The Impact of Climate Change on Agriculture and Adaptation in Nepal

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Abstract Understanding climate change is not only complex but also extensive. Humanity has never embarked on such a huge challenge of trans-national scope: a problem that began in the past continues now and will be continuing for a long time in the future. Nepalese have also significantly felt the impact of global climate change. The scenarios of climate change indicate that the increased temperatures will cause snow-melt which will result in floods, droughts, and uneven weather patterns. The impact of such unexpected climate hazards and weather patterns have already been felt and will continue to be felt in Nepal. These climate change-induced hazards and risks particularly threaten the agriculture sector, which results in food insecurity and makes poor and vulnerable people face increasingly unanticipated impacts to their lives and wellbeing. This paper explores the climate vulnerability of the Nepalese in terms of their physical, social, economic and primarily agricultural losses due to the increasing impact of climate change. The paper argues the need for a timely adaptation of measures to maintain an environment suitable for agriculture and for the well-being of the population residing in the area.

Keywords climate change, agriculture, adaptation, rain-fed agriculture, environment, strategic adaptation and autonomous adaptation.

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1 Introduction

There is no doubt the world is heating up. The United Nations General Assembly (UNGA) mandated an International Panel on Climate Change (IPCC) for gathering and disseminating scientific knowledge on climate change in 1988 (UNGA Resolution A/RES/43/53). It has so far produced four assessment reports. In the beginning, no one really knew whether climate change was anthropogenic, but as time went by it became more and more obvious. The language of the IPCC also kept changing from weak to more authoritative. In 1995, IPCC reported that the balance of evidence suggested a discernible human influence on global climate (Assessment Report 2); in 2001, it reported that there is new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities (Assessment Report 3), and IPCC's report of 2007 authoritatively stated that most of the observed increase in globally-averaged temperatures since the mid-twentieth century is very likely (more than 90 per cent certain) due to the observed increase in anthropogenic (caused by humans) greenhouse gas concentrations (Assessment Report 4).

The challenges of climate change on Himalayan regions, which includes Nepal, are well-noted in the IPCC's fourth assessment report (IPCC 2007). In 2004, the Initial National Communication of Nepal (INCN) to the United Nations Framework Convention on Climate Change (UNFCCC) and a range of recent studies show that Nepal is highly vulnerable to the potential negative impacts of climate change (Regmi and Poudyal 2009). Climate change scenarios estimate that the temperature of this region is highly likely to accelerate. This will result in a considerable retreat of the glaciers, the over-flowing of rivers for a certain period of time, and consequently a gradual shortage of clean water supplies. Floods and landslides, from erratic precipitation, have been significant causes of loss of life and fertile land has been lost due to changes

in geographical structures. The delay in the monsoon season due to changes in global weather patterns has also made thousands of hectares of farm land fallow and has reduced agricultural production due to a lack of adequate water supply (Regmi and Adhikari 2007). This paper illustrates the climate vulnerability of the Nepalese in terms of their physical, social, economic and primarily agricultural losses because of the increasing impacts of climate change and argues the need for timely adaptation for maintaining an environment suitable for agriculture and for the well-being of the population residing in the area.

Our knowledge of climate change has increased and improved significantly in these last decades. Yet there are many uncertainties about to what extent a warmer world might affect our ecosystem. We have already started to experience some significant changes in the global climate system and we could face more climatic surprises in the future. The IPCC and some other scientific bodies have projected a sea level rise of between 18 and 59 centimetres because of the melting of glaciers and snow (Fourth Assessment Report 2007). The impact of climactic change on the planet is affecting the world's tallest mountain, Mount Everest in Nepal. Sherpas are fretting as to whether warmer climates will render Mount Everest un-climbable. The climbers and local inhabitants are afraid that rapid changes in the climate can make this tallest mountain become a snow-free ascent. Media worldwide have reported the words of Apa Sherpa, one of the custodians and champions of climbing Mount Everest, who stated that "In 1989 when I first climbed Everest there was a lot of snow and ice but now most of it has just become bare rock. That, as a result, is causing more rockfalls which is a danger to the climbers" (Radio Australia 26 March 2012).

