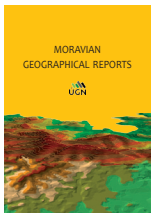

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SCIENTIFIC COMMUNICATION

Scientific citizens, smartphones and social media – reshaping the socio-spatial networks of participation: Insects, soil and food

Matt REED [a *]

Abstract

The conjunction of citizen science and social media through the mediation of the smartphone is investigated in this Scientific Communication, following on from the last issue of the Moravian Geographical Reports (2019, Vol. 27, No. 4). Through a reconsideration of three previously published articles, in part written by the author, this paper reflects on these topics with regard to farmer innovation, local food networks and citizen-informed ecology. Each of these papers has used Twitter to gather data about practices of innovation and observation that have revealed new insights about innovation networks amongst farmers, urban-rural connections and insect behaviours. The reflections reported here are embedded in a discussion of the rise of the term 'Citizen Science'. Recent experiences in areas as diverse as fisheries management and combating Ebola, have informed societal needs for greater engagement in finding inclusive, comprehensive solutions to urgent socio-ecological problems. This paper suggests a compositional approach to studies using citizen scientists and their data as a new avenue of practice and investigation.

Keywords: *citizen science; innovation practices; food networks; farmers; insect behaviours; Twitter*

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1. Introduction

Many societies are facing a crisis of confidence in their institutions. Voting and consumption practices do not address this malaise, as technologies impact society in unanticipated ways. Simultaneously, there are a series of grand challenges such as the climate emergency, the diseases of affluence, the urban transition and the relative stagnation of many economies. All of these crises have elements that engage with science and technology, giving rise to the need to navigate the social change collectively, often called 'innovation' or 'disruption'. Greater engagement in science would seem to offer an essential adjunct to citizenship as part of the way out of this situation.

The loose use of the term 'citizen science' has conflated a discussion of the importance of participation, understanding science and access to the forums in which people can produce solutions. This paper focuses on three case studies from the United Kingdom that explore how a more nuanced understanding of the intersection of citizenship, technologies and social innovations, might inform a better understanding of science and citizenship. This communication follows from several questions raised in the last issue of the Moravian Geographical Reports (2019, Vol. 27, No. 4).

Social scientists have observed for more than two decades that the velocity of the development of the Internet, the technologies needed to access it, and the consequent societal changes are epochal in importance. In the smartphone, an array of technologies has come together, providing a mobile point of access to not only telephony but also to data networks. Portable and haptic smartphones have increased the scope of the devices, which now include built-in audio-visual capture, location tracking and sensors that allow for extensive data capture, as well as self-expression. Smartphones have penetrated many societies profoundly in less than two decades. Social media platforms, such as Facebook, Twitter and Instagram, allow people to create, share and discuss content within and between

[a] Countryside and Community Research Institute, University of Gloucestershire, UK (*corresponding author: M. Reed, e-mail: *mreed@glos.ac.uk*)

social networks. Financed by advertising and managed by algorithms, these platforms that are seemingly allowing open expression of ideas and experiences, have become part of the daily practices of billions of people. These social media are displacing, replacing, augmenting, and reconfiguring previous communication and cultural habits, such as letter writing, newspaper reading, radio listening, leaf-letting and TV viewing. The dynamic interaction between technological developments, software innovations, global distribution and social changes are intertwined in complex ways and at various levels, making policy interventions difficult.

Early discussions of the Internet and associated technologies were concerned with their unequal distribution of access, across gender, educational status, space and social status. As the technologies have developed, the infrastructure has spread and prices have fallen, so the discussion has deepened to focus on the data generated by users, the uses made of it, and the appropriate use of it. There has been a shift from questions of access to the technology to questions about the data that access generates. Scientists of many disciplines have found these new streams of data, often in unprecedented volumes, to be a valuable new field of enquiry. As a mass and collective phenomenon, the initial enquiries were quantitative in form. More recently, qualitative methods have become both applicable and available. Initially, it appeared that the smartphone was the choice of those with fewer financial means and technological tools – that these devices both enabled and constrained access to Information and Communications Technology (ICT). Similarly, the focus on these technologies was on the city, reflecting the dominant form of economic development but also the structures of the technology. Mobile telephone networks carrying data, satellite technologies and the spread of fibre cables mean that many rural areas have parity of connection with urban ones. This development validates Castells' observation that part of the innovation of the online is not to make space redundant but to cast it in different forms (Castells, 1996).

