in planning.
- They are global but not uniform throughout the globe as some geographical areas may benefit by climate change while many others may not.
- They are too complex to comprehend as the impacts are interrelated and compounded.
- There is too little information on the exact nature of the full risk as climate risks are evolving and our understanding improves over time.
- It is inherently uncertain in its behaviour due to the limitation of our understanding about the physical processes of climate and human interaction.[10]
- Climate change is a crescive (i.e., cumulative, incremental, no definitive beginning and no specific convenient location to act upon).[16]
- It is a future-oriented problem with immense costs to be increased incur by the current generation.

Chichilnisky and Heal have put forward that the climate risk is unique in two ways.[17] One is the uncertainty in basic scientific

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principles and the other is the uncertainty about the relationship between global mean temperatures and climate. They proclaimed that the classical formulations of uncertainty in economics no longer suffice to explain and deal with the climate change-related uncertainties. The incomplete information and inherent uncertainty of climate risk makes it unique and distinguishing from other forms of risks such as environmental degradation being faced by the humanity today. Willows et al opined that the uncertainty is a result of lack of knowledge of either the probability of the event or its consequences (Fig. 12.1).[18] In Fig. 12.1, the top-right quadrant shows risk. The other three quadrants show different kinds of uncertainty. The uncertainty in climatic risk is due to data uncertainty, knowledge uncertainty and model uncertainty. The data uncertainty arises from measurement errors, incomplete or insufficient data and extrapolation based on uncertain data. Knowledge uncertainty arises from partial understanding of the problem which includes uncertainty about the future. Model uncertainty, from the simulation models used in producing future scenarios, could be due to choices made in selection of model parameters and model input values which in turn are due to partial understanding of the future which is imperfectly modeled (One may recall that models are often said as GIGO which is a famous acronym for garbage in and garbage out). However, decisions must be made despite uncertainty as the price of not taking a decision could be costlier than taking a decision. The knowledge that the climate has changed in the past, and is now changing as a result of elevated atmospheric concentrations of greenhouse gases, requires that decisions be taken to exploit potential benefits and reduce deleterious impacts.[19] In this context, a decision to do nothing should be viewed as an appropriate and positive risk management option. It is advised that the climate risk management professionals and policy makers acknowledge the uncertainty while making decisions and keep the decision

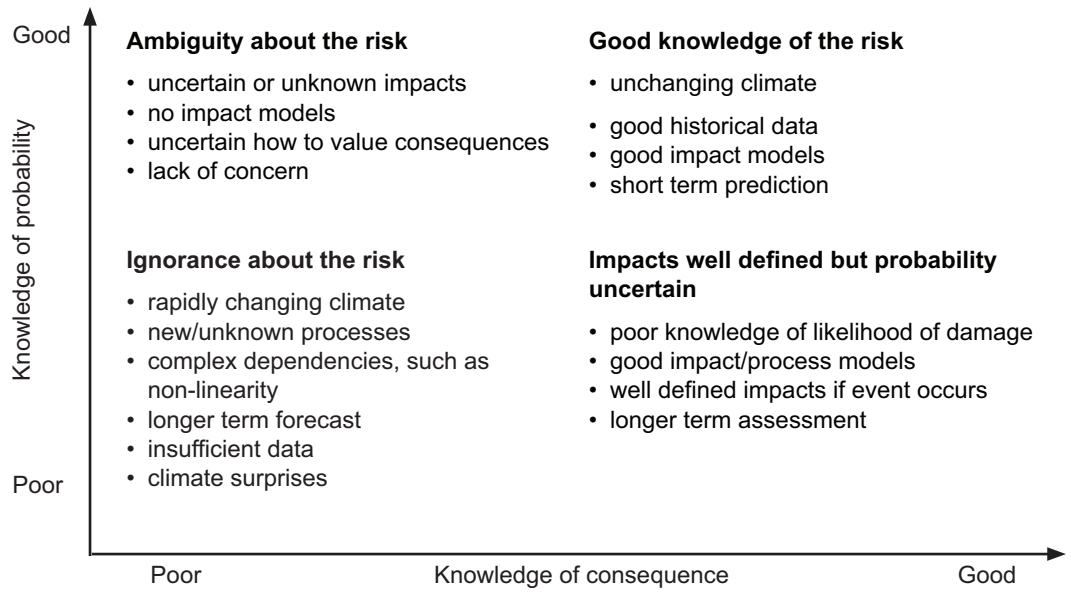

Fig. 12.1 Uncertainty as a result of lack of knowledge of consequence and probability of an event. *Source:* Ref [18]

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making process transparent so that the society is well informed about the choices made.

Climate Risk Management Decision Framework

Risk management refers to a gamut of operations taken up to deal with the risk. Managing climate risk is not a new activity. In medieval England, a farmer's land was broken into many widely dispersed parcels. Economic historians interpret this as a way of hedging climate risk.[20] Because land in different locations can be affected differently by droughts, floods and fires; by spreading landholdings over different regions and by buying insurances, farmers have managed climate risk for centuries.[17] However, as said earlier, the current discussion about climate risk is much beyond the understanding of how farmers managed the climate risk. Today's climate change risk management framework needs to address the uncertainties that are far from the understanding of many economists and risk management professionals. The characteristics of climate risks listed in the previous section makes the problem unique requiring unique approaches.

Two broad options emerged to deal with the climate risk. They are mitigation and adaptation based climate risk reduction options. Figure 12.2 forms the basis for explaining the mitigation and adaptation options.[21] It simply shows that in response to concerns over climate change impacts on ecological and human systems, actions could be taken to mitigate the changes and or adapt to their effects. Due to the vastness of the subject and the relevance, we focus on the mitigation-based frameworks while elaborating on the adaptation-based frameworks in the later sections.

