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Big data or small data? A methodological review of sustainable tourism

Feifei Xu, Nicholas Nash, Lorraine Whitmarsh

Abstract

Research in the field of sustainable tourism is increasingly important due to significant growth in tourism industries and the unsustainable impacts incurred. Innovation in sustainable tourism studies is required to meet a number of challenges including socio-ecological impacts; the critical turn in tourism research; and the growth of ICTs, mobile technologies and big data analytics. These shifts in particular are transforming the field and creating new research opportunities. This paper seeks to identify potential new methodological areas of application to sustainable tourism studies for both quantitative and qualitative methods. A range of methods are reviewed, focusing on big data (e.g., mobile device signaling, GPS, social media and search engine data) that elucidates wider patterns of tourist movement, as applied to forecasting travel demands and sustainable management of a destination. Three novel 'small data' methods are also discussed, comprising visual methods, autoethnography, and qualitative GIS, that provide deeper, contextual insights into the drivers, dynamics and impacts of sustainable tourism. We consider how expansive qualitative methodologies might yield potentially important insights concealed by existing methodologies. Furthermore, we argue that combined big data and small data approaches can address methodological imbalance and generate mutually reinforcing insights at a number of levels.

Key words: big data; small data; sustainable tourism; mobility; research methods

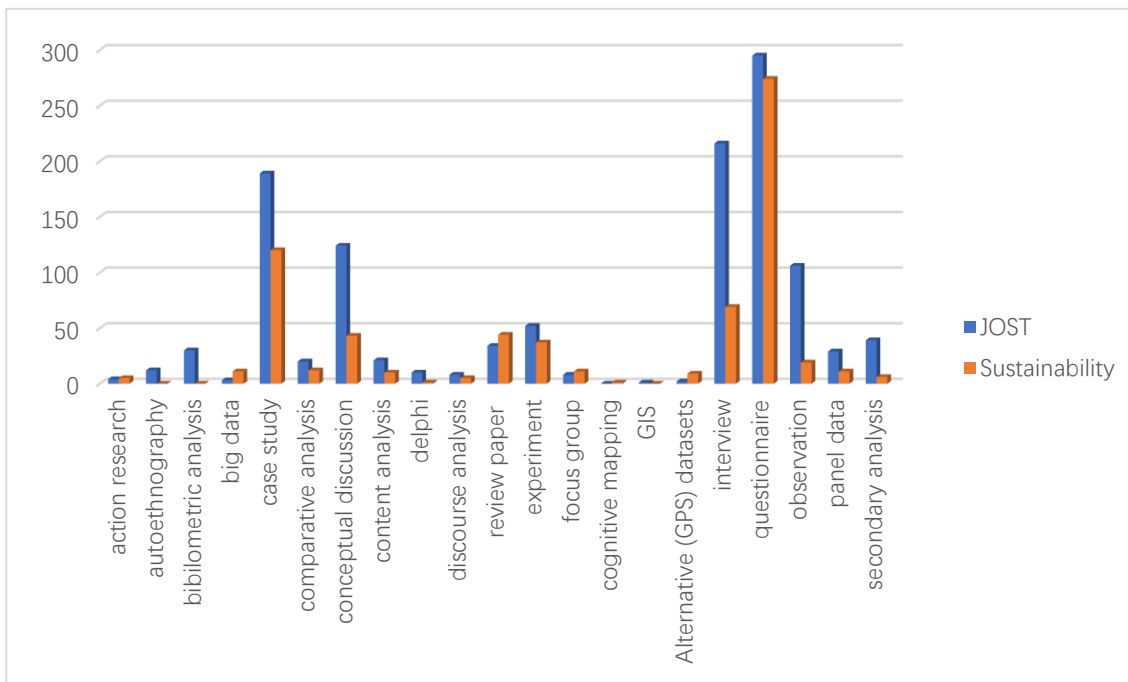
1.0 Introduction

Research on sustainable tourism has grown rapidly over the last 25 years, as indicated by the growth of specialist journals like Journal of Sustainable Tourism (JOST). However, Buckley (2012, p. 534) states that mainstream tourism is still 'far from sustainable' due to various negative environmental and social impacts (e.g., climate change, community exploitation). Relatedly, the characteristics of sustainable tourism imply distinct challenges for researchers. First, the *scale* of tourism and its sustainability implications span the global to the local: for example, rising emissions from tourist transport (including aviation) are contributing to global climate change as well as to local air quality, particularly in urban areas (IPCC, 2014). At the same time, international tourism tends to benefit multi-national companies rather than the local communities that host tourists (Wall & Mathieson, 2007). Second, fundamental to sustainability is a *long-term* perspective – considering future generations' needs as well as today's (UN, 2016) – and this implies using longitudinal methods. However, in the context of tourism research, there is a lack of longitudinal research (Bramwell et al., 2017). Third, sustainability as a 'wicked' problem is *value-laden and complex* (Gibbons et al., 1994), implying that no single perspective is adequate to analyze or address it; thus, sustainable tourism may be understood in different ways by different groups of stakeholders (visitors, governments, businesses, NGOs) and different methods will offer distinct insights to inform decision-making. These dimensions of space, time, values and complexity require a unique range of research methods. To date, there have been few attempts to span multiple scales, to apply longitudinal methods, or to reconcile different perspectives on sustainable tourism.

Because unsustainable tourism is predominantly a problem of aggregated behavior and its impacts collective and long-term, 'big data', comprising much larger datasets, can capture information at a much larger scale and potentially reflect longitudinal change in real-time (Kitchin, 2013). Indeed, the rapid development of technology and big data analytics is transforming tourism research (DeLyser & Sui, 2013). Conversely, to understand the impacts of tourism on local communities and to explore the motivations and perspectives of diverse stakeholders (from tourists to governments), 'small data', including more detailed qualitative approaches are key. Critically, to provide a more complete picture, there is a need for mixed methodologies that bring together these big and small viewpoints in this complex field. Yet, to date, such methods in sustainable tourism have been partial (see Figure 1) and dominated by conventional methods like questionnaires and interviews.