This paper focuses on three case studies (Hart et al., 2018; Reed and Keech, 2017; Mills, Reed, Skaalsveen and Ingram, 2019) to explore how social media is being used to reconfigure how people participate in society, illustrating varying degrees of reflexivity and deliberation across urban, rural and peri-urban spaces. These already-published case studies will be used to explore how citizen science might be understood more fully. The first study focuses on the role of users of social media as reporters of phenomena, which then can then be collected and analysed by researchers to gain more information about insect behaviours (Hart et al., 2018). This study focuses on the observational and collaborative role of citizens in the production of science. The second case considers an example of an affinity network around urban food, with a focus on how social media can be used to augment in-person networks of innovation. Through observational data, the study illustrates the social labour needed to foster social change and the emotional work around being critical (Reed and Keech, 2017). The third example is a case study focused on the activities of a network of farmers in sharing information and experimentation about farming practices aimed at securing the ecological health of the soil (Mills, Reed, Skaalsveen and Ingram, 2019). This trans-national network illustrates people developing, experimenting and sharing knowledge.

All of these examples intermesh complex networks of knowledge and social interaction. They raise important questions about how science can engage in promoting citizenship but also the need for greater sophistication in policy creation.

2. Theoretical departures

The public understanding of science, which shades into public engagement with science, has a long scholarly tradition that has significantly informed broader social theory, as well as being informed by it (Irwin, 2001). A brief consideration of this literature allows us to locate discussions of citizen science in a broader discussion, before coming to focus on some specific understandings of the term. Working from a broadly Foucauldian tradition, Rose identifies contemporary forms of science as they impact, particularly on the body, as creating a form of 'biocitizenship': "Strategies for making up biological citizens 'from above' tends to represent the science itself as unproblematic; they problematise how citizens misunderstand it. But these vectors 'from below' pluralise biological and biomedical truth, introduce doubt and controversy, and relocate science in the fields of experience, politics and capitalism" (Rose, 2007, p. 143).

This perspective places contemporary citizenship with a series of 'projects' in modernity, whereby various technologies shape, and are shaped, by people. For Rose, the emergence of genomic knowledge, a product of contemporary computational technologies, is paramount. Genomic information brings new responsibilities of taking on prudential actions, information seeking and new disciplines of the body. Significantly these are the grounds for hope: "Hope, here, is not mere wishing and anticipating - it postulates a certain achievable and desirable future, which requires action in the present for its realisation" (Rose, 2007, p. 148). The biocitizen is an active citizen, making use of the technologies and knowledges in this role to be agents in their world, working with others in the present to re-position science.

If we take Rose's schema of citizenship from above and from below to consider a few examples of citizens' engagement with 'science', then the constellation of different definitions of citizen science becomes apparent. The EU's Common Fisheries Policy makes use of ecological models to manage not fish populations but fishing effort, through the allocation of quotas of fish to be caught. Failure to comply with such quotas can lead to fishers being heavily fined or even imprisoned. The conformity of aquatic realities to these models is contested (Symes and Phillipson, 2009). Many critics point to how the limitations of the scientific models when engaged in the reality of fishing technologies, the actions of markets for fish and the failure of nature to conform to the models, has seriously denuded the marine environment whilst damaging coastal communities. Stephenson and colleagues argue, from evidence across Europe, North America and Australia, that the engagement of fishers as citizens results in better science (Stephenson et al., 2016). In this example, science 'from above', creating a specific form of citizenship via science for fishers, has begun to accept the necessity of plurality and discussion.

The desperate situation analysed by Richards in his work on popular science during the west African Ebola outbreak 2013–2014, illustrates how citizen science 'from below' can negotiate joint epistemologies (Richards, 2016). Richards illustrates how citizens working with local medics and Medicines San Frontičres (MSF) had begun to contain

the epidemic before the arrival of the US military's and the UK's NHS outreach operations. Richards argues that the treatment and containment of Ebola was not about the deficiency of medical facilities in the afflicted communities. High-tech, well-funded hospitals struggled with the disease, but success lay with knowing how to manage it in its social context. By using local knowledge of other diseases, such as cholera, and using protective gear fabricated from plastic bags and swimming goggles, combined with an acute sensitivity to the social context, an effective people's science was created. The innovations required were simultaneously medical and social scientific, with local people at the core of this process. In particular, the citizens were able to show medics how not caring for the bodies of the dead was as socially dangerous as it was medically risky. The dead could not be abandoned, and that medical framings of the disease would not be adopted until they attended to the socio-spiritual aspects, as well as the virological. The negotiation of this new science allowed people to work together with clinicians to defeat the outbreak. This vibrant example demonstrates the urgency but also the possibilities of science created from below.

