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# LAND USE AND LANDSCAPE CHANGE IN THE COLORADO MOUNTAINS I: THEORY, SCALE, AND PATTERN

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ABSTRACT Residential and commercial land development quickened during the 1990s throughout the U.S. Rocky Mountains, especially in Colorado, increasing the pace and extent of regional land use and landscape change. Unlike previous booms in mining, cattle, or energy, the current development wave is driven by growth in the secondary and tertiary economies—services, recreation, and information businesses—instead of commodity production. The result is sprawling land-use conversion, mostly from agricultural to residential, in even the most rural areas. This development pattern is examined in light of mountain and rural land-use theory, and its effects are evaluated at three scales in the Colorado mountains—regional, landscape, and site. The social and ecological impacts cited in previous rural development literature are evident, but also documented are landscape effects associated with the particular affluence of Colorado mountain development and the emergence of far-reaching rural sprawl and gentrification. Current development tends more than in the past to fragment land ownership, steepen land-use gradients at public/private boundaries, and increase human presence and disturbance in the urban/wildland interface. The paper concludes with suggestions for planning focused at the landscape scale.

RÉSUMÉ *Utilisation des terres et changement du paysage dans les montagnes du Colorado I: Théorie, échelle et configuration.* L'aménagement des terres résidentielles et commerciales s'est accéléré dans les années 90 dans l'ensemble des Montagnes Rocheuses des Etats-Unis, en particulier au Colorado, augmentant la vitesse et l'étendue de l'utilisation régionale des terres et du changement du paysage. A l'opposé des booms précédents de l'industrie minière, de l'élevage du bétail ou de l'énergie, la vague actuelle d'aménagement est propulsée par la croissances des économies secondaire et tertiaire, à savoir les services, les loisirs et l'information, au lieu de la production primaire. Le résultat en est une vaste conversion de l'utilisation des terres, principalement des terres agricoles en quartiers résidentiels, même dans les zones les plus rurales. Cette configuration de l'aménagement est examinée dans la perspective de la théorie de l'utilisation des terres montagnardes et rurales, et ses effets sont évalués à trois échelles dans les montagnes du Colorado, à savoir la région, le paysage et le site. Les impacts sociaux et écologiques mentionnés dans les publications précédentes sur l'aménagement rural sont évidents, mais on a également documenté les effets associés à la richesse particulière de l'aménagement des montagnes du Colorado et l'émergence d'une expansion et d'un embourgeoisement considérables. L'aménagement actuel tend plus que dans le passé à fragmenter les propriétés, à accroître les gradients d'utilisation à la jonction des terres publiques et privées, et à augmenter la présence et les perturbations humaines à l'interface des zones urbaines et des terres en friche. Cet article offre en conclusion des suggestions pour une planification à l'échelle du paysage.

ZUSAMMENFASSUNG *Landnutzung verändert das Landschaftsbild in den Bergen von Colorado, Teil I: Theorie, Skalierung und Entwicklungsmuster.* In den Rocky Mountains der U.S.A., besonders im Staat Colorado, beschleunigten sich in den 1990-iger Jahren Tempo und Ausmaß der Landerschließung für kommerzielle und Siedlungszwecke, was zu regionalen Veränderungen in der Landnutzung führte, und das Landschaftsbild modifizierte. Im Gegensatz zu früheren Hochkonjunkturen im Bergbau, der Rinderzucht oder Energiewirtschaft, die Gebrauchsgüter erzeugten, wird die derzeitige Entwicklung vom Wachstum in der sekundär- und tertiär Wirtschaft bestimmt, die Dienstleistungen, Freizeit und Informationsdienste umfaßt. Als Ergebnis zeigt sich eine unkontrollierte Landnutzung, die in der Mehrzahl der Fälle, selbst in abgelegenen Gebieten dazu führt, daß landwirtschaftlich genutzte Flächen in Siedlungsgebiete umgewandelt werden. Nutzungstheorien für Berg- und Agrargebiete werden auf die neuen Tendenzen angewendet. Für die Colorado Mountains werden drei spezifische Aspekte, nämlich regionale, landschaftliche und lokale Einflüsse ausgewertet. Die offensichtlichen sozialen und ökologischen Folgen des Entwicklungsprozesses sind bereits in früheren Veröffentlichungen beschrieben worden - für Colorado muß außerdem noch ein Wohlstandsfaktor berücksichtigt werden, der zu ungewöhnlichen Bebauungsprojekten und Exklusivität führt. Die gegenwärtige Entwicklung führt mehr als in der Vergangenheit dazu, daß der Landbesitz zerstückelt wird, daß sich die Abgrenzung zwischen öffentlicher und privater Landnutzung verschärft, und es an der Schnittstelle zwischen zunehmender Besiedelung und Naturgebieten zu Störungen kommt. Die Veröffentlichung schließt mit Planungsvorschlägen, die das Landschaftsbild in den Mittelpunkt stellen.

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## INTRODUCTION

A new wave of land development, driven by residential and commercial expansion, is under way in the U.S. Rocky Mountains. Unlike previous booms, the current development wave is driven by secondary and tertiary economic sectors—services, recreation, and information businesses—instead of commodity production, and is marked by widespread land-use conversion, mostly from agricultural to residential, in even the most rural areas. Rocky Mountain development is examined here in light of mountain and rural land-use theory, and its effects are evaluated at three scales in the Colorado mountains—regional, landscape, and site—based on regional literature and socioeconomic data and results of a case study described in the companion paper (Theobald *et al.*, this issue, pp. 407–418). To conclude, planning approaches focused at the landscape scale are suggested. The companion paper analyzes landscape change in a single Colorado mountain valley using methods from landscape ecology and social impact assessment.