Meanwhile, the critical turn in tourism studies (Ateljevic, Pritchard & Morgan, 2007) has permeated sustainable tourism (Bramwell et al., 2017; Bramwell & Lane, 2014). Researchers debate the limitations of current epistemological assumptions based on a dominant social scientific paradigm that privileges a focus on the psychological processes and behaviors of individuals, while neglecting wider socio-technical systems that lock together unsustainable practices (Bramwell et al., 2017). From a methodological perspective, several gaps have been highlighted. For instance, the challenges posed by the complex nature of sustainable tourism require the application of multiple perspectives and methods working together (Budeanu, Miller, Moscardo, et al., 2016). JOST has tended to reflect *multidisciplinary* rather than *interdisciplinary* approaches (Lu & Nepal, 2009). While published studies combining quantitative and qualitative methods have increased over time, their integration is typically limited (e.g. a predominance of sequential designs to augment results and fewer simultaneous designs involving triangulation of findings; Molina-Azorin & Font, 2016). In addition, while methodological sophistication has also increased (Ruhanen et al., 2015), a recent review of JOST publications in 2015-2016, found methodological gaps including a scarcity of multi-sited case studies, field experiments, longitudinal designs, big data analyses and studies using direct measurement of variables (Bramwell et al., 2017). Expanding this analysis, following Bryman (2015) and Bernard (2013), we coded articles in leading tourism and sustainability journals (JOST and Sustainability) since their inception (1993 and 2009, respectively); similarly, we found relatively little diversity in methods used, with questionnaires and interviews dominating (Figure 1). Clearly, while methods in sustainable tourism are evolving, in order to meet the current challenges outlined above, further methodological development and innovation are needed.

Figure 1. Research methods used in example tourism and sustainability journals



This paper identifies novel methodological areas for sustainable tourism studies in relation to big data and small data approaches. We identify developments outside sustainable tourism, and discuss how innovative approaches could be utilized to open new methodological pathways and sources of knowledge. The next part of the paper focuses on the current use of ‘big data’ and ‘small data’ approach in tourism and sustainable tourism research. In each section, we discuss existing methodological limitations for each respective approach, and ways to overcome such obstacles. The final part of the paper examines the potential across the subject for new synergies centering on mixed-methods approaches, giving consideration to reducing gaps between big and small data, and quantitative and qualitative methodologies. The review is selective and framed as a narrative discussion aimed at addressing these issues in sustainable tourism methodologies; this organic, interpretive approach is arguably more suited to a complex literature base including qualitative studies, than that offered by a more systematic approach (Cohen & Cohen, 2019; Dixon-Woods, Bonas, Booth, et al., 2006).

In this paper, ‘big data’ and ‘small data’ refer to (unconventional or traditional) data sources; they do not necessarily imply quantitative and qualitative data analyses. While big data is associated with quantitative analysis and small data more so with qualitative analysis, big data may be analyzed qualitatively and small data subject to quantitative analysis. This distinction runs through the paper.

2.0 Big data

Recent advances in technology and ‘big data’ analytics have brought innovative research approaches, unconventional data sources, and massive amounts of information, providing new opportunities for research on sustainable tourism. While there is no complete definition of what big data is, key features include data volume (immense in scale), velocity (data generated in real-time), variation (both structured and unstructured) and resolution (very detailed) (Kitchin, 2013). Data sources include not only large administrative datasets, such as registration in education, healthcare, or vehicle licensing (Connelly 2016), but also data generated by sensors, mobile phones and radio frequency identification (RFID chips) (Heerschap et al. 2014). These data have been used not only to improve management but also analysis of consumer behavior for marketing strategies, predicting trends and producing faster

and more detailed statistics. For example, the non-structured dataset might bring issues that were not previously attended to, shifting social science research to be data driven, the so called fourth research paradigm (Kitchin 2014). In big data research, the world is ‘dominated by connective relationships rather than causal relationships’ (Zhang, 2018, p.5) and brings traditional research from micro to macro level (Wu et al. 2015).

Within JOST, and in generic sustainability journals (e.g., Sustainability) there is currently limited use of big data (Figure 1). A recent review (Li et al., 2018) divided use of big data in tourism into three categories: *user-generated content (UGC) data*, (e.g. social media); *device data*, (e.g. from mobile devices, GPS, and Bluetooth); and *transaction data*, (e.g. web search data and online forms). The focus of these research relates mainly to wider patterns of tourist movement, as applied to forecasting travel demands and sustainable management of a destination. Next, we review specific examples where big data could benefit sustainable tourism research.

2.1 Device data: Mobile phone signaling

Mobile phone data is a relatively new but increasing source for tracking individual behavior (Qin & Zhen, 2017). Mobile phone data refers to temporary and spatial information and corresponding personal information generated through mobile phone use. At present, there are three main types of mobile phone data; *billing data*, *signaling data*, and *applications data* provided by software suppliers. It is the signaling data we are referring to. Signaling data includes the cell number of the base station, signaling success time, encrypted mobile phone identification number, etc., which can be used to track user location (Ahas et al. 2007).

Currently, there is limited use of mobile phone data in tourism studies due to data privacy. Research mainly includes destination loyalty of tourists (Tiru, Kuusik, Lamp, & Ahas 2010), temporal and spatial flows of visitors (Ahas et al., 2007; Raun et. al. 2016) and distances travelled by tourists (Nilbe, Ahas, & Silm 2014). Table 1 provides some examples.

These studies demonstrate how mobile phone data can be used to identify tourist movement patterns within and between destinations (Pan & Yang, 2015). It can also be useful for marketing as mobile phone positioning technology can trace tourist origins. It is able to capture and analyze temporal and spatial changes of users in real time, and generates much bigger volumes of data, at larger scales (e.g., country-level, see Ahas et al., 2007), at low cost, and applicable in both indoor and outdoor environments (Ahas et al., 2007; Pan & Yang, 2015). However, this type of data is hard to access and due to data privacy, the information that can be used lacks socio-economic attributes of users. As mobile phone data relies on the constant updating of base stations for positioning, the obtained location accuracy is relatively low. Another challenge is how to distinguish leisure from business visits, and local residents from mobile roaming services, as not all mobile users are tourists.

