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The IPCC's Fifth Assessment Report and Its Implications for Nepal

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Executive Summary

The Intergovernmental Panel on Climate Change (IPCC), convened under the auspices of the United Nations, in 2013-2014, released its Fifth Assessment Report (AR5). In this context, each of the IPCC's three working groups (WG) based their newest assessment on the latest available scientific research. WG1 on Physical Science reported new scenario results and improvements in the quality of evidence. Compared to previous ARs, the report of the WG2 on Impacts, Adaptation and Vulnerability laid greater emphasis on the social dimensions of climate change, particularly the interaction of climatic and non-climatic stressors. WG3 on Mitigation discussed new findings in the context of multiple objectives, such as sustainable development and the increased coverage of co-benefits and issues pertinent to developing countries. This briefing brings together salient messages and themes from across these three working groups and relates them to Nepal.

Limiting global warming to 2°C is a challenge, as is adapting to it. As the impacts of climate change are already being felt, Nepal has a tall order of adapting to the effects of climate change and encouraging the international community to achieve fast and deep reductions in greenhouse gases.

Short-lived climate forcers, such as black carbon, may not have a large impact on temperature changes in the long run. However, as the abatement of these pollutants would generate a strong set of co-benefits, particularly for human health and agricultural yield in rural areas, incorporating them into a mitigation strategy would facilitate the use of these synergies.

One of the key interactions that climate change will affect is the energy-water-food nexus. Impacts on the water sector, with consequences for agriculture and food security are projected to be from high to very high, depending on the emissions pathway. Considering these interactions and climate impacts, Nepal's water-dependent energy sector and its water-intensive agricultural sector need to be seen together. In this context, glaciers play an important regulating role in controlling the timing and the volume of water in rivers. Therefore, the impact of climate change on glaciers will be far reaching for all three: the energy, the water, and the agricultural sector. Notably, the AR5 has updated its assessment of climate impacts on glaciers with a special focus on Himalayan glaciers. Unfortunately, the AR5 is very sparse on other impacts on human and natural systems specifically in the Himalayan region.

Climate change adaptation and mitigation demand a risk-based, iterative decision-making process, in which organisational learning takes on a critical role. Organisational knowledge can be generated through the monitoring and evaluation of all stages of climate policy. Further, robust governance structures are instrumental, particularly when decisions need to be made about transformational adaptation. Similarly, the development of boundary organisations that mediate between science and policy will be essential to respond to policy needs. At the international level, an ambitious climate agreement with wide participation is vital. At the same time, Nepal must be aware of the strengths and limitations of pursuing its climate-related objectives through alternative forums.

"Climate change is one of the most critical challenges to the global development agenda."

UNDP, 2014

CLIMATE ANALYTICS

Introduction

Climate change is a challenge that not only threatens Nepal's future development potential. It could also undermine significant development gains that have been achieved in previous decades. Climate change impacts are expected to increase poverty levels in high mountain states, mainly through channels such as diminished food security, the depletion and destruction of assets, which in the end can become poverty traps for parts of the population. Climate change is also a critical stressor that interacts with other stressors such as high levels of poverty, low human development, and high inequality, as well as with cultural and institutional factors that shape development outcomes.

The Intergovernmental Panel on Climate Change's (IPCC) Fifth Assessment Report (AR5) brings together the latest scientific evidence on climate change and assesses the literature with a view to provide policymakers with policy relevant input. The IPCC's work is organised along three working groups (WG): WG1 on the Physical Science basis, WG2 on Impacts, Adaptation and Vulnerability, and WG3 on Mitigation. These working groups completed their work for the AR5 in mid-2014, and preparations for the synthesis report are underway.

The AR5 has been adopted at a time crucial for Nepal, both from the perspective of the international climate change negotiations and in view of Nepal's domestic policy context: On the one hand, Nepal needs to be equipped to shape the design of the emerging international climate change architecture, a responsibility that has become more salient as Nepal holds the current Chair of the Least Developed Countries Group; On the other hand, Nepal's new Constituent Assembly, elected in November 2013, provides a fresh opportunity for policymakers to address climate change, as it allows wider institutional arrangements and coordination activities to be discussed and institutionalised. Accordingly, the insights from the IPCC are valuable for Nepalese policymakers.

Under any plausible scenario, *residual damages* of climate change will mean that climate impacts will be felt even under very stringent mitigation scenarios. Therefore, a focus on adaptation is absolutely necessary. Yet, WG3 showed that the Cancun Pledges were insufficient to alter the trajectory of emissions to a level that would allow warming to be limited to 2°C. Building on these IPCC-findings and in light of Nepal's high degree of vulnerability, the average increase in global temperature needs to be related to factors context-specific for Nepal, in particular to the interaction between climate stressors and other vulnerabilities. Some key impacts that are reported in the IPCC are captured in Box 1.

Nepal faces the dual challenge of having already to adapt to evident climate impacts, whilst needing to prepare for the risk of inaction by the international community to limit warming to below 1.5 as demanded by the LDC Group. Near-term impacts of climate change are expected to be similar across the range of Representative Concentration Pathways (RCP).[1] How these impacts translate into welfare outcomes depends largely on progress regarding adaptation. However, as impacts are expected to deviate substantially in line with each future emissions scenario (RCP)

[1] Representative Concentration Pathways (RCPs) are trajectories of greenhouse gas concentrations. The AR5 has identified four RCPs, each named after a radiative forcing value in the year 2100 (relative to preindustrial levels). As many scenarios could lead to the same forcing level, they are described as pathways.

from about the 2040s, we will enter unchartered territory where the efficacy of adaptation is not clearly known. To limit serious long-term impacts during the second half of the century, and given the time delays in the global climate system, it is important to pay attention to the scale of mitigation efforts today.