## MOUNTAIN LAND USE AND DEVELOPMENT

In theory, land use is a result of two, somewhat countervailing, forces: the land market and the regulatory state (Alonso, 1960). In market terms, land-use patterns result from three main factors: demand, location, and site characteristics, the latter including adjacent and nearby uses and natural characteristics judged in relation to intended use (e.g., soils, topography, climate, and natural hazards—factors assumed to be especially important in mountain settings). Government regulation (through zoning, master planning, and public ownership) is obviously important to actual use patterns, but often neglected in land-use models, which are typically framed in terms of urban economics and industrial location (Hall, 1966; Berry, 1967; Abler *et al.*, 1971). Most land use in United States mountain areas has a rural character, and most mountain settlement is dispersed or in small towns rather than in cities. Thus, the urban dictates of land-use analysis apply weakly, if at all. Yet, agricultural models (Kellerman, 1989 a, b) also mis-apprehend rural land use in the contemporary U.S.A., assuming that most land is in the private market (not true of many mountain areas, especially in the western U.S.A.) or that agricultural potential is the key determinant of land use, an assumption weakened by the decline of the agricultural sector. Rural analysts are left searching for conceptualizations of land use that are not simply modifications of pure urban *or* agricultural models (Birch, 1968; Lonsdale and Holmes, 1981; Robinson, 1990), but rather models that can cast light on the dispersed residential and tertiary commercial uses emerging as populations grow in many rural areas, especially mountain zones.

The forces driving population growth in the small-town and rural Rocky Mountains are actually well understood. Fuguitt and Zuiches (1975), Williams and McMillan (1983), and Williams and Jobes (1990) have shown that a mixture of economic and quality-of-life considerations attract people to amenity-rich areas of the Rockies. Jobes (1988, 1995) studied immigrants to the Gallatin Valley in Montana for two decades, concluding that natural amenities and recreation opportunities, and not necessarily job prospects, attracted both rich and poor. Population is also leaking from cities in the West into rural hinterlands as people already living in the region take advantage of new residential mobility to seek improved quality of life; Davis *et al.* (1994) showed how cities with charismatic hinterlands (their case study was the coastal city of Portland, Oregon) develop an "exurban" zone of countryside dwellers, some of whom maintain their city-center or suburban jobs and others who eventually wean themselves of the city completely. A significant literature also documents the retirement component of this so-called amenity-migration (e.g., Cuba, 1989; McHugh, 1990). Even the transformation of seasonal resorts into permanent residences for urban out-migrants has been examined (Halseth, 1993; Halseth and Rosenberg, 1995).

Yet it is less clear how this Rocky Mountain renaissance affects the region's ecological and cultural landscapes. Mountain development studies tend to make the link between social cause and landscape effect using models based on transportation or agricultural constraints (e.g., Allan, 1986); other studies focus on the evolution of mountain resort towns (e.g., Kariel, 1989). Here, this literature is reviewed and the insights it offers to the current land-use transformation in the Rocky Mountains is assessed.

### Land Development in Mountain Settings

The most detailed work on mountain development patterns in industrialized countries focuses on resort areas. Research in the Swiss and Austrian Alps (Messerli, 1987; Price, 1987; Kariel, 1989; Pfister and Messerli, 1990), and the more limited work on mountain resorts in the U.S.A. and Canada (Kariel and Kariel, 1988; Culbertson *et al.*, 1993) provided a base for this study because of their strong land-use components (much additional literature exists on tourism and resorts in mountain and non-mountain areas; see, for example, Gill and Hartman, 1992, and Ritchie and Goeldner, 1994). Researchers created a roster of development effects, including increases in employment and income, tax base, wildlife habitat disturbance, traffic and air pollution, property values, and demand for facilities and services of all sorts. These are accompanied by a decline in traditional commodity production—grazing, logging, and mining—and growing tensions between socioeconomic classes and among the values held, for example, by permanent and seasonal, or new and old, residents. Some mountain resort studies yielded conceptual land-use models (e.g., Kariel, 1989) and the European Man and the Biosphere projects, such as the Obergurgl Study, simulated land-use and ecological impacts of tourism with quantitative models (see Moser and Moser, 1986; Price, 1995).

Most resort studies focus on concentrated development (e.g., hotels and other facilities), which is clearly an important element of landscape change in the Rocky Mountains, but which offers little insight on changes outside of resort towns. Allan's (1986) model of mountain land use would seem to apply here. He illustrated how access and infrastructure overcome altitudinal zonation—that is, how an ecologically-based land-use model is eclipsed by transportation and land rent conceptualizations in most of the world's mountain areas (see also the debate over Allan's model: Greenland, 1986, and Uhlig, 1986).