2.2 Device data: GPS and GPS enabled location services

GPS is a satellite-based radio navigation system that provides geolocation and time information to a GPS receiver (Shoval & Isaacson, 2007) and has been well used in tourism-related studies. Early research looked at identifying tourists’ movements, examining spatial and temporal behavior of visitors to events and tourist destinations (see Table 1 for details). For example, Gang et al. (2013) used Taxi GPS logs to trace tourists’ movements starting and ending at tourist destinations. Recent work has explored GPS as a predictor of tourist destination choices (Zheng, Huang and Li, 2017), while other research has correlated GPS data with patterns of emissions from taxi transportation (Luo et al., 2017). GPS has also been used in combination with other research methods, for example, with semi-structured interviews to analyze visitor flows in Sydney (Edwards and Giffin, 2013).

GPS data mainly emerges from two sources (Li et al., 2018): *GPS loggers* carried by volunteers, and *GPS-enabled mobile applications*. The former is used in participant-based tourist samples (Shoval et al. 2013) and is associated with smaller sample sizes and higher cost, while the latter is related to third party mobile application data and is relatively inexpensive, with more flexible channels, therefore, GPS-enabled mobile applications have become main source of research (Ayscue, Boley & Mertzlufft, 2016). However, other GPS-enabled data sources, such as shared/rented public bicycles, which have been used in transportation studies (see Luo et al. 2017) but are less used in tourism studies.

Compared with mobile phone positioning, GPS provides more accurate behavioral data in time and space as it continuously collects information without intervals (Shoval, Isaacson & Chhetri, 2014). This method also works regardless of weather conditions. A disadvantage of using GPS data can be smaller sample sizes if using participant-based samples, which inevitably have issues of sample bias; but this can be avoided if using GPS-enabled mobile applications (See Table 1 for details).

2.3 Other device data: Bluetooth & WIFI

Bluetooth and WIFI data are utilized infrequently in tourism research. Bluetooth is an open and wireless communication technology (Li et al. 2018) in smart phones, laptops and other mobile devices that can monitor large numbers of users and are tracked without notifying device owners. Bluetooth data is mainly focused on monitoring visitor movement at events or festivals (Versichele et al. 2012). For example, Versichele et al. (2014) used a Bluetooth tracking data in Ghent, Belgium to explore tourist flow patterns (see Table 1). Bluetooth is low cost, convenient, and avoids the need for pre-registration (compared with mobile apps and other methods), as it supports unannounced tracking (Versichele et al. 2014; Yoshimura et al. 2014). It can be used in indoor settings, where GPS or mobile phones might not work due to weakened signal strength. However, there is relatively small coverage of monitoring areas due to limited node radio ranges (Delafontaine et al. 2012), therefore, Bluetooth is more often used in smaller-scale contexts. Like other big data methods, due to its unannounced tracking, Bluetooth data conflicts with the ethical principle of voluntary participation in research. In addition, Bluetooth data only provides a time-stamped sequence of individual transitions, but less detailed information in terms of measuring temporal-spatial movements (Li et al. 2018).

Compared with Bluetooth, WIFI data is more convenient and cost-effective (Bonne et al., 2013); it is also compatible with all modern smart phones. However, similar to Bluetooth data, it has a small range of coverage (compared with mobile phone data) and unannounced tracking. To date, few tourism studies have used WIFI data. Bonne et al. (2013) suggested a method of scanning at multiple locations for packets sent out by the WIFI interface on visitors' smartphones, and correlating the data captured at these different locations in the context of a music festival. With increasing provision of WIFI services within destinations, in future WIFI data will become broader in coverage and more convenient to access.

2.4 Administrative data: vehicle registration

Large administration datasets have been widely used in healthcare and other fields, but less used in tourism. Tourism-related registration datasets include registered vehicle licensing for tourist transportation etc. (see Table 1). Huang et al. (2017) measured self-driving tour carbon emission flow data and analyzed its relationship with scenic spots. Jin et al. (2018) used expressway traffic flow data at toll-gates across Jiangsu Province in China to examine carbon emission flows. Scuttari, Lucia and Martini (2013) used traffic flow data to estimate the environmental impact of tourism traffic on Italy's South Tyrol region. These examples show that large administrative datasets such

as vehicle registration information can be used to investigate tourist flows, identify tourist origins, and environmental impact of tourists.

Obviously, there are many other sources of administrative data that can be used in sustainable tourism, such as energy use by a wide range of organizations, cross-border tourist flows, employment and revenue in different sectors within and beyond the tourism industry, registered hotels, restaurants, etc. These are areas worth exploring in future research. However, this type of data is often proprietary and hard to access. Yet, some destinations aiming at smart tourism could provide a good platform for administrative data.

2.5 UGC data: social media and online reviews platforms

Online social network platforms have been used as alternative data sources for capturing movements and travel patterns of tourists on a large scale, although they lack detailed contextual information on tourist activities for further analysis (Vu et al. 2017). Earlier research focused on identifying movement patterns, and geotagged photos, texts, check-ins etc. (e.g., Girardin, et al., 2008). Recent studies tend to use this type of geo-information with other datasets to verify or compare visitor movements (See Table 1). Hawelka, et al. (2014) compared the geo-located Twitter data of cross-country tourist flows with official international tourism statistics and found similarities between the two. Geotagged data allows for street-level precision so that more detailed spatial-temporal information can be obtained compared to methods previously used such as check-ins at accommodations and surveys at tourist offices. Vu et al. (2017) combined check-in data of Foursquare (Location-based services app) and Twitter accounts, which include more detailed information on location, time and activities of the users.

