Mining and small-scale farming in the Andes: Socio-environmental roots of land-use conflict

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ABSTRACT

The Peruvian Andes are one of the most important water sources for the country. Therefore, their exploitation might pose critical threats for local farming activities, national economy, and water quantity and quality. At the same time, the Andes have experienced activities of the mining industry over the last decades, which has boosted the national economy. The mining concessions and operations have brought together campesino communities and mining companies. This has led to the escalation of conflicts due to mining impacts on water, the mining-related misinformation, the distribution of mining royalties, and the compensations in return to the rent of campesino community lands to mining companies. Focused on the farming-mining lands, this research adapts mixed-methods to analyze the land-use conflicts and to build a risk index to support decision-making processes. It aims to evaluate the environmental, social and institutional roots of land-use conflicts to model conflicting situations between the small-scale farming communities and mining companies. It follows four key objectives. First, the analysis of heavy metal concentrations in water and soil with land-cover classification and participatory mapping allowed the measurement of key biophysical parameters in farming-mining lands. Second, mixed-methods via semi-structured surveys, in-depth interviews, social and content analyses were used to assess the social and institutional aspects related to the management of water and soil. Third, the results from the multi-criteria analysis were compared with content analysis, surveys and interviews to integrate and consolidate the aforementioned biophysical, social and institutional components in a theoretical framework and land-use conflict risk index. Fourth, three main scenarios were developed to simulate the conflicts between communities and mining companies. The resulting land-use conflict risk index can provide a useful decision-making tool for the governments to tackle conflict management through revealing the conflict-triggering criteria and indicators. Furthermore, this is the first interdisciplinary research that depicts a thorough understanding of the interaction of the fourteen studied campesino communities with state institutions, civil society, and mining companies once the mining concession is given.

KURZFASSUNG

Die peruanischen Anden sind eine der wichtigsten Wasserquellen des Landes. Daher könnte ihre Nutzung eine kritische Bedrohung für die lokale Landwirtschaft, die Volkswirtschaft sowie die Wassermenge und -qualität darstellen. Gleichzeitig haben die Anden in den letzten Jahrzehnten eine potenzielle Bergbauindustrie beherbergt, die die Volkswirtschaft ankurbelt. Die Bergbaukonzessionen und -aktivitäten haben kleinbäuerlichen Gemeinden und Bergbauunternehmen in den Anden zusammengebracht. Die Bauern sind aufgrund der Auswirkungen des Bergbaus auf das Wasser, der Bergbau-verbundenen Fehlinformationen, der Aufteilung der Bergbaugebühren und der Ausgleichszahlungen für die Verpachtung ihres Geländes an die Bergbauunternehmen in Konflikte geraten. Diese Forschung konzentriert sich auf bergbau-landwirtschaftlich genutzte Gebiete und verwendet gemischte Methoden, um Landnutzungskonflikte zu analysieren und einen Risikoindex zur Unterstützung von Entscheidungsprozessen zu erstellen. Diese Doktorarbeit zielt darauf ab, die ökologischen, sozialen und institutionellen Ursachen von Landnutzungskonflikten zu evaluieren, um Konfliktsituationen zwischen kleinbäuerlichen Gemeinden und Bergbauunternehmen zu modellieren. Diese Forschung verfolgt vier Hauptziele. Erstens ermöglichte die Analyse der Schwermetallkonzentrationen in Wasser und Boden mit dem Klassifikationssystem der Bodenbedeckung und der partizipativen Kartierung die Messung der wichtigsten biophysikalischen Parameter in bergbau-landwirtschaftlichen Geländen. Zweitens wurden gemischte Methoden mittels halbstrukturierter Befragung, der Tiefeninterviews, der sozialen Analyse und Inhaltsanalyse verwendet, um die sozialen und institutionellen Aspekte im Zusammenhang mit der Bewirtschaftung von Wasser und Boden zu bewerten. Drittens wurden die Ergebnisse der Mehrkriterienanalyse mit Inhaltsanalysen, Umfragen und Tiefeninterviews verglichen, um die oben genannten biophysikalischen, sozialen und institutionellen Komponenten in einen theoretischen Rahmen und einen Landnutzungskonflikt-Risikoindex zu integrieren und zu konsolidieren. Viertens wurde die Entwicklung von drei Hauptszenarien durchgeführt, um die Konflikte zwischen Gemeinden und

Bergbauunternehmen vorherzusehen. Der Risikoindex des Landnutzungskonflikts kann der Regierung ein nützliches Entscheidungsinstrument zur Bewältigung des Konfliktmanagements liefern, indem er die konfliktauslösenden Kriterien und Indikatoren enthüllt. Darüber hinaus ist diese Doktorarbeit die erste interdisziplinäre Forschung, die ein gründliches Verständnis des Zusammenwirkens der vierzehn untersuchten kleinbäuerlichen Gemeinden mit staatlichen Institutionen, der Zivilgesellschaft und Bergbauunternehmen nach Erteilung der Bergbaukonzession ergeben hat.

RESUMEN

Los andes peruanos poseen una de las fuentes hídricas más importante en el país, por lo que su explotación puede amenazar críticamente las actividades agrarias, la economía nacional y tanto la calidad como la cantidad de agua de uso local. Simultáneamente, el potencial de la industria minera en los Andes ha impulsado la economía en las últimas décadas. Así las concesiones y operaciones mineras han reunido a las comunidades campesinas y compañías, conllevando al conflicto debido al impacto sobre el agua, la desinformación relacionada a dichas operaciones, la distribución del canon minero, y la compensación por la renta de tierras comunales. Ésta investigación adaptó métodos mixtos para analizar los conflictos de uso de la tierra y para construir un índice de riesgo con el fin de apoyar los procesos de toma de decisiones en tierras andinas agro-mineras. Este estudio evalúa las causas ambientales, sociales e institucionales de dichos conflictos para analizar situaciones conflictivas entre las comunidades campesinas y las compañías mineras. Los resultados de esta investigación se basan en cuatro objetivos clave: primero, el análisis de las concentraciones de metales pesados en agua y suelo, la clasificación de cobertura de suelo y el mapeo participativo permitieron la medición de los parámetros biofísicos en tierras agro-mineras. Segundo, los métodos mixtos mediante encuestas semiestructuradas, entrevistas en profundidad, análisis social y de contenido fueron usados para evaluar los aspectos sociales e institucionales relacionadas al manejo de agua y suelo. Tercero, los resultados del análisis multi-criterio fueron comparados con el análisis de contenido, encuestas y entrevistas para integrar y consolidar los mencionados componentes físicos, sociales e institucionales en un marco teórico y un índice de riesgo de conflicto de uso de la tierra. Cuarto, el desarrollo de tres escenarios principales fue hecho para simular los conflictos entre las comunidades y las compañías mineras. El índice de riesgo de conflicto de uso de la tierra puede convertirse una herramienta útil para la toma de decisiones a nivel del gobierno a fin de manejar el conflicto, dilucidando los criterios e indicadores que lo originan. Asimismo, este estudio es la primera investigación interdisciplinaria que plasma una comprensión profunda de la interacción de catorce comunidades estudiadas con las instituciones estatales, sociedad civil, y compañías mineras cuando la concesión minera ya ha sido otorgada.

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ACRONYMS AND ABBREVIATIONS

ACM	Active community members
ANA	National Authority of Water
CENEPRED	National Center for the Prevention and Reduction of Disaster Risk
CMD	Community-Mining Dialogues
CPMC	Cerro de Pasco Mining Company
CSR	Corporate social responsibility
DEM	Digital Elevation Model
EQS	Environmental Quality Standards
GDP	Gross domestic product
GEOCATMIN	System of Geological Information and mining cadastral of INGEMMET
GII	Involvement of Governmental Institutions
GLM	General Mining Law
ICP-AES	Inductively Coupled Plasma-Atomic Emission Spectrometry
IGP	Geophysical Peruvian Institute
INEI	National Institute of Statistics and Informatics
INGEMMET	Mining, Metallurgical and Geological Institute
KMO	Kaiser-Meyer-Olkin test
LCC	Land Cover Classification
LU	Land Use
LUCRI	Land-use Conflict Risk Index
MC	Ministry of Culture
MEM	Ministry of Energy and Mining
MINAM	Ministry of Environment
MLC	Maximum Likelihood Classification
OEFA	Agency for Environmental Assessment and Enforcement
ONDS-PCM	National Office of dialogue and Sustainability of the Presidency of Ministry Council
PCA	Principal Component Analysis
PEN	Peruvian sol currency
RQ	Research question
SF	Soil Fertility

1. INTRODUCTION

The neoliberal policy of Peru has promoted private investment that has led to extractivism (Gustafsson, 2018; Gustafsson and Scurrah, 2019). In the last decades, mining concessions have increased, boosting the Peruvian economy via the increase of the gross domestic product (Gudynas, 2015). Mining concessions are overlapping water sources, protected areas, and community lands especially in the Andean region (Bax et al., 2019; Bebbington and Williams, 2008). Due to the social, economic and environmental interests in mining, Peru needs well-established and inclusive environmental regulations and reforms to face the challenges of extractivism (De Echave, 2018). However, Peru is characterized by weak political organization and governing state institutions, poor networking of communities with state institutions and the lack of resources and strategic abilities to empower land-use planning and better conditions for extractivist projects (Gustafsson, 2018; Gustafsson and Scurrah, 2019; Henríquez, 2015).

The political and institutional weakness has influenced the development of environmental institutionalism—a set of state institutions and instruments of public policy that focuses on the problems of the degraded environment on which people depend (Damonte and Vila, 2014). However, environmental institutionalism is also undermined in order to benefit pro-extractivism investments. Despite the isolated efforts of the epistemic community[1] to be involved in environment-related state institutions and Peru´s participation in international agreements, the country´s environmental policy still needs to be improved, clarified, and made more inclusive (Arce, 2014) in order to support environmental institutionalism (Andaluz Westreicher, 2011) and ensure the sustainable use of resources. These goals could improve mining-community relations and the socio-environmentally responsible use of resources in mining operations. Peru has improved its environmental institutionalism by enacting new laws and regulations such as prior consultation and community participation in the

[1] Epistemic community is defined as a network of professionals who are recognized by their expertise and competence in a particular domain, and have an authoritative claim to policy-relevant knowledge within their domain (Haas, 1992).

decision-making process (MEM, 2008). However, these mechanisms have only become tools to inform affected stakeholders rather than effectively preventing conflicts (Bebbington et al., 2013). Although the government has attempted to integrate communities into the decision-making process, these attempts lack coherence and lead to very marginally inclusive political agreements (Arce, 2014).

In weak environmental institutionalism, on the one hand, land-use conflicts caused by the change of land use from farming to mining activities jeopardizing local livelihoods (Hilson, 2002) could be a tool to negotiate better conditions for the communities. The need to negotiate with the government also arises because communities face poverty, impoverished public services, limited economic opportunities and a lack of farming development (Conde and Le Billon, 2017; Haslam and Tanimoune, 2016). On the other hand, conflicts are criminalized and their inappropriate management may result in violence due to the absence of suitable mechanisms within the government. As a result, farming-based communities experience resistance to mining activities due to the vulnerability of water sources and mining operations overlooking their total water consumption (Bebbington et al., 2013; Bebbington and Williams, 2008; Preciado Jerónimo and Álvarez Gutiérrez, 2016). Community resistance has also increased because mines tend to locate upstream (at headwaters), and their activities influence the water supply of downstream communities (Bebbington et al., 2013; Bebbington and Williams, 2008). Consequently, mining-community relations are crucial to prevent conflicts and are influenced by environmental institutionalism and natural resources.

In the central Peruvian Andes, a long mining history is associated with environmental complaints of campesino communities (Caballero Martín, 1981). Since the early twentieth century, there has been a movement of the population from campesino communities to the settled mines in order to gain a paid job (Cotler, 2016; Li, 2017). These mines initially promoted railway and road construction to facilitate mining production, and thus influenced the local livelihoods (Caballero Martín, 1981). These changes generated a diversification of local economies and promoted temporal migration to the nearby urban areas. As a result, mining operations have affected the

Andean ecosystems and community livelihoods over time via water, soil and air pollution (Abanto Kcomt, 2007; Blacksmith Institute, 2007; Caballero Martín, 1981; Reuer et al., 2012; Rodbell et al., 2014). In 2017, 78.6% of the conflicts that occurred in the Central Andes had socio-environmental roots related to mining operations (Ombudsman of Peru, 2017a).

In this study, an interdisciplinary approach is used to analyze land-use conflicts in the central Peruvian Andes. Most studies, rather than integrating the biophysical, institutional and socio-economic aspects, have viewed these aspects in isolation (Bebbington et al., 2008; Bebbington and Bury, 2009; Figueroa et al., 2010; McDonell, 2015). An interdisciplinary approach (Cathain et al., 2008; Schönenberg et al., 2017) is thus suggested to view the impacts of mining from different perspectives. This study analyzed the biophysical parameters and the social and institutional aspects in farming-mining lands, and integrated these elements to develop a risk index of land-use conflicts. Additionally, the research aimed to synthesize different approaches in order to understand the social, environmental and institutional roots of a land-use conflict (Nature, 2015; Schönenberg et al., 2017). The research fields are extractivism (Gudynas, 2015), environmental institutionalism (Damonte and Vila, 2014), water security (Grey and Sadoff, 2007), state capture (Durand, 2015), and livelihoods (Chambers, 1995; De Haan, 2012). This research focuses on lands where communities and mining companies interact and there are no active conflicts. This stems from findings of previous studies that have reported the emergence of new stakeholders (e.g. "social instigators") where (personal) interests can fuel conflict, suggesting that future research should avoid these instigators in order to obtain a better impression of the status quo in mining-affected communities.

1.1. Research objectives

Based on biophysical, social and institutional assessments in farming-mining lands, the general objective of this research is to evaluate the environmental, social and institutional roots of land-use conflicts to model conflicting situations between the small-scale farming communities and mining companies in the Central Andes of Peru. The specific objectives and research questions (RQ) are:

a. To measure key biophysical parameters (e.g. water and soil) in campesino community farming-mining lands.
    - **(RQ 3-1)** Do biophysical measurements in farming lands reflect the impacts of heavy metals?
    - **(RQ 3-2)** How are these biophysical factors influencing the community livelihoods in the Junin Region?
b. To assess social and institutional aspects related to the management of water and soil in the campesino community farming-mining lands.
    - **(RQ 4-1)** How is the environmental institutionalism perceived locally?
    - **(RQ 4-2)** How do local stakeholders perceive environmental institutionalism in a context of non-active land-use conflict?
    - **(RQ 4-3)** What are the profiles and the challenges of campesino communities?
    - **(RQ 4-4)** What are the main causes of land-use conflicts in community mining lands?
c. To integrate and consolidate the above biophysical, social and institutional components.
    - **(RQ 5-1)** How can the biophysical, socio-economic, and institutional components be combined in a risk index?
d. To develop scenarios to simulate the conflicts between campesino communities and mining companies.
    - **(RQ 5-2)** Based on the implications of this risk index, how can it be improved through future research?

Above all, this research aims to answer the following question: How can the assessed environmental, social and institutional roots of land-use conflicts be integrated into a model to determine the risk of conflict in farming-mining lands?

1.2. Thesis structure

This thesis is organized in six chapters. The first two chapters are introductory, the following three chapters provide the main results of this research, and the final chapter provides a summary and conclusions.

Chapter 1 gives a general introduction, the research questions and objectives, and the overview of the thesis.

Chapter 2 presents the background for the thesis that provides the historical background of mining and campesino communities, the definition of concepts and theories, and a literature review of land-use conflicts. It also provides the research design and conceptual framework, including an overview of the methodology used and data collection.

Chapter 3 provides an overview of how agreements between mining companies and campesino communities are developed and what are their main clauses. As a consequence of such agreements, communities rent their lands to mining companies, which might influence biophysical factors. Therefore, this chapter also provides an assessment of water and soil quality in farming-community lands. Finally, this chapter presents an example of the influence of an agreement on farming lands.

Chapter 4 provides an analysis of environmental institutionalism in the Central Peruvian Andes. Stakeholders and their network are identified to assess their interactions before a conflict escalates. The influence, interests, legitimacy, and authority of stakeholders are also assessed as well as the livelihoods and challenges of the campesino communities. Finally, the drivers of land-use conflicts that were reported by stakeholders are described.

Chapter 5 provides a decision-making support tool that indicates the risk level of manifested land-use conflict per community. The developed risk index of land-use conflicts integrates the indicators and criteria that were given by stakeholders (e.g. mining companies, state institutions) and community members. The risk index was validated by experts to evaluate its outputs and applicability.

Chapter 6 highlights the main findings and conclusions of this research. This chapter also provides the study limitations and recommendations for future research and the development of the risk index. Since this study is the first one of its kind that focuses on the integration of biophysical, institutional and socio-economic aspects, the results are indicative and lead the way for further interdisciplinary studies regarding the land-use conflicts.

1.3. Published chapters

This research has produced two published articles (Chapter 3 and Chapter 4) in scientific journals, one article published in conference proceedings (Chapter 2), and one accepted book chapter for publication (Chapter 4). All articles and book chapters were published in peer-reviewed journals and books.

Quispe-Zuniga, M. R.; Ortiz-Quispe, C. M.; Plasencia, R. **Mining projects and socio-Environmental factors that weaken campesino (peasant) communities in the Central Andes of Peru.** *Gestión y Ambiente.* 2018, *21* (2), 47–61. https://doi.org/10.15446/ga.v21n2supl.77833.

Abstract: In the central Peruvian Andes, the potential impact of mining and the overlap of mining areas with community lands have caused different impacts, ranging from those affecting the environment to those affecting the community institution. The objective of this study is to analyze the socio-environmental factors that would weaken the *campesino* (peasant) communities of Huasicancha and Chongos Alto in the central Andes. The study applies mixed methods, including in-depth interviews with open-ended questions and non-participant observation from November 2016 to July 2017. In total, 50 stakeholders (e.g. community members, state institutions, mining companies, etc.) were interviewed. The results reveal that both communities face socio-environmental factors such as the economic and environmental influence of mining projects, the economic influence of social programs, the state institutions, the lack of interest of community members in community activities, the existing territorial conflicts, lack of job opportunities, and the decline of farming production. These socio-environmental factors have weakened the *campesino* community as an institution.

Keywords: campesino or peasant community; comunero; mining project; compensation; institution.

Quispe-Zuniga, M. R. **Mining and campesino community: Land-use conflict in Central Peruvian Andes.** In *International Conference Economic Management in Mineral Activities*; Nguyen Thi Hoai Nga, Ed.; Publishing House for Science and Technology: Hanoi, 2018; pp 38–55.

Abstract: Mining exploitation in Peruvian Andes overlaps campesino community lands, generating the initial step for building a relationship between mining companies and communities. The Peruvian government and its institutions are the regulators of all extractivism projects and the protectors of campesino communities. Campesino communities have the autonomy to decide on the use of their community lands; however, these lands can be used for a public purpose (e.g. mining activities) with corresponding compensation. Land-use conflicts among communities and mining projects mainly occur in remote areas. Mining projects have become an economic opportunity for the national and subnational government due to the mining royalties. Since the affected community does not directly receive the mining royalties, it negotiates with the respective mining companies. Nevertheless, the environmental impact and the vulnerability of the community´s livelihoods enhance land-use conflicts. Therefore, this study analyses the interactions among stakeholders in communities that are currently influenced by mining projects in the central Andes of Peru to understand the mining-community-government context, the resistance factors and the interactions of stakeholders before the land-use conflict escalates. To analyze these interactions, an exhaustive literature review, observations and in-depth interviews of 23 stakeholders (including community authorities, mining companies and state institutions) were conducted in the south-western part of the Junin region, central Peruvian Andes. The results reveal the interactions of these stakeholders before the land-use conflict escalates. The findings show how the interactions increase from a simple complaint by a community to a conflict and then the establishment of a dialogue table.

Keywords: Campesino community; state institution; mining projects; farming activities; resistance factors.

Quispe-Zuniga, M.R.; Callo-Concha, D.; Plasencia, R.; Greve, K. **Implementing Environmental Reforms in the Central Peruvian Andes: Socio-Economic and Institutional Aspects of Mining Affected Campesino Communities.** In *Civilizing Resource: Investments and Extractivism Societal negotiations and the role of law*; Laube, W., Pereira, A. R. B., Eds.; Lit Verlag: Bonn, 2019 (Forthcoming).

Quispe-Zuniga, M.R.; Santos, F.; Callo-Concha, D.; Greve, K. **Impact of Heavy Metals on Community Farming Activities in the Central Peruvian Andes**. *Minerals* 2019, *9*, 647.

Abstract: The high mining potential of the Peruvian Andes has promoted booming foreign investments. The mining activity takes place on campesino community lands and headwaters. Once the government awards a mining concession, mining companies must regularly negotiate land rent with communities over the whole duration of the mining operation, often leading to disagreements. Our research objective is to identify the mining impacts on the farming activities of campesino communities in the Junin region, central Peruvian Andes. Using a mixed-methods approach involving in-depth interviews, water and soil analysis, land-cover classification and participatory mapping, we analyzed the mining-community agreements and the mining impacts on the farming lands. We arrived at two primary conclusions. First, mining activities in terms of heavy metal concentrations impact on farming lands, although the contribution of previous and concurrent activities cannot be distinguished. Second, the diverging and short-termed interests of the involved parties which circumscribe the agreements may potentially lead to conflicts.

Keywords: Water and soil quality; community lands; mining operations; land-use conflicts.

2. RESEARCH BACKGROUND

2.1. Mining potential in the Peruvian Andes

The Andes are 900 km north to south and 750 km east to west (Graham, 2009). The mountain chain regularly faces the impact of the El Nino phenomenon along with population growth, climate change, and extractivist projects (Buytaert and De Bièvre, 2012; Kohler and Maselli, 2012; Perreault, 2014). The Peruvian Andes are the main water source of the country and there is great concern regarding the impact of extractivism and water stress on the coastal and mountain populations (Bebbington and Williams, 2008; Perreault, 2014; Preciado Jerónimo, 2011; WB, 2018). In the last decades, Peru has promoted irrigation projects in the arid coast with water from the Andes in order to boost the economy and development (Arroyo and Boelens, 2013). However, there are also small-scale farmers in the mountain regions, i.e., indigenous and campesino communities, who depend on water and land for their livelihoods. These natural resources are truly "the means of gaining a living" (Chambers, 1995) despite the economic diversification of the local communities (Boelens et al., 2010; Brain, 2017). Currently, water security, i.e., "the availability of water in terms of acceptable quantity and quality for the health, livelihoods, ecosystems and production that couple with water-related risks for people, environment and economies" (Grey and Sadoff, 2007) is not only threatened by the rapid glacial melting and irrigation mega-projects, but also by mining operations. Despite water use at different intensities and volumes in mining operations (Arroyo and Boelens, 2013; Bebbington and Williams, 2008; Perreault, 2014; Preciado Jerónimo, 2011), no study exists on the current actual water consumption by mining operations (Preciado Jerónimo, 2011; Preciado Jerónimo and Álvarez Gutiérrez, 2016). It is evidenced, however, that the Peruvian Andes have been transformed due to the increase in mining concessions and operations (Figure 2-1) through neoliberal policies and pro-mining policies (Bury, 2002; Li, 2009; Perreault, 2014).

Most mining operations are located upstream at headwaters, and their activities influence the water supply of downstream communities, making these worry about the source and quality of the water for their daily activities (Bebbington and Williams, 2008). The use of subsurface and surface water in mining activities (i.e., hydroelectric generation and mechanisms) increases shortages for local communities and cities (Bury et al., 2013). In addition, pressuring water resources for their functioning, mining operations are also negatively affecting the water quality of the watercourses due to the annual release (>13 billion m^3) of mining effluents into water bodies (Bebbington and Williams, 2008). Affected communities try to negotiate with the relevant mining company for compensation in return for the rent of their community lands and resources. In other cases, communities have to sell their lands to mining companies, generating the displacement of the community and the loss of livelihoods (Arellano-Yanguas, 2011a).

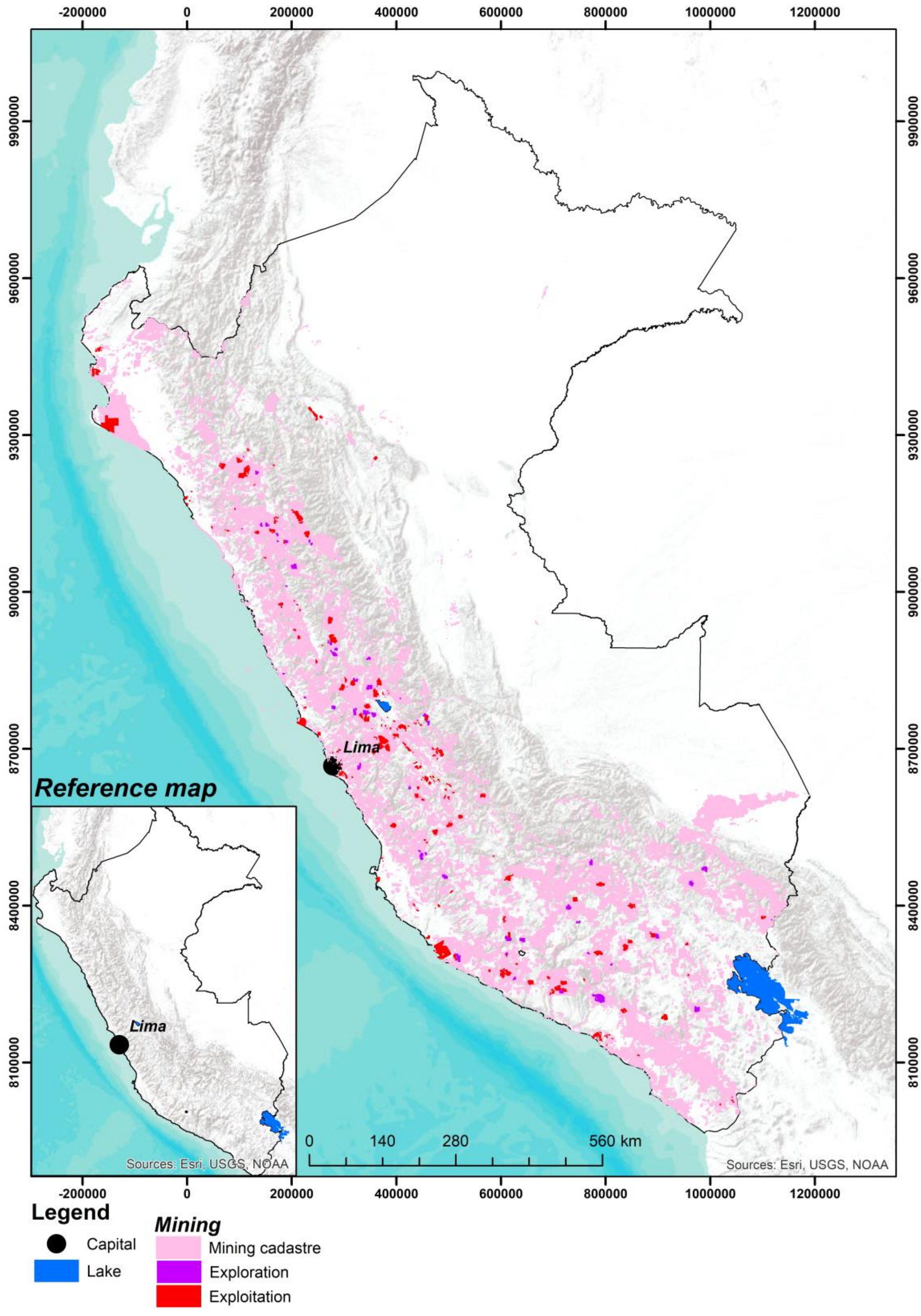


Figure 2-1. Peruvian Andes and mining concessions (mining cadastre) indicating mines at exploration and exploitation stages.
Based on INGEMMET (2018).

Peru has a history as a mining country (Perreault, 2014). During Spanish colonization, the colonial governors took the “mita” (Inca mandatory work) to exploit the indigenous population in order to bring rural people to mining sites, thus reducing the Incan population and increasing gold production (Moore, 2003; Perreault, 2014). Since the independence of Peru (1821), mining activities have not been well regulated by the subsequent governments. In the early twentieth century, the number of mining workers increased in the central Peruvian Andes with the foundation of the Cerro de Pasco Mining Company (CPMC), concentrating mining workers in the cities Pasco and La Oroya. The company recruited its workers from neighboring communities allowing them to complement their farming tasks with mining activities (Cotler, 2016; Li, 2017). The economic dynamics that were generated by mining exploitation led to the railway construction in the Central Andes to connect the two cities and mining sites with Lima, thus influencing local livelihoods by the introduction of manufactured products (Caballero Martín, 1981).

In the 1920s, CPMC installed smelters in La Oroya to facilitate their processes, which affected the neighboring communities (Caballero Martín, 1981; Li, 2017). In the 1980s, mining pollution increased and dispersed due to the weak regulation of the emissions from La Oroya smelters (Figueroa et al., 2010; Li, 2017; WB, 2005). La Oroya, which is located close to the smelters, was considered in 2006 as one of the top ten most polluted cities in the world, highlighting the environmental concerns related to mining activities (Blacksmith Institute, 2007; Li, 2017). However, the environmental impact of the smelters had occurred long before 2006, as reports on the impacts and complaints from neighboring communities date from the very start of the operations of the smelters (Caballero Martín, 1981; Cotler, 2016; Li, 2017). These complaints and reports affirm that the emissions from the smelters caused a toxic smoke that killed the livestock in the surrounding area and made the local inhabitants sick. The long-term use of the smelters has also caused fluvial and aeolian transportation of sediments affecting the daily activities of the local people and grazing of livestock (Caballero Martín, 1981; Razo et al., 2004; Roberts et al., 1974).

In the late twentieth century, environmental impacts occurred primarily as a result of weak or lacking appropriate laws and regulations for mining companies. The Peruvian government established neoliberal policies in the 1990s (President Alberto Fujimori, 1990-2000) and tax exemptions for investors to promote private investment (Bury, 2005; CRP, 1991). During Fujimori´s government, mining was prioritized over community livelihoods and local ecosystems (Bebbington and Bury, 2009; Gustafsson, 2018; Gustafsson and Scurrah, 2019) due to the ‘state capture’ by the private sector and corruption (Durand, 2016; Quiroz, 2013). The state capture is manifested in the influence of private companies in the making of laws and decrees to promote extractivist investments (Durand, 2016; Hellman et al., 2000a, 2000b) and to influence the staff exchange between public regulators and the companies they were meant to regulate. In Peru, many companies combine their organizational capacities and networks to strongly influence the investment-related decision-making of the government (Durand, 2016). This has undermined the creation of strict mining-related state legislation (Dargent et al., 2017).

The national economy is attracting foreign investment and developing extractivism. Extractivism is defined as the extraction of natural resources at high volume and intensity to export these as raw materials without or with only minimal processing (Damonte and Peralta, 2015; Gudynas, 2017, 2015; Lang and Mokrani, 2013). In 1992, the Peruvian government implemented the General Mining Law (MEM, 1992) to boost mining investment (Arellano-Yanguas, 2011a). This law focuses on the state property of mineral resources, the environment, public health, mining activities, and the collection and distribution of “*canon minero*[2]” and mining royalties[3]. Since the enactment of this law, mining investment and royalties have boosted the Peruvian gross domestic product while increasing the dependency on mining royalties (Gudynas, 2015).

[2] “*Canon minero*” refers to 50% of taxes from mining sector that are distributed among the affected subnational governments (Arellano-Yanguas, 2010; CRP, 2001; CRP, 2004a; SNMPE, 2018).

[3] Mining royalties refers to the economic consideration that the owners of the mining concessions pay to the Peruvian government for the exploitation of metallic mineral resources (CRP, 2004a).

Since the 2000s, the Peruvian government has established laws for the royalties, special taxes, and a special mining levy[4] for the mining companies (CRP, 2011a, 2011b, 2004a, 2004b).

The *canon minero* is mainly given to the affected subnational governments in order to reduce the poverty of the affected population (Gamu et al., 2015). The *canon minero* is distributed as follows: 10% to the district where the mining site is located and 25% to its corresponding province, 40% to neighboring districts and provinces within the same region, and 25% to the regional government (including 5% to public universities of the region) (Arellano-Yanguas, 2011a; CRP, 2004a; Wall and Pelon, 2011). Although the communities affected by mining in the benefited district are not directly receiving the *canon minero* due to their autonomy, 50% of the funds given to the district government have to be invested in order to benefit the affected communities via the improvement or provision of public services (CRP, 2004a, 2004b).

Despite the economic importance of mining operations for the central government, there is a controversy in the economic and ecological trade-offs for the affected areas. These trade-offs represent ca. 33% of the depreciation of natural capital impacted, a figure that underestimates the loss of ecosystem services (Figueroa et al., 2010). According to Cuba et al. (2014), the neoliberal Peruvian economy promotes mining concessions while the country and its inhabitants do not know that their lands might be under concession. Although INGEMMET (Mining, Metallurgical and Geological Institute) provides an online and public platform (e.g. GEOCATMIN) to spatially observe the current mining concession areas in the country (INGEMMET, 2018), its effective use by communities needs to be assessed.

2.2. Campesino communities

In the twentieth century, Peruvian indigenous communities were considered to be the lowest social class, and most of them worked under conditions of semi-slavery in large farms and mining exploitation sites (Cotler, 2016). The abolishment of the indigenous

[4] The special mining levy (*"gravamen especial a la minería"*) created in 2011 is a tax-deductible trimestral levy (CRP, 2011c).

tax in 1821 and land distribution among literate community members in 1824 attempted to remove the colonial holdover and to change the indigenous status into campesino as an integration measure (Cotler, 2016). Another integration measure was the sale of community lands to trigger small landholdings and reduce communities[5] (Caballero Martín, 1981). However, landowners took over the community lands to build a serfdom system that assimilated the community members (Caballero Martín, 1981). Until 1840, commercial and colonial disarticulation caused the fragmentation of inter-regional economies and the emergence of feudalism and regional oligarchy. During the 1860s, small traders with economic capital started gathering the most productive crop/grazing lands, consequently uprooting the campesino communities from their lands (Caballero Martín, 1981). In the late nineteenth and early twentieth century, the campesino community members were used for different tasks inside large farms and new mining projects. Consequently, the impact of mining sites (e.g. CPMC in the Central Andes) on agriculture first occurred due to the acquisition of large agricultural areas for mining activities (De Wind (1985, 1987) cited in Arellano-Yanguas (2011a).

From 1920 onwards, Peru recognized the legal existence of indigenous communities referring to these communities as native communities (including Amazonian people) (PCR, 1920; SICCAM, 2016). In 1933, the government officially registered these communities in order to (1) recognize their legal identity, (2) build a land registry of their communities, and (3) compensate them in case of expropriation of their lands (PCR, 1933). For the first time in history, in the political constitution of 1979, the Peruvian government referred to communities as native and campesino communities. It identified community areas as inalienable land unless the land was required for public use. In this case, around 66% of the community population was to approve the land concession and economic compensation in return (PCR, 1979). In accordance with the ad hoc law 24656 in 1987, campesino communities were recognized as fundamental democratic institutions with the autonomy to develop and

[5] The promotion of sales of community lands was based on the inconsistency of the existence of communities within the established liberal regime in Peru, where all inhabitants must identify themselves as Peruvians (Caballero Martín, 1981).

use their land within the national constitutional framework (CRP, 1987). After the new political constitution of 1993, the government confirmed the autonomy of campesino communities regarding the organization, communal work, and land use, which need to respect the Peruvian laws (PCR, 1993). Currently, a community member can be anyone born inside the registered community, the child of a community member or any person integrated into the community (PRP, 1991). Inside a community, a community member can choose its authority, e.g. community president (PCR, 1993; Szablowski, 2002). Although there can be a level of disorganization inside a community, it may integrate stronger when common interests are threatened or there are opportunities to obtain benefits (Remy, 2004).

Peru has tried to join the isolated and detached towns and communities in the Andes and Amazonia despite the complex geomorphological conditions (Cotler, 2016; Soifer, 2015). However, less economic opportunities and internal armed conflicts triggered the migration of campesino communities to urban areas, thus decreasing their populations. In the Andean region, armed internal conflicts took place during the 1980s and mainly affected campesino communities (Urrutia, 2003). Two groups were involved: The Shining Path and the Revolutionary Movement Tupac Amaru (MRTA). The Shining Path tried to topple the Peruvian government by internal attacks where thousands of campesino community members died (CVR, 2003; Ruiz Peralta, 1996; Starn, 1995; Taylor, 1998). Consequently, migration of community families took place from 1984, with those having the economic means migrating to other districts or provinces, while only the youth in poor families left the community (CVR, 2003; INEI, 2009). Migration has also triggered a shift in perspective in agricultural production within communities, where farmers are motivated to know their market and use a production plan (Sánchez Aguilar, 2015). Other factors triggering migration were lack of drinking water, electricity, education, and health services, which were weaknesses in the Andes before and during the 1990s (Laszlo, 2008; Salas Carreño, 2008). Food scarcity was also managed through the migration process, which led to the depopulation of most communities.

Campesino communities usually engage in subsistence and small-scale farming as a consequence of the agrarian reform (1969-1972) that made it possible for them to obtain land from large farms (PRP, 1969, 1972; Szablowski, 2002). Considered as one of the main economic activities in Peru, agricultural production depends on altitude, soil conditions, rainfall patterns, climatic hazards, and other factors (Inbar and Llerena, 2000; Milan and Ho, 2014). Livestock is also used to boost the economy and diversify family incomes in campesino communities (Kristjanson et al., 2007), and is used by the families as a source of food, fertilizers, investment, savings and insurance (Bustamante Becerra, 2007; Kristjanson et al., 2007; Valdivia and Quiroz, 2003). Since most families strongly depend on livestock, livestock grazing, and cattle nutrition, family labor influences their ability to produce livestock-related products (e.g. milk, meat) (Bartl et al., 2009). In the 2012 Peruvian agricultural census, farming activities covered 30.1% (38 742 465 ha) of the country, while this area was 57.7% (22 269 271 ha) in the Andean region (INEI, 2013a). This region comprises 15% productive agricultural area, 70% natural pastures, and 7% forest and mountains. However, not all agricultural land is used for crop production due to a lack of water (122 923.65 ha affected in 2012), lack of credit for farming investment (40 403.12 ha), lack of workforce (31 419.84 ha), soil erosion, and lack of seeds (INEI, 2013b). Consequently, campesino communities that mainly depend on farming activities tend to be resistant to mining activities due to the environmental impacts and because these cause the temporal/permanent migration[6] of new community generations to urban areas (Bury, 2002; Conde and Le Billon, 2017; Inbar and Llerena, 2000). In addition to the farming activities, campesino communities that are close to urban areas have diversified their economies. Communities consequently face the temporal or permanent migration of their members who aim to get a paid job, which is more attractive to farmers than the uncertain income from agriculture and livestock rearing under the threats from climatic hazards (CTRJ, 2015a; Escobal, 2001).

In the Andes, many mining sites are located at headwaters and thus affect downstream communities (Brain, 2017; Li, 2017). Mining sites also require surface water

[6] Temporal migration refers to the movement of community members from the communities to urban areas in order to work. They stay in the city on weekdays and come back to the community at the weekend.

or have to drain groundwater, increasing concern among the affected communities regarding both water quantity and quality (Brain, 2017; Preciado Jerónimo, 2011). Thus, mining sites affect water, land, the cohesion of social networks and local employment of the campesino communities (Brain, 2017).

2.3. Peruvian state institutions

Although the Peruvian government has promoted environmental reforms and regulations (e.g. environmental impact assessment, environmental certification), these are still too weak to deal with the challenges generated by extractivism (De Echave, 2018). The weakness of state institutions undermines these policies, failing to trigger development strategies (Arellano-Yanguas, 2011b; Hinojosa, 2011). In 2008, Peru created the Ministry of Environment (MINAM) and its state institutions such as the Agency for Environmental Assessment and Enforcement (OEFA) (PRP, 2008). However, following governments have not enforced the environmental management of projects of extractivism, and have weakened environmental institutionalism by removing central functions of MINAM and restricting the work of state institutions of MINAM (CRP, 2015; Damonte and Vila, 2014; De Echave, 2018; PCM, 2013; PRP, 2014). Environmental institutionalism, i.e., the set of state institutions and instruments of public policy that focus on the problems of degraded environments on which people depend (Damonte and Vila, 2014), has been negatively affected by current policies. This has occurred despite the creation of new state institutions like SENACE (Peru´s Environmental Licensing Agency) that aims to face the environmental public demands (SENACE, 2018; Preciado Jerónimo and Álvarez Gutiérrez, 2016).

The weak state institutions are still characterized by low stability, social fragmentation (Henríquez, 2015), low institutional confidence (Gudynas, 2017), and weak enforcement capabilities (Levitsky and Murillo, 2009). In addition, the presence of state institutions in most regions is weak in the regulation of mining concessions and investments and the relationship between communities and mining companies (WB, 2005; Henríquez, 2015). In a context of weak environmental institutionalism, communities may be poorly informed for the decision-making process regarding extractivist projects (Arellano-Yanguas, 2011a; Hilson, 2002). Despite communities requesting a proper prior consultation for mining projects (De Echave, 2018), the lack of poor community consultation causes misinformation and misunderstanding between local people and mining companies (Bebbington et al., 2008; Bebbington and Bury, 2009; McDonell, 2015). As a consequence, some communities look for technical support from non-governmental institutions in order to be better prepared for facing mining companies (Haarstad and Fløysand, 2007).

Once extractivism faces environmental institutionalism, the processes of state institution building and democratization are usually involved with the extractivism-related conflicts (Bebbington, 2012; Gudynas, 2017). As a result, conflicts may arise in weak environmental institutionalism. The conflicts are defined as a complex process where society, government, and the private sector perceive that their goals/interests/values/needs are contradictory, leading to violence[7] (Ombudsman of Peru, 2017b; Kriesberg and Dayton, 2011). Land-use conflicts are the response of communities to the threats of their ecosystems and livelihoods through water and soil pollution (Bebbington et al., 2008; Bebbington and Bury, 2009; Li, 2009; McDonell, 2015).

Socio-environmental factors have become the main reason for conflicts (Figure 2-2) in mining-community shared areas. Besides these underlying root causes, there are also socio-environmental and economic reasons behind the land-use conflicts. For instance, despite the assigned public benefits for the communities, poverty and marginalization have increased, as well as the probability of occurrence of conflicts (Haslam and Tanimoune, 2016). In addition, the latent problems of the community (e.g. poor irrigation systems) affect their agricultural opportunities (i.e., less available agricultural land), increasing land competition and land-use conflicts (Haslam and Tanimoune, 2016; Urrutia, 2003).

[7] Violence is defined as a destructive demonstration of the conflict (Ombudsman of Peru, 2017b).

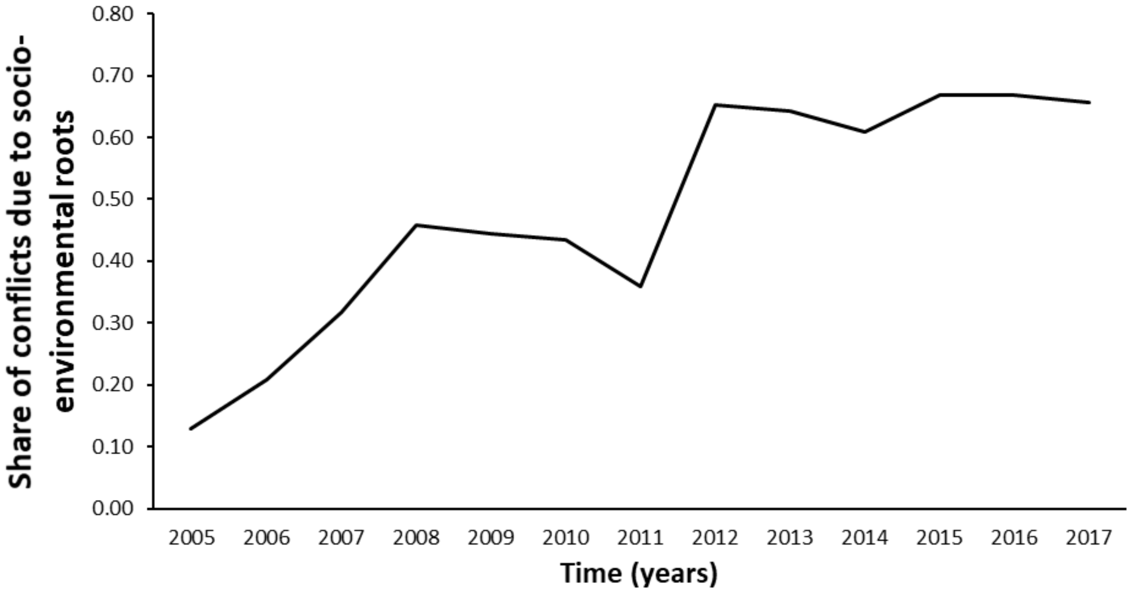


Figure 2-2. Annual share of conflicts due to socio-environmental drivers in Peru, 2005-2016.
Based on the Ombudsman of Peru (2005-2017b).

Initially, land-use conflicts are rooted in the environmental impacts of mining activities on farming livelihoods and even the displacement of small-scale farmers (Adam et al., 2015; Arellano-Yanguas, 2011b; Delgado and Romero, 2016; Helwege, 2015; Triscritti, 2013). As the conflict escalates, other reasons and stakeholders´ interests emerge such as the question of economic compensation for the communities (Arellano-Yanguas, 2011a). Also, the distribution of mining royalties in the sub-national government and the deterioration of the environment have triggered conflicts and the formation of non-governmental groups to deal with these conflicts (Bebbington and Bury, 2009; Durand Guevara, 2014; Melucci, 1999; Triscritti, 2013). Current researchers propose different forms of implementation, approaches, and models for mining-community relations. However, the improvement of these relations requires effective public institutions and changes in political norms (Bebbington and Bury, 2009; Helwege, 2015).

2.4. Land-use conflicts in Peru

A land-use conflict occurs when the use of land and its resources deviates from the use found through the capability evaluation (i.e., natural use) and affects the livelihoods of local communities (Campbell et al., 2000; Hilson, 2002; Valle Junior et al., 2014; Von Der Dunk et al., 2011). Site-specific ecological, social and economic interactions trigger land-use conflicts (Campbell et al., 2000) involving different parties and socio-environmental impacts (Tudor et al., 2014). Conflict drivers are related to values (e.g. landscape value such as biodiversity, water, livelihood), resource scarcity, social power imbalances, property rights, and weak institutions with the lack of a clear environmental policy (Brown and Raymond, 2014).

In the mining context, most conflicts are rooted in the environmental impacts of mining activities on community livelihoods, the mismatch of interests on land use, and displacement of small-scale farmers (Delgado and Romero, 2016; Valencia and Riaño, 2017). Although campesino communities have the autonomy to decide on the use of their community lands, this autonomy includes only the depths of the agriculture soil. The subsoil of Andean lands belongs to the Peruvian government, meaning that the government has the legal power to decide the land use (De Echave, 2018). Thus, once a mining company gets a concession from the government, it enters the reality of campesino communities and generates or increases the inequality and politicization of the community (Henríquez, 2015). Loayza and Rigolini (2016) applying the Gini coefficient found high inequality in mining districts compared to non-mining districts. Although inequality is enhanced by mining operations, it is also based on the previous circumstances of the community members (e.g. education, qualified skills). Likewise, the politicization of the community, although triggered by mining operations, is based on the pre-existing conflicts in the community.

In the period 1990-2010, the beginning mining boom increased the gross domestic product through the applied neoliberal reforms and promotion of investments (De Echave, 2018; Loayza and Rigolini, 2016; Zegarra et al., 2007). This boom was boosted by high metal prices and the economic expansion of China and India (Loayza and Rigolini, 2016; Perreault, 2014; Zegarra et al., 2007) (Figure 2-3) with peaks in 2008 and 2011-2012. In 2008, mining-related conflicts also occurred in different regions simultaneously (Dargent et al., 2017) (Figure 2-2 and Figure 2-3).

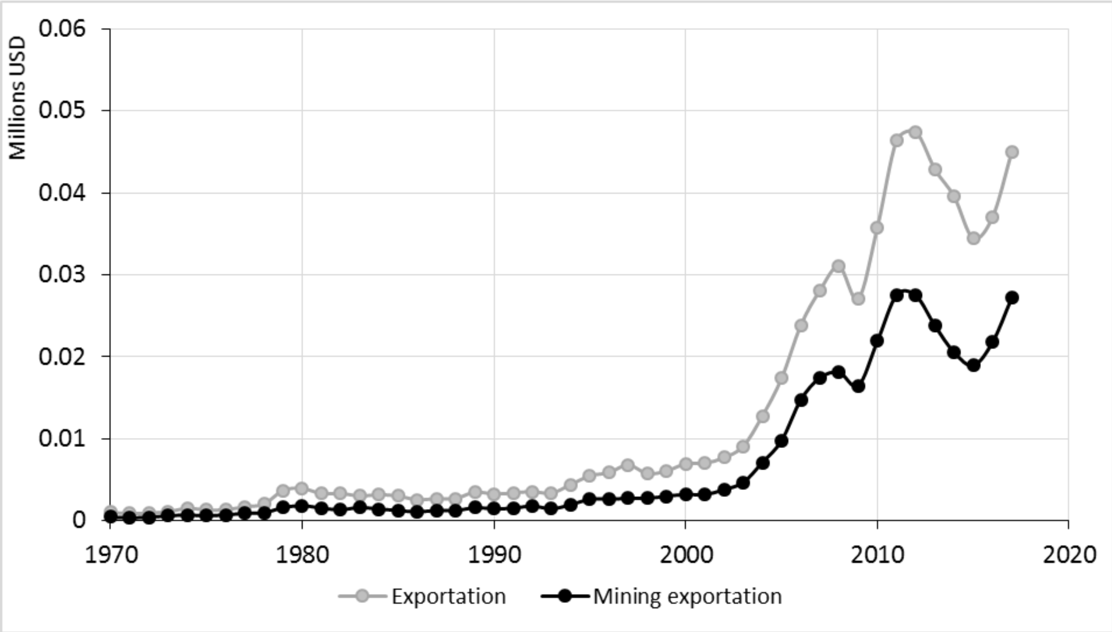


Figure 2-3. Annual total and mining-related exportations in USD millions in Peru, 1970-2017.
Based on BCRP data (BCRP, 2018).

On account of the mining boom, resistance to mining, i.e., `spoken, cognitive or physical´ counter-actions or the contraposition/mobilization/opposition forms (Hollander & Einwohner, 2004; Rose, 2002; Conde, 2017), has risen at the community level where mining operations are active (Conde, 2017). Communities base their resistance on factors that are related to four main actors: mining projects, a mining company, the community itself, and the state (Conde and Le Billon, 2017). Figure 2-4 shows the interaction of the actors and factors involved. For instance, marginalization is a community-related factor but involves the government and the community as actors because the government needs to reduce the economic and political marginalization among communities. The current central Peruvian government has agreed with regional governments to set as a priority building or improving roads to connect cities, thus stimulating local economies and reducing marginality (PRP, 2017a). Marginalization restricts the ability of people to find opportunities and take advantage of them when they arise for improving their livelihoods (von Braun and Gatzweiler, 2014).