This brief uses the IPCC's Fifth Assessment Report to identify insights relevant for Nepal. Initially, general trends and the difficulties in limiting warming to 2°C are described. Thereafter, key risks and challenges that Nepal faces are identified. Subsequently, the synergies and linkages arising from the interconnected nature of the energy, water, and agricultural sectors are discussed. In the final part of the briefing, relevant themes are brought together and discussed with a view to inform domestic and international policymaking.

Box 1: Major Climate Change Impacts Identified by the IPCC Relevant for Nepal

- Increase in poverty in low and lower middle income countries, including high mountain states (AR5, WG2, Technical Summary)
- Increase in mountain phenomena such as slope instabilities, mass movement, glacial lake outbursts[2] and increase in hazards due to moraine dammed lakes (AR5, WG2, Chapter 3, Box 3-1)
- Decrease in mountain glaciers[3] (AR5, WG2, Chapter 3, 3.4.3).
- Increase in economic losses from weather- and climate-related events.[4]
- Decrease in biodiversity in mountain ecosystems given the limited range of population movement of the species. (AR5, WG2, 4.3).[5]
- Greater radiative effect of deposited soot and, therefore, a bigger impact on snow melt[6](AR5, WG2, Box 3-1 and Qian et al 2011)

[2] High confidence in observations, attribution, and projections.

[3] High confidence in observations and projections. For a 4°C world, with the current level of adaptation, the risk level is very high. And even under an ambitious adaptation scenario it still is high. For a 2°C world, with the current level of adaptation, the risk level is high, and under ambitious adaptation it is medium. (AR5, WG2, Chapter 3, page 65) The proportion of glacier melt is expected to decrease with the annual peak shifting to the spring. By 2100, the IPCC projects a decline in global glacier volume of 15 to 55% for RCP2.6, and by 35-85% for RCP 8.5 (medium confidence) (AR5, WG1, SPM, page 25; AR5, WG1 Chapter 13, 13.4, 13.5).

[4] High confidence in observations and projections.

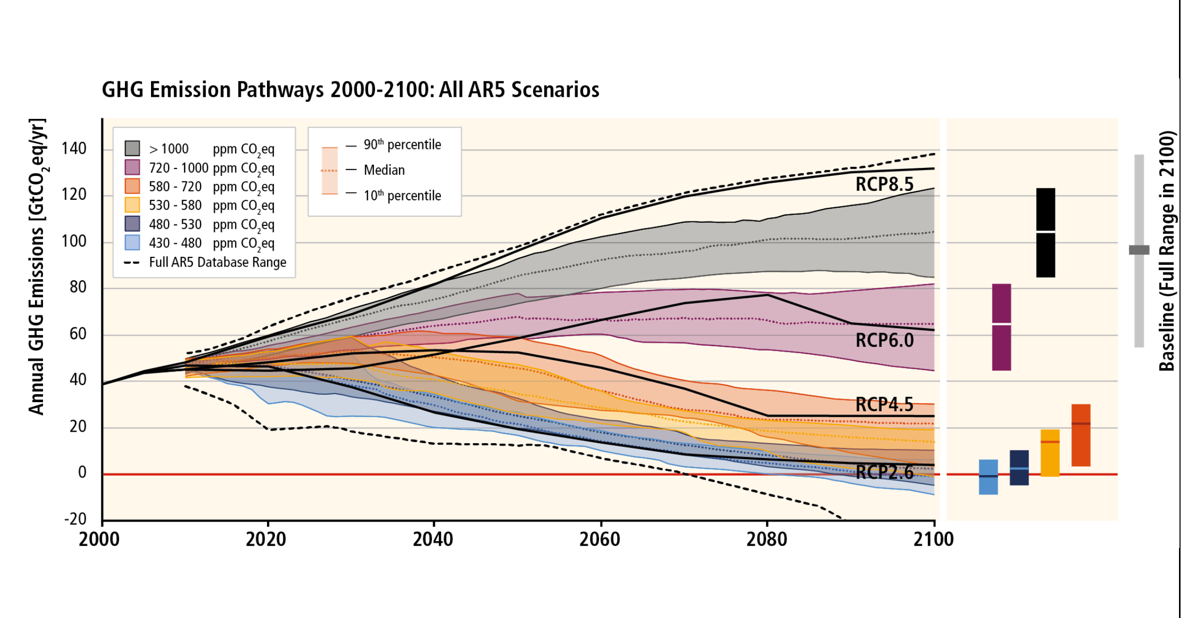
[5] For low levels of warming (RCP 2.6) the projected effects are low, while being severe (AR5, WG2, 4.3) for the highest levels (RCP 8.5).

