Climate Change, Disasters and Security ……Issues, Concerns and Implications for India

By

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ABSTRACT

Climate change and disasters are fast emerging as the most defining challenges of the 21st century as global risks with impacts far beyond just the environment and implications on national security and development. The paper examines the climate change-disaster-security nexus in context of India, the future projections of the IPCC and other regional assessments, along with the disaster profile of the country and the trend of rising disasters. For India, tackling the challenge of climate change and increasing in disaster risks posits particular significance, presently poised as she is in an upward development trajectory. Valuable time and resources would be consumed in handling the increasing risks, which would impinge on its development, unless appropriate mitigation measures and mechanisms are not put in place now, and policies redefined to address the challenge. An analysis of the impact of climate change on the risk of natural hazards and its implications for national security is put forth with proposed preparedness strategies and emergent policy imperatives. A range of options and strategies to deal with disaster risk reduction and climate risk reduction are viewed from a 'risk management' approach. Ensuring that development planning processes integrate climate risks as well as disaster risks will require 'risk identification', i.e. bringing together and effectively disseminating information on vulnerability and hazards. Translating the macro level options into courses of action at the micro local level poses a complex challenge and will require a range of risk reduction and risk spreading options micro-scoped to the regional/local context.

Keywords: climate change, disasters, security, integrated risk management, climate change risk indices, adaptation, mitigation

CLIMATE CHANGE, DISASTERS AND SECURITY ……ISSUES, CONCERNS AND IMPLICATIONS FOR INDIA

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INTRODUCTION

Climate change and disasters are fast emerging as the most defining challenges of the 21st century. The Fourth Assessment Report (AR4) of the Intergovernmental Panel on Climate Change (IPCC); IPCC AR4 has provided compelling evidence that climate change is advancing rapidly as a global risk with impacts far beyond just the environment. Recent projections and analytical studies indicate that the increasing global temperatures, arctic and glacial melt down, sea level rise and other climate change induced environmental degradation will give rise to extreme weather events and overstretch many societies' adaptive capacities within the coming decades thus increasing societal vulnerabilities. Concomitantly a global review of the statistics of disasters by the Centre for Research on the Epidemiology of Diseases (CRED) indicates that natural disasters are increasing in terms of frequency, complexity, scope and destructive capacity. Hitherto disasters were linked to climate change through short term natural variability manifesting in extreme weather events such as cyclones, storms, floods, droughts, heat waves, windstorms and other natural hazards with potential for catastrophic loss of human lives, damages to infrastructure and environment. However, with the climate change manifesting at an unprecedented rate with increased variability and frequency of extreme events, long term implications and possibility of abrupt change, fuelled largely through anthropogenic cause, these two processes have the potential to coalesce generating destructive forces which could cause mega disasters unless urgent, radical and resolute mitigation actions are not implemented.

For India, tackling the challenge of climate change and increase in disaster risks posits particular significance, presently poised as she in becoming a major global power. Valuable time and resources would be consumed in handling the increasing risks, which would impinge on geo-strategic imperatives, unless appropriate mitigation measures and mechanisms are not put in place now, and policies redefined to address the challenge.

The subsequent arguments analyze the impact of climate change on the risk of natural hazards in India and implications for security and propose preparedness strategies and emergent policy imperatives.

THE CONTEXT- CHANGING CLIMATE

IPCC AR4 has categorically established that climate change is advancing rapidly with global warming as a prime causative factor. The warming of the climate system has

been termed "unequivocal" by global scientific consensus as evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global average sea level (IPCC, 2007a). This has been unprecedented in the last 1300 years and most of the warming has been convincingly attributed to human influence.

According to the latest evaluations, the average temperature at the surface of the earth has increased by 0.74 (0.56-0.92) °C during the twentieth century. The temperature increase, though widespread, is greater at higher northern latitudes. Land regions have warmed faster than the oceans. Such a rise in global temperature is very large by historical standards, making the 1990s the warmest decade of the past millennium. Eleven of the last twelve years (1995-2006) rank among the twelve warmest years since 1850. Because of warming, the global extent of snow cover has receded by some 10% since 1960s and the annual average Arctic sea ice extent has shrunk by 2.7 % per decade since 1978. Mountain glaciers and snow cover on average have declined in both hemispheres. The global average sea level has risen by 0.1 to 0.2 meters in the century consistent with warming. Precipitation has increased in the higher latitudes of the northern hemisphere while it has decreased in subtropical regions. Climatic phenomena such as heavy rains in parts of the northern hemisphere, warm episodes of the El Niño Southern Oscillation (ENSO) over the tropics, and droughts in some regions of Asia and Africa have gained in intensity and frequency (IPCC, 2007b).

According to the future scenario projections by IPCC AR 4 global warming is expected to intensify during the 21st century. Green House Gases concentration in the atmosphere will be 45% above the present level in 2100 under the most favorable set of hypotheses, and 260% above it in the worst case. Without resolute mitigation, a global increase in temperature of 2-7°C relative to pre industrial levels and a rise of 0.1 to 0.9 meters in the sea level can be expected to occur by 2100 (Parry et al, 2007). Only very rapid and radical changes in emissions of greenhouse gases or aerosols, or unforeseeable events such as a major volcanic eruption or meteorite impact would bring about any marked deviation from the forecast outlined in the next 25 years. Gradual emissions reductions over the coming decades, which would most likely be implemented as part of an effective climate protection policy, would not bring about any notable slowdown in the global warming trend until after 2030 (WBGU, 2008). The IPCC projections are supported and substantiated by other climatic models. A ten-year climate prediction model developed by the Hadley Research Center of the UK Meteorological Office, predicts that the world is warming up faster than at any time in the past 100 years. It shows that global warming will begin in earnest in 2009, at least half of the years 2009 to 2014 will be hotter than 1998, the warmest year on record. The model predicts 2014 to be 0.3°C warmer globally than 2004 and that by 2015 global temperatures will be 0.5°C above the average value for the last 30 years (Doug, 2007). This is a sharp increase, as the average global temperature has risen by only 0.8°C since 1900.

Due to the long lead times involved in climatic changes, global warming is expected to continue during the 21st century. Future projections indicate that there is increased confidence that some weather events and extremes will become more frequent, more widespread and/or more intense during the 21st century and impacts due to altered frequencies and intensities of extreme weather, climate and sea level events are very likely to change (IPCC, 2007c). A few examples of possible impacts of climate change due to

changes in extreme weather and climate events to the mid- to late 21st century are (Parry et al, 2007):-.

