Changing Rural Landscapes in Albania: Cropland Abandonment and Forest Clearing in the Postsocialist Transition

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Postsocialist transitions in eastern Europe have focused on the establishment of private property rights, often to the exclusion of other aspects of rural land-use systems. After the demise of socialism in 1991, Albania privatized virtually all agricultural land by redistributing formerly collective land on an equal per capita basis. This article examines the dramatic effects of the transition in general and the land reform in particular on Albania’s rural landscapes. A village-level survey was conducted to analyze household resources and constraints. The survey was integrated with data derived from satellite image interpretation and geographic information systems to develop statistical models of two key land-cover changes of interest: the abandonment of cropland and forest-cover loss. Statistical corrections were implemented to control for cross-scale interactions and geocomputation was employed to assess the goodness of fit of the models and the robustness of the results. Findings indicate that most cropland abandonment at the onset of the transition period was concentrated in marginal, less densely populated areas. More recently, abandonment was increasingly shaped by economic returns from cultivation and the growing competition with nonfarm livelihood strategies. Land fragmentation, an outcome of Albania’s land reform, was associated with greater abandonment in the later stages of transition. Patterns of forest clearing were subsistence driven and found around populated areas in the period immediately following the collapse of socialism, whereas more commercial clearing patterns emerged over time. Because of the range of social and environmental impacts of large-scale policy shifts, studies of postsocialist landscapes necessitate a multiscale spatial framework. Key Words: Albania, integrated analysis, land-use change, postsocialist, spatial model.
It has been more than fifteen years since the fall of the Berlin Wall marked the end of Soviet hegemony in central and eastern Europe (CEE) and processes of postsocialist transition began. At the time there was pervasive euphoria that the West had triumphed over socialism. A second assertion accompanying this geopolitical shift was that Western-style institutions were (and had proven to be) the most effective. The countries of CEE largely implemented similar macrolevel policy changes following the collapse of socialism. Most countries discontinued the “command and control” role of a centralized government in favor of privatization, price and trade liberalization, and currency devaluation (Hamilton 1999). The establishment of private property rights in industry and agriculture was a key part of the privatization of economic assets, given the belief in the central role of private property in the fabric of society (Blacksell and Born 2002). Large-scale policy shifts led to fundamental reorganizations in economic practice, with myriad implications for land use (Lambin et al. 2001). In Albania, the political and economic changes of the postsocialist transition resulted in significant land-use and land-cover changes with associated environmental consequences.

Establishing private property rights for former agricultural workers was the main objective of the Albanian land reform, although the policies were also intended to realign land-use incentives to new market conditions. With significant external support, Albania mapped its agricultural and residential land and set up a unified, parcel-based system for the legal registration of real estate. However, the registration system did not stimulate land transfers as expected, as the economic and social incentives to sell or buy were lacking (Bloch 1998). Rural landscapes exhibit the effects of the macroeconomic shock of the transition, followed by short-term reactions as well as more a gradual adaptation of local land-use practices to new market conditions, and the persistent secondary consequences of the reform (e.g., land fragmentation).

The postsocialist transition and the accompanying land reform are inherently complex, multiscale processes. Because of the heterogeneous social and environmental impacts of large-scale policy shifts, studies of postsocialist landscapes necessitate a spatially explicit, multiscale framework. The land reform in Albania was constructed at the national level. The decision of the Albanian government to redistribute the land on a per capita basis was framed by political and economic considerations (Cungu and Swinnen 1999). The reform was in turn implemented at lower levels of administration, mediated by district-level investment and policy decisions, and finally implemented at the village level by village commissions (Stahl 2007). These policies touch down in a spatially heterogeneous landscape, shaped by variations in agroclimatic suitability, biogeophysical conditions, market accessibility, and rural development levels, where land-use adjustments unfold over time.

In this article, we present a multiscale, spatial-temporal framework to examine the local outcomes of the postsocialist transition on land cover in southeastern Albania between 1988 and 2003. Our empirical focus is the abandonment of cropland and forest clearing. Within these fifteen years, our study area lost a total of 258 km$^2$ of cropland, equivalent to a 28 percent reduction of the cropland from 1988. Cropland abandonment is arguably an important indicator of changing rural livelihood strategies in Albania. New practices effected by the transition can range from family farm enterprises (Swinnen, Vranken, and Stanley 2006), often supported by foreign remittances (Nicholson 2004; Miluka et al. 2007); the abandonment of remote areas concomitant with massive internal and external migration; and, finally, entrenchment and reversion to subsistence in the most remote areas (Müller and Sikor 2006). Total forest cover remained stable between
1988 and 2003. However, 5 percent of the natural, old-growth forest of 1988 was cleared by 2003, and both old-growth and secondary forest regenerated on former bush and grassland, as well as on 94 km² of abandoned cropland. Thirty-nine percent of the landscape was forested in 1988; 202 km² or roughly 13 percent of the land that was forest in 1988 was cleared by 2003. Substantial changes in forest integrity stem from the continuing reliance on forest biomass for heating and cooking. In addition, forests and other communal resources can suffer greatly when collective systems are replaced with market-based ones due to new collective action problems that arise in transitional periods (Sikor 2004).

Examining a landscape before and after a major transition is useful in situations where an abrupt change leads to multiple adaptations, resulting in an evolution of rural land-use practices. The loss of cropland and forest cover in Albania indicates that the transition and the associated macroeconomic recession led to dramatic changes in the landscape. Declining revenues from agriculture were accompanied by new livelihood strategies in a rapidly globalizing world. This sparked demographic changes and pushed people into other sectors of the economy, leaving large tracts of cropland idle. The resulting land-use changes are associated with interesting patterns such as the persistence of land fragmentation and the realignment of agricultural production as, over time, predominantly more remote and less productive areas fall out of cultivation. Forests have been threatened by the transition because a new delineation of rights to forest uses remains to be implemented. In addition, many households still rely on forest resources.

One major challenge of land-use and land-cover change (LUCC) analysis relates to the necessary integration of disciplinary perspectives, data, and methods (Rindfuss et al. 2004). Land use occurs in a local biogeoophysical context, and is shaped by social, political, economic, and institutional processes at levels ranging from the household to the globe (Moran, Ostrom, and Randolph 2002); local land-use changes reflect the influence of these processes, whether they are directly observable in the region or not. Assessment of the relative effect of each of these processes demonstrates the complexity of LUCC (Leemans and Semeels 2004). Mertens and Lambin (2000) underscore that land-cover changes are dynamic, often multidirectional; a spatially and temporally explicit approach is required to link land-cover change to land-use influences.

We examine the changes that happened due to the transition and the reform by focusing on two key time periods: the initial period following the transition until an economic shock in 1996 and a second period later in the transition after 1996 until 2003. Data sources include time series of satellite images, a large-scale survey implemented at the village level in 2004, and spatially referenced biogeophysical data. The analysis in this article follows in the tradition of statistical LUCC models (Veldkamp and Lambin 2001), drawing from prior work to connect observed land-cover changes to hypothesized land-use drivers via a statistical framework based on the notion of spatially varying land rents (Chomitz and Gray 1996; Nelson and Hellerstein 1997). We present several methodological improvements on prior work. We account for temporal dependence by considering the state of land cover at the beginning of each period, excluding all locations that have no chance to change (e.g., nonforested pixels cannot be deforested). Village-level socioeconomic data were linked to pixel-level environmental data based on village boundaries. Contrary to most other approaches, we use a robust estimation technique that controls for intracluster correlations induced by integrating social and environmental data across scales, following Müller and Munroe (2005) and Gellrich et al. (2007). In that way, we account for the fact that multiple remote-sensing pixels fall within a common socioeconomic sphere of influence (in this case, the village). In addition, unobserved effects at the district level, varying policy implementations, or differing investment decisions are captured using dummy variables. Spatial autocorrelation is controlled for with a spatially stratified sampling approach based on distance between non-neighboring locations. The sensitivity and robustness of the model fit was assessed across varying sampling distances.