[6] This impact may be more intense than that of the current greenhouse effect compared to pre-industrial levels

2. The Challenge to Limit Global Warming

The IPCC recognises that the timing and the levels of mitigation of greenhouse gases will determine the rate of climate change and the nature and severity of its impacts. While global climate-change projections for the first half of the 21st century display similar trends across RCPs, they start to diverge substantially after 2040. For example, under RCP 8.5, people are three times more likely to be exposed to a flood once-every hundred years than under RCP 2.6 (AR5, WG2, Technical Summary).

Figure 1: Annual Emissions and RCPs



Source: AR5, WG3, Chapter 6, page 25

Since the 1990s, limiting the average global surface temperature increase to 2°C over preindustrial levels[7] has been commonly regarded by scientists and policymakers as adequate means of avoiding dangerous climate change. Yet, given the scale of mitigation cuts needed, the temperature implications of overshoot and peak emissions, and the time scale and level of international participation in reducing greenhouse gases to limit global warming to 2°C will be a challenge. To achieve this goal with a "likely" probability (more than 66%), and taking into account the role of non-CO_2 forcers, cumulative CO_2 emissions will need to be limited to the range of 0–1,000 $GtCO_2$ from 2011 onwards, and this budget is closing fast. To illustrate this point: by 2011, about 1900 $GtCO_2$ had already been emitted since 1870 (AR5, WG1, SPM). With about 34 GtCO2/year of emissions, the remaining budget of about 1,000 $GtCO_2$ is expected to suffice for roughly 30 years. By that time the currently estimated probability that warming is below 2°C drops to below the "likely" (more than 66%) range.[8] Similarly, we know from WG3, that to limit

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[7] 1861-1880.

[8] The full budget for more than 66% probability since 1870 is 2900 $GtCO_2$, of which 1,000 $GtCO_2$ remained by 2011. Annual CO_2 emissions from fossil fuel combustion and cement were on average 30.4 GtCO2/year between 2002-

concentrations to the range of 430-530 ppm by 2100, the 2020-emission level needs to be lower than those relating to the Cancun Pledges (AR5, WG3, Chapter 6, page 62). Near-term mitigation ambition, therefore, is central to the achievement of temperature goals.

Similarly, overshoot scenarios and peak concentrations are of particular importance in light of long-term temperature goals. Scenarios that overshoot the 2100 concentration goal by more than 0.4 W/m^2 lead to higher temperature levels by 2050 and, thus, to changes that are more substantial than scenarios with less or without overshoot (AR5, WG3, pages 33-34). Accordingly, the peak concentration level to 2100 is of great interest to Nepal (please see Figure 6.14 in AR5, WG3, Chapter 6 for further detail).

Box 2: Short Lived Climate Forcers (SLCF)

> Reducing ozone and particulate matter has near-term benefits for climate and air pollution (AR5, WG3, Chapter 6). While the short or medium term reduction in warming may not be significant (studies report a range of 0.16°C to 0.5°C by 2050), the importance of regional albedo forcing (in the Arctic and the Himalayas), has been acknowledged (Shindell et al. 2012). The near-term co-benefits of SLCF mitigation, particularly in terms of avoiding premature deaths due to air pollution exposure and increasing agricultural yields, provide a strong justification for mitigation action on black carbon and methane.
>
> Of particular concern to Nepal is the impact of black carbon and the corresponding effect on glacier albedo resulting into 70-200 mm/year of additional melt-water (Yasunari et al., 2010). Soot deposits could, in fact, be a larger force for snowmelt than greenhouse gases (Qian et al., 2011).

Over the 2016-2035 period, the global mean surface air temperature is very *likely* to be between 1-1.5°C above the 1850-1900 mean (AR5, WG1, Chapter 11, Executive Summary, page 4). Yet, one major caveat applies. These figures are reported at the global level. What is relevant for Nepal, however, is the local temperature change: IPCC WG1 data reveals that a global average of 2.5-3.5°C warming means a *local* warming of 3-4° C for Nepal. And for 2081-2100, local warming in Nepal is projected to be approximately 1.5°C higher than the global average (see AR5, WG1, Chapter 13, Figure 12.10).