Allan's attention to diffusion of ideas, technology, and goods along valley-bottoms and up newly accessible slopes certainly anticipates the sprawling pattern of recent Rocky Mountain development, but his focus on market accessibility pushes mountain development theory into a conventional urban-spatial and economic determinism. However, the affluent and "footloose" qualities of recent development in the U.S. Rocky Mountains are poorly reflected in studies of resort centers, or by focusing on multiple costs (labor, money, equipment, risk) and distance decay functions associated with moving goods from production site to market. The region increasingly attracts permanent and part-time residents willing and able to travel long distances by various means (from private jets to four-wheel-drive family automobiles) for occupational and recreational pursuits. Telecommuting and personal, technical, and information service activities (e.g., consulting, advising, and writing via electronic mail) allow more people to live where they please, not where their jobs dictate (Rasker and Lick, 1994). The newer mountain residents want to live on large lots in rural and wildland settings, and even value a sense of isolation (Davis *et al.*, 1994; Arendt, 1994) although they also want services and access to some urban amenities (Jackson and Wall, 1995). The combination, then, of a services and information economy that allows more residential flexibility, and the Rocky Mountains' charismatic landscapes, yields land-use patterns that appear to be economically and geographically irrational: a few "rural" mountain areas of Colorado, near Ridgeway and Aspen, for example, fetch some of the highest residential land prices in the country! Rocky Mountain settlement patterns now clearly differ substantially from those associated either with a population tied mostly to natural resource extraction or to market centers and their distance-decay hinterlands.

Mountain resort studies also neglect to determine how resorts and their wildland settings attract non-recreational economic activities such as software development firms, financial services, mail order companies, retirees, and self-employed workers of all types, from writers to lawyers. Several economists argue that this process now dominates Rocky Mountain development, and drives new land-use patterns (Rasker, 1994; Rasker and Lick, 1994; Power, 1995). The footloose services economy, enabled by almost ubiquitous mobility of both people and information, and attracted by a rural charisma, results in sprawl of suburban-like development into even the most deeply rural parts of the Rockies.

## RECENT DEVELOPMENTS IN THE ROCKY MOUNTAINS

Population in the Rocky Mountain states (i.e., Colorado, Wyoming, Montana, Idaho, Utah, Nevada, Arizona, and New Mexico) has grown faster than the U.S. as a whole since the 1970s and Rudzitis and Johansen (1989) found that "wilderness counties" in the Rockies (those that contain or are adjacent to federal wilderness areas) grew two-to-three times faster than all other counties in the country, both rural and urban, beginning in the 1970s. Rural parts of Rocky Mountain states grew more consistently than rural areas nationwide; indeed, the region is the only part of the U.S.A that did not experience a decline in urban-to-rural migration during the 1980s (Cromartie, 1994; Fuguitt, 1994). Ten of the fifty fastest growing counties in the U.S. between 1990 and 1994 were in the Colorado mountains; the fastest growing county was a Denver suburb that includes substantial foothill and mountain terrain, and the second-fastest growth was registered in Summit County, Utah, a mountain area that hosts three ski areas (U.S. Bureau of the Census, 1995).

Some of this growth fits the classic resort town pattern, perhaps best exemplified in the Rockies by the transition of Jackson, Wyoming, from ranching town to amenity migration magnet (McGinnis, 1992). The town's transformation began in earnest in the late-1960s with ski development, and followed a now familiar pattern (nicely illustrated as a spiral of transformation in Kariel's 1989 Austrian case studies) in which skiing and other outdoor recreational activities merge into year-round tourism, and new residential and retail growth replaces the traditional culture and economy (e.g., tourist shops replace ranch supply and hardware stores in the U.S.A.).

A well-documented social pathology accompanies such transitions. Its most abstract expression is phrased as a loss of "sense of community," the perception among long-term residents that new immigrants lack commitment to place and simply do not fit into the local ethos. Class tensions in resort towns are heightened by inflation of land and housing prices, and by the very nature of the service economy, in which less affluent residents hold jobs servicing the needs of richer visitors (McGinnis, 1992). Recreation-dependent and service-dominated economies inevitably include many minimum-wage jobs, and most debates about resort development in the Rockies, including proposals for new ski areas, include disparaging comparisons between growing service jobs and the declining resource production jobs, which paid more.

It does appear that many migrants to amenity-rich areas in the Rockies accept lower paying jobs to live in a desirable place (Von Reichert and Rudzitis, 1992). Power (1991, 1995), however, argues that the "service sector" should not be stigmatized as all menial labor because it also includes highly paid professions in medicine, law, engineering, and finance—and many of the immigrants responsible for land-use changes in amenity-rich mountain areas are part of this segment of the service economy. Indeed, many of the new immigrants do not ski! McGinnis' view of Jackson, Wyoming, neglects the growing, non-tourist sector of the area's economic and settlement patterns (Power, 1991, 1995; Jobes, 1993; Rasker, 1993;

Johnson and Rasker, 1993)—an element bemoaned by the superintendent of nearby Grand Teton National Park:

> There's no longer any slack season.... And now we even have jet commuters from New York and Chicago who keep their businesses going with faxes and cellular telephones (quoted in Hodgson, 1995).

Many new residents do not build houses in town, but rather, they sprawl out onto former ranch land, as discussed later.

Both poor and affluent immigrants demand different land use in their adopted regions (Williams and Jobes, 1990). Rudzitis and Johansen (1989) found that attitudes and values of recent immigrants to counties with wilderness areas differed significantly from those of long-time residents. Most recent immigrants were younger (between the ages of 21 and 50), more highly educated, and more likely to have been raised in an urban area than the long-time residents. The newcomers were also more often professionals with higher incomes. Newcomers wanted more wilderness protection than did long-time residents (only 35% of residents vs. 60% of migrants wanted more wilderness nearby), and, not surprisingly, newcomers assigned more importance to natural landscapes and pristine views, and disliked activities that alter the landscape, such as timber cutting, fencing, and mining. They rated landscape amenities more important than economic considerations such as job opportunities or even cost of living.