Many studies have focused on the demand side, which is related to the nature of this type of data, however, there are other studies adopting a different angle by focusing on the supplier side (See Table 1). For example, Xu et al. (2018) used data from online review platform Dianping.com, to analyze the distribution of E-WoM (Electronic Word-of-Mouth) of catering providers in Nanjing, China. Yang et al. (2017a) used data from US restaurants to explore the relationship between neighborhood sociodemographic characteristics and restaurant locations. Others (Gutierrez et al. 2017; Benítez-Aurioles, 2018) similarly used Airbnb location information to explore accommodation relationship with tourist attractions or POI (Point-of-Interest). The large scale of online platforms has made it possible to study cross-country, transnational issues. For example, Adamiak (2018) used data from Airbnb in Europe to compare the supply patterns of Airbnb in different scales of European cities. These studies demonstrate how online platform data (including text reviews, photos, location information) can be used for sustainable urban planning for hotels, restaurants, and Airbnb.

Social media and online platforms allow us to understand the relationships between individuals, and between people and place. This type of information is critical in managing environmental sustainability, understanding socio-cultural contexts of visitors, and providing a better service. However, there are also issues relating to the reliability of UGC and online review data, for example in the case of fake reviews.

2.6 Transaction data: Search engines

Search engines such as Google, Yahoo or Baidu are one of the first steps in planning a holiday. This set of data is mainly focused on the tourist demand side, and it has been used for forecasting tourist arrivals at a destination (Gunter & Onder, 2016). For example, Yang, Pan and Song (2014) used Google Analytics website traffic indicator (numbers of website visitors and website visits) for forecasting tourist demand; while Volchek and colleagues (2018) used Google Trends data to predict visitors to London museums. These research demonstrate that search engine can provide rich information to improve the accuracy of tourism demand, therefore contributing to sustainable tourism

management. Search engine data can also provide useful information about tourists' travel experiences. For example, Marine-Roig (2017) analyzed perceived and transmitted tourist destination image of Île-de-France by using metadata from search engines, which were based on online travel reviews (See Table 1).

2.7 How can big data be applied to sustainable tourism?

Having reviewed the application of big data methods to tourism studies, we can draw out the advantages of these methods for sustainable tourism studies in particular. First, big data methods arguably introduce a new epistemology and research paradigm (Kitchin 2014; Graham, 2013) that is more data-driven than theory-driven, identifying and visualizing new phenomena (e.g., unequal distribution of environmental impacts from tourism) and ultimately informing new models of sustainable tourism. Second, large scale datasets allow for analysis of environmental, economic and socio-cultural sustainability of tourism at a macro-level, for example, by examining cross-country, trans-national, or global spatial patterns of tourists and their impacts on CO₂ emissions. Third, at a local or regional scale, different data sources allow for different dimensions of sustainability to be explored: GPS/mobile/search engine-related data at a destination can be used to monitor tourist flow and to deal with issues relating to carrying capacity and over-tourism; social media data, such as geotagged sentiment data, allows us to explore human relationships with place (Wu et al. 2015); while administrative datasets can be used to monitor biodiversity loss and manage environmental impacts at the destination. Fourth, the multi-dimension, multi-scale, multi-granularity nature of data mining and analytics of big data, made it possible to exploit mixed methodologies in sustainable tourism (Wu et al. 2015). Multi-source big data is able to understand the whole system of tourism rather than fragmented sectors, as well as providing more detailed contextual information within the system. However, as different stakeholders hold different datasets, collaboration with different stakeholders is required. This could be driven by public sector initiatives, such as the US government open data effort. Fifth, big data facilitates longitudinal studies due to constant/regular data capture, easy data storage and low cost. In some cases, data can be traced back to 1950s (Graham & Shelton, 2013) allowing for analysis of trends and disruptive change. Sixth, there is the potential to use big data to intervene to foster sustainable tourism. Personalized recommendation and marketing are a strength of big data, it could be employed in influencing individuals' environmental behavior, for example using pervasive technology to encourage responsible tourist behavior on holiday. Finally, we need to understand individual's behavior within the framework of a wider socio-cultural context (Xu & Fox, 2014), and large datasets showing individual and group interactions with, and meanings associated with, place can contribute to our understanding and respect of other cultures.

Although big data has its advantages in research, it also has limitations. First, big data can cover a large sample, but not necessarily the whole sample. The application of network data, for example, only covers part of the tourist population, more inclined to be younger, higher educated groups who are technology-savvy, therefore findings from these groups may not generalize to others (Qin & Zhen, 2017). Second, big data is not all shared open data, although social media and online platform data are relatively easy to obtain, mobile phones, smart cards, video sensing devices which involves personal data privacy, trade secrets, and destination security are difficult for researchers to access. However, these data are the key to studying tourists' behavior, business operations and sustainability problems. Finally, big data can describe a phenomenon but cannot explain why; in other words, it focuses on connectivity rather than causality (Zhang 2018). For example, through GPS data analysis, researchers can understand the spatial and temporal activities that tourists attend, but it is difficult to understand why tourists attend a certain activity. Therefore, researchers have begun to question the scientific value of these data. Another challenge of big data research relates to research ethics and data security. For example, big data has been criticized as a breach of privacy, with potential for discrimination or other abuse. Issues also relate to resale of consumer data to other companies (Martin 2015), and with each country having its own data privacy legislation, this makes hard to generate

universal data protection standards.

Some of these limitations can be addressed by applying different research methods, for example to provide insights into why certain patterns have emerged in big datasets or to research populations who are not captured in big data. As we now discuss, this includes ‘small data’ approaches, particularly qualitative methods that provide more detailed insights into sustainable tourism issues.

3.0 Small data

While ‘qualitative’ methodologies lack a common definition (Wilson & Hollinshead, 2015), most share a number of common features, including an interest in description rather than quantification, generating theory through inductive processes, recognition that knowledge is subjective and contingent, and a focus on describing detail and context over generalization (Flick, 2014). Qualitative approaches are typically more reflexive, recognizing that researchers are situated in the world they study and the production of knowledge (Alvesson & Sköldbörg, 2017). Samples in qualitative approaches tend to be small (sometimes comprising a single case), non-representative of the populations from which they are drawn, and subject to different conventions regarding validity and reliability from those applied to quantitative methods (Flick, 2014). Therefore, we use the term ‘small data’ here to describe a suite of qualitative approaches of potential utility to sustainable tourism research, while recognizing that quantitative methods can also be used with small datasets.

