CLIMATE CHANGE AND PERUVIAN POTATO FARMING: TRADITIONAL KNOWLEDGE IN CLIMATE CHANGE ADAPTATION

by

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Anthropogenic climate change is impacting Peruvian potato farming as a result of increased temperatures, erratic weather and unpredictable precipitation. In Peru, potato farming is not only a means of subsistence, but it also embodies significant beliefs and traditions of Quechua culture. As climate change intensifies, the need for farmers to adapt to the impacts is increasing. This situation is applicable across the globe in other agricultural communities. Focusing on the Peruvian highlands, this thesis asks: considering the impacts of climate change on Peruvian potato farming, how can farmers most effectively adapt? This thesis answers this question by exploring the current literature on adaptation and assessing how four stakeholders – potato farmers, U.S. media, the Intergovernmental Panel on Climate Change (IPCC), and institutions – approach adaptation strategies. The theme that emerges from this research is the effectiveness of traditional knowledge in Peruvian potato farming considering farmers' historical experience with climate variability. I argue that traditional knowledge is an effective adaptation strategy and should be given a legitimate space in the adaptation discussion. The significant role traditional knowledge can play in adaptation is consistent with emerging adaptation literature. In the broader context, while this thesis focuses on the role traditional knowledge plays in climate change adaptation with Peruvian potato farming, it is applicable on a larger scale. Rethinking the concept of adaptation and questioning certain related terms such as vulnerability and resilience could result in a more well-rounded and effective approach to adaptation globally.

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Abbreviations

ANDES	Association ANDES
AR4	Fourth Assessment Report of the IPCC
AR5	Fifth Assessment Report of the IPCC
CBD	Convention on Biological Diversity
CCA	Climate Change Adaptation
CIP	International Potato Center
ENSO	El Niño-Southern Oscillation
IDB	Inter-American Development
IIED	International Institute for Environment and Development
IPCC	Intergovernmental Panel on Climate Change
IPCCA	Indigenous Peoples' Biocultural Climate Change Assessment Initiative
NGO	Non-governmental Organization
TK	Traditional Knowledge
UN	United Nations
UNEP	United Nations Environmental Programme
UNESCO	United Nations Education, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change

Introduction

Imagine opening a bag of Lay's Potato Chips. Instead of pulling out a crisp yellow chip, you find an array of colors – purple chips, blue chips, even a few red chips. They must have dyed the potatoes, you think; but they did not. These chips are Lay's Andinas Crisps, made from native Peruvian potatoes. The potato originated in the southern region of Peru, near Lake Titicaca, and was domesticated over 8,000 years ago.[1] In Peru alone, there are over 2,800 varieties[2] of native potatoes and they come in all colors, shapes and sizes. There are potatoes called "Azul Ñawi Gaspar," which are small, tan in color, and known for their large blue/purple eyes.[3] There are "Kullwash" potatoes, purple/brown in color with lumpy skin, and known for their thin eyes, making it look like the potato just woke up.[4] And there are "Tuqra Papa" potatoes, with bright purple meat, which are often mixed with vegetables and quinoa.[5] The list goes on.

Native potatoes are a staple of both diet and culture in the Peruvian Andes, but anthropogenic climate change is impacting the cultivation of potatoes in terms of growing methods, varieties grown and the reliability of yields produced. According to Kroschel et al., "global warming is projected to raise the mean temperature of the earth by 1.5-5.8^{o}C by the end of the century and is expected to aggravate the already serious challenges to food security and economic development, especially in developing

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[1] "Understanding and Conserving Traditional Potato Practices," *International Potato Center*, http://cipotato.org/press_room/blogs/understanding-and-conserving-traditional-potato-practices/.
[2] Amanda Stephenson, "The Quechua: Guardians of the Potato," *Cultural Survival Quarterly* 36 (2012).
[3] Stef de Haan, *Catálogo de Variedades de Papa Nativa de Huancavelica, Perú* (Lima: International Potato Center, 2006), 55.
[4] Ibid., 74.
[5] Ibid., 83.

countries."[6] Specifically in the Peruvian Andes, this increase in temperature means more aggressive potato diseases, which can result in significant yield losses for farmers and their families.[7]

Increased incidence of disease and a shortened growing season are among the impacts that climate change is having and will have on Peruvian potato farming. Therefore, my central research question is: *considering the impacts of climate change on Peruvian potato farming, how can farmers most effectively adapt?* In order to answer this question it is necessary to present the current and projected impacts of climate change on potato farming and introduce the discussion surrounding the concept of adaptation. Furthermore, there are multiple stakeholders discussing potato farmers' adaptation to climate change. It is crucial to acknowledge these different voices and their points of agreement in order to answer the research question. The perspectives I will present in detail are: 1) the potato farmers themselves, 2) U.S. media, 3) the Intergovernmental Panel on Climate Change (IPCC), and 4) institutions such as non-governmental organizations (NGOs).

By presenting these perspectives, I argue that, considering climate change impacts on Peruvian potato farming (such as higher temperatures, erratic weather and increased pests), traditional knowledge (TK) should play a key role in adaptation strategy. Since farmers have been practicing these adaptations for centuries, they are effective in the highland region and they incorporate farmers' experience and

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[6] J. Kroschel, M. Sporleder, H.E.Z. Tonnang, H. Juarez, P. Carhuapoma, J.C. Gonzales, and R. Simon, "Predicting climate-change-caused changes in global temperature on potato tuber moth Phthorimaea operculella (Zeller) distribution and abundance using phenology modeling and GIS mapping," *Agricultural and Forest Meteorology* 170 (2013): 228.

[7] Rodomiro Ortiz, *Climate Change and Agricultural Production* (Washington DC: Inter-American Development Bank, 2012), 13.

knowledge rather than outside technologies that must be brought in, taught, and sustained. This does not mean that imported technology should not or will not play a part in climate change adaptation or that farmers are unable to learn these new technologies, but traditional knowledge must be regarded as a crucial part of adaptation.

Background – Climate Change Impacts on Peruvian Potato Farming

Three specific changes illustrate the current impacts of anthropogenic climate change on Peruvian potatoes: one, how erratic weather and temperature changes are altering the growing season; two, how potato yields and varieties are being affected; and three, how potato pests are intensifying with rising temperatures.

1) Changes in the growing season

As a result of climate change, the timing of the wet season[8] and the predictability of the rains in the Peruvian Andes are changing. As a result of these changes, the potato-growing season has shortened on both ends. According to an Oxfam report, "40 years ago in the Middle Zone of Peru's mountains, rain was recorded from September to October, while for the past years, the rainy season has only started in November."[9] In the highlands region, the first potato planting is determined by the onset of the rainy season; therefore, change in the start of the rainy season means change in the growing calendar. Cirilo Quispe Latorre, a farmer and mayor in the Cusco region, explains this change:

[8] Peru's climate is based around a wet season and a dry season.
[9] *Building on farmers' perceptions and traditional knowledge: Biodiversity management for climate change adaptation strategies* (The Hague: Oxfam Novib, 2013), 8.

> Eighty percent of the farmland is seasonal. In other words, if there is rain, we plant. If there isn't enough rain, we can't keep planting. I'm a native of this region. When I was a child, there was quite a lot of water in this region. […] The rains used to start in October, and we would plant broad beans, wheat, and potatoes. Now the rains begin around mid-December, and we lose more than a month and a half of growing time. Now, by the end of March the rains are over. It used to rain throughout most of April, with the dry season only starting in May. So the rain has decreased at the beginning and the end.[10]

Papa Arariwas in the Potato Park[11] also note changes in the growing season. The Papa Arariwas explain that before, when their parents were farming, they would plant potatoes in September; now they plant them later, in October or November.[12] Similarly, they used to harvest potatoes in June; now, the harvest happens earlier in April or May to avoid the frosts.[13] These observations also show a reduction at both ends of the growing calendar, resulting in a shorter season overall.

2) Changes in crop yields and number of varieties

The increase in both mean temperature and erratic weather events resulting from climate change has affected which varieties of native potatoes can be successfully planted as well as the season's yield. In the highlands, farming families plant around one hundred or more varieties of potatoes. Lino Mamani Huarka, a farmer in the Potato Park says his family plants between 120 and 140 native potato varieties.[14] Climate change has impacted the number of varieties planted in several ways. Some varieties,

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[10] Chris Hufstader, "Climate change affecting Peru right now," *Oxfam*, Aug. 17, 2009, http://www.oxfamamerica.org/explore/stories/climate-change-affecting-peru-right-now/.

[11] The Potato Park (Parque de la Papa in Spanish) is a collaboration of six Quechua communities near Pisac, Peru working to protect and celebrate the biodiversity of native potatoes, traditional rights and Quechua culture. The Potato Park, which is where I completed my initial research while studying abroad, is affiliated with Association ANDES, an NGO based in Cusco. Papa Arariwas, also known as local technicians, are community members of the park who collaborate with Association ANDES and provide knowledge and expertise about native potatoes, farming and traditional practices.

[12] Papa Arariwa (potato technician with Association ANDES) at Potato Park, interviewed by Lisa Giamberso, November 11, 2012.

[13] Ibid.

[14] Amanda Stephenson, "The Quechua: Guardians of the Potato," *Cultural Survival Quarterly* 36 (2012).

which only are only able to grow at lower altitudes, have disappeared completely, due to the increase in temperature and presence of pests.[15] Furthermore, as a result of climate change, the variety of potato types planted has become more crucial. When farmers plant a greater variety of potatoes, it is less detrimental if one or two varieties do not survive due to unexpected weather events such as frost because there is a higher likelihood that a different variety will be more resistant.[16]

In addition to shortening the rainy season, climate change is causing erratic weather events such as hailstorms and rains that come out of the typical season; together these changes can be detrimental to the potato yield. According to a Papa Arariwa from the Potato Park, "before, the rains came during their season; now it is not like this, sometimes it rains, sometimes it does not and when it does, the rains are stronger and less spread out."[17] The Papa Arariwa also explains that the occurrence of hail and ice can no longer be predicted; they can come any day.[18] According to a group of researchers from the International Potato Center and prominent universities, Condori et al. explain, "production risk for potato is high due to several recurrent factors, particularly drought, hail, and frost."[19] An unexpected frost or hailstorm can be extremely damaging to the potato crop and in some cases can result in an entire lost chacra of potatoes. With the increase of erratic weather events and temperature, agrarian scientists such as Ortiz predict that overall yields will decrease.[20] Ortiz writes that the

[15] Papa Arariwa, interview.
[16] Stephenson, "The Quechua."
[17] Papa Arariwa, interview.
[18] Papa Arariwa, interview.
[19] Bruno Condori, Robert J. Hijmans, Jean Francois Ledent, and Roberto Quiroz, "Managing Potato Biodiversity to Cope with Frost Risk in the High Andes: A Modeling Perspective," *PLoS One* 9, no. 1 (2014): 1.
[20] Ortiz, *Climate Change and Agricultural Production*, 13.

