

# Reflections on Paper-2-GIS: Bridging the digital divide and ‘fuzzy’ boundaries in the Himalayas, India.

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## **Summary**

Critique of the Paper-2-GIS software using a case study from Leh, Ladakh in Northern India. The paper reflects on the successes and limitations in mapping human emotions through GIS specifically using the Paper-2-GIS software. Further research is suggested, with a similar case study being conducted in a western city to help conquer language barriers and map orientation being vital.

**KEYWORDS:** *vagueness, GIS, Himalayas, digital divide, PPGIS.*

PPGIS (Public Participatory Geographical Information Systems) allows in-depth analysis of spatial relationships, creating better understanding of humanity’s interaction with the world (Huck et al., 2016., Carver et al., 2009., Montello *et al.*, 2003., Evans and Waters., 2008). Wright et al. (2009) comment that PPGIS ‘blurs the line between science and non-science’. Closing this gap between the public and scientists encourages inclusivity of decision making on social and environmental issues (Wright et al., 2009., Sieber, 2009). People talk about a particular area by name, or vague geographical terminology, for example “beyond the woods” (Carver et al., 2009., Huck et al., 2014., Evans and Waters., 2008). When a place or region is referred to, what is present or absent within that area can usually be determined. However, if asked to define the particular location that an object is included within that boundary or is not, the boundaries become ‘fuzzy’, varying between individuals (Varzi, 2001, Fisher et al., 2004., Fisher, 2000., Carver et al., 2009., Montello *et al.*, 2003).

Vagueness is difficult to illustrate utilising GIS; areas appear on maps digitally in the form of points, lines and polygons (Huck et al., 2014., Carver et al., 2009). Cartesian-GIS systems can be biased and selective when used with people, thought to “intrude on the interactions between humans and their environments”, making human perception badly suited to traditional GIS (Montello *et al.*, 2003., Huck *et al.*, 2016).

In 2014, Huck et al. used Spraycan PPGIS to address the problem of vagueness in traditional GIS. Online software allows participants to “spray-paint” areas, thus avoiding reduction of place to a line, dot or polygon (Huck *et al.*, 2014). Although results demonstrate success in overcoming vagueness, the issue of digital accessibility remains. Web-based PPGIS allows non-professionals input into topical issues, however, their viewpoints may be over-represented as those without access to technology or who are not ‘digitally competent’ are excluded creating a digital divide (Huck *et al.*, 2014., Dunn, 2007). Paper-2-GIS aims to overcome issues of vagueness and digital divide in GIS, by allowing participants to draw on paper, before uploading a photo of the paper to QGIS for analysis.

## GIS Data Production – Paper-2-GIS (Fig 1.)

1. Paper maps were generated with a QR code containing georeferencing information, and ArUco markers to aid with detection (Fig 1.0 picture 1)..
2. Each map was photographed and uploaded to a computer. The Paper-2-GIS software took the reference image and grey-scaled it (Fig 1.0 pictures 2a and 2b).
3. The map was then extracted from the image using ‘image homography’, and ‘differenced’ against a template map to obtain the information that the participant had drawn (Fig 1.0 picture 3). This is stored as both a GeoTiff, and Shapefile, the latter was then loaded into QGIS for analysis (Fig 1.0 picture 3).

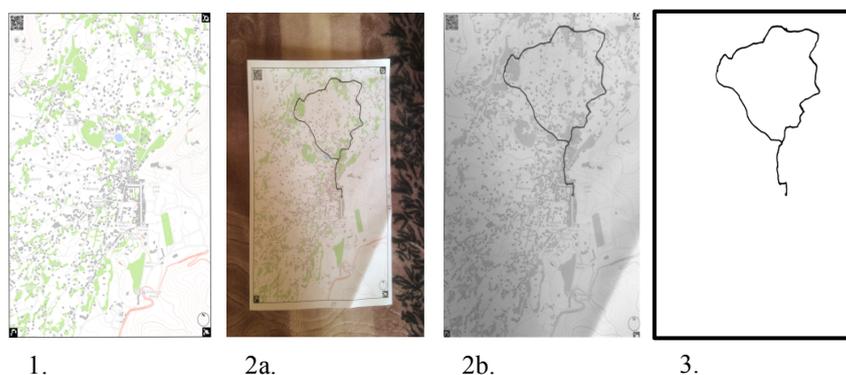


Figure 1.0 – Left to right illustrates the production of GIS maps using Paper-2-GIS software.

