[DA-039] GIS&T and Recreation Planning and Management

Abstract

Human interactions with each other and the environment are intrinsically connected to the opportunities and limitations of where we live and where we are able to go. The connections between places of origin, destinations, and travel routes mean that recreation and tourism inherently rely on spatial concepts of place and human-environment interactions. Tourism and recreation are major economic drivers, yet these sectors are constantly evolving as people embrace different ways to travel and recreate and environmental and socio-economic conditions change. Advances in GIS technology and computing ability are shaping the questions asked and tools used by researchers to understand the drivers and impacts of recreation. In this entry, we highlight current research and approaches used to characterize access to green spaces in urban areas, to understand recreational behaviors and tourist preferences through social media, to map landscape aesthetics and cultural ecosystem services, and to quantify the impacts of tourism and recreation on protected areas. Starting with urban areas and local extents and moving to protected areas and regional processes, we summarize scholarship focused on different types of places and occurring across different extents and scales to provide a digest of current research.

Keywords: human well-being, landscape aesthetics, planning, protected areas, recreation, social media, tourism, visual assessment, wilderness

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Explanation

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1. Introduction

Our interactions with each other and the environment are intrinsically connected to the opportunities and limitations of geography (Hall and Page 2014). Who we are and what we

do is shaped both by where we live and where we are able to go. Geography and GIS approaches and techniques offer critical insights into everything from access to local green spaces, to the regional impacts of recreation, to international tourism patterns. Recreation, tourism, and their impacts on both communities and the environment are not evenly distributed over space or time, but rather exhibit weekly, seasonal, and annual patterns with preferred destinations changing over time. The connections between places of origin, destinations, and travel routes mean that recreation and tourism inherently rely on spatial concepts of place and human-environment interactions (Hall and Page 2014). Tourism and recreation are major economic drivers — the direct contributions of travel and tourism to global gross domestic product (GDP) are estimated at $2.9 trillion USD annually, accounting for 10.6% (334 million) of all jobs (UN WTO, 2021). Similarly, in the United States alone, spending by local park and recreation agencies generates $91 billion in total economic activity, supporting more than 732,000 jobs that account for nearly $34 billion in salaries, wages, and benefits (NRPA, 2020). At the same time, these sectors are constantly evolving, as people embrace different ways to travel and recreate, opportunities to travel expand globally, and environmental and socio-economic conditions change. Advances in GIS technology and computing ability, coupled with emerging ideas about the relationships between people and nature and greater interest in the equitable distribution of benefits and access to recreational opportunities, are shaping the questions that researchers ask and the tools available to answer those questions.

In this entry, we highlight current research and approaches used to characterize recreational opportunities and access to green spaces in urban areas, understand recreational behaviors and tourist preferences through social media, map landscape aesthetics and cultural ecosystem services, and quantify the impacts of tourism and recreation on protected areas. Here we move beyond park and recreation facilities as stand-alone structures or disconnected spaces and consider streets, public spaces, protected areas and wilderness as places for park and recreation opportunities. This is by no means an exhaustive inventory of research in geographic information science and technology (GIS&T) and recreation and tourism. Rather, we summarize scholarship focused on different types of places and occurring across different extents and scales to provide a digest of current research. We start with urban areas and local extents and move to less-populated and protected areas and landscape to regional processes, all of which shape our understanding of global patterns and impacts.

2. Recreation and Well-Being in Urban Areas

Over the past 20-plus years, researchers have evaluated and improved methods and data that link recreation and active living to our everyday environments (Berrigan et al. 2015). Recent reviews have focused on the links between green spaces and natural areas and multiple wellbeing benefits including physical, social, and psychological health (e.g. Marselle et al. 2021). By 2019, the National Academies of Sciences, Engineering, and Medicine (NASEM 2019) published their strategies to enhance public health and physical activity surveillance in the US. The Community Supports and Physical Activity working group outlined priority needs and strategies to improve the collection, integration, and usability of spatially relevant data. These included; 1) macro-level community design features such as parks and street connectivity, 2) micro-level street design features including sidewalks, street trees, and vacant lots, 3) safety (e.g., reported crime), 4) policy

maps, and 5) transit systems such as greenways. Associated with these priorities were strategies to enhance the U.S. Environmental Protection Agency's Smart Location Database, support consensus processes in GIS measures, methods, and databases (e.g., consistent park metadata), harmonize existing spatial data across scales and regions, support further collection of spatial data with rural communities and tribal nations, establish common GEOIDS to be used for recreation policies, environments, and programs, further investigate remote sensing and computer vision methodologies for improving park and recreation measures, and incorporate citizen science into existing data collection.

