FOOTPRINTS ON THE LAND HOTSPOT MAPS

Data and Method of Analysis

These maps examine spatial interactions between measures of abundance of 6 types of natural lands/land cover and 4 measures of human pressure across the over 3,000 counties of the coterminous U.S. These spatial interactions are identified through a constructed interaction index for each resource-by-human pressure combination. The aim is to identify those counties with relatively high levels of remaining natural resources which at the same time are experiencing high levels of human pressure. Thus defined, hotspots in future (2020) time frames will be identified.

To control for inherent differences in the makeup and abundance of natural lands between different regions of the country, hotspot indices are computed relative to within-region ambient conditions, rather than relative to overall national ambient conditions. Thus, each region is analyzed independently. It would be misleading, for example, to compare the abundance of forests or of water and wetlands in the East with that of the more arid West. Four regions are used in this analysis–South, North, Rocky Mountains/Great Plains and Pacific Coast. Alaska and Hawaii are included in the Pacific Coast region. States making up these regions are identified later in this section.

The maps contained here refer to "local" conditions and limit that to human population and other social conditions within the political boundaries of a county. For each U.S. county, we have computed 4 human pressure x 6 natural land interaction indices for a total of 24 maps at a future time scale (2020). Below we describe the technical steps followed in computing these indices.

Step 1 Select indicative categories of natural lands that make up the natural environment of the United States. The 6 categories of natural lands we selected and for which we obtained county scale measures are described below. The basic unit of measure for all categories listed below is area in acres with one exception. That exception is wilderness, explained later. This basic areal unit of measure is then normalized by converting it to proportion of total county land area for all counties in the United States.

The primary sources of data were the National Resources Inventory[1] (NRI), USDA Natural Resources Conservation Service (USDA 1994), the National Outdoor Recreation Supply Information System (NORSIS) (Betz 1997), and *USGeoData* (USDI Geological Survey 1990).

1. Undeveloped natural land

Undeveloped natural land is the proportion of a county's total land area that is undeveloped and uncultivated, both in public and private ownerships. It excludes developed or built-up land, urban land, and land dedicated to transportation, such as roads and railroads. It also excludes land cultivated for agricultural crops or dedicated to pasture.

2. Public natural lands

Public land is the proportion of county area in national forests, national parks, national wildlife refuges, Bureau of Land Management areas, Bureau of Reclamation areas, Tennessee Valley Authority properties, U. S. Army Corps of Engineers projects, and state and local government-managed forests, parks or wildlife reserves. The data were obtained from the NORSIS. Data for NORSIS were obtained from each respective government agency. Additional public forest, range, and wildlife land measures were from the 1992 NRI.

3. Wilderness

This measure focuses on acreage in the federal National Wilderness Preservation System across all four of the federal wilderness managing agencies (Loomis 1999). Existence-nonexistence is considered the appropriate measure for this natural resource, rather than proportion of total county area, because designated wilderness tends to be a very small proportion of any given county's total area. The significance of wilderness lies more in its existence as preserved portions of natural systems, as contrasted to more general measures of the makeup of a county landscape.

[1]Data collected by the Inventory did not include the State of Alaska.

4. Forests

The measure for the abundance of forests is the proportion of total county area in nonfederal forest cover plus acreage within the National Forest System, administered by the USDA Forest Service.

5. Wildlife habitat

This measure of natural resource abundance is the ratio of relatively undisturbed land uses and cover (forest, range, wetlands) to total surface area in a county. This ratio was developed by Hof et al. (1999) to indicate level of landscape disturbance, a measure they found to be highly correlated with biologically based indices of habitat structure. The original source of county-level land use and vegetative cover data were extracted from *USGeoData*, Land Use and Land Cover Digital Data (from 1:250,000 and 1:100,000 Scale Maps) compiled by the USDA Geological Survey's National Cartographic Information Center at Reston, Virginia. The data were derived from NASA high-altitude aerial photographs and photographs from the National High-Altitude Photography (NHAP) program (USDI Geological Survey 1990).

6. Water and wetlands

The abundance measure for water and wetlands was obtained from the *USGeoData* database. It is expressed as the proportion of total county area under water or classified as wetland.

Step 2 Stratify United States counties into four regions of relatively homogeneous natural landscapes. Regions consist of the following states:

North: ME, NH, MA, RI, CT, NJ, DE, MD, VT, NY, PA, WV, OH, IN, MI, IL, WI, MO, IA, MN

South: KY, VA, NC, SC, TN, GA FL, AL, MS, LA, AR, OK, TX

Rocky Mountains and Great Plains: MT, ND, SD, WY, ID, NE, KS, CO, NM, AZ, UT, NV

Pacific Coast: WA, OR, CA, HI and AK.

