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To Review the Impact and Copping Strategies of Climate Change in Developing Countries

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***Abstract*—** *Rapid change in climate is set to alter the delicate balance that exists between man and nature. The literature to this effect points out that the poorest countries and communities are likely to suffer the most because of their geographic locations, low income and low institutional capacity, as well as their greater reliance on climate-sensitive sectors like agriculture. Even if climate mitigations plans are implemented properly there will be some degree of warming due to inertia of emissions already released. As such, there is a strong consensus about the need of adaptation to changing climatic conditions. Adaptation to climate change is given increasing international attention as the confidence in climate change projections is getting higher. Developing countries have specific needs for adaptation due to high vulnerabilities, and they will in this way carry a great part of the global costs of climate change although the rising atmospheric greenhouse gas concentrations are mainly the responsibility of industrialized countries. Adaptation is believed to enhance the resilience against increasing climate variability. In this backdrop, the objective of the present paper is, therefore, to systematically and critically review the existing literature on the impacts of climate change and choice of adaptations across countries and draw insights for suggesting a comprehensive policy framework particularly for developing countries in this regard. The paper finds that the role of government and civil society is crucial for enabling efficient adaptation methods. Development policies and programs having synergy effect with climate change initiatives help adapt with the changing climate better. However, the availability of clean technology in developing countries will play the decisive role in controlling their growth rate of emission.*

***Keywords*— *Climate change, vulnerability, cooping strategy, impact, developing country*.**

I. INTRODUCTION

1.1. Background of the Seminar

The aim of the article is to show how countries' current development challenges place them at greater risk of the effects of climate change, as these inequities are likely to be exacerbated by climate change, thereby jeopardizing their future economic development. Studies show that climate change would trigger erratic weather events such as droughts, floods, rising sea levels and rising temperatures, all off which will take their fee on developing countries (World Bank, 2010; Sarkar, 2012). Such weather extremes could affect agricultural production, the availability of and access to water resources, livelihood patterns, food security and the health burden of countries. It has been argued that climate change extends beyond environmental policy, making it primarily a development issue and a key adjunct of sustainable development. Developing countries already face huge challenges with their present climate, and are still disadvantaged in terms of their economic development, a situation that could be compounded by climate change and cause them to lag behind even further (Sarkar, 2012).

The impact of climate change will be more severe in poor developing countries. This is because (1) the physical impacts are expected to be relatively large in developing country regions, where, for example, increases in the already high temperatures are likely to lead to large evaporation losses and in many developing countries precipitation is not likely to increase as is expected in many high-latitude regions (Christensen*et al.*,2007), (2) many developing countries, in terms of national income and employment, rely heavily on agriculture that is directly affected by climatic change, (3) the high number of poor people in these countries is generally more vulnerable and likely to feel the negative effects of climate change (Yohe and Tol, 2002), and (4) the economic and technological capacity to adapt to climatic change is often very limited in developing countries.

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Adaptation to climate change did not receive much attention in the first years of the international climate change studies; however here is an emerging process of seeing climate change as a mainstreaming issue that implies that vulnerabilities and adaptation strategies are linked to the development of poverty reduction strategies (Halsaes and Taerup 2009). Climate impacts are described with increasing confidence by IPCC (2007). These impacts might be direct (e.g., changes in agricultural potential caused by rainfall change or inundation of cities and infrastructure due to sea level rise and higher disease burden) or they might be indirect (e.g., through effects of climatic change on world market prices of agricultural and fisheries products). The need for adaptation is inevitable no matter how efficiently we manage to reduce the growth in emissions (Yohe, 2000).

The vulnerability of the agricultural sector in many developing countries is caused by poverty and limited economic capacities (e.g., to accumulate and sell products when prices are attractive) and the current socioeconomic and technological drivers of change in agriculture have hitherto rendered climate change ‘‘just’’ another stressor of the system (Burton and Lim 2005; Mertz et al., 2009). Under such circumstances, one option available for developing countries to counter the negative effects of climate change is to adapt to changing climate. However, because of lack of adequate financial and technological resources, only few developing countries can afford to do and countries like sub-Saharan nations may find it extremely difficult to cope with the changing circumstances in the line in which developed countries often do. It is; therefore, increasingly felt that there is a need to understand the socio-economic compulsions and constraints of underdeveloped countries in suggesting and formulating adaptation strategies so as to help tackle the problem better. The present paper is an attempt in this direction. For this purpose, the paper critically reviews the existing literature on the impacts of climate change on different aspects of life and choice of adaptations across countries. Experiences of efficient adaptations across developing nations helps to identify the key factors of adaptation and make a comparative analysis that can provide necessary insights for suggesting a comprehensive policy framework for developing countries in this regard.

