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Re-visioning public engagement with emerging technology: A digital methods experiment on 'vertical farming'

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Abstract

This article presents the results of a public engagement experiment on a project trialling 'vertical farming', an emerging technology addressing urban food issues. The experiment developed within an issue mapping project, analysing debates about vertical farming on the digital platforms, Twitter and Instagram. The article presents a software tool designed to engage 'offline' publics in the issue mapping process, using images collected from Instagram. We describe testing this software tool with visitors to exhibitions of vertical farming in two science and technology museums. Our findings highlight the predominance of commercial publicity about vertical farming on Twitter and Instagram and the organisation of public attention around technological novelty. The article discusses the challenges such publicity dynamics pose to mapping issues on platforms. We suggest some ways digital methods might contribute to public engagement with technologies, like vertical farming, that are a focus of organised commercialised innovation.

Keywords

digital methods, emerging technologies, issue mapping, participation, platforms, public engagement, vertical farming

1. Introduction

Many recent participation experiments have aimed at involving publics in controversies about emerging technologies (Chilvers et al., 2018; Horst and Michael, 2011; Joss and Durant, 1995; Lezaun et al., 2016). At the centre of participation experiments with emerging technologies have been social scientists' attempts to both design procedures for public engagement and articulate

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issues relating to sociotechnical uncertainties (Callon et al., 2001). Yet, a recent edited collection on participation experiments argues that many methodologies are shaped by a 'residual realism' (Chilvers and Kearnes, 2015: 8) about relations between science and society, all too often enacting 'normative models of participation that assume a correspondence theory of an external "public" existing in a natural state waiting to be discovered by participatory techniques and procedures'. Furthermore, relatively few such experiments have explored in depth how participation methodologies relate to the formats of public interaction that emerge online and on digital platforms (for instance, Madsen and Munk, 2019).

This article describes an issue mapping study on 'vertical farming', an emerging technology designed to address urban food issues. Issue mapping research draws on controversy analysis techniques from the social study of science and technology and applies them to analyse and visualise debates on digital platforms (Marres, 2015; Rogers et al., 2015). Controversies can be understood as 'informal' processes of technology assessment that take place in public (Rip, 1986). By studying the ways in which publics engage with debates about technologies, issue mapping research aims to analyse interactions between the problems and social dynamics shaping technological controversies (Venturini et al., 2015). Issue mapping approaches, therefore, assume that social contestations over the definition of public issues may not be separable from technological disputes between experts (Callon et al., 2001). Such an approach contrasts with research methodologies for eliciting public understandings of emerging technologies, such as risk perception studies, that require controversy between science, technology and society to be, at least in principle, resolvable (see discussion in Lezaun and Soneryd, 2007). In the issue mapping study presented here, digital platforms are approached as sites where sociotechnical controversy may emerge enabling the identification of issues otherwise obscured in research approaches that aim to represent public views about emerging technologies.

The issue mapping research presented here developed on an European Union (EU)-funded project aiming to engage European publics with questions about the future roles vertical farming might play in food systems. Central to the project were gallery exhibitions of vertical farming in the Deutsches Museum (Munich) and the Science Museum (London) – at which our project partners demonstrated a controlled environment in the form of a vertical farming set-up – where we engaged 'offline' publics in the issue mapping research. As we discuss below, mapping vertical farming debates on digital platforms proved challenging. This was, in part, because platforms did not appear to host engaged public debates about vertical farming. Instead, the platforms enabled small groups of actors to dominate the discourse about vertical farming, promoting the technology as commercially and financially valuable. The experiment we designed, therefore, attempted to repurpose content from one platform, Instagram, for exploring issues relating to vertically farmed food beyond economic viability.

The article is structured in three sections. First, we introduce the aims and scope of the study reviewing key debates about the relationship between issue mapping and public engagement with emerging technologies. The second section presents an overview of the issue mapping methods used and data collected from two online platforms: Twitter and Instagram. This section also presents the software tool we developed – which we called the 'Re-visioning Device' – to use images of vertical farming from Instagram to engage 'offline' publics in the issue mapping process. The third section presents an analysis of vertical farming content on Twitter and Instagram. We report the results of our attempts to test the Re-visioning Device and present an analysis of the data collected. The 'Discussion' section focuses on the extent to which the digital method we developed challenged the publicity dynamics we identified as structuring debates about vertical farming on Twitter and Instagram. The article concludes with some suggestions for developing digital methods for issue mapping and the roles devices play in mediating public engagement with platforms.

2. Issue mapping and public engagement with emerging technologies

In early 2017, the authors were invited by an industry partner of the EU Consortium EIT Food, the European Institute of Innovation and Technology Food (then in its initial year) to design a participation forum on 'vertical farming'; the subject of an innovation project being developed by the Consortium. The issue mapping research described here, therefore, developed in relation to a hybrid science-industry approach to innovation and public engagement.

Playing the roles of designers of participation processes, social scientists have often found themselves enrolled in organisation-led attempts to represent the public and demonstrate technological innovation as a transparent process, for example, the United Kingdom's *GM Nation* debate (Lezaun and Soneryd, 2007; Wynne, 2006). Indeed, some advocates of the public understanding of science movement proposed that social scientists would play a critical role not just in communicating science but promoting science as commercially valuable to industries (Elam and Bertilsson, 2003; Thorpe and Gregory, 2010). Implicated in the business of *organising* participation, social scientists have often had to tread a fine line between, on one hand, bringing public opinion to bear on debates about emerging technologies and, on the other hand, legitimating innovation pathways by performing as spokespersons for *the public*.

