

LAND CHANGE SCIENCE,
POLITICAL ECOLOGY,
AND SUSTAINABILITY

Synergies and divergences

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DEFORESTATION AND THE WORLD-AS-REPRESENTATION

The Maya forest of Southern Belize

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Introduction

The broadleaf tropical forests of Southern Belize are inundated with around four meters of water each year, much of it falling in torrential rains during July and August, the most intense months of the wet season. This is a time when the Maya farmers relax a bit, having cleared their milpa grounds from the forest, and watch the young corn plants rise from the hillside limestone soils. The rain is not, however, the only guest from the sky. Since the mid-1970s, an array of satellites has passed over these lands, generating data from the electromagnetic radiation reflecting off the canopy. This chapter is about these data and the stories they tell: their truths and their politics.

According to the Government of Belize, the Q'eqchi' and Mopan Maya communities of Southern Belize do not hold indigenous title to the forest lands from which they produce a livelihood. The government's contention has been reiterated in various fora since 1981 (when Belize became formally independent from England), most recently through several rounds of legal defense against Maya claims to indigenous rights in the courts.¹ A lengthy legal and political struggle culminated in a landmark decision in the Supreme Court of Belize on October 24, 2007. The court found that the long-standing customary land use practices in the Maya communities constituted a form of property, hence protected by the Constitution. To cite Chief Justice Conrath's decision:

[The Maya communities'] rights and interests in lands based on Maya customary land tenure . . . constitute 'property' within the meaning and protection afforded to property generally, especial here of the real type, touching and concerning land—'communitarian property', perhaps, but property nonetheless, protected by the

Constitution's prescriptions regarding this institution in its protective catalogue of fundamental human rights.

(Conteh, 2007, p. 52, para. 102)

The court concluded that the Maya communities

hold collective title to the lands their members have traditionally used and occupied within the boundaries established through Maya customary practices; and that this collective title includes the derivative individual rights and interests of Village members . . . in accordance with and subject to . . . Maya customary law.

(Conteh, 2007, p. 66, para. 136[b])

Notwithstanding this unambiguous victory for the Maya communities, the facts on the ground have changed very little since 2007. Land tenure remains uncertain; no formal titles to community lands have been granted. Moreover, state officials have publicly rebuffed the court's key contention that the Maya communities have indigenous rights to their lands. Indeed, the Government of Belize has refused to recognize the Supreme Court's decision and has appealed it to the Caribbean Court of Justice (formed 2001).

One of the more effective popular representations of the government's argument that the Maya communities do not (or should not) own their lands is to assert that the Maya destroy the forest through "slash and burn" farming. Consequently, the geographical evaluation of land cover takes on a political character. Our analysis below examines the validity of this claim about "Maya deforestation." We mention it at the outset because it explains this chapter's existence. Having defeated the government in the Supreme Court in 2007, the Maya communities found that they faced intense pressures from the state to cede authority over community-based land ownership, especially forest management. In this context, Wainwright (who has worked in Southern Belize since 1993) was encouraged by the Maya Leaders Alliance to produce an analysis of forest change that might be of assistance in land management or in countering the government's narrative. He turned to his colleague, Liu, for assistance; with Liu's student Jiang, we formed a team to execute this work.

Our results include, we believe, the most thorough analysis of forest use in our study area to date. The full results of the project exceed the scope of this chapter. Here we briefly present three main findings from spatio-temporal analysis of forest change in Southern Belize by interpreting Landsat images from 1975 to 2011. We focus on changes during the 1990s, a decade for which we have especially clear and consistent Landsat data. This analysis shows that while the forest has indeed changed, previous studies have overstated the rate of deforestation. We conclude by reflecting upon the limitations of land-cover analysis for the task of decolonizing knowledge about contested spaces like Southern Belize.

Study area

Our study area, in the southwest of Belize's Toledo District, is comprised of five Maya communities: San Jose, Pueblo Viejo, Santa Elena, Santa Cruz, and Blue Creek (see Figure 9.1 below); additionally, some members of the community of San Antonio use the land in the eastern part of our study area. Taken together, this area was home to approximately 3,000 people in 2000, of whom approximately 95 percent spoke either Q'eqchi' or Mopan Maya as their native language (Stratistical Institute of Belize, 2000). We focus on this small region (144 square kilometers) for three reasons. First, with respect to their size, composition, geography, history, and livelihoods, these villages are typical rural Maya communities. Second, the forest in this area has been continuously occupied and used by Maya people since pre-colonial times (the present-day residents are aware of this cultural-geographical continuity). The land between these five communities—i.e., in the center of Figure 9.1—exemplifies the customary Maya land tenure system found in Toledo before division into private parcels (discussed below). Third, the Maya Leaders Alliance (an umbrella body of community leaders) asked us to focus on research here because the village at the center of this region, Santa Cruz, was one of two named in the aforementioned lawsuit against the Government of Belize in 2007.²

This region has been consistently inhabited by Maya people for thousands of years. Archeological evidence from Uxbenkaj—the ancient Maya ceremonial site that overlaps the contemporary community of Santa Cruz—demonstrates dense occupation from as early as 350 AD until 850 AD. In 800 AD, the population of Santa Cruz was 10–15 times greater than it is today (Levanthal, 1997, p. 4). Although British colonial historiography posited that Toledo was devoid of Maya people in the 19th century, in recent decades, scholars have demonstrated cultural-geographical continuity between the present Maya residents and pre-contact Maya communities (Jones, 1997; Wainwright, 2003; Wilk, 2007; Grandia, 2012).

Today this area is part of the cultural hearth of the "upland" Mopan Maya³ region (Wilk, 1997, pp. 57–59). Geographically, it is structured by the karstic foothills of the Maya mountains, the Moho River watershed, and a prominent limestone ridge (known locally as *witz*, the Mopan word for mountains) that forms its southern border. These villages are orientated along the streams that organize the village nucleus, as well as by trails which give access to the free-draining black soils sought by Maya farmers (Wright et al., 1959). The terrain is highly uneven, with steep hills of Cretaceous limestone and mudstone dissected by a dense network of small streams. With the exception of the tops of the *witz* and a few other steep hills, the original broadleaf forest has been largely cleared by farmers. Hence the land is mainly under secondary forest growth of various stages. This has been true for some time. In 1959, Wright et al. wrote of the land within the San Antonio Indian Reservation

