Comparing Flickr tags to a geomorphometric classification

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ABSTRACT: User Generated Content (UGC), for example, in the form of geotagged Flickr images provides us with new ways to explore the naïve geography of landforms. Here, we compare descriptions elicited from Flickr tags to a geomorphometric classification based on slope, convexity and texture. Slope appears to influence tags most, with tags describing more natural objects being used more in steeper areas. Whilst these results are perhaps not surprising, they suggest that UGC has potential for collecting more nuanced data which will allow us to explore more qualitatively the way in which landscapes are described.

KEYWORDS: Geomorphometry, terrain modelling, user generated content, volunteered geographic information, geotags

1. Introduction

Geographic Information Systems (GIS) typically partition the world into either individual objects or continuous fields – in other words the classic object or field models of space. These models are well suited to representing both anthropogenic *fiat* and *bona fide objects* and more or less *bona fide* natural objects (such as roads, buildings, city council regions or even lakes) and to the representation of properties which can be measured everywhere in space (such as elevation, temperature or snow depth). Thus, asking questions of a GIS such as "how many houses are in Portsmouth?", "what's the total length of roads in the UK?" or "what's the average snow depth in Edinburgh?" are, providing the necessary objects and fields are represented, relatively straightforward.

Perhaps, since much of the development of GIS has been driven by the need to represent and manage anthropogenic objects, and since natural scientists typically conceive the world in terms of fields, it appears that the representation of natural, fiat objects in GIS has received much less attention. Thus, typical datasets represent mountains and valleys through their toponyms which are associated only with a point. Such representations don't allow us to ask questions which appear natural, such as *what is the average slope of the Matterhorn?* (Derungs and Purves, 2007) or *how many farms are in Lauterbrunnental?* These questions seem to be among the class of challenges set out as *naïve geography* by Egenhofer and Mark (1995), defined as "the body of knowledge that people have about the surrounding geographic world". David Mark and colleagues have in recent years pursued work on ethnophysiography, where they have demonstrated that people from different cultures and backgrounds also have differing perceptions of the space around them (e.g. Mark and Turk, 2003). However, gathering information through traditional ethnographic methods is very time consuming, and so-called User Generated Content (UGC) in the form of, for example, descriptions associated with georeferenced images provide us with new avenues to explore how people describe and categorise their surroundings.

Increasing volumes of UGC or, more specifically, Volunteered Geographic Information (VGI) are being captured and harvested from the web to explore, for example, how well road networks are described by volunteers (Haklay, 2010) or the extent of vernacular regions such as "Downtown" which have no official borders (Hollenstein and Purves, 2010). To date most research in GIScience utilising UGC has focussed on anthropogenic objects and regions. In this paper, we set out to explore

how tags associated with georeferenced images from Flickr relate to different landform classes, as derived by geomorphometric methods.

Geomorphometry is defined in Pike et al. (2009) as the "science of quantitative landform analysis. The basic principle of geomorphometry is the "extraction of land surface parameters and objects out of Digital Elevation Models". Land surface parameters are continuous fields which can typically be derived from a Digital Elevation Model (DEM) such as for example the *slope* component of the Matterhorn question above and are typically relatively straightforward to both define and derive, at a given scale. Land surface objects include products which can be directly derived from a DEM algorithmically with relatively straightforward definitions such as *watershed* and much more vague objects such as *mountains* and *valleys*. Recent work in geomorphometry has used land surface parameters to infer classes of landform objects, for example at a global scale in the work of Iwahashi and Pike (2007).

In this paper we explore the relationship between UGC, in the form of *tags* describing georeferenced Flickr images, which we assume provides us with a perspective on the naïve geographies of people visiting those regions, with a geomorphometric classification of the region carried out using the method developed by Iwahashi and Pike (2007). In other words, we want to establish the extent to which quantitative geomorphometric measures can be related to descriptions found in UGC.

2. Methodology

The land surface form classification by Iwahashi and Pike (2007) is based on a signature consisting of three parameters: slope gradient, local convexity and surface texture. The algorithm requires a DEM as input and results in classification of 8, 12 or 16 output categories representing different landform classes. The different classes are defined by using the mean of each variable as the dividing threshold (Iwahashi and Pike, 2007). We used a post-processed SRTM (Shuttle Radar Topography Mission) DEM (version 4, made available by CGIAR Consortium for Spatial Information) with a resolution of 90 Meters to classify landform classes for a region in the American Rocky Mountains.