The general objective of this review is to review the impact of climate change in developing countries. The specific objectives of the review were:

1. To review the impact of climate change in developing countries.
2. To review how the current socio economic condition in developing country is more vulnerable to the effect of climate change.
3. To review the policy option that could mitigate the effect of climate change.

II. REVIEW OF RELATED LITERATURE

Climate change refers to a change in the state of the climate that can be identified (e.g., by 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. Climate change may be due to natural internal processes or external forcing, or to persistent anthropogenic changes in the composition of the atmosphere or in land use. Note that the united nation framework convention on climate change (UNFCCC), in Article 1, defines 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. The United Nations framework convention on climate change (UNFCCC) thus makes a distinction between climate change attributable to human activities altering the atmospheric composition, and climate variability attributable to natural causes. Climate variability refers to variations in the mean state and other statistics (such as standard deviations, the occurrence of extremes, etc.) of the climate on all spatial and temporal scales beyond that of individual weather events. Sarkar (2012) describes climate change as a development problem that is rooted in sustainable development policy and is something that will gravely encumber poorer countries.

Climate change will lead to an intensification of the global hydrological cycle and can have major impacts onregional water resources, affecting both ground and surface water supply for domestic and industrial uses,irrigation, hydropower generation, navigation, in-stream ecosystems and water-based recreation. Changes inthe total amount of precipitation and in its frequency and intensity directly affect the magnitude and timing ofrunoff and the intensity of floods and droughts; however, at present, specific regional effects are uncertain. Impacts of climate change will depend on the baseline condition of the water supply system and the abilityof water resource managers to respond not only to climate change but also to population growth and changesin demands, technology, and economic, social and legislative conditions. In some cases - particularly in wealthier countries with integrated water-management systems - improved

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management may protect water users from climate change at minimal cost; in many others, however, there could be substantial economic, social and environmental costs, particularly in regions that already are water limited and where there is considerable competition among users (Karl *et al.*,2002).

Local communities, especially dry land dwellers, have used a wide range of strategies to deal with climatic hazards such as drought. Whereas coping refers to the short-term responses that are utilized to face a sudden, unanticipated climatic risk, adaptation is a more long-term process that often entails some socio-economic and institutional changes to sustain livelihood security (O'brien and Welisen, 2008). Farmers have minimized or spread risks by managing a mix of crops, crop varieties and sites; staggering the sowing/planting of crops; and adjusting land and crop management to suit the prevailing conditions (Blench, 2003). Pastoralists have also developed useful strategies including: transhumance (strategic movement of livestock to manage pasture and water resources); distributing stock among relatives and friends in various places to minimize the risk of losing all animals if a drought strikes one particular area; and the opportunistic cultivation of food and cash crops to meet some of their needs (Eriksen, 2007).

Two important questions that need to be asked, however, are: the one is to what extent are these coping/adaptive strategies working? and; the other is will these strategies be relevant in the advent of climate change in the future? To vulnerable people, coping with disasters is often synonymous with search for survival. As a result, some of these survival responses may undermine an individual or family's capability to cope with disasters in the future. For instance, overstocking (keeping a high number of animals), expansion of agricultural land to compensate for low yields, and cutting of trees for firewood or to make charcoal are common coping strategies. While these offer short-term relief to local communities, they also lead to land degradation that has a multiplier effect on the impacts of natural disasters. Other factors such as demographic pressure, conflicts, inadequate agricultural/environmental policies, and trade are also negatively impacting some of these coping mechanisms (Mertz *et al.*, 2009).