Mitigation

The latest IPCC report establishes that the anthropogenic greenhouse gas rise and resultant global warming as undisputable facts. Figure 12.3 presents the impacts of global warming. The projected impacts demand that the

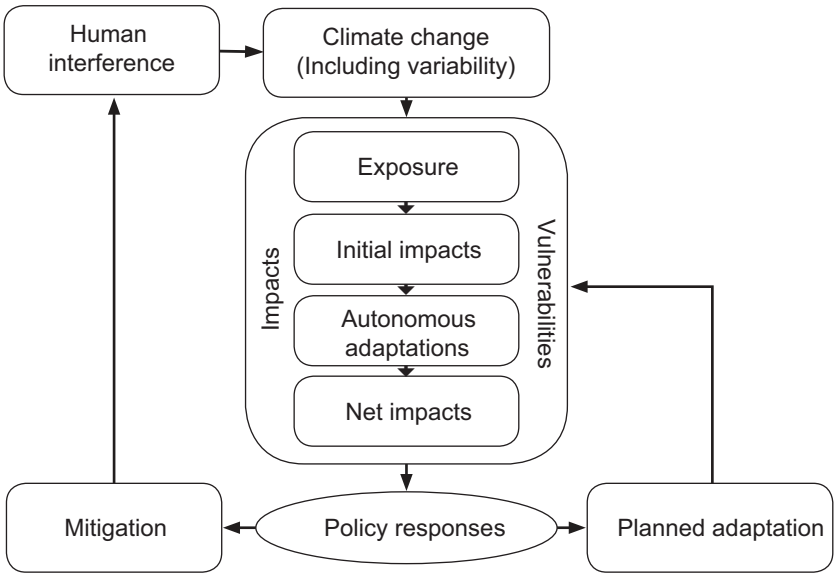

Fig. 12.2 Places of adaptation and mitigation in climate change issues.
Source: Ref [22]

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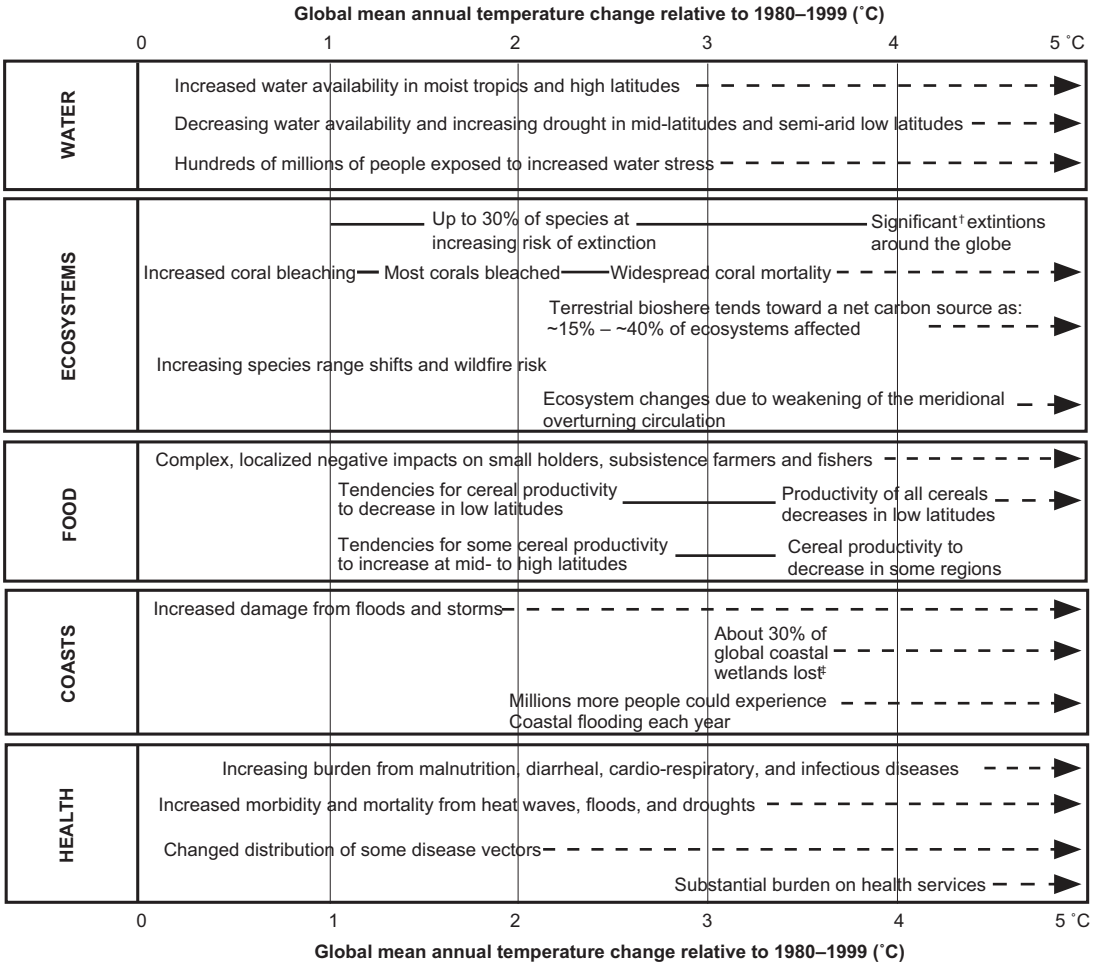

† Significant is defined here as more than 40%.
‡ Based on average rate of sea level rise of 4.2 mm/year from 2000–2080

Fig. 12.3 Illustrative examples of global impacts projected for climate changes (and sea level and atmospheric carbon dioxide where relevant) associated with different amounts of increase in global average surface temperature in the 21st century.
Source: Ref [52]

climate change needs to be mitigated through collective action of reduction in greenhouse gas emissions. Climate change mitigation refers to reduction in emission of greenhouse gases such as carbon dioxide and methane to a level that is not detrimental to the humans. United Nations Framework Convention on Climate Change (UNFCCC) is the single most significant step by the global community to deal with the climate change related risks. UNFCCC refers to mitigation as follows:

> [The ultimate objective of UNFCCC is to] achieve, in accordance with the relevant provisions of the Convention, stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within

> a timeframe sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner.

Hence, mitigation refers to the anthropogenic intervention to limit the magnitude and rate of climate change by reducing the sources or enhancing the sinks of greenhouse gases. The strategy of stabilizing greenhouse gases is based on the assumption that there exists a value of stable greenhouse gas concentration that is not detrimental to human, geological and biological systems and the stated concentration could be achieved by concerted global and regional actions. However, there are numerous problems in this theory. The basic assumption of existence of stable greenhouse gas concentration is debatable. The accepted value of dangerous levels of greenhouse gases has also been debated widely. In addition, who should strive to achieve this concentration as it means incurring costs which many developing countries are not willing to incur.

