The Geographical Journal, Vol. **170**, No. 1, March 2004, pp. 78–91

Livelihoods in transition: transnational gold mining operations and local change in Cajamarca, Peru

JEFFREY BURY

Department of Geography and Human Environmental Sciences, San Francisco State University, 1600 Holloway Avenue, San Francisco, CA 94132, USA

E-mail: bury@sfsu.edu

This paper was accepted for publication in September 2003

This paper examines how transnational gold mining operations are transforming rural household livelihoods in the Cajamarca region of Peru. In particular, this paper evaluates how Newmont Mining Corporation's Minera Yanacocha (MYSA) mining operations are altering access to the produced, human, natural and social capital resources that households utilize to produce their livelihoods. The paper argues that while access to produced and human capital resources has increased in the past decade, albeit unevenly, access to natural and social capital resources has declined. The paper begins with a discussion of new frameworks for evaluating local livelihood change and household access to resources. Subsequently, the paper describes Peru's new transnational mining sector, livelihoods and livelihood change in the Cajamarca region. The paper then presents the results of case study field research evaluating the impacts of MYSA on household access to resources in three communities. Finally, the paper concludes with a critical discussion of livelihoods frameworks and how they can contribute to geographic studies.

KEY WORDS: Peru, Cajamarca, livelihoods, mining, households

Introduction

One of the most prominent elements of change in the Peruvian Andes over the course of the past decade has been a dramatic increase in both the pace and scale of mineral exploration and exploitation activities. Following the country's sudden turn to neoliberal economic policies and structural adjustment in the early 1990s, transnational mining corporations have transformed Peru into one of South America's leading exporters of mineral resources. New transnationally based 'mega' mining operations have become some of the largest and most influential landowners and agents of change in regions of the country that have traditionally been plagued by high rates of poverty and unemployment.

This paper explores the relationships between Andean Peru's new transnational mineral-based political economy and household livelihoods in new mining areas. In particular, through a case study of one of the largest transnational mining operations in Peru, Minera Yanacocha (MYSA), the contribution of mining operations to dramatic and complex transformations of resources that households access and utilize to produce their livelihoods is evaluated. This paper adopts a rural livelihoods conceptual approach in order to evaluate how access and utilization of produced, human, natural and social capital resources are being transformed in the Cajamarca region and to demonstrate how a livelihood framework can contribute to geographic research concerned with the relationship between global and local change.

Capitals and concepts: livelihoods literature review

In the past decade a substantial amount of research has been conducted in geography and development studies concerned with the question of how livelihoods are produced and the types of resources upon which they are based. What emerged from

0016-7398/04/0001-0078/$00.20/0

many of these discussions is that our understanding of how livelihoods are produced in many developing countries has been far too simplistic and that livelihood production strategies are complex, diverse, dynamic and draw on a variety of resources in combination (Chambers and Conway 1992; Chambers 1995). New research has proposed more complex frameworks for understanding how resource access, household livelihoods and resources interact (e.g. Bebbington 1999; Leach *et al*. 1999; Scoones 1998). These new frameworks have become increasingly apparent features of development studies undertaken by the World Bank, the United Nations Development Programme (UNDP) and other development practitioners as they provide more comprehensive indicators to measure how the quantity and quality of resources are changing in a given geographic area, as well as a link between the terminology of economic development and sustainable resource use (DfID 1999; UNDP 2001; World Bank 2000).

The common element of these new approaches is an emphasis on a wider array of resources that households access to construct livelihoods. While some difference exists between labels and discrete conceptual categories, scholars draw on the heuristic of capital terminology to identify several important categories of resources upon which livelihoods are produced. Generally, scholars have identified four important types of capital resources that are involved in livelihood production and change. These include produced, human, natural and social capitals (Bebbington 1999; Scoones 1998).

Generally, as development discussions have evolved, each of these four types of resources have been identified as important resources for household livelihood production and development efforts. Produced capital has generally been conceived as savings and convertible liquid assets, as well as regular flows of money such as earned income, pensions, transfers from the state and other remittances. In addition, produced capital has also been conceived to have an infrastructural component, which includes buildings, transportation and electrical services (Lewis 1955). Human capital has come to be seen as human capabilities such as skills, education, knowledge, ability to labour and health (Shultz 1964; Strauss and Thomas 1995). Natural capital, as it entered development discussions in the 1990s, has often been referred to as consisting of two elements. First, natural capital includes non-renewable resources such as minerals, forests and soils. Second, natural capital includes renewable resources such as ecosystem services and nutrient cycling (Costanza and Daly 1992; Barbier 1994).

Finally, while social capital has only recently emerged as a concept in development discussions, it has rapidly been taken up by scholars and development practitioners (e.g. World Bank 2000). The notion of social capital owes much of its present genesis to James Coleman (1988), and Robert Putnam (1993), who first utilized the concept to explain social capital, respectively, as relational structures (both horizontal and vertical) that facilitate action and as the elements of civil society that have fostered economic development and good governance in modern Italy. Since these studies, scholars (e.g. Woolcock 1998; Harriss and De Renzio 1998) have elaborated substantially on the notion of social capital. While the conceptual definitions of social capital are still being debated, the general notion is that stocks of mutual trust or 'connections' between people exist that provide a flow of resources that enables both solutions to problems and the pursuit of economic and political activities.

Overall, while the discussion of capital resources is still underway and elements of frameworks based on capital resources (such as social capital) are still being debated, the potential utility of the framework is probably best demonstrated by the rapid adoption of the approach in formal development organizations (e.g. World Bank 2000). However, while rural livelihoods frameworks are being adopted rapidly around the world, relatively little empirical work has been done to operationalize them in local contexts. While early lessons and observations from fieldwork have been completed by a few scholars (e.g. Ashley 2000; Ashley and Carney 1999; Farrington 1999), much work has yet to be done.

Adopting a rural livelihoods approach in geographic studies can contribute greatly to our understanding of how livelihoods are produced and transformed in particular geographic settings, as well as link the activities of actors at broader scales to local resource transformations. In order to illustrate how and why livelihoods approaches can contribute to geographic discussions of local change, this paper operationalizes the rural livelihoods framework in an attempt to contribute to a better understanding of the utility and empirical plausibility of such approaches. Equally important, rural livelihoods frameworks tend to be weak in linking scales of analysis and in engaging wider questions of political economy. This paper extends their focus to transnational business actors, whose very activities and existence link the international scale with local household activities. Overall, this research then serves as a link between new development research and geographic understanding of transnational corporations and local livelihood transformations.

