

**CLIMATE CHANGE ADAPTATION AND DEVELOPMENT:
FROM THEORY AND CONCEPTS TO PRACTICES AND
PROCESSES IN PERU'S TROPICAL HIGHLANDS**

by

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ABSTRACT

In Peru's tropical highlands adaptation to climate change is underway as policy-makers and local inhabitants respond to warming trends and rapid glacier melt. This paper explores the social and economic aspects of climate change adaptation in the developing world. Key concepts common to climate change discourse are examined, along with the relationship that adaptation has with development agendas. By applying theories and concepts found in climate change literature to actual adaptation policy occurring in Peru, I uncover some of the factors influencing successful adaptation. The impacts and specific adaptation measures, ranging from the technical to the behavioural, are analyzed in the context of Peru. It is found that enhancing inherent adaptive capacity through traditional human development practices is increasingly promoted as a strategic approach to adapting to climate change.

Keywords: adaptation; climate change; development; environmental policy; glacier melt; Peru; sustainable development

Subject Terms:

**Agriculture -- Environmental aspects;
Climatic changes -- Environmental aspects;
Climatic changes -- Government policy;
Climatic changes -- International cooperation;
Global environmental change;
Economics -- Sociological aspects**

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INTRODUCTION

The broad scientific consensus is that climate change is anthropogenic, or in other words, largely the result of emissions of carbon dioxide and other greenhouse gases from human activities including industrialization, fossil fuel combustion, and deforestation. Some of the strongest evidence has been delivered by Intergovernmental Panel on Climate Change (IPCC) reports which highlight the 'hockey stick' palaeo-temperature graph showing a sharp rise in temperatures at the end of the last millennium (Weart 2003, 184). Arguments surrounding climate change have shifted into policy circles and social science researchers are weighing in on what the International Human Dimensions Programme on Global Environmental Change (IHDP) terms the "human dimensions" of climate change (Vogel 2006, 235).¹ Research on the human dimensions of climate change is described as working on the interface between science and practice, investigating the human causes, consequences and responses to global environmental change from a political, economic, social and cultural perspective (Vogel 2006, 235).

Within this human dimensions framework, adaptation to climate change is increasingly being explored. Scientists, policy-makers and academics alike

¹ The International Human Dimensions Programme on Global Environmental Change is an international, interdisciplinary, non-governmental science programme dedicated to promoting, catalyzing, and coordinating research on the human dimensions of global environmental change.

believe that some degree of climate change is either underway, or coming in the near future, and the need to adapt to these changes is unavoidable. The most recent IPCC assessments stress that past emissions are estimated to involve some unavoidable warming and even the most stringent mitigation efforts cannot avoid further impacts of climate change, making adaptation essential” (IPCC, 2007: Summary for Policymakers, 20). Coinciding with the interest in adaptation, is an awareness that the developing world is disproportionately vulnerable to climate change impacts, as it is relatively ill-equipped in terms of human, financial and technical resources. Many developing countries are already experiencing, or anticipating, the impacts of climate change and there is concern that climate change will exacerbate existing inequities. Because climate change adaptation is now being implemented, or at the very least anticipated, in much of the developing world, researchers and policy analysts also see a need to assess adaptation strategies and analyze the conflicts and synergies that arise with development practice. There is progressively more recognition that climate change will impact development efforts and it is believed that climate change is as much of a development problem as it is an environmental one (Dessai, Lu and Risbey 2005, 89).

Structure of Paper

This paper explores the interactions between climate change adaptation and international development not only through a review on emergent literature, but also by applying theories and concepts to actual practices and processes occurring in Peru’s tropical Highlands. Through this paper, I expose some of the

limits and challenges to climate change adaptation and examine the policies and factors which can influence successful adaptation.

While researchers and policy-makers express divergent views surrounding adaptation, most strongly agree that effective adaptation measures are highly dependent on specific, geographical and climate risk factors as well as institutional, political and financial constraints (IPCC, 2007: Summary for Policymakers, 19). Keeping this in mind, I have chosen to focus on a specific climate change issue, namely tropical glacier melt, within a specific developing country, that being Peru. Peru is particularly vulnerable in terms of changes in precipitation patterns, and the disappearance of glaciers are projected to significantly affect critical water resources. According to researchers at the United Nations Development Programme, Peru is ranked third globally in terms of risk to climate-related disasters (Trigoso Rubio 2007, 1).

Utilizing a human dimensions lens, this paper is structured to provide a review of climate change adaptation and its relationship to development, followed by an analysis of adaptation approaches that have been enacted in Peru. Section one is a conceptual analysis, reflecting on concepts that are relevant within discourse on adapting to climate change. Section two provides an overview of the interaction between climate change and development. Section three integrates current theory and concepts into an analysis of Peru's efforts to adapt to climate change in its tropical highlands region. Section four concludes with a summary of challenges to adaptation and recommendations.

SECTION ONE: REFLECTIONS ON KEY CONCEPTS

An excursion into commonly used concepts in climate change literature not only provides a foundation for later analysis, but also provides an opportunity to link concepts together within the human dimensions context. Many of these concepts do not have a universally accepted definition and have recently been “borrowed” from other disciplines. The ambiguity in terminology not only underscores the remaining uncertainty that surrounds climate change, but also reflects the novelty of climate change adaptation analysis.

Climate Change

In brief, human-induced climate change is caused by the emission of greenhouse gases (carbon dioxide, methane and nitrous oxide) which trap long-wave radiation in the upper atmosphere and raise atmospheric temperatures (Eriksen et al. 2007, 10). The Intergovernmental Panel on Climate Change (IPCC) defines climate change as “any change in climate over time, whether due to natural variability or as a result of human activity” (IPCC, 2007: Summary for Policymakers, 21). Interestingly, the IPCC definition differs from that used by the United Nation’s framework Convention on Climate Change (UNFCCC), which refers to climate change as “a change in climate attributed directly to human activity that alters the composition of the global atmosphere, and that is in addition to natural climate variability observed over comparable time periods” (IPCC, 2007: Summary for Policymakers, 21). For the purposes of this paper, I

choose to utilize the IPCC definition and will enumerate on my reasoning in subsequent sections.

Although climate change was “discovered” by researchers decades ago, it is recent studies, in particular IPCC reports, that have confirmed warming on a global scale with a high degree of consensus and confidence. IPCC reports have not only “allowed a broader and more confident assessment of the relationship between observed warming and impacts”, but also “observational evidence from all continents and most oceans shows that many natural systems are being affected by regional changes, particularly temperature increases” (IPCC, 2007: Summary for Policymakers, 8). This recent evidence has been instrumental in shifting the focus of the international community towards adaptation.

Adaptation

Origins and Definitions

Although the UNFCCC and IPCC have historically promoted a climate policy on paper that includes both mitigation and adaptation, throughout the 1980s and 1990s international dialogue and treaties focused disproportionately on mitigation. This is attributed to several factors, including the belief that an explicit focus on adaptation might weaken the willingness to mitigate climate change, or confidence that market forces would drive adaptation in the absence of government intervention, or perhaps even a lack of understanding on what exactly constitutes adaptation (Eriksen et al. 2007, 11). The UNFCCC 2001

Marrakech Accords are seen as the turning point where a focused and well-funded policy framework on adaptation developed. Financing (through the Least Developed Countries Fund and Special Climate Change Fund) for adaptation projects was expanded under the United Nation's Global Environment Facility (GEF) programme (Yohe et al. 2007, 818). Throughout the last few years, adaptation has gained considerably more attention in policy circles, in particular at an international level. In December 2007, at the United Nation's Thirteenth Conference on Climate Change (also known as the post-2012 framework on the Kyoto Protocol), a revised Adaptation Fund was established intended to streamline the funding of projects in the developing world (Massai and Kondas 2007).

While adaptation to climate change has only recently taken centre stage, the term and act of adaptation are far from novel. Adaptation as a concept has its origins in a multitude of disciplines, most notably anthropology, political ecology, evolutionary biology and psychology. Human beings have a long record of adapting to changes in the environment, often without government intervention. Irrigation, crop diversification, and insurance are just a few examples. On the other hand, the efforts to develop a global strategy to adapt to climate change are taking humans into new territory.

The IPCC short version of adaptation is an "adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities" (Klein et al. 2007, 750). Adaptation includes not only anticipatory, but also reactive acts, as well as

informal and formal measures (Adger et al. 2007, 720). Some measures are simply an adjustment (e.g. utilizing drought resistant crops), while other adaptations are more significant and life altering (e.g. switching livelihoods or locations).

A broadened definition within the human dimensions framework refers to adaptation as “a process, action or outcome in a system (household, community, group, sector, region, country) in order for the system to better cope with, manage or adjust to some changing condition, stress, hazard, risk or opportunity” (Smit and Wandel 2006, 282). In this context, adaptation is linked to the concepts of vulnerability, resilience and adaptive capacity. In theory, successful adaptation, whether planned or spontaneous, can reduce vulnerabilities to climate change impacts and strengthen resilience by tapping into a system’s intrinsic adaptive capacity.

Economics of Adaptation

The Stern Review estimates that adaptation costs in non-OECD countries are likely to accrue in the tens of billions of dollars (Stern 2006, xxi); while a recent UNFCCC estimate concluded that \$28-67 billion a year of additional investments and financial flows will be needed for developing country adaptation efforts to address impacts (McGray et al. 2007, 8). More than 100 estimates of the social cost of carbon exist, with the Stern Review garnering the most attention (Yohe et al. 2007, 14). Although there is considerable variance in estimated costs, especially at a regional level (due to climatic uncertainties and questionable data on response lags, discount rates and non-economic impacts),

there is convergence on the belief that adaptation costs will increase as temperatures increase (IPCC, 2007: Summary for Policymakers, 17).

If adaptation requirements, and thus adaptation costs, increase over time, many analysts assert a desire to enact adaptation policies as soon as possible, especially considering that adaptation, in and of itself, is a lengthy process consisting of technical, legislative and social change (Vergara 2005, 9). This is particularly of concern when considering large infrastructure (also known as capital stock), such as dams, that have economic lifetimes of 30-50 years. The concern is not just about developing more cost-effective projects, but also avoiding business-as-usual investments that could “lock-in” very high emission rates for the next half-century.

Adaptive Capacity

Adaptive capacity is the ability of a system to adjust to climate change, to moderate potential damages, to take advantage of opportunities, or to cope with the consequences (IPCC, 2007: Summary for Policymakers, 21). Adaptive capacity is determined by a locality’s economic wealth, access to technology, infrastructure, information and skills, and institutions (Klein and Smith 2003, 320). Increasingly adaptive capacity is attributed to increased levels of human and social capital (e.g. education and social networks) and good governance (e.g. access to and participation in decision-making processes). The ability of an individual or family to cope can be dependent on the capacity of the community, which is subsequently reflective of the resources of the larger region (Smit and Wandel 2006, 287).

Within political economy theories it is recognized that local initiatives designed to improve adaptive capacity may be reinforced or constrained by broader social, economic and political forces (Smit and Wandel 2006, 289). Political conflict and violence, globalization and regulatory frameworks (both national and international) can undermine or strengthen efforts to cope with or adapt to climate change at local levels. In many respects, building adaptive capacity for climate change is in essence much the same as traditional development. Indeed, livelihood diversification, local capacity building and the role of assets are all studied within development and increasingly amongst climate change researchers.