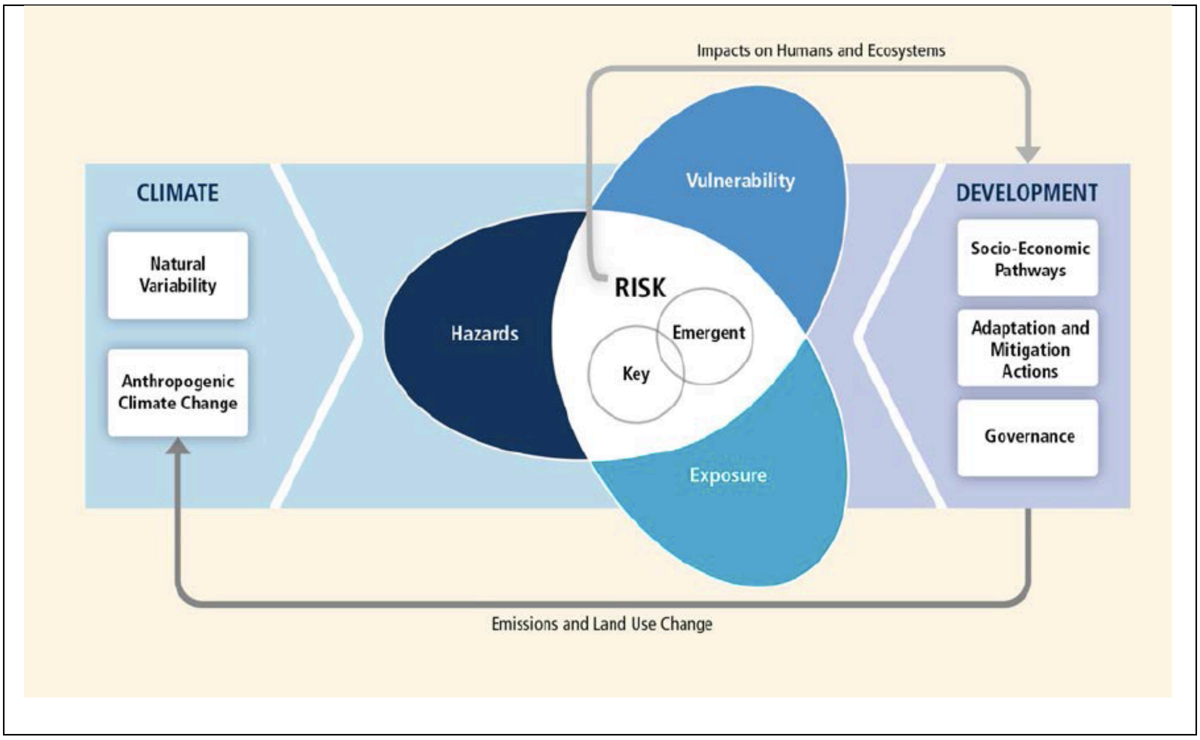
A scenario in which global warming is with a 50% probability limited to 450 ppm, that is, to 2°C, rests on key assumptions such as the availability and use of carbon capture and sequestration technologies, the use of bio-energy, the scale of renewable energy technologies, and universal participation in the new global climate agreement. In case these assumptions are not met, the 2°C scenario is challenged.

Another consideration that needs to be taken into account for any long-term goal is the extent and timing of participation. In its assessment, the IPCC finds that with regional fragmentation, out of the ten models, only two could generate a 450ppm outcome by 2100. This has an important implication: The costs saved by certain countries due to delaying participation to later rounds, may be outweighed by the costs incurred by climate action that will become necessary later in the 21st century to achieve more rapid and steep emissions reductions. Therefore, avoiding carbon lock-ins today by countries that do not take on formal mitigation commitments is essential to avoid higher costs of mitigating greenhouse gases later on.

2011. An additional 3.3 $GtCO_2$/year is added from net land use change. These figures mean that with 33.7 $GtCO_2$/year of emissions added in very year, the remaining budget based on the preceding line is fast closing.

In order to understand emerging climate-related risks, IPCC AR5 WG2 brings together evidence that assesses risks on the basis of Article 2 UNFCCC, where key vulnerability, key risks, and emergent risks are identified. In contexts where there is high vulnerability and high exposure to hazard, risks have been identified as *key risks. Emergent risks,* on the other hand, involve complex interactions between climate and socio-ecological systems, and may become key risks with a greater level of scientific understanding. Figure 2 provides a graphical conceptualization of risks that depicts the nexus between climate and development.

Figure 2: Understanding Risk



Source: AR5, WG2, Chapter 19, Figure 19-1

To illustrate how multiple drivers can interact to increase vulnerability, let us focus on the risks for pastoralists in rural areas. Their vulnerability can be raised by droughts that result in the degradation of rangelands, and an increase in conflict over natural resources. The lack of political access and the state of land rights that inhibit livelihood support can add to this vulnerability. The risks involved include potential famines and loss of revenue due to the inability to trade livestock. An example of an *emergent* risk is the interaction of the spread of animal disease during drought periods, which would amplify rural vulnerability.

In AR5, the IPCC has updated the reasons for concern and, in this, context, assesses two risks at a higher level than before - both of which are relevant for Nepal: First, risks to unique and threatened systems as e.g. biodiversity loss in mountain ecosystems[9] The report projects, for example, that a 2°C warming results in a high vulnerability to climate change of 24-50% of birds, and 22-44% of amphibians[10] (AR5, WG2, Chapter 19, page 40). And second, risks of large-scale

[9] Chapter 19 in AR5 WG2 provides further details.
[10] (high sensitivity, high exposure, and low adaptive capacity).

singular events. The IPCC WGII AR5 report identifies that the risks associated with such large changes to the Earth system grow from moderate at 1.5° to 2°C above pre-industrial levels to high for warming of 3-4°C above preindustrial.

Box 3: Key Risks

- Food insecurity and the breakdown of food systems
- Severe harm due to inland flooding and the limited coping and adaptive capacities of large urban populations
- Loss of rural livelihoods and income of rural residents due to insufficient access to drinking and irrigation water
- Multiple interacting hazards affecting infrastructure in combination with high dependency of people on critical services

Source: AR5, WG2, Chapter 19

The key risks identified in Box 2, together with the reasons for concern in general, allow us to interpret the notion of climate risks with reference to Article 2 UNFCCC. The key risks also guide us to salient interactions across issues and sectors. Energy, food, and water are closely linked and their interactions will significantly govern how climate impacts manifest themselves in Nepal. These interactions are the subject of the following section.

