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Preferences of Wyoming residents for siting of energy and residential development

Amy Pocewicz [a,*], Max Nielsen-Pincus [b]

[a] The Nature Conservancy, Wyoming Chapter, 258 Main St., Suite 200, Lander, WY 82520, USA
[b] Department of Environmental Science and Management, Portland State University, Portland, OR 97207, USA

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A B S T R A C T

Many communities are challenged with balancing growing demands for energy and residential development with the protection of places having cultural or biological importance. Incorporating the preferences and values of local residents early in decision-making processes through public participation GIS (PPGIS) data may help to limit land use conflicts. We used a PPGIS dataset from three counties in Wyoming to determine 1) if there are spatial relationships among mapped cultural or biological values and preferences for new energy or residential development that indicate compatibility or conflict and 2) if there is evidence of geographic discounting or a not-in-my-backyard (NIMBY) pattern associated with development preferences. We found strong overlap, or compatibility, between mapped cultural and biological values and little or no overlap among mapped biological or cultural values and energy development siting preferences. These relationships could identify opportunities for conservation initiatives and inform siting of new developments. Where people live influenced their mapping patterns. Participants mapped perceived positive environmental conditions closer to home than negative conditions, demonstrating geographic discounting. We observed NIMBYism for wind development, as participants mapped wind preferences further from their homes than where development is anticipated. We also observed NIMBYism for residential development, but at a reduced spatial discounting rate compared to wind development. Participants mapped their preferences for oil and gas development further from home than existing or anticipated wells but tended to place them near a large oil and gas field, which may reflect a preference for concentrated development, rather than NIMBYism. We noted distinct preferences for contrasting values in different locations, and this consistency among participants shows that PPGIS datasets have potential to communicate a useful collective vision to inform development siting.

Introduction

Many communities in the western United States are challenged with balancing growing demands for energy and residential development with the protection of other important cultural and biological values. These challenges stem from the West's abundant energy resources (Copeland, Pocewicz, & Kiesecker, 2011), along with natural amenities that have attracted many new residents (Frentz, Farmer, Guldin, & Smith, 2004; Hansen et al., 2002; Radeloff et al., 2010). Between 1990 and 2007, development of oil and natural gas doubled in the Intermountain West (Naugle et al., 2011), and similar increases are expected in the next 20 years (Copeland, Doherty, Naugle, Pocewicz, & Kiesecker, 2009). Many of the new wind farms needed to meet U.S. renewable energy goals are also being constructed in this region (US Department of Energy 2008). Energy development brings economic benefits, including jobs, but new energy and residential development can also reduce open space, increase the costs for community services (Coupal, McLeod, & Taylor, 2002) and have impacts on recreational activities, wildlife habitat (Hansen et al., 2005; Maestas, Knight, & Gilgert, 2003; Naugle et al., 2011; Sawyer, Kauffman, & Nielson, 2009), water quality (Entrekin, Evans-White, Johnson, & Hagenbuch, 2011; Frost & Mailloux, 2011; Lohse & Merenlender, 2009), and agriculture (Gosnell, Haggerty, & Travis, 2006; Nielsen-Pincus et al., 2010). Conflicts over land use often arise due to the potential impacts of development on other resources that communities value (Bengston, Fletcher, & Nelson, 2004). Incorporating the preferences and values of local residents early in the land use

* Corresponding author. Tel.: +1 307 335 2131; fax: +1 307 332 2974.
E-mail addresses: apocewicz@tnc.org (A. Pocewicz), maxn@uoregon.edu (M. Nielsen-Pincus).

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decision-making process may help to reduce conflicts over land use change.

Public participation GIS (PPGIS) captures community preferences and values in a spatially-explicit way, which can support and empower public participation in land use planning, natural resource management, and policy development (Sieber, 2006). In PPGIS, individual participants identify locations that represent where they feel certain values are most important, their preferences for where specific land uses or activities should occur, or other preferences or knowledge associated with places. PPGIS has been used for many applications (Brown, 2005), including planning for forests and national parks (Beverly, Uto, Wilkes, & Bothwell, 2008; Brown & Reed, 2009; Brown & Weber, 2011; Clement & Cheng, 2010), identifying places with conservation or wilderness value (Brown & Alessa, 2005; Zhu, Pfueller, Whitelaw, & Winter, 2010) and determining siting preferences for residential or tourism development (Brown, 2006; Nielsen-Pincus et al., 2010). PPGIS has also been applied to understand perceptions related to climate change (Raymond & Brown, 2011) and ecosystem services (Brown, Montag, & Lyon, 2012; Raymond et al., 2009; Sherrouse, Clement, & Semmens, 2011).