Resilience

Origins and Definitions

Much like adaptation, resilience is a term common to biological and ecological sciences, in particular in reference to ecosystems, and by definition means “the capacity to absorb disturbance and re-organize while undergoing change so as to still retain essentially the same function, structure, identity and feedbacks” (Folke 2006, 259). The term resilience is also utilized by those coming from a social sciences background. A resilient community is able to withstand external shocks (e.g. climate, economic, or political stresses) to social infrastructure and successfully adapt to new conditions and even capitalize on change to develop and innovate (Folke 2006, 259). Whereas a system (community or region) that is losing resistance may not have the ability to adapt, and small disturbances are not absorbed. In contrast to resilient communities

and regions, are vulnerable systems that cannot absorb external stresses and even small disturbances may have dramatic negative impacts.

Vulnerability

Origins and Definitions

The concept of vulnerability has its roots in the study of natural hazards and poverty. Vulnerability is essentially the ability to be harmed and applies to both people and systems that are exposed to an array of harms (McGray et al. 2007, 7). Vulnerability is determined to a fair extent by a multitude of economic and political factors. Using a political economy perspective, high levels of vulnerability in the developing world are attributed to a high reliance on natural resources, a limited ability to adapt financially and institutionally, low per capita GDP, high poverty and lack of safety nets (Thomas and Twyman 2005, 116). A human dimensions lens conceives of vulnerability as the “social and ecological contextual conditions that result in the inability to cope or secure well-being in the face of climate variability and change” (Eriksen et al. 2007, 14). Social conditions, also called determinants, can include lack of access to resources, marginalization, loss of employment opportunities, and loss of human and social capital; all of which contribute to economic development. Ecological conditions can include marked warming, precipitation decreases and increases in extreme climate events.

Links to Poverty and Natural-Resource Dependency

Geographic and climatic factors are also central to assessing vulnerability, especially in countries that depend on natural resources. Many people in the developing world are engaged in livelihoods that are based upon highly climate-sensitive resources (forests, fisheries, water) and climate change makes access to these resources less reliable and possibly more costly. With fewer resources to draw upon during stressful periods, people stand to lose critical income and their way of life.

Yet, an overemphasis on high-levels of natural-resource use being a determinant of vulnerability can undermine efforts to focus on community resilience and ignores the observed resilience and capabilities of people close to the land (Thomas and Twyman 2005, 117). While natural-resource dependency does make developing countries more vulnerable, especially considering the reliance on agriculture in rural areas, many communities are already engaged in adaptation efforts, in response to both climatic and economic impacts. Livelihood diversification is one way in which communities are reduce their vulnerability. Livelihood diversification is not a new strategy in the developing world, and “by the colonial era many natural-resource dependent societies had to cope with changes to livelihood practices as well as changes to asset bases”, and most recently these societies have weathered increasing interventions, from both governmental and NGO institutions (Thomas and Twyman 2005, 118).

Mitigation

The IPCC and the UNFCCC have both promoted policy that involves what is described as “a portfolio of diverse adaptation and mitigation activities”, with mitigation being defined as an “anthropogenic intervention to reduce the sources or enhance the sinks of greenhouse gases” (Klein et al. 2007, 750). While the focus of this paper is adaptation, the relationship between mitigation and adaptation is inextricable. Adaptation alone, without mitigation, could lead to a level of climate change that makes adaptation impossible, or entirely too costly, for some natural and human systems (Klein et al. 2007, 747). While interconnected, mitigation and adaptation are also inherently different, often operating within different time spans, scales and governance levels.

Time Spans, Scales and Governance Levels

Because emissions have a residual effect in the atmosphere, the benefits of mitigation efforts enacted today will be experienced by future generations. In contrast, adaptation measures provide more immediate gratification and the time span between expenditures and tangible results on adaptation is shorter than with mitigation (Klein et al. 2007, 750). Another key difference is that mitigation policy has generally been enacted at an international level, giving it a “top-down” nature. With a few exceptions, mitigation efforts have generally been governed by international agreements. The participation of major greenhouse-gas emitters and national governments is critical. In contrast, adaptation experts often work and research at the regional or local level with local stakeholders (Klein et al. 2007, 749). The costs and benefits of adaptation are usually experienced at a

local or national level; whereas mitigation benefits accrue globally. The “spill-over” effects of adaptation activities are generally small, although there are some instances where impacts from adaptation measures, such as biofuel initiatives, can cross national boundaries resulting in changes such as fluctuating commodity prices (Klein et al. 2007, 750).

Synergies and Trade-offs

Mitigation efforts can lead to either positive or adverse impacts on adaptation and vice-versa. A diverse set of outcomes is possible, partly because mitigation policies are developed at an international level and adaptation activities remain localized. The conflicts and synergies between adaptation and mitigation that arise in climate policy are a study in itself, and in keeping with the scope of this paper, I provide only a brief overview.

The development of carbon sinks are a prime example of a synergy between adaptation and mitigation. At an international level carbon sequestration schemes can reduce greenhouse gas emissions, while creating economic benefits at the local level. A forest (or piece of land) that is protected through carbon credits can provide a revenue stream in lieu for the protected forest which also improves conservation efforts and potentially restores resources within the forest (animal, water and plant resources). The local economy benefits through the revenue stream leading to improved adaptive capacity and the community is thus better equipped to cope with climate change. Theoretically speaking, reforestation and afforestation activities can also provide mitigation benefits within carbon sequestration strategies, yet in the wrong

context they can also diminish biodiversity (through planting too much of one dominant species) and reduce water yields which may negatively impact rural farmers in adjacent communities leading to maladaptation (Klein et al. 2007, 758). The trade-offs in energy policy are particularly illuminated in looking at hydropower. Reducing the availability of hydroelectric generated energy could stifle economic development, reducing adaptive capacity. And while hydropower creates close to zero greenhouse gas emissions, building more dams requires energy inputs and can potentially negatively impact stream flows which diminishes both human and natural resilience, especially in areas prone to water conflicts (Klein et al. 2007, 760).

The Adaptation, Mitigation, Development Nexus

The links between climate policy and development have typically been defined primarily in terms of mitigation. Most arguments centre around the trade-off between development and mitigation strategies. For example, an overly aggressive emissions reduction strategy could hamper economic development. Generally, this argument is relevant to developing country emissions, but it can also play out in more subtle ways. A move by Economic Co-operation and Development (OECD) countries to reduce greenhouse gas emissions and move towards alternative energies may benefit some industries (e.g. solar and wind energy) and any small economic losses may be absorbed. Yet these economic losses could potentially be amplified in the developing world, especially in a globalised world where many poorer exporting countries are positioned to operate within existing development paths (Klein et al. 2007, 755). Increasingly

climate policy research is framed as a nexus between adaptation, mitigation and development. Adaptation to climate change implies doing something differently, or augmenting current development. Subsequent projects require additional inputs (e.g. infrastructure, investments, irrigation pumps) and additional energy use, thus undermining mitigation efforts if the energy originates from greenhouse-gas-emitting sources and diminishes already stressed resource bases. Research on the adaptation, mitigation, development nexus has led to a push to “mainstream” climate change adaptation, as well as underscore the need to further cultivate sustainable development pathways, both of which will be discussed in the following section.

SECTION TWO: CLIMATE CHANGE ADAPTATION MEETS DEVELOPMENT

While adaptation was initially constructed as a pollution problem, it is increasingly viewed as a development issue. The factors that are prevalent in economic development discourse and increasingly in climate change adaptation literature are discussed. In many respects, adaptation and development are co-evolving practices.

Early Approaches to Adaptation

Early adaptation policy is characterized as essentially being responsive in nature. An example is the response after an extreme weather event (e.g. floods, hurricanes, extended drought), and includes large infrastructure projects or changes in insurance structures. In the 1990s more anticipatory approaches emerged under the Intergovernmental Panel on Climate Change (IPCC) and United Nations frameworks with a greater emphasis on climate scenarios and risk assessment. Reducing glacial lake outburst floods through draining practices is an example of anticipatory practice.

Until recently climate change policy has couched adaptation in dialogue that presents climate change as a pollution problem linked to mitigation efforts at the global level, most specifically through the Kyoto Protocol and United Nations Framework Convention on Climate Change (UNFCCC). A top-down, approach has dominated adaptation practice with a strong emphasis on climate model

scenarios and technology. “Climate-proofing” practices developed hand-in-hand with climate scenarios and include technological approaches such as drought resistant crops (McGray et al. 2007, 21). The climate model scenario studies provide critical knowledge on impacts on a global scale; however models are greatly undermined by uncertainty, both in terms of climate and socioeconomic factors, in particular at the regional levels where adaptation practices are based (van Aalst 2008, 166).

Sustainable Development and Mainstreaming

More recent adaptation strategies essentially view adaptation as an extension of development practice with sustainable development² and mainstreaming taking centre stage in adaptation policy. Theoretical analysis linking human development to climate change impacts has led to a concurrent linking of development and adaptation agendas. An overlap between adaptation and development practices is seen in the emphasis on access to resources, entitlements (property rights), capital (human, manufactured, social, natural and manufactured), institutions to facilitate exchange and governance, and technology (Yohe et al. 2007, 816). Sustainable development is deemed as a way reduce vulnerability to climate change by meeting development goals and strengthening ecosystem resilience. Climate change is also considered a stressor that limits development efforts and there is concern that climate change

² In accordance with the Bruntland Commission, sustainable development is defined by the IPCC as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” and emphasises the economic, ecological and social dimensions that are the pillars of sustainable development (Yohe et al. 2007, 814).

will prevent countries from meeting development goals, in particular, the Millennium Development Goals (MDG) (Liverman 2008, 5).

Millennium Development Goals

Many development experts view the Millennium Development Goals as a benchmark, or measure of progress, towards sustainable development. The MDGs are a framework by which nations can assess tangible progress including specific targets for progress by 2015 or 2020 (Yohe et al. 2007, 826). Because of the perceived two-way causality between development and climate change adaptation, it seems logical to conclude that climate change could adversely affect, if not impede, the world's progress towards meeting the MDGs.

Yet, authors in the most recent IPCC report are careful to distinguish between meeting short-term and long-term targets (Yohe et al. 2007, 826). In fact, the IPCC authors believe the short-term targets (2015 and 2020) will be difficult to reach, regardless of climate change, and it will be difficult to ascertain that climate change is to blame (Yohe et al. 2007, 826). Arguments within IPCC literature focus on how climate change adaptation and mitigation might hinder meeting long-term targets (e.g. along the 2050 timeline). Considering the recent emphasis on development and climate change, it is interesting to note that there is no mention within the MDGs of potential changes to development related to climate-related disasters (Yohe et al. 2007, 819).

Framing the debate on climate change adaptation as a development issue has also led to the theory of mainstreaming. Mainstreaming, much like the

sustainable development approach, is based on integrating climate adaptation practices into current development and according to its proponents offers the opportunity to capitalize on the synergies, and minimise the conflicts, between development and climate change policies (Agrawala 2005, 32). The idea is that development agencies will consider climate change adaptation in day-to-day operations and adaptation is integrated by including adaptation measures in land-use policy and infrastructure projects (IPCC, 2007: Summary for Policymakers, 19). Mainstreaming stresses a no-regrets policy, which essentially promotes the belief that climate change simply reinforces the need to implement measures that should be environmental or development priorities in the first place (Agrawala 2005, 20). Mainstreaming is not only a strategy to increase funding for adaptation efforts, but also offers the potential of expanding the range of decision-makers into adaptation policy. While most agree with mainstreaming in theory, there is also concern that adaptation efforts could divert funds from general development assistance and undermine more urgent efforts to provide sanitation, education, food and water (Klein et al. 2007, 768). Unfortunately, it has also been found that efforts to mainstream national adaptation policies into development agendas can fail, as demonstrated by the lack of coordination between Poverty-Reduction Strategy Papers (PRSPs) and adaptation policy (McGray et al. 2007, 34).