- Warmer and fewer cold days and nights, warmer and more frequent hot days and nights over most land areas - virtually certain (greater than 99% chance)
- Heat waves frequency increases over most areas - very likely (90–99% chance).
- Heavy precipitation events frequency increases over most areas- very likely (90–99% chance).
- Area affected by drought increases- likely (66–90% chance).
- Intense tropical cyclone activity increases- likely (66–90% chance).
- Increased incidence of extreme high sea level (excludes tsunamis)-likely (66–90% chance).

CLIMATE CHANGE- DISASTERS-SECURITY NEXUS

Climate Change and Disasters

The United Nations defines disaster as '*a serious disruption of the functioning of the community or society, causing widespread human, material, or environmental losses which exceed the ability of the affected community or society to cope using its own resources'* (UNDHA, 1992). Climate has always been linked with disasters, hitherto, through climate variability manifesting in extreme weather events such as cyclones, storms, floods, droughts, heat waves, windstorms etc, with potential for catastrophic loss of human lives, damage to infrastructure and environment. These short term climate fluctuations and extreme weather events have been the most frequently occurring hazards and in combination with social vulnerability have been responsible for the vast majority of disaster losses worldwide. CRED categorizes these disasters resulting from climatic variability and other climatic and meteorological causes as *hydro-meteorological disasters* (floods, landslides, mudflows, avalanches, tidal waves, windstorms, including typhoons, cyclones, hurricanes, storms, winter storms, tropical storms and tornadoes, droughts, extreme temperatures, and complex disasters associated with drought) as distinct from *geological disasters* (earthquakes, volcanic eruptions and tsunamis) (CRED, 2007). The hydro-meteorological disasters resulting from climate variability and other climatic and meteorological causes are also commonly referred as 'climate disasters' in disaster studies.

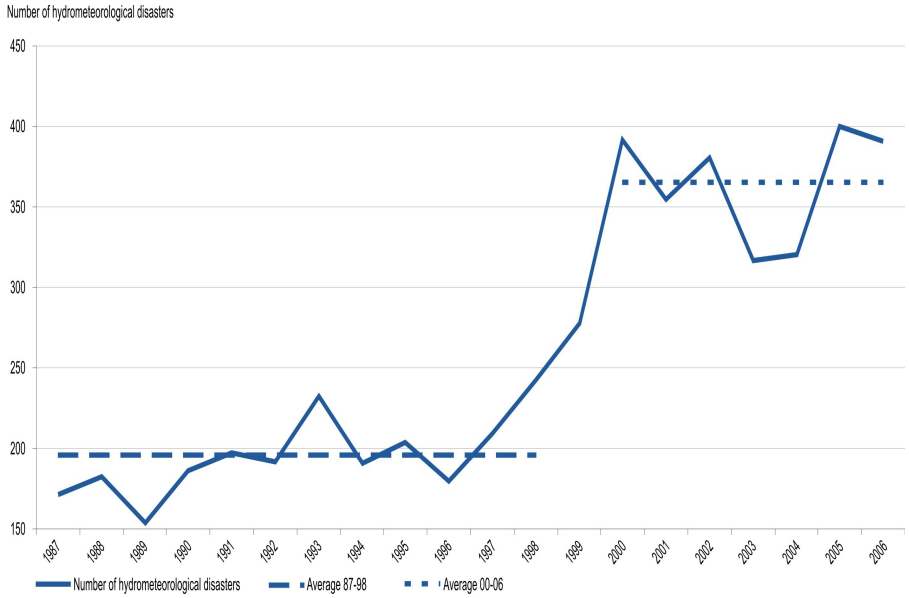
Climate disasters have always been a recurring theme in human history, and are on a rising trend.

> **-Trends - 20th Century**. Over the 20th century, climate related disasters were *seven* times as frequent as those including geo physical hazards globally, and accounted for *nine* times as many deaths and caused economic losses that were *three* times higher (UNDP, 2007b).

-Trends - 21st Century. In the 21st century over the past three decades, climate related natural disasters occurred *five* times as frequently, killed or affected *seventy* times as many people, and caused *twice* as much damage worldwide as did earthquakes and volcanoes. In the past decade, weather-related natural hazards have been the cause of 90% of natural disasters and 60% of related deaths, and have been responsible for 98% of the impacts on disaster-affected populations, the majority in areas of developing countries (IFRC, 2005). Between 2000 and 2004 an average of 326 climate disasters was reported each year. Some 262 million people were affected annually for 2000-2004, more than double the level in the first half of the 1980's (UNDP, 2007a).

-Climate Disasters Statistical Review 1987-2006. The global review of the statistics of climate disasters by CRED also indicates that climate disasters are increasing in terms of frequency, complexity, scope and destructive capacity. A comparison of the occurrences of climate disasters from 1987-2006(CRED, 2007) with averages for periods 1987-1998 and 2000-2006 is at Fig 1.

Fig 1- Occurrence of climate disasters: 1987-2006 with averages for periods 1987-1998 and 2000-2006



(Source : CRED 2007)

[The statistics indicates that during the period 1987-2006, climate disasters show a significant increase. For 1987-1998, the average number of climate disasters reported was 195; for the years 2000-2006, this numbers increased by 187 % to an average of 365(the years 1998-1999 and 2000 reflect a turning point and an escalation in the number of disasters reported, with 1999 showing the most dramatic inflection. Accordingly, for purposes of the comparing the two periods, data for 1999 was excluded).]

-Disaster Figures for 2007/08. The recent data from CRED for 2007/08 reveals a marked increase in the number of climate disasters, especially floods, compared with the average of the last seven years, with Asia as the hardest hit continent (UN/ ISDR, 2008/01). Eight out of the 10 countries with the highest disaster deaths of

2007 were in Asia, with 4,234 killed in Bangladesh by cyclone Sidr in Nov 2007, and more than 3,000 fatalities from severe floods in Bangladesh, India, North Korea and China. The number of people affected by disasters continued to increase and floods remain the main disaster that affects populations in the world. More than 164 million people were affected by floods in 2007 out of the 197 million affected by disasters.

Climate Change and Increasing Disasters- Is there a Link?