Mining and livelihoods in Peru: history and context

For the past decade, the mining sector has come to occupy an important position in the overall

Peruvian economy as a critical source of national foreign trade earnings. For example, the mining sector accounted for 45% of all exports in 2000 (IMF 2001). Historically, mining has been an important sector of the Peruvian economy, but it has often been subject to the vicissitudes of Peruvian political reversals and nationalization (Becker 1983).

Beginning in 1990, President Alberto Fujimori's administration adopted a wide-ranging privatization program that offered international investors attractive mining opportunities and eliminated competition from nationalized firms that controlled significant access to mineral deposits. In addition, the Fujimori government implemented a floating exchange rate, eliminated price controls, direct subsidies and restrictions on foreign investment and lifted exchange controls and restrictions on remittances of profits, dividends and royalties. Fujimori's administration also offered tax stability contracts and a host of legal and financial protections for large foreign investors. Furthermore, a radical reformation of land tenure rights under the National Mining Cadastre Law guaranteed mining firms control of the necessary land resources to implement their operations (Ministry of Energy and Mines, Peru 2000; Peru Monitor Monthly 2000).

Overall, since the early 1990s, Peru has been converted to a neoliberal economy dominated by private sector and market forces. Comparatively, while neoliberal reforms have swept through Latin America in the past decade, Peru has become one of the most open and liberal economies not only in Latin America, but in the world (IMF 2001). The mining sector in post-Fujimori Peru has retained its importance. While mining investment in the country slowed between 2001 and 2002, as investor uncertainty and a global recession plagued the country, the mining sector has retained its prominence in the Peruvian economy under President Alejandro Toledo's administration.

Mining and livelihoods in Cajamarca

Newmont's Minera Yanacocha operations

Of all the new transnational mining operations that have begun in Peru in the past decade, one of the most influential has been that of the Denver-based Newmont Mining Corporation. In 1992, Newmont began construction of the Yanacocha gold mining operation in the Cajamarca region of Peru (Figure 1) in cooperation with its Peruvian partner, Compania de Minas Buenaventura, S.A., and the International Finance Corporation (known as Minera Yanacocha or MYSA). The Yanacocha project was the first large foreign investment in Peruvian mining since 1976.

The Newmont Mining Corporation is the largest gold producer in North America and the largest gold company in the world. Newmont is also one of the lowest cost producers of gold in the world. Newmont's worldwide gold production in 2000 was 5.8 million ounces, with an average cost of US$179 per ounce. In 1998, Newmont's sales were US$1.73 billion (Newmont Mining Corporation 2001). Newmont is headquartered in Denver, Colorado, and it has large mining operations in the United States, Peru, Australia, Canada, Mexico, Uzbekistan, Indonesia and Bolivia.

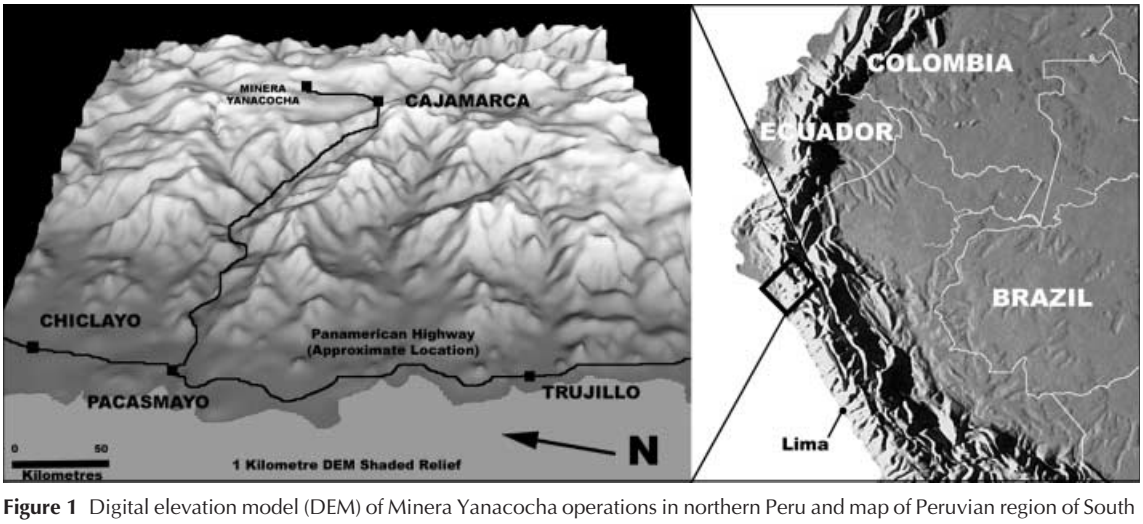

Figure 1 Digital elevation model (DEM) of Minera Yanacocha operations in northern Peru and map of Peruvian region of South America

MYSA gold reserves in the Cajamarca region are estimated to amount to approximately 37 million ounces. MYSA has become Latin America's leading gold producer with annual gold production of 1.8 million ounces in 2000 at an average cost of US$88 per ounce, one of the lowest in the world. Since MYSA began operations in the region, it has produced more than 7.5 million ounces of gold and reserves have grown more than five-fold over the same period. In terms of Peruvian gold production, MYSA accounted for 43% of the country's gold production in 2000 (Newmont Mining Corporation 2001).

In order to extract gold in the Cajamarca region, MYSA utilizes open pit mining and the largest cyanide heap-leaching operation in the world. In 2001, MYSA was operating six open pits accompanied by four cyanide heap-leaching pads. In 2001, MYSA mineral rights in the Cajamarca region totalled 138 564 ha (Newmont Mining Corporation 2001).

Livelihoods in Cajamarca

Alongside MYSA's operations in Cajamarca are the households and communities of the region. Household livelihoods are situated within the larger physical, historical and human geography of the region, which has greatly influenced their composition and the distribution of resources upon which they are produced.

Physically, the region surrounding the mine is located high in the northern inter-Andean valleys of the Peruvian Andes, ranging from 2800 to 4300 m.a.s.l. The climate of the region is punctuated by two important seasonal variations and the human population of the region surrounding the mine is distributed vertically among four altitudinal life zones. In addition, the human population is almost entirely situated in a rural context. For example, in 1993, more than 96% of the 1.3 million people in the Department of Cajamarca (the larger political division of the country in which the city of Cajamarca and MYSA are located) were rural dwellers (Indacochea *et al.* 1998).

