Introduction

This book is an ethnographic, historical, and ecological account of the social and environmental impacts of large-scale mining development in the Papua New Guinea (PNG) highlands. In the chapters that follow, I examine two intersecting themes: first, the making of a "resource frontier" (Tsing 2005) in the homelands of the Porgeran people—predominantly subsistence horticulturalists who are also hosts to the world-class Porgera Gold Mine—and second, how a people whose lives are tied so closely to the land negotiate massive social and environmental transformations. Woven within these two themes are two topics central to environmental anthropology: resilience and ontology. Resilience, or "the ability of ... systems to absorb changes ... and still persist" (Holling 1973: 17), compels us to study social and ecological changes not as aberrant but as a means to highlight both the adaptive creativity and the vulnerabilities of coupled social-ecological systems. A focus on ontology, or the study of the nature of being, allows us to examine the various ways that the world is actualized by different peoples (Descola 2013; Viveiros de Castro 1998, 2004) and the implications of the encounters between locally derived ontologies and the ontologies of capitalism and Christianity.

As a resource frontier, the Porgera case is particularly compelling because it complicates simple narratives regarding multinational development practitioners and indigenous people: quite simply, Porgerans complain that there is in fact not enough development occurring in their
valley (see also West 2012). The Porgera Valley has been the site of alluvial gold mining since the late 1940s, when Australian prospectors paid Porgeran workers with shells and steel tools, then, beginning in the late 1950s, with Porgerans as alluvial miners selling their gold for cash. In 1990 a world-class gold mine opened that was operated by the Porgera Joint Venture (PJV), a consortium of multinational mining companies, the Papua New Guinean state, and customary landowners within the Special Mining Lease area. Porgera is one of only four mines in the world where riverine tailings disposal is practiced (Vogt 2012), and both tailings and waste rock are dumped into the Porgera River. As the hard-rock mining wastes buried the alluvial gold beds, gold mining—which in the alluvial mining years had been a “second garden” (Pacific Agribusiness 1987) for Porgerans—in this new era radically reshaped local and regional political dynamics, processes of social organization and land tenure reckoning, and land management practices. More generally large-scale resource development in PNG has created a new category of citizenry—“landowners” (Ernst 1999; Filer 1997; Gilberthorpe 2007; Golub 2007; Jorgensen 2001)—who, as the recipients of development proceeds and practices, often benefit at the expense of the “nonlandowners” who are their kin and neighbors. The disparities in wealth between the landowners and the nonlandowners have generated significant social tension as most Porgerans have come to realize that the promises of development are not forthcoming in the ways promised by local elites and state politicians. In response to the failure of development, many young men have turned to “working in the life market,” a local term that is used to describe the act of engaging in armed conflict against relatively wealthier social groups in the valley in the hopes of extracting mining money in the form of compensation.

Despite all of the tensions and conflicts that resource development can generate, this is not a simple morality tale of evil multinationals dispossessing naive indigenous rain forest peoples of their land, such as the story depicted in the highest-grossing movie of all time, Avatar (2009). Instead the Porgera case highlights the complex and uneven ways in which development occurs and the unexpected outcomes it creates (Smith 2008). While people desire the benefits associated with development (Connell 1997; Errington and Gewertz 2004; Gewertz and Errington 1999) and actively court resource exploration on their own lands, they simultaneously describe these changes as undermining the very foundations of their universe (see also Kirsch 2001). For Porgerans gold is a cosmological resource in that gold deposits are the products of ancestral spirits; in the case of the mine, gold is the shed skin of a python spirit.
that their ancestors made sacrifices to in the recent past. Other groups in the area also sacrificed to python spirits, and consequently gold is believed to permeate the entire region. The sacrifices that were fed to the python spirits were the pigs and garden produce that came from human labor. In exchange for these gifts, the spirits ensured that the land remained fertile and that people, crops, and animals were healthy and fecund. The reciprocity that existed among people, the land and its resources, and the spirits has withered with the advent of large-scale mining, conversion to Christianity, the recent importation of firearms, and limited integration into capitalist markets. This demise of reciprocity is captured in the phrase *yu koyo peya*, “the land is ending,” which many Porgerans see in the transformations of various ecological and social processes in their lives.

To address how the land is ending, I examine social memory (Cruikshank 2005) and the forms of knowledge and morality that humans use to engage with the environment from a Porgeran perspective (Viveiros de Castro 1998, 2004) and the implications that these moral and cognitive systems have for practical engagement with the land and its resources. In Porgera landslides, earthquakes, and rivers that disappear into limestone sinkholes and flow underground all highlight the idea that the landscape is active and alive and thereby open to ritual and practical manipulation by humans. Spiritual entities that live in the ground provide omens of future events that Porgerans read as having tangible effects on their society. Good relations with these nonhuman spirits are said to result in the health and productivity of people, plants, and animals. In essence, as one researcher described for the neighboring Huli people, there is a “sense of the interconnectedness of geological and human affairs” (Frankel 1986: 17). I would go one step further for the case of Porgera and argue that there is an interconnectedness of the total environment—geology, ecology, climate, and so on—and human affairs. This book explores this total environment and the contradictory yet mutually reinforcing, tensions between the active quest for socioeconomic development and the ending of the land that such development brings.