"potato will be vulnerable to heat that affects the plant growth and tuber initiation, thereby reducing yield."[21]

3) Increase in potato pests and diseases

In the Peruvian Andes, potato late blight is the most important concern for potato growers.[22] Farmers are already seeing an increase in the presence of potato diseases such as late blight due to the increasing temperatures from climate change. Potato late blight is caused by *Phytophthora infestans* and "in a recent survey of farmers in Cajamarca, Contumaza, and San Miguel, Peru, late blight was perceived as the most important potato pest."[23] Late blight is challenging for potato farmers "because the pathogen generally is not visible to the naked eye, and because the symptoms of the disease are not immediately visible due to a latent period."[24] As temperatures rise, potato late blight is becoming more rampant and so farmers are moving their chacras higher up the mountain to find colder temperatures, sometimes by 900 feet.[25] However, plant scientists and researchers Garrett et al. explain that as temperatures rise, "the old strategy of using cooler highlands for susceptible varieties may disappear as farmers will eventually be limited by available lands or laws to protect vulnerable high-altitude

[21] Ortiz, *Climate Change and Agricultural Production*, 13.
[22] O. Ortiz, K.A. Garrett, J.J. Heath, R. Orrego, and R.J. Nelson, "Management of Potato Late Blight in the Peruvian Highlands: Evaluating the Benefits of Farmer Field Schools and Farmer Participatory Research," *Plant Disease* 88 (2004): 565.
[23] Ibid.
[24] Ibid.
[25] Joanne Silberner, "In Highland Peru, a Culture Confronts Blight," *NPR*, March 3, 2008, http://www.npr.org/templates/story/story.php?storyId=87811933.

systems."[26] In addition to these concerns, planting at higher altitudes requires farmers to climb higher and for more hours in order to tend to their potato crops.

While potato late blight is cause for the most concern, increasing temperatures will result in an increase in other potato pests such as the potato tuber moth and the Andean potato weevil. Similar to late blight, the "potato tuber moth, which is now in coastal areas and inter-Andean valleys, will also climb [in terms of altitude] due to climate change."[27] According to Kroschel et al., "the potato tuber moth *Phthorimaea operculella* has coevolved [with the potato] in the center of the origin of the potato [the Andes]."[28] The potato tuber moth larvae attack both the foliage and tubers of the potato plant[29] and thrive in warmer conditions, which are only becoming more frequent with climate change.

Highland farmers' observations about these growing pest problems are outlined in a 2013 study done by Oxfam entitled, "Building on Farmers' Perception and Traditional Knowledge: Biodiversity Management for Climate Change Adaptation Strategies." According to the study, "almost 50% of the households in Peru indicated that climate change has resulted in an expansion of the range of major pests, such as moths and the Andean potato weevil."[30]

Placement in existing literature

The authors cited throughout this discussion of climate change impacts on potato farming represent much of the existing literature about the topic of Peruvian

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[26] K.A. Garrett, G.A. Forbes, S. Savary, P. Skelsey, A.H. Sparks, C. Valdivia, A.H.C. van Bruggen, L. Willocquet, A. Djurle, E. Duveiller, H. Eckersten, S. Pande, C. Vera Cruz, and J. Yuen, "Complexity in climate-change impacts: an analytical framework for effects mediated by plant disease," *Plant Pathology* 60 (2011): 22.
[27] Ortiz, *Climate Change and Agricultural Production*, 13.
[28] Kroschel et al., "Predicting climate-change-caused changes," 229.
[29] K. V. Raman, *Potato Tuber Moth* (Lima: International Potato Center, 1980), 4.
[30] *Building on farmers' perceptions*, 9.

potatoes and climate change. In other words, the majority of literature that specifically discusses the issue of climate change and Peruvian potato farming covers quantifiable impacts such as temperature data, climate projections, yield measurements and studies about pests and diseases.

Another issue discussed in the literature about Peruvian potato farming and climate change addresses the concept of adaptation. For example, two scholars, Sanabria and Lhomme conducted a study about climate change in the Peruvian Altiplano and made distinctions between potato yields with and without adaptation. According to their research, "adaptation strategies to mitigate these climatic changes appear to be essential."[31] However, this adaptation literature about Peruvian potato farming is relatively limited. Therefore, in order to fully place my research within the existing literature, a broader discussion on adaptation and its role in the climate change discourse is required. Additionally, as the concept of traditional knowledge (TK) is central to my argument, I will analyze the literature that focuses on the definition of TK as well as how it currently fits into the scholarly discussion of adaptation.

According to the existing literature, adaptation is a combination of strategies and actions that aim to reduce the impact of climate change. Scholars largely agree that adaptation is not a new concept and that communities have been adapting to changes and variability in climate for centuries. According to W. Neil Adger, a Professor of Geography and prominent scholar of adaptation literature, "adaptation is made up of actions throughout society, by individuals, groups and governments. Adaptation can be motivated by many factors, including the protection of well-being or improvement of

[31] J Sanabria and J.P. Lhomme, "Climate change and potato cropping in the Peruvian Altiplano," *Theoretical and Applied Climatology* 112 (2013): 693.

safety."[32] In a different publication Adger writes, "individual and societal adaptation to climate is nothing new, neither as an empirical reality nor as a theoretical construct."[33] This recognition of adaptation as a long-standing practice is a theme throughout the literature and one of few points of agreement among scholars. The discussion of adaptation to modern anthropogenic climate change has become a complex debate with multiple emerging arguments and alternatives.

One such debate involves the limits of adaptation. There is emerging literature, led by Adger, which questions the effectiveness of adaptation, considering certain social, cultural and natural limits. As Adger et al. write, climate change adaptation "has been enshrined in the policy debate through its appearance in Article 2 of the […] UNFCCC, where the ultimate objective of the Convention concedes that adaptation to climate change in relation to food production, ecosystem health and economic development can and will occur."[34] In the conclusion of the same article, the authors suggest a critical analysis and reshaping of how adaptation is considered. The authors write, "the ability to adapt is determined in part by the availability of technology and the capacity for learning but fundamentally by the ethics of the treatment of vulnerable people and places within societal decision-making structures."[35] Adger et al.'s argument creates the space and need for a reframing of adaptation policy and also how the people who are trying to adapt are assessed. Within the reexamination of adaptation, the

[32] W. Neil Adger, Nigel W. Arnell and Emma L. Tompkins, "Successful adaptation to climate change across scales," *Global Environmental Change* 15 (2005): 77.
[33] W. Neil Adger, Suraje Dessai, Marisa Goulden, Mike Hulme, Irene Lorenzoni, Donald R. Nelson, Lars Otto Naess, Johanna Wolf and Anita Wreford, "Are there social limits to adaptation to climate change?" *Climatic Change* 93 (2009): 336.
[34] Adger et al., "Social limits to adaptation?" 336.
[35] Ibid.

definition and significance of the terms resilience, adaptive capacity, and vulnerability must also be reassessed.

These terms – resilience, adaptive capacity, and vulnerability – are central to climate change adaptation in terms of their frequency of use and influence on adaptation policy,[36] and are key to this thesis. Gaillard's article in the *Journal of International Development* provides concise summaries of these terms' history, significance and emergence in both climate and disaster literature. In this article, Gaillard, a professor in France, presents several approaches to resilience:

> Pelling views resilience as a component of vulnerability or the ability of an actor to cope with or adapt to hazard stress. That includes the planned preparation and the spontaneous or premeditated adjustments undertaken in the face of natural hazards. Others interpret resilience as the 'flip'—positive—side of vulnerability or the ability to resist damage and change in the event of the occurrence of a climate-related or other natural hazard. A third approach breaks away from the previous two to define resilience as the capacity of a system to absorb and recover from the occurrence of a hazardous event.[37]

This overview illustrates the complexity around the term resilience as well as its close relationship with the other two terms, capacity and vulnerability. As Gaillard's article demonstrates, these three terms are inextricably linked.

The definition of capacity is more straightforward. According to Gaillard, adaptive capacity can be described as "people's ability to face climate-related and other natural hazards, which was not captured in the mainly negative concept of vulnerability. Capacities refer to the resources and assets people possess to resist, cope with and recover from disaster shocks they experience."[38] These definitions do not delve into

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[36] J.C. Gaillard, "Vulnerability, Capacity and Resilience: Perspectives for Climate and Development Policy," *Journal of International Development* 22 (2010): 218.
[37] Gaillard, "Vulnerability, Capacity and Resilience," 220-221.
[38] Ibid., 220.

examples of resources and assets to cope, but they can be both tangible such as greenhouses to protect seeds or more engrained in a community's values, such as a closely linked social networks or traditional knowledge.

Vulnerability, which comes with a negative connotation, can also be controversial. Gaillard explains that in disaster literature, definitions of vulnerability "refer to the susceptibility to suffer damage in a potentially dangerous event, either natural, economic or political. Vulnerability thus stresses the condition of a society, which makes it possible for a hazard to become a disaster."[39] More specific to climate change, vulnerability is related to two factors: a society's exposure to stress and its ability, or inability, to cope.[40] Climate change literature often emphasizes the vulnerability of marginalized groups such as indigenous peoples and smallholder farmers. These are vulnerable societies, but as scholars point out, the label is unproductive and complicates discussions around climate change adaptation.