Rose's binary allows us to develop an understanding of the tension between a popular, participatory science and one which is imposed on people. As an example, Silvertown, in a widely-cited paper, describes the benefits of the involvement of citizens, as providing a cheaper, volunteer workforce, which is seen positively by funding bodies, but he does not see their inclusion as changing the ontological grounding of science (Silvertown, 2009). This instrumental view of citizen participation continues to inform many environmental science approaches, as it does not challenge the power of scientists. Many proponents of citizen science are proposing a hybrid form which continues elements of the science from above, with the active participation of those below. Hinchcliffe and colleagues in their commentary on the 'fifth wave' of public health, note that publics are heterogeneous, hybrid and emergent (Hinchliffe et al., 2018). They argue that a 'compositional' approach needs to be taken, bringing the bio-medical sciences together with the humanities and social sciences to create new forms. Only by working together, sharing knowledge and experience, can complex problems such as anti-biotic resistance be countered. They identify "a process that is neither top down nor bottom up, but compositional, enabling the development of alliances where questions and approaches are co-created" (Hinchliffe et al., 2018, p. 8). They signal this transition by reversing 'public health' to 'healthy publics', suggesting an active, emergent and collective response rather than a singular solution. In this context Richards' 'popular science' is less from below than compositional, aligning western medics from MSF embedded in local communities with the people in those communities.

In less urgent contexts there are two intersecting spheres where active citizenship is coalescing with these mobile technologies, which bring accounts of social movement activity into contact with broader accounts of social change. Social movement scholars have noted for some time that social movements can produce new ways of knowing, creating new practices and technologies that are as diverse as petrol-powered cars, organic farming, recycling schemes and low carbon power generation. With the advent of pervasive ICT these technologies have become interwoven with these personalised practices to create what Bennett has described at Digital Network Activism (Bennett, 2012). Through these networks, protests are more easily coordinated, but also innovations such as changes in tactics can be quickly disseminated and the processes of learning are accelerated.

Such an ability of relatively small groups of people to create socially beneficial innovations has been noted and promoted by authors such as Geoff Mulgan, who terms this as 'social innovation': "Social innovation refers to innovative activities and services that are motivated by the goal of meeting a social need and that are predominantly diffused through organisations whose primary purposes are social" (Mulgan, Steinberg and Salem, 2005). Mulgan and collaborators draw attention to the processes of innovation that happen outside of business-orientated innovation or research and development, but rather point to the creativity of those working in the state, NGOs and coalitions of citizens. These accounts have tended to focus on the science of citizenship as applied in the field by those wanting to create pro-social change, which has clear correspondence with some of the goals of citizen science.

3. Methods and case studies

The social media platform that is the focus of these three papers and provides this text with a constant theme, is Twitter. This micro-blogging platform allows for short sections of text with attached images and videos to be posted online with networks of followers, and interaction through sharing (re-tweeting) or approval through a 'like'. To enable navigation through the vast flows of discussion, indexing terms (#hashtags) allow conversations to be interlinked. Weaving between these user-controlled and created elements are targetted advertisements and suggestions of possible connections generated by the Twitter algorithms. Significantly, for research purposes, it is possible to capture a small fraction of the streams of Twitter data, subject to limitations imposed by Twitter, either through bespoke programs or analytical packages such as Nvivo (Gonçalves, Perra and Vespignani, 2011). Most users understand that contributions to Twitter are published and can be subject to legal sanctions such as libel, as well as discussion and scrutiny. These features make Twitter an unusually public and readily available form of social media when compared to the more tightly-controlled platforms of Facebook or Instagram.

