Framing Nature: Using Augmented Reality to Communicate Ecosystem Services

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Abstract

Public awareness and understanding of ecosystem services has tended to lag behind the increasing use of the concept in landscape planning and design. Augmented reality tools on mobile devices such as smartphones have the potential to help communicate the provision of ecosystem services in different landscape settings and enhance the scope for more participatory landscape governance. This paper discusses the development of such a smartphone-based tool and examines its merits compared to a more traditional paper leaflet in the context of an evaluation by members of the public attending short organised walks in urban and rural river landscapes in Norfolk, UK.

1 Introduction

The concept of ecosystem services (ES) is increasingly important in environmental and landscape planning (e.g. UK NATIONAL ECOSYSTEM ASSESSMENT 2011; DEPARTMENT OF COMMUNITIES & LOCAL GOVERNMENT 2012). However, public awareness and understanding of the concept has tended to lag behind the level of use by professional planners and designers (THE NATURE CONSERVANCY 2013). This is a challenge and a potential problem given the move towards more participatory landscape governance (LANGE & HEHL-LANGE 2010). The use of mobile devices (such as augmented reality applications on smartphones) has considerable educational potential and offers a means of providing supplementary information regarding landscape attributes and changes (LANGE 2011; JOHNSON & JOHNSON 2013). To date, however, empirical evaluation of such an approach has been focused more on urban environments (e.g. CHOU & CHAN-LIN 2012) than rural landscapes. This paper therefore discusses the development of a smartphone-based augmented reality tool to communicate ES in river landscapes and then evaluates how it was used by members of the public attending short organised walks in Norfolk, UK. The smartphone tool was also compared with a more traditional leaflet to assess the relative merits of the two approaches in communicating both the locations of ES and the functions of different features within the landscape settings.

2 Developing the Augmented Reality Application

The augmented reality application VESAR (Visualising Ecosystem Services using Augmented Reality) employs a combination of camera, GPS, compass, accelerometer and a high quality mobile internet (or data) connection. GPS determines the exact location of the device (within a few meters) and the compass and accelerometer define the field of view.

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The person using the device sees the world via the camera image which is displayed on the screen; this image is augmented with additional digital information such as text, images and animations which appear on top of the camera display and are accessed by the user touching Points of Interest (POI) as they come into view (see figure 1). The information is accessed live via the internet rather than being downloaded previously.

Fig. 1: VESAR on an HTC Android phone

VESAR was developed using two internet-based tools: the Hoppala web service (HOPPALA 2013) and the layar™ augmented reality provider (LAYAR 2013), with base data prepared in ArcGIS 10.1 (ESRI 2013). Hoppala holds the location, descriptive and display information for the POIs designated in the base data, while the layar app on the mobile device shows location-appropriate POIs from Hoppala on-screen and allows the viewer to expand them to gain more information (see figure 2).

