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A participatory WebGIS platform to support biodiversity inventory in the Geneva cross-border area

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Abstract: The context is the URBANGENE project which aims at estimating the impact of urbanization on biodiversity using genetic information. The paper discusses the opportunities to involve citizens in a conservation process through the development of a participatory platform based on user-friendly, specially adapted and reusable crowdsourcing tools.

Keywords: Urban biodiversity, citizen Science, crowdsourcing, participatory WebGIS, social media

1 Introduction

Green spaces and biodiversity have an extremely important role in urban areas. They have a clear impact on water flow, on micro-climate regulation, on air quality, and on the health of residents. In recent years, the growth of the population combined with the reduction in the number of persons per household has led to a high consumption of green areas (Rietsch 2014). As there is empirical evidence showing that interacting with nature in cities delivers measurable benefits to people (Aldous 2007, Fuller & Irvine 2010), this progressive urbanization implies a strong

fragmentation of semi-natural environments, what clearly endangers urban biodiversity and causes decline in the quality of life of the population.

The URBANGENE project (urbangene.epfl.ch) will estimate the impact of urbanization on biodiversity using genetic information. Similarly to a study carried out in Marseille in 2011 (Schoville et al. 2013) it will measure the diversity and biological connectivity in three species (one plant, one butterfly, and one amphibian) in order to obtain objective information (quantitative measures) on their ability to migrate between habitats and to adapt to the urban environment. In the context of the planning and of the management of the urbanization process, important goals of the project are to establish a diagnosis of the current state of biodiversity dynamics and identify the ecological, socioeconomic and sociodemographic factors influencing gene flow and adaptation of plant and animal species in urban areas.

Six-hundred individuals of the broad-leaf plantain plant species were sampled during summer 2013, and meadow brown or small white butterflies will be sampled during summer 2014. As regards amphibians, the sampling phase took place during spring 2014. But in this case, it was necessary to target private ponds to complete the official list of sampling areas provided by the Swiss Confederation and by the State of Geneva. To this end, a WebGIS-based participatory platform was developed in order to make it possible for Geneva residents to indicate on an interactive map the geographic location of ponds, and to transmit information on the species they were able to observe in this area.

2 Crowd-sourcing for biodiversity inventory

The recent evolution of the Internet has generalized crowd-sourcing approaches also in the field of geographic information through Public Participation Geographic Information Systems (PPGIS) initiatives (Merrick 2003, Elwood 2006). After the first age of the Web was about one-directional publication of informational content, the second age started with the ability to comment on blog posts and is going on its way by the involvement of web users in the production of raw data and of structured content. OpenStreetMap is one famous and relevant project, a collaborative and community-based action for digitizing and mapping the world. We may notice that such actions are often associated with open data licensing.

Related to the field of biology and biodiversity monitoring which corresponds to the URBANGENE project, an interesting example is The Atlas of Living Australia (www.ala.org.au). The type of collective effort to constitute such an atlas is named "citizen science", which is a systematic collection and analysis of data, the development of technology, the testing of natural phenomena and the dissemination of these activities by researchers on a primarily avocational basis, as defined by the OpenScientist website (<http://www.openscientist.org/>). As mentioned by Cohn (2010), the collaboration between scientists and volunteers is likely to enhance the ability to collect scientific data, but it is also expected that public www.ogrs-community.org

participants may contribute valuable information as they learn about biodiversity (in the present case) in their local communities.

Anyway, in such contexts, it is key to rely on robust computer platforms and on user-friendly applications to facilitate the task of contributors when they input their data (Haklay & Tobon 2003). From a technical point of view, even if such crowd-sourcing platforms may be based on classical Content Management Systems (CMS), they are usually tailor-made according to the investigated topic. Moreover, we must admit that there is a plethora of plug-ins to publish maps based on CMS plug-ins, but there are currently only few CMS offering integrated and ready-to-use crowd-sourcing solutions (Palazzolo & Turnbull 2011).

3 The URBANGENE web-based PPGIS platform

Given the above technological state, the present project aims at exploring possibilities to develop a CMS oriented approach based on a generic plug-in. The advantage of such a plug-in would be to provide an adaptable and configurable tool to match the needs of any underlying investigated topic (e.g. configuration of a custom geodata-type, editing tools for point/line/polygons, survey builder, etc). The developments will benefit from the concrete URBANGENE experimentations and help to lay down the relevant questions useful to frame the adaptability of a generic plug-in. To this end, a first step consisted of the creation of a standalone web application (Figure 1) based on a HTML5/CSS3 development making use of an open source stack of JavaScript libraries providing useful online mapping standard features. Indeed, Leaflet - the core mapping framework - is a modern library for user-friendly interactive maps, it is designed with simplicity, performs well and gives importance to usability.

Leaflet is able to access different base maps (e.g. Openstreetmap, etc.), to organize information layers, to handle geographic objects, to pan and zoom, etc. This library has several plug-ins or controls, among which the "Leaflet markercluster" enabling the aggregation of points when a large geographic scale is displayed. Leaflet also permits to access third party data (e.g. Google geocoding service) and facilitates user input with an auto-completion functionality. The jQuery UI library permits to comfortably manage the elements of the user interface. It is used in particular to provide and manage interactions like the "drag & drop" functionality also available on tactile devices (jQuery UI Touch Punch). Finally, the jQuery.kinetic plugin improves user experience through fluid map manipulations.