Underlying the above parks, recreation, and well-being priorities and strategies are the needs for better measures and surveillance of community walkability and parks and recreation access. Walkability refers to the design, infrastructure, and destinations communities are able to walk to from home, school, and work. Initially these included macro design spatial attributes including the number of 3- and 4-way street intersections, land use mix, and residential density. "Destinations to walk to" has been added to most current walkability metrics (WalkScore(R)), including nearby parks and transit access. Current efforts are trying to overlay actual pedestrian infrastructure including sidewalks, crosswalks, and greenways.

Better data on walkability and actual pedestrian and cycling infrastructure leads to better understanding of access to park and recreation amenities. In urban settings, the 10-Minute Walk campaign is working to ensure all residents in each US city have access to a park or greenspace within a 10-minute walk from their home. This equity work is built on spatial analysis and network buffers of urban greenspaces and parks, allowing city planners to identify communities within cities that are greater than a 10-minute walk to a park. Further access and parkspace equity work includes the Trust for Public Land's ParkScore(r) and ParkServe(r) indices that rate and rank US cities on their park and recreation access, investment, amenities, acreage, and equity.

Beyond evaluating access, geospatial tools and analytics are used to more precisely measure where recreation is occurring and how active individuals and communities are. Research participants wear accelerometers and GPS to detail where and how active they are across their daily lives (Marquet et al. 2020). Cameras and trail counters are being used across park systems and pedestrian/cycling infrastructure to evaluate use and activity (Hipp 2018). Augmented and virtual reality are also providing further opportunities to understand use of parks and recreation and importantly preferences for future improvements (Tabrizian et al. 2018).

As outlined by the National Academies, there are many opportunities for spatial analysis to support national surveillance of park access and physical activity. Limitations certainly remain as highlighted in their strategies and by Peter James and colleagues (James et al. 2016) who further detail conceptual, technical, analytical, and ethical questions in performing spatial analyses and physical activity research. However, emerging tools and collaborations, including use of social media, are expanding opportunities for better spatial understanding of park and recreation planning and utilization.

3. Social Media to Understand Tourist Preferences and Recreation Behaviors

Recreation and tourism planners, managers, and operators across settings and scales

require information about visitor preferences and behaviors to successfully market and sustain services aligned with visitor and local community interests, conserve environmental and cultural resources, and facilitate economic opportunities. Many methods are available to gather such information, including spatiotemporal attributes, ranging from surveys, interviews, ticket sales, and electronic counters to Bluetooth technologies and participatory GIS methods. However, the rapidly growing demand for recreation and tourism opportunities and increasing visitor numbers at destinations worldwide can challenge the ability to collect such information for decision making efficiently at managerially-relevant spatial extents and resolutions. In response, innovative approaches supported by user-generated or crowdsourced digital content have increased in popularity among practitioners and researchers.

Through the sharing of their experiences on social networking (e.g., Facebook, Instagram, Twitter, Flickr) and online review platforms (e.g., Booking.com, TripAdvisor.com), visitors generate a wealth of quantitative and qualitative information, including geospatial information, relevant to planners and managers. Point data derived from geotagged social media (e.g., photos, videos) has been used as a reliable proxies for visitor counts, usage hot spots, and visitor flows (Wilkins et al. 2020). Evaluating the geotagged images has generated insights about visitor experience indicators and values, landscape quality, and the distribution of human-landscape interactions and ecosystem services (Rossi et al. 2020; Havinga et al. 2021). Text (e.g., hashtags, Tweets, online reviews) can also be analyzed using machine learning to identify and parse place names to coordinates to understand how visitors are feeling about a particular destination or service at given locations and times using sentiment analysis.