The well-documented process of land-value inflation in growing resort towns is one of the forces for the enlarging rural reach of mountain land-use change. Lack of affordable housing pushes "locals" and workers out to other small towns or to more deeply rural settings; workers in the recreation and tourism industry often commute quite long distances to resort towns (Gober *et al.*, 1993; Knudson, 1993), creating sprawling "bedroom communities" and isolated "rural subdivisions."

A great deal of town planning in the Rockies now focuses on maintaining community well-being in the face of rapid growth (Ringholz, 1992, 1996). But, infusion of dispersed residential development into rural areas confuses even the geographic and sociological notions of community, and calls for greater attention to the more extensive cultural and ecological landscape in which mountain towns are embedded. We explore this pattern in more detail for the Colorado mountains.

## MOUNTAIN DEVELOPMENT PATTERNS IN COLORADO

The new wave of development is draped onto previous land-use patterns. Colorado's settlement history is similar to much of the Rocky Mountain region (see Wyckoff and Dilsaver, 1995, for an overview of mountain settlement in the American West). The first Colorado mountain settlements were mostly temporary Native American camps; permanent European settlement began in the mid-1800s with mining towns such as Leadville and Silverton, located in high, poorly accessible valleys because of resource, rather than market, location. Some of these became ski resorts, while others languished or suffered the boom-and-bust mineral economy.

Ranching settlement began in earnest after the 1872 Homestead Act, which distributed large plots of land for minimal fees. Settlement was difficult, however, due to terrain and climate, and extensive lands remained in government ownership (over 80% of some mountain counties), complicating the geographical patterns of modern development. Traditional land-use theory neglects public ownership, typically assuming that all parcels are in the market and available, at a price. But public lands—which account for the majority of Colorado mountain areas—were closed to residential and most commercial development at the turn of the century, after the mining and ranching patterns were established, and have now become, according to some analysts, the main attraction to amenity migrants (e.g., Rudzitis, 1993). Anecdotal evidence suggests that public lands attract new residential development away from transportation corridors and town centers, to the periphery of wildlands. Adjacency to public lands is a key selling feature of mountain real estate, resulting in building locations high on slopes and far along the dirt roads created in the past chiefly to convey resource commodities out of the federal lands.

### DRIVING SOCIAL FORCES

The first century and a half of Colorado mountain settlement was driven by extractive industries, chiefly timber, mining, and grazing, often in boom-and-bust cycles. Energy development (oil, gas, and coal) caused the last of the great commodity boom-and-bust cycles during the 1970s and early 1980s; the service, retail, and real estate sectors then grew to dominate most mountain areas of the state in the 1980s and 1990s. Tourism and recreation are increasingly important in the regional economy, but the recent residential boom also reflects growth in high-wage, highly mobile professional employment such as engineering, law, financial services, health, and higher education (Culbertson *et al.*, 1993; LaMendola and Martin, 1993; Cromartie, 1994).

As part of a national population shift to the South and West, Colorado's population grew at an annual rate of 2.9% between 1991 and 1994, the third fastest state growth in the nation. Reflecting another national trend, the shift from urban to rural areas, Colorado mountain population grew at a brisk pace, especially in resort areas, while growth rates in the urbanized Front Range region (including Denver) slowly declined (Figure 1). An early-1980s decline in energy and mining industries reduced growth rates everywhere between the 1980 and 1990 censuses, but all areas rebounded in the early-1990s. Growth at 2–4% annual rates, mostly due to in-migration rather than fertility, is expected over the next two decades in both mountain and urban areas (Colorado Division of Local Affairs, 1994). In short, a significant migration to the mountains is under way and expected to continue in the near future.

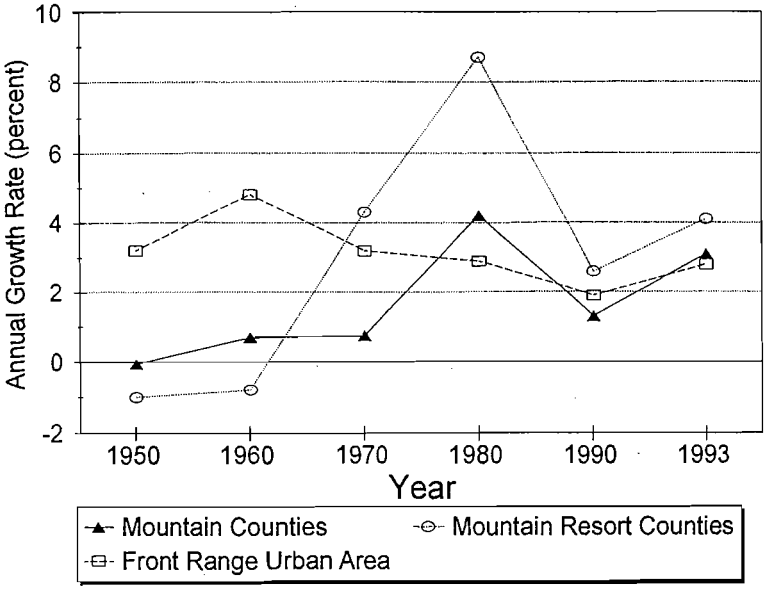


FIGURE 1. Population growth rates in Colorado, 1950–1993: urban, mountain, and mountain resort counties. Source: Colorado Department of Local Affairs monthly and annual demographic reports.