Vulnerability-Reduction

Emerging adaptation theory and policy promotes a vulnerability or poverty-reduction approach, along the same lines as human development practice.

Poverty-reduction policy takes very little account, in any, of future climate and socioeconomic scenarios and focuses on current conditions, with an emphasis on improving adaptive capacity and resilience to both climate and socioeconomic impacts. The United Nations Development Programme (UNDP) has created a policy framework called the Adaptation Policy Framework (APF) which focuses on improving the determinants of adaptive capacity (Dessai, Lu and Risbey 2005, 89). In short, the UNDP policy is to develop a plan to adapt for current conditions in local communities which can be built upon in the future. This approach has grown out of an effort to develop bottom-up, or community level, approaches to climate change adaptation that engage local stakeholders in the process.

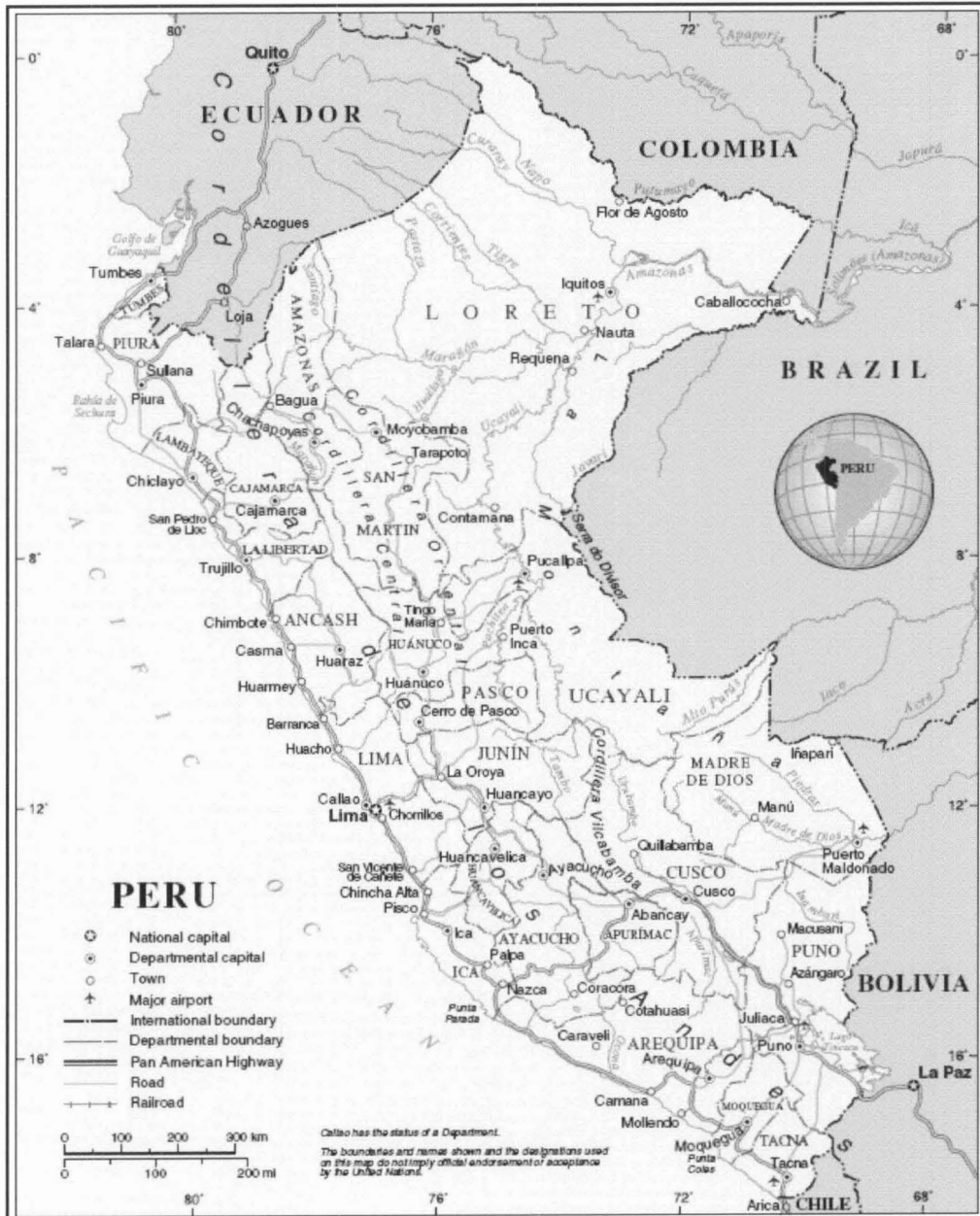
The appeal of a vulnerability-reduction approach is that it not only addresses present-day poverty, but also frames climate change as a development problem. Currently some researchers believe that one of the greatest barriers to effective climate change adaptation, is that climate change is viewed as strictly an environmental problem, discounting that one of the most effective strategies to reduce vulnerability is economic growth. Much vulnerability-reduction literature also acknowledges that good governance and institutions are necessary to complement economic, technological and infrastructure improvements.

SECTION THREE: CLIMATE CHANGE ADAPTATION IN PERU'S TROPICAL HIGHLANDS

In this section, I connect case studies, grey literature, and relevant research on Peru to the theories and concepts on climate change adaptation and development discussed above. Briefly, I begin by placing Peru in the context of the developing world and outline climate change factors specific to the Latin American region. Latin America is considered extremely vulnerable to climate change impacts and many of its regions are already experiencing perceived changes in precipitation and temperatures along with extreme weather events that are detrimental to development. The impact of climate change in Latin America's productive sectors is estimated to be a 1.3% reduction in the region's GDP for an increase of 2 degrees Celsius in global temperature (Magrin et al. 2007, 585). Impacts that are underway, or expected, include sea level increases, increased intensity of weather disturbances, catastrophic melting of tropical glaciers and snow caps, and warming of high altitude ecosystems in the Andes (Vergara 2005, 1). Latin American economies are heavily dependent on natural resource based industries which are expected to be affected significantly by climate change (Eakin and Lemos 2006, 9). Yet Latin America as a region is not a major contributor of greenhouse gas emissions (GHG) and currently only accounts for about 6% of global emissions of GHG (Vergara et al., World Bank Sustainable Development Working Paper no.30, 2007, 8).

While weather patterns, resource dependence, and geography are significant determinants of vulnerability, other main drivers specific to Latin America include demographic pressures (e.g. continued population increases), urbanisation, poverty and rural migration, low investment in infrastructure and services, and problems with inter-sectoral co-ordination (Magrin et al. 2007, 585). Much of this vulnerability is exacerbated by land-poor populations settling in precarious settlements (e.g. unstable and flood-prone lands). These settlement practices are prevalent in Peru's tropical highlands and are exacerbated by agro-pastoral livelihoods that are carried out in environments (e.g. tropical alpine grasslands, shrub and wetland areas) that are sub-optimal for crop and livestock production (Young and Lipton 2006, 76).

Figure 1: Map of Peru. Note: from United Nations by Department of Peacekeeping Operations Cartographic Section, 2004. Reprinted with permission.



Map No. 3898 Rev. 3 UNITED NATIONS
May 2004

Department of Peacekeeping Operations
Cartographic Section

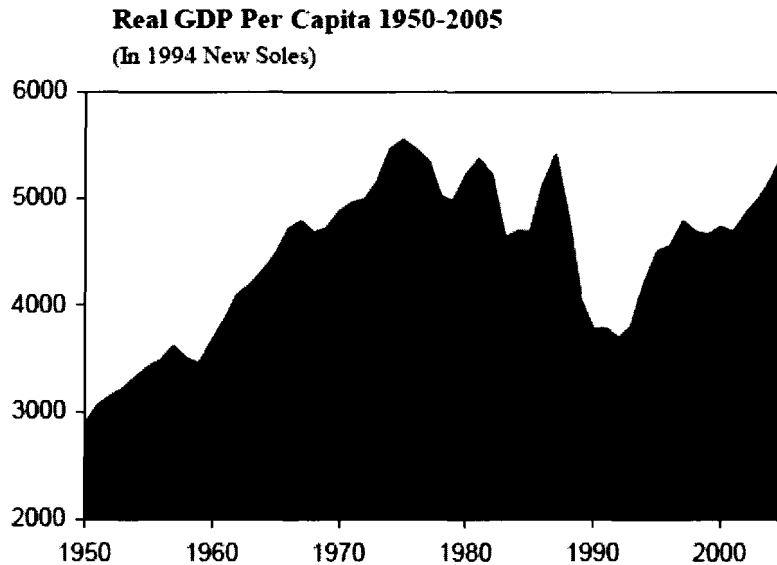
Vulnerability Assessment

Peru

Although Peru presents many of the characteristics of a country vulnerable to climate change, it is also exhibiting strong macroeconomic growth. In recent years Peru has become one of Latin America's fastest-growing economies, as a result of an evolving manufacturing and export sector, and record prices for mineral exports. Peru is benefiting from the current commodity boom which has led to high international prices for its metal exports. Trade, coupled with private investment, and domestic consumption have grown Peru's economy at a pace which is quite remarkable, particularly in Latin America.

Gross domestic product (GDP) was greater than 5% for the last five consecutive years, and in the year to February 2008, GDP grew by 9.2% (Economist 2008, Poverty Amid Progress, 46). Peru's economy is forecast to grow by an average of 6.1% in 2008-12, slightly below the average of 6.5% for 2003-07, but stronger than its long-term average of 4.6% (Economist website, Economic data, 2008). Figure 2 provides a graphical presentation of GDP growth per capita since 1950 and illustrates the remarkable growth that Peru has sustained in the last decade, returning to levels not experienced since the 1970s.

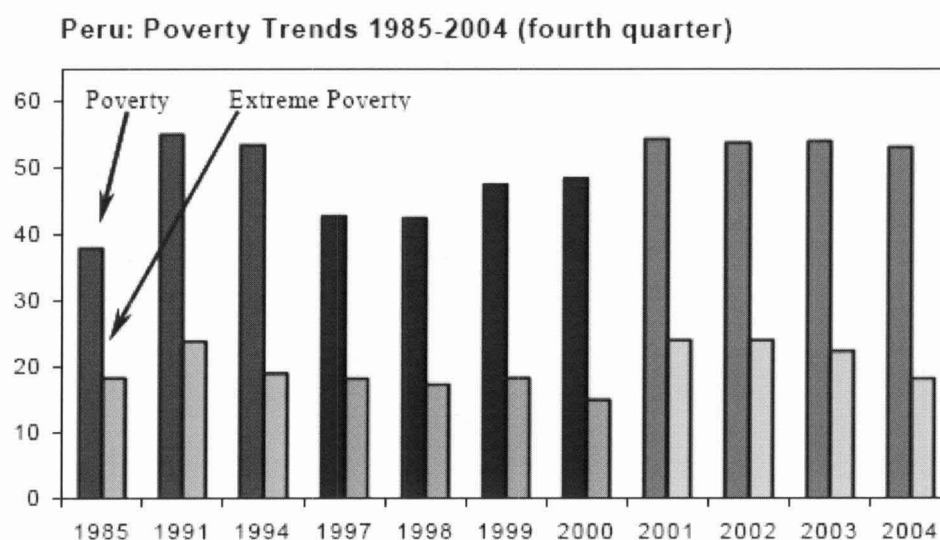
Figure 2: Historical real GDP per capita. *Note: from International Monetary Fund by Eva Jenkner, 2006. Real GDP Per Capita 1950-2005, Economic Growth and Latin America: What Have We Learned? IMF Western Hemisphere Department Workshop Publications, <http://www.imf.org/external/np/seminars/eng/2006/growth/> (Accessed 29 July 2008). Reprinted with permission.*



Despite recent economic growth, much of Peru's population is considered highly vulnerable to climate change due in large part to socioeconomic factors. As indicated above, much of Peru's recent positive economic growth is greatly attributed to natural resource extraction industries, which are highly capital-intensive, and generate relatively few jobs compared to other sectors such as manufacturing. A dependence on the export of primary products also exposes Peru's economy to shocks from volatile commodity prices and weather conditions (Economist Intelligence Unit 2008, 23). Peru's other employment sectors (e.g. rural agricultural and urban informal) are characterized by low productivity and low wage growth (World Bank 2008).

