Alternative future growth scenarios for Utah's Wasatch Front: identifying future conflicts between development and the protection of environmental quality and public health

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Abstract

Utah's Wasatch Front spans a narrow 20 by 130 km corridor between Ogden/Salt Lake City to the north, and Provo to the south. Bounded by the Great Salt Lake to the west and the Wasatch Mountains to the east, the region faces physical barriers in its ability to accommodate new growth. Further constraints to growth are likely to include water availability, regulatory restrictions to protect air quality, and a host of ecological concerns. Current forecasts predict that the region's population of 1.9 million will increase 70% by 2030 – a rapid rate of growth that threatens to undermine traditional land uses, ecosystem services, and the quality of life for many residents. This study used a GIS-based planning system with a 100m x 100m pixel resolution to identify areas critical to the protection of environmental and human health in a three-county region covering 25,900 km^2. These areas were then compared with sites exhibiting physical features favorable to development to identify areas of likely future conflict between conservation and development.
Keywords: agriculture, conservation, critical lands, demographics, economics, land use planning, open space, public health, sprawl, sustainable development, urban growth models.

1 Introduction

Over the past 20 years, rapid development along Utah's Wasatch Front has threatened to irreversibly alter the region's character and quality of life. This rapid development has raised concern among federal, state, county and community leaders over issues related to public health, the provision of various ecosystem services, and the loss and/or fragmentation of open spaces and related wildlife and aquatic habitats (Toth et al. [1]). Also of concern is the anticipated need for higher taxes to support poorly planned infrastructure, and the continued economic viability of historic downtowns and traditional land uses like agriculture and grazing (Toth et al. [2]).

This study covers 25,900 km^2 (10,000 mi^2) within the Wasatch Front including Summit, Wasatch, and Utah counties – an area slightly larger than the state of Vermont. The study area's population is expected to double over the next 25 years – from 300,000 residents today, to more than 600,000 by 2030. Without proactive planning, the magnitude of projected growth could easily undermine the long-term quality of life for many residents.

This study was designed to provide local planning officials with a multi-county overview of open space and alternative growth scenarios for the region. We first identified lands critical to the protection of environmental quality and public health, safety, and welfare. These lands were then compared to areas in the study region favorable for future development, to arrive at a spatial map of likely future land use conflict.

2 Methods

The study area includes the three counties, plus a 10-km (6.2 mi) buffer. A geographic information system (GIS) database of biophysical, socio-demographic, and economic attributes of the region was assembled, including the basic infrastructure. Due to the region's expansive size, large scale data (1:100,000) were primarily used. Most of the regional scale data were obtained from federal and state agencies. The Utah Automated Geographic Reference Center (AGRC) also contributed to GIS data collection. By obtaining a comprehensive set of primary data layers, a versatile foundation was established for landscape analysis, modeling, and planning activities. The regional data is in the Universal Transverse Mercator (UTM) projection and North American Datum of 1927.

A 3-step process was used to identify areas of likely future conflict. First, we identified areas critical to the protection of environmental quality and public health. Next, we identified where future development was likely to occur based on location and physical site characteristics. Finally, we overlaid the maps resulting from the first two steps to arrive at a conflict map identifying areas of likely future conflict between development and the protection of environmental quality and human health.

2.1 The Maximum Conservation Model (MCM): identifying lands critical to the protection of environmental quality

The Maximum Conservation Model (MCM) identifies locations within the study area that have high conservation value like stream and river corridors, major water bodies, wetlands, wildlife habitat, and watersheds (Fausold and Lilieholm [3]). The MCM also identifies current open spaces that regional stakeholders may wish to remain as open space. Each data layer within the MCM is described below.

2.1.1 Wetlands and major water bodies

Wetlands serve a number of important roles in an ecosystem, from nutrient cycling and flood abatement, to the provision of wildlife habitat and recreational opportunities (USGS [4]). The role of wetlands is especially important in arid regions like the study area, where they serve as important corridors and islands of diversity in a dry, oftentimes parched, landscape. This component of the MCM includes major water bodies and wetlands. Wetlands were identified around water bodies and stream corridors using a 90-m (295 ft) buffer.