## EMERGING LAND-USE PATTERNS

This amenity migration has created two new land-use patterns in the Colorado mountains. First, as mentioned above, towns without ski resorts are becoming bedroom communities to the resort towns, or booming simply because they are situated in attractive settings. Ringholz (1992, 1996) describes the bedroom community phenomenon for Kremmling, a timber town on the Colorado River. Even when the timber mill closed, the town's location between two fast-growing resort areas (Steamboat Springs to the north, and Summit County to the south), and growing demand for other mountain-based recreation, such as fly fishing and river rafting, fueled continued population growth and even a housing shortage. The same pattern occurred in Rifle and Leadville, which began to grow as bedroom communities even as their primary energy and mineral economies declined. Indeed, most Colorado mountain towns within an hour's travel time from a ski resort are growing rapidly.

The second pattern, of affluent, dispersed residential development in rural areas, is the focus of the remainder of this paper. Ranches that comprise the private open spaces between mountain towns are shifting to residential use. The pastures are divided into both dense subdivisions removed from town centers and into large "ranchette" developments of homes scattered across valley bottoms and far up the mountain slopes (Theobald *et al.*, this issue, pp. 407–418).

Widespread residential development outside the traditional townsites is a relatively recent phenomenon in Colorado's mountains, one which began in the 1970s and mushroomed into an important landscape feature in the 1990s. Two socioeconomic trends fuel this rural subdivision and building pattern. First, construction of second-homes is burgeoning as affluent urbanites acquire a house in the countryside. Many of the mountain counties record about 50% absentee home ownership according to U.S. Census Bureau statistics, including counties without ski resorts. Second, rural residential development is encouraged by national employment trends and enabled by information technology. The decentralization of many industries and businesses, along with improved transportation and telecommunications, allow greater mobility and more flexible work patterns, including working at home (a phenomenon referred to as "telecommuting"). Although statistics are rare, numerous news and business magazines have described the recent boom in small, footloose industries and entrepreneurs moving into the Rocky Mountains (e.g., Bonfante, 1993). A mixture of employment at nearby (or even distant) recreational facilities (ski areas and national parks, for example), retail sales and service, retirement, and telecommuting to flexible jobs in distant urban and suburban areas, offer mountain immigrants a great deal of locational flexibility which enables them to live in remote, charismatic rural settings.

The rate of home building is more complicated than anecdotes about the mountain "building boom" would suggest, however. Building permits in mountain counties peaked in the late-1970s (Figure 2) at the tail end of the energy boom when the service economy was still weak and federal tax law changes made multi-family property investment less profitable. The rise of single-family house construction in the late-1980s (Figure 2), especially in comparison to multi-family construction (Figure 3), reflects the new residential boom and supports the frequent observation that dispersed homes are sprouting up in rural areas.

The landscape pattern of home building can be ascertained only by a parcel-by-parcel analysis, and Theobald *et al.* (this issue, pp. 407–418) indicate that, at least in one Colorado mountain valley, significant home building has shifted to subdivisions and large lots far from existing townsites. In this area, and all the other valleys with highways that were visited during a "windshield survey" (i.e., through a car window) to choose a study site, residential

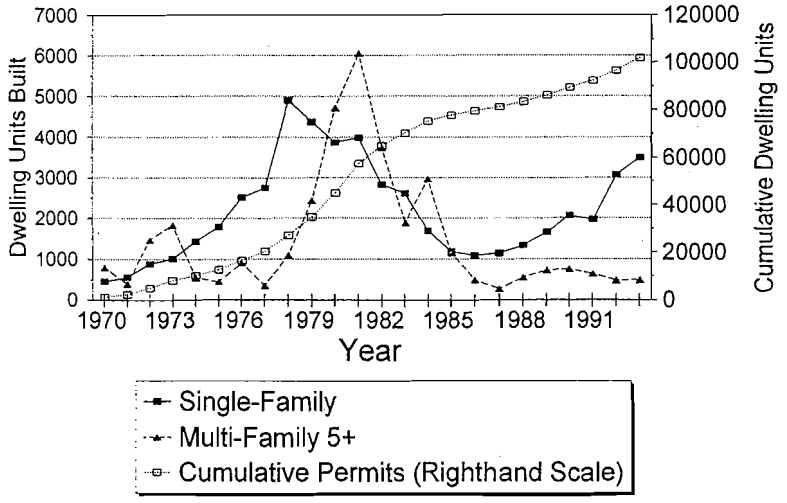


FIGURE 2. Colorado mountain county building permits, 1970–1991. Total dwelling units permitted annually for single-family homes and for multi-family complexes of 5 or more units; cumulative totals for all dwelling units over the time period are shown, with scale on the right. Sources: U.S. Bureau of the Census, Census of Housing; Colorado Department of Local Affairs; and Marquette University, Housing Start Forecast Center.