Households in the Cajamarca region also reside in a highly impoverished social and economic context. By almost all standards Cajamarca is a very poor region. For example, per capita income in the Department of Cajamarca is less than one-half of the national average and less than one-third of per capita income in Lima; 86% of houses do not have water or electrical services; nearly two-thirds of all children in the first grade of primary school suffer from chronic malnutrition; and roads and motorized transport are almost non-existent in many areas of the region (UNICEF 1998). Statistically, 79% of the population cannot meet basic needs and more than half of the population lives, according to Gonzales and Trivelli, 'in a state of misery' (1999, 97).

The extreme rural poverty of Cajamarcan livelihoods is inextricably linked to a succession of historical transformations in the region. Cajamarca was one of the central focal points of the Spanish conquest as Francisco Pizarro captured and killed the Incan ruler, Atahualpa, in Cajamarca. Subsequently, the physical and human geography of the region was dominated by haciendas, textile factories and silver mining operations. As a result, the human population was soon concentrated onto large landholdings, which remained in place for several centuries. Deere (1990) estimates that at the beginning of the twentieth century the Department of Cajamarca had one of the highest concentrations of populations living on haciendas in the country.

In the early 1900s, Cajamarca underwent another significant transformation as the region's economy was re-oriented into cattle and dairy production. Large haciendas intensifying cattle and dairy production expelled peasants and forced them onto more marginal lands or to migrate to the coast for work. These changes led to a dramatic de-populating of productive lands in the region and by the 1960s, when Peru's military government implemented a radical land reform program, Cajamarca had the lowest concentration of people living on haciendas in the country. Anticipating radical land reform measures and the loss of their lands, large landholders preemptively redistributed their most productive lands in the fertile valleys, thus denying local peasants claims to the lands. By mid-1981, and the end of the land reform process, only 10% of rural households in Cajamarca had received new land holdings (Deere 1990).

By the mid-1980s and continuing to the present, rural livelihoods in the region surrounding the mine have been based upon access to and the use of a complex and diverse array of resources, which often change over time and vary between households. However, the most important resource, which constitutes the majority of household livelihood activities either directly or indirectly, is natural capital. Nearly every household activity that takes place in the case study communities is related to access to natural capital resources such as land and water resources.

The natural capital based livelihoods that households produce are based primarily upon agricultural production, agroforestry and animal husbandry. Generally, rural households utilize several small landholdings across ecological production zones, with little access to improved irrigation or terracing. Through access to these land resources, households produce a variety of agricultural products, primarily

tuber crops, corn and grains such as alfalfa. In addition, households also raise a variety of animals such as cattle, sheep and pigs, which are pastured seasonally among land holdings and between vertical ecological zones. Agroforestry crops are also distributed across landholdings, which provide wood (the major source of energy for communities distributed around MYSA) and construction materials. Households also draw upon natural capital based activities to produce dairy products such as cheese and milk and engage in the artesanal production of ceramics and textiles.

Households also access a complex array of produced, human and social capital resources in their livelihoods. In order to access produced capital resources, households sell many of their agricultural and livestock products in markets or to dairy enterprises. However, households are only marginally integrated into local and regional markets and have limited access to produced capital resources. Consequently, households rely on seasonal and semi-permanent migration to the coast, Lima or other regions of the country for access to financial capital such as wages. Households also draw upon human capital such as education and training in the production of agriculture and animal husbandry, as well as in the maintenance of family health. Finally, households utilize social capital resources through access to intra- and inter-family networks for such activities as crop planting, harvesting and livestock pasturing and care.

A decade of livelihood transformations

By the early 1990s, under Newmont's joint venture with Companias Buenaventura, S.A., MYSA became Cajamarca's single largest land owner and economic force. The mine's operations above the city have generated substantial impacts in the immediate surroundings (see Figure 2).

Because MYSA is located close to the city of Cajamarca, which is the major urban centre of the region, the mine's operations and impacts are being felt throughout both the city and the local region surrounding the municipality. In addition, because MYSA has very quickly become the largest cyanide heap-leaching operation in the world and the largest gold mine in Latin America, it has drawn a significant amount of national and international attention. Consequently, the impacts of the mine have been heavily debated and discussed in a variety of forums regionally, nationally and internationally[1]. However, no comprehensive studies utilizing livelihood frameworks have been conducted in the region and few studies have incorporated transparent and rigorous methodological considerations.

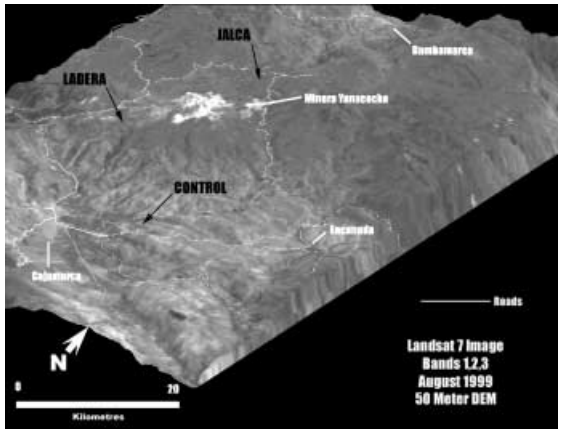

Figure 2 Elevated perspective of topographical model of Cajamarca region with Landsat Visible Image overlay showing scale of Minera Yanacocha Project with case study community locations (noted in black)

In brief, the impacts of MYSA in the region have dramatically transformed the economic, human, natural and social context of the region. In terms of economic impacts, MYSA has invested more than US$750 million in mine facilities, employs thousands of workers from locations throughout Peru and has purchased thousands of hectares of land from hundreds of landowners (Martinez *et al*. 2000). In addition, MYSA has significantly altered the infrastructure of the region through the construction or improvement of roads, electrical facilities and buildings. Furthermore, the mine's operations are radically transforming the land and water resources of the region through open-pit mines, massive heap leach pads, water diversions and landcover changes. Aside from the impacts of MYSA's gold extraction activities, the mine has also implemented a series of social programs both in the city of Cajamarca and in communities surrounding the mine. MYSA social programs began in 1993 when the mine began operations. Since 1993, MYSA has implemented several different programs for fostering economic development in the region that have had differing goals, methods of implementation and impacts[2]. Overall, these programs have included health and nutritional assistance, the construction of medical posts and schools, road construction, technical assistance, reforestation programs, agricultural development, rural credit and the construction of potable water systems (Indacochea *et al*. 1998).