Certain efforts were made to define and elaborate on what constitutes dangerous climate change. Earlier assessments suggested a 2°C rise as the dangerous level beyond which the risk of grave damage to the ecosystems and non-linear responses are expected to increase rapidly.[22] More recently, Hansen et al concluded that a rise of temperature by 1°C, relative to 2000, would lead to dangerous rise in sea level and extermination of species.[23] The IPCC fourth assessment report did agree that "defining what is dangerous anthropogenic interference with the climate system, and hence what are limits to be set for policy purposes is a complex task and can only partially be informed by science, as it inherently involves normative judgments".[9] Decisions made in relation to UNFCCC Article 2 (see the quoted text above) would determine the level of greenhouse gas concentrations in the atmosphere (or the corresponding climate change) that is set as the goal for policy and have fundamental implications for emission reduction pathways as well as the scale of adaptation required. Choosing a stabilization level implies the balancing of the risks of climate change (risks of gradual change and of extreme events, risk of irreversible change of the climate, including risks for food security, ecosystems and sustainable development) against the risk of response measures that may threaten economic sustainability. There is little conformity about what constitutes anthropogenic interference with the climate system thus on how to operationalize Article 2. The IPCC report urges that there is a need for early initiation of mitigation efforts if the level of reduction in greenhouse gases would have to be low enough so that the impact on emerging economies is less.

Despite the debate over what constitutes dangerous anthropogenic greenhouse gas emissions, there is an urgent need to curtail the greenhouse gases due to the reason that not taking any action might prove fatal to the humanity and one cannot afford to do nothing. Article 3.3 of Framework Convention clearly states what is called the precautionary principle "...The parties should take precautionary measures to anticipate, prevent or minimize the causes of climate change and mitigate its adverse effects." Subsequently, the Third Conference of Parties to the Framework Convention on Climate Change (COP-3) met at Kyoto, Japan agreed to commit the industrialized nations to an overall reduction of 5.2% in their collective annual emissions of the main greenhouse gases in the commitment period of 2008–12 compared with the 1990 levels. To achieve this, different countries were set different target levels to adhere to. For example, Japan was to reduce by 6%, European Union by 8% and United States of America by 7% from the 1990 levels. The protocol was designed to enter into force once a minimum of 55 countries had ratified it, including 55% of Annex I countries.

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Climate change mitigation: Japan

Japan makes a good example for various mitigation initiatives taken by a country. Japan, being the signatory to the Kyoto Protocol with set numerical target of CO_2 emission reduction, has implemented various mitigation measures which include carbon sink enhancement measures such as afforestation and reforestation, enhancing the energy use efficiency in various sectors, promoting public transportation system, investment in Kyoto Mechanisms such as CDM, reduction measures for methane and nitrous oxide, supply side carbon dioxide emission reductions such as fuel switching from coal to natural gas and promotion of nuclear fuel, promoting renewable energy sources such as solar, wind and biomass, efficient management of waste so as to reduce the emissions from burning of waste, promotion of concepts such as low carbon society, changes in the people's lifestyles. As of 2005, Japan is 14% short against its target of 6% reduction with reference to the base year 1990. This means that Japan need to enhance its mitigation efforts in order to achieve its target by the end of the commitment period of 2008–2012. Japan could achieve this target through promoting the mandatory measures in place of voluntary measures, introduction of carbon tax and other kinds of policy mixes.

The Kyoto Protocol eventually came into existence from 16 February 2005, after Russia ratified the treaty in November 2004, making the treaty legally binding. The United States of America and Australia have so far declined ratifying the protocol. US took a stance not to ratify the treaty.[24] On 25 July 1997, the United States Senate unanimously (95–0) passed Senate Resolution 98 (also referred to as the Hagel-Byrd Resolution) which notified the Clinton Administration that the Senate would not ratify any treaty that would: (i) impose mandatory greenhouse gas emissions reductions for the United States without also imposing such reductions for developing nations, or (ii) result in serious harm to the economy. Thus, at the end of the Clinton Administration, the Kyoto Protocol lay dormant with little likelihood of being ratified by the Senate. Then, in March 2001, President George W Bush denounced any plans to establish carbon dioxide emissions reductions for US power plants and subsequently announced that the US has no intention of abiding by the Kyoto Protocol—an act which provoked international dismay and hostility.

Kyoto Protocol was looked upon as a breakthrough in international negotiations because: (i) it promised substantial emission reductions for the developed world vis-à-vis business as usual (BaU) emissions, and (ii) it established a broad international mechanism for widening and deepening climate protection activities in the future.[25] The Kyoto Protocol provides three different mechanisms to help the binding countries to realize the agreed levels of greenhouse gas emissions. These mechanisms include joint implementation mechanism among Annex I countries (Article 6 of the Protocol), the Clean Development Mechanism for use between non-Annex I (developing) and Annex I (Developed) countries (Article 12 of the Protocol), and emission/carbon trading among Annex I countries (Article 17 of the Protocol). Besides countries, private firms and other business bodies can use Kyoto Mechanisms.

According to the Text of the Kyoto Protocol, the purpose of the Clean Development Mechanism (CDM) is stated as "to assist parties not included in Annex I in achieving sustainable development and in contributing to the ultimate objective of the Convention, and to assist parties included in Annex I in achieving compliance with their quantified emission limitation and reduction commitments under Article 3. Under the clean development

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mechanism, the Parties not included in Annex I will benefit from project activities resulting in certified emission reductions; and the Parties included in Annex I may use the certified emission reductions accruing from such project activities to contribute to compliance with part of their quantified emission limitation and reduction commitments, as determined by the Conference of the Parties serving as the meeting of the Parties to this Protocol.