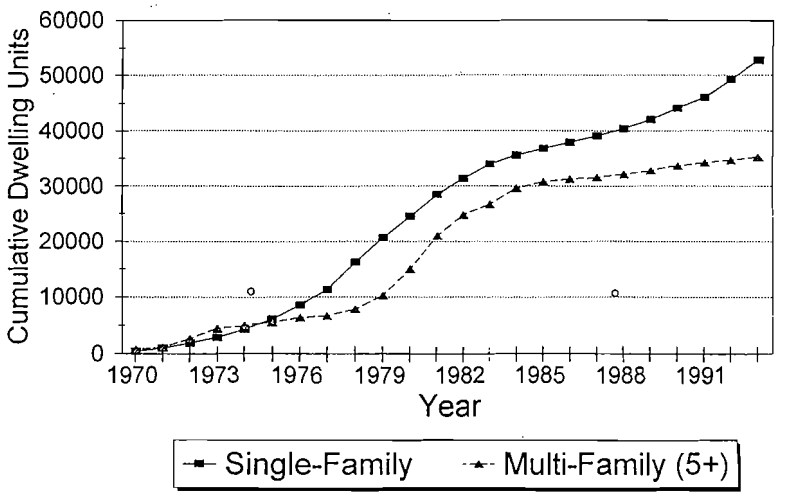


FIGURE 3. Cumulative permits issued for single-family homes and for multi-family complexes of 5 or more units, 1970–1991. Sources: U.S. Bureau of the Census, Census of Housing; Colorado Department of Local Affairs; and Marquette University, Housing Start Forecast Center.

development appeared to have little tie to the location of commodity resources or urban services, and quite visible residential development occurred far from existing settlements.

Real estate inflation, common to resort towns, can also be found in non-resort areas of the Colorado mountains, a further indication of sprawl and gentrification into more rural locations. Although economists tend to focus on the astronomical rise of real estate prices in resorts like Aspen or Vail (where median home values exceed US $1 million according to local realtors), land prices have also risen in valleys with no resort facilities: median property values have more than quadrupled since the 1970s in Jackson County, one of the least developed and most rural mountain areas of Colorado. Jackson County officials and residents report increased demand for "recreational" properties—ranches and parcels purchased for hunting, fishing, second homes, cabins, or just camping sites. Some of this may be speculation that, someday, Jackson County will host a ski resort (it has the necessary physical factors), but similar reports come from other rural counties such as Rio Blanco, in which ski development is unlikely, but where property is desired for hobby ranching, trout fishing, and hunting.

## SCALES OF COLORADO MOUNTAIN DEVELOPMENT

Geographical scale offers one way to conceptualize the implications of mountain development in Colorado. The land-use studies and planning tradition is followed here by applying three scales—regional, landscape, and site—recognizing that differences arise in their definition among different analysts (as cited below). Not only does development exhibit distinctive patterns at different scales of analysis, but landscape effects at one scale establish constraints or incentives for development at other scales.

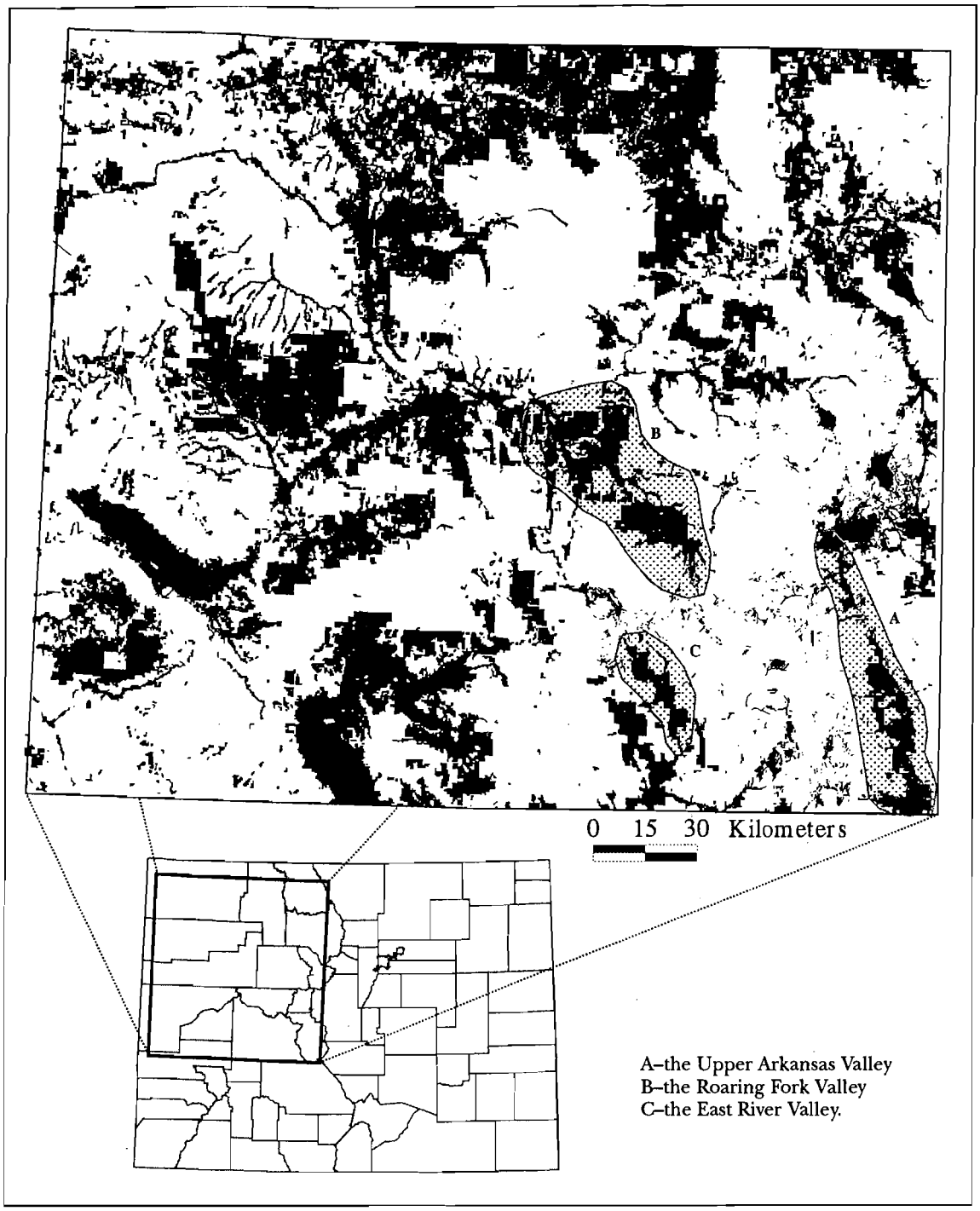


FIGURE 4. Private (black) and public (white) lands in a section of the Colorado mountains. Selected valley swaths of private land are indicated by stippling.