The benefits of geospatial social media data can include their accessibility depending on platform, with data retrievable using online portals or programming languages to connect to and query remote databases. Coupled with advances in machine learning and computer-vision algorithms, the ability to automate the analysis of the growing amount of geospatial social media data is accelerating insight generation. The spatial and temporal resolutions often associated with social media data also enable addressing questions at multiple geographic scales (van Zanten et al. 2016), and has been supporting the emerging field of conservation culturomics, which is of particular relevance to nature-based tourism and recreation managers.

As with any method or tool, social media data have limitations. A widely recognized limitation is that of sampling bias, both geographic and demographic. Not all recreationists or visitors will have access to or will post on social media and some activities or locations may be more shareable than others (Tenkanen et al. 2017). There can be privacy concerns as users may be unaware that although they’ve agreed to share their information publicly, it can be used for other purposes like research or management. Additionally, not all social media platforms have tools to enable data querying, or they may limit, disallow, or change access policies due to privacy or content protections. While the popularity of particular platforms may fluctuate over time, collectively social media is an integral part of many recreationists and tourists' experiences. From pre-visit information gathering to sharing experiences during or after, the data generated by visitors can provide insights into visitor preferences and behaviors at greater spatial extents and frequency than ever before, supporting planners and managers in providing this cultural ecosystem service.

4. Landscape Aesthetics and Cultural Ecosystem Services

Natural amenities, such as scenic vistas, rugged mountain topography, expansive natural areas, and biodiversity, are a draw for tourists worldwide and heavily influence the availability of recreational opportunities for both tourists and residents (Tenerelli et al. 2016). Areas with abundant natural amenities can hold significant cultural identity and symbolism that provide vital cultural ecosystem services (e.g. Inglis and Vukomanovic 2020). Importantly, the very amenities that drew residents and draws visitors can be altered and even degraded by heavy demand and use. Understanding the drivers of amenity migration, wilderness tourism, and recreation is thus important for both present-day management and future planning. There are many ways to study and start to untangle the draws of different natural and cultural amenities and how they interact with local and regional community dynamics. Classification of landscape features and scenic quality to experience-based zoning constitutes one of the earliest GIS applications in recreation planning (Brabyn 2009). Interviews, focus groups, and workshops are valuable sources of rich narratives that can speak to motives, community values, and challenges. Social media (see above) and public participatory GIS (PPGIS; e.g. Beier et al., 2016) can help connect narratives to locations and can provide some qualitative metrics of use and importance. Cultural values are often harder to map or quantify than biophysical characteristics and conditions, but translating place values into spatial data helps put services such as sense-of-place or cultural identity on more equal footing with natural values in assessments and planning (Smart et al. 2021).

Viewscapes - the visible portions of a landscape with which people form a connection - are an essential component of landscape aesthetics and cultural ecosystem services. Visibility and visual quality affect almost every aspect of human-environment experiences and interactions and are fundamental to the formation of spatial preferences (Inglis and Vukomanovic 2020). The use of geospatial computation in modeling visibility is increasingly accessible through viewshed algorithms within widely distributed software (e.g. ESRI ArcGIS applications and GRASS GIS) and researchers continue to develop new algorithms, leveraging high performance computing and GPU processing to improve computational efficiency and accuracy (Zhu et al. 2019). GIS-based visibility models offer insight into values of cultural and economic importance by identifying what is visible from a human vantage point. Viewscape modeling has been used to characterize the value of scenic drive corridors, measure the aesthetic value of natural landscapes, and explore the drivers of housing development (reviewed in Inglis and Vukomanovic 2020).

As spatial representations of landscape amenities, viewscapes can also be coupled to other spatial models of land change—urbanization and land use (including transportation planning, infrastructure, and development), wildfire, sea level rise and inundation, pest and pathogen spread—and human health stressors, such as extreme heat. For example, by combining a spatially explicitly, process-based ecological model with viewscape models, under different scenarios of climate change, Inglis and Vukomanovic (2020) forecasted the future distributions of quaking aspen along scenic byways as an example of how viewscapes change through time. Overall, this culturally and economically valuable species was projected to decline, but the loss of visible aspen along scenic byways was significantly greater than loss overall. The combination of ecosystem process modeling and viewscape approaches is useful for characterizing the disproportionate decline in the aspen trees that people actually see relative to total population declines, and in pinpointing when and where this cultural ecosystem service will be most vulnerable or resilient in the future. The drivers

and impacts of human use and amenity migration, coupled with the multi-faceted impacts of climate change, will increasingly alter landscapes, communities, and the conditions suitable for recreation; geospatial tools and approaches can help us understand and attempt to manage those changes.