While the Pacific coastal strip, including the capital city, Lima, is benefiting from globalization and experiencing an economic transformation, the southern Andean region is where poverty still effects 70% of the population, a majority of which is indigenous. Because of geographic and social isolation which restricts communication and transport, indigenous groups in the Andes are essentially cut off from the benefits of globalization and the growing market economy, relying on informal jobs and subsistence farming for income generation (Economist 2008, Poverty Amongst Promise, 46). In 2006, 44.5% of Peru's population was considered at or below the poverty level (World Bank 2008). As illustrated in figure 3, poverty remains high.

Figure 3: Poverty trends in Peru. Note: from International Monetary Fund by Eva Jenkner, 2006. Peru: Poverty Trends 1985-2004 (fourth quarter), *Economic Growth and Latin America: What Have We Learned? IMF Western Hemisphere Department Workshop Publications*, <http://www.imf.org/external/np/seminars/eng/2006/growth/> (Accessed 29 July 2008). Reprinted with permission.

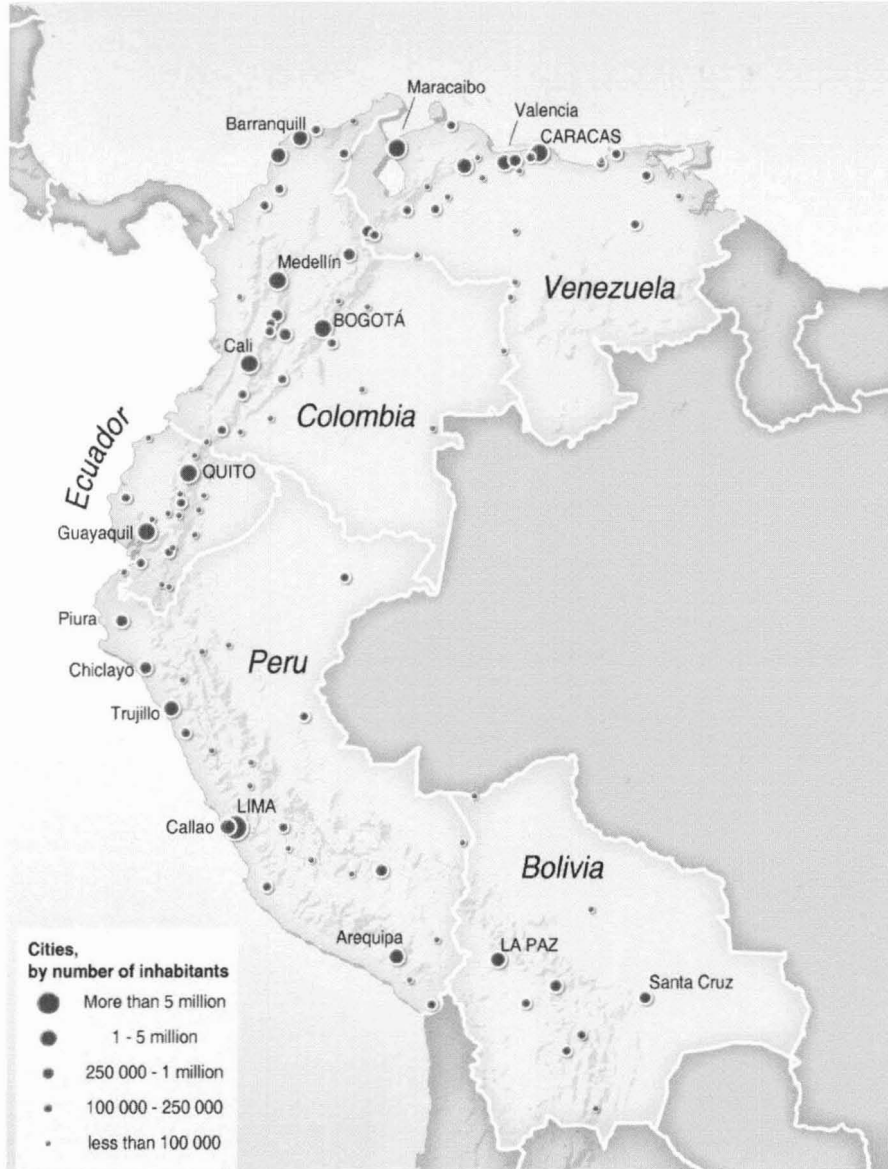


Tropical Highlands

Throughout the last few centuries, Peru's Andean region, also known as the tropical highlands, has been considered a poor region marked by isolation, lack of infrastructure, malnutrition and subsistence farming. While agrarian and other livelihood activities have always been constrained by high altitude factors and climate variations, the last few decades have seen dramatic changes in the region with respect to temperature, precipitation and glacier melt. Like many of the world's mountainous regions, the high elevations in the tropical Andes are where climate change is very much underway. There is now observable evidence that both the world's polar and mountain regions are experiencing the greatest impacts on livelihoods and ecosystems with reduced ice and snow covering and Intergovernmental Panel on Climate Change (IPCC) reports have indicated that "there is high confidence³ that natural systems are affected (IPCC, 2007: Summary for Policymakers, 8). In Peru climate change is not an abstract concept, nor a distant concern only for future generations, but a reality that local populations are increasingly facing (see figure 4).

³ The authors of the Working Group II Fourth Assessment report utilize a set of terms to describe and communicate uncertainties in current knowledge. By assigning a "confidence level" to major statements on the basis of their assessment of current knowledge the authors can provide a "description of confidence" to the reader. The following terminology is used with correlating degrees of confidence: "Very High Confidence" equates to at least 9 out of 10 chance of being correct, "High Confidence" equates to at least 8 out of 10 chance of being correct, "Medium Confidence" equates to at least 5 out of 10 chance of being correct, "Low Confidence" equates to at least 2 out of 10 chance of being correct, and "Very Low Confidence" equates to less than 1 out of 10 chance of being correct. (IPCC, 2007: Summary for Policymakers, 21).

Figure 4: Population in mountain ranges of the Andes. Note: from ESRI data & maps 2002 by Hugo Ahlenius, UNEP/GRID-Arendal, 2002. Major cities in the Andean community, UNEP/GRID-Arendal Maps and Graphics Library, http://maps.grida.no/go/graphic/major_cities_in_the_andean_community (Accessed 29 July 2008). Reprinted with permission.



Mountains that extend into the troposphere⁴ tend to warm faster than adjacent lowlands, and thus high-elevation areas in the tropics, such as Peru's tropical highlands, are undergoing dramatic changes in climate and are predicted to do so into the near future (Vergara 2005, 2). Scientific observations have concluded that "there is very high confidence, based on more evidence from a wider range of species, that recent warming is strongly affecting terrestrial biological systems, including such changes as: poleward and upward shifts in ranges in plant and animal species" (IPCC, 2007: Summary for Policymakers, 8). Since the evidence of warming is consistent throughout the Andes, it is very unlikely that recently documented impacts such as rapid glacier retreat, enlargement of glacial lakes, and rock avalanches are due to micro-climate effects (Vuille et al. 2003, 77).

Tropical glacier melt and increased variability in climate

Tropical glaciers contained within these tropical mountainous regions are considered particularly sensitive to climate changes. They are exposed to considerably higher levels of radiation since they are located in a low tropical latitude, but in higher altitudes, and the periods of maximum precipitation which feed upper zones through snowfall, coincides with the summer period when temperatures are highest (Chevallier et al. 2004, 7). The Andes is the planet's longest (10,000 km) and second highest mountain chain in the world and within Peru's Andes lie 70% of the planet's tropical glaciers (Chevallier et al. 2004, 6).

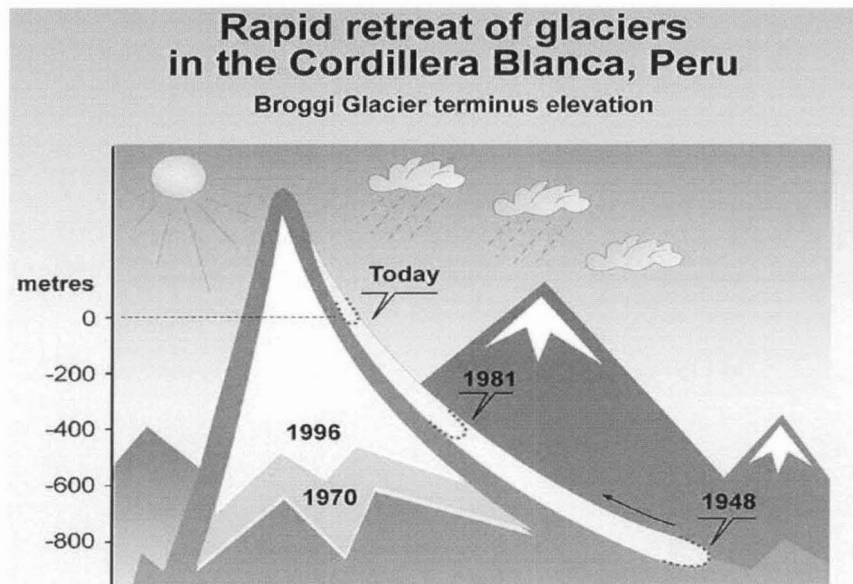
⁴ Troposphere is the atmospheric layer closest to the planet and is where weather occurs; it is the region of rising and falling packets of air.

Most of Peru's glaciers are located in the Cordillera Blanca region of the Andes, making it the most glaciated tropical mountain zone in the world (Carey 2005, 124). Above 5000 meters is where most of the glaciers are located.

During the second half of the 20th century, scientists began to document changes in Peru's tropical glaciers reporting significant retreat and melting. Field observations and historical records indicate a pace of glacier retreat that is consistent with upward shifts in the freezing point isotherm and coincides with an overall warming of the Andean troposphere (Vergara et al., World Bank Sustainable Development Working Paper no.30, 2007, 261). One of the most widely published statistics regarding Peru's glacier melt, states that "since the early 1980s Peruvian glaciers have lost about 22 % of their surface" which is equivalent to 7,000 million cubic meters of water or about ten years of water supply for Lima (Vergara 2005, 35). Changes in precipitation, temperature, cloud cover, and humidity are thought to be the primary cause of glacier retreat and the IPCC has stated with high confidence that over the next decades, Andean tropical glaciers are very likely to disappear (Magrin et al. 2007, 583). There is clear evidence that the last two decades in particular have seen an acceleration in glacial retreat and modelling work has shown that in the next 10-20 years many of the smaller, lower-altitude glaciers will disappear altogether (Vuille et al. 2003, 77). Some of Peru's glaciers are predicted to be at least 19,000 years old and are believed to hold long held cultural significance to the local inhabitants, mainly indigenous bi-lingual Quechua-Spanish speakers. In one case study researchers noted local toponyms that describe the shapes of ice caps. A

mountain that had been referred to as “sleeping lion” was now called “the lion that left” (Young and Lipton 2006, 70).