3.1 Intra-national networks: Observing insects

Recent concerns about the declining population of all insects, but pollinators in particular, has focused media attention on their situation. A range of studies and interventions have encouraged interested citizens to report sightings of various insects via specially created apps (applications), and even to kill and collect some insects to further the study of their population dynamics (Hart et al., 2018). In part, these studies build on more extensive surveys such as the U.K.'s Royal Society for the Protection of Birds (RSPB) annual 'Big Bird' survey, which encourages bird watchers to submit their observations to a national survey. Through the popular media, and targetted appeals to interested groups, many thousands of people have participated in such studies. Participants have been encouraged to record their observations using smartphone apps and even posting samples of dead insects to scientists. These studies have provided environmental scientists with data they would otherwise not have been able to access, as well as a public profile for the topic.

The critical literature of this approach within the ecological sciences notes the drawbacks to this form of research as results cannot be validated, it is less likely to address complexity, less consistent in form and tends towards densely populated areas. As it can generate large data sets, however, it is particularly suited to understanding species' populations and behaviours across space, and the seasons. The paper advanced from the hypothesis that Twitter users were moved to record the presence of insects for another reason. Flying ants were a likely candidate because of their propensity to swarm (Hart et al., 2018). This swarming happens only at particular times and in particular conditions, offering phenomena that might be recorded spontaneously. The team were able to provide earlier observations of flying insect data collected by citizen scientists deliberately, in a structured interaction with ecologists, which provided a way of validating the Twitter data.

The results of the paper broadly demonstrated that Twitter data for complex ecological phenomena has limitations, some of which related to the indirect and retrospective method of collection. Via GPS (Global Positioning System) tagging it is possible for Tweets to be located, but often this option is turned off by users or, in a small minority of cases, set to be misleading (Hart et al., 2018). It does show that there is a potential to gather important data through the analysis of casual chat on Twitter, as people discuss events of passing interest to them. The paper found that it was possible to consider that accurate socio-spatial data could be collected, in this instance, the emergence of the flying ants, and this was useful at a national level. Testing specific hypotheses was not possible through data collected in this way (Hart et al., 2018). That Twitter might be a valuable tool for collecting phenological data, about the appearance of seasonal or cyclic events in readily identifiable species, may be of increasing salience as climate change begins to disrupt established patterns.

3.2 Urban to rural networks: A circle of friendship

There have been widespread discussions about the intersection of urban infrastructure with ICT capabilities and 'mobiquity', intending to create a 'smart city' (Kitchin, Lauriault and McArdle, 2015; Saunders and Baeck, 2015; Wiig, 2015). Many of these schemes are promissory, awaiting an anticipated but yet to be realised intermeshing of technologies, but nascent examples are apparent. Already many cities have been significantly altered by peer-to-peer marketing platforms such as Airbnb (accommodation), Trip Advisor (dining), Uber (transport) and Facebook (advertising) (Calafiore, Boella, Grassi and Shcifanella, 2018). As Castells argues, there is already considerable evidence of a bottom-up movement to make the city smart through the quotidian use of information sharing through social media (Castells, 2012).

Urban agriculture has become a prominent topic in part because it presents opportunities to connect to, and link, a range of social problems in a relatively non-contentious manner (Moragues-Faus and Morgan, 2015; Morgan and Sonnino, 2010). In this way, at times the discussion of urban agriculture is a proxy for debating the future of urban forms, food system resilience, the future of urban governance or the development of new communities of interest, and sometimes it is about urban agriculture. The city of Bristol has become a prominent node in the discussion of urban agriculture because of the vibrant networks of experimentation that are taking place in and around the city, as well as the self-publicity/reflection those networks generate (Carey, 2013; Halliday and Barling, 2018).

Twitter accounts were identified through semi-structured interviews with some of the participants in the networks (Reed and Keech, 2017). These become the entry points into mapping the social networks of these groups through social network analysis software, focused around a prominent vegetable box scheme operating in Bristol. This large-scale analysis identified 23 sub-networks or communities within the Twitter networks, revealing the network as a series of loosely connected groups rather than a tightly bound or coherent group. Through detailed consideration of these smaller networks, including textual analysis of the material being exchanged, it was apparent that social media plays a role in re-affirming social connections there are personal, friendly and positive in tone. This disposition creates on-line networks of social appreciation and a space that promotes the goals of the network into social media; in this way, interpersonal connections are congruent with those online. In part, this can be anticipated as those engaged in these networks are individuals who are trying to work collectively to reshape consumerism and use food as a tool for creating community. It is also apparent in these network diagrams that key activists play a role in both creating and sustaining these networks. Their social skills, energy and examples are essential as they act as movement entrepreneurs. The findings of this paper suggest that social media is not inherently anti-social (Reed and Keech, 2017). Instead, there are questions about its uses as a primary tool of social interaction or as an additional means. This example does confirm the importance of social media 'bubbles' which reinforce pre-existing norms and attitudes, albeit, in this case, they are pro-social.