### Case Study Illustrating the use of Paper-2-GIS in Leh, Ladakhi Region, North India

The research aimed to identify which areas were most valued by the local population of a constantly developing town. The resultant data may aid protection of valued areas from urbanisation through improved policy (Wright et al., 2009, Sieber, 2009). A wide, as apposed to deep study was conducted, surveying a diverse range of local inhabitants. It was preliminary inductive research; data being collected, analysed and patterns drawn from it without a previous hypothesis, creating the opportunity for further focused studies. (Kitchin, 2014).

6 researchers interviewed a total of 80 tourists and locals of both genders throughout Leh. The total data collected is shown in figure 2.0. General questions were agreed beforehand; where participants lived, what places they liked and what areas were valued. Figure 2.1 shows data from 19 females, figure 2.2 data from 36 males.

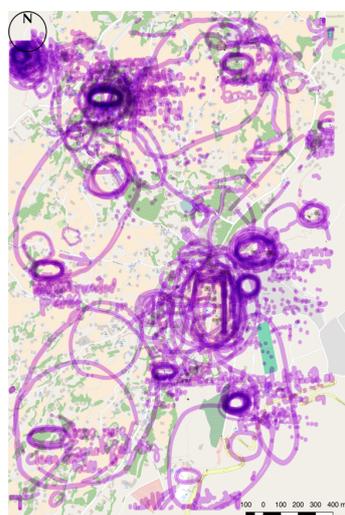


Figure 2.0– QGIS Map to show the areas all participants valued.

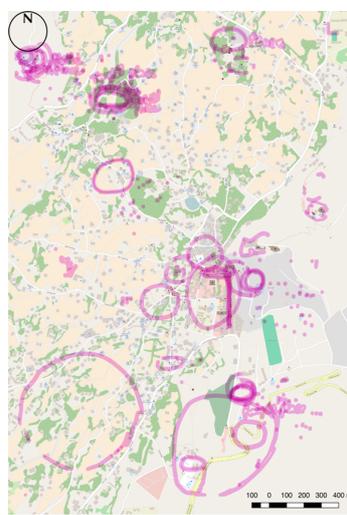


Figure 2.1– QGIS Map to show the areas all female participants valued.



Figure 2.2– QGIS Map to show the areas all male participants valued.

It was difficult to interview the women as they were often “too busy” to talk; a recurring theme. The perceived lack of available time has not discouraged women from aspiring to travel, with some expressing disappointment that men had greater opportunities, regardless of economic status or occupation. Gender disparity is apparent.

In general younger women venture out more frequently, perhaps for education or in response to modern lifestyle change. (However one young woman was expected to ask permission from in-laws to visit her family home and in contrast an elderly lady who owned a tourist agency was very mobile, visiting multiple areas within Leh and further afield.) Both genders

would visit similar locations, often peaceful places, where participants could escape the ever-increasing hustle and bustle of Leh.

### Reflection and Conclusion

In theory Paper-2-GIS should provide a simple method of collecting and representing the 'fuzzy boundaries' that accompany human thoughts, yet in practice this may not be the case.

Paper-2-GIS successfully eliminated the problem of digital divide, evidenced by the ability to create a coherent, well-presented GIS map of collected data, despite being in an area without Internet access. Manual drawing was essential in Leh as few participants had used a computer regularly, making participation impossible had Spraycan been used.