## REGIONAL SCALE

Regions are defined in various ways, especially with regard to land use (Meyer and Turner, 1994) and this study is based on the physiographic notion of regions like the "Southern Rocky Mountains" (Hunt, 1974). At the regional scale, mountain development is constrained in a very obvious way by physiography and land ownership. The regional physiography tends to constrain development to valleys and to other limited areas of gentle slope. A regional pattern particular to the Rocky Mountains is the almost total ownership of higher elevations by the federal government. Settlers, given land under the Homestead Act, chose valley-bottom sites for ease of access, water availability, and milder weather. Control of valley-

bottom land also resulted in de facto control (without ownership) of valley slopes and ridge tops, due to limits on access and water. The pattern of federal land ownership was itself constrained by this homesteading pattern. Congress did not wish to buy back private lands in establishing the public lands, and the timber that was the *raison d'être* of the National Forests was typically on the middle and upper slopes, not in the settled valleys. Public lands thus tend not to extend to lower valley elevations except where homesteading failed.

The cumulative regional result of these factors is a complicated fragmentation of public and private land (Figure 4). The key implication of land subject to development surrounding public lands in a net-like pattern is for the potential of regional ecosystems to function as large, interactive wholes. Animals and plants forced to migrate for any reason (such as climate change and other stresses) contend with impassable or poorly permeable development corridors. Some ecologists argue that large-scale habitat fragmentation, which occurs in the Rockies as valley corridors develop, causes genetic isolation of wildlife and makes efforts to re-introduced regionally-extinct species more difficult (see, for example, Agee and Johnson, 1988; Shafer, 1990; Schonewald-Cox and Buechner, 1992). The core areas are not sufficiently large to provide entire habitats to mobile species like wolves and moose who must use the developed corridors on a seasonal basis or must cross them to move from one habitat block to another, increasing the potential for conflicts between wildlife and humans.

Finally, the net-like pattern of private lands maximizes the interface of public and private lands, thus enlarging the geography of social tension over issues like wildfire and predator control. In terms of the cultural landscape, the net-like pattern of private lands can make provision of some services, such as transportation and utilities, more efficient, but can also encourage the very "strip" development that many mountain immigrants are leaving the cities and suburbs to escape.

### LANDSCAPE (VALLEY) SCALE

The term landscape is used here to refer to individual watersheds or valleys of approximately 100–1,000 $km^2$ in extent although it is also intended to imply the notion of landscapes as land units perceived by people as coherent entities, as suggested in much of the literature (as in Dorward, 1990, the benchmark text on mountain landscape and community design, and as applied by the U.S. Forest Service; see Litton, 1968). At the landscape scale, the net of private lands in the Colorado mountains disaggregates into corridors and peninsulas shaped by topography (Figure 4). Mining claims, the equivalent of private property, perforate the public lands, creating islands and spotty in-holdings, but these account for a relatively small amount of land. Some of the swaths of private land are still relatively undeveloped, such as parts of the Upper Arkansas Valley (Figure 4, area A). Other areas, like the Roaring Fork Valley below Aspen (Figure 4, area B), are ribbons of residential and commercial development squeezed in between public land borders and steep valley sides. Theobald *et al.* (this issue, pp. 407–418) focus on a peninsula of private land jutting into the Gunnison National Forest along the East River Valley (Figure 4, area C).

Patterns of land subdivision and transformation from agricultural to residential and commercial use begin to be resolved at the landscape scale. Mountain residential subdivisions increasingly carve out swaths of agricultural land removed from townsites and services. This comes from newcomers' desires to own property in rural or wildland settings and a regional tradition of strong county governments which resist town annexation to keep the property taxes associated with rural development. A pattern of large-lot subdivision is especially evident in Colorado because of affluent residential demand and state law that encourages developers to design subdivisions as assemblages of parcels of at least 35 acres (14 ha), each with one house, in order to avoid detailed county subdivision regulations. These 35+ acre lots are referred to colloquially as "ranchettes," and this term is used here to signal the new pattern of extensive ranchland subdivision in the Rocky Mountains (which, in other states, may be characterized by lots up to 160 acres, 65 ha). The term subdivision is applied to traditional residential lots typically under one acre in area.

The spread of ranchettes in the Colorado mountains is perhaps the region's most unique modern land-use feature after the ski resort complex. Its ecological effects are discussed in detail by Theobald *et al.* (this issue, pp. 407–418), but all types of residential land subdivision and development in the mountains have effects at the landscape scale. For example, building lots tend to occupy critical ecotones, especially the lower forest boundary and valley-bottom riparian areas. Subdivisions and their roads tend to affect particular land-cover types, especially aspen, sagebrush, and lower forests. When entire ranches are subdivided, the resulting home construction and habitat disturbance can affect the entire valley cross-section below the public land boundaries, and thus disrupt landscape continuity by blocking migration routes along the valley's long axis.