Changes in the Albanian Landscape

A Brief History of the Postsocialist Albanian Economy

Before the transition, Albania was primarily an agricultural country; more than one-third of gross domestic product (GDP) came from agricultural production during the 1990s (World Bank 2006b), and more than half of the population was employed in agriculture (Food and Agriculture Organization [FAO] 2006). The share of agriculture in GDP initially increased to 56 percent in 1995 and then gradually dropped to 25 percent in 2004. The industrial sector contracted from 48 percent in 1991 to 20 percent in 2005, as the share of the service sector gradually increased to 55 percent, most of
it being concentrated in Tirana and the coastal region (World Bank 2006b).

The immediate consequence of the transition was a sharp economic recession in 1991, followed by a slow recovery. In 1996 there was a proliferation of bogus investment opportunities with alleged high rates of return offered by several investment firms. These pyramid investment schemes attracted deposits up to roughly half the size of Albania’s GDP, finally collapsing in early 1997, leading to a second sharp decline in GDP followed by a second recovery (Korovilas 2005). The collapse of the pyramid schemes triggered a period of anarchy from January to June 1997 in which the police and army were dissolved and 2,000 people were killed (Jarvis 2000). The anarchy led to the resignation of the government, a collapse of state revenues, and the depreciation of the national currency.

Migration outflows were sizable during the entire period of transition, reaching peaks in the early period of transition at the beginning of the 1990s and after the fall of the pyramid investment schemes and the subsequent insecure period (Carletto et al. 2006). The Ministry of Labor and Social Affairs puts the number of Albanians living abroad at more than 700,000 out of a total of 3.1 million in 1999 (Barjaba 2000). In 2004, the number rose to 1 million, according to the Ministry of Labor and Social Affairs (cited in King 2005). At present, international migration rates in Albania are among the highest in Europe, as are poverty rates (Zezza, Carletto, and Davis 2005).

Land Reform in Albania

Prior to World War II, the distribution of land in Albania was unequal. The most productive agricultural areas were owned by a few families. Under socialism, Albania was the only country in CEE that effectively nationalized all land, based on its 1976 Constitution (Lerman 2001). After the demise of socialism, Albania implemented a comprehensive land redistribution program that established private property on virtually all cropland under use during the socialist period. Land redistribution was a politically feasible strategy; restitution to former owners would have resulted in less than 5 percent of the population owning the most productive land (Swinnen 1999). The Albanian land reform of 1991, the Land Law 7501, was intended to redistribute all collectivized land to former members of the cooperatives on an equal per capita basis. Other rural residents who were not members of the cooperatives were also awarded land but in smaller quantities (Law 7501, Art. 6). Land to be redistributed was stratified by variations in distance to the farmstead, soil fertility, and irrigation capacity. Village-level land distribution councils were formed to allocate plots, often in distant locations within the village territory, to each farm family proportional to their household size, including the elderly and small children (Stanfield and Kukeli 1995). This egalitarian land reform resulted in the extreme fragmentation of agricultural holdings and represented the starkest break with the collectivist past within the CEE region (Mathijs and Swinnen 1998).3

The land reform established a legal basis for land transfers and the sale of land was formally allowed in 1995. A digital real estate registration system was developed with considerable international support. However, land market activity has been limited and land owners were reluctant to exchange (Bloch 1998; Swinnen, Vranken, and Stanley 2006; World Bank 2006a). Swinnen, Vranken, and Stanley (2006) found that only 5 percent of households were reported to have sold land and the share of rented land is around 10 percent in all of Albania, but only a minority of the transactions was registered in the land administration system. The aversion to register may be partially explained by the corrupt practices of the land administration agency (Immovable Property Registration Offices [IPRO]; Stahl, Sikor, and Dorondel forthcoming). Precommunist owners have continued unsuccessfully to demand state compensation for the loss of their historical land claims, which has led to a lack of title security, impeding the development of a more active land market (World Bank 2006a).

The Fragmentation of Land Use and Land Ownership

The complete breakup of the agricultural collectives in Albania led to fragmentation of land ownership (Bloch 1998; Cungu and Swinnen 1999). In 2000, 440,000 farm families operated on approximately 1.8 million parcels. An average farm household possessed 1.5 ha, spread over three to five parcels (Ministry of Agriculture and Food 2002). The inactive land market with few land sales and rentals hinders land consolidation. Therefore, the fragmentation of both land ownership and land use resulting from the chosen land reform strategy, the Land Law of 1991, largely persists today.4

Figure 1 depicts a “before and after” image of the land reform in a rural area in Albania. It is clear that the redistribution of collective agricultural land (Figure 1, left, shows the collective fields in 1988) greatly
increased the number and reduced the size of agricultural plots (Figure 1, right, illustrates the redistributed land as of 2003). Figure 2 further demonstrates the spatial distribution of plots for four households within one village (Figure 2, left). The actual Euclidean distances between these plots are depicted on the right side of Figure 2 for one household that possesses seven dispersed plots that range from 150 to 3,000 m² in size (a total of 5,650 m²). These plots, which vary in steepness and soil quality, are located at variable distances from the household’s residence (the total one-way distance to all plots is almost 6 km).

Reform of Forest Ownership

Land privatization in Albania initially focused on agricultural land and only recently extended into other parts of the landscape, such as forest. At the time of collectivization in 1944, only 6.4 percent of forested land in Albania was private property; 92 percent and
1.6 percent were under state and communal ownership, respectively (De Waal 2004). After the collapse of socialism, Albania’s private forests were officially restituted to precollectivization owners and their heirs following the 1993 Law No. 7699 (Ministry of Agriculture and Food 2002). In practice, forests largely remained in state ownership, and as of 2001 only 10,000 ha, or 1 percent, were returned to presocialist owners out of a total 1 million ha of forestland (Ministry of Agriculture and Food 2002). Meanwhile, use rights to 40 percent of the state-owned forests are in the process of being transferred to commune administrations (World Bank 2006a). Countrywide, forest thinning and loss of forestland are among the most profound changes in land cover (Jansen et al. 2006). Forest health is a concern for local livelihoods that strongly depend on forest resources in the absence of other energy sources. From a global perspective, the effects of forest degradation and forest-cover loss on biodiversity may be significant, as Albania is located within the Mediterranean Basin that is recognized as a global biodiversity hotspot in terms of endemic flora and fauna species (Myers et al. 2000).

**Study Area**

This research focuses on an area of considerable economic and agroecological diversity. The study area comprises the four districts Elbasan, Gramsh, Librazhd, and Pogradec in the southeastern portion of Albania (Figure 3), covering a total land area of 3,800 km². In the west and east, flat, drier plains used intensively for crop production are to be found, whereas the north, south, and central parts of the region are humid and hilly uplands.

The fast-growing city of Elbasan, the capital of the district of Elbasan, is the third largest city in Albania with a population of 100,000. The district capital of Pogradec in the east is another major market center that attracts migrants from proximate areas. Lake Ohrid, one of Europe’s oldest lakes, is also found in Pogradec, and is a major tourist destination. In contrast, the less accessible mountains in Librazhd district contain poorer areas. Poverty estimates for 2001 place 37 percent in Librazhd, 35 percent in Gramsh, 31 percent in Pogradec, and 29 percent in Elbasan below the national poverty line of US $411 per capita per year (World Bank 2003).

**Land-Cover Changes: 1988–2003**

Changes in land cover were measured using time series of remotely sensed satellite data. Visual on-screen interpretation was used to derive land-cover information for the years 1988 (Landsat Thematic Mapper [TM]), 1996 (TM), and 2003 (TM and the Terra Advanced Spaceborne Thermal Emission and Reflection Radiometer [ASTER]).