Research design and methodology

In order to evaluate how household access and utilization of capital resources have been changing

since MYSA began operations in the region, field research was conducted in the region beginning in 1999 and continuing through 2001. The research design for the study was based on a purposive and quasi-experimental case study evaluation of the impacts of both MYSA's mining activities and its social programs on rural households surrounding the mine. First, archival research was conducted to identify the entire range of communities affected by MYSA's operations in the region (Martinez *et al.* 2000). Second, three communities were selected to study the geographically diverse nature of livelihoods in the region and the impacts of MYSA on household access to resources. Consideration was also given to the diverse ecological production zones in the region and communities were selected from two of the most prevalent zones. The first community (Ladera) that was selected has the largest cross section of impacts from the mine and the mine's social programs. The second community (Jalca) that was selected approximates an intermediate range of impacts. The third community (Control) was selected to provide experimental control, where there have been few indirect and no direct impacts from MYSA. It was also selected to address the fact that there were very few baseline household studies conducted in the region prior to 1993. Thus control was selected to approximate baseline conditions prior to MYSA's presence in the region.

Within the three case study communities, households were interviewed in Spanish in order to evaluate both their livelihood strategies and changing household access to and utilization of capital resources. Households within each community were randomly sampled using participatory mapping procedures and randomly generated numbers. A sample of 20 households was drawn in each community. From each sample of 20 households, 10 households were then randomly sampled again to assign the gender of the interviewee. Overall, 60 households were interviewed during the course of the fieldwork, but only the results from 59 interviews are included in this research as one interview was lost in the field. Table 1 summarizes the household sample demographics for each community included in the study.

A formal semi-structured questionnaire was developed and field-tested that incorporates each of the capital variables. The questionnaire was composed of 112 questions and was designed to elucidate information on how households access and utilize each capital resource and how this may have changed since MYSA began operation in the region. In addition to the formal questionnaire, extensive archival research, key informant interviews and focus groups were conducted during the course of the study.

Table 1 Case study household sample demographics

	Ladera	Jalca	Control
Total households sampled	19	20	20
Total sample population	100	142	107
% of community	18	25	25
Average age of interviewees	42	44	43
Gender % sample			
Male	47	50	50
Female	53	50	50

Capital transformations in the case study communities

Since MYSA began operations in the Cajamarca region, it has significantly affected household access and utilization of resources. The following sections present an analysis of the case study results for the three communities included in the study. Generally, MYSA has positively affected access to produced and human capital resources, while negatively affecting access to natural and social capital resources. The following sections illustrate the ways in which household livelihoods are being transformed in response to these changes.

Produced and human capital impacts

The most significant changes that have occurred in household access and utilization of resources in the case study communities are those related to produced capital. This is due largely to the fact that MYSA has prioritized improvements in rural infrastructure, but also due to the nature of MYSA's natural resource extraction activities. In terms of infrastructure, MYSA has improved or constructed roads, built community potato seed banks and health posts, improved or provided potable water systems, improved irrigation systems and constructed latrines in communities. In terms of financial resources, MYSA has affected household income generation through the provision of infrastructure, land purchases, employment and rural credit programs. This has affected the tangible produced assets of households, most notably the agricultural and livestock resources that households possess. Overall, the changes in produced capital that have taken place in case study communities are diverse and generally positively increasing household capabilities and livelihood opportunities. However, these changes are taking place in an uneven fashion both between communities and among households.

One of the most prominent features of produced capital changes in the case study communities is related to the construction of roads and other

physical infrastructure. Between 1994 and 1999, MYSA improved more than 133 km of road surface in the region (Martinez *et al*. 2000). As the roads that MYSA has improved often pass through or by many of the small communities around the mine, it has also impacted their access to the changing physical infrastructure of the region, increasing household access to local and regional markets for agricultural, livestock and dairy products. Respondents in the case study community most impacted by MYSA's infrastructure improvements, Jalca, reported significant increases in access to markets due to the construction of new roads, while in Ladera and Control, where road improvements have not been implemented, respondents reported much smaller increases. Table 2 illustrates these changes across the case study communities[3].

Another important change in access to produced capital resources that has been taking place is related to financial capital. Generally, households reported some increases in financial assets in the case study communities affected by the mine. These increases are related to the fact that households have sold land to the mine, sold more livestock and agricultural products and have accessed and converted credit into productive livelihood assets. However, these impacts have been uneven and isolated across households and communities. Despite these limitations, an overall assessment of total household income suggests that it has increased since the mine began in Ladera and Jalca. For example, 15% of respondents in Ladera and 5% of respondents in Jalca indicated that they are earning more now than before the mine began operations. Contextual data collected in qualitative interviews suggest that respondents who indicated increased earnings also attribute these increases to MYSA's activities.

MYSA has also affected household access to and the utilization of human capital resources in the case study communities. This is due primarily to MYSA social programs as they have been directed towards improving household access to educational and health resources. Overall, the types of resources that have been affected are formal education and adult technical training, health services, preventative health care and sanitation.

One of the primary elements of human capital that MYSA social programs have impacted in the case study communities is access to education and training. This includes increases in the availability and length of formal education for children as well as the provision of training and education programs for adults. In both Ladera and Jalca, MYSA social programs have significantly impacted both the quality of formal education and its availability. Between 1994 and 1998, MYSA either constructed or improved schools in Ladera and Jalca, donated school furnishings and supplies for children, supported transportation costs for teachers, improved school kitchens and electrified schools with solar power facilities. Comparatively, Ladera and Jalca demonstrated higher rates of access to human capital resources than the control community. Table 3 illustrates these changes in terms of school attendance rates, school supplies, school lunches and access to teachers in the case study communities[4].

Another aspect of human capital resources that MYSA social programs have affected in the case study communities is health resources. In combination with other capital improvements such as infrastructure and education, households have been able to

Table 2 Increasing household access to markets

Livelihood activity	Ladera	Jalca	Control
% of households that indicated increased access for agricultural products	21	65	35
% of households that indicated increased access for livestock products	16	70	25
% of households that indicated increased access for dairy products	11	45	15

Table 3 Educational changes in the case study communities

	Ladera	Jalca	Control
% of households with children attending school	79	85	65
% of children possessing school supplies	63	70	50
% of children eating at school	68	15	35
% of households indicating they have increased access to teachers	68	40	20

Table 4 Comparative evaluation of illness prevalence (household average occurrence in past year) in case study communities

Illness	Ladera	Jalca	Control
Respiratory	2.4	4.65	3.65
Stomach	0.7	1.6	0.45
Skin	0.2	1.75	0.3

access a variety of preventative health practices and new health services. Comparatively, the differential incidences of illnesses between the case study communities do demonstrate some differences, which may be related to MYSA's activities. Table 4 illustrates the average number of household illnesses over the course of 2000–1. Generally, Ladera has had the lowest incidence of illnesses, which is where MYSA has implemented the largest cross section of health-related programs and improvements. However, as Table 4 indicates, there is no consistent comparative trend in the data between all three case study communities. Thus, a very tentative conclusion would be that Ladera has experienced at least some positive impacts in access to health resources.