A number of experts link these current trends in extreme weather events with the increase in the global mean temperature. The CRED report states that there *'there is increasingly conclusive evidence which confirms that global climate change will have an impact on the occurrence and magnitude of extreme events. These impacts are envisaged to increase human vulnerability to natural disasters, thus emphasizing the need for improved measures of preparedness in every part of the world'* (UN/ISDR, 2008/01). CRED report also surmises that the current trends are consistent with the predictions of IPCC AR4, in that Asia, and also West Africa are already suffering from more severe and frequent floods (Sapir, 2008). The future projections by IPCC AR4 also indicates that there is '*increased confidence that some weather events and extremes will become more frequent, more widespread and/or more intense during the 21st century and impacts due to altered frequencies and intensities of extreme weather, climate and sea level events are very likely to change*' (IPCC, 2007c; Parry et al, 2007).

Notwithstanding the predictions of IPCC AR4, supported by CRED through trend analysis of rising climate disasters, a direct attribution to climate change is not possible as every weather event is the product of random forces and systemic factors. However, climate change will steadily increase the exposure of the poor and vulnerable to climate shocks and place increased pressure on coping strategies and adaptive capacities of societies by resource and environment degradation. Current evidence points very clearly that climate change is creating systemic conditions for extreme weather events and will increase the risk of exposure to climate disasters through increasing societal vulnerabilities. Shifts from long term averages could raise the level of background stress, thereby increasing vulnerability to acute environmental stresses. The character and frequency of the acute stresses themselves could change, manifesting as extreme events. Lastly, climate change could exacerbate the scope and intensity of chronic hazards and contributing elements associated with such stresses by increasing vulnerability because of increasing background environment stress (Hultman et al, 2006).

Also, there is evidence now that climate change, with present developmental trends, will not express itself in through slow shifts in average conditions, but will manifest at an unprecedented rate with increased variability, frequency of extreme events, long term implications and possibility of abrupt change, fuelled largely through anthropogenic causes. Under such trajectory these two processes do have the potential to coalesce generating destructive forces which could cause mega disasters unless urgent, radical and resolute mitigation actions are not implemented.

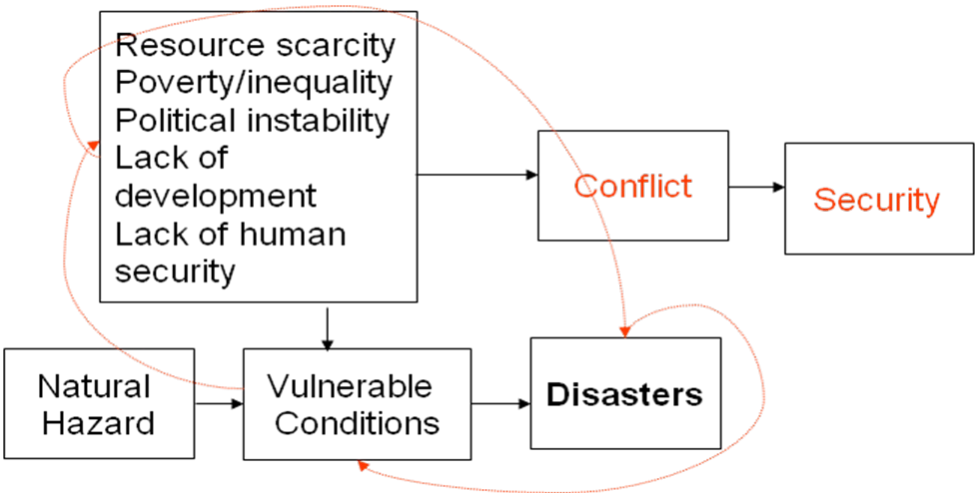
Disasters and Security

Though viewed principally as cataclysmic events that cause mass losses and upheaval in society, major disasters are much more than mere 'disaster events' and could result in severe social, political, economic and environmental consequences, posing many new threats and challenges to national security and stability. Major disasters disrupt a stable social system and the aftermath is a chaotic unstable random system with conditions of inequality, resource scarcity, social grievances, and political tension- conditions ripe for heightening inter-state and intra-state conflicts. Disasters can cause mass disruption of social functioning, impacting individual behaviour, groups and organisations that serve them. Essential utilities and services are crippled by catastrophic damages, physical infrastructure and the built environment is severely damaged, crops are destroyed, leading to food shortages, famines and localised conflicts over resources. Disasters could also destroy main political and social institutions, threatening political stability. The resulting increased competition for scarce resources, exacerbated inequality, changing power relations between individuals, groups and organisations could create conflict. The earthquake in Guatemala in 1976 caused widespread destruction in the rural mid section of the country that eventually brought an abrupt and violent change of leadership from the 21 year old military regime. Similarly the country of Bangladesh was formed after angered victims of the 1970 typhoon instigated civil war in East Pakistan. A major disaster thus has the potential to reshape society and catalyse political change.

To understand how disasters impact security, an analysis is required that goes beyond the disaster period to look at root causes of vulnerability, inequality, grievances, and resource scarcities. As discussed, a disaster is a disruption in the normal pattern of life generating suffering, socio economic breakdown, damage to environment… to such extent that there is need for external assistance. Much literature exists on what causes disasters and it is well accepted now that disasters are not natural phenomena, but 'acts of society' and are caused by vulnerability at different levels, viz, ecological, economic, social, human and political and are rooted in developmental failures (DFID, 2005). While a hazardous event may take place (a natural phenomenon, or a man made), disasters result from developmental failures which increase the vulnerability to the hazard event. Also while disasters may be natural phenomena, but their impacts are not. Their effects are the result of the actions of human beings and are determined by the circumstances of the country, i.e., poverty, social inequalities, lack of resources, among other factors. There is great risk inherent in treating disasters as discrete events detached from people's lives (Blaike, 1994). In the developing countries, this serves as a warning against analyses that separate natural disasters from their political and socio-economic context, from economic growth, and from the vulnerabilities inherent in the process, which affect the impact of major disasters.

Security, on the other hand, in simple terms, is 'lack of conflict', extant or potential. Conflicts do not occur unexpectedly and there many obvious causes of conflicts. But behind the immediate factors that trigger conflicts, analysis reveals deeper causes, such as territorial demands, socioeconomic inequalities, economic interests, the defence of political ideologies, burgeoning nationalism, and the struggles of ethnic minorities, racism and arms proliferation, ie, vulnerable human conditions. The tentative framework at Fig 2 shows the progression of a hazard event to a disaster and the disaster potential in exacerbating/generating threat to security.