The resistance factors are the base of the "Ecological Distribution Conflicts", i.e., conflicts of interests and values over the access to environmental resources (Martinez-Alier, 2002), and relate to the theory of "Environmentalism of the Poor". This theory focuses on the conflict between poor people and the government/market, where poor people (e.g. campesino communities) defend their environment (Martinez-Alier, 2002). Thus, although Peru´s case has shown a break between the government and local communities due to land/water concessions in the context of extractivist projects (De Echave, 2018), livelihood dependency on water and land has changed as communities have evolved due to increased temporal proximity with urban areas, diversification of local economies and migration.

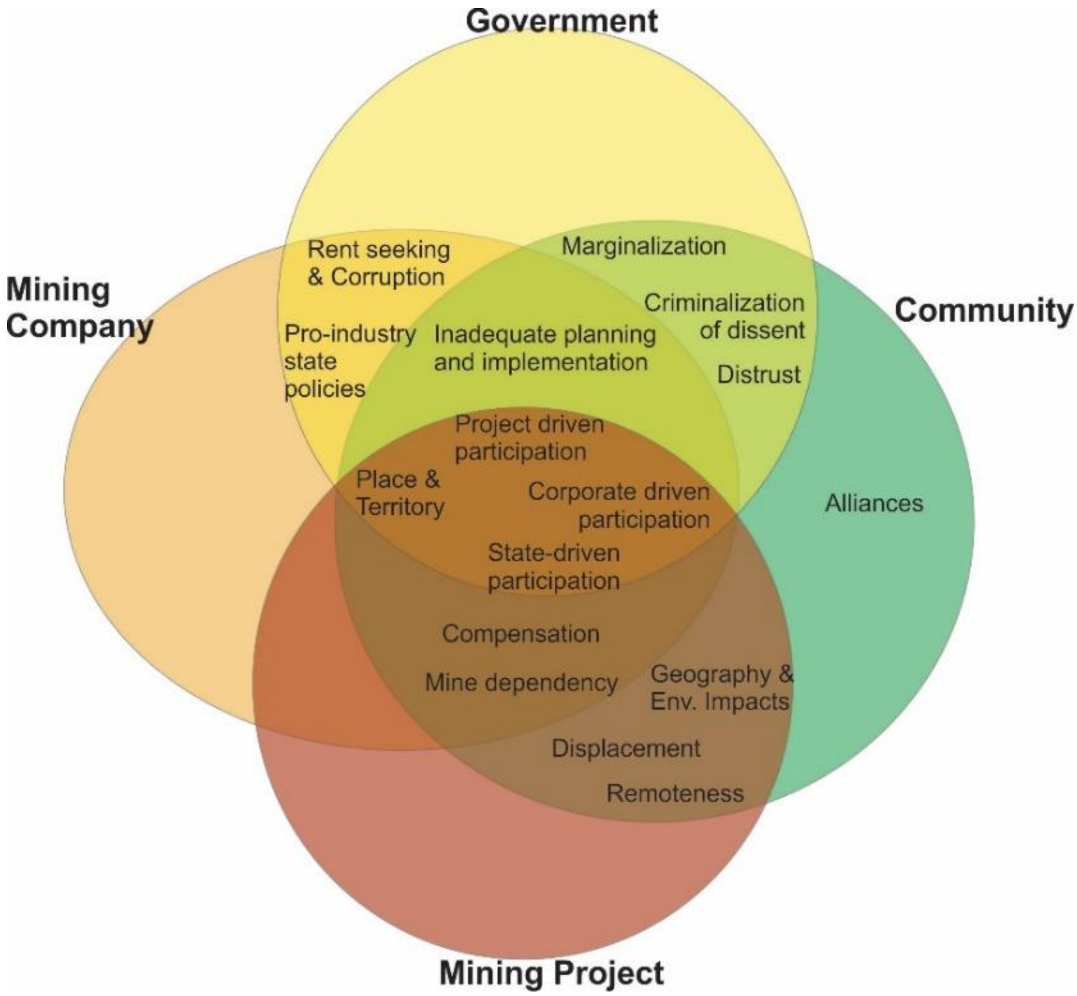


Figure 2-4. Mining resistance factors in community-government-mining company-project context. Based on Conde and Le Billon (2017).

In mining-farming environments in Peru, an unstable order marked by conflicts and demonstrations has developed, where state institutions face difficulties in managing conflicts (Calderón, 2012a; Henríquez, 2015). Conflicts may be used to pressure the state and private sector to negotiate with the campesino community to provide them with better benefits (Burneo de la Rocha and Chaparro Ortiz de Zevallos, 2010; De Echave, 2018). Although conflicts related to extractivism do not derive from problems of ‘governance’, conflicts deepen due to the disconnection among different levels of government and political bodies (Arellano-Yanguas, 2011a; Damonte and Glave, 2012; Merino Acuña, 2015). In the last decade, most mining-related conflicts have been considered radical (De Echave, 2018). According to Calderón (2012a), the radicalization of the conflict consists of the enunciation of the conflict, the verbal expression of the unrest, and the threat of public demonstrations or direct actions. However, this radicalization reflects the perception promoted by the media to the population, and sometimes their partial position regarding the conflict (De Echave, 2018).

2.5. Research design and conceptual framework

During the last decades, the high mining potential of the Andes has boosted the Peruvian economy, with most of the mining operations overlapping with campesino community lands. Most of the mining concessions have been done at high elevations, encroaching on farming lands and jeopardizing the livelihoods of campesino communities. The history of campesino communities, Peru´s national history, neoliberal policies and the national dependence on industries of extractivism have all left their mark on the current development of land-use conflicts. Mining impacts have provided the impetus for mining resistance from communities due to the vulnerability of their natural resources (e.g. water quality) and farming-based livelihoods (Conde and Le Billon, 2017). Mining concessions positioning themselves at headwaters, the insufficient negotiation power of communities, mining-related laws, and weak environmental institutionalism combine to trigger land-use conflicts. Land-use conflicts may strongly depend on how the government, the mining company, and communities play their own roles to gain economic profit from mining operations while attempting to maintain a healthy environment and good relations.

The present research focuses on land-use conflicts in the Central Peruvian Andes. The following conceptual framework (Figure 2-5) guides the research and its operationalization of the interdisciplinary approach implemented. Drawing from previous studies on land-use conflicts, this research used a mixed-methods approach (Creswell and Creswell, 2017) and is defined by three phases: (i) water/soil assessment, (ii) identification of stakeholders and disclosure of community livelihoods, and (iii) integration of the findings into a land-use conflict risk index.

First, the assessment of metal concentrations was applied for water and soil downstream from mining sites. Biophysical factors were both sampled following the Peruvian protocols (ANA, 2016a; MINAM, 2014) and analyzed by inductively coupled plasma-atomic emission spectrometry (EPA, 1994). The results were compared to secondary government data and land-cover classification. Participatory mapping with community authorities and key informants was used for the comparison with land-cover classification data that was obtained by processing Landsat images by maximum likelihood classification.

Second, the livelihoods of the campesino community were identified to assess their economic activities. This focused on the disclosure of the family income and the problems that may affect their involvement in the local economy. Likewise, the interactions among stakeholders and the functions of state institutions were determined to establish the legitimacy/authority and influence/interest of stakeholders (Chevalier and Buckles, 2013) in community-mining lands. The drivers of land-use conflicts were obtained from in-depth interviews and a semi-structured survey of stakeholders and community members, respectively. This phase shows the conditions before a land-use conflict in community-mining lands develops and escalates.

Third, the land-use conflict risk index is based on the results and data collected using the aforementioned methods. The main aim was to integrate and consolidate the above biophysical, social and institutional components, and to develop scenarios to simulate the conflicts between campesino communities and mining companies through GIS-based multi-criteria decision analysis. The risk index provides a useful tool for supporting managers and the government in making more informed decisions and progress towards managing or preventing land-use conflicts.

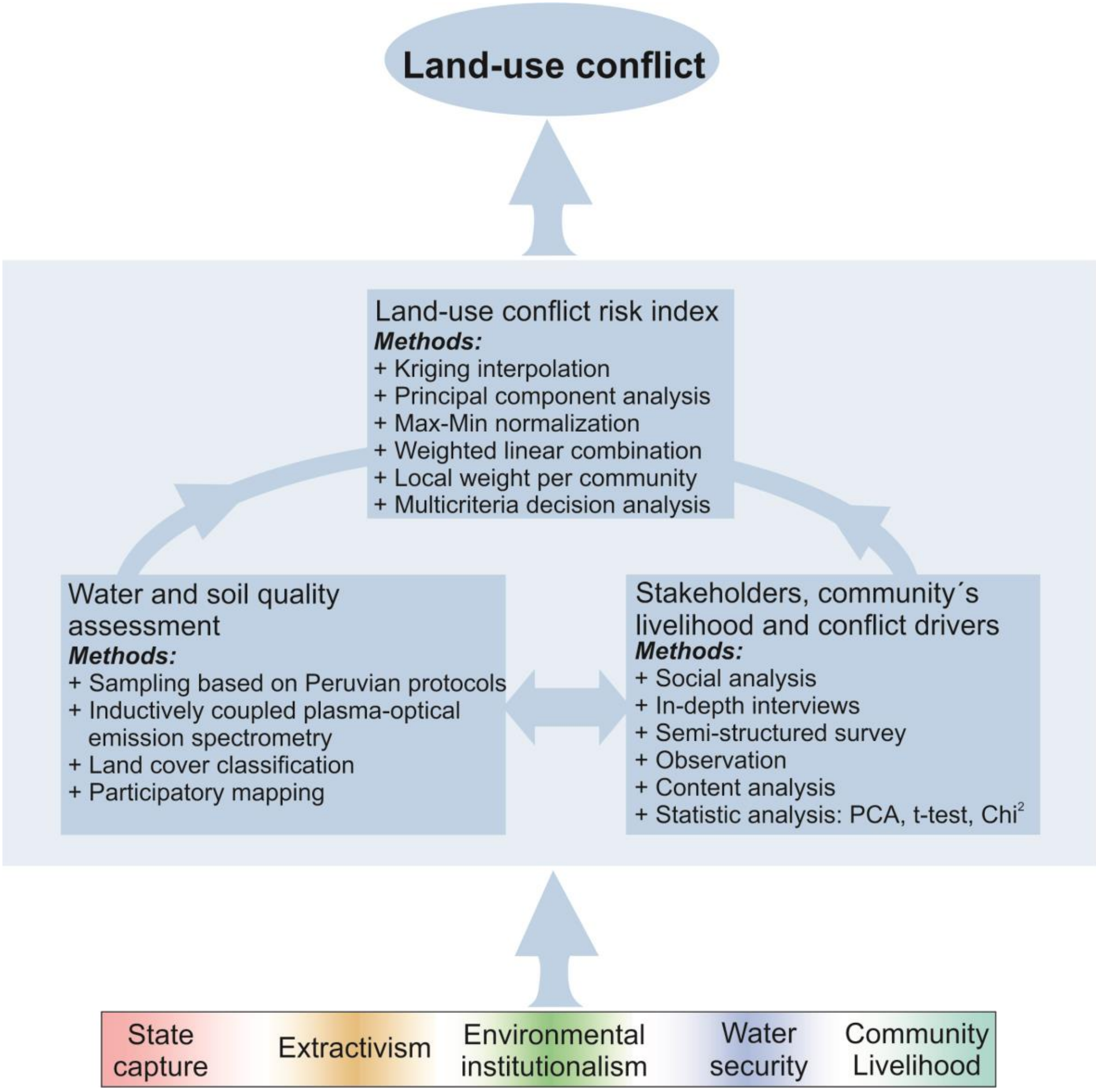


Figure 2-5. Conceptual framework and research design

3. IMPACT OF HEAVY METALS ON COMMUNITY FARMING ACTIVITIES IN THE CENTRAL PERUVIAN ANDES

3.1. Introduction

A recent boom in mining exploitation has extended along the Andes, overlapping with community lands and water bodies (Bebbington and Williams, 2008). It is estimated that the livelihoods of 40 million people depend on these Andean ecosystems (Becker and Bugmann, 2001; Josse et al., 2009). In the case of Peru, most of the Andes are occupied by campesino communities. Legally, a campesino community is a set of neighboring households that share the collective ownership of a determined area (Castillo et al., 2004; CTRJ, 2015b; CRP, 1987) and are economically dependent primarily on agricultural and livestock-related activities (Bartl et al., 2009; Kristjanson et al., 2007; Postigo et al., 2008; Valdivia and Quiroz, 2003).

Recently, land-use conflicts have emerged between campesino communities and mining operations (Arellano-Yanguas, 2008; Preciado Jerónimo, 2011; Robbins, 2012). These mainly occur due to the underrepresentation of campesino communities in the decision-making processes (Bebbington and Williams, 2008; Robbins, 2012), location of the mining projects and subsequent endangerment of water quality, and inefficient use of water (Bebbington and Williams, 2008; FAO, 1999; Franks et al., 2014; Järup, 2003; Jaskoski, 2014; Preciado Jerónimo, 2011).

Nevertheless, the number of mining projects has increased in Peru due to legislation that favors investments (Preciado Jerónimo, 2011). The General Mining Law (GLM) of 1992 sets a roadmap for establishing mining operations that mainly considers the ‘exploration’ and ‘exploitation’ phases (MEM, 1992). Generally, the operation requires the permission of the Ministry of Energy and Mining (MEM) and the campesino community/communities that own the land (Arellano-Yanguas, 2011a; Jaskoski, 2014). Based on the *canon minero*, 50% of the taxes from the mining sector are distributed among the affected subnational governments (Arellano-Yanguas, 2010; CRP, 2004b, 2001; SNMPE, 2018). The subnational governments directly affected by mining may receive up to 75% of this tax (Arellano-Yanguas, 2008; Damonte and Glave, 2012; MEM, 1992), while campesino communities are excluded from receiving it directly. As a result, the communities tend to negotiate compensations separately with the mining companies. Both *canon minero* and compensations are aimed at reducing land-use conflicts. Despite this, conflicts have increased (2005-2011), reduced in 2012 and have remained constant (ca. 162 yearly conflicts) since then (Arellano-Yanguas, 2011a; Ombudsman of Peru, 2005-2017a). In 2017, Peru allocated 16 million ha for mining concessions (INGEMMET, 2017), although not all of these became viable mines. The most common mining practice in Peru is open-pit mining, as this model is preferred for exploiting metal deposits. There are 36 open-pit mines throughout the country (América Economía, 2018). The environmental impacts of open-pit mining mainly relate to water infiltration and supply to rivers (Hartman and Mutmansky, 2002; King et al., 2017; Martín-Duque et al., 2010; Preciado Jerónimo, 2011), which impact the socio-economic situation of local households (Bebbington and Bury, 2009; Bebbington and Williams, 2008; Figueroa et al., 2010; McDonell, 2015).

Most studies have split these biophysical and socio-economic aspects rather than integrating them (Bebbington et al., 2008; Bebbington and Bury, 2009; Figueroa et al., 2010; McDonell, 2015). Therefore, an interdisciplinary approach (Cathain et al., 2008) is suggested to broaden the understanding of the impacts of mining from different perspectives. In this sense, the overarching objective of this chapter is to identify the mining impacts on the farming activities of campesino communities in the Junin Region. Therefore, this study first analyzed the agreements between mining companies and communities via in-depth interviews with stakeholders. Then the study evaluated the influence by open-pit mining sites on the water and soil quality and assessed the effects on farming lands. The following two research questions guide this chapter: **(RQ 3-1)** Do biophysical measurements in farming lands reflect the impacts of heavy metals? **(RQ 3-2)** how are these biophysical factors influencing the community livelihoods in the Junin Region?

3.2. Materials and Methods

Under the interdisciplinary approach, this investigation applied mixed-methods (Hesse-Biber, 2010a, 2010b) including in-depth interviews to analyze the negotiation process between campesino communities and mining companies, laboratory analyses to measure heavy metal concentrations in streams and farmland soils around the mines, and participatory mapping and GIS-based land-cover classification to assess the perspectives of the community members and effects on their livelihoods. For the water and soil analyses, this study used inductively coupled plasma-optical emission spectrometry (ICP-OES) (EPA, 1994) and for the mapping ArcGIS (Hagner and Reese, 2007), and R programming language (Hijmans et al., 2017; Leutner et al., 2018; R Core Team, 2015) (Figure 3-1).

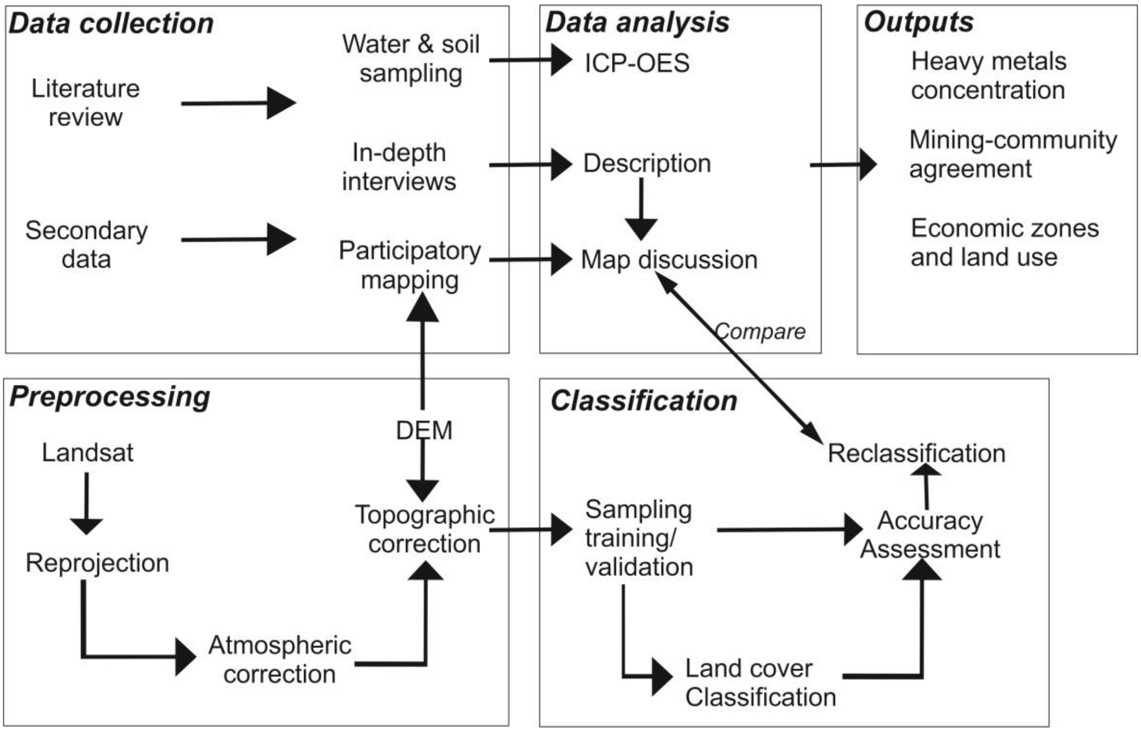


Figure 3-1. Overview of research methodology
Based on (Gottlicher et al., 2009; Ramirez-Gomez et al., 2016; EPA, 1994).

3.2.1. Research site

The Junin Region (S11°29’-W74°59’) within the Mantaro watershed hosts a large number of mining companies, is of great importance for agricultural production, and encompasses 389 campesino communities (CTRJ, 2015c, 2015d; INEI, 2018a; Osorio, 2009). The study site includes the sub-basins Cunas and Aimaraes of the watershed (CTRJ, 2015a; IGP, 2012, 2005) within which are located the 14 campesino communities and three mining sites. The Azulcocha mine is in the Cunas sub-basin, while Corihuarmi and Huacravilca mines are in the Aimaraes sub-basin (Figure 3-2). The Azulcocha mine is situated on glacial and glaciofluvial bedrocks in an irregular gorge with different landforms (CTRJ, 2015a). The mine currently covers 8600 ha at 4400 m above sea level (MASL) for zinc production, and a concentrator plant with 500 ton/day processing capacity (Bloomberg, n.d.; Clean Technology S.A.C., 2007). The Corihuarmi mine, located in an epithermal gold-silver belt, is an open-pit mine covering 10 168 ha at ca. 5000 MASL and exploits gold (ANA, 2016b, 2015; Barradas, 2013; Minera IRL, n.d.). The Huacravilca mining mine covers 2000 ha for exploration at 4700 MASL over fluvial and glaciofluvial deposits and six sedimentary units (Blache Snow Consulting, 2012; Fresnillo Perú S.A.C., 2017; Rumbo Minero, n.d.).

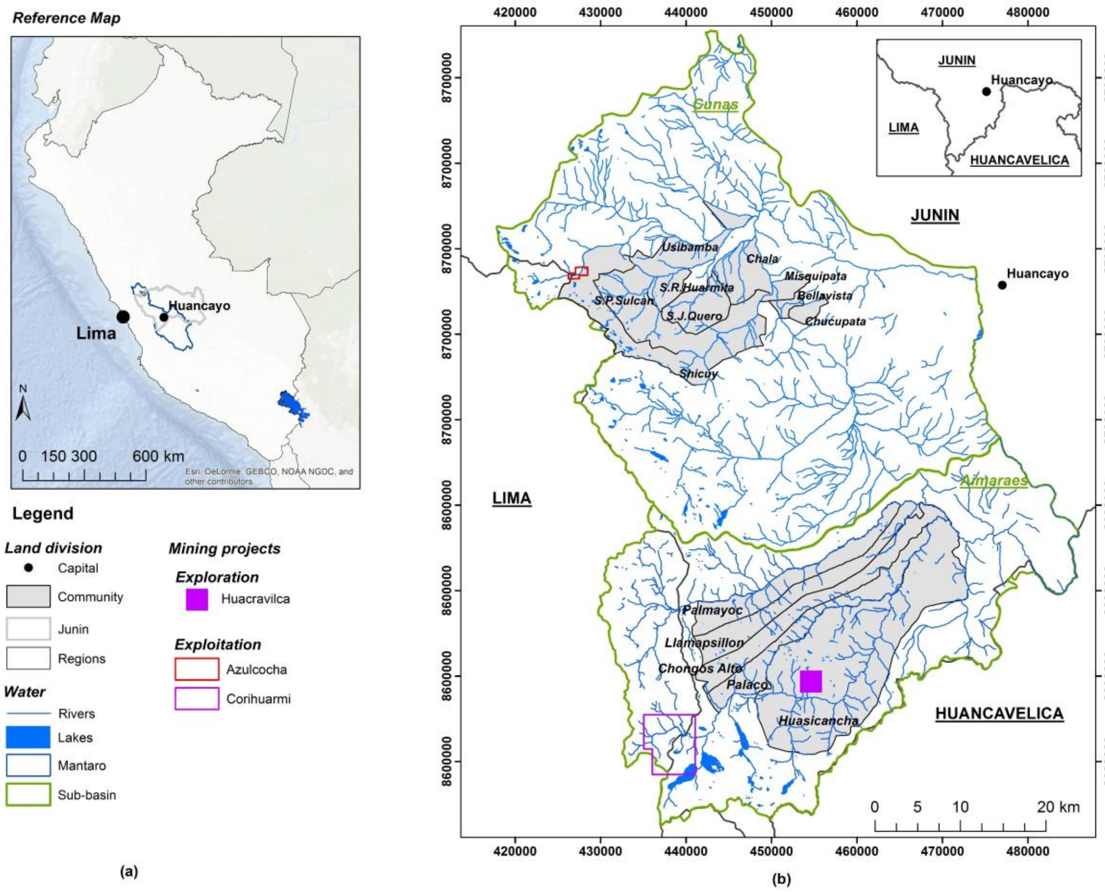


Figure 3-2. Research area in (a) Junin Region, and (b) location of mining operations and campesino communities in Aimaraes and Cunas sub-basins. Based on government data and INGEMMET (INGEMMET, 2018).

After subnational governments and community authorities had authorized this study, 14 out of 18 communities agreed to participate, i.e., nine from the Cunas sub-basin and 5 from the Aimaraes sub-basin. As not all communities are affected by mining operations in the same way, the considered campesino communities were divided into mining-affected and not mining-affected communities (Figure 3-2, Table 3-1).

Table 3-1. Mining operations with the stage of use and assessed campesino communities with the number of active members in parentheses.

	Cunas Sub-Basin	**Aimaraes Sub-Basin**
Mining Operation	Azulcocha (exploitation: Zn)	Huacravilca (exploration: Ag) Corihuarmi (exploitation: Au)
Mining-Affected Communities	San Pedro de Sulcan (25) Usibamba (238) Shicuy (75)	Huasicancha (251) Chongos Alto (108) Palmayoc (22) Palaco (23) Llamapsillon (55)
Not Mining-Affected Community	Chala (72) Santa Rosa de Huarmita (23) San José de Quero (30) Bellavista (50) Misquipata (30) Chucupata (20)	No control community

3.2.2. Interviews with stakeholders

To understand the negotiation dynamics between mining operations and campesino communities, in-depth interviews with community authorities and representatives of the mining operations were carried out (Appendix 8.1). In total, this study interviewed authorities from each mining-affected community and five representatives of four mining companies. In addition to the mining companies operating in the study area (Table 3-1), a fourth mine—Volcan mining company—was included considering its long history (ca. 75 years) in the Junin Region and its track record of negotiations with the communities. The identity of all stakeholders was anonymized given the sensitive character of the revealed information. All in-depth interviews were carried out in Spanish.

3.2.3. Water and soil sampling

To explore the historical presence of heavy metals in the surroundings of the sample points (Table 3-2), the used data were the regional geology and geochemistry of the Geological, Mining and Metallurgical Institute (INGEMMET) (INGEMMET, 2018).
Also, this study used the assessments of the Agency for Environmental Assessment and Enforcement (OEFA), which found concentrations of heavy metals that were higher than the threshold allowed by Environmental Quality Standards (EQS) (Ayers and Westcot, 1985; MINAM, 2017a, 2015) (Appendix 8.2).In this study, 12 sample points were selected along the rivers Pucara (Cunas sub-basin) and Aimaraes. At each sample point, this research took two samples, i.e., 24 water samples, during the dry season (October-November) of 2016.

Azulcocha and Corihuarmi are located at the headwaters of the Aimaraes and Cunas sub-basins. In each sub-basin, four case sample points and two control sample points were selected, i.e., a total of eight cases and four control samples. Case sample points were taken upstream (approx. 50 to 100 m) and downstream (approx. 100 to 500 m) of the mining sites and campesino communities (Figure 3-3). Water sampling followed the national protocol of Peru´s National Authority of Water (ANA, 2016a). The 24 samples were sent to the Corrosion and Protection Institute (ICP) of the Pontifical Catholic University of Peru (PUCP) to determine total heavy metal concentrations through inductively coupled plasma-optical emission spectrometry (ICP-OES) according to the EPA (United States Environmental Protection Agency) method 200.7 – Rev. 4.4. (EPA, 1994).

Regarding the presence of heavy metals, INGEMMET identified contents of mercury (Hg), chromium (Cr) and/or arsenic (As) in the Aimaraes glacial deposits and contents of Cr, As, lead (Pb) and cadmium (Cd) in colluvial deposits (INGEMMET, 2018). In the Cunas river, Cr contents were found in alluvial and glacial-fluvial deposits and in the Mataula[8] and Casapalca[9] formations. High concentrations of As and Cd in two Cunas alluvial deposits had also been previously identified (INGEMMET, 2018). The presence of heavy metals in the sample locations is summarized in Table 3-2.

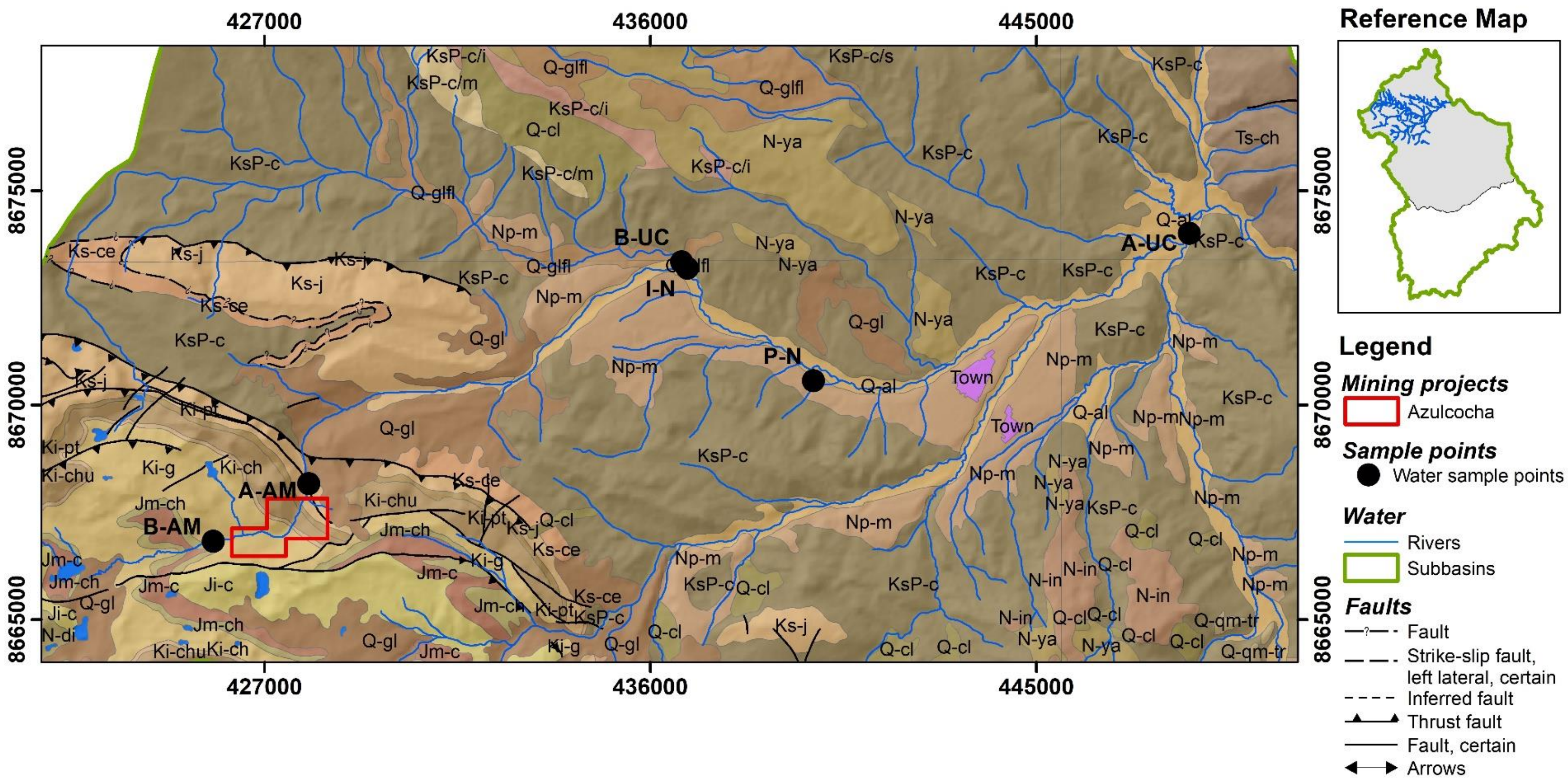
Table 3-2. Geological characteristics and natural heavy metals (HM) presence in water sample points and their surroundings.

Sub-Basin	**Sample**	**Lithology and Geochemistry**		**Surroundings of Sample Points**	
		Geological unit	HM	Geological unit	HM
Cunas	B-AM (upstream Azulcocha)	Goyllarisquizga Group (Ki-g)		Chunumayo F. (Jm-ch)	
				Cercapuquio F. (Jm-c)	
	A-AM (Downstream Azulcocha)	Jumasha F. (Ks-j)		Pariatambo F. (Ki-pt)	
				Glacial D. (Q-gl)	
	B-UC (Control 1, upstream Usibamba)	Glacial, fluvial D. (Q-glfl)	Cr	Casapalca F. (KsP-c)	
				Alluvial D. (Q-al)	
	A-UC (After Usibamba)	Alluvial D. (Q-al)	Cr, As, Cd	Casapalca F. (KsP-c)	Cr
	I-N (Confluence of rivers)	Glacial, fluvial D. (Q-glfl)		Alluvial D. (Q-al)	
				Casapalca F. (KsP-c)	
	PN (Control 2)	Mataula F. (Np-m)	Cr	Alluvial D. (Q-al)	
				Casapalca F. (KsP-c)	
Aimaraes	I-L (Control 1)	Glacial D. (Q-gl)		Domo andesítico (N/dmand)	
	L-S (Control 2)	Glacial D. (Q-gl)		Chúlec F. (Ki-chu)	
				Casapalca F. (KsP-c)	
	A-CM (Downstream Corihuarmi)	Glacial D. (Q-gl)	Hg, Cr, As	Jumasha F. (Ks-j)	
				Chúlec F. (Ki-chu)	
	B-HM (upstream Huacravilca)	Condorsinga F. (Ji-c)		Cercapuquio F. (Jm-c)	
				Granite (N-gr)	
	A-HM (Downstream Huacravilca)	Glacial D. (Q-gl)	Hg, Cr, As	Granite (N-gr)	
				Cercapuquio F. (Jm-c)	
	A-CA-S (Downstream Huasicancha disputed area)	Colluvial D. (Q-cl)	Cr, As, Pb, Cd	Yanacancha F. (N-ya)	
				Rhyolite (Nri)	

D: Deposit, F: Formation; Based on INGEMMET (2018), Mégard (1968), Wise (2007)

[8] Mataula formation is characterized by lacustrine layers, sands and sandstones and fluvial conglomerates (Wise, 2007; CTRJ, 2015d).

[9] Casapalca formation is older than the Mataula formation and is characterized by shales, siltstones, sandstones and hematite-based conglomerates (Wise, 2007; CTRJ, 2015d).



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Town
Reference Map
Legend
Mining projects
Azulcocha
Sample points
Water sample points
Water
Rivers
Subbasins
Faults
Fault
Strike-slip fault, left lateral, certain
Inferred fault
Thrust fault
Fault, certain
Arrows

(a)

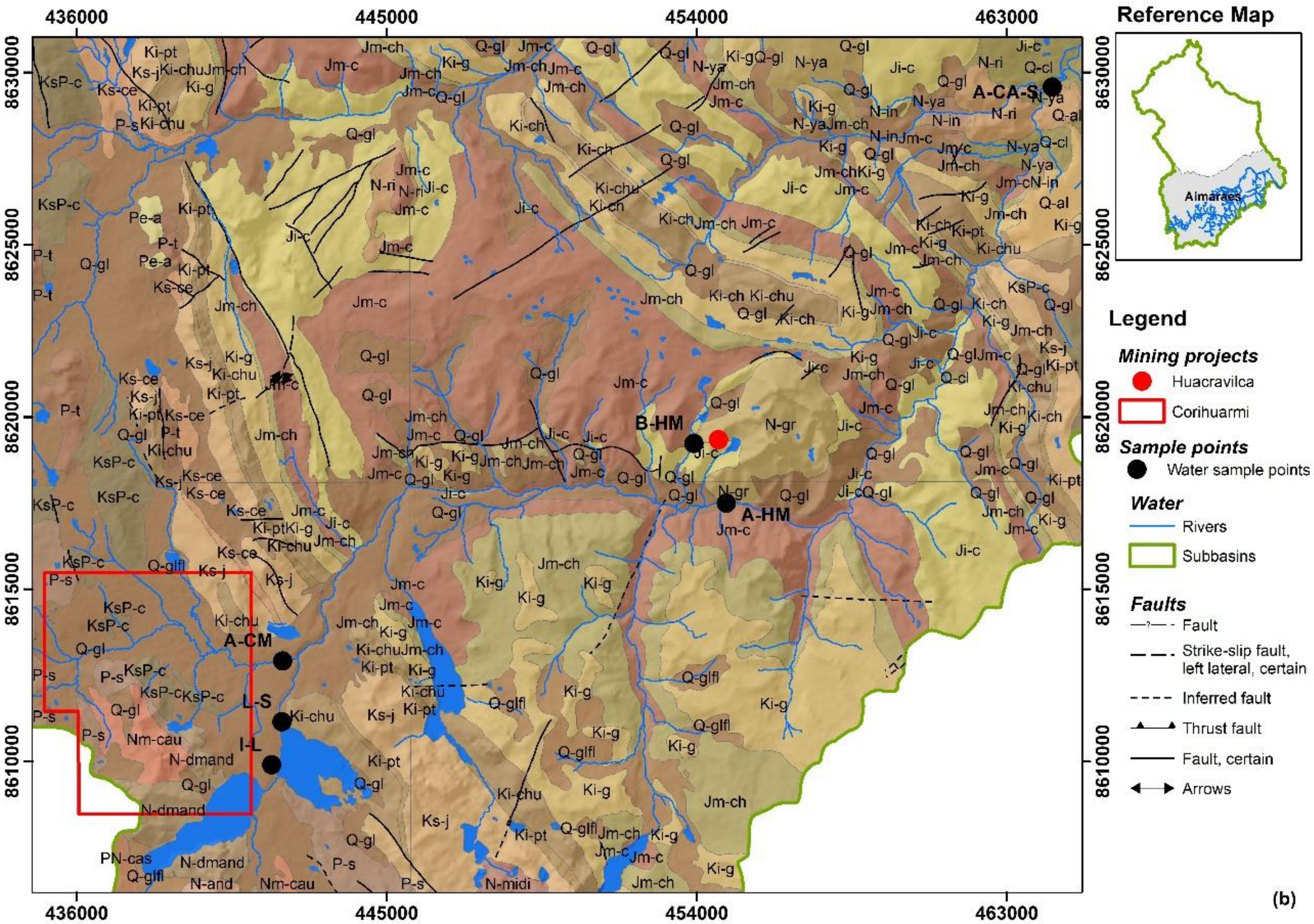

Figure 3-3. Water sample points and geology in sub-basins in (a) Cunas and (b) Aimaraes; based on INGEMMET (INGEMMET, 2018).

Regarding soils, the sample sites correspond to natural pastures used for grazing by the communities. It was verified that in each sample site there was no evidence of recent landslides that would alter results. In each sub-basin, the sample points were located 12 km and 24 km away from the mining exploitation sites near the aforementioned river courses (downstream). Control sample points were taken in non-mining areas that have the same dominant geological type. Due to the farming nature of lands and the Peruvian protocol for soil sampling, two samples were taken at 30 and 60 cm depth per sample point (Bech et al., 2012; MINAM, 2014). At each sample point, this study measured a 3-m square in which 2-5 samples per depth (20cm and 60 cm) were taken, combined and partitioned to obtain a representative soil sample (ca. 2 kg). Thus, eight case and four control soil samples were taken and sent to the PUCP to determine total heavy metal content through ICP-OES according to the EPA method 200.7-Rev. 4.4. Table 3-3 shows the geological characteristics and the natural presence of relevant heavy metal.

Table 3-3. Geological characteristics and natural presence of heavy metals (HM) in soil sample points and their surroundings.

Sub-Basin	Sample Point	Lithology and Geochemistry		Surroundings to Sample Points	
		Geological Unit	HM	Geological Unit	HM
Cunas	12 km	Glacial, fluvial D. (Q-glfl)	Cr	Casapalca F. (KsP-c)	Cr
	24 km	Alluvial D. (Q-al)	As, Cr, Cd	Mataula F. (Np-m)	
				Casapalca F. (KsP-c)	
	Control	Glacial, fluvial D. (Q-glfl)	Cr	Alluvial D. (Q-al)	
				Casapalca F. (KsP-c)	
				Matula F. (Np-m)	
Aimaraes	12 km	Glacial D. (Q-gl)	Cr, Hg, As, Pb	Condorsinga F. (Ji-c)	
				Cercapuquio F. (Jm-c)	Cr
	24 km	Colluvial D. (Q-cl)	Cr, As, Cd, Pb	Yanacancha F. (N-ya)	
				Riolita (Nri)	
	Control	Alluvial D. (Q-al)	Cr	Condorsinga F. (Ji-c)	
				Yanacancha F. (N-ya)	

D: Deposit, F: Formation; Based on INGEMMET (1983, 2018), Mégard (1968)

Although this research offers a more comprehensive and interdisciplinary insight into the mining companies-communities interactions, several drawbacks are to be acknowledged. These mainly relate to the restrictions on water and soil sampling due to mining companies´ demarcations, privatization, and latent territorial conflicts between communities.

3.2.4. Participatory mapping

In the Usibamba community, a participatory mapping exercise was conducted following the methods of Ramirez-Gomez et al. (2016). As there is no agreement with the Azulcocha mine, community members rely strongly on farming for their livelihoods. Mining impacts have been reported because of the effects on community livelihoods. Via participatory mapping, this study aimed to (i) identify community settlements, livestock water sources, and grazing and agriculture areas, and (ii) to contrast the site conditions with the results of this study on heavy metal content and land-cover classification, and with official reports from the regional government (e.g., available community maps) and the OEFA (OEFA, 2014a, 2013a). The exercise was in two stages. In the first stage (March 11, 2017), ten volunteer community members participated, and in the second (March 23, 2017) two key informants plus nine neighborhood presidents. In both cases, a detailed map including roads and streams as well as the digital elevation model (DEM) of the 90-m resolution was used. The DEM was obtained from the Shuttle Radar Topography Mission (http://srtm.csi.cgiar.org/; (Jarvis et al., 2008).

The participatory mapping outcomes were overlaid with a land-cover classification (LCC) that considered crops, infrastructure, rocky outcrops, vegetation, and water for which two Landsat surface reflectance images from the U.S. Geological Survey (USGS, 2019) were processed (Appendix 0). These images belong to Path 6 and Rows 68 (10.64% cloud cover) and 69 (0% cloud cover) on August 07 and July 22 in 2017 (dry season). The LCC consisted of the following processing steps: (1) normalize topographic shadow on images (bands 2-7) with the Minnaert algorithm (Pimple et al., 2017) (Appendix 0), (2) extract training/validation samples, (3) apply a maximum likelihood classification (MLC) (Gottlicher et al., 2009), and (4) reclassify misclassified pixels (Appendix 8.4) by comparing results with participatory mapping zonification and high-resolution imagery from Google (Esri, 2019). The resulting product is shown in Figure 3-4.

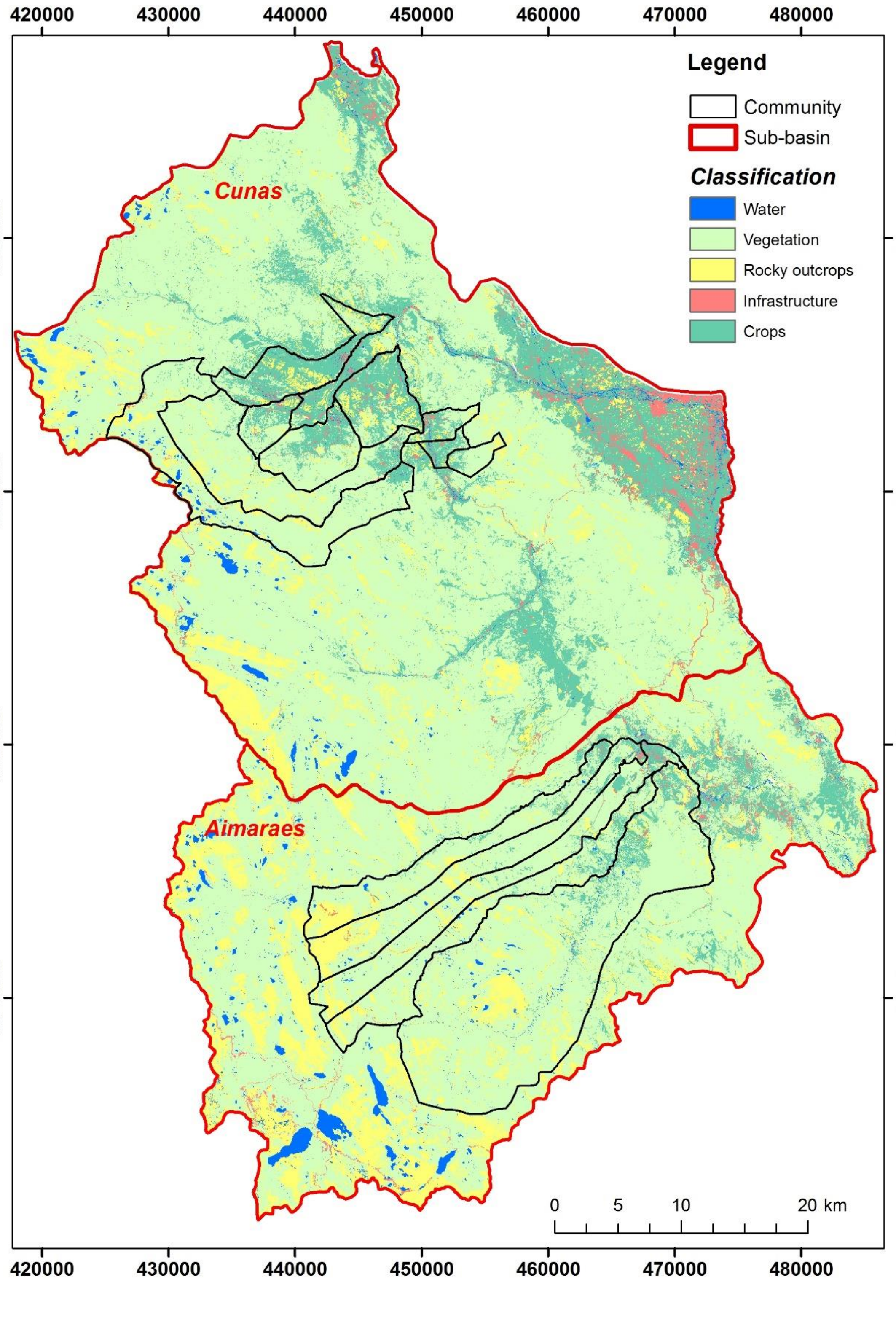

Figure 3-4. Land-cover classification of the research area (maximum likelihood classification method).

In total, 1647 samples were randomly taken considering a minimum distance of ~1 km between each sample. From these, this study selected 1320 samples for training and reserved 327 for validation (i.e., 80% training and 20% validation). During the training, for each land cover class, 280 samples were taken, except in infrastructure that accounts for 200 samples since minimum distance did not allow us to sample more than this number. Similarly, for validation, this study took 70 samples for each land cover class, except in infrastructure where 47 samples were taken. The confusion matrix is presented in Table 3-4.

The accuracy metrics calculated indicated that the map achieved an overall precision of 0.90. The class crops indicated that omission error was the highest in the map while vegetation was for the commission error. Nevertheless, Kappa indicated a score of 0.87, which is considered strong (64–81% of data are reliable) (McHugh, 2012). Because the Usibamba community was considered for participatory mapping, the reclassified LCC map was focused on this community for its later integration with the heavy metal contents and secondary data.

Table 3-4. Accuracy percentage of land-cover classification

Land cover classes		**Reference (Number of Samples)**					**Row total**	
		1	**2**	**3**	**4**	**5**	**Total**	**Commission**
Predicted	1. Crops	57	2	0	4	0	63	0.09
	2. Infrastructure	2	45	1	0	0	48	0.06
	3. Rocky outcrop	3	0	59	0	1	63	0.06
	4. Vegetation	6	0	10	65	0	81	0.19
	5. Water	2	0	0	1	69	72	0.04
Column total	Total	70	47	70	70	70		
	Omission	0.18	0.04	0.15	0.07	0.01		

3.3. Results

3.3.1. Agreements between mining companies and communities

This study previously assumed that the main stakeholders were the mining companies, sub-national government, and campesino communities. However, the meetings with campesino communities revealed that an agreement is only between the community and the mining company representatives. During the meetings, campesino communities indicated that the agreements reached with the mining companies were weak and often tended to be dissolved from the very beginning up to the end. In other words, the agreements were rarely kept. To understand the reasons behind this, in-depth interviews were undertaken to explore (1) how an agreement is established, (2) the clauses it contains, and (3) the communities' expectations regarding the agreements.

Agreements include social, economic and environmental clauses. The community's corresponding benefits depend on the stage of the intervention of the mining company. For example, during the exploration stage, benefits mainly focus on the annual payment and job quotas (personal conversations with Huacravilca representatives). During the exploitation stage, better benefits are offered (pers. conv. with Huacravilca and Corihuarmi representatives). The main economic clause refers to the annual payment to the community, which depends on the negotiation capacity of both stakeholders (pers. conv. with representatives of Huacravilca). The negotiation of the agreement is usually long (e.g., six months), depending on the mining-related negotiating position of the community and the occurrence of previous experiences. Negotiations start with the mining company establishing contact with the president of the community or an accessible community authority (pers. conv. with Volcan, Huacravilca and Corihuarmi representatives) since a good relationship with a community authority is crucial to the desired outcome. An example of this negotiation is given by the representative of the Cunas sub-basin:

> *"In the first meeting with (the mine) Azulcocha, Shicuy (community) authorities requested balls for the children, food supplies and 10 000 PEN/year in return for the rent of 700 ha of land. Shortly after, Shicuy realized the real price of land rent and tried to change the agreement (…) The situation escalated into a conflict as Azulcocha refused initially (…) Finally, better clauses were negotiated and the agreement changed, now the payment is 300 000 PEN/year."* (LQ, representative of Cunas sub-basin, Tambo, 2016).

Once the annual payment is set, the campesino community usually adds other economic clauses such as a job quota for community members, installation of productive projects (e.g., promotion of small-animal farming), and work for the community-formed companies that can provide services to the mine (pers. conv. with Volcan representative and representative of Cunas sub-basin). Regarding the social clause, the mining company sustains projects such as the provision of sports clothes for school children, financing of a school library, school materials for children, annual health campaigns, prizes, and transportation for community members. The environmental clause may include the commitment of the mine to re-forest eroded areas and carry out participatory monitoring of the environmental impacts, mainly water quality (pers. conv. with Corihuarmi representative).

However, community authorities have expressed that most clauses of the agreement are not fully accomplished (pers. conv. with Shicuy community authority). Regarding the breaching of the environmental clause, community authorities often mention pollution in higher zones (upstream headwaters), which affect wildlife and livestock. For instance, the Chongos Alto community authority said that:

> *"Community members who visited upstream zones reported that they saw signs of pollution due to mining activities"* (PH, representative of Chongos Alto, Huancayo, 2016).

At the end of the year, the benefited community signs a certificate of compliance when the agreement has been fulfilled (pers. conv. with Huacravilca and Corihuarmi representatives). However, neighboring communities may also experience the indirect impacts of mining activities but have no agreement. These communities expect to be included in the consultation process and considered for a mining-community agreement:

> *"Llamapsillon (neighboring community of Chongos Alto) does not have any agreement with Huacravilca mine…There should be a prior consultation including all neighboring communities, as they did with the directly affected community, so we can have the possibility to accept or not their activities" (BC, representative of Llamapsillon, Llamapsillon, 2016).*

3.3.2. Mining impact on water streams

The water results were compared with the values reported by the Peruvian monitoring agency (i.e., OEFA) to provide the historical background. OEFA inspected Corihuarmi three times (2010, 2012 and 2013), and Azulcocha mine twice in 2013 (Appendix 8.2: Table 8-1 and Table 8-2). In the Cunas sub-basin, eight case samples were taken at 100 m upstream (B-AM) and 500 m downstream (A-AM) of the Azulcocha concentrator plant, at the confluence of the Tambo and Consac rivers (I-N), and 500 m downstream of the Usibamba community (A-UC). Four control samples (B-UC and P-N) were taken at non-mining sites (Figure 3-5a). In the Aimaraes sub-basin, eight case samples were taken at 500 m downstream of the Corihuarmi mine (A-CM), ca. 500 m downstream of the disputed area (A-CA-S), and 500 m upstream (B-HM), and 500 m (A-HM) downstream of the exploration platforms of Huacravilca. Here four control samples (L-S and I-L) were taken at two non-mining sites (Figure 3-5b).