On-screen interpretation was conducted in conjunction with an Albanian forestry expert on a scale not larger than 1:40,000. Six spectral bands (at 30-m resolution), excluding the thermal band, of the Landsat TM images, and all three 15-m bands in the visible and near-infrared spectral range from the ASTER images were used. Interpretation resulted in one land-cover map for each of the respective years. Land-cover classes were defined following the Land Cover Classification System (LCCS) used in the Albania National Forestry Inventory (ANFI; Jansen et al. 2006). Before and during interpretation in 2004 more than 300 reference points on the ground were compared to the estimated land-cover classes and cross-checked with results from the ANFI. Using the year 2003 as a base, interpretation of the historical images was only conducted for areas that had visibly changed to avoid coregistration errors. Overlays of two land-cover maps produced land-cover change maps that indicate the extent and location of changes between 1988 and 1996 (period one) as well as between 1996 and 2003 (period two). Cropland abandonment was defined as those pixels with land cover that was categorized as cropland in the first year but not in the subsequent one. Cropland is distinct from pasture or grazing land and consists of all land under annual and perennial crop production, including orchards of fruits and olives. Given that the primary agricultural land use in the socialist period was large collective farms producing grain crops, this category is a salient element of the postsocialist transition. Second, forest-cover loss was measured by those pixels that were forested in the first but not in the subsequent year. The employed definition for forest includes all forest and woodland categories and does not distinguish between closed and open forest or between broadleaved, coniferous, and mixed forest. All other land-cover categories including shrubland, coppice, or grassland that may be used as pasture were excluded from the analysis. Changes within any of these categories as well as an expansion of cropland or the regeneration of forestland were not considered.

The spatial distribution of land-cover change in the study area reflects how the period of transition has reshaped the landscape (Figure 4). Net abandonment amounted to 339 km² between 1988 and 1996 and 155 km² between 1996 and 2003, which is a 36 percent
decrease of cropland from 1988 and a 21 percent decrease from 1996, respectively. Significant cropland abandonment was visible in Librazhd and Pogradec in the first period (Figure 4). Total forest cover (i.e., stable forest less forest clearing plus regrowth) remained stable. However, there were significant spatial changes within the forest category. Between 1988 and 1996, forest cover was cleared on 16 percent of the forested pixels in 1988 (238 km$^2$). Of the pixels covered by forest in 1996, 13 percent (284 km$^2$) were nonforest by 2003 (Figure 4). As much of forest biodiversity is likely associated with long-standing forest, we only consider pixels that were cleared and ignore areas that regenerated during the fifteen years as these mainly consist of young, secondary forest. Forest-cover loss was concentrated in Elbasan in the first and in Gramsh and Pogradec district in the second period, predominantly close to the district capitals (Figure 4).
Over the past couple of decades there has been significant study and synthesis of the socioeconomic and political influences underlying land-use change that inform studies of land-cover change (Lambin et al. 2001). Such influences are particularly relevant in the transition from command to market-oriented economies (Global Land Project 2005). The scope and magnitude of rural changes in CEE since the transition are profound, and there are a variety of social and environmental consequences of such changes.

We base our methodology in this article on a framework that has been used in other studies of LUCC (first developed by Chomitz and Gray 1996; see also Nelson and Hellerstein 1997; Mertens and Lambin 2000; Munroe, Southworth, and Tucker 2002). Assuming that the unit of analysis is the decision-maker (in this case, an average household within a village), the choice of land use relates to the potential utility or profit (land rent) that the decision-maker can expect to receive from a particular land use compared to a set of alternatives. The geographic, economic, demographic, and social contexts—spatial and aspatial—influence the returns that a farm household can expect to receive from this land use. Spatial factors include the biogeophysical and agroclimatic suitability of a particular parcel of land and cost of access to local, regional, and national markets. Road existence, road quality, and market infrastructure are important factors affecting land rent because transport costs to input and output markets are a substantial portion of total production costs. Other important influences include farmer characteristics (age, education, household size, income) and technical inputs (machinery, irrigation).

The Connection Between LUCC and Postsocialist Transitions

Much of the interest in LUCC has focused on the degradation and destruction of tropical forests and the corresponding impacts on the carbon cycle and biodiversity levels. A substantial literature exists discussing institutional arrangements and natural resource governance, challenging conventional notions that communal forms of resource management (such as common property systems) lead to resource degradation (Ostrom 1990; Agrawal 2001; Lambin, Geist, and Lepers 2003). Despite this large body of empirical, theoretical, and analytical work addressing property rights, institutional reform, and land-cover change, there have been surprisingly few integrated analyses of postsocialist circumstances. Land reform is a major intervention that redirects land-use incentives. Kaimowitz and Angelsen (1998) and Lambin et al. (2001) point out that periods of transition in such institutional contexts can exhibit rapid, even drastic change of land-use strategies, particularly in times of risk and uncertainty. Analyses of postsocialist landscapes can also provide insights regarding the multiscale effects of transition on land use (Stahl 2007).
There is an established tradition within the LUCC literature to test statistically for the influence of land tenure on land-use incentives. Theoretically, land relations influence land-use change in a variety of ways. First, particular sets of land-use policies may allow certain land uses and forbid others, as in the case of protected areas (Cropper, Puri, and Griffiths 2001; Nelson, Harris, and Stone 2001; Müller and Munroe 2005). Second, insecurity of land tenure may decrease the investments that a farm household is willing to make via the discount rate or the length of time the user is willing to wait for returns to investment in land uses. Other work has examined how land reform has shaped land-use change by identifying communal-level influences (Bray et al. 2004), variations in land-cover trajectories across differing land reform programs (McCusker 2004), or the influences of conservation programs in a context of rapid infrastructural development (Soares-Filho et al. 2004).

**Conceptual Framework**

Figure 5 summarizes our multiscale framework for statistical modeling of cropland abandonment and forest clearing following a major economic and political transformation like the one in Albania. Local land-cover change happens in a spatially heterogeneous environment and is embedded within broader social, political, and economic contexts that range from the household to the globe. As one increases in scale (y-axis), the number of observations (N) on the x-axis decreases. At the national and global level, such factors as markets, prevailing technology and infrastructure, and other policies provide the external context that shapes land users’ opportunities and constraints. These factors are framed by the specific circumstances of the transition, which are associated with market liberalization, asset privatization, and land reforms. It is important to illustrate that land reform is also a multiscale process. The legal

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**Figure 5.** Framework for a multiscale, spatially explicit analysis of cropland abandonment and forest clearing in Albania. Source: Authors; inspired in part by Kaimowitz and Angelsen (1998).
framework is supported, designed, operationalized, and mediated at different levels from the international to the village, with outcomes also occurring at the plot and pixel level.

District effects represent particular influences on land use that originate from the district level, such as unmeasured biogeophysical variations (district boundaries may correspond to water catchments or soil variations), differing governance strategies (district governments have their own budgets and can decide on local taxes and fees; Hoxha 2001), and other proxies, such as the regional economy or social context.

Below the district level are nucleated villages in our framework that are surrounded by cropland and pastures (Müller and Sikor 2006). The village level is an important functional unit in Albania and village land councils implemented the land reform. Socioeconomic data for demography, education, agricultural technology, livestock, forest utilization, and the impact of the land reform were measured at this level. Higher household density within a village increases the demand for cropland and for forest products. More reliance on the transfer of remittances, as an important contributor to rural livelihoods, reduces the propensity of maintaining cropland under production and of the use of forest products. The influence of educational attainment may be unclear a priori, but one could expect that families with higher education may be better equipped to adapt to market conditions and expand as well as intensify agricultural production. On the other hand, higher education may increase the chance to access employment opportunities elsewhere. Higher levels of capital-intensive inputs (e.g., irrigation and tractors) may keep agricultural land under production. Other village-level factors influence forest density. Higher numbers of goats per village often render afforestation projects and natural forest regeneration more expensive and less likely to thrive as goats forage on tree seedlings. Village-level firewood usage is also important. Although the effects of firewood usage may have been disguised by the spatial resolution of the satellite data employed, we expect a measurable forest-reducing effect because 95 percent of the households in the sample rely on the use of firewood for cooking and heating and use an average of 10 m³ of firewood per year.