Natural and social capital impacts

Natural capital constitutes one of the primary resources for livelihoods in the case study communities. MYSA has impacted household access to and the utilization of both water and land resources either through the operations of the mine or through the effects of its social programs. Generally, MYSA has negatively affected household access to natural capital resources.

MYSA's large-scale mining operations have had substantial impacts on the water resources that households access in the region. In the case study communities, MYSA has impacted household access to water resources in three domains: potable water, watershed resources and irrigation water supplies.

Of the three case study communities, Ladera's access to potable water resources has been most impacted by MYSA as it is located below the mine's operations (see Figure 2). Interviewees indicated that the water is now cloudy, smells bad, tastes terrible and that they believe the water is responsible for human and animal health problems as well as crop yellowing and stunting. However, while households are greatly concerned about the changing quality of the water resources they utilize in the production of their livelihoods, they are unable to demonstrate scientifically that the water is contaminated. They understand that the water now carries a large amount of sediment and that it has changed in both taste and smell, which to them suggests that the water is also contaminated. Thus there is widespread perception among households that MYSA, because it is contaminating the water, is also responsible for increasing risks of household health problems, animal illnesses and death, and agricultural failures[5]. However, this is in stark contrast to the frequent statements made by MYSA interviewees that the mine is not contaminating the water resources in the region and that its water discharges are in compliance with the regulations governing water quality.

MYSA began to monitor water resources in the region before mine operations commenced, beginning in 1991 and continuing up until 1993 (MYSA-EIA 1994). From this archival data, a water quality baseline was constructed. Water sample data were also collected for 26 different elements across the more than 100 water monitoring locations that have been established throughout the region since 1993 in order to evaluate how and where water chemistry is changing due to MYSA mining activities. The water data results presented in this section include the water testing results for the baseline period (1991–3) through 1999. However, the water data are not chronologically uniform because project research personnel were denied complete access to the relevant water monitoring data by the Peruvian Ministry of Energy and Mines and MYSA.

Before MYSA began mine operations, it stated in environmental impact assessment reports that it would adhere to the standards of the United States Environmental Protection Agency (USEPA) for water quality that regulate its operations in Nevada because it sought to be a leader in environmental quality in Peru (MYSA-EIA 1994). These standards are significantly higher than the Peruvian standards that the mine is legally obligated to respect.

In Peru, the two administrative agencies that legally enforce water quality standards are the Ministry of Energy and Mines and the Ministry of Health. The Ministry of Energy and Mines' water quality standards are those that MYSA is legally obligated to respect. These standards set maximum concentrations for a limited set of elements and require mining operations to submit quarterly water testing results to demonstrate that they are in compliance. The Ministry of Health has two additional sets of water standards that regulate the quality of water for human consumption (Class II) and agricultural production (Class III). Table 5 details the water quality standards for each of the various agencies previously mentioned, as well as water quality standards established by the World Bank.

Table 5 Water standards parameters

Parameter	MYSA (mg/l)[1]	Class II (mg/l)[2]	Class III (mg/l)[3]	MEM (mg/l)[4]	World Bank (mg/l)[5]
Aluminum	0.05–0.2	0.10	0.20		
Arsenic	0.05	0.10		1	1
Barium	2				
Cadmium	0.005	0.01	0.05		0.1
Calcium					
Chrome	0.05	0.05	1		
Cobalt		1			
Copper	1.3	1		1	0.3
Cyanide	0.2	0.2	1	1	0.5
Fluorides	2–4	1.5	2		
Iron	0.3–0.6	0.3	1	2	2
Lead	0.05–0.1	0.05	0.1	0.4	0.6
Magnesium	125–150		150		
Manganese	0.05–0.1	0.1	0.5		
Mercury	0.002	0.002	0.01		0.002
Nitrates	10		100		
pH	6.5–8.5	5.0–9.0	5.0–9.0	6.0–9.0	6.0–9.0
Potassium					
Selenium	0.05	0.01	0.05		
Sodium					
Sulphates	250		400		
Zinc	5	5	25	3	1
Dissolved solids	500–1000				
Solids in suspension	25			50	

1 MYSA standards according to Nevada Profile I Standards; source: MYSA-EIA (1999).
2 Water standards for domestic human use according to Peruvian Ministry of Health.
3 Water standards for irrigation and animal consumption.
4 Ministry of Energy and Mines standards.
5 World Bank water quality standards.
Sources: MYSA-EIA (1995 1999).

Up until the mid-1990s, MYSA argued that it was upholding USEPA environmental standards, for which it was recognized by the Ministry of Energy and Mines as a leader of environmental quality in the mining sector (Ministry of Energy and Mines, Peru 1998). However, in response to allegations over the course of the past several years that MYSA is contaminating the watersheds in the region, mine officials have appealed to Class III standards (MYSA-SUNASS 1999). Overall, based on MYSA's changing positions on the water quality standards governing its operations, it is unclear what standards should be recognized. Legally, MYSA is only required to uphold the Ministry of Energy and Mines' standards. However, MYSA's public relations statements have maintained that it is upholding higher standards.

Resolving which standards MYSA is obligated to uphold and which standards it should uphold is a difficult and contentious issue, which this research does not pretend to resolve. Consequently, the water quality results presented in Table 6 compare the water chemistry data for selected elements to all four relevant standards for the watershed near Ladera that households regularly access for human and animal consumption (World Bank guidelines are excluded in the data results). No significant increases in concentrations of heavy metals or contaminants such as arsenic, cyanide, lead, mercury and selenium were reported in the water data. Therefore, these data have been excluded from the data presented in Table 6.