Figure 5: Detail of glacier melt in Cordillera Blanca located in tropical highlands. *Note:* from United Nations Environmental Program (UNEP) by UNEP/GRID-Europe, 2001. UNEP/GRID-Arendal, Rapid retreat of glaciers in the Cordillera Blanca, Peru, UNEP/GRID-Arendal Maps and Graphics Library, http://maps.grida.no/go/graphic/rapid_retreat_of_glaciers_in_the_cordillera_blanca_peru (Accessed 29 July 2008). Reprinted with permission.



Associated with glacial melting are glacial lake outbursts and avalanches which can destroy entire towns and kill thousands in the montane valleys below. In 2005 it was estimated that Peru had over 12,000 lakes and ponds that could be destabilized from glacier melt (Vergara 2005, 35). While glacial lake outbursts have always been a hazard to populations living in the Andes (see figure 4), the difference under a global warming scenario is that the rapid glacier retreat is

increasing the size and number of proglacial⁵ lakes (Young and Lipton 2006, 65). Glacier retreat also loosens the rocky sides of mountain slopes and can give rise to major rock-slides (Chevallier et al. 2004, 10).

Tropical highlands, including lower elevation moorlands and valleys located below glaciers, are also of particular interest to scientists as climate, vegetation and hydrology all change rapidly with small changes in altitude and distance (Trigoso Rubio 2007, 5). While global warming-induced glacier retreat is well documented, scientists are still working to distinguish between El Niño-Southern Oscillation⁶ (ENSO) events and events specific to global warming when studying changes in the lower elevation areas. Although erratic variations in the hydrologic system and rainfall patterns are occurring, it is not known with high confidence if all current weather patterns in these lower elevations are attributed to global warming alone. If these variations in the hydrologic system are a result of global warming, it could exacerbate an already stressed system.

Hazard and Impact Assessment

Climate change and rapid glacier melt will have serious repercussions on Peru's water supply, agricultural, energy sectors, ecosystems and biodiversity. Recently published scientific reports predict that "changes in precipitation patterns and the disappearance of glaciers are projected to significantly affect water availability for human consumption, agriculture and energy generation" (IPCC, 2007: Summary for Policymakers, 14). Of greatest concern is the impact

⁵ A proglacial lake is a lake formed during the retreat of a melting glacier.

⁶ The El Niño-Southern Oscillation is the dominant mode of climate variability in Latin America and is the natural phenomenon with the largest associated impacts (Magrin et al. 2007, 585).

that the disappearance of glacier melt will have on water supplies throughout Peru. As glaciers drastically reduce in size, or altogether disappear, high elevation basins are likely to experience a significant decrease in water discharge in the next two decades leading to serious implications for water management (Vergara 2005, 2). Peru's neighbour, Ecuador, is also experiencing rapid glacier loss in its Andes range. Ecuador's Cotacachi glacier has disappeared and according to researchers the surrounding area is not adapting well. It is experiencing declines in agriculture and tourism and biodiversity, providing Peruvians with an example of the challenges that lie ahead (Vergara et al., Economic Impacts of Rapid Glacier Retreat in the Andes, 2007, 261).

Water Supplies

Although Peru possesses 70% of the planet's tropical glaciers, it is often referred to as South America's most water-stressed country. This is attributed to the fact that 70% of its population lives in the coastal desert, where only 2% of water resources are found (Trigoso Rubio 2007, 1). Or in other words, 98% of Peru's available water is located east of the Andes, where population density and economic activity is relatively low (Vergara et al., Economic Impacts of Rapid Glacier Retreat in the Andes, 2007, 261). The coastal desert is home to the majority of Peru's population, including Lima, which has a growing population of over eight million and is undergoing rapid economic growth in its manufacturing and export sectors. The coastal desert is also where commercial agricultural centres are located and undergoing economic growth under globalization and free trade (e.g. export of mangoes and artichokes). The coastal population and

its economy is currently reliant on river runoff from the Andes mountains, which is supplied by seasonal melting of glaciers and runoff from glacierized basins (Trigoso Rubio 2007, 1). Below 2000 meters and down to the foot of the Andes, is where hydrological power is most-heavily generated and where water from rivers is used to irrigate commercial agricultural zones located in arid coastal regions (Chevallier et al. 2004, 10). Although it is the more developed regions of Peru (e.g. coastal regions) that most intensively use these water resources, the less energy-intensive economic sectors (e.g. smallholder farms and informal sectors) will also suffer consequences because of reduced river flows.

Melting glaciers are not merely an environmental issue localized in the tropical highlands, but could have repercussions that reverberate through Peru. During the rainy season, the rivers flowing to the Pacific Ocean are fed by rainfall in the mountains, in addition to glacier melt. Come dry season, rivers are maintained by glacier melt coming from mountain tops higher than 5000 meters or from water that is diverted from reservoirs (Chevallier et al. 2004, 6). This runoff is not only critical to assure year round flows for economic activities and household consumption (e.g. potable water), but also affects decisions regarding water budgets and large capital stock projects in the hydrologic sector. Much of Peru's hydrologic infrastructure, including the coastal areas, have been developed based on the current hydrologic cycle (e.g. precipitation levels and seasonal runoffs from the Andes). The predicted changes in runoff levels, coupled with drought conditions (whether from ENSO events or global warming), could potentially raise the cost of water and ultimately impair the ability of cities to

maintain economic growth (Vergara et al., Economic Impacts of Rapid Glacier Retreat in the Andes, 2007, 261).

On a regional and local level, changes in water supplies could induce the migration of plants, animals and human populations. Some animals and plant life are moving up to colder and wetter areas closer to intact glaciers. Human populations may move closer to irrigation channels or cultivate crops at higher elevations and “commute” from lower elevation areas where they reside to higher elevations where their crops and livestock have access to water and more favourable soil conditions. While glacierized basin runoff has consistently been a source of water, the course of natural runoff carries water only to certain areas. Some areas below glaciers receive little or no meltwater at all and depend heavily on seasonal rainfall, small irrigation channels and stored water (Parry et al., Cross-chapter case studies, 2007, 864).

Agriculture

Below the mountain tops (e.g. elevations of less than 5000 meters) in semiarid mountainous areas and valleys, climate change is also being observed in the form of floods, frosts, droughts and considerable changes in temperature precipitation levels and patterns. Peru’s high altitude moorlands⁷, located at elevations between 3900 to 5000 meters, are not only unique ecosystems, containing diverse flora and fauna, but for centuries have also provided land for agrarian activities. Some land serves as grazing lands for livestock (cattle,

⁷ Moorland is a type of habitat found in upland areas, characterised by low growing vegetation on acidic soils.

horses, sheep, alpacas or llamas) and at lower elevations the land is used to grow crops (Young and Lipton 2006, 68). In between 2000 and 4000 meters slope agriculture is practised using a complex systems of small irrigation channels, also known as acequias. Case studies indicate that local campesinos (or peasant farmers) are noting drops in precipitation, differences in water drainage patterns, and changes in hail and sleet occurrences (Young and Lipton 2006, 70).

While rural livelihoods have always been constrained by availability of water, the continued droughts and increased variability in precipitation, coupled with diminished glacier runoffs, could further undermine already precarious land-use systems leading to decreased productivity rates, reductions in yields, loss of livestock, and increases in food insecurity and poverty (Vergara 2005, 35). Destruction of the natural water system could also contribute to a gradual process of desertification. Another limiting factor is the natural topography of the valleys often make creating reservoirs difficult (Chevallier et al. 2004, 11). The issue of water supply is becoming more acute as the population grows, therefore demand for water increases, while simultaneously, sources of water are becoming more and more limited (Magrin et al. 2007, 605). As noted above, the valley and coastal regions have especially low rainfall patterns and are highly dependent on glaciers and snowcap runoff for water supply. Highland campesinos have already expressed concern about increasingly scarce water supplies being utilized to sustain Peru's coastal growth. While campesinos require water for household use and irrigation, there is increasing pressure to

divert highland water supplies for hydroelectric projects, industry use (e.g. mining, tourism), and commercial agricultural use (Young and Lipton 2006, 72). Conflicts over water could exacerbate existing intraregional and country-scale inequities and mistrust between the centralized government in Lima and highland campesinos.

Studies on climate change scenarios indicate that those who live in the Andes region and maintain a livelihood based on agriculture are those who stand to incur the greatest impact from climate change. Indeed, the link between climate change and development is particularly apparent here. A change in climate translates into a change in agro-pastoral productivity. Continued water scarcity, poverty and population growth will make an agricultural based livelihood more and more difficult to maintain. However, it should be noted that some climate change scenarios predict that on a national scale climate change could bring positive aggregate growth in cereal production when considering potential yield increases in other regions of Peru (Trigoso Rubio 2007, 8). A scenario that leads to varying degrees of agricultural production depending on the region and type of agricultural activity (e.g. subsistence versus commercial) underscores the belief that one of the greatest impacts that climate change could have on Peru is exacerbating current inequalities.

Energy Generation

Water in Peru is not only critical for irrigation and consumption, but also for energy generation. At least 75% of Peru's energy is hydroelectrically generated and many rivers that are glacier-fed power hydroelectrical plants (Vergara et al.,

Economic Impacts of Rapid Glacier Retreat in the Andes, 2007, 262). Of particular concern is the Mantaro River, where a hydroelectric plant generates 40% of Peru's electricity and provides energy supply for 70% of the country's industries, the majority of which are concentrated in Lima (Magrin et al. 2007, 598). If adaptation measures are not successfully enacted, a reduction in water flows could lead to serious consequences for Peru's economic development as well as greenhouse gas (GHG) mitigation efforts. Other hydroelectric-dependent countries such as Costa Rica and Brazil have recently experienced power issues and even outages when demand has increased during droughts or if seasonal rains are delayed. According to IPCC reports, "a combination of increased energy demand and drought caused a virtual breakdown in hydroelectricity generation in most of Brazil in 2001, contributing to a reduction in GDP" (Magrin et al. 2007, 586).

To fill the energy gap and reduce reliance on hydropower, many researchers are forecasting that Peru's power sector will inevitably move towards thermal sources of energy (e.g. coal-fired and natural gas plants, nuclear, geothermal, solar thermal electric, waste incineration plants). It is believed that Peru has extensive untapped energy potential in both gas and petroleum and the current administration under Alan Garcia is encouraging oil and gas exploration and foreign investment to develop a worldclass petrochemical industry (Economist 2008, Rumble in the Jungle, 43). This predicted move away from clean sources of energy and towards thermal sources will result in a gradual increase in GHG emissions. Researchers in a study titled *Economic Impacts of*

Rapid Glacier Retreat in the Andes obtained data from Peru's Ministry of Energy and Mines and forecasted economic costs to Peru's power sector based on reduced hydropower capacity and increased thermal-power capacity. They forecast not only higher capital requirements, but also found that the move towards thermal-based alternatives will mean higher operation and maintenance costs and a substantial increase in the carbon footprint of the power sector (Vergara et al., *Economic Impacts of Rapid Glacier Retreat in the Andes*, 2007, 262). It was concluded that annual incremental costs to Peru's power sector are estimated at US\$1.5 billion (should rationing conditions be allowed to occur), or \$212 million if a gradual adaptation scenario is implemented (Vergara et al., *Economic Impacts of Rapid Glacier Retreat in the Andes*, 2007, 262). Advanced planning and the diversification of Peru's power sources, including the gradual displacement of hydropower capacity by alternative energy sources, and additional reservoir capacity were all recommended (Vergara et al., *Economic Impacts of Rapid Glacier Retreat in the Andes*, 2007, 262). Additionally, it was found that rationing costs could be triggered if the rapid reduction in runoff continues and if adaptation measures are not implemented in anticipation of these changes. While Peru is expected to incur costs to improve its infrastructure, especially in times of rapid economic and population growth, the costs to adapt to reduced glacier melt can be perceived as a climate tax imposed by energy-intensive societies on populations that have contributed little to the climate change problem (Vergara et al., *Economic Impacts of Rapid Glacier Retreat in the Andes*, 2007, 262).