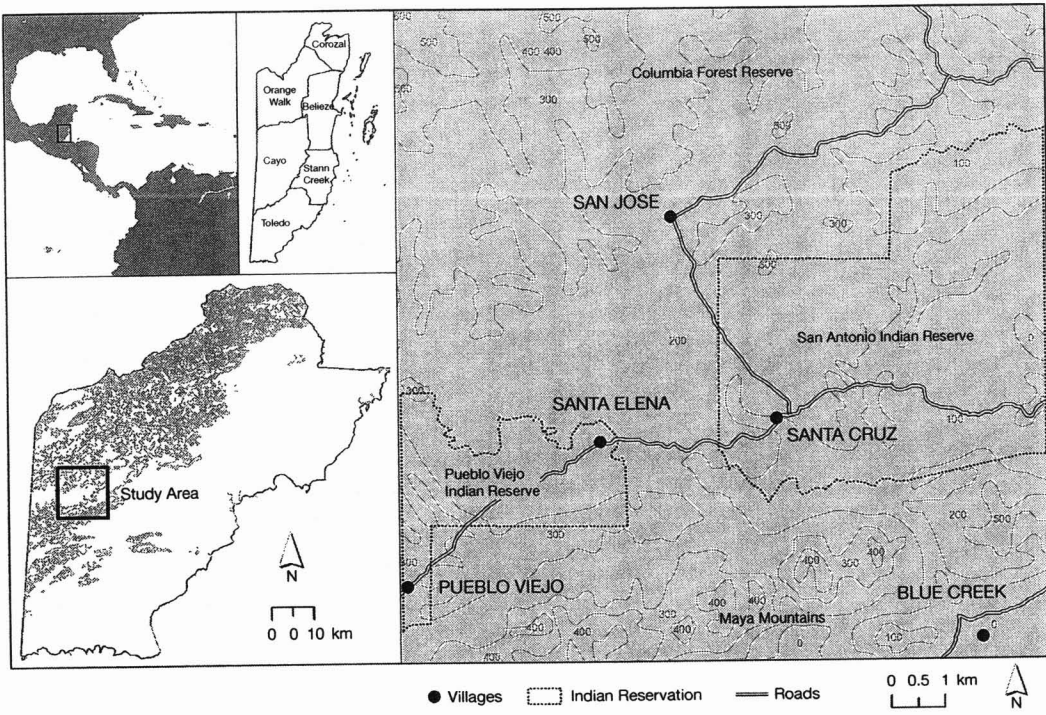


Figure 9.1 Map of the study area. These lands have been used by the Maya continuously since before the British colonization of the region. In the late 19th century, the British colonial state created “Indian Reservations” (see Wainwright, 2007, chapter 1). These Reservations are noted on this map, but are not demarcated on the landscape and hold little practical meaning in, or provide legal protection for, these communities.

Source: Figure by authors.

(on the eastern margin of our study area): “Both the plain and the hills were once forested but within the Indian Reservation the original tall rain forest has been almost completely removed by Indians seeking land on which to grow their subsistence crops” (p. 131).

Most of the Maya households in these villages produce a livelihood through a set of customary land use practices, rooted in household agricultural production of corn, beans, and squash (principally for home consumption) as well as rice and cacao (principally cash crops).⁴ A number of rigorous studies and government reports have documented these agricultural practices (e.g., Thompson, 1930; Wilk, 1981, 1997; Osborn, 1982; Diemont et al., 2010; Grandia, 2012). In the tripartite geography of land use in these Maya communities, the village nucleus is surrounded by a zone of intensive agricultural and forest use, in turn surrounded by a peripheral zone for hunting, some agriculture, and the collection of forest products. Beyond the village nucleus lies an extensive agricultural area where milpa fields are cut from the forest and cultivated. The principal maize crop is planted into the clearing created by burning the felled forest. A second crop is planted during the rainy season directly into a mulch that is not burned (the use of macuna or velvet bean to replenish soils is common). Farmers select the location of their farm after careful consideration of the landscape features that suggest a promising harvest: rich, black soil; relatively level slopes; and abundant forest cover. Because farmers normally travel to and from their fields on foot, all else being equal, areas closer to the village are preferred.

The temporality of agriculture is shaped by the rhythms of soil fertility. The farmer will customarily return to the same land after a fallow period, allowing for a period of forest regrowth and soil rejuvenation. The traditional cycle of shifting cultivation involves one to three years of cultivation after clearing and burning, followed by a fallow period (Reina & Hill, 1980; Levasseur & Olivier, 2000; Wainwright, 2008).

Customary land use practices allocate usufruct rights to individuals and families. Beyond the village nucleus, land is shared by the community rather than owned by individuals. Farmers are generally free to clear the forest and plant wherever they wish, provided the land is not already farmed by others. If a farmer does not return to a previously cut area of forest, it reverts to the common pool and is available to any resident who clears the forest again. One might expect that disagreements would arise between farmers who wish to farm in the same place, yet in practice, conflicts are rare. Community residents are familiar with the landscape and customary practices provide safeguards against conflict. For instance, in December or January, farmers will typically cut a thin trail around the periphery of the area that they intend to clear for their annual burn, to mark their space. Disputes tend to be resolved through discussion, often involving the village leaders.

That, at any rate, is the sort of description we might expect in a study by political ecologists. By contrast, Belizean government officials tend to portray Maya farming less positively, speaking of it as inefficient and destructive, “slash and burn.” This statement from a report by the Ministry of Natural Resources (1985, p. 2) is paradigmatic: “[T]he milpa system, or slash and burn agriculture . . . has resulted in significant and unplanned deforestation in the southern districts. Due to the present pressure for land for milpa farming, lands are being left fallow for shorter periods.” No evidence is offered here for these claims. Similarly, when Forest Department officials claimed (Government of Belize, 1995, p. 2) that “the greatest loss the forest [in Southern Belize] has suffered [sic] in recent years is by agricultural expansion by local farmers,” they provided no evidence.

The notion that the Maya people are damaging the forest was also brought by the government before the Inter-American Commission on Human Rights (IACHR) in 2004 as part of its defense against Maya claims to indigenous lands:

The State also asserts that the Petitioners [i.e., the Maya communities] must assume responsibility for the impact of their own agricultural practices on the environment, including their traditional “slash and burn” method of agriculture . . . and deforestation caused by small farming.⁵

(IACHR, 2004, para. 84)

Such statements are rooted in British colonial discourses on Maya farming (see Wainwright, 2008, chapter 2). For British colonial administrators like Don Owen-Lewis (personal communication, July 1, 2001), Maya farmers were essentially “slash and burn people.” To generalize, the British saw Maya milpa farms as sites to be developed through the application of research and investment of capital (Wilk, 1997; Wainwright, 2008). Yet British colonial texts on Maya farming are marked by curious ambivalences. For instance, the most important 20th century study of Maya farming in Belize (Wright et al., 1959) demonstrated that Maya farming practices were remarkably effective; nevertheless, its authors concluded that “the wandering [Maya] ‘milpa’ must be pinned down” (p. 132). Several development projects subsequently aimed to do so, partly to reduce deforestation, working from the logic that “the expansion of . . . milpa farmers seems to be one of the major causes of deforestation” (López & Scoseria, 1996, p. 292) in Belize.⁶

