

A briefing for government advisors and development practitioners

This briefing focuses on the impact of climate change on Nepal's rural poor. A great deal has been written on the challenges of providing clean energy and the risks to urban populations but, as this paper outlines, climate change also has many other consequences. Rural communities, whose livelihoods are intimately tied to the environment, are profoundly affected by the climate, yet have received little attention in the climate change literature. This aim of this briefing is to help address this shortcoming by first, setting out the current understanding of climate change and its impacts for Nepal and second, demonstrating that through immediate government action and community based adaptation the needs of those most affected by climate change can be met.

Introduction

- Global warming means more than just rising temperatures: climate change affects all aspects of the climate, making rainfall less predictable, changing the character of the seasons, and increasing the likelihood or severity of extreme events such as floods.
- Poor communities face the challenge of adapting to climate change through a process of building their ability to adapt and reducing their vulnerability to the impacts of climate change.

The changing climate

In 2007, the International Panel on Climate Change (IPCC) considered data from climate observations across the world and concluded that the evidence for warming of the global climate is 'unequivocal'. Current projections estimate that the increase in global temperature by the end of this century will range from 1.8 - 4.0°C, predominantly depending on the level of future greenhouse gas emissions. However, these figures demonstrate that dangerous climate change – conventionally understood as a global temperature rise of 2°C or greater – is becoming increasingly likely. And even this picture is evolving rapidly: recent studies suggest that the impacts of climate change may be even more severe and more rapid than those reported by the IPCC at the start of 2007.

Whilst many reports of climate change focus on rising temperature, global warming means more this: climate change affects all aspects of the climate, making rainfall less predictable, changing the character of the seasons, and increasing the likelihood or severity of extreme events such as cyclones and floods. Worse, the impact of these changes is often aggravated by existing environmental problems, such as when deforestation and extreme rainfall combine to produce landslides or floods.

Hitting the poorest first

Far from being an issue that only has implications for energy supply or the environment, climate change touches all the resources that we depend on in life. In particular, the current and future impacts of climate change hurt the well-being of the poor and vulnerable. Climate change puts extra burdens on the social and economic challenges that the poorest already face, emphasizing and increasing their vulnerabilities due to the dependence of their livelihoods on climate sensitive natural resources and their weak social protection

structures. By directly eroding the resources that poor people depend on for their livelihoods, climate change makes it easier for people to fall into poverty and harder for the poorest to escape from it:

- *Physical resources.* Shelter and infrastructure will be damaged or destroyed by an increased frequency of flooding, storms and climate-related disasters.
- *Human resources.* Malnutrition and the incidents of infectious diseases are predicted to rise with changing weather patterns.
- *Social resources.* Reduced livelihood security and prolonged or more frequent droughts and floods will lead to the displacement of communities
- *Natural resources.* Ecosystems are directly threatened by climate change. Change to the natural environment undermines the poor who depend on local ecosystems for a variety of goods and services, and rely on the productivity of their environment to support agriculture. Changes in local ecosystems may require changes to agricultural systems and practices.
- *Financial resources.* The repeated failure of crops or loss of infrastructure and homes leads to increased household costs, decline in income, slower economic development and lower livelihood security.

Adaptation to meet the challenge

The scale of the long term impacts of climate change can be controlled through mitigation, the process of reducing the concentration of greenhouse gases in the atmosphere. However, the effects of climate change are being experienced now. Worse, because of long delays in the climate system, the level of greenhouse gases in the atmosphere today means that further climate change is now unavoidable, regardless of efforts to reduce greenhouse gas emissions – meaning that the need to adapt to the impacts is equally unavoidable. Poor communities therefore face the challenge of adapting to climate change through a process of building adaptive capacity and reducing vulnerability.

- *Building adaptive capacity* means incorporating climate change into community-based development and improving the availability of appropriate information and skills, effective institutions, access to technology and opportunities to raise incomes.
- *Reducing vulnerability* to climate change requires the protection of existing assets (including the ecosystems on which communities depend), improved risk management, increased assets and broadening the available range of livelihood options.

The challenge is simultaneously to protect existing livelihood assets against the new risks posed by climate change, whilst securing more assets that can be accessed to help cope with the disruption and change that climate change will bring.