Most important, this study is not a lament of change, what Marshall Sahlins (1999: iii), borrowing from development discourse, so aptly called “despondency theory.” Instead I seek to understand creative and dynamic responses to change and uncertainty as critical elements in theorizing Porgeran peoples’ involvement with such diverse processes as horticultural production, multinational mining ventures, climatic variation, and Christian missionization. I draw on insights from both cultural and ecological theory, in which change and transformation are

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central to social and environmental systems. In the social sciences there are a number of scholars whose works are instrumental in understanding how capitalism and modernization are appropriated and refracted through local cultural schemes and practices (Ferguson 1999, 2006; Ong 2010; Sahlin 1988, to name but a few). From ecology the concept of resilience offers a useful frame of reference for understanding social and environmental resilience (see also Berkes et al. 2003b; Gunderson and Holling 2002). At the same time, though, I temper this with an awareness of the importance of “place” (Basso 1996a; Escobar 2008; Massey 1994), or the enduring associations that people have with their landscapes through their subsistence livelihoods, histories, and myths. Studies of place offer insights into sources of stability, or “groundedness,” between people and the lands they inhabit. I also take seriously the effects of development and Christianity on Porgeran ontologies (cf. Cruikshank 2012; Descola 2013; Kohn 2007; Latour 2009; Nadasdy 2007; Viveiros de Castro 1998, 2004), addressing what Eduardo Kohn (2007: 6) refers to as “an anthropology of life,” which is “the practice of a kind of anthropology that situates all-too-human worlds within a larger series of processes and relationships that exceed the human.” While this new attention to ontology in anthropology allows us to expand the scope of our inquiry to the relationships between humans and nonhuman others, this book also examines the implications of ontological dissonance, or the implications of how people’s lived-in worlds transform due to external events and influences.

Besides change, I seek to understand struggles over access to and control over land and resources, one of the key concerns of “political ecology” (Biersack 2006b; Blaikie and Brookfield 1987b; Paulson and Gezon 2005; P. Robbins 2004). Political ecology, according to Blaikie and Brookfield (1987a: 17), “combines the concerns of ecology and a broadly defined political economy. Together this encompasses the constantly shifting dialectic between society and land-based resources, and also within classes and groups within society itself. [It] also derive[s] from political economy a concern with the role of the state.” Struggles and conflicts over land and resources in Porgera have resulted in large areas of deforestation and forest degradation, another major concern of political ecology (P. Robbins 2004). In this light I attend to Vayda and Walters’s (1999: 169) critique that within political ecology what is often studied “are political controls or political contests over natural resources and not, or at least not to any significant extent, how the resources are affected by those controls or contests.” Combining ecological sampling with remote sensing, I demonstrate that deforestation is detrimentally
impacting areas adjacent to the mine and main roads in Porgera. Deforestation and forest degradation are complex phenomena, however, and understanding these processes highlights that population pressures and development alone are not enough to explain habitat change. Property rights, kinship connections, spiritual beliefs, habitat types, and rules over resource management all intertwine to produce varying outcomes on forests in Porgera.

While it is essential to ensure that political ecologists attend to ecology, it is also critical that we define whose ecology we are talking about (West 2005). There is a long tradition in anthropology of studying indigenous ecological knowledge (Berlin et al. 1973; Conklin 1954; Nazarea 1999). However, research on indigenous ecological systems needs to move beyond the narrow focus on classification and taxonomic categorization that defines much of this work. As Hviding (1996: 26) argues, “Systems of classification must be considered in a wider context, comprising cognition, productive activities, and social relations.” To this end I devote a major portion of this book to detailing an indigenous philosophy of ecology, or an ontology, as Porgerans expressed it to me. A key concept in Porgeran ecological understanding is the flow of a vital force called ipane or “grease” that permeates all living things. Correspondingly the flow of grease across trophic levels sustains the social-ecological system. However, in Porgera the food web involves not just the feeding relationships of biotic organisms but also includes spirits and the land (cf. Rappaport 1984). The sacrifice of pigs and the burning and offering of pig fat (via ipane) to ancestral spirits resulted in the spirits making the land fertile—giving it yu ipane, “land grease.” Plants and trees are dependent on land grease and incorporate it during their growth cycle. The consumption of plants and food crops by pigs and humans puts grease into their bodies. The grease of pigs flows to both ancestral spirits through sacrifice and to humans through consumption. The ecological system in Porgera tends toward entropy, however, as the land grease (yu ipane) and the grease in humans (ipane) is expended through production and reproduction, ultimately culminating in a catastrophic destruction of the world so that it can be reborn again. However, it is primarily through human labor (piape, “work”) that entropy and catastrophe are mitigated.

Porgeran ecology, as such, is not the ecology of equilibrium or homeostasis between social and ecological systems, such as depicted in an earlier era of environmental anthropology in the PNG highlands (Rappaport 1984). Geological and climatic anomalies, such as volcanic eruptions, landslides, droughts, and frosts, and social disruptions, such as endemic warfare, Christianity, and multinational resource extraction,
have contributed to a suite of dynamic and creative social and environmental practices and perceptions by Porgerans regarding their precarious existence. In fact it is anticipation of uncertainty—crop failures, tribal fighting, spirit attacks—that defines Porgeran socioenvironmental practices. This same attitude permeates their recent involvement with colonialism, gold mining, and Christianity. Yet there are limits to resilience (Adger et al. 2009; Nelson et al. 2007; Ogden et al. 2013), and in the final chapters of this book I examine these in more detail in order to contribute to the growing chorus of voices that seek to promote sustainable livelihoods in the face of ecological degradation and capitalist intrusion.