Land cover in Southern Belize

Numerous studies have examined the changing land cover of Southern Belize (Fairweather & Gray, 1994; White et al., 1996; Emch et al., 2005; Binford,

2007; Moore, 2007; Cherrington et al., 2010). Here we will only consider the three most significant studies (see Binford [2007] and Cherrington et al. [2010] for reviews). In 1996, the Government of Belize, working with the Bureau of Economic Geology at the University of Texas, conducted the first study to use automated computer-assisted image classification techniques. Their aim was to determine “the extent of deforestation . . . in mainland Belize between 1989/92 and 1994/96” (White et al., 1996, p. 1). They defined deforestation as “the ‘permanent’ removal of most of the natural tree cover of an area, and is more or less synonymous with land clearing” (White et al., 1996, p. 3). The authors single out Maya “slash-and-burn type clearings” as their archetype for deforestation, reasoning that the “regrowth of natural vegetation is only temporary and recolonization by diverse species incomplete” (pp. 3–4). This may seem like a reasonable definition, but it biases the evaluation of the SPOT images against those milpa farmers, like the Maya of our study area, who clear patches of forest temporarily. Nonetheless, the report’s own figures indicate that, with an average rate of forest cover loss in Toledo of less than 5,000 hectares (ha) per year, the Toledo District had the lowest rate of deforestation in Belize (p. 45).

Emch et al. (2005) conducted a supervised classification of two Landsat images, one from 1975 and one from 1999, focusing on the Toledo District (including our study area). They found that 14.4 percent of their study area had been deforested between these two dates, and 4.6 percent was reforested, resulting in approximately 10 percent forest loss. This deforestation was concentrated in two areas: near the border of Guatemala and in the central highlands (the latter includes our study area). Since both areas are home to Maya communities, the authors “surmise that the deforested area expanded at least partly because of population pressure” (Emch et al., 2005, p. 262). Yet they also noted that “the areas that experienced reforestation are mostly within the central Toledo District Mayan population center” (p. 263). This seemingly paradoxical result, and the broader dynamics of population and land use, are not carefully explored in the paper (see Moore [2007] for a critique and re-analysis).⁷

The most recent and detailed study to include our study area, by Cherrington et al. (2010, extended 2012), provides a national-scale analysis of Belize’s land cover through a supervised classification of Landsat images from 1980, 1989, 1994, 2000, 2004, and 2010.⁸ They found that Toledo’s forest cover declined by 16.4 percent between 1980 and 2010, an annual decline rate of 0.6 percent. More narrowly, they found that the Moho River watershed, which includes our study area and is comprised mainly of rural Maya communities, had the highest rate of deforestation in the district (declining from 89 percent to 65 percent forest cover: p. 28).

Upon the release of Cherrington et al. (2010), Belize’s leading newspaper, the *Amundak*, published a story summarizing its results under the headline “Belize’s forests vanishing!” (Ramos, 2010). The story suggested that the

country's forests were being destroyed and emphasized the role of Maya farmers in this process:

Only a sliver of land in the central part of the [Toledo] District and an area in the north east [of the District] seemed properly cleared in 1980, but a sizeable span of the district has now been cleared, and the district is now home to more than 30 Maya villages and other settlements.

(Ramos, 2010, para. 12)

The suggestion is that increasing Maya population is causing the forests to “vanish.” At a time of legal conflict over the ownership of these lands, this sort of hyperbole has political consequences for the Maya.

Limitations of earlier studies

This literature on forest change in Belize provides a valuable basis for our research, but is marked by three noteworthy limitations. First, these previous studies employed remote sensing images with time gaps, often of several years. Such “gap years” decrease accuracy in mapping forest change (Lunetta et al., 2004). Kimes et al. (1998) found that errors in quantifying forest age and regeneration rates can be as large as 23–32 percent due to data gaps in multi-temporal image sequences.

Second, the earlier studies which do employ images from multiple years face a methodological challenge in defining “non-forest.” In practice, most studies have defined a pixel as “deforested” if a given pixel was “forest” in one image and became “non-forest” in any later image. Consider, for instance, this passage where Cherrington et al. explained their methodology:

[T]his dataset was filtered thoroughly to remove values such as “000100” which would have indicated that a parcel of land was [forest at one time, but then] deforested between 1989 and 1994, and six years later appeared forested. . . . This does rule out the possibility of showing forest regrowth (and afforestation) within the final dataset, but there are various reasons why, in terms of forest dynamics areas deforested continue to be treated as non-forest even when satellite imagery indicates that forest *may* have regrown.

(Cherrington et al., 2010, p. 15)

The authors only offered one pertinent reason for treating “000100” signals as non-forest: “Meerman et al. (2010) for instance argue that in southern Belize, prevailing land use practices such as *milpa* (shifting cultivation) agriculture dictate that farmland which is reforested during fallow cycles is later re-cut” (2010, p. 15).

The implication is that a Maya farmer who cuts a clearing in the forest and then allows the field to revert to forest would have “deforested” the land—since even when the milpa reverts to forest, it becomes forest again only *temporarily*. Forest regeneration is simply ignored. This is an analysis that essentially defines milpa farming as deforestation. But as previous land-cover studies have shown, regeneration cannot be ignored (e.g., Moran et al., 1994; Jepson, 2005).

A third limitation of these previous studies is that they have failed to take account of phenological effects; i.e., concerning the timing of image collection within the year and growing season. This can produce serious error in the context of annual shifting cultivation. In Southern Belize, the forest is usually cut and burned during the dry season (March to May). Images taken before the intense drying of felled plant material (e.g., during January or February), or during the height of the growing season (e.g., August or September) may have difficulties identifying the new farm field clearings. More generally, images collected at the height of the rainy season will reveal a more verdant landscape than during the dry season. Consistent timing of data collection is therefore important.

In various ways, all previous studies have failed to address these three issues. As a consequence, we contend that the literature has overstated the rate of deforestation, at least in our study area, and thereby contributed to the negative view of Maya customary land use practices. We sought a methodology to offer an assessment that focuses on the temporal dynamics of forest use in our study area.

Methodology

We obtained images from the United States Geological Survey (USGS) online Landsat archive (USGS, 2012). After extensive searching on the Landsat archive, we selected 11 images with minimal cloud cover (Table 9.1). To resolve the phenological issue, all images were taken from a 10-week window during the height of the dry season, a time when Maya farmers cut and dry their forest patch in preparation for burning and planting. The images have been rectified by USGS and the pixels are well-aligned for all the images. The selected images capture the study area when relatively cloud-free.