Structure of this paper

Following this introduction, the middle section of the paper considers climate change in more detail. Regional and national data are reviewed to provide summaries of recent climate change observations, the expected climate changes over the coming century, and the implications for those living in Nepal. The next section explores the process of adaptation, emphasising that efforts should focus on the needs of those most affected by climate change. The principals of community based adaptation are then outlined and illustrated through examples of Practical Action's experiences. Finally, the paper concludes with a review of the key messages for those responsible for addressing the impacts of climate change in Nepal.

Climate change in Nepal

- Climate change is likely to bring particularly rapid temperature increases in Nepal – faster than the average global rate of warming.
- Winter temperatures will increase more than summer temperatures. The level of winter rainfall is expected to decrease, whilst summer rainfall will increase.
- Extreme weather events such as heatwaves and very high rainfall are likely to become more frequent.
- Overall, Nepal is likely to become wetter, with the east of Nepal experiencing more rain than the west.

Some level of uncertainty is inevitable in measuring and anticipating climate change. Attributing individual current events to climate change is impossible due to inherent climate variability, whilst a lack of observations over a sufficiently long time frame or narrow geographical area can hamper the analysis of climate trends. However, the degree of certainty over all aspects of climate change has increased in recent years, and in particular between the publication of the IPCC's reports in 2001 and 2007.

As a result, there is now higher confidence in climate projections, including regional-scale warming, wind patterns, precipitation and some aspects of extreme events. Country-scale trends and projections, however, remain difficult to discern and as a result there have been many more studies focussed on South Asia than on Nepal. However, many regional observations and predictions have particular relevance for Nepal and are therefore included in the following summary of current and future climate change and the associated impacts.

The following is drawn predominantly from the IPCC's 2007 report but also relies in places on Nepal government sources, and Practical Action's own experiences in Nepal.

Climate change today

The South-Asia region is broadly defined by the IPCC as consisting of Pakistan, India, Nepal, Sri Lanka, Bhutan, Bangladesh, Myanmar and the Tibetan Plateau. However, the whole region has large climate variability, making climate change harder to identify and meaning that the current level of understanding of how the climate is influenced by human activity is low. Despite this, climate anomalies and changes in extreme events have been observed throughout the region, with intense rains, floods and droughts reported. Of particular note is severe and recurrent flooding in Nepal. More gradual year-on-year changes in temperature have also been observed, with a 0.09°C per year increase in recorded in the Himalayas and 0.04°C per year increase in the Terai (with higher increases in winter).

These regional climate extremes and climate changes have produced multiple impacts across the South Asia region and in Nepal in particular.

- Many parts of the region have suffered a reduction in food production due to reduced water availability, increases in temperature and a reduction in rain fall days.
- Water shortages and poor water quality have been attributed to the effects of rapid urbanisation and industrialisation, aggravated by climate change, in India, Pakistan, Nepal and Bangladesh.
- The incidence of diarrhoeal diseases and other infectious diseases such as cholera, hepatitis, malaria and dengue fever is expected to increase due to severe floods, rainfall and droughts in combination

with poverty, poor access to safe water and poor sanitation. High temperatures and poor hygiene contribute to bacterial proliferation.

A study by Practical Action in the Jugedi watershed region in Chitwan District has revealed the range of problems that the changing climate has brought in Nepal. The weather has been observed to have become be hotter in the summer months, yet colder in the winter, whilst the number and quality of water resources have fallen. Monsoon rainfall has increased whilst winter rainfall has become scarcer and periods of drought have become longer. Higher levels of sediment have altered the course of rivers, liver disease has been observed in cattle and cereal crop production has fallen. The effect on livelihoods has been seen through an increase in alcohol production to offset the failure of agriculture, whilst paddies have been converted to maize, millet and gram fields as the agricultural conditions change.

Climate change predictions

The vast majority of climate change predictions relevant to Nepal have been made using regional climate models. These indicate that warming across Asia will accelerate. The rate of warming in the South Asia is projected to be significantly faster than that seen in the 20th century, and more rapid than the global mean rate of warming.