In Table 3-5 and Table 3-6, the results from OEFA and this study show where total metal concentrations were higher than the EQS. The total metal concentrations of the control and remaining case sample points were lower than the EQS (Appendix 8.2). In the Cunas sub-basin, the sample point downstream of Azulcocha (A-AM) showed high concentrations of As, Cd, and manganese (Mn), metals that are geologically absent in the area (Table 3-2). Compared to the OEFA reports (OEFA, 2014a, 2013a), in 2013 the As and Cd levels in the Huasi Viejo stream of the Cunas sub-basin were also high (Figure 3-5a). The highest concentration of As was 13.43 mg L^{-1} in e02 at 100 m from the A-AM sample point. In this sample, there was also a higher concentration of Mn, which is related to the enhancement of the oxidation of arsenite in manganese oxides. In the Aimaraes sub-basin, the sample point upstream of Huacravilca (B-HM) and OEFA results showed a pH between 6.5 and 9, which is within the accepted pH range for Andean rivers (MINAM, 2017a). B-HM revealed a high concentration of Cd, Mn, and iron (Fe), but there were no reports by the OEFA in the surroundings of the sample point with which to compare because Huacravilca started the exploration in 2016.

Table 3-5. Total metal concentrations (mg L^{-1}) in water samples exceeding Environmental Quality Standards (EQS) in the Cunas sub-basin.

	Site	pH	Zn	As	Cd × 10^{-2}	Mn
EQS	Irrigation	6.5-9	2	0.1	1.0	0.2
	Livestock drinking	6.5-9	24	0.2	5.0	0.2
This research*	1 A-AM	7.8	12.3	0.6	2.3	18.5
	2 A-AM		12.5	0.6	2.2	18.7
OEFA report*	e01	8.2	0.2	3.0	<0.0004	18.1
	e02	8.1	0.2	13.4	<0.0004	-
	pcp01	8.0	1.1	0.3	0.2	2.3
	hv01	8.3	0.1	0.1	<0.0004	0.1
	esp01_14	8.0	0.1	0.1	0.1	0.1
	esp02_14	7.9	0.3	3.0	0.2	19.8
	vi01	8.2	0.8	0.2	1.0	-

*In these sample points, INGEMMET did not report the presence of heavy metals in 2017.

Table 3-6. Total metal concentrations (mg L^{-1}) in water samples exceeding EQS in the Aimaraes sub-basin.

	Site	pH	Cu	As	Cd × 10^{-1}	Fe	Mn
EQS	Irrigation	6.5-9	0.2	0.1	0.1	5	0.2
	Livestock drinking	6.5-9	0.5	0.2	0.5	-	0.2
This research*	1 B-HM	5.4	0.071	<0.010	0.1	50.0	2.1
	2 B-HM		0.072	<0.010	0.1	52.0	2.1
By OEFA*	sw02_10	4.6	0.2	0.5	0.1	36.1	0.4
	sw10_10	4.4	0.0	<0.005	0.0	4.1	0.4
	sw14_10	5.0	0.0	0.0	0.0	0.4	1.1
	EBMI	4.2	0.3	0.0	-	-	-
	sw10_13	3.2	0.1	0.1	0.0	16.5	0.9
	sw20_13	3.3	0.1	0.1	0.0	16.6	0.9
	sw01_13	3.1	0.1	0.0	<0.0024	25.9	1.4
	sw19_13	3.1	0.1	0.0	<0.0024	18.5	1.4

*In these sample points, INGEMMET did not report the presence of heavy metals in 2017

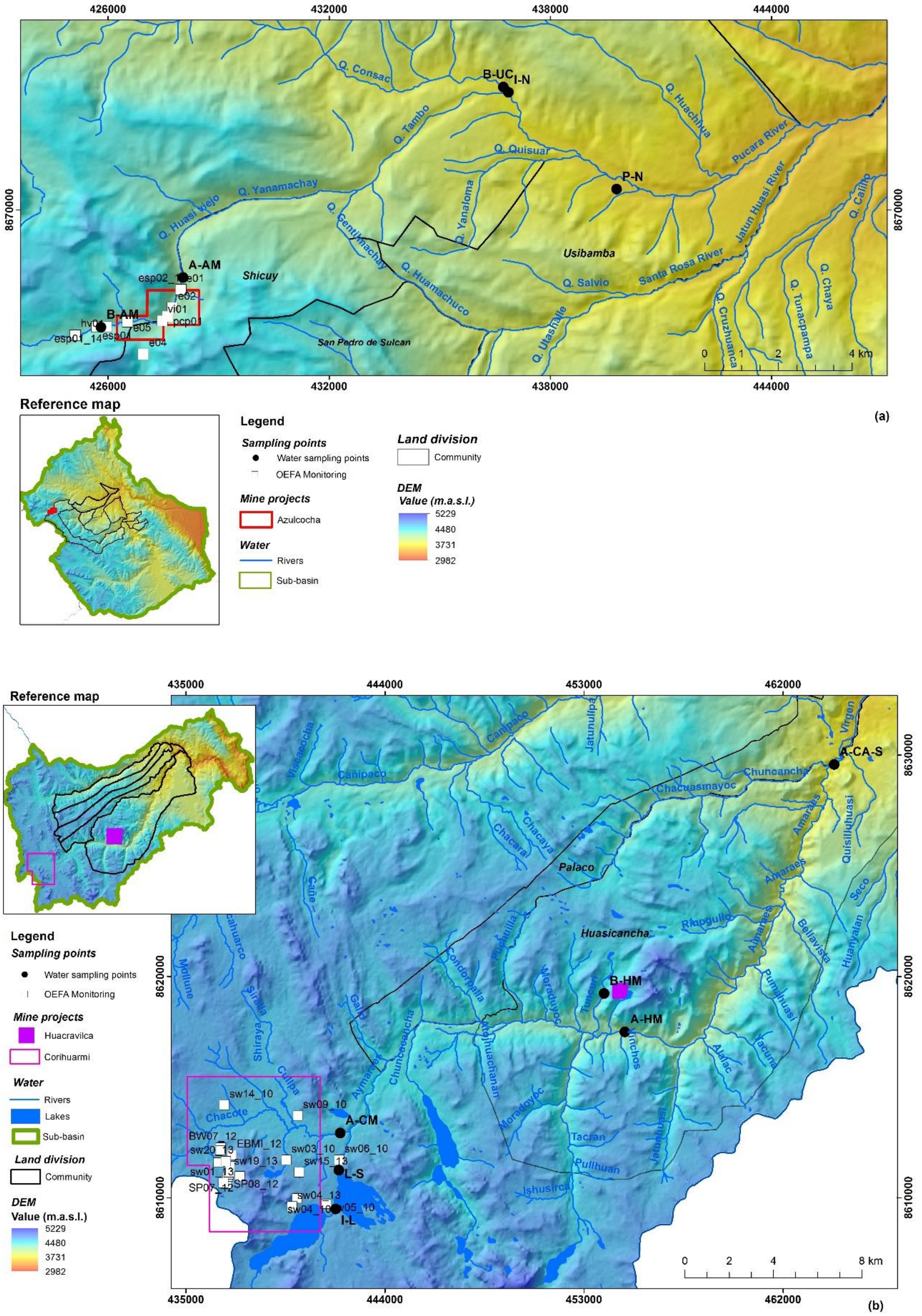

Figure 3-5. Water monitoring and elevation in (a) Cunas and (b) Aimaraes sub-basins. Based on OEFA (2014b, 2014c, 2014a, 2013a, 2012).

3.3.3. Mining impact on soil

Table 3-7 shows that the concentrations of As, Cd, and/or Pb exceed at least in some cases the EQS (MINAM, 2017b). In the Cunas sub-basin, four case samples were taken at 12 km and 24 km downstream of the Azulcocha mining site as well as two control samples (NC30 and NC60) at non-mining sites. In all soil sample sites, there was a high presence of cadmium at 30 cm and 60 cm depth. This may be explained by the geochemistry of the research area (INGEMMET, 2018) (Table 3-3) characterized by the presence of arsenic and cadmium at 24 km downstream. While this situation may explain the high concentrations of cadmium and arsenic, it does not explain that of lead.

Table 3-7. Total heavy metal and other metal concentrations (mg Kg^{-1}) in the Cunas sub-basin.

	Sample	As	Cd	Cr	Pb
EQS	Farming soil	50	1.4	*	70
Control samples	Control-30 cm	26.5	1.6	14.8	13.8
	Control-60 cm	20.7	1.8	16.8	9.9
Case samples	12 km-30 cm	330.2	4.8	9.8	103.8
	12 km- 60 cm	78.1	2.4	14.8	17.1
	24 km-30 cm	77.5	2.7	19.4	26.2
	24 km-60 cm	62.6	2.6	17.4	27.7

* Based on supreme decree N° 011-2017-MINAM (MINAM, 2017b), total Cr is not a parameter in farming soil. However, this study aimed to indicate the Cr contents.

In the Aimaraes sub-basin, a parallel sampling procedure was implemented. Here, four case samples were taken in the two aforementioned layers at both 12 km and 24 km downstream of the Corihuarmi mine, plus two control samples at non-mining sites. Table 3-8 shows that concentrations of As and Cd are higher than the EQS in 12 km downstream of Corihuarmi. These may relate to the geochemistry of the site. A similar situation is observed 24 km downstream (Table 3-3) for Cd. For the control sites, Cd is above EQS, but the site geochemistry only indicates the presence of Cr (Table 3-8).

Table 3-8. Total heavy metal and other metal concentrations (mg kg^{-1}) in the Aimaraes sub-basin.

	Sample	As	Cd	Hg	Cr
EQS	Farming soil	50.0	1.4	6.6	*
Control samples	Control-30 cm	13.3	3.3	<2.0	27.8
	Control-60 cm	13.2	3.1	<2.0	26.4
Cases samples	12 km-30 cm	84.6	4.4	9.4	22.4
	12 km- 60 cm	99.9	4.0	5.4	20.8
	24 km-30 cm	11.9	2.7	<2.0	18.4
	24 km-60 cm	6.9	2.8	<2.0	17.4

* Based on supreme decree N° 011-2017-MINAM (MINAM, 2017b), total Cr is not a parameter in farming soil. However, this study aimed to indicate the Cr contents.

3.3.4. Community livelihoods and mining impact

In the Cunas sub-basin, the Shicuy community rents its lands to the Azulcocha mine through an agreement. However, Usibamba authorities affirmed that the flow of the Pucara river transports the mining impacts downstream to the Shicuy community. The authorities expressed concern since they use the river water for grazing and agriculture. This concern is supported by the aforementioned water results, which indicate high concentrations of arsenic and cadmium downstream of the Azulcocha concentrator plant. Interestingly, the Usibamba community does not want to settle an agreement with Azulcocha but rather to protect its livestock and dairy production on which its economy is based.

Figure 3-6 shows the LCC and the land use proposed during the participatory mapping exercise. The LCC assessed the current land use in Usibamba and contrasted it with the established croplands (highlighted in bright green) and settlements identified during participatory mapping. Vegetation represents natural pastures grazed by the livestock of the Usibamba farmers. These livestock drink water from the Pucara and Jatun Huasi rivers. It is suspected that the Pucara river is affected by mining activities (pers. conv. with Usibamba authorities), which in turn pollute the Huasi Viejo, Yanamachay and Tambo rivers. When asked about this, the Azulcocha mine representative stated that the Azulcocha mine uses its concentrator plant for processing extractions from other mining concessions (outside of the research area), and the granted water use is done properly. However, Azulcocha was fined in 2013 due to the lack of prevention measures related to water accumulation in mining tailings (OEFA, 2013b).

Figure 3-6 shows the water and soil sample sites and also the INGEMMET sites (i.e., geochemistry database) with the Cd and As that had higher contents than the EQS. Based on the LCC, the crop areas might be influenced by the geochemistry of the area. Regarding Azulcocha, the INGEMMET did not record the presence of heavy metals near the mine. The aforementioned results of the OEFA support the study findings of high concentrations of cadmium and arsenic downstream of the concentrator plant. Thus, the concerns of the Usibamba community regarding water and their livelihoods may well be justified.

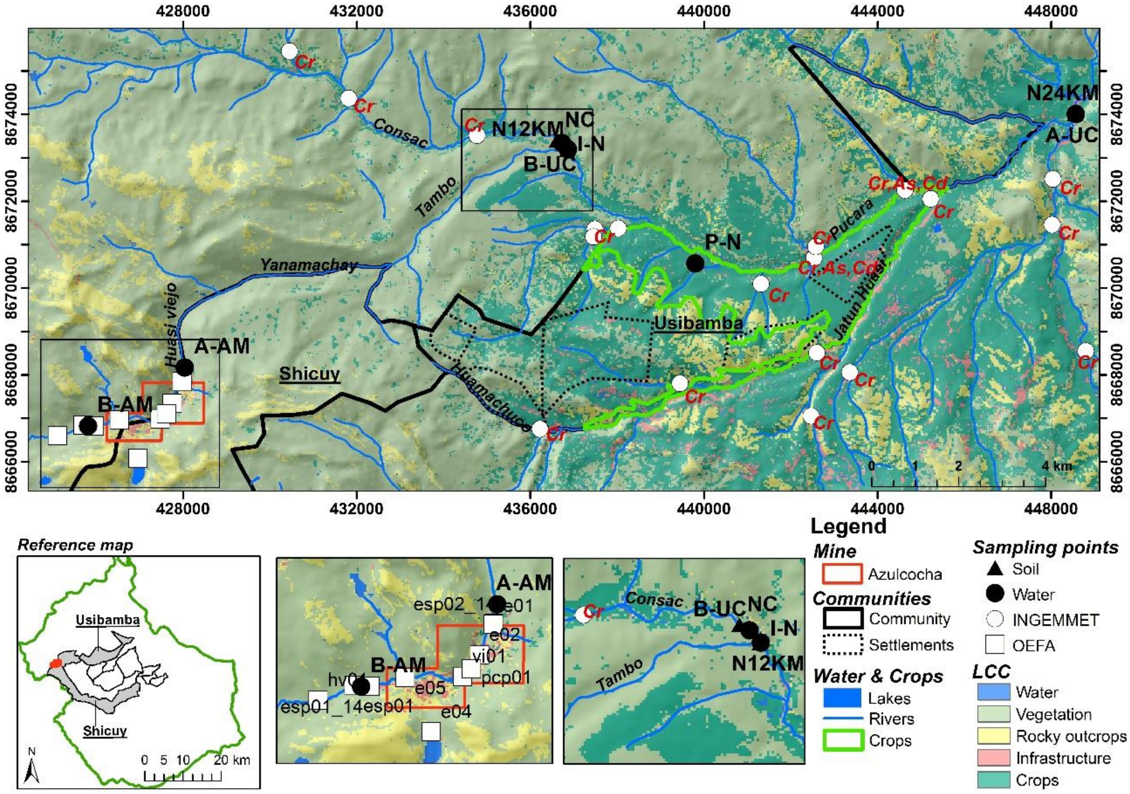

Figure 3-6. Land-cover classification and participatory mapping in Usibamba community. OEFA refers to the location of the samples collected by the OEFA in 2013. The locations of geochemistry values reported in 2014-2016 by the INGEMMET are indicated by white dots (○) with the relevant presence of heavy metals. In the case of As and Cd, they had higher concentrations than EQS. The locations of the water and soil results are referred to as water (●) and soil (▲). The Usibamba settlements are delineated by dotted lines. This figure is based on the participatory mapping, official community maps, INGEMMET (INGEMMET, 2018), and OEFA reports (OEFA, 2013b).

3.4. Discussion

This study provides an insight into the negotiations between mining operations and communities operationalized through an agreement. This agreement is established via a regularly negotiation process in which the expectations and needs of the campesino communities are supposed to be met by the mining company as a counterpart. These negotiations are guided by previous experiences, the negotiation skills of the community authorities, and the knowledge on the mining potential of the community lands. It should be noted that there are also communities that oppose the signing of these agreements (Arellano-Yanguas, 2011a; Hoogesteger and Urteaga, 2013). Despite the economic offset, communities remain concerned about the impacts of mining on water quality, livelihoods, and the general health of the ecosystems (Preciado Jerónimo, 2011; Rodbell et al., 2014). To analyze mining impacts on farming lands, this study compared the heavy metal concentrations exceeding the EQS in the study results with the results of the OEFA and the contents reported by the INGEMMET.

3.4.1. Effects on the ecology

Water quality testing in these sub-basins is novel. Previous studies have only focused on the Junin Lake, located between Cerro de Pasco mine and La Oroya mine, the latter one made the nearest city one of the top ten most polluted cities worldwide (Blacksmith Institute, 2007; Martin et al., 2001; Rodbell et al., 2014). In the Cunas sub-basin, the study results indicate that the total concentrations of arsenic and cadmium exceed the EQS. There is the possibility that the concentrator plant of the Azulcocha mine led to the high concentration of arsenic in the Huasi Viejo river given that arsenic is a by-product of metal smelting and a component of dust from metal ore roasting (Ng et al., 2003). On the other hand, there are non-exploited areas within the Azulcocha mining concession where the presence of heavy metals may relate to its geogeny, and the detected arsenic may have been released through both natural weathering and mining production (Flora, 2015). Since a higher concentration of manganese was also found, this might be related to the enhancement of the oxidation of arsenite in manganese oxides (Flora, 2015). Arsenite could be the dominating element due to a pH < 8 (7.8) downstream of the Azulcocha concentrator plant. This situation has become a source of conflict because the Huasi Viejo river is used by the livestock in the Usibamba community located downstream.

In the Aimaraes sub-basin, this study found high concentrations of cadmium, iron, and manganese, although the geochemical characteristics of the surroundings (Condorsinga formation) are not characterized by the natural occurrence of these elements. However, in the nearby Cercapuquio formation, zinc and cadmium are inherent elements, and the high cadmium concentration was possibly due to the neighboring abandoned and non-remediated Cercapuquio mine. After 1912, the Cercapuquio mine (W75°26´—S12°25´, 4380 MASL) was irregularly exploited, for example producing 180 ton/day of lead, zinc, and iron between 1935 and 1938 (Levi Rendón, 1960). This mining was underground and located on an ore deposit (Cercapuquio ore) that provides lead (as PbS), zinc (as ZnS), silver (as a combination of AgS and PbS), cadmium (as CdS), manganese (as MnO) and iron (as $Fe(OH)_2$) (Levi Rendón, 1960). The proximity of Cercapuquio ore to the B-HM sample point and the constant soil erosion may have influenced the presence of cadmium, iron, and manganese. Moreover, cadmium persistence may have led to its accumulation in the environment (WHO, 2007).

The results of the soil analyses indicate the presence of cadmium and arsenic in the samples of both sub-basins, where the geology is characterized by the natural presence of chromium (INGEMMET, 2018; Mégard, 1968). Chromium accumulates in the topsoil layer where it is absorbed and accumulated in plant roots with a small possibility of translocation to shoots (Kabata-Pendias and Pendias, 2001; Shahid et al., 2017). Cadmium can also reach the roots of grass species (Peralta-Videa et al., 2009). In the research area, rough grass (*Jarava ichu*) is the main forage source of livestock (pers. conv. with community members). To better analyze the bioaccumulation, this study suggests an in-depth analysis of the cadmium and chromium concentrations obtained by plants, animals and human consumers (Peralta-Videa et al., 2009). In the light of the soil findings, this study suggests several possible reasons for high heavy metal contents: (1) the long-term mining activity that has led to transportation of heavy metals to water streams, (2) the soil erosion and proximity to the Cercapuquio ore, and (3) the airborne transportation of heavy metals from the long-term use of smelters at the La Oroya mine. Regarding the first reason, this might explain the presence of arsenic in the soils. Streams crossing the zones erode and disperse soils dragging arsenic and lead downstream eventually reaching the flood plain, and is a more intense process during the rainy season (Razo et al., 2004). Regarding the second reason, the study results were overlaid with the geochemical characteristics of the site reported by INGEMMET (INGEMMET, 2018). The presence of chromium is due to the underground lithological units. The high concentrations of other heavy metals (e.g., arsenic and cadmium) might be related to the geology, but could also be influenced by the long history of mining, e.g., the Cercapuquio mine was abandoned in the early twentieth century and never remediated. Regarding the third reason, since 1922 the three smelters at the La Oroya mine —located 167 km north-west from Cercapuquio— have emitted non-regulated toxic smokes that have affected land and water bodies, presumably including the Cunas sub-basin (Caballero Martín, 1981; Cotler, 2016; Martínez Alier and Roca Jusmet, 2015; Neumann, 2016). Although the air transportation of cadmium, lead and arsenic mostly occurs over short distances (Cooke and Abbott, 2008), there are reports that this has also occurred over great distances from the smelters (Caballero Martín, 1981). From 2002 to 2007, the emissions from La Oroya contained cadmium, lead, and arsenic (Abanto Kcomt, 2007). Cadmium particles (ca. 1µm) can travel for days depending on meteorological parameters and the density of particles (WHO, 2007).

3.4.2. Effects on the community livelihoods

The decrease in water and soil quality either directly or indirectly due to mining activities has affected communities' livelihoods and unleashed land-use conflicts (Bury, 2002; Conde, 2017; Prado Fernández et al., 2013). The negotiation process described above is often improperly conducted and neglects community members or leaves behind indirectly affected communities (Warnaars, 2012). The participatory mapping and land-cover classification show how the Pucara river, which is possibly affected by mining, impacts other non-mining areas of a downstream community (Usibamba). Hence, the Usibamba community, relying mostly on livestock rearing, has developed an anti-mining position since the establishment of the Azulcocha mine. The community decided to prioritize the conservation of the environment for their development. Upstream and most-affected communities, like Shicuy, hold a different position. In Shicuy, their agreement awards them economic benefits (i.e., 300 000 PEN/year ≈ € 80174.46/year), and livestock are allowed to graze and drink near concession areas (pers. conv. with Shicuy authorities).

Regarding water access and quality, farmers agree that the pollutants in the tailings from the Azulcocha mining project leak out into the Huasi Viejo river. They then flow into the Consac river and later to the Pucara river, which is used by the Usibamba community farmers for watering livestock and other activities, e.g., crop irrigation. However, the bioaccumulation of heavy metals in crops and pastures was not explored, and appears to remain a major challenge. The research findings, matching previous studies, show that water insecurity due to poor water quality is triggered by mining sites located at headwaters (Bebbington and Williams, 2008; Hoogesteger and Urteaga, 2013). The poorer water quality causing water insecurity in the Usibamba community jeopardizes the community´s livelihoods (Ahlers, 2010; Hoogesteger and Urteaga, 2013), and prevents future negotiations with mining companies. This, taken together with disagreements arising from the community interests, may be the seeds of future land-use conflicts.

3.5. Conclusions

The establishment of legal mining activities and the overlapping with the economic interests of communities trigger environmental concerns among communities regarding water and soil quality. Based on the study of three mining sites and 14 campesino communities, agreement clauses were identified that provide economic, social and environmental benefits in return for the rent of community land. However, not all communities can be considered for signing an agreement with the mining company, and many do not want to do this as was the case in Llamapsillon and Usibamba communities. This study also revealed the impacts of heavy metal concentrations in water and soil that were linked to community livelihoods.

Mining impacts—in terms of heavy metals in soil and water—might affect downstream communities, including those who have no agreements with mining companies. Soil analyses show that cadmium and other metal contents were higher than the national EQS. The water analysis shows that concentrations of arsenic and cadmium near mining sites also exceeded the EQS. In contrast with results from the Peruvian monitoring agency and those based solely on the local geochemistry, these results indicate a relationship between the high concentrations of heavy metals and current mining activities, which cannot be attributed to the long-term mining exploitation of the region. The results of this study indicate that the livelihood of a neighboring community that does not have an agreement can be affected by mining activities in terms of livestock grazing and watering. Therefore, although the findings are significant, they are still indicative, and the heavy metal concentrations and bioaccumulation in the research area should be further explored. Finally, the findings of this interdisciplinary research have the potential to be used in other contexts to assess impacts on both the environment and community livelihoods at the intersection of mining and community interests.

4. IMPLEMENTING ENVIRONMENTAL REFORMS IN THE CENTRAL PERUVIAN ANDES: SOCIO-ECONOMIC AND INSTITUTIONAL ASPECTS OF CAMPESINO COMMUNITIES AFFECTED BY MINING

4.1. Introduction

Most Andean countries have large territories with diverse geographies, which pressures governments to prioritize their investments in state building to administer these appropriately (Bowman, 1980; Herbst, 2000; Pulgar Vidal, 2014; Soifer, 2015; Stasavage, 2011). State building is defined as the establishment and strengthening of state institutions within a country (Fukuyama, 2004). In Peru, state building has occurred at sites where geographic conditions are favorable while being absent in remote areas (Fearon and Laitin, 2003; Herbst, 2000). Along with the improvement of state institutions, the expectation of improved economic integration encouraging economic development has been the dominant neoliberal variant prevalent in Peru (Wilson, 2004).

However, between 1990 and 2000, Fujimori´s government reduced the power of the state and established measures to enforce neoliberal policies that promoted private sector growth and weakened civil society (Bury, 2004; CRP, 1995; Durand, 2015; Perreault, 2014; Radcliffe, 2005). The Peruvian legislation and institutions were reformed to attract foreign investments, which came mainly in the form of extractivism projects, i.e extraction of natural resources in high volumes and intensity to export them as raw materials with minimal or no processing (Damonte and Peralta, 2015; Gudynas, 2017, 2015). With the fall of Fujimori´s government in 2000, subsequent governments inherited a state with a high level of “state capture”, i.e., influence in decision-making, by the private sector (Dargent et al., 2017; Durand, 2015), and they continued supporting extractivist projects although these created land-use conflicts (Gudynas, 2017). State capture manifested in the influence of private companies in the making of laws and decrees to promote (extractivist) investments (Durand, 2016; Hellman et al., 2000a, 2000b), and frequent staff exchange between public regulators and the companies they were meant to regulate. In Peru, many companies combine their organizational capacities and networks to strongly influence the investment-related decision-making of the government (Durand, 2016). This has undermined the creation of strict mining-related state legislation (Dargent et al., 2017).

Peru and several other Latin American countries depend on extractivism to boost their economies (Bebbington, 2009; Bebbington and Humphreys Bebbington, 2011; Vélez-Torres, 2014). However, extractivism has unleashed a set of land-use conflicts (Arellano-Yanguas, 2008; Damonte and Glave, 2012). Land-use conflicts arise as a response by communities to threats to their ecosystems and livelihoods through water and soil pollution (Bebbington et al., 2008; Bebbington and Bury, 2009; Li, 2009; McDonell, 2015). Furthermore, extractivism has triggered corruption, divided communities from their government, and weakened the capabilities of the latter to resolve conflicts (Bannon and Collier, 2003; Gudynas, 2017). So far, no single government has come up with a comprehensive mining strategy, and only deals with mining issues and conflicts once they become urgent (De Echave, 2018). This can also be seen with regard to the water sector. Because mining concessions are estimated to cover 25% to 67% of watersheds nationwide, it is expected that they will negatively affect future water provision (Bebbington, 2009; Preciado Jerónimo, 2011). Therefore, for most campesino communities, often located in watersheds of high mining potential, environmental concerns relate mainly to the pollution of water supplies due to mines upstream (De Echave, 2018; Li, 2017). Consequently, it is concluded that the environmental impacts of mining may threaten the health and livelihoods of the communities and also create conflicts between communities and companies (Bury, 2002; Conde and Le Billon, 2017; Walter and Urkidi, 2017). Therefore, Walter and Urkidi (2017) argued that community consultation is an important strategy to prevent social rejection of mining projects, and that participatory processes have to include state institutions, mining companies, and potentially affected communities.

The International Labor Organization 169 convention, held in 1989, was added to the Peruvian political constitution in 1994. It became a law (Law of prior consultation—Law N° 29785) and was implemented in 2011 and 2012 (CRP, 2011b; ILO, 1989). This convention promotes the right of communities to be consulted before a prospection and exploitation take place on their land (ILO, 1989). However, unlike land concession for oil exploitation for which consultation is done before land concession, consultation for mining operations is only required after the land has been granted to the mining company and before the start of the exploration operations (MC, 2012). The law for campesino communities (Law N° 24656) states that community lands belong to the community (CRP, 1987), but the corresponding sub-soils belong to the government. Because the general mining law (D.S. N° 014-92-EM) established that the sub-soil belongs to the government, land grants for mining operations are managed by the Peruvian government through the Ministry of Mining and Energy (MEM) (MEM, 1992).

During the government of Ollanta Humala (2011-2016), there was a political controversy regarding mining operations and prior consultation (Remy, 2013; WB, 2016). Based on the law of prior consultation, communities need to be registered in a database as native communities in order to be considered for prior consultation. However, the inclusion of all communities in this database has taken more time than expected (De Echave, 2018; WB, 2016). Although the Ministry of Culture[10] maintains that there is no binding relationship between the registration of communities in the database and their consideration for prior consultation, the MEM did not apply prior consultation in the mining sector until 2015. The MEM argued that prior consultations were impractical, and because mining concessions do not involve any activities on lands, concessions were provided before 2011, and communities were not registered in the database. In late 2015, the MEM, however, started this process for the mining sector and to date there have been 17 prior consultation processes (MEM, 2018a; Sanborn and Ramirez, 2016). One explanation for this is that the law of prior consultation should not be imposed retroactively (WB, 2016). Thus, prior consultation has not been as effective as expected because many land grants were given before the enactment of this law (i.e., before 2011) (SERVINDI, 2015; WB, 2016). Prior consultation must not be confused with the public participation of communities, because public participation aims to inform communities about the mining project while prior consultation is for decision-making processes (CRP, 2011b; MEM, 2010; WB, 2016).

[10] The Ministry of Culture was created in 2010 and is responsible for the creation of registration of communities in the database and the promotion of prior consultation (CRP, 2011b; Sanborn and Ramirez, 2016).

A campesino community[11] traditionally sustains its livelihoods through agriculture and livestock rearing (Marcos, 1994, Bury 2002). Communities consider land rights to encompass water, soil, and rock elements, which also form the mountains used for mining exploitation activities (Long and Roberts, 2001; Silva-Macher and Farrell, 2014). Land distribution and social organization in campesino communities developed out of a combination of the Spanish 'cabildo[12]' and the Inca's 'ayllu[13]' (Castillo et al., 2004; CTRJ, 2015b; Remy, 2013). The development of campesino communities has been influenced by four major historical processes, i.e., the reign of the landlord oligarchy (1821-1920), the integration of campesinos into the mining workforce (1920-1969), the agrarian reform (1970-1990), and the recognition of campesino communities as democratic institutions with autonomous land use, followed by the subsequent loss of this very autonomy (1990-present) (CRP, 1995; Dale et al., 1990; Gustafsson, 2018; Henríquez, 2015). Based on the general law of campesino communities, the community is governed and administrated by a community directive that is comprised of a president (legal representative of the community), vice-president and four authorities (e.g. treasurer) (CRP, 1987). The community is also governed by the general assembly[14] formed by all active community members[15] and special committees (Robles Mendoza,

[11] In 1570, Viceroy Toledo created `towns of reduction´ to join the reduced population of Indians (i.e., inhabitants of *Las Indias* as was called the population of Andean countries during Spanish colonial rule) due to the death of 90% of their population. Viceroy Toledo created these towns to join the dispersed Indians and provided them with land for the growth of their population and economy. Based on the political and economic interests of the Spanish colony, communities were formed and recognized officially, including their authorities and customs (Remy, 2013; Robles Mendoza, 2004).

[12] Cabildo refers to the paternal origin from Spanish crown. The RAE dictionary defines cabildo as the church community (Diccionario de la lengua española, n.d.).

[13] Ayllu refers to the maternal origin from Inca culture. The RAE dictionary defines Ayllu (in Quechua) as a family who belongs to a lineage. A group of ayllus forms a community (Diccionario de la lengua española, n.d.).

[14] The general assembly discusses all community issues in order to provide a consensus decision. The participation in the assembly is mandatory for active members.

[15] In a campesino community, members are categorized in active and passive community members. Active members pay their annual contribution and taxes to their community. The active members always have to participate in community meetings and their vote and opinions are important in the decision-making process of the community.

2004).

Due to increased criticism and land-use conflicts regarding extractivist projects, the Peruvian state has followed the international trend towards apparent increased social and environmental awareness. This has manifested in the creation of ad-hoc institutions and enacted laws and decrees supposedly safeguarding the environment and protecting people. These are often enshrined within broader international economic agreements, e.g., free trade agreements (Barandiarán Gómez, 2008; Damonte and Vila, 2014; Dargent et al., 2017). The set of state institutions and instruments of public policy that focuses on the problems of a degraded environment on which people depend is envisaged as environmental institutionalism[16] (Damonte and Vila, 2014). A milestone in Peru's environmental institutionalism was the creation of the Ministry of Environment (MINAM) and several state institutions with specific mandates, such as the Agency for Environmental Assessment and Enforcement (OEFA) in 2008 (Bebbington et al., 2018b, 2018a; Damonte and Vila, 2014; PRP, 2008). However, subsequent reforms have resulted in the weakening of these environmental institutions rather than reinforcing their capacity for environmental protection. For example, key functions were taken away from MINAM (e.g. the right to create nature reserves), the authority of environmental agencies has been restricted, and even environmental quality standards have been modified (CRP, 2015; Damonte and Vila, 2014; De Echave, 2018; PCM, 2013; PRP, 2014). Further, the barriers for state institutions such as the National Authority of Water (ANA) to enforce their functions via law and regulations exemplify weak environmental institutionalism. The ANA, via its decentralized offices in each watershed,

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After a predetermined period, active members retire and become passive members. Passive members are not obliged to participate in community meetings and are exempt from paying community taxes.

[16] Environmental institutionalism (Spanish*: institucionalidad ambiental*) in Peru can be traced back to 1991, when environment-related state institutions were assigned to oversee corporate activities. In 2008, the creation of MINAM enforced environmental institutionalism and restricted the working areas of the new ministry, i.e., mining and hydrocarbon sectors (Barandiarán Gómez, 2008). Thus, based on how environmental institutionalism has been built, it can be considered a type of historical institutionalism. Hall (1986) defined this institutionalism as "formal and informal procedures, routines and conventions" (Lowndes and Roberts, 2013).

provides the right to water use via the request by any user (e.g. mining company) in exchange for a payment (ANA, 2010; CRP, 2009). However, mining companies have incurred debts from water use and ANA still faces difficulties to recuperate these (Salazar Vega, 2017).

This institutional weakening has undermined the trust of communities. State institutions have struggled to rebuild this trust and promote stakeholder participation in consultations to prevent the outbreak of conflicts (Conde and Le Billon, 2017). For instance, until 2015, community consultation and the conducting of environmental impact assessments were the mandates of MEM (Dargent et al., 2017), which also had the responsibility for promoting mining projects (Dargent et al., 2017; De Echave, 2018). In an attempt to regain the trust of the citizens, in late 2015 the Environmental Licensing Agency (i.e., SENACE) under MINAM was put in charge of carrying out environmental impact assessments and ensuring the participation of all stakeholders in the process. Nevertheless, gaining citizen trust is still a major challenge for state institutions (Arellano-Yanguas, 2011a; SENACE, 2018).

So far, most studies on land-use conflicts have focused on cases where conflicts had already occurred, e.g., Conga[17], La Oroya and Tambogrande (Haarstad and Fløysand, 2007; Neumann, 2016; Silva-Macher and Farrell, 2014). However, this research focused on an area where communities and mining companies seem to peacefully interact without conflicts. Previous studies have reported that the emergence of new stakeholders (e.g. "social instigators") and their (personal) interests fuel the conflicts, and suggested that future research should avoid these in order to gain a good idea of the status quo in communities affected by mining (Arellano-Yanguas, 2016, 2011a). The aim in the present study was to investigate the impact of environmental institutionalism in the central Peruvian Andes by profiling campesino communities, identifying stakeholders' interactions, and disclosing determinant factors of land-use conflicts. The

[17] Conga is a controversial conflict that involved the death of protesters, and the intervention of the central government to support a third-party evaluation of the environmental impact assessment of the project. The conflict ended when the expansion project was terminated and the water became the conflict core (Guzmán Solano, 2016).

following research questions were addressed: **(RQ 4-1)** How is the environmental institutionalism perceived locally? **(RQ 4-2)** How do local stakeholders perceive environmental institutionalism in a context of non-active land-use conflicts? **(RQ 4-3)** What are the profiles and the challenges of campesino communities? **(RQ 4-4)** What are the main causes of land-use conflicts in community-mining lands?

4.2. Materials and Methods

4.2.1. Research site and sampling

The research was carried out in the Mantaro Valley located in the Junin Region in the core of the Central Andes of Peru. The valley hosts ca. 368 campesino communities with a population of 45,702 listed in the community registers of 2012, and its agricultural importance is widely recognized (CTRJ, 2015a; INEI, 2014). At the same time, the Junin Region is a prime target of mining-related investments. In 2013, these reached almost USD 10 billion, and after a considerable drop nevertheless reached almost USD 5 billion in 2017 (MEM, 2018b).

The study site is located in the south-western zone of the Junin Region between 12°00´S 75°45´W and 12°22´S 75°07´W at an altitude of over 3500 MASL. In this zone, three mines are located: Azulcocha, Huacravilca and Corihuarmi; the study included the campesino communities neighboring these mines. These communities possess both irrigated and rain-fed lands, and livelihoods are mainly subsistence agriculture and livestock rearing (CTRJ, 2015c).

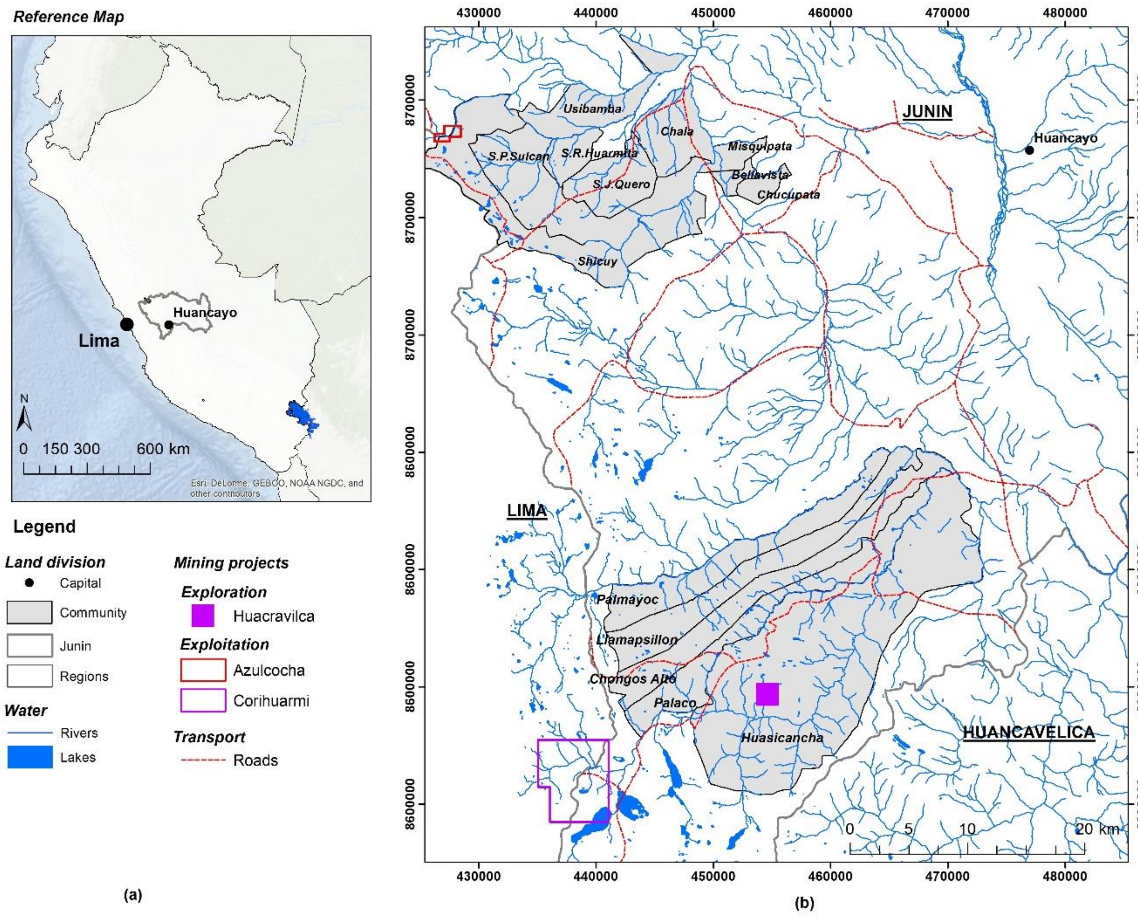


Figure 4-1: Campesino communities in the south-western zone of the Junin Region, Peru (a) Location of the Junin Region, (b) two open-pit mines (Corihuarmi and Azulcocha), one mining project (Huacravilca) and 14 campesino communities.

The selection of the communities followed a stepwise procedure that required consultation with local authorities (district and province mayors), contact and permission of the community presidents, and the final acceptance of the community assembly. Finally, 14 communities volunteered to participate, including a total of 273 active community members (ACM) who represented their households (Figure 4-1, Table 4-1).

Table 4-1. Campesino communities based on interviews with community authorities, 2016[18]

District	Community	Description
San Jose de Quero	San Pedro de Sulcan*	• Formed by 25 ACM. • Mainly rain-fed subsistence agriculture. • Problem to access suitable land for agriculture due to the dominance of rocky zones.
	Usibamba*	• Formed by 238 ACM. • Livestock rearing and dairy products. • Irrigated and rain-fed agriculture.
	Chala	• Formed by 72 ACM. • Livestock-based economy. • Land is characterized by poor soils. • Farming activities are affected by climatic hazards (i.e., droughts, hail, and frost).
	Santa Rosa de Huarmita	• Formed by 23 ACM. • Drought and lack of irrigation affect (subsistence) agriculture.
	San José de Quero	• Formed by 30 ACM. • Farming and livestock rearing. • Dairy products are a source of family income.
San Juan de Jarpa	Shicuy*	• Formed by 75 ACM. • Livestock rearing (80% of land) and agriculture (20% of land).
	Bellavista	• Formed by 50 ACM. • Lack of water for livestock. Crops constantly affected by climatic hazards.
	Misquipata	• Formed by 30 ACM. • Irrigated agriculture despite limited access to irrigation channels. • Livestock rearing and supplementary economic activities.
	Chucupata	• Formed by 20 ACM. • Livestock rearing and agriculture affected by climatic events, poor access to water and land suitable for agriculture.
Huasi-cancha	Huasicancha*	• Formed by 251 ACM. • Agriculture and livestock. • Rain-fed subsistence agriculture.
Chongos Alto	Chongos Alto*	• Formed by 108 ACM. • Agriculture affected by the lack of irrigation systems and climatic hazards. • Lack of roads to the community
	Palmayoc*	• Formed by 22 ACM. • Livestock rearing and agriculture.
	Palaco*	• Formed by 23 ACM. • Agriculture and livestock rearing affected by climatic hazards.

[18] Description is based on information provided by community presidents and other members of the community directive during in-depth interviews.

	• Lack of technical/veterinary support by the Ministry of Agriculture.
Llamapsillon*	• Formed by 55 ACM. • Livestock-based economy. • Overgrazing and lack of technical/veterinary support by the Ministry of Agriculture.

*Affected by ongoing mining activity; ACM=active community members

4.2.2. Methods

This research applied a mixed-methods approach that included observations, in-depth interviews with key stakeholders, application of a semi-structured survey in 273 rural households, and an adapted social analysis.

Observations were carried out during community meetings and every-day economic activities. They were recorded and pictures were taken when necessary and possible (Clifford et al., 2016). Observation of community meetings aimed to determine the level of influence of mining companies on community decision-making. For that, communities were divided into two groups: case study communities affected by mining activities and control communities where no influence of mining activities was observed (Table 4-1). Mining company representatives mostly interacted with the communities during their general assemblies. Furthermore, discussions took place with the community president/authority during economic compensation measures organized by the company. Observing these events and company-community interactions helped to set the theoretical framework of the research (Clark et al., 2009).

In-depth interviews were held with relevant stakeholders (n=34), i.e., representatives of state institutions, campesino community authorities, local government authorities (mayors of provincial and district governments) of the Junin Region, civil society, and mining companies. These representatives were identified according to their knowledge and political relevance and later contacted (Table 4-2). The interviews were interpreted using content analysis (Silverman 2015), which included manual coding and categorization.

Table 4-2. Number of stakeholder interviews per category, 2016-2017

Category	Group	N
State institutions	Ministry of Energy and Mining, Ministry of Environment	2
	State institutions (e.g. OEFA, ANA, ONDS-PCM)	7
Mining Company	Community Relations Office	6
Local Government	Provinces of Huancayo and Concepción	2
	Districts of Chongos Alto and Huasicancha	2
Civil society	Agriculture-related (e.g. Agriculture Federation of Junin Region) and community-related federations (e.g. Campesino and native communities federation), faith-based organizations (e.g., environmental round table of Junin Region), Defense Coalition of Chupaca[19]	4
Community	Presidents	10
	Leader (i.e., person indicated as a leader in Shicuy)	1
	Total	**34**

The socio-economic (semi-structured) survey was carried out in 14 communities. Households were selected applying the snowball technique (Reed et al., 2009) among the active members of each community because most communities have a low number of active members (see Table 4-1). In total, 273 ACM were surveyed. The survey covered (i) the relationship with the mining operation, (ii) the environmental concerns regarding water and soil, (iii) the household socio-economic situation, and (iv) the household´s farming activities. Data were tabulated in Microsoft Excel and analyzed using STATA/SE and SPSS (IBM Corporation, 2017; Rothman, 2012; StataCorp, 2017). Principal Component Analysis (PCA) was applied to analyze the relations among the presence of mining activities and 16 other variables such as family economy, education, sex, age, economic activity, climatic hazards, and livestock. To compare the influence of the presence of mining activities on the other variables, a short model (i.e., using only two or three variables such as mining presence and water-related problems) and large model (i.e., using the variables of the short model and the remaining variables such as

[19] The Defense Coalition of Chupaca is formed by one president and 14 secretaries who are chosen through elections every two years. Their mission is to defend the inhabitants regarding health, investment and management of funds, and the environment.

education, age, etc.) were created. Depending on the main variable of the correlation, either logistic or simple linear regression was used.

All stakeholders who were interviewed (Table 4-2) were also invited to participate in a workshop in which the Social Analysis Conflict/Collaboration, Legitimacy, Interests, Power (CLIP)[20] approach was applied (Chevalier and Buckles 2013). This social analysis delves into the relations among parties regarding their collaboration, legitimacy, interests, and power (CLIP) to describe their characteristics/relationships in conflict escalation. This research added an authority (a form of power) component to the social analysis to compare it with legitimacy, because communities are more familiar with this concept, referring to it as political authority[20]. Thus, the CLIP method enabled the assessment of the following components: power (i.e., influence), interests, legitimacy, and authority of each stakeholder. During the workshop, the stakeholders agreed on the influence of each stakeholder regarding the escalation of a land-use conflict, based on the following question: What is the level (i.e., degree) of each stakeholder component regarding the escalation into land-use conflict? In the workshop, stakeholders were divided into three groups to assess the components, and the results were averaged to obtain the overall component scores. The workshop aimed to (i) define the mining and farming situations, (ii) inquire and discuss the stakeholders'

[20] Based on Chevalier & Buckles (2013):

- Power is defined as the ability to influence others and use resources (e.g. economic wealth, political position, and the ability to use force or threats of force, information access) to achieve goals.
- Interests is defined as the gains and losses that affect power and resource uses experienced as a result of an existing conflict.
- Legitimacy is defined as the recognition of the rights and responsibilities of a stakeholder by other parties through law or local customs.
- Collaboration/conflict is defined as a social relation involving the existing ties that affect stakeholders in conflicts and that they can use to influence the conflict.
- Political authority is defined as a recognized office, position or role by an institution or by local customs, giving the stakeholder the ability to reach decisions and pass or implement rules and regulations.

positions, their collaboration (i.e., working relationship), legitimacy, authority, interests, and power, and (iii) identify factors that trigger campesino-company conflicts.

Fieldwork took place from July 2016 until April 2017. The interviews, surveys and the workshop were carried out in Spanish. Before the interviews and the administration of questionnaires, the oral or written consent of the respondents was sought.

4.3. Results

In Peru, most studies tackle environmental reform processes and implementation from the approach of institutional development and political aspects at a national scale (Andaluz Westreicher, 2011; Damonte and Vila, 2014; OXFAM, 2008). Furthermore, they focus on the performance of specific environmental state institutions in conflicts (Arellano-Yanguas, 2011b; Bebbington and Bury, 2009; Bebbington and Humphreys Bebbington, 2009; Merino Acuña, 2015). Due to the escalation of conflicts related to extractivist projects, there is a growing necessity to study the impact of environmental reform processes in areas with latent conflicts. This will help to elucidate the outcomes of the implementation of environmental institutionalism at the local level. This study evaluates the local perception of environmental reforms and agencies, the typical interactions among stakeholders, the economic profile of community households and the possible roots of land-use conflicts.

4.3.1. Stakeholders´ views

At the end of the 1990s, Peru’s central government had become a highly centralized state. Therefore, after the fall of Fujimori’s authoritarian regime in 2000, the decentralization of state institutions became a key component of the re-establishment of democracy and renewed state building (PNUD, 2006; Arellano-Yanguas, 2008; Dargent et al., 2017). The decentralization process aimed to contribute to a full, harmonious and sustainable development (CRP, 2002), and also led to the opening of decentralized offices of environmental state institutions such as the Agency for Environmental Assessment and Enforcement (OEFA) and the National Authority of

Water (ANA) of the Ministry of the Environment and Ministry of Agriculture, respectively. In 2010, OEFA assumed the environmental supervision of mining activities (OEFA, 2010, 2016) to be carried out by offices in all the regions of Peru (MINAM, 2009). However, during the interviews, still, 8 out of 34 stakeholders claimed that the absence of state institutions continues to affect the community development decision-making process regarding extractivist projects.

In the research area, communities did not have prior consultation, since mining concessions occurred before 2011 (i.e., enactment of prior consultation law). Also, only four of the studied communities are currently registered as campesino communities (Huasicancha, Chongos Alto, Palmayoc and Palaco) in the database of the Ministry of Culture (MC, 2019). These factors affect the perception of communities regarding their functions in the decision-making process and the presence of state institutions. On the other hand, prior consultation should not be mistaken with participation (WB, 2016). In the general assemblies of the case study communities, ACM could participate to establish the agreements[21], and the representatives of the mining companies could discuss with ACM to elucidate, for example, the clauses of the agreement or concerns related to mining activities. When the community requires the guidance of state institutions such as OEFA, the community authorities might request this from the decentralized OEFA office. This would then be followed by the provision of an informative workshop based on the working area and needs of the community during a general assembly. Representatives of state institutions often argue that the capacity and technical resources of decentralized offices do not suffice to effectively deal with a large number of mining conflicts they have to deal with. This was explained by a representative of the regional office of OEFA in Junin:

[21] The agreement is set only between the community and the mining company representatives. Agreements include social (e.g. support for schools), economic (i.e., annual economic compensation) and environmental clauses (e.g. respect of environmental standards, remediation). The community's corresponding benefits depend on the stage of intervention of the mining company (e.g. exploration or exploitation).