CDM helps Annex I Parties which have emissions reduction targets (caps), assist non-Annex I Parties which do not have emission caps, to implement project activities to reduce GHG emissions (or remove by sinks), and credits will be issued based on emission reductions (or removals by sinks) achieved by the project activities. A party where CDM project is implemented is called a host party and the credit from the CDM is called certified emission reduction (CER). Annex I Parties can use CERs to contribute to compliance of their quantified GHG emissions reduction targets of the Kyoto Protocol. As a result, the total amount of emission cap of Annex I Parties will increase.[26]

While CDM promotes collaboration between Annex I and Non-Annex I Parties, Joint Implementation (JI) is aimed at facilitating collaboration among Annex I Parties in achieving the stipulated emission reductions. Here, the Party where JI project is implemented is called a host Party and the credits earned by such implementation are called Emission Reduction Units (ERU). According to the text of Protocol, the purpose of the JI is stated as 'any party, included in Annex I (developed countries) may transfer to, or acquire from, any other such Party emission reduction units resulting from projects aimed at reducing anthropogenic emissions by sources or enhancing anthropogenic removals by sinks of greenhouse gases in any sector of the economy, provided that:

1. Any such project has the approval of the parties involved,
2. Any such project provides a reduction in emissions by sources, or an enhancement of removals by sinks, that is additional to any that would otherwise occur,
3. It does not acquire any emission reduction units if it is not in compliance with its obligations,
4. The acquisition of emission reduction units shall be supplemental to domestic actions for the purposes of meeting commitments.

Another mechanism put in place for Annex I parties is the International Emission Trading (IET). This mechanism was put in place for the Annex B parties of the Kyoto Protocol. The IET works through market mechanisms and can reduce the total cost of Annex I Parties to achieve their collective emission reduction targets. IET enables those parties which have high potential for reducing their emissions to trade their emission reductions with those who cannot reduce their emissions due to already stringent standards in place.

Kyoto Protocol provides several mechanisms for the Annex I and Non-Annex-I countries to engage in emission reduction initiatives and hence has been praised for its success. However, the Protocol has also attracted several criticisms. Some of the criticisms are given below:

- Deeply flawed agreement that manages to be both economically inefficient and politically impractical,
- Non-ratification of Kyoto Protocol by USA and Australia who account for majority of the global greenhouse gas emissions,
- International permit trading [as the principal policy instrument of the Kyoto Protocol] runs the risk of being highly inefficient, given uncertainties in the marginal cost of abating greenhouse gas emissions... and would probably

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generate large transfers of wealth between countries,[27]

- 'Kyoto does not deter free-riding and non-compliance',[28]
- Defective on both efficiency criteria [spatial and temporal equalization of abatement costs] because it omits a substantial fraction of emissions (thus failing the spatial criterion) and has no plans beyond the first period (thus not attending to the temporal dimension),[29]
- Has an arbitrary allocation of transfers... moreover, since developing countries are omitted, they are completely over looked in the transfers,[29]
- The policy lacks any connection to ultimate economic or environmental policy objective,[29]
- 'No individual government has an incentive to police the agreement. . . . The Kyoto Protocol can only work if it includes an elaborate and expensive international mechanism for monitoring and enforcement',[27]

Given the large uncertainties in the science of climate change and the fundamental incentive problems of sovereign states, it is clear that a perfect climate policy cannot be achieved in practice. The Kyoto Protocol is thus necessarily only one out of much possible imperfect architecture to address the risks posed by global climate change.[25] A search for a suitable alternative after 2012 has already begun on an informal basis. Many of these negotiations aim to overcome the weaknesses in the existing regime (Table 12.1).[30] Several suggestions came out in the consultation process for future climate regime. They include:

- Distributed governance, better communication and engagement of diverse stakeholders,[30]
- Identification of 'tipping points' in technology that could bring considerable GHG mitigation benefits,
- Talking beyond numerical targets and including voluntary and contractual measures, especially for large developing countries,
- Designing optional protocols for adaptation, technology transfer, and forestry,
- A credible system of direct or indirect sanctions must be developed that can deter free riding; applied research should be dedicated to the question of which sanction mechanisms are likely to provide concrete improvements in practice.[25]

Developing countries have been urged to take the lead in the ensuing discussions for what may follow after Kyoto Protocol as they have been marginalized during the entire negotiation process of the first climate regime.[31] The climate regime will be a stronger regime if it forcefully re-establishes its links with sustainable development; it will certainly get more support from the developing countries if it does. Ignoring sustainable development's importance to climate policy may or may not impact the future of sustainable development but will nearly certainly adversely impact the future of the global climate regime.[32]

While mitigation is important, developmental needs of the developing countries cannot be overlooked. In introducing the twin concepts of 'adaptive' and 'mitigative' capacity (by working groups II and III, respectively) the third assessment of the IPCC (2001) has made a significant contribution to the policy discourse by outlining what types of capacities are required, by whom, and when.[33] The most pressing challenge in this regard is to strengthen the social, economic and technical resilience of the poorest and most vulnerable against extreme climatic events. The priority must be on those countries that are climatically most vulnerable as well as economically impoverished and therefore unable to 'cope' or 'adapt' with sudden and

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Table 12.1 Major achievements and weaknesses of the current climate regime process

Achievements	Weaknesses
• Prompt start of negotiations on climate change • Broad participation of countries in the Convention (189 parties) • Coming into force of the Kyoto Protocol • Marrakech accords on market-based mechanisms and adaptation • National Communications Engagement of the private sector • Engagement of civil society; increasing attention on adaptation issues • Architecture for the first effective compliance regime • Mechanisms for enabling transfer of technologies and financial flows, and capacity building	• Long international negotiation process and considerable delay in coming into force of the Kyoto Protocol • Weakening of Kyoto Protocol objectives and targets in search for consensus leading to limited environmental effectiveness • Differing positions on global participation (for example, rejection of the Protocol by major Annex I countries such as USA and Australia, and lack of agreements on national actions) • No major change in emissions growth trends by Annex I countries • Rigidity of top-down, intergovernmental process Undue focus on assigning blame thereby exacerbating North-South differences • Complexities of market mechanism such as Clean Development Mechanism (CDM) • Failure to link climate change and sustainable development, and the lack of effective mainstreaming options • Inadequate progress in technology transfer, climate finance and capacity building Inadequate attention to adaptation (as compared with the size and complexity of the issue) • Poor communication to society on effective strategies to tackle climate change