Alchemy in the Rain Forest

As mentioned, one of the main themes in this book is to document the making of a resource frontier in Porgera, especially from the perspective of nonlandowners who receive few if any benefits from mining. An analysis of a resource frontier highlights the ways that resource development commodifies nature and social relations, the implications of these processes, and the new ways that people think about and act on each other and their environments (Agrawal 2005). The second main theme in this book is about change—cultural and environmental change and how they are inextricably linked—captured by the phrase the land is ending. For a horticultural society to say that the land is ending is more than just a statement of the perceived degradation of the material environment. It is a statement that encompasses transformations in concepts of personhood, social relations, kinship dynamics, and cosmological understandings. Traditionally Porgerans engaged in large-scale ritual efforts to prevent the end of the land. Paradoxically the very forms of change that Porgerans desire through development amplify traditional concerns about the land ending. Environmental destruction brought by mining, Christianity with its apocalyptic end times, and the social devastation wrought by the adoption of firearms entangle concerns about the end of the land with the moral decline of society.

My title, Alchemy in the Rain Forest, draws attention to two sets of processes regarding change that encompass this larger ontological perspective: the transformation of land and the transformation of people. These are two inseparable and interlinked processes that have both material and ideological consequences. The goal of alchemy in the ancient and medieval world was to transmute base metals into gold. I use the imagery of alchemy to explore the implications of turning Porgeran lands into gold, which affects the material, social, and cultural landscapes in
the region. In material terms, tailings waste dumps, riverine pollution, and deforestation are detrimental legacies of the mine. At the same time, though, infrastructure development, electrification, and other material benefits are viewed in a positive light by most Porgerans. Socially Porgeran society has been bifurcated between those people who receive monetary and other benefits from mining and those who do not. A key feature of social life in the valley today centers around (often violent) political contestations over institutions related to land tenure and social organization. Alternatively some Porgerans have been able to mobilize their social capital through broadened social networks, giving them access to places and opportunities closed to them just a few decades ago. In a cultural view, gold is said to come from the shed skin of an ancestral python spirit that is linked to regionwide social and ecological renewal rituals. Gold extraction therefore threatens the very cosmological underpinnings of the Porgeran worldview. In contrast to this, some see this gold as a gift from the python spirit that allows them to channel mining wealth into their kinship networks and communities (Golub 2006).

A second, perhaps loftier goal of alchemy sought the transformation of people by improving the human condition (Moran 2005; Newman 2005; Smith 1997). In alchemical science the philosopher’s stone, the source of the elixir that would transmute metals into gold, could also be used on the human body to prolong life, bring enlightenment to its discoverer, and refine both body and soul (Linden 2003). In this sense the alchemy of development depends on images of progress, advance, and betterment. Since first contact with the outside world Porgerans have fervently sought to incorporate outsiders and their ideas, first in their efforts to obtain the wealth of outsiders through ritual means, then using imprisonment by colonial agents to learn Tok Pisin and become acculturated in colonial practices as a path of upward mobility. Through mining, Porgerans and non-Porgerans alike have envisioned the transmutation of Porgerans from tribal horticulturalists to entrepreneurs and wage laborers embedded in capitalist processes. From the perspective of Christianity, Porgerans see their involvement in a global religion as ushering in an era of not just economic development but also social transformation. As scholars across the social sciences have shown, however, development is itself highly contested as both a concept and a practice (Escobar 1995; Ferguson 1994; Sachs 1992; Scott 1998). Exploring the pursuit of alchemy in Porgera, then, allows us to examine the motivations and practices of a variety of agents and institutions at various scales across space and time. It also lets us explore the materiality of resources (Bakker and Bridge 2006) as we examine how gold—as an agent that
shapes human social relations itself—is simultaneously a cosmological substance, an extractive resource, and a globally sought-after commodity that links Porgerans with other Papua New Guineans, transnational mining corporations, international financiers, and everyday consumers. As such it provides a means for us to understand the everyday politics of resource development in an “out-of-the-way place” (Tsing 1993) and the real-world impacts of humanity’s desire for gold on the lives and lands of a people who themselves had no word or use for the mineral until the mid-twentieth century. Moreover the metaphor of alchemy highlights the point that as much as we may want to control and manage social and environmental change, the end results may be just as elusive for us in the twenty-first century as they have been for alchemists in the past.

The Global Demand for Gold

In Porgera I was often asked, “Where does all of this gold go? What do people do with it?” Porgerans had been alluvial-mining it themselves for fifty or so years and of course knew of the wealth that was associated with selling it. But what outsiders were doing with the gold they took from the valley was beyond their imagination, as they have no indigenous use nor word for gold. During fieldwork in the late 1990s, the question caught me off guard. I assumed that it was used for jewelry and industrial applications, and maybe global finance, but in what proportions I had never thought to consider.

Surprisingly, most of the global demand for gold is in the form of jewelry and gold bars, primarily used as a form of wealth storage in developing countries. According to the World Gold Council’s Global Demand Trends reports (available at www.gold.org), between 2001 and 2010 about 68 percent of the global demand for gold went into the jewelry market. Investment (gold bars, coins, and exchange traded funds) accounted for 20.5 percent of the demand, while technology accounted for 11.5 percent. In 2010 four countries—India, China, Turkey, and Saudi Arabia—accounted for 58 percent of the jewelry, bar, and coin demand in the world. The average annual gold demand from 2001 to 2010 was 3,569 metric tons. The supply for this demand comes from two sources: mining and recycled gold jewelry. In 2010 mines around the world produced 2,543 metric tons of gold, while 1,653 metric tons came from recycled gold.