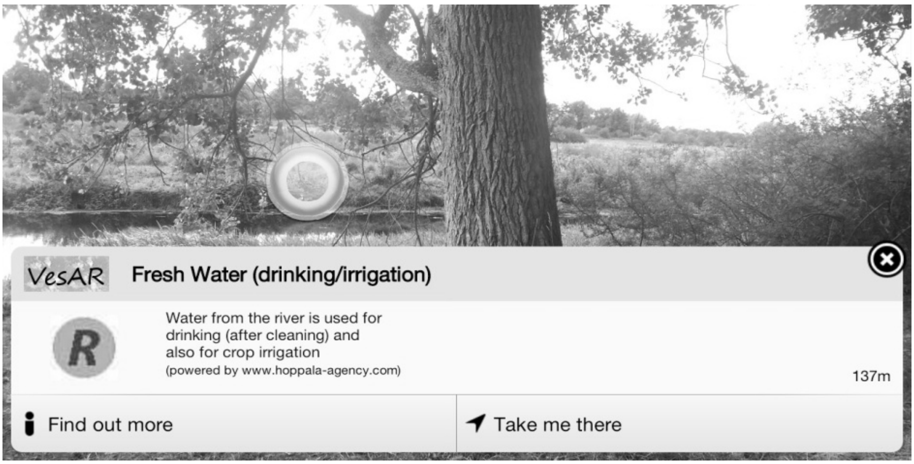

Fig. 2: A view through the camera showing example text

The Hoppala web service limits text files to three lines of up to thirty characters so it was necessary to describe each ES in 90 characters. The MILLENNIUM ECOSYSTEM ASSESSMENT (2005) and the UK NATIONAL ECOSYSTEM ASSESSMENT (2011) were key sources for identifying landscape features providing ES and creating descriptive text about each service. Creating such summary statements proved more challenging than initially anticipated (see examples in Table 1). Based on previous research (DEFRA 2007) it was also decided to adopt the phrase 'nature's benefits' as more meaningful to non-experts than 'ecosystem services', a decision supported by other recent advice (THE NATURE CONSERVANCY 2013).

Initial trials of the augmented reality application highlighted the need for strong GPS and mobile data signals. Evaluation site visits were made to four river valley sites on the fringe of the King's Lynn and Norwich urban areas to assess the quality of signals as well as the range of ES present. Once the strength of signal appeared satisfactory the degree of public access was checked and the features providing ES were recorded using maps and photos, then subsequently digitised into a GIS database. The locations of these features formed the POIs in the augmented reality application. In addition, the route of a planned walk at each site was digitised into the GIS and proximity to the features was assessed to determine a suitable distance buffer within which POIs would become visible in VESAR. Each site had 10-15 different features providing ES.

Table 1: Examples of POI text used in the VESAR application

Name of POI	Type of POI	Text description
Flood Alleviation	Regulating	Drainage ditches allow flood waters to drain away slowly and recharge groundwater
Recreation	Cultural	Many people enjoy the sense of tranquillity provided by the open spaces
Allotments	Provisioning	About 4% of people grow fruit and vegetables within urban spaces including allotments

3 Evaluating the Communication Potential

Participants for the evaluation walks were recruited through collaboration with the Interreg IVB SURF project working in the Gaywood Valley near King's Lynn (HARWOOD et al. 2012), publicity in local press and on social media, and emails to community groups in Norwich. Forty four participants took part in these events during 2012 and early 2013 which involved a group of typically 6-8 people undertaking a guided walk where information on the local ES provision was available via two different tools: the VESAR application on a smartphone or tablet and a more traditional paper leaflet (see figure 3).