Qualitative methodologies have been in use across tourism studies throughout its development (Riley & Love, 2000), though quantitative methods continue to dominate the field. This is mainly because of an epistemological legacy in which the latter are seen as more scientifically rigorous and more relevant to stakeholders and policymakers in applied contexts (Hewlett & Brown, 2018). Despite attempts at reconciling their differences, tourism studies continues to reproduce a bias toward more statistical methods, in which qualitative approaches are often viewed as more supplementary. However, the contribution of qualitative approaches within tourism studies has been acknowledged as both enriching theory and contributing to the development of the field, as well as generating deeper understandings of the wider sociopolitical and cultural contexts of tourism studies more broadly (Riley & Love, 2000).

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The emergence of methodological approaches involving big data is not only set to transform quantitative methods, but will recast qualitative approaches. Responding to neo-positivist developments and critiques of conventional qualitative methodologies, some scholars have heralded the arrival of a ‘*post-qualitative*’ paradigm, sparking novel methodological directions (Adams St. Pierre, 2014). The post-qualitative is loosely defined as an emergence of novel approaches extending beyond the normative boundaries and structures of qualitative post-structural methods (Lather & Adams St. Pierre, 2013). In the context of tourism studies, while the aforementioned emergence of big data presents new opportunities and new obstacles for qualitative methods, the post-qualitative offers exciting prospects for researchers to transcend methodological boundaries and to pioneer innovative and tailored approaches as part of the ongoing evolution of sustainable tourism .

3.1 Qualitative enquiry and sustainable tourism

Conventional qualitative methods have been in use within sustainable tourism for some time, mainly comprising interviews (e.g., Smith et al., 2018), focus groups (e.g., Waligo et al., 2015), and observational techniques (e.g., Iaquinto, 2015). While these will continue to be valued methods of generating rich descriptions across the range of

topics relevant to the field, greater critical reflection is needed to highlight ways in which conventional methods can reify existing societal norms and rules (Wilson & Hollinshead, 2015). DeLyser and Sui (2013) question whether developments in digital technologies and big data might sideline qualitative, interpretive methods. However, big data networks do not speak for themselves but rely upon interpretations of micro-level processes constituting larger information networks (Snijders et al., 2012). Big data will always need to be interpreted within social, economic, and political contexts (Kitchin, 2013). Kitchin (2013) remarks that big data is also less able to capture more complex and intangible elements of sense-making (e.g. emotions, values, and beliefs), which rely on context.

Following evidence from reviews reporting that methods in sustainable tourism have remained consistent (Lu & Nepal, 2009; cf. Figure 1), Houge Mackenzie (2016) asserts that tourism methods need to evolve in order to better capture previously hidden aspects of the tourist experience. While quantitative methods have been supplemented with more sophisticated analytical tools such as multi-dimensional modelling, geographical information systems and computer simulations, qualitative methods have largely relied on methods that impose structured ways of responding (e.g. interviews), raising questions about the validity and reliability of analyses of complex touristic behaviors (Lawson et al., 1996). As qualitative approaches will remain a valuable part of the sustainable tourism methodology and debates, we outline three methods that we feel are especially relevant to the field, yet, to the best of our knowledge, remain under-utilized. These comprise visual methods, autoethnography, and qualitative GIS.

3.2 Visual methods

Touristic experience is inherently visual (Scarles, 2014). Visual methods in tourism include but are not limited to the analysis of photographs, film, postcards, brochures, maps, blueprints, diagrams and drawings (Margolis & Pauwels, 2011). They are advantageous because they allow access to knowledge that lies beyond the reach of other methods (Rakić & Chambers, 2011), can promote rapport and facilitate stakeholder engagement and address power imbalances between researchers and research participants (Hillman et al., 2018; Pain, 2012).

Visual approaches within sustainable tourism rely heavily on content-thematic analysis and there is a need to embrace alternative visual analyses (Bramwell & Lane, 2014). Hunter (2016) is one of few studies to have expanded a methodological focus beyond analysis of manifest content, applying a content-semiotic approach to the study of images of Seoul, South Korea. More recently, Canavan (2017) analyzed online social media content (including posted images) using an existential framework, to understand sustainability commitments expressed by backpackers travelling within Asia. Other work in sustainable tourism has applied principles of critical discourse analysis to visual data (Yudina & Grimwood, 2016). Positioning research participants as co-producers of visually-generated knowledge can benefit community mobilization, advocacy (Masterson et al., 2018) and a means of catalyzing change within communities (Wang, 2006; Pain, 2012). Emerging work has used images produced by community members to inform responsible tourism planning represent the interests of communities marginalized by tourism (Canosa et al., 2017).

Technological advances have changed the way that images are produced, shared and stored, enabling analysis of large collections of tourist images beyond that the capacity of traditional visual methods. Visual analytics have been applied to images of tourism destinations (Marine-Roig et al., 2019), tourist practices (Ma and Kirilenko, 2018) and spatial preferences (Encalada and colleagues, 2017). Visual data is becoming increasingly spatially and temporally referenced, or '*geotagged*' (see 2.2), yielding information about the image location, mobility and other behavioral elements using visual analytics and scalable computational techniques to process the huge numbers of images available online (Andrienko et al., 2009). Such analyses can track the behavioral trajectories of a single individual, or individuals in aggregation, over time and space, moving beyond current snapshot approaches and providing valuable longitudinal information (Andrienko et al., 2009).

The availability of online social networks allows new ways for tourists to connect with others beyond traditional physical networks and to form new image-based collective identities (Wang et al., 2014). Online research methodologies such as netnography (O'Donohoe, 2010) have adapted interpretive ethnographic methods to the study of meaning and interaction through digital communications in ways that are less costly, time-consuming and obtrusive than other methods. Examples include studying tourist commitments to sustainability. (Canavan, 2018) and promotion of sustainable travel modes (Dickinson et al., 2017).