Critical studies of organised, or 'invited', participation (Wynne, 2007) have highlighted the role social science techniques, like surveys, play in framing issues and, therefore, also the capacity of the public to influence the governance of emerging technologies (Jasanoff, 2003). Proposals to 'open up' technology appraisal processes (Stirling, 2008) and move public engagement 'upstream' in regulatory cycles (Wilsdon and Willis, 2004) have shown that innovation problem definitions are often multiple and can destabilise relations between technology and society. While such proposals often aim to introduce contingency into technology assessment processes they also implicitly suggest that the formulation of innovation problems develop largely out of public view (Marres, 2012).

In contrast, a range of experimental approaches to participation in technology assessment argue that, rather than attempting to represent public opinion, social scientists should 'map' the emergence of debates around technological controversies (Marres, 2012). One programmatic version of this argument is made by Callon et al. (2001) who highlight that social science attempts to represent public opinion about controversial technologies can inflame antagonisms and lead to disengagement. They argue that democratising technology assessment requires treating participation as an experimental and collective endeavour. Callon et al. propose that social scientists should map how actors engage with technological controversies rather than seek to organise public debate. How social science practices of mapping technological controversies relate to the design of participation experiments has been widely taken up in recent scholarship on digital controversy analysis and online issue mapping (see Madsen and Munk, 2019; Marres, 2015; Venturini et al., 2015**).**

Drawing on digital methods techniques (Rogers, 2013), issue mapping research repurposes digital media artefacts – such as hashtags – for social analysis (Rogers et al., 2015). Early issue mapping used hyperlinks to map how actors used the web to form 'issue networks', proposing that the web could be understood as a 'neo-pluralist' forum of debate about science and technology (Rogers and Marres, 2000). More recently, the 'platformisation' of web design has challenged notions of the Internet as a coherent public space (Helmond, 2015; Rogers, 2013). Partly in recognition of the un-network-like structures of contemporary digital platforms, many approaches to issue mapping treat the web as a media 'landscape' that takes multiple forms (sites, platforms, apps, etc.) where controversy can be *detected* (Venturini et al., 2018a).

In the platform-centric Internet, social researchers widely rely on the application programming interfaces (APIs) provided by platforms in order to collect data (Perriam et al., 2020). Yet, social

researchers are increasingly pessimistic about the ability of online platforms, shaped by surveillance marketing techniques and popularity algorithms, to perform as spaces for meaningful interaction (Rogers, 2018). Rather than assuming social data can be extracted from online platforms, issue mapping research requires researchers to engage with the ways online platforms shape interactions that take place on them, for example, how popularity algorithms influence issue visibility (Marres, 2015; Birkbak and Carlsen, 2016). Contemporary issue mapping approaches have, therefore, tended to focus on developing methods to detect public concerns across online platforms (Marres and Gerlitz, 2016; on cross-platform analysis, see Pearce et al., 2020).

The extent to which digital platforms are understood as the instruments of an issue mapping research methodology or the objects of its analysis have been widely debated (Marres and Gerlitz, 2016; Venturini et al., 2018a). Studies of technoscientific innovation show that online platforms play an increasingly central role in innovation processes, particular where innovation is focused on gaining control over access to intellectual property and personal data (Birch et al., 2020). The commercialisation of public 'attention' in digital societies has been widely documented (Madsen, 2015) – for instance, pay-per-click advertising – and often occupies a key place in contemporary innovation strategies (Birch et al., 2020). To avoid adopting platform logics that equate popularity with importance, issue mapping approaches, therefore, require a sociotechnical understanding of how platform dynamics contribute to the visibility of issues (Marres, 2015; Moats, 2019). This point is pertinent for analysing how online publicity for a speculative invention like vertical farming can contribute to inflating its value as a focus for technological innovation.

A significant methodological criticism about online issue mapping centres on how to reality-check an issue map, for example, to test whether visualisations of issues on online platforms hold empirical relevance to public debates. A key concern here is that social media research methods can take for granted the public relevance of digital media, often implicitly operationalising distinctions between online and offline publics that are native to particular platforms (Moats, 2019). To address the problem of public relevance, we designed an experiment in which we developed a simple software tool (which we call a "device", building on Marres and Lezaun, 2016) to engage 'offline' publics in the process of mapping issues on one platform.

3. Methods and data

Datasets from two online platforms, Twitter and Instagram, were collected for the issue mapping research.[1]

Between April 2017 and May 2018, we collected 51,806 Twitter posts about vertical farming. We collected these tweets using the DMI-TCAT software (Rieder and Borra, 2014), which connects to Twitter's Streaming API and enables users to query this 1% stream for tweets containing particular terms. The query design for collecting this dataset used permutations of the term 'vertical farming', and so does not include closely associated terms like 'controlled environment agriculture' or 'urban farming' (although these terms appear frequently in the tweets collected). We analysed these data using a combination of the DMI-TCAT software and the analysis of exported csv files in Excel. Network visualisations were constructed in Gephi using the forceatlas2 layout algorithm designed for social science analysis of complex networks (Jacomy et al, 2014).

