Abstract:
The Sea-To-Sky Highway hazards project is a geographic information system and volunteer geographic information themed project that defines cyclist hazards along the highway as felt by the riders themselves. Both cycling and VGI are popular subjects in GIS, each lending different insight to the types of maps possible. To accomplish this, a website and map were designed to combine different third party sources together, such as Twitter and Flickr, with user-form data and past project data. Mitigating the hazards along the road involves replacing grates, increasing the frequency of sweeping and potentially installing sharrow lanes.
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Introduction

Traveling along the Sea-to-Sky Highway in British Columbia is one of the most beautiful scenic routes displaying the topography of the province. The highway was originally built to accommodate cars and freight trucks. As tourism has become one of the leading ploys to generate revenue within the province, the highway has acted as a lure for many, including drivers, cyclists and even pedestrians. As a result, safety has become one of the leading concerns for tourists and government alike. Various projects and attempts have been made in BC to establish what risks and hazards exist and how to mitigate them. This report aims at addressing the issue of safety for cyclists using Volunteer Geographic Information (VGI) provided by those who cycle the route. From there, the cyclist perspective provides vital insight into the problematic areas of the highway allowing for future mitigation efforts and rebuilding of the highway to focus these areas.

Using Geographic Information Science (GIS) to map cyclist activity and the environmental conditions they experience have been done before in other countries and cities. The focus of each GIS may be slightly different but it does provide an understanding of how and where cyclist information is mapped using GIS tools. Additionally, using social media and VGI to map safety have also been explored in many ways and in different incarnations of the same issue. A study in Edmonton using VGI and form data mapped sexual assaults in an anonymous fashion. Another study mapped tweets in Africa. The sea-to-sky mapping hazards project bridges these two themes together: VGI (Twitter and Form) and Cyclists.
Project Context

Other cyclist mapping projects such as Cyclopath, BikeNet, and BikeTastic are very good examples of the efforts taken in GIScience to map cyclist activity and to use cyclists as a focus of transportation and safety concerns. This was achieved by concentrating on route and environmental conditions the cyclists faced. Collectively conditions such as speed, velocity, health, potholes, pollution and various others were mapped using cyclist participation and recent innovations in cellphone and GPS technology (Eisenman, et al., 2009; Reddy, et al., 2010; Torre, Sheppard, Priedhorsky, & Terveen, 2010). Where this project differs is the focus on the hazardous environmental conditions and less on routes or health of the riders. Additionally, the means of gaining this information is focused on using third party participants such as Twitter and the cyclists’ own recognisance.

The shift away from sensor mapping and into the field of social media mapping is a fairly recent one. This method of obtaining data brings greater depth and understanding in real-time social practices, cultural phenomenon and various other forms of qualitative data. There are many examples of using mapping tweets made by users on the website Twitter. Mark Graham and the Floating Sheep published and created several maps that took geo-locational data such as longitude and latitude from generic tweets and mapped them to display the trend in tweeting and technology use (Floating Sheep, 2013). Another example of using social media to create social maps is a sexual assault study performed in Edmonton that involved mapping form data as well as personal anecdotes of the assaults (Sexual Assault Map of Edmonton).
Cycling and GIS

As mentioned, there are many GIS maps created using cyclist information and maps created to benefit cyclists in general. Some of the more recent maps were created by Reddy et al. (2009), Eisenman et al. (2010), and Torre et al (2010). The Cyclopath geowiki map created by Torre et al. (2010) is one of the greater examples of methods employed to tag certain data characteristics. When using third party information and participants such as Twitter and Flickr, accessing the right data becomes an issue of contention. Torre et al (2010) focused on creating their own tags within user form data (Torre, et al., 2010), this allowed users to correctly identify different characteristics of the path they were taking. Although the purpose alters from the Sea-to-Sky project, it resembles greatly the notion of creating and utilizing hash-tags from Twitter to target cyclist specific information. The hash-tags are the same as normal tags, containing short lines of text that are universally shared. These tags contain the ‘#’ symbol before any tag as a note of distinction between normal tagging methods.

Using online web-specific tags is only one way to target the right information. The other method is to employ a more direct approach such as with Eisenman et al. (2009) and Reddy et al. (2010). Both teams of authors employed the method of sensor mapping. They attached sensors to the cyclists who volunteered in the study (Eisenman, et al., 2009; Reddy, et al., 2010). These sensors were a mix of Nokia phones and GPS transmitters (Eisenman, et al., 2009). By tracking the riders’ location using the GPS, they could calculate the speed of the rider. If the rider encountered a pothole, there would be a reduction of speed (Reddy, et al., 2010). This method can be considered indirect VGI, as volunteers within the cyclist community helped with the
initial research. Later, more sophisticated mobile applications continued tracking the cyclist routes for whoever activates them.