Source: Ref [30]

significant climatically induced disasters. This highlights the need to focus on the issues of adaptation, especially in developing, least developed countries and small-island developing states where the threat of climate change is more immediate and intense due to the less capacity to adapt.[34]

Adaptation

'Adapt' means to make more suitable (or to fit some purpose) by altering (or modifying). 'Adaptation' refers to both the process of adapting and the condition of being adapted.[21] Adaptation refers to an adjustment in response to actual or expected climatic stimuli, which aims at moderating harm from climate change or exploiting beneficial opportunities.[35] Watson et al defined adaptability as "the degree to which adjustments are possible in practices, processes, or structures of systems to the projected or actual changes of climate", and noted that

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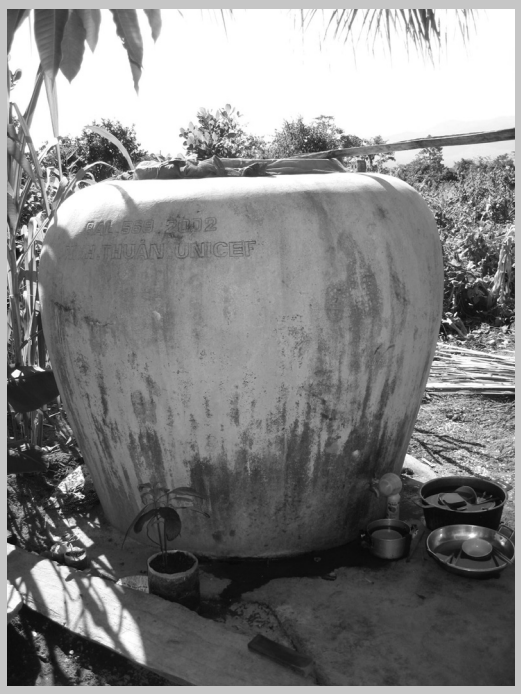
Adaptation to drought risk: Some examples from Vietnam



Water jars supplied by NGOs are significantly reducing the drought impact on communities

Source: Ref [37]

Vietnam, a country known for frequent floods by Mekong river, is increasingly facing droughts during recent times. This signifies the changing disaster profile of the country, which could partially be attributed to climate change related influence due to absence of credible information on the cause. Such change in disaster profile has taught the local communities to devise several interesting adaptation mechanisms. Some such adaptation mechanisms include:

- Saving crop seeds for sowing immediately after cessation of drought,
- Changes in crop planning such that the drought impacts could be reduced,
- Shifting from drought vulnerable crop varieties to drought resistant ones,
- Growing drought tolerant animal breeds,
- In situ water harvesting and conservation practices to reduce drought stress,
- Enhancing the water use efficiency and hence saving water for other purposes,
- Livelihood diversification through temporary migration to nearby cities, dependence on forest usufructs.

"adaptation can be spontaneous or planned, and can be carried out in response to or in anticipation of change in conditions."[36] What constitutes climatic stimuli is an interesting point to look into. The vulnerability cum adaptation literature recognizes explicitly that the systems' environments are inherently variable from day-to-day, month-to-month, year-to-year, decade-to-decade, and so on.[38] Changes in the mean conditions that define those environments can actually be experienced most noticeably through changes in the nature and/or frequency of variable conditions that materialize across short time scales and that adaptation necessarily involves reaction to this sort of variability.[39] Some researchers have used the concept of "hazard" to capture these sorts of stimuli, and claim that adaptation is warranted whenever either changes in mean conditions or changes in variability have significant consequences.[40] For most systems, though, change and variability over short periods of time fall within a "coping range"—a range of circumstances within which, by virtue of the underlying resilience of the system, significant consequences are not observed.[41] The coping range can be regarded as the adaptive capacity of a system to deal with current variability. Adaptive capacity

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to climate change would refer to both the ability inherent in the coping range and the ability to move or expand the coping range with new or modified adaptations.[42] However, there are limits to resilience for even the most robust of systems. As a result, it is important to understand the boundaries of systems' coping ranges—thresholds beyond which the consequences of experienced conditions become significant. Coping ranges are not necessarily fixed over time, of course. Smit et al made it clear that judging adaptive capacity depends critically upon both defining a coping range and understanding how the efficacy of any coping strategy might be expanded by adopting new or modified adaptations.[43]

Adaptation to climatic stimuli depends on the adaptive capacity of the systems in question.[44] Adaptive capacity is defined as the degree to which adjustments in practices, processes, or structures can moderate or offset the potential for damage or take advantage of opportunities created by a given change in climate. The adaptive capacity of the system is determined by the range of available technological options for adaptation, the availability of resources and their distribution across the population, the structure of critical institutions, the derivative allocation of decisionmaking authority, and the decision criteria that would be employed, the stock of human capital including education and personal security, the stock of social capital including the definition of property rights, the system's access to risk spreading processes, the ability of decisionmakers to manage information, the processes by which these decisionmakers, determine which information is credible, and the credibility of the decision-makers, themselves, and the public's perceived attribution of the source of stress and the significance of exposure to its local manifestations.

The Working Group II of the Third Assessment Report of the IPCC (2001) concludes the following with relation to the adaptation:[45]

1. The vulnerability of any system to an external stress (or collection of stresses) is a function of exposure, sensitivity, and adaptive capacity.
2. Human and natural systems tend to adapt autonomously to gradual change and to change in variability.
3. Human systems can also plan and implement adaptation strategies in an effort to reduce potential vulnerability or exploit emerging opportunities even further.
4. The economic cost of vulnerability to an external stress is the sum of the incremental cost of adaptation plus any residual damages that cannot be avoided.