In a UNESCO report, Nakashima et al. provide a productive suggestion to how vulnerability as a label can be reassessed:

> In summary, rather than describing indigenous men and women as vulnerable to climate change, it would be more accurate to emphasize their high degree of exposure-sensitivity, while drawing attention to their considerable adaptive capacity. Adaptive capacity contributes to resilience in that it relates to people's ability to modify their behaviour and environment to manage and take advantage of changing climatic conditions.[41]

Considering how resilience, adaptive capacity and vulnerability are connected both to each other and to the concept of adaptation, reframing one means reframing all. The

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[39] Gaillard, "Vulnerability, Capacity and Resilience," 219.
[40] D.J. Nakashima, K. Galloway McLean, H.D. Thulstrup, A. Ramos Castillo, and J.T. Rubis, *Weathering Uncertainty: Traditional Knowledge for Climate Change Assessment and Adaptation* (Paris and Darwin: UNESCO and UNU, 2012), 39.
[41] Ibid., 41.

reframing of these terms relates directly to the emergence of traditional knowledge as a crucial part of adaptation strategy.

Scholar Lars Otto Naess explains the emergence of traditional knowledge in adaptation literature, using instead the term local knowledge. According to Naess, "attention to linkages between local knowledge and CCA has emerged in the literature mainly over the past decade […] The majority of the early studies on local knowledge and climate change focused on Arctic environments, but attention has since spread to all parts of the world." While slightly overly optimistic in terms of the global acknowledgment of TK in adaptation, Naess rightly explains the recent recognition of TK in CCA. This means that, as a new concept in adaptation literature, there is significant debate about TK's role, promise and limitations, not as an individual practice, but as part of adaptation strategy.

As there are multiple terms that refer to traditional knowledge, including local knowledge, ancestral knowledge, and traditional ecological knowledge, the meaning of these terms can be confusing. Nakashima et al. explain that the terms "make reference to knowledge and know-how accumulated across generations, which guide human societies in their innumerable interactions with their surrounding environment."[42] A similar definition by Berkes is "'a cumulative body of knowledge, practice, and belief, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment.'"[43] This form of knowledge emphasizes the importance of cultural transmission and embodies a worldview that can contribute to the

[42] Nakashima et al., *Weathering Uncertainty*, 29.
[43] Ibid.

reframing of adaptation. While anthropogenic climate change is now intensifying, climate variability is not a new phenomenon and therefore, the utilization of knowledge that has been passed down through generations should not be disregarded.

There is a growing number of scholars that support the inclusion of traditional knowledge in climate change discussions, not as an old or outdated practice, but as a current and relevant practice deserving of attention. As a result of a study involving Quechua farmers in Bolivia, Berkes and Boillat write, "these considerations highlight the importance of traditional knowledge to assess and adapt to climate change."[44] Reiterating this growth in awareness and support, Nakashima et al. summarize, "all of these efforts have contributed to an increasing realization that the observations and assessments of indigenous peoples and local communities offer valuable in situ information, provide for local verification of global scientific models and satellite data sets, and ensure that adaptation measures align with local needs and priorities."[45]

The emergence of traditional knowledge as an adaptation strategy presents significant questions and issues, including if and how to incorporate traditional and scientific knowledge and how TK might be misused. However, this thesis focuses on the use of TK as a climate change adaptation strategy specifically within Peruvian potato farming. This has been explored slightly in the literature, but less so than in regions such as the Arctic. Furthermore, as climate change adaptation is influenced by certain stakeholders, such as NGOs, and portrayed by others, such as the media; this thesis looks at TK in climate change adaptation from the four perspectives of 1) potato

[44] Sébastien Boillat and Fikret Berkes, "Perception and Interpretation of Climate Change among Quechua Farmers of Bolivia: Indigenous Knowledge as a Resource for Adaptive Capacity," *Ecology and society* 18, no. 4 (2013): 10.
[45] Nakashima et al., *Weathering Uncertainty*, 25.

farmers, 2) the U.S. media, 3) the IPCC, and 4) institutions. Elements of these four perspectives in relation to climate change and Peruvian potato farming are referenced in the literature, however, there has not yet been an analysis of how the four perspectives together contribute to the climate change discussion.

Methodology

The methodology of my thesis is broken into two sections: one, direct observation and interviews conducted within The Potato Park in Pisac, Peru, and two, the analysis of existing literature and non-peer reviewed sources, such as newspaper articles and development reports.

1) Direct observation and interviews

Map of Peru (source: CIA World Factbook; http://cia.gov).

During November 2012, I lived in the community of Paru Paru, which is one of the six indigenous communities located within the Potato Park, outside of Pisac in the Peruvian Andes. The first phase of my research comes from interviews and observations from the week I spent in this community. During this week, I interviewed

Papa Arariwas and spoke with the directors of Association ANDES to learn about the role the organization plays in the Potato Park and its stance on climate change adaptation. I also observed how potatoes are planted and tended to, and attended community meetings and conferences about planning (e.g. when to plant) and how to deal with potato pests. These interviews and observations contribute to the background and context of my thesis and also provide farmers' experiences.

2) Literature, newspapers and reports

The second element of my research involves analyzing both peer-reviewed academic literature and non-academic sources, such as newspapers. In both of these categories, I researched topics including climate change, potato farming, adaptation, traditional knowledge and the significance of native potatoes in Andean life and culture in order to fully cover the complexity of my research question.

The first category, academic sources, is essential to both the background of my thesis and the literature review, as it helps assess what has and is being said in order to identify holes, disagreements and where I can contribute. The search methods I used most extensively in this category were Google Scholar, Academic Search Premier and JSTOR. These search engines allowed me to analyze articles from journals such as *Theoretical and Applied Climatology*, *Mountain Research and Development*, *Plant Disease* and *The American Journal of Potato Research*.

The second category, non-academic sources, has helped me identify how farmers, U.S. media, IPCC and institutions are approaching the issue of Peruvian potato farming and adaptation. By analyzing my personal interviews with Association ANDES and the Potato Park as well as data and interviews with farmers from other sources such

as Oxfam; newspaper articles (*San Francisco Chronicle*, *Washington Post*, *Miami Herald*); recent assessment reports by the IPCC (both the fourth and fifth); reports by NGOs (*Oxfam*, *Practical Action*) and multilateral institutions (*World Bank*, *Inter-American Development Bank*), I was able to assess how each stakeholder portrays climate change, potato farmers and the role of adaptation. A significant part of this process was identifying the similarities and differences between the stakeholders' approaches to adaptation in order to assess the most effective adaptation strategy.

3) Limitations

As this research attempts to cover multiple perspectives and discuss current and debatable topics, such as the role of traditional knowledge, there are limitations to consider. With more time and access to actual Peruvian farming communities, such as the Potato Park, my research could have been more heavily based in personal communication rather than the analysis of sources once removed from the actual farmers. Furthermore, as an undergraduate college student living in Oregon, it was challenging to not place my own biases into the process. For example, discussing traditional knowledge as a non-indigenous person is challenging. I found myself second-guessing my analysis given my lack of experience and exposure to traditional knowledge as a practice. This does not mean that my opinions or analyses are invalid, but it is necessary to keep in mind.

Broader context and significance

As traditional knowledge emerges as an adaptation strategy and is given more weight in climate change policy, there will be ongoing debates about its effectiveness and ethicality. Regardless, it is significant to note this evolution in climate change

discourse, recognizing the need to reframe adaptation and incorporate different worldviews and forms of knowledge. Therefore, this research and thesis, while focused on Peruvian potato farming, is applicable globally in the development of adaptation strategies for agricultural communities facing climate change. For example, an Oxfam study outlines parallel situations to that of Peruvian potato farming in both Vietnam and Zimbabwe. Indigenous Vietnamese rice farmers and Zimbabwean maize farmers are both using traditional practices to develop adaptation strategies to climate change, which is already impacting their crop yields and planting patterns. According to the Oxfam report:

> The three sets of data survey suggest that, in terms of responding to climate variability and change, farmers are resourceful and act based on locally-developed (indigenous) knowledge and practices. Although traditional knowledge is diverse and site-specific, the data show that observable natural and/or environmental indicators are the main means for farmers to predict weather and to develop their corresponding adaptation strategies.[46]

It is true that traditional knowledge varies across communities; however, in the broader context it has been and is becoming a key resource for farmers to adapt to climate change. TK is also a tool for institutions, governments, and policymakers to consider the historical and cultural contexts around climate change in order to develop more interdisciplinary, creative, and successful adaptation strategies.

[46] *Building on farmers' perceptions*, 10.

Chapter 1: Peruvian Potato Farmers Approach to Adaptation

In assessing climate change adaptation by Peruvian potato farmers, there are multiple perspectives to consider such as the outside media reporting on the issue, the IPCC summarizing the latest adaptation strategies, and NGOs working to provide the farmers with support, through loans, workshops or other methods. However, one critical perspective to present is that of the farmers themselves, as they are the ones actually observing and interpreting the climatic changes and deciding if and how to react. This chapter will present potato farmers' views on adaptation, through their own voices and opinions.

The primary limitation of this chapter is the difficulty in accessing these voices and opinions since the majority of the farmers' opinions are presented through the lens of NGO statements or newspaper articles. Meaning, other than going to Peru and talking directly with the farmers, which presents its own limitations, there are few sources of information that come straight from the farmers. That is not to say that the farmers' opinions presented in news sources and NGO reports are false, but those opinions can be altered depending on what the author is discussing. Therefore, in addition to presenting the direct opinions of farmers, through personal and secondary interviews, I will discuss the cultural history of the native potato and how potatoes are grown. While not direct opinions from farmers, this cultural and historical context helps explain how farmers have approached adaptation to historical climate variability. This can shed light on how farmers are adapting today and how they will adapt in the future.

Background

Today, the native potato is central to life in the Andean highlands of Peru as well as in many communities across the globe. Native potatoes are an important nutrient source for Peruvians, both in rural and urban areas, containing half the daily requirement of vitamin C when boiled.[47] In the highlands of Peru, potatoes are eaten for breakfast, lunch, and dinner. However, the centrality of the potato does not come only from its nutritional value and climate compatibility, but also from the role it plays in Peruvian history and culture.