Glacier-related disasters

Rapid glacier melt, as indicated above, is often associated with loss of water, in particular with respect to reduced river and stream flows. Yet rapid glacier melt will also lead to flooding and sudden glacial outflows creating high levels of risk for mountain populations and infrastructure. The short-term increases in glacial runoff create excess volume which leads to overflows and the destruction of morainal (mountain sediment carved out by movement) dams. Global warming increases the instability of glacier ice creating serac avalanches that project heavy materials into surrounding lakes and subsequent shock waves which provoke sudden overflow and destruction of banks. The Andes is also a region of considerable seismic activity and any earthquake could amplify these events (Chevallier et al. 2004, 10).

Glacier-related events can lead to catastrophic disasters destroying entire towns in the montane valleys below. As of 2005 half a million people were known to live in close proximity to Cordillera Blanca glaciers and glacial lakes (Carey 2005, 123). Peru's glacier retreat since the 19th century has triggered some of the world's most deadly avalanches and glacial lake outburst floods. Such disasters are not new to Peru, killing 5,000 in 1941 and 18,000 in 1970. All in all, thirty glacier disasters have killed 30,000 people in the region since 1941 (Carey 2005, 122). Even if people can escape in time, such climate-related disasters can also undo years of development progress and impede economic growth (Oxfam America 2008, 4).

Government intervention to mitigate glacier-related disasters began in earnest in the 1940s with the introduction of surveillance programmes and drainage projects for mountain lakes. Since then international scientists have joined Peruvian authorities in research and mitigation efforts. Beginning in the 1980s government authorities augmented hazard reduction policies to include management of water supply from mountain lakes as part of larger hydrologic plans. This policy shift, amongst others, has led to communication and governance issues between local indigenous populations and government authorities.

Ecosystems and Biodiversity

The international environmental and development communities have expressed concern over the climate-driven degradation of ecosystems within Peru's tropical highlands. The hydrological and ecological changes occurring in the highlands will likely result in a loss of global biodiversity, as well as losses in ecosystem-dependent services. Although the tropical Andes is geographically smaller than the Amazon, researchers estimate that it has a similar amount of plant and mammal diversity (Young and Lipton 2006, 89). Climate change could lead to a loss of species, as some mountain flora and fauna species have "no way up" and are in danger of extinction as their natural habitats become increasingly warmer (Vergara 2005, 1). Another threat to biodiversity and ecosystem integrity is desertification (which is already being observed in other Andean regions).

Increasingly, ecosystem integrity is framed as critical, not only to maintain biodiversity, but because ecosystems provide “goods and services”. Ecosystem goods and services are defined as the benefits that people obtain from ecosystems, generally in the name of sustaining livelihoods and development, and can be broken down into provisioning, regulating and cultural services (McGray et al. 2007, 8). The ecosystems of Peru’s tropical highlands, in particular watersheds, have traditionally provided such goods and services, most of which benefit all Peruvians. Examples of critical goods and services found in tropical highland ecosystems are fresh water, regulation of water quantity and quality, hydropower potential, and economic benefits through tourism. In previous sections I touched upon the economic costs of developing new infrastructure to replace the natural water regulating system and power generation that glaciers provide and the costs that will occur in increased emissions. At a community level the loss of ecosystem goods and services is a loss of livelihood-dependant resources; therefore, potentially undermining resilience and increasing vulnerability.

While Peru’s tropical highlands are highly vulnerable, they are also populated by communities which have a long history of adapting to adverse climate conditions and social changes. The following section outlines how the international community is responding to these imminent changes and how Peruvians are themselves responding and adapting.

Adaptation Practices and Processes

Peru is adapting to climate change through a diverse set of approaches, with some practices and processes being developed by international and national policymakers, while others have a bottom-up quality. Using a human dimensions of climate change lens, I examine how different policies and activities interact to strengthen the adaptive capacity of populations living in Peru's highlands. Mainstreaming and sustainable development are evident, while some approaches can be categorized as climate-proofing and are explicit in their function to address climate change impact. Still, other approaches focus on vulnerability reduction, reinforcing and being complemented by development pathways.

International and National Policy

As touched upon in previous sections, much of the international community views mainstreaming as the most viable strategy to promote adaptation activities. The World Bank promotes a "proactive" mainstreaming agenda as part of its "sustainable development strategy" and has attempted to integrate climate change adaptation into its programmes such as "Country Assistance Strategies (CAS), Country Environmental Assessments (CEA), and Development Program Loans (DPL)" (Vergara 2005, 41).

In addition to mainstreaming efforts, the United Nations Framework Convention on Climate Change (UNFCCC) supports programmes through funding mechanisms that contribute to adaptation-specific activities. The Global Environment Facility (GEF) was established in 1991 to implement provisions of

the Marrakech Accords (Conference of the Parties-7) and is a joint project and main financial instrument regarding climate change for the United Nations Development Programme (UNDP), United Nations Environmental Program (UNEP) and the World Bank. More specifically, GEF grants support projects related to climate change (in addition to biodiversity, land degradation, ozone layer, and other environmental related projects) (GEF website, n.d). The GEF also became charged with administering the Kyoto Protocol's Adaptation Fund, Least Developed Country Fund and Special Climate Change Fund. GEF funding is allocated through a staged process intended to support developing governments to undertake National Adaptation Programs of Action (NAPA). The NAPA process encourages governments to not only prepare studies on vulnerable regions and populations, but also outline adaptation plans and policy development. After going through the staged NAPA process, countries apply for additional GEF funds to support the initiation of adaptation strategies (Adger et al. 2003, 191).

Much World Bank specific policy and funding overlaps with and complements GEF activities and has a strong emphasis on technical assistance including monitoring, analysis and planning. One of the most published limits to current climate scenario models is that despite significant progress on global models, there is a dearth of scientific documentation on local and regional trends and projected impacts. The World Bank is assisting in Peru's efforts to further develop climate scenarios, downscaling tools, and forecasting at the regional and local levels and assess impacts. The belief is that better forecasting models can

be utilized to justify and formulate effective adaptation activities (Vergara 2005, 13). In addition to supporting climate observing systems, the World Bank supports glacier monitoring stations and the promotion of hazard reduction activities including prevention planning which may even include relocation practices. Other technical support includes research on transgenic crops and initiatives to utilize drought-tolerant varieties and diversify away from monocultures (Vergara 2005, 35). The World Bank is keenly aware of Peru's imminent energy concerns and in response promotes initiatives such as carbon sequestration schemes (through its BioCarbon Fund) that mitigate emissions and promote conservation (Vergara 2005, 30). While the Bank is also involved in dam construction, which can further divert water from upstream subsistence farmers, it does promote using funds generated from hydropower to conserve high-elevation watersheds that are critical to sustaining water supplies (Vergara 2005, 30). World Bank reports on adaptation support efforts that complement adaptation efforts such as ecosystem restoration (land degradation and biodiversity preservation programs) and measures that include identification of vulnerable economic activities (e.g. agrarian activities), stakeholder analysis and institutional analysis (Vergara 2005, 41).

In some respects, Peru is leading the way in Latin America on climate change adaptation efforts. On a national level, Peru has a well-developed regulatory and legal framework which includes environmental laws and coordinating agencies. A study by the Peruvian Society for Environmental Law (SPDA) found that beginning in 1900 environmental regulations were enacted,

including approximately five thousand laws and regulations (including international treaties) related to environmental protection and natural resource conservation (Ruiz Muller 2001, 2). CONAM (Comision National del Medio Ambiente or the National Council on the Environment) is the national agency charged with governing and coordinating this environmental framework. Because environmental competences are carried out by individual sectors (e.g. Ministry of Mining, Ministry of Agriculture), CONAM's initial role was to co-ordinate and ensure that sectoral policies are in accordance with overall national environmental policies (Ruiz Muller 2001, 5). The coordinating efforts of CONAM are also essential in ensuring that sectoral interests and initiatives are compatible and in conformity with national interests and other sectoral interests (e.g. the Ministry of Industry takes into account the interests of the Ministry of Agriculture or the Ministry of Fisheries when developing policies or promoting a project or budgeting for its annual activities) (Ruiz Muller 2001, 20). Breaking down sectoral barriers and promoting inter-sectoral cooperation is an on-going challenge and process in and of itself. In recent years CONAM's mandate has expanded beyond coordination and it has become recognized as an effective technical assistance entity as well as providing a forum for multiple stakeholders to contribute input, in particular surrounding biodiversity (Ruiz Muller 2001, 5).

In May of 2008 President Alan Garcia also created Peru's first Ministry of Environment which is intended to promote reforestation efforts and carbon trading systems. While there is some speculation that the new Ministry of the Environment was setup to fulfil requirements under free trade agreements, it is

none the less a step in the right direction. Indeed, part of the adaptation process is the internalization, or mainstreaming, of sustainable development and adaptation concepts. The fact that President Garcia and high-level public agencies are increasingly using and understanding concepts such as “biodiversity”, “climate change”, “desertification”, “benefit sharing”, “carbon sinks” is progress (Ruiz Muller 2001, 18). National institutions are also reinforced when policymakers develop ties with foreign researchers and non-governmental organization (NGO) actors, such as the United Nations, who bring funding, skills and global media attention to Peru (Young and Lipton 2006, 83). Although many of these international and national policies are being developed in Lima and abroad, they are intended to promote and support local initiatives and connect financial and technical resources to local stakeholders.

Livelihood Diversification and Technological-Based Practices

The region of Puno, located in the southern Andes, has been identified by CONAM as highly vulnerable to climate change and has also been the focus of many case studies and research. Puno contains most of the climate-related dangers in Peru including reoccurring floods, droughts, frosts, risky occupation of floodplain areas and deforestation practices. Other on-going socioeconomic concerns include poor access to resources, geographic and social isolation, lack of infrastructure, and the majority of the economically active population is employed in agrarian activities. Food security is one of the issues of most concern. Puno is one of the regions where the United Nations Development Program is involved in projects that help subsistence farmers adapt to climate

change through livelihood diversification and technological-based practices intended to increase food security.

Even prior to global warming, tropical highland households developed land-use systems to adapt to complex mountain environments. Attuned to harsh climate conditions resilience was developed by utilizing multiple fields and grazing lands at different elevations (e.g. parcel zoning diversification), using a variety of seeds and crops, and creating a household that is diversified in terms of employment. On-going forms of livelihood diversification that have created buffers to financial shortfalls in the event of disturbances or stochastic events include exporting (meat and wool), renting land, receiving assistance from family members (e.g. remittances), and most recently wage labour in the tourism, manufacturing and mining sectors (Young and Lipton 2006, 80).

In a case study conducted by university researchers partnered with staff from the United Nations and Peru's International Potato Centre, the authors looked at asset management with cattle and local economic development. It was found that dairy production contributed to a more "diverse portfolio" in agriculture, serving as a cash source through milk sales, and off-farm employment, while also allowing communities to develop links with regional markets (Valdivia et al. 2003, 6). Households engaged in these activities were identified as more resilient and better able to cope with climate fluctuations that might reduce crop yields. Other researchers confirm these findings, reporting that households at risk in the developing world have also self-identified livelihood security as the key

strategy to their resilience, and rate it higher than technological-based approaches to adaptation (Handmer 2003, 65).