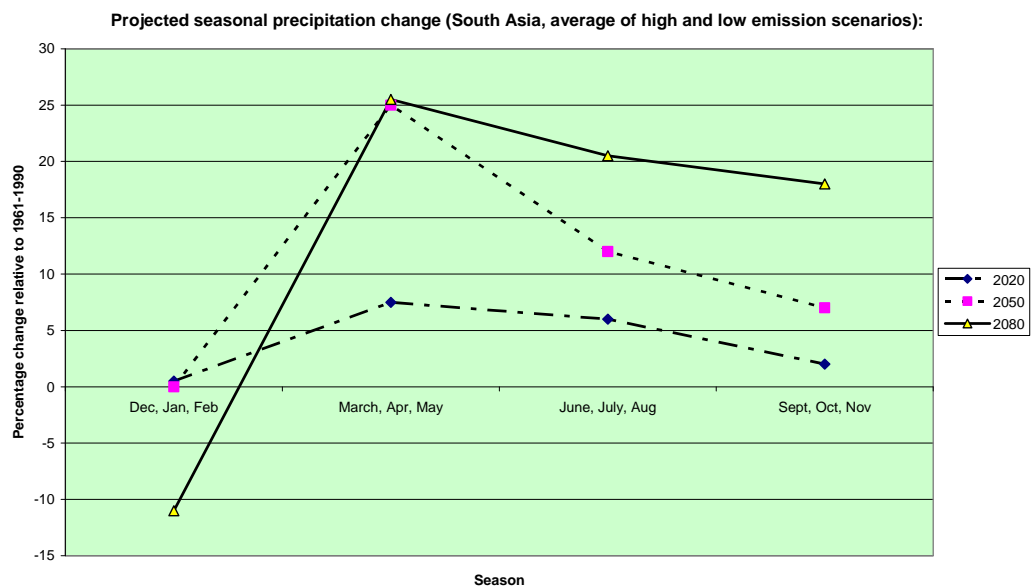
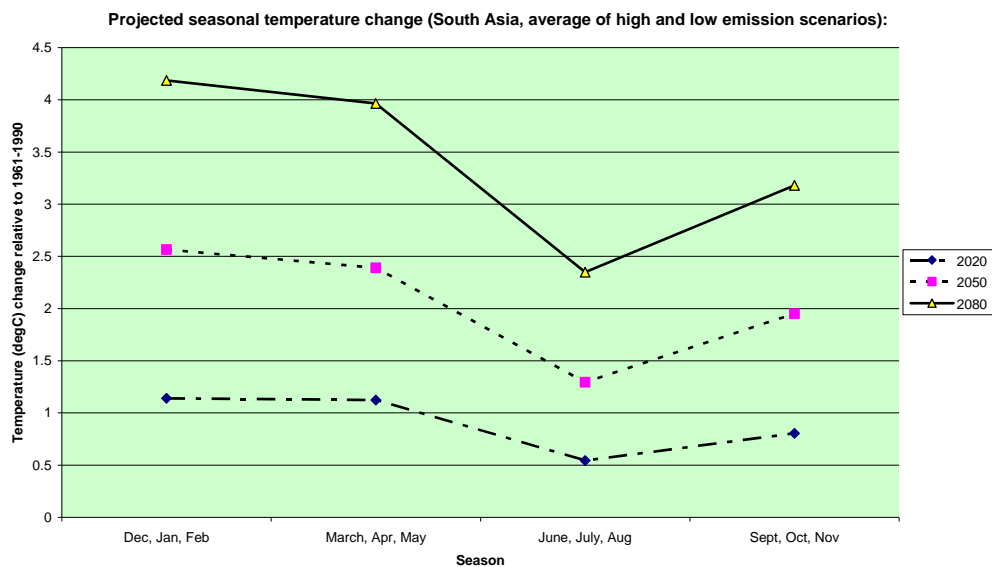
- Extreme weather events are projected to increase in frequency in South Asia, including heatwaves and high rainfall.
- During December, January and February warming is expected to be at its greatest and associated with a decrease in precipitation, whilst the consensus of regional models is that summer rainfall will increase.
- Nepal's National Communication to the UNFCCC – one of few reports that attempts climate modelling at the national scale – agrees with regional precipitation change predictions. The report suggests that an overall increase in precipitation is to be anticipated, but with the increase greater in the east of the country than in the west.