Identifying the spatial agreement or disagreement among different types of values or preferences mapped by communities could be valuable to inform land-use decisions. PPGIS participants often place multiple values or preferences in the same locations, and these relationships can be used to understand which values or land uses may be perceived as compatible (Brown, 2006; Brown & Reed, 2012; Zhu et al., 2010). Relationships among mapped values can also be used to identify places having high potential for land use conflicts (Brown & Donovan, 2013; Brown & Reed, 2012; Nielsen-Pincus, 2011). A commonly-used typology of mapped values (Brown, 2005) clustered spatially into two groups, representing socioeconomic quality (e.g. economic values) or personal/environmental quality (e.g. aesthetics, biodiversity), and biological and economic values avoided each other spatially in three counties in the northwestern US (Nielsen-Pincus, 2011). Places where socioeconomic and personal or environmental values did overlap were identified as places having high potential for conflict over resource management (Nielsen-Pincus, 2011). These types of relationships have not previously been investigated with respect to energy development siting preferences.

Where people live may influence how they assign values and preferences across landscapes. Geographic discounting theory suggests that people prefer to be close to what they like or consider "good" and follow predictable patterns in willingness to pay to maintain distance between themselves and what they dislike (Hannon, 1994; Norton & Hannon, 1997). Geographic discounting is an expression of the spatial preferences for consumption of market or non-market goods over space, and is generally found to vary inversely with distance from an individual's reference location (Kozak, Land, Shaikh, & Wang, 2011; Perrings & Hannon, 2001). Some evidence of geographic discounting has been observed with PPGIS data. Mapped environmental values were clustered around communities, with values associated with direct uses located closer to communities than those associated with indirect uses (Brown et al., 2002) and different mapping patterns were observed for participants who lived in different towns (Alessa, Kliskey, & Brown, 2008). However, these studies did not ask participants to locate positive ("good") and negative ("bad") evaluations of the landscape, or where potentially impactful land use changes should occur. A specific case of geographic discounting is the not-in-my-backyard (NIMBY) effect sometimes associated with development. NIMBY refers to the motivation local residents have to avoid locally undesirable land uses (Dear, 1992). NIMBYism has been observed during the siting of wind energy facilities, where people living closest to wind farms in the U.S. had the lowest support for or most negative attitudes about the developments (Jacquet, 2012; Swofford & Slattery, 2010; Thayer & Freeman, 1987). The inverse of this pattern has been observed in Europe (Devine-Wright, 2005). All of these previous studies have used the fixed location of existing development and measured how attitudes about the existing development changed for people at living at varying distances from it. In contrast, PPGIS allows the location of the participants to be fixed, and they can be asked where they would like to see future development. This seemingly small difference may be of importance for planners who often have to navigate the future rather than evaluate the past or present. Possible NIMBY effects associated with energy development have not been previously investigated using PPGIS data.

In this study we used a PPGIS dataset from Wyoming to further investigate the utility of PPGIS data to inform land use decision making, particularly the siting of energy and residential development. Community preferences for where new energy development should be located have not been included previously in similar PPGIS analyzes and could be useful to inform siting of widespread and increasing energy development in the western U.S. and globally. We applied a typology of values representative of land use issues in the western U.S. First, we tested whether there are spatial relationships among mapped cultural, biological, and economic values, perceived positive and negative biological conditions, and preferences for future energy and residential development that indicate compatibility or conflict. Second, we tested for evidence of geographic discounting based on the distance from participants' homes at which perceived positive or negative conditions were mapped. Finally, we tested for evidence of a NIMBY pattern associated with preferred siting for oil and gas, wind energy, or residential development. If a NIMBY pattern were present, we would expect development preferences to be mapped further from participants' homes than existing or potential developments of that type. Additionally, we would expect development preferences to be mapped further from participants' homes when attitudes about the type of development are negative. To help explain mapping patterns, we also evaluated how well mapped development preferences corresponded with locations of existing and anticipated development.

Methods

Study area

We surveyed residents of Albany, Carbon, and Sweetwater counties in Wyoming, USA (59,000 km^2; Fig. 1). This is a mostly rural area, having a combined population of 96,000 (http://2010.census.gov/2010census). The majority of this population lives in the cities of Green River, Laramie, Rock Springs and Rawlins. These counties were selected because of ongoing and anticipated changes related to energy development that are leading to conflicts between economic development and protection of places important for wildlife or for cultural reasons. Extraction of oil and gas has traditionally been important to the local economy here, and in recent years, wind energy development has increased rapidly. Mining for coal and trona (source of sodium bicarbonate) also occurs here. Agriculture, which is dominated by ranching rather than crop fields in our study area, is also an important part of the local economy and cultural identity. Ranches provide habitat for a number of important species of fish and wildlife and often serve as an important recreational asset for hunting and fishing. While some areas have been affected by energy resource (oil, gas, wind) infrastructure, much of this landscape remains intact and provides important habitat for wildlife species such as the greater sage-