“OEFA started in 2008 (…) but OEFA still needs a greater decentralization of its activities because of the many mining-related conflicts (…) The problem for extending decentralization is not the budget, but the management and prioritization of OEFA (…) In OEFA-Junin, for instance, there are difficulties related to human resources for applying protocols and a lack of equipment” (YM, representative of OEFA-Junin, Huancayo, 09.12.2016).

Most stakeholders also decried a lack of basic information on the mandates and responsibilities of state institutions. The representatives of OEFA and ANA confirmed that the regional offices have to address the information gap that can affect the decision-making process of communities with regard to extractivist projects. A well-informed community can request technical advice and support from state institutions when interest in an extractivist project is shown in or near the community. In the case of ANA – created in 2008 to develop policies and strategies to manage water resources (MINAGRI, 2008) – the representative confirmed that only if a community knows about ANA´s work are they able to request assistance:

“ANA needs to do more outreach in order to be visible in communities, so local people can request its assistance [if needed]” (CC, representative of ANA, Huancayo, 23.11.2016).

A similar concern was shared by OEFA representatives:

“The coordination between OEFA and the community has problems regarding the lack of information about OEFA in the community, hindering the work between both sides” (YM, representative of OEFA-Junin, Huancayo, 09.12.2016).

Acknowledging and clarifying the concern raised by a regional representative of OEFA-Junin, a representative of the national office of OEFA in Lima claimed that OEFA is trying to inform the public about their mandates and responsibilities:

“OEFA currently does studies (i.e., information campaigns) in communities to make them aware about OEFA (…) However, to inform communities in an appropriate way (e.g. to have the support of accredited interpreters or someone from the same community) is still a challenge for OEFA” (MT, representative of OEFA-Lima, Lima, 16.02.2017).

Similar outreach problems are experienced by the National Office of Dialogue and Sustainability of the Presidency of Ministry Council (ONDS-PCM) that is in charge of managing conflicts, as the representative of the OEFA in Lima affirmed:

“Although ONDS-PCM focuses on prevention of conflicts, they fail to reach out to the communities” (MT, representative of OEFA-Lima, Lima, 16.02.2017).

Timely and proper information regarding mining projects and state institutions, as well as laws and reports of environmental impact studies, would help communities to safeguard their own interests, as previously pointed out by Arellano-Yanguas (2011a) and De Echave (2018). Besides a lack of information, the lack of capacity and equipment mentioned above further weakens the capacities of regional environmental offices for implementing environmental institutionalism and even increases the disinformation. In general, this study found that a lack of information on the side of campesino communities is leading to the perception of an absence of state institutions, which in turn undermines the implementation of environmental institutionalism because campesinos do not even attempt to seek official assistance. As a consequence, the weak implementation of environmental regulations that were meant to curb mining conflicts rather than facilitate conflicts (Damonte and Vila, 2014).

4.3.2. Environmental institutionalism and stakeholder interaction

Contrasting with previous research that studied conflicts after they have manifested and escalated (Arellano-Yanguas, 2011a; Dargent et al., 2017), this research studied conflicts in their latent stage. Statements of stakeholders disclosed the details of their interactions. Representatives of the civil society (Federation of Campesino and Native communities, and the Defense Coalition of Chupaca) stated weak collaboration between campesino communities and civil society, although it was also expected that the collaboration improves if a conflict were to start and then escalate. This is consistent with the findings of Arellano-Yanguas (2011a) and Li (2017). On the other hand, state institutions claimed to have good collaboration among themselves and praised the existing policy frameworks for enabling their collaboration. Nevertheless, a certain level of disarticulation regarding how to coordinate their work to tackle land-use conflict among state institutions was identified. This disarticulation was described by representatives of ONDS-PCM and OEFA-Junin:

> *"[There is] no harmonic articulation [coordination of the work] of all sectors for the solution of the conflict" (HM, representative of ONDS-PCM, Lima, 17.12.2016).*
>
> *"Since there are so many stakeholders, it is difficult to coordinate the negotiations, letting each institution focus on its own competences and establishing its own home grounds (…) OEFA and ANA try to coordinate but they don't have any cooperation/effective communication when there is a water-related problem. ANA and OEFA work together in meetings, but they don't have a joint approach in the field" (YM, representative of OEFA-Junin, Huancayo, 09.12.2016).*

This disarticulation might lead to a weak institutional response to land-use conflicts and result in the communities distrusting the dialogues or further negotiations with the state institutions and mining companies. The weak institutional response can be seen in the failure of monitoring of extractivist projects like Camisea (gas exploitation) by state institutions (Bebbington et al., 2013), triggering the need to pursue the enforcement of environmental institutionalism. Another example of weak institutional response is that the measures for conflict prevention or solution are temporal and make use of the police force (e.g. the police confronts communities during the conflict) (Bebbington et al., 2018a).

Despite water-sector reforms, a lack of cooperation and coordination also exists between institutions like ANA and other related institutions such as their decentralized offices (Boelens et al., 2010). The reason could be that these institutions have been weakened by environmental institutionalism through the restriction of their functions (e.g. modification of environmental standards and promotion of investments) (Bebbington et al., 2018; CRP, 2015). Another reason is the 'dual bureaucracy' according to Arellano-Yanguas (2008). This promotes the union of determined sectors and state institutions with macroeconomic stability in order to enact reforms on the one hand, while on the other promotes a lack of power to defend unfavorable policies for extractivism. In addition, other institutions like ONDS-PCM have been restructured recently. ONDS-PCM, created in 2012, has been restructured by the Presidency of the

Council of Ministers (PCM) in 2017 to become the Secretary of Social Management and Dialogue as part of the recently created Vice-ministry of Territorial Governance (ONDS, 2014; Maquet, 2018; Montoya, 2018). The constant changes may affect the progress of this institution regarding the management of land-use conflicts.

Because of weakened environmental institutionalism, representatives of mining companies, state institutions, civil society, and community authorities were asked to assess their own levels of power (influence), interests, legitimacy, and authority to prevent land-use conflicts between campesinos and mining companies in a common exercise (i.e., adapted CLIP method). Figure 4-2 shows their interests and influence with regard to latent mining conflicts for each stakeholder and their level of collaboration among the other entities. Most state institutions have a medium level of influence, although this differs slightly by institution. For instance, ONDS-PCM was indicated as having a low level of influence and interest given that it only operates once the conflict has erupted. It was also interesting to learn that community authorities first became aware of the existence and functions of some state institutions and legislation through this study, confirming the lack of information about state institutions and their functions as one of the factors driving conflicts.

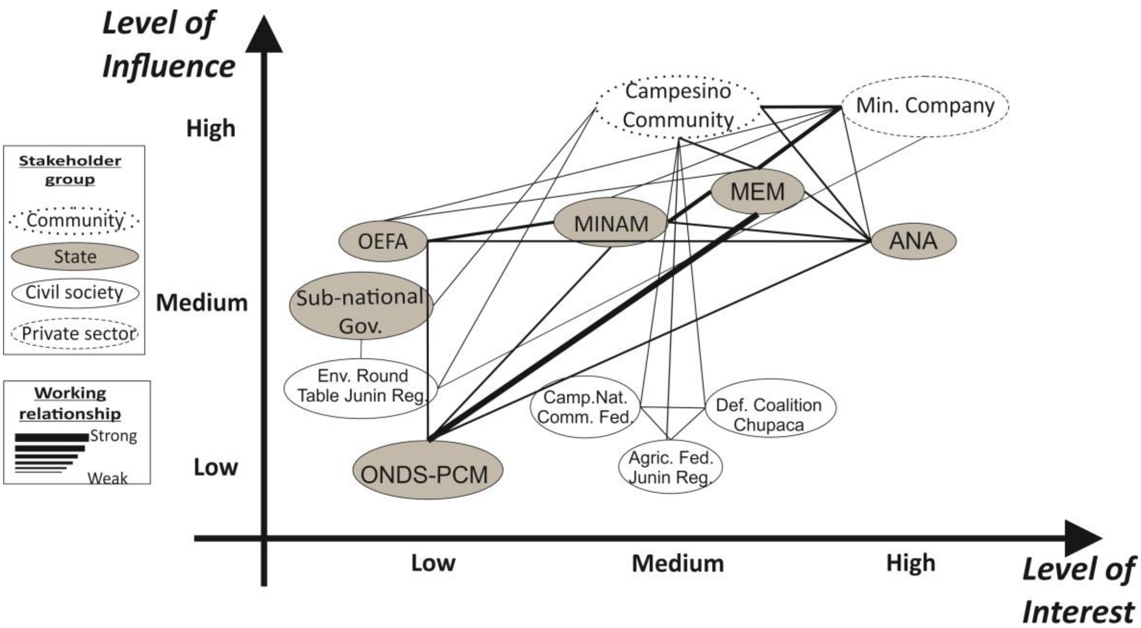


Figure 4-2: Level of influence, interests and working relationships among stakeholders involved in latent land-use conflicts in south-western Junin.

Communities were described as having a medium level of interest regarding conflict escalation. The reasons could lie in the national and local context. In the Central Andes, there has been a diversification in the economies of communities due to the increased temporal proximity to markets or the capital city (i.e., Huancayo). This proximity has made communities more aware of potential jobs. Thus, a diversified economy changes the farming-dependent livelihoods of communities, reducing the chances that conflict escalates due to mining impacts on their environment. Although a principle finding outlined in the following section is that the family income of communities is mainly dependent on livestock, community members with diversified jobs were possibly not represented by the survey. The absence of city workers (i.e., community members who mainly work in the city) could be because the interviews took place in the communities, and city workers tend to migrate temporally, i.e., they stay in the city on weekdays and come back to the community on weekends or stay in the city during the day. Another reason for the medium level of influence could be due to the criminalization of the conflicts by the central Peruvian government. This is demonstrated in the use of police force and the declaration of states of emergency in the conflict-related local government as has been reported in previous studies (Bebbington, 2012; De Echave, 2018). Consequently, the level of interest in conflict escalation is only medium for communities because, although a conflict could ultimately lead to better conditions, conflicts also represent possible casualties of community members and imposed states of emergency.

The mining companies were assigned a high level of interest and influence, implying a good position to establish alliances given that their influence stretches to the highest levels of decision-making (Durand, 2016, 2015). Despite the existence of several processes like local participation, citizen referendums, prior consultation, etc. (Walter and Urkidi, 2017), civil society has a low level of influence and interests. Furthermore, despite the medium level of interest but a high level of influence of communities, a community representative can request to have its community considered for prior consultation despite the mining concession having already been granted to the mining company. This was stated by a representative from Llamapsillon, a neighboring community near the Huacravilca project:

> *"There should be prior consultation from the Huacravilca [mining project] in our community" (BC, representative of Llamapsillon community, Huancayo, 08.12.2016).*

A similar analysis was made to determine the levels of authority and legitimacy among institutions. ONDS-PCM, MEM and ANA show high levels of authority, while OEFA and MINAM show low levels. Despite being state institutions with relatively high positions in terms of government hierarchy, ONDS-PCM and MEM have only a medium level of legitimacy. The same holds true for MINAM. The representatives of ONDS-PCM, MEM, ANA and OEFA were present during the workshop, and created a shared space among stakeholders to understand and get to know the functions of these state institutions regarding the land-use conflict. With the participation of these state institutions, the consensus of stakeholders agreed on the level of authority of each state institution. Unlike ANA´s visibility via the management of water use, OEFA´s work was relatively unknown to community authorities. However, OEFA´s visibility nationally only began when it started to impose fines on companies in 2014 (Granados Agüero, 2016). OEFA received a higher level of authority than MINAM because of its work with the monitoring of mines (e.g. Azulcocha, Volcan) compared to the silent work of MINAM. Therefore, although OEFA is under MINAM, community authorities are not very aware of MINAM work in their region.

These findings show a trend towards the community perspective because, despite the inclusion of different stakeholders, the workshop had a higher attendance of community authorities. Most involved state institutions were given a medium level of legitimacy since MEM and ANA are more active in the area and OEFA is dealing with informing communities about their institution. In the case of MINAM and the local government, both institutions were considered to have a low level of legitimacy and authority. Local government (i.e., district and province) does not directly distribute the received *canon minero*. However, the type of relationship that could be established with their respective communities might depend on the mayor and their ruling party (De

Echave et al., 2009). On the other hand, allegations of corruption and the capacities of the mayor may also affect their legitimacy and authority from the perspective of communities and civil society (Arellano-Yanguas, 2011a). For MINAM, these low levels could be due to the absence of their work with communities, reducing the recognition of their role, position, rights, and responsibilities. Although the other participating state institutions recognized the authority and legitimacy of MINAM, community authorities have only recently found out about this institution. In the case of ANA, its medium level of legitimacy might relate to the fact that this institution provides the right of water use and it is under the Ministry of Agriculture, which is better known by the communities (Figure 4-3). While one representative from ANA attended the workshop, some community authorities did not know ANA. Similarly, past studies have found low levels of legitimacy in state institutions, mainly due to their responsibility in enacting investor-favoring policies (e.g. MEM and its controversy related to the Mining Program Solidarity with People[22] and allegations of corruption) (Arellano-Yanguas, 2011a).

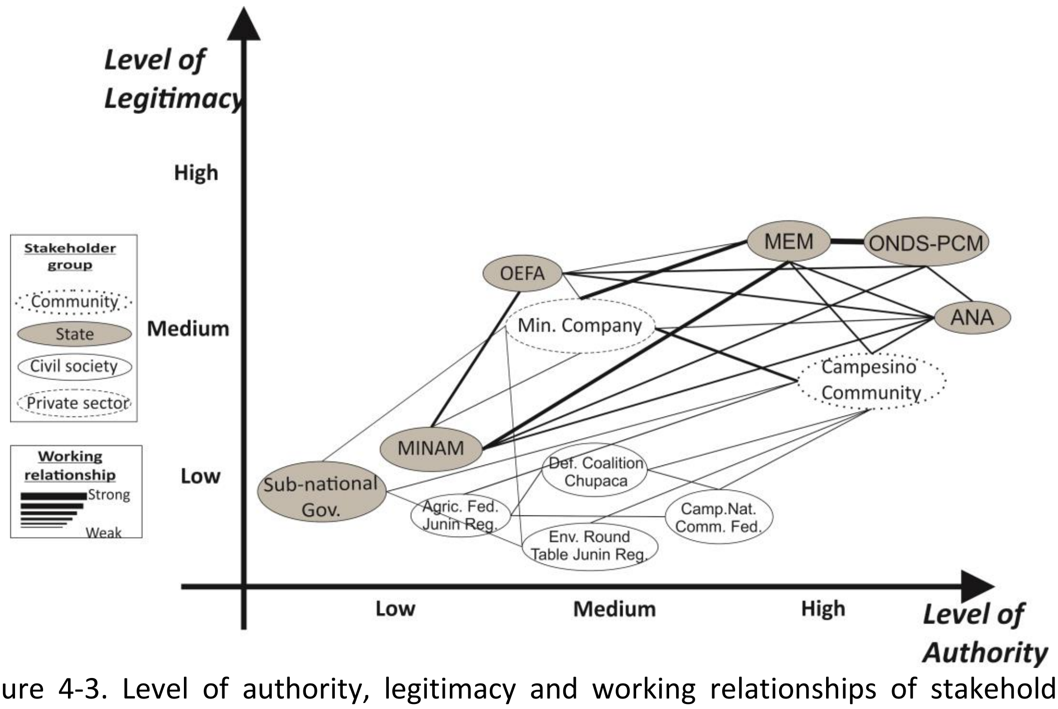


Figure 4-3. Level of authority, legitimacy and working relationships of stakeholders involved in the latent land-use conflicts caused by mining in the south-western region of Junin

[22] "Programa Minero de Solidaridad con el Pueblo" (2006-2011) allowed the mining company to provide a temporal voluntary payment, depending on the price of metals, in order to improve the living conditions of mining-affected people (MEM, 2006).

4.3.3. Livelihood characteristics and challenges

This section provides a perspective from the main local stakeholder, i.e., the campesino communities, which are able to trigger land-use conflicts. The existing socio-environmental conditions such as pollution, negotiation of agreements, or misinformation can potentially degenerate into a full-fledged conflict (Arellano-Yanguas, 2011a; Orihuela et al., 2018). In the meantime, mining companies are only focusing on their operations because they have a favorable context for working. Farming in the high Andes is confronted with challenges mainly related to climate hazards (e.g., frost and precipitation) and soil fertility. Consistent with the reports of the IGP (2012) and CENEPRED (2018), which affirm that the research area is highly prone to the occurrence of frosts, most surveyed ACM of the campesino communities expressed that frost and hail are the major challenges of farming. Concerning the water supply and how it is affected by the neighboring mines in terms of quality, quantity, and access, this research observed that the perception between control and case study communities differed significantly (Table 4-3). This confirms the findings of previous studies from Bebbington (2009), Li (2009; 2017) and Brain (2017). Problems of soil fertility, however, are not related to mining projects (Table 4-3).

Table 4-3. Statistical tests for case study and control communities

Mining Influence	
Pearson Chi^2: Presence of water-related problem	Pearson $chi^2(1)$=13.2808 Pr=0.000*
Pearson Chi^2: Presence of soil-related problem	Pearson $chi^2(1)$=0.0714 Pr=0.789
Pearson Chi^2: Type of economic activity	Pearson $chi^2(1)$ =0.6356 Pr = 0.425
Independent t-test of family income	t = -1.2920 Pr(|T| > |t|) = 0.1975
Independent t-test of income from livestock	t = -2.7154 Pr(|T| > |t|) = 0.0070*

*statistically significant

To evaluate the results of water problems related with mining, logistic regression was applied to determine if other variables, apart from the presence of mining activities, (e.g., education, sex, family expenses, agriculture for self-consumption) correlated with water-related problems. Thus, a small and a large logistic model were calculated. The small model, testing for the reasons behind water problems, soil problems (z=4.34, Pr=0.000) and mining (z=4.18, Pr=0.000) were statistically significant. The correlations between water and soil problems with mining could be due to the mining impact on the environment, which are two constant reasons for conflicts, as previous studies also observed through studies in the Tambogrande district (Haarstad and Fløysand, 2007). The overall logistic model fit was LR $chi^2(2)=45.60$ (Pr=0.0000). For the large model, an additional variable PCA_all, which refers to the results of PCA to all observations of other variables, was added to the logistic regression model. The Barlett Test of sphericity and Kaiser-Meyer-Olkin (KMO) indicated that PCA was appropriate (Table 4-4). The KMO test indicated that there were enough observations per variable to do PCA, the results from which were used in the large logistic regression model. For water-related problems, it was found that soil problems (z=4.39, Pr=0.000) and mining (z=4.09, Pr=0.000) were significant predictors. PCA_all (Z=-1.75, Pr=0.08) was not significant. The overall model fit resulted in LR $chi^2(2)=45.60$ (Pr>F=0.000) at 95% confidence. Comparing both models, it was found that there was no significant difference between the small model and large model (LR $chi^2(1)=3.11$, Pr=0.0781) at 95% confidence. Based on the Occam's razor principle (Baker, 2007), the small model was applied, since all assessed variables in PCA_all were not statically significant. Thus, the correlations of the water problems related to mining and soil problems might be possibly causal.

Table 4-4. KMO and Bartlett´s tests for water-related problems

Kaiser-Meyer-Olkin measure of sampling adequacy	0.6033
Bartlett´s Test of Sphericity Approx. (Chi-Square)	377.670
df.	28
Significance	0.000

Regarding the families' economic activities in the case communities, 89.73% of the surveyed ACMs are only involved in livestock and 8.90% perform other supplementary activities (e.g., education, building, transport, mining). In the control communities, 86.61% only engage in agriculture and livestock, while 13.39% complement their income by other economic activities (e.g., transportation, education). Consequently, no significant difference was revealed between the presence of mining activities and family income in the communities (Table 4-3). Despite the similarities, the case communities may be benefited by job quotas in the mines, since the average monthly income of the control communities ($\bar{x} = 702.73$ PEN) was higher than that of the case study communities and statistically significant ($\bar{x} = 511.181$ PEN). This could be related to the factors explained in the previous section such as that the research survey in the communities missed the city workers, and also the small job quota per community, e.g., Huasicancha, had a job quota of 15 in 2016, although this may vary with the needs of the mine. Similar to previous studies (Arellano-Yanguas, 2011a; Zegarra et al., 2007), this study found lower incomes in the case study communities than in the control communities, which indicates poverty. Besides income, families can also receive a proportion of the economic compensation from mines according to their agreements. However, this compensation falls short of solving their economic problems, because the annual economic compensation is sometimes shared among community members (e.g., 500 PEN/person), or it can alternatively be used for buying an asset for communal use. The mine size and the mining stage influence economic compensation through the agreement, and communities still face the challenges of economic and livelihood improvement despite these benefits.

Due to the income difference, in order to evaluate whether there were other variables (e.g., age, education) influencing the causality between family income and livestock income, a simple linear regression was executed. Similar to the comparison of the two logistic regression models described above, linear regression models were also created to compare a small and large model. When family income was predicted in the small linear regression model, it was found that livestock income (t=17.51, Pr=0.000), age (t=-2.19, Pr=0.029), and supplementary economic activity (t=6.13, Pr=0.000) were significant. Besides these variables, the presence of mining activities in the community (t=1.06, Pr=0.290) was not statistically significant to influence family income. The overall model fit was adjusted R^2= 0.5729 (Pr>F=0.000) at 95% confidence. For the large model, PCA was used to reduce the number of independent variables (i.e., 14 variables) that may affect the family income. To assess the adequacy of PCA, a Barlett Test of Sphericity and a KMO test were carried out (Table 4-5). Once both tests indicated the adequacy of PCA, the resultant variable called PCA_all was added in order to run a large linear regression model. When monthly family income was predicted in the large model (i.e., the variables of the short model with PCA_all), it was found that the monthly livestock income (t=17.12, Pr=0.000) and supplementary economic activity (t=5.84, Pr=0.000) were significant predictors. Age (t=-1.84, Pr=0.067), the presence of mining activities in the community (t=0.92, Pr=0.357) and PCA_all (t=1.19, Pr=0.236) were not significant. The overall model fit was adjusted R^2= 0.5736 (Pr>F=0.000) at 95% confidence. Thus, 57.36% of the variation in family income is mainly explained by livestock and supplementary income. Comparing both models, no significant difference between the small and large models were found (LR $chi^2(1)$=1.44, Pr=0.2302) at 95% confidence. Finally, because of Occam's razor (Baker, 2007), the small linear regression model should be used to explain family income.

Table 4-5. KMO and Bartlett tests for the family income of campesino communities

Kaiser-Meyer-Olkin measure of sampling adequacy	0.5227
Bartlett´s Test of Sphericity Approx. (Chi^2)	322.741
df.	28
Significance	0.000

In general, the results of this study show that the presence of water-related problems is associated with soil degradation and mining, while family income is related to livestock income, age of respondents, and supplementary economic activity. This tends to agree with the results of previous studies in the Andean region, which found that households located in mining areas tend to be poorer than those in non-mining areas (Arellano-Yanguas, 2011a; Zegarra et al., 2007). Unlike other case studies where communities have improved their livelihoods thanks to mining-induced road construction that improves market access, provision of high-quality seeds, etc. (Bury, 2005, 2004), this improvement was not observed in our study area despite the support from mines. For instance, the representative of Corihuarmi highlighted their support to improve farming in Chongos Alto:

> *"In the case of the Chongos Alto community, Corihuarmi [a mine] has trained them to increase the quality of dairy production in the form of pasteurization of milk and the production of yogurt and cheese with higher product quality (…) In the case of Huasicancha, the community received pots of marmite to pasteurize milk." (HZ, representative of community relations office, Tambo, 17.10.2016).*

The training and supplementary support from mines for communities could empower small community businesses. However, the improvement of these businesses might depend on the willingness of the community members.

4.3.4. Determinants of land-use conflicts

In an attempt to establish factors determining latent land-use conflicts, the analysis of the in-depth interviews with 34 stakeholders identified a total of 35 factors[23], clustered in six themes. The factors that were most frequently mentioned are shown in Figure 4-4.

[23] The remaining conflict-triggering factors reported are: (1) lack of environmental awareness in communities, (2) problems with community integration, (3) reduction of crop production because of poor soil quality, (4) low agricultural yields because of water scarcity and poor soil quality, (5) economic dependence on mining, (6) presence of social programs for communities, (7) deficient human and (8) economic resources in decentralized offices, (9) no constant monitoring for environmental impact assessment, (10) bad relations between communities and representatives of mines, (11) emigration of community members, (12) mining-related misinformation in communities, (13) inefficient prior consultation, (14) problems related to distribution of mining royalties, and (15) not all communities receiving an agreement with mining companies.

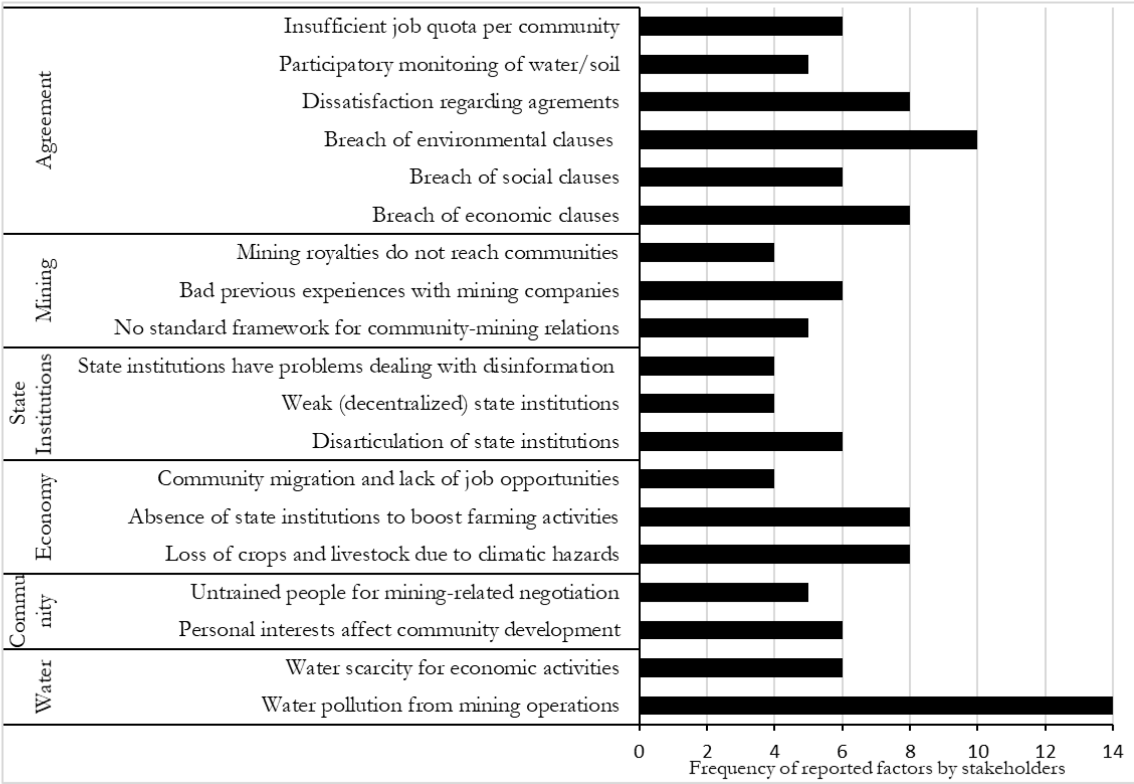


Figure 4-4. Frequency of reported causes of land-use conflicts (N=34)

All stakeholders except the mining companies indicated “Water pollution by mining activities” as the most important category. Water pollution and mining activities become more pressing as water scarcity increases in the community, as corroborated:

> *“We do not have water. Our spring only supplies to some neighborhoods [of our community]. Water is not enough and there is no support from any state institution” (JH, representative of the community of Santa Rosa de Huarmita, Santa Rosa de Huarmita, 14.10.2016).*

This statement shows how difficult it can in fact be for communities to have water for their activities. Thus, if there is an external factor such as mining operations that use this resource, water-related conflict is more likely to occur. Previous studies have highlighted that water scarcity is fueled by the activities of mining companies and is possibly triggering conflicts (Arellano-Yanguas, 2011a; De Echave, 2018; Larrain Vial SAB, 2012; Li, 2017). It is worth mentioning that until now there has been no official report on the quantity of water used by the mining sector (De Echave, 2018; Preciado Jerónimo, 2011). Formally, however, mining projects in Peru have to obtain their water use licenses from ANA in agreement with the existing policy framework (CRP, 2009; PRP, 2017).

Other conflict-triggering factors are related to the agreements between mining companies and campesino communities regarding the lease of community lands. These agreements include economic-, social- and environment-related clauses that describe the benefits the communities should enjoy. The agreements come after the mining company has obtained a concession from the MEM and the approval of mandatory environmental impact studies by the Environmental Licensing Agency. This study observed that breaching these clauses can easily create conflicts between mining communities and companies. Especially negative environmental impacts of mining, for instance, the pollution of community water resources, is the second most common reason for land-use conflicts. Several ACMs interviewed in Shicuy explained some of the environment-related clauses included in their agreement with Azulcocha. They said that the agreement states that: “Azulcocha should not pollute our environment,” “Azulcocha should take care of the environment,” and “Azulcocha should be careful with the soil.” However, other ACMs expressed their concerns about the possible breach of these clauses: “Azulcocha might be polluting the rivers and our irrigation channel”.

If the company disregards the environmental conditions of the agreement and fails to heed its economic promises, this generates a common dissatisfaction. Conflicts can also arise from the fact that the agreements differently benefit directly and indirectly affected communities, e.g., directly affected communities obtain higher compensation than indirectly affected ones. This happened for instance in the case of Huasicancha that received more money than Chongos Alto in the agreement with the Huacravilca mine. Although this disparity was finally negotiated:

> *“Huasicancha has become the main beneficiary of Huacravilca (…) Due to the better economic benefits obtained by Huasicancha, the dispute among both communities arose. Although Chongos Alto is not directly influenced by Huacravilca, the community relations office [of Huacravilca] asked them to sign an agreement, so the mining company disbursed money to benefit Chongos Alto and*

has hired 10 community members" (LG, representative of Huacravilca, Huancayo, 16.11.2016).

The breach of the clauses of the agreement thus triggers land-use conflicts. Besides the clauses of the agreement, environmental institutionalism was also reported as a conflict-triggering factor due to the absence of state institutions in communities, the disarticulation of state institutions to provide coherent support, and the poor support or lack of support for farming. This study seeks to highlight that a conflict cannot be solved if a well-established and strong environmental institutionalism does not attempt to find a solution. Peru needs to strengthen its environmental reforms and state institutions in order to empower its environmental institutionalism.

4.4. Discussion

This examination of the introduction of environmental institutionalism in Peru focused on the influence environmental reforms have had on latent land-use conflicts. This was done by assessing different stakeholder perspectives, looking at household livelihood profiles, and identifying the main reasons leading to full-fledged conflicts. This study found that the following factors can trigger land-use conflicts: (1) The absence of state institutions in areas of potential conflict is due to the lack of personnel, equipment, and information about the responsibilities and mandates of public environmental agencies on the side of the communities. (2) Campesino communities and mining companies are the most influential actors in land-use conflicts and have a higher level of influence than the state institutions who could potentially intervene. The legitimacy of state institutions was also evaluated differently. (3) A lack of substantial local livelihood improvement in mining-affected communities. (4) The pollution of community water resources by mining.

As there was no active conflict in the study area – which usually triggers stronger official intervention – the observed situation was taken as a good reflection of the status quo of the implementation of environmental reforms at the regional level. Unlike previous studies focusing on active conflicts, this research shows that there is weak environmental institutionalism in areas where there are no active conflicts. This weak environmental institutionalism, the lack of information about the mandate and responsibilities of public environmental agencies, and their complete absence in areas with potential for land-use conflicts undermine citizen trust. Campesino communities, instead of relying on the support of public environmental agencies, rather take up matters themselves, which can easily lead to conflicts with mining companies. The absence of state institutions and the unleashing of land-use conflicts has been established by previous studies, which have revealed that weak state capacities affect environmental regulation and monitoring (Arellano-Yanguas, 2011a, 2008; Barton, 2005; Bebbington and Bury, 2009; Gustafsson, 2018). The weakening of environment-related state institutions and regulations was enhanced in the last decade, as some functions of MINAM and its agencies (i.e., OEFA) were restricted and removed (CRP, 2015; Damonte and Vila, 2014; De Echave, 2018; PCM, 2013; PRP, 2014). The law 30230, enacted in 2014, restricted OEFA´s imposition of fines to companies following Article 19[24]. Consequently, after three years of complaints from communities, this article was retracted in 2017, and OEFA has recovered its previous functions (MINAM, 2009). Similarly, the lack of information on the roles of the institutions was also reported by De Echave (2018) as a determinant of conflict, as most state institutions only contact the campesino communities when the conflicts have already escalated. This study highlighted the fact that interviewed stakeholders already know their difficulties and how to tackle them. However, creating the necessary political will to strengthen environmental institutions to improve the performance of institutions and build citizen trust in state institutions is needed.

The level of participation and involvement of stakeholders in conflict solution is crucial (Viveros, 2017). This study identified 13 stakeholder groups actively involved in mining conflicts (see Table 4-2). Active civil society organizations tend to be interconnected among themselves but have few links with stakeholders with higher levels of influence or legitimacy (e.g., state institutions). Arellano-Yanguas (2011a)

[24] Law N° 30230 establishes tax measures, simplification of procedures and permissions for promotion and stimulation of investment. Article 19 of this law focuses on the function of OEFA for the prevention and correction of infringing behavior (PRP, 2014).

advises NGOs to gain legitimacy by connecting with other institutions of higher legitimacy. This study indicates that it is important to increase the collaboration between civil society and other stakeholders to provide a joint response when a conflict occurs. This response might help to solve or prevent conflicts. Other studies established that the involvement of civil society organizations increases the chances that all stakeholders are treated fairly (Aydin et al., 2017) and that environmental regulations are enforced.

This study also shows that state institutions, despite relatively high levels of influence and legitimacy, do not effectively coordinate their activities. This weakens their impact on the latent conflicts and creates distrust among the citizens, undermining the effective implementation of environmental institutionalism. Although the conflict-related roles of state institutions depend on their functions and their influence and legitimacy in the communities, state capture and extractivism-driven policies reduce citizen trust and negatively affect the work of institutions. The general distrust in state environmental institutions was also highlighted by other researchers (Arellano-Yanguas, 2011a; Bebbington and Bury, 2010, 2009). Another important finding is the fact that it is rather the mining company instead of state agencies that have the necessary influence to prevent a conflict from erupting. The influence of mining companies in remote areas could be used to assume some state responsibilities and solve some local problems, thereby contributing to conflict prevention (Quiñones et al., 2013). However, this study shows that mining companies avoid encroaching on state responsibilities. In reality, their high level of influence and legitimacy are used by mining companies to endorse agreements with communities and improve the negotiation with communities in opposition to mining projects. However, the campesino communities themselves also have a high level of influence and legitimacy, since they control the resources the companies are interested in. Unfortunately, this is not the case for neighboring communities indirectly affected by mining. Often they do not partake in the benefits accrued from mining even if they participate in public hearings. Since communities are the ones that get involved in conflicts, state institutions need to understand the mining-related livelihood impacts and problems they face. However, their absence on the ground and the resulting lack of information on local conditions and dynamics negatively affects the legitimacy of state institutions and therefore the local implementation of environmental reforms. This, in turn, enhances the likelihood of the outbreak of conflicts between campesino communities and mining companies.

Since the communities are the main stakeholders in potential conflicts, the research used household profiling to evaluate the economic challenges mining-affected communities are experiencing. Econometric modeling showed that differences in family income in these communities mainly depend on profits from livestock rearing, the age of respondents, and livelihood diversification, rather than on benefits directly derived from the mining companies. Since rural livelihoods are hardly changing, sustaining important agricultural resources like water and land remains extremely important. Despite the relevance of water consumption for mines and communities, the Peruvian government did not assess the total water consumption that had been used from the watershed since 1990 (Preciado Jerónimo, 2011; Preciado Jeronimo et al., 2015). Reliance on resources, in turn, explains why the pollution or degradation of these resources by mining companies can easily cause conflicts with campesino communities. This is especially the case with regard to water resources. The Andes of Peru are a water-stressed area, and the protection of water resources is critical for livelihoods (WB, 2018). Land-use conflicts have mainly been driven by water, e.g., in the case of the Conga project for gold and copper mining (Delgado and Romero, 2016; Helwege, 2015; PCM, 2012). Like the studies by Bebbington and Williams (2008) and Isch et al. (2012), this research confirms that water-related problems are associated with the occurrence of soil-related problems and the interference of mining companies. In line with other research, the findings of this study therefore suggest that the key preventive measure to avoid conflicts is the maintenance of good access to quality water for the communities (Bianchini et al., 2015; Brain, 2017; Preciado Jerónimo, 2011). Apart from domestic needs, adequate water resources are very important for livestock production, and a key poverty-alleviating factor of the livelihood strategies of campesino families. Through the sale of dairy products, families are able to generate a cash income while relying on subsistence production for consumption.

Despite regular problems and conflicts, many campesino families hope that mining projects in their area will eventually increase their incomes and improve their quality of life through the creation of employment opportunities (Basombrío et al., 2016; De Echave, 2018). Indeed, local job creation is one important component of the agreements between the mining companies and communities. Perreault (2014) reported that open-pit mines offer only a few and generally non-qualified jobs, which usually does not match community expectations. Similarly, the studied open-pit mines offer a low and only temporal job quota for communities that have an agreement. However, although they are often only temporary, these jobs provide fixed salaries, which are more attractive to farmers than the uncertain income from agriculture and livestock rearing under threat from climatic hazards (CTRJ, 2015c). Apart from employment, the mines can also improve the economic development of campesino communities through the annual payment of land rents. However, the tendency of mining companies to delay or default on the payment of land rents is a frequent reason for complaints and can escalate into conflict. In general, disagreement about the clauses and the fulfillment of the agreements between mining firms and campesino communities often triggers conflicts. Conflicts can also arise because community members are only marginally involved in the negotiation of the agreements and often dissatisfied with the contracts negotiated by their community authorities.

4.5. Conclusions

In summary, this study investigated the local and regional implementation of environmental institutionalism in mining-affected communities in the central Peruvian Andes. Local and regional implementation of reforms was rather weak. Communities lacked the necessary information about their rights and the mandates and responsibilities of environmental agencies. The stakeholder analysis clearly showed that latent conflicts are mainly negotiated between the communities and the mining companies with little or no involvement of the relevant environmental agencies. While they had some influence and legitimacy, the agencies often failed to cooperate, and their performance was undermined by the lack of capacity (human resources and equipment), which created a feeling of distrust within the communities. As a result of the poor performance of environmental agencies, environmental degradation, particularly the pollution of vital water resources, was named as the most important reason for conflicts between campesino communities and mining firms. Since local families continue to largely depend on agriculture and livestock rearing for their livelihoods and mining employment does not have any significant impact on the income of most campesino communities, water issues become critical. Diminishing access as well as pollution not only affect domestic consumption but also irrigated agriculture and livestock production, an especially important component of local livelihood strategies. For these reasons, water-related problems often result in conflicts. Because of the breach of environmental and economic clauses of community-mining firm agreements and the failure of decentralized government agencies to intervene with a coordinated effort, latent conflicts often erupt. The findings show that the establishment and actual implementation of a policy framework facilitating the negotiations between campesino communities and mining projects are urgently needed. This must be coupled with efforts to strengthen the outreach and performance of environmental institutions at local and regional levels. Only through these measures is there hope for the improvement of the livelihood of campesino communities and their relationship with mining companies.

5. LAND-USE CONFLICT RISK INDEX: BUILDING AND APPLICATION IN FARMING-MINING LANDS OF THE CENTRAL PERUVIAN ANDES

5.1. Introduction

This chapter describes the design and application of a Land-Use Conflict Risk Index (LUCRI) to be used as a decision-making tool for conflict prevention and management. The index can help policy-makers, mining companies, and academics to identify communities at the greatest risk of escalation into land-use conflicts. To the author's knowledge, no such risk index exists, making this research a unique contribution and basis for further studies. The proposed risk index uses an interdisciplinary approach, unlike some environment-related risk indexes that focus on a single factor such as water scarcity (Lezzaik et al., 2018; Ohlsson, 2000) or soil pollution (Albuquerque et al., 2017). Hence, a mining company, e.g., through its corporate social responsibility (CSR) unit, could use and adapt the index for interacting with relevant communities.

Because of coexisting spaces between communities and mining operations, as well as the predominant national pro-extractivist policies, mining-related conflicts have increased in Peru (Arellano-Yanguas, 2011a; Schuldt et al., 2009). Once a mining company has obtained the license to explore and/or exploit, campesino communities might have to rent or sell their lands to facilitate mining operations (Bury, 2005; Schuldt et al., 2009). For instance, campesino communities in the northern Andes sold their lands to the Yanacocha[25] mine, which changed their livelihoods and led to conflicts (Arellano-Yanguas, 2011a; Li, 2009; Schuldt et al., 2009). These conflicts resulted in the modification of the social practice of the mine, increasing the investment for remediation and social responsibility (Schuldt et al., 2009). The Yanacocha case demonstrates that conflict is used to modify the social approach of the mining company towards the benefit of communities. The risk index aims to unveil the most relevant

[25] Yanacocha is an open-pit gold mine in Cajamarca (northern Andes) that had two main conflicts: Choropampa conflict due to a large mercury spill in 2008, and Conga conflict due to mining expansion project and water sources near Cajamarca (Basombrío et al., 2016).

potential roots of conflict before this occurs, thus preventing conflicts and the associated hindering of mining operations.

Land-use conflicts are manifested by the change of land-use from farming to mining occurring once the land tenure and use differ among stakeholders (e.g., mines and communities) (Havel, 1986; Hilson, 2002). Resulting conflicts can increase resistance to mining operations and the interest of respective companies (Conde and Le Billon, 2017). However, mining operations have boosted the local economy through the distribution of mining revenues (i.e., *canon minero*) among subnational governments. Specifically, the federal government assigns 75% of the *canon minero* to the affected subnational governments (CRP, 2004a, 2001). However, the poor capacity of local governments affects the investments of the *canon minero* (50% of taxes from the mining sector), developing problems for investing in and executing long-term projects that could improve local livelihoods (Arellano-Yanguas, 2011a). Since the *canon minero* cannot be directly given to campesino communities, it must benefit them indirectly through public projects such as road construction. Besides, campesino communities have to negotiate with the respective mining company to gain agreement on compensation for renting their lands. Although not all communities opt for establishing an agreement, they may nevertheless be affected by indirect impacts, e.g., pollution of water sources and lands.

The land of the campesinos is comprised of water and soil, and consequently, they claim the protection of it against extractivist operations (Arellano-Yanguas, 2011a; De Echave, 2018; Schuldt et al., 2009; Silva-Macher and Farrell, 2014). Together with these claims, poverty, and marginalization have deepened land-use conflicts (Schuldt et al., 2009) as detailed in previous chapters. In this framework, this chapter deals with two main research questions: **(RQ 5-1)** How can the biophysical, socio-economic, and institutional components be combined in a risk index? **(RQ 5-2)** is based on the implications of the risk index, i.e., how can it be improved through future research?

5.2. Land-use Conflict Risk Index

5.2.1. Study Area

The study area is situated in the south-western zone of the Junin Region. Located in the Mantaro watershed of the Central Peruvian Andes, Junin includes 389 campesino communities and one of Peru´s oldest mines (La Oroya). This study worked with 8 campesino communities influenced by mining, i.e., 3 communities in the Cunas sub-basin and 5 communities in the Aimaraes sub-basin (Figure 5-1), belonging to four districts in total. Three mining companies participated in the study (Table 5-1). The fieldwork took place from August 2016 to April 2017.

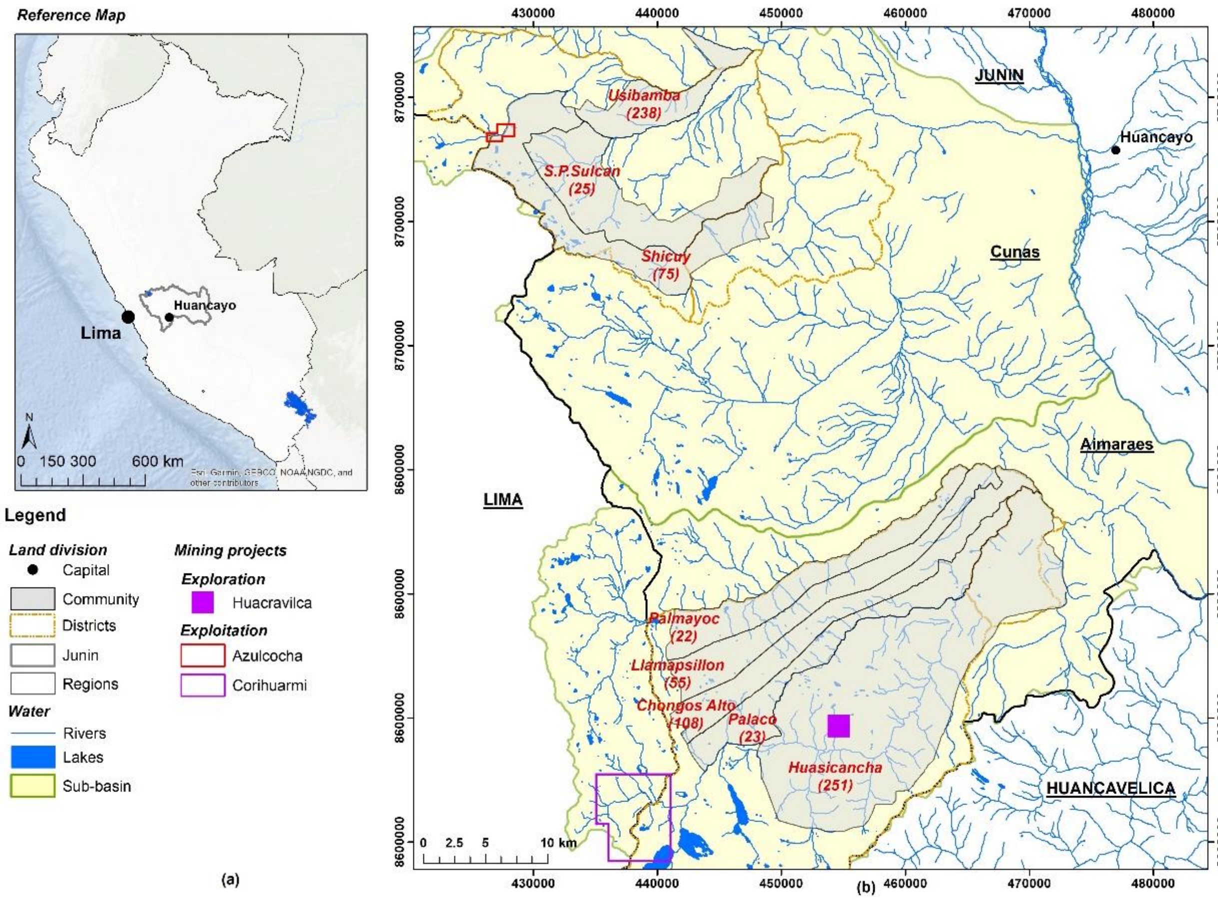


Figure 5-1. Location of mining operations and *campesino* communities (in red) with the total number of active community members (in 2016) in the Aimaraes and Cunas sub-basins.

Table 5-1. Description of mining companies at research zones

Sub-basins	Mine	Mining company	Exploitable metal	Community
Cunas	Azulcocha	Brynajom-Trafigura	Zn	Usibamba, Shicuy, Sulcan
Aimaraes	Huacravilca	Fresnillo	Ag	Huasicancha, Chongos Alto
	Corihuarmi	Minera IRL S.A.	Au, Ag	Chongos Alto, Llamapsillon, Palaco.

5.2.2. The Land-Use Conflict Risk Index design

The design of the Land-Use Conflict Risk Index (LUCRI) can be divided into three main stages. First, criteria and indicators are defined via content analysis of the in-depth interviews (Chapter 4). Second, indicators are estimated according to their origin and composition. Third, the risk index is calculated and three hypothetical scenarios run. Figure 5-2 presents the sequential steps followed in the development of the LUCRI, from methods of data collection to the selection of the criteria and indicators, their weighting and aggregation and finally the resulting index. According to Mitchell et al. (1995), this indicator-based approach “communicates a sense of the condition of the whole”, providing data to experts, policy-makers, and modelers. The indicators are operational representations of an attribute and a single output value that collects important information from the dataset (Gallopin, 1997; WWAP, 2003). Although the LUCRI only provides a snapshot of the situation upon data collection, it allows the most reported concerns relevant to land-use conflicts to be integrated in order to anticipate them before their occurrence (Mitchell et al., 1995). The concerns used in this index are based on those reported by stakeholders and communities in the research area (section 5.2.3).

The information presented in Figure 5-2 is also useful for end-users and allows the examination of the development process. This could lead to contributions in the form of feedback and further improvements to the index. The modeling of the LUCRI is based on the additive aggregation model, which is appropriately simple and understandable for decision-makers (Choo and Wedley, 2008).

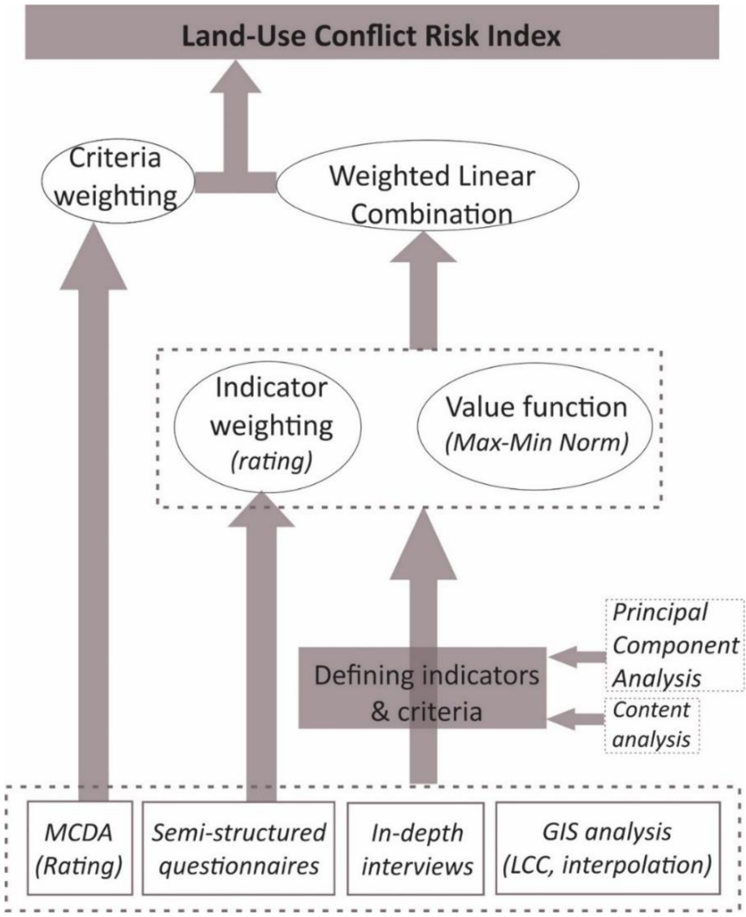


Figure 5-2. Flowchart of the main developmental stages in building the LUCRI

The scale of the LUCRI is from 0 to 1. The following ranges were considered to determine the level of risk of escalation into a land-use conflict: 0–0.2 = very low risk, 0.21–0.4 = low risk, 0.41-0.6 = moderate risk, 0.61-0.8 = high risk, and 0.81-1.0 = very high risk.