The household is the fundamental unit of land-use decision-making, which is in turn implemented at the plot level. However, the costs of obtaining plot-level information can be prohibitive. Instead, the remotely sensed data used to measure land cover are often used as a proxy for land managers’ decision units in statistical LUCC models. In pixel-level statistical analyses, the spatial resolution of the satellite data governs the choice of the highest possible spatial resolution of the land-cover data. Chomitz and Gray (1996) motivate observed pixel-level land cover as a function of unobserved land-use decision-making occurring at the plot level. To the degree that each pixel is managed according to its optimal use, this assumption is appropriate, but unobserved heterogeneity occurs across households and within plots.

At the pixel level, factors describing both the biogeophysical environment and local spatial accessibility (to road infrastructure, markets, and dwellings [populated places]) can be successfully integrated. Geophysical and agroclimatic suitability determine the natural potential inherent in a specific plot of land and include rainfall, soil suitability, elevation, and slope. Rainfall was expected to be negatively associated with cropland abandonment because water availability is a constraining factor for crop production in the study area. Rainfall is likely to be positively associated with forest-cover loss because there is more rainfall at higher altitudes where more forest tends to be located. More abandonment and higher forest loss were expected at steeper slopes and higher elevations. We further hypothesized less abandonment on better soils. With regard to accessibility, cropland abandonment is more likely in remote places at the onset of the transition, and more abandonment was expected closer to populated places in the second period when physically more remote parcels were already abandoned. Forest clearing possibly expanded in the opposite direction, from locations closer to dwellings to more remote areas over time. In this study, the two dependent variables (cropland abandonment and forest clearing) result in a range of outcomes that can be potentially realized at any level. The relevant but unmeasured outcomes in the Albanian case may include livestock and crop production, the cultural landscape, biodiversity, and biomass.7

Data Sources and Methods

To study the salient land-use changes since the land reform of 1991, we incorporated remotely sensed land-cover information from 1988, 1996, and 2003; biogeophysical and accessibility characteristics; and village-level survey data via a series of statistical models.
Biogeophysical Data

Rainfall data stem from twenty-three rainfall stations in and another twenty around the research area. Continuous surfaces were created from the station points via a regularized spline interpolator (Mitas and Mitasova 1999). Contour lines at 10-m intervals from 1:50,000 topographic maps were used to derive a digital elevation model from which elevation in meters and slope in degrees were calculated. A soil map was obtained from the Joint Research Council and was reclassified into ordered suitability classes for agricultural production based on the World Reference Base for Soil Resources (WRB) of the FAO of the United Nations.

100-Village Survey

To study land-use change, one would ideally like to have household data for a large region, but such data are not publicly available and may not be financially or logistically feasible to collect (Rindfuss et al. 2004). The strategy used in this analysis was to conduct key informant interviews in a large number of villages to obtain a statistically representative sample for the entire study area to link a broad cross section of socioeconomic data to a spatial framework. Because land redistribution was implemented at the village level, studies at this level capture the influence of such processes. Sixteen Albanian enumerators were trained in survey and interviewing techniques. Two enumerators administered structured questionnaires in each village to a group of respondents, including the village mayor or vice mayor and elderly villagers.

The survey was carried out in the fall of 2004 in a stratified sample of 100 rural villages, drawn from a total of 425 rural villages in the four districts. Using proportional random sampling, fifty villages were selected from two groups stratified by cost distance. Cost distance was measured as the distance from each village centroid to the closest market center, adjusting for present land cover, the density and quality of the road network, and slope.

Data were collected for land-use influences hypothesized to result in the two land-cover changes of interest. The survey focused on the years 1991, 1996, and 2004; 1991 was used as a starting point of interest, as the year when socialist distributional networks ceased to function and the land reform was implemented; 1996 was chosen as an intermediate point in time corresponding to the peak of the pyramid investment schemes. Both years were followed by a period of anarchy, and the political upheavals of 1997 marked the beginning of a second phase of postsocialist transformation in Albania (Müller and Sikor 2006).

To avoid large biases arising from the long recall periods, recall techniques connecting the past event to major landmark events (Groves 1989) were used to capture major retrospective changes since the collapse of socialism. The questions were related to the collapse of socialism in 1991 and the collapse of pyramid investment schemes at the end of 1996. Villagers were highly motivated to talk about issues surrounding livelihood changes, agricultural production, and land use. Discussions among the respondents, typically between five and ten, were facilitated by the enumerators to reach a broad consensus.

Different land-use dynamics were hypothesized for each period of postsocialist transformation. Additional information to triangulate and cross-check village-level data was compiled from local officials and secondary socioeconomic and land-use statistics at the village, commune, and district level.

Independent Variables

We included the distance to the national road network as a covariate. This road network was established long before the period under consideration and is, therefore, assumed to be exogenous to the land-cover changes observed during the postsocialist period. Further, the distance from every pixel to the closest dwelling, that is, to all populated places in the study area, was included, as well as the transportation costs from each pixel to the four district capitals. Village-level variables include population density, measured as the number of households per square kilometer. Migration returns, proxied by the importance of remittances as an income source for the village economy, were measured as the percentage of villagers who cited remittances as their main source of cash income.

Land fragmentation as an outcome of the village-level land redistribution was measured as the average number of redistributed plots per households within a village. Due to the inactive land markets in Albania with very few rentals or sales, the number of plots owned by a household remained virtually constant in the study area since the land reform in 1991. More plots per household correspond to a higher fragmentation of cropland because each household received a set of non-contiguous plots stratified by market distance and soil fertility. Educational attainment was measured as the percentage of villagers with a high school certificate.
Two indicators measuring input intensity, the irrigated area per village in hectares and the density of tractors used for agricultural production, were included in the models. Unobserved differences across districts were captured by the inclusion of three binary variables as fixed effects for Gramsh, Librazhd, and Pogradec, with Elbasan as the reference district.

Two additional independent variables were included in the regressions for forest loss: the number of goats per village and firewood usage.

**Sampling Strategy for Statistical Analysis**

Several sampling strategies were applied to reduce the size of the spatial data set, limit the estimations to the pixels of interest, and reduce spatial autocorrelation across observations. We accounted for inherent dependencies in land-cover change on the previous state of land cover by excluding all pixels that were not part of the respective class at the beginning of the period. That is, cropland abandonment between 1988 and 1996 or 1996 and 2003 could only take place on pixels that were used to grow crops in 1988 or 1996, respectively. Equally, forest-cover loss was confined to those pixels that were forested at the start of the respective period. Thus, we included 64 percent of the pixels in the study areas in 1988 and 62 percent in 1996 in the sample (all land covered by either cropland or forest in the respective year). The inclusion of all pixels would underestimate the coefficients as, for example, nonforested pixels cannot be deforested.

Spatial autocorrelation in the dependent variables or in the residuals may cause biased coefficients (Anselin 1988). The land-cover data certainly contain spatial autocorrelation because the smallest patch of contiguous land cover in the study area is 19,000 m² (roughly the area of two Landsat TM pixels). We controlled for such autocorrelation by calculating the spatial averages for the geophysical variables elevation and slope in a five-by-five window to reduce spatial autocorrelation and noise in the data (Nelson, Harris, and Stone 2001). We further generated a series of spatially stratified samples (following Besag 1974), as done in Nelson and Hellerstein (1997), Müller and Zeller (2002), and Munroe, Southworth, and Tucker (2002), by selecting a subset of pixels separated by a specified orthogonal distance. We expect that observations are less dependent the farther they are from the next selected pixel. To assess the robustness of the results, the sampling distance was varied from 120 m to 600 m in steps of 60 m.