The paper begins with an analytical framework to show how climate change affects therural community who are mostly poor, and based on climate-sensitive resources. This is particularly true in case of underdeveloped countries. In the following section, the paper highlights global evidence on impacts of climate change and the various adaptation strategies which differs across regions and sectors. It discusses some of the successful coping mechanisms in developing countries and tries to find out the factors behind their successful implementation through a comparative analysis of the circumstances of developing countries. The paper finally draws on coping strategies and suggests way forward in the form of various adaptation options and initiatives that a developing country may undertake to strengthen particularly the adaptive capacity of their rural community to fight against climate change.

2.1. Analytical frameworks

A vast majority of poor people in the world live in less-developed countries and their livelihoods are largely dependent on climate-sensitive resources such as local water supplies and agricultural land, livestock husbandry; and natural resources such as fuel wood and wild herbs (Hunter, 2007). Rapid climate change can drastically reduce the availability of services that these local natural resources provide and limit the options for rural households that depend on these resources for consumption or trade.Global warming affects the agriculture sector mainly through three channels of environmental resources—air, water and land.The increasing global temperature is likely to intensify the global hydrologic cycle (Loaiciga*et al.*,1996).This will result in the change of the level of precipitation and soil moisture content and increase extreme weather events like flood, drought, cyclone, and expected to speed up the retreating of glaciers, sea-level rise and coastal flooding beside a host of other unpleasant effects like soil erosion, change in monsoon trend etc. As a result, agriculture and allied activities are likely to be hit most by this climate change. Adaptation to vulnerability is also largely affected by social, economic and institutional factors (Saldana-Zorrilla 2008) like land tenure system, level of irrigation, availability of cheap credit etc. Several recent studies emphasize the importance of local assessments of vulnerability to capture the diversity in the social, economic, and natural environment of communities (e.g. Vedwan 2006; Beharaand Vaswani 2007; Ali and Kapoor 2008; Deressa et al. 2008; Acosta-Michlik et al. 2008;Byg and Salick 2009; Keskitalo and Carina 2009). The model highlights possible social, economic and ecological impacts that may result due to climate change and affects the livelihood options of rural poor in developing nations. However, the effect of global warming is not limited to poor countries only but is wide spread.In order to have a comprehensive understanding of

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climate change, it is imperative to know the effect of climate change across regions irrespective of the level of their economic development. The developing countries are likely to be worst affected due to their excessive dependence on climate-sensitive sectors and poor infrastructures (Nanda, 2009). This applies particularly to the poorest people within the large populations of both sub-Saharan Africa, and South Asia (Stern, 2006). On the other hand, developed countries are considered to be better poised to cope with the climate change as they have better resources to adapt: socially, technologically or financially. The strategies and approaches in this document are part of a continuum of adaptation actions ranging from broad, conceptual application to practical implementation.