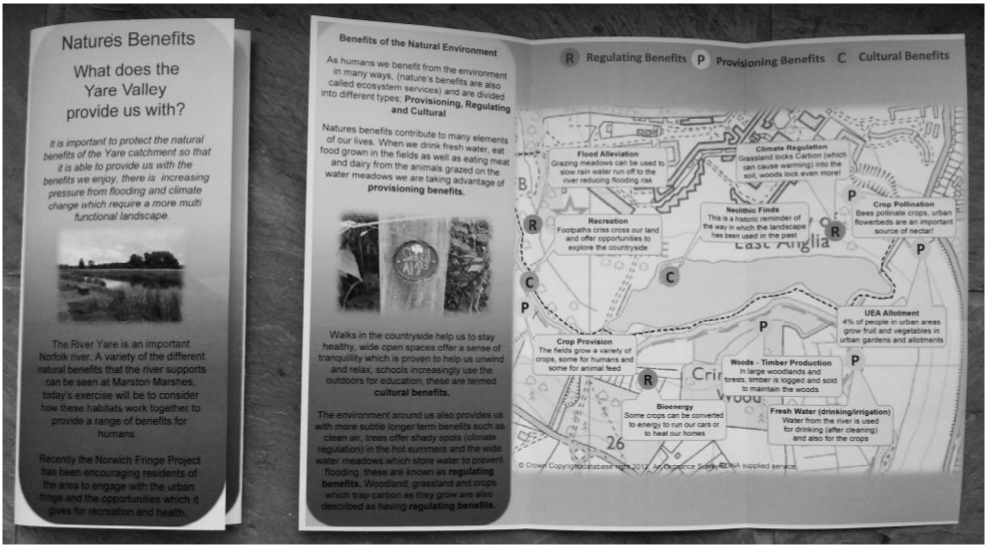

Fig. 3: An example of the leaflet format

The walks lasted between 45 minutes and an hour in total; participants used one tool on the way out from the start, and the other on the way back walking the same route. A three-part questionnaire was answered by each participant. The first section of the questionnaire, completed prior to the walk, evaluated baseline understanding of ES and technological familiarity. The second section was answered after the first tool was used and included multiple choice questions to test understanding of the information shown; the third section was completed at the end of the tour after using the second tool and included similar multiple choice questions.

Additional feedback about the use of the tools was collected via researcher observations during the walks. After each walk participants were encouraged to take part in a debriefing to gather more qualitative data, these post session debriefings provided valuable insight into the way the participants engaged with and used the tools.

4 Results

Of the 44 participants 59% were women and 41% men. Technical awareness was quite high with 93% owning a computer or laptop and 57% a smartphone (defined as a Blackberry, Nokia Symbian, Android or iPhone). However, only 57% had previously heard of ecosystem services.

It was anticipated that age would be a key influence on how people engaged with the ES communication tools. Seven participants were aged up to 25, fifteen in the range 26-35, eighteen from 36-60 and four over 60. Ideally there would have been more participants, particularly of younger ages, but for the purposes of analysis the sample was simply divided into two equal sized groups of those aged up to 35 and those older.

Analysis of the questionnaire data indicated that slightly higher proportions of the younger age group had heard of ecosystem services and owned a computer or laptop. A stronger contrast existed in smartphone ownership (73% in the younger age group and 41% in the older one). When asked at the end of the event which communication tool they liked best, of those who expressed a preference the proportion favouring the smartphone application was 50% in the younger age group and 33% in the older one. However, none of these differences between age groups were statistically significant at the 0.05 level when evaluated using Chi-Square tests.

During the walk participants completed twelve multiple choice questions about ecosystem services after using their first tool and another similar set after the return walk to assess what had been learnt. Table 2 summarises the average scores (out of a maximum total of 12) according to age group and which tool was used first. The results indicate that there was a slight tendency for the test score to be higher in the younger age group after using the smartphone application while for older participants the better scores were more clearly associated with use of the paper leaflet. However, neither of these differences was statistically significant at the 0.05 level when assessed using Mann-Whitney U tests.

Table 2: Average scores on the ES questions by age group and communication tool used

Communication tool used first	**Aged up to 35**		**Aged 36 or older**	
	ES Test Score 1	ES Test Score 2	ES Test Score 1	ES Test Score 2
Smartphone	10.2	10.2	9.0	9.4
Paper leaflet	10.1	10.3	9.9	8.9

At the end of the activity the participants were also asked to rate the two communication tools on a 1-5 scale (5 highest) in terms of how well they helped them understand the locations of ES and the benefits provided. Average ratings for each question by age group and overall are shown in Table 3. These results indicate that the smartphone was evaluated as less useful by older participants while there was no age difference for the leaflet. Across the entire sample there was no significant difference in ratings of the two tools in terms of helping to understand ES locations, but for benefits a Mann-Whitney U test indicated that those of the leaflet were significantly higher at the 0.05 level.

Table 3: Average ratings of communication tools in terms of location and benefits of ES

Age group	**Smartphone helped understanding of ES locations**	**Leaflet helped understanding of ES locations**	**Smartphone helped understanding of ES benefits**	**Leaflet helped understanding of ES benefits**
Aged up to 35	2.9	2.9	3.0	3.2
Aged 36 or older	2.4	2.9	2.6	3.2
Total	2.6	2.9	2.8	3.2

Table 4 lists some examples of comments provided during the debriefing sessions which provide additional perspectives on the two tools. These illustrate positive aspects of the VESAR application such as the interactivity, but also negative dimensions. In particular, far from engaging people in the landscape for some participants the smartphones detracted from the enjoyment of the open space due to needing to constantly review the phone screen.

