

Open Mapping with Official Cartographies in the Americas

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Abstract

Governments need data to be effective and accountable to the SDGs. Spatial data are key to meeting these goals, and youth open mapping represents one way to support official cartographies, especially to advance SDG 16. We explored how youth could add value by integrating OSM data into public agency maps while offering education opportunities (SDG 4).

Keywords

Public institutions · Volunteered geographic information · Official cartography · Belize · Jamaica · Colombia · Costa Rica · Dominican Republic · Mexico · Panama



1 The Case for Open Spatial Data in Public Institutions

Public government institutions are responsible for providing many critical services to all citizens. They also are the entities that report to the United Nations on official statistics about the Sustainable Development Goals (SDGs) (Stuart

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et al. 2015; UN 2014). To accomplish this mission, and remain both effective in delivering services and accountable, including indicators like the global goals, our public institutions need to leverage spatial data (Brovelli et al. 2019). They do this typically through a national spatial data infrastructure (NSDI), which is created and managed by official government cartographic agencies like national mapping institutes.

But it is often difficult and expensive to maintain comprehensive NSDIs for many countries, especially lower-income nations. It is a related challenge to do so in ways that offer open public access to this public institution's information.

On the other hand, crowdsourced maps produced by volunteers contain important information for building NSDIs and supporting the efficient services and accountable metrics related to them. But unfortunately, this open volunteered spatial information like that found on OpenStreetMap (OSM) is not frequently well integrated into official cartographies. Some of the barriers to this include that local and national public institutions may not trust data quality, official standards may not coincide, and sometimes even volunteered data is still incomplete.

We developed a project to explore these kinds of challenges and barriers using YouthMappers as a testbed for finding opportunities to link OSM data with official cartographies within a group of seven countries in Central America and the Caribbean. These case studies fit into a larger study focused on expanding our knowledge concerning the challenges and conditions of acceptance of volunteered geographic information being incorporated into the official framework of geographic data, users, tools, and applications of the Western Hemisphere (Wintemute et al. 2021). Our main goal was to connect with government geographers and cartographers to explore how OSM and YouthMappers could support building effective, accountable, and inclusive institutions, especially related to their NSDIs, meeting SDG 16. In the process, by engaging a team of YouthMappers and involving and establishing local chapters, our work offered significant networking and learning opportunities. The placement internships within hosting public agencies

serve as an exciting potential educational model for advancing SDG 4 as well.

1.1 How Do Governmental Institutions Benefit?

Despite the increased availability of internet mapping sites (Google Maps, Google Earth Engine, Microsoft Bing, Nokia Here) that also provide current and historical high-resolution satellite imagery for public access, and data creation tools (such as OpenStreetMap), many governments find difficulty in using or integrating it with official data. If some of the challenges and barriers to using them could be discovered and mitigated, and if the open mapping communities could leverage moments of opportunities to participate with their national mapping agencies, the public as a whole would benefit from more efficient and effective services, and students could gain valuable educational experience. This is particularly true in countries where public access to geospatial data is restricted, or the costs are currently out of reach of government budgets.

It is clear that officials rely on official cartographic data to make informed decisions about a wide range of applications – from infrastructure development to governmental services to locating schools and health care facilities or responding to disasters like droughts and floods. Benefits also include support for economic development and planning, land tenure and taxation, renewable energy resources, and public actions addressing virtually all of the SDGs.

1.2 Where and Why the Americas?

This region is of particular interest because this part of the world has significant experiences with cross-border harmonization of official fundamental spatial datasets to build upon. We also bring our YouthMappers experiences with universities and students to build volunteered open mapping datasets. With funding from the National Science Foundation's broader research project on these questions, the students were able to imme-

diately connect to important officials who are members of the Pan American Institute of Geography and History (PAIGH). PAIGH is a specialized organization of the Organization of American States and provided the context and relationships needed to engage geographic institutes of the specific countries in the region. PAIGH was the platform for accomplishing cross-border spatial harmonization efforts that provided both information and a collaboration context for our work (Norori et al. 2013). As interns, we were competitively selected from among YouthMappers chapters located throughout the United States (eligible to receive NSF stipends), and we choose individual countries to carry out the case studies that supported the larger research project.