It is said that "Climate change and temperature-rise have been stripping Nepalese mountains of their white clothes. The untouched virgin layers of snow are gradually melting. Loss of this virginity is the ample evidence of imminent impacts of climate change" (Pandey 2011). The receding snow from Everest has several negative consequences for both the short and long term. In the short term, the height of Mount Everest will need to be re-measured and clearly its height will be reduced; it will also make more difficulty in climbing the mountain as expert climbers claim that when there is no snow the rocks move and fall, making the ascent more risky and difficult. In the long term it will make life more difficult and unsustainable for the local population by altering the social, economic and geographical realities; the quick melting of the snow will cause the rivers to overflow for some time, and as the amount of snow is reduced it will cause droughts, which will have serious consequences for local agriculture and the mountain water-dependent population. If unchecked in time through adaptation, the consequences will be huge, producing large numbers of climate refugees wanting to migrate from these regions. For example, all the villagers from the village of upper Mustang had to be relocated to Thanchung in lower Mustang (Shah 2010).

Climate change consequences are much more than periodic droughts and bad harvests. "Entire belts of arable land are likely to shift as climate patterns change permanently. Water resources, already strained, could dry up as the mountain glaciers that feed them vanish. In human terms, this could mean famine, competition over remaining resources, and migration, either within countries or across national borders" (O'Neill 2009, 45). Climate change has also threatened the life of people on Pacific Islands by raising sea levels which have forced them to look for alternative places to live where they won't necessarily sacrifice their cultural identity (Ralston et al. 2004). New diseases and old ones that have previously been thought eradicated are appearing because of climate change (Patrick and Capetola 2012). Climate change is not only an environmental problem, but is also connected to changing disease patterns: overpopulation, ozone layer depletion, and urban pollution are also influential in infectious diseases ranging from childhood asthma to skin cancer (McCally 2002).

Climate change is also a threat to food security because at some point the spread of genetically modified seed and other proprietary biotechnologies will be a threat to farmers' livelihoods, and the food security of the population is dependent upon this group (Shiva 1993). The link between climate change and environmental change on agriculture and food security has been becoming more and more serious in terms of the local scope of Nepal. Concerns for food and drinking water along with water for irrigation tighten the knot of relationship between climate change and the population that live around mountains and other places, and who depend on mountain-source water resources and rain water for their agricultural production.

The warnings of climate change are so serious that Nepal and Nepalese farmers must act to adapt to, or at the very least, mitigate the speedy rate of widespread flooding from snow-melt or changes in weather patterns. Agriculture is the mainstay of the Nepalese economy, which continues to be dependent upon monsoon rainfall due to the lack of sufficient irrigation facilities, and changing weather patterns will further damage the agricultural capacity (Bhujel and Ghimire 2006). However, no in-depth scientific studies have so far been conducted to verify such

dire changes in the Himalayas and the resulting economic and social consequences. Conducting an in-depth scientific study to provide clear definitive and scientific accounts of the rate of snow-melt is a necessity, but it is a daunting task to galvanize the local, national and international responses needed because Nepal has very little to offer in way of mitigation. Nevertheless, the weight carried by Nepal over the interests of mountain countries during the two-day Mountain Countries seminar in Kathmandu on April 5 and 6 of 2012 is symbolically significant (Pandey 2012).

The reference of Ministry of Environment Nepal (MOE) states that the temperature rise rate for Nepal is 0.06 per cent (MOE Climate Change Policy 2011). However, it claims that the actual rate of temperature rise is higher than this in the Himalayas. Others also claim that there is a variance in average temperatures across the country (i.e. higher in the mountains and the Himalayas - 0.08 degrees c. as compared to Terai - 0.04 degrees c.) (Gautam and Pokhrel 2010). Some NGOs in Nepal have also been conducting their own studies to better understand climate change in the mountains and the impact it has on agriculture. IPCC's fourth assessment report noted that "glaciers in the Himalayas are receding faster than in any other part of the world" (Working Group II: Impacts, Adaptation and Vulnerability 2007, 10.6.2) but the report was widely criticized on the ground that it was not peer-reviewed (Thomas 2012). Yet all the critics, including geologist Vijay Kumar Raina of India, who presented a paper against the IPCC claim, admitted that some glaciers in the Himalayas are retreating (Carrington 2010) and their impact is being seen in various spheres of the ecosystem. Thus, there is no doubt that global warming is affecting the glaciers of the mountains and the eco-system around it, resulting in gradual but unexpected consequences in various sectors of the ecosystem including agriculture.