**Data Integration**

Analysis was conducted at the pixel level with a spatial resolution of 30 m. All pixel-based variables were referenced to the Pulkovo 1942 Transverse Mercator projection that is common in Albania. The integration of the survey data at the village level with the spatially continuous land-cover change categories and the biogeophysical and distance measures required information regarding the spatial extent of village influences on the landscape. However, digital village boundaries are not available in Albania, but cadastral boundaries for agricultural plots distributed in the land reform were. The extent of peripheral areas effectively managed at the village level—mainly covered by forest, shrub, and grassland, but also including remote and unproductive agricultural land that was refused by villagers in the redistribution process—was approximated by local technicians using expert knowledge, topographic base maps, and remote-sensing information. These approximated village boundaries were used to represent each village’s sphere of influence.

**Statistical Model**

A useful land-use model is able to explain land-cover changes in multidimensional space, accounting for local variations in socioeconomic, biogeophysical, and accessibility characteristics (Veldkamp and Lambin 2001). In this article, the hypothesized drivers of land-use change are linked to observed land-cover change via a binary logit model (following Chomitz and Gray 1996; Mertens and Lambin 2000; Munroe, Southworth, and Tucker 2004). The logistic models regressed the probability of observing a particular land-cover change on the underlying land-use processes in a spatially explicit environment to understand and explain land-cover change.

Binary logit models were estimated for the two periods and both land-cover changes of interest. To assess the robustness of the results we estimated the four models for nine different sampling distances. Consequently, the number of observations ranged from 426 selected observations of cropland in 1988 at a sampling distance of 600 m to 19,379 observations for forested pixels in 1988 at a distance of 120 m between selected neighbors.

Because socioeconomic data were collected at the village level, pixels within a village are not necessarily independent of each other but are more likely to be independent across villages (Müller and Munroe 2005; Gellrich et al. 2007). Therefore, the assumption
of independence of observations within villages is violated (Overmars and Verburg 2006). To relax the assumption of independence we used the Huber and White sandwich estimator to adjust for within-village correlations. This technique yields robust standard errors without affecting the estimated coefficients (Williams 2000; Gutierrez and Drukker 2005). As this approach further allows for any arbitrary correlation of observations within clusters, it also accounts for potential spatial autocorrelation in the model residuals (Gellrich et al. 2007).

Because land-cover changes are a response to the socioeconomic conditions at the beginning of the respective period (Perz and Skole 2003), temporally lagged independent variables are employed. In other words, land-cover change over one period was regressed on the value of the time-variant variables (household density, the importance of remittances, the educational proxy, and the two input measures) at a prior state. In addition, all variables were tested for multicollinearity in each spatial sample. The descriptive statistics of all the covariates and of the two dependent variables used for estimating the models are listed in Table 1 for a sampling distance of 480 m.

### Lessons from Postsocialist Albanian Landscapes

**Cropland: What Influences the Abandonment of Cropland?**

In both periods, agricultural land was more likely to be abandoned at lower elevations and farther from the national roads, as expected (Table 2 for a sampling distance of 480 m). Areas that are closer to the four

<table>
<thead>
<tr>
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<td>0.49</td>
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<td>7.97</td>
<td>0</td>
<td>77</td>
<td>652</td>
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<td>5</td>
<td>650</td>
<td>3.78</td>
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<td>629.98</td>
<td>251.50</td>
<td>102</td>
<td>1,233</td>
<td>652</td>
<td>653.65</td>
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<td>21.36</td>
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<td>121.58</td>
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<td>14.85</td>
<td>0</td>
<td>90</td>
<td>652</td>
<td>52.67</td>
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<td>1.12</td>
<td>1</td>
<td>10</td>
<td>652</td>
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<td>Villagers with high school certificate (%)</td>
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<td>30</td>
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<td>657</td>
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<td>1</td>
<td>1,683</td>
<td>0.13</td>
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<td>1,683</td>
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<td>1</td>
<td>5</td>
<td>1,682</td>
<td>3.68</td>
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<td>Distance to national road (km)</td>
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<td>7.76</td>
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<td>1.00</td>
<td>0.03</td>
<td>6.32</td>
<td>1,683</td>
<td>1.43</td>
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<td>Households per km², 1991</td>
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<td>11.43</td>
<td>2.20</td>
<td>121.58</td>
<td>1,683</td>
<td>11.55</td>
</tr>
<tr>
<td>Most cash income from remittances, 1991 (% hh)</td>
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<td>8.02</td>
<td>15.43</td>
<td>0</td>
<td>90</td>
<td>1,683</td>
<td>48.73</td>
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<td>Number of redistributed plots/household</td>
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<td>2</td>
<td>10</td>
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<td>Villagers with high school certificate (%)</td>
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<td>0</td>
<td>30</td>
<td>1,683</td>
<td>3.33</td>
</tr>
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<td>91.12</td>
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<td>2,000</td>
<td>1,683</td>
<td>458.64</td>
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<td>Firewood usage (%), 1991</td>
<td>1,579</td>
<td>99.85</td>
<td>3.43</td>
<td>5</td>
<td>100</td>
<td>1,683</td>
<td>97.80</td>
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</table>
Table 2. Estimated coefficients for binary logit model of cropland abandonment and forest clearing, 1988–1996 and 1996–2003; spatial sample drawn with spacing of 480 m between observations

<table>
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<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Coefficient</td>
<td>p value</td>
<td>Coefficient</td>
<td>p value</td>
</tr>
<tr>
<td>Spatial lag slope (degrees)</td>
<td>-0.002</td>
<td>0.923</td>
<td>0.049*</td>
<td>0.012</td>
</tr>
<tr>
<td>Spatial lag elevation (100 m)</td>
<td>-0.002***</td>
<td>0.000</td>
<td>-0.002*</td>
<td>0.015</td>
</tr>
<tr>
<td>Rainfall (100 mm)</td>
<td>-0.001</td>
<td>0.994</td>
<td>0.282*</td>
<td>0.034</td>
</tr>
<tr>
<td>Soil suitability</td>
<td>-0.161</td>
<td>0.316</td>
<td>0.026</td>
<td>0.917</td>
</tr>
<tr>
<td>Distance to national road (km)</td>
<td>0.221***</td>
<td>0.001</td>
<td>0.251**</td>
<td>0.003</td>
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<td>Distance to dwellings (km)</td>
<td>1.119***</td>
<td>0.001</td>
<td>0.490</td>
<td>0.095</td>
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<tr>
<td>Cost distance to district capital</td>
<td>-0.002**</td>
<td>0.006</td>
<td>-0.001</td>
<td>0.541</td>
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<tr>
<td>Households per km², 1991/1996</td>
<td>-0.031**</td>
<td>0.007</td>
<td>-0.016</td>
<td>0.127</td>
</tr>
<tr>
<td>Households with most cash</td>
<td>-0.011</td>
<td>0.584</td>
<td>0.006</td>
<td>0.571</td>
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<tr>
<td>Household income from remittances, 1991/1996 (%)</td>
<td>-0.229</td>
<td>0.197</td>
<td>0.420*</td>
<td>0.012</td>
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<tr>
<td>Villagers with high school certificate (%)</td>
<td>-0.001</td>
<td>0.987</td>
<td>0.036</td>
<td>0.553</td>
</tr>
<tr>
<td>Irrigation (ha), 1991/1996</td>
<td>-0.002</td>
<td>0.394</td>
<td>0.001</td>
<td>0.819</td>
</tr>
<tr>
<td>Tractors per km² cropland, 1991/1996</td>
<td>-0.063</td>
<td>0.123</td>
<td>0.031</td>
<td>0.839</td>
</tr>
<tr>
<td>Goats (heads), 1991/1996</td>
<td>0.000</td>
<td>0.431</td>
<td>0.000</td>
<td>0.431</td>
</tr>
<tr>
<td>Firewood usage (%) 1991/1996</td>
<td>-0.018</td>
<td>0.352</td>
<td>0.001</td>
<td>0.12</td>
</tr>
<tr>
<td>Gramsh district</td>
<td>1.240</td>
<td>0.074</td>
<td>0.421</td>
<td>0.607</td>
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<tr>
<td>Librazhd district</td>
<td>3.154***</td>
<td>0.000</td>
<td>-0.508</td>
<td>0.608</td>
</tr>
<tr>
<td>Pogradec district</td>
<td>2.299**</td>
<td>0.010</td>
<td>3.322*</td>
<td>0.020</td>
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<tr>
<td>Constant</td>
<td>1.348</td>
<td>0.465</td>
<td>-8.238**</td>
<td>0.005</td>
</tr>
<tr>
<td>Pseudo R²</td>
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<td>0.29</td>
<td>0.16</td>
<td>0.27</td>
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<td>Bayesian information criterion</td>
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<td>615.35</td>
<td>1263.94</td>
<td>1133.99</td>
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<tr>
<td>N</td>
<td>852</td>
<td>650</td>
<td>1578</td>
<td>1682</td>
</tr>
</tbody>
</table>