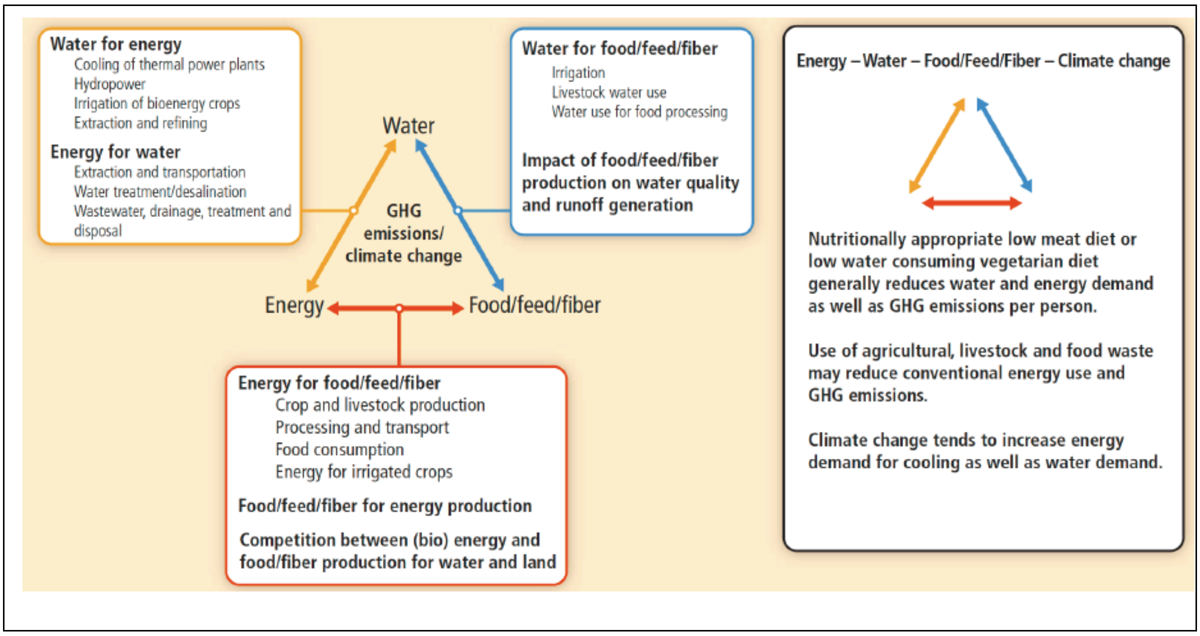
2. The Water-Food-Energy Nexus: Impacts, Risks and Synergies

The IPCC identifies degradation of ecosystem services and the associated consequences for agriculture and water supply as an emergent risk (AR5, WG2, Chapter 19). For example, climate change is expected to negatively affect water quality by altering the ratio of sediments and nutrients, thereby, affecting agricultural yield and the maintenance costs and lifespans of hydroelectric power plants. Changes to river flow due to glacial melt further increase this risk. This section focuses on the interconnections between energy, water and food illustrated in Figure 3, and includes a separate subsection dedicated to the IPCC's findings on Himalayan glaciers.

To start with the water sector: Variability in precipitation particularly affects areas relying on rain-fed agriculture. With such variability, the difference in yield between irrigated and rain-fed agriculture is likely to grow bigger. As with other impacts, the severity is expected to increase after 2050. The IPCC expects that an increase in local temperature by 1°C will have negative impacts on yield for wheat, rice and maize. These effects are likely to manifest from 2030 (AR5, WG2, Chapter 7, Section 7.4), when average yields are expected to decrease by 0-2% per decade (from the median). If warming is to continue, with *local* temperature increases at 3-4°C above pre-industrial levels, agricultural productivity is expected to be negatively affected beyond the 'projected adaptive capacity' (AR5, Chapter 7, page 3). In places like

Nepal, where local warming is projected to exceed 4°C, the gulf between productivity and demand is expected to result in 'very significant' risks for food security.

Figure 3: Interaction of Water, Energy and Food



Source: AR5, WG2, Technical Summary, Box TS.9

As for the food sector: An increase in food demand due to population growth (in conjunction with climate effects) can increase the need for irrigation, place a higher premium on groundwater extraction and the energy needed to do so. With the reduced surface availability of water, groundwater will experience increased stress. As groundwater recharge differs greatly from location to location, the relationship between climate change and the resultant consequence on groundwater availability is, however, not uniform.[11] While market access allows communities to escape local variations in weather, it also increases the exposure to commodity prices. In conjunction with other stressors, such shocks could have a deleterious effect on welfare by increasing food insecurity. Communities are more vulnerable to commodity price rises, if agricultural markets are not well integrated, if farmers are net buyers (as opposed to net sellers), and the pre-existing state of food security is poor.

Finally, on the energy sector: The IPCC finds that run-of-river plants are more vulnerable to changing river discharge than reservoir plants.[12] Projections of future hydropower generation have to consider uncertainties associated with precipitation and discharge. For Nepal, this problem is further confounded, as glacial melt will also need to be taken into account. But the coinciding of the monsoon and the peak melt season make it difficult to disentangle the effects. Increases in precipitation and glacier melt-water are expected to increase the sediment load by 26% by 2050 (Neupane and White 2010), thereby reducing the life span of hydroelectric plants and increasing maintenance costs. However, as soil erosion strongly

[11] AR5, WG2, Chapter 19, Page 18.