The Instagram data were collected in October 2017 and contained 16,405 images of vertical farming posts between 2011 and 2017. The data were collected through Instagram's API using the Digital Methods Initiative's Visual Tagnet Explorer tool (Rieder, 2015). The query term used was 'vertical farm*', and was likewise analysed in Excel. Network visualisations were also constructed in Gephi using the forceatlas2 layout algorithm (Jacomy et al, 2014). It is notable that Instagram's API no longer enables data collection by the Visual Tagnet Explorer tool used in this study.[2]

Questions about the public relevance of the data collected from Instagram are, therefore, a central focus of the 'Discussion' and 'Conclusion' sections below.

The main issue mapping technique used on both datasets is 'co-hashtag analysis' (Marres, 2015). Both Twitter and Instagram enable users to add hashtags (#) to content they post as a device for making this content visible to other users. Hashtags enable users to interact over common topics rather than only on the basis of personal relations (e.g. friends or followers). Co-hashtag analysis draws on techniques of co-word analysis from science studies that, in their original formulation, analysed the co-occurrence of keywords in scientific papers to identify emerging topics of scientific interest (Callon et al., 1986; Leydesdroff, 1989). Co-word analysis focuses on how researchers use keywords across established fields and disciplines and aims to enable social researchers to examine the role played by both social and cognitive dimensions of science in the development of research problems (Callon et al., 1986). Repurposing co-word analysis for the study of hashtags aims to detect issues in large social media datasets that may be obscured by popularity metrics, such as aggregated likes or retweets (Rogers, 2018).

Both Twitter and Instagram enable users to apply hashtags to content they post. However, they do so in different ways. Twitter has a character limit on posts, thus limiting the number of hashtags in a single post, whereas Instagram does not have this constraint, and so users often attach many hashtags to posted images. Co-hashtag analysis does not, therefore, provide a strict method of comparison between these platforms. Our analysis, therefore, focuses on analysing the specific affordances of each platform for public engagement with vertical farming.

The participatory method we developed aimed to engage 'offline' publics in the issue mapping process. Working with the Deutsches Museum in Munich and the Science Museum in London, the project arranged gallery spaces for our partners to demonstrate and publicise their vertical farming experiments alongside which we could engage visitors. For that purpose, we designed an interactive software tool that randomly visualised vertical farming images from the Instagram dataset and invited users to collage 'visions' of vertical farming by selecting three images. We called this software tool the 'Re-visioning Device'.[3] The aim of engaging museum visitors was both to (1) curate two corpora of images and written statements on vertical farming for a comparative analysis and (2) to explore (by taking participant observations) whether, or in what ways, Instagram images might mediate visitors' engagements with our partners vertical farming experiments.[4]

The Re-visioning Device software tool enables users to scroll through and select three images, and to mark up their selection with a description, as well as answering optional questions about their relationship to technological innovation and food. By randomly visualising images from the dataset, the Re-visioning Device circumvents the influence of platform algorithms with the aim of offering users a more open approach to engaging with vertical farming publicity. A colleague prototyped a script to randomly visualise images from the database that we tested in a workshop at the vertical farming industry conference *Skyberries*, in Vienna. We subsequently developed a more complete web application based on this prototype, in collaboration with a software developer. By inviting users to curate a corpus of images from the dataset, we aimed to reduce the arbitrariness in the relations between images and vertical farming hashtags – a finding from preliminary analysis, discussed below – and to allow for surprising and unlikely combinations of vertical farming imagery to emerge. Installing the software on touchscreen tablets, we engaged visitors to the galleries over 3 days, collecting 111 'visions' from both the Deutsches Museum and 147 from the Science Museum between 1.5 and 3 days.

The "visions" of vertical farming collected through this process were analysed both qualitatively and using a modified form of co-hashtag analysis. We coded the images to distinguish those in which *technologies* comprised the central focus of the image (broken down by controlled environment technologies, greenhouse technologies and architectural designs) from images in which *plants* comprised the central focus (broken down by urban gardens, individual plants species and plants as food) and,

finally, images which are neither of technologies or plants and hold no clear relation to the topic (termed "obscure images" below). We then conducted a co-hashtag analysis to analyse whether, and how, these images were related by hashtags. To do this, we aggregated the hashtags relating to each of the three images selected and visualised as a bipartite network: one set of nodes representing the "vision" submitted by the user and the other set of nodes the aggregated hashtags relating to the three images. In addition, the "vision" nodes are colour coded based on whether all three images are technological or plant-focused, hybrids of these image types or predominantly obscure images.[5] The analysis contextualises the findings from the Re-visioning Device with observations of the engagement process collected during the gallery demonstrations of vertical farming at the museums.

4. Mapping engagement with vertical farming

Vertical farming as an emerging technology

A figure widely associated with the concept of vertical farming is Dickson Despommier, professor emeritus of microbiology from Columbia University. Despommier's (2011) book *The Vertical Farm: Feeding the World in the 21st Century* has become a central reference for commercial interest in highly automated urban food production (see Germer et al., 2011; Pinstrup-Andersen, 2018). Concurrently, it has provided the focus of a range of criticism among plant scientists and agronomists for its lacking evidence of (energy) efficiency and insufficiently founded claims to address global food security issues (see Cox, 2012; Goodman and Minner, 2019; Hamm, 2015).