Potatoes are said to have fueled the great Incan empire, which spanned from southern Colombia to central Chile in the 15th and 16th centuries. The native potato is essential to the Quechua people, the descendants of the Incas. According to Papa Arariwas in the Potato Park, who identify as Quechua, the potato is the basic nutrient source and it is "how we eat [and] how we live."[48] In Quechua culture, the potato plays a role in structuring everyday routines, upholding important planting and marriage traditions, and connecting with the highland's historical past.[49]

Cultural significance of the potato

In Peru, the potato is central to the culture. Potatoes originated in and are still grown in the highland region where there is a large indigenous Quechua-speaking population (comprised mostly of farmers).[50] Quechua culture and tradition are closely

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[47] Caddie Brain, "Why the future belongs to the potato?" *Australian Broadcasting Corporation*, Dec. 19, 2013, http://www.abc.net.au/news/2013-12-04/native-potato-cip-international-centre-peru/5096840.
[48] Papa Arariwa, interview.
[49] Stephenson, "The Quechua."
[50] The Aymara are another indigenous group in Peru and they live mainly in the southern Andes region. There are between 500,000 and 600,000 Aymara in Peru. While potato farming is also an Aymara practice, the Quechua population is the larger indigenous group; therefore, I refer to Quechua people with the term indigenous unless specifically noted. The Aymara would likely be studied in the context of climate change and potato farming in Bolivia where there is a larger population.

linked with the potato as a food source and cultural symbol. The Quechua people in highland Peru make up approximately one-third of Peru's total population; eight million Peruvians identify as Quechua.[51] Quechua is Peru's second official language and the country's most widely spoken indigenous language. Quechua speakers represent 39 percent of the population in urban areas and 86 percent of the rural population.[52]

The Quechua cultural practices around potato farming are as significant to consider as the technical practices, such as how deep to plant the seed. An example of a cultural practice comes before planting and harvesting potatoes. Quechua people practice a ritual called *quintu*, in which they "give thanks to the Pachamama[53] [by placing] multiple sets of three coca leaves, which are combined with llama fat and placed into the first hole where potatoes are to be planted."[54] The potato is not simply an expendable crop, planted only for consumption, but is integrated into the cultural history and practices of the region.

The potato is also used in marriage proposals. When a man and woman want to be married, the wife-to-be must pass a test involving a lumpy, cone shaped purple potato. The potato is named directly for its ability to "make the daughter-in-law cry."[55] The wife-to-be must carefully peel the potato and if she removes more of the peel than is necessary, she will not be able to marry the man.[56] Reiterating the indispensability of the potato, this tradition could not be done with just any crop. The complex and lumpy

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[51] "Indigenous Cultures," *University of Minnesota*, 2011, http://lt.umn.edu/earthducation/expedition4/indigenous-cultures/.
[52] Anna Saroli, "Can Quechua Survive?" *Cultural Survival Quarterly* 25 (2001).
[53] Pachamama means Mother Earth in Quechua and is an important cultural symbol in the Andes.
[54] Stephenson, "The Quechua."
[55] Silberner, "In Highland Peru."
[56] Ibid.

shape of native potatoes presents a challenge for the woman, ensuring that she is worthy, and capable of preparing such an essential food.

How potatoes are grown: Physical and cultural methods

Potatoes grow in the highland region of the Andes Mountains (spanning the countries of Colombia, Ecuador, Peru, Bolivia, and Chile) and can be cultivated at altitudes up to 4,600 meters above sea level (MASL) where conditions are too harsh for other crops.[57] The Andes Mountains are characterized by high peaks and steep slopes, and have been inhabited by the Quechua and Aymara people for centuries. The potato is largely a subsistence crop and traditional tools, such as the Incan hand-plow, are still widely used for tilling and preparing the soils of the chacras. There are three distinct regions (according to altitude) in which potatoes are grown: the low region, between 3,000 and 3,500 MASL, the middle region between 3,500 and 4,000 MASL, and the high region, above 4,000 MASL.[58] Considering the difference in elevation between these regions, farmers can easily tend to their chacras in the lowest region, but must spend more traveling time in order to reach their potatoes in the highest region.

Unlike industrial agriculture where a farmer might grow just one or two single crops, Peruvian potato farmers grow a variety of native potatoes. For example, one family might grow close to 140 different varieties.[59] Growing such a diversity of varieties not only provides farmers with potatoes for different uses, but also helps reduce the impact of pests and climate changes. According to the scholar Stephenson, there are four traditional categories of potatoes: chuño potatoes are prepared through a freezedrying method and then stored for 10-15 years; the moraya potato is prepared

[57] Brain, "Future belongs to the potato."
[58] John Reader, *Potato: a history of the propitious esculent* (New Haven: Yale University Press, 2009), 4.
[59] Stephenson, "The Quechua."

similarly, but is freezedried in running water; a third type is used for soups and dishes that require peeled or cut potatoes; and the fourth type of potato is reserved for watya, which uses a small wood-fueled oven.[60]

The potato's growing calendar is directly linked with Peru's annual climate patterns. Peru's annual climate is based around two seasons, rainy and dry.[61] The first planting date "is chosen from considerations on rainfall events at the beginning of the growing season"[62] and the success of the year's crop depends on the season's weather. A dominant influence on Peru's climate is El Niño-Southern Oscillation (ENSO). According to Ludescher et al., ENSO "is the most important contemporary natural climate variability. It can be perceived as a self-organized dynamical see-saw pattern in the Pacific ocean-atmosphere system, featured by rather irregular warm (El Niño) and cold (La Niña) excursions from the long-term mean state."[63] For my research, it is not necessary to understand ENSO as a global phenomenon; rather, the key is to recognize how ENSO impacts Peru's highland climate and therefore, the potato farmers. In Peru, El Niño results in climate variability and uncertainty, making it challenging for farmers to determine when to plant crops.[64] As Orlove et al. explain, based on their scientific study published in *Nature*: "Though the effect of temperature on crop growth is not obvious, the consequence of ENSO for potato yields is convincingly demonstrated from preliminary analysis of potato-yield data from the Puno department near Lake Titicaca.

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[60] Stephenson, "The Quechua."
[61] *Building on farmers' perceptions*, 7.
[62] Sanabria and Lhomme, "Climate change and potato cropping," 685.
[63] Josef Ludescher, Avi Gozolchiani, Mikhail I. Bogachev, Armin Bunde, Shlomo Havlin and Hans Joachim Schellnhuber, "Improved El Niño forecasting by cooperativity detection," *PNAS* 110, no. 29 (2013): 11742.
[64] Sanabria and Lhomme, "Climate change and potato cropping," 683.

Significant reductions in potato yield are observed for warm ENSO years."[65] In a later publication by Orlove et al. they write "because potatoes are sensitive to drought, it makes sense that they feel the effects of the lowered precipitation El Niño brings. The higher-than-normal temperatures during an El Niño may also stress the crop."[66]

Andean Potato farmers also observe the Pleiades grouping of stars to predict variations in rainfall, influencing planting dates. According to Orlove et al. farmers observe 1) the brightness of the star cluster, 2) the timing of the heliacal rise, 3) the size of the cluster, which relates to atmospheric clarity, and 4) the relative position of the brightest star.[67] Orlove et al. explain how the farmers interpret and act on these observations:

> [Farmers] use these attributes to forecast the timing and quantity of rains and to estimate the size of the harvest, concentrated between March and May of the following year. The attributes associated with clearer skies indicate earlier and more abundant rains and larger harvests, while the opposite is linked to less clear skies. If poor rains are predicted, villagers postpone the planting of potatoes […] By delaying for 4-6 weeks after the usual October-November planting time, the farmers reduce these risks by starting the potato crop in months of higher rainfall. This forecasting system is likely to be more than four centuries old. The Incas […] worshipped and closely observed the Pleiades. It is not established that they used its appearance to forecast weather, but several sources do document such forecasts soon after the conquest.[68]

This practice is an example of indigenous knowledge, used both in the past and present, which helps farmers maintain yields based on observations of the environment. Overall, the study's evidence affirms that the Pleiades observations are a successful practice. In

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[65] Benjamin S. Orlove, John C. H. Chiang and Mark A. Cane, "Forecasting Andean rainfall and crop yield from the influence of El Niño on Pleiades visibility," *Nature* 403 (2000): 71.
[66] Benjamin S. Orlove, John C. H. Chiang and Mark A. Cane, "Ethnoclimatology in the Andes: A cross-disciplinary study uncovers a scientific basis for the scheme Andean potato farmers traditionally use to predict the coming rains," *American Scientist* 90, no. 5 (2002): 431, accessed Dec. 12, 2013, http://www.jstor.org/stable/27857722.
[67] Orlove et al., "Forecasting Andean rainfall and crop yield," 68.
[68] Ibid.

support, Orlove et al. write, "the farmers believe that they can use the particular appearance of the Pleiades to forecast the timing and quantity of precipitation that will fall in the rainy season, months later. Although this odd form of astrology might seem just a quaint superstition […] our research has, in fact, uncovered its scientific basis."[69]

Farmers' approaches to adaptation

Among the impacts of climate change on Peruvian potatoes, the increased presence of potato diseases is a high concern. One main action farmers are taking to adapt to this increase is to move their chacras higher up the mountain relative to the potato's three planting zones (low, middle, and high). Farmers are moving the potatoes from the low zone to the middle zone and in some cases, the middle zone to the high zone. Diseases such as late blight become more rampant in warmer temperatures and therefore, have been especially challenging to control in the lowest zone. With the rising temperatures of climate change, the potato diseases are occurring at higher altitudes. In an interview with a Papa Arariwa at the Potato Park, he explained that the potato is "rising" in terms of altitude.[70] He said that in the Potato Park, they no longer produce potatoes in the lowest zone due to the large amount of diseases.[71] Moving the chacras higher up the mountain helps farmers maintain a sufficient potato yield for their families. Not all potato varieties can grow in the higher zones, given the colder conditions, but as previously noted farmers have a great number of varieties to choose from.