* p < 0.05, ** p < 0.01, *** p < 0.001.

district capitals were more likely to be abandoned in the first period, though the coefficient is small. Abandonment increased with distance from populated places (dwellings) in the first period. Villages with lower household density appeared to be reducing the amount of cultivated cropland in the first period. A positive and significant influence was exerted from the measure of cropland fragmentation on abandonment in the second period.

Some of the district dummies were strongly significant in both periods. The significance of the fixed district effects points to substantial remaining differences between the districts that were not captured by the other variables included in the models. Cropland abandonment was more likely in Librazhd and Pogradec in the first, and in Pogradec in the second period compared to the omitted reference district Elbasan. In one of the two poor and remote districts (Gramsh), abandonment was not significantly different from Elbasan, whereas it was higher in the other (Librazhd). The other village measures did not show a statistically significant relationship with cropland abandonment. Also, rainfall patterns and soil suitability were insignificant determinants of cropland abandonment. The documented results are robust to all sampling distances.

The Importance of Agricultural Land Rents Increased Over Time. Postsocialist transitions have had strong effects on cropland use in the Albanian countryside. After the socialist system effectively collapsed, all the associated land institutions, agricultural processing, and distribution networks collapsed along with it. The land redistribution in 1991 triggered a first, immediate wave of cropland abandonment, caused by the refusal of farmers to accept the most marginal plots redistributed (Ministry of Agriculture and Food 2002). Over time, the importance of the physical suitability of a plot for production increased and abandonment was initially higher in areas farther from populated places. Land-use patterns also provide an indication of the changing relative importance of agriculture within the national economy. At the onset of the
Table 3. Selected accuracy assessments across all spatial sampling schemes

<table>
<thead>
<tr>
<th>Sampling distance, meters</th>
<th>120</th>
<th>180</th>
<th>240</th>
<th>300</th>
<th>360</th>
<th>420</th>
<th>480</th>
<th>540</th>
<th>600</th>
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<tr>
<td>Cropland abandonment,</td>
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<td></td>
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<td>1988–1996</td>
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<td></td>
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<tr>
<td>Kappa</td>
<td>0.433</td>
<td>0.432</td>
<td>0.427</td>
<td>0.442</td>
<td>0.417</td>
<td>0.413</td>
<td>0.486</td>
<td>0.393</td>
<td>0.456</td>
<td>0.433</td>
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<tr>
<td>Area under ROC</td>
<td>0.795</td>
<td>0.792</td>
<td>0.793</td>
<td>0.802</td>
<td>0.791</td>
<td>0.794</td>
<td>0.815</td>
<td>0.800</td>
<td>0.794</td>
<td>0.797</td>
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<tr>
<td>Percent correct</td>
<td>74.21</td>
<td>74.37</td>
<td>73.94</td>
<td>74.65</td>
<td>73.17</td>
<td>73.19</td>
<td>75.12</td>
<td>73.72</td>
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<tr>
<td>Kappa</td>
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<td>0.466</td>
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<tr>
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<td>0.853</td>
<td>0.865</td>
<td>0.856</td>
<td>0.865</td>
<td>0.859</td>
<td>0.851</td>
<td>0.839</td>
<td>0.842</td>
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<tr>
<td>Percent correct</td>
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<td>81.98</td>
<td>82.56</td>
<td>82.35</td>
<td>83.95</td>
<td>81.26</td>
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<td>843</td>
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<td>519</td>
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<td>0.086</td>
<td>0.081</td>
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<td>0.097</td>
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<td>0.107</td>
<td>0.201</td>
<td>0.108</td>
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<tr>
<td>Area under ROC</td>
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<td>0.782</td>
<td>0.776</td>
<td>0.783</td>
<td>0.775</td>
<td>0.783</td>
<td>0.806</td>
<td>0.831</td>
<td>0.789</td>
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<tr>
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<td>86.11</td>
<td>86.21</td>
<td>86.04</td>
<td>86.16</td>
<td>85.62</td>
<td>85.81</td>
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<td>9,328</td>
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<td>3,781</td>
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<td>2,010</td>
<td>1,579</td>
<td>1,264</td>
<td>1,065</td>
<td>5,075</td>
</tr>
<tr>
<td>Forest clearing,</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1996–2003</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Kappa</td>
<td>0.205</td>
<td>0.201</td>
<td>0.228</td>
<td>0.109</td>
<td>0.209</td>
<td>0.210</td>
<td>0.298</td>
<td>0.191</td>
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</tr>
<tr>
<td>Area under ROC</td>
<td>0.845</td>
<td>0.843</td>
<td>0.852</td>
<td>0.837</td>
<td>0.851</td>
<td>0.844</td>
<td>0.853</td>
<td>0.844</td>
<td>0.843</td>
<td>0.846</td>
</tr>
<tr>
<td>Percent correct</td>
<td>87.57</td>
<td>87.38</td>
<td>87.70</td>
<td>86.74</td>
<td>87.46</td>
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<td>87.46</td>
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<tr>
<td>N</td>
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<td>9,876</td>
<td>6,009</td>
<td>4,012</td>
<td>2,846</td>
<td>2,123</td>
<td>1,682</td>
<td>1,340</td>
<td>1,118</td>
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</table>

Note: ROC = receiver operating characteristic.

aResults presented in Table 1 and Table 2.

transition, economic returns from other sectors of the economy were significantly lower than at present; as a result, cropland production was more likely to be an economically feasible livelihood option, even in relatively remote locations. These areas were largely abandoned in the second period.

Higher household density raised the demand to keep land under production within a village. It seems obvious that more households cultivate more land, but careful interpretation is required. The young and economically active often embark on internal or international migration and reduce the available on-farm labor pool (Miluka et al. 2007). The resulting remittances are rarely invested in intensifying or expanding farming, but are most likely used to purchase consumer goods and durables. Those who remain in the villages cultivate the land, but land-use intensity (the amount of labor or capital inputs per unit of land) may have stagnated or even decreased (cf. Stahl 2007). Our data do not directly capture this effect because we exclusively focus on land-cover change (a change from cropland to noncropland) and have no spatially explicit data at hand to analyze patterns of land-cover modifications (e.g., intensification) at the pixel level.

Land fragmentation as a consequence of the land reform could potentially have both positive and negative effects on the profitability of crop production. In the Albanian context, given the postsocialist experience of several periods of turmoil and political volatility (Stahl 2007), farm households may put greater weight on risk reduction than on output maximization. One way to reduce risks is to diversify production by maintaining plots of different conditions and in different locations. This would imply that villages with more fragmented fields tend to work smaller fields, as they achieve the same level of protection from risk as villages with less fragmented but larger fields.