Image processing and classification

We adopted a binary classification system: forest and non-forest. Unlike Cherrington et al. (2010), in our scheme, any pixel which is found to be “forest” is “forest,” even if in the previous year it was “non-forest.” Non-forest includes areas that are cleared and burned to be planted (hereafter referred to as “crop”) as well as communities (built-up areas) and roads. We randomly selected 100 cluster samples as training data and 100 cluster samples as

Table 9.1 Images used in the analysis

Date	Sensor*	Cloud cover in the study area (%)
25/03/1975	MSS2	Free
17/03/1993	TM4	Free
28/03/1994	TM5	Free
18/05/1995	TM5	Free
17/03/1996	TM5	Free
20/03/1997	TM5	-1%
26/05/1998	TM5	<1%
27/04/1999	TM5	Free
28/03/2000	TM5	Free
31/03/2001	TM5	Free
27/03/2011	TM5	Free

Note: * TM4/5: Landsat 4/5 Thematic Mapper

MSS2: Landsat 2 Multispectral Scanner System

rest data. Training and test samples for the two classes were identified through visual interpretation of the Landsat images. The validity of the visual interpretation method has been verified by previous studies (Jin & Sader, 2005; Masek et al., 2008). We tried two classifiers: Maximum Likelihood Classification (MLC), and Support Vector Machine (SVM). We found that SVM provided better classification results. Each classified map is validated using the randomly selected test samples. Overall accuracies for the classification of all the images range between 97 percent and 99 percent.

Post-classification processing was carried out to separate burned farm fields from roads and village nucleus lands. This process comprised five steps:

- 1 The nine classified maps in 1993–2001 were stacked together. All pixels classified as “non-forest” for more than three years (i.e., >3) were identified as community built-up area and roads.
- 2 The digitized road system was integrated with the results from (1) and edited to create a mask which is composed of roads and communities (see Figure 9.2(a) below).
- 3 The mask was applied to the non-forest area and the remainder is burned area (cultivation or crop).
- 4 A majority filter was applied to remove small areas.
- 5 The final crop area (Figure 9.2(b)–(l) below) was generated after intensive manual editing based on visual interpretation to correct both the omission and commission errors. For example, during 1993–2011, the community built-up area expanded and new roads were built. The influence of these two changes on the crop area has been reduced to be negligible. Similar editing was applied to the crop map of 1975 and 2011.

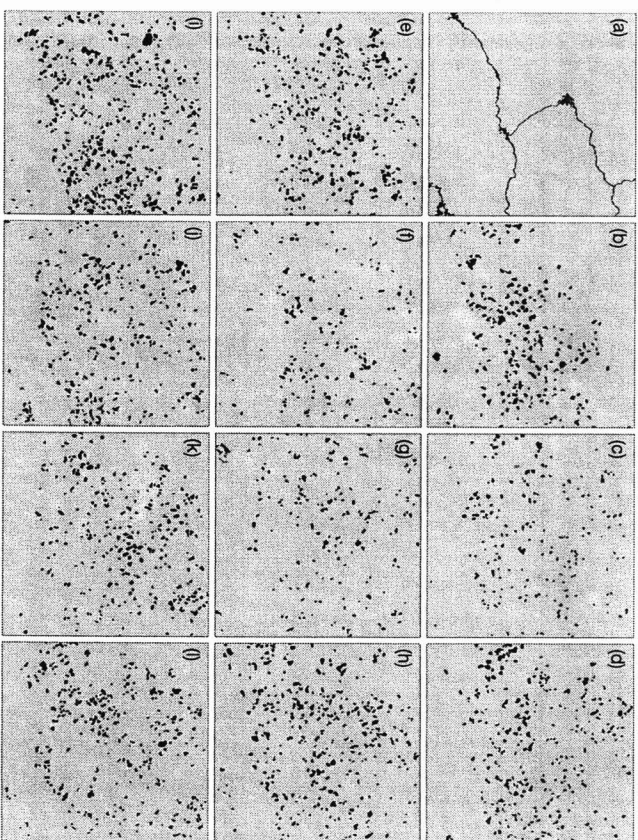


Figure 9.2 Community built-up area, roads, and agricultural use.⁹

Source: Figure by authors.

Note: (a) Community built-up area and roads; (b) cultivation in 1975; (c)–(k) cultivation in 1993–2001; (l) cultivation in 2011.

Results

Forest use, 1975–2011

If one only considers the two end points during the period 1975–2011, the overall change in forest use is negligible. In 1975, the area of cultivated field is 726 ha, nearly identical to the 2011 estimate of 724 ha. In other words, we see no evidence of significant change in the extent of Maya farming. However, considering the data for each year, the total area cultivated varies greatly between 1975 and 2011 (see Table 9.2 and Figure 9.3 below). As Table 9.2 summarizes, the average area cultivated each year during 1975–2011 is 690 ha, which accounts for 4.8 percent of the total study area.

Annual cultivation (1993–2001)

Although the first part of our analysis gives us the overall picture of forest use, it does not reveal details of annual clearing. To address this while avoiding the

Table 9.2 Cultivated farm fields ("patches") by year¹⁰

Year	No. of patches	Total area (ha)	Average patch size (ha)
1975	211	726	3.4
1993	181	373	2.1
1994	260	713	2.7
1995	305	889	2.9
1996	162	386	2.4
1997	166	383	2.3
1998	300	858	2.9
1999	370	1,177	3.2
2000	284	709	2.5
2001	273	649	2.4
2011	295	724	2.5
Average	255	690	2.7

"gap year" problem, we compared pixels in a year-over-year study for nine consecutive years from 1993 to 2001. For convenience of presentation, the study area is divided into three classes. The first class is comprised of the roads and village nucleus, which occupied 1.9 percent of the total area. The second class is composed of permanent forest, which lies in the mountainous areas that Maya farmers consider as non-cultivable (though they are used for other purposes). A mask of permanent forest is created, which accounts for 16.8 percent of the total study area. The remaining 81.3 percent belongs to the third class, which is the potential agro-productive area. The land in the third class is further divided into four groups based on the cultivation frequency (see Table 9.3 and Figure 9.4 below). For the study area of 160,000 pixels, 63.2 percent has never been cultivated in the nine-year period, 27.8 percent has been

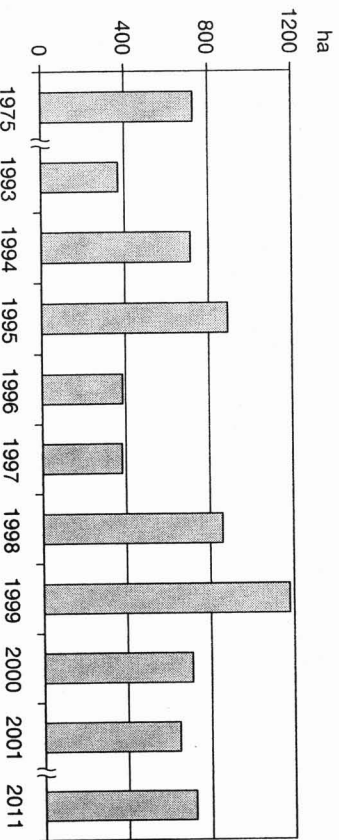


Figure 9.3 Cultivated area by year.