The importance of adaptation arises from the fact that adaptation can modify the impacts of climate change and variability on the communities and it can also be considered as an important policy option or response strategy to the concerns about climate change.[46] Adaptation is also important because even if current agreements to limit emissions are implemented, they will not stabilize the atmospheric concentrations of GHG emissions and climate. As a result, the climate change impacts are still felt. Hence, there is a need to enhance the capacity of the systems to withstand the impacts of the climate change such that the damage is minimized. As mentioned earlier, the process of adaptation is not new; communities and governments have been adapting to the climatic stimuli for the ages. In the context of climate change, what is new is adapting to the future climate change threats and mainstreaming this concept in the policy and decision making realms. Adaptation should also be understood as:[47]

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- Adaptation to short-term climate variability and extreme events is included as a basis for reducing vulnerability to longer-term climate change.
- Adaptation policy and measures are assessed in a development context, which is a deviation from project based approach to development based long-term approach.
- Adaptation occurs at different levels in society, including the local level. It is important to promote the bottom up risk management approach.
- Both the strategy and the process by which adaptation is implemented are equally important. Hence, engagement of stakeholders in the process is essential to the adaptation.

Two kinds of adaptations could be identified (Fig. 12.2), autonomous adaptation and planned adaptation. Autonomous adaptation refers to the changes in the system after it has already faced certain impacts. In this kind of adaptation, the losses are apparent and the system undergoes changes only after it faces the impacts. Autonomous adaptation happens when the climate change impacts are within the resilience of the system.[48] Autonomous adaptation has costs. Planned adaptation becomes important when the climate change impacts exceed the resilience of the system. Planned adaptation refers to all those changes the system undergoes in anticipation to the expected climatic stimuli. In the context of climate change adaptation, this kind of adaptation has high significance as it can reduce the vulnerability of the system to climatic risks, enhance the capacity of the system, and mitigate the impacts of future climate risks. However, it is also important that we have a good understanding of autonomous adaptation as it reflects the vulnerabilities and capacities of the system to the known climate change in the past. This understanding would help us in planning for the future that includes consideration of uncertainty. Deciding on 'adapting to what' constitutes dealing with considerable amount of uncertainty due to the fact that the future climate change and its impacts are uncertain. Hence, there is a possibility that such adaptation options may not be found useful in the course of the time. This demands that any decisions related to planned adaptation involves consensus among the stakeholders.

Two significant frameworks have emerged to help the planned adaptation. They are the Adaptation Policy Frameworks (APF) for Climate Change and Climate adaptation: Risk, uncertainty and decision-making framework by the UK Climate Impacts Program.[49,50] While the UNDP APF is considered as more elaborate and complex process aimed at policy makers and project formulators, the UK CIP decision framework is simpler and covers broadly the uncertainty that one may face with while taking decisions related in those sectors which are impacted by the climate change. Table 12.2 provides a comparison of both the approaches in terms of objectives, target audience they address, stages in which they can be implemented, and complexity. For the reason that the UK CIP is simpler than the UNDP APF, we provide a general overview of the UK CIP framework for decision-making.

Decision-making framework

Climate change poses a risk to the decision-makers. The risk has its origin from the impacts of the climate change as well as the decisions made to deal with those risks as those decisions would have come from the information that is uncertain and incomplete. In this sense, climate change also poses a risk to decisionmakers on how many counts they may go right in their decisions. This necessitates a structured framework within which the decision makers can make decisions pertaining to climate change. Such a structured framework needs

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Table 12.2 Comparison of UNDP APF and UKCIP climate adaptation frameworks

S No	Element of comparison	UNDP Adaptation Policy Framework	UKCIP Climate adaptation
1	Objective	To guide studies, projects, planning and policy exercises (collectively called projects) towards identification of appropriate adaptation strategies, policies and measures and integration of same into local, sector specific and national developmental planning.	To take account of the risk and uncertainty associated with climate variability and change; and to identify and appraise measures to mitigate the impact or exploit the opportunities presented by future climate change, i.e., to identify good adaptation options.
2	Target audience	Primarily designed for technical analysts, climate project coordinators and developers and climate change policy makers.	Particularly relevant to decisionmakers and their advisors who work in climate sensitive sectors, who manage the climate related consequences and whose decisions are vulnerable to climate risks.
3	Number of stages	Five main components and two cross-cutting processes.	Eight stages grouped into four.
4	Complexity	The assessment heavily relies upon available data on various climate parameters and developmental indicators.	While dependent on model outcomes and scenarios, it gives due emphasis to other kinds of techniques such as checklists, consultation processes and pedigree analysis.
5	Methods and tools	A mix of quantitative analytical and qualitative tools is used. Uses model outputs in assessing future climate risks.	Uses a mix of qualitative and quantitative methods and tools. It lists various tools to be used at every decision making step listed in the methodology.

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6	Practicality	Is more of a practice than theory. More complex process requiring thorough understanding of various concepts, methods and tools.	Practical approach with more focus on decision-making process.
7	Dealing with uncertainty	Deals with uncertainty while assessing the future risks and using the same in APF.	The process is designed in such a way that the uncertainty is discussed and dealt with at almost all the stages of decision making process.
8	Flexibility	Provides sufficient flexibility by providing options such as hazard-based approach, vulnerability-based approach, adaptive-capacity approach, and policy-based approach.	The process is more a risk-based approach and provides sufficient flexibility in decision making process.
9	Levels covered	Covers both local level and national levels in the decision-making process.	Covers both local level and national levels in the decision making process.
10	Intended outcomes	Policy development, integrated assessments, and project formulations	Provide answers to questions such as what kind of adaptation decisions can be taken and when in a changing climate with due emphasis on uncertainty.
11	Advised user level	For advanced users and professionals	For beginners with basic understanding of principles underlying climate vulnerability and risk assessments.

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to be flexible enough to provide room for innovation and for inclusion of learning from the process. In general, two kinds of decisions are taken in any sector that has something to do with the climate. The decisions are called climate adaptation decisions if they are directly driven by the need to reduce the climate risks, current or future. The decisions are called climate-influenced decisions if climate only constitutes one of the many factors that influence the decision.

The climate adaptation and decision-making framework proposed by the UK Climate Impacts Program (UK CIP) (hereafter called as UK CIP framework) provides structured framework for decision makers to make decisions in the uncertainty of changing climate. The UK CIP framework consists of eight key stages comprising goodpractice in decision making. They include:

1. Identify problem and objective,
2. Establish decision-making criteria, receptors, exposure units and risk assessment endpoints,
3. Assess risk,
4. Identify options,
5. Appraise options,
6. Make decision,
7. Implement decision,
8. Monitor, evaluate and review (Fig. 12.4).