Social Media and GIS

The other side of the equation of mapping hazards along the sea-to-sky highway using cyclist VGI rests with the concepts behind mapping social media phenomenon. The social media phenomenon came into being with the production of the World Wide Web (WWW). In relation to Geographic Information Systems and Sciences, the geographies of social interaction within the web have given birth to the concepts of cyberscape, and digiplace. Graham & Zook describe cyberscape as the “type, amount, and quality of geo-coded data on the Internet about places” (2011). Contrary to cyberscapes, digiplace is defined as “the sense of place created when cyberscapes influence our understandings and interactions with and through material place.” (Graham & Zook, 2011). These concepts are prevalent in maps created using VGI methods. This is due to the paradigm shift from government produced datasets to user-generated datasets (Elwood, 2010).

The Sexual Assault Map of Edmonton is a great example of user-generated datasets, shifting away from traditional forms of data, such as the Canadian census. This map uses Google maps and Google documents as a means of data collection of voluntary participants. The anecdotes are anonymously submitted and geographically displayed using street addresses and other clues of location. The website comments that this type of mapping can “voice what is usually silenced” (Sexual Assault Map of Edmonton). VGI in this context acts as a means of bridging the gaps between analyst and participant. The maps generated also contain data that is not typically displayed in more traditional point, line and polygonal maps.
Although the Sexual Assault Map of Edmonton used form-data to collect data, there are other methods to map social media phenomenon and VGI. Twitter is one of the most popular forms of social interaction within the Web. Additionally, Twitter allows for its 140 character statements to be geo-coded with latitude and longitudinal coordinates. Applying this to GIS technology yields research such as Graham and the Floating Sheep’s Urban Geographies of Tweets in Africa whereby generic tweets in various cities were mapped (Floating Sheep, 2013). They describe certain cities as “swimming in thick clouds of information” (Floating Sheep, 2013), implying different levels of participation via Twitter for different cities with different levels of access to the technologies that ultimately reveal the digital divide.

The notion that different levels of participation will yield different results lends credence to the concept of the cyclist perspective that we are attempting to negotiate in the construction of the sea-to-sky hazards project. The user-form data and tweeting capacity of the cyclists information will reveal any road hazards as seen by the cyclist themselves. This method of mapping the highway does employ exclusionary practices. Vehicle drivers and pedestrians will not perceive a hazard as strongly or weakly in relation to a cyclists needs, making the need for the Cyclist perspective crucial to understanding the hazards that exist and how to mitigate them.

Methods

The means of achieving our design of a cyclist VGI map along the sea-to-sky highway involves using various online platforms to mine for data and display them. The primary sources we are using are: Google, Twitter and Flickr. A secondary data source was decided upon to allow for greater anonymity and that is user generated form data. Mobile devices are the primary source by which users can contribute data to the map in real-time. Modern phones have GPS
functions included with the mobiles, allowing for pictures and statements made on twitter to be geo-tagged with coordinates that correspond to their general location. Once the data has been mined and filtered using tags, they will then be fed directly into the map. In the case of the user generated form data, the form data will be stored in a PHP script (or Hypertext Pre-processor script) before being saved in an XML file (Extensible Mark-up Language) which Google maps can interpret and display. Beneath the VGI data, data from the 2012 Sea to Sky Highway: Cycling Safety Project will act as a base from which users can identify previously defined hazards, safety measures and proposed safety measures.

Coding

Both the Twitter and the Flickr encoding require similar needs to targeting and determining certain data. Within the coding, there are specific functions that allow for returns to be made for tweets less than a week old. This is due to Twitter's policy of keeping tweets for API usage within 7-10 days forcing the protocols to continuously search and data mine for newer tweets. Contrary to Twitter, Flickr allows for its API access to all photographs within its database. This means that photos as old as the website's construction are possible to access. API refers to the application programming interface which is supplied by Twitter and Flickr. Both programming codes use a search API to create a JSON (JavaScript Object Notation). JSON’s allow for text-based standards meant to make it easier for both people and machine to interpret and read (Json.org).