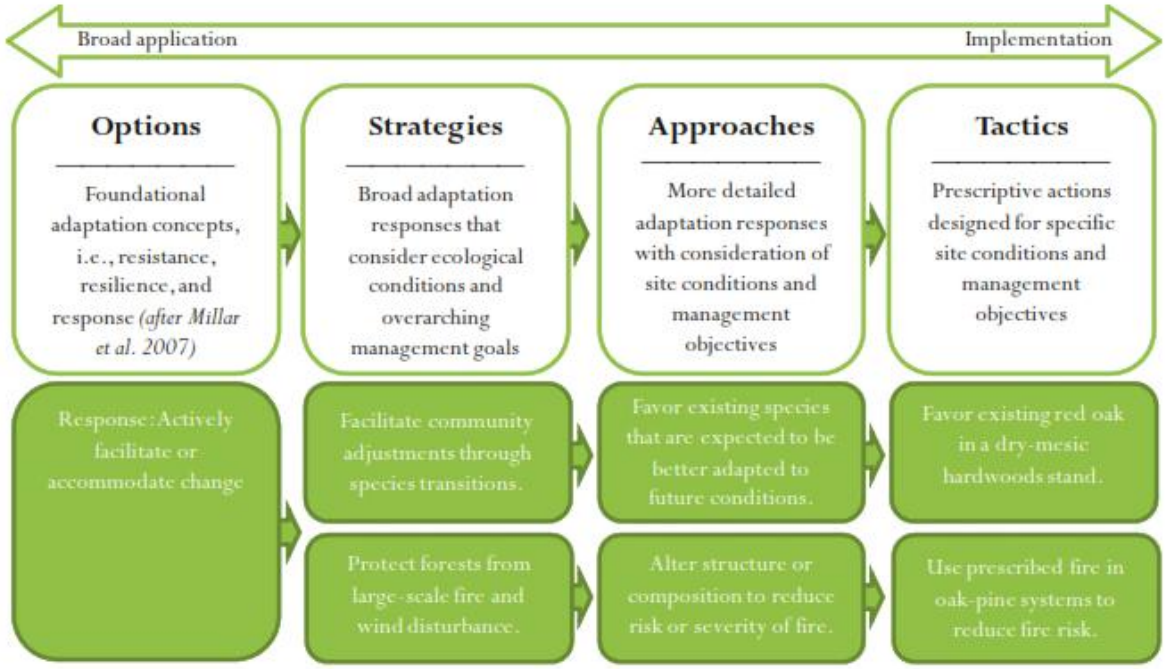

Fig.1: A continuum of adaptation actions is available to address needs at appropriate scales and levels of management (top) (Modified from Janowiak et al., 2011.)

2.2. Impact of Climate Change in Developing Countries

Estimates imply that even a 2^{o}C warming above pre-industrial temperatures (which is the minimum the world is likely to experience) will give rise to two eventualities. Firstly GDP in Africa and Asia will fall by 4 to 5% as opposed to a 1% GDP loss in high-income countries; and, secondly, it will unleash variations in weather patterns that will put between 100 million and 400 million people at risk of hunger, and place between 1 billion to 2 billion people at risk of not having enough water to meet their needs (Niasse*et al.,* 2004). Natural disasters also have economic consequences, and in developing countries 90% of economic losses due to storms, floods and droughts are borne by households, businesses and governments. It is estimated that developing countries will have to absorb most of the damages arising from natural disasters – that is, about 75% to 80% of such damages (World Bank, 2010).

Higher atmospheric temperatures cause more water evaporation, increasing humidity and leading to higher levels of precipitation in many areas of the world. The combination of heat and humidity in itself leads to an increase in morbidity rates (Gawith*et al.,* 1999). The number and severity of natural disasters such as hurricanes, droughts, and floods appear to be increasing as global warming increases. There is a corresponding increase in the number of victims and their injuries, hospitalization, and financial losses. This has important repercussions for insurance companies. For developing countries with poor economies and weak socioeconomic structures, climatic phenomena have especially grave consequences (IFRC, 1999).In lower developing countries, climate change and its variability will an impact which directly or indirectly reduces their economic activity through:

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Poverty: climate change and climate variability worsen existing poverty, exacerbate inequalities, and trigger both new vulnerabilities and some opportunities. There is robust evidence that these hazards act as a threat multiplier for poor people, meaning climate change represents a huge additional barrier to poverty eradication in LDCs. Climate change will affect those most in need of social protection, making providing protection harder. Food-related impacts indirectly affect poverty (IPCC,2014).