The Mool et al. (2001) study recorded that there are 2323 glacial lakes in Nepal covering 75 square kilometres. Geoscientists have recorded that the number and volume of Glacier Lake Outburst Flooding (GLOF) hazards are increasing in Nepal (Richardson and Reynolds 2000). Richardson and Reynolds (2000) found that some of these floods have produced discharge rates of up to 30000 m3/second and can run for distances of up to 200 kilometres. "Although some crops may benefit from the extra CO2 in the atmosphere, research suggests this may be offset by damage from higher temperatures, water stress, more virulent disease and pest attacks" (Yamin and Depledge 2004, 22). Extreme natural disasters such as drought, prolonged rain, glacier retreat, flooding, landslides, and temperatures hotter than usual in summer and colder than usual in the winter, have affected the livelihoods of the vulnerable poorest among the poor, women and children as well as indigenous and other marginalized people, along with severe damage to crop production. Natural disasters are causing the destruction of infrastructure such as houses, roads and irrigation channels, as well as resulting in insecurity about food and water for drinking and irrigation. The population residing in these zones do not have adequate knowledge of global climate change or access to information about global climate change and its localised impacts. They also do not have sufficient knowledge to develop effective resource management and local planning structures for their short- and long-term adaptation to these climatic changes.

By category, Nepal is a least developing country, landlocked and one of the poorest in the world (International Monetary Fund 2012). Its greenhouse gas emissions are 0.025 per cent of the world's total (MOE Climate Change Policy 2011). So a focus on climate control as a policy of mitigation is important, but a focus on more effective adaptation techniques is more salient than mere mitigation in order to stop the more vulnerable people from becoming the victims of the more detrimental impacts of the climate change that is a consequence of the actions of others. Adaptation is vital in order to reduce the risk and impact of climate change on Nepal. The United Nations Framework Convention on Climate Change (UNFCCC) has developed some key frameworks for addressing the issues of adaptation, such as the Bali Roadmap (BR), Cancun Adaptation Framework (CAF) and National Adaptation Programmes of Actions (NAPAs) to support the Least Developing Countries (LDCs) that are most vulnerable in their efforts to reduce the impact of climate change and increase their resilience through capacity-building for adaptation (UNFCC Bali Climate Conference 2007 and Cancun Climate Conference 2010). The Global Environmental Facility (GEF) has been channelling funds for adaptation mechanisms such as NAPAs. As Nepal is also an LDC and a most vulnerable country, she is also eligible for adaptation mechanisms funding through UNFCCC.

2 Background Study

Cline's estimations predict that as a result of global warming and climate change, global agricultural productivity will decline between 3 to 16 per cent by 2080 (Cline 2008). These estimations and predictions vary as geographical re-

gions differ. IPCC has estimated that the agricultural productivity of Sub-Saharan Africa will decline between 30 to 50 per cent if global temperatures increase by 2 degree Celsius (Fourth Assessment Report 2007). India's agricultural productivity will decline 30 per cent by 2080 (Cline 2008). Estimates of agricultural output have not been made for the Himalaya region, where the primary concern of researchers and politicians is with retreating glaciers, since the mountains constitute the 'water tower' for 1.3 billion people living in Asia (Aase et al. 2010). There is general agreement that for low income countries, climate change will lead to significant reductions in agricultural productivity (Gitay et al. 2001). Climate change-related drought in recent years has emerged as a source of household-level vulnerability in the hill agriculture of Nepal (Ghimire et al. 2010). The farmers cannot grow crops when there is no rainfall during the cropping season. They have a weak adaptive capacity against drought due to the poor asset base and low access to services and facilities (Ghimire et al. 2010). The estimations of climate change do not provide clear data on the magnitude of the temperature change and there are uncertainties as to the extent of change in precipitation and the monsoon system. Holland and Bitz (2003) noted that empirical research on global warming shows a positive correlation with physical altitude, which means that a one degree rise in temperature at sea level corresponds to a rise of two degrees in the territorial regions of the world's highest mountains. They argued this correlation suggests quite gloomy prospects for the Himalayan glaciers (2003).

Since reliable models of future climate conditions have not been produced at the local level so far, Aase, Chaudhary and Vetaas (2010) focused on the flexibility of farming systems in terms of adaptability to changing conditions of production, whatever those changes may be. They attempted to identify potentialities among subsistence farmers in a remote part of the Himalayas. They followed Bateson's (1972) definition of flexibility as 'uncommitted potentiality for change' and revealed four 'uncommitted potentialities' for adaptation to a future situation that would be climatologically different from the present (Aase et al. 2010). Chhetri et al. (2012) focused their studies on the innovation mechanism of adaptation based on cultural and social values of society in Nepal. They have explored how farmers and their supporting institutions are evolving and co-producing climate-sensitive technologies on demand (Chhetri et al. 2012). Ghimire et al. (2010) have explored vulnerabilities such as drought and the challenges of rain-fed agriculture applying multivariate independent techniques. Another study conducted by Chhetri and Sterling (2010) concentrated on whether or not climate variability and change serves as a driver of appropriate technological change and investigated the interaction of two closely-related factors, (climate and technology), in agricultural production in Nepal. These studies are valuable as they identify climate vulnerabilities in Nepal although they have not clearly identified different adaptation processes, whether planned or spontaneous. This study puts perspective on the impact of climate change on agriculture from different angles. It focuses on the negative impact of climate change on life and agriculture and then outlines remedial steps by illustrating planned as well as spontaneous adaptation to the effect of climate change.