Yet normally reliant coping measures may be limited by new conditions under climate change. One of the limiting factors undermining adaptation activities in Puno is lack of irrigation exacerbated by dwindling access to water and small parcel sizes. Agricultural statistics indicate that only 3.67% of land for agriculture has access to irrigation and a significant percentage of parcel sizes are relatively small affecting efforts to enact parcel zoning diversification (Trigoso Rubio 2007, 7). While cattle is normally a good investment and valuable asset that allows for income diversification, the reduced fodder due to climate change can lead to lower milk production diminishing resilience during times of stress. Subsequently gaining usage rights to utilize more favourable grazing grounds may further complicate adaptation efforts. The international community is searching for additional tools to help reduce vulnerability and increase land-use resiliency under increasingly challenging conditions. Additional short and medium-term practices include developing policies for market development of new and existing crop and livestock products, the breeding of drought-tolerant crops, further modification of farm-management practices, and improved infrastructure for off-farm employment generation (Magrin et al. 2007, 602).

Agro-ecological and Pre-Colombian Practices

Longer term adaptation strategies recommended by both the UNDP and the IPCC include not only livelihood diversification, but also so-called softer engineering approaches. Agro-forestry and agro-ecological methods, such as

land restoration and establishing ecological corridors are practices that are particularly attractive considering the overlap between protected areas and agricultural zones (Magrin et al. 2007, 601). Complementary policy includes strengthening and enforcing existing water and forestry laws which ensures better water management and the restoration of critical watersheds.

Compensating forest and landowners for conserving forests and lands that contribute to watershed health and therefore, water supplies, is another policy approach that is being explored (Magrin et al. 2007, 591).

Other soft engineering approaches include borrowing from, or even returning to, the agricultural practices developed by ancestors prior to the arrival of the Spanish colonialists. The theory behind a return to pre-Colombian practices stems from the belief that the communities in the highlands have an inherent capacity to adapt to high-altitude climate conditions. Training and education on locally developed techniques such as raised fields, native crops, artificial swamps, and agricultural terraces complement western based techniques such as drought-resistant varieties, rainwater harvesting and storage systems. It is believed that Puno is where early first intensive agricultural societies domesticated crops intended for high altitude resistance to climate fluctuations (Erika Trigoso Rubio 2007, 6). Under the support of the UNDP an

ancient Waru Waru Irrigation System⁸ project was initiated in Puno. Although it was labour intensive, the project was found to raise yields and reduce risks associated with frosts and droughts in addition to helping communities bring more land into production (UNFCC website n.d.). Today the project also serves as a demonstration for adjacent communities.

Strengthening of Local Knowledge and Social Networks

The appeal of the above approaches (pre-Colombian and agro ecological approaches) is that they both are based on local resources and inherent capacities. Many experts within the human dimensions framework promote scholarship that reveals not only adaptive capacities, but the processes involved in developing resilience. Research is being developed under what is called the “analogue approach” which essentially looks at past and current responses to climate variability (e.g. ENSO events) with the aim of seeing how individuals and systems respond and how policy evolves (Adger et al. 2003, 187). In other words, “understanding the present-day effects and responses to climate variability at all levels of social organization is a prerequisite for studying the effects and responses to future climate change and for identifying the key determinants of successful adaptation in the future” (Adger et al. 2003, 187). This approach can be particularly instrumental in looking at successful adaptation

⁸ Waru waru, or raised field, agriculture makes it possible to bring into production the low-lying, floodprone, poorly drained lands found all over the Altiplano. The aim of the Waru waru project is to recover a technology, invented by an ancient culture. Excavated soil leaves a depression resulting in canals of like size and depth and when filled with water, the shallow canals ensure a microclimate that acts as a buffer against night-time frosts and provides moisture during droughts and drainage during the rainy season. The canals also keep out pests and the system provides farmers with greater harvest security and reduces the risks associated with frosts and drought (UNFCC website n.d.).

at the community level, in terms of both technical knowledge bases and collective action.

Local knowledge in the Andes is a resource that has foundations in pre-Colombian traditions and is constantly being updated to adapt to changing social, economic and climate conditions. Traditions serve as a vessel for local knowledge and information to be passed down to subsequent generations through both household and community networks. An example of local knowledge in action has been illustrated in case studies that document campesinos cultivating different plant varieties over the course of centuries, in particular with the potato. One field could have 40-60 potato variants with unique names and tastes, all of which contribute to genetic diversity, therefore developing resilient strains and providing for future generations (Young and Lipton 2006, 76). Another example of local knowledge cited throughout several case studies is the use of traditional forms of climate forecasting that involves observations of indigenous plants and animals. Often decisions on where and what to plant are made based on local observations, and campesinos are known to rely more firmly on the advice of local forecasters over scientifically-validated signals (Young and Lipton 2006, 70).

Researchers, in particular those subscribing the human dimensions framework, are also broadening the lessons learned from pre-Colombian civilizations to include not only the soft engineering techniques as described above, but to also look at how highland communities have created systems to organize their sowing schedules and to programme their yields (Parry et al.,

Cross-chapter case studies, 2007, 864). Adaptation, much like human development, is not just about strengthening infrastructures and changing agricultural practices, but also about fostering community ties and developing processes to propel collective action. The importance of community networks and social capital amongst communities of the tropical highlands cannot be overstated, nor over-rated. Social ties are often created around shared goals regarding scarce resources and reciprocity. Larger social networks are a form of insurance in a region marked by poverty, isolation and low education levels and a household's community duties and responsibilities all factor into daily and seasonal activities (Young and Lipton 2006, 79). Case studies indicate a communal element to many agrarian activities (e.g. harvesting, tillage, maintaining irrigation systems), including labour exchanges that ensure a household gains access to water rights, land, or help with an upcoming harvest (Young and Lipton 2006, 81). Social networks are also an informal governance mechanism. Allocation of water-flow to individual parcels within irrigation networks are often controlled through community-based institutions and are critical for individual households to extend plant seasons and cultivate water-demanding crops (Young and Lipton 2006, 77). Moving forward towards climate change adaptation, existing social networks may prove vital to creating community-based water conservation programmes and could serve as links to outside researchers and national policy makers.

Grounding adaptation in a historical context by looking at past adaptations is a valuable tool in climate change adaptation, as is recognizing the innate and

persistent adaptive capacity of highland communities. The Andes have supported well-developed societies through-out millennia, with current day campesinos adapting through ongoing decisions on livelihood strategies, asset allocations, and agricultural approaches. However, it is also important to recognize the constraints being placed on these traditional forms of adaptation in a modern day context and the challenges to the adaptation “toolset” outlined in this paper. In the following sections, I analyze social, economic and political challenges that limit efforts towards climate change adaptation.

SECTION FOUR: CHALLENGES TO ADAPTATION

An analysis of adaptation measures should not only take into account the local context in which climate change is occurring, but also recognize the macro environment in which adaptations are taking place. Both context-specific issues and political economy factors are creating challenges to building adaptive capacity in Peru's tropical highlands. Adaptation is constrained by prevailing uncertainty, institutional limits, governance issues, funding instruments and socioeconomic factors.

Uncertainty

Uncertainties regarding not only future climate conditions, but also future socioeconomic factors is one of the greatest challenges to successful adaptation. As touched upon in earlier sections, while scientists have gained some confidence in predicting global climate change, much uncertainty remains regarding future climate scenarios on a local and regional scale. Because climate change models do not produce projections at regional scales with confidence, their use in developing policy for mitigation and adaptation has remained very limited (Magrin et al. 2007, 585).

Maladaptation is a valid concern regarding adaptation strategies. Climate-proofing activities based on future scenarios could prove ineffective, especially when other factors in development pathways are unknown. There is the very

real potential of creating infrastructure or promoting technologies that actually increase future risks because they create conditions that ultimately raise vulnerability (McGray et al. 2008, 7). Emissions scenarios are also subject to great uncertainty, as they reflect patterns of economic development, population growth, consumption and other factors that are difficult, if not impossible, to predict over a 100-year period (Eriksen et al. 2007, 10). Another problem related to climate certainty is the occurrence of possible climatic surprises when certain thresholds are surpassed, which is of particular concern in Peru as the Intergovernmental Panel on Climate Change (IPCC) has determined that both tropical glaciers and forests are likely candidates for “surprises” (Magrin et al. 2007, 607). An overarching concern is that developing certainty with climate modelling is a prerequisite for climate change action. The concern is that policymakers will wait for more certainty (e.g. higher confidence observations) regarding climate risk. This could not only stifle action on adaptation, but also detract from possibilities located in current conditions and historical lessons.

For these very reasons, much discourse on adaptation is promoting an agenda that shies away from a reliance on future scenarios to guide adaptation activities and rather focuses on reducing vulnerabilities to current climate and non-climate sources of harm. Indeed, poverty-reduction and development initiatives may prove to be some of the most effective strategies in climate change adaptation. There is also the argument that policy should include a mandate to not only focus on adaptation practices but also social processes (e.g. governance and institution building). Rather than preparing to adapt to an

anticipated impact (e.g. water scarcity), planning for adaptation decision-making processes lays a foundation for on-going adaptation efforts (e.g. community-based water conservation programmes) that can adjust and improve as new information, techniques or conditions are encouraged (McGray et al. 2007, 26).

Increasingly, researchers are also promoting an approach with the core strategy of building the capacity to cope with uncertainty itself. This argument stems in part from a shift away from “equilibrium centred, command-and-control strategies” that aim at controlling the variability of a resource, which is a perspective that influenced contemporary natural resource and environmental management (Folke 2006, 255). Instead of aiming to restore equilibrium, or aspire to control changes in systems assumed to be stable, the belief is that that uncertainty is inevitable and surprises are likely. Out of this belief a resilience perspective has emerged which recognizes that people and systems are capable of managing by change, rather than reacting to it (Folke 2006, 254). In the context of this paper, policy that manages for resistance can be applied to not only climate change policy, but also broadly speaking sustainable development.

Governance and Institution Building

A good governance structure throughout all levels of government is critical to successful adaptation. As mentioned earlier, especially in reference to mainstreaming, one of the greatest challenges is fostering inter-sectoral communication. Creating linkages between sectors at the national level is an ongoing process in adaptation. Another element to governance in Peru is improving communication and links between national administrators, often based

in Lima, and the inhabitants in the tropical highlands. Policy regarding hazard-management, water allocation and conservation are often developed in Lima and then implemented in the local communities. A deep-seeded distrust of Lima based government officials and coastal-oriented leadership, coupled with a lack of participation in decision-making, have led highland communities to resent and protest against national policies and adaptation tools that are perceived as more relevant to coastal populations. As recently as 1990, centralism was reinforced through the Fujimori administration. Beginning in 2002, subsequent administrations embarked on process of decentralization, including initiating Peru's first regional elections and efforts to transfer fiscal resources to local governments (Economist Intelligence Unit 2008, 28).

In a case study that examined historical vulnerability to avalanches and outburst floods in Peru, the author found that the general lack of trust and communication amongst the local, scientific and policy communities prevented proper hazard-management and heightened local inhabitants vulnerability to glacier disasters (Carey 2005, 123). Past missteps by government officials (e.g. not considering disaster warnings from international scientists) have led local inhabitants to challenge government decisions and locals now seek out information and advice from NGOs and international scientists (Carey 2005, 123). The case study documented one incident where people ignored government safety warnings to evacuate and when national engineers and planners tried to resettle inhabitants outside potential hazard zones, people

protested citing state intervention instead of disaster mitigation (Carey 2005, 130).