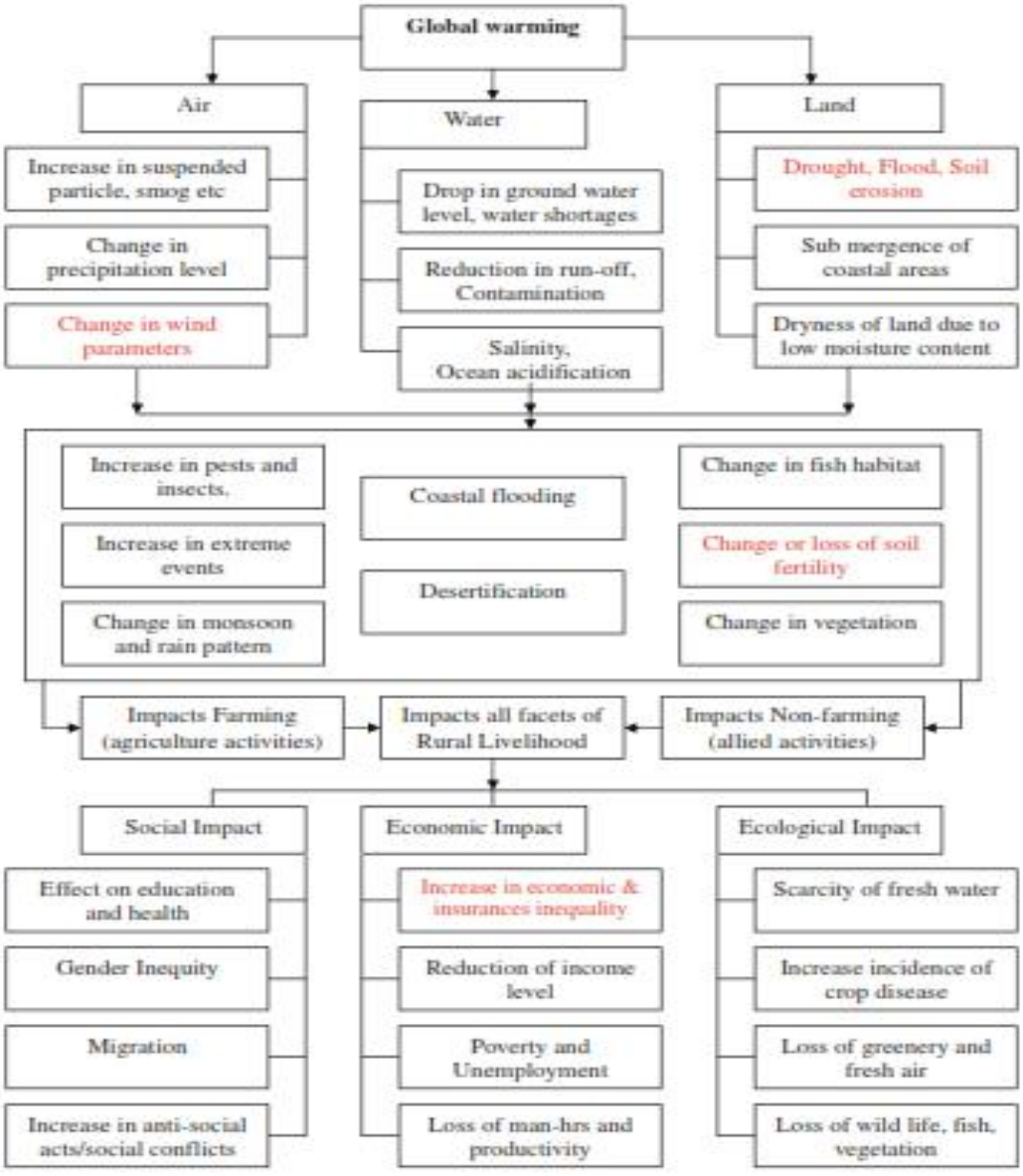

Fig.2: Shows how agriculture and rural livelihood affected by global warming (Sustain,2010)

Hunger and food security: All dimensions of food security — availability, access, utilization and stability — are vulnerable to climate change. Climate change may lead to 170 million more undernourished people in 2080.Crops already near their maximum heat tolerance are particularly vulnerable. By 2080, major decreases in land productivity are expected in sub-Saharan Africa 14–27% and Southeast Asia 18–32%. Losses to genetic diversity are also projected.

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Health and well being: In Africa, the IPCC states that children and pregnant women are particularly vulnerable to climate-related health risks. There is medium confidence about the increasing risk of water-borne diseases and water pollution. Extreme events can also affect mental health. Extreme events and climate-sensitive diseases pose occupational risks to health workers.

Education: Education facilities could be vulnerable to climate-related disasters. In Ethiopia and Malawi, droughts and floods have increased pressure to take children out of school.

Gender equality: There are significant gender dimensions to climate change. Migration impacts can be gender-specific: in Niger, male migration is increasing, leaving women with no labour support; in Ethiopia, girls often spend more time fetching water during droughts. Climate change also threatens equal access to resources In Uganda, men were found to be able to amass land after floods, while droughts reduced women's non-land assets (Stott, 2014).