3.3 Autoethnography

Traditional ethnography uses participant observation, interviews, and document analysis that describes systems of structure and meaning from a particular culture perspective (Lareau, 2018). Autoethnography (AE) emerged from traditional ethnography with the aim of situating and describing the researcher's experience (Ellis et al., 2011; Scarles, 2010). AE uses a rich array of methods, utilizing material including personal stories, reflective diaries, conversations and poetry (Wilson and Hollinshead, 2015), enabling penetration beyond simple notions of sustainable tourism, to deeper understandings of community responses to such issues (Hales & Larkin, 2018) in ways that can more readily capture more intangible emotional and cultural meanings associated with tourist practices (Bærenholdt et al., 2017).

AE has been relatively underutilized in sustainable tourism research but used to examine experiences connected to volunteer tourism (Barbieri et al., 2012), and cycling charity challenge tourism (Coghlan, 2012). Miller (2008) used an AE methodology to understand the tourist experience of areas affected by natural disasters. These studies focus on personal, emotional and self-reflective processes, in which AE was used as a means of immersing the reader in the journey. AE has been innovative its use of reflexive, dyadic interviews, in which importance is placed on the production of meanings and emotional dynamics through interaction, creating an additional layer of comprehension, uncovering tensions between the subjectivities of researcher and research participant, which can be traced and which are integral to touristic experiences (Scarles, 2010).

Emerging strands within sustainable tourism enquiry are linked to vanishing landscapes and cultural heritage (Lemelin, Dawson, Stewart, et al., 2010). Such topics are suited to AE approaches in which the purpose is to convey experience in ways that connect to wider social, cultural and political themes of relevance to the author. These are set in narrative forms that emphasize issues of emotional complexity, ambiguity, and contradiction that color experience. Such studies also present novel challenges to sustainable tourism research, including development of academic rigor and negotiating limitations linked to the generalizability of findings (Houge MacKenzie, 2015).

3.4. Qualitative geographic information systems

Geographic information systems (GIS) refers to an array of methods, technologies and techniques that broadly comprise digital frameworks for the storage, management, analysis and representation of spatial and geographic data (Lü, Batty, Strobl, et al., 2019). and has been applied to sustainable tourism (e.g. Albuquerque, Costa & Martins, 2018). Recent critiques of GIS have emerged partly because GIS analyses neglect the broader social, cultural and political contexts of GIS data (Hall, 2012). *Qualitative* GIS (QGIS) approaches have sought to integrate subjective, qualitative and contextual forms of data with quantitative GIS in ways that yield increasingly detailed spatial analyses (Elwood & Cope, 2009). Qualitative content can take multiple forms, including photographs, images, field notes and interview material, linking with novel visual methods (see above) and seeks to spatially represent embodied experience (Elwood, 2009; Pavlovskaya, 2009).

QGIS has not been appeared in tourism and sustainable tourism contexts as frequently as traditional GIS, but is growing in sustainable tourism contexts as a critical method. Battista & Manaugh (2018) applied QGIS methodology to study travel-mode choice in the context of urban walking. Similarly, Nightingale (2003) conducted a QGIS study of natural resource management and forest change in Nepal, developing a mixed epistemological approach to transcend the limitations of traditional GIS. QGIS encourages attention to the workings of power inherent within ways of doing methodologies, the active agency of the researcher and a focus on alternative, overlooked forms of knowledge relating to understanding tourist phenomena (Wilson, 2009). Within sustainable tourism, GIS methods have often privileged tourist perspectives (for example, Boers & Cottrell, 2007), while neglecting the wider perspectives of other voices, including local communities and tourism industry employees (Hall, 2012).

Voluntary geographic information (VGI) apps can be transposed to participatory GIS (PGIS) in sustainable tourism. Walden-Schreiner, Rossi, Barros, et al., (2018) report on the use of crowd-sourced photographs of protected mountain areas to assess seasonal use, while Sinclair, Ghermandi, Moses et al., (2019) document the use of geotagged photographs to estimate the environmental impact of visitors to wetland habitats. Munro et al., (2018) use PGIS to identify areas of potential conflict over spatial planning policy in ways that explicitly recognize the values of local communities, domestic tourism industry workers and international tourists. Such platforms can generate a mass response from those who are closest to the phenomenon of interest (Sieber & Haklay, 2015).

4.0 Mixed methods in sustainable tourism

Despite associations of qualitative and quantitative methods with divergent epistemological and ontological paradigms (Blaikie, 1991), this should not imply that qualitative and quantitative methods are fundamentally incommensurate (Bryman, 1988). The distinction between qualitative and quantitative methods is primarily technical, and not necessarily philosophical. Different approaches offer different insights into sustainable tourism and answer *different types of research question*. Thus, the rationale for combining methods stems from “the basic and plausible assertion that life is multifaceted and is best approached by the use of techniques that have a specialized relevance” (Fielding & Fielding, 1986, p.34). Applying multiple methods allows interesting lines of inquiry exposed through one method to be explored further through another (Whitmarsh, 2009). However, it is not assumed that aggregating data sources can provide a complete or ‘true’ picture of the social world (Silverman, 2001). Indeed, “the differences between types of data can be as illuminating as their points of coherence” (Fielding & Fielding, 1986, p.31), leading to a re-examination of conceptual frameworks or assumptions (Tashakkori & Teddlie, 2003). The distinct challenges of researching and addressing sustainable tourism warrant both big and small data approaches in a field where a reasonable balance of published quantitative and qualitative studies has been offset by a relative dearth of mixed-method approaches (Lu & Nepal, 2009).

In selecting methods, tourism scholars are required to make critical choices extending beyond pragmatic concerns relating to conducting research, to wider philosophical debates (Wilson & Hollinshead, 2015). We assert the importance of pluralistic methods as a means of reinvigorating these debates enabling researchers to question existing methodological assumptions, redefine methodological boundaries, and question processes of enquiry and knowledge generation.