Central to the vertical farming experiments conducted by our Consortium partners was the controlled environment; an indoor plant growth chamber widely used in the plant sciences. Developing and patenting such technology for food production is often a central focus of horticulture and technology start-ups that identify as practising vertical farming, often with a view to attracting venture capital investments.[6] Vertical farming with controlled environments has also been associated with non-food-related industries, notably the emerging US cannabis industry.[7] Vertical farming is often used as a synonym for urban horticulture, that is, horticultural practices in cities.[8] Although Despommier's book suggests vertical farming as something of a synthesis between tech start-ups and community gardens, how these approaches relate to each other in practice is left unclear. For instance, Goodman and Minner (2019) show that vertical farming urban horticulture is often driven by social aims, such as maintaining community and public space, rather than productive rationales.

Vertical farming on Twitter

Dynamics of engagement with vertical farming on Twitter appeared more organised around commercial interest than interactions between heterogeneous individuals and collectives. Between April 2017 and May 2018, we collected 51,806 tweets about vertical farming posted by 25,148 user accounts. The vast majority of users ($n = 19{,}677$, $> 75\%$) posted only once. Among these users, 80% of posts ($n = 18{,}769$) were either retweets or (partial) duplicates of other tweets in the dataset.[9] The majority of engagement with vertical farming was therefore to recirculate content. The dataset also suggests limited interactions between users: of the 1328 replies to posts in the dataset, almost half (48%) were from the group of single-post users (i.e. the reply constituted their only tweet about vertical farming).

By comparison, the 20 most frequent users in the dataset accounted for 13% of all tweets ($n = 6687$). These users primarily represented organisations involved in vertical farming rather than individuals, such as Urban Vine Co, Agritecture and Grow X. Accounts representing individuals in this group were, on further inspection, all professionally linked to the organisation Seeds & Chips

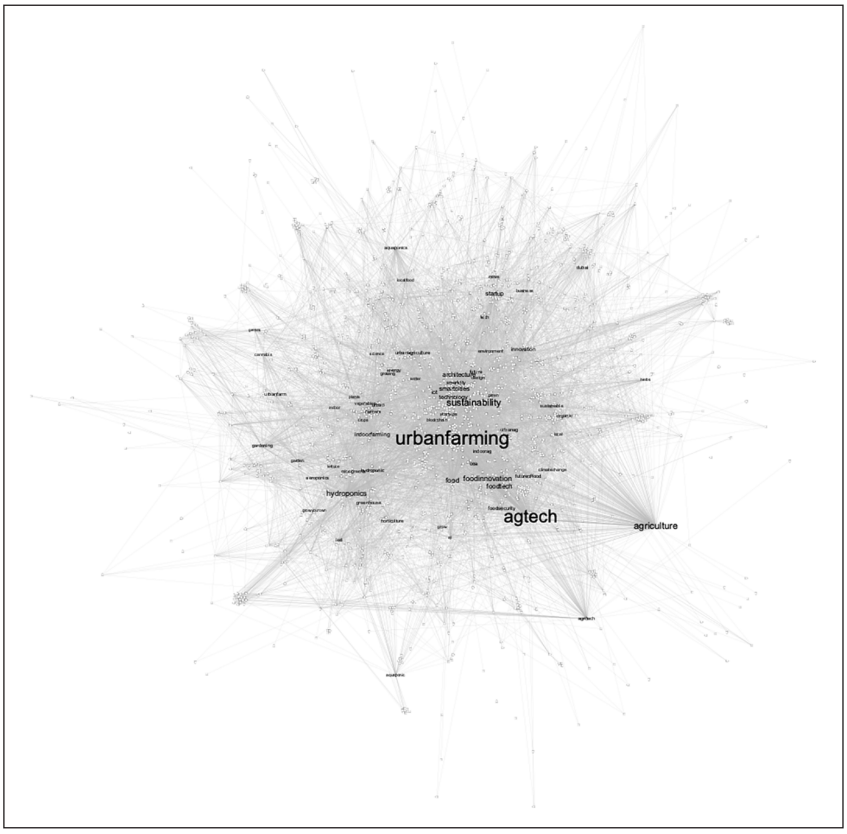

Figure 1. Hashtags co-occurring in tweets about vertical farming, after removing retweets and partial duplicates. Network laid out in Gephi using the forceatlas2 layout algorithm with settings: linlog mode, gravity = 2.0, scaling = 1.0, prevent overlap. Hashtags derived from query terms (e.g. #verticalfarm) were removed. Labels for nodes with > 50 edges, relationally sized by number of tweets containing hashtag, scale 1–10. Edges weighted by aggregating number of times hashtags co-occur. Original GEXF file available on request.

that organises agri-tech conferences, whose content they largely retweeted. Of these 20 users' tweets, 85% ($n = 5712$) contained hyperlinks to a total of only 10 websites (for the most part, those of the companies the accounts represented), all of which are US-based with the exception of Seeds&Chips (Italy) and a UK-based food blog.

Removing retweets and partial duplicates left 11,921 tweets of original content from 4893 user accounts. Analysis of the hashtags associated with this original content further suggested engagement organised around commercial interests. As illustrated by the dense and centralised network showing the co-occurrence of hashtags in tweets (see Figure 1 and associated Table 1 below), a number of descriptive and industry terminology hashtags (e.g. #food, #agtech) are used widely across the dataset in combination with many idiosyncratic hashtags (of 3865 distinct hashtags in corpus 70% were used in only one post ($n = 2735$)). Hashtags, therefore, appeared to be used more like labels for branding content rather than devices for associating posts with topical issues or positions in a debate. Our finding here contrasts with studies of the way Twitter hashtags are often used in debates about controversial technologies (cf. Wonneberger et al., 2020), suggesting that Twitter does not perform primarily as a platform of debate about vertical farming.