Water and sanitation: Many climate impacts are water-related, including increased floods and droughts. Sanitation and water quality are both threatened as storm runoff adds to sewage. Adapting water infrastructure may add 10–20% to the costs to developing countries of meeting water-related Millennium Development Goals. Water-related ecosystems, including mountains and forests, are vulnerable. In future decades, glacier shrinkage will threaten water supplies(IPCC, 2014).

Infrastructure: Climate change can impact on infrastructure, including energy, water, transport and health. The IPCC provides robust evidence about impacts on water supply infrastructure, and high agreement about negative impacts on transport infrastructure. Cotonou, Benin, is just one city where property, infrastructure and water sources will be negatively affected. Without sustainable infrastructure policies, there is also a risk of 'locking-in' high-carbon infrastructure (Care *et al.*, 2014).

Increase in Infectious Diseases: Many infectious diseases, especially in the tropics, are borne by vectors (such as the anopheles mosquito) that have no control over their own temperature regulation system. A rise in humidity or of ambient temperature can have a sustained influence on the activity, dispersal, and spread of such vectors and can thereby increase the spread of a variety of tropical diseases like; malaria, Meningococcal meningitis, Dengue fever, Leishmaniasis, Hantavirus disease, Cholera and the like (Arnell, 2011).

The key impact of climate change faced by developing countries specially in Africa are: uncertain rainfall change; shifting ecosystem ranges; increased stresson water availability; increased vulnerability of agricultural systems; multiplied health vulnerabilities. Climate change will significantly hamper LDCs' ability to achieve the SDGs on poverty, hunger, health, water, growth, infrastructure, cities, marine resources and ecosystems. It may also decrease LDCs' ability to meet goals on education, gender, energy, inequality, sustainable consumption and production, peace, and implementation. In addition to this extreme climate change will make combatting climate change itself more difficult. Climate impacts are also very likely to increase the cost of meeting all SDGs in LDCs, especially under high-emission scenarios. Climate change will undermine LDCs' ability to achieve the SDGs most critical to their own development strategy: building productive capacity, adding value in natural resource sectors and achieving sustainable structural transformation. Climate change is felt through the interaction of biophysical effects with social and institutional factors: the LDCs' starting point of high poverty levels and weak institutional capacity potentially moves the already huge challenge of the SDGs beyond their reach (Barnett*et al.*, 2013).

Many of the negative health effects of climate change befall countries in the tropical zones of Africa, Latin America, and Asia, while the emissions of greenhouse gases that underlie these problems stem mainly from the industrialized countries of the Global North. Yet the underdeveloped lands are the very nations that lack the means to establish expensive infrastructures—flood dams, for example—in response to these threats. On the other hand, they face huge costs: the cost of treating victims of the dengue fever epidemic in Puerto Rico in 1994 was estimated at more than US$12 million. The inequity between causes and effects of climate change must be acknowledged by decision makers in politics and economics. On a global level the health of a population can be a "biomarker" for the effectiveness of measures that have been implemented (Carcavallo, 1996).

Populations in the southern regions of the world are far more vulnerable to such catastrophes than those in the industrialized nations. When drought strikes, the consequences for health are mostly an indirect result of impaired food production. Chronic Undernourishment Intensifies quickly into starvation. When water is scarce, its priority use is in cooking, with little left over for washing and hygiene. These results, among other things, in an increased

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incidence of trachoma and scabies. When water is stored for long periods, or has fecal contamination, outbreaks of diarrhea occur. Undernourishment in this situation increases susceptibility to infection.

2.3. Coping strategies of climate changes in developing countries

Some adaptation by individuals is undertaken in response to climate threats, often triggered by individual extreme events other adaptation is undertaken by governments on behalf of society, sometimes in anticipation of change, but, again, often in response to individual events. But these levels of decision-making are not independent they are embedded in social processes that reflect the relationship between individuals, their networks, capabilities and social capital, and the state (Adger*et al.*, 2007). Political ecology approaches demonstrate that, for example, when faced with a flood risk, residents of marginalized but risky areas have only a limited set of adaptation options and the state allows such risks to exist as part of the polarized nature of urban planning and control (Pelling, 1999).