Since opening in 1990 the Porgera Gold Mine has produced between 0.7 and 1.3 percent of the world’s gold demand annually (18.4 million ounces from 1990–2013; 766,150 ounces on average yearly)—a fractional amount for such a huge impact on Porgeran lands and lives.
Given the diverse and seemingly contradictory tensions between socioeconomic development and biodiversity conservation, it is imperative that we seek sustainable futures that improve peoples' lives while preserving global biodiversity. This can be an extremely difficult goal to achieve (Oates 1999). However, given that humans dominate nearly all major ecosystems today (Vitousek et al. 1997), it is apparent that any solution will require us to understand problems in conservation and development as aspects of linked social-ecological systems. The concept of resilience is one avenue of inquiry that offers promise for resolving the dilemma between development and conservation (Gunderson and Holling 2002; Leslie and McCabe 2013; Nelson et al. 2007). Coupled social-ecological systems that are resilient are able to absorb perturbations, adapt to changing circumstances, and yet still retain their same function and structure (Berkes et al. 2003b). Papua New Guineans have a forty-five-thousand-year history (Summerhayes et al. 2010) of living in their diverse environments, during which time they have adapted to the end of the last Ice Age, the independent invention of agriculture, the arrival of new crops and domesticated animals, and the benefits and ills of the past century of globalization—truly a case of resilience if ever there were one. Yet over the past decade or so, conflicts over resource development and environmental conservation have resulted in the loss of lives, destruction of property, ecological degradation, and other harbingers of severe social-ecological stress (Ballard and Banks 2003; Connell and Howitt 1991; Filer 1999; Hyndman 1994; Imbun and McGavin 2001; Kirsch 2006; May and Spriggs 1990; West 2006a). All of these pose serious challenges to social and ecological resilience in PNG. A critical concern for environmental anthropology is to examine how human societies respond to changes in social-ecological systems in ways that are both adaptive and maladaptive (Rappaport 1993). By doing so we can explore responses and processes that offer hope for finding sustainable solutions to the challenges that face us in the fields of development and conservation.

This book complements recent works in PNG on resource development (Golub 2014; Kirsch 2006; West 2006a) yet also stakes out new theoretical and methodological ground. Paige West's long-term research among the Gimi, who figure centrally in a conservation and development project at Crater Mountain Wildlife Management Area, highlights the contentious and divergent expectations over development between conservation NGO workers and local communities. These tensions eventuated in the demise of conservation efforts around Crater Mountain as locals aligned themselves with mining companies who promised to
bring them the development the Gimi hoped for but which conservation had not delivered in the ways they anticipated. To date the Gimi are still waiting for their mine as the prospect is still in the exploration stage. Working in the communities some distance downriver from the world-class Ok Tedi copper and gold mine, Stuart Kirsch’s book examines the environmental costs of mining on a lowland Papua New Guinean society. Like Porgera, the Ok Tedi mine practices riverine tailings disposal that has devastated the aquatic ecology and subsistence of the Yonggom, as well as destroying riverside gardens and forests several kilometers inland from the river banks due to siltation-caused flooding. Similar to this book, Kirsch situates these impacts in an indigenous framework, describing the ontological dissonances that a lowland PNG society faces through the deterioration of their environment. While both West and Kirsch work in a political ecology framework and provide compelling accounts of mining (actual and imagined) on indigenous lifeworlds, neither ethnography is situated among a group of people living directly adjacent to, and hence impacted along multiple dimensions socially and ecologically by, a large-scale mine. One of the methodological contributions this book makes is to situate the social and ontological changes that West and Kirsch also discuss alongside empirical observations of environmental changes through remote sensing and ecological sampling. Alex Golub’s recent book on elite landowners in Porgera is an excellent companion to this book. Golub and I overlapped in Porgera for a period of several months in 1999 and 2000, and while I worked among nonlandowners, Golub worked among landowners. His book is a contribution to political anthropology in that he examines how collectives (what he calls “leviathans,” in this case Ipili landowners and the mine) form out of the actions of disparate individuals pursuing their own ends. While Golub provides a nuanced microanalysis of negotiations over a proposed resettlement scheme, this book explores the ontological and ecological stakes of resource development from a more holistic perspective.

Research in Porgera

Determining what to call the people of Porgera is difficult. The term that I and other researchers have used is Ipili. People like Ben and Peter fit the description of Ipili well (i.e., Ipili-speaking parents, Ipili ancestors, long-term family history in the valley). Accounting for people like my Enga-speaking friend Epe Des (figure 1.1), however, is why I use the term Porgeran to describe the people in this book rather than Ipili.
The ethnographic data used in this book come from two research trips that total sixteen months. When not in Porgera, I followed events from afar through a variety of sources: news articles, emails and letters from Porgerans, conversations and articles from other scholars working in the area, and corporate reports. I have also analyzed environmental changes from ecological surveys in 1999 and 2006 and remotely sensed satellite imagery and aerial photos from 1972 to 2013 to document the growth of the mine, deforestation and land cover changes, and infrastructure expansion. While most of the data in this book come from ethnographic research, the rest derive from these supplementary sources.