The process is cyclic in nature as it allows the assessment of decisions taken at regular intervals and make corrective actions when necessary. The tiered nature of the process also allows decision maker to identify and prioritize climate risks for decision-making. The decision makers are cautioned to avoid answers of the kind of 'Yes' or 'No' and provide more elaborate explanation for the decisions made. They are also suggested to identify any uncertainties for which decisions couldn't be made and be explicit about the choice of decisions made and policy strategies formulated.

Stage 1: Identify problem and objectives: This is a critical stage for the decision maker as identification of critical issues forms the basis for the entire adaptation framework. In order to arrive at realistic list of critical issues, the decision maker is advised to identify and prioritize those areas which are influenced by the climate change directly and those indirectly. This will set the basis for climate-sensitive decisions and climate-influenced decisions. There are chances that some times decisions are maladaptive in nature which include those decisions which may be detrimental to the vulnerability reduction. As decision makers would have to regret for this kind of decisions, due care needs to be taken to avoid them. This is also the stage where the level of decision-making is to be decided. For example, the decisions could relate to those of grassroots level or related to regional and national level. Decision makers would have to be aware that the uncertainty may make their decisions look foolish as the time passes by. Various tools could be used at this stage with their own strengths and limitations. For example, consultation exercises could engage many stakeholders while making the process difficult to handle as discussions heat up. Other tools such as analysis of interconnected decision areas, problem mapping tools, free-form gaming, and policy exercise could be used with varying degree of success in identifying related decisions.

Stage 2: Establish decision-making criteria: The objectives set out in Stage 1 need to be translated into operational criteria that can be used in a formal risk assessment. The decision making criteria should reflect the uncertainty about future climate risks and should reflect the organization's decision-making culture and risk. At this stage, it is appropriate for the decision maker to establish exposure units (system considered to be at risk) and

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receptors at risk (population at risk) and agree preliminary risk assessment endpoints that relate to the decision criteria. This process represents an important link between objectives set in Stage 1, criteria established in Stage 2 and the subsequent risk assessment and appraisals done in Stages 3 and 5. Policy problems, where future climate risk is a concern, will in general encompass larger exposure units and greater potential numbers of receptors and assessment endpoints. Key features to be considered when choosing tools are how familiar decision-makers are with the problem area and the number and range of stakeholders involved. Tools such as brainstorming, consultation process, focus groups, AIDA, problem mapping tools could be used at this stage.

Stage 3: In its very essence, risk management thrives upon risk assessment. It is the risk assessment which tells the risk manager about the magnitude and depth of the risk to be managed, which will in turn decide the kind of risk management techniques to be employed. Hence, risk assessment is the beginning point for managing the risk. The basic purpose of risk assessment is to characterize the nature of risk, provide qualitative estimates of the risk, assess the consequences of uncertainty for decision options, and compare sources of risk, including climate risks. The climate risk assessment till date has been marred with many limitations which are also limiting the management of climate risk to certain extent. Some of the current limitations in our future climate risk assessment are uncertainty about the future anthropogenic and natural GHG emissions, uncertainty in global and regional climatic responses to emissions and uncertainty in impacts of climatic changes on economies

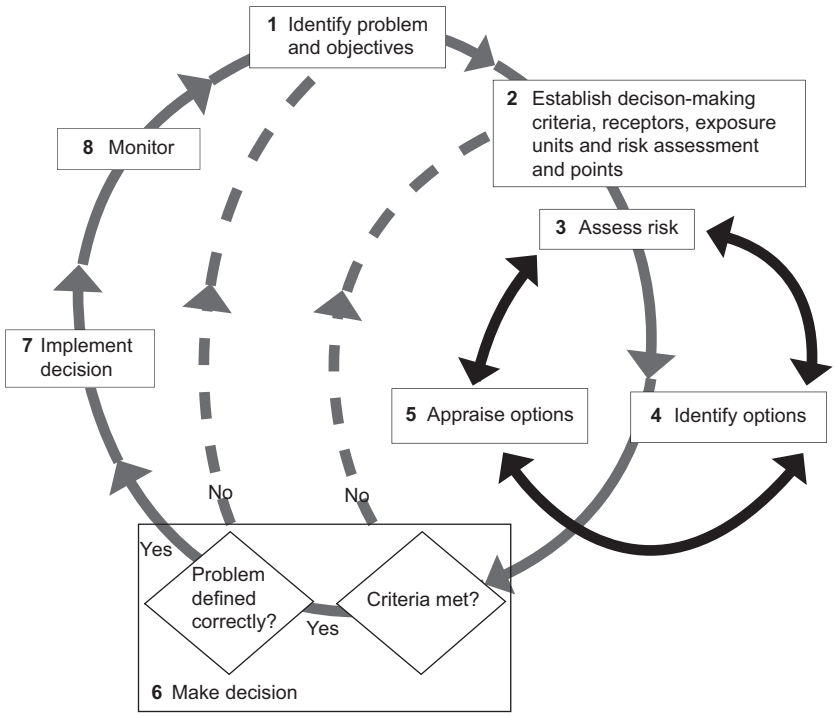

Fig. 12.4 A framework to support good decision-making in the face of climate change risk.
Source: Ref [50]

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and the biosphere.[51] Because climate change risk analysis is a long term analysis, it is also difficult due to uncertainty about how human systems respond to actual and perceived changes through mitigation or adaptation.

The UK CIP Framework suggests a tiered risk assessment which means conducting risk assessment at all the administrative and geographical levels set out in the Stage 1. The Framework also suggests using a combination of quantitative and qualitative methods such as participatory workshops, consultancy support, and research and development activities. As a first tier, preliminary climate change risk assessment should be done by preparing a checklist of impacts. Such a checklist will help identify whether or not climate change related impacts may be important to the selection of options at Stage 5. At the second and third tier, more qualitative and quantitative risk assessment should be undertaken using tools such as statistical models, climate change scenarios, cross-impact analysis, downscaling, and Markov Chain modelling.