5.0 Concluding remarks

This selective review has identified potentially fertile areas for future methodological extension in tourism and sustainable tourism studies, drawing on methodological development in the discipline thus far, and considering the wider repertoire of quantitative and qualitative methods from an interdisciplinary perspective. While sustainable tourism has done much to develop its own approaches to the field, new developments in the wider social sciences

and technological development, require that sustainable tourism studies needs to move with the times in response to these wider shifts.

Big data approaches represent exciting opportunities for sustainable tourism studies, in which the sheer scale of data and analytic potential opens up new ways of understanding tourism-relevant behavior. Arguably, such approaches will need to broaden their focus beyond the narrow range of stakeholders to include other relevant actors, objects and forms of analysis. For example, while current tourism research using big data methods mainly focus on the tourists, we should also pay attention to other stakeholders, particularly commercial stakeholders. In addition, the analysis of tourist flows could be expanded to incorporate more detailed analyses, identifying the movements of specific actors and other specific criteria for a more fine-grained analysis. There are also ethical issues concerning privacy, access to and ownership of big data. These are currently limited to private industry and government; therefore, it is crucial that data is protected, securely stored and that citizens' right to privacy is maintained. Finally, in terms of sustainability dimensions, while big data afford insights into tourist movement and carbon emissions, issues relating to inequality, food and water security, health and wellbeing, socio-cultural change, clean energy, biodiversity, resource depletion, and climate change also need to be explored in sustainable tourism (Bramwell 2017).

With reference to smaller, qualitative approaches, such methods have been established in tourism and sustainable tourism studies for decades now. However, recent critical shifts have raised issues in terms of taken for granted ideological assumptions that are reproduced, as well as a neglect of the wider ideological and sociopolitical contexts within which research is produced. There is therefore a need for sustainable tourism studies to embrace the critical turn, and to move on from conventional qualitative methods, moving beyond the boundaries of existing methods. In our selective review of the three approaches detailed, each of the methods goes some way to pushing understandings of knowledge generation forward, in original and innovative ways. In addition, while representing discrete methods in themselves, the three approaches detailed are methodologically commensurate, and there is some degree of overlap between visual methods, AE, and multimodal CDA.

Importantly, we also assert the complementary nature of potential relationships between big data and small data approaches. In order to understand the vast networks of big data analysis, qualitative processes are needed to interpret and flesh out the micro-processes that enable the visualization of quantitative data. Conversely, big data approaches may be used to triangulate qualitative theory development on a massive scale. These mixed-method approaches are set to raise new ontological and epistemological debates, and the dilemma of the sustainable tourism studies researcher is in making informed choices and reconciling potential difference, though we would propose that the dividends in enriching sustainable tourism studies enquiry that might follow such debates, are fundamental to theoretical and methodological development.

Due to word limit, this research only reviewed a few methods in relation to big data and small data approaches. There are many other innovative methods that can be used in sustainable tourism. Although selective, this review hopes to shed light on the importance of pluralistic methods and to question existing methodological assumptions.

6.0 References

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Table 1. Examples of big data methods and their use in sustainable tourism research

Type of Data	Examples	Data ownership	Advantages	Limitation	Examples in Tourism	Potential benefits to ST research
Device Data	Mobile Phone	Mobile network	<ul style="list-style-type: none"> • Larger spatial area (country level) • Record tourist origins • Monitor movement • Low cost 	<ul style="list-style-type: none"> • Limited access • Not very accurate as only record locations on active users • How to identify leisure tourists from business visits can be challenging • Limited information about the user due to data privacy 	<ul style="list-style-type: none"> • Tourist flow (Ahas et al. 2007; Raun et al. 2016) • Destination loyalty (Tiru, Kuusik, Lamp & Ahas 2010) • Segmentation of domestic and foreign visitors (Ahas, Asa, Roose et al. 2008) • Distance travelled (Nilbe, Ahas & Silm 2014) • Identify tourist source market (Xu et al. 2019) 	<ul style="list-style-type: none"> • Challenge conventional methods and epistemologies • Alternative sources of information available to triangulate findings • Larger scale (cross country/continent scale) movement of visitors • Can cover wider range of stakeholders besides visitors • Can produce partnerships as requires data owners/users to work together • Government initiatives to support open data provide access to datasets • Can reach end users and influence behavior • Better monitoring of environment • Potentially facilitates longitudinal studies due to easy data storage and low cost • Combined datasets could provide more detailed contextual information of both visitors and other stakeholders
	GPS	GPS logger owners or GPS enabled mobile apps owned by 3 rd party	<ul style="list-style-type: none"> • More accurate data in time and space • Not weather-dependent 	<ul style="list-style-type: none"> • Participant based smaller sample if collects data from GPS loggers; • Data associated with graphs and metrics 	<ul style="list-style-type: none"> • Spatial & temporal movement of visitors (McKercher, Shoval, Ng & Birenboim 2012; Shoval, McKercher, Birenboim, & Ng 2015; Gang 2013); • Recommendation (Yoon, Zheng, Xie, & Woo 2010; Zheng, Huang & Li 2017); • Use taxi GPS to explore carbon emission (Luo et al. 2017) 	
UGC	Online platforms/ reviews	Online platform companies	<ul style="list-style-type: none"> • Can target both users and providers • Relatively easy access to data • Can be larger scale (cross country, cross continent) 	<ul style="list-style-type: none"> • Lack of detailed profile information • Data reliability due to fake reviews 	<ul style="list-style-type: none"> • Destination image (Pan, Maclaurin, & Crotts 2007) • Customer satisfaction (Xiang et al. 2015) • Restaurant distribution and planning (Yang et al 2017a; Xu et al. 2018) • Airbnb distribution (Adamiak, 2018) • Location of Hotels (Yang et al. 2017b) 	
	Social media platforms/ check ins	Social media companies	<ul style="list-style-type: none"> • Can provide information about profile of users • Can have location or geotagged information • Can reflect larger scale (cross country, cross continent) 	<ul style="list-style-type: none"> • Not very accurate 	<ul style="list-style-type: none"> • Identify hotspots for visitors using Geo-tagged photos (Girardin, et al., 2008) • Combine with other Geo-information dataset to provide user profiles (Chua, Servillo, Marcheggiani and Moere, 2016; Vu et al. 2017) 	
Transaction data	Search engine	Search engine companies	<ul style="list-style-type: none"> • Forecasting tourist demand 	<ul style="list-style-type: none"> • Data deviation 	<ul style="list-style-type: none"> • Forecasting demand (Gunter & Onder, 2016; Volchek, Song, Law & Buhalis, 2018) 	
Registration data	Vehicles registration information	Government departments	<ul style="list-style-type: none"> • More accurate than social media data 	<ul style="list-style-type: none"> • Data access is difficult 	<ul style="list-style-type: none"> • Carbon emissions (Huang et al. 2017; Jin et al. 2018); • Environmental impact (Scuttari, Lucia & Martini, 2013) 	