[12] Most of the hydroelectric plants in Nepal are run-of-river. See Adhikari, D. 2006. "Hydropower Development in Nepal." *Economic Review* 18: 70.

depends on land cover changes, estimates are subject to uncertainties. Depending on how precipitation changes, among other variables, competition between energy production, ecosystem function maintenance, and domestic and industrial uses is likely to grow.

Due to their prominence in AR5[13] and their relevance for Nepal, lastly a word is in place on the role of glaciers in the water-food-energy nexus. The IPCC finds that there is committed change in water resources (primarily availability) during the 21st century, given the mismatch between decreasing glacier size and increase in emissions. A shift in peak glacial melt from Summer to Spring is expected for the Western Himalayas, but the shift is less pronounced for the Eastern side, owing to the coincidental monsoon and peak melt periods. Further, there is growing evidence that glacial melt-water will peak in the 21st century. Due to the projected increase in precipitation, the decrease in glacial size is not seen as a major problem for Kashmir and Eastern Nepal (Immerzeel et al., 2013). Projections of changes in glacier mass until 2035, range between a 2% gain and a 29% loss, while projections until 2100, point to losses in the range of 15-78%, both for RCP 4.5 and RCP8.5. The mean loss under RCP 4.5 is 45%, and under RCP 8.5 68%. These figures are thought to be substantial improvements in estimates compared to the AR4, where the Asia chapter based its assessment of complete loss of Himalayan glaciers by 2035 on one erroneous study. However, the loss in glacier size also means that the discharge regulating role that glaciers play will be significantly weakened. This has corresponding implications for agriculture and the energy infrastructure.

Climate impacts, such as high intensity rain and mountain slope instability, can wash out roads and bridges, thereby, affecting access to rural areas (AR5, WG2, Chapter 9). Bridges and culverts have been identified as particularly vulnerable to the effects of heavy precipitation. This is important not just for disaster relief work, but also to provide unimpeded access to markets, as functioning markets help to increase the stakeholders' adaptive capacity.

Energy infrastructure is also vulnerable to such climate impacts. AR5 further identified the co-benefits and the adverse effects of mitigation measures in the energy sector, which could be substantial (see WG3 Chapter 7 on energy, and Chapters 6 and 15 for syntheses). For example, the pursuit of clean energy sources such as hydropower would not just be a mitigation measure, but would also offer co-benefits including health benefits, enhanced energy security, and water regulation benefits through flood control and irrigation. However, reservoir hydropower could also yield adverse effects such as the displacement of people and the loss of habitats. Considering the prospect for mountain slope instabilities and similar hazard, the need for system resilience needs to be underscored through a diversified energy mix. While decentralized energy systems can have benefits on the adaptation side, they can also contribute to the system resilience of the energy infrastructure. For example, they can increase adaptive capacity in rural areas and allow sustainable agricultural practices like conservation tillage, thereby, reducing emissions (AR5, WG3, Chapter 6, page 72).

[13] Given the controversy surrounding Himalayan glaciers in the AR4, the IPCC dedicated special attention to it in this assessment round.

3. Discussion

Following up on the above discussion of emission trends and projected climate impacts, this section is focusing on national and international decision-making processes. Given Nepal's needs, the discussion initially revolves around adaptation and other domestic decision making processes, whereas the final part examines climate-related decision-making processes at the international level.

3.1 Adaptation

To design adaptation measures, policymakers need to be cognizant of the options, opportunities, and limits of adaptation. Box 4 summarises the wide range of factors that according to AR5, WG2, Chapter 14 need to be considered when selecting adaptation options, as well as the adaptation constraints, identified in AR5 WG2 Chapter 16, that can impose *adaptation limits.* Tools such as multi-criteria analysis are available to select options. An adaptive management style, that incorporates lessons-learned into successive actions, is known to encourage incremental changes.

Box 4: Factors Influencing Adaptation Options and Limits

Factors influencing adaptation options:	**Factors imposing adaptation constraints:**
• Policy and market conditions • Co-benefits and other goals • Non-climatic drivers • Uncertainty, rate and cumulative effects • Framing	• Knowledge, awareness and technology • Governance and institutional • Physical environment • Social and cultural • Biological • Human resources • Economic • Financial

Source: AR5, WG2, Chapter 14

The adaptation constraints listed above interact and operate across scales. They represent factors that impede the effectiveness of adaptation actions, or restrict the choices of actions available. They apply to both ecological and social systems.

In the past, the dominant approach to cost-benefit analysis put emphasis on adaptation actions. According to AR5, however, respective projections need to consider how climate change evolves in conjunction with non-climatic drivers of change and, therefore, need to include adaptation opportunities, limits and constraints. Accordingly, the climate-centric approach is giving way to a more flexible approach that addresses the emerging need for a risk-based iterative process of adaptation assessment and decision-making that also aims to identify adaptation limits. This new approach has a stronger focus on learning based on monitoring and the incorporation of evaluation results. While the limits of biophysical systems have been operationalised through proxies such as species extinction, the modelling of limits to social systems has proven more difficult. But the underlying notion is that social systems only have a finite ability to adapt.

Previously, mainstreaming has featured prominently as an approach to integrate adaptation into development work. According to the AR5, however, institutional arrangements can also restrict mainstreaming of climate adaptation, if they challenge the effectiveness of climate mainstreaming, for instance due to the requirements for multi-level institutional coordination; difficulties regarding inter-institutional coordination, and the prescribed degree of coordination between government agencies and stakeholders (AR5, WG2, Chapter 15).