The predicted seasonal changes for the South Asia region are summarised in the table overleaf. The changes have been calculated relative to the average temperature and precipitation in the period 1961-1990. Note that the results of climate projections for high and low future global greenhouse gas emissions are presented – demonstrating the enormous difference in the impacts that result from alternative future levels of greenhouse gas emissions, particularly by the end of the century. The figures also demonstrate the impact that the highest emitting countries – the most developed countries in the West – have on South Asia. The 'high emissions' figures assume rapid, fossil fuel-intensive economic growth over the coming century: very much a business as usual in the global economy. The 'low emissions' figures, on the other hand, assume reductions in the use of natural resources and the introduction of clean and resource-efficient technologies during the course of this century. The implication is clear – large cuts in carbon emissions and radical changes in global patterns of consumption, particularly in the West, will be required to prevent climate change from bringing catastrophic changes across South Asia.

A simplified illustration of the data in the table is offered in the two graphs, in which an average of the high and low future emissions results have been plotted.

South Asia seasonal temperature and precipitation projections (relative to 1961-90 average)

	2010-2039				2040-2069				2070-2099			
	Temperature change °C		Precipitation change %		Temperature change °C		Precipitation change %		Temperature change °C		Precipitation change %	
Future emissions	High emissions	Low emissions	High emissions	Low emissions	High emissions	Low emissions	High emissions	Low emissions	High emissions	Low emissions	High emissions	Low emissions
Dec, Jan, Feb	1.17	1.11	-3	4	3.16	1.97	0	0	5.44	2.93	-16	-6
March, Apr, May	1.18	1.07	7	8	2.97	1.81	26	24	5.22	2.71	31	20
June, July, Aug	0.54	0.55	5	7	1.71	0.88	13	11	3.14	1.56	26	15
Sept, Oct, Nov	0.78	0.83	1	3	2.41	1.49	8	6	4.19	2.17	26	10



Future impacts and vulnerabilities

- The most profound impacts of climate change in Nepal will be in agriculture and food security, water resources, water induced disasters, biodiversity changes, and human health.

The IPCC offer the following summary of the vulnerability of key sectors in the South Asia region. In keeping with the IPCC approach, the summary reports both the degree of vulnerability and the level of confidence. The South Asia region has the highest proportion of 'highly vulnerable' sectors of all the Asia sub-regions.

Food and fibre	Biodiversity	Water resource	Coastal ecosystem	Human health	Settlements	Land degradation
-2/H	-2/H	-2/H	-2/H	-2/M	-1 / M	-2/H

Vulnerability

-2	<i>Highly vulnerable</i>
-1	<i>Moderately vulnerable</i>
0	<i>Slightly/not vulnerable</i>
+1	<i>Moderately resilient</i>
+2	<i>Most resilient</i>

Level of confidence

VH	<i>Very high</i>
H	<i>High</i>
M	<i>Medium</i>
L	<i>Low</i>
VL	<i>Very low</i>

In keeping with the regional assessment, the most profound impacts of climate change in Nepal will be in agriculture and food security, water, biodiversity changes, and human health.

- Agriculture and food security:*** Overall crop yield (wheat, maize and rice) could decrease in South Asia by up to 30% by the end of this century (compared with an increase of up to 20% in East and South East Asia). In Nepal, the predicted decrease in precipitation during the winter months will reduce winter and spring crop production. Temperature increases are also expected to reduce wheat and maize yields, whilst increased variability in both temperature and precipitation will present significant challenges to farming practices. Irrigation fed agriculture will be increasingly threatened as water resources deplete. Landslides and flash floods have already reduced the area of land available for cropping and are likely to continue to reduce productivity in the future. However, some estimates suggest that rice production will increase if there are moderate temperature and precipitation increases, whilst wheat production may increase the westernmost areas of Nepal.
- Water resources:*** Reductions in winter snow means less precipitation stored on the glaciers, in turn decreasing spring and summer runoff. However, earlier snowmelt and precipitation falling as rain rather than snow due to increased temperatures will increase winter runoff. Glacier melting has a significant impact. As glaciers start to melt, river runoff will initially increase during winter or spring, but beyond 2050 the ice resource is predicted to deplete and the supply of water will reduce. Those areas that rely on irrigation for agriculture will be particularly affected. Projections for Nepal suggest a 20% loss of snow and glaciated area above 5000 meters for a 1°C increase in temperature, rising to 58% and 70% loss for 3°C and 4°C increases. One impact of these changes is the increased likelihood glacial lake outburst flooding (GLOF), whilst increased annual precipitation of more than 20% will contribute to significantly increased sediment deposits – silting up river beds and increasing flood risk. Irrigation problems will be compounded by changing rainfall patterns, which are predicted to provide greater rainfall during monsoon when river flow is already high and lower rainfall during the already dry winter