Table 6 illustrates that between 1991 and 1999, MYSA has violated its own self-stated standards and those of other regulatory agencies in the watershed near Ladera many times. For example, average dissolved and suspended solids as well as concentrations of copper, iron, zinc, manganese and sulphate exceed MYSA's self-stated standards on average many times and at extremely high

Table 6 Water quality results for selected measures in Ladera

Parameter concentrations ($n = 45$)	Baseline average 1991–93 (mg/l) ($n = 5$)	Average discharge 1993–1999 (mg/l)	Maximum value (mg/l)	% of *n* above MYSA standards	% of *n* above Class II standards	% of *n* above Class III standards	% of *n* above MEM standards
Dissolved solids	44.05	1162	5220	31	n/a	n/a	n/a
Solids in suspension	n/a	294	2192	98	n/a	n/a	93
Copper	0.032	0.49	6.29	22	22	n/a	22
Iron	1.24	23.76	93	76	76	76	76
Zinc	0.038	1.72	5.99	9	9	0	11
Manganese	0.04	5.10	17.56	80	80	76	n/a
Potassium	0.85	2.48	9	n/a	n/a	n/a	n/a
Calcium	2.29	97	249	n/a	n/a	n/a	n/a
Sulphates	20.94	741	2410	44		44	
Sodium	1.81	154	1560	n/a	n/a	n/a	n/a

Sources: MYSA-EIA (1994 1995 1999); MEM-AMB (1998a 1998b 1999).

concentrations in several cases. In quarterly reports to the Ministry of Energy and Mines, MYSA has recognized that concentrations of solids in suspension, copper, iron, manganese and zinc in the watershed have been too high, but this has not been recognized publicly, nor has MYSA been cited for any water quality infractions by Peruvian authorities (e.g. MEM-AMB 1998a 1998b 1999). The observed increases in sodium, calcium and potassium concentrations are not regulated by Peruvian or USEPA standards, but have clearly altered the quality of water resources in the watershed as well.

Overall, the water data illustrate that the quality of water in the watershed near Ladera that households access in the production of their livelihoods has indeed decreased. Thus, in terms of respondents who indicated that the water has caused health and animal problems, it is possible that these incidents have taken place. The more general point to be drawn is that the quality of water resources in the watershed have declined, sometimes alarmingly so, since MYSA began operations. Thus, for households in Ladera, there has been a substantial decrease in their ability to access clean and reliable water resources for their animals, crops and human consumption.

The last set of changes in access to natural capital resources that have occurred in the region since MYSA began operations are related to the land resources that households access and utilize in their livelihood strategies. Two important changes have taken place since MYSA began operations in the region. First, because MYSA has purchased extensive land in the region, land prices have increased dramatically. Consequently, in Ladera and Jalca, landholdings have also increased in value. This is important because as land prices have increased so have the opportunities for households to convert their landholdings into other forms of productive capital for livelihood activities. For example, a few interviewees in Ladera sold land to other households or to land speculators in order to invest in business opportunities in Cajamarca. However, very few households have engaged in this type of activity.

Conversely, dramatic increases in land prices have also had negative consequences for households with few land holdings, which includes the majority of households in the case study communities. For example, households in Ladera that had insufficient land before the mine began operations have been unable to acquire additional land. Several respondents in Ladera indicated that they were not able to feed their families because they did not have enough land and could not purchase any more because it was so expensive. In addition, the negative impacts of increasing land prices have been most severe for households who sold land to the mine at low prices. They have been unable to replace their land and, in several cases in Ladera, were forced to move either to another community or to Cajamarca because they did not have enough land for their crops and livestock.

The second change in access to land resources that is underway is related to the quality of landholdings. Generally, pressure on household land holdings has increased since the mine began

operations. These changes are linked closely to increases in produced capital as households have increased their livestock herds, adopted new crops and intensified crop production on agricultural lands. This is particularly important in the case of former landowners who sold land to the mines as they often did not have adequate grazing land for their livestock. They have had to intensify the use of their land to provide for both livestock needs and agricultural production. The effect of this has accelerated the degradation of their land holdings.

One indicator of how households have intensified their use of land resources is based on interviewee responses to questions regarding their fallow land practices. In Ladera and Jalca, 95% of interviewees indicated that they rotated their crops and practiced land fallowing in order to rejuvenate soil fertility. However, since the mine began operations, interviewees indicated that the amount of time they have left the land fallow has shortened considerably. The primary reason interviewees indicated that they have decreased fallow land periods is because they need to cultivate more grazing land for their livestock herds, which have increased as households have diverted new credit and income into cattle stocks.

The relationship between land use intensification and the creation of produced capital such as livestock represents an important process that is taking place in both case study communities affected by MYSA's activities. Generally, the relationship is such that as produced capital is increasing (e.g. cattle holdings) for households, natural capital in the form of land quality is decreasing. This should be qualified by the fact that some households have also diverted some produced capital resources into land improvement practices such as fertilizer, but this practice is very limited throughout the case study communities.

The last category of resource transformations that have occurred since MYSA began its operations in the region are those related to social capital. Households in the case study communities rely upon access to networks of relationships and organizations outside the household to produce their livelihoods. These linkages constitute an important and diverse array of resources that range from horizontal intra-communal networks among households to vertical networks of relationships with community organizations and supra-communal organizations. Generally, MYSA has eroded access to inter-household social capital resources in the case study communities through its interaction with households and community organizations. In addition, relationships between households and supra-communal social capital resources have also changed dramatically. This includes new, and not always positive, access to supra-communal organizations and a shift in household and community linkages with national and transnational social protest networks.

Table 7 Household perceptions of difference (% who perceive large difference) across case study communities

Measure	Ladera	Jalca	Control
Education	73	70	45
Money	52	30	30
Inequality	85	75	55

At the inter-household level, the most significant negative impacts that MYSA has had on access to social capital resources are a result of the way in which it has unevenly interacted with households in the case study communities. Generally, the impacts of MYSA's social programs, hiring practices and land purchasing strategies have been very unequal and without transparency. This has led to an increase in distrust, social differentiation and conflict among households. At a comparative level, measures of perceived differences among households help to illustrate how inter-household social capital has decreased. Table 7 illustrates that in Ladera, where MYSA impacts have been the greatest, the levels of perceived difference among households are also greatest. Key interviewees and qualitative responses by households indicated that levels of difference have increased since MYSA began operations in the region. Thus, networks of reciprocity and mutual exchange among households in Ladera have become more asymmetrical.