1.3 Why and How to Engage YouthMappers?

Youth voices tend to attract the attention of decision makers in ways that other types of research may not be able to draw. But they also might reinforce the distrust that officials have for the quality and completeness of volunteered spatial data. In addressing the issue of trust, student volunteers need to put in place processes to produce data with controls for accuracy and complexities required to successfully support public uses of the data or to meet government standards. Programs such as YouthMappers offer a peer-review data training, collection, and validation system that has proven to work, which ideally can increase the level of trust to work with youth on data campaigns. Although the resulting data might not be fully integrated or taken up as is into the official cartographies, they could serve as useful additional sources for validation, triangulation, or public consultation in order to support decision-making or provision of services. They could also serve as an independent source for measures of accountability, such as to ensure inclusive public services or just outcomes. Doing this does require partnerships across government institutions, especially between cartographic agencies and universities, which may already be

public. Engaging local university students means building educational opportunities that simultaneously address global education goals (Fig. 26.1).

In this project, a competitive call for university research interns resulted in the selection of eight students with Latin American cultural knowledge, Información Geográfica Voluntaria (VGI) experience, and a minimum level of conversational Spanish fluency. While the research interns were being selected, the principal investigators (PI) presented the project to the directors of the National Geography Institutes within Central America, Mexico, Colombia, and PAIGH observer nations in the Caribbean to request their participation in the case studies.

2 A Summary of Six Case Studies

The broader research project was carried out in three main phases: a roundtable forum, user surveys, and then individual country case studies to pilot ideas (Wintemute et al. 2021). Our YouthMappers portion of this effort focused on the case studies. There were two core requirements for each case. The first element was to conduct a series of interviews with both government officials and volunteer mapping participants in the country. The second was to implement a jointly agreed upon a pilot project that yielded some tangible deliverable that would benefit the hosting government agency and ideally involve local chapters of YouthMappers – whether they were already existing or could be gathered and encouraged to establish new chapters at national universities. At first, we expected to spend six weeks in our assigned country but because of COVID-19, the effort had to shift to virtual activities online.

Directors of the National Geography Institutes of Belize, Colombia, Costa Rica, the Dominican Republic, Jamaica, Mexico, and Panama all agreed to participate in the case studies and (virtually) host YouthMappers interns from the United States. The seven countries involved showed differences in the level of involvement and awareness, availability of data and coordina-



Fig. 26.1 YouthMappers researcher Vivian Arriaga presents the project to delegates at a scientific diplomatic meeting of official government cartographic and geographic representatives in the Dominican Republic

tion of VGI from OSM, varied presence of existing YouthMappers chapters and NGOs, and unique opportunities for how the connection between volunteered and official data might be possible in the national context. Below are summaries of that context, the activities, and main takeaways from each case.

2.1 Belize and Jamaica

This case study united the efforts of interns for two countries, in an exchange of training and experiences: in Belize, the host was the Land Information Centre, Ministry of Natural Resources, and in Jamaica, the host was the National Spatial Data Management Branch in the Ministry of Economic Growth and Job Creation.

As for official cartographies, data in Belize is collected by governmental employees and is typically only shared within agencies, private enterprises, and institutions of higher education through the Belize NSDI, via a website that allows registered government and NGOs viewer access in a geoportail and simple download access of non-georeferenced pdfs of base cartographic layers. Official Jamaica's Land Information Council National Spatial Data Management Division coordinates the NSDI policies, training, and access. Limited land information data is available through eLandJamaica web map. Users can view data and purchase proprietary products for download. Jamaica's NSDI is well-developed

but most of the data is sold to recover production costs.

As for OpenStreetMap contexts, in Belize, the OSM community is very small with limited data compared to other countries. Here one finds an average of just under 15 active OSM members at any given time. In Jamaica, there are over 100 senior OSM mappers who frequently work on mapping their own communities and abroad. Additionally, YouthMappers chapters, such as at the University of the West Indies in Mona, Jamaica, regularly contribute to local and foreign projects.