months. As ice stocks decrease and winter precipitation reduces, the areas in water stress will increase. Ground water depletion is likely due to long dry seasons, irregular rains, and high intensity rainfall leading to high run-off rather than water absorption. Water stress is predicted to become one of the most pressing environmental problems in South Asia: all future emissions scenarios predict increasing water stress, with the effects being felt as early as 2020.

- *Energy infrastructure:* The glacial runoff and rainfall changes described above pose particular problems for hydropower infrastructure, which will have to adapt to changing patterns of flow and ranges of volume of runoff. Whilst additional problems will result from reservoir evaporation and increased sedimentation, perhaps the most dramatic impact would result from glacial lake outburst flood (GLOF), which has the potential to destroy hydropower installations.
- *Ecosystems and biodiversity:* In South Asia, grasslands are particularly under threat. Large decreases in grasslands are likely as temperatures rise and evaporation increases, threatening the livelihoods of livestock keepers. Significant changes in vegetation are anticipated in Nepal under the models considered in the National Communication: tropical wet forest and warm temperate rain forest will disappear, and cool temperate vegetation will turn into warm temperate vegetation. Currently, there is no rain forest in tropical and subtropical regions in the Nepal, but a doubling in carbon dioxide would see an emergence of rain forest in these regions. The sub-alpine and alpine regions of Nepal will be significantly changed by warming, and the altitude at which vegetation is found could rise by up to 500m, extending the area with potential for cultivation for those living on the hills. However constraints in soil fertility and irrigation water restrict the chance of harnessing this opportunity.
- *Human health and migration:* The burden of climate attributable diarrhoea and malnutrition is already high in Nepal relative to elsewhere in Asia. Future climate projections suggest that this large relative risk is expected to continue, with flooding causing pollution in surface water and an increase in cholera and diarrhoeal diseases. Analysis suggests that the risk of malaria and kalaazar (a deadly disease transmitted by sandfly bite) is likely to increase, particularly in the subtropical and warm regions of Nepal, with Japanese encephalitis risk also rising the subtropical region. Generally, increasing temperatures are likely to yield a spread in insect borne diseases and exposure of communities to diseases that they have no experience of or immunity to. Human migration following extreme weather events is also to be anticipated.

Adaptation: Responding to the threat of climate change

- Adaptation must focus on the needs of the people most affected by climate change impacts and aim to secure their livelihoods and reduce the most significant hazards they face.
- Identifying communities' own priorities and needs, and valuing their knowledge alongside science-based knowledge is key to development of sound adaptation strategies.
- The primary role of governments is in developing policies that are enabling for local-level action. However, important adaptation activities, such as management of increasingly scarce water resources, will require coordination and investment at the national and intergovernmental levels.

Climate change is currently causing increased hardship for rural communities throughout Nepal. Moreover, current levels of global greenhouse gas pollution mean that the impacts of climate change are now set to worsen over the coming decades regardless of future emissions. However, whilst the most profound impacts of climate change may still be some years away, our understanding of future climate scenarios means that actions to help prepare communities can be taken now. Importantly, strategies that build communities'

ability to adapt to climate change can and must be undertaken now: it will be too late to act once the last crops have failed or glacial lakes have burst.

Strategies for adaptation need to focus on the needs of the people most affected by climate change impacts and aim to reduce the most significant hazards they face. Identifying communities' own priorities and needs, and valuing their knowledge alongside science-based knowledge is key to development of sound adaptation strategies. Sharing experiences, obstacles and positive initiatives with other communities and development policy-makers must be an integral part of national adaptation strategies. The primary role of governments and international processes is in developing and implementing policy that is enabling for local-level action. Governments must allocate resources to preparing for the inevitable impacts of climate and in developing adaptation activities and skills within communities. However, some important adaptation activities, such as management of increasingly scarce or flood prone water resources, will require coordination at the regional and intergovernmental levels.