As described in the introduction, we wished to explore naïve geographies (in this case for the Rocky Mountains) by using geotagged Flickr images. The metadata for images in this region were mined using Flickr's API through the Java flickrj class and we used the coordinates and tags describing an image in our analyses.

In order to gain a representative picture of the geography represented by the tags they were filtered and weighted. First, the tags were filtered by a so-called *geographic intersection*, using a second region in the Canadian Rocky Mountains (hypsometric integral: 0.366), which was considered to be morphometrically similar to the American Rockies (hypsometric integral: 0.385). Only tags occurring in both regions were assumed to represent the given context described by the Flickr users. A manual filtering of the tags was also necessary in order to filter technical related expressions (e.g. camera type) which could not be eliminated by using the geographic intersection. Singular and plural tags were also amalgamated into a single tag.

In this paper we perform two exemplar analyses. In the first analysis, we aggregated the landform categories from Iwahashi and Pike (2007) into four classes to investigate tag clouds relating to different kinds of slope ("gentle" and "steep") and texture ("fine" and "coarse"). The tag clouds for these four morphometric subdivisions were generated by weighting the tags using TF-IDF (Term Frequency-Inverse Document Frequency) method, where the classes are considered as "documents". This method reduces the weight of tags which are common in both the collection as a whole and for a landform class and increases the weight of tags which are common for a landform class, but relatively rare in the collection and is a standard technique in information retrieval. For every class, the weighting factors were normalised between 0 and 1, so that the resulting tag clouds remain comparable by font size.

animal backpacking bird butte camping christian church cloud cycling dog fall fishing foothills friends fun gdmtbr ghosttown glaciernationalpark grass greatdivide hike hiking idaho lake landscape life ministry montana motorcycle mountain mt night outdoor river sarah sign sky snow snowboarding stream summit sunset suspensionbridge thanksgiving travel tree vacation water waterfall white

Number of photos: 4716

alberta animal backpacking blue brown canada cascade church cliff cloud continentaldivide cute cycling dog fall family flora flower forest glacier glaciernationalpark hiking idaho lake landscape life montana mountain mt nationalpark nature park pass peak people red rock rockymountains snow tree trip view water waterfall wedding weiner wildlife winter wood worldheritagesite