3.3 Rural to rural networks: saving the soil

Historically, farmers and the rural communities in which they reside, have been relatively isolated with the advent of mass broadcast media connecting rural areas to urban ones in new ways. While in many rural areas, interconnectivity via broadband lags behind urban areas, mobile telephone networks have advanced more uniformly. As with many other small business operators, farmers have found smartphones to be useful (Roberts and Townsend, 2015; Salemink, Strijker and Bosworth, 2017). This technology has opened the opportunity for rural-to-rural networking, as people in rural areas can connect directly to their peers, overcoming some of the problems associated with innovation in rural areas.

Simultaneously, the EU has emphasised the importance of farmer-led innovation, in line with CAP initiatives, but also agri-tech innovations as an opportunity for the heavily mechanised UK industry to gain comparative advantage and potentially export markets (Faure, Desjeux, and Gasselin, 2012; Mills et al., 2013). Research findings have consistently pointed to the importance of peer-to-peer exchange as the preferred mechanism, which has informed policy (Dwyer et al., 2007; Gibbs, 2013). These initiatives to encourage farmers are in addition to spontaneous self-organisation by farmers, who are sharing their innovations on social media and networking via this medium. With the advent of cheap 'action' video cameras mounted on equipment, as well as video cameras in smartphones, they are sharing images of the equipment in action. Farmer-to-farmer learning networks are emerging based on experimentation and sharing experience.

In this paper (Mills, Reed, Skaalsveen and Ingram, 2019) a content analysis of a Twitter account of the EU research project 'SoilCare' was combined with in-depth qualitative interviews with five farmers using Twitter, and was used to explore the extent and type of peer-to-peer knowledge exchange about sustainable soil management practices. The research identified evidence of learning taking place through these exchanges. Twitter offers a medium which captures the immediacy of the field operations through visually impactful media, based in the field. The brief messages channelled through Twitter appeal to farmers, who feel themselves to be time-constrained. Hashtags, as indexing terms, have allowed networks of practice concerning sustainable soil management to coalesce and within these networks: 'farmer champions' are emerging who are respected by their peers. These champions have committed considerable effort to Twitter, for example posting over 100,000 tweets, but as they are attentive to, and responsive to farmers, they are important conduits of information. The interviewees view Twitter as working best for those actively seeking information, echoing the role of the bio-citizen as an active user, as well as creators of knowledge. This perspective suggests that optimally Twitter should be combined with forms of face-to-face interaction as part of a blended approach to learning. Additionally, Twitter offers a space for researchers and advisers to share insights and experience with farming to widen the informational base of the networks (Mills et al., 2019).

4. Discussion

This trio of papers begins to suggest some ways a more nuanced account of the interactions between social media usage, smartphones and citizenship could emerge (Hart et al., 2018; Reed and Keech, 2017; Mills, Reed, Skaalsveen and Ingram, 2019). Although each of the papers is different in focus, disciplinary field, and approach to the data, there are some intersections that suggest important commonalities:

i. collecting data;

ii. an understanding of who is active in these networks; and

iii. what it says about participation.

4.1 Collecting data

All of these data are in the public domain, available to be accessed, collected and analysed by any interested party. For those posting this material, on one level this is assumed. This activity is the deliberate creation of new and public knowledge in an open forum. Some of those taking up the building of alternative food networks in Bristol, for example, had only one audience in mind, those with whom they had interacted off-line. In these ways, social media as a public forum is a part in the flying ant study, those participating did so knowing that ecologists were looking for these data. The farmers looking to protect the soil used hashtags so that others could find their discussions. Those delivering crucial new knowledge and opportunities to learn were enabled.

There are two important caveats to this public domain of knowledge. The first is that the researchers are not able directly to return the knowledge to these networks. Lags in time caused by analysis and publishing, mean that there is little opportunity for direct, timely feedback. Second, the role of the platform remains opaque, in that data collection is limited and the part of advertising algorithms in these networks is unknown.