Development of adaptation strategies at the national level is underway in some Least Developed Countries, where National Adaptation Programmes of Action (NAPAs) identify priorities for adaptation projects. At the time of writing, Nepal had not published a NAPA. To ensure a positive impact on the most vulnerable communities, climate change adaptation should support the development of community based systems of adaptation based on sustainable livelihood options and sound management of ecosystems through strengthening capacities, skills and institutions to react and adapt to climate generated changes. More specifically, climate change adaptation strategies, including the NAPAs, should:

- Begin with vulnerability assessments based on strong gender analysis to focus on the most vulnerable and their needs within the communities and to identify and reduce the most significant vulnerabilities they face.
- Value the knowledge and strategies that the poor are already using to cope with climate change and use this as a basis to identify priorities and define action.
- Empower communities to participate in the development of climate change sensitive interventions and policies, ensuring effective interaction between decision-makers and planners from key climate change affected sectors in both government and donors' structures.
- Facilitate delivery of resources, support and services to community level, including information, skills, technology, finance and basic services and activities aimed at Disaster Risk Reduction.
- Require agriculture, energy, transport and health departments of Government to undertake an analysis of predicted climate change and how it impacts on their sector.
- Ensure that risks related to climate change and community-based responses to adaptation are mainstreamed into the most appropriate planning frameworks and development plans (including PRSPs).

Community based adaptation - reaching Nepal's rural poor

Climate change will have a significant impact on Nepal's rural farmers. The impacts will force profound lifestyle changes and destroy livelihoods if communities are not made aware of climate change and supported in finding ways to adjust and respond. However, through community based adaptation, there is much that can be done:

- Awareness of climate change is a key pillar of community based adaptation. Active participation in workshops, meetings and events that have been organised within communities can allow them to relate

their own experiences to climate change and understand how future weather patterns may differ to those they have known in the past.

- Action on adaptation can produce benefits now and in the future. Many adaptation activities help to provide communities with diversified livelihoods, alternative sources of income, or better infrastructure. Such ‘no regrets’ strategies are attractive as they have immediate positive impacts whilst also supporting the ability of communities to adapt to climate changes in the future.
- Adaptation can be made more effective by focussing on two existing areas of policy: disaster risk reduction and supporting livelihoods. When undertaken through community organisations, these overlapping activities address key climate vulnerabilities and build capacity to deal with future challenges.

Examples of Practical Action’s experience with community based adaptation in Nepal are provided in the following section, and demonstrate how low cost interventions can make a huge difference to those most affected by climate change. However, whilst local community based interventions are an essential aspect of adaptation, there is also an urgent need for adaptation planning and investment across all sectors of government. Reducing staple food crop yields, short term glacial river floods or glacial lake outbursts and long term reductions in water supply, risks to hydropower installations, vegetation changes and the disappearance of forests, and new challenges to human health are all examples of anticipated climate change impacts that need planning for now. Government at all levels needs to support both community based adaptation and, together with communities, develop and implement strategies that respond to the wider and larger scale implications of climate change.

Practical Action's experiences of community based adaptation

The following examples of community based adaptation demonstrate that support for communities facing climate change can be provided now, and at little cost. New farming techniques or alternative seed varieties are low-cost changes that can directly address the threat to the livelihoods of the rural poor. Whilst these strategies provide for improved livelihoods for the communities involved, they are ‘win-win’ approaches to adaptation as they also target the twin goals of community based adaptation: building adaptive capacity and reducing vulnerability.

Community based adaptation also emphasises the need for communities to understand that climate change means that traditional responses to climate variation may no longer be sufficient when long term shifts in temperature and rainfall are predicted. Women, who frequently play a key role in natural resource management, are central to ensuring that the impacts of climate change are properly understood. By building on their understanding of the climate and their environment, and by sharing their experiences with others, communities are able to develop their own strategies for climate change adaptation. Local and national government policy is therefore needed to support the communities in this process of defining and achieving their own goals.