In this research, the LUCRI was calculated for each case community (8) in the study area using (Equation 1). Per community, the LUCRI uses the resultant value $V(A_i)$ and weight ($W_{stakeholders}$) that was given by stakeholders. $W_{stakeholders}$ uses the overall given rate to estimate the weight of each criterion. Thus, the LUCRI is calculated for each community as follows:

$$LUCRI = \sum \left(V^q(A_i)\right)_i W_{stakeholders} \qquad \text{(Equation 1)}$$

where:
RI is the risk index that varies from 0 to 1
$V^q(A_i)$ is the overall value of the *i*th alternative at each community
$W_{stakeholders}$ is the local weight that was given by stakeholders via MCDA.

The LUCRI is based on an additive aggregation model (Choo and Wedley, 2008) and weighted linear combination (Malczewski and Rinner, 2015):

$$\text{LUCRI}_{Com} = (V_W)(W)_W + (V_{SF})(W)_{SF} + (V_{LU})(W)_{LU} + (V_{CMD})(W)_{CMD} + (V_{GII})(W)_{GII} + (V_E)(W)_E \quad \text{(Equation 2)}$$

where:
LUCRI_{Com} is the land-use conflict risk index in a community
$V_{criterion}$ is the overall value of the *criterion* estimated in a community
$W_{criterion}$ is the overall weight of the criterion estimated in a community

The value of each $V(A_i)$ was calculated using Equation 3. The indicator weights (w_k) and value functions $v(a_{ik})$ do not consider the spatial heterogeneity within decision-making (Malczewski and Rinner, 2015) but are based on linearity and additive assumptions. Indeed, spatial heterogeneity does not influence weights and values here because focuses is on only one area. Community members provided the indicator weights and values during the semi-structured survey. $v(a_{ik})$ is the average or median of each indicator per community. w_k is based on the average of the weights per indicator. $V(A_i)$ is the sum of the indicators within each criterion per community. The weighted linear combination is calculated as:

$$V(A_i) = \sum_{k=1}^{n} w_k \, v(a_{ik}) \quad \text{(Equation 3)}$$

where:
$V(A_i)$ is the overall value of the criterion
i refers to the location of the community
$v(a_{ik})$ is the value of the community with respect to the *k*th criterion measured
w_k is the indicator weight given by local people via a rating exercise

5.2.3. Theoretical framework of the Land-Use Conflict Risk Index

To build the LUCRI, the conceptual basis for selecting the criteria and corresponding indicators that may affect land-use conflicts was established. After a literature review and content analysis of the in-depth interviews (Chapter 4), the following criteria were extracted to be included in the LUCRI: soil fertility (SF), water (W), land-use (LU), community-mining dialogues (CMD), involvement of governmental institutions (GII), and economy (E). Table 5-2 shows the categories clustered in six criteria to better depict the frequency of their mention by community members and stakeholders via in-depth interviews (open-ended questions). Table 5-3 shows the indicators included with the aim of being as understandable and plausible as possible to all participant stakeholders. The local participants could thus easily assess the criteria and indicators during data collection.

Table 5-2. Frequency of the categories mentioned by stakeholders

From in-depth interviews		**To LUCRI**	
Categories	**Freq.**	**Criteria**	**Mean Freq.**
Water pollution by mining operations	14	Water	10
Water scarcity for economic activities	6		
Reduction in crop production by soil quality	3	Soil Fertility	3
Low farming production by water scarcity and soil quality	3		
Loss of crops and livestock due to climatic hazards	8	Land-Use	8
Absence of state institutions to boost farming activities	8		
Mining-related misinformation in communities	3	Community-Mining Dialogues	6
No standard framework for community-mining relations	5		
Bad previous experiences with mining companies	6		
Personal interests affect community development	6		
Untrained people for mining-related negotiation	5		
Breach of economic clauses	8		
Breach of social clauses	6		
Breach of environment clauses	10		
Dissatisfaction regarding agreements	8		
Participatory monitoring of water/soil	5		
Insufficient job quota per community	6		
Canon minero does not reach communities	4	Involvement of Governmental Institutions	4
Disarticulation of state institutions	6		
Weak (decentralized) state institutions	4		
State institutions have problems dealing with disinformation	4		
State institutions mainly reach communities during conflicts	3		
Economic dependence on mining	3	Economy	4
Community migration and lack of job opportunities	4		

Table 5-3. Indicators and criteria for triggering socio-environmental conflicts in the Central Andes of Peru

Criterion (k)	**Indicator**	**Description**
Water (W)	Drought level (Drought)	Drought is a constant problem for agriculture and livestock. Data obtained from the semi-structured survey. (1 = household has problems with droughts in daily activities, 0 = no drought problems)
	Water access (W_access)	Awareness of water access per household obtained from the survey. (1 = household has problems with water access for their daily activities, 0 = no problems with water access)
	Water availability (W_availability)	Water availability reported by household head during survey. (1 = problems related to water availability for daily activities, 0 = no problems)
	Water quality (W_quality)	Water quality reported by household head during survey. (1 = concern regarding water quality for daily activities, 0 = no concern)
	Mining stage (M_stage)	Mining stage of the mine based on interviews/secondary data
	Fish absence (F_absence)	Absence of wild trout in the rivers reported during survey. (1 = death/absence of fishes, 0 = no problems)
Soil Fertility (SF)	Compost	Use of compost for crop production mentioned during semi-structured survey. (1 = use of compost, 0 = no use of compost)
	Crop products (C_products)	Agriculture products classified at the level of nutrient requirements based on semi-structured survey and secondary data from DRA. (0 = no crops/pastures, 1 = pastures [low nutrient requirement], 2 = crops [high nutrient requirement])
	Crop production (C_production)	Annual production of main product per household reported during semi-structured survey.
	Soil quality (S_Quality)	Soil quality based on interpolation of cadmium concentration in the research area.
Land-Use (LU)	Community area (Com_area)	Total community area (m^2) estimated during map creation, in-depth interviews and secondary data from the Peruvian government.
	Grazing area (Graze_area)	Estimation of grazing area (m^2) per community using GIS mapping.
	Livestock grazing (Graze_Livestock)	Extent of livestock grazing obtained from survey per household. (1 = household practices livestock grazing, 0 = household does not practice livestock grazing)
Community-Mining Dialogues (CMD)	Number of dialogues (N_dialogues)	Dialogues conducted since the first meeting in which mining company introduced mining project to directly affected community. Obtained from surveys and interviews.
	Time since the first meeting (Length_meet)	Time (in years) from first meeting with mining company until now. Obtained through semi-structured surveys and in-depth interviews with community authorities.
	Level of community/mining company relationship (Relation)	Level of the relationship between community and mining company is categorized as: Dialogue (1st level), Complaint (2nd Level), Protest (3rd Level), Conflict (4th Level). Obtained from the semi-structured survey and in-depth interviews with mining companies and *campesino* community authorities.

	Level of socio-economic benefits (SE_benefits)	Level of socio-economic benefit from the mining company to the community: 1st level (only in community festivities), 2nd level (development of small projects), 3rd level (annual agreement between community and company).
Involvement of Governmental Institutions (GII)	Level of awareness of institutions (Institutions)	Level of awareness of community regarding institutions obtained during semi-structured survey. (0 = Did not know any institutions, 1 = Knew one institution, 2 = Knew 2 to 3 institutions, 3 = Knew 4 or more institutions).
	Community-city distance (Distance)	Distance (km) from the community to the capital (i.e., Huancayo) estimated by GPS and GIS mapping.
	Community altitude (Altitude)	Altitude (MASL) of each community measured by GPS, referring to community building.
	Road access to communities (Road_access)	Presence of paved road to reach the community based on surveying community lands. (0 = no paved road, 1 = paved road, 2 = mixed roads)
Economy (E)	Family income (Income)	Family income per month based on semi-structured survey with ACM.
	Family expenses (Expenses)	Family expenses per month based on semi-structured survey with ACM.
	Community-mining economic benefits (M_payment)	Annual payment from mining company to benefited community reported by mining companies and *campesino* community authorities.

The justification and methodology used to derive each criterion and indicator are detailed below.

Water

Justification

The Peruvian Andes have high regulatory and reputational risk related to public confidence in sustainable water use by companies (Orr et al., 2009; Richards, 2016; Schulte et al., 2014), and medium to high physical risk related to water quality and availability (WRI, 2015). In the Andean farming-mining lands, competition for water occurs among communities and mining companies due to the shift of water property from the government to the private sector (Glave and Kuramoto, 2007; Sosa and Zwarteveen, 2012). As a result, water security is considered one of the main conflict drivers due to impacts on local livelihoods (Conde, 2017; Perreault, 2014).

In Peru, the provision of drinking water and irrigation water is still a major constraint for local wellbeing and economic activities (Boelens et al., 2010). In 2007, 67.5% of the households in Peru had access to drinking water, while 32.5% got their water supply from rivers, ditches, or some other unsafe source (INEI, 2010). By 2012, access to drinking water had increased to 87% nationwide, and up to 72% in rural areas (AQUASTAT, 2015). Unlike drinking water, irrigation water in most croplands relies primarily on inefficient gravity irrigation (Eda and Chen, 2010), and is weakened by the lack of long-term policies for water management (Eda and Chen, 2010).

The water criterion is comprised of six indicators, data for which were obtained during interviews with stakeholders and surveys of campesino communities: drought, water access, water availability, water quality, mining stage, and absence of fish. In the Andes, **drought** is one of the root causes behind the weakened irrigation infrastructure (Boelens et al., 2010). Due to the significant negative impacts of drought, local Andean livelihoods over the last decade (PCM, 2016; Sanabria et al., 2014), and irrigation plans based on the ground- and surface water have become contingency plans to protect crops and increase productivity (Hoogesteger and Verzijl, 2015; Taft, 2015).

In the Andes, **water access** changes according to the needs of the established mines, as occurred between Yanacocha mine and the users of irrigation canals from communities (Sosa and Zwarteveen, 2012). The government enters into a position in which they have to take the water from communities and grant it to mining companies. This indicates the power of such companies, as these can later decide to whom water access is provided (Swyngedouw, 2009).

Land-use conflict drivers such as **water quality** and **availability** are affected due to the mine location and its impact on water sources of downstream communities, the underestimation of water consumption by the mines, and the extension of impacts on aquifers and rivers (Bebbington et al., 2013; Bebbington and Williams, 2008; Gudynas, 2015; Méndez Zegarra et al., 2007; Salem et al., 2018). In the Yanacocha conflict, the mine and local people disputed the granted water for mining and irrigation (Bury, 2002; Li, 2017; Wagner, 2013), proving that water-related concerns of communities can lead to violent conflict and public demonstrations (Triscritti, 2013).

In Peru, the National Authority of Water (ANA) is in charge of giving water-use grants to mines (MINAGRI, 2015, 2008). The financial compensation for water use by mines is given annually and based on water availability and the used volume (MINAGRI, 2018, 2017, 2016). In the mine´s operations (MEM, 1992) there are the two **mining stages** exploration and exploitation. Depending on the size of the mine, the impact during exploitation is often higher. Although mining technology for exploitation aims to prevent environmental accidents (e.g., mining tailing spills), these accidents can occur as a result of the intensity, spatial cover, and complexity of the mines (Gudynas, 2015). For example, a spill of 50000 m^3 of mining tailings from the Lincuna S.A. mining company spread in the Sipchoc watershed (Ancash region in the northern Andes) in March 2018 due to the increase in surface water of the tailing (TFA, 2018), which affected the water sources and crops of neighboring communities (El Comercio, 2018). An environmental consequence of mine tailing spills could be the **absence of fish** in rivers, which is a food supply for local communities. Previous studies have documented claims by communities in regard to reduced fish catches and the presence of mines, which affected their livelihood activities (Bury, 2002).

Methodology

Prior to reaching out to the communities, this study informed the subnational government regarding the research, and requested its support in contacting campesino community authorities. Once community authorities had been informed, the voluntary participation of each community in the research was requested during their general assemblies (meetings with all active community members). If permission was given, the research was able to begin.

Data for the water criterion were obtained by a semi-structured survey involving the active community members (ACM) and in-depth interviews with stakeholders (including community authorities and mining companies). Drought, water access, water availability, water quality, and the absence of wild trout were assessed in the survey. The surveys were applied to elicit local knowledge and perceptions of possible conflict drivers related to mining and farming activities. The results provided values for each ACM. In the case of the indicator mining stage, the value was obtained by requesting the information for each community through in-depth interviews based on an unstructured survey (Baxter *et al.,* 2015) with stakeholders.

Soil fertility

Justification

The soil fertility criterion is justified by the importance of soil for community livelihoods, which can be affected by mining activities. Defined as the soil's ability to produce crops and sustain high yields, soil fertility is related to the potential and capacity of profits and productivity (Gisi et al., 1997, p236). In the Peruvian Andes, soil fertility has decreased due to grazing intensification, which is the result of reduced grazing land because of land concessions to mining activities (Bebbington and Bury, 2009). State institutions evaluate the feasibility of the location of mines and determine whether the mine can affect the soil through filtration of pollutants from mine tailings (De Echave et al., 2009). Therefore, since communities depend on farming activities, the soil is included as a criterion for the LUCRI. Based on the literature review and the fieldwork, the soil fertility criterion is operationalized by four indicators: crop production, crop products, compost, and soil quality.

Crop production in the Andes depends on the altitudinal gradient. Based on the altitude, specific ecological characteristics create production zones and opportunities (Wiegers et al., 1999). Intensive agriculture is done at altitudes lower than 3800 MASL while extensive agriculture is done at higher altitudes (Fonte et al., 2012). In the research area, the altitude of the studied communities varies from 3500 to ca. 5000 MASL[26]. Crop production is also affected by hydrometeorological hazards (e.g., hail, frost), water irrigation, droughts and soil nutrients (Fonte et al., 2012).

In the Andes, smallholder farmers and campesino communities sow traditional **crop products** such as potato (*Solanum spp.*), quinoa (*Chenopodium quinoa*), oca (*Oxalis tuberosa*), mashwa (*Tropaeolum tuberosum*), and ullucu (*Ullucus tuberosus*) (Fonte et al., 2012; Hellin and Higman, 2005). These crops are for self-consumption or small-scale commercialization. Crops require soil nutrient levels that are frequently replenished

[26] The altitudes of the communities were measured using their meeting center as a reference point. Chongos Alto (3571 MASL), Llamapsillon (3628 MASL), Usibamba (3654 MASL), Palmayoc (3696MASL), Huasicancha (3732 MASL), Palaco (3879 MASL), Sulcan (3922 MASL), and Shicuy (3934 MASL).

from the inorganic/organic components of the soils and from manure (Weil and Brady, 2017). Crops are also influenced by temperature and altitude, with temperature generally decreasing as altitude increases. For instance, potatoes require daytime temperatures of ca. 20°C in contrast to pastures that can thrive at temperatures of ca. 0°C (Weil and Brady, 2017). Therefore, higher communities tend to shift crop production to pasture to feed their livestock.

Since the fallow period length and number of consecutive years of cultivation reduce potato yields (Sarmiento and Bottner, 2002), farmers improve soil nutrients through the **compost** of crop residues and manure (Fonte et al., 2012). They also widely use manure during sowing (Caycho-Ronco et al., 2009).

A decrease in **soil quality** endangers farming activities and food security (Özkaynak and Rodriguez-Labajos, 2017). Claims against mining operations regarding soil and water pollution are frequently related to the perception of communities with respect to the death of livestock, decrease in farming production, and soil erosion through mining activities (Bury, 2002; Rodríguez-Labajos and Özkaynak, 2017). Indeed, soil pollution through high concentrations of heavy metals in leachate plumes has been observed (Ngole and Ekosse, 2012), and there has been evidence of pollution transfer from soil to plants in open-pit mines (Ashraf et al., 2011). In the case of smelters in mines, heavy metal particles can be transported and impact soils and crops in distant areas (Pruvot et al., 2006; Razo et al., 2004; Rötting et al., 2014). In the current research area, there have been reports of mining impacts on the Sulcan and Usibamba communities as well as complaints from neighboring communities dated from the start of operations of La Oroya smelters in the early twentieth century (section 3) (Caballero Martín, 1981; Cotler, 2016; Li, 2017).

Methodology

The soil fertility criterion was obtained with community permission through a survey of ACM. Crop production, crops, and manure use were assessed. The results provided aggregated values at the community level. Soil quality was obtained using kriging interpolation in a GIS application with the data of cadmium concentration from INGEMMET via the GEOCATMIN platform.

Land Use

Justification

The traditional land use in the Andes is agriculture and livestock. As the communities are dependent on environmental factors, changes in land use can breed conflicts among the local people (Havel, 1986). Such changes are mainly related to the presence of extractivist projects close to or on community lands, and these operations may generate the use and deterioration of natural resources (Calderón, 2012b; De Echave et al., 2006; Hilson, 2002). Livestock is a key economic resource for the communities for income and products (e.g., wool, meat, dairy products) (Bebbington, 2001; Brain, 2017; Brush, 1976; Chambers, 1995; Fonte et al., 2012; Wiegers et al., 1999), and thus the land-use criterion includes the indicators total community area, grazing area, and livestock grazing.

The **total community area** is relevant because the larger the area, the greater the presence of vital resources for communities, e.g., water sources, pastures. The socio-economic value of the land for the community is not the same as that for extractivist projects, one cause of land-use conflicts (Hilson, 2002). Land ownership can be individual or common in the communities. Common land property has stronger cooperation norms than individual property (Braaten, 2014). Legally, land as common property requires a community´s decision to sell or rent for mining operations (CRP, 1987).

Regarding **grazing area**, communities allocate their economic activities and resources in production zones, e.g., grazing and agriculture (Fonte et al., 2012). A larger grazing area can accommodate greater livestock (De Koning et al., 1999; Postigo et al., 2008). Reductions in the productivity of pastures may cause the migration of community members if they cannot live on their lands (Bury, 2004). Grazing is part of the livelihoods of communities since agriculture becomes increasingly difficult at higher altitudes, which generates a resource competition with mining operations (Bury, 2002; Li, 2017).

Besides mining, **livestock grazing** is affected by climatic hazards, geography, and soil and water quality and access, making it more likely to induce conflict escalation

(Recharte et al., 2002). Depending on altitude and land resources, livestock may differ. At lower altitudes, communities have cattle for dairy products while communities at higher altitudes have sheep and camelids (Postigo et al., 2008).

Methodology

The land-use criterion used land-cover classification and semi-structured surveys of ACM while the survey of each community member relied on obtaining grazing livestock information. The grazing area per community was extracted from the land-cover classification (Chapter 3).

To map the total community areas, the available maps of each community were acquired from the Office of Native and Campesino Communities of DRA[27]. These official maps were produced in the 1920s and 1930s. Based on these maps and the in-depth interviews with community authorities, this study confirmed that most of the community boundaries were formed by rivers.

Community-mining dialogues

Justification

The arrival of a mining company in a community can generate two main positions, i.e., a positive position through the promises of the company to communities and a negative position through the establishment of the enclave economy (Gudynas, 2015). Enclave economy refers to the geographical focus of investment through extractivist projects (Damonte, 2012), which can foster discontent and contention among neighboring communities without the mining-related benefits. To avoid conflict escalation, a constant and direct dialogue between communities and representatives of mining companies is essential to deal with any misunderstandings. This dialogue leads to the establishment of negotiation spaces, which are important for local people giving them the opportunity to listen to the mining company and the government (Salas Carreño, 2008). The community-mining dialogues criterion has four indicators: number of

[27]Regional Direction of Agriculture of Junín.

dialogues, time since the first meeting, level of community/mining company relationship, and level of socio-economic benefit.

Regarding the **number of dialogues**, mine representatives need to have experienced dialogues and worked with communities in order to avoid conflicts (Salas Carreño, 2008). A dialogue space allows the participation and dynamism of civil society, communities and other stakeholders (Li, 2017). Previous conflicts have shown (e.g., the Conga case) that the arguments of communities change with time and through the interaction with other stakeholders (e.g., civil society) (Li, 2017). Therefore, reliable and legitimate dialogue spaces allow a better understanding of the roots of conflict and their shifts. Depending on the legitimacy of state institutions, their influence in mining-farming areas through reports can aggravate or decrease the probability of conflict (Li, 2017). From 2008 to 2017, dialogue-related reasons were a common underlying cause of conflict (e.g., Espinar, Tía María, Conga) (De Echave, 2018).

The **time since the first meeting** is important because a regular dialogue can be key to preventing conflicts (Salas Carreño, 2008). Several cases have shown that state institutions and mining companies engaged in appropriate and consistent dialogue with communities only when conflicts have escalated. Repeated dialogues can allow communities to ask and understand mining operations, impacts, and benefits. Although this indicator defines the time that has passed since the first dialogue with the mining project, it provides an idea of a history of negotiation that later can be observed in the relationship level and the socio-economic benefits to the community.

The indicator **level of community/mining company relationship** relates to the relationship of the mining company with the communities. The importance of the relationship will define future prospects regarding the benefits that communities can obtain from the mining company. After the implementation of neoliberal reforms to enhance extractivist projects, communities as mining-potential landowners have become crucial role-players for the negotiations and the feasibility of these projects (Damonte, 2011). With a collective awareness, communities are featured as an economic and political institution whose resistance to extractivist projects can generate a mobilization of interests or a conflict, e.g., in Peru and Ecuador (Arellano-Yanguas, 2011a; Avci and Fernández-Salvador, 2016; Conde and Le Billon, 2017; Damonte, 2011). Therefore, the relationship between companies and communities is crucial for facilitating the execution of extractivist projects.

Regarding the **level of socio-economic benefit**, the agreement between communities and mining companies (Chapter 3) aims to meet the needs and expectations of both sides. In some cases, e.g., the Antamina[28] mine, communities were grateful for the relationship with the mining company due to the benefits provided to their people (e.g., jobs) (Drinot, 2014; Salas Carreño, 2004). However, if community expectations are too high once a mining project has started, dissatisfaction may result in conflicts (Salas Carreño, 2008). Other cases, e.g., the Espinar mine, have experienced environmental problems (e.g., death of livestock) as a reason for conflict and have subsequently negotiated better agreements that included environmental clauses (De Echave, 2018; MINAM, 2019).

Methodology

All indicators of these criteria were obtained through a semi-structured survey of ACM of campesino communities and in-depth interviews with stakeholders (including community authorities and mining companies). The obtained data were cross-checked among stakeholders and communities.

Involvement of Governmental Institutions

Justification

Political marginalization in communities negatively affects the participation in mining-related decision-making processes (Ballard and Banks, 2003). To reduce marginality, the current Peruvian government agreed with the regional government to build or improve roads to connect cities with remote areas (PRP, 2017a). Road construction also facilitates the closeness of state institutions with communities. Despite the increased

[28] Antamina is an open-pit copper-zinc mine in the Ancash region in the northern Andes. This mine had problems due to spill of copper that affected neighboring communities (De Echave, 2018).

connectivity, environmental institutionalism and the presence of state institutions in communities can encourage conflicts. Therefore, this criterion has the following indicators: level of awareness of institutions, community-city distance, community altitude, and road access to the community.

The **level of awareness of institutions** can determine whether conflicts escalate due to the demands of communities on the government (Arroyo and Boelens, 2013). Communities learn about the existence of state institutions in their regions in order to establish formal complaints. Along with road construction, the decentralization of state institutions started in the early 2000s and aimed to re-establish democracy and state building (PNUD, 2006; Arellano-Yanguas, 2008; Dargent et al., 2017). This decentralization process aimed to contribute to a full, harmonious and more sustainable development (CRP, 2002), and permeated environment-related state institutions, e.g., the Agency for Environmental Assessment and Enforcement (OEFA) and the National Authority of Water (ANA) of the Ministry of the Environment and Agriculture. On the other hand, local governments, which gained political power after decentralization started, are more widely known to community members due to their management of economic resources that come from *canon minero* and the central government (Drinot, 2014). Despite efforts towards decentralization and attempts to join the country, there are constant conflicts that reveal social gaps and low levels of legitimacy in state institutions (Calderón, 2012b).

Road access to communities varies because road construction differs among regions and communities. In Peru, 86.5% of the roads were not paved in 2017 (MTC, 2019a). The uneven geography of the Andes has even hindered the connections of these roads with other cities. Although non-paved roads can help connect communities with the capital city (Carrillo Hoyos, 2011; Ospina Ovalle, 2016), paved road construction has become part of negotiations with mining companies due to the lacking presence of the state (De Echave et al., 2009).

The **community-city distance** as the actual physical distance is also a determinant of conflict, since the farther from the capital, the easier it is to delegitimize community claims (De Echave, 2018). Economically, distance influences market access and the farming-subsistence of communities, where a greater distance makes subsistence farming more likely to be the main livelihood (Caycho-Ronco et al., 2009).

Community altitude refers to the physical altitude of each community, which is also related to issues of access. Paved roads become more difficult at higher altitudes and decrease the possibility of consistent access to capital cities, markets, and state institutions. Also, the higher the altitude, the more vulnerable a community is to climate hazards, and water-, and soil-related problems (INGEMMET, 2014).

Methodology

The level of awareness of institutions was obtained through the semi-structured survey of ACM, access to communities by observation during fieldwork, and the community-city distance and community distance using GPS and secondary data from the Ministry of Transport and Communication (MTC, 2019b).

Economy

Justification

Campesino communities share the collective ownership of a determined area (Castillo et al., 2004; CRP, 1987) and depend mostly on agricultural and livestock-related activities for income (Bartl et al., 2009; Bebbington, 2001; Fonte et al., 2012; Kristjanson et al., 2007; Postigo et al., 2008; Valdivia and Quiroz, 2003). Despite the environmental constraints (e.g., precipitation, temperature), community households often get money from the sale of livestock and dairy products (Fonte et al., 2012; Wiegers et al., 1999). Despite the potential economic benefit from the presence of mining operations, nearby communities might not have improved human development indicators, as was the case in Yanacocha (Cajamarca), Antamina (Ancash), Tintaya (Cusco), and Buenaventura (Huancavelica) (Arellano-Yanguas, 2011a; Gudynas, 2015). In return for land concession, the *canon minero* is distributed at the sub-national level, which is also a driver of land-use conflicts because communities do not receive it directly (Salem et al., 2018). As a result, the economy criterion consists of the household economy through family income and expenses and the benefits that are provided from the mining company to communities.

Family income depends mainly on farming activities, which facilitates the establishment of mining projects due to the more attractive benefits for community members such as job quotas and salaries (Basombrío et al., 2016). Access to public services and assets (e.g., education, roads) increases the diversification of community economies (Brain, 2017; Escobal, 2001). For instance, the improvement of public assets incentivizes communities to prefer grazing lands and dairy production over agriculture given the potential generation of higher profits (Li, 2009).

Family expenses of the communities are supported through farming and complementary activities. The need to meet family expenses has evolved along with globalization and national issues, e.g., internal armed conflicts and migration leading to remittances (Robles Mendoza, 2004). Along with agriculture, communities also participate in local commerce through small trade fairs for supplementary income (Diez Hurtado, 2001; Martínez Valle, 2002).

Community-mining economic benefits mainly refer to the annual economic payments and job quotas to communities in return for the rent of their lands to mining companies. However, job quotas are rare since community members are often not qualified (Brain, 2017). Despite this, there are collateral job opportunities for the internal economy of communities such as infrastructure building, restaurants, etc. (Brain, 2017). In addition, the annual payment that is arranged within agreements (see Chapter 3) represents a benefit for the community.

Methodology

Family income and expenses were obtained through the semi-structured survey of ACM. The indicator of community-mining economic benefits was obtained from the in-depth interviews with community authorities and stakeholders.

5.2.4. Selection, weighting, and aggregation

Selection of criteria and indicators

To establish the theoretical framework, the identification of indicators as socio-environmental root causes of conflicts was done via content analysis using data from in-depth interviews with stakeholders (e.g., state institutions, mining companies, community authorities, and civil society) (Table 5-2). The proposed indicators of the LUCRI aimed to be as understandable and plausible as possible for all participants because their values and weighting needed to be obtained directly from campesino communities. Local participants were able to easily provide responses to these criteria and indicators during data collection. Table 5-2 shows the frequency of categories clustered in six criteria: Soil Fertility (SF), Water (W), Land-Use (LU), Community-Mining Dialogues (CMD), Involvement of Governmental Institutions (GII), and Economy (E).

Indicator values

The indicator values were first normalized due to their different units. These values were obtained from the semi-structured questionnaires of ACM, in-depth interviews with stakeholders, secondary data from state institutions (e.g., ANA) and satellite images (Landsat 8) (section 5.2.3).

Normalization: Value Function $v(a_{ik})$

Data transformation was needed to integrate indicators into a composite index. To integrate the selected indicator (Table 5-3) per community, a linear transformation was done through min-max normalization in order to preserve the relationship among original data (Jain and Bhandare, 2011; Malczewski, 2011; OECD, 2008; Patro and Sahu, 2015). The min-max normalization works with a value range of $[0,1]$, so the $\min_i\{a_{ik}\} = 0$ and $\max_i\{a_{ik}\} = 1$. The global value function for each indicator was calculated in Equation 4:

$$v(a_{ik}) = \frac{a_{ik} - \min_i\{a_{ik}\}}{\max_i\{a_{ik}\} - \min_i\{a_{ik}\}}, for\ the\ k-th\ criterion\ to\ be\ maximized \quad \text{(Equation 4)}$$

where:

a_{ik} is the level of the $k-th$ indicator for the i-th alternative

$v(a_{ik})$ is the worth or desirability of that alternative with respect to that indicator and varies from 0 (the least-desirable outcome) to 1 (the most-desirable score).
$\min_i\{a_{ik}\}$ and $\max_i\{a_{ik}\}$ are the minimum and maximum indicator values for the $k-th$ indicator, respectively.

Indicator weighting w_k

This study refers to PCA as an automatic index, where each component is a linear weighted combination of the used variables (Abdi and Williams, 2010; Mckenzie, 2003; Vyas and Kumaranayake, 2006).

Weights are used to assess the relevance of a given indicator, i.e. the greater the weight, the higher the importance of the indicator (Malczewski, 2011; Malczewski and Rinner, 2015). Community respondents and authorities provided indicator weights through ratings. The ratings for each community were the resultant average or median of respondents´ weights per community. After this weight was categorized per criteria, the weights were proportioned based on the number of indicators per criterion and the averaged weight of each indicator. Indicator weights $(w_1, w_2, \dots, w_k \dots, w_n)$ meet two conditions: $0 \le w_k \le 1$ and $\sum_{k=1}^{n} = 1$.

However, there are two main limitations to using PCA here, i.e., not all variables (indicators) must be different for each respondent because some indicators refer to the whole community rather than to individuals (e.g., community-mining economic benefits) and the lack of the added value from the local knowledge, historical and cultural background, and experience of the respondents.

Imputation of missing data

Composite indexes often use data imputation to replace missing data with substitute values (Lezzaik et al., 2018). In the LUCRI, there were two cases of missing weighting data that should have been given by local experts (i.e., neighboring community authorities). In the Cunas sub-basin, three of five invited communities of San Jose de Quero district participated in the MCDA workshop. The required information of the absent communities was obtained from the average of the participant communities, justifiable given their geographic proximity (Brennan and Martin, 2012).

Criteria Weighting $W_{stakeholders}$

During a workshop, 22 stakeholders provided the criteria weights via a multi-criteria decision analysis technique. This method was used due to its easy comprehension and use for stakeholders who were mainly community authorities. Adapted from Mendoza et al. (1999), the combined weight for each criterion was estimated. This combined weight was then averaged among all stakeholders in order to obtain a unique score per criterion that represents the socio-environmental system in the research area. Criterion weights ($W_1, W_2, \dots, W_{stakeholders}$) fulfill two conditions: $0 \leq W_{stakeholders} \leq 1$ and $\sum_{Stakholders=1}^{n} = 1$.

5.2.5. Validation of the proposed risk index

The purpose of validation is to increase confidence in a technique with respect to its ability to successfully carry out a task (Lewis and Bardon, 1998). Although the validation might not prove the accuracy of the index, this process can invalidate it (Addiscott et al., 1995; Bockstaller and Girardin, 2003; Konikow and Bredehoeft, 1992) or otherwise increase user confidence. Due to the difficulty of validating a risk index that uses mixed-methods, e.g., multi-criteria decision analysis (Malczewski and Rinner, 2015), the validation is based on the workflow shown in Figure 5-3 and includes expert judgment, which is a suitable option for indexes using qualitative and quantitative data (Bockstaller and Girardin, 2003). Although other forms of validation could be complementary (Bockstaller and Girardin, 2003), this research does not include them due to the lack of available data that show the occurrence of land-use conflicts in the research area.

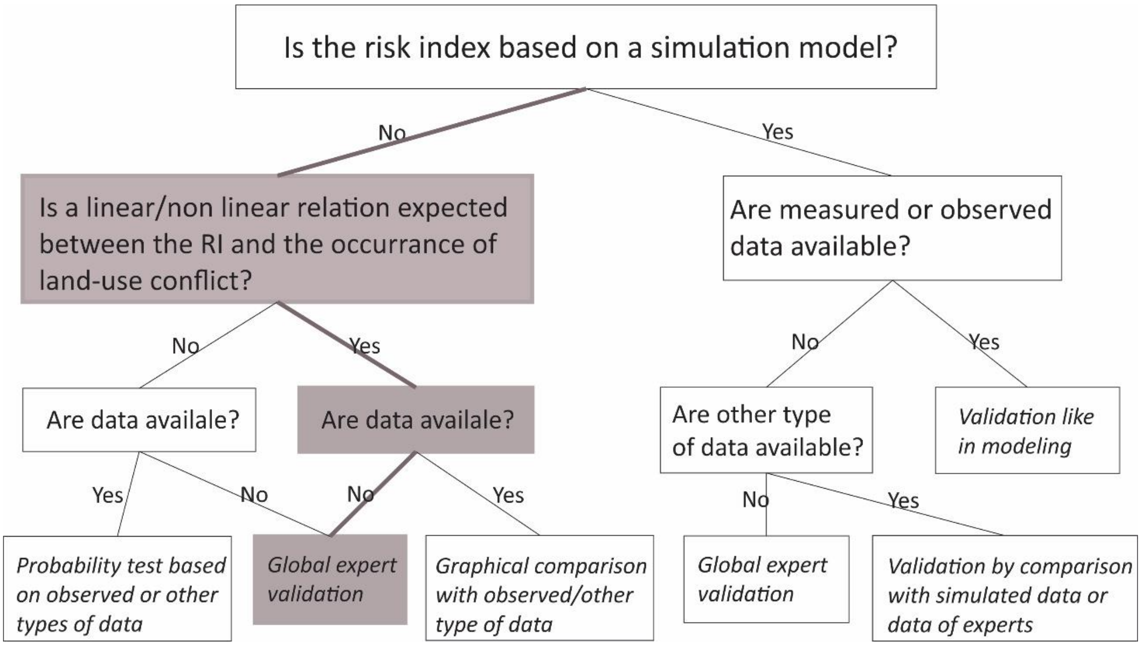


Figure 5-3. Flow diagram for selection of validation method based on indicators Adapted from Bockstaller and Girardin (2003).

The validation process was adopted based on previous research (Bockstaller and Girardin, 2003; Konikow and Bredehoeft, 1992; Lewis and Bardon, 1998). As a result, a group of experts was chosen considering their experience and knowledge in (1) the research area, (2) with campesino communities generally, and (3) with conflicts involving campesino communities. The experts first were provided with a characterization of the communities, the building process of LUCRI, and followed by the results with their explanation. After the experts had submitted their assessments through a short survey (Appendix 8.4), these were compiled and sent back to them for a final assessment. The experts reached a consensus on the compiled assessment.

In addition, in-field validation was done through cross-checking of the selected indicators and criteria in a semi-structured survey with the results of the content analysis of in-depth interviews.

5.2.6. What-if scenarios

The final step of the LUCRI involves running hypothetical scenarios based on findings from the epistemic community.

The scenarios were developed based on the recommendations in previous studies (Arellano-Yanguas, 2011a; Bebbington et al., 2018a; Li, 2017; Salas Carreño, 2008). The simulation of these scenarios aimed to: (i) differentiate three frequent recommendations from the epistemic community, and (ii) assess the criteria and indicators that are modified to have their optimal score. Thus, three main scenarios were established: (1) strong environmental institutionalism, (2) strong environmental institutionalism and community economy, and (3) environmental security.

For scenario development and analyses, the simulation was done by changing the values of certain indicators from their actual values (section 5.2.4) to their optimal values in order to reach the conditions of the established scenario. The criterion and indicator weights were held constant because their calculated importance reflects the status quo for the interested community.

The community with the highest risk level was used to simulate the different scenarios. Thus, the results section (section 5.3.5) first describes the context of the community with the highest risk level. In the following subsections, the framework behind each scenario is outlined.

Scenario 1: Strong environmental institutionalism

This scenario represents the opposite reality to the situation analyzed in this study. It was indicated (Chapter 4) that there is weak environmental institutionalism, which is characterized by the absence and disinformation of state institutions. Environmental institutionalism, i.e. the set of institutions and public policy that focuses on environmental quality affected by human-nature interactions (Damonte and Vila, 2014), was simulated through GII and CMD criteria. This scenario hypothesizes that strong environmental institutionalism can significantly decrease the escalation of land-use conflicts because communities will acknowledge state institutions through the decentralization, connect with the central government, and have legitimate negotiation spaces.

Better connectivity among communities to major cities facilitates their ability to reach state institutions, reducing the absence of state institutions in community lands

(Conde and Le Billon, 2017). For communities, connectivity through road building has become an issue for social justice[29], transportation with dignity, market access, farming techniques to improve production, and other factors (Wilson, 2004). However, the improvement of road access does not necessarily mean better conditions in communities, but could, in fact, be a contingent of disadvantages, e.g., illegal mining, drug traffic (De Echave, 2018; Perz et al., 2013; Wilson, 2004). Also, although the decentralization process has promoted the presence of offices of main state institutions in regions beyond the capital, conflicts have revealed persistent low levels of the legitimacy of state institutions (Calderón, 2012b).

In the case of the CMD criterion, the engagement of the community in negotiation is done through their participation (Conde and Le Billon, 2017). A constant negotiation between both actors enhances the flux of information, thus establishing a community-driven negotiation table. However, most conflicts have been characterized by insufficient dialogues and negotiations with communities (Arellano-Yanguas, 2011a; De Echave, 2018; Salas Carreño, 2008). This poor negotiation lacking the presence of state institutions and their low legitimacy decreases the possibility of establishing legitimate negotiations and preventing or managing conflicts (Salas Carreño, 2008). Although the longest period of negotiation does not necessarily mean a better negotiation, more time may allow establishing a stronger relationship with the community.

Scenario 1 required the optimum values of the GII and CMD criteria (section 5.2.6, Table 5-4).

Table 5-4. Values of indicators of GII and CMD criteria with reasons behind the value scaling

Indicator	Value	Reason
N_dialogues	1	A higher value refers to many dialogues between the community and mining company.
Length_meet	1	The longer the length of the first meeting, the higher the probability of establishing a positive relation.

[29]Social justice is defined as "justice at the level of a society or state as regards the possession of wealth, commodities, opportunities, and privileges"(Oxford English dictionary online, n.d.).

Relation	0	A lower value for community-mining relation refers to a less difficult relation between both actors.
SE_benefits	1	The higher the score, the better are the benefits provided to communities.
Institutions	1	Communities know more state institutions, increasing the legitimacy of institutions.
Distance	0	The shorter the distance to the capital, the more connected the community is, increasing its likelihood to contact institutions.
Altitude	0	The lower the altitude of a community, the better connectivity the community has with the capital city.
Road_access	1	The higher the access, the better connectivity the community has with the capital city.

Scenario 2: Strong environmental institutionalism and community economy

The economic criterion was added to the previous scenario to evaluate if a strong community economy in a context of strong environmental institutionalism helps avoids conflict escalation. The criterion is based on the family economy (i.e., family income and expenses) and the community-mining economic benefits. This scenario hypothesized that a strong community economy will raise the environmental concern and resistance related to mining operations due to the productive and beneficial farming activities. Improved agricultural opportunities and connections with markets can provide a strong community farming-based economy. Likewise, the presence of a strong environment institutionalism will not influence the decision making of the communities with respect to being against mining operations.

Poor community families are correlated with a higher risk of conflict (Haslam and Tanimoune, 2016). The poverty of farming-dependent communities is also due to their income, poor public services (road building and maintenance, water, electricity, education, and health services) and lack of farming opportunities (Conde and Le Billon, 2017; Haslam and Tanimoune, 2016). Regarding the community-mining economic benefits, the annual payment is commonly seen as compensation that might be achieved through the bargaining power of communities in negotiations during land-use conflicts (Arce, 2014; Arellano-Yanguas, 2012, 2011a, 2010; Conde and Le Billon, 2017; Hinojosa, 2011; Zegarra et al., 2007). However, this compensation might only last as long as the mining company is operating on the community land.

Along with the indicators and values of Table 5-4, the values of the indicators of Table 5-5 are input for this scenario.

Table 5-5. Values of indicators of the economy criterion with reasons behind the value scaling

Indicator	Values	Reason
M_payment	1	The higher the annual payment to communities, the less probable a conflict is to escalate. In the case of Shicuy, the high annual payment still buffers the escalation of a conflict.
Income	1	The higher the income, the lower the dependence on mining-related benefits.
Expenses	0	The lower the expenses (combined with higher income), the higher profits for families.

Scenario 3: Environmental security

This scenario is also the opposite of the current situation analyzed in this study. In Chapter 3, water and soil were assessed where mining companies were located in the rented community lands. Previous studies have shown that mining operations have polluted water bodies through their activities, tailings and environmental liabilities (Preciado Jerónimo and Álvarez Gutiérrez, 2016). Thus, this scenario assesses environmental security through used water, soil fertility, and land-use criteria. This scenario hypothesized that if it is possible to ensure environmental security to the communities, defined as the absence of risk of the environment in which a community depends on (Vivekananda et al., 2014), the risk of land-use conflict might be reduced in the current context. Environmental security might have to be granted by the mining company, since there is an absence of state institutions in communities.

In mining, water and soil are the biophysical factors that are used as roots of conflict escalation (Bebbington and Williams, 2008; De Echave, 2018; Li, 2017; Perreault, 2014). Bebbington and Williams (2008) highlighted that communities have concerns related to water quantity and quality due to mining activities. The pressure on water access and availability has also increased among communities due to the decisions of the central government over water use (Hoogesteger and Verzijl, 2015; Sosa and Zwarteveen, 2012). As with water pollution, soil pollution by mining operations has a long history with an outstanding case, i.e., La Oroya, where local people were affected (Reuer et al., 2012). The concern of the community regarding soil is based on the need to increase and produce crops for their own consumption (Fonte et al., 2012). As with agriculture, livestock rearing is considered an insurance mechanism for most communities, because they can sell their livestock or derived products (Postigo et al., 2008; Swinton and Quiroz, 2003). However, mining operations negatively affect water quality and quantity, and the land-tenure practices in the Andes (Brain, 2017). Therefore, it is necessary to ensure environmental security for communities that are affected by mining operations.

For this scenario, indicator values were set to the optimal scores for the criteria water, soil fertility and land-use (Table 5-6).

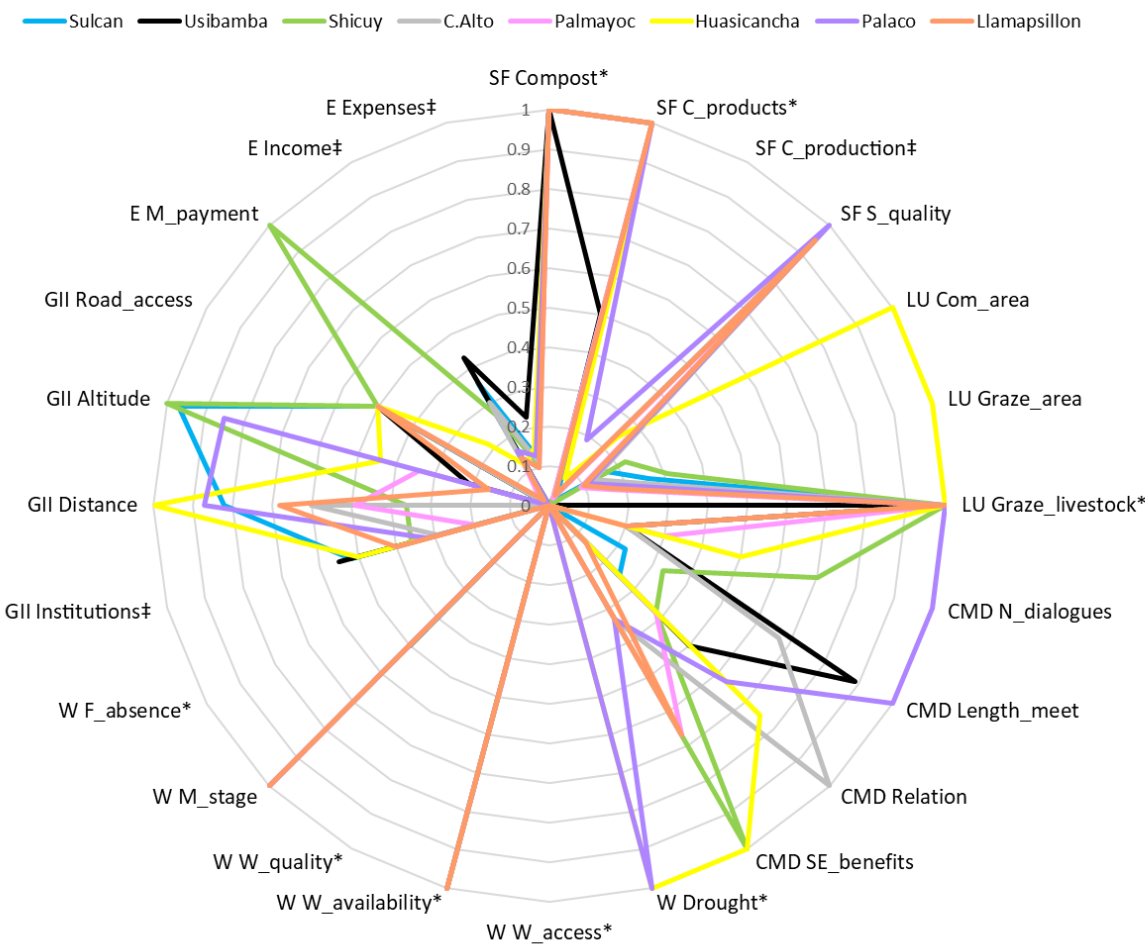
Table 5-6. Values of indicators of soil fertility and water criteria with reasons behind value scaling

Indicator	Value	Reason
Compost	1	Use of compost is crucial to improve community crops.
C_products	1	Land use could be for crops or pasture. The higher the productivity of land the more likely it is to be used for crops.
C_production	1	The higher the main crop production, the higher the likelihood of community families having sufficient food and being able to sell products.
S_quality	0	The lower the concentration of heavy metals (i.e., cadmium), the fewer possible grievances for a conflict.
Com_area	1	The larger the community land, the more resources for community economic activities.
Graze_area	1	The larger the grazing lands, the more pasture for feeding livestock.
Graze_livestock	1	The more livestock, the higher the livestock-based income.
Drought	0	The fewer the drought events, the better conditions for crops and livestock production.
W_access	0	The fewer problems with water access, the better water conditions for communities.
W_availability	0	The fewer problems with water availability, the better water conditions for communities.
W_quality	0	The fewer problems with water quality, the better water conditions for communities.
M_stage	0	The lower the mining stage (i.e., exploration), the lower the likelihood of causing an environmental impact on community lands.
F_absence	0	The fewer events of the absence of fish in rivers, the fewer possible grievances for a conflict.

5.3. Results

5.3.1. Value Scaling

Figure 5-4 shows the average values of the indicators per community (see methodology in section 5.2.3). The normative values between 0 and 1 depending on the indicator and can be binary or continuous (Table 5-3). For instance, some indicators use 1 for indicating that they are concerned or have problems such as drought, water access, water availability, water quality, or absence of fish. Other indicators use 1 to describe an activity, i.e., compost, crops, and livestock grazing. The indicators with a continuous scale use 1 as the maximum value of their scale.



‡ = average, * = median

Figure 5-4. Values of indicators per community

Figure 5-4 shows that the indicator values vary among communities. Compost, livestock grazing, and the absence of fish have the same value for all communities. All respondents use compost for their croplands and do livestock grazing. The absence of fish was also not a concern among communities.

5.3.2. Weighting

Figure 5-5 shows the weights of the indicators by the community. The indicator with the maximum weight was the community-mining economic benefit that is given as a result of an agreement. Llamapsillon, despite not having an agreement or receiving this payment, is the community that considers this annual payment to be the most important indicator. Shicuy and Huasicancha, currently receiving the benefits of their agreements, show the same tendency although their weights are lower than non-benefited communities such as Usibamba and Palmayoc.

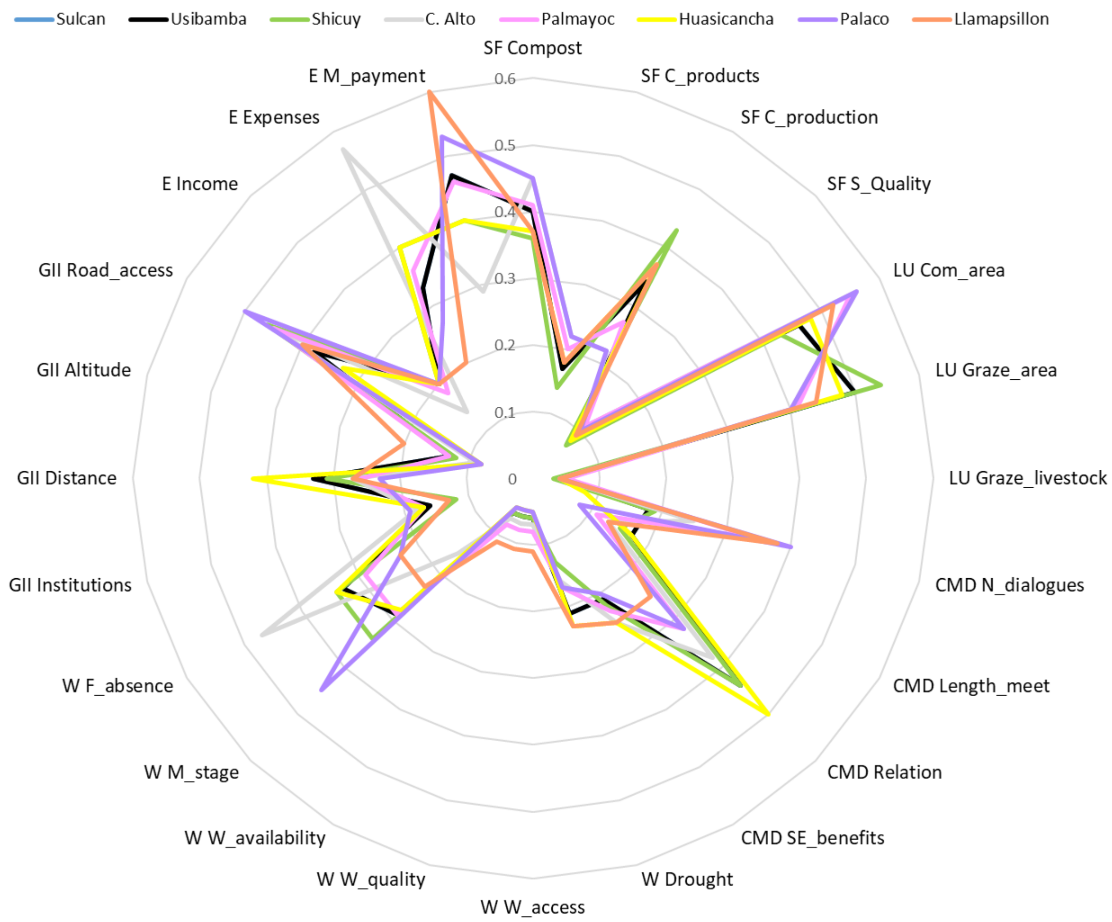


Figure 5-5. Weights of indicators given by respondents
Scale from 0 to 1, where 1 is the highest possible weight.