Fig 2- Linking Disasters with Security



Both in analytical and practical terms, studies (Nel, 2008; Bhavnani, 2006) have illuminated the interconnectedness and the interface between disasters and security through vulnerable conditions as depicted in Fig 1. *Hazards become disasters only through societal vulnerabilities; societal vulnerabilities above threshold of tolerance lead to conflict; disasters exacerbate existing vulnerabilities and generate new ones thus creating conditions ripe for conflict*. This interface viz, reinforcing pre-existing vulnerabilities and creating new insecurities for individuals, families and communities is a toxic cocktail and is the principal conjunction between disasters and security.

CLIMATE CHANGE, DISASTERS AND SECURITY: THE INDIA CONTEXT

Climate Change in India

For the Indian subcontinent, the projected changes by IPCC, based on the General Circulation Model (GCM), project warming of 2-4.7 °C, with the most probable level being around 3.3 °C by the year 2100(A1B scenario) (Solomon et al, 2007). Warming is expected to be more marked in the winter half of the year (3.6 °C) than in summer (2.7 °C), and stronger in the north than in the south. Most scenarios project a decrease in precipitation during the inter dry period and an increase for the rest of the year. At the same time, an increase in heavy rain events is probable, particularly in the north of India. The global sea level rise of 0.1 to 0.9 meters is particularly expected to be high in the Indian Ocean, especially on the west coast.

Assessments by Indian Scientist using the Hadley Centre Regional Model (HadRM2) climate models show similar outputs and indicate that over the Indian region the temperatures will increase by 3 to 4°C towards the end of the 21st century. The warming may be about 2.1 to 2.6 º C in the 2050s and 3.3 to 3.8 º C in the 2080s (DEFRA/ GoI, 2005a). The different models/experiments generally indicate the increase of temperature to be of the order of 2-5°C across the country. In case of mean annual temperature, the increase is of the order of 3 to 6ºC. The warming is projected to be

widespread over the country, and relatively more pronounced over northern parts of India. While the rainfall is projected to increase, there would be variations in the spatial pattern, with some pockets showing increase and others experiencing decline in rainfall. Most models project an increase in rainfall between 10 and 40% from the baseline period (1961–90) to the end of 21st century, with the maximum expected increase in rainfall over northwestern and central India. There is very little or no change noted in the monsoon rainfall over a major part of peninsular India (Kumar R. et tal, 2006). The climate change would cause global sea to rise between 0.09 to 0.88 m by 2100 and enhance extreme events like excessive rain, flash flood, droughts, cyclones and forest fires.

The projected climate change will affect India particularly severely. Its consequences include a rise in sea level, threatening areas such as the densely populated Ganges delta, changes in the monsoon rains, the melting of the glaciers in the Hindukush-Karakorum-Himalaya region(crucial for the water supply in the dry seasons), and the foreseeable increase in heavy rain events and intensity of tropical cyclones (Parry et al, 2007). The thousands of glaciers located across the 2,400 km of the Himalayan range are at the epicenter of an emerging crisis.

The impacts will vary from region to region. The effect of possible changes in the intensity of the monsoons will be particularly sensitive, because large parts of India receive the majority of their annual precipitation during the summer monsoon rains, which already vary noticeably in different regions (Lal et al, 2001). The summer monsoon is crucial to the annual precipitation total of the Indian subcontinent. The effect that global warming will have on the Indian monsoon is still unclear, but increased variability in the monsoon rains is probable (Solomon et al, 2007).

Likely Impact of Climate Change on Disasters in India

India is among the world's most disaster prone areas. India support 1/6th of the world's population on just 2 % of it landmass. Nearly 59 % of India's land area is prone to earthquakes of moderate to very high intensity, over 40 million hectares (12 % of land), is prone to floods, close to 5700 kms of its 7516 km coast line (about 8%), is cyclone prone and exposed to tsunamis and storm surges, 2% of land is landslide prone, and 68% of India's arable land is affected by droughts. Of the 35 States and Union Territories, as many as 27 are disaster prone (GoI, 2004a). Most disasters in India are water related.

The global disaster trends are alarming, singularly so in India. The figures for 2006 indicates that Asia remains the continent most hit by disasters, with over 44% of all reported disasters (CRED, 2007). At aggregate country level, India ranks third with 21 significant disasters recorded (China recorded 38, followed by US which recorded 31). In terms of victims India ranked third with 7.3 million victims after China-88 million and Philippines-8.6 million. China, US and India also remained the countries reporting the highest damages (China- 13.5 billion US $, US- 5 billion US $ and India -3.3 billion US $) (CRED, 2007). The available data for 2007/08 also has India reporting third highest number of significant disasters, viz, 18 as against 22 reported by US and 20 by China. In terms of victims India ranked the second highest recorded 1103 deaths, mainly due to floods, as against Bangladesh which recorded 5534(Cyclone Sidr and floods) (ISDR/CRED, 2008). A scrutiny of the past records of 100 years too indicates that India

figures in the first 10 in the world in terms of fatalities and economic losses in a variety of disasters.

These trends are likely to exacerbate in future with climate change. The projected increase in precipitation and rainfall, the glacial meltdown and rising sea levels will affect India particularly severely, creating conditions for more hazardous events and will lead to increase in incidence of floods, cyclones, and storm surges. Though it is not possible to predict the future frequency or timings of extreme events but there is evidence that the risk of drought, flooding, and cyclone damage is increasing and will continue to do so. Climate change is also likely to threaten India's food security, increase water stress, and increase occurrences of diseases especially malaria.

Lack of availability and access to technological and financial resources coupled with a high dependence on climate sensitive sectors-agriculture, fisheries, forestry-have made India highly vulnerable to climate change. A large and growing population, densely populated and a low-lying coastline, and an economy closely tied to its natural resource base, further intensifies this vulnerability.