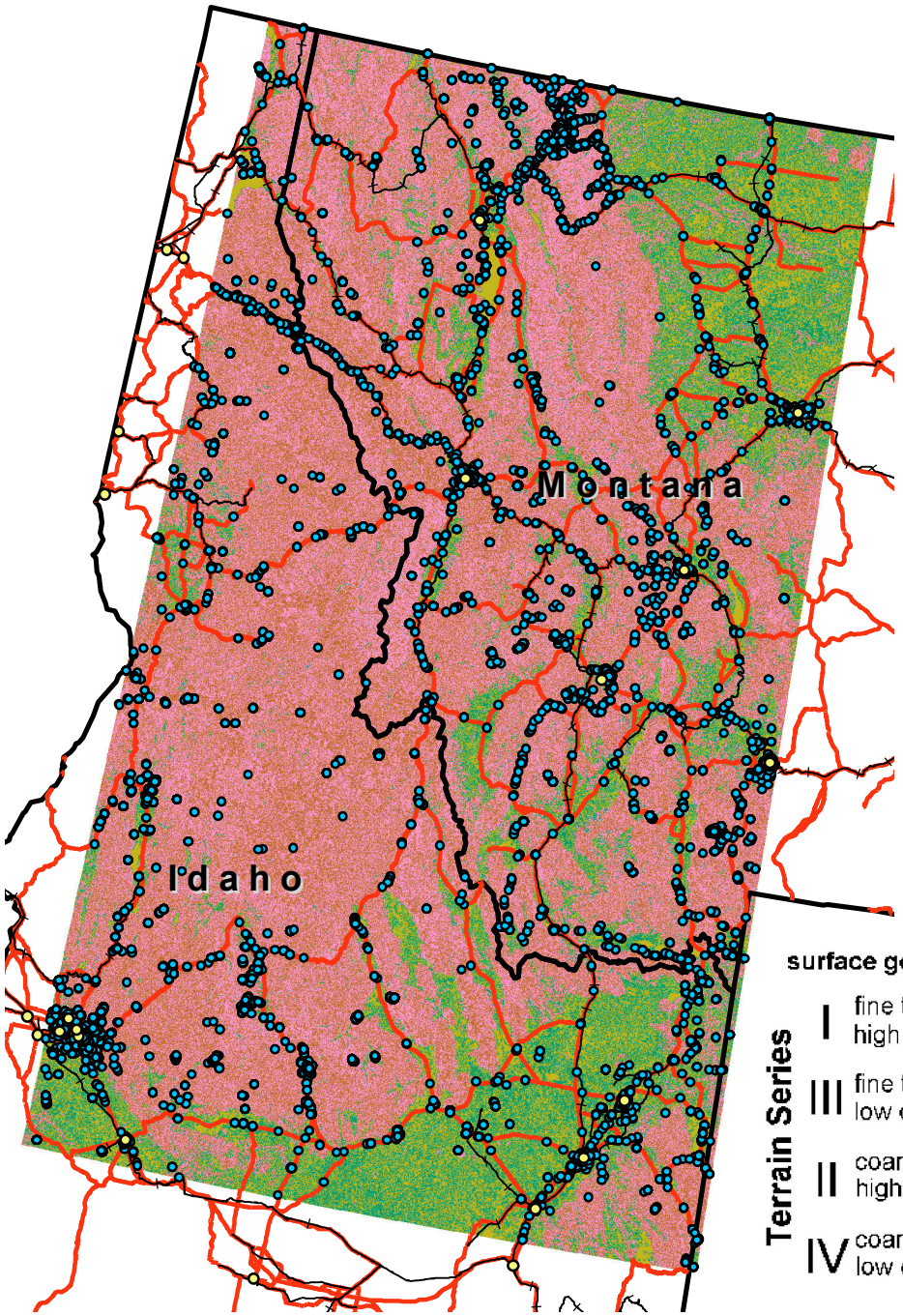
Number of photos: 5197

bar bicycle biggreensign bird birthday blue church cloud cycling dog downtown family flower home idaho june kid life light locomotive mike montana mt music nevadacity night parade park people pond railroad railway reflection river roadtrip rock ruin shield show sign sky snow spring summer theater train tree water wedding winter

Number of photos: 13205

animal architecture autumn bear big biggreensign blue building cloud color fall family glacier glaciernationalpark grass idaho june lake landscape locomotive montana moose mountain mt nationalpark nature outdoor railroad railway reception river rodeo sculpture sign sky snow spring statue summer sunset train training travel tree trip truck vacation water wedding winter

Number of photos: 6933



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Data sources
photo metadata:
Flickr, 2010
major cities & state borders:
ESRI, 2008
railroads & major highways:
ESRI, 2010

N

0 25 50 100 km

Flickr photos
major cities
railroads
major highways
state borders

surface geometry

Terrain Classes

Terrain Series					
I	fine texture, high convexity	1	5	9	13
III	fine texture, low convexity	3	7	11	15
II	coarse texture, high convexity	2	6	10	14
IV	coarse texture, low convexity	4	8	12	16

steep ⟷ gentle

Figure 1. Tag clouds for different slope and texture categories by Iwahashi and Pike (2007)
(tag clouds created with http://www.tocloud.com/javascript_cloud_generator.html, accessed: 1/3/2011)

In the second analysis, for each tag from the American Rocky Mountains we calculated mean slope by taking into account slope at all locations where photos with the same tag were taken. Here, the weighting of the tags is directly proportional to tag-occurrence and additionally to the different users, who chose a given tag. Thus, common tags chosen by many different users are given a higher importance in representing the naïve geography of this region.

3. Initial results and discussion

Figure 1 shows the results of the first analysis, where naïve geography is compared with quantitative landform classes by Iwahashi and Pike (2007). Very obviously, a large number of Flickr images are taken in accessible areas, such as around major cities or along highways and railroads. This fact is also reflected in the greater frequency of images in relatively flat regions (North-East Montana and South Idaho).

Independent of the quantitative separation of landforms by Iwahashi and Pike (2007), toponyms like “montana” and “idaho” are very important for people to reference their image demonstrating the importance of toponyms in describing geotagged Flickr images (c.f. Hollenstein and Purves, 2010). In the tag clouds related to steeper slopes (brown and pink), descriptions of natural landscape (e.g. glacier, mountain, snow, water) and outdoor activities (e.g. cycling, hiking) emerge in comparison to flatter areas (turquoise and light green), where anthropogenic terms (e.g. railroad, railway, train, sign) gain importance. Particularly, in the coarse, flat regions (light green) tags relating to railways are very dominant.