Source: Figure by authors.

Table 9.3 Cultivation frequency by class, 1993–2001

Class no.	Class	Cultivation frequency	Count (pixel)	%
1	Roads and village nucleus	–	3,015	1.9
2	Permanent forest	0	26,807	16.8
3	Potential agro-productive area	0	74,299	46.4
		1	44,516	27.8
		2	10,431	6.5
		3	932	0.6
	Sum		160,000	100.0

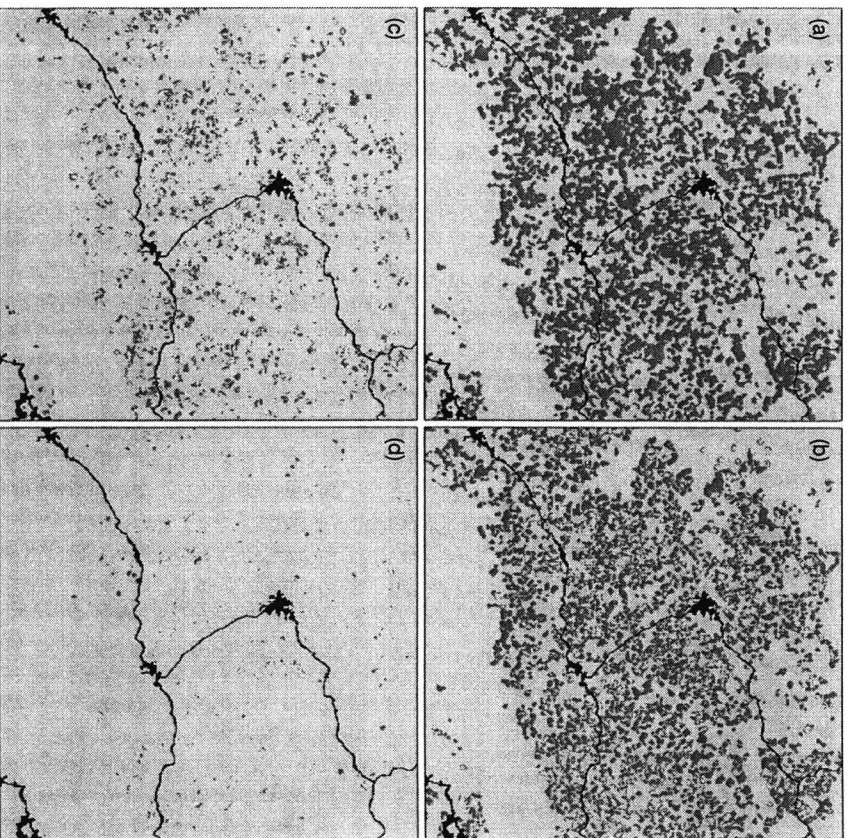


Figure 9.4 Cultivation frequency (1993–2001).

Source: Figure by authors.

Note: (a) stack of nine maps; (b)–(d) cultivated for 1–3 years respectively.

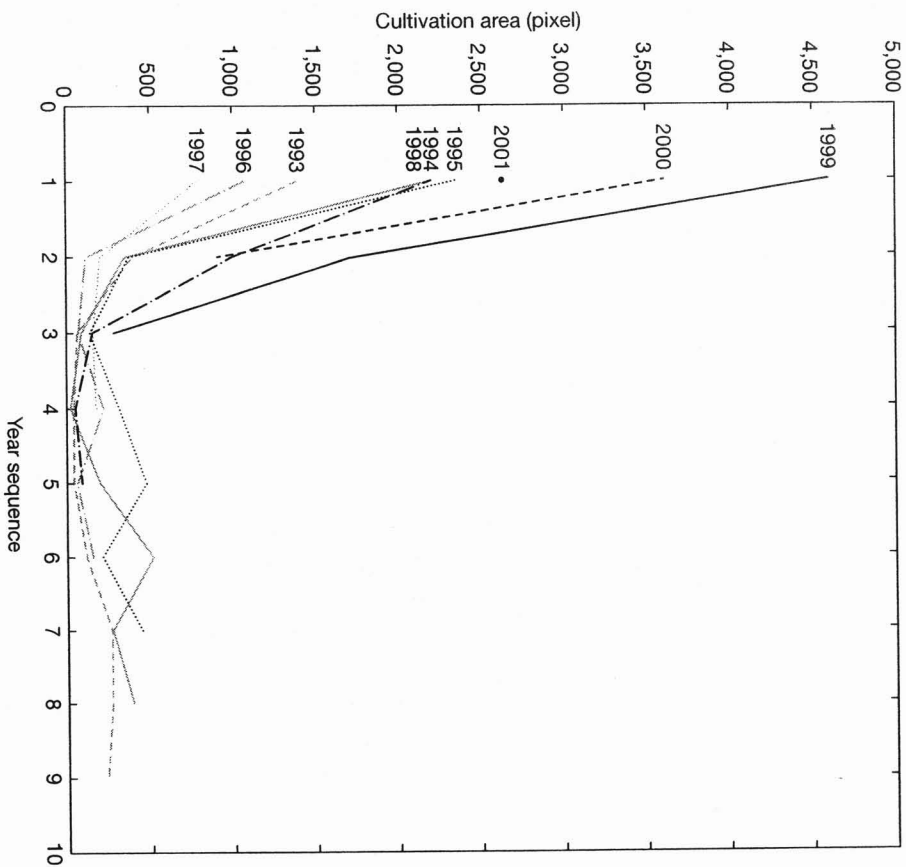


Figure 9.5 Temporal patterns in which Maya farmers reuse patches for cultivation in multiple years.

Source: Figure by authors.

cultivated once, 6.5 percent has been cultivated twice, and 0.6 percent has been cultivated three times. Thus, repeated cultivation only accounts for about 7.1 percent of the total study area.⁹

As indicated in Table 9.3, 11,363 pixels (10,431 + 932) experienced repeated cultivation during 1993–2001, of which 92 percent (10,431 pixels) were cultivated twice.

Figure 9.5 (above) shows temporal patterns in which Maya farmers reuse patches for cultivation in multiple years. Consider 1993; i.e., let 1993 = year 1.

For all the cultivated areas in 1993, 1,930 pixels were re-cleared and re-farmed within the eight following years, with 389 pixels in year 2 (i.e., 1994), 63 pixels in year 3, 266 pixels in year 8, and 228 pixels in year 9 (i.e., 2001). The general trend for all the years for which we have cloud-free data is the same: A fraction of land which is cleared in a given year is reused a second time, but the likelihood of reuse falls off quickly (and is nearly zero by year 3). After six or seven years, the likelihood that the same pixel is cleared begins to increase. The data reveal that Maya farmers do not clear and cultivate forest land repeatedly. This leads to the question: How long is the fallow period? Is it declining?