Table 4: Participant comments on the two communication tools

Positive smartphone comments	Negative smartphone comments
Smartphone can give a greater range of data	Leaflet can be used in all weathers the phones didn't like the rain
Smartphone provides a much better sense of direction	Liked the leaflet, it's what I'm used to!
Knew the area well, but learnt lots of new info in a new way	Smartphone made me feel too disconnected from outdoors
Smartphone much greener – no litter or waste!	Smartphone distracted me from my walk

4.1 Practical experience of using the VESAR application

Four key technological restrictions were noted by the research team while observing the participants engaging with this technology. Feedback during the debriefing sessions indicated that all of these led to some participants choosing the leaflet as their favoured communication method.

- Screen glare – despite using an 'anti-glare' protector there was difficulty in clearly viewing the phone or tablet screen on days where the sun was very bright or directly overhead.
- Battery life – during the pilot site visits it became apparent that the phones needed to be turned off between evaluation walks, or the battery charged, due to the GPS accuracy being directly affected by the battery strength. Using maximum screen brightness to increase visibility outdoors (see above) added to the power demands.
- Accuracy – the POIs had a tendency to 'dance' and disappear from the field of view when a device was stationary. This is primarily a GPS accuracy issue and varied across handsets, other layar users have reported this problem so it is not unique to VESAR. The problem could usually be managed by restarting the application and was less apparent on later version of the layar software.
- Data Signal – the application worked better as a communication tool where there were open vistas such as across farmland and on a wetland nature reserve; use within a more built-up area became confusing when POIs appeared and the associated feature was not within the line of sight. However, the more rural landscapes had poorer signal quality. The intended rollout of 4G networks in the UK should improve this situation. It may also be possible to reduce problems with feature visibility by setting a smaller display radius for POIs in urban areas.

Several of the hardware issues noted above are dependent on general technological progress for solutions, but two other issues which could be addressed in future research are:

- Display design – there were comments that the text size was too small and hard to read. Improved design coupled with a stronger data signal could increase the amount of imagery contained in the applet and the web links, so improving the content.
- Develop a proximity alert so that there is no need to continually review the information on the screen. This would beep or buzz as the user came within range of an augmented reality POI and alert them to the fact that there was information available nearby.

Design options (such as text size) in Hoppala were limited. Making such improvements would most likely require coding a new applet from scratch. This would also enhance the reliability of the technology compared to dependence on third party services: during the final phase of data collection the Hoppala server became unavailable on several occasions (reasons unknown) and survey sessions had to be cancelled, with inevitable consequences for respondent numbers. As with any free service there is no contract of service provision and so developing a self-hosted service would help guard against such issues. These are two clear illustrations of the trade-offs to be made between the convenience of off-the-shelf components and the amount of control over the resulting system.

5 Conclusions

The events and evaluations discussed above indicate that mobile devices such as augmented reality applications on smartphones have considerable potential for communicating the extent and nature of ecosystem services in landscape settings. The novelty of such an application will generate interest, particularly amongst experienced smartphone users, but this research also indicates that at present there are a number of practical limitations and that some members of the public are likely to prefer more traditional communication methods such as paper leaflets. These problems and attitudes may well change over time as devices such as smartphones become more ubiquitous and supporting technology such as GPS and mobile data signals improve, but based on the experience of this study not everyone will appreciate having their attention distracted from their surroundings. It therefore seems likely that while smartphone-based augmented reality could become a valuable tool for the landscape planner or designer it will not be a universal solution and to gain the maximum benefit from such technology it will be important to embed it in appropriate wider decision-making processes. In common with many other aspects of landscape visualisation (e.g. BISHOP et al. 2013) there is consequently still much to learn about how to best apply such communication tools.

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