The IPCC recognises that the initial process for adaptation includes reducing vulnerability, leveraging co-benefits to take action, and achieving synergies with other issue-areas like disaster risk reduction. These incremental measures, however, may not be enough. When vulnerability is high and/or when climate change threatens the resilience of the system, *transformational adaptation* is needed. While we do not have a precise definition for transformational adaptation, experts agree that it involves a change in the fundamental attributes and goals of a system. It is important to recognise that transformational adaptation can be both deliberate government action as well as reactive measures taken in response to an extreme event. Further, transformational adaptation can generate positive and negative externalities. Physical displacement, for example, involves a loss of sense of identity, belonging and culture, but also facilitates adjustment when adaptation limits are breached.

AR5 also offers guidance on how decisions for transformational adaptation can be made. There the IPCC suggests that policymakers need to address four factors: 1. Adaptive management, 2. Robustness and resilience, 3. Deliberation, and 4. Iterative risk management. Institutions that are responsive and that allow deliberate decisions to take place open opportunities to minimize negative externalities. In highly vulnerable countries with significant adaptation limits and constraints, such as Nepal, the robustness of institutions to handle issues of transformational adaptation will be highly critical. The framing of climate-resilient pathways in the context of sustainable development provides a basis for assessing trade-offs and for understanding the synergies between mitigation, adaptation, and sustainable development.

3.2 Domestic decision-making

In AR5, the IPCC notes that scientific and technical information is necessary, but not sufficient for climate change decision-making (AR5, WG2, Chapter 2). While the conventional decision-making approach has been climate science-driven, the need to adopt a multidisciplinary approach is gaining ground for two reasons: First, knowledge on the effects of climate change does not automatically result in the most effective decisions. Second, the heavy emphasis on impacts could underplay the role of other stressors and drivers of vulnerability. Apart from the difficulties in modelling the necessary phenomena and the uncertainties governing climate change, the context specific nature of adaptation calls for an iterative process.

Here, the IPCC identifies three criteria that are conducive to establishing effective institutional decision-making processes. First, institutions that are flexible in handling uncertainty can rapidly adapt arrangements in light of new, or revised information. Second, institutions capable of coordinating and communicating with other relevant institutions are better fit to address climate change. Third, institutions that successfully integrate the needs of stakeholders are more adept at handling diverse stakeholders in changing circumstances.

The above discussion highlights the need for *boundary organisations* to be taken serious in the context of climate decision-making. A boundary organisation is "a bridging institution, social arrangement, or network that acts as an intermediary between science and policy" (AR5, WG2, Glossary). Its function is threefold: 1) It facilitates communication between researchers and stakeholders; 2) It produces, transfers, and communicates knowledge; and 3) it facilitates the interpretation and translation of expert knowledge into actionable forms. The theoretical case for this approach is that science needs to be situated within a larger social context, so that science and policy can be considered together, and not separately.

Box 5: Common Principles of Effective Decision Support

1) Begins with user's needs, not scientific research priorities 2) Emphasizes processes over products 3) Incorporates systems that link users and producers of information 4) Builds connections across disciplines and organizations 5) Seeks institutional stability, either through stable institutions and/or networks 6) Incorporates learning

Source: AR5, WG2, Chapter 2, page 7

In Nepal, the 19 participant NGOs of the Climate Change Network Nepal represent potential boundary organisations. Currently, however, those engaged in the network seem to focus more on the implementation and stakeholder engagement level. But such networks, nevertheless, provide an interface for different users and producers of information and, therefore, can play a critical role in institutionalising learning across scales. Here, a case could be made for greater engagement with organisations from higher governance levels. Therefore, an assessment of the various governmental and non-governmental organisations involved in climate governance is needed.

Whether boundary organisations can help government agencies and research institutions to engage more actively with one another, however, also depends on the latters' ability to interact with boundary organisations. The links between institutes such as the Integrated Centre for International Mountain Development (ICIMOD), the National Academy of Science and Technology (NAST), the Ministry of Environment, Science and Technology, and other branch ministries, and governmental and non-governmental organizations needs to be more evident. Furthermore, AR5 emphasises the need for collaboration across governance levels (at the local, regional, and national scale) and different portfolios (across government agencies). In this regard, organisational learning supported by boundary organisations takes on a critical function.

The IPCC's AR5 has identified a lack of attention paid to adaptation implementation and, accordingly, listed the following key lessons for adaptation planning and implementation:

- Adaptation and implementation processes need to recognise and integrate various sources and types of knowledge and expertise;
- Monitoring and evaluation need to be integrated across adaptation planning and implementation;
- Coordination needs to occur across scales and government agencies;
- Stakeholders need to be involved from the very initial stage of assessing vulnerability to the operational and implementation stages of adaptation.

In this context, the IPCC highlights the role of local governments and private stakeholders. Regarding mitigation, the lessons are similar. While there are efficiency gains associated with economy-wide instruments, sub-national action can help pave the way for action at the national level, and have an important impetus for learning.