On the other hand, fragmentation may have contributed to lowering agricultural returns by increasing labor demand and raising management requirements; as a result, a more fragmented distribution of cropland would have caused cropland to fall out of production in later stages of the transition, when market forces became more influential in shaping the landscape. Land consolidation via land market transactions could potentially ameliorate this abandonment, but in a context of uncertainty, poor access to credit, and collapses in input and output markets, these transactions are not occurring. Sabates-Wheeler (2002) and Lerman, Csaki, and Feder (2004) identify the high transaction costs of formal arrangements, complex administrative procedures, and suboptimal land administration systems as major constraints of formal land consolidation in CEE countries more generally. Rural households also view land assets as a safety net in light of the past volatile economic conditions and maintain strong social ties to land. The low price of agricultural land in many regions adds to these disincentives to become involved in permanent land transactions, which may hinder the reduction in farm fragmentation (De Soto et al. 2002).
It is difficult to make conclusions about household-level processes empirically with our village-level data. Nevertheless, the results indicate that in the first period, there is no significant relationship between cropland abandonment and land fragmentation, but in the last decade, fragmentation was associated with greater abandonment. A more fragmented distribution of cropland involved the distribution of plots that are difficult to access and therefore were left uncultivated in later stages of the transition when economic rents became a more decisive factor shaping land use.

There are significant spatial variations across districts, which are not otherwise captured in the statistical models. Abandonment was more likely in Pogradec, which contains a major market center as well as limited tourist opportunities, than any other district in the second period. In Pogradec, the growing market orientation led to little abandonment around the district capital, whereas most of the remaining cropland in more remote areas of the district was abandoned in the second period (see also Figure 4). Pogradec also experienced large emigration to Greece, which is less than 50 km away. Elbasan contains a large and intensively used plain that has good road access to the district capital. In Gramsh, there is a greater reliability on subsistence production, preventing large-scale abandonment. The district divergence was not attributable to the land reform, which was implemented identically in the four districts; variations in land reform outcomes should have only been realized locally where village councils decided on the land redistribution.

**Cropland Abandonment in a Nutshell: Retreat from Remote Areas at the Onset of the Transition, Then Gradual Market Alignment.** The statistical results indicated an increasing importance of market influences over time that manifest in a significant reshaping of the landscape. In particular, perennial crop cultivation fell behind compared to more profitable strategies within the agricultural sector like livestock production, and, more important, to broader changes in livelihood strategies away from agriculture toward other economic sectors. By the late 1990s, land fragmentation induced by the village-level reform choice significantly accelerated the abandonment of cropland.

**Forests: Why Does Forest Cover Decrease?**

A decrease in forest cover (more forest clearing) was likely to be observed at lower slopes, lower elevations, farther from national roads, but closer to the dwellings, in villages where cropland was more fragmented, and in Pogradec in the first period (Table 2). Forest-cover loss in the second period was concentrated far from the national roads, in areas with better access to district capitals, and in villages with less irrigated area. The differences between the two periods are interesting. In the first period, forest clearing was more likely in areas that are located closer to the populated areas (dwellings) but not in the second period. That is in part due to the measurement of the dependent variable; pixels deforested during the first period did not enter the sample used for the estimations of the second period. Forest clearing was more likely in Gramsh (a relatively poor district) and Pogradec in the first period but did not show statistically significant differences among districts in the second period. Other variables did not exert an influence on forest loss.

**From Subsistence-Oriented Village Clearing to Commercial Timber Extraction.** Early clearings concentrated on locations that were easily accessible from the villages, whereas in later stages the retreating forests forced local people to travel farther to harvest forest products. At the same time, rising incomes have enabled local people to purchase fuel wood on local markets, thereby creating an active local fuel wood trade. As a result, a share of the forest extraction activities shifted from predominantly subsistence-based extraction driven by village demand to more commercially oriented clearing, integrated into local and regional markets for fuel wood trade (Müller and Sikor 2006; Stahl 2007).

The forested areas around the dwellings were largely cut in the period immediately following the collapse of socialism. In contrast, the association of forest clearing with the distance to the national road network was considerably stronger in the second period with a coefficient three times as high as in the first period. The influence of the state of anarchy after the collapse of the pyramid schemes may have led to such a strong relationship by creating an open-access state that caused sharp increases in forest loss and much forest extraction close to roads, indicating that illegal sales and exports of timber may have been an important strategy for rural households in that period. Forest control and the enforcement of forest regulations virtually ceased in this period and forest resources were depleted rapidly (cf. Stahl 2007). At the same time, higher clearing rates closer to the major market centers (district capitals)
indicate the emergence of a second, commercially ori-

tented extraction strategy.

Hotspots of forest loss are visible in both periods
with distinct spatial clusters across the study area. In
the second period, forest clearing has occurred in the
more remote and the poorer regions of the study area
(Figure 4), when more easily accessible forested areas
were already exploited. Much of the forest clearing in
the second period was possibly caused by the period
of anarchy that created an open-access state. Never-
theless, large old-growth forested areas seem to be well
protected by their inaccessible setting. In other parts,
young secondary forest is regenerating on abandoned
cropland and unused pastures.

**Forest Clearing in Brief: Firewood Trade Spurs
Commercial Clearing and Partly Replaces Subsis-
tence Extraction.** Patterns of forest clearing followed
different trajectories from the changes seen in cropland
area. In the absence of other energy sources, rural Al-
banians are still highly reliant on firewood extraction.
With almost constant wood demand since the start of
the transition, clearing patterns bifurcated into mainly
subsistence-oriented extraction at more remote loca-
tions and more commercially oriented clearing closer
to the major market centers.

**Key Lessons**

Over time, market forces permeate farther into the
landscape, which is visible in the spatial patterns of
both cropland abandonment and forest clearing. Initial
land-use strategies tended to be based on semisubsis-
tence food production and fuel wood extraction, forced
on the majority of the rural population due to a lack
of nonfarm income opportunities and few connections
to migration networks. Access to a much more diverse
set of livelihood opportunities shifted incentives away
from crop cultivation in many villages, partly toward
higher valued production strategies within agriculture,
but more important toward income-earning strategies
in other sectors (cf. Stahl 2007). The temporal changes
we observe for forestry activities point in a similar direc-
tion. Higher cash incomes have facilitated purchases of
firewood, thus commercializing the forestry sector and
spurring a higher share of commercial clearing activi-
ties. In sum, both in agriculture and in forestry, growing
market integration is increasingly shaping the Albanian
landscape.

**Goodness of Fit and Validation**

Despite the large variation in the number of selected
observations, the signs and the significance levels of
all biogeophysical, distance, and access variables were
largely stable across the various sampling schemes. To
assess and validate further the robustness of the models,
we calculated the area under the receiver operating
characteristic (ROC) curve, kappa statistic, and the
percent correct metric (PCM) for all sampling dis-
tances. The three metrics quantify the agreement be-
tween observed and estimated land-cover changes. All
three were derived from comparing two-by-two con-
tingency tables of observed to fitted values (Pontius
2002). PCM is the percentage of correctly predicted
pixels divided by the total number of pixels. The stan-
dard kappa statistic quantifies the level of agreement
between the estimated and actual land-cover changes
compared against a random map (Pontius 2002). The
ROC curve plots the rate of true positives on the vertical
against the rate of false positives on the horizontal axis
(Metz 1978). The area under the curve was estimated
using the nonparametric version of ROC and indicates
how much the estimated probability deviates from ran-
don. The greater the area under the ROC curve, the
better is the model goodness of fit. Both kappa and the
area under the ROC are excellent metrics for study ar-
eas with large changes and clumped patterns of changes
(Pijanowski, Alexandridis, and Müller 2006).