Fallow period

Based on our data, we can get a rough estimate of the lower bound for the fallow period (meaning that the actual fallow period may well be greater).¹⁰ Since the permanent forest area is non-cultivable land, it is excluded from the calculation of the fallow period. For the potential agro-productive areas (130,178 pixels in total), 74,299 pixels were never cultivated during the period 1993–2001. Therefore, the fallow period was nine years. Similarly, 44,516 pixels were cultivated once with the fallow period being eight years; 10,431 pixels were cultivated twice with the fallow period being 3.5 years; 932 pixels were cultivated three times with a fallow period of two years. The fallow period (FP) is estimated using data from Table 9.4 (below):

$$FP = 9 \times 57.1\% + (9 - 1) \times 34.2\% + (9 - 2) \div 2 \times 8.0\% + (9 - 3) \div 3 \times 0.7\% = 8.2$$

Therefore, the estimated fallow period in the study area is about 8 years. Wainwright has compiled data on the fallow period for one of the villages in our study area, Santa Cruz (see Table 9.5 below), which support this finding. We conclude that the fallow period in our study area has been stable in the period 1983–2006.

Table 9.4 Cultivation frequency for potential agro-productive area

Cultivation years	Fallow years	Pixels	%
0	9	74,299	57.1
1	8	44,516	34.2
2	3.5	10,431	8.0
3	2	932	0.7
Sum	—	130,178	100

Table 9.5 Age of forest cleared for maize by farmers in Santa Cruz, 1983–2006

Year	No. of farmers	Mean age of forest cleared (years)	Standard deviation
1983	88	6.47	2.17
1984	89	7.39	2.02
2006	11	7.59	3.81
Mean	62.7	7.15	2.67

Source: Toledo Resource Development Project land pressure surveys of 1983 and 1984; Wainwright fieldwork, 2006.

Conclusions

The forests in our study area, where customary land use and tenure have been practiced consistently since the colonial era, are not disappearing. They persist as secondary forests, used periodically by Maya farmers. The area cleared annually by Maya farmers is not increasing. The fallow period is stable. So too is the farming population.¹¹

These findings do not deny the possibility of deforestation, of course. But they suggest that the popular association of “slash and burn farming” with “deforestation” may have led to an exaggerated emphasis on Maya communities in discussions about the changing forests of Belize. It is worth noting that the relative stability of land use, fallow period, and population in our study area may be due to the persistence of customary Maya land use and tenure. As Emch et al. (2005) observed, areas close to major roads and near the Guatemalan border have seen the greatest reductions in forest cover in Southern Belize. To generalize, these are areas where customary Maya land use practices are no longer the norm.

Nevertheless, we do not expect our findings to substantially change the government’s conception of our study area. Nor is it likely to influence the long-standing view that the Maya are destroying the rainforest. For those with an interest in parcelization of these commonly managed lands (including the commercial interests just mentioned and fractions of the state, but also many environmentalists), our results will do little to dislodge the notion that the Maya are misusing the forest. And as for the Maya residents of these communities, our interpretation of the satellite data will not be especially revealing. (At a meeting where we presented our results, our interlocutors expressed their enthusiasm for the presentation—but made it clear that our data only demonstrate things they “already knew.”) Our research is therefore quite unlikely to change the basic dynamics of the discourse on “Maya deforestation.” Nor will the next round of analysis—and more are sure to follow (indeed, we are involved in one). Such is the nature of this kind of research. New results, like ours, raise new questions, leading to calls for further research, raising new questions. And as sure as the rains, the satellites will

keep sending us their data. Land-cover analyses will follow: young sprouts in fields of maize.

What lies behind the desire for the elusive integration of political ecology (PE) and land change science (LCS)? It seems that we crave technical research with a political edge, even “policy adoptable” results. Yet the mere existence of more or better geographical studies is unlikely to result in positive policy changes. More generally, integrated LCS and PE projects are likely to contribute little to the task of addressing the wrenching social divisions and political problems of our time. That such projects fail in this respect does not mean that we should not engage in them; only that we should be modest about our claims to challenge power dynamics, for instance, and that we should approach our research with a measure of self-critique. In this spirit, our study raises two questions with which we will conclude. Why are research and representation seemingly endless? To the extent that LCS justifies itself by its utility in describing and analyzing the Earth in a time of planetary change, could it contribute to the critique of the politics of representation?

In 1938, Martin Heidegger delivered a lecture, subsequently published under the title “The age of the world picture,” which offers lucid insights into these questions. Heidegger’s central argument was that the “fundamental event of the modern age”—what makes modernity modern—is “the conquest of the world as picture.” His argument began by noting that one of modernity’s essential qualities is its emphasis on discerning truth through scientific research.

The essence of what we today call science is research. In what does the essence of research consist? In the fact that knowing establishes itself as a procedure within some realm of what is, in nature or in history. Procedure does not mean here merely method or methodology. For every procedure already requires an open sphere in which it moves. And it is precisely the opening up of such a sphere that is the fundamental event in research.

(Heidegger, 1977[1938], p. 118)

What is this “open sphere” that Heidegger refers to? With respect to LCS, it is the Earth itself. More precisely, it is the world conceptualized as an object-sphere to be mapped and calculated. For Heidegger, this has important implications. Research such as we have conducted consists essentially in the calculation of nature, the objectification of what is. Even before the research is complete, the world is “calculated in advance,” “set in place,” and produced as an object via “a representing that explains” (pp. 126–127). Modern science, by this argument, is essentially a drive for power of a particular sort,

a compulsion to produce representations which deepen the objectification of what is. Since objectivity is ostensibly science's strength, this may seem positive. But Heidegger's critique was not simply to suggest that we are not as "objective" as we might believe (in the sense of value-free or neutral). Rather he contended that our very conception of the world is far from value-free, insofar as what it knows—its truths, its being—is limited to what is calculable within the "open sphere" of scientific research.

Consider our research. The essence of a study such as this one is to produce a specific representation of the world, one that is rigorous precisely because of its objectification of the land cover of Southern Belize and its categorical reduction into forest and non-forest. The existence of the satellites and their capacities to objectify the world changes and reflects our being. Heidegger elaborated:

We first arrive at science as research when the Being of whatever is, is sought in such objectiveness. This objectifying of whatever is, is accomplished in a setting-before, a representing, that aims at bringing each particular being before it in such a way that man who calculates can be sure, and that means be certain, of that being. We first arrive at science as research when and only when truth has been transformed into the certainty of representation. (Heidegger, 1977[1938], p. 127)

Is there a way out of modernity's essential commitments? Heidegger, at least, implied that there was not. Yet he concluded his essay with an enigmatic remark, that we could "safeguard" the "incalculable"—to allow that which exceeds our calculative thinking to be true—only through "creative questioning" and "genuine reflection." We do not claim that this chapter results from such questioning and reflection. But we hope it shows their necessity. If PE has a contribution to make to LCS, it would seem to lie here—in provoking the sort of creative questioning about nature, politics, and representation that facilitates "genuine reflection" on the world and its transformation.