2.1.2 Wildlife habitat

Critical wildlife habitat areas were also included in the MCM. These areas included ungulate and bird migration corridors, forage and calving areas, and threatened and endangered species locations. Protecting these areas will benefit not only wildlife, but also residents through increased opportunity for hunting, fishing, and wildlife viewing. Also, if wildlife have sufficient habitat, they may be less likely to encroach upon urban areas, where the potential for conflict is high (Toth et al. [2]).

2.1.3 Agricultural and working lands

Fields, orchards, forests, pastures and rangelands comprise the working landscape of the study area. These lands not only support an important way of life for many Utahns, but provide critical habitat, open space, and aesthetic values. The working lands data layer in the MCM includes current agricultural and working lands, as well as lands under private ownership that have the potential to become productive for agriculture (USDA [5]).

2.1.4 Primary watersheds

Protecting primary watersheds consisting of first- and second-order streams is crucial for the protection of water quality and quantity. Based on visual comparisons of GIS layers of water courses at various elevations, primary watersheds in the MCM were identified as streams occurring above 2,390 m (7,800 ft).

2.1.5 Areas important for outdoor recreation

Finally, the MCM included lands suited for recreational activities. These areas were identified based on their potential for both winter (e.g., skiing, sledding, cross-country skiing, etc.) and summer recreation activities (e.g., walking, hiking, biking, horseback riding, fishing, etc.). Factors considered included slope, aspect, precipitation, land ownership, visual quality and attractive views, natural/cultural legacy, access, and proximity to water and forested edges.

2.1.6 The Maximum Conservation Model (MCM)

The data layers described above were combined to develop the MCM (Figure 1). An additive process was used to identify areas with the highest ecological importance, where areas with two or more criteria overlapping were assigned greater ecological value (i.e., darker green in Figure 1). Oftentimes, riparian and wetland areas ranked the highest due to their importance in sustaining multiple conservation objectives.

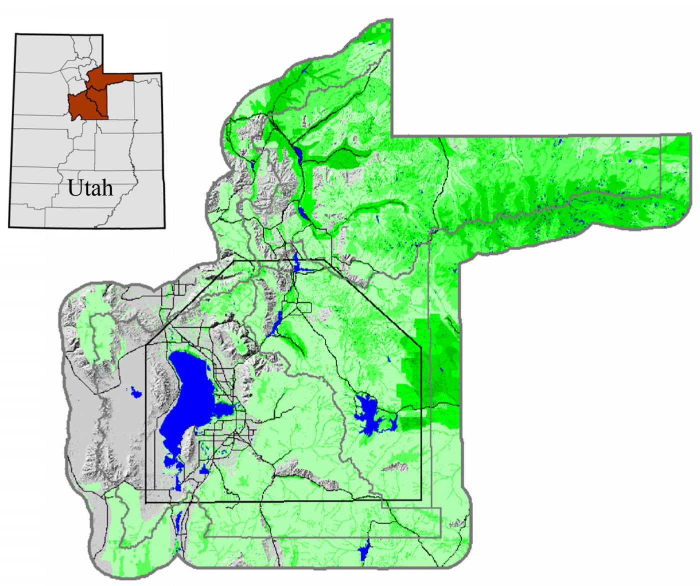

Figure 1: The Maximum Conservation Model (MCM). Darker green indicates greater conservation value.

2.2 The Public Health, Safety and Welfare (HSW) model: identifying lands critical to the protection of public health, safety and welfare

The Public Health, Safety and Welfare (HSW) Model identifies areas where development could pose a risk to public welfare. Such areas present excellent opportunities for open space preservation. Site factors included in the HSW Model are described below.

2.2.1 Avalanche potential

Utah's Wasatch Mountains receive up to 8 m (25 ft) of snow a year, with many sites susceptible to avalanches. Since avalanches may pose great risk to human health, structures, and transportation and utility corridors, this portion of the HSW Model included sites with slopes greater than 30 degrees (Tremper [6]).

2.2.2 Fault lines

Utah's Wasatch Front masks an active and extensive geologic fault system. While most of the roughly 600 earthquakes occurring each year are minor, about 13 register a magnitude of 3.0 or greater (UUSS [7]). The Wasatch Fault is overdue for a magnitude 7.0 to 7.5 earthquake – a quake of sufficient size to rupture fault lines 32 to 64 km long (20 to 40 mi) and produce surface displacements of 3 to 6 m (10 to 20 ft) (UUSS [7]). This layer of the HSW model identified fault lines and included a 1-km buffer along each side.