Table 1. The 10 most frequent co-occurring hashtags in tweets about vertical farming, ranked by degree. Retweets and partial duplicates removed.

Hashtag	Number of tweets with hashtag	Degree (number of links in network)
urbanfarming	367	482
hydroponics	285	380
agriculture	293	372
food	221	372
agtech	394	295
innovation	137	244
sustainability	155	220
indoorfarming	117	160
organic	73	153
startup	102	151

Reading through the 20 most frequently retweeted posts, we found that they fell into the following three loose categories: commercial publicity, investment news and media coverage of Despommier's book. The presence of references to Silicon Valley venture capital and tech companies like Dell were notable throughout. Many of these tweets also used sensationalist language, appearing to promote a sense of uncertainty in global food systems. For example, among the five most frequently retweeted posts, vertical farming is variously described as: 'the green solution to the growing global food crisis', a 'futuristic' technology that 'could feed an entire African town' and a food production method that can 'reverse the plundering of the earth'. Of the original content, 73% ($n = 8808$) of the tweets contained hyperlinks to external sites. Many of these links simply syndicated content from other (often American-focused) media sites, including The New Yorker, Forbes, the New York Times, Maschable, or NBC. Examining events in the dataset (i.e. spikes in the number of tweets-per-day on a time series) further highlighted the role of advertising campaigns – for example, promoting the vertical farming operations Plenty, Aerofarms, GrowXInc and Bowery Farms – in shaping retweeting behaviour.

Rather than a space of interaction between heterogeneous individuals and collectives, the vertical farming Twitter-sphere appeared to be a much more hierarchically ordered space. Messages were propagated by a small number of organisations, typically promoting vertical farming as a novel technological solution to often vaguely defined food production problems.

Vertical farming on Instagram

The Instagram posts analysed in this study were collected in October 2017 and contained 16,405 images posted between 2011 and 2017. Preliminary analysis suggested similar dynamics of engagement to those observed in the Twitter dataset. The distribution of posts-per-users showed both limited engagement of most users and a small concentration of frequent posters. The top 20 most frequent posters together accounted for almost a third ($n = 5677$) of all images. Like the Twitter dataset, almost all frequent posters in the Instagram dataset represented organisations rather than individuals: the only individual present in the frequently posting accounts was linked to a company (theplantcharmer). Distributions of likes and comments between users were similarly asymmetrical.[10] The top 1000 most liked posts come from only 20 user accounts (the first 100 of these from a single account, Hydrovegan), the top 1000 most commented posts from 38 user accounts.

Taking a similar approach to the analysis of the Twitter posts, we attempted to perform co-hashtag analysis on the dataset with the aim of detecting issues represented by individual hashtags, or clusters of hashtags, in a network. Although the Instagram dataset contained only images from the query term (verticalfarm*), our initial attempts to analyse the data suggested that the relation between the images and the hashtags could be distorted by particular platform effects. Disconnects between images and the literal associations of hashtags appeared common in the Instagram dataset. For example, one of the most liked images in the dataset was posted by an account named Ecospire. The image is a close-up of a tomato plant and the accompanying text discusses the 'vertical farming revolution', crediting Dickson Dispommier with the concept, ending the post with the following hashtags:

'#photography #red #ecospire #cleaneating #greenlife #photooftheday #healthychoices #picoftheday #fruit #nutrition #green #foodporn #verticalfarming #choices #yummy #beautiful #tomato #healthy #peace #yum #instagood #nomnom #vegetarian #vegan #instadaily #healthyeating #foodforthought #fruitarian #color'[11]

The average (median) number of hashtags used in our Instagram dataset was 15, meaning that visual analysis of the co-occurrence of hashtags could, therefore, only practically be performed on small samples. Instagram does not limit the number of characters that can be used in a post and, as the above hashtag list illustrates, hashtags can be bundled together with many others that might be only loosely related to the topic of the post or platform-specific (e.g. #instadaily).

In order to construct small samples of Instagram images on which to perform co-hashtag analysis, we therefore designed a participatory approach that would engage 'offline' publics in the issue mapping process. As described in the methodology, we developed a simple software tool – which we called the Re-visioning Device – that would allow users to collage 'visions' (selections of up to three images) of vertical farming from images in the Instagram dataset. We now describe the process of engaging visitors to our partners' gallery demonstrations of vertical farming at the Science Museum and Deutsches Museum and present an analysis of the data collected from the Device.

5. Engaging 'offline' publics in issue mapping

The gallery demonstrations of vertical farming, where we tested the Instagram software tool (the Re-visioning Device), took place at two science and technology museums of comparative national significance. The set-up in both museums was slightly different in that the event at the Deutsches Museum was a stand-alone, walk-through installation in a large hall (the Ehrensaal), while at the Science Museum it was part of the week-long event 'We Are Engineers Family Event', with a smaller stand. At the Deutsches Museum, the Ehrensaal was a passage hall where we installed displays and materials that comprised roll-up banners, a demonstration model including lettuce plants and light-emitting diodes (LEDs), four high tables with snacks and several tablets, and a table with a fixed monitor for the Re-visioning Device. The location at the Science Museum was in a basement area dedicated to temporary family activities of the above mentioned festival. Our project partners' displays and materials comprised roll-up banners, one large TV monitor presenting vertical farming operations instead of the installation, and four large tables with postcards for children to draw on, felt-tipped pens and coloured pencils.