From December 1998 to February 2000 I lived in the eastern Porgera valley in the hamlet of Kolatika while conducting research for my dissertation. The entire eastern Porgera valley is called Tipinini by outsiders; it comprises I pilili speakers, the original inhabitants of the Porgera valley, Enga speakers, and some Huli speakers; the latter two groups have mostly married and migrated in since mining began. I interviewed over two hundred people living in approximately ten hamlets throughout Tipinini and also among other communities along the main road, such as Kairik and Paiam. I also interviewed government workers at Porgera Station (the government headquarters) and mining officials at the Porgera Mine. During this first research period I also worked in several hamlets in Wailya, a community of Enga speakers just to the northeast of Tipinini. In addition to holding semistructured and unstructured interviews, I also conducted participant observation, working with, eating with, and accompanying people throughout their daily routines of work, church, and leisure. Throughout 1999 I conducted resource mapping exercises in several hamlets, gathering data on preferred sites for hunting, gathering forest resources, and harvesting wild pandanus.

During this initial research period I became closely integrated into a subgroup of the Tokoyela clan, the landowning group at Kolatika. Kolatika served as a government base in the eastern Porgera valley and was the location of a patrol officer’s house and an agricultural extension officer’s house. Patrol officers serve as liaisons between the government and community, but the post was currently vacant at Kolatika, so the government allowed me to live in the patrol officer’s house during my dissertation research. I shared this house with two research assistants, Peter Muyu (figure 1.2) and Ben Penale (figure 1.3), both from the Tokoyela-Maia subclan. Ben and Peter were both married, and each had three children ranging in ages from two to nine. Their families, who lived a few minutes’ walk away, absorbed me graciously into their lives and homes.
In 1971 Epe Des left Yelum, his home area among the western Enga, which is several days' walk from Porgera to the northeast across the Lagaip River. He had heard that gold mining companies had moved into the Porgera valley and men were needed as laborers. Arriving in Porgera, Epe soon found out that all of the jobs were taken, but he had a cousin in the eastern part of the Porgera valley (Tipinini) and stayed with him a while to see if any jobs would open up. While living there, he met and fell in love with Isam Tiyupe, an Ipili woman. They married and returned to Yelum, but the constant tribal fighting prompted Isam to return to Porgera within a year or so. Epe stayed to fight and help his group with compensations, but after one battle he was shot six times with arrows and nearly died, which convinced him to leave Yelum permanently. As soon as he was well enough to make the journey, he walked back to Porgera to join Isam. They settled in the Tipinini area, maintaining homes simultaneously at various hamlets, such as Lese, Kolatika, and later Kukulama. Over the years they had four children. When I first became acquainted with Epe in 1998, he had recently been elected to his fifth term as the village councilor for Tipinini #1 ward (local-level government districts are divided into census wards, of which there are ten in
Figure 1.3. Ben Penale.

Figure 1.4. Research assistants in 2006. Jerry Loa, Wanpis Kaipas, Epe Des, and Iki Peter (back, left to right); Timoti Peter and Kala Kaipas (middle, left to right); Solomon Kaipas (front).
the Porgera valley) and was also the Seventh Day Adventist (SDA) pastor at Kolatika.

Epe's case of being an outsider and also a leader is not unique and illustrates the need to think creatively about ethnic identities in this region of the highlands. An immigrant Engan married to an Ipili woman, Epe came to dominate political and religious life for thirty years in the eastern Porgera valley as a pastor and councilor. At times in this book I use categories like Enga, Ipili, and Huli, mostly to talk about language and precolonial ethnic identities, but I also use Porgeran to capture some of the dynamics that have resulted from the long-term influx of people from surrounding communities to this area. As Paul Sillitoe (1999) argues for the nearby Wola of Southern Highlands Province, fixedness of identity and localization of the group is what New Guinea highlanders are working against socially (see also Biersack 1995a). The movement of families and groups across the landscape allows people to continually renegotiate issues of boundary and identity, which is crucial in these acephalous, stateless societies. The intrusions of the Papua New Guinea state and developers who cannot accommodate such social flux are a key source of the tensions in contemporary highlands societies, a point that is central to understanding how introduced vulnerability challenges resilient social-ecological systems.

In November and December 2006 I returned to Porgera excited to see all of my old friends and acquaintances. While I normally traveled by public bus to Porgera from the airport at Mt. Hagen, I had just given a talk at the University of Papua New Guinea, which was attended by one of the upper-level managers of Barrick Gold, PNG—the current operators of the mine—who arranged for me to fly in on a Porgera Joint Venture plane. (A friendly gesture despite the fact that my talk was critical of how restricted development was in Porgera for most Porgers. This same Barrick executive also dashed my hopes regarding studying mine closure.) With the recent uptick in the price of gold and the discovery of some new gold-bearing veins, the earliest that mining would end would be in 2032! I flew into Porgera as the only passenger on a forty-seat airplane; the remainder of the seats were filled with bundles of the latest edition of the national newspaper, the Post-Courier, and cartons upon cartons of eggs. As I left the razor wire–topped, fenced enclosure around the Kairik airstrip, set my bags on the side of the road, and waited for a passing vehicle to take me to Tipinini, the airport security guards struck up a conversation with me. They wanted to know where I was going, and I told them Kolatika. They looked shocked and said, “You can’t go there, they’re in the middle of a big fight now.” I learned that two clans
were fighting over a compensation payment from PV. More disturbing, 
two women and a man, all Huli from the Tari area, had been killed the 
day before in the midst of fighting on the road to Kolatika. Even the se-
curity guards were disturbed. “Women being killed, can you imagine?” 
one of them asked me.