Importantly in two of these papers (Reed and Keech, 2017; Mills, Reed, Skaalsveen and Ingram, 2019, the authors combined qualitative analysis with that of an understanding of the Twitter networks, overcoming some of the problems of the large-scale quantitative analyses of Twitter. Understanding that social media is only part of a broader constellation of information and interactions is essential to contextualising it. Considering the sub-communities of networks within an affinity network in Bristol counters the idea of undifferentiated blocs or 'bubbles' of opinion. Thick and detailed descriptions of Twitter are essential in understanding how these platforms become woven into daily practices and ways of knowing.

4.2 Who is active in the process?

In each of these studies, a diverse range of people is present, although unified in sharing access to the platform. This access is vital in changing the demographics and dynamics of participation, with smartphones being the critical technology. Each of these papers is focused on a different field, but each is remote from deskbound computing. The soil saving farmers are Tweeting from and videoing farm machinery in their fields, the observations of flying ants are from people watching the swarming insects on a summer evening. Smartphones and their attendant data connections allow for the spontaneity that underpins these interactions.

Much of the literature about citizen science implies a binary division between those contributing the data – the citizens – and the experts, who can analyse the results. Much of the literature and some of the practice of citizen science appears to embed those assumptions. Yet in the detailed work in these papers, it is clear that there is a mixture of citizens, who might be farmers or food activists but also those who hold professional status and expertise. Rather than a binary of expert/non-expert, we are observing a mixing of expertise. Some of this expertise is in the pragmatics of no-till farming, others in the statistical analysis of Tweets. What is incomplete in these studies is the access of the 'citizens' to the agendas of knowledge in scholarly domains. Citizen science in this context reflects the power structures of peer-reviewed science in contrast to other forms of knowledge.

4.3 The nature of participation

As noted above, many of those active in these Twitter networks are self-consciously creating new forms of knowledge and social practice. Interwoven with the unwitting contributor are those attempting to develop new types of agricultural practice or new systems of food distribution. The contributors are expressing and sharing their expertise in a public forum to share and co-create new forms of knowledge, with the academic researchers contributing to this effort much later. This model is far from the binary of top down/bottom-up creation of knowledge inherent in some models of citizen science. Instead, we are closer to the 'compositional model' proposed by Hinchcliffe and colleagues (Hinchliffe et al., 2018, p. 8). In this model, people create alliances to co-create new knowledge together.

This effort is both self-conscious and voluntary, and although conducted in public, is done so through the medium of a corporately-owned social space – Facebook, Twitter, Whatsapp and the like. It raises important questions about how policy should respond to citizens taking up such initiatives. Would it be helpful for such data to be routinely

available via a data commons rather than left on the servers of a corporate actor? Or should, over time, new spaces of civic debate be created to which policy actors are more integrated. While these debates are being held, alliances of citizens are forming new knowledge in the spaces afforded to them.

5. Conclusions

Currently, a backlash is developing against the advertisement-driven, corporate surveillance model of social media, and how it has been open, or even party to, forms of manipulation that are unethical and potentially illegal. This movement suggests that there could be advantages in academics forming a partnership with those who are seeking to wrest control of the Internet back to its users, preserving it from being solely a space of entertainment and associated marketing efforts. The case studies in this paper hint at a more purposeful and constructive use of social media, even when used in a recreational format as users provide data indirectly (Leadbetter, 2008). Some might argue for a market mechanism through which users get paid for the data they generate. A parallel route might be to allow scholars to access data preferentially, with a tighter on access and the management of that data after the Cambridge Analytica scandal (House of Commons, 2019).

It also suggests that the focus on big data and computational insights has overshadowed the study of the meso-level uses of social media. In comparison, text messages (SMS), 'WhatsApp' groups and micro-blogging are the non-dramatic but increasingly quotidian communication forms that are bringing groups together and can be inaccessible to researchers. A common feature of all the discussions of the citizen, be they top-down or bottom-up, is that these new forms of (bio)citizenship are suffused with hope. The studies in this paper offer a new form of observational data that suggests that more accurate data are possible through gathering social media postings, the 'chat' of online social life. The possibilities of deeper engagement, when people take up forms of (bio)citizenship suggest that this hope may not be misplaced. The grand challenges of the transition to greater sustainability are that environmental management, in various forms, will be met by new forms of association and collaboration, re-making places and re-locating, as people work together with their smartphones in their hands.

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