"Adaptation to the adverse effects of climate change has been recognized as an important element of the climate change regime since its inception" (Yamin and Depledge 2004, 213). Adaptation has been a fundamental component of agriculture and biodiversity in a world where climate is constantly changing due to global warming. The IPCC identified adaptation for climate change in its first assessment report of 1990 (IPCC 1990). An early vulnerability assessment and adaptation followed the guidelines of IPCC with a seven-step linear assessment process (Carter et al. 1994). These seven steps are: problem definition, methodology selection, methodology testing, scenario selection, impact assessment, assessment of autonomous adjustments, and evaluation of adaptation options (Carter et al. 1994). For the priority risks identified at the sector and farm levels in the assessment of impact, a number of possible adaptation responses, such as policy level and farm or local level, were evaluated with respect to the following criteria: technical difficulty, potential cost of implementation and potential benefit (Iglesias et al. 2012). Although each study quantifies these indicators in a different way, most of the studies extensively used these criteria of adaptation in their studies (Leary 1999). Adaptation measures were further categorised as technical (e.g. introduction of new cultivars), management (e.g. changes in cropping patterns, soil, landscape and/or water), or infrastructural (e.g. changes in drainage, irrigation systems, access and/or buildings (Iglesias et al. 2012). Thus, this study is founded on IPCC's guidelines for adaptation: autonomous and planned or strategic adaptation with a focus on autonomous adaptation (IPCC Working Group II: Impacts, Adaptation and Vulnerability 2007). This is due to continual potential political instability (Pandey 2011), a period of prolonged transition, and the view that the concerned institutions have not been very active in addressing the nationwide climate change challenges. IPCC notes :

> Adaptation is used here to mean both the actions of adjusting practices, processes and capital in response to the actuality or threat of climate change as well as changes in the decision environment, such as social and institutional structures, and altered technical options that can affect the potential or capacity for these actions to be realised. Adaptations are divided here into two categories: autonomous adaptation, which is the ongoing implementation of existing knowledge and technology in response to the changes in climate experienced, and planned adaptation, which is the increase in adaptive capacity by mobilising institutions and policies to establish or strengthen conditions favourable for effective adaptation and investment in new technologies and infrastructure (IPCC Working Group II : Impacts, Adaptation and Vulnerability 2007).

3 Impact of Climate Change on Agriculture in Nepal

The landscape of Nepal is divided into three parts: Mountainous, Hilly and Terai. The total land area of Nepal is 147,181 km2. Agriculture is the dominant profession and the major economy in Nepal. The World Bank (2011) cites agriculture as the principal source of food, income, and employment for the majority of the population. Particularly for the poorest in Nepal the World Bank (2011) notes, the growth in agriculture is crucial for reducing poverty, and preliminary findings from the National Living Standards Survey indicate that despite the Maoist insurgency, the sector has made a significant contribution to poverty reduction. Agriculture has been a major contributor of Nepalese gross domestic product (GDP) and has contributed 35 per cent of the total GDP although only 21 per cent of the total land area is properly cultivated (Central Intelligence Agency 2010).

Climate change is threatening the traditional way of agriculture, and so the creation of a sustainable agricultural approach to counter the impact of climate change has been a main priority for the country (Malla 2008). The main challenge for cultivating sustainable agricultural development in Nepal is to turn subsistence farming into commercial farming as well as adapting to the new patterns of farming as a result of increasing temperatures. The average size of individual land holdings is very small in Nepal. The visible pattern of land ownership in Nepal is unequal, and its distribution is highly lopsided. Forty-five per cent of farmers have less than 0.5 hectares and share only 13% of the total land (Central Bureau of Statistics 2004). Agriculture is largely based on low-value cereals and subsistence production, with a mere 13 per cent of output traded in markets and the absence of economic opportunities outside subsistence agriculture keeps most Nepalese poor (World Bank 2011).