Bewildered about where to go, I made my way to Porgera Station to 
see if I could find a room at Porgera’s lone hotel, the Mountain Lodge, 
a place that evokes none of the qualities that the name promises. Out-
side the razor-wire fence surrounding the cobbled-together temporary 
housing facilities that are the lodge, I was overjoyed to see that the se-
curity guard was a Tipinini man from Kolatika, Jakob Inama. Jakob was 
amazed to see me, and we both lamented the fighting that had broken 
out in Tipinini. I asked him to send word to Epe (mobile phone service 
was still a few years away) that I was in Porgera and needed a place to 
stay now that it seemed I couldn’t return to Kolatika. He promised he 
would, and we parted.

The following morning Epe arrived at the Mountain Lodge, and we 
sat in the grass and gazed down the Porgera River valley and told each 
other how our lives had transpired during the previous six years. In 
2003, the same year I defended my dissertation and took a university 
position, Epe became the pastor of the SDA church at Kukulama, built a 
permanent materials house next to the church, and moved his family 
there. In 2005 the Tipinini fight started; to avoid the violence Epe moved 
down the road to Kairik. (In April 2008 I received an email from Epe’s 
son, George, who said that the house and church in Kukulama had been 
burned down during another tribal fight.) Epe’s family was doing well 
despite the disruptions; George was working in community affairs at 
the mine; his elder daughter, Angie, was married and raising children; 
his daughter Rose was working for an NGO in the valley that worked on 
women’s issues; and his younger son, David, was in high school. Epe 
encouraged me to come live in Kairik at a hamlet called Apone Camp. 
He lived next door to the Lutheran pastor of Kairik, Kaipas Wangi, an 
Enga man from Maramuni, who had already agreed to let me stay at his 
house. I knew few people in Kairik, although many of them remembered 
seeing me during my first stint in Porgera, and so with few options, I 
reluctantly moved to Apone Camp adjacent to the Kairik airstrip.

Over the following weeks, as word spread throughout the eastern 
Porgera valley that I was living in Kairik, my friends from Kolatika came 
to visit. The reunions were bittersweet. While some of my younger 
friends were now married and starting families, many of my closest 
middle-aged and elder friends and informants had died of old age or
other ailments or, more commonly, been murdered in revenge killings. Kipan, whom I met my first night in Kolatika in 1998 and who thereafter was a constant companion, came hobbling into the Lutheran church compound one afternoon on crutches, suffering from a festering wound in his lower leg. Due to all the fighting, he had made the difficult journey along forest trails to spend an afternoon with me and “see [my] face again.” I gave him money for medical treatment, and we spent the afternoon reminiscing about the past and pondering what the future held for us. Within a few days Peter and Ben each came separately to visit. Peter was suffering from malaria that he had picked up while mining for alluvial gold in the lower reaches of the Porgera valley. Ben had also experienced some rough times since 2000; due to the fighting he had lost a government job he had held for five years. Since alcohol had been legalized for sale and consumption in Porgera since 2002, he was now the co-owner of a beer hall in Kukulama; however, in emails in 2013 he writes that he now has a government job again with the Enga Provincial Government.

While I lived at Apone Camp, the fighting between the two clans raged on. Every day we heard gunshots in the distance, and every couple of days someone else was killed. I hired Epe and several young men—Solomon and Wanpis, Kaipas’s teenage sons, Kala, their cousin and Timoti and Iki Peter, two young men from the Bipe clan whose land we were living on—to help me do ecological surveys. Jerry Loa, a Bipe man about my own age (fortyish), joined our team after the first day to help with land use histories and to aid in negotiating access to his clan members’ gardens and forested lands (figure 1.4). Our days were active and full of camaraderie as we surveyed primary- and secondary-growth forests, measured gardens, and compiled garden inventories. The young guys would sing Enga songs and crack jokes about the differences between “pomberena [black, in Ipili] Jerry” (Loa) and “one [white, in Ipili] Jerry” (me). It was hard to ignore the turmoil that the fighting was causing in people’s lives, though. Every morning we would wait to hear where gunfire was coming from before we set out in the opposite direction to begin our work. Most days we would run into people singly and in groups furtively making their way along a forest trail to pass through the war zone en route to Porgera Station. Men armed with spears and bows and arrows would seek us out in the forest to drive us off, thinking we were a raiding party from one of the two clans. Upon finding a group of guys counting and measuring trees and writing down all of their cultural and economic uses, they would relax and hang out with us for a bit before continuing on their patrols.
Eventually the fighting reached Apone Camp. During my second month there, in the middle of the night a young man was shot and killed in the center of the hamlet, less than fifty meters from where I was staying. A few days earlier, as I was watching the funeral procession of a politician who had died (from sorcery, everyone said) in Port Moresby leave the Kairik airstrip, a group of young men wielding machetes sidled up behind me. Flustered, and for the first time in Porgera fearing for my safety, I told them to stand somewhere else. They refused to do so, and only when Epe yelled at them did they move on. With these two recent events I realized it was getting too dangerous to remain in Porgera. The morning after the killing in Apone Camp I caught a bus to Mt. Hagen to begin the long journey home. My last memory of Porgera is seeing Jerry Loa, wearing the Australian bush hat I had given him for a present, waving good-bye to me while standing alongside the road in Kairik in the pouring rain.