At the Science Museum, there were many more visitors to the event, and less reluctance to engage with the Re-visioning Device compared to Munich. The children's activity that we offered created at times a quid pro quo situation, where parents or caretakers engaged with the device in exchange for their child's supervision. The TV monitor showing a short video on vertical farming received much attention and led many visitors to stop and engage at the stand. Not having had the

Table 2. The 10 most frequent co-occurring hashtags in Figures 2a and 2b.

Deutsches Museum corpus		Science Museum corpus	
Hashtag	Degree	Hashtag	Degree
urbanfarming	76	urbanfarming	84
hydroponics	61	hydroponics	66
food	47	sustainable	37
agriculture	31	microgreens	34
microgreens	31	food	32
organic	31	agriculture	31
healthy	29	organic	30
green	26	aquaponics	27
gardening	25	gardening	27
vegetables	25	healthy	27

demonstration model at the Science Museum highlighted the significant role material culture plays in this setting, as museum staff and some visitors were keen on seeing a physical example as well.

The two samples of the Instagram data collected from engaging visitors to the museum galleries were coded by using a simple framework to categorise images (described earlier) and subsequently analysed to explore relations between the 'visions' collected. Approximately, a third of the selected images in each corpus were posted by the 20 most frequent users (see analysis above), similar in proportion to the total dataset.[12] In each corpus, approximately half[13] of all images were focused around technologies, two-thirds of these were images featuring controlled environment technologies[14] and a quarter were images of greenhouses.[15] In terms of images of plants, in each corpus, approximately 2/5 images depicted scenes of urban gardening[16] and 1/6 were images of particular plant species.[17] It is notable that despite the different gallery settings the image themes are remarkably similar.

The figures below represent a co-hashtag analysis of the 'visions' of vertical farming collected in the each image corpus. The figures, therefore, show how participants' visions are related through the hashtags assigned by those Instagram users originally posting the images (see most frequent co-occurring hashtags in Table 2).

Visually (on visual network analysis, see Venturini et al., 2018b), the networks appear structurally similar: both have relatively dense centres with multiple satellite clusters (i.e. small groups of nodes connected principally to each other). In both figures, the two hashtags with the highest number of occurrences are also those most visible on Twitter (see above): #urbanfarming and #hydroponics. Where groupings of visions appear detectable in these figures – for instance, of technological visions in Figure 2a – they only weakly relate to the few core hashtags at the centre of the network. In both figures, we find hybrid visions (i.e. combinations of plants and technologies) distributed throughout the networks, suggesting that many hashtags are flexibly applied to both technological and plant-focused images. Notably, the visions with images coded as 'obscure' in their relation to vertical farming did not appear distinct in their network positioning (e.g. they appear disconnected or peripheral). Rather, like many of the vision nodes, they seemed to mix together descriptive or industry terminology hashtags with idiosyncratic hashtags.

As well as data gatherers, it was notable that the social scientists were sometimes engaged as experts on vertical farming, which at times lead to role confusions characteristic of participation experiments (Lezaun et al., 2016). One such occasion occurred at the Deutsches Museum when the Bavarian Broadcast (Bayerischer Rundfunk) requested to make a short feature of the event. The journalist wanted a representative of the project (one of the authors, who was also leading