One of the more notable findings of this research in terms of social capital is that as MYSA has negatively impacted household access to natural and social resources, they have also mobilized and strengthened the political relationships between households and supra-communal organizations that are focused on resisting these changes. These linkages have extended all the way to the transnational level. Thus, in a sense, MYSA has generated opposition to its operations because of the way it has chosen to interact with the local communities affected by its activities. One example from the case study findings that best illustrates this argument in a comparative sense concerns the way in which households have been mobilized in the communities most impacted by MYSA. Table 8 illustrates that in Ladera, where MYSA has most strongly impacted access to resources, more households have spoken with government officials about problems, have participated in protests and have joined political campaigns. Qualitative interviews confirmed that

Table 8 Household social capital and resistance to MYSA (% of households)

Households that have:	Ladera	Jalca	Control
Spoken with government official	21	0	0
Engaged in a protest	21	10	0
Joined a political campaign	20	5	5

these activities are related to problems with the mine.

Overall, many of the vertical networks that households have established with supra-communal institutions have only minimally increased their access to new resources as they have been temporary or controlled by MYSA. However, another set of strong vertical networks, which are largely political in nature, have been established that are related to the negative impacts of MYSA on access to natural and social capital resources. Thus, as households have experienced these negative impacts, they have mobilized and created access to a new array of relationships with supra-communal actors that are ostensibly concerned with ameliorating these impacts and creating new opportunities for the improvement of their livelihoods.

Conclusions

Based on this paper's evaluation of how MYSA has affected the produced, human, natural and social capital resources that households access to produce their livelihoods in the case study communities, one important set of conclusions is that there have been increases in access to produced and human capital resources and decreases in access to natural and social capital resources. However, these conclusions are subject to important caveats, as the resource transformations taking place in the Cajamarca region have not been uniform, nor have they been distributed evenly between households and communities. Thus, the complex and uneven geographic distribution of livelihood changes taking place should be kept in mind as the results of the research are interpreted.

As household access and utilization of capital resources has been transformed in the case study communities since MYSA began operations in the Cajamarca region, livelihoods in each zone have also been changing. Generally, in Ladera, agricultural production has intensified, even though natural capital resources have been threatened. In addition, households that sold lands at higher elevations to MYSA have had to concentrate their livestock at lower elevations, thus intensifying pressure on land resources, or reduce their livestock holdings. Consequently, because land use has both intensified and become more expensive in the region, livestock production has become less possible for households.

Conversely, in Jalca, households have intensified their livestock activities. For example, as the road to Jalca has been improved, households have had relatively more access to cattle buyers and markets for their dairy products. Thus, they have increased their livestock holdings and engaged in more dairy production as their resource portfolios have changed. Furthermore, across both case study communities affected by MYSA's operations, access to inter-household social capital resources has been eroded, but vertical linkages with national and international organizations have been strengthened as preoccupation with the negative impacts of the mine have increased. Overall, household livelihoods in the communities affected by MYSA have entered a new stage of transition, which is uncertain and composed of shifting resource access opportunities and livelihood capabilities.

The findings of this research also illustrate the magnitude of the changes that are taking place in the Cajamarca region and how transnationally based mining operations can transform local regions. One of the important questions that this research raises is how might the changes across capital categories be interpreted? In other words, if access to produced and human capitals is increasing and access to natural and social capitals is decreasing for households, is it possible to synthesize these findings into a more parsimonious conclusion that explains whether household livelihoods are better or worse off since MYSA began operations in the region? This question raises important issues for livelihood frameworks and research. While a livelihood approach enables the generation of a series of findings across capital resources, it says little, at present, about how to evaluate these changes in a more comprehensive fashion. In a sense, there is relatively little 'fungibility' between capital resources in livelihoods approaches. This research does not pretend to answer this question, but raises it as an important issue for future discussion.

Finally, this research serves as an example of how livelihoods analytical frameworks can contribute to our understanding of local transformations in geographic studies. While there are some limitations to utilizing a livelihoods approach, it does enable researchers to address a complex set of indicators within discrete categories and organize them into a matrix of roughly generalizable conclusions. In this research, a livelihoods approach has allowed for an understanding of how access to a complex array of resources upon which households

draw to produce their livelihoods is being transformed, as well as how Peru's new transnationally based mining economy is linked to these transformations, which are both important questions not only for development studies but also for understanding geographies of local change and their relationships to larger scales of analysis. Overall, geographic studies of this nature would benefit by adopting a livelihoods approach as a means of evaluating these questions.

Acknowledgements

The author would like to thank Anthony and Denise Bebbington, Andrew Oliphant, Nancy Wilkinson, Felipe Portocarrero and the anonymous reviewers for their assistance and timely discussions. In addition the author would like to thank the Rondas Campesinas Femininas del Norte del Peru, Wilson Marin, Vania Cuenca and Gladys Munoz for their invaluable efforts on behalf of this research. This research was conducted with the support of a National Science Foundation Doctoral Dissertation Improvement Grant in Geography and Regional Sciences (BCS-0002347). All opinions, data, omissions and errors are the sole responsibility of the author.

Notes

1 For example, GRADE (2000), Kuramoto (1999) and Indacochea *et al.* (1998) have all conducted evaluations of MYSA impacts in the region, particularly the economic impacts in the city of Cajamarca and the larger region. In addition Martinez *et al.* (2000) have conducted an exhaustive study of MYSA rural activities. See also Burke and Gibbins (1999) for critical studies of MYSA activities. In addition, a number of academic essays have been written about MYSA. For example, see Martin (1999) and Wendell (2000). For more extensive reviews of these works see Bury (2002).

2 See Caravedo (1998), Chang (1997), GRADE (2000) and Martinez *et al.* (2000) for reviews of MYSA social programs.

3 Jalca is the only community where advanced road construction was completed and has been maintained by MYSA. Thus, while Ladera has experienced the largest cross section of capital resource impacts, Jalca has experienced the most significant produced capital impacts in relation to road construction.

4 The indicators utilized in Table 3 to measure access to education were considered useful proxy measures to illustrate increasing household access to educational opportunities, as well as improvements in the quality of education that children were receiving. These measures are recognized as less valid measures of human capital abilities. Actually measuring increases in knowledge or understanding within households was beyond the scope of the project.

5 It is important to note that while households in Ladera generally indicated fewer incidences of illness over the course of 2000–1, respondents also attributed the cause of many of these problems to the impacts of MYSA on water resources surrounding the community. This was also the case for animal illnesses and death.