The population growth rate of the country is one of the most troubling obstacles in developing agriculture in a sustainable way to cope with climate change. The census data released by the Central Bureau of Statistics (2012) shows that the population growth rate was 2.25 per cent per annum. A recent preliminary assessment however, shows that it has decreased to 1.4 per cent. The increased population needs more houses to live in, more trees to build houses, and more arable land for farming, all of which cause huge areas of forest to disappear every year. The overexploitation of natural resources has created a significant problem in sustainable agriculture and helped to increase the negative effect of climate change on agriculture and life.

Most of the agricultural land, in both Terai and Hilly regions, depend on seasonal rain for the proper crop growth in Nepal. At one time the monsoon rains originating in the Bay of Bengal would support the crops and the farmers who planted them according to their expertise and experience of the seasonal cycles over the years. However, as weather patterns have been changing, farmers have had a dilemma. Over-exploitation of natural resources has resulted in an environmental degradation which is deeply connected with permanent loss, depletion or pollution of natural resources, adverse weather conditions, changing microclimates and unbalanced situations which affect the inherent chain within the ecosystem. Excluding adverse physiographical, ecological, geological and meteorological factors resulting in common natural hazards such as floods, earthquakes, droughts, cold and hot waves, hailstones, windstorms and cyclones, landslides, disease epidemics, GLOF, avalanches, lightning and fires, the environmental degradations are basically caused by human intervention in the form of modern technological adaptations (Ghimire 2008).

Apart from rapid population growth, global warming and its effect on the environment (and resulting in climate change) has also significantly affected Nepalese agriculture. Of the more than 6,000 vascular plant species found in Nepal, about 550 species and sub-species have food value and some 200 of those are cultivated (Ministry of Forest and Soil Conservation 2002). The diversity of livestock (both improved and indigenous breeds) also plays a major role in contributing to the well-being of rural

communities. This diversity can be illustrated even for staple cereal crops where in different production zones and conditions rice, wheat, barley, maize, finger millet and buckwheat are all important grain staples (Regmi and Paudyal 2009). As noted above, an average temperature rise of 0.06 per cent has been recorded in the country. This rise has shown the multidimensional impact of climate change on agriculture. Frequent drought and prolonged rains as well as many fatal floods and landslides are some of the major obstacles being experienced in Nepal in agricultural as well as other sectors of social life. A study conducted by the Nepal Agricultural Research Council (NARC) showed that the change in temperature has had a positive effect on the yield of rice and wheat in all regions but also showed a negative impact on the yield of maize, particularly in the plains land of Nepal, otherwise known as Nepal's bread basket (Malla 2008). Changes in weather patterns, such as unseasonal heavy rains, hailstones, floods etc. have frequently caused serious damage to crops.

Rising annual temperatures, a delayed monsoon season, prolonged or increased annual rainfall as the result of glacial melting, and intense rainfall have all affected many rain-fed communities in Nepal. Extreme climatic conditions increase vulnerability to erosion, landslides, avalanches, flooding, loss of flora and fauna and decreased agricultural production (Nepal and Chipeniuk 2005). UNFCCC and IPCC have forecast that climate change will increasingly damage the capacity of agricultural production in two decades (Third Assessment Report 2001). The IPCC clearly demonstrates that human activities have accelerated the process of global warming, resulting in climate change (Fourth Assessment Report 2007). Increasing greenhouse gas emissions have contributed to an increase in global temperatures. Global climate change has caused a change in seasons and rainfall intensity and patterns. These changes will have both a direct and an indirect impact on forests and biodiversity, health, infrastructure development, tourism, livelihoods, water resources, agriculture and the whole ecological chain. Recognizing the challenges of climate change, the international community has engaged in efforts to minimize the current effects and likely future adverse impacts through effective implementation of the UNFCCC policies (MOE Climate Change Policy 2011).

The MOE states "Nepal is also highly affected by climate change. It has been an urgent necessity to address the issue of climate change by formulating a policy and implementing relevant programmes to minimize the existing effects and likely impacts in different ecological regions—from the Southern plains to the middle hills and to the high Himalayan mountains in the North, and their peoples, livelihoods, and ecosystems" (MOE Climate Change Policy 2011, 1). The global climate model (GCM) projections indicate that a potential increase in temperature will bring many challenges in all areas of life, including agriculture, in the coming decades in Nepal (Nepal Climate Vulnerability Study Team 2009). Indeed, Nepal has to throw all its weight towards finding measures of adaptation in order to reduce the impact of the uncertainties of climate change in an overall way, but for food security, a focus must be cast on agricultural production.