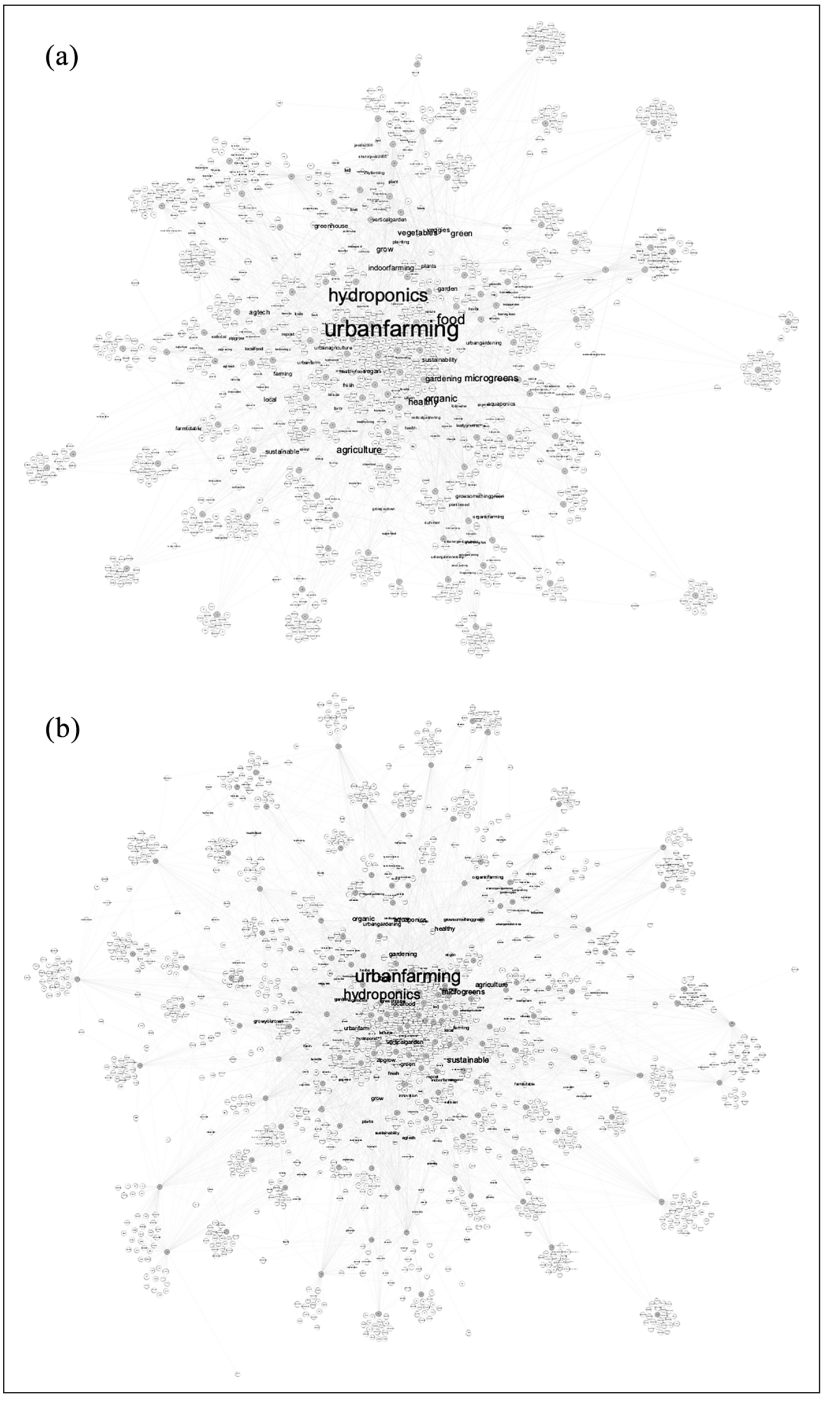

Figure 2. a) hashtag-vision networks collected at the Deutsches Museum. b) Hashtag-vision networks collected at the Science Museum. Both networks laid out in Gephi using the forceatlas2 layout algorithm with settings: linlog mode, gravity = 2.0, scaling = 1.0. Hashtags = white nodes, visions = grey nodes. Colour-coded images and GEFX files available on request.

the project) to provide a short statement on vertical farming, and an equally short shooting of a simulated interaction with visitors. Despite Gugganig's suggestion to also interview a representative from the vertical farming company – one of the project partners – the journalist preferred one person only (and presumably one that spoke German, which was not the case with the industry representative). After Gugganig asked two visitors if they would be willing to replay their interaction from a moment ago, she pretended to show them the tablet with the Re-visioning Device. Yet, the journalist wanted her to show the visitors the vertical farming installation, as it was visually much more intriguing. Gugganig later recalls in her fieldnotes:

> This was the clear break between my role as social scientist and [the industry project partner] as spokesperson for vertical farming, and it was an interesting one: the work of the social scientist – with her object, the visually less appealing tablet – did not work as well for the film crew as the work of the technical expert and her object – the installation with purple LED lights shining on a row of lettuce. And just like that I became the person explaining to the visitors the light spectrum in vertical farming.

Later, the journalist asked Gugganig brisk questions on vertical farming: what is it, what are the benefits, what are the disadvantages and so on. These circumstances – choosing the visually more appealing medium, and asking the social scientist (rather than the industry partner) about vertical farming – revealed a general dynamic in the project: walking on a tight rope between researching and representing vertical farming, where social scientists may be interpreted as spokesperson for a specific topic.

6. Discussion

Analysing the co-occurrence of hashtags in data from online platforms aimed to detect topics of engagement that might otherwise be obscured by platform algorithms designed to give visibility to popular content (Marres, 2015; Rogers, 2018). The results of our attempts to engage 'offline' publics in the issue mapping process suggest some qualifications for the use of this method. The remarkable similarity between the results we obtained from our tests with the Re-visioning Device in the two museum settings suggests that simply removing platform algorithms from the process of engagement is not, on its own, sufficient to limit the structuring effects that platforms, like Instagram, have on publicity.

While our experiment attempted to repurpose Instagram images to cultivate an openness with respect to how visitors engaged with vertical farming, the corpora we obtained from the Re-visioning Device suggest that we might have fallen short of fully realising these aspirations. The presence of dominant Instagram accounts in each corpus, in proportions similar to the overall dataset, casts some doubt on whether our Re-visioning Device did in fact perform as a more open interface than the native platform interfaces employing Instagram's algorithms. Some of these limitations may be due to our design of the Re-visioning Device. Notably, particular forms of 'idiocy'[18] appearing in the dataset (not uncommon in participation experiments, see Horst and Michael, 2011) suggested that our framing of the Re-visioning Device as a technology for opening up engagement with vertical farming might not be necessarily shared by its users. Indeed, the data also suggest that some users engaged with the Re-visioning Device much like they would with a survey instrument designed to assess their comprehension of vertical farming – for example, the following response: 'They [the images] best demonstrated my understanding of what vertical farming is' – rather than engaging them in a critical debate about technology, food and cities. Nonetheless, Instagram's lack of limits on hashtag use also appears an important factor. We might expect such a laissez-faire approach to hashtag use to facilitate

diverse interpretations of vertical farming images, minimising the influence of organised interests in shaping public understanding. However, the above networks suggest that rather than making for decentred networks of interpretation, Instagram's lack of limitations on hashtag use seems to contribute to dynamics of network *centralisation* and the reaffirming of *core* descriptive and industry terminology hashtags.