Local agendas often differ significantly from decision-makers based in Lima or coastal regions reflecting the divergence of interests and perspectives among different stakeholders in Peru (Young and Lipton 2006, 73). The same case study on illustrates how government officials may prioritize hydroelectric needs and water demands generating from more populated regions. This entails not draining glacial lakes and utilizing the lakes as a natural reservoirs for downstream users. The un-drained lakes, while precarious for adjacent settlements, provide valuable research to study the Cordillera's hydrology (Carey 2005, 128). The local adjacent communities perceive these government policies as prioritizing safety in the name of hydro power and commercial irrigation.

Similar perceptions to park protection have also been cited by researchers. Campesinos may also consider national institutions affiliated with conservation as "hypocritical, corrupt and paternalistic" (Young and Lipton 2006, 73). Even if there is compelling support at the global level to protect a habitat or species, local campesinos may interpret an act to restrict their land-use as satisfying the centralized economy and political needs before addressing local conditions (Young and Lipton 2006, 84). These case studies, along with previous analysis on water supplies, illustrate how climate change impacts and adaptation measures may disproportionately impact some regions over others and exacerbate perceived inequalities. Decisions that favour commercial interests and park conservation over campesinos reinforce the opinion that

natural resource management, in particular with respect to water, is highly politicized and that outside institutions and actors have political and economic clout (Young and Lipton 2006, 72).

The lack of trust in outside actors is also a reflection of the resilient social networks developed over the course of generations. Highland community members share an “overriding bond of collective action, trust and community cohesion” that supersedes not only the authority, but also the knowledge, of external scientists and administrators (Young and Lipton 2006, 73). Another case study documents how campesinos did not incorporate scientific forecasts regarding ENSO events into their agricultural decisions, instead relying on local, traditional forecasts. This decision-making process can be attributed to a tendency to rely on local social connections. Yet, it also highlights an apparently widespread belief amongst campesinos that forecasts are only valid for the location in which they are generated – i.e. a forecast produced by an office in Lima or La Paz is only valid (at best) for Lima and La Paz (Valdivia et al. 2003, 6).

Recent scholarship on climate change adaptation not only emphasizes the role of good governance processes, but also recognizes that institution building complements the more technical aspects of adaptation (e.g. ecosystem conservation, climate forecasting instruments, transgenic crops). In short, the effectiveness of adaptation practices are enhanced or undermined by a government’s regulatory, financial and political frameworks. As mentioned above, Peru has a relatively well-developed legal framework, including multiple

international and regional treaties as well as national regulations and laws.

Although these treaties and laws are technically in place, they are not adequately implemented, enforced and funded (Ruiz Muller 2001, 2). One example of an agency that struggles to maintain its mandate because of budget and personnel constraints is the Glaciology and Hydrological Resources Unit which is charged with hazard-management of glacial lakes. Although glacial lake monitoring is a key element of climate change adaptation, the agency has a very limited staff that oversees the Cordillera Blancas' approximately 600 glaciers and 374 glacial lakes (Carey 2005, 125).

The United Nations Framework Convention on Climate Change (UNFCCC) framework requires a top-down approach that places the national government in Lima at the centre of policy surrounding adaptation that is being implemented in the tropical highlands. The national government ostensibly creates an "enabling environment" for international adaptation policy to be carried out through international treaties and national institutions (Eakin and Lemos 2008, 10). Multilateral treaties (e.g. Kyoto Protocol), policy directives (e.g. NAPAs, technology transfers), lending instruments (e.g. GEF), property rights, environmental laws, regulations and budgets are established and coordinated by national and regional government actors (Eakin and Lemos 2008, 10). This framework requires an element of centralization to climate change action and carries with it an expectation that the state will carry out planned action on both mitigation and adaptation approaches. NGOs, local governments and private markets play a role in adaptation, but do not have the authority or financial

resources to carry out politically charged action on adaptation (e.g. relocation, land redistribution, large engineering endeavours) which require a centralized hand (Eakin and Lemos 2006, 11).

In a sense, the expectation of targeted national policy interventions in adaptation policy is embedded within the broader discourses in human development (Eakin and Lemos 2006, 9). On the one hand, much discourse emphasizes the need for improved institutions, market incentives and regulatory mechanisms (Eakin and Lemos 2006, 9). On the other hand, the agendas of international development organizations, such as the International Monetary Fund (IMF), and other analysts call for decentralization and a shrinking of the centralized bureaucratic state apparatus. Specific case studies cite centralism as permeating the Peruvian political structure and thus constraining local decision making capabilities (Trigoso Rubio 2007, 10). Yet local and regional authorities tend to be isolated, ill-equipped and resource-poor which can constrain capacity building and enforcement mechanisms at a local level (Eakin and Lemos 2006, 8). While recent presidents have made devolving power to the local level a priority, the institutional capacity of the regions outside of Lima remain in doubt (Economist Intelligence Unit 2008, 28).

The above examples and analysis illustrate an overarching challenge to adaptation policy. Without considering the social conditions in which adaptation takes place, a technological solution may fall short of expectations. Despite the best intentions, a tendency to not acknowledge, utilize and include social networks and traditional community leaders can undermine adaptation efforts by

national policy makers and international community members. In other words, while place-based adaptation on a local scale is critical, local level governments still require a strong and responsive central government to provide financial and legal resources.

Funding Constraints

While Peru's greenhouse-gas emissions up to this point have been relatively low, it is at the so-called receiving end of anticipated impacts. Adaptation to impacts will require considerable funding as illustrated by Stern Review estimates and the aforementioned study on the economic costs surrounding energy generation in Peru. The international community has recognized that funding for adaptation is an enormous undertaking for developing countries and most developed countries are willing to bear the brunt of financial implications. Much of adaptation can also be considered a public good, and as such, is funded by national governments and international institutions. Public awareness campaigns, scenario and assessment building, climate modelling systems and the conservation of critical habitats (e.g. Amazonian forest) can all be considered public goods that deliver global benefits (Stern Review 2006, xxi).

Developing countries support the United Nation's efforts through contributing to the GEF fund and other instruments. The UNFCCC has outlined this obligation to its signatories in Article 4.4 and explicitly requires developed countries to "assist developing country Parties that are particularly vulnerable to the adverse effects of climate change in meeting costs of adaptation to those adverse effects" (McGray et al. 2007, 9). Some developed country governments

have contributed a total of \$116 million to a voluntary set of funds at the GEF. And the countries that belong to the Kyoto Protocol have created an international Adaptation Fund that will likely receive a few hundred million dollars a year in proceeds from an international mechanism for trading greenhouse gas emission credits (Oxfam America 2008, 8). Additional funding for adaptation also flows out of official development assistance (ODA) and mainstreaming activities.

While it is progress that financial instruments have been established under the UNFCCC framework to funnel money from the developed world to adaptation specific projects in Peru, the GEF mechanism has been criticized for being overly bureaucratic and cumbersome, making access to funds a difficult and lengthy process. This is unfortunate considering recent reports (e.g. the Stern Review) calling for an urgent call to action regarding climate change. UNFCCC funding also excludes private actors and local communities from funding. Only official government endorsed activities are funded through the UNFCCC. This policy is not congruent with recent development prescriptions that promote decentralization and emphasize the role of civil society.

Another reason why adaptation and development blend together is that in many regions scientists have yet to disassociate anthropogenic climate change and climate variability. However, as noted in my introduction, the UNFCCC definition of climate change excludes climate variability and its funding policy is an extension of this definition. UNFCCC policy restricts funding of adaptation activities specific to anthropogenic climate change. If articles 4.3 and 4.4 are followed, funding for current climate variability and development is excluded

under the UNFCCC. This is especially unfortunate considering recent research advocates an adaptation approach that focuses on poverty-reduction and the reduction of vulnerability to any current stresses, whether they are related to current climate disturbances or socioeconomic factors. Traditionally funded development efforts are increasingly being recognized as an important adaptation tool and adaptation to climate change is also funded through official development assistance (ODA).

The UNFCCC would benefit from recognizing that there is not a clear line between climate change adaptation and development. A funding approach that delineates between climate variability and anthropogenic climate change is also unrealistic considering the current uncertainties in forecasting models at the local and regional levels where climate change adaptation is actually taking place. This is particularly relevant in Peru's tropical highlands where uncertainties regarding climate scenarios exist most acutely in the lower elevations.

Socioeconomic Constraints

In addition to climate change disturbances, campesino communities are also experiencing novel socioeconomic stresses. The impacts that tropical highland inhabitants are enduring certainly make them a prime example of a population experiencing "double exposure", with globalization and climate change simultaneously influencing livelihoods, traditional ways of life, coping mechanisms and interactions with the world outside of their rural Andean communities.

In many respects it is not clear how globalization and other 21st century socioeconomic trends will affect adaptive capacity, yet some processes are underway and already undermining traditional coping strategies. Young people are increasingly migrating to urban centres in search of new experiences and job opportunities. An on-going out-migration trend can divert younger generations from participating in local social networks and communal activities (Young and Lipton 2006, 77). Community networks will also inevitably change as they are globalised linking into both national and international networks that include NGOs, international climate change researchers, policymakers and market actors. Community networks are also utilized by both external actors and local households to transmit news on market conditions and prices. National and regional policymakers and administrators are wisely trying to overcome trust issues and create linkages with community social networks to disseminate information on adaptation activities and gain support of conservation or risk mitigation efforts.

Export opportunities should expand under free trade, yet campesinos that engage in the production of commodities could potentially engage in agricultural activities that decrease resilience to climate disturbances, require more inputs and potentially aggravate food insecurity. While cash crops such as wheat, oats, alfalfa and barley provide much needed income, they also require more inputs, and divert from efforts to cultivate traditional crops such as tubers, maize and potatoes that grow well in high altitude conditions.

Recommendations and Conclusion

The factors that limit successful adaptation are in many respects the same that stifle human development. While Peru's economic growth has been considered remarkable in recent years, inequality between the tropical highlands and the coastal region continues to challenge policymakers and administrations. If development in the form of poverty-reduction and economic growth is the best antidote to climate change, more equal development that penetrates the tropical highlands will be necessary to ensure that Peruvians as a whole can adapt and lessen the potential to create a winners and losers paradigm within climate change adaptation. Considering the current challenges that Peru faces in adapting to climate change, I recommend the following be incorporated into climate policy.

- Increasingly there is a recognition that an overemphasis on climate can lead to a tendency to undervalue the role of socioeconomic factors in forecasting. Additionally, the dearth of knowledge on future socioeconomic conditions makes forecasting increasingly difficult. Peru should prepare for continued uncertainty and focus on reducing current vulnerability, with an emphasis on poverty-reduction and increasing resilience in terms of communities and ecosystems. While climate model scenarios should continue to be developed, the focus should lie on adapting to current climate while keeping in mind historical adaptations.

- Funding mechanisms under the UNFCCC should consider the overlap between development and adaptation and reconsider its definition that distinguishes between anthropogenic climate change and natural climate variability.
- To gain the trust of those most adversely affected and improve the adaptation process, researchers and government officials should take care to build solid relations with local communities. Efforts should be made to increase the involvement of local decision-makers in regional and national plans to minimize the rejection of beneficial projects and ideas coming out of Lima.
- Joint scenario-building initiatives between international and national scientists and local experts could tap into local indigenous knowledge. Local, traditional forecasters could incorporate science-based evidence into their climate knowledge, while also serving as a conduit by which national forecasters could reach local campesinos.
- Studies and research are needed on the embedded negative perspectives and perceptions that local indigenous people have towards administrators in the coastal leadership. The regional, national and international institutions that are interested in preserving biodiversity and ecosystem goods and services through conservation corridors and protected areas, would benefit from addressing and understanding these perspectives and perceptions.

- Continue to expand the definition of climate change adaptation beyond practices that emphasize infrastructure and climate-proofing, to processes that emphasize developing good governance, strengthening community ties internally and with regional and international actors, and institution building.

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