[69] Orlove et al., "Ethnoclimatology in the Andes," 431.
[70] Papa Arariwa, interview.
[71] Ibid.

In addition to moving their chacras higher, farmers in the highlands are also adapting to climate change by planting a diversity of potato varieties, a strategy that has been practiced for centuries. As explained by the International Potato Center, "traditionally, vulnerability to pests and disease has been addressed by diversifying risk. Ancestral farming practices in the Andes basically follow the 'don't put all your eggs in one basket' credo by planting a diverse range of potato species across numerous plots spread out over a wide area."[72] While this practice is not a new idea, having been done for centuries, in the context of anthropogenic climate change, it is an effective adaptation strategy. By planting a variety of potato types and determining which varieties are resistant to different factors, farmers better their chance of having a successful potato yield even with unexpected frosts, unpredictable rainfall, and increasing diseases. As several Papa Arariwas explain, in the past twenty years, the number of varieties they cultivate has increased, providing a greater variety of potatoes with possible resistance to climate change impacts.[73] This ability to diversify potato varieties helps ensure that farmers have potatoes to eat and feed their families, and helps them identify which varieties are more resilient in the face of climate change.

The adaptation strategies that move fields higher and diversify potato varieties, as well as the practice of observing the Pleiades, are all different examples of the implementation of traditional knowledge. For example, Boillat and Berkes explain, "Andean indigenous peoples have been experts in dealing with climate uncertainty and risk, significant because climate change is often manifested in terms of increases in variability and in extreme weather events.

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[72] "Climate Change Takes a Toll on Andean Potato Farming," International Potato Center, http://cipotato.org/press-room/press-releases/climate-change-takes-a-toll-on-andean-potato-farming.
[73] Papa Arariwa, interview.

They interpret and react to climate change, drawing on traditional knowledge as well as new technologies, […] diversification being a universal risk diffusion strategy."[74] These strategies, both practiced by the farmers themselves and discussed in current literature, reinforce the effectiveness of adaptation strategies that stem from traditional knowledge.

[74] Boillat and Berkes, "Perception and Interpretation of Climate Change," 2.

Chapter 2: Climate Change and Potato Farming in the U.S. Media

In today's world, connected intricately by the Internet and social media, there are endless sources of information. Identifying these sources, not to mention their credibility, is a significant task. Print newspapers are no longer the main news source, as people can acquire information from an array of websites, online magazines, blogs, and other sources. To simplify this, this chapter will present news sources from well-known and widely read newspapers (*San Francisco Chronicle*, *Washington Post*) and news sources (*NPR*) as well as press releases from well-known institutions (United Nations Environmental Programme, International Potato Center). The articles from these sources reference the concept of adaptation in relation to climate change and Peruvian potato farming and ultimately suggest traditional knowledge as an effective adaptation strategy.

The reason for including only U.S. media sources in this chapter is based on the fact that the U.S. is one of the top contributors to climate change in terms of emissions. Therefore, it is significant that the U.S. population is informed on the impacts climate change is having. I am aware of the limitations that excluding non-U.S. media sources might have, but this is an interesting opportunity to identify how the U.S. media is presenting the issue of Peruvian potato farming and how it approaches the concept of adaptation.

Throughout the news articles about Peruvian potato farming and climate change several recurrent themes emerge, some of which are in conflict. The themes presented include: 1) farmers are vulnerable and ill-prepared to deal with climate change; 2) adaptation, whether from the outside (e.g. from NGOs) or the inside (e.g. from the

farmers) is a necessity and a new idea; and 3) traditional knowledge is the key to confront climate change.

While there are points of overlap among these themes, the authors often disagree with each other and create confusion. For example, in a 2008 article originally published in the *Miami Herald* (republished on Fresh Plaza), Eliza Barclay writes about changing weather patterns in the Peruvian highlands and says "farmers like Huanuco, who depend heavily on a predictable climate, are finding themselves vulnerable and ill-prepared to handle new pests and diseases that have materialized as temperature and rainfall patterns have shifted."[75] This quote portrays farmers as ill equipped with the knowledge and/or technology to adapt to climate change, thus making them more vulnerable to changes. While it is true that farmers are vulnerable to climate change due to "historical colonialism, land dispossession, and marginalization,"[76] it is false to present them as lacking the ability and experience to deal with shifting climates. Potato farmers in the highlands have been confronted by changing weather patterns due to ENSO for centuries. While this experience does not mean that farmers will not face difficulties with climate change, it is necessary to acknowledge that modern anthropogenic climate change is not the first time the farmers' environment and climate has shifted.

In direct contrast, an article by Silberner published in *NPR* quotes an interview with Alejandro Argumedo of Association ANDES, affiliated with the Potato Park. Argumedo explains that "throughout history, these farmers have nurtured thousands of

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[75] Eliza Barclay, "Peru's potato farmers adapt to climate change," *Miami Herald*, Sept. 16, 2008, http://www.freshplaza.com/article/28715/Perus-potato-farmers-adapt-to-climate-change.
[76] Mark Carey, "Apocalyptic Climate Change Narratives and the Ecologically Noble Indian: Historical Perspectives from the Andes," Paper presented at the American Society for Environmental History annual meeting, San Francisco, March 2014, 2.

potato varieties, because El Niño has always brought changes in the weather […] 'they have to adapt their crops to those conditions, and they look for how to create conditions in every little niche […] 'so the diversity of crops they created is a response to the chaos of the system.'"[77] This quote recognizes the potato farmers' experience with variable climates in the past and their ability to cope with these changes thanks to their experimentation with, knowledge of, and access to such a diversity of potatoes. Argumedo's interview disagrees with Barclay's article above by portraying the farmers as having the tools to cope with climate change due to their historical knowledge of adaptation and utilization of a diversity of potato varieties.

Considering how multiple news articles contradict each other, it is challenging to analyze them to present the media's stance on how farmers can most effectively adapt to climate change. In fact, there is not one view on adaptation that is consistent throughout these articles. Rather, there are articles that present certain opinions on the farmers' approach to adaptation, such that it requires outside technology, and others that discuss contrasting opinions, such that farmers already have the tools to adapt in their traditional knowledge. In analyzing these news articles using current adaptation literature however, the articles arguing that farmers' effective adaptation comes from their traditional knowledge make a more convincing argument.

In a 2010 *Newsweek* article, the authors explain the farmers' adaptation strategies. "The campesinos have a natural weapon against climate change: the rich diversity of crop strains that flourish in the Andes's diverse system of habitats […] Peru has 2,700 native varieties of potato […] suitable to different climate circumstances, including length of growing season, water and nutrient requirements, and pest

[77] Silberner, "In Highland Peru."

resistance."[78] This article suggests that the potato diversity, which is already part of the farmers' practice, is essential in adapting to climate change. Farmers can select for the varieties that are more resistant to higher temperatures, pests, and unexpected frosts (some of the current effects of climate change), and they have an expansive selection to choose from. If one variety is not highly pest resistant, but does well in cold frosts, farmers could plant that variety at a higher altitude. Each potato variety does not need to be resistant to all climate effects, rather the farmers must utilize a selection of varieties that include resistance to different effects, to increase the chance of survival overall.

Krystyna Swiderska, a prominent researcher at the International Institute for Environment and Development (IIED), emphasizes the importance of diversity and seed access in a recent publication about climate change adaptation and traditional knowledge. Swiderska writes, "farmers in all study sites choose traditional crop varieties over modern ones because they are better adapted to local conditions and are more likely to survive environmental stress and climate variability."[79] In the case of potato farmers in the Peruvian highlands, traditional potato varieties have been adapted to local conditions over centuries, including climate variability associated with ENSO.

The *NPR* article discusses the topic of tradition versus modern seeds explaining, "this Andean potato heritage could be the solution to climate change for the indigenous farmers. They turned down new varieties the government offered because the plants would need fungicides, pesticides, and fertilizers. They prefer […] varieties that have

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[78] "Peruvian Farmers Adapt to Global Warming," *Newsweek*, March 13, 2010, http://www.newsweek.com/peruvian-farmers-adapt-global-warming-93101.

[79] Krystyna Swiderska, Yiching Song, Jingsong Li, Hannah Reid and Doris Mutta, "Adapting agriculture with traditional knowledge," *International Institute for Environment and Development (IIED)*, Oct. 2011, 2.

been boiled, fried, mashed and poached for centuries."[80] This statement, alongside Swiderska's analysis, illustrates a key reason for the need for traditional knowledge in climate change adaptation. The farmers have a lifetime of experience, plus passed down knowledge, working with these varieties. Introducing modern varieties that require new technologies would require the farmers to learn and become accustomed to an entirely new system and method. That is not to say that the farmers would be incapable of learning that new system, but why not use their current one if it is already ingrained and proven to work with past climate variability.

In the same publication, Swiderska explains that "it is because traditional varieties or landraces are more genetically diverse than modern varieties that they can better withstand environmental stress such as lack of water or nutrients […] farmers understand and appreciate diversity – not only as a natural gene bank for resilient crop varieties but also as a key farming practice to reduce risk."[81] This is another example of how TK can be an effective adaptation strategy for the potato farmers. The diversity of potato varieties can serve as a way to determine which varieties are resilient to certain climate effects, increase the farmers' chances of producing a decent yield, and also preserve these practices for future generations.