The physiography in both glaciated and non-glaciated valleys enhances the visual impact of residential and commercial development. It is difficult to build houses, especially the large houses associated with rural gentrification, that are not visible from most valley-bottom and opposite-slope sites, and the spotty forest cover of this relatively dry mountain zone makes most houses and infrastructure difficult to screen. Worse, preference for ridge top and other "view" sites has become painfully obvious in many Colorado mountain valleys (Heicher, 1995).

### SITE SCALE

Little research attention has been paid by geographers to the individual land parcel and building-site scale, especially in rural areas; site and design characteristics are the main purview of architecture and landscape design. Dorward's (1990) guide to mountain residential and commercial design takes several examples from Colorado, although she focused on resort towns rather than sur-

rounding rural areas. The effects of building sites and design on wildlife habitat are beginning to receive attention by ecologists (Knight, 1992), and wildlife concerns are now included in mountain area development plans (Summit County Planning Department, 1994).

A "windshield survey" of building patterns was conducted along most Colorado valleys with highways during the summers of 1993 and 1994. Guided by data on population increase and building permits, as well as Dorward's (1990) design handbook, we identified valleys with rapid residential development for repeat photography and the detailed analysis reported by Theobald *et al.* (this issue, pp. 407–418). This qualitative field survey indicated at least three preferred site types or "habitats" for home building in recent years: near streams; on the edge of aspen and conifer forests; and on ridge tops and open hill sides with good views.

Each site preference yields ecological and social effects. Stream-side development disrupts riparian areas, which are habitat for more than two-thirds of Colorado's animal and plant species, and also worsens the flood hazard. Forest edge development tends mostly to affect those species habituated to lower elevation forest cover (especially aspen) and to ecotones, the edges between different vegetation structures. Finally, "view sites" make development more visible from other parts of the valley, and thus degrade the natural aesthetic of the mountain landscape. Additionally, because the lower forest limit is often coterminous with National Forest boundaries, and because public land adjacency is an attractive real estate trait, residential building sites tend to press up against public lands boundaries, and thus, in many cases, against the most wild and protected lands.

Contradictions between aesthetic and ecological goals in land-use planning are especially strong at the site scale. For example, a common goal of county master plans in mountain areas is to reduce house visibility, especially by restricting ridge-top development and pushing houses out of open sites and edges and into forests and further back from roads. But, the ecological ramifications of these guidelines are rarely examined. "Viewshed protection" (attempts to conceal structures) might actually cause more ecological harm: by forcing houses out of xeric shrublands and into forests or from relatively unproductive ridges into more valuable wildlife habitats; by encouraging longer driveways that fragment more vegetation; and by pressing houses further back from roadsides, thus widening the zone of influence of road corridors. Such interactions should, at the least, be examined in master planning, and efforts are needed to assess the cross-scale effects of land use.

## LANDSCAPE IMPLICATIONS

The landscape scale may be the most appropriate nexus for consideration of land use and its effects on the ecological and cultural qualities of mountain areas. Although defined differently by various professional groups, landscape connotes a wholistic land unit exhibiting repetitive social and/or ecological patterns (see definitions of landscape, for example in Meinig, 1979; Forman and Godron, 1986). In many ways, the notion of region and landscape coalesce, as in the idea, assumed in this study, that the Rocky Mountain region has meaning as both a geographical area and a recognizable landscape (mountains and plateaus).

Landscapes also take on the cumulative qualities of numerous site-scale land-use processes. The challenge to regional analysts and planners is to recognize the interacting social and ecological processes and structures that give a landscape its unique character and to assess how land-use change can alter that character over time. Some key elements of this approach in the Rocky Mountains would include attention to: interactions among geographic scales and development types; public–private land relationships; and the relationship between landscape and land-use planning.

### INTERACTIONS AMONG SCALES AND TYPES OF DEVELOPMENT

Land-use patterns at different scales influence one another in both a top-down and bottom-up fashion. Topographic and land ownership patterns in the Colorado mountains force development into a network of development corridors. Each landscape-scale corridor further establishes constraints on site development. For example, high density developments occur in valley bottoms, and dispersed homesites are arrayed up the valley slopes. Yet the pattern of individual development sites, especially dispersed homes attracted to particular land covers like aspen forests, create cumulative effects on a valley's total stock of that habitat type. If it happens that aspen, or some other land cover preferred for development, is rare, then individual development siting that otherwise appears to cause only minor ecological disturbance can, in the cumulative, deplete that habitat type in a valley. Finally, the attraction of public lands boundaries tends to place more homes, and more stakeholders, within the immediate physical and political sphere of public lands management, thus complicating landscape-scale and regional-scale policies meant to deal with natural processes such as wildlife migration and forest fire.

### SOME IMPLICATIONS FOR PUBLIC LANDS MANAGEMENT

The regional pattern of land ownership (Figure 4) creates an extremely large interface of private and public terrain. Tension at this boundary will inevitably increase as agricultural lands adjacent to federal land are subdivided into smaller, more intensively-used parcels. Nearby development also increases the demand for public land uses, especially for recreation, and extends demands for certain types of management as land owners push for policies on adjacent public land that protect and even enhance their own land values. For example, public land agency efforts to adopt natural fire policies, to let some fires burn, become less politically acceptable as private

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