3.3. Decision-making at the International Level

As discussed earlier, Nepal needs to champion an immediate reduction in global emissions. The primary implication of this situation is that Nepal should advocate an ambitious, robust post-2020 agreement. At the same time, however, it needs to push for an agreement that scales-up action in the pre-2020 period. And, given the inevitability of climate impacts even under stringent climate policy scenarios, Nepal also needs to start preparing for the era of committed climate change.

Black carbon is of extremely high interest for Nepal, considering its radiative forcing, effect on glacial melt and snow-pack changes and the co-benefits that its mitigation would generate, As the sources of soot are primarily located inside Nepal or in neighbouring countries, joint action through regional forums and bilateral agreements seems appropriate. The contemporaneous approaching of black carbon through the UNFCCC may provide the necessary anchor for action at the regional level, for instance through a work programme targeting stationary sources of black carbon such as brick kilns and cook-stoves, or by harmonising standards for emissions, particularly from heavy-duty vehicles. Given the strong co-benefits associated with black carbon mitigation, non-UNFCCC venues will also provide opportunities for action. For example, the health benefits associated with reduced exposure to biomass burning can be an opportunity for health actors operating locally to internationally to get involved.

Given the climate impacts projected for Nepal and the scale of emissions reductions needed to keep warming below 2°C globally, one gets a fair sense of the task at hand at the climate change negotiations. However, one also needs to raise the question how Nepal will deal with a lack of agreement to its favour in Paris, in order to be prepared to handle suboptimal scenarios. To be prepared for such a scenario and, thus, to improve Nepal's negotiation position, two things need to be assessed: First, what non-climate issues could Nepal link to climate change to pursue in non-UNFCCC forums? And, second, from the strengthening of which UNFCCC core aspects would Nepal benefit? Such an approach would also take into consideration the IPCC's argument that trade-offs are likely to exist between environmental effectiveness, distributional effects, institutional feasibility, and economic performance, that is between different assessment criteria for domestic and international policies.

Box 6 points to some critical gaps that the author identified in the scientific literature that are pertinent to Nepal. A far more careful analysis of research gaps could help Nepal shape the content of future assessments and identify a division of labour between global scientific assessments and original research on the ground.

Box 6: Key Research Needs Relating to Nepal

Mitigation: Project the drivers of emission growth with options and costs for abatement; develop key storylines for emissions scenarios with a focus on mitigation-adaptation synergies in the land use sector, identify black carbon reduction options and associated co-benefits

Energy: Study portfolios of energy sources in response to a range of stressors and projections of resource availability against emissions scenarios; assessing the trade-offs between energy generation design, food production, flood protection and ecosystem health maintenance

Governance: Assess national and local level interactions in the context of multi-level governance for adaptation; identify governance gaps by studying the current role of stakeholders, their functions, and effectiveness; examine resilience of the social system and its determinants

Agriculture: Assess Nepal's exposure to shocks in the food system as a whole and their effect on food security; study changes in yield for grains beyond rice and wheat

Regarding sustainable development, AR5 goes further than any of the previous assessment reports as an entire chapter in the WG2 report provides a framework to consider mitigation and adaptation in the context of sustainable development. However, sustainable development as a framing concept has not penetrated deeply into the other chapters.

One important avenue that Nepal, as a Least Developed Country, could pursue would be to think more concretely about how the two working groups could integrate the climate resilient trajectories focus of WG2 across the sectoral chapters through special reports and assessment reports. For example, one mean of achieving synergies between the WGs on Adaptation and Mitigation could be to produce a series of special reports on regions. Furthermore, the Adaptation Working Group that produces its report with chapters dedicated to geographic regions could be urged to include a chapter on South Asia that integrates insights from mitigation.

Similarly, the government, together with national research institutions could align with Nepali IPCC authors and engage them after the assessment reports are completed to transfer the knowledge and soft skills that these authors acquired in the process and further enhance their capacity. Finally, the government's participation from the very outset, that is, from the scoping meetings, will be essential to shaping the content and its relevance for Nepal.

Conclusion

From Nepal's perspective, the current level of international cooperation, as reflected in the Cancun Pledges, is not sufficient, as a global average increase in temperature by 2°C, is projected to lead to higher levels of warming in Nepal, as well as to adverse impacts that arise across Nepal ahead of many other regions in the world, even at global levels well below 2°C, such as 1.5°C. As a result, Nepal needs to advocate ambitious mitigation action, while also having to prepare to adapt. Given the unique, mountainous ecosystems and the risk of singular events, the reasons for concern updated by AR5 collectively underline Nepal's vulnerability.

The energy, water and food sectors are intricately linked and jointly affected by climate impacts. For Nepal, that is heavily dependent on hydropower for energy and rain-fed agriculture for food, climate impacts on these sectors are pertinent. There are substantial co-benefits associated with pursuing clean energy, which help to provide an additional layer of incentives to reduce the use of fossil fuels. Similarly, climate action focusing on the abatement of short-lived climate forcers may mitigate glacial melting and produce benefits for human health and agriculture.

Considering the risks and uncertainties associated with climate impacts, climate change is posing new challenges for decision-makers. Decision-making processes can be improved by increasing flexibility and learning opportunities across the various governance levels with a specific focus on stakeholder needs. As adaptation is heavily context-specific, policy makers need to be informed about its opportunities, constraints, and limits. Given Nepal's high level of vulnerability, transformational adaptation may be needed. Strong governance is vital to ensure the externalities stemming from such types of adaptation are taken into account.

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