4 Institutional Setup for Climate Change Adaptation in Nepal

The central and official channel for action on adaptation relating to climate change is the MOE of Nepal. The MOE is working with UNFCCC towards developing a National Adaptation Programme of Action (NAPA) and facilitating it within Nepal (MOE Climate Change Policy 2011). The MOE also formulated the National Climate Change Policy (NCCP) in January 2011, which provides basic information but yet still needs more homework to be an appropriate document of NCCP. Between 2007 and 2009, in the process of implementing the Convention, Nepal carried out a number of tasks, such as: preparation of the action plan related to capacity building under the National Capacity Needs Self-Assessment Project, in order to implement the Rio Conventions (Climate Change, Desertification and Biological Diversity); issuance of CDM project-approval processes and procedures to benefit from the provisions of the Kyoto Protocol; prepared the National Adaptation Programme of Action (NAPA); began preparing the Second National Communication (SNC); and implemented a project on strengthening capacity for managing climate change and the environment (MOE Climate Change Policy 2011). The Ministry of Agriculture has also been seen to be active in research and in the attempt to adapt the farming system to the increasing temperatures. Since 1995 Nepal has implemented a twenty-year Agricultural Perspective Plan (APP) to overcome the problems of food security and poverty (Nayava and Gurung 2010).

Among all of the mechanisms noted above, NAPA has specifically focused on adaptation. NAPA enables a country to identify priority activities that must be implemented in the immediate future in order to address urgent national climate change adaptation needs (Burton et al. 2002). The NAPA Project to Climate Change in Nepal was signed on 14th November 2008 between the MOE and the United

Nations Development Programme (UNDP) Nepal Country Office, who are the implementing partners of the NAPA project, with further support from the Danish International Development Agency, the Global Environment Fund, and the UK Department of International Development (MOE 2010). The project goal is to enable Nepal to strategically respond to the challenges and opportunities posed by climate change. The NAPA Project has three components : 1) Preparation of a National Adaptation Programme of Action (NAPA) ; 2) Development and maintenance of a learning and knowledge platform to act as a clearing platform for climate change ; and 3) Development of a multi-stakeholder framework of action on climate change (MOE 2010). UNFCCC has created 9 projects that should be responded to through NAPA Nepal (UNFCCC NAPA Prioritize Database 2010).

The nine projects (MOE NAPA Bulletin 2010) prioritise are : 1) Promoting community-based adaptation through integrated management of the agriculture, water, forest and biodiversity sectors ; 2) Building and enhancing the adaptive capacity of vulnerable communities through improved systems and access to services related to agricultural development ; 3) Community-based disaster management for facilitating climate adaptation ; 4) GLOF monitoring and disaster risk reduction ; 5) Forest and ecosystem management for supporting climate-led adaptation innovations ; 6) Adapting to climate challenges in public health ; 7) Ecosystem management for climate adaptation ; 8) Empowering vulnerable communities through sustainable management of water resources and clean energy supplies; and 9) Promoting climate-smart urban settlement.

To ensure an effective and inclusive adaptation response, NAPA (2010) formed six thematic working groups (TWG), each led by a concerned ministry. The six TWG are : 1) Agriculture and Food Security under the coordination of the Ministry of Agriculture and Cooperatives (MOAC) ; 2) Forests and Biodiversity under the coordination of the Ministry of Forests and Soil Conservation (MOFSC) ; 3) Water Resources and Energy under the coordination of the Ministry of Energy (MOE) ; 4) Climate-Induced Disasters under the coordination of the Ministry of Home Affairs (MOA) ; 5) Public Health under the coordination of the Ministry of Health and Population (MOHP) ; 6) Urban Settlements and Infrastructure under the Department of Urban Development and Building Construction.

5 Climate Change Adaptation in Nepal

The addressing of climate change adaptation areas as identified through a nationwide vulnerability assessment, by way of an extensive consultation process, and by implementing them as soon as possible, can help improve the adaptation abilities of the most vulnerable people in and around the mountainous regions through the NAPA Nepal. This is because it is “a process of assessing the country’s climate vulnerability and identifying priority adaptation measures” (United Nations Development Programme 2010, 1). Yet NAPA Nepal is still in its beginning phase and has not been able to launch fully-fledged projects to target sectors. The actions taken by MOAC have not reached the target groups in an efficient way. It seems that the projects of MOAC are focused only in particular regions. During this writing process, the author asked one local from both the Western Development Region and the Central Development Region to ask 20 farmers in each of these regions about the role of MOAC in providing subsidies and in creating awareness for adaptation. The farmers who participated and responded said that they had not received any support from MOAC and they still have to buy their chemical fertilizers on the black market because some corrupt officials, in conjunction with the local dealers involved, continue to hoard agricultural items and create a fake shortage to increase prices. This gives an extra financial burden to farmers who are suffering already. Most farmers stated to the author that any support from the government is just talk and only ‘on paper’ (Farmers’ Interviews Responses 2012).