Functions which define the data mining search within the encoding protocols go something like this:
The function uses `json?callback` which creates the JSON file to allow for Google maps to identify and read the mined data. The `pos.lat` and `pos.lng` segments define the area which is to be targeted from geocoded tweets (and by extension, Flickr) data. To ensure that the right information is targeted, the “Q=S2SCycleSafe&” segment was added. S2SCycleSafe is a hashtag that was used in this project so as to call upon tweets from users who more than likely have enabled geocoding. The segment ‘100km&’ defines the radius of the search around the initial coordinates of the target area. For the Sea-to-Sky hazards project, our target area is Squamish, with a 100 km radius around the town. This was so as to extend to both ends of our section of highway, from Horseshoe bay to Whistler. Lastly, the segment ‘rpp=100’ is the number of tweets that are returned from the search and subsequently displayed.

A similar function is found in the Flickr encoding. The difference between the two is that the Flickr code does not have a return number; instead, it can hypothetically return all images uploaded onto the Flickr website. To avoid the issue of data mining the wrong information from Flickr (and Twitter), the notion of tags came into play. Websites such as Flickr and Twitter allow for some form of tagging images and tweets using short text. In the instance of the Flickr encoding, the ‘ryan’ aspect is an interchangeable designation, but the `.getFlickr()` segment is the function that calls upon textually tagged data. Keeping with the theme of our project, the key words used are cycling, bicycling, and the twitter for hashtag which users can also use to identify photographs of the road.
The encoding needed for the user-generated form data was a bit more complex than the functions and scripts used to data mine Twitter and Flickr for corresponding information to the Sea-to-Sky highway hazards. The interface of the form allows for the user to click on the map, whereby a Google marker will appear with an info window, allowing the user to fill out the pertinent information about the hazard before clicking the save button (Appendix A). Saving the data will run the PHP script, causing the form data values to be placed in the markers. XML file. This creates one ‘entry’ into the XML file. Thus, every time a user submits data using the form, the XML file will be updated with a new ‘entry’ without overwriting previous ones. To ensure that the markers are displayed properly, a JavaScript code draws the markers from the XML file with the corresponding values displayed in the info window upon clicking on the marker. When the PHP script has finished running, the page automatically resets, updating the marker.xml file that is being interpreted by the website and ultimately adding new markers to the map.

**Results and Discussion**

Given that this project required active participation from volunteers within the cyclist community, our results are not immediate. As this project provides a framework by which to navigate safety concerns and hazards along the sea-to-sky highway, any results will be revealed in the aftermath of the website launch and subsequent use. Instead, this section is devoted to hypothesising future results based on previous data on the Sea-to-Sky highway cycling hazards.
There are undoubtedly a few errors and hypothetical results to be expected in the subsequent use of the website and map. Using the previous data collected by A. Yew and her associates in the Sea to Sky Highway: Cycling Safety Project as a base, we can hypothesize that cyclists will experience similar hazards along the highway. These hazards were identified as drainage, shoulder width, signage and debris maintenance (Cairns, Brear, Dixon, Szabo, & Gamon, 2012). Geographically, the hazardous drainage grates are more numerous from Horseshoe Bay to Lions bay before dropping off as they near Squamish (Appendix B). For narrow shoulder widths, just after Porteau Cove and before entering Britannia Mine, are the two most concerning areas. These areas are likely to reflect trends in the VGI in the following months of the websites launch. However, there are concerns that the results will be skewed geographically.

There are two ways that the results can be inaccurate geographically on the map. The first is by simply understanding that the user-form data allows for individuals to place their markers anywhere on the map. This implies both possible abuse of the map and inaccuracy. At best, the user-form data allows for a very general understanding of where hazards might be located on the highway in both northbound and southbound lanes. The second way in which data may become inaccurate was brought up in discussion with the Hub North Shore advocacy group. They hypothesized that a cyclist would not be able to continuously tweet data in route from the highway due to safety issues (Hub North Shore, personal). Therefore, we can also expect in future results that the data will reflect ‘safe spots’ whereby the cyclist deems it advantageous to stop either in a wider stretch of road or in a parking area to report a hazard they had just passed. This means that data could be geographically inaccurate up to hundreds of meters depending on the capability of the cyclist to navigate the highway.
Mitigation

There are a few ways to mitigate the hazards along the Sea-to-Sky highway, some of which has been addressed in the previous project. Replacing grates with bike friendly ones, increasing signage along the highway, installing bike activated signal lights, and sweeping the shoulders were the solutions discovered in the past projects report (Cairns, et al., 2012). We will briefly highlight mitigation possibilities that the Sea to Sky Highway: Cycling Safety project propose before suggesting alternate methods. Another possible mitigation effort for hazards and potential accidents on the Sea-to-Sky highway is the idea of the shared bike lanes, especially when entering the popular towns and tourist areas where the speed limit is lower.