Natural entities are also perceived from flat areas, because landforms like mountains are of a larger scale and therefore can be photographed over large distances. Slope is strongly related to the accessibility of terrain and therefore people settle and build cities, and thus describe anthropogenic objects, in gently sloping areas. This is exactly what we can see in the naïve geography, extracted from Flickr tags.

Perception changes with slope, but not in a systematic way with texture. In Figure 2, we can observe that photos with naturally related terms (e.g. glacier, mountains, peak, trees) appear to correlate with steeper slopes and anthropogenic products (e.g. boat, building, car, train) are much more related to flat areas. Thus, landforms classified according to Iwahashi and Pike’s algorithm (2007) at given scale also lead to differences in naïve geography descriptions in the form of Flickr tags. The main difference in description appears to relate to the difference between steep and gentle slopes (the horizontal axis in Iwahashi and Pike’s classification (Figure 1)).

When we relate quantitative landform classification and naïve geography, the scale of analysis plays an important role. The scale at which a landscape is perceived need not coincide with the dimensions of delimited landforms determined by DEM resolution. Furthermore, the coordinates assigned to an image may be located to the photographer’s position or an object in the image. Moreover, at a landform scale a point in the form of coordinates may not represent the landform depicted in the image. The sensitivity of our results to this uncertainty and abstraction is the subject of future work.

Nonetheless, these initial results suggest that meaningful conclusions can start to be teased from UGC, which go some way towards starting to bridge the gap between standard methods and data in GIS, and the notions of naïve geography proposed by Egenhofer and Mark (1995). However, there is still much to be done, and we are very much at the beginning of work to link quantitative and qualitative descriptions of natural landscapes in ways which go beyond the descriptive and allow us to ask complex questions of these new data sources.

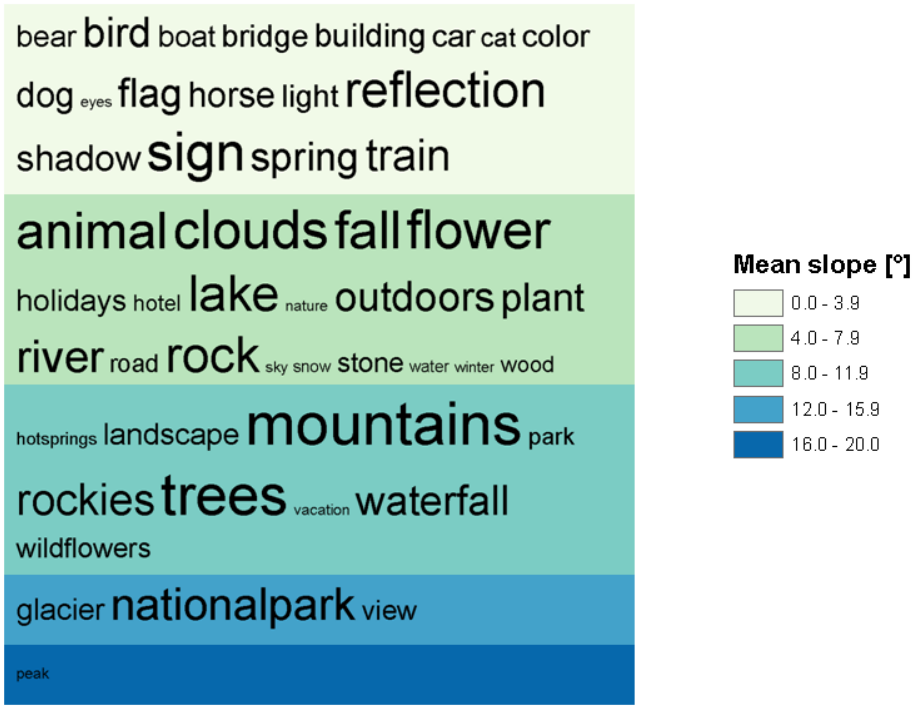

Figure 2. Tag cloud for terms from Rocky Mountains (USA) – tag size indicates popularity and colour mean slope used in conjunction with this tag (created with http://www.tocloud.com/javascript_cloud_generator.html, accessed: 2/22/2011)

4. References

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5. Biography

Christian Gschwend recently completed his Masters in Geography at the University of Zurich, of which the work described here forms the core. Currently he has just started his PhD at the GIS unit. Ross Purves is a lecturer with the Department of Geography and his research interests include geomorphometry, geographical information retrieval and uncertainty.