On the server side, PHP is used while collected data are stored in a database managed by PostgreSQL/PostGIS. The prototype developed here implemented a very simple data model. A single table was used to collect the coordinates (X, Y) of a pond, the name of the species observed around, a type of pond (private or public), an email address in the case the owner provides the authorization to sample in his private property, a name (user inputs are anonymous with the opportunity to

provide a name or a pseudonym to appear in the list of acknowledgments) and an optional section with 6 short general questions on biodiversity perception.

Open source software components are used both at client and server sides because it allows to access the underneath models and algorithms without any limitation (Rey 2012). This is especially relevant for the evaluation of the Leaflet JavaScript library in comparison to the famous OpenLayers. Both being became mapping libraries of reference (Steiniger & Hunter 2013), the first is relatively recent and promising while the second is currently progressing towards a third major release. Indeed, the capacities of the underlying cartographic model and the flexibility to control user interactions are critical requirements for the creation of a user-friendly crowdsourcing application. Also, the level of extensibility is an important aspect to consider for a generic plug-in approach. Such an exploration and evaluation helps to choose the adequate webmapping library able to answer the objectives at best. It will be pursued during the next steps of the project. Finally, the project itself is planned to be released under a free license and managed as a GitHub project (github.com/comem/urbangene).

In a successive phase of the project, we will evaluate how existing plugins - e.g. WordPress Form Maker as a survey builder, Drupal Geofield to create geodatatypes - or other components may be integrated so as to create specific crowdsourcing features.



Figure 1: User interface of the URBANGENE Web PPGIS application. The map shows the Geneva cross-border area (the border between France and Switzerland appears in grey). On the right, the panel displays observed species to be indicated by users and additional questions.

4 Tentative results and conclusion

In March 2014, advertised by efficient media coverage (Overney 2014), the URBANGENE PPGIS web-platform gave the opportunity to Geneva cross-border area residents to participate in the inventory of private ponds. This permitted to collect an initial list of 99 target areas (on April 23, 2014) likely to facilitate the task of biologists. Indeed, collaborators were able to start the sampling of common toads along 5 main urban development directions. In a successive step, DNA will be extracted, and then sequenced to enable the computation of genetic diversity indices to be compared with the urbanization process in the metropolitan area.

As the urban natural environment and its biodiversity belong to the residents, such an action is a good opportunity to give people a chance to get involved in a conservation process. The feedback received during the first month of data collection shows that the project called the attention of urban residents on an important but often unrecognized issue in urban planning. It also created an involved community in the domain (www.facebook.com/urbangene).

From a technological point of view, the development of a generic CMS plugin will facilitate the adaptation of the application to various use cases, and favour its reuse for the deployment of future biodiversity PPGIS initiatives.

References

- Aldous, D.E. (2007), Social, environmental, economic, and health benefits of green spaces. *In* Proceedings of the International Symposium on Horticultural Plants in Urban and Peri-Urban Life, 171-85.
- Cohn, J. P. (2008), Citizen Science: Can Volunteers Do Real Research? *BioScience* **58**, 192-197.
- Elwood, S. (2006), Critical Issues in Participatory GIS: Deconstructions, Reconstructions, and New Research Directions, *Transactions in GIS* **10**, 693-708.
- Fuller, R.A., Irvine, K.N. (2010) Interactions between People and Nature in Urban Environments. *In* Urban Ecology, Gaston, K.J., Ed., Cambridge University Press: Cambridge, UK, pp. 134-171.
- Haklay, M., Tobón, C. (2003), Usability evaluation and PPGIS: towards a user-centred design approach, *International Journal of Geographical Information Science* **17**, 577-92.
- Merrick, M. (2003), Reflections on PPGIS: A view from the trenches. *URISA Journal* **15**, 33-40.
- Multispecies investigation of the impact of the urbanization process on genetic diversity in the Geneva cross-border area,
 URL: <http://urbangene.epfl.ch/> [accessed on January 31th, 2014]
- Overney, J. (2014), Contribute to Science by Locating Geneva's Wildlife Habitats. EPFL News.

URL: <http://actu.epfl.ch/news/contribute-to-science-by-locating-geneva-s-wildl-4/>
[accessed 12.5.2014].

Palazzolo, A., Turnbull, T. (2011) *Mapping with Drupal, Navigating Complexities to Create Beautiful and Engaging Maps*, O'Reilly Media, Cambridge (MA).

Rietsch, R. (2014), Informations Statistiques n° 4 - Janvier 2014,

URL:

http://www.ge.ch/statistique/tel/publications/2014/informations_statistiques/autres_themes/is_population_04_2014.pdf

Schoville, S. D., Widmer, I., Deschamps-Cottin, M., Manel, S. (2013) Morphological Clines and Weak Drift along an Urbanization Gradient in the Butterfly, *Pieris rapae*, *PLoS ONE* **8**, e83095.

Rey, S. J. (2012), Open source spatial analysis: lessons for research and education from PySAL, in *OGRS2012: Proceedings of the second Open Source Geospatial Research & Education Symposium*, Lulu.com Self-publishing, Olivier Ertz, Stéphane Joost, Marj Tonini, Yverdon-les-Bains, Switzerland, pp. 66-71

Steiniger, S., Hunter, A. J. S. (2013) The 2012 free and open source GIS software map - A guide to facilitate research, development, and adoption, *Computers, Environment and Urban Systems* **39**, 136-50