Floods. In India 40 million hectares are prone to floods with 8 million hectares being affected every year. The Brahmaputra and the Gangetic basin are the most flood prone areas. The other flood prone areas are the North West region of west flowing rivers such as the Narmada and the Tapti, Central India and the Deccan region with major rivers flowing like Mahanadi, Krishna and Cauvery (GoI, 2002). Flood disasters are the largest cause of economic damages and losses of human lives in India. The population affected by floods in 2005 was 32.03 million and 1504 lives were lost. In addition about 96,713 livestock were killed and 1683 houses damaged. The crop loss was Rs 4,600.7 million (US $ 103), and the damage to public utilities was Rs 3,772.48 million (US $ 85 million) (Kumar S, 2006). In 2006 India recorded the highest economic damages from floods in the world with losses amounting to 3,390 US $, and with over 40 lakh people affected (second to China, over 41 lakh victims for flood).The floods in 2007 have also taken a significant toll with over 1500 deaths, being the second highest with Bangladesh recording the most (ISDR/CRED, 2008). Climate change will influence stream flow patterns through changes in the precipitation, changes in volume and timing of snow melt from glaciers, and changes in the type of precipitation, snow or rain, in the Himalayan region. An assessment undertaken by Indian Scientists of the Indian Institute for Technology (IIT) Delhi, India as part of the National Communication (NATCOM) on climate change project under the Ministry of Environment and Forests (MoEF), India, using the HadRM2 daily weather data to determine the spatial-temporal availability of in the river systems in India has indicated that that the severity of floods under the projected climate change is likely to intensify (Gosain et al, 2006). The study shows that western India may experience very high river discharges more frequently than it does at present. Apart from changes in snowmelt and precipitation in the Himalaya, changes in the pattern, intensity and frequency of rainfall will have significant impacts on floods. Climatic changes could result in more frequent high-intensity rainfall events.

Cyclones. India has an 8000 km-long coastline with two cyclone seasons, during the southwest and northeast monsoons. Cyclones have been observed to be more frequent in the Bay of Bengal than the Arabian Sea. Consequently the states of West Bengal, Orissa, Andhra Pradesh, and Tamil Nadu along the Bay of Bengal are the most affected as

compared to Maharashtra, Kerala, Karnataka, and Gujarat which are along the Arabian Sea. Most of the destructive cyclonic storms usually occur during the transition periods: pre - (April-May) and post- (September-December) monsoon, the latter being the most active period. The coastal districts of Orissa, Andhra Pradesh and Gujarat are most prone to the impacts of cyclone (GoI, 2006). About 1.3 storms form on an average during a year (GoI, 2004b). The east coast of India, which lies in the path of tropical hurricanes from the Gulf of Bengal, is particularly at risk of being damaged by storms and floods (Emanuel, 2005; IPCC, 2007b). The projections by the National Institute of Oceanography (NIO), under the Council of Scientific and Industrial Research (CSIR), Government of India on the impacts of climate change on sea level, to assess the degree to which mean sea level and the occurrence of extreme events may change, showed an increased occurrence of cyclones in the Bay of Bengal, particularly in the post-monsoon period, along with increased maximum wind speeds associated with cyclones and a greater number of high surges under climate change (DEFRA/GoI, 2005b). In addition, the strength of tropical cyclones, which represent a threat to the eastern coast of India and to Bangladesh, could increase. The risk to these areas will be aggravated by the rising sea level (WBGU, 2006).

Drought. Along with floods India also suffers acute water shortage. Of the net area sown in the country, 68 percent is prone to drought, and of this 33 percent is chronically drought-prone, receiving rainfall of less than 750 mm per annum, while 35 percent receives rainfall between 750-1,125 mm per annum (GoI, 2002). The steady shrinking of the Himalayan Glacier ranges will drastically cut down water availability in downstream plains of Uttar Pradesh and Bihar. India's initial National Communication to the United Nations Framework Convention (UNFCCC) on Climate Change projects that Luni, the west flowing rivers of Kutchh and Saurashtra occupying about one fourth of the area of Gujarat and 60 % of Rajasthan are likely to experience acute physical water scarcity. The river basins of Mahi, Pennar, Sabarmati and Tapi are also likely to experience constant water scarcities and shortages (GoI, 2004b).

Landslides. Landslides can affect large areas of the country every year during monsoons. They can also be caused by earthquakes. The areas that suffer from landslide hazards are located in the hilly tracts of the Himalayas, Northeast India, Nilgiris, Eastern Ghats and Western Ghats. With the melting of the glaciers in the Hindukush-Karakorum-Himalaya region, and the foreseeable increase in heavy rain events and intensity of tropical cyclones (Parry et al, 2007), the incidences of landslides are likely to increase.

The Coastal Zone. The coastal zone, a highly fragile eco system, is an important and critical region for India. It is densely populated and stretches over 800 km with the Arabian Sea in the West and the Bay of Bengal in the East. The area occupied by the coastal districts is around 379,610 Km^2, with an average population density of 455 persons per Km^2, which is about 5 times the national average of 324 persons per Km^2. Under the present climate conditions it has been observed that a sea level rise (0.4-2.00 mm) along the Gulf of Kutchh and the coast of West Bengal is the highest. Along the Karnataka coast, however there is a relative decrease in sea level (GoI, 2004b). Future climate change in the coastal zones is likely to be manifested through worsening of some of the existing coastal zonal problems. Some of the main climate related concerns in the context of the Indian coastal zones are erosions, flooding, submergence and deterioration of coastal ecosystems, such as mangroves and salinization. In many case these are caused by, or, exacerbated by, sea level rise and tropical cyclones. The key climate related risks in the

coastal zone include tropical cyclones, sea level rises, and changes in the temperature and precipitation. A rise in sea level is likely to have significant implications on the coastal population and agriculture performance of India. A one meter sea level rise is projected to displace approximately 7.1 million people in India and about 5,764 Km^2 of land are will be lost, along with 4200 Km of road (GoI, 2004b). The diverse impact expected as a result of sea level rise include land loss and population displacement, increased flooding of low lying coastal area, loss of yield and employment resulting from inundation and salinization. Damage to coastal infrastructure, aquaculture and coastal tourism, due to erosion of the sandy beaches is also likely. The extent of vulnerability however depends not just on the physical exposure to sea level rise and the population affected but also on the extent of economic activity of the areas and capacity to cope with impacts. Natural ecosystems such as mangroves, grasslands and coral reefs are also likely to be affected by climate change. Sea level rise would submerge mangroves as well as increase the salinity of wetlands. The projected sea level rise of 0.1- 0.9 m seems within the ability of the Sunderban mangrove ecosystems which presently face tidal amplitudes up to 5 m. This may be not true for other mangroves such as the Pichavaram and Muthupet where tidal amplitudes are much lower at 0.64 m (Shukla et al, 2003). However increased snow melt in the Western Himalayas could bring large quantities of fresh water into the Gangetic delta. This would have significant consequences on the composition of Sunderban mangroves species, favoring species that have least tolerance to salinity.