Apart from that, the unavailability of peer-reviewed data on the impact of climate change and the difficulty of identifying regions based on priorities, are further points of organisational headache and inefficiency. There is a drought of institutional and stakeholder capacity effectiveness at all levels of the state bureaucracy, as well as from the extremely isolated national societies and leaders in local communities. This concern also stretches to the role of the leaders in Kathmandu, who have little or no understanding as to how potentially detrimental the impact of climate change could be for the Nepalese and the Nepali economy in the long term. The problem is that Nepal is heavily reliant on its agricultural sector, which accounts for 35% of GDP and comprises 76% of the labour force (Central Intelligence Agency 2010). In a period of fluid political transition several alternatives can be used to help such societies better adapt to the impact of climate change in general, with a more specific focus on agriculture in particular.

The literature on adaptation, as pointed out elsewhere in this paper, shows that there are two main branches of adaptation : strategic or planned, and autonomous (Bates

et al. 2007). Policy-based strategic adaptations to climate change have been identified for the agricultural, forests and fisheries sectors (Aggarwal et al. 2004). The national level responses, policies, strategies and planning that proactively supports adaption against the impact of climate change, is 'strategic adaptation'. This includes the direct construction of infrastructure, capacity building, disaster relief planning as well as a host of other methods that increase national resilience to the potential impact of climate change on both ecosystems and human populations (IPCC Working Group II : Impacts, Adaptation and Vulnerability 2007). The impact of climate change is particularly related to issues of global warming and the increase in sea level, thus creating the concern over unavailability of water for many local communities. The impact of extreme climatic changes on crop productivity will more likely be far greater than effects attached to the average change in climatic conditions (Mearns et al. 1997). Thus, the strategic adaptation projects should also be particularly focused on the issue of providing and implementing effective water management (Smit et al. 2000). Agriculture is the main profession of the Nepalese, so Nepal is heavily-dependent on agriculture for livelihoods and agriculture is in turn dependent on a proper irrigation system. The management of water is very important in Nepal. Other significant issues of strategic adaptation concern the development of infrastructures such as modern safe housing, better roads, 24/7 availability of electricity and means of communication. These strategic adaptations have still not been properly constructed and implemented by the relevant ministries. Therefore, greater care must also be given, for the time being, to more autonomous adaptation strategies until those government agencies become appropriately-functional.

Autonomous adaptation refers to the actions of individuals taken at the household level to make changes that reduce vulnerability to a changing climate, regardless of planning, policies and strategies implemented at the national level (Bartlett et al. 2010). "If widely adopted, these autonomous adaptations, singly or in combination, have substantial potential to offset negative climate change impacts and take advantage of positive ones" (IPCC Working Group II: Impacts, Adaptation and Vulnerability 2007). Autonomous or spontaneous adaptations are the ones that take place—invariably in reactive response to climatic stimuli—as a matter of course, without the directed intervention of a public agency (Smit et al. 2000). It is a bottom-up approach and is enriched with the potential of local knowledge from tapping into the experiences of the local peoples. However, in many cases these autonomous adaptation techniques cannot be achieved unless assistance from the national level, or unless Non-governmental Organizations (NGOs) or Civil Society Organizations (CSOs) are available. Some examples of autonomous strategy are : agricultural household management techniques that involve water storage and less water use, crop diversification from more water-dependent crops to less water-dependent crops, infrastructure development in safer places for housing, a tracking of changes in employment from local to national and international levels, an option to migrate, or anything else that improves resilience during fluctuating climatic conditions. Yet this also requires resources, updated information and knowledge to cope with the increasingly unpredictable impact of climate change. The availability of these resources enables local people to find a new and different resource-management scheme which is more ideally suited to that particular community. The flow of information and knowledge provides communities with a better understanding of the impact of climate change and accordingly allows them to seek, learn and build infrastructures for future climate change adaptation.