According to the Neena Foundry some drainage grates are better than others regarding Bicycles. The Type L Vane style grate (Appendix C) they suggest allows for passage over the grate from both ends and allows for small debris to pass unobstructed (Neenah Foundry). However the Highway is, at many points, close to cliff walls and vegetation, implying that there will be larger debris than the grate may handle. The Department of Transportation in North Carolina suggests Type E, F or G grates (North Carolina Department of Transportation, 1994). These grates allow for the passage of slightly larger material than the Type L Vane grate. These grates would allow for cyclists to transverse safely without fear that their tires would catch on the grate or between the slots causing an incident.

Debris from vehicles, vegetation and wildlife are another concern for cyclists. The British Columbian Ministry of Transportation presented a maintenance schedule for all of BC in 2004 that detailed a debris removal schedule for all their contractors. When debris reached volumes of over 1000 cubic centimetres, removal was to occur within hours of the spill (British Columbia
Ministry of Transportation, 2003-2004; Forbes & Robinson, 2004). The Sea-to-Sky highway is prone to vegetative creep along the sides of the highway where cyclists are forced to pedal. This implies that the build-up of debris and material is slower than a crash site or tanker spill. Like debris removal, the roadside removal of vegetation increases depending of the class of highway. In order to increase the frequency of road debris removal and sweeps along the shoulders for vegetation, the class of the highway needs to decrease in order to justify the expenditure. One of the ways to decrease the class of highways to become more critical is to increase traffic along that highway (Toronto.ca, 2013).

One of the newer ideas of mitigating hazards along the Sea-to-Sky highway in regards to narrow shoulders is to create shared bike lanes. The idea is to paint bicycle signs on the road to inspire drivers to be watchful of cyclists, yet the signs do not necessarily mean a separate bike lane. The narrow part of the highway at Porteau Cove and Britannia Mine is too narrow to expand into the cliff face (for Porteau Cover) or the ocean (for Britannia Mine). The shared bike lanes, called sharrows, are known to improve cyclist maneuverability when traversing difficult areas of the road (US Department of Transportation, 2010). On the highway, the sharrows would prevent cars from passing the cyclist until it was safe; one of the reasons for proposing the sharrows only be installed in areas where the speed limits are declining and entering more tourist areas and towns. The Porteau Cove area is once such tourist spot, with Britannia Mine being another. As the highway cannot be widened in these areas, sharrows might be a good way to raise awareness of cyclists and increase the amount of space they have (US Department of Transportation, 2010).
Future Efforts

This Preliminary report is only meant to highlight the possibilities of the VGI cycling map. Just as this project was building upon a previous project we hope that our work can be further improved upon in order to aid in identifying and reducing hazards to cyclists. It would be the responsibility of whoever takes on this project beyond the preliminary report to assess and analyse the findings as the VGI gets added to the map. In terms of other mapping possibilities, there may be other projects that can combine the protocols of this project to the entire Metro Vancouver area, for example. Other ideas include mapping the hazard of speed, not just for cyclists but for all vehicles traversing the highway. Speed is not often thought of as a hazard.

Conclusion

Both cycling and VGI have become very popular subjects in GIS. This report acted as a bridge between these two ideas and created a cyclist interactive map that specialized in using VGI to locate potential hazards. Creating the map and website involved many different protocols process such as JavaScript, PHP, XML, to name a few. None of the authors of this report are programmers, making the attempt even more interesting. Hypothetical results based from previous data collected gives us the ability to perceive where the VGI may come from, where cyclists would find the most difficulty and where they would likely report from. To avoid repeating the entire previous project’s information, the mitigation possibilities outlined involved discussing the types of grates to reinstall over the dangerous grates: increasing the frequency of roadside sweeps for debris and vegetation; and for narrow shoulders, to introduce the possibility of sharrow lanes so as to increase awareness for drivers.
This project and preliminary report may have reached its limits of possibilities for mapping the hazards along the Sea-To-Sky highway, but the processes here and the protocols within the coding can also be applied to other areas of British Columbia.

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References


Appendix A:

The above is the user form detailing all aspects asked for. It is noted that an Image URL can be added to the form, which other users can click upon and see the image of the hazard the author of the marker has supplied with.
Appendix B:

The above is a Map detailing the previous project, the Sea to Sky Highway: Cycling Safety Project’s results. Based on these results, we can expect similar instances of tweeting in these areas regarding types of hazards. This image was retrieved from:
http://www.sfu.ca/geog/stsbikesafe/map.html
Appendix C

The following schematic images are of grates suggested by the Neenah Foundry and the North Carolina Department of Transportation as “bike safe” grates.