Crop diversification in regions affected by flooding: One effective way for communities to cope with increased flooding and the threat to their land is by growing a range of new and different crops that have a higher market-value. By introducing crops that are more resilient to the changes in rainfall patterns, crop diversification also allows alternative crops to be cultivated at different times of the year, despite of changes to the weather. To support these activities, Practical Action has offered seedlings and training in crop diversification.

In one village Practical Action has helped a farmer by buying seedlings and offering training and advice on growing different crops. The farmer has been growing off-season tomatoes – but also cereals at the seasonal times.

"It's been far better for me to grow tomatoes than only wheat and rice. My wheat crop has been about 50kg but with extra tomatoes too I have been able to make a much better living. I am even thinking of paying someone to help me on the land because there is so much more to do now and I have extra money I can use to pay them"

The farmer is now moving into different types of vegetables, including black gourds and okra. In another example, Practical Action worked with a young farmer whose family used to grow only rice and wheat, but found that that only provided him and his family with enough food for about 3 months a year. He went on a training course with Practical Action to learn about vegetable cultivation and goat rearing. As part of that course he went on a tour to meet a range of farmers and there he learnt about the possibility of growing bananas as well as traditional crops.

"It's better now that me and my family are growing bananas as well as other crops. The crop is better and more reliable even when the rainfalls are crazy and erratic – the wheat and rice are really affected when the rains don't come. Now I don't have to spend so much time on the land either, which means that I am not just farming – I am also directly selling some of my products at market, which means I have some extra income. I have a better life now and I am full of hope for the future".

Preventing land erosion and landslides: Land erosion and landslides will become more common with increased rainfall and extreme rainfall events. To promote farming orientated towards soil and land conservation, 18 demonstration plots of 'sloping agriculture land technology' (SALT) have been established in different villages. The plots are planted with different fodder species in hedge rows to preserve the soil from erosion, with leguminous plants in between. 17 kg of seeds and 11,000 plants of different multipurpose fodder forestry species were provided to establish the hedge rows. Farmers who have established SALT plots with different varieties of plants have found that learning the new approach has brought several benefits:

"Once Practical Action Nepal introduced us to the technology, I became impressed and started to begin a plot with different varieties of plants. ... It is really a good technology which has multiple uses; it can be used to protect land from erosion and solve fodder supply problems. I have learnt the technical aspects of SALT and now I am capable enough to apply SALT in my own land."

Irrigation systems to cope with changing rainfall: In a village in Chitwan district, Practical Action has helped to provide an irrigation system which ensures that the village can continue to grow crops, even in the context of more erratic rainfall. The farmland in the village is higher than the river, so even though there are floods, water supply remains a problem. When rainfall does come it just washes down through the land. When the rains pass there is no way of getting water to the land even when it is only a short distance from the river. As rainfall becomes less predictable these problems become more difficult to overcome.

Using support from Practical Action, the community has built a dam as source of water for irrigation. Construction of the dam took 5 days, and a further 30 days were taken to build the irrigation system. Practical Action's contribution was to buy the pipes, cement, and skilled labour to support the community during the build. There is a concrete channel that runs alongside the river to carry the irrigation water. However, the irrigation system was damaged in floods of during 2006. As flooding is known to be likely to increase with climate change, the community has subsequently worked hard to repair it, collectively filling stone gabions that were being placed along the river-bank in order to protect the irrigation channel – the most vulnerable area when the monsoon rains come and there are floods. One female community member working on the repairs explained the motivation for the villagers coming together on this project:

"It's so urgent to do this work – I am delighted to be involved. It's so necessary I can't even begin to tell you. If I don't help with this work – if we don't all get involved – we won't be able to grow any food because the irrigation system might be damaged. I'd have nothing to feed my family let alone sell at market."

Summary of recommendations for Nepal

Policy makers from all sectors urgently need to focus attention on the implications of climate change. Support for adaptation to the impacts must start now. Many aspects of climate change and variability are already having a profound effect on the livelihoods of poor rural communities, and enough is known about the future impacts of climate change for action to be taken now. The vulnerability of the poorest to climate change is a central challenge and 'no regrets' adaptation options, which focus on poverty relief through diversifying livelihoods and extension support for sustainable agricultural systems, must be a priority.

