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Ada and Canyon counties have experienced significant urban development in the past decade. Population increased over 30% from the 2000 to 2010 according to U.S. Census Bureau estimates. Furthermore, urban land increased over 10% from 2001 to 2011 according to the National Land Cover Database (NLCD). The rapid growth of urban population and land in the Boise metropolitan area has increased the attention that various stakeholders pay on the potential impacts on natural resources and ecosystem services. It is thus important to model past development in order to understand the impact that urban growth has had on the Boise metro landscape. But also, to establish forward-looking scenarios of growth that can project the implications of future growth on the resources that are critical for the well-being of Boise residents.

Our models of urban growth are built on observed patterns of urban growth from 2001-2006, validated using observed patterns of urban growth from 2006-2011, and our future scenarios focus on two main drivers of urban expansion: (1) urban population change and (2) population density (i.e. the degree of concentration of population within an urban area). We first formulate a spatially-explicit *land use change model* that can explain past patterns of urban growth in the Boise metropolitan area based on socioeconomic and geographic characteristics variables. We then develop distinct scenarios of population growth (high, medium and low) and population density (high, medium and low), and combine them with our model for the purpose of predicting the conversion of non-urban land to urban. The resulting product is a 3x3 matrix of urban growth projections.

Our scenario building and modeling process is accomplished through the following steps:

Step 1. Model recent urban expansion in Ada/Canyon counties using geographic/landscape and socio-economic features. Our modeling is developed using various spatial data sources, including U.S. Census data, NLCD data and Idaho BLM data, The model is founded on statistical logistic regression analysis with a dependent variable being the development (or not) using NLCD-derived measurements of a pixel change from non-urban to urban use between years 2001 and 2006. To model urban expansion we employed the following variables: distance to a highway, distance to a body of water, distance to an urban center, the population within a given census block group, the percentage urban build up within a census block group, and the preservation of protected lands. Based off these characteristics of our units of observation, the first part of the statistical model determined a spatial probability map showing the probability that a certain location will be converted to an urban use/cover. We validated the model by generating predictions of land use change from 2006 to 2011 (using the model generated from the 2001 to 2006 time-step), and comparing predicted land use in 2011 with observed land use from the NLCD 2011 dataset. Model accuracy was 93.23%.

Step 2. Calculate how much non-urban land will need to be developed over time to meet the needs of the population and the population density. We developed a mix of scenarios of population and density up to year 2100, using our knowledge of local growth rates in tandem with data on nation-wide city population patterns as well as statistical regression techniques. The projected amount of land for urban expansion depends on the combination of the scenario of population change and density (e.g. high/high, high/low, etc.). For our first scenario dimension, population, we arrive at the projections of 1.25, 1.50, and 1.75 million people to capture a broad spectrum of plausible population scenarios. These numbers were chosen using a quantile

regression and confidence interval analysis on Metropolitan Statistical Area (MSA) population data. For our second scenario dimension, density population, we establish our middle-of-the-road scenario as the existing average density in the Boise metro area. The low and high density scenarios estimate a decrease/increase in urban density using nation-wide data and the same regression techniques as the population scenarios. Thus, we have nine total unique scenarios based off our three population and three population density scenarios.

Step 3. Use a land use allocation algorithm to pinpoint locations of urban change across time. We use a land use allocation algorithm that reclassifies non-urban land to urban dependent on the calculated probabilities determined in Step 1. The output from the algorithm is a map that represents urban expansion in Ada/Canyon counties up to year 2100 conditional on the given population/density scenario.

Our mixed population growth/density scenarios and land use allocation model offer important insights into potential developments in the urban environment. They are extremely helpful for visualizing the impacts that changes in urban density and population can have on urban growth. Further, it becomes clear that urban expansion leads to the reduction of agricultural lands and a greater demand on natural resources. Urban expansion scenarios are thus a useful tool for sustainable planning for the future.

Products created from this research include:

- Raw raster datasets for each decade and for each scenario available here. https://scholarworks.boisestate.edu/miles_data/23/
- A white paper with a summary of the study and policy implications available here. https://cid.boisestate.edu/hes/wp-content/uploads/sites/5/2017/10/Whitepaper-Projecting-Urban-Expansion-in-the-Treasure-Valley-to-2100.pdf

- A storymap showing visualizations of the main results of the study available here.

http://boisestate.maps.arcgis.com/apps/Cascade/index.html?appid=e3a6b19aec4042038501795d23cdefd1