In the intervening years I have felt challenged about how to write about my experiences there. Given the complexities of the situation in Porgera, there are a range of viewpoints that one could choose to convey the events and circumstances surrounding the development of mining there. As an anthropologist, my primary perspective aligns with the community, although I underscore the ways this is a perspective fraught with factional differences based on locale, gender, age, and other factors. As an environmental anthropologist, my goal is also to argue for the indivisibility of social from environmental factors. How Porgerans conceptualize the changes they have experienced through engagement with mining is as much a story about cultural as environmental changes and the transformations that structure people’s interactions with the land. From this perspective, the environment itself has an agency that helps to shape our understanding of this story. As an environmental scientist trained in geographic information system and ecological survey methods, I focus on the impacts of mining and development on the biophysical environment to understand the relationships between resilience and vulnerability in social-ecological systems. Finally, as a political ecologist, I provide a perspective that examines how capitalism, in different ways at different scales, affects concepts and institutions related to property rights, resources, and environmental conservation. My main goal, though, is to tell a story that doesn’t reduce the Porgeran experience to one of complete despair in the face of capitalist development, on the one hand, nor one that portrays the bright, hopeful future as represented in glossy brochures produced by the mine, on the other hand. A better story about Porgera is a story that examines
change and the ways that complex social and environmental dynamics both foster and challenge sustainable livelihoods in order to build resilient responses to the problems that face us in the twenty-first century (Ogden et al. 2013).

The Structure of the Book

The ethnographic chapters are divided into three parts: “The Making of a Resource Frontier,” understanding “development” in its historical and contemporary contexts through such diverse people and institutions as Porgerans, colonial agents, Christian missionaries, the PNG state, and multinational mining companies; “Indigenous Philosophies of Nature, Culture, and Place,” detailing Porgeran interactions with their environment, both materially as a source of subsistence and symbolically as a source of cultural meaning; and “Social-Ecological Perturbations and Human Responses,” documenting changes in the coupled human-environment system to explore the adaptive and mal-adaptive responses people make to large-scale resource development in Porgera.

In chapter 1 I position Porgera within contemporary debates in Papua New Guinea over resource development and concerns about conservation. PNG is one of the most culturally, linguistically, and biologically diverse places on the planet, yet this immense repository of human and nonhuman diversity is threatened by capitalist resource extraction and the changing social relations wrought by capitalism (Durkheim 1997; Marx 1990; Weber 1997). Conceptually I deploy theories of resilience, political ecology, ontology, and place to describe the “different landscapes and ecological dynamics” (Scoones 1999: 494) at play in the making of Porgera’s “resource frontier.” In chapter 2 I focus on the historical encounters between Porgerans and outsiders. Gold prospectors, colonial patrol officers, and Christian missionaries formed the foundation of Porgeran experiences of the outside world, and gold, guns, and the Bible remain essential elements of Porgeran identity today.

Part II delineates a Porgeran ecological philosophy that is developed in chapters 3 through 5. There is no word for ecology or nature in Porgera, and as such, beliefs and practices associated with the environment contain “an extraordinary amount of human history” (Williams 1980: 67). In other words, to describe Porgeran ecology it is necessary to discuss kinship relations, social organization, spirit beliefs, and other such “social” factors that in Western tradition are not considered part of “natural” systems (see also Descola 2013). The Porgeran social-ecological system pivots
around three critical concepts: land, people, and spirits. The essence that unites these, as mentioned, is grease or ipane, and a reciprocal triad of people, spirits, and the land are key for the maintenance of ipane in the system. Chapter 3 deals with how the land is conceptualized cosmo-
logically and the implications of this for local resource management. In chapter 4 I address people, work, kinship, and social organization, and in chapter 5 I explore spirits and their role in earth fertility rituals and the transformation of spirit beliefs in the present.

In part III, I explore resiliency and vulnerability in the face of social and ecological perturbation. Despite being in the tropics, livelihoods in the high-altitude ecology of Porgera are vulnerable to frosts, droughts, and other environmental calamities. Likewise significant levels of inter-
group violence are a constant threat. To counter these challenges, the social and ecological practices that I detail in part II emphasize flexibility and openness to change in order to foster resilience. In chapters 6 and 7 I evaluate this flexibility and openness in more detail but also highlight the unexpected forces and processes that are increasing ecological and social vulnerabilities. In particular in chapter 6 I examine human responses to volcanic eruptions, droughts caused by El Niño–Southern Oscillation, and deforestation. Oral and other historical sources are in-
tegrated with remote sensing analysis and forest plot surveys to de-
cipher local and regional environmental changes. In chapter 7 I take a detailed look at social disruptions brought by mining development.

Benefits from mining create “wealth without work” (Reed 2009: 3) and re-
shape attitudes about productive labor. For many of the disenfranchised young men left out of the mining wealth, warfare acquires new value as a means to extort money from groups receiving mining proceeds (“working in the life market”). Other disenfranchised individuals seek wage labor opportunities with variable success or turn to millenarian Christianity in hopes for a better life.