Impact of Climate Change on Security: What is at Stake for India?

India's is touted to emerge as a leading global player in future. India's economy is growing at a remarkable 5-7 % per annum (the present economic recession could lower this rate), and if this trend is sustained economic projections indicate that by 2035, India would become the world's third largest economy after China and the US (DCDC, 2007). Much would however depend upon how she manages her environmental, political and demographic challenges and importantly the emerging challenge of climate change and the unexpected shocks to the economy- increasing disasters. For countries with developing economies like India, the financial setbacks disasters inflict can be ruinous, in contrast to developed counterparts, ~~as~~ disasters disrupt short term financial and economic management, simultaneously necessitating substantial realignment in spending plans, adjustments in economic targets and shifts in economic policy, and have negative longer term consequences for economic growth, development and poverty reduction. More than 95% of deaths caused by disasters occur in developing countries and the losses in developing countries are 20 times greater (as percent of GDP) than in industrial countries, because of limited coping mechanisms, prevention, mitigation and adaptation capabilities. Economic losses due to disasters in India were estimated to be Rs 28,678 crores for the period 1994-98, and rose to Rs 47,464 crores in 1998-2003. In 2005 alone, disasters in India caused direct losses approaching Rs 87,500 crores (GoI, 2004a). This was more than the Indian Defence Budget for the year, 83,000 crores. For 2006-07 the direct losses approximate 1,12,000 crores, again greater than the defence budget of 1,07,000 crores. Estimates for 2008 are not yet available, but are also anticipated to be well over the Indian Defence Budget. So much of India's anticipated economic growth and emergence as a leading global power would depend upon how India deals with disaster events.

While India is a high growth economy, there is great inequity and a large human development backlog. Around 28.6 % of the population, some 320 million people, live below the poverty line (UNDP, 2007a). Superimposing the incremental risk of climate change on this large development deficit would compromise the ambition of 'inclusive growth' set out in India's Eleventh Five Year Plan.

India is already battling high population and rapidly increasing urbanization. The population of India is forecast to be around 1.4 thousand million by 2020. The urban population is growing faster than the rural population. The coastal megacities of Chennai (2005: population 6.9 million), Calcutta (14.3 million) and Mumbai (18.2 million) lie generally only a few meters above sea level (WBGU, 2008). The high population pressure combined with increasing cyclone intensity and sea-level rise as a result of climate change will put millions of people at risk of being hit by storm and flood disasters.

With rapid development of coastal areas, industrialization and urbanization, more populations are becoming vulnerable to climate-associated calamities and many have no choice but to move to safer places. It is estimated that approximately 142 million people may inhabit coastal India in 2050 and India's total number of flood zone refugees alone could be anywhere between 20 and 60 million, with 30 million as a conservative figure (Myers, 1993).

Nearly 700 million rural people in India directly depend on climate-sensitive sectors (agriculture, forests and fisheries) and natural resources (water, biodiversity, mangroves, coastal zones and grasslands) for their subsistence and livelihood. Under changing climate, food security of the country might come under threat. In addition, the adaptive capacity of dry-land farmers, forest and coastal communities is low. Climate change is likely to impact all the natural ecosystems as well as health and socio-economic systems, as indicated by the Indian Governments' National Communication to UNFCCC on Climate Change.

The linkages between climate change and national security work both indirectly and directly. In India, climate change is expected to have deep impact on food, energy, water, internally displaced persons and migrants, health and economy. It could aggravate numerous existing conflicts. At the same time, it could generate new stresses, tensions and conflicts. Climate change could become a major issue in India's bilateral relations with its neighbours.

The South Asian region is highly vulnerable to the adverse impact of climate change. According to the various studies, discussed later in this report, the pattern of monsoons in South Asia will become erratic. The overall precipitation may increase but there will be considerable regional variations. The Himalayan glaciers may also melt significantly in the next 40 to 50 years. More floods, droughts, desertification and extreme weather events are predicted for the region. The rise in sea level will have serious impact on the coastal regions of Bangladesh and India. Maldives and island regions of India could be submerged to a considerable extent.

Such geophysical changes will lead to soil erosion and increase in vector borne diseases. The variation in temperature and monsoon, the soil erosion due to floods and sea level rise will create food and water scarcity. The adverse impact on human security would

bear on national security as well. There could be more hunger, more law and order problems, overcrowding of cities as a result of food and water scarcity. Since many of the countries in South Asia have weak governance structures, inadequate public health systems and low adaptation capacity, there would be greater strain on governments' resources. Climate change could create chronic economic problems including unemployment. Unemployed youth could take to militancy, terrorism and organised crime. It could create fresh conflicts due to environmental reasons and also aggravate the existing conflicts. Environmental distress due to climate change will create pressure on populations to migrate to safer locations in search of livelihood.

India could also face bilateral problems with neighbouring countries due to climate change reasons. For instance, a large number of environmental refugees could come to India from Bangladesh thereby altering the demographic balance in the Indian states. Migrations could also take place from Sri Lanka, Maldives and Nepal. Water sharing issues could arise between India and China, India and Bangladesh, India and Pakistan.

The frequency and intensity of natural disasters including hurricanes, floods and famines could increase. This will put greater strain on the armed forces in disaster management. The border security forces will have to contend with increased migration flows from the neighbouring countries. The armed forces may also be compelled to change their war-fighting doctrines and operations in light of climate change. They may be required to undertake new humanitarian missions as during the Tsunami 2004, connected with disasters management domestically and internationally. A few implications of greater disasters: -

-The impacts of the growing risk of disasters and the damaging effects on development could increase the pressure for Indian military forces to participate in inreasing humanitarian assistance, disaster relief and evacuation operations. This has already manifest in the major disasters of the past 4-5 years.

-With increasing resource scarcity and environmental security concerns, the key natural resources, especially energy and mineral resources of strategic value, will have to be sourced from unstable areas. Maintaining access and containing instability in these areas is likely to increase in importance, alongside wider developmental and stabilisation roles. Military intervention may be required to protect the integrity of sites where resources are located, and to secure investments.

-Defence spending may reduce because of the increasing disasters. Governments may increasingly modify the priority that is afforded to defence, in view of the increased imperatives for disaster risk reduction, and other changes in the dynamics of security.