5.3.3. Land-use Conflict Risk Index (LUCRI)

Table 5-7 shows the criterion weighting based on the assessments by the local experts, i.e., stakeholders. In this assessment, there is an implicit inclination towards the community perspective because, despite the inclusion of different stakeholders, the workshop had a higher attendance of community authorities. This index thus highlights the perspective of the main local stakeholder (campesino communities) who can trigger land-use conflicts. While community complaints may later result in conflicts for different reasons, e.g., pollution, improvement of agreements, mining-related misinformation, the mining company only aims to extract and produce in their established context. In the research area, the experts agreed that the water (W) criterion is the most important one, followed by land-use (LU) and community-mining dialogue (CMD).

Table 5-7. Criterion weight based on the assessment of stakeholders

Weight	**Soil Fertility**	**Land-Use**	**Community-Mining Dialogues**	**Water**	**Involvement of Governmental Institutions**	**Economy**
$W_{criterion}$	0.14	0.20	0.19	0.26	0.16	0.06

Based on Equation 3, Figure 5-6 shows the overall values per criterion among communities. These values are joined with the weights in Table 5-7 to obtain the risk level (LUCRI).

Figure 5-7 shows the risk level of each community for escalating into a conflict. Huasicancha and Palaco, communities with high risk, have land-use (LU) and water (W) as the most important criteria, respectively. This also demonstrates that conflict-triggering factors change from one case to another. Consequently, the different weighting of criteria indicates the complexity that a land-use conflict can reach. The risk index thus may help indicate which criterion could be the determinant of conflict and consequently inform decision-makers to focus on that criterion to prevent escalation.

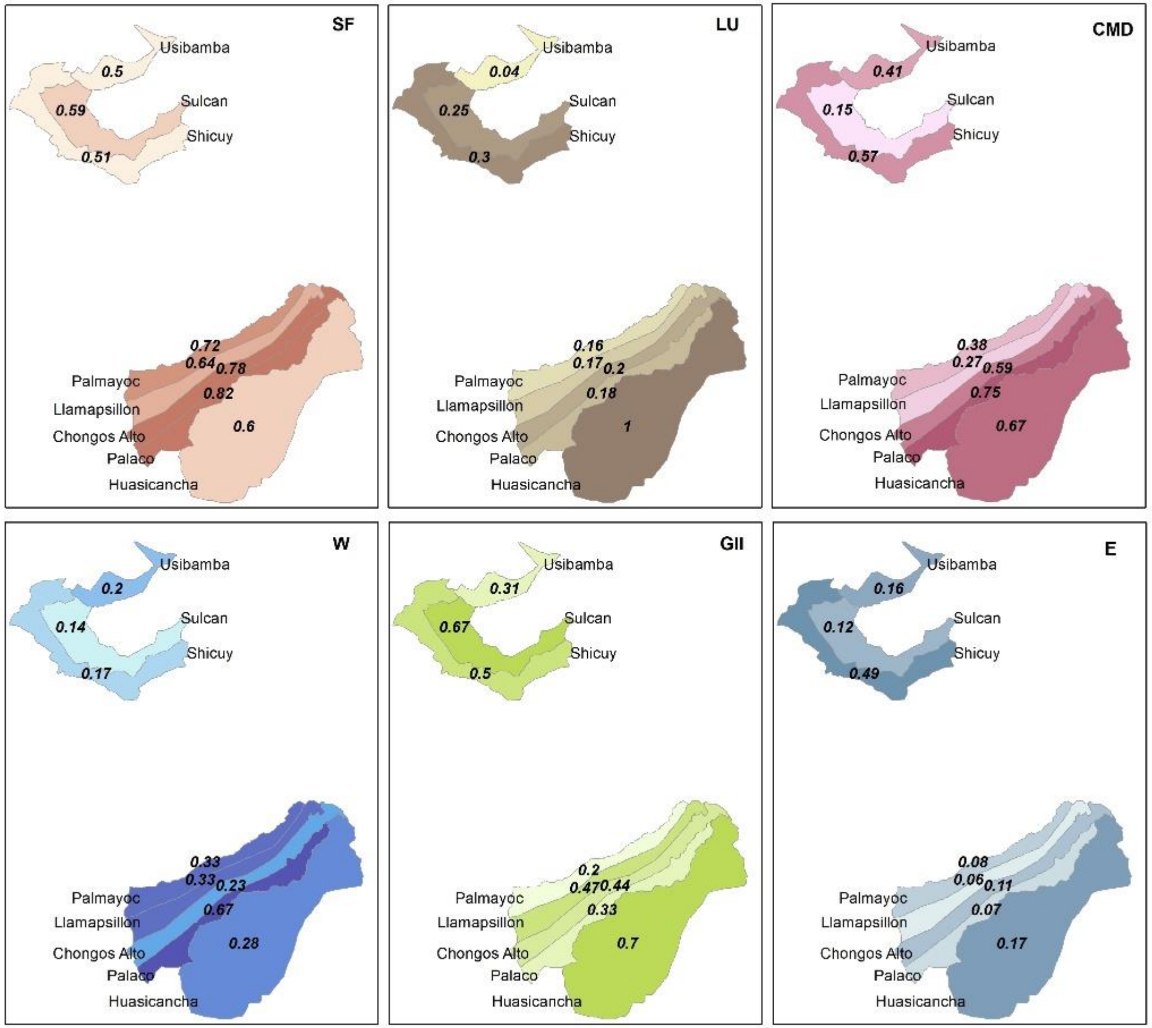


Figure 5-6. Overall values of criteria per community (Darkest color tone refers to the highest criterion value)

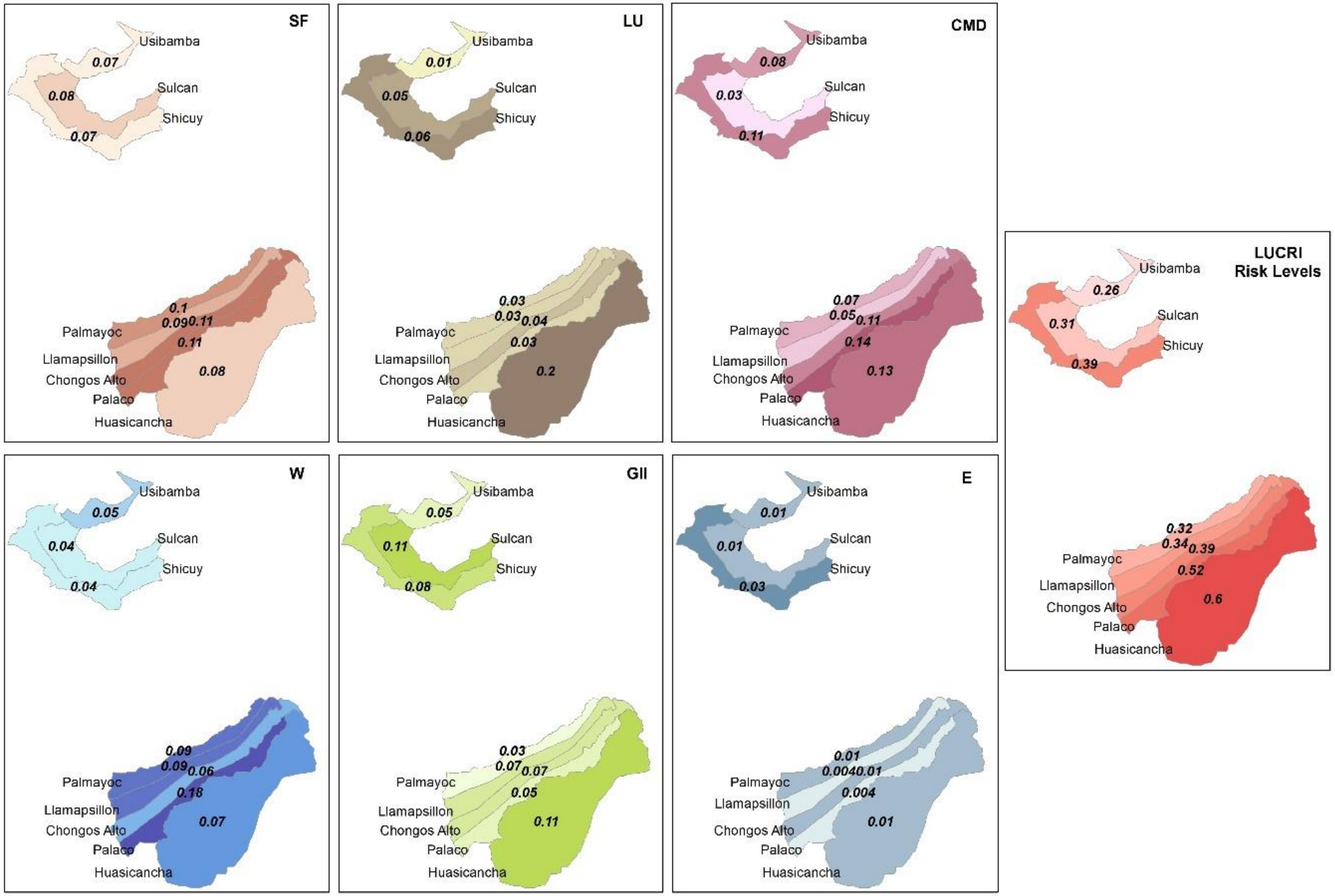


Figure 5-7. Criteria scores and risk levels per community applying land-use conflict risk index (LUCRI).

5.3.4. Validation of risk index

Automatic vs expert index

In this study, PCA was applied to create the risk index and determine its feasibility to provide indicator weighting. Most indicators that resulted from the survey of community respondents (Table 5-3) were entered in PCA. Based on Vyas and Kumaranayake (2006), the weights of each principal component were given by the covariance matrix, since the original data from the survey were standardized. In this study, the first component (PC1), which explains the largest possible amount of variation of the assessed data, resulted in 18.40%. The second component (PC2) only explained 15.23% of the data. Consequently, this indicates that PCA might only explain 33.63%. Since an overall assessment of data resulted in low inter-indicator correlation, PCA was then applied to each community to evaluate if the results or the expert-built risk index better captures the message behind the data. However, even PCA per community resulted in a lower explained variance than 30%. Since PCA did not adequately capture the data, local people and stakeholders assessed the indicator weights in the semi-structured survey. Community respondents weighted the indicators via a rating that used a scale ranging from 0 to 100% of importance (the highest rate).

Figure 5-8 shows the scores of PC1 from the automatic index and the resultant scores of the expert risk index. Only four of the eight communities have similar scores. The automatic index did not use the common community data (e.g., community-mining economic benefit), but the data of ACM of the communities. Thus, the scores between each index differ. Therefore, the expert risk index (i.e., LUCRI) was used to involve the added value of the common community data, increasing confidence in the indicators and criteria.

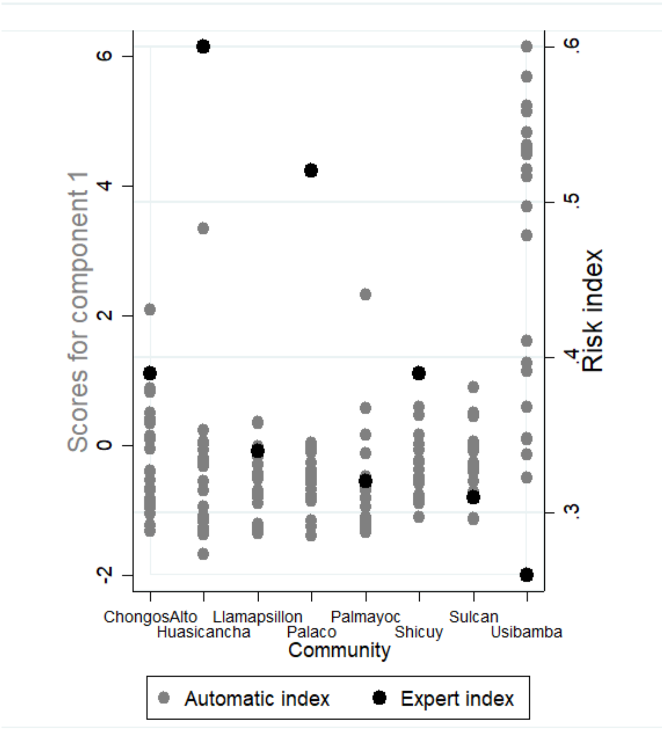


Figure 5-8. Comparison of automatic and expert indexes

Expert validation

The consensus reached by the experts of the Peruvian epistemic community regarding the LUCRI risk index results is shown in Table 5-8. This validation resulted in new indicators to be considered in the LUCRI. However, the complexity of the suggested indicators will require further and more in-depth studies.

Table 5-8. Summary of assessment related to design, results, and use of LUCRI

Design	Results	Use
Regarding Communities: • The economies of communities in the Central Andes are diversified and consequently, an in-depth study is required. • Each community is considered as unique, hindering the generalization of behavior in a conflict. Regarding indicators/criteria: • Beneficial to include other indicators such as:	• The reality of communities that inhabit the Central Andes. • The articulation of a variety of indicators, portraying the problem of the conflict risk broadly • Informs on the reality, although LUCRI still needs a greater depth in the social and political context.	• LUCRI could be highly useful for decision-making if the proposed modifications are considered in the design. • LUCRI could reach 80% utility, assuming 100% would be a perfect prediction of conflict. Some of the remaining 20% is affected by the rebuttal based on the commentaries in the design section. • LUCRI aims to reduce the conflict to a minimum, which

→ Personal interests (i.e., opportunists), the emergence of new interests and emotions in the community. → A political criterion in the national, regional and local levels, regarding leadership and conflict resolution. • Due to the inclusion of different types of indicators, clear definitions of the indicators avoid any inaccurate conclusions. Further studies • Could focus on improving this index by in-depth interviews to disclose the social reality within communities.	• LUCRI is an effort to show the conditions of the community agriculture and livestock in a possible conflict, however, it is impossible to portray completely this farming reality.	could be considered impossible because of the latency of conflicts. • LUCRI could be used in decision-making, although it needs to add the mentioned indicators (see design column) in order to provide a more complete view of the reality.

As the experts mentioned, a risk index of land-use conflict needs a deeper understanding of the social, economic and political context of communities. Consequently, this complexity cannot be captured by PCA. Experts explained that it is necessary to include the pressure on the community (e.g., social instigators) in the LUCRI. However, during the multi-criteria analysis, community authorities highlighted that it is not social instigators that cause a conflict. The total score for the weight of social instigators was only 6.32 in the rating (100 as max). Based on previous conflicts (e.g., Yanacocha and Conga in the northern Andes) and current conflicts (i.e., Las Bambas in the southern Andes), this research recommends that further studies should include this pressure on the communities. However, a longer study period might be required to determine presence, assessment, and inclusion in the risk index.

The inclusion of economic and political interests in the LUCRI could lead to a more subjective approach to the risk index. It is well known that this kind of interest can arise before a conflict escalates because of the possible manipulation of the community, the economic benefits from the mining company, and the visibility that is earned even before the conflict starts. Li (2017) highlighted how a regional mayor joined the anti-mining position during the Conga conflict, earning visibility in 2011, and then he became a presidential candidate in 2016. Another example of political interest was a priest who was part of the anti-mining group during the Conga conflict in 2011 and became a congressional representative for the period 2016-2021. In the case of economic interests, some respondents mentioned that previous community authorities were allegedly involved in receiving economic benefits from mining companies. As a result, the inclusion of the political and economic interests in the risk index could also require a longer period of study to manage subjectivity in the index.

5.3.5. What-if scenarios

The Huasicancha community covers the Huasicancha district and consequently most of the district's population belongs to the campesino community. 52% of the population comprises the labor force, and 47.45% of this labor force is involved only in farming activities (INEI, 2018b, 2018c). Created in 1930, the Huasicancha community performs subsistence agriculture (e.g., potato and other native crops), and has a long-term territorial conflict with Chongos Alto (Quispe-Zuniga et al., 2018). It is worth mentioning that Palaco, Llamapsillon, and Palmayoc also belong to the Chongos Alto district and recognize each other as one composite community. Since the Huacravilca project is located in the conflict area, the economic interests of these communities might influence possible conflict escalation.

Scenario 1: Strong environmental institutionalism

This scenario establishes that the decentralized state institution has the best working conditions, and that there are well-established environmental reforms and regulations, which could be provided effectively to the communities. The risk level was 0.17 (0.09 of CMD and 0.08 of GII) of 1.00. In this simulation, a reduction in risk score was obtained from 0.6 to 0.17. The change in score indicates that stronger environmental institutionalism could be used to reduce the number of land-use conflicts in Peru. Thus, decision-makers need to consider socio-economic conditions, quality of state institutions, and proper implementation of policies to reduce conflicts, as other studies have also suggested (Arellano-Yanguas, 2010).

Scenario 2: Strong environmental institutionalism and community economy

In this scenario, the risk index of Huasicancha was simulated under conditions of strong environmental institutionalism and a strong community economy. The risk score was 0.21 (0.09 for CMD, 0.08 for GII and 0.04 for E) of 1.00. In this simulation, an increase in the risk score was from 0.17 to 0.21. The increase could be related to the possibility of a high income from farming activities and a diversified economy combined with lower expenses. This generates a higher profit for the families of the community, making the community land and resources more attractive for campesinos.

Scenario 3: Environmental security

In this scenario, the risk level of Huasicancha was simulated considering environmental security. The risk score was 0.32 (0.12 for SF, 0.20 for LU and 0.00 for W) of 1.00. In this simulation, an increase in risk level was from 0.21 to 0.32. However, this still represents a low risk for the development of a land-use conflict. It is worth mentioning that if the water criterion changes, the risk level will increase considerably. This fact was also corroborated by previous studies (Bebbington and Williams, 2008; Perreault, 2014; Preciado Jerónimo and Álvarez Gutiérrez, 2016). Environmental security, appropriately applied, could be used to reduce or manage land-use conflicts.

Finally, in Figure 5-9 the scenarios are joined (Table 5-4 to Table 5-6) and the scores of the criteria values (Figure 5-6). The risk levels of these combinations also followed the trend of the scenarios. Thus, Huasicancha had the highest risk level in scenario 3 (i.e., 0.57), and lower risk levels in scenario 2 (i.e., 0.56) and scenario 1 (i.e., 0.53).

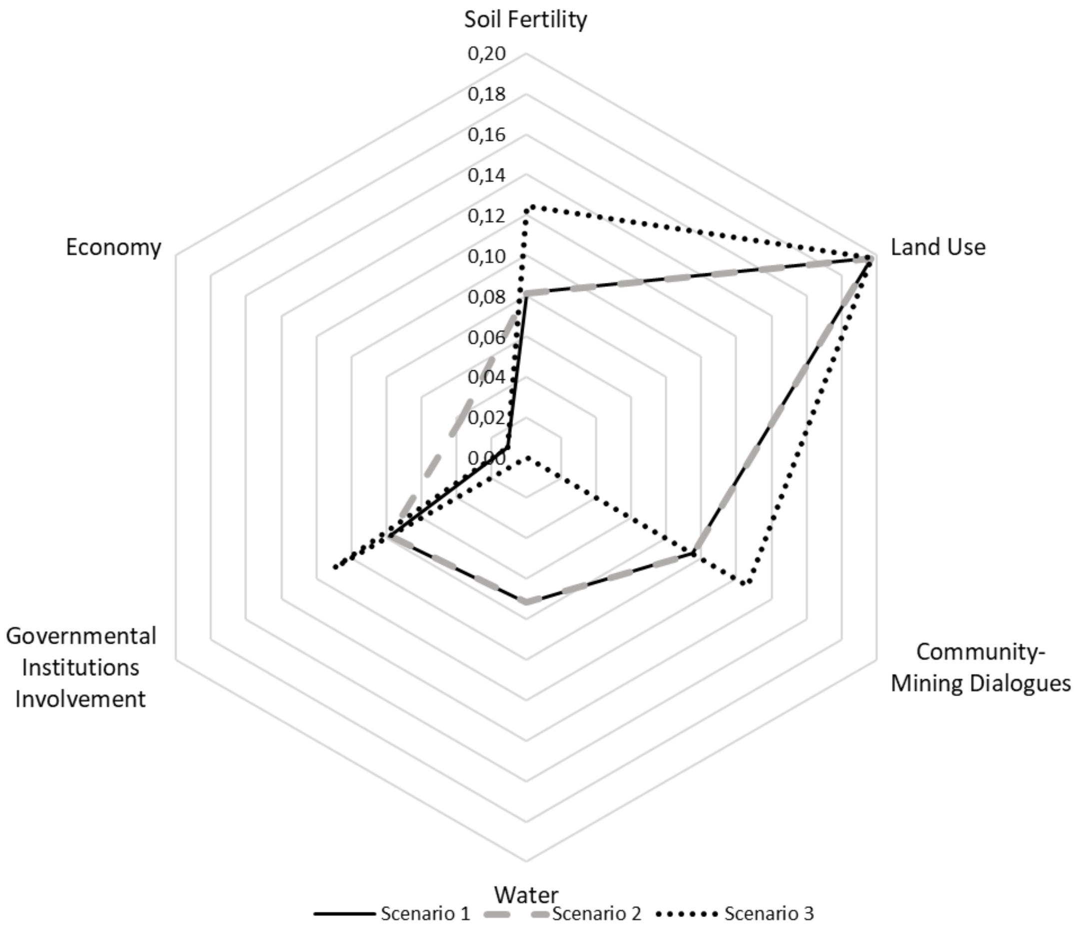


Figure 5-9. Comparison of three scenarios for Huasicancha community

5.4. Discussion

The Land-use Conflict Risk Index (LUCRI) first required establishing a theoretical framework to join the identified indicators and criteria that drive conflicts. These indicators include biophysical, social, economic and institutional components. To reflect reality as closely as possible, the LUCRI indicators and criteria relied on an assessment by local stakeholders to obtain values and weighting. The use of a variety of indicators better reflects the complexity of the land-use conflict. Thus, LUCRI aims to support decision-makers in order to manage or prevent land-use conflicts.

The simulation showed the possible changes in the risk level of a community under different contexts (see section 5.3.5). Mirroring previous studies (Arellano-Yanguas, 2011a, 2010; Salas Carreño, 2008), the LUCRI shows that strong environmental state institutions and well-established dialogues between communities and mining companies might reduce the level of conflict risk. To reach strong environmental institutionalism, the role of the government is crucial because the custodial rights of the resources are managed by the government on behalf of the citizens (Collier, 2010). In the case of Peru, the subsoil of Andean lands belongs to the Peruvian government, giving it the legal power to decide on its use (De Echave, 2018). However, due to the state capture by the private sector and allegations of corruption (Durand, 2016; Quiroz, 2013), the Peruvian government promotes mining over community livelihoods and local ecosystems (Bebbington and Bury, 2009; Gustafsson, 2018; Gustafsson and Scurrah, 2019). Khodeli (2009) claims that if state institutions exert good governance for resource exploitation, then economic growth and poverty reduction can be reached in the country. However, in this study, it was found an indication of water and soil pollution (Chapter 3), weak environmental institutionalism (Chapter 4) and the need to improve community livelihoods.

Land-use conflicts might be used to generate more inclusive politics, although the generated changes may not represent an actual improvement (Arellano-Yanguas, 2012). The analysis of land-use conflict reveals certain conditions that might determine the effectiveness of any decision-making tool such as this risk index. These conditions can be the influence of political and economic interests of certain groups, allegations of corruption, citizen trust, use of the appointed budget, and varying flows of information among stakeholders (Conde, 2017; Gudynas, 2017; Li, 2017; Ormachea Choque et al., 2014). Regarding these conditions, in Chapters 4 and Chapter 5, the conflict drivers within the indicators used to assess them via the risk index are revealed.

Mining operations have fueled existing internal conflicts in the communities, thus weakening the community as an institution. However, this situation can also integrate the remaining community to negotiate better conditions (Burneo de la Rocha and Chaparro Ortiz de Zevallos, 2010). The LUCRI was designed to work directly with campesino communities that are currently influenced by mining activities because these communities become negotiators with mining companies and at the same time the main actor to trigger conflicts (Bebbington, 2007; Burneo de la Rocha and Chaparro Ortiz de Zevallos, 2010; Diez Hurtado, 2001).

Despite the complexity of land-use conflicts, the risk index aims to support the decision-making process and include all stakeholders. However, the LUCRI as a decision-support tool cannot be used to make precise forecasts, but rather to provide a broad perspective of land-use conflicts based on local experience and target actions in areas where there is more room for conflict escalation or stakeholder engagement. Currently, land-use conflicts have called the attention of politicians, investors, civil society, research community, and society because of the consequences. During 2006 and 2018, there were 279 deaths and 4816 injuries due to mining-related conflicts (Ombudsman of Peru, 2018). Besides casualties, land-use conflicts affect the work of mining operations, the national and local economy, citizen trust in state institutions, and future mining investments (Basombrío et al., 2016; Conde, 2017).

The building of the LUCRI has some limitations. An index could be considered an overgeneralized method with subjective judgments from the participants (Lezzaik et al., 2018), regardless of being based on an exhaustive theoretical framework and integrating extensive data. Another weakness of this index is that there is only one temporal instance of data collection. Mitchell et al. (1995) indicated that the index requires consistent and historical data to establish greater validity. Therefore, it is recommended for decision-makers to collect data annually in order to monitor mining-influenced communities and prevent conflicts. However, this study was not suited for this purpose due to time and budget restrictions. Another limitation of this research regarding the risk index is that the study is based on eight communities and three mining companies in only one research area. A higher number of mining-affected communities and mining companies would bolster the indicators and criteria, including possibly the addition of new indicators. Lastly, not all stakeholders could participate (e.g., MINAM) in the criteria and indicator weighting exercise, despite efforts to gather all possible stakeholders. Nevertheless, the participation of the main stakeholders was successful (e.g., campesino communities, mining companies, MEM, ANA, and OEFA).

As part of the validation of the risk index, the automatic PCA method could not fully capture the complexity of the land-use conflict. This is because the integration of common community data is crucial and not supported by the statistical method. Despite the mentioned drawbacks, the LUCRI has joined biophysical, socio-economic, and institutional components through the theoretical framework, the applied mixed-methods approach, an additive aggregation model, and a weighted linear combination. It simulates the community most likely to suffer from an escalating land-use conflict. Although the index does not indicate when the conflict may occur, it helps to indicate both where it could take place and the potential root causes (e.g., indicators and criteria) of the conflict. The results indicate that the most frequent criteria with higher variable scores were water (W), soil fertility (SF) and community-mining dialogues (CMD).

In the case of the water criterion (W), only Palaco and Llamapsillon communities highlighted the importance of water as the main criterion for conflict escalation. The reason could be based on the constant constraint of water sources on their lands. Previous studies have shown that communities are not only affected by water quality but also by its extraction for mining activities, which affects livelihoods and ecosystems (Bebbington and Williams, 2008; Budds, 2014; Preciado Jerónimo, 2011). In the case of open-pit mines, groundwater level and water fluxes are affected, despite denials from the mining companies (Li, 2017; Preciado Jerónimo, 2011). In the case of the soil fertility (SF) criterion, Chongos Alto, Llamapsillon and Palmayoc reported this as the main criterion of land-use conflicts. This could be related to their high dependence on livestock grazing, potentially limited by pasture production and soil pollution. Community-mining dialogues with communities, e.g., Antamina mine, have highlighted the necessity of clear communication for the negotiations and the management of land-use conflicts. As was asserted by the consensus from Salas Carreño (2008), the lack of timely participation of expert groups to work with communities and clear communication are common mistakes that cause land-use conflicts. In addition, conflict prevention could be done through adequate protection by the government from extractivism, enhanced citizen trust to turn to this protection, and the willingness of all stakeholders to negotiate (Horowitz, 2009).

Due to the aforementioned drawbacks, the LUCRI was validated by experts, who highlighted that the challenge of the index is the complexity of conflicts due to social and political contexts. As mentioned in the previous sections, the risk index could not include these factors due to the necessity of a long-term study to analyze the emergence of new stakeholders and their interests during conflict escalation. Nevertheless, the LUCRI is the first risk index for land-use conflicts and has the potential to integrate more political and economic causal conflict factors in further studies.

5.5. Conclusions

This research demonstrates that mixed-methods can be integrated into a risk index to form a participatory and inclusive decision tool to improve the management and prevention of land-use conflicts. The risk index was calculated based on non-active conflict communities to analyze previous and typical community-mining relationships. In this way, the approach avoids the more likely emergence of new stakeholders in a context of active conflicts as well as ongoing personal interests. The results indicate which communities are more likely to experience land-use conflicts and which criterion is likely to be the driver. As the LUCRI is the first of its kind, it faces some limitations that could be tackled in further research.

The proposed theoretical framework provides the necessary interdisciplinary approach for the risk index. By using quantitative and qualitative data, the plausible results help to validate the suitability of the index. In addition, the testing methodologies of automatic and expert index methodologies indicate that the LUCRI provides the added value of the experience and knowledge of stakeholders, strengthening the estimation of the risk level for conflicts. The validation of the risk index highlights that it can be considered a tool for decision-makers if it is later improved with respect to political, economic and social aspects. The development of the LUCRI focused on indicators that limit subjectivity as much as possible to avoid biased speculation. However, the experts recommended including more social and political indicators to provide a more accurate result. Therefore, the research concerning the assessment and simulation of land-use conflicts is still a work in progress. With further studies, this risk index could become a very useful tool for supporting local and national managers to make more informed decisions and progress towards reducing land-use conflicts.

6. SUMMARY, RESEARCH SYNTHESIS, CONCLUSIONS AND RECOMMENDATIONS

6.1. Summary

Neoliberal policy, private investment, and high mining potential have promoted mining operations in the Andes, and this has affected campesino communities. The interactions between communities and mining companies have escalated into land-use conflicts. These conflicts arise due to the overlapping of mining concessions with community lands and headwaters, the misinformation around mining concessions and state institutions, mining impacts on water and soil, and the emergence of new stakeholders and personal interests. This research aimed to evaluate the environmental, social and institutional roots of land-use conflicts between the campesino community and mining companies in the Central Peruvian Andes. This integrated and interdisciplinary study was developed to measure key biophysical parameters, to assess the social and institutional aspects related to the management of water and soil, to integrate these components through a risk index, and to develop scenarios to analyze possible situations to prevent conflict escalation. At present, no studies exist that analyze land-use conflicts using an interdisciplinary approach and provide the integration of conflict drivers via a risk index.

6.2. Main research findings

6.2.1. Measurement of key biophysical parameters in campesino community farming-mining lands

Based on data from three mining projects and fourteen campesino communities, the results of this study assessed the impacts of heavy metal concentrations on water and soil that are influenced by open-pit mines **(RQ 3-1),** and assessed their effects on community livelihoods **(RQ 3-2)**. Mining impacts, in terms of heavy metal concentrations in soil and water, may continue to affect all communities, including those who have no agreements with mining companies.

During the dry season of 2016, the heavy metal concentrations were assessed in (i) 24 indicative water samples from streams crossing the mining exploitation operations and community lands, and (ii) 12 soil samples at farms 12 km and 24 km away from mines. The results indicate that the concentrations of cadmium and arsenic in water, and arsenic, cadmium, and chromium in soils exceeded the national environmental quality standards. In the water analysis, concentrations of arsenic and cadmium near mining operations also exceeded the national standards. In contrast with results from the Peruvian monitoring agency (i.e., OEFA) and those based solely on the local geochemistry (INGEMMET), the results highlight that there might be a relationship between the high concentrations of heavy metals and current mining operations due to the long-term mining exploitation of the region. However, further studies are needed in the area that can compare different sample points and seasons.

Land-cover classification and participatory mapping of land uses were applied to compare water and soil analyses. The results indicate that mining activities affect community livelihoods, and that the livelihoods of a nearby community that does not have an agreement can still be affected by mining activities in terms of livestock grazing and watering.

Further studies are recommended to explore the heavy metal concentrations and bioaccumulation in the research area. Finally, this interdisciplinary research has the potential to be used as a tool to assess both impacts on the environment and community livelihoods occurring at the intersection of mining and community interests.

6.2.2. Assessment of social and institutional aspects related to the management of water and soil in the campesino community farming-mining lands

This study investigated environmental institutionalism in mining-affected communities in the Central Peruvian Andes. The research carried out 273 surveys (semi-structured questionnaires) with campesino community members, 34 in-depth interviews and a social analysis workshop with key stakeholders. The analyses included statistics, social analysis, and content analysis.

Based on the research questions, the results indicate that communities lacked the necessary information about their rights and the mandates and responsibilities of environment-related state institutions **(RQ 4-1)**. In addition, the social analysis indicated that there is little or no involvement of the state institutions before conflict escalation **(RQ 4-2)**. While the state institutions had some influence and legitimacy, they often failed to cooperate, and their performance was undermined by the lack of human resources and equipment, creating a feeling of distrust within the communities. Because of the poor performance of environment-related state institutions, environmental degradation, particularly the pollution of vital water resources, was named as the most important reason for conflicts between campesino communities and mining companies.

Besides environmental institutionalism, this study characterized the livelihoods and challenges of the communities. Since campesino families continue to depend on agriculture and livestock rearing for their livelihoods, mining employment does not have any significant impact on the income of most communities **(RQ 4-3)**. Water access and pollution might not only affect domestic consumption but also irrigated agriculture and livestock production. For these reasons, water-related problems often result in conflicts. Thus, the breach of environmental and economic clauses of the agreements and the failure of decentralized state institutions to intervene with a coordinated effort often cause land-use conflicts to erupt **(RQ 4-4)**. The findings show that the establishment and actual implementation of a policy framework facilitating the negotiations between campesino communities and mining projects are urgently needed. This must be coupled with efforts to strengthen the outreach and performance of state institutions at local and regional levels. Only through these measures is there hope for the improvement of the livelihoods of campesino communities and their relationship with mining companies.

6.2.3. Integration and consolidation of biophysical, social and institutional components into a risk index

The developed risk index can support decision-making in community-mining relationships. This research demonstrates that multi-criteria analysis, semi-structured questionnaires, in-depth interviews, and GIS methods can be integrated into a risk index to form a participatory and inclusive decision tool to improve the management and prevention of land-use conflicts. The applied mixed-methods allowed obtaining interdisciplinary data that disclosed the socio-environmental factors that may set off a conflict in the region. The LUCRI index and its theoretical framework allowed the biophysical, socio-economic, and institutional components to be integrated in the risk index **(RQ 5-1).** The LUCRI reflects reality by using in-situ collected data from stakeholders and mining-influenced communities. The index is also based on non-active conflict communities analyzing the previous and typical community-mining relations thereby avoiding the potential emergence of new stakeholders (i.e., social instigators) and high influence of personal interests.

The proposed theoretical framework incorporates stakeholder perspectives using indicators and criteria, the integration of which is recognized as the most challenging aspect of building an index. Long-term data and a socio-political approach to determine the criteria and indicators were perceived by experts as the main challenges for the risk index. Due to the challenge of integration, two validations of the index were conducted. First, the comparison of the automatic index (using PCA) with the expert-based index (LUCRI) demonstrated the superior methodology. The results of this research show that an expert-based index is recommended due to the complexity of conflicts. The comparison of both indexes indicates that the LUCRI provided the added value of experience and knowledge of stakeholders, thus providing a stronger estimation of the risk level for conflicts.

Secondly, the validation by experts indicated that the LUCRI can be considered a tool for decision-makers. With the inclusion of an in-depth analysis of the political and social aspects of the local and national context, the LUCRI could become very useful in this sense.

6.2.4. Development of scenarios to simulate the conflicts between campesino communities and mining companies

The LUCRI indicates how likely a community is to become engaged in a conflict and which criterion is the driver for this likelihood. In the research area, the risk level of the case study communities was assessed with the LUCRI, and Huasicancha community was seen to have the highest score (0.6/1.0). Next, the weights of the Huasicancha indicators were used to simulate three different scenarios generated based on the recommendations of the epistemic community **(RQ 5-2)**. The simulation of the three scenarios aimed to show

how the risk level of the community with the highest risk could be reduced if environmental institutionalism, community economy, and environmental security were strengthened.

The LUCRI as a decision-support tool cannot be used to make precise forecasts but rather to provide a broad view of possible land-use conflicts based on local experience and target indicators. The scenarios reveal three main take-home messages. First, decision-makers need to consider the previous and current socio-economic conditions, the quality of state institutions, and the proper implementation of policies for better conflict management. Second, a high family livestock-dependent income and the diversification of the economy in the community make its lands more attractive for its inhabitants, generating a high probability of mining resistance and conflict escalation. Third, an appropriately applied increased environmental security could be used to reduce the number of land-use conflicts in Peru.

Although the LUCRI aimed to reflect and simulate different scenarios, it still needs further studies on the inclusion of political and social indicators. Thus, further inter- and transdisciplinary research is required to improve the index. For instance, it was not considered adding political aspects since the index is only applied for communities in a closed area, whereas the national political aspects tend to be the same for the whole country. Despite the uniqueness of each community, social aspects also showed similarities because of the shared history in the research area. However, it is recommended to expand the creation of this kind of risk index to other communities in Peru or elsewhere in Latin America to improve its prediction quality and ultimately give a truer view of land-use conflicts.

6.3. Conclusions and recommendations

The results of this interdisciplinary research indicate the influence of mining operations on community lands at the environmental, social and institutional levels. As there was no active conflict in the study area, the observed situation was taken as a good reflection of the status quo of the implementation of environmental reforms at the regional level.

The assessment of the biophysical factors allowed an analysis of the environmental root causes of land-use conflicts, and water and soil pollution by mining operations are regarded as the main roots of conflict escalation. The identification of this conflict driver was based on the geological, the historical and the newly assessed heavy metal concentrations in water and soil on community lands. Although this research was designed to only indicate heavy metal concentrations, it provides a baseline for future studies since it was the first of its kind in the research area. However, not only should environmental root causes be seen as the main conflict drivers but also relevant economic factors. Furthermore, communities sometimes see the mining company as an opportunity for acquiring economic benefits. The socio-economic conflict driver was thus analyzed once the available agreements of communities and mining companies were disclosed. The community livelihoods were then analyzed, where it could be seen that there is still a strong livestock dependence.

On the other hand, as in the case with the socio-economic and environmental drivers, understanding environmental institutionalism has become a key to better assessing the likelihood of conflicts, despite environmental reforms. In this study, all state institutions were analyzed that can interact with communities and companies before or during a land-use conflict. The results of the study show that environmental institutionalism is weak. However, it must be understood that this is in constant flux and strengthening could improve from one government to another.

The building and validation of the risk index were key to interpreting different scenarios. Data collection from community members and stakeholders and the validation by experts formed the overarching research steps involving the index. Both processes allow identifying the challenges of building a risk index that could be useful for decision-making. With further studies, the index could become a very useful tool for supporting local and national managers in making informed decisions and progress towards conflict prevention.

Regarding the limitations, it was found that the time allocated for fieldwork was not adequate for an in-depth analysis in each community. While other studies focused their research on one or three communities, this study analyzed 14 communities, which reduced the time spent in each. Time constraint was another challenge for obtaining a more in-depth analysis of the social composition and work of the communities. Another limitation was water/soil sampling due to the location of water origins in mining areas and the forbidden areas due to the territorial conflict between Huasicancha and Chongos Alto. Furthermore, the budget for water/soil sampling was capped due to the high price of water/soil analysis in an accredited laboratory, reducing the number of analyzed samples. Another difficulty was gathering all the representatives of state institutions and communities due to their institutional budget or commitments (e.g., community elections). Lastly, the complexity of conflicts can be seen as a limitation since it is not possible to include all conflict-triggering indicators.

Further studies need to consider a longer period of research per community in order to better describe their social contexts. Studies aimed at better capturing the environmental drivers should consider increasing the number of soil/water samples and the repetitions of sampling in order to identify heavy metal concentrations during the operation of the mining concentrator plant and rainy periods. In addition, an in-depth analysis of the social and political context in the risk index would be useful in order to improve it as a decision support tool.

Finally, this research contributes to the understanding of land-use conflicts from a local to a national perspective in Peru. As a country with a strong policy for extractivism, land-use conflicts require more structured, interdisciplinary and realistic approaches to research that can promote strong environmental institutionalism and better relationships with campesino communities.

7. REFERENCES

Abanto Kcomt, C., 2007. Segundo informe sobre evolución de la calidad de aire en La Oroya. Lima.

Abdi, H., Williams, L.J., 2010. Principal component analysis. WIREs Comput. Stat. 2, 433–459. https://doi.org/10.1002/wics.101

Adam, A.., Owen, J.R., Kemp, D., 2015. Households, livelihoods and mining-induced displacement and resettlement. Extr. Ind. Soc. 2, 581–589. https://doi.org/10.1016/j.exis.2015.05.002

Addiscott, T., Smith, J., Bradbury, N., 1995. Critical Evaluation of Models and Their Parameters. J. Environ. Qual. 24, 803–807. https://doi.org/10.2134/jeq1995.00472425002400050002x

Ahlers, R., 2010. Fixing and Nixing: The Politics of Water Privatization. Rev. Radic. Polit. Econ. 42, 213–230. https://doi.org/10.1177/0486613410368497

Albuquerque, M.T.D., Gerassis, S., Sierra, C., Taboada, J., Martín, J.E., Antunes, I.M.H.R., Gallego, J.R., 2017. Developing a new Bayesian Risk Index for risk evaluation of soil contamination. Sci. Total Environ. 603–604, 167–177. https://doi.org/10.1016/j.scitotenv.2017.06.068

América Economía, 2018. Perú iniciará este año nueve proyectos mineros por más de US$11.500M | AméricaEconomía | AméricaEconomía [WWW Document]. URL https://www.americaeconomia.com/negocios-industrias/peru-iniciara-este-ano-nueve-proyectos-mineros-por-mas-de-us11500m (accessed 7.25.18).

Andaluz Westreicher, C., 2011. La institucionalidad ambiental que necesitamos. Advocatus 25, 83–93. https://doi.org/10.26439/advocatus2011.n025.385

Arce, M., 2014. Resource Extraction and Protest in Peru, 1st ed. ed, Resource Extraction and Protest in Peru. University of Pittsburgh Press, Pittsburgh. https://doi.org/10.2307/j.ctt9qh8z9

Arellano-Yanguas, J., 2016. Mining policies in Humala's Peru. A patchwork of improvised nationalism and corporate interests, in: Haslam, P.A., Heidrich, P. (Eds.), The Political Economy of Natural Resources and Development: From Neoliberalism to Resource Nationalism. Routledge, New York, pp. 174–190.

Arellano-Yanguas, J., 2012. Mining and conflict in Peru: sowing the minerals, reaping a storm, in: Bebbington, A. (Ed.), Economic Development and Extractive Industry: Evidence from South America. Routledge, New York, pp. 89–111.

Arellano-Yanguas, J., 2011a. ¿Minería sin fronteras? Conflicto y desarrollo en regiones mineras del Perú, 1st ed. ed. Instituto de Estudios Peruanos; Pontificia Universidad Católica del Perú; Universidad Antonio Ruiz de Montoya, Lima.

Arellano-Yanguas, J., 2011b. Aggravating the Resource Curse: Decentralisation, Mining and Conflict in Peru. J. Dev. Stud. 47, 617–638. https://doi.org/10.1080/00220381003706478

Arellano-Yanguas, J., 2010. Local politics, conflict and development in Peruvian mining regions. University of Sussex.

Arellano-Yanguas, J., 2008. A Thoroughly Modern Resource Curse? The New Natural Resource Policy Agenda and the Mining Revival in Peru (No. 300), IDS Working Paper, IDS WORKING PAPER. Brighton.

Arroyo, A., Boelens, R., 2013. Aguas Robadas Despojo hídrico y movilización, 1st ed. ed.

Instituto de Estudios Peruanos—IEP, Quito.
Ashraf, M.A., Maah, M.J., Yusoff, I., 2011. Heavy metals accumulation in plants growing in ex tin mining catchment. Int. J. Environ. Sci. Technol. 8, 401–416. https://doi.org/10.1007/BF03326227
Autoridad Nacional del Agua—ANA, 2016a. Protocolo Nacional para el Monitoreo de la Calidad de los Recursos Hídricos Superficiales. Lima, Perú.
Autoridad Nacional del Agua—ANA, 2016b. Evaluación de Recursos Hídricos de doce cuencas hidrográficas del Perú. Lima, Perú.
Autoridad Nacional del Agua—ANA, 2015. Evaluación de recursos hídricos en la cuenca de Mantaro, Autoridad Nacional del Agua. Autoridad Nacional del Agua, Lima.
Autoridad Nacional del Agua—ANA, 2010. Reglamento de procedimientos administrativos para el otorgamiento de derechos de uso de agua.
Avci, D., Fernández-Salvador, C., 2016. Territorial dynamics and local resistance: Two mining conflicts in Ecuador compared. Extr. Ind. Soc. 3, 912–921. https://doi.org/10.1016/j.exis.2016.10.007
Aydin, C.I., Ozkaynak, B., Rodríguez-Labajos, B., Yenilmez, T., 2017. Network effects in environmental justice struggles: An investigation of conflicts between mining companies and civil society organizations from a network perspective. PLoS One 12, 20. https://doi.org/10.1371/journal.pone.0180494
Ayers, R.S., Westcot, D.W., 1985. Water quality for agriculture. Food and Agriculture Organization of the United Nations.
Baker, A., 2007. Occam's Razor in science: a case study from biogeography. Biol. Philos. 22, 193–215. https://doi.org/10.1007/s10539-006-9027-9
Ballard, C., Banks, G., 2003. Resource Wars: The Anthropology of Mining. Annu. Rev. Anthropol. 32, 287–313. https://doi.org/10.1146/annurev.anthro.32.061002.093116
Banco Central de Reserva del Perú—BCRP, 2018. Balanza comercial [WWW Document]. URL https://estadisticas.bcrp.gob.pe/estadisticas/series/mensuales/balanza-comercial (accessed 11.6.18).
Bannon, I., Collier, P., 2003. Natural Resources and Violent Conflict: Options and Actions, 1st ed. ed, The World Bank. The World Bank, Washington, DC. https://doi.org/10.1596/0-8213-5503-1
Barandiarán Gómez, A., 2008. Análisis de la Institucionalidad Ambiental en los Decretos Legislativos de la Implementación del TLC Perú-EE.UU., 1st ed. ed. Red Peruana por una Globalización con Equidad—RedGE, Lima.
Barradas, S., 2013. Corihuarmi mine, Peru [WWW Document]. Min. Wkly. URL http://www.miningweekly.com/article/corihuarmi-mine-peru-2013-08-30 (accessed 8.30.17).
Bartl, K., Mayer, A.C., Gómez, C.A., Muñoz, E., Hess, H.D., Holmann, F., 2009. Economic evaluation of current and alternative dual-purpose cattle systems for smallholder farms in the central Peruvian highlands. Agric. Syst. 101, 152–161. https://doi.org/10.1016/j.agsy.2009.05.003
Barton, B.D., 2005. A Global/Local Approach to Conflict Resolution in the Mining Sector: The Case of the Tintaya Dialogue Table. Tufts University, Boston, MA.
Basombrío, C., Rospigliosi, F., Valdés, R., 2016. Conflictos sociales en el Perú 2008-2015:

Un análisis a profundidad a partir de la evidencia empírica, 1st ed. ed. CAPITAL HUMANO Y SOCIAL S.A; Fundación Konrad Adenauer (KAS) en, Lima.

Bax, V., Francesconi, W., Delgado, A., 2019. Land-use conflicts between biodiversity conservation and extractive industries in the Peruvian Andes. J. Environ. Manage. 232, 1028–1036. https://doi.org/10.1016/j.jenvman.2018.12.016

Bebbington, A., 2012. Social conflict, economic development and the extractive industry: Evidence from South America, 1st ed. ed. Routledge, London.

Bebbington, A., 2009. The new extraction: Rewriting the political ecology of the Andes? NACLA Rep. Am. 42, 12–20. https://doi.org/10.1080/10714839.2009.11722221

Bebbington, A., 2007. Minería, movimientos sociales y respuestas campesinas : una ecología política de transformaciones territoriales, 1st ed. ed. Instituto de Estudios Peruanos—IEP, Lima.

Bebbington, A., 2001. Globalized Andes? Livelihoods, Landscapes and Development. Ecumene 8, 414–436. https://doi.org/10.1177/096746080100800403

Bebbington, A., Abdulai, A.-G., Humphreys Bebbington, D., Hinfelaar, M., Sanborn, C.A., 2018a. Governing Extractive Industries: Politics, histories, ideas, 1st ed. ed. Oxford University Press, Oxford.

Bebbington, A., Bury, J., 2010. Minería , instituciones y sostenibilidad: desencuentros y desafíos. Antropología 53–84.

Bebbington, A., Bury, J., 2009. Institutional challenges for mining and sustainability in Peru. Proc. Natl. Acad. Sci. U. S. A. 106, 17296–301. https://doi.org/10.1073/pnas.0906057106

Bebbington, A., Humphreys Bebbington, D., 2011. An Andean Avatar: Post-neoliberal and neoliberal strategies for securing the unobtainable. New Polit. Econ. 16, 131–145. https://doi.org/10.1080/13563461003789803

Bebbington, A., Humphreys Bebbington, D., 2009. Actores y ambientalismos: conflictos socio-ambientales en Perú. Íconos 117–128.

Bebbington, A., Humphreys Bebbington, D., Bury, J., Lingan, J., Muñoz, J.P., Scurrah, M., 2008. Mining and Social Movements: Struggles Over Livelihood and Rural Territorial Development in the Andes. World Dev. 36, 2888–2905. https://doi.org/10.1016/j.worlddev.2007.11.016

Bebbington, A., Humphreys Bebbington, D., Sauls, L.A., Rogan, J., Agrawal, S., Gamboa, C., Imhof, A., Johnson, K., Rosa, H., Royo, A., Toumbourou, T., Verdum, R., 2018b. Resource extraction and infrastructure threaten forest cover and community rights. Proc. Natl. Acad. Sci. 115, 13164–13173. https://doi.org/10.1073/pnas.1812505115

Bebbington, A., Scurrah, M., Chaparro, A., 2013. Las industrias extractivas y los procesos de cambio en la institucionalidad ambiental (No. 6), Proyecto Industrias Extractivas , Conflictos Sociales e Innovaciones Institucionales en la Región Andino-Amazónica.