6 Climate Change Adaptation for Agriculture

The impact of climate changes on agriculture are multidimensional and intricately vicious as agriculture is an end result of the function of several biotic and abiotic factors such as water, energy input supply and management, weather, land system, soil environment, forest and biodiversity, labour availability, physical infrastructure, market functions, knowledge, tradition, policy matters and other socioeconomic aspects which are themselves in multitudinal ways influenced by climate change (Pokhrel and Pandey 2011). The primary concerns of climate change in agriculture are early seasonal monsoons which result in rain deficits. This rain deficit generally reduces the production of crops in Nepal. Heavy rain with floods can destroy planted crops and reduce crop production. The NARC annual report shows that early maturity of crops due to an increase in temperature may help to produce more crops but only in the same crop cycle, because it also causes the extinction of natural local vegetation such as basmati rice, maize, wheat and other agricultural products (Malla 2008). High dependence on rain-fed irrigation and the impact of climate change on weather patterns have been major concerns for Nepalese farmers. Increased temperatures, drought, floods, and pests are some of other challenges of agriculture due to the rise of global temperatures.

The prospect of expanding agricultural land in Nepal

is virtually non-existent. Increased food production to meet the needs of the growing population in the long term will have to come mainly through improvements in production efficiency and appropriate reorganization of existing agricultural land (Adhikari and Bjorndal 2012). For agricultural adaptation, Nepal should act on vulnerability assessment in order to conduct appropriate resource management tasks such as land-use planning, water management and investigating the possibility of introducing crops that suit the changing temperature (Ghimire et al. 2010). Issues for the future will include the availability of water due to climate change. For this reason, technological interference, required to increase the availability of water through greater community participation in management and maintenance, must be more effective for long-term sustainability. The focus should also be directed towards better adaptation to increased temperatures and drought by developing efficient irrigation systems such as drippers and sprinklers. Pest-resistant and higher temperature-friendly crops should also be investigated. Crops and agricultural adjustments, embankments, drainage management, water storage and management, innovative practices against floods and drought can make the community stronger and ensure its successful adaptation to changing climatic and weather patterns. Climate forecasting systems should also be developed to enable farmers and others to better prepare against disasters, thereby reducing their impact.

Yet, there are other challenges to combat in order to reduce the impact of climate change on life and agriculture. The people in the rural areas need to be educated through campaigns, training and other means of awareness-creation. Generating knowledge of ecosystem-based adaptation is a function of the policy-makers, along with community participation, which can play a more dominant role in surmounting the impact of climate change. The country should now focus on creating low carbon technology, and the general public should be encouraged through education to utilize low carbon technologies or green growth. They should also be encouraged to increase their crop insurance for both agricultural and social security. The government should develop policies such as provision of subsidies for agricultural investment and inputs to provide incentives for rural people, particularly farmers, to become more climate-change focused. Climate-change consequences, as presented by TWG during NAPA process on Agriculture and food security, now call for the optimum management of genetic resources, as well as pest and agricultural inputs such as seed, crop varieties, animal breeds, forage and pasture. There is a special emphasis laid on agricultural water, soil fertility and food security management in addition to related technological development and dissemination (Pokhrel and Pandey 2011). For implementation of action related to these issues, the concerned ministries should enhance and equip their staff with the appropriate knowledge and ensure they are not corrupt.

7 Conclusion

The impact of climate change is gradually being seen in all sectors of life, including agriculture, in Nepal. This impact is clearly affecting the poor and vulnerable in Nepal, most of whom are farmers working on their farms for survival. These rural people are usually un- or less-educated and do not understand the complete and immense impact of climate change on their lives and their way of farming. Because of this, it is the duty of the government of Nepal to move to the forefront on these challenges and their impact on agriculture as well as other aspects of life. The MoE and MoAC have been working to minimize the effect, but their work has not had much impact on the way farming is done except in their own research areas. NAPA has recently launched a few projects to look into these problems. Given the fact that these impacts are many while the actions of the government are few, more needs to be done towards the process of adaptation. Non-governmental organizations, civil societies and groups of farmers can disseminate and exchange information to prepare for unexpected climate damage. This dissemination of information on the impact of climate change on agriculture can assist farmers in their use of autonomous adaptation in the methods of farming until the government comes up with full-fledged strategic adaptation policies. The government should also implement concrete plans to help vulnerable communities combat climate change, but political volatility, frequent changes of bureaucrats from one office to another, lack of climate change knowledge among bureaucrats, politicians and the common people, widespread corruption within governmental sectors, unavailability of actual data of the impact of climate change, and the topology of Nepal have all been constraints in the fight against climate change through adaptation. Yet, these factors cannot prevent climate change from occurring, so effective autonomous and strategic adaptation must be carried out simultaneously, along with constant monitoring, particularly on the national level. Finally, a strategic plan is needed to reduce rampant corruption and allow funding to reach the proper target groups.

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