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Notes

- 1 See Conrath (2007), Wilk (2007), Grandia (2009), and Wainwright and Bryan (2009).
- 2 This section draws upon Wainwright (2007).

- 3 While these communities are commonly identified as "Mopan Maya villages" their residents include native Mopan and Q'eqchi' speakers. Although Q'eqchi' and Mopan are both Maya languages, they are part of distinct language groups and are not mutually intelligible. Mixing and intermarriage between Q'eqchi' and Mopan language groups have been common in the Toledo District since Spanish colonization (Jones, 1997; Wilk, 1997). This region has seen multiple waves of Maya migration into the area over the past 500 years.
- 4 There are also orchards in the village agricultural zone (e.g., cacao). Various forms of forest produce—cohune palm, construction materials, spices, and so on—are also collected. More distant secondary forest provides a haven for game animals including deer, peccary, gibbon, and armadillo.
- 5 The IACHR report cites the government's "Preliminary Response to the Petitioners' Petition," May 8, 2001, p. 16.
- 6 López and Scoseria are World Bank economists.
- 7 The population density of Belize has long been lower than its neighbors, and within Belize, the Toledo District has recorded the lowest population density since reliable census data have been collected. With a density of only 11 people per square mile (Census, 2000), Southern Belize has roughly the same population density as Australia. Yet whereas per capita energy and resource consumption levels are high in Australia, they are negligible in Southern Belize. Moreover, population growth has not been especially rapid. A 1992 consultant report to the Forest Department noted that the population in the study area grew by only 21 from 1980 to 1991, "considerably less than the population growth for Belize as a whole (48%)" (Namis & Glaser, 1992, p. 1). In the subsequent decade (1990–2000), the population in the study area grew even more slowly as our-migration increased.
- 8 An additional report by Cherrington et al. (2012), covering 2010–2012, was published after our chapter was complete.
- 9 We have yearly continuous data only for 1993–2001. Due to edge effects, the fallow period calculated is conservative and thus forms a lower bound.
- 10 One large patch from 1975, the result of a forest fire, is not included in the calculation.
- 11 Given the need to raise income for households, many young Maya men and women are leaving these villages in search of greater opportunities. In time, customary Maya farming may decline, and—if commercial agriculture, oil or logging interests do not acquire the land, which is an open political question—this forest may become more complex and diverse (as has occurred recently elsewhere in Central America; see Rosenthal, 2009).

References

- Binford, E. (2007) "Dynamics of land use among Maya of Southern Belize." Master's Thesis, University of Florida, Gainesville, FL.
- Census 2000 (2000) "Census of Belize." available at <http://www.carciconsstats.org/Files/Publications/NCR%20Reports/Belize.pdf>, accessed April 14, 2013.
- Cherrington, E., Ek, E., Cho, P., Howell, B., Hernandez, B., Anderson, E., Flores, A., Garcia, B., Sempis, E., & Erwin, D. (2010) *Forest Cover and Deforestation in Belize: 1980–2010*. SERVIR (El Sistema Regional de Visualización y Monitoreo) & Belmopan, Belize: CATHALAC (El Centro del Agua del Trópico Húmedo para América Latina y el Caribe).
- Cherrington, E., Cho, P., Waight, I., Santos, T., Escalante, A., Nabet, J., & Usher, L.