Stage 4: There could be number of options for a particular problem identified in the earlier stage. It is important that all the options are listed out and classified into no regret and low regret options. They could range from 'do nothing' to 'do little' to 'do a lot'. Example of options include insurance type strategies, diversification, other new financial products that off-lay the risk. Option could also include 'research' if not much information is available to take a decision in some area. Identification of options is largely governed by the factors including whether the decision is operating at the policy, programme or project level, the non-climate impacts of concern, the relevant climate change impacts, the decisionmaker's attitude to risk, and degree of risk and uncertainty surrounding the decision. Tools such as brainstorming, focus groups, AIDA, problem mapping, checklists, and policy exercises can be used at this stage.

Stage 5: This stage comprises of evaluation of the options against the criteria established at Stage 2. This is to provide a robust basis upon which to recommend the best way to meet the overall decision criteria. Options appraisal informs the decision to be made. Option appraisal depends on how much adaptation is needed and when. There are costs and environmental and social impacts for the choices made between options and hence the decision-maker needs to be careful in making choices. This also demands that the options are screened for the lower environmental, social and economic impacts they have. A tiered approach could be followed for screening the options. At the first tier, a systematic and qualitative analysis may be made. There should be an emphasis on ranking the options in terms of costs and benefits. Tier 2 can consist of semi-quantitative and semi-qualitative analysis where in some aspects of the risks, costs and benefits are assessed in quantitative terms while others are assessed qualitatively. Tier 3 can be fully quantitative where the probable performance of each option is quantified in terms of costs and benefits. A wide range of tools were suggested for this stage. Some of them include cost-effectiveness analysis, cost-benefit analysis, decision analysis, discounting, risk-risk analysis, fixed rule-based fuzzy logic; and maximax, maximin, minimax and regret analysis.

Stage 6: This step brings the information together and evaluates it against the objectives and defined decision criteria. This stage also includes effective communication of the analysis that helps the stakeholders and decision makers in understanding the trade-offs between different courses of action. Since the future is uncertain, any predicted outcome of selecting a particular option (preferred option) will carry with it a degree of uncertainty. In some cases, the policy makers may want to select a less

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uncertain option. Areas with large uncertainty may demand use of complex probabilistic decision criteria for making decisions. In other cases, the decision maker may want to implement number of options with broadly equivalent prospects. At this stage, tools such as hedging and flexing, expected value, portfolio analysis, sensitivity analysis, ranges and intervals, deliberate imprecision, pedigree analysis and policy exercise can be used.

Stages 7 and 8: These are the stages where the decisions made in the previous stage are implemented, monitored and evaluated. Constructive communication must be used to address the misunderstanding over the policy decisions made and help seek the public support. Emphasis should be given to communicate the importance of uncertainty to the end decision made and its success. Transparency and clarity of presentation are important while assessing and describing the uncertainty involved in the decision making process. Quantified targets would help monitor the performance of implemented decisions. Monitoring should also include review of climate change risk assessments and decisions, following updated climate change scenarios or new information about climate change impacts.

CONCLUSIONS

Climate change is a significant threat to the sustainable development. Climate risk management has emerged as an all inclusive process with both mitigation and adaptation becoming important strategies for overcoming what is known as one of the most important threats to the human existence. Instead of debating on who the culprit is, i.e., human induced or natural process, there is a dire need for global community to unite and fight for their own existence as costs of not acting could be much higher and irreversible than acting upon the emerging risk. There are costs to be incurred and uncertainties to be faced. On the positive front, climate risk management has brought in a new culture of decision making. The decision making that is now designed to consider uncertainties, much more than was done before. There is a tremendous rise in general awareness about what constitutes climate change and the risks it is posing. With this, the global and regional planning is believed to move from shortsightedness to long-term, perspective and strategic thinking so that the threats of the kind of climate change can be dealt with effectively.

Challenge is immense. Meeting the developmental needs of the developing countries while simultaneously reducing the climate change risks is a gigantic task. Adaptation has emerged as an important strategy to enhance the capacity of developing and small island nation states whose vulnerability to climate change lies in their developmental level. Climate change mitigation, through global treaties and Kyoto Protocol based mechanisms, and adaptation could bring substantial resources, both financial and technological, to these countries enabling them to meet their both ends. Climate change could be seen as an opportunity for these countries to set the things right and not to follow the same path that the developed countries have followed in their bygone histories. Sustainable development is only the only path left.

While the efforts should be kept ON, both on adaptation and mitigation fronts, the global community also need to improve the understanding on climate and its future impacts and address much of the uncertainty that is plaguing a consensus to be reached. For this, one of the alternatives is to reach a post-Kyoto agreement that is addresses the limitations identified in the Table 12.1. Any such future protocol should be sustainability centric and give due importance to the adaptation.

Though climate change is a global issue, the impacts are felt very much on the ground at the local level. While global negotiations continue to take place, meanwhile, it is important that

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the vulnerabilities of the local communities are well understood and addressed. Reducing the vulnerability to climate change including climate change adaptation involves identification of climate related vulnerabilities, quantifying risks and identification of adaptation measures that are win-win solutions. The no regret options, options which do not depend on the impact projections, should be identified and implemented. The community based adaptation mechanisms over the length and breadth of the country should be identified, improved upon them and scaled up to larger areas with similar socio-economic backgrounds.[52] Such no-regret options could be identified in a participatory manner involving wider group of stakeholders such as local communities, NGOs, and local governments. Effective implementation is indispensable. As highlighted in previous sections, effective implementation is possible if measures are identified and prioritized based on consensus. Political consensus is an important as channeling funds and other resources are mainly affected by the decision making at higher levels.

In addition to the local level initiatives, global level efforts such as global treaties should be able to address the local vulnerabilities and channel the required resources to deal with the same.[53] Due to the nature of the problem, there may be a rush to push decisions from above making them less suitable to deal with the local vulnerabilities. Hence, any climate risk management process should address the local vulnerabilities as they are linked with the global issues. A new vision is required that will enable every one effectively see the problem at the global level and deconstruct its linkages with the local level such that local solutions are automatically designed to dismantle the multiple linkages of global evil.

Acknowledgements

The authors would like to acknowledge the inputs from various anonymous reviewers. The authors would like to thank Japanese Society for Promotion of Science (JSPS) that provided Postdoctoral Fellowship to carryout research on climate risk at Kyoto University.

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