While these results highlighted some limitations of the data collected by the Re-visioning Device, our museum test suggested other ways in which the Device contributed to destabilising relations between the social and technological dimensions of vertical farming. The encounter involving the *Bayerischer Rundfunk* highlights that in public engagement processes it is often not possible, even in the presence of technological experts, for social scientists to remain neutral on questions of how an emerging technology is publicly represented. A more strongly interventionist digital methods approach might affirm such instability around questions of expertise as a basis for public engagement in issue mapping processes: for instance, modifying the Re-visioning Device to present users with competing propositions about vertical farming images, such as its sustainability or productivity for food production. Our results suggest that the development of digital methods for issue mapping requires approaching the analysis of issues on platforms as inseparable from design concerns about the sociotechnical devices through which platforms engage publics.

7. Conclusion

The issue mapping experiment presented in this article aimed to study online debates about an emerging technology, vertical farming and the extent of public engagement with it as a method of food production. Our study of vertical farming on Twitter and Instagram finds a particular kind of emerging technology whose commercial development is associated predominantly (although not exclusively) with US technology start-ups. Although the credibility of vertical farming as a food production method appears disputed among scientific communities, we found little evidence of such controversy in the platform data we analysed. Instead, popular content on these platforms foregrounds the technological novelty of vertical farming and its future promises to provide 'solutions' to systemic problems in food production. In our co-hashtag analysis of these data, which aimed to detect issues relevant to technology assessment, hashtags appeared to be used more as branding labels than devices for issue articulation and engagement. Analytically, it was therefore difficult to disentangle public debate about future food production from publicity designed to stimulate commercial investment. Vertical farming appeared, in our analysis, a highly *speculative* invention, both in the epistemological sense that it seems to have little basis in science and in the sense that vertical farming intellectual property is a focus of commercial speculation.

Our efforts to engage 'offline' publics in the issue mapping process, using the Re-visioning Device, aimed to control media effects of platform algorithms on content visibility and engagement. This process, however, did not generate more diverse 'visions' of vertical farming but rather appeared to reproduce the hierarchical content structures we identified in the initial dataset. This finding suggests that controlling platform algorithms may not, alone, be sufficient for limiting the influence digital platform architectures and formats have on the articulation of issues and public engagement. Nonetheless, the analysis of commercial publicity about an emerging technology like vertical farming can reveal much about how corporate actors attempt to organise its innovation. Regardless of whether analysis of emerging technology on platforms reveals dynamics characteristic of liberal debate, we suggest that attending to the devices through which publics engage with platforms is central for the development of digital methods for issue mapping.

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Supplemental material

Supplemental material for this article is available online.

Notes

1. Files containing the tweet IDs and image IDs relating to these datasets can be found in the supplemental material.
2. See discussion by the developer of the Visual Tagnet Explorer at: http://thepoliticsofsystems.net/ (accessed 19 August 2020)
3. We have published the source code for the Re-visioning Device at: https://github.com/cultivating-engagement/re-visioning-device (accessed 19 August 2020)
4. More detailed information about these events was written up in two project reports (Gugganig, 2018; Nees and Gugganig, 2018).
5. Visions with at least two obscure images were coded as such.
6. See, for instance: https://www.plenty.ag/company-news/plenty-attracts-largest-ever-agriculture-technology-investment-led-by-the-softbank-vision-fund-to-solve-global-fresh-produce-shortages/ (accessed 12 June 2018).
7. Our Twitter dataset (discussed below) contained a range of tweets making these links, for instance: 'Fluence Bioengineering Launches New Vertical Farming Lighting Solutions https://t.co/XML3cORtyj #cannabis #training'
8. Indicative is the hashtag #urbanfarming which was most frequently used in both Twitter and Instagram datasets analysed below.
9. Tweets syndicated by multiple users often contain external hyperlinks which Twitter converts into a shortened link form. While the text of the tweet is identical, the link therefore often is not. We count as partial duplicates those in which the first 50 characters are identical.
10. Since these metrics are built-in to Instagram and designed to influence the ways in which images are served to platform users, they are also the focus of organised advertising activities aimed to make particular kinds of content visible to users. Although it is hard to draw many valid inferences from these data alone, as metadata, it provides useful context when comparing individual entries within our data set.
11. See https://www.instagram.com/p/BRYOwNolngv/ (accessed 17 July 2020)

12. Of the images collected at the Deutsches Museum, 33% came from top 20 accounts, at the Science Museum it was 30%.
13. In total, 53% of images selected in the Science Museum were technology focused, in the Deutsches Museum it was 49%.
14. Controlled environment technologies accounted for 66% of images in both Science Museum and Deutsches Museum corpora. In neither corpus appeared any images of controlled environment technologies in scientific contexts (at least in so far as we could make out).
15. Images of greenhouses accounted for 25% of in the Deutsches Museum corpus and 23% in the Science Museum corpus.
16. Images of urban gardening accounted for 36% of images in the Deutsches Museum corpus and 39% in the Science Museum corpus.
17. Images of particular plant species accounted for 16% of images in the Deutsches Museum corpus and 17% of the Science Museum corpus.
18. One such 'idiotic' vision simply comprised three identical images of the same post.

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