Realizing that action is required to enhance the adaptive capacity of the most vulnerable societies and groups, an emerging research agenda is focused on identifying generic determinants of resilience. This is being undertaken in part through learning the lessons from present and past adaptations. These determinants include the social capital of societies, the flexibility and innovation in the institutions of government and the private sector to grasp opportunities associated with climate change, and the underlying health status and wellbeing of individuals and groups faced with the impacts of climate change (Adger, 2007).

This review suggests that there are critical limits as to how far analogues of past and present adaptation experiences are relevant for adaptation to future climate change as a result of two inter-related phenomena. First, there may well be nonlinearities, or critical thresholds, in the climate change impact or response function of natural and social systems. And, secondly, the magnitude and rate of the change in climate in many parts of the world may turn out to be unprecedented in human history. Taking these factors together, human societies may experience what is already hypothesized in emerging ecosystem science that smooth change and adaptation can be interrupted by sudden and dramatic switches to another state, resulting in the inability to cope with new circumstances. These sudden shifts can be seen in forest, coral reef, grassland and other ecosystems as a result of apparently gradual climate change (Schmidhuber and Tubiello, 2007).

There is also the reverse situation where climate change is not gradual i.e., a sudden discontinuity in climate or more than one extreme weather event coming in close sequence which may also undermine the inability to cope. Indeed, this characteristic of the sequencing and recovery time from weather-related hazards is well understood within the hazards research area. Blaikie*et al.* (2004) suggest that the timing of hazardous discrete events in nature constitutes a building of pressure on the vulnerability of marginalized populations. The vulnerability of populations is both event based and a product of political and economic structural factors (Mackson, 2006).

Developing countries are therefore currently faced with urgent needs for development to improve food security, reduce poverty and provide an adequate standard of living for growing populations. Addressing these urgent and current development priorities needs better understanding of changing climate scenario and taking pro-active measures to cope up with it. However, pro-active adaptation requires in-depth information and knowledge about the nature of problem, i.e. climate change. This in turn depends upon a host of factors such as level of education of the farmers; social networking; ownership of assets; access to services like health, availability of cheap credit; infrastructural support like irrigation, markets, transport and communication, etc. For example, it has been found that irrigation is a very effective tool to counteract the harmful effects of either warming or drying. The incomes of irrigated farms are generally less vulnerable to warming than rain-fed farms (Mendelsohn, 2009).

In 2007, the World Bank undertook a review of how climate change impacts poor developing countries. The review highlighted the strong links between poverty and climate vulnerability and emphasized the need for increased resources to assist countries with the higher cost of climate risk management and asset rehabilitation due to more frequent and severe natural disasters and to adapt within their core development strategies (Mani *et al.*,2008). Resources such as availability of appropriate technology, right information and cheap credit facilities are central to promoting effective adaptations. But here too the underdeveloped countries are constrained by crunch of crucial resources. Therefore, some of the adaptation measures taken so far are largely on individual and community effort withlittle or no government support.

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Community effort in a number of cases have been found to be very effective as it helps in pooling of scarce resources and sharing the burden of risk and management (Preker*et al.*,2001).

Ecosystem-Based Adaptation (EBA) is an approach that builds resilience and reduces the vulnerability of local communities to climate change. Through considering the ecosystem services on which people depend to adapt to climate change, EBA integrates sustainable use of biodiversity and ecosystem services in a comprehensive adaptation strategy (CBD, 2009).

Coping strategy is seen as a key element in creating a resilient society. EBA puts special emphasis on ecosystem services that underpin human well-being in the face of climate change. This approach suggests that ecosystem-based solutions can contribute to address climate change through providing social benefits and ecosystem conservation. EBA approaches consider that both natural and managed ecosystems can reduce vulnerability to climate-related hazards and gradual climatic changes. The sustainable management of ecosystems can provide social, economic and environmental benefits, both directly through a more sustainable management of biological resources and indirectly through the protection of ecosystem services (World Bank, 2010).