As Hayes writes in a *Washington Post* article, "the women of Aymara rely on their ancestral knowledge of each tuber's virtues as they sort through hundreds of potatoes at harvest time, deciding which to eat, sell, store for seeds or trade to diversify their stock. 'Our parents and grandparents have taught us since we were children […]

[80] Silberner, "In Highland Peru."
[81] Swiderska et al., "Adapting agriculture with traditional knowledge," 2.

the knowledge is part of our nature.'"[82] This quote illustrates the pride the farming communities have in their traditional knowledge and also explains the importance of the passed down TK in understanding and working with such a diversity of potatoes. Hayes's article also touches on another element of Swiderska's publication, which says, "another key advantage of traditional crop varieties – particularly for poor communities – is that they are cheap and easily accessible. This is because they come from farmers' own saved seeds and are commonly shared within and between villages."[83]

In an article by Sarah Stankorb published on American University's website in 2012, the author summarizes an American professor's recent visit and work in the Potato Park in Peru. Stankorb writes that in the Potato Park, "[the professor] found, on steep farm plots, potato farmers facing a modern crisis with the trade of their ancestors and a method that models a more intimate way to farm."[84] Stankorb's quote emphasizes the knowledge that farmers have acquired from past generations and recognizes the significant role this knowledge and method play in potato farming today. The quote summarizes the theme throughout these articles, that traditional knowledge is a crucial contributor to climate change adaptation.

In analyzing the news articles that do not acknowledge or emphasize traditional knowledge, it is interesting to see how the portrayal of the state of potato farming and climate change would change if the author considered traditional knowledge as an adaptation strategy. For example, an article published by the United Nations

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[82] Monte Hayes, "Peru Celebrates Potato Diversity," *Washington Post*, June 24, 2007, http://www.washingtonpost.com/wp-dyn/content/article/2007/06/24/AR2007062400727.html.
[83] Swiderska, "Adapting agriculture with traditional knowledge," 2.
[84] Sarah Stankorb, "Peruvian Farmers Reject Genetically Modified Seeds," *American Today*, Feb. 23, 2012, http://www.american.edu/americantoday/20120223-Peruvian-Potato-Farmers-Reject-Genetically-Modified-Seeds.cfm.

Environmental Programme (UNEP) News Center discusses a radio broadcast, which is presented in Quechua and talks about adapting to climate change. The authors Alexander Juras and Mia Turner write, "living at altitudes of over 3,000 meters, these communities are far from the urban knowledge hubs that are researching solutions for dealing with climate change, and largely rely on the radio for information."[85] This quote implies that no climate change solutions are coming from the highland region or the farmers themselves. It is problematic because it portrays the farmers as needing to acquire solutions for climate change from outsiders and does not recognize the strategies farmers have from centuries of passed down knowledge and experience adapting to ENSO climate variability. If the article acknowledged the significant role of traditional knowledge as an adaptation strategy, there would still be challenges to discuss, such as how to work with both TK and certain technical solutions, but the lack of access to places that research climate change solutions would not be one.

In another article by Barclay, published in the *San Francisco Chronicle*, she discusses how the Agriculture Ministry in Peru is working to provide highland farmers with the "technical know-how"[86] to cope with climate change. Barclay also quotes a Peruvian farmer who says, "'we know that climate change means we need to try new things, but we don't know how to do it.'"[87] If this article, along with the Peruvian Agriculture Ministry, regarded traditional knowledge as an effective adaptation strategy, this quote could present a more accurate perspective. For example, at this

[85] Alexander Juras and Mia Turner, "International Indigenous Peoples Day: Radio and Climate Change in the Andes," *United Nations Environmental Programme News Centre*, Aug. 9, 2012, http://www.unep.org/newscentre/default.aspx?DocumentID=2692&ArticleID=9249.
[86] Eliza Barclay, "Warming Andes stymies Peruvian potato farmers," *San Francisco Chronicle*, Oct. 5, 2008, http://www.sfgate.com/green/article/Warming-Andes-stymies-Peruvian-potato-farmers-3267106.php#page-2.
[87] Ibid.

point, it does seem necessary to adapt to climate change, however, those adaptation strategies do not need to come from all "new things." The Agriculture Ministry might provide some technical solutions, along with explanations of how to implement them, but the farmers can also provide certain adaptation strategies, coming from TK.

Another example of an article that would present a drastically different situation with the consideration of traditional knowledge is from a 2012 publication of the *New Agriculturist*. The author says that "with little knowledge about new technologies that would increase the resilience of the agriculture sector, smallscale farmers are particularly vulnerable to the effects of climate change."[88] Again, this quote fails to recognize the farmers' experience and ability to adapt to changes in climate patterns or the possibility that traditional knowledge could increase the resilience of the agriculture sector. Farmers are vulnerable to climate change, but the vulnerability comes from marginalization, not the lack of tools to establish resilience.[89]

[88] "Resilient agriculture: training Peruvian farmers," *New Agriculturist*, 2012, http://www.new-ag.info/en/focus/focusItem.php?a=2632.
[89] Nakashima et al., *Weathering Uncertainty*, 40.

Chapter 3: Intergovernmental Panel on Climate Change

The Intergovernmental Panel on Climate Change (IPCC) is "the leading international body for the assessment of climate change [and] is a scientific body under the auspices of the United Nations (UN). It reviews and assesses the most recent scientific, technical and socio-economic information produced worldwide relevant to the understanding of climate change. It does not conduct any research."[90] The IPCC only represents one aspect of the scientific studies and data on climate change, but is the most well-known entity involved in presenting climate change science and policy analysis. Given the authority and expertise of the IPCC as a key participant in the climate change discussion, it is crucial to include the panel's perspective on adaptation as part of this thesis.

While the IPCC is a key player in climate change discussions concerning science, policy and social impacts, it has faced certain criticisms. One critique, according to Ho-Lem et al., from the University of British Columbia, is that European and North American experts make up "more than 75% of all authors."[91] This is a concern as countries not represented in the process might be less trusting of the legitimacy of the reports; though the IPCC is working to diversify representation. Another related critique concerns the IPCC's incorporation, or lack thereof, of sources from traditional and indigenous knowledge in contrast to peer-reviewed science.

Until this year, the latest available assessment report from the IPCC was the fourth (AR4), published in 2007. Therefore, critiques in the literature mainly discuss the

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[90] "Organization," *Intergovernmental Panel on Climate Change*, http://www.ipcc.ch/organization/organization.shtml.

[91] Claudia Ho-Lem, Hisham Zerriffi and Milind Kandlikar, "Who participates in the Intergovernmental Panel on Climate Change and why: A quantitative assessment of the national representation of authors in the Intergovernmental Panel on Climate Change," *Global Environmental Change* 21 (2011): 1308.

content in this seven-year-old report. According to an article published in *BioScience* by Alexander et al., "because the IPCC is subject to intense public scrutiny, it tends to rely primarily on information from peer-reviewed scientific studies, and, in the past, has largely excluded traditional indigenous knowledge as a source of information for its assessment reports as a result of a general bias against evidence from non-peer reviewed sources."[92] In considering this critique, it is significant to note the references to traditional knowledge (as a concept rather than a source for the actual assessment) throughout the fourth, and now fifth assessment reports. The release of the fifth assessment report (AR5) in March 2014 allows us to compare reports, noting changes the approach to adaptation, and the recognition and role given to the concept of traditional knowledge. In looking specifically at how often and in what context traditional knowledge is referenced throughout the reports, it becomes clear that it is considered by the IPCC to be an effective adaptation strategy.

Instead of examining the common critiques in the literature such as the underrepresentation of non-North American contributors and the lack of traditional knowledge as an information source, I focus on one specific critique below and on several improvements by analyzing the fourth and fifth reports both individually and in comparison. Since the IPCC deals with climate change in a broad sense, the analysis I focus on relates more specifically to the Andes region and what is considered effective adaptation (since these are the two main components of my research question). My main critique is the IPCC's lack of recognition of current traditional knowledge

[92] Clarence Alexander, Nora Bynum, Elizabeth Johnson, Ursula King, Tero Mustonen, Peter Neofotis, Noel Oettlé, Cynthia Rosenzweig, Chie Sakakibara, Vyacheslav Shadrin, Marta Vicarelli, Jon Waterhouse and Brian Weeks, "Linking Indigenous and Scientific Knowledge of Climate Change," *BioScience* 61, no. 6 (2011): 477, accessed Feb. 20, 2014, http://www.jstor.org/stable/10.1525/bio.2011.61.6.10.

specifically in the Andes region of South America in both the fourth and fifth assessment reports. For example, in discussing the role of TK in Nigeria, Burkina Faso, and other African communities in the Africa chapter of the AR4, Boko et al. write "the term 'indigenous knowledge' is used to describe the knowledge systems developed by a community as opposed to the scientific knowledge that is generally referred to as 'modern' knowledge. Indigenous knowledge is the basis for local-level decision-making in many rural communities. It has value not only for the culture in which it evolves, but also for scientists and planners striving to improve conditions in rural localities."[93] Furthermore, in the "Cross-chapter case studies" section of the AR4, Parry et al. write, "this Arctic indigenous knowledge offers detailed information that adds to conventional science and environmental observations, as well as to a holistic understanding of environment, natural resources and culture. There is an increasing awareness of the value of Arctic indigenous knowledge and a growing collaborative effort to document it."[94] These examples are significant in the recognition of traditional knowledge in some parts of the world, but the IPCC reports could improve with the incorporation of TK practiced the Peruvian Andes such as the understanding of the use and resilience of native potato varieties.

While the fifth assessment report does not recognize traditional knowledge in the Peruvian Andes more than the fourth, other than one sentence referencing crop

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[93] M. Boko, I. Niang, A. Nyong, C. Vogel, A. Githeko, M. Medany, B. Osman-Elasha, R. Tabo and P. Yanda, "Africa," in Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, eds. M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson (Cambridge: Cambridge University Press, 2007), 456.