References

Ashley C 2000 Applying livelihood approaches to natural resource management initiatives: experiences in Namibia and Kenya Working paper No. 134 ODI, London

Ashley C and Carney D 1999 *Sustainable livelihoods: lessons from early experiences* DFID, London

Barbier E 1994 Natural capital and the economics of environment and development in **Jansson A M, Hammer M, Folke C and Costanza R** eds *Investing in natural capital: the ecological economics approach to sustainability* Island Press, Washington DC 291–322

Bebbington A 1999 Capitals and capabilities: a framework for analyzing peasant viability, rural livelihoods and poverty *World Development* 27 2021–44

Becker D 1983 *The new bourgeoisie and the limits of dependency: mining, class, and power in 'revolutionary' Peru* Princeton University Press, New Jersey

Burke A and Gibbins A 1999 Un informe sobre los impactos medioambientales, sociales y culturales de Minera Yanacocha S.R.L. Project Underground, San Francisco

Bury J 2002 The political ecology of transnational gold mining corporations and the transformation of livelihoods in Cajamarca, Peru Unpublished PhD thesis Department of Geography, University of Colorado-Boulder

Caravedo B 1998 El impacto social de las empresas mineras en el Peru Seguimiento Análisis y Evaluación para el Desarrollo, Lima

Chambers R 1995 Poverty and livelihoods: whose reality counts? *Environment and Urbanization* 7 173–204

Chambers R and Conway R 1992 Sustainable rural livelihoods: practical concepts for the 21st century IDS discussion paper No. 296 IDS, Brighton

Chang J 1997 Asociación Yanacocha Newmont Mining Corporation, Cajamarca

Coleman J 1988 Social capital in the creation of human stock *American Journal of Sociology* 94 S95–120

Costanza R and Daly H 1992 Natural capital and sustainable development *Conservation Biology* 6 37–46

Deere C D 1990 *Household and class relations: peasants and landlords in northern Peru* University of California Press, Berkeley

DfID (Department for International Development) 1999 *Sustainable livelihoods guidance sheets* DfID, London

Farrington J ed 1999 *Sustainable livelihoods in practice: early applications of concepts in rural areas* ODI, London

Gonzales O E and Trivelli C 1999 *Andenes y desarrollo sustentable* Instituto de Estudios Peruanos, Lima

GRADE 2000 *Gran minería y la comunidad* Grupo de Análisis para el Desarrollo, Lima

Harriss J and De Renzio P 1998 'Missing link' or analytically missing? The concept of social capital: an introductory

bibliographic essay *Journal of International Development* 9 919–37

IMF 2001 Peru Selected Issues IMF country report No. 01/5 International Monetary Fund, Washington DC

Indacochea A, Avolio B, Bedoya L, Carrillo J, Negron G, Sanchez L and Santillana M 1998 Cajamarca Competitiva Lima

Kuramoto J 1999 *Las aglomeraciónes productivas alrededor de la minería: el caso de Minera Yanacocha S.A.* Grupo de Análisis para el Desarollo, Lima

Leach M, Mearns R and Scoones I 1999 Environmental entitlements: dynamics and institutions in community-based natural resource management *World Development* 27 4–14

Lewis A W 1955 *The theory of economic growth* R D Irwin, Homewood

Martin J 1999 Thwarting violence: a case study of Newmont Gold Company Unpublished Masters thesis, Ohio University

Martinez J N, Villa J N, German E, Mendo M, Matilde P, Mario C, Angulo L and Jackeline J 2000 *Evaluacion de impacto del programa de desarrollo rural en las comunidades aledanas a MYSRL (1993–1999)* Asociacion Yanacocha, Cajamarca

MEM-AMB 1998a *Informe de monitoreo ambiental Carachugo/ Maqui Maqui/Yanacocha: resultados del monitoreo de aguas julio 1997–diciembre 1997* Ministry of Energy and Mines, Lima

MEM-AMB 1998b *Informe de monitoreo ambiental Carachugo/ Maqui Maqui/Yanacocha: resultados del monitoreo de aguas enero 1998–junio 1998* Ministry of Energy and Mines, Lima

MEM-AMB 1999 *Informe de monitoreo ambiental Carachugo/ Maqui Maqui/Yanacocha: resultados del monitoreo de aguas julio 1998–diciembre 1998* Ministry of Energy and Mines, Lima

Ministry of Energy and Mines, Peru 1998 Referential Mining Plan (http://www.mem.gob.pe/new/mineria/planrefe/indice.html) Accessed 3 August

Ministry of Energy and Mines, Peru 2000 Referential mining plan (http://www.mem.gob.pe/new/mineria/planrefe/indice.html) Accessed 1 September

MYSA-EIA 1994 Anexo D: estudio de calidad de agua para linea de referencia in *EIA de Maqui Maqui* Ministry of Energy and Mines, Lima 152–234

MYSA-EIA 1995 *Estudio complementario final del impacto ambiental: proyecto Carachugo* Ministry of Energy and Mines, Lima

MYSA-EIA 1999 *Estudio complementario de impacto ambiental: proyecto Carachugo* Ministry of Energy and Mines, Lima

MYSA-SUNASS 1999 Letter to the Intendente de Normas y Fiscalización from Peter Orams Cassinelli, Superintendent of the Environment 18 May

Newmont Mining Corporation 2001 *Newmont annual report 2000* Newmont Mining Corporation, Denver

Peru Monitor Monthly 2000 Mining: plenty of glitter *Peru Monitor Monthly* 7 75–8

Putnam R 1993 *Making democracy work: civic traditions in modern Italy* Princeton University Press, Princeton

Schultz T 1964 *Transforming traditional agriculture* Yale University Press, New Haven

Scoones I 1998 Sustainable rural livelihoods: a framework for analysis IDS working paper No. 72 Institute for Development Studies, Brighton

Strauss J and Thomas D 1995 Human resources: empirical modeling and household and family decisions in **Behrman J and Srinivasan T N** eds *Handbook of development economics* vol III Elsevier Science, London 1885–2007

UNDP (United Nations Development Programme) 2001 *Human development report 2000* Oxford University Press, New York

UNICEF 1998 *Informe annual PROANDES Cajamarca 1998* UNICEF, Cajamarca

Wendell K 2000 Beggars on a bench of gold: identities and multinational mining in the Cajamarca region Unpublished thesis Department of Anthropology, Yale University

Woolcock M 1998 Social capital and economic development: toward a theoretical synthesis and policy framework *Theory and Society* 27 151–208

World Bank 2000 *World development report 1999* Oxford University Press, Oxford