2.4. Findings and policy implication for coping strategies in developing economies

People in under developed countries are largely indifferent to climate change issues. The role of civil societies and NGOs are also very limited in creating awareness and generating pressure upon the government to act. As such, neither the political parties nor the government in power is interested in dealing the issue on priority basis. Thorough vulnerability analysis and impact assessment for enabling appropriate design and implementation of adaptation measures is lacking in almost all under developed countries. Under developed countries have negligible contribution to environmental pollution in comparison with developed countries. It is, however, not by mere choice but by economic compulsions too. It is therefore feared that with improvement in economic wellbeing in developing countries, their emissions are likely to increase manifold. In fact, the emission growth rate of some of the developing nations is one of the highest in the world.

The relationship between climate change on one hand, and domestic and international economic, social, and political spheres on the other generate a multiplicity of impacts requiring a multi-dimensional approach for its effective management. Among the dominant issues on the agenda of developing countries and in the discourses on climate change is the lack of capacity of the international framework for managing environmental problems to enforce its numerous agreements due largely to an ability to extract compliance, especially from industrialized countries. Often, this leaves developing countries at the receiving end. While they contribute relatively insignificant proportions of the causations of climate change generally, this group of countries bears the brunt of the costs of mitigating climate change. This becomes obvious when we consider the relative scientific and technological weakness of the developing countries that also lack the financial, and other logistics capacity to mitigate the effects of global warming (Salisu, 2013).

III. SUMMERY AND CONCLUSION

Climate change presents an urgent challenge to the well-being of all countries, particularly the poorest countries and the poorest people in them. The poorest countries and communities are likely to suffer the most because of their geographic location, low income and low institutional capacity, as well as their greater reliance on climate sensitive sectors like agriculture. From the foregoing review on climate change and the policy challenges it poses for developing countries, it is evident that a dominant cause of environmental degradation in general and climate change in particular is located in human activities, (anthropogenic factors) particularly those that emit GHGs. This process of human activity is characterized by inequity, in the appropriation and use of natural resources in which developing countries bear the brunt of the costs of climate change, even though they contribute significantly little or nothing to the causes of the phenomenon.

Even if efforts to reduce GHG are successful, there will be some degree of warming due to inertia of emissions already released. Therefore, building up resilience against the adverse effect of climate change and minimizing its impact is very important. It is increasingly felt that strengthening adaptive capacity is very important especially in developing nations. However, the kind of stressors varies across region and even within a sector and therefore adaptation strategy should be framed keeping in view local resources and constraints. Further, the experience of developed and developing countries shows that adaptation strategies work better when there is a synergy between climate change

initiatives with other socio-economic goals and policies. The role of government is crucial in this respect to help initiate appropriate measures and provide necessary support system for better adaptation. The government in developing nations however is often pre-occupied with other socio-economic issues and is reluctant to climate change issues. But this to happen would require more coordinated and integrated efforts between developed and developing nations. The countries need to come out of the ongoing blame game and have a joint strategy with a sense of shared responsibility where developed countries reduce their ongoing emissions and developing countries monitor and check their rapid growth rate of emissions for a better and safe future.

As long as there are large uncertainties about the permanence of observed short-term climate effects, it is recommended to first introduce more climate resilient development strategies and robust risk management strategies that both support general development goals and climate change adaptation. Moreover, many general development efforts in the poorest communities are likely to be the most efficient way of increasing their adaptive capacity and thereby the possibility of choosing between various adaptation options.

Finally, depending on the country in question, it is also important to focus on co-benefits and risks of adaptation measures, especially of long-term investments. This implies that the selection of adaptation measures should be assessed in the context of a broader agenda than only climate change. Many examples might be given: Development of irrigation systems might be an adaptation to rainfall change, yet it might also promote economic growth in general. On the other hand, they might produce an increased risk for diseases requiring investments in health and education. Building of dikes might increase the cultivated area by reducing the effect of flooding by saline water but might also negatively affect marine ecosystems that support livelihoods. Further, the experience of developed and developing countries shows that adaptation strategies work better when there is a synergy between climate change initiatives with other socio-economic goals and policies. The role of government is crucial in this respect to help initiate appropriate measures and provide necessary support system for better adaptation. The government in developing nations however is often pre-occupied with other socio-economic issues and is reluctant to climate change issues.

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