Bebbington, A., Williams, M., 2008. Water and mining conflicts in Peru. Mt. Res. Dev. 28, 190–195. https://doi.org/10.1659/mrd.1039.

Bech, J., Duran, P., Roca, N., Poma, W., Sánchez, I., Roca-Pérez, L., Boluda, R., Barceló, J., Poschenrieder, C., 2012. Accumulation of Pb and Zn in Bidens triplinervia and Senecio sp. spontaneous species from mine spoils in Peru and their potential use in phytoremediation. J. Geochemical Explor. 123, 109–113.

https://doi.org/10.1016/j.gexplo.2012.06.021

Becker, A., Bugmann, H., 2001. Global change and mountain regions : the Mountain Research Initiative. IGBP Rep. ; 49 86.

Bianchini, F., Pascali, G., Campo, A., Orecchio, S., Bonsignore, R., Blandino, P., Pietrini, P., 2015. Elemental contamination of an open-pit mining area in the Peruvian Andes. Int. J. Environ. Sci. Technol. 12, 1065–1074. https://doi.org/10.1007/s13762-013-0493-8

Blache Snow Consulting, 2012. Primera Modificación de la Declaración de Impacto Ambiental: Proyecto de Exploración Huacravilca. Lima, Perú.

Blacksmith Institute, 2007. Peru—La Oroya Lead Pollution [WWW Document]. Pure Earth. URL https://www.pureearth.org/project/la-oroya-lead-pollution/ (accessed 2.5.19).

Bloomberg, n.d. Azulcocha Mining S.A.: Private Company Information - Bloomberg [WWW Document]. URL https://www.bloomberg.com/research/stocks/private/snapshot.asp?privcapId=104768226 (accessed 8.30.17).

Bockstaller, C., Girardin, P., 2003. How to validate environmental indicators. Agric. Syst. 76, 639–653. https://doi.org/10.1016/S0308-521X(02)00053-7

Boelens, R., Getches, D., Guevara-Gil, A., 2010. Out of the Mainstream: Water rights, politics and identity, 1st ed. ed. Earthscan, Washington, DC.

Bowman, I., 1980. Los Andes del sur del Perú, 2nd ed. ed. Editorial Universo, Lima.

Braaten, R.H., 2014. Land Rights and Community Cooperation Public Goods Experiments from Peru. World Dev. 61, 127–141. https://doi.org/10.1016/j.worlddev.2014.04.002

Brain, K.A., 2017. The impacts of mining on livelihoods in the Andes: A critical overview. Extr. Ind. Soc. 4, 9. https://doi.org/10.1016/j.exis.2017.03.001

Brennan, J., Martin, E., 2012. Spatial proximity is more than just a distance measure. Int. J. Hum. Comput. Stud. 70, 88–106. https://doi.org/10.1016/j.ijhcs.2011.08.006

Brown, G., Raymond, C.M., 2014. Methods for identifying land use conflict potential using participatory mapping. Landsc. Urban Plan. 122, 196–208. https://doi.org/10.1016/j.landurbplan.2013.11.007

Brush, S.B., 1976. Man's use of an andean ecosystem. Hum. Ecol. 4, 147–165. https://doi.org/doi.org/10.1007/BF01531218

Budds, J., 2014. Acceso de agua y justicia hídrica: un análisis de las relaciones de poder entre Southern Copper Corporation y comunidades rurales en Moquegua y Tacna, Perú., in: Perreault, T. (Ed.), Minería, Agua y Justicia Social En Los Andes: Experiencias Comparativas de Perú y Bolivia. Justicia Hídrica, Centro Bartolomé de Las Casas, Lima, pp. 41–58.

Burneo de la Rocha, M.L., Chaparro Ortiz de Zevallos, A., 2010. Poder, comunidades campesinas e industria minera: el gobierno comunal y el acceso a los recursos en el caso de Michiquillay. Anthropologica XXVIII, 85–110.

Bury, J., 2005. Mining mountains: Neoliberalism, land tenure, livelihoods, and the new Peruvian mining industry in Cajamarca. Environ. Plan. A 37, 221–239. https://doi.org/10.1068/a371

Bury, J., 2004. Livelihoods in Transition: Transnational Gold Mining Operations and Local Change in Cajamarca, Peru. Geogr. J. 170, 78–91.

Bury, J., 2002. Livelihoods, Mining and Peasant Protests in the Peruvian Andes. J. Lat. Am. Geogr. 1, 1–19. https://doi.org/10.1353/lag.2007.0018

Bury, J., Mark, B.G., Carey, M., Young, K.R., McKenzie, J.M., Baraer, M., French, A., Polk, M.H., 2013. New Geographies of Water and Climate Change in Peru: Coupled Natural and Social Transformations in the Santa River Watershed. Ann. Assoc. Am. Geogr. 103, 363–374. https://doi.org/10.1080/00045608.2013.754665

Bustamante Becerra, J.A., 2007. Grazing Intensity, Plant Diversity, and Rangeland Conditions in the Southeastern Andes of Peru (Palccoyo, Cusco), in: Spehn, E.M., Liberman, M., Körner, C. (Eds.), Land Use Change and Mountain Biodiversity. Taylor & Francis Group, Boca Raton, Florida, pp. 153–266. https://doi.org/10.1659/mrd.mm012

Buytaert, W., De Bièvre, B., 2012. Water for cities: The impact of climate change and demographic growth in the tropical Andes. Water Resour. Res. 48, 13. https://doi.org/10.1029/2011WR011755

Caballero Martín, V., 1981. Imperialismo y Campesinado, 1st ed. ed. Instituto de Estudios Andinos, Lima.

Calderón, F., 2012a. La protesta social en América Latina, 1st ed. ed. Siglo Veintiuno Editores, Buenos Aires.

Calderón, F., 2012b. Diez tesis sobre el conflicto social en América Latina. Rev. la CEPAL 7–30.

Campbell, D.J., Gichohi, H., Mwangi, A., Chege, L., 2000. Land use conflict in Kajiado District, Kenya. Land use policy 17, 337–348. https://doi.org/10.1016/S0264-8377(00)00038-7

Carrillo Hoyos, S.V., 2011. Comunidades y Minería: La Comunicación en el Conflicto. Pontif. Univ. Católica del Perú. Pontifical Catholic University of Peru.

Castillo, M., Castillo, L., Monge, C., Bustamante, M., 2004. Las comunidades campesinas en el siglo XXI: situación actual y cambios normativos, 1st ed. ed. Grupo ALLPA - Comunidades y Desarrollo, Lima.

Cathain, A.O., Murphy, E., Nicholl, J., 2008. Multidisciplinary, Interdisciplinary, or Dysfunctional? Team Working in Mixed-Methods Research. Qual. Health Res. 18, 1574–1585. https://doi.org/doi.org/10.1177/1049732308325535

Caycho-Ronco, J., Arias-Mesia, A., Oswald, A., Esprella-Elias, R., Rivera, A., Yumisaca, F., Andrade-Piedra, J., 2009. Tecnologías sostenibles y su uso en la producción de papa en la región altoandina. Rev. Latinoam. la Papa 15, 20–37.

Centro Nacional de Estimación Prevención y Reducción del Riesgo de Desastres—CENEPRED, 2018. Escenarios de Riesgo por Heladas y Friajes [WWW Document]. CENEPRED. URL https://cenepred.gob.pe/web/6788-2/ (accessed 12.14.18).

Chambers, R., 1995. Poverty and livelihoods: Whose reality counts? Environ. Urban. 7, 173–204. https://doi.org/10.1177/095624789500700106

Chevalier, J.M., Buckles, D., 2013. Participatory action research: Theory and methods for engaged inquiry, 1st ed. ed. Routledge, Abingdon.

Choo, E.U., Wedley, W.C., 2008. Comparing Fundamentals of Additive and Multiplicative Aggregation in Ratio Scale Multi-Criteria Decision Making. Open Oper. Res. J. 2, 1–7. https://doi.org/10.2174/1874243200802010001

Clark, A., Holland, C., Katz, J., Peace, S., 2009. Learning to see: lessons from a participatory observation research project in public spaces. Int. J. Soc. Res. Methodol. 12, 345–360. https://doi.org/10.1080/13645570802268587

Clean Technology S.A.C., 2007. Estudio de Impacto Ambiental Unidad Económica Administrativa Azulcocha Tomo I. Lima.

Clifford, N.J., French, S., Valentine, G., 2016. Key methods in geography, 2nd ed. ed. SAGE Publications Ltd, London.

Collier, P., 2010. The Political Economy of Natural Resources. Soc. Res. (New. York). 77, 1105–1132.

Comisión de la Verdad y Reconciliación—CVR, 2003. Informe Final [WWW Document]. URL http://www.cverdad.org.pe/ifinal/index.php (accessed 8.7.17).

Comisión Técnica Regional Junín ZEE—CTRJ, 2015a. Memoria Descriptiva del Estudio Geológico del departamento de Junín a escala 1:100 000. Huancayo.

Comisión Técnica Regional Junín ZEE—CTRJ, 2015b. Memoria Descriptiva del Submodelo de Valor Histórico Cultural del departamento de Junín a escala 1:100 000. Huancayo.

Comisión Técnica Regional Junín ZEE—CTRJ, 2015c. Memoria Descriptiva del Submodelo de Aptitud Urbano Industrial del departamento de Junín a escala 1:100 000. Huancayo.

Comisión Técnica Regional Junín ZEE—CTRJ, 2015d. Memoria Descriptiva del Estudio Cultural del departamento de Junín a escala 1:100 000. Huancayo.

Comisión Técnica Regional Junín ZEE—CTRJ, 2015e. Memoria Descriptiva del Estudio Económico del departamento de Junín a escala 1:100 000. Huancayo.

Conde, M., 2017. Resistance to mining: A review. Ecol. Econ. 132, 80–90. https://doi.org/10.1016/j.ecolecon.2016.08.025

Conde, M., Le Billon, P., 2017. Why do some communities resist mining projects while others do not? Extr. Ind. Soc. 4, 681–697. https://doi.org/10.1016/j.exis.2017.04.009

Congreso de la República del Perú—CRP, 2015. Law Nº 30327—Ley de Promoción de las Inversiones para el Crecimiento Económico y el Desarrollo Sostenible.

Congreso de la República del Perú—CRP, 2011a. Law 29789-Ley que crea el impuesto especial a la minería.

Congreso de la República del Perú—CRP, 2011b. Law N° 29785—Ley del derecho a la consulta previa a los pueblos indígenas u originarios, reconocido en el Convenio 169 de la Organización Internacional del Trabajo (OIT).

Congreso de la República del Perú—CRP, 2011c. Law N° 29790-Ley que establece el marco legal del gravamen especial a la minería.

Congreso de la República del Perú—CRP, 2009. Law N° 29338, Ley de Recursos Hídricos. El Peru.

Congreso de la República del Perú—CRP, 2004a. Law N° 28258-Ley de regalía minera.

Congreso de la República del Perú—CRP, 2004b. Law N° 28322—Ley que modifica artículos de la Ley N° 27506.

Congreso de la República del Perú—CRP, 2002. Law N° 27783—Ley de Bases de la descentralización.

Congreso de la República del Perú—CRP, 2001. Law N° 27506—Ley del Canon.

Congreso de la República del Perú—CRP, 1995. Law N° 26505 Ley de la inversión privada

en el desarrollo de las actividades económicas en las tierras del territorio nacional y de las comunidades campesinas. El Peru.
Congreso de la República del Perú—CRP, 1991. Decreto Legislativo—DL N° 662 Otorgan un régimen de estabilidad jurídica a las inversiones extranjeras mediante el reconocimiento de ciertas garantías.
Congreso de la República del Perú—CRP, 1987. Law N° 24656—Ley general de comunidades campesinas. El Peru.
Cooke, C.A., Abbott, M.B., 2008. A paleolimnological perspective on industrial-era metal pollution in the central Andes, Peru. Sci. Total Environ. 393, 262–272. https://doi.org/10.1016/j.scitotenv.2007.12.034
Cotler, J., 2016. Clases, estado y nación en el Perú, 3rd ed. ed. Instituto de Estudios Peruanos, Lima, Perú.
Creswell, J.W., Creswell, J.D., 2017. Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, 5th ed. ed. SAGE Publications, London.
Cuba, N., Bebbington, A., Rogan, J., Millones, M., 2014. Extractive industries, livelihoods and natural resource competition: Mapping overlapping claims in Peru and Ghana. Appl. Geogr. 54, 250–261. https://doi.org/10.1016/j.apgeog.2014.05.003
Dale, C., Gastellu, J.-M., Valer, L., 1990. Familia, comunidad campesina y unidad de producción en el Perú, in: Agricultura Andina: Unidad y Sistema de Producción (Diálogo Entre Cc. Agrarias y Cc. Sociales). Ed. Horizonte, pp. 440–456.
Damonte, G., 2012. Dinámicas rentistas: transformaciones institucionales en contextos de proyectos de gran minería, in: Escobal, J., Ponce, C., Glave, M., Damonte, G. (Eds.), Desarrollo Rural y Recursos Naturales. Grupo de Análisis para el Desarrollo—GRADE, Lima, pp. 95–122.
Damonte, G., 2011. Minería y Política : la recreación de luchas campesinas en dos comunidades andinas, in: Bebbington, A. (Ed.), Minería, Movimientos Sociales y Respuestas Campesinas: Una Ecología Política de Transformaciones Territoriales. Instituto de Estudios Peruanos—IEP, Centro Peruano de estudios sociales—CEPES, Lima, pp. 147–192.
Damonte, G., Glave, M., 2012. Rent Distribution and Extractive Industry Conflicts: The Latin American Approach. ELLA Econ. Dev. Extr. Ind. Confl. Manag. 7.
Damonte, G., Peralta, J.A., 2015. Extracción y naturaleza: agricultura y minería a gran escala, in: Damonte, G., Peralta, J.A. (Eds.), Desigualdades En Un Mundo Globalizado. CISEPA & desigualdades.net, Lima, pp. 183–200.
Damonte, G., Vila, G., 2014. Agenda de investigación en temas socioambientales en el Perú: Una aproximación desde las ciencias sociales, 1st ed. ed. Centro de Investigaciones Sociológicas, Económicas, Políticas y Antropológicas de la Pontificia Universidad Católica del Perú, Lima.
Dargent, E., Orihuela, J.C., Paredes, M., Ulfe, M.E., 2017. Resource booms and institutional pathways: The Case of the extractive industry in Peru, 1st ed. ed. Palgrave Macmillan, Lima. https://doi.org/10.1007/978-3-319-53532-6
De Echave, J., 2018. Diez años de minería en el Perú (2008-2017), 1st ed. ed. CooperAcción, Lima.
De Echave, J., Diez, A., Huber, L., Revesz, B., Ricard Lanata, X., Tanaka, M., 2009. Minería y Conflicto Social, 1st ed. ed. CBC, CIPCA, CIES, IEP, Lima, Perú.

De Echave, J., Keenan, K., Romero, M.K., Tapia, A., 2006. Dialogue and management of conflicts on community lands: The case of the Tintaya Mine in Peru. CooperAccion, Lima.

De Haan, L.J., 2012. The livelihood approach: A critical exploration. Erkunde 66, 345–357.

De Koning, G.H.J., Verburg, P.H., Veldkamp, A., Fresco, L.O., 1999. Multi-scale modelling of land use change dynamics. Agric. Syst. 61, 77–93. https://doi.org/10.1016/S0308-521X(99)00039-6

Defensoría del Pueblo—Ombudsman of Peru, 2018. Documento de Análisis de la conflictividad social. Lima.

Defensoría del Pueblo—Ombudsman of Peru, 2017a. Vigésimo primer Informe Anual de la Defensoría del Pueblo. Lima.

Defensoría del Pueblo—Ombudsman of Peru, 2017b. Reporte de Conflictos Sociales N° 165. Lima, Perú.

Defensoría del Pueblo—Ombudsman of Peru, 2016. Vigésimo Informe Anual de la Defensoría del Pueblo. Lima, Perú.

Defensoría del Pueblo—Ombudsman of Peru, 2015. Decimonoveno Informe Anual de la Defensoría del Pueblo. Lima.

Defensoría del Pueblo—Ombudsman of Peru, 2014. Decimonoveno Informe Anual de la Defensoría del Pueblo. Lima, Perú.

Defensoría del Pueblo—Ombudsman of Peru, 2013. Decimoséptimo Informe Anual de la Defensoría del Pueblo. Lima.

Defensoría del Pueblo—Ombudsman of Peru, 2012. Decimosexto Informe Anual de la Defensoría del Pueblo. Lima.

Defensoría del Pueblo—Ombudsman of Peru, 2011. Decimoquinto Informe Anual de la Defensoría del Pueblo. Lima, Perú.

Defensoría del Pueblo—Ombudsman of Peru, 2010. Decimocuarto Informe Anual de la Defensoría del Pueblo. Lima.

Defensoría del Pueblo—Ombudsman of Peru, 2009. Decimotercer Informe Anual de la Defensoría del Pueblo. Lima, Perú.

Defensoría del Pueblo—Ombudsman of Peru, 2008. Decimosegundo Informe Anual de la Defensoría del Pueblo. Lima, Perú.

Defensoría del Pueblo—Ombudsman of Peru, 2007. Undécimo Informe Anual de la Defensoría del Pueblo. Lima.

Defensoría del Pueblo—Ombudsman of Peru, 2006. Décimo Informe Anual de la Defensoría del Pueblo. Lima, Perú.

Defensoría del Pueblo—Ombudsman of Peru, 2005. Noveno Informe de la Defensoría del Pueblo. Lima, Perú.

Delgado, A., Romero, I., 2016. Environmental conflict analysis using an integrated grey clustering and entropy-weight method: A case study of a mining project in Peru. Environ. Model. Softw. 77, 108–121. https://doi.org/doi.org/10.1016/j.envsoft.2015.12.011

Diccionario de la lengua española, n.d. cabildo [Definition 1]. Real Acad. Española.

Diccionario de la lengua española, n.d. Aillu [Definition 2]. Real Acad. Española.

Diez Hurtado, A., 2001. Organizaciones e integración en el campo peruano después de las políticas neoliberales, in: Giarracca, N. (Ed.), ¿Una Nueva Ruralidad En América Latina? Consejo Latinoamericano de Ciencias Sociales—CLACSO, Buenos Aires, pp. 191–219.

Drinot, P., 2014. Peru in theory, 1st ed. ed. Palgrave Macmillan US, New York.

Durand, F., 2016. Cuando el poder extractivo captura el Estado, 1st ed. ed. OXFAM, Lima, Perú.

Durand, F., 2015. La captura del estado en los tiempos de globalización, in: Damonte, G., Göbel, B. (Eds.), Desigualdades En Un Mundo Globalizado. Centro de Investigaciones Sociológicas, Económicas, Políticas y Antropológicas—CISEPA, Lima, Perú, pp. 49–74.

Durand Guevara, A., 2014. Movimientos sociales y política en el Perú de hoy. Latinoamérica. Rev. Estud. Latinoam. 58, 59–84. https://doi.org/10.1016/s1665-8574(14)70101-2

Eda, L.E.H., Chen, W., 2010. Integrated water resources management in Peru. Procedia Environ. Sci. 2, 340–348. https://doi.org/10.1016/j.proenv.2010.10.039

El Comercio, 2018. Áncash: minera paraliza operaciones por derrame de relaves en Recuay 1.

Escobal, J., 2001. The determinants of nonfarm income diversification in rural Peru. World Dev. 29, 497–508. https://doi.org/10.1016/S0305-750X(00)00104-2

Esri, 2019. World Imagery [WWW Document]. URL http://www.arcgis.com/home/item.html?id=10df2279f9684e4a9f6a7f08febac2a9 (accessed 6.1.18).

FAO's Information System on Water and Agriculture—AQUASTAT, 2015. Peru [WWW Document]. URL http://www.fao.org/nr/water/aquastat/countries_regions/PER/index.stm (accessed 1.18.19).

Fearon, J., Laitin, D., 2003. Ethnicity , Insurgency , and Civil War. Am. Polit. Sci. Rev. 97, 75–90.

Figueroa, E., Orihuela, C., Calfucura, E., 2010. Green accounting and sustainability of the Peruvian metal mining sector. Resour. Policy 35, 156–167. https://doi.org/10.1016/j.resourpol.2010.02.001

Flora, S.J.S., 2015. Arsenic: Chemistry, Occurrence, and Exposure, in: Flora, S.J.S. (Ed.), Handbook of Arsenic Toxicology. Elsevier Inc., London, pp. 1–49. https://doi.org/10.1016/B978-0-12-418688-0.00001-0

Fonte, S.J., Vanek, S.J., Oyarzun, P., Parsa, S., Quintero, D.C., Rao, I.M., Lavelle, P., 2012. Pathways to Agroecological Intensification of Soil Fertility Management by Smallholder Farmers in the Andean Highlands, in: Sparks, D.L. (Ed.), Advances in Agronomy. Elsevier Inc., California, pp. 125–184. https://doi.org/10.1016/B978-0-12-394277-7.00004-X

Food and Agriculture Organization—FAO, 1999. Fishery Harbour Manual on the Prevention of Pollution - Bay of Bengal Programme [WWW Document]. URL http://www.fao.org/documents/card/en/c/ede95f62-dcfc-59c9-b598-20462a0488a3/ (accessed 8.31.17).

Franks, D.M., Davis, R., Bebbington, A., Ali, S.H., Kemp, D., Scurrah, M., 2014. Conflict translates environmental and social risk into business costs. Proc. Natl. Acad. Sci. 111, 7576–7581. https://doi.org/10.1073/pnas.1405135111

Fresnillo Perú S.A.C., 2017. Informe Técnico sustentatorio: Reubicación de plataformas, redimensionamiento de accesos y ampliación del cronograma del proyecto Huacravilca.

Fukuyama, F., 2004. The Imperative of State-Building. J. Democr. 15, 17–31. https://doi.org/10.1353/jod.2004.0026

Gallopin, G.C., 1997. Indicators and their use: Information for decision-making, in: Moldan, B., Billharz, S. (Eds.), Sustainability Indicators: Report on the Project on Indicators of Sustainable Development. Wiley, Chichester, pp. 13–27.

Gamu, J., Le Billon, P., Spiegel, S., 2015. Extractive industries and poverty: A review of recent findings and linkage mechanisms. Extr. Ind. Soc. 2, 162–176. https://doi.org/10.1016/j.exis.2014.11.001

Gisi, U., Schenker, R., Schulin, R., Stadelmann, F.X., Sticher, H., 1997. Bodenökologie, 2nd ed. ed. Thieme, New York.

Glave, M., Kuramoto, J., 2007. La minería peruana: lo que sabemos y lo que aún nos falta por saber, Investigación, políticas y desarrollo en el Perú.

Gottlicher, D., Obregón, A., Homeier, J., Rollenbeck, R., Nauss, T., Bendix, J., 2009. Land-cover classification in the Andes of southern Ecuador using Landsat ETM+ data as a basis for SVAT modelling. Int. J. Remote Sens. 30, 1867–1886. https://doi.org/10.1080/01431160802541531

Graham, A., 2009. The Andes: A geological overview from a biological perspective. Ann. Missouri Bot. Gard. 96, 371–385. https://doi.org/doi.org/10.3417/2007146

Granados Agüero, A.P., 2016. La construcción de la fiscalización ambiental en un contexto adverso de boom de recursos naturales : el caso del OEFA. Pontificia Universidad Católica del Perú.

Grey, D., Sadoff, C.W., 2007. Sink or Swim? Water security for growth and development. Water Policy 9, 545–571. https://doi.org/10.2166/wp.2007.021

Gudynas, E., 2017. Extractivismos y corrupción: Anatomía de una íntima relación, 1st ed. ed. CooperAcción; RedgE; CLAES, Lima, Perú.

Gudynas, E., 2015. Extractivismos Ecología, economía y política de un modo de entender el desarrollo y la naturaleza, 1st ed. ed. Red Peruana por una Globalizacíon con Equidad, Lima.

Gustafsson, M.-T., 2018. Private Politics and Peasant Mobilization Mining in Peru, 1st ed. ed. Palgrave Macmillan, Cham.

Gustafsson, M.-T., Scurrah, M., 2019. Unpacking the extractivist state: The role of weak state agencies in promoting institutional change in Peru. Extr. Ind. Soc. 6, 206–214. https://doi.org/10.1016/j.exis.2018.08.007

Guzmán Solano, N., 2016. Struggle from the margins: Juridical processes and entanglements with the Peruvian state in the era of mega-mining. Extr. Ind. Soc. 3, 416–425. https://doi.org/10.1016/j.exis.2016.02.004

Haarstad, H., Fløysand, A., 2007. Globalization and the power of rescaled narratives: A case of opposition to mining in Tambogrande, Peru. Polit. Geogr. 26, 289–308. https://doi.org/10.1016/j.polgeo.2006.10.014

Haas, P.M., 1992. Introduction : Epistemic Communities and International Policy Coordination. Int. Organ. 46, 1–35.

Hagner, O., Reese, H., 2007. A method for calibrated maximum likelihood classification of forest types. Remote Sens. Environ. 110, 438–444. https://doi.org/10.1016/j.rse.2006.08.017

Hall, P.A., 1986. Governing the Economy: The Politics of State Intervention in Britain and France, 1st ed. ed. Oxford University Press, Oxford.

Hartman, H.L., Mutmansky, J.M., 2002. Introductory mining engineering, 2nd ed. ed. John Wiley & Sons, New Yersey.

Haslam, P.A., Tanimoune, N.A., 2016. The Determinants of Social Conflict in the Latin American Mining Sector: New Evidence with Quantitative Data, in: World Development. Elsevier Ltd, pp. 401–419. https://doi.org/10.1016/j.worlddev.2015.10.020

Havel, J.J., 1986. Land use conflicts, in: Dell, B., Hopkins, A.J.M., Lamont, B.B. (Eds.), Resilience in Mediterranean-Type Ecosystems. DR W. Junk Publishers, Dordrecht, pp. 147–160.

Hellin, J., Higman, S., 2005. Crop diversity and livelihood security in the Andes. Dev. Pract. 15, 165–174. https://doi.org/10.1080/09614520500041344

Hellman, J., Jones, G., Kaufmann, D., 2000a. Seize the state, Seize the Day: State Capture, Corruption and Influence in Transition (No. 2444), Policy Research Working Paper, September. Washington, DC.

Hellman, J., Jones, G., Kaufmann, D., Schankerman, M., 2000b. Measuring governance, corruption, and state capture: How firms and bureaucrats shape the business environment in transition economies (No. 2312), Policy Research Working Paper, April. Washington, DC. https://doi.org/10.2139/ssrn.236214

Helwege, A., 2015. Challenges with resolving mining conflicts in Latin America. Extr. Ind. Soc. 2, 73–84. https://doi.org/10.1016/j.exis.2014.10.003

Henríquez, N., 2015. La política de las protestas sociales, movilizaciones y negociaciones en torno a los recursos naturales, in: Desigualdades En Un Mundo Globalizado. CICEPA, desiguALdades.net, Lima, Perú, pp. 101–133.

Herbst, J., 2000. States and power in Africa: comparative lessons in authority and control, 1st ed. ed. Princeton University Press., New Jersey.

Hesse-Biber, S., 2010a. Mixed Methods Research: Merging Theory with Practice, 1st ed. ed. Guilford Press, London.

Hesse-Biber, S., 2010b. Qualitative approaches to mixed methods practice. Qual. Inq. 16, 455–468. https://doi.org/10.1177/1077800410364611

Hijmans, R.J., van Etter, J., Cheng, J., Mattiuzzi, M., Summer, M., Greenberg, J.A., Lamigueiro, O.P., Bevan, A., Racine, E.B., Shortridge, A., Ghosh, A., 2017. Package "raster." R CRAN Proj.

Hilson, G., 2002. An overview of land use conflicts in mining communities. Land use policy 19, 65–73. https://doi.org/10.1016/S0264-8377(01)00043-6

Hinojosa, L., 2011. Riqueza mineral y pobreza en los Andes. Eur. J. Dev. Res. 23, 488–504. https://doi.org/10.1057/ejdr.2011.11

Hollander, J.A., Einwohner, R.L., 2004. Conceptualizing resistance. Sociol. Forum 19, 533–554. https://doi.org/10.1007/s11206-004-0694-5

Hoogesteger, J., Urteaga, P., 2013. Agua e inequidad : discursos, políticas y medios de vida en la región andina, 1st ed. ed. Instituto de Estudios Peruanos, Lima, Perú.

Hoogesteger, J., Verzijl, A., 2015. Grassroots scalar politics: Insights from peasant water struggles in the Ecuadorian and Peruvian Andes. Geoforum 62, 13–23. https://doi.org/10.1016/j.geoforum.2015.03.013

Horowitz, L.S., 2009. Environmental violence and crises of legitimacy in New Caledonia. Polit. Geogr. 28, 248–258. https://doi.org/10.1016/j.polgeo.2009.07.001

IBM Corporation, 2017. IBM SPSS Statistics 25 Core User´s Guide.

Inbar, M., Llerena, C. a., 2000. Erosion Processes in High Mountain Agricultural Terraces in Peru. Mt. Res. Dev. 20, 72–79. https://doi.org/10.1659/0276-4741(2000)020[0072:EPIHMA]2.0.CO;2

Instituto Geofísico del Perú—IGP, 2012. Eventos meteorológicos extremos (sequías, heladas, lluvias intensas) en el valle del Mantaro-Tomo I, 1st Ed. ed. Instituto Geofísico del Perú, Lima, Perú. https://doi.org/10.1017/CBO9781107415324.004

Instituto Geofísico del Perú—IGP, 2005. Diagnóstico de la Cuenca del Mantaro bajo la visión del cambio climático, 1st ed. ed. Fondo editorial del CONAM, Lima, Perú.

Instituto Geológico Minero y Metalúrgico—INGEMMET, 2018. Geocatmin [WWW Document]. URL http://geocatmin.ingemmet.gob.pe/geocatmin/ (accessed 10.2.18).

Instituto Geológico Minero y Metalúrgico—INGEMMET, 2017. Atlas Catastral Minero y Geologico del Peru. Lima, Perú.

Instituto Geológico Minero y Metalúrgico—INGEMMET, 2014. Atlas Catastral Minero y Geológico al 31 de Diciembre del 2014, 1st ed. ed. INGEMMET, Lima.

Instituto Geológico Minero y Metalúrgico—INGEMMET, 1983. Cuadrángulos de Mala, Lunahuaná, Tupe, Conayca, Chincha, Tantará y Castrovirreyna abarcan parte de los departamentos de Lima, Huancavelica y Junin (Huancayo). Lima, Perú.

Instituto Nacional de Estadística e Informática—INEI, 2018a. Principales Indicadores [WWW Document]. URL https://www.inei.gob.pe/ (accessed 7.30.18).

Instituto Nacional de Estadística e Informática—INEI, 2018b. Junín: Resultados Definitivos—Población Económicamente Activa Tomo I. Lima.

Instituto Nacional de Estadística e Informática—INEI, 2018c. Junín: Resultados Definitivos—Población Económicamente Activa Tomo II. Lima.

Instituto Nacional de Estadística e Informática—INEI, 2014. Las Comunidades Campesinas y Nativas como Persona Jurídica del Sector Agropecuario, in: INEI (Ed.), Características Socioeconómicas Del Productor Agropecuario En El Perú: IV Censo Nacional Agropecuario 2012. Instituto Nacional de Estadística e Informática, Lima, p. 388.

Instituto Nacional de Estadística e Informática—INEI, 2013a. Resultados Preliminares IV Censo Nacional Agropecuario 2012. Lima, Perú.

Instituto Nacional de Estadística e Informática—INEI, 2013b. Resultados definitivos IV Censo Nacional Agropecuario 2012, Resultados Definitivos. IV Censo Nacional Agropecuario. Lima, Perú.

Instituto Nacional de Estadística e Informática—INEI, 2010. Perú: Mapa del Déficit de Agua y Saneamiento Básico a Nivel Distrital, 2007. Lima, Perú. https://doi.org/10.14257/astl.2013.35.03

Instituto Nacional de Estadística e Informática—INEI, 2009. Perú: Migraciones Internas. Lima, Perú.

International Labour Organization—ILO, 1989. C169 - Indigenous and Tribal Peoples

Convention, 1989 (No. 169) [WWW Document]. URL https://www.ilo.org/dyn/normlex/en/f?p=1000:12100:0::NO::P12100_INSTRUMENT_ID,P12100_LANG_CODE:312314,en:NO (accessed 4.15.19).

Isch, E., Boelens, R., Peña, F., 2012. Agua, Injusticia y Conflictos, 1st ed. ed, Serie Agua y Sociedad. Instituto de Estudios Peruanos—IEP, Lima. https://doi.org/10.13140/2.1.4340.7045

Jain, Y., Bhandare, S., 2011. Min max normalization based data perturbation method for privacy protection. Int. J. Comput. … 45–50.

Järup, L., 2003. Hazards of heavy metal contamination. Br. Med. Bull. 68, 167–182. https://doi.org/10.1093/bmb/ldg032

Jarvis, A., Reuter, H.I., Nelson, A., Guevara, E., 2008. Hole-filled seamless SRTM data V4, International Centre for Tropical Agriculture (CIAT) [WWW Document]. CGIAR-CSI SRTM 90m DEM Digit. Elev. Database. URL http://srtm.csi.cgiar.org/ (accessed 7.20.18).

Jaskoski, M., 2014. Environmental Licensing and Conflict in Peru's Mining Sector: A Path-Dependent Analysis. World Dev. 64, 873–883. https://doi.org/10.1016/j.worlddev.2014.07.010

Josse, C., Cuesta, F., Navarro, G., Barrena, V., Cabrera, E., Chacón-Moreno, E., Ferreira, W., Peralvo, M., Saito, J., Tovar, A., 2009. Ecosistemas de los Andes del Norte y Centro. Bolivia, Colombia, Ecuador, Perú y Venezuela. Secretaría General de la Comunidad Andina, Programa Regional ECOBONA-Intercooperation, CONDESAN-Proyecto Páramo Andino, Programa BioAndes, EcoCiencia, NatureServe, IAvH, LTA-UNALM, ICAE-ULA, CDC-UNALM, RUMBOL SRL., Lima, Perú.

Kabata-Pendias, A., Pendias, H., 2001. Trace elements in soils and plants, 3rd ed. ed, New York. CRP Press LLC, London.

Khodeli, I., 2009. From curse to blessing? Using natural resources to fuel sustainable development, 1st ed. ed. Wiley-Blackwell/UNESCO, Chichester.

King, B., Goycoolea, M., Newman, A., 2017. Optimizing the open pit-to-underground mining transition. Eur. J. Oper. Res. 257, 297–309. https://doi.org/10.1016/j.ejor.2016.07.021

Kohler, T., Maselli, D., 2012. Mountains and Climate Change, 3rd ed. ed. Geographica Bernensia with the support of the Swiss Agency for Development and Cooperation (SDC), and an international team of contributors., Bern.

Konikow, L.F., Bredehoeft, J.D., 1992. Ground-water models cannot be validated. Adv. Water Resour. 15, 75–83. https://doi.org/doi.org/10.1016/0309-1708(92)90033-X

Kriesberg, L., Dayton, B.W., 2011. Constructive Conflicts: From conflicts to resolution, 4th ed. ed. Rowman & Littlefield Publishers, Plymouth.

Kristjanson, P., Krishna, A., Radeny, M., Kuan, J., Quilca, G., Sanchez-Urrelo, A., Leon-Velarde, C., 2007. Poverty dynamics and the role of livestock in the Peruvian Andes. Agric. Syst. 94, 294–308. https://doi.org/10.1016/j.agsy.2006.09.009

Lang, M., Mokrani, D., 2013. Beyond development: Alternatives visions from Latin America, 1st ed. ed. Rosa Luxemburg Foundation, Quito.

Larrain Vial SAB, 2012. Minería en el Perú: Realidad y perspectivas, 1st ed. ed. LarrainVial, Lima, Perú. https://doi.org/https://dx.doi.org/10.1016/j.aju.2011.03.005

Laszlo, S., 2008. Education, Labor Supply, and Market Development in Rural Peru. World Dev. 36, 2421–2439. https://doi.org/10.1016/j.worlddev.2008.04.001

Leutner, B., Horning, N., Schwalb-Willmann, J., Hijmans, R.J., 2018. Tools for Remote Sensing Data Analysis [R package RStoolbox version 0.2.3]. Comprehensive R Archive Network (CRAN).

Levi Rendón, C., 1960. Estudio del yacimiento minero de Cercapuquio. Univ. Nac. Ing. Universidad Nacional de Ingeniería.

Levitsky, S., Murillo, M.V., 2009. Variation in Institutional Strength. Annu. Rev. Polit. Sci. 12, 115–133. https://doi.org/10.1146/annurev.polisci.11.091106.121756

Lewis, K.A., Bardon, K.S., 1998. A computer-based informal environmental management system for agriculture. Environ. Model. Softw. 13, 123–137. https://doi.org/10.1016/S1364-8152(98)00010-3

Lezzaik, K., Milewski, A., Mullen, J., 2018. The groundwater risk index: Development and application in the Middle East and North Africa region. Sci. Total Environ. 628–629, 1149–1164. https://doi.org/10.1016/j.scitotenv.2018.02.066

Li, F., 2017. Desenterrando el conflicto : empresas mineras, activistas y expertos en el Perú, 1st ed. ed. Instituto de Estudios Peruanos, Lima, Perú.

Li, F., 2009. Negotiating livelihoods: women, mining and water resources in Peru. Can. Woman Stud. 27, 97–102.

Loayza, N., Rigolini, J., 2016. The Local Impact of Mining on Poverty and Inequality: Evidence from the Commodity Boom in Peru. World Dev. 84, 219–234. https://doi.org/10.1016/j.worlddev.2016.03.005

Long, N., Roberts, B., 2001. Mineros, campesinos y empresarios en la sierra central, 1st ed. ed. Instituto de Estudios peruanos, Lima.

Lowndes, V., Roberts, M., 2013. Why Institutions Matter: The new institutionalism in political science, 1st ed. ed. Palgrave Macmillan, Hampshire.

Malczewski, J., 2011. Local Weighted Linear Combination. Trans. GIS 15, 439–455. https://doi.org/10.1111/j.1467-9671.2011.01275.x

Malczewski, J., Rinner, C., 2015. Multicriteria Decision Analysis in Geographic Information Science, 1st ed. ed. Springer New York, New York.

Maquet, P.E., 2018. TERRITORIAL Y LA EVOLUCIÓN RECIENTE DE LOS. Boletín electrónico Actual. Minera del Perú April, 19.

Marcos, J., 1994. Disolución de comunidades campesinas y dinámica municipio-comunidad. Debate Agrar. 19, 87–109.

Martín-Duque, J.F., Sanz, M.A., Bodoque, J.M., Lucía, A., Martín-Moreno, C., 2010. Restoring earth surface processes through landform design. A 13-year monitoring of a geomorphic reclamation model for quarries on slopes. Earth Surf. Process. Landforms 35, 531–548. https://doi.org/10.1002/esp.1950

Martin, A.J., McNee, J.J., Pedersen, T.F., 2001. The reactivity of sediments impacted metal-mining in Lago Junin, Peru. J. Geochemical Explor. 74, 175–187. https://doi.org/10.1016/S0375-6742(01)00183-2

Martinez-Alier, J., 2002. The Environmentalism of the Poor. World Submit Sustain. Dev. 56. https://doi.org/10.1016/j.geoforum.2013.04.019

Martínez Alier, J., Roca Jusmet, J., 2015. Economía ecológica y política ambiental, 3rd ed. ed. Fondo de Cultura Económica—FCE, Mexico D.F.

Martínez Valle, L., 2002. Economía política de las comunidades indígenas, 2nd ed. ed. Ediciones Abya-Yala, Instituto Lationamericano de Investigaciones, Facultad Lationamericana de Ciencias Sociales, OXFAM, Quito, Ecuador.

McDonell, E., 2015. The co-constitution of neoliberalism, extractive industries, and indigeneity: Anti-mining protests in Puno, Peru. Extr. Ind. Soc. 2, 112–123. https://doi.org/10.1016/j.exis.2014.10.002

McHugh, M.L., 2012. Interrater reliability: the kappa statistic. Biochem. medica 22, 276–282.

Mckenzie, D.J., 2003. Measure inequality with asset indicators (No. 042), BREAD Working Paper. Cambridge, MA.

Mégard, F., 1968. Geología del cuadrángulo de Huancayo. Serv. Geol. y Minería 125.

Melucci, A., 1999. Teoría de la acción colectiva, in: Melucci, A. (Ed.), Accion Colectiva, Vida Cotidiana Y Democracia. El Colegio de México, Centro de Estudios Sociológicos, Mexico D.F., pp. 25–54.

Méndez Zegarra, E., Orihuela, J.C., Paredes, M., 2007. Minería y economía de los hogares de la sierra peruana: Impactos y espacios de conflicto (No. 51). Lima.

Mendoza, G.A., Macoun, P., Prabhu, R., Sukadri, D., Purnomo, H., Hartanto, H., 1999. Guidelines for Applying Multi-criteria Analysis to the Assessment of Criteria and Indicators, The Criteria & Indicators Toolbox series 9. CIFOR, The European Commission, Deutsche Gesellschaft für Technische Zusammenarbeit—GTZ, USAID.

Merino Acuña, R., 2015. The politics of extractive governance: Indigenous peoples and socio-environmental conflicts. Extr. Ind. Soc. 2, 85–92. https://doi.org/10.1016/j.exis.2014.11.007

Milan, A., Ho, R., 2014. Livelihood and migration patterns at different altitudes in the Central Highlands of Peru. Clim. Dev. 6, 69–76. https://doi.org/10.1080/17565529.2013.826127

Minera IRL, n.d. CORIHUARMI GOLD MINE [WWW Document]. URL http://www.minera-irl.com/corihuarmi-3/ (accessed 8.30.17).

Ministerio de Agricultura y Riego—MINAGRI, 2018. Decreto Supremo—DS N° 014-2018-MINAGRI Decreto Supremo que aprueba valores de retribuciones económicas a pagar por uso de agua superficial y subterránea y por el vertimiento de agua residual tratada a aplicarse en el año 2019.

Ministerio de Agricultura y Riego—MINAGRI, 2017. Decreto Supremo—DS N°017-2017-MINAGRI Decreto Supremo que aprueba valores de retribuciones económicas a pagar por uso de agua superficial, subterránea y, por el vertimiento de agua residual tratada a aplicarse en el año 2018.

Ministerio de Agricultura y Riego—MINAGRI, 2016. Decreto Supremo—DS N° 021-2016-MINAGRI Decreto Supremo que aprueba valores de retribuciones económicas a pagar por uso de agua superficial y subterránea y por el vertimiento de agua residual tratada a aplicarse en el año 2017.

Ministerio de Agricultura y Riego—MINAGRI, 2015. Decreto Supremo—DS N° 007-2015-MINAGRI Decreto Supremo que regula los procedimientos de formalización o regularización de licencias de uso de agua.

Ministerio de Agricultura y Riego—MINAGRI, 2008. Decreto Legislativo—DL N° 997 Decreto Legislativo que aprueba la ley de organización y funciones del ministerio

de agricultura.
Ministerio de Cultura—MC, 2019. Base de Datos de Pueblos Indígenas u Originarios—BDPI [WWW Document]. URL http://bdpi.cultura.gob.pe/busqueda-localidades (accessed 4.15.19).
Ministerio de Cultura—MC, 2012. Decreto Supremo—DS N° 001-2012-MC Reglamento de la Ley Nº 29785, Ley del Derecho a la Consulta Previa a los Pueblos Indígenas u Originarios reconocido en el Convenio 169 de la Organización Internacional del Trabajo (OIT).
Ministerio de Energía y Minas—MEM, 2018a. Informativo Minero N ° 04-2018. Lima.
Ministerio de Energía y Minas—MEM, 2018b. Inversión - Ministerio de Energía y Minas [WWW Document]. URL http://mineria.minem.gob.pe/dashboard/inversion/ (accessed 12.10.18).
Ministerio de Energía y Minas—MEM, 2010. Resolución Ministerial Nº 304-2008- MEM-DM Aprueban Normas que regulan el proceso de participación ciudadana en el subsector minero.
Ministerio de Energía y Minas—MEM, 2008. Decreto Supremo—DS N° 028-2008-EM.
Ministerio de Energía y Minas—MEM, 2006. Decreto Supremo—DS N° 071-2006-EM Aprueban formato del Convenio para el aporte econ6mico voluntarfo, extraordinario y temporal denominado “Programa Minero de Solidaridad con el Pueblo” que celebraran el Estado y las empresas mineras.
Ministerio de Energía y Minas—MEM, 1992. Decreto Supremo—DS Nº 014-92-EM- Ley General de Minería. https://doi.org/10.1017/CBO9781107415324.004
Ministerio de Transportes y Comunicaciones—MTC, 2019a. Estadísticas: Informes y publicaciones [WWW Document]. URL http://portal.mtc.gob.pe/estadisticas/transportes.html (accessed 2.25.19).
Ministerio de Transportes y Comunicaciones—MTC, 2019b. Catálogo de Metadatos [WWW Document]. Geoservicios. URL http://mtcgeo2.mtc.gob.pe:8080/geonetwork/srv/spa/catalog.search#/search?facet.q=type%2Fdataset (accessed 2.25.19).
Ministerio del Ambiente—MINAM, 2019. Los motivos del conflicto [WWW Document]. URL http://www.minam.gob.pe/espinar/los-motivos-del-conflicto/ (accessed 2.20.19).
Ministerio del Ambiente—MINAM, 2017a. Aprueban Estandares de Calidad Ambiental (ECA) para Agua y establecen disposiciones complementarias. El Peru.
Ministerio del Ambiente—MINAM, 2017b. Decreto Supremo—DS N° 011-2017-MINAM.
Ministerio del Ambiente—MINAM, 2015. Decreto Supremo N° 015-2015-MINAM Modifican los estándares nacionales de calidad ambiental para Agua y establecen disposiciones complementarias para su aplicación. El Peru. 3.
Ministerio del Ambiente—MINAM, 2014. Guía para el Muestreo de Suelos. Lima.
Ministerio del Ambiente—MINAM, 2009. Law N° 29325: Ley del Sistema Nacional de Evaluación y Fiscalización Ambiental.
Mitchell, G., May, A., McDonald, A., 1995. PICABUE: A methodological framework for the development of indicators of sustainable development. Int. J. Sustain. Dev. World Ecol. 2, 104–123. https://doi.org/10.1080/13504509509469893
Montoya, D., 2018. Conflictividad social, diálogo y gobernanza territorial. Ideele Rev.
Moore, J.W., 2003. The Modern World-System as environmental history? Ecology and

the rise of capitalism. Theory Soc. 32, 307–377. https://doi.org/10.1023/A:1024404620759

Nature, 2015. Interdisciplinarity [WWW Document]. Special. URL https://www.nature.com/collections/jcfdbccgjj (accessed 3.25.19).

Neumann, P., 2016. Toxic Talk and Collective (In)action in a Company Town: The Case of la Oroya, Peru. Soc. Probl. 63, 431–446. https://doi.org/10.1093/socpro/spw010

Ng, J.C., Wang, J., Shraim, A., 2003. A global health problem caused by arsenic from natural sources. Chemosphere 52, 1353–1359. https://doi.org/10.1016/S0045-6535(03)00470-3

Ngole, V.M., Ekosse, G.I.E., 2012. Copper, nickel and zinc contamination in soils within the precincts of mining and landfilling environments. Int. J. Environ. Sci. Technol. 9, 485–494. https://doi.org/10.1007/s13762-012-0055-5

Oficina Nacional de Diálogo y Sostenibilidad—ONDS, 2014. Diálogo: Dos años después. Lima, Perú.

Ohlsson, L., 2000. Water conflicts and social resource scarcity. Phys. Chem. Earth, Part B Hydrol. Ocean. Atmos. 25, 213–220. https://doi.org/doi.org/10.1016/S1464-1909(00)00006-X

Organisation for Economic Co-operation and Development—OECD, 2008. Handbook on Constructing Composite Indicators: Methodology and User Guide. OECD Publications, Paris. https://doi.org/10.1787/9789264043466-en

Organismo de Evaluación y Fiscalización Ambiental—OEFA, 2016. La Fiscalización Ambiental en el Peru (2011 - 2015). Lima, Perú.

Organismo de Evaluación y Fiscalización Ambiental—OEFA, 2014a. Reporte público del informe de supervisión directa N° 165-2014-OEFA/DS-MIN.

Organismo de Evaluación y Fiscalización Ambiental—OEFA, 2014b. Reporte público del informe N° 352-2011-OEFA/DS.

Organismo de Evaluación y Fiscalización Ambiental—OEFA, 2014c. Reporte público del informe N° 070-2014-OEFA/DS-MIN.

Organismo de Evaluación y Fiscalización Ambiental—OEFA, 2013a. Reporte público del informe de supervisión directa N° 389-2013-OEFA/DS-MIN e informe N° 166-2014-OEFA/DS-MIN.

Organismo de Evaluación y Fiscalización Ambiental—OEFA, 2013b. Resolución directoral N° 491-2013-OEFA/DFSAI.

Organismo de Evaluación y Fiscalización Ambiental—OEFA, 2012. Reporte público del informe N° 889-2012-OEFA/DS.

Organismo de Evaluación y Fiscalización Ambiental—OEFA, 2010. Resolución de Consejo Directivo Nº 003- 2010-OEFA/CD.

Orihuela, J.C., Pérez, C.A., Huaroto, C., 2018. Does fiscal windfalls increase mining conflicts? Not always. Extr. Ind. Soc. 6. https://doi.org/10.1016/j.exis.2018.07.010

Ormachea Choque, I., Caravedo García, J., Moreno Chocano, G., Bedoya Hermoza, C., 2014. Minería, conflicto social y diálogo, 1st ed. ed. ProDiálogo, Prevención y Resolución de Conflictos, Lima.

Orr, S., Cartwright, A., Tickner, D., 2009. Understanding water risks. A primer on the consequences of water scarcity for government and business (No. 4), WWF Water Security Series. Surrey.

Osorio, S., 2009. Las Comunidades Campesinas en la región Junín. Lima.

Ospina Ovalle, G., 2016. El papel de las vías secundarias y los caminos vecinales en el desarrollo de Colombia. Rev. Ing. 20–27. https://doi.org/10.16924/riua.v0i44.911

OXFAM, 2008. Pobreza, desigualdad y desarrollo en el Perú: Informe Anual 2007-2008. OXFAM, Lima, Perú.

Oxford English dictionary online, n.d. Social Justice [Definition 3] [WWW Document]. URL http://www.oed.com/view/Entry/183739?redirectedFrom=social+justice (accessed 5.7.19).

Özkaynak, B., Rodriguez-Labajos, B., 2017. Mining Conflicts, in: Spash, C.L. (Ed.), Routledge Handbook of Ecological Economics: Nature and Society. Routledge, Abingdon, pp. 414–424.