All of the metrics listed in Table 3 were consistent
over the various spatial sampling distances, although
the number of observations (N) decreases by a factor of
eighteen. Across the two land-cover change processes,
the kappa measures indicated moderate fit for cropland
abandonment with kappas above 0.4, but very low fit
for the forest loss equations, particularly in the first
period with an average kappa of 0.11. Conversely,
the model fit measured with the area under the ROC
curve and with the PCM is high for all four models, in
both periods and across all samples (Table 3). The area
under the ROC ranges from 0.77 to 0.87 and the PCM
from 73 percent to 88 percent, taking the highest prob-
ability as the predicted change. Overall, the statistical
model showed relatively good fit with high PCMs but
poor kappa statistics for the forest models in the first
period. This result, although disappointing, is not that
surprising because of the difficulty in predicting where
forest would be cleared at the pixel level. The smallest
patch of contiguous land cover in the study area is
19,000 m². Therefore, there is likely to be some inde-
determinacy in predicting the exact area of small-scale
clearing for firewood extraction by households because we do not directly observe the trees that are cleared.

**Conclusion**

In this analysis, we controlled for the impacts of multiscalar, spatially heterogeneous land-use incentives on land cover to allow us to examine evolving land-cover transitions following the large-scale policy shifts immediately following the transition and the subsequent realignment of land-use incentives due to land reform. We found that agricultural abandonment in Albania is strongly mediated by both the biogeophysical environment and transportation infrastructure. District-level effects provide some evidence that abandonment is more likely in some regions than others, but was most likely in relatively remote areas, or in the presence of other economic opportunities, such as tourism. Interestingly, the importance of remittance income was not a significant correlate of cropland abandonment, perhaps because a low share of remittance income is channeled into agricultural investments (Miluka et al. 2007). Forest-cover loss was highly sensitive to the time period. Forest clearing tended to shift from subsistence orientation in the first years after the collapse of socialism to more commercial extraction in later stages.

Regarding the long-term impacts of cropland abandonment in Albania, the situation is not clear-cut. On the one hand, virtual autarchy, and the socialist distributional system more generally, kept a greater number of people working the land than can be sustained under a market economy, so the shedding of agricultural labor is inevitable. The abandonment of large areas of cropland partly reflects the adjustment of the rural sector to the evolving market conditions and leads to a concentration of cultivation on more productive areas (Ioffe, Nefedova, and Zaslavsky 2004). However, the removal of land from production can in the short term increase soil erosion and have other such undesirable effects, although in the longer term, the regeneration of vegetation may lead to increases in biomass (Houghton, Hackler, and Lawrence 1999). Our data indicate that abandonment is highest in those areas that are neither the most remote nor the most accessible. It may be the case that the poorest families in remote locations have moved toward subsistence production, which can mean greater rural poverty and higher inequality. Conversely, those farmers who can invest in more market-oriented agriculture have shifted from cereal production to higher valued products (cf. Stahl 2007). For instance, livestock production indexes almost doubled between 1991 and 2005 (FAO 2006).

In a broader context, widespread abandonment of agricultural areas has occurred across western Europe (MacDonald et al. 2000) and across CEE after 1990 (Brouwer, Baldock, and la Chapelle 2001; Kuemmerle et al. 2006) and will possibly continue on a larger scale (Verburg et al. 2006). In Albania, further abandonment of cropland may continue as returns from internal and international migration will become the most important livelihood strategy for the younger generation and as many of the remaining elderly farmers decease. Future abandonment in Albania may be aggravated by the projected reductions in crop productivity caused by high temperatures and drought in a region already vulnerable to climate variability (Intergovernmental Panel on Climate Change 2007).

Bush encroachment and natural forest regeneration will result as secondary vegetation on abandoned cropland with significant implications for the environment. The impact of the successional vegetation on biodiversity, soil conditions, or the carbon sequestration potential depends on the prevailing natural conditions and will therefore vary across regions (Verburg et al. 2006). For example, to preserve biodiversity values in areas where endemic biodiversity is connected to specific farming techniques, significant investments from the international community and the Albanian government are necessary to maintain traditional rural landscapes and their associated agricultural production systems. Furthermore, investments in rural infrastructure, particularly in the dilapidated rural road network, may offer competitive income opportunities in more remote areas and may help reducing rural emigration, at the same time exerting positive influences on the local, regional, and global environmental services provided by rural landscapes in postsocialist Albania.

Rural landscapes will continue to evolve and change. Land reforms, particularly the establishment of private property rights, are based on the logic that efficiency gains in agricultural production will occur as a result. The reality is, over time and space, that there is much variation in this outcome (Hamilton 1999). Lerman (2000) provides an interesting summary of empirical evidence on the success of land reform in terms of increasing farm output in CEE. He points out that starkly varying degrees of success in implementing such policies must relate to local social and political contingencies. Moreover, he notes that private property rights do not always translate into individual farming, and individual farming
can happen in the absence of strictly private property rights.

In summary, the integrated, multiscale data set employed indicated that a large part of the spatial and temporal variation in land-cover change was a function of biogeophysical, socioeconomic, and policy-related variables across a diverse region in southeastern Albania. Statistical analyses are important tools to combine multidimensional data relating to land use and land cover, in a spatially and temporally relevant context. Nevertheless, considerable unexplained variance remains that points to various factors influencing postsocialist landscapes that were not a priori hypothesized. Other important factors cannot be captured in our probabilistic framework. For example, the effect of migration may not be directly observable in a spatial framework. Social networks and connections that are difficult to quantify at the village level may play a crucial role. In such circumstances, qualitative data collection and household-level information can strengthen insights on such processes that are otherwise difficult to observe and to explain.

Acknowledgment

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Notes

1. We use the term transition to refer to the transformation of a centrally planned economy to a market-oriented one. Transition specifically emphasizes the period of reform, or the time horizon of the policies implemented, and the resulting socioeconomic changes, as is our focus.

2. We use the term socialist country according to the definition of Janos Kornai (1992), which generally refers to a state under control of a Communist party. Synonyms include Soviet-type system, centrally administered economy, centrally planned economy, command economy, or state socialism (Kornai 1992). This term is meant to facilitate comparative studies, within and outside of eastern Europe, but not to encompass all socialist movements, institutions, or practices.

3. Despite this legislation a substantial amount of land has been restituted by ad hoc village commissions. Kodderitzsch (1999) estimates that in total about 15 to 20 percent of Albania’s agricultural lands were restituted.

4. We concentrate on physical land fragmentation that is defined as the spatial dispersion of fields into separate and distinct parcels over a large area (Binns 1951).

5. Communes are the first administrative unit with a legal jurisdiction in Albania. Each commune consists of several villages where the elected elders (kryeplaku) implement decisions of the commune. Districts represent the second administrative level and are responsible for coordination of activities, development, and the implementation of state policies (Hoxha 2001).

6. Land-use practices such as grazing are also a relevant change, but we could not distinguish pasture from shrub or grassland with sufficient accuracy from the imagery and thus we limit our discussion to cropland abandonment.

7. Feedback effects from outcomes to various levels exist but are unobserved, omitted from the statistical analysis, and not included in Figure 5 for the sake of simplicity.


9. Sequential decision processes can lead to sample selection bias that can be corrected using other estimation procedures; for example, a two-stage approach. However, such a selection bias is not present in this case, because the empirical model is specified for a specific subset of the entire population; that is, all pixels. Therefore, we could proceed using standard econometric methods (Wooldridge 2002).

10. One reviewer suggested using cross-validation to assess the goodness of fit with observations (pixels) that did not enter the analyses. However, we believe that our approach does not only address model goodness of fit but has the additional advantage that it deals with spatial autocorrelation across the various sampling distances.

11. The accuracy of these village boundaries was not verified statistically but appears to yield better estimates than other approaches to derive village boundaries employed previously by, for example, Mertens et al. (2000) and Muller and Munroe (2005).

12. We are grateful to Thomas Sikor for pointing us in this direction.

13. Tables containing the logit coefficients and p values at different sampling distances are omitted due to space limitations but can be obtained from the authors upon request.

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