2.2.3 Mudslides

Mudslides occur when the shear strength of a hillside is not sufficient to resist the pull of gravity (Bryant [8]). Slope instability is oftentimes compromised by high rainfall, reduced vegetation, and earthquakes [8, 9, 10]. Development in slide-prone areas can pose a significant risk to life and property. In September of 2002, for example, more than 40 homes were damaged by mudslides in two Utah communities (Canham [11]). This layer of the HSW Model identified locations with potential or historic risk for this hazard.

2.2.4 Expansive soils

While many of the soils in the study area are suitable for agriculture and development, there are several soil types with high percentages of clay that can shrink and swell, causing damage to the foundations, floors, and walls of structures. This component of the HSW Model identified locations with the potential for expansive soils.

2.2.5 Shallow groundwater

Groundwater near the soil surface is susceptible to contamination from many sources, including septic systems, agricultural and residential chemicals, and businesses like dry cleaners, automotive repair shops, and restaurants [12, 2]. Areas with shallow groundwater may also experience subsidence if wells remove water from aquifers faster than it can be replaced (Bryant [8]). This layer of the HSW Model identifies areas with shallow groundwater within two thresholds – 3 m and 9 m (10 and 30 ft) below the surface. In the HSW Model, the shallower depth is weighted more heavily due to its greater susceptibility to contamination.

2.2.6 Floodplains

Floodplain development risks include loss of life and health, damaged structures and infrastructure, and increased insurance costs (Turcotte and Haselton [13]). Indeed, damage from flooding is increasing faster than any other natural disaster, with the social costs of flooding disproportionately affecting poorer residents because low-lying areas are typically less expensive to own and rent [14, 15]. This layer of the HSW Model identifies two land types susceptible to flooding in the region – low-lying areas near lakes and rivers, and areas susceptible to flash flooding from heavy rainstorms or rapid snowmelt (Bryant [8]).

2.2.7 Wildfire danger

Decades of wildfire suppression, coupled with prolonged drought, make many parts of the study area at risk from catastrophic wildfire (Bryant [8]). Indeed, during the summer of 2000, nearly 2,000 fires covering 227,825 acres burned in Utah (Utah Bureau of Land Management [16]). Such fires can not only degrade water quality and habitat, but also pose a significant risk to development and residents in backcountry areas (Bryant [8]). This layer of the HSW Model identified fire-prone areas using a risk rating system based on fuel load, slope, and average annual precipitation developed in 1998 by the Utah Department of Forestry, Fire, and State Lands.

2.2.8 The Public Health, Safety and Welfare model (HSW)

Each of the features described above was located on the landscape. When examined separately, the data layers described above represent sites that could pose a threat to human health, safety and welfare. Examined collectively, the areas show where human development should be avoided if possible – or at least designed with the site's inherent risks in mind. Each of these layers was combined into final Public HSW Model depicting areas that pose the greatest threat (Figure 2). In Figure 2, areas of darker red symbolize increased risk due to the presence of multiple threat factors.

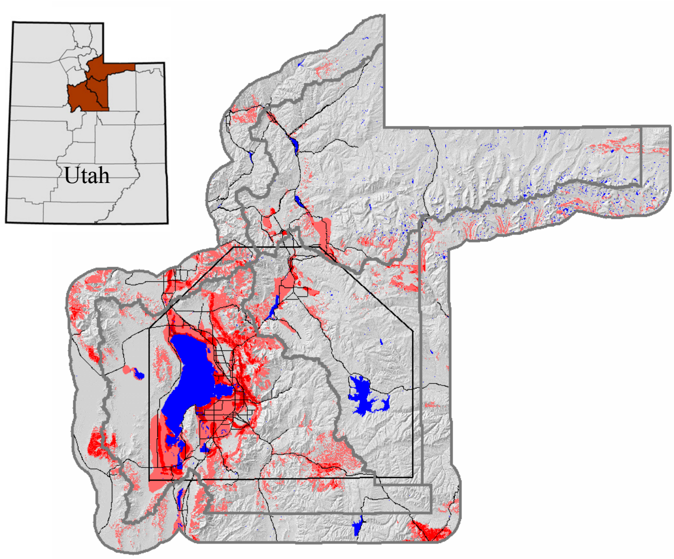

Figure 2: The Public Health, Safety and Welfare (HSW) model. Darker red indicates higher risk potential.