Paper-2-GIS attempts to combat the traditional GIS problem of vagueness by removing the need for a single point, line or polygon. Figure 3.0 shows the most common glyphs drawn by the participants; almost all being a point, line or polygon, with no shading or place identification.



Figure 3.0 – A selection of glyphs drawn by participants.

The intended outcomes of the study may not have been clear due to the language barrier. Many participants asked us to draw on the maps for them, as they felt unable to interpret or visually orientate themselves with the map.

It proved time-consuming to take clear photographs of individual maps ensuring an adequate border surrounded each image, that were acceptable to Paper-2-GIS software. When inputting results, the software was effective, allowing opening of the drawings directly into QGIS without the need for manual drawing onto the GIS interface as Carver *et al.* (2009) found necessary. When uploading Shapefiles to QGIS, some maps were so dark that houses in the reference image were picked up as points of interest. This caused confusion during analysis, but could have been avoided or improved by printing off lighter maps and using a dark black pen.

Although the study had limitations, it was a preliminary inductive study leaving ample scope for improvement. Conducting a further similar study in Manchester may improve the issues of language barriers and map orientation. Immediate improvements would result from having

access to a scanner to upload multiple maps. Ensuring multiple maps are available so each topic of conversation could be recorded on a separate map would allow creation of a cleaner final map avoiding the need to remove individual irregularities.

In conclusion Paper-2-GIS *does* solves the issue of digital divide, producing the means to collect and create maps without Internet, in one of the most rural regions of India. The software *does not* combat vagueness; there are still uncertainties around the places highlighted, and the point at which one place becomes another. Vagueness is present everyday but never discussed outside an academic environment, so when an individual is asked to define a boundary, their perceptions of place become uncertain. Additional research is required to fully understand the concept of ‘vagueness’ in geography, and to improve the representation of vague entities in a digital format by PPGIS.

## References

1. Carver, S., Watson, A., Waters, T., Matt, R., Gunderson, K., & Davis, B. (2009). Developing computer-based participatory approaches to mapping landscape values for landscape and resource management. In Planning support systems best practice and new methods (pp. 431-448). Springer Netherlands.
2. Dunn, C. E. (2007) Participatory GIS – a people’s GIS? *Progress in Human Geography*, 31(5), pp.616-637.
3. Evans, A. J. & Waters, T. (2007). Mapping Vernacular Geography: Web-based GIS tools for capturing “fuzzy” or “vague” entities. *International Journal of Technology, Policy and Management*, 7 (2), pp.1468-4322.
4. Fisher, P. (2000). Sorites paradox and vague geographies. *Fuzzy sets and systems*, 113(1), pp.7-18.
5. Fisher, P., Wood, J., & Cheng, T. (2004). Where is Helvellyn? Fuzziness of multi-scale landscape morphometry. *Transactions of the Institute of British Geographers*, 29(1), 106-128.
6. Huck, J., Whyatt, D., & Coulton, P. (2014). Spraycan: a PPGIS for capturing imprecise notions of place. *Applied Geography*, 55, pp.229-237.
7. Huck, J., Whyatt, D., & Coulton, P. (In Review). Draft available at <http://huckg.is/vague>
8. Kitchin, R. (2014). Big Data, new epistemologies and paradigm shifts. *Big Data and Society*, 1(1). doi:10.1177/2053951714528481
9. Montello, D. R., Goodchild, M. F., Gottsegen, J., & Fohl, P. (2003). Where's downtown?: Behavioral methods for determining referents of vague spatial queries. *Spatial Cognition & Computation*, 3(2), pp.185-204.
10. Sieber, R. (2009). Public Participation Geographic Information Systems: A Literature Review and Framework. *Annals of the Association of American Geographers*, 96(3), pp.491-407
11. Varzi, A. C. (2001). Vagueness in geography. *Philosophy & Geography*, 4(1), pp.49-65.