These four regions were selected to control somewhat for the vastly heterogeneous composition of ecosystems across the country as reflected by indices of abundance across the above 6 types of natural lands. Stratification by region also meets a need by the U. S. Forest Service for region-level analyses.

Step 3 Within each region, stratify all counties (both metro and rural) by their relative endowments of each of the 6 types of natural resources.

For each resource, create 4 strata representing the within-region relative abundance of that resource:

1. **negligible** natural land area endowment – 10 % of counties with lowest proportion of total area remaining in natural condition, assigned a score of 0. This level of resource endowment acknowledges that the natural resource of interest either never existed to any appreciable extent in a county or no longer exists as a significant component of the landscape.
2) **low** resource endowment – 11th to 40th percentiles of county area proportions, assigned a score of 1
3) **moderate** resource endowment – 41st to 70th percentiles, assigned a score of 2
4) **high** resource endowment – 71st to 100th percentiles, assigned a score of 3.

The wilderness resource land cover, as mentioned earlier, is an exception to the above method of assigning endowment scores. Since relatively few U.S. counties have NWPS land, a score of 0 was assigned to those counties that do not have wilderness, and the highest score of 3 was given to those counties that have any amount of area in the NWPS.

Step 4 Identify 4 primary social variables to be used as human population pressure indicators.

2. **Population density** in persons per square mile (proxy for urbanization pressure). The source are projections of population for 2020 from the U.S. Census Bureau and from Woods and Poole Economics, Inc..
3. **Earnings in construction, manufacturing, and all other non-agriculture economic sectors** in millions of dollars per square mile

(proxy indicating economic pressures to convert natural land to developed uses.) Sectors include mining, construction, manufacturing, transportation/communications/public utilities, wholesale trade, retail trade, finance, insurance, real estate, services, federal civilian government, military, and state/local government.

4. **Earnings in farm and agricultural services** measured in millions of dollars of earnings per square mile is used here as a proxy to measure pressure to convert natural land to cultivated uses. The source is Census Bureau and Woods and Poole Economics, Inc.
5. **Level of outdoor recreation demand** measured as participation in outdoor recreation activities. Specifically it is measured as the number of resident participants per square mile and serves as a proxy for pressures for direct use of natural areas. The source is the Forest Service's Social, Economic, Environmental and Leisure Assessment data base (SEELA) (Betz 1997). Participation estimates at county scale were developed by the Forest Service for the decennial national assessment of outdoor recreation and wilderness demand and supply (Cordell 1999).

Step 5 **Score local human pressure conditions**. A value of 1 was assigned to a local county having the lowest level of social condition (low population, economic or recreation demand pressure), a value of 2 was assigned for a medium level of human pressure, and 3 for the highest level of pressure. Again, these scores were computed separately for each region. Scoring for local social conditions was:

1= low level is 0 to 35th percentile for an indicator (e.g., population density) across all counties within a region
2= medium level is 36th to 75th percentile
3= high level is 76th to 100th percentile.

Step 6 Develop a simple **population/land interaction indicator** that will highlight likely future hotspots where the greatest pressures from human population and its activities on natural land are or will likely be occurring. Compute an additive scalar indicator for each county in the country. Computation is to sum the natural land endowment score (0 to 3, negligible to high) and the social condition score (1 to 3, low to high) to derive the natural land cover/population interaction indices. Index values range from 0 to 6. Interpretations of these values are as follows:

- Counties with **negligible** land endowment scores (0) are constrained to an index score of 1, regardless of the social condition value, since there are minimal natural lands to be impacted, regardless of the level of human pressure. Often negligible equates to already developed areas, such as metropolitan centers or widely cultivated areas such as in the Midwest.

- "**Hotspots**" are identified as those counties where the interaction index is at level 6. Index scores are interpreted generally as follows:

  1. *Negligible* = negligible natural land resources
  2 or 3. *Light* = some pressure, but at a light level because of either or both low human pressures (e.g., population density and construction) and little land resources (e.g., forests and wildlife habitat)
  4. *Moderate* = moderate pressure from population and economic development
  5. *Moderately heavy* = relatively heavy pressure either because of high natural land endowment or high social conditions
  6. *Heavy* = a **hotspot** of significant human pressure on natural lands because of <u>both</u> high land endowment and high social pressure