2.3 The Future Development Model (FDM): identifying lands likely to be developed in the future

Population forecasts estimate that the study area will see an increase of 300,000 people by the year 2030 – the addition of roughly 10,000 new residents each year. These new residents will require homes, schools, highways, and jobs. The Future Development Model (FDM) seeks to predict where new development is likely to occur based on the criteria described below. Areas excluded from the FDM included: (1) slopes greater than 25%, (2) public lands, and (3) water bodies.

2.3.1 Proximity to roads and existing development

New development tends to occur near existing roads and development, where access, population, services, and infrastructure are already in place (Hunter et al. [17]). To model this phenomenon, a 120-m (394 ft) buffer was created around all roads and existing developments to indicate areas likely to experience greater development pressure.

2.3.2 Location within a municipal boundary

Earlier research in the study area found that new development is correlated with location within existing municipal boundaries (Busch et al. [18]). To model this impact, undeveloped areas within municipal boundaries were assigned a higher likelihood of development.

The FDM depicts locations where future development is likely to occur. Importantly, it does not recommend where development should occur, nor does it seek to protect areas from being developed. Also, the extent of area depicted is not dependent upon forecasted future population growth. It simply depicts areas likely to experience relatively high growth and development pressures.

3 Results and discussion

Figure 3 illustrates where conflicts between development and the protection of human health and environmental quality are likely to occur. The Figure was created by first combining the MCM and HSW Models (Figures 1 and 2, respectively), and then overlaying the result with the FDM.

In Figure 3, red areas indicate likely future conflict over land use – unless protected, these areas will most likely be lost to development. In contrast, green areas show compatibility (i.e., high protection value and low development pressure) – these areas should be incorporated into open space protection plans because their high conservation value and limited development pressure makes for cost-effective protection. Yellow areas show where development value is high while protection values are low – in short, sites suitable for new development. Finally, blue areas depict locations where both protection and development values are low. These lands, while potentially valuable for open space, are unlikely to face immediate development pressures and are thus of secondary importance to planners and conservationists.

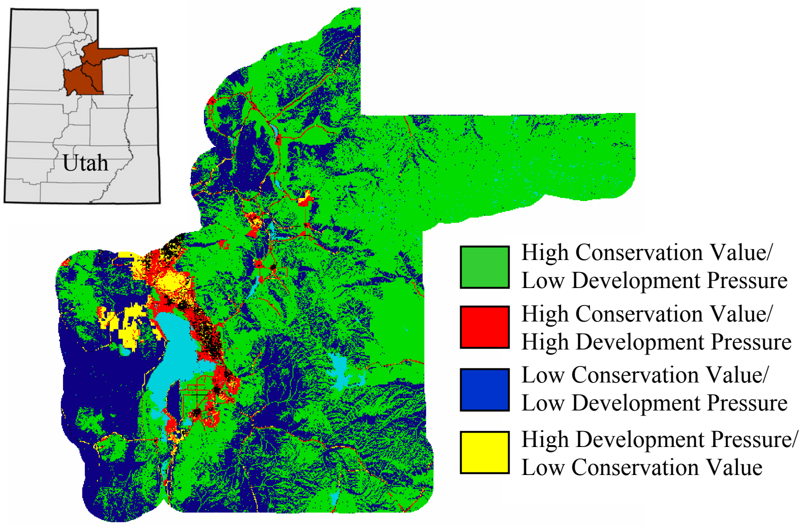

Figure 3: Conflict map showing areas where future development is likely to displace areas of high conservation value or public risk (current development shown in black).

4 Conclusions

Rapid population growth and projections of continued growth pressures have forced many communities in Utah to begin looking comprehensively at development within their jurisdictions (Lilieholm and Fausold [19]). This paper presented a methodology that allows planners, city officials, and various stakeholders the opportunity to assess the ecological, social, and development attributes of their communities, and determine locations best suited for various land uses. By identifying lands likely to experience development pressures 15 to 20 years in advance, communities can proactively plan for the future, thereby reducing conflict and ensuring that new development protects and enhances quality of life.

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