- (2012) *Executive Summary: Forest Cover and Deforestation in Belize: 2010–2012*, SERVIR (El Sistema Regional de Visualización y Monitoreo) & Belmopan, Belize; CATHALAC (El Centro del Agua del Trópico Húmedo para América Latina y el Caribe).
- Conth, A. (2007) "Judgment in the Supreme Court of Belize: Consolidated claims no. 171 and 172 of 2007, A. Cal, et al. v. Belize," available at http://www.law.arizona.edu/Depis/iplp/advocacy/maya_belize/documents/ClaimsNos171and172of2007.pdf, accessed December 18, 2012.
- Diemont, S., Bohn, J., Rayome, D., Kelsen, S., & Cheng, K. (2010) "Comparisons of Mayan forest management, restoration, and conservation," *Forest Ecology and Management*, 261(10), pp. 1696–1705.
- Ench, M., Quinn, J., Peterson, M., & Alexander, M. (2005) "Forest cover change in the Toledo District, Belize from 1975 to 1999: A remote sensing approach," *Professional Geographer*, 57(2), pp. 256–267.
- Fairweather, P., & Gray, D. (1994) *The Land Use of Belize: 1989/92*. Land Information Centre, Ministry of Natural Resources, Belmopan, Belize.
- Government of Belize, Forestry Department (1995) "Press statement," November 7.
- Grandia, L. (2009) "Milpa matters: Maya communities of Toledo v. Government of Belize," in B. R. Johnston & S. Shymovics (Eds.) *Waging War, Making Peace: Reparations and Human Rights, Left Coast Press, Walnut Creek, CA*, pp. 153–182.
- Grandia, L. (2012) *Enclosed: Conservation, Caribs, and Commerce among the Q'eqchi' Maya Lowlanders*. University of Washington Press, Seattle, WA.
- Heidegger, M. (1977[1938]) "The age of the world picture," in *The Question Concerning Technology*, Harper, New York, pp. 115–154.
- Inter-American Commission on Human Rights (IACHR) (2004) "Report N° 40/04," case 12.053. Merits: Maya indigenous communities of the Toledo District, Belize," October 12, available at <http://www1.umn.edu/humanrts/cases/40-04.html>, accessed April 14, 2013.
- Jepson, W. (2005) "A disappearing biome? Reconsidering land-cover change in the Brazilian savanna," *Geographical Journal*, 171(2), pp. 99–111.
- Jin, S., & Sader, S. (2005) "MODIS time-series imagery for forest disturbance detection and quantification of patch size effects," *Remote Sensing of Environment*, 99(4), pp. 462–470.
- Jones, G. (1997) "Historical perspectives on the Maya-speaking peoples of the Toledo District, Belize," affidavit for case before the Supreme Court of Belize between the Toledo Maya Cultural Council and Toledo Alcaldes Association, claimants, and the Attorney General of Belize and the Minister of Natural Resources, defendants.
- Kimes, D., Nelson, R., Skole, D., & Salas, W. (1998) "Accuracies in mapping secondary tropical forest age from sequential satellite imagery," *Remote Sensing of Environment*, 65(1) pp. 112–120.
- Levanthal, R. (1997) "Maya occupation and continuity in Toledo," affidavit for case before the Supreme Court of Belize between the Toledo Maya Cultural Council and Toledo Alcaldes Association, claimants, and the Attorney General of Belize and the Minister of Natural Resources, defendants.
- Levasseur, V., & Olivier, A. (2000) "The farming system and traditional agroforestry systems in the Maya community of San Jose, Belize," *Agroforestry Systems*, 49(3), pp. 275–288.
- López, R., & Scoseria, C. (1996) "Environmental sustainability and poverty in Belize: A policy paper," *Environmental and Development Economics*, 1(3), pp. 289–307.
- Lunetta, R., Johnson, D., Lyon, J., & Crowell, J. (2004) "Impacts of imagery temporal frequency on land-cover change detection monitoring," *Remote Sensing of Environment*, 89(4), pp. 444–454.
- Masek, J., Huang, C., Wolfe, R., Cohen, W., Hall, F., Kutler, J., & Nelson, P. (2008) "North American forest disturbance mapped from a decadal Landsat record," *Remote Sensing of Environment*, 112(6), pp. 2914–2926.
- Meerman, J., Eprings, J., Seiningert, M., & Hewson, J. (2010) "Forest cover and change in Belize circa 1990–2000–2004," preliminary draft, Belize Tropical Forest Studies, Conservation International, Belmopan, Belize.
- Ministry of Natural Resources, Government of Belize (1985) "Draft project proposal for a soil survey and land capability classification for the country of Belize," unpublished manuscript, Belmopan, Belize.
- Moore, M. (2007) "An examination of contributing factors to land use/land cover change in Southern Belize and the use of satellite image analysis to track changes," Master's Thesis, Iowa State University, Ames, IA.
- Moran, E., Brondizio, E., Mausel, P., & Wu, Y. (1994) "Integrating Amazonian vegetation, land-use, and satellite data," *BioScience*, 44(5), pp. 329–338.
- Namis, N., & Glaser, M. (1992) "Toledo uplands fieldwork findings," unpublished manuscript, FPPM, Belmopan, Belize.
- Osborn, A. (1982) "Socio-anthropological aspects of development in southern Belize," unpublished manuscript, TRDP, Punta Gorda, Belize.
- Ramos, A. (2010) "Belize's forests vanishing!" *Amandala*, October 8, available at <http://www.amandala.com.bz/index.php?id=10404>, accessed October 8, 2010.
- Reina, R., & Hill, R. (1980) "Lowland Maya subsistence: Notes from ethnography and ethnography," *American Antiquity*, 45(1), pp. 74–79.
- Rosenthal, E. (2009) "New jungles prompt a debate on rain forests," *The New York Times*, January 30, available at http://www.nytimes.com/2009/01/30/science/earth/30forest.html?pagewanted=all&_r=0, accessed April 28, 2013.
- Statistical Institute of Belize (2000) "Census 2000," available at <http://www.statisticsbelize.org/bz/>, accessed April 14, 2013.
- Thompson, J. (1930) "Ethnology of the Mayas of southern and central British Honduras," *Field Museum of Natural History*, 17(2), pp. 27–213.
- Toledo Resource Development Project (TRDP) (1983 and 1984) "Land pressure surveys," unpublished manuscript, Blue Creek, Belize.
- United States Geological Survey (USGS) (2012) "EarthExplorer," available at <http://earthexplorer.usgs.gov/>, accessed April 14, 2013.
- Wainwright, J. (2003) "Decolonizing development: Colonialism, Mayanism, and agriculture in Belize," PhD Dissertation, University of Minnesota, Minneapolis, MN.
- Wainwright, J. (2007) "Historical land use patterns in Santa Cruz, Belize," affidavit for case before the Supreme Court of Belize between the Maya village of Santa Cruz, claimants, and the Attorney General of Belize and the Minister of Natural Resources, defendants.
- Wainwright, J. (2008) *Decolonizing Development: Colonial Power and the Maya*, Blackwell, Oxford.
- Wainwright, J., & Bryan, J. (2009) "Cartography, territory, property: Postcolonial

- reflections on indigenous counter-mapping in Nicaragua and Belize," *Cultural Geographies*, 16(2), pp. 153–178.
- White, W., Raney, J., Tremley, T., Crawford, M., & Smith, S. (1996) *Deforestation in Belize: 1989/92–1994/96*, Bureau of Economic Geology, University of Texas at Austin, USAID, & the Forest Department of the Government of Belize.
- Wilk, R. (1981) "Agriculture, ecology and domestic organization among the Kekchi Maya," PhD Dissertation, University of Arizona, Tucson, AZ.
- Wilk, R. (1997) *Household Ecology: Economic Change and Domestic Life among the Kekchi Maya in Belize*, Northern Illinois University Press, DeKalb, IL.
- Wilk, R. (2007) "Mayan people of Toledo: Recent and historical land use," affidavit for case before the Supreme Court of Belize between the Maya village of Santa Cruz, claimants, and the Attorney General of Belize and the Minister of Natural Resources, defendants.
- Wright, A. C. S., Romney, D. H., Arbuckle, R. H., & Vial, D. E. (1959) *Land in British Honduras: Report of the Land Use Survey Team*, HMSO, London.

10

SHIFTING SPACES AND HIDDEN LANDSCAPES IN RURAL SOUTH AFRICA

Brian King

Introduction

Landscape has served as a central theme for nature–society geography (Sauer, 1925, 1956; Hartshorne, 1939) and remains an important concept for evaluating how the natural environment is perceived, managed, and transformed by human populations. Central to Turner and Robbins's article "Land-change science and political ecology" (2008) is the contention that, irrespective of relatively distinct histories and methodological and epistemological positions, there are key areas of convergence between the fields of land change science (LCS) and political ecology (PE). The authors asserted that this is rooted in a shared history that began with the German *Landschaft* (landscape) tradition, which then unfolded within divergent research trajectories that included human ecology, cultural ecology, hazards, agrarian studies, and PE. Turner and Robbins suggested that as LCS evolved, the field retained a general interest in remote sensing, modeling, and statistical analysis, thereby concentrating attention upon human–environment dynamics associated with land-use and land-cover change (LULCC) in order to contribute to the sciences of global environmental change and sustainability. While concerned with related topical matter, Turner and Robbins (2008) asserted that PE has tended to emphasize a commitment to political economy perspectives on processes of social and environmental change, constraints over access, and governance over rural and urban landscapes. Even as the field of PE emerged into several, and sometimes competing, understandings, Turner and Robbins (2008, p. 298) suggested that it "retained an orientation geared toward explaining what political and economic factors produced and perpetuated socioeconomic vulnerability and undermined sustainable outcomes."

The intention of this chapter is to engage with the landscape concept to consider the possible convergences between LCS and PE. The chapter begins