-With increasing disasters, the Indian defence forces would be increasingly used in post disaster reconstruction and development activities. The failure to achieve self sustaining development progress following major disasters will pose instability risks, with likely impacts on neighbours and the international system. The scale and intensification of these risks is likely to elicit military responses as national interests would be threatened. The participation of Indian military contingents in Iraq reconstruction activities testifies this.

The probability of such events taking place are not deterministic as quantitative predictions are not possible. The likely climate change impacts are based on models whose predictions are not totally reliable. Moreover, the impact of climate change would unfold gradually over several decades thereby providing time for adaptation. Therefore, while assuming an alarmist view of the impact of climate change on national security for India may not seem correct, it would be unwise to ignore the issue. With considerable uncertainty about climate change, its impact and its link with national security, it would be useful for India to adopt a risk-based approach. A "no regrets" approach would stand India in good stead.

To cope with these challenges, India will have to devise its strategies carefully. On the one hand, it will have to resist the international pressure on it to take binding objections with regard to CO_2 emissions as this will seriously affect the prospects of economic growth. On the other, it will have to undertake suitable adaptive measures to ensure that its economic growth is based on sound principle of energy efficiency resource conservation. As India is being labelled as a significant emitter, it will also have to craft its negotiating position carefully to safeguard its national interests without being isolated.

POLICY RECOMMENDATIONS

Both climate change and increasing disasters will play out in future against the back drop of other global trends and developments. Both climate change and disasters are largely anthropogenic processes, fuelled largely through development. Development processes are currently largely associated with *risk accumulation* and not *risk reduction.* During the next 20-30 years, every aspect of human life will change at an unprecedented rate, throwing up new features, challenges and opportunities. The Global Risk Network, an initiative of the World Economic Forum, in its Global Risk 2007 Report, identified 23 core global risks to international community over the next ten years. A total of 9 of these 23 risks (39 %), pertain to risks related to natural, health and climate related disasters in the environmental and societal domains (WEF, 2007). Consequently, a nations' ability to prevent, mitigate, respond and recover from catastrophic events is increasingly being recognised as a prime driver for national security and strategic growth. Clearly, the forecast places managing these growing risks as a frontrunner imperative for any aspiring global power. The challenge of climate change and increasing disasters will have to be addressed in the back drop of the key drivers of change, viz, economic growth, population rise, resource competition, changing demographics, increasing diseases, mass displacement and environmental impacts.

Given the lack of resources, and access to technology and finances India has limited capacity to develop an adopt strategies to reduce its vulnerability to changes in climate. To manage the climate change-disasters-security nexus, the country needs to have improved scientific understanding, capacity building, networking and broad consultation processes across every section of the society. A few important policy recommendations are enumerated in the succeeding paragraphs.

Integrated Risk Management Framework. The possibility of climate change and natural disaster forces coalescing and generating greater destructive forces imposes imperatives for a comprehensive integrated risk management framework. In India disaster management is being addressed by the National Disaster Management Authority (NDMA) as the apex body for addressing policy issues and for laying guidelines. Climate change is being addressed at various levels, by the Ministry of Environment and Forests, the Ministry of Science and Technology, the Ministry of External Affairs well as by the Prime Minister's Office. There is wide divergence among these entities. There is an urgent need to bring climate change and disaster communities on a common platform, and develop an integrated risks management framework or model for the challenges of climate change and increasing disasters, which are intrinsically linked through societal vulnerability. An integrated approach would mean: -

-Better coordination among the climate change, disasters and development communities,

-Even-handed attention to the reduction of greenhouse gases and of the risks associated with climate change, including through enhanced disaster management.

-Improved conceptual and methodological approaches to understand and respond to local manifestations of disasters while simultaneously addressing underlying the complex global processes.

Adaptation and Mitigation. Both adaptation and mitigation have been key levers in disaster risk reduction and climate change strategies. An integrated risk management framework needs to build on these two vial strategies. However adaptation, in comparison to mitigation has been the neglected stepchild in both disaster risk reduction and global negotiations and debates over climate change, mainly due to the complexity of separating adaptation from other socio economic, environment and development issues. Mitigation (structural, reduction of green house gases etc) with clear visible manifestation of actions has been the easier chosen option. India has many mitigation projects for disasters, viz, earthquake, flood, drought mitigation, etc, but adaptation is largely spoken about only in discussions. This must change. The key levers of adaptation include poverty reduction, progressive change in economic structures, shifting away from primary (agriculture) livelihoods into (secondary and tertiary) knowledge based forms of economic activity that are less vulnerable to direct impacts of risks, changes in land use and cropping patterns etc and enhancing the resilience of people. Adaptation will involve coping with climate change in the context of several factors that influence vulnerability. The Government of India has many polices in place that are directed to enhancing the adaptive capacity. However, implementation of these at the local level has been poor, as manifest in the slow eradication of poverty, inequity etc and low human development index.

From Structural to Non Structural Mitigation. The Ninth Five-year Plan (1997-2001) of India saw the beginning of a gradual shift away from purely structural measures toward other forms of non-structural mitigation. In the Ninth Plan it was observed that in addition to the progress made in implementing structural flood protection measures, flood forecasting and warning systems had played a great role in mitigating the loss of life and enabling the protection of movable property. However, notwithstanding the growing understanding, the response of governments to floods and droughts (as evidenced from the

flood and drought response synthesis reports) reveal that investment strategies focus on structures and other physical interventions designed to increase control over water availability and flow. These investments are intended primarily to increase the physical availability of water during dry periods. In the case of floods, most investments are directed toward the construction and maintenance of embankments and other flood control structures. Both floods and droughts, in the practical sense of investment, are seen as external events that can be controlled through the construction of physical structures. Concepts of flood and drought proofing exist and do include the recognition of wide measures related to the vulnerability of livelihoods. Translating such concepts into governmental programs that actually direct significant investment into something other than the construction of water control structures has not, however, occurred on a widespread basis. Lessons from past efforts toward flood control indicate that structural actions often increase long-term vulnerability. There has been a gradual shift from purely structural measures to nonstructural measures for flood mitigation. This is reflected in the Tenth Five-year Plan of the Government of India, although much of the shift still remains on paper.