5. Impacts of Recreation and Tourism on Protected Areas

While recreation and tourism in protected areas, such as state and national parks, wilderness areas, and nature reserves, generate a multitude of benefits by connecting people with nature, these protected areas, which are often established for their conservation values, can be negatively impacted by growing and diversifying visitor use, resulting in degrading conditions of natural resources and recreation infrastructure. Common examples of impacts include soil and vegetation damage, wildlife disturbance, and contamination of water quality.

Visitor use in protected areas is not evenly distributed in space and time, and neither are the impacts generated by such uses. Intense visitor impacts are concentrated spatially at the individual recreation sites and trails where visitor activities take place, but these impacted sites and corridors are distributed through extensive nodes and links of roads, trails, and facilities over a larger landscape/protected area scale, compounding the habitat fragmentation effects induced by the creation of the recreation infrastructure (Hammitt et al. 2015). The importance of spatial considerations in understanding and managing visitor use and impacts, and the associated needs for spatial data, spatial tools and spatial analysis, are well articulated by Beeco and Brown (2013).

Thanks to recent advances and growing accessibility, GIS&T has found itself an essential component in most, if not all, visitor impact studies during the past decade. The types of GIS&T tools deployed in this topical area are also becoming more diverse and sophisticated. In general, there are two broad types of GIS&T applications that correspond to information needs or research objectives. The first type places its primary focus on the conditions of protected area resources or facilities (Hammitt et al. 2015). These studies seek to identify, map, quantify and/or monitor the spatial extent and distribution of different forms of visitor impact in protected landscapes, such as resource conditions on formal recreation sites and trails and proliferation of visitor-created informal trails. GIS&T tools applied include hand-held GPS and unmanned aerial vehicles/drones for field-based assessments, as well as image analysis tools with high-resolution aerial and satellite imagery (Kim et al. 2014). Some studies have integrated datasets from visitor impact assessments and natural resource data to quantify spatial overlaps between visitor impact and ecologically sensitive zones (e.g., Sarmento and Berger 2017), while others have sought to detect temporal trends in impacts, such as trampled vegetation in Acadia National Park due to informal trail use (e.g., Kim et al. 2014).

The second type of GIS&T applications focuses on the “agent of change” in the visitor impact problem. Specifically, these studies seek to quantify and examine the spatial and temporal trends of visitor use and activities over protected areas that have direct ramifications for natural landscapes and the infrastructure located within. For example, D’Antonio and Monz (2016) utilized a GPS tracking method and GIS analysis to map and quantify visitors’ spatial behavior in several protected areas in the western U.S. They found

that the degree of visitor dispersal was a function of the amount of use, with higher levels of dispersal occurring at lower levels of visitation. Due to the high costs of obtaining visitor's spatial data, especially in larger landscapes, there has been a rapid growth of studies in which volunteered geographic information from social media platforms, such as Flickr, were used to estimate spatial-temporal patterns of visitor use, and in some cases, integrate with ecological data through GIS. This research trend in visitor impact research is consistent with very similar needs of visitors' spatial data in other contexts, as described in the preceding sections.

6. Conclusions

Human interactions with each other and the environment are intrinsically connected to the opportunities and limitations of where we live and where we are able to go. Tourism and recreation have complex social-economic, cultural, and environmental dimensions and their impacts range in scale from the global economy to individual access to green space. Computational and technological advances are accelerating geospatial analytics related to recreation and tourism by leveraging everything from wearable technology and social media to high performance computing. By enabling researchers to both better understand and communicate about the spatial drivers and outcomes of tourism and recreation, spatial tools and approaches can help governments, communities, and the private sector to meet the needs of the present, plan for the future, and adapt to change. At the same time, researchers and users of spatial data must balance its tremendous potential with concerns about privacy, consent, and open access to data. We look with anticipation to future work that pushes the boundaries of computing and interactive visualizations, while also advancing ethical and equitable research.

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