In the concluding chapter I comment on the practical and policy implications of large-scale resource development in Papua New Guinea. Resource exploitation will be a centerpiece of economic development in PNG for the next several decades, and with a combination of foresight and in-depth case studies such as this book hopefully developers and the PNG state will not repeat many of the mistakes that have occurred at Porgera and other mines (Kirsch 2014). I also explore how locally derived ontologies and myths intersect with a resilience framework focused on coupled human and natural systems. I end with a discussion of the agency of gold and how gold mining in particular has lent itself to perceptions of the land ending in Porgera.
Porgera is exemplary of the kinds of places that the anthropologist Anna Tsing (2005: 28) calls “resource frontiers,” spaces where global capital, multinational extractive corporations, and increasingly militarized Third World countries interact, often on the homelands of tribal and indigenous populations. They are places where local ecologies and livelihoods are disengaged from nature by national governments and where the “natural resources” are offered up as “corporate raw materials.” As Tsing notes, these frontiers “aren’t just discovered. . . . They are projects in making geographical and temporal experience. Frontiers make wildness . . . [that] is both material and imaginative” (28–29). Anthropological concerns with “new frontiers of land control” (Peluso and Lund 2011; see also Fairhead et al. 2012; White et al. 2012) have gained prominence as transnational corporations allied with national elites have increasingly appropriated local people’s lands and resources. Peluso and Lund (2011: 668–69) argue that these “new frontiers of land control are being actively created.” Building on Tsing’s definition, they write, “These created frontiers are . . . sites where authorities, sovereignties, and hegemonies of the recent past have been or are currently being challenged by new enclosures, territorializations, and property regimes. . . . Land control can [also] be understood as embedded within broader political struggles over identities . . . and change[s] the ways we think about enclosure, territorialization, and property as iterative
processes productive of environmental subjects." These are important considerations, but what makes the Porgera case so compelling is that it disrupts easy generalizations about how resource frontiers are made. It is not just multinationals, militaries, and national elites that have offered up Porgera's land and resources as raw materials for capitalism, but many Porgerans are also involved in this frontier-making project.

Porgera serves as a microcosm in which to examine contemporary global concerns such as sustainability, deforestation, economic development, resource conflicts, and social-ecological resilience—all the elements involved in making a resource frontier. In chapter 1 I situate Porgera within the larger political economy and ecology of PNG and address my two main themes—the making of a resource frontier and the corresponding implications for social and environmental change—within the theoretical literature on the intersection of society and ecology. From this literature I draw on theories of resilience and change, political ecology, and ontology and place to argue that the mutual constitution of societies and their environments is integral to an engaged environmental anthropology for the twenty-first century. At the end of the chapter I provide a brief ethnographic overview of Porgera as a place and the people who live there.

Porgera is a place that is produced materially, imaginatively, and discursively through the concept of development (cf. West 2006a). Discourses and practices surrounding development stem from two overlapping yet sometimes contradictory forces: resource extraction and Christianity. In chapter 2 I delineate the interactions between colonial agents of development and Porgerans. My goal is to situate the historical process of making a resource frontier from the perspective of Porgerans. How did they understand what they were undergoing, and who benefited and who lost from these engagements? In an attempt to overcome anthropology's focus on the "local" (Wolf 1982), the anthropology of postcolonialism and globalization tends to overemphasize global interconnection. Akhil Gupta and James Ferguson (1992: 8) write, "If one begins with the premise that spaces have always been hierarchically interconnected, ... then cultural and social change becomes not a matter of cultural contact and articulation but one of rethinking difference through connection." They argue that places are formed out of "interconnected space that always already existed. Colonialism, then, represents the displacement of one form of interconnection by another."

Porgerans live in a multiethnic and multilingual social world; they are deeply aware of their interconnections with other groups. However, it is difficult to claim that the larger exchange networks they were
involved in during the precolonial era radically reshaped their lives and environments. Today many of them say about the precolonial era that it was a time of "living in a fence"; mobility was restricted and the onset of colonialism either "broke the fence" or "opened the roads," allowing for a greater movement of people. Communities and kin groups were interconnected to an extent in the precolonial era, but not hierarchically.

In chapter 2 I trace the history of "breaking down the fence," from first contact to recent events of large-scale mining. This history is based on documents that I investigated in historical archives, published accounts, and interviews conducted between 1998 and 2006. As I attempt to illustrate, one of the novel effects of colonialism, Christianity, and the postcolonial mining era has been to introduce expanded forms of interconnection that indeed are hierarchical and that profoundly shape Porgerans’ sense of their place in the global order. Through interactions with colonial administrators, expatriate miners, and missionaries, Porgerans sought the alchemical transformation of their bodies that I addressed in the introduction, although the outcomes of this process varied greatly from individual to individual. To this end I explicitly document how gold mining interests, implemented in the 1940s, laid the foundation for indigenous mining ventures in the 1950s, which initiated the era of economic inequalities. As a counter to the growing power of the indigenous miners, other men sought alternative avenues to power through engagement with colonial regimes and Christianity. As such, the typical "triad stakeholder" model of the state, the developer, and the community needs more ethnographic attention (Ballard and Banks 2003; see also Agrawal and Gibson 1999; Golub 2014) in order to show how each of these entities is more diverse and factionalized. The aim of the following two chapters is to highlight the diversity and factions at play in Porgera’s resource frontier.