Future Climate Change-Disaster Scenarios- Impact Assessment. Practical strategies in an integrated framework risk management would require reliable impact assessment of future risk scenarios. Impact assessment of climate change -disaster – security nexus is complex as it includes geophysical, and socio economic aspects. However tools used for these assessments need to be continuously evolved. Climate change research, monitoring and modeling is an emerging area in India and the assessments are in their nascent stage. The preliminary assessments are mostly sectoral in dimension, which do not explicitly look at inter sectoral connection. Identifying and using appropriate tools for integrated assessment with adequate data inputs can lead to improved projections with reduced uncertainties. There is a need to enhance technical and institutional capacity. Though India has a large science and technology institutional base in many areas relevant to climate change, these have to develop a shared vision, integrated approach and networking for synergistic assessment relevant to policy making.

Climate Change/ Disaster Risk Indices (CCDRI). Quantitative indices are an important tool in risk management. International initiatives and research on developing risk indices for disaster and climate sensitivity exist, though in isolation. UNDP has developed a Disaster Risk Index (DRI) with a global level of observation and a national level of resolution allowing comparison between countries with respect to three types of hazards, viz, earthquakes, cyclones and floods (India ranks highest risk prone to floods with China a close second; for cyclones India ranks second with China leading, and for earthquakes India is ranked 10^{th}) (UNDP, 2004). With the confluence of climate change with disasters, development of climate change induced disaster risks indices need to be initiated. Tyndall Centre for Climate Change in UK has commenced an initiative on this and is in the process of developing a methodology for climate change/disaster risk index at the global level. A similar initiative must commence by the Indian national steering committee on climate change.

Climate Change Modeling. India has presently evaluated the outputs of 10 General Circulation Models (GCMs), and only one regional model, viz, HadRM2 with a resolution of 50 X 50 Km. Regional climate modeling has to be strengthened and it is desirable to acquire /develop and set up more Regional Climate Models (RCM) to

ascertain their simulation accuracy of the current India climate, and then use the appropriate RCM for more robust projections.

Vulnerability Atlas. A vulnerability map of India has been developed by the Building Material Council and Technology Promotion (BMCTP) showing multi-hazard zones based on earthquakes, wind and cyclones, and floods. This aids in preparedness, quick risk assessment and action as well as being an invaluable tool for proactive planning and has given enough warning regarding possible hazards that might get converted into disasters in the future. The vulnerability atlas needs to be revised in the context of the climate change projections and extreme weather events that India has faced in the last few years and also in the past on intermittent basis.

Climate Change to 'Climate Affairs'- a Multi Disciplinary Approach. Climate change as become a dominant issue, important to governments, corporations, public and humanitarian organisations. Thus there is a need to make climate science usable by the public as well as the policy makers at all levels of social organization. This can be done by fostering a multidisciplinary approach to climate issues for purposes of awareness. 'Climate affairs' and not climate change should be the way to educate how climate knowledge can improve the quality of climate sensitive decisions. Climate affairs encompasses climate science, climate policies, and laws, climate economics, and climate ethics and equity.

New Approach to Vulnerability. There have been changes in the concept of vulnerability recently, and this requires a new approach. India has a unique vulnerability profile and each disaster affects the other. The poor are the most affected as they are unable to break the cycle. Extreme weather events occur more often and are becoming more severe, and vulnerability will increase. Trends in India show that rescue and rehabilitation do not solve problems, prevention and planning are required. Communities must be made more resilient. Strategies and policies must cope with climate change and adaptability and increasing vulnerability. The top-down approach has been left with very minimal impact. A proactive risk reduction bottom-up driven approach is required and the government should work as a facilitator, for which political will is necessary.

Development as a Tool for Reducing Risk. Climate change and disasters interface with diverse social and natural processes and consequently with the developmental process. The conventional view has been to consider disasters and climate change as a barrier to development and simultaneously developments as a threat to climate change. However development can be the driving force to overcome challenges and risks of climate change. The Indian national perspectives on sustainable development are consistent with this view, and the India Vision 2020 articulates a vision for India's future and throws up a range on interesting possibilities, critical issues and crucial decision points for government and private bodies for future action. Many actions for adaptation and mitigation need to be integrated with and incremental to ongoing projects to meet our vision and the Millennium Development Goals (MDG). Disaster and climate change are increasingly being considered as a development constraint; hence, mainstreaming them into the development policy is all the more pertinent in the current context.

Logical Approach to the Disaster Management Cycle. Until recently the focus of disaster management was on relief and rehabilitation. This focus has shifted to

prevention, mitigation, preparedness, response and recovery. The logical approach to the disaster management cycle should be mitigation as the first priority; rehabilitation and reconstruction must also include mitigation in the disaster risk reduction cycle. In a non-disaster scenario, planning, prevention, mitigation and preparedness are all required to address hazard risks and vulnerability reduction. Only this will be relevant in the context of development and environment sustainability.

Centre- State Relations, Policy Issues. The broader and deeper geopolitical dynamics of center-state relations continue to influence both official perceptions and policies toward climate change- disaster management. In many, if not most, cases the allocation of responsibility among key agencies within each state and between states and the Central government in India, is both highly politicized and far from clear.

Command and Control. The conventional 'command-and control' management, undertaken by 'specialised' and rigid institutions, dictated and driven by govern-mentality, is full of pitfalls. It seriously lacks the capacity to respond to climate change with wisdom and persistence. There is a clash of paradigms which converts natural resource into a geopolitical resource. The nationalisation of nature and natural resources for reasons of the state leads to exploitation of nature and natural resources. Sustainable development calls for a need to return to pre-colonial geographies that will also mean a return to human and cultural geographies.

International Cooperation. Climate change and disasters know no boundaries, and will spread across geographical divides. We need to broaden and deepen the nature and scope of on-going dialogues to encompass the entire subcontinent. Ironically, climate change offers humanity an opportunity for a quantum leap in sustainable development and in peace making. If international cooperation, as opposed to competition, is strengthened in response to the threat of climate change and increasing disasters, international stability, governance, and development could also benefit. As quoted by UNDP regarding MDG 8: *"Climate change, a global phenomenon, calls for a collective response in the form of global partnerships"* (UNDP, 2007c).

Climate Change: Need for Single Authority. In India, on climate change, different ministries feud over turf. With climate change becoming a hot issue, both internationally as well as nationally, several ministries and agencies are now looking to get a bit of the carbon pie (Sethi, 2008). Ministry of Environment and Forests, the Ministry of Science and Technology, the Ministry of External Affairs, the Planning Commission, as well as the recently appointed office of the Prime Minister's special envoy are all addressing climate change from their perspectives. The integrated climate change and disaster risk management framework proposed above needs to be put under one authority/ ministry.

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