Patro, S.G.K., Sahu, K.K., 2015. Normalization: A Preprocessing Stage. arXiv:1503.06462 20–22. https://doi.org/10.17148/IARJSET.2015.2305

Peralta-Videa, J.R., Lopez, M.L., Narayan, M., Saupe, G., Gardea-Torresdey, J., 2009. The biochemistry of environmental heavy metal uptake by plants: Implications for the food chain. Int. J. Biochem. Cell Biol. 41, 1665–1677. https://doi.org/10.1016/j.biocel.2009.03.005

Perreault, T., 2014. Minería, agua y justicia social en los Andes: Experiencias comparativas de Perú y Bolivia, 1st ed. ed. Justicia Hídrica, Centro Bartolomé de Las Casas, Lima.

Peru´s Environmental Licensing Agency—SENACE, 2018. The ABC of SENACE. SENACE, Lima, Perú.

Perz, S.G., Qiu, Y., Xia, Y., Southworth, J., Sun, J., Marsik, M., Rocha, K., Passos, V., Rojas, D., Alarcón, G., Barnes, G., Baraloto, C., 2013. Trans-boundary infrastructure and land cover change: Highway paving and community-level deforestation in a tri-national frontier in the Amazon. Land use policy 34, 27–41. https://doi.org/10.1016/j.landusepol.2013.01.009

Pimple, U., Sitthi, A., Simonetti, D., Pungkul, S., Leadprathom, K., Chidthaisong, A., 2017. Topographic correction of Landsat TM-5 and Landsat OLI-8 imagery to improve the performance of forest classification in the mountainous terrain of Northeast Thailand. Sustain. 9, 1–26. https://doi.org/10.3390/su9020258

Postigo, J.C., Young, K.R., Crews, K.A., 2008. Change and continuity in a pastoralist community in the high Peruvian Andes. Hum. Ecol. 36, 535–551. https://doi.org/10.1007/s10745-008-9186-1

Prado Fernández, J.M., Manzanares Cáceres, D., Velázquez Díaz, F., Taya Acosta, E., 2013. Agua, Minería Y Comunidades Campesinas En La Región Tacna Water, Mining and Rural Communities in the Región Tacna. Cienc. Desarro. 73–80.

Preciado Jerónimo, R., 2011. El agua y las industrias extractivas en el Perú: un análisis desde la gestión integrada de recursos hídricos, in: Urteaga, P. (Ed.), Agua e Industrias Extractivas Cambios y Continuidades En Los Andes. Instituto de Estudios Peruanos, Lima, Perú, pp. 171–215.

Preciado Jerónimo, R., Álvarez Gutiérrez, C., 2016. Gobernanza del agua en zonas mineras del Perú: Abriendo el diálogo, 1st ed. ed. CooperAcción, Lima.

Preciado Jeronimo, R., Rap, E., Vos, J., 2015. The politics of Land Use Planning: Gold mining in Cajamarca, Peru. Land use policy 49, 104–117.

https://doi.org/10.1016/j.landusepol.2015.07.009
Presidencia de Consejo de Ministros del Perú—PCM, 2016. Decreto Supremo—DS N° 089-2016-PCM Declaran el Estado de Emergencia por peligro inminente por déficit hídrico en los departamentos de Apurímac, Ancash, Ayacucho, Cajamarca, Cusco, Huancavelica, Ica, Junín, Lambayeque, La Libertad, Pasco, Piura, Puno, Tacn.
Presidencia de Consejo de Ministros del Perú—PCM, 2013. Decreto Supremo—DS N° 054-2013-PCM Aprueban disposiciones especiales para ejecución de procedimientos administrativos.
Presidencia de Consejo de Ministros del Perú—PCM, 2012. Informe de la comisión multisectorial creada por resolución suprema N° 189-2012-PCM: Ejes estratégicos de la gestión ambiental.
Presidencia de la República del Perú—PRP, 2017a. República del Perú: Memoria de Gobierno, 1st ed. ed. Presidencia del Consejo de Ministros del Perú, Lima, Perú.
Presidencia de la República del Perú—PRP, 2017b. Law Nº 30640 Ley que modifica la ley 29338, ley de recursos hídricos, mediante el establecimiento de los criterios técnicos para la identificación y delimitación de las cabeceras de cuenca.
Presidencia de la República del Perú—PRP, 2014. Law N° 30230—Ley que establece medidas tributarias, simplificación de procedimientos y permisos para la promoción y dinamización de la inversion en el pais.
Presidencia de la República del Perú—PRP, 2008. Decreto Legislativo—DL N° 1013 Decreto Legislativo que aprueba la ley de creación, organización y funciones del ministerio del ambiente.
Presidencia de la República del Perú—PRP, 1993. Constitución para la República del Perú.
Presidencia de la República del Perú—PRP, 1991. Decreto Supremo DS-008-91-TR Aprueban reglamento de la ley general de comunidades campesinas.
Presidencia de la República del Perú—PRP, 1979. Constitución para la República del Perú (12 de Julio de 1979).
Presidencia de la República del Perú—PRP, 1972. Decreto Ley N° 19400 El gobierno dicta normas relativas a la estructura y funcionamiento de las organizaciones agrarias.
Presidencia de la República del Perú—PRP, 1969. Decreto Ley N° 17716 Nueva Reforma Agraria.
Presidencia de la República del Perú—PRP, 1933. Constitución Política del Perú (29 de Marzo de 1933).
Presidente Constitucional de la República—PCR, 1920. Constitución para la República del Perú.
Programa de las Naciones Unidas para el Desarrollo—PNUD, 2006. Informe sobre Desarrollo Humano Perú 2006. Hacia una descentralización con ciudadanía, Informe sobre Desarrollo Humano Perú 2006. Lima, Perú.
Pruvot, C., Douay, F., Hervé, F., Waterlot, C., 2006. Heavy metals in soil, crops and grass as a source of human exposure in the former mining areas. J. Soils Sediments 6, 215–220. https://doi.org/10.1065/jss2006.10.186
Pulgar Vidal, J., 2014. Las ocho regiones naturales del Perú. Terra Bras. (Nova Série) 20. https://doi.org/10.4000/terrabrasilis.1027
Quiñones, P., Bernaola, D., Zavaleta, M., 2013. Los Límites de la Expansión minera en el

Perú, 1st ed. ed. Asociación Servicios Educativos Rurales (SER), Lima, Perú.
Quiroz, A.W., 2013. Historia de la corrupción en el Perú, 2nd ed. ed. Instituto de Estudios Peruanos—IEP, Lima, Perú.
Quispe-Zuniga, M.R., Ortiz-Quispe, C.M., Plasencia, R., 2018. Mining projects and socio-environmental factors that weaken campesino (peasant) communities in the Central Andes of Peru. Gestión y Ambient. 21, 47–61. https://doi.org/10.15446/ga.v21n2supl.77833
R Core Team, 2015. R: A language and environment for statistical computing. https://doi.org/ISBN 3-900051-07-0, URL http://www.R-project.org/
Radcliffe, S.A., 2005. Neoliberalism as we know it, but not in conditions of its own choosing: A commentary. Environ. Plan. A 37, 323–329. https://doi.org/10.1068/a37407
Ramirez-Gomez, S.O.I., Brown, G., Verweij, P.A., Boot, R., 2016. Participatory mapping to identify indigenous community use zones: Implications for conservation planning in southern Suriname. J. Nat. Conserv. 29, 69–78. https://doi.org/10.1016/j.jnc.2015.11.004
Razo, I., Carrizales, L., Castro, J., Díaz-Barriga, F., Monroy, M., 2004. Arsenic and Heavy Metal Pollution of Soil, Water and Sediments in a Semi-Arid Climate Mining Area in Mexico. Water, Air, Soil Pollut. 152, 129–152. https://doi.org/10.1023/B:WATE.0000015350.14520.c1
Recharte, J., Albán, L., Arévalo, R., Flores, E., Huerta, L., Orellana, M., Oscanoa, L., Sánchez, P., 2002. El grupo en Páramos-Jalcas y Punas del Peru: Instituciones y acciones en beneficio de comunidades y ecosistemas alto andinos, in: Anales de La Reunión Del Grupo Internacional de Páramos. Bogotá, pp. 785–804.
Reed, M.S., Graves, A., Dandy, N., Posthumus, H., Hubacek, K., Morris, J., Prell, C., Quinn, C.H., Stringer, L.C., 2009. Who's in and why? A typology of stakeholder analysis methods for natural resource management. J. Environ. Manage. 90, 1933–1949. https://doi.org/10.1016/j.jenvman.2009.01.001
Remy, M.I., 2013. Historia de las comunidades indígenas y campesinas del Perú (No. 202). Lima.
Remy, M.I., 2004. Autoridad, gobierno y ciudadanía. Sociedades rurales en democracia, in: Eguren, F., Remy, M.I., Oliart, P. (Eds.), Perú: El Problema Agrario En Debate Sepia X. Seminario Permanente de Investigación Agraria—SEPIA, Lima, pp. 237–276.
Reuer, M.K., Bower, N.W., Koball, J.H., Hinostroza, E., De la Torre Marcas, M.E., Surichaqui, J.A.H., Echevarria, S., 2012. Lead, Arsenic, and Cadmium Contamination and Its Impact on Children's Health in La Oroya, Peru. ISRN Public Health 2012, 1–12. https://doi.org/10.5402/2012/231458
Richards, A.A., 2016. Physical, Regulatory and Reputational Water Risks as Predictors of Water Stewardship among Global Corporations. George Mason University.
Robbins, P., 2012. Political ecology : a critical introduction, 2nd ed. ed. J. Wiley & Sons, Oxford.
Roberts, T.M., Hutchinson, T.C., Paciga, J., Chattopadhyay, A., Jervis, R.E., VanLoon, J., Parkinson, D.K., 1974. Lead Contamination around Secondary Smelters: Estimation of Dispersal and Accumulation by Humans. Science (80-.). 186, 3.

Robles Mendoza, R., 2004. Tradición y modernidad en las comunidades campesinas. Investig. Soc. VIII, 25–54.

Rodbell, D., Delman, E., Abbott, M., Besonen, M., Tapia, P., 2014. The heavy metal contamination of Lake Junín National Reserve, Peru: An unintended consequence of the juxtaposition of hydroelectricity and mining. GSA Today 24, 4–10. https://doi.org/10.1130/GSATG200A.1.4

Rodríguez-Labajos, B., Özkaynak, B., 2017. Environmental justice through the lens of mining conflicts. Geoforum 84, 245–250. https://doi.org/10.1016/j.geoforum.2017.06.021

Rose, M., 2002. The seductions of resistance: Power, politics, and a performative style of systems. Environ. Plan. D Soc. Sp. 20, 383–400. https://doi.org/10.1068/d262t

Rothman, K.J., 2012. Epidemiology: An Introduction, 2nd ed. ed. Oxford University Press, New York.

Rötting, T.S., Mercado, M., García, M.E., Quintanilla, J., 2014. Environmental distribution and health impacts of As and Pb in crops and soils near Vinto smelter, Oruro, Bolivia. Int. J. Environ. Sci. Technol. 11, 935–948. https://doi.org/10.1007/s13762-013-0313-1

Ruiz Peralta, V., 1996. Prensa, opinión pública y terrorismo en Perú (1980-1994). Universidad Complutense de Madrid.

Rumbo Minero, n.d. Entérate de las nuevas modificaciones al proyecto Huacravilca en Junín [WWW Document]. URL http://www.rumbominero.com/noticias/mineria/enterate-de-las-nuevas-modificaciones-al-proyecto-huacravilca-en-junin/ (accessed 8.30.17).

Salas Carreño, G., 2008. Dinámica social y minería : familias pastoras de puna y la presencia del proyecto Antamina (1997-2002), 1st ed. ed. IEP Instituto de Estudios Peruanos, Lima.

Salas Carreño, G., 2004. Política distrital, propietarios individuales e institucionalidad comunal la administración de los fondos de la venta de tierras al Proyecto Antamina (San Marcos, Huari, Áncash), in: Eguren, F., Remy, M.I., Oliart, P. (Eds.), Seminario Permanente de Investigación Agraria—SEPIA X. Semianrio Permanente de Investigación Agraria, Lima, pp. 385–424.

Salazar Vega, E., 2017. Las deudas pendientes de ocho mineras por el uso del agua [WWW Document]. OjoPúblico. URL https://ojo-publico.com/502/el-agua-que-las-empresas-mineras-no-pagan (accessed 4.22.19).

Salem, J., Amonkar, Y., Maennling, N., Lall, U., Bonnafous, L., Thakkar, K., 2018. An analysis of Peru: Is water driving mining conflicts? Resour. Policy. https://doi.org/10.1016/j.resourpol.2018.09.010

Sanabria, J., Calanca, P., Alarcón, C., Canchari, G., 2014. Potential impacts of early twenty-first century changes in temperature and precipitation on rainfed annual crops in the Central Andes of Peru. Reg. Environ. Chang. 14, 1533–1548. https://doi.org/10.1007/s10113-014-0595-y

Sanborn, C.A., Ramirez, T., 2016. La consulta previa en el Perú: avances y retos, 1st ed. ed. Universidad del Pacífico, Lima. https://doi.org/http://dx.doi.org/10.21678/978-9972-57-366-8-2016

Sánchez Aguilar, A., 2015. Migraciones internas en el Perú. Organización para las

Migraciones (OIM), Lima, Perú.
Sarmiento, L., Bottner, P., 2002. Carbon and nitrogen dynamics in two soils with different fallow times in the high tropical Andes: Indications for fertility restoration. Appl. Soil Ecol. 19, 79–89. https://doi.org/10.1016/S0929-1393(01)00178-0
Schönenberg, R., Boy, J., Hartberger, K., Schumann, C., Guggenberger, G., Siebold, M., Lakes, T., Lamparter, G., Schindewolf, M., Schaldach, R., Nendel, C., Hohnwald, S., Meurer, K.H.E., Gerold, G., Klingler, M., 2017. Experiences of inter- and transdiciplinary research—A trajectory of knowledge integration within a large research consortium. Erkunde 71, 177–193. https://doi.org/doi.org/ 10.3112/erdkunde.2017.03.02
Schuldt, J., Acosta, A., Barandiarán, A., Bebbington, A., Folchi, M., CEDLA—Bolivia, Alayza, A., Gudynas, E., 2009. Extractivismo, Política y Sociedad, 1st ed. ed, Cuadernos de Capacitación. CAAP and CLAES, Quito.
Schulte, P., Orr, S., Morrison, J., 2014. Shared Risks and Interests, in: Peter H. Gleick (Ed.), The World’s Water. Island Press/Center for Resource Economics, Washington, DC, pp. 19–33. https://doi.org/10.5822/978-1-61091-483-3_2
Servicios en comunicación Intercultural—SERVINDI, 2015. Perú : Primera consulta previa en minería sería un saludo a la bandera [WWW Document]. URL https://www.servindi.org/actualidad/139133 (accessed 4.15.19).
Shahid, M., Shamshad, S., Rafiq, M., Khalid, S., Bibi, I., Niazi, N.K., Dumat, C., Rashid, M.I., 2017. Chromium speciation, bioavailability, uptake, toxicity and detoxification in soil-plant system: A review. Chemosphere 178, 513–533. https://doi.org/10.1016/j.chemosphere.2017.03.074
Silva-Macher, J.C., Farrell, K.N., 2014. The flow/fund model of Conga: Exploring the anatomy of environmental conflicts at the Andes-Amazon commodity frontier. Environ. Dev. Sustain. 16, 747–768. https://doi.org/10.1007/s10668-013-9488-3
Silverman, D., 2015. Interpreting Qualitative Data, 5th ed. ed. SAGE Publications Ltd, London.
Sistema de Información sobre Comunidades Campesinas del Perú—SICCAM, 2016. Directorio 2016 de Comunidades Campesinas del Perú, 1st ed. ed. Centro Peruano de Estudios Sociales; Instituto del Bien Común, Lima.
Sociedad Nacional de Minería Petróleo y Energía—SNMPE, 2018. El canon, sobrecanon y las regalías en el Perú (2008-2017), 1st ed. ed. Sociedad Nacional de Minería Petróleo y Energía—SNMPE, Lima.
Soifer, H.D., 2015. State building in Latin America, 1st ed. ed. Cambridge University Press, New York.
Sosa, M., Zwarteveen, M., 2012. Exploring the politics of water grabbing: The case of large mining operations in the Peruvian Andes. Water Altern. 5, 360–375.
Starn, O., 1995. Maoism in the Andes: The Communist Party of Peru-Shining Path and the refusal of history. J. Lat. Am. Stud. 27, 399–421.
Stasavage, D., 2011. States of credit : size, power, and the development of European polities, 1st ed. ed. Princeton University Press, Princeton.
StataCorp, 2017. Stata: Release 15. https://doi.org/10.1016/j.eneco.2014.12.008
Swinton, S.M., Quiroz, R., 2003. Is poverty to blame for soil, pasture and forest degradation in Peru’s Altiplano? World Dev. 31, 1903–1919.

https://doi.org/10.1016/j.worlddev.2003.06.004
Swyngedouw, E., 2009. The Political Economy and Political Ecology of the Hydro-Social Cycle. J. Contemp. Water Res. Educ. 142, 56–60. https://doi.org/10.1111/j.1936-704x.2009.00054.x
Szablowski, D., 2002. Mining, displacement and the World Bank: A case analysis of compania minera antamina's operations in Peru. J. Bus. Ethics 39, 247–273. https://doi.org/10.1023/A:1016554512521
Taft, H.L., 2015. Water Scarcity: Global Challenges for Agriculture, Food, Energy, and Water: The Chemistry Connection. Elsevier Inc. https://doi.org/10.1016/B978-0-12-800211-7.00016-8
Taylor, L., 1998. Counter-insurgency strategy, the PCP-Sendero Luminoso and the civil war in Peru, 1980-1996. Bull. Lat. Am. Res. 17, 35–58. https://doi.org/10.1016/S0261-3050(97)00059-4
The World Bank—WB, 2018. Peru–2030 Water Resources Group [WWW Document]. World Bank. URL https://www.2030wrg.org/peru/ (accessed 10.29.18).
The World Bank—WB, 2016. La Consulta Previa en el Perú: Aprendizajes y desafíos, 1st ed. ed. Licencia: Creative Commons de Reconocimiento CC BY 3.0 IGO., Washington, DC.
The World Bank—WB, 2005. Wealth and Sustainability: The Environmental and Social Dimensions of the Mining Sector in Peru (No. 33545).
Tribunal de Fiscalización Ambiental—TFA, 2018. Resolución Nº 296-2018-OEFA/TFA-SMEPIM.
Triscritti, F., 2013. Mining, development and corporate–community conflicts in Peru. Community Dev. J. 48, 437–450. https://doi.org/10.1093/cdj/bst024
Tudor, C.A., Iojă, I.C., Pătru-Stupariu, I., Nită, M.R., Hersperger, A.M., 2014. How successful is the resolution of land-use conflicts? A comparison of cases from Switzerland and Romania. Appl. Geogr. 47, 125–136. https://doi.org/10.1016/j.apgeog.2013.12.008
U.S. Geological Survey—USGS, 2019. EarthExplorer - Home [WWW Document]. URL https://earthexplorer.usgs.gov/ (accessed 2.5.18).
United Nations World Water Assessment Programme—WWAP, 2003. Water for people, water for life: The United Nations World Water Development Report. Paris. https://doi.org/10.1017/CBO9781107415324.004
United States Environmental Protection Agency—EPA, 1994. Method 200.7, Determination of metals and trace elements in water and wastes by inductively coupled plasma-atomic emission spectrometry. Ohio.
Urrutia, J., 2003. Cambios y permanencia comunales en medio siglo: Revisita a un texto olvidado. Debate Agrar. 35, 183–194.
Valdivia, C., Quiroz, R., 2003. Coping and adapting to increased climate variability in the Andes. Am. Agric. Econ. Assoc. Annu. Meet. 1–28.
Valencia, L., Riaño, A., 2017. La minería en el postconflicto: Un asunto de quilates, 1st ed. ed. Editora Géminis S.A.S., Bogotá.
Valle Junior, R.F., Varandas, S.G.P., Sanches Fernandes, L.F., Pacheco, F.A.L., 2014. Groundwater quality in rural watersheds with environmental land use conflicts. Sci. Total Environ. 493, 812–827. https://doi.org/10.1016/j.scitotenv.2014.06.068

Vélez-Torres, I., 2014. Governmental extractivism in Colombia: Legislation, securitization and the local settings of mining control. Polit. Geogr. 38, 68–78. https://doi.org/10.1016/j.polgeo.2013.11.008

Vivekananda, J., Schilling, J., Mitra, S., Pandey, N., 2014. On shrimp, salt and security: livelihood risks and responses in South Bangladesh and East India. Environ. Dev. Sustain. 16, 1141–1161. https://doi.org/10.1007/s10668-014-9517-x

Viveros, H., 2017. Unpacking stakeholder mechanisms to influence corporate social responsibility in the mining sector. Resour. Policy 51, 12. https://doi.org/10.1016/j.resourpol.2016.10.014

Von Braun, J., Gatzweiler, F.W., 2014. Marginality-a framework for analyzing causal complexities of poverty, 1st ed. ed, Marginality: Addressing the Nexus of Poverty, Exclusion and Ecology. Springer, Dordrecht. https://doi.org/10.1007/978-94-007-7061-4_2

Von Der Dunk, A., Grêt-Regamey, A., Dalang, T., Hersperger, A.M., 2011. Defining a typology of peri-urban land-use conflicts - A case study from Switzerland. Landsc. Urban Plan. 101, 149–156. https://doi.org/10.1016/j.landurbplan.2011.02.007

Vyas, S., Kumaranayake, L., 2006. Constructing socio-economic status indices: How to use principal components analysis. Health Policy Plan. 21, 459–468. https://doi.org/10.1093/heapol/czl029

Wagner, J.R., 2013. The Social Life of Water, 1st. ed. ed. Berghahn Books, Oxford.

Wall, E., Pelon, R., 2011. Sharing mining benefits in developing countries. Extr. Ind. Dev. 21, 1–60.

Walter, M., Urkidi, L., 2017. Community mining consultations in Latin America (2002–2012): The contested emergence of a hybrid institution for participation. Geoforum 84, 265–279. https://doi.org/10.1016/j.geoforum.2015.09.007

Warnaars, X.S., 2012. Why be poor when we can be rich? Constructing responsible mining in El Pangui, Ecuador. Resour. Policy 37, 223–232. https://doi.org/10.1016/j.resourpol.2011.10.001

Weil, R.R., Brady, N.C., 2017. The Nature and Properties of Soils, 15th ed. ed. Pearson, Essex.

Wiegers, E.S., Hijmans, R.J., Hervé, D., Fresco, L.O., 1999. Land Use Intensification and Disintensification in the Upper Cañete Valley, Peru. Hum. Ecol. 27, 319–339. https://doi.org/10.1023/A:1018729428781

Wilson, F., 2004. Towards a political economy of roads: Experiences from Peru. Dev. Change 35, 525–546. https://doi.org/10.1111/j.1467-7660.2004.00364.x

Wise, J.M., 2007. Tectono-stratigraphic histoy of the Huancayo intermontane basin, central Peru. Bol. la Soc. Geológica del Perú 102, 63–72.

World Health Organisation—WHO, 2007. Health risks of heavy metals from long-range transboundary air poluution, Joint WHO l Convention Task Force on Health Aspects of Air Pollution. Copenhagen.

World Resource Institute—WRI, 2015. Aqueduct Water Risk Atlas [WWW Document]. URL: www.wri.org/resources/maps/aqueduct-water-risk-atlas (accessed 1.11.19).

Zegarra, E., Orihuela, J.C., Paredes, M., 2007. Minería y economía de los hogares en la Sierra peruana: impactos y espacios de conflictos, 1st ed. ed, GRADE. GRADE and CIES: Lima, Perú.

8. APPENDICES

8.1. Guidelines of an in-depth interview to mining and community representatives

To mining projects:

- Which are the campesino communities directly and indirectly affected by the mining project?
- Which campesino communities have or had a mining-community agreement with the mining project?
- Which are the disagreements or conflicts within the community and with the mining project?
- Could you explain the process (negotiation) from the first contact to the signing of the agreement?
- Which are the main difficulties to establish dialogues that lead to the negotiation of the agreement?
- How was the frequency before and after signing the agreement?
- How is the renewal of the mining-community agreement?
- How has the relationship evolved between the mining project and the campesino community from the first contact up to now?
- Which are the main reasons to trigger a land-use conflict?
- What are the main reasons for breaching the mining-community agreement?

To campesino communities:

- Has your community had any contact with the mining project? If so, when and how was the first contact with the mining project?
- Has your community ever been contacted by another mining project? If so, how was this experience?
- How was the negotiation that led to signing the agreement?
- How and why did your community accept signing a mining-community agreement?
- Which are the clauses of the agreement?

- Has your community changed after signing the agreement? If so, which are these changes?
- Is your community satisfied with the accomplishment of the agreement?
- Has the mining-community agreement been completely accomplished?
- What are the main reasons for breaching the mining-community agreement?
- Which are the main reasons to trigger a land-use conflict?

8.2. Heavy metal concentrations in water and soil analyzed during this research and by state institutions

Table 8-1. Total metal concentrations (mg L^{-1}) in water samples evaluated by OEFA in Aimaraes sub-basin. Values exceeding EQS are in bold.

Year	ID	pH	Pb	Cu	Zn	As	Hg	Cr	Cd	Ni	Fe	Mn
2010	sw02_10	**4.59**	<0.005	**0.219**	0.279	**0.529**	<0.0001	0.007	0.009	0.036	**36.12**	0.400
	sw04_10	**5.34**	<0.005	0.036	0.07	0.019	<0.0001	0.002	0.0008	0.009	4.309	0.072
	sw05_10	8.27	<0.005	<0.001	<0.001	0.008	<0.0001	<0.001	<0.0007	<0.002	0.148	0.033
	sw06_10	**9.37**	0.022	0.002	0.007	0.009	<0.0001	<0.001	<0.0007	<0.002	0.079	0.006
	sw09_10	8.14	<0.005	0.002	<0.001	0.007	<0.0001	<0.001	<0.0007	<0.002	0.044	0.045
	sw10_10	**4.36**	<0.005	0.034	0.154	<0.005	<0.0001	0.002	0.0016	0.022	4.096	**0.400**
	sw14_10	**4.96**	<0.005	0.038	0.184	0.006	<0.0001	<0.001	0.0013	0.018	0.440	**1.148**
2012	BW07_12	7.0	0.0008	0.0004	0.009	0.0009	<0.0001	<0.0005	-	<0.0004	-	0.0093
	sw10_12	**4.3**	0.0124	0.0534	0.0974	0.0356	<0.0001	0.0018	-	0.0117	-	0.378
	MA08_12	**3.0**	0.0209	0.0874	0.1494	0.0503	<0.0001	0.0037	-	0.0205	-	0.1072
	MA02_12	8.4	<0.0002	0.0002	0.0042	0.0007	<0.0001	<0.0005	-	<0.0004	-	0.0056
	EBMI_12	**4.2**	0.0022	**0.3256**	1.0173	0.0068	-	-	-	-	-	-
2013	sw04_13	**3.16**	<0.010	0.0085	<0.14	0.0222	<0.0003	-	<0.0024	-	4.377	0.0911
	sw10_13	**3.16**	<0.010	0.0968	0.24	0.0949	<0.0003	-	0.003	-	**16.5**	**0.896**
	sw20_13	**3.32**	<0.010	0.1046	0.26	0.0936	<0.0003	-	0.0038	-	**16.6**	**0.8772**
	Sw01_13	**3.09**	<0.010	0.1137	0.23	0.0492	<0.0003	-	<0.0024	-	**25.851**	**1.3723**
	sw19_13	**3.11**	<0.010	0.131	0.21	0.0206	<0.0003	-	<0.0024	-	**18.5**	**1.3533**

Based on OEFA reports (OEFA, 2014b, 2014c, 2012).

Table 8-2. Total metal concentrations (mg L^{-1}) in water samples evaluated by OEFA in 2013 in Cunas sub-basin

Code	pH	Pb	Cu	Zn	As	Hg	Cr	Cd	Fe	Mn
vi01	8.18	<0.001	0.0135	0.779	**0.23**	<1	<0.010	**0.01**	-	-
e02	8.07	0.009	<0.0083	0.196	**13.43**	<1	<0.010	<0.0004	-	-
e01	8.24	<0.001	0.0092	0.197	**2.977**	<0.00003	-	<0.0004	0.1232	18.11
e05	8.22	<0.001	0.0117	0.082	0.050	<0.00003	-	<0.0004	0.3218	0.0479
pcp01	7.96	<0.001	0.0111	1.057	**0.333**	<0.00003	-	**0.0016**	0.5555	2.288
esp01	8.00	<0.001	0.0101	0.077	0.088	<0.00003	-	<0.0004	0.1744	0.0307
e04	8.31	<0.001	0.0078	0.044	<0.008	<0.00003	-	<0.0004	0.0989	0.1464
hv01	8.27	0.009	0.0106	0.088	**0.139**	0.0007	-	<0.0004	0.3655	0.0897
esp01_14	8.02	<0.001	0.0105	0.088	**0.102**	0.0008	-	**0.0012**	0.5415	0.0504
esp02_14	7.92	<0.001	0.0108	0.279	**2.97**	0.001	-	**0.0016**	0.1175	19.82

Based on OEFA (OEFA, 2014a, 2013a).

Table 8-3. Concentration (mg L^{-1}) of total metals in water samples in this research in Cunas sub-basin

	Code	pH	As	Cd	Ni	Hg	Pb	Cu	Fe	Mn	Zn
Control	1 I-N	**9.68**	0.017	N.D.	N.D.	<0,010	N.D.	<0,004	0.033	0.0055	0.004
	2 I-N		0.015	N.D.	N.D.	<0,010	N.D.	<0,004	0.031	0.0055	0.004
	1 P-N	8.07	<0.010	N.D.	N.D.	<0,010	N.D.	0.005	0.006	<0,0003	<0,003
	2 P-N		<0.010	N.D.	N.D.	<0,010	N.D.	0.005	0.012	<0,0003	0.004
Cases	1 B-AM	8.31	0.089	N.D.	N.D.	<0,010	N.D.	0.005	0.111	0.025	0.007
	2 B-AM		0.094	N.D.	N.D.	<0,010	N.D.	0.006	0.112	0.026	0.009
	1 A-AM	7.78	**0.56**	**0.023**	0.019	<0,010	<0,028	0.008	0.926	**18.505**	12.34
	2 A-AM		**0.562**	**0.022**	0.019	<0,010	<0,028	0.007	0.913	**18.735**	12.47
	1 B-UC	**9.7**	0.016	N.D.	N.D.	<0,010	N.D.	<0,004	0.032	0.0103	0.007
	2 B-UC		0.017	N.D.	N.D.	<0,010	N.D.	<0,004	0.031	0.0065	<0,003
	1 A-UC	**9.37**	0.011	N.D.	N.D.	<0,010	N.D.	<0,004	0.022	0.0065	<0,003

2 A-UC	0.016	N.D.	N.D.	<0,010	N.D.	<0,004	0.025	0.006	0.009

N.D. < Detection limit in mg L^{-1}: Cd (0.002), Cu (0,001), Cr (0,002), Ni (0,004) and Pb (0,009)

Table 8-4. Total metal concentrations (mg L^{-1}) in water samples in this research in Aimaraes sub-basin

	Code	**pH**	**As**	**Cd**	**Ni**	**Hg**	**Cu**	**Fe**	**Mn**	**Zn**
Control	1 L-S	**10.9**	<0.010	N.D.	N.D.	<0,01	<0,004	0.029	0.006	0.004
	2 L-S		0.011	N.D.	N.D.	<0,01	<0,004	0.056	0.006	<0.003
	1 I-L	**9.5**	<0.010	N.D.	N.D.	<0,01	0.007	0.260	0.015	0.006
	2 I-L		<0.010	N.D.	N.D.	<0,01	**0.017**	0.273	0.016	0.008
	1 A-CM	**9.18**	<0.010	N.D.	N.D.	<0,01	<0,004	0.017	<0,0003	0.004
	2 A-CM		<0.010	N.D.	N.D.	<0,01	0.005	0.018	0,0035	0.007
Cases	1 B-HM	**5.4**	<0.010	**0.006**	<0,013	<0,01	**0.071**	**50.020**	**2.140**	0.102
	2 B-HM		<0.010	**0.006**	<0,013	<0,01	**0.072**	**52.000**	**2.134**	0.097
	1 A-HM	**9.9**	<0.010	N.D.	N.D.	<0,01	<0,004	0.032	<0,0003	<0,003
	2 A-HM		<0.010	<0,005	N.D.	<0,01	<0,004	0.028	<0,0003	<0,003
	1 A-CA-S	**9.83**	<0.010	N.D.	N.D.	<0,01	<0,004	0.023	0.005	0.004
	2 A-CA-S		<0.010	N.D.	N.D.	<0,01	<0,004	0.046	0.008	0.006

N.D. < Detection limit in mg L^{-1}: Cd (0.002), Cu (0,001), Cr (0,002), Ni (0,004) and Pb (0,009)

Table 8-5. Environmental Quality Standards (EQS) (mg L^{-1}) established by the Peruvian Ministry of Environment in 2017.

Category (C)	Use	As	Cd	Hg	Cr	Pb	Cu	Fe	Mn	Zn
C3: Farming activities	Irrigation	0.1	0.01	0.001	0.1	0.05	0.2	5	0.2	2
	Livestock drinking	0.2	0.05	0.01	1	0.05	0.5	n/a	0.2	24
C4: Conservation of aquatic life	Andean rivers	0.15	0.00025	0.0001	0.011	0.0025	0.1	n/a	n/a	0.12

8.3. Code for topographic correction of DEM in RStudio

```
####### libraries ########
library(raster)
library(RStoolbox)

####### inputs ########
input_image <- "S:/Data/inputs/Mosaic06686918S.tif"
input_dem <- "S:/Data/inputs/srtm_21_15_pro_clip.tif"
input_metadata <-
"S:/Data/inputs/LC08_L1TP_006069_20170722_20170728_01_T1_MTL.txt"
output_folder <- "S:/Data/outputs"

####### reading data ########
sta.file <- stack(input_image)
elevation <- raster(input_dem)
extent(elevation) <- extent(sta.file)
meta.info <- readMeta(input_metadata)

####### processing ########
sta.output <- list()
for(i in 1:nlayers(sta.file)){
```

```
  x <- topCor(img=sta.file[[i]],dem=elevation,metaData=meta.info,method="minnaert",stratImg = "slope")
  sta.output[[i]] <- x
}
sta.output <- stack(sta.output)
#save
output.name <- paste0(output_folder,"/img_corrrected.tif")
writeRaster(sta.output,output.name,overwrite=T)
```

8.4. Code for recode land cover classification

This script intends to recode a categorical raster $\boldsymbol{R_{cat}}$ with a polygon-based shapefile $\boldsymbol{S_{pol}}$ with a target_column and recode_column on its attribute table. The name specified in target_column of $\boldsymbol{S_{pol}}$ is used to filter values in $\boldsymbol{R_{cat}}$ and overwrite them with those indicated in recode_column.

```
############### libraries #############
library(raster)
library(gdalUtils)
library(rgdal)

############### inputs #############
classification_filename="D:/Data/mel/class_20180621cat2.tif"
recoding_shapefile="D:/Data/mel/recla_FIX.shp"
target_column="tar"
recode_column="rec"
overwrite=F

############### reading data #############
#start routines
if(!file.exists(recoding_shapefile)){
  stop("'recoding_shapefile' do not exists")
}
if(!file.exists(classification_filename)){
  stop("'classification_filename' do not exists")
}
#open shapefile
recod.shp <- shapefile(recoding_shapefile)
if(recod.shp@proj4string@projargs!=raster(classification_filename)@crs@projargs){
```

```
  stop("shapefile do not have the same projection system as classification")
}
recod.lyr <- unlist(strsplit(basename(recoding_shapefile),"[.]"))[1]
#open classification
class.ras <- raster(classification_filename)
#folders
temp.folder <-
paste0(dirname(classification_filename),"/temp");dir.create(temp.folder,showWarning
s=F)
if(length(list.files(temp.folder))!=0){
  unlink(list.files(temp.folder,full.names=T),recursive=T,force=T)
}

############### processing ###############
#info needed
ras.res <- res(class.ras)
ras.ext <- extent(class.ras)
ras.ext <- c(ras.ext@xmin,ras.ext@ymin,ras.ext@xmax,ras.ext@ymax)
#prepare shapefiles
tar.ras <- paste0(temp.folder,"/temp_tar.tif")
rec.ras <- paste0(temp.folder,"/temp_rec.tif")
#target raster
gdal_rasterize(src_datasource=recoding_shapefile,
          dst_filename=tar.ras,
          te=ras.ext,
          tr=ras.res,
          a=target_column,
          l=recod.lyr,
          ot="Byte")
#recode raster
gdal_rasterize(src_datasource=recoding_shapefile,
          dst_filename=rec.ras,
          te=ras.ext,
          tr=ras.res,
          a=recode_column,
          l=recod.lyr,
          ot="Byte")

#input values
class.val <- values(class.ras)
class.val[is.na(class.val)] <- 0
#modifying values
tar.val <- values(raster(tar.ras))
rec.val <- values(raster(rec.ras))
#recode
```

```
class.val[class.val==tar.val] <- rec.val[class.val==tar.val]
class.val[class.val==0] <- NA
values(class.ras) <- class.val

############### save ###############
if(overwrite){
  output.name <- classification_filename
  writeRaster(class.ras,output.name,overwrite=T)
}else{
  output.name <-
paste0(dirname(classification_filename),"/recoded_",basename(classification_filename
))
  writeRaster(class.ras,output.name,overwrite=T)
}
#clean
unlink(temp.folder,recursive=T,force=T)
```

8.5. Validation of risk index

The following subsections were provided to an expert panel for validation of the developed risk index.

8.5.1. Land-use conflict

Definición: Los conflictos por uso de tierra son generados por el cambio de uso de agricultura y/o ganadería hacia minería, afectando los medios de subsistencia tradicionales (Hilson, 2002). Estos conflictos son la respuesta de las comunidades ante las amenazas de sus ecosistemas y medios de subsistencia (contaminación de agua y suelo) (Bebbington et al., 2008; Bebbington and Bury, 2009; Li, 2009; McDonell, 2015).

8.5.2. Descripción de las comunidades

A pesar del avance en proveer servicios públicos a las comunidades, la pobreza y marginalidad ha aumentado así como la probabilidad de conflictos (Haslam and Tanimoune, 2016). Por otro lado, las comunidades enfrentan problemas relacionados a los eventos climáticos (ej. sequía) que afectan las oportunidades agrarias, incrementando la presión sobre la tierra y conflictos por su uso (Haslam and Tanimoune, 2016; Urrutia, 2003).

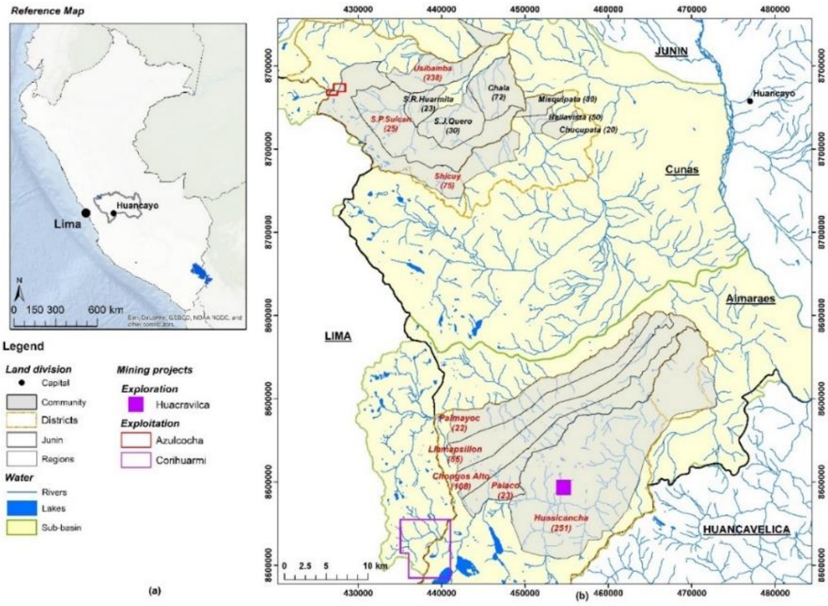


Figure 8-1. Ubicación de minas y comunidades campesinas con total de comuneros activos (2016) en sub-cuencas de Aimaraes y Cunas.
Comunidades estudiadas en el índice de riesgo estuvieron vinculadas con minería fueron resaltadas en rojo.

Nuestro estudio incluyó 8 comunidades campesinas de la región Junín. Table 8-6 presenta una descripción de las comunidades, basada en el trabajo de campo 2016-2017.

Table 8-6. Descripción de comunidades

Distrito	Comun.	Descripción
San José de Quero	San Pedro de Sulcan	Formado por 25 comuneros activos. Depende de las lluvias para la agricultura de autoconsumo. Sin embargo, tiene dificultades en acceso de tierra y agua. Es un vecino colindante de la mina Azulcocha pero desconocen sobre las implicancias de las actividades de la misma. No tiene un convenio con la mina Azulcocha.
	Usibam-ba	Formado por 238 comuneros activos. Su economía se basa en ganadería y productos lácteos. Realiza agricultura a través de irrigación y lluvias. Es un vecino colindante de la mina Azulcocha pero no quieren tener un convenio con la mina.
San Juan de Jarpa	Shicuy	Formado por 75 comuneros activos. Ganadería (usa el 80% de su territorio) y agricultura (usa el 20% de su territorio) son sus principales actividades económicas. Tiene un convenio activo con la mina Azulcocha desde 2016.
Huasi-cancha	Huasi-cancha	Formado por 251 comuneros activos. Ganadería y agricultura son sus principales actividades económicas. Depende de las lluvias para la agricultura de autoconsumo. Renta tierras al proyecto minero Huacravilca, mediante un convenio.

		Huasicancha y Palaco (y comunidades pertenecientes al distrito Chongos Alto) tienen un conflicto latente por un territorio (10 mil ha), el cual se renta actualmente a Huacravilca.
Chongos Alto	Chongos Alto	Formado por 108 comuneros activos. Depende de la ganadería y agricultura, aunque la última es afectada por la falta de sistema de irrigación apropiado y eventos climáticos (granizo, heladas). Presentan precarias carreteras que acceden a la comunidad. Antes del 2015, se beneficiaba de la mina Corihuarmi, sin embargo, el convenio se canceló hasta la fecha.
	Palma-yoc	Formado por 22 comuneros activos. Ganadería y agricultura son sus principales actividades económicas que son afectadas por los eventos climáticos. Cercanía a la mina Corihuarmi.
	Palaco	Formado por 23 comuneros activos. Ganadería y agricultura son sus principales actividades económicas que son afectadas por los eventos climáticos. Comuneros se quejan sobre la falta de apoyo por parte de MINAGRI. Cercanía a la mina Corihuarmi y proyecto Huacravilca.
	Llamapsi-llon	Formado por 55 comuneros activos. Ganadería y agricultura son sus principales actividades económicas que son afectadas por los eventos climáticos y la reducción de pastos para ganado. Falta de apoyo por parte de MINAGRI para ganadería. Cercanía a la mina Corihuarmi.

8.5.3. Índice de riesgo de conflictos por uso de la tierra

Table 8-7 se presenta a los indicadores y sus criterios obtenidos de un análisis de contenido de las entrevistas realizadas a los grupos de interés que se involucrarían en un conflicto por uso de tierra. Con la finalidad de evitar la influencia de actores oportunistas y de nuevos intereses que desencadenen un probable conflicto, la presente investigación se realizó en comunidades que actualmente no están en un conflicto activo con las compañías mineras.

Table 8-7. Descripción de indicadores usados en el índice

Criterio (*k*)	**Indicador (*i*)**	**Descripción para la obtención de valores**
Agua (W)	Sequía	La sequía es un problema constante para ganadería y agricultura. Fue obtenido a través del cuestionario semi-estructurado (1=Hay problema por sequía, 0=no hay dicho problema)
	W_acceso	Conocimiento de acceso a fuentes de agua por familia. Fue obtenido a través del cuestionario semi-estructurado (1= Hay problema por acceso a agua, 0=no hay dicho problema).
	W_disponibilidad	Conocimiento de disponibilidad de agua por familia. Fue obtenido a través del cuestionario semi-estructurado (1= Hay problema por disponibilidad de agua, 0=no hay dicho problema).
	W_calidad	Conocimiento de calidad de agua por familia. Fue obtenido a través del cuestionario semi-estructurado (1= Hay problema por calidad de agua, 0=no hay dicho problema).
	M_actividad	Actividad minera de la mina o proyecto minero (ej. Exploración, explotación).

		Fue obtenido a través de entrevistas y data secundaria.
	F_ausencia	Ausencia de trucha en los ríos en comunidades. Fue obtenido a través del cuestionario semi-estructurado (1= Ausencia de truchas en ríos, 0=presencia de truchas en ríos).
Suelo (SF)	Compost	Uso de compost para cultivos. Fue obtenido a través del cuestionario semi-estructurado (1= Uso de compost, 0=no uso de compost).
	C_productos	Los productos agrícolas fueron clasificados según su uso. Fue obtenido a través del cuestionario semi-estructurado (0= No cultivos ni pastos, 1= pastos, 2=cultivos como tubérculos).
	C_producción	Producción anual de su cultivo principal reportado durante el cuestionario semi-estructurado (en kg).
	S_calidad	Calidad del suelo en base a la concentración de un metal (en este caso Cadmio). Fue obtenido a través de la interpolación (ArcGis) de las concentraciones de Cd reportados por INGEMMET.
Uso de tierra (LU)	Com_area	Área total por comunidad (m^2) que fue estimado mediante la georreferenciación y elaboración del mapa de la comunidad (ArcGis, entrevista y data secundaria del gobierno).
	Pastoreo_area	Área para pastoreo por comunidad (m^2) que fue estimado mediante la clasificación de cobertura de suelo de imágenes satelitales Landsat.
	Pastoreo_ganadería	Cada entrevistado manifestó si realiza pastoreo de su ganado. Fue obtenido a través del cuestionario semi-estructurado (1= realiza pastoreo, 2=No realiza pastoreo).
Dialogo Comunidad-Minería (CMD)	N_diálogos	Número de diálogos realizados entre la comunidad y la compañía minera hasta el momento del cuestionario. Fue reportado durante el cuestionario semi-estructurado, y entrevistas a grupos de interés.
	Tiempo_reunión	Estimación del tiempo (en años) desde la primera reunión que se llevó a cabo entre la comunidad y la compañía minera. Fue reportado durante el cuestionario semi-estructurado, y entrevistas a grupos de interés.
	Relación	El tipo de relación entre la comunidad y la compañía minera fue categorizado desde un accidente ambiental (1) hasta conflicto (9). Fue reportado durante el cuestionario semi-estructurado, y entrevistas a grupos de interés.
	SE_beneficios	Nivel de los beneficios socio-económicos percibidos por la comunidad y brindados por la compañía minera (1=solo en fiestas de comunidad, 2=ayuda en pequeños proyectos comunales, 3=convenio entre la mina y la comunidad).
Involucra-miento de instituciones estatales (GII)	Instituciones	El nivel de conocimiento de la comunidad sobre las instituciones del gobierno (e.g. OEFA, ANA). Fue reportado durante el cuestionario semi-estructurado (1=conoce solo al gobierno distrital/provincial, 2=conoce a 2 instituciones, 3=conoce a más de 3 instituciones).
	Distancia	Distancia (en km) desde el local comunal hasta Huancayo. Basado en la data proveída por el Ministerio de Transporte y comunicaciones.
	Altitud	Altura (msnm) de cada comunal. Fue obtenido a través de la medición por GPS en el local comunal.

	Carretera_acceso	Condición de las vías de acceso para la comunidad (0=trochas, 1=pistas asfaltadas, 2=pistas asfaltadas y trochas). Obtenido a través de la observación en trabajo de campo.
Economía (E)	Ingreso	Ingreso familiar mensual (PEN) reportado por el entrevistado.
	Gastos	Gasto familiar mensual (PEN) reportado por el entrevistado.
	M_retribución	Retribución anual (PEN) de la mina para la comunidad que fue acordado en el convenio. Reportado en cuestionarios y entrevistas a grupos de interés.

El índice de riesgo se basó en el modelo de agregación aditiva (Choo and Wedley, 2008) y combinación linear ponderado (Malczewski and Rinner, 2015). Ecuación 1 indica los componentes del índice de riesgo RI.

$$\mathrm{RI}_{Com} = (V_W)(W)_W + (V_{SF})(W)_{SF} + (V_{LU})(W)_{LU} + (V_{CMD})(W)_{CMD} + (V_{GII})(W)_{GII} + (V_E)(W)_E$$

Ecuación 1. Índice de riesgo de conflicto de uso de tierra

Donde:

RI_{Com} es el índice de riesgo de conflicto de uso de tierra por comunidad

$V_{criterion}$ es el valor total del criterio estimado por comunidad

$W_{criterion}$ es el peso total del criterio estimado por comunidad

Los valores totales obtenidos en cada criterio (*k*) (ver table 2) fueron reemplazados en la ecuación del índice de riesgo (RI). Los pesos de cada indicador (*i*) fueron obtenidos por la calificación de los entrevistados comuneros activos. Los pesos totales de los criterios (*k*) fueron obtenidos de la calificación de los grupos de interés.

La Table 8-8 muestra el puntaje obtenido por cada criterio (*k*) y el índice de riesgo (RI) resultante. Como se observa, Huasicancha and Palaco se encuentra en el límite de riesgo moderado a desarrollar un conflicto. La escala del índice va de 0 (muy bajo nivel de riesgo) a 1 (máximo nivel de riesgo).

Table 8-8. Índice de riesgo por comunidad

Comunidad	SF	LU	CMD	W	GII	E	RI
Sulcan	0.08	0.05	0.03	0.04	**0.11**	0.01	**0.31**
Usibamba	0.07	0.01	**0.08**	0.05	0.05	0.01	**0.26**
Shicuy	0.07	0.06	**0.11**	0.04	0.08	0.03	**0.39**
Chongos Alto	**0.11**	0.04	**0.11**	0.06	0.07	0.01	**0.39**
Palmayoc	**0.10**	0.03	0.07	0.09	0.03	0.01	**0.32**
Huasicancha	0.08	**0.20**	0.13	0.07	0.11	0.01	**0.60**

Palaco	0.11	0.03	0.14	**0.18**	0.05	0.004	**0.52**
Llamapsillon	**0.09**	0.03	0.05	**0.09**	0.07	0.004	**0.34**

8.5.4. Questionnaire applied to experts

Based on (Bockstaller and Girardin, 2003; Mitchell et al., 1995), the following questionnaire was established to assess the validation via an expert panel. This expert validation aimed to assure the credibility of the developed risk index.

En base a la información brindada, por favor brinde Usted su opinión con respecto al diseño, resultados y uso:

Diseño:

Basado en el análisis de contenido de entrevistas, se ha desarrollado el índice de riesgo considerando 24 indicadores organizados en 6 criterios. El índice de riesgo se enfoca en los datos obtenidos directamente del actor principal que desarrolla el conflicto, es decir, las comunidades.

Basado en lo mencionado, ¿Haría Usted alguna modificación al presente índice? Si es así, indique dichas modificaciones.

Resultados:

¿Considera que este índice de riesgo informa la realidad? ¿Es realista el resultado que se obtiene?

Uso

¿Podría este índice de riesgo ser útil para la toma de decisiones?

¿Usted utilizaría este índice de riesgo?

¿Cuál sería la probabilidad y las razones de refutación de este índice de riesgo (0 al 100)?

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