In particular, action is required in the following areas:

Central government

Issue:

- Climate change is not just an issue for those in government with responsibility for the environment.

Recommendations:

- All government departments must acknowledge the importance of climate change and analyse the impacts for their sector. Disaster planning and risk reduction strategies must account for the new challenges of climate induced disasters.
- Central government will need to support decentralised policy development so that appropriate adaptation activities can be planned and to prevent the imposition of 'one size fits all' solutions. National level activities need to support the distribution of resources and extension services to the local level, training and awareness raising in communities, research for technology generation, information provision, and take forward international lobbying.
- Nepal needs to speed up the process for formulating its National Adaptation Programme of Action (NAPA). This process not only provides an important opportunity for examining the impacts of climate change for Nepal but also, once completed, opens opportunities for bilateral and multilateral cooperation to help Nepal with financing adaptation.

Water resources management

Issue:

- Melting glaciers will cause an initial increase winter and spring in river flows but lead to a long term reduction in water supply after 2050 as the ice resource depletes. Water stress will become a significant factor in for agriculture and human consumption. In the short term increasingly frequent flooding from increased glacial outflow and extreme rain events is anticipated.

Recommendations:

- At the local level, action plans and concrete implementation activities are required for irrigation systems, drinking water, and water induced disasters. Training, awareness raising and mobilisation of resources are essential at the local level; this will require decentralised funds that are managed at the local level, for *example through community based organisations*.

Agricultural policy and extension support

Issue:

- As temperature and precipitation rates change and precipitation in particular becomes less predictable, farmers will need to change their practices and diversify crops. Changes in vegetation may have significant implications for livestock keepers if grassland areas decrease in line with predictions, whilst the disappearance of tropical wet forest and temperate rain forest will change the livelihood options of those who depend on these natural resources. More positively, the rise of the vegetation line in mountain regions may offer an opportunity for the cultivation new land. However, irrigation and soil fertility will be important considerations.

Recommendations:

- Action will be required at several levels to support adaptation in agriculture, including in the Department of Agriculture, Nepal Agriculture Research Council, and District Development Council. Identification and investment is required on appropriate cropping patterns and systems, crop varieties and species, emerging pests and diseases, and evolving and anticipated climate stresses on crops and livestock. Training and the support of extension worker for farmers will be necessary in all these areas.

Health

Issue:

- Diarrhoea diseases are already a significant problem in Nepal and flooding is likely to increase the pollution in surface water, increasing both diarrhoea and cholera. The subtropical and warm regions are likely to see an increase in malaria and kalaazar whilst Japanese encephalitis risk will increase in the subtropical region.

Recommendations:

- Local and national planning will be required to secure local drinking water supplies, drainage, and health facilities. The distribution of vaccinations as people are exposed to new diseases to which they have are not immune will be essential.

Forestry and natural resources

Issue:

- A change in Nepal's forest composition is anticipated, with tropical wet forest and warm temperate rain forest disappearing and rain forest emerging in the tropical and subtropical regions. Forestry policy is critical as forests act as carbon sinks and provide a source of livelihoods. As extreme rainfall events increase in likelihood, flood and landslide protection offered by forests become ever more important.

Recommendations:

- Community forestry approaches will be a key component in developing and preserving the ecosystem resources (livelihoods, flood and landslide protection, and carbon sinks) that forests provide as the climate changes.
- Attention should also be paid to alternative livelihoods as the current natural resource based livelihoods are likely to be affected by climate change. Strategies for alternative livelihoods must offer affected communities a range of employment opportunities and should include support for local labour, industrial and business initiatives.
- Strengthening of natural resources and with enhanced livelihood options strengthens the coping capacity of the landscape to climate extremes and enables communities to better cope with adversities. Community based adaptation which integrates the natural resources on which the livelihoods of most of the population is based is thus the most viable option for adaptation to climate change.

Practical Action is a UK-based development organisation that has offices in seven countries in four regions of the world. Practical Action works with communities to develop appropriate technologies to ensure sustainable improvements in their lives. Practical Action advocates an integrated approach to tackling climate change and poverty reduction, based on justice for poor men and women.

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