Table 2. Examples of some small data methods

Type of data	Analytic approach	Advantages	Limitations	Examples in tourism	Potential benefits to ST
Visual data	Semiotic analysis	<ul style="list-style-type: none"> Reveals the ways in which signs communicate ideas, attitudes and beliefs (connotative and denotative) Situates projection and perception of images as theoretically mingled Can identify operation of 'soft' power 	<ul style="list-style-type: none"> Reliance on interpretive judgements Labor-intensive: can only be applied to small numbers of images 	<ul style="list-style-type: none"> Tourist destination images (Hunter, 2012) Tourism images at national borders (Chhabra, 2018) Cultural values of online images (Mele & Lobinger, 2018) 	<ul style="list-style-type: none"> Provides set of alternative approaches to analyzing visual content of tourism-relevant data Can be used in innovative ways to generate visual evidence documenting the experiences of a range of stakeholders
	Participatory	<ul style="list-style-type: none"> Integrates images into participatory research Useful at grassroots level (e.g. community-generated images) 	<ul style="list-style-type: none"> Validity and reliability challenged due to value-laden nature of research Limited to participant-generated images 	<ul style="list-style-type: none"> Responsible tourism planning (Cahyanto, Pennington-Gray & Thapa, 2013; Brickell, 2012) Representing tourism-marginalized communities (Canosa, Wilson & Graham, 2016) 	<ul style="list-style-type: none"> Can be applied more flexibly in certain communities where language or literacy are problematic Can enhance participation and rapport over and above traditional methods
	Critical discourse analysis	<ul style="list-style-type: none"> Gets at meanings beyond overt visual messages Can be used to identify the workings of power at the community level Focuses on intricate power dynamics rather than overt political actions 	<ul style="list-style-type: none"> Relies on textual analysis of images Reliance on interpretive judgements 	<ul style="list-style-type: none"> Power relations between tourism professional and locals (Xue & Kerstetter 2018) Adverting in in-flight magazines (Small, Harris & Wilson, 2008) Wildlife tourism (Yudina & Grimwood, 2016) 	<ul style="list-style-type: none"> Can document indicators of sustainability-related change visually Can be used in interventions to target more sustainable tourism decision-making
	Visual analytics	<ul style="list-style-type: none"> Can handle large volumes of images Can be applied to complex problems Can plot data in time and space 	<ul style="list-style-type: none"> Copyright/ownership of uploaded image content used for analysis. Algorithms used to mine data are subject to change 	<ul style="list-style-type: none"> Destination image analysis Marine-Roig, Martin-Fuentes & Ferrer-Rosell (2019) Spatial distribution of tourist activities (Ma & Kirilenko, 2018) Identifying tourist places of interest (Encalada, Boavida-Portugal, Cardoso Ferreira, & Rocha, 2017) 	<ul style="list-style-type: none"> Offers a way for researchers to investigate tourist places without need for carbon-intensive travel

Autobiographical and ethnographic data (e.g. narratives, interviews, fieldnotes, images)	Autoethnographic	<ul style="list-style-type: none"> • Highlights salience of the role of the researcher's self-reflection in the research process • Connects autobiographical accounts to wider political, cultural and social meanings and understandings • Personal narratives focused on motivating positive social change and motivating action • Opens new ways of approaching narrative forms in research 	<ul style="list-style-type: none"> • Difficult to generalize beyond the existing context • Fallibility of memory of the researcher in reconstructing experience • Accused of being insufficiently rigorous in accordance with social science standards 	<ul style="list-style-type: none"> • Experience of sustainable tourism community protest (Hales & Larkin, 2018) • Experiences of volunteer tourism (Barbieri, Santos & Katsube, 2012) • Cycling charity tourism (Coghlan, 2012) • Experiences of natural disaster tourism (Miller, 2008) 	<ul style="list-style-type: none"> • Repositions the ST researcher in the research process and their relationships to research participants and alternative ways of knowing
Mapping data	QGIS	<ul style="list-style-type: none"> • Allows rich, contextual forms of data to be incorporated into traditional GIS mapping • Enables inclusion of alternative epistemologies and situated forms of knowledge 	<ul style="list-style-type: none"> • Lack of guidance on how to assess QGIS mixed method designs 	<ul style="list-style-type: none"> • Marine and coastal development planning (Munro, Kobryn, Palmer, Bayley & Moore; Brown, Strickland-Munro, Kobryn, & Moore, 2017) 	<ul style="list-style-type: none"> • Enables the spatial and temporal mapping of a wide range of data encompassing an array of ST stakeholder groups (particularly indigenous communities) • Offers stakeholders opportunities to meaningfully participate in decision-making processes that impact on the sustainability of communities
Crowd-sourced visual data (e.g. images)	VGI	<ul style="list-style-type: none"> • Enables generation, collation and dissemination of large volume of user-generated content • Inexpensive: data provided voluntarily • Can be used to generate accurate data by individuals locally • Gives communities an active role in planning and development 	<ul style="list-style-type: none"> • Generated by individuals with no formal training, therefore of questionable reliability • Can be difficult to assess the credibility of VGI data 	<ul style="list-style-type: none"> • Visitor monitoring of protected mountain areas (Walden-Schreiner, Rossi, Barros, Pickering, & Leung, (2018) • Visitor monitoring of wetland areas Sinclair, Ghermandi, Moses & Joseph (2019) 	