[94] M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson (eds.), "Cross-chapter case study" in Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (Cambridge: Cambridge University Press, 2007), 866.

diversification,[95] other improvements are worth noting. For example, it is significant that the value placed on traditional knowledge has increased in the 5AR. For example, as Jones et al. explain in Chapter 2 of the 5AR:

> Indigenous forms of knowledge – including the specialized knowledge of any stakeholder – are becoming increasingly relevant for climate services *(high confidence)*. Indigenous knowledge in the form of oral histories and other traditional knowledge are being compared or combined with remote sensing technologies and model-based scenarios to co-produce new knowledge, and to create a new discourse on adaptation planning. The challenge will be to collaborate in a way that enables their integration into a shared narrative on future adaptation choices.[96]

This paragraph reflects the perspective on traditional knowledge throughout the 5AR that it is an important resource in climate change discussion and must be considered in adaptation planning. As the authors state, collaboration between traditional and scientific approaches will be a challenge. Berkes poses a productive suggestion to this challenge saying, "scholars have wasted (in my view) too much time and effort on a science versus traditional knowledge debate; we should reframe it instead as a science *and* traditional knowledge dialogue and partnership."[97]

Comparing the attention paid to traditional knowledge between the IPCC's Latin America sections of the fourth and fifth assessment reports provides a clear example of a similar improvement. In the 4AR, TK is not directly referenced. In one box about adaptation capacity of pre-Colombian communities in the South American highlands, the authors suggest that "today, under the vagaries of weather and climate […] it would

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[95] G. Magrin and J. Marengo (lead authors), "Central and South America," in Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (2013), 25.
[96] R. Jones and A. Patwardhan (lead authors), "Foundations for Decision Making," in Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (2013), 20.
[97] Fikret Berkes, "Indigenous ways of knowing and the study of environmental change," *Journal of the Royal Society of New Zealand* 39, no. 4 (2009): 151.

be extremely useful to revisit and update such adaptation measures. Education and training of present community members on the knowledge and technical abilities of their ancestors would be the way forward."[98] Considering the number of communities possessing traditional knowledge in the Peruvian highlands, not to mention in Latin America as a whole, this is an insufficient discussion of the role that ancestral knowledge could play in the present and future of climate change adaptation. Furthermore, this box does not acknowledge the communities that currently utilize traditional knowledge and would not need to be taught the ways of their ancestors.

In contrast, the recognition of traditional knowledge in the AR5 report's chapter "Central and South America" is more satisfactory, in some ways. According to Magrin et al., "local and indigenous knowledge have the potential to bring solutions even in the face of rapidly changing climatic conditions; although migration, climate change and market integration are reducing indigenous capacity for dealing with weather and climate risk."[99] On the one hand, this statement recognizes the contribution that traditional knowledges can make to local resilience to climate change. However, the statement then cites climate change as one factor reducing indigenous capacity to deal with climate change risks. Later in the same chapter, Magrin et al. write that:

> Research on adaptation and the scientific understanding of the various processes and determinants of adaptive capacity is also mandatory for the region, with particular emphasis on increasing adaptation capacity involving the traditional knowledge of ancestral cultures and how this knowledge is transmitted. Linking indigenous knowledge with scientific knowledge is important. Although some adaptation processes have been

[98] G. Magrin, C. Gay García, D. Cruz Choque, J.C. Giménez, A.R. Moreno, G.J. Nagy, C. Nobre and A. Villamizar, "Latin America," in *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, eds. M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden, and C.E. Hanson (Cambridge: Cambridge University Press, 2007), 605.
[99] Magrin et al., "Central and South America," 25.

> initiated in the recent years, there is no literature assessing their efficiency so far.[100]

This statement is more supportive of traditional knowledge citing the "importance" of the link between it and science. While this paragraph does not treat TK with the same enthusiasm as other recent literature, it at least regards the importance of this knowledge in increasing adaptive capacity, something that was not done in AR4.

It is within the last decade that traditional knowledge has been increasingly recognized as an important knowledge source both in the IPCC and in climate change literature.[101] Concerns and challenges still exist including how is TK recognized and utilized broadly in climate change policy and whether or not the possessors of such knowledge are given a fair voice.[102][103] However, it is positive to observe the growing presence of TK in large-scale publications such as from the IPCC. Given the credibility of the IPCC in climate change discussion, the acknowledgement of traditional knowledge as an important process demonstrates that it is and increasingly will be regarded as a significant part of adaptation strategy.

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[100] Magrin et al, "Central and South America," 40.
[101] Lars Otto Naess, "The role of local knowledge in adaptation to climate change," *WIREs Climate Change* 4 (2013): 100.
[102] Boillat and Berkes, "Perception and Interpretation of Climate Change," 1.
[103] Alexander et al., "Linking Indigenous and Scientific Knowledge," 477.

Chapter 4: Institutions' Perspectives on Climate Change Adaptation

Institutions including non-governmental organizations (NGOs), multilaterals, and research centers such as the International Potato Center (known by its Spanish acronym CIP) play a significant role in climate change adaptation. Depending on their mission (e.g. development, research, poverty reduction), these institutions influence and make decisions about policy, priorities, and goals around climate change adaptation. Therefore, it is essential to examine the institutions working with Peruvian potato farming and climate change in order to understand the most effective adaptation strategies. The actions institutions are taking and proposing in relation to potato farmers and climate change illustrate the institutions' priorities and also provide the opportunity to assess the success of these actions.

The institutions presented in this chapter are 1) NGOs including Association ANDES and Practical Action; 2) Multilateral organizations including the Inter-American Development Bank (IDB) and the World Bank; and 3) the International Potato Center. These institutions do not represent the entire range of institutions involved with potato farming and climate change, but they present helpful examples in order to observe common trends and priorities.

In examining these institutions from the perspective of the current adaptation literature, the majority of the organizations incorporates traditional knowledge into their policies and approaches to climate change and adaptation, or at least acknowledges its significance. The institutions that disregard or discredit TK as an important aspect of climate change adaptation seem less credible. These institutions make assumptions without considering the communities' knowledge or adaptive capacity.

Non-Governmental Organizations

According to the United Nations Rule of Law, an NGO is "a not-for-profit group, principally independent from government, which is organized on a local, national or international level to address issues in support of the public good."[104] Among the NGOs working with climate change and potato farming, Association ANDES (ANDES) is a key example. Based in Cusco, ANDES is an "indigenous peoples' non-governmental organization working to protect and develop Andean biological and cultural diversity and the rights of indigenous peoples in Peru."[105] In collaboration with six Quechua communities, ANDES helped establish the Potato Park. Outlining the organization's main principles, directors Alejandro Argumedo and Tammy Stenner explain that the organization is structured by a combination of traditional and modern organization systems and is based on principles of indigenous Quechua people.[106] According to Argumedo and Stenner:

> ANDES methodology includes the active participation of local people [which] involves close collaboration between formal and informal Quechua technicians. These technicians have diverse experience in a wide range of disciplines, especially in traditional knowledge […] The practice of working with these community elders and others with specific cultural and environmental knowledge reflects the respect and value ANDES places on traditional knowledge and has been instrumental in the success of our programmes.[107]

This paragraph clearly outlines ANDES' values of collaboration, cultural preservation, and the appreciation of indigenous experience and values, such as traditional knowledge. These same values are seen in the organization's approach to adaptation in

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[104] "Non-governmental organizations," *United Nations Rule of Law*, http://www.unrol.org/article.aspx?article_id=23.
[105] Alejandro Argumedo and Tammy Stenner, *Association ANDES: Conserving Indigenous Biocultural Heritage in Peru* (London: International Institute for Environment and Development, 2008), 1.
[106] Ibid., 7.
[107] Ibid.

its broad application (not only with climate change). For example, in discussing the Potato Park, Argumedo writes, "The Potato Park experience incorporates the maintenance of traditional knowledge and practices with adaptation to changing international economic relations to provide for the food security of Andean indigenous peoples."[108]

Furthermore, on the organization's website, the overview of ANDES' work with the Indigenous Peoples' Biocultural Climate Change Assessment Initiative (IPCCA) states that "assessments of conditions and trends are producing evidence of the use of indigenous knowledge for responding to extreme climatic events, developing strategies that can build resilience and support adaptation to safeguard rights and promote well-being."[109] ANDES' values and priorities are consistent with the current adaptation literature that emphasizes the importance of traditional knowledge. According to a joint UNESCO and Convention on Biological Diversity (CBD) publication by Nakashima et al. "to ensure that the views of indigenous peoples are incorporated into climate change adaptation plans, programme design and implementation should integrate indigenous knowledge and support customary rights to lands and natural resources."[110] This is the premise of the approach and the actions that ANDES is taking and working towards.

Practical Action is another NGO working on potato farming and climate change based out of the United Kingdom. Practical Action "works alongside communities to find practical solutions to the poverty they face. [They] see technology as a vital

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[108] T. Amend, J. Brown, A. Kothari, A. Phillips and S. Stolton (eds.), *Protected Landscapes and Agrobiodiversity Values*, volume 1 in the series, *Protected Landscapes and Seascapes* (Switzerland: IUCN & GTZ, 2008), 47.
[109] "Indigenous Peoples' Biocultural Climate Change Assessment Initiative (IPCCA)," *Association ANDES*, 2013, http://www.andes.org.pe/program-indigenous-peoples-biocultural-climate-change-assessment-ipcca--about.
[110] Nakashima et al., *Weathering Uncertainty*, 69.

contributor to people's livelihoods. [Their] definition of technology includes physical infrastructure, machinery and equipment, knowledge and skills and the capacity to organise and use all of these."[111] In the chapter "Native Potatoes Defying Climate Change," of Practical Action's publication, *Climate change adaptation in Peru: The local experiences*, Clements et al. present the results of a project about climate change adaptation and mitigation technologies. Biodiversity and traditional knowledge are cited as the two key adaptation strategies.[112]

Under the "Biodiversity" heading of the "Adaptation strategies" section, Clements et al. discuss the diversity of potato varieties that exists in the Peruvian highlands and the relationship between vulnerability and diversity. They explain that "the vulnerability of potato crops, i.e. their susceptibility to adverse weather events, is greater in Yungay where fewer varieties exist […] the opposite occurs in Canchis, where farmers grow between 20 and 50 varieties per family. Of the provinces covered by the study, Canchis is the least vulnerable due to greater […] diversity of species."[113] Communities with a higher diversity of varieties are less vulnerable; this is a key element of why traditional knowledge is crucial to successful adaptation. According to Nakashima et al., "indigenous knowledge relating to climate change, whether it concerns agricultural techniques, biodiversity, indicators of change, or weather prediction and response, provides the basis for many successful and cost-effective adaptation measures."[114] Practical Action's emphasis on biodiversity and TK illustrate the organization's belief in these cost-effective adaptation strategies, which recognize

111 "Our distinctive practical approach," Practical Action, 2014, http://practicalaction.org/our-approach.
112 Rebecca Clements, Mario Cossío and Jonathan Ensor, Climate change adaptation in Peru: The local experiences (Lima: Practical Action, 2010), 7.
113 Ibid., 50.
114 Nakashima et al., Weathering Uncertainty, 10.

the systems already in place (such as the thousands of potato varieties) that are helping communities cope with climate change.

Multilateral Organizations

Multilateral organizations are organizations formed between three or more nations to work on issues that relate to all of the countries in the organization.[115] This section will analyze the Inter-American Development Bank (IDB) and the World Bank, two multilaterals involved in developing solutions to climate change and its impacts on agriculture. Both the IDB and the World Bank are large organizations, working on multiple projects across many countries; therefore, while they have worked with Peruvian potato farming, it is not the focus of entire reports or initiatives.

The IDB is Latin America's leading source of development financing, providing loans, grants, and technical assistance.[116] The IDB also conducts research on economics and development. While focused heavily on statistics and scientific data, the IDB's publication "Climate Change and Agricultural Production," expresses a multifaceted approach to adaptation. The adaptation strategies mentioned by the publication's author Ortiz include giving more value to "indigenous and traditional knowledge for addressing climate change [and strengthening] interdisciplinary research on adaptive capacity of agriculture."[117] The publication also cites the importance of technology and market integration illustrating that effective adaptation strategies should not pit traditional versus modern approaches. Rather, a community could adapt to the impacts of climate change utilizing both traditional practices and modern technologies.

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[115] "Multilateral Organizations," *Global Energy Network Institute*, Jan. 23, 2014, http://geni.org/globalenergy/library/organizations/.
[116] "About the Inter-American Development Bank," *Inter-American Development Bank*, 2014, http://www.iadb.org/en/about-us/about-the-inter-american-development-bank,5995.html.
[117] Ortiz, *Climate Change and Agricultural Production*, 22.

The IDB's publication also highlights the importance of agrobiodiversity, an element of traditional knowledge also promoted by Practical Action. Ortiz writes, "agro-biodiversity at the gene, species, and agro-ecosystem levels increases resilience to the changing climate. Promoting agro-biodiversity remains therefore crucial for local adaptation and resilience of agro-ecosystems […] Local breeds—which appear to be better than exotic germplasm at coping with climate change […] could assist in adapting livestock to global warming and drought."[118] The practice of agrobiodiversity is given significant importance in this publication, demonstrating the IDB's approach to adaptation, incorporating both "modern" (e.g. scientific or newly developed technology) and traditional strategies.

The World Bank presents a slightly different approach to adaptation. Similar to the IDB, though on a larger scale, the World Bank provides loans to developing countries with the intention to "end extreme poverty within a generation and boost shared prosperity."[119] In a World Bank publication about indigenous peoples and climate change, Jakob Kronik and Dorte Verner, both economists, write that "new [climate change] threats and possibilities may force or urge people to change their customs and traditional forms of production as well as their community relationships […] Indigenous peoples are highly vulnerable to such changes, given their high dependence on their traditional knowledge for managing the environment."[120] This statement is problematic and disagrees with aspects of the current adaptation literature. Kronik and Verner cite indigenous peoples as being vulnerable given their high

[118] Ortiz, *Climate Change and Agricultural Production*, 16.
[119] "Mission," *The World Bank Group*, 2014, http://www.worldbank.org/en/about.
[120] Jakob Kronik and Dorte Verner, *Indigenous Peoples and Climate Change in Latin America and the Caribbean* (Washington DC: The World Bank, 2010), 45.

dependence on traditional knowledge; however, this is misleading as utilizing different forms of knowledge is one way to foster adaptive capacity.[121]

In reference to adaptation, the World Bank makes a clear distinction between hard and soft adaptation. A different World Bank publication edited by Verner, states, "for example, although decentralized, "soft" adaptation measures, such as capacity building and promotion of stakeholder participation, are crucial, they will need to be complemented by more costly, "hard" adaptation measures, such as building infrastructure and providing technology and communication facilities, projects that often require action by the national government."[122] The need for this additional hard adaptation stems from the limitations of local capacity. It is realistic to consider the limitations of local capacity for large-scale change; however, this again discredits the depth of local capacity and possibility to expand it. The publication also does not prove how "hard" adaptation would be more effective. In the same publication, while discussing ways to enhance the use of TK, Verner cites that "development agencies and national meteorological services must begin with respect for traditional knowledge and use it as a starting point for their projects."[123] This request for respect for traditional knowledge illustrates the variety of approaches discussed by the World Bank.

International Potato Center

The International Potato Center (CIP), based in Lima, Peru, represents its own category as it is best described as a research facility. CIP was established in 1971 by decree of the Peruvian government as a root and tuber research-for-development

[121] Boillat and Berkes, "Perception and Interpretation of Climate Change," 1.
[122] Dorte Verner, *Reducing Poverty, Protecting Livelihoods, and Building Assets in a Changing Climate* (Washington DC: The World Bank Group, 2010), 52.
[123] Ibid., 311.

institution delivering sustainable solutions to the pressing world problems of hunger, poverty, and the degradation of natural resources."[124] CIP's projects are entirely based on the potato and issues including climate change, food security, and the preservation of native varieties. As an institution, CIP provides a unique perspective on adaptation strategy because while based in Lima and closely connected with highland potato farmers, CIP also engages in laboratory-based scientific research and collaboration with universities and scientists from the United States and Europe.

While structured much like a development organization, CIP's values in respect to their work with native Peruvian potatoes emphasize the importance of resilience, agrobiodiversity, and empowerment of communities. While not directly engaged in developing adaptation strategies, CIP worked with potato farmers to develop a catalog of native potato varieties. The catalog provides extensive details about each potato variety including whether or not it is particularly resilient to certain climate effects, and the range of altitudes at which it can be planted.

Furthermore, CIP's website clearly states the institution's belief in the importance and credibility of traditional knowledge. A press release states, "sophisticated traditional potato practices still exist today, despite the advance of modern farming techniques, and around the world they are continually being adapted to changing environments. By conserving and adapting these traditions and farming dynamics, farmers may increase varietal selections, reduce the use of harmful fertilizers and pesticides, and produce healthier potato crops."[125] As a result of this belief, one of CIP's main objectives is to help maintain the vast potato diversity that exists in Peru.

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[124] "About CIP," *International Potato Center*, 2014, http://cipotato.org/about-cip/.
[125] "Understanding and Conserving Traditional Potato Practices."

Conclusion

Peruvian potato farmers, the U.S. media, the IPCC and institutions such as Practical Action and the World Bank represent a wide variety of perspectives and motives. However, they all play a role in the issue of climate change and Peruvian potato farming; whether through developing policies and providing loans, informing the U.S. public about what is happening, or planting the potatoes themselves. The climate change adaptation strategies promoted by these four stakeholders vary in some ways, but from each perspective, there are examples that support traditional knowledge as a credible and valuable practice.

It is all too easy to overstate the potential of traditional knowledge, claiming that since it has been passed down through generations, even climate change could not stop it. But this is equally unproductive as giving TK no place at all.

Based on the research for this thesis, climate change is impacting Peruvian potato farming. The temperatures are higher, the rains are less predictable, and the diseases are more aggressive. This is a legitimate challenge for the farmers and is worthy of great concern. Great concern, however, does not mean presenting the farmers as more vulnerable than they are or disregarding their capacity to cope with climate variability. Based on the recent adaptation literature, which is engaging in a significant debate and reframing of the concepts of resilience, adaptive capacity, and vulnerability, I am optimistic since a better understanding of the complexity and potential of these terms could result in more well-rounded and effective adaptation strategies. Vulnerability does not represent such dire situations as some articles portray. Rather, a community can be both vulnerable and resilient. Vulnerability can serve as a tool to

build adaptive capacity. Climate change literature and policy can be overpowered by these terms and definitions, forgetting that the terms apply to individual people and communities.

While this thesis focuses specifically on Peruvian potato farming, this analysis about the state of adaptation and climate change discourse is applicable around the globe. Each situation has unique factors, but many parallels emerge. For example, if this research focused on indigenous rice farmers in the Philippines or maize growers in Zimbabwe there would be similar patterns of vulnerability, adaptability, and uncertainty. Much like the Peruvian farmers, the label of vulnerability could likely be critiqued in order to start a more productive conversation. These communities would also have their own forms of traditional knowledge and practices based specifically on their climate region and experience with adaptation.

Furthermore, connecting these regions allows for more learning and the opportunity to discover additional adaptation strategies. As Peruvian potato farmers practice crop diversification, farmers in countries such as Zimbabwe and Vietnam have developed strategies to cope with climate change by mulching to deal with drought. Even when these strategies are not applicable in certain climate regions, this research emphasizes the value in sharing knowledge as a way to rethink climate change discourse and approaches to adaptation. If these values were shared more effectively around the world, there could be a huge change in climate change discourse.

While it is difficult to imagine climate change adaptation strategies on such a large scale, looking at the individual situations and the emergence of traditional knowledge is a significant step. As is often the case, climate change adaptation will not

be most effective from either a scientific or traditional knowledge approach, but rather by identifying the strengths of each. Some communities will rely more heavily on scientific practices, while others, such as the Peruvian potato farmers will utilize significant traditional knowledge. This would be a positive approach, utilizing multiple perspectives, and hopefully would help mitigate the impacts of climate change (either on Peruvian potato farming or another community). Additionally, the use of technology can play a crucial role in sharing these strategies and knowledge forms globally.

To conclude on a personal note, is it both challenging and rewarding to complete research of this nature as it involves a variety of stakeholders and perspectives. Climate change and Peruvian potato farming is a current issue. It is constantly evolving and is challenging to approach. Do I believe that traditional knowledge contains the solution to climate change? Do I disagree with the use of technology? What do the farmers really think? This research has presented an array of significant and complex issues, such as the concept of vulnerability, indigenous rights, and the problems with climate change policy. My hope is that each stakeholder involved in climate change on both local and global levels gives these issues as much time, thought and consideration.

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