In connecting the dots, discussions with employees of the Belize Land Information Council illuminated for us that VGI has been a topic of discussion, but no project has yet emerged because of time and resources and fear of data quality. A unique example of a government-supported VGI network in Jamaica is their National Emergency Response GIS Team (NERGIST). This is a volunteer group of government employees trained and coordinated by the Land Information Council to collect data during natural disasters, a highly effective response effort.

Our interns in Jamaica and Belize designed a plan to virtually host a joint multi-sector workshop with OSM volunteers, university students, and government officials across both countries. The objectives were (1) to introduce YouthMappers and OpenStreetMap; (2) to conduct a mapathon for data in Belize that supports

the management of COVID-19 near Orange Walk; and (3) to seed exchange between geographers in the two countries and between prospective geography students and government geographers within each country. More than seventy people participated in the two-hour session which included local guest speakers, and training on data collection, standards, validation, and satellite imagery interpretation. Jamaican participants remotely mapped buildings and roads, while Belizean locals tagged grocery stores, town halls, and other entities. In all, nearly 40 percent of the task was completed, with 80 percent of changesets later validated without errors; 15 percent required very minor corrections (mostly squaring building edges), and 5 percent were significantly in error and were corrected or deleted by YouthMappers interns (Fig. 26.2).

The experience demonstrated the possibility for cross-nation collaboration and sharing of expertise in terms of official use of volunteer spatial data, at least for uses that deal with emergencies and public health. It also generated enthusiasm for student exchanges.

2.2 Colombia

Multiple host institutions in Colombia offered a platform for the internship, including the Instituto Geográfico Agustín Codazzi (IGAC), Universidad Pedagógica y Tecnológica de Colombia (UPTC), Unidad de Planificación Rural Agropecuaria (UPRA). Of the seven countries involved, only Mexico and Colombia have legislation to allow free and open access to official geographic spatial information. They allow the public to directly download data in a GIS format from their open web portals. In Colombia, VGI success is most visible in citizen or participatory science initiatives. There are over 100 initiatives of citizen science projects focused on collecting data for environmental factors such as forestry, flora, fauna, and air and water quality. YouthMappers are also very strong in Colombia, where there have been chapters formed at seven universities across the country. As a result, the OSM network is inclusive of students in a significant way.

Through conversations sparked by our internship pilot case study, we grew interest on the part of the national geographic institute to apply open mapping applications for geographic names and cadastral data updates in collaboration with student mappers. A longstanding formal agreement between IGAC and UPTC provided a unique opportunity for us to offer new trainings and advance a focused dialogue around deepening connections between student volunteer mapping to official data of Colombian government agencies. We thus facilitated two workshops to encourage greater participation in the very active OSM and YouthMappers networks. The workshops increased the university students' familiarity with iD Editor and KoBo Toolbox. Examples of YouthMappers projects were shared by the YouthMappers regional ambassador and posted to our YouTube channel and the Resource Library as resources for Spanish-speaking students and faculty at other institutions. Another result of this work was that UPRA and our team collaborated to design a new project, titled: "How to Incorporate VGI in the Official Cartographies of Agricultural Landscapes of Colombia: A Methodology Developed for the Rural Agricultural Planning Unit."

2.3 Costa Rica

In Costa Rica, the Instituto Geográfico Nacional of the Registro Nacional (IGN) hosted the internship. IGN manages the Sistema Nacional de Información Territorial (SNIT). Here users can integrate the base cartographic, orthophotos, and thematic data layers in their Open Geospatial Consortium web-based software applications. They can use MapServer, ArcGIS Server, and GEOServer for visualizing, but not downloading data. At the same time, the OSM community here has mapped the majority of the road networks as well as tourist and travel facilities, including with assistance from outside of Costa Rica, making these layers largely complete and of high quality. This is partly due to the fact that OpenStreetMap Costa Rica has developed and documented editing guidelines created by experienced OSM con-



Fig. 26.2 Building footprint data is visible for Orange Walk in Belize, site of a mapathon conducted by the YouthMappers during the project

tributors around the world. There is an active student community at the University of Costa Rica through their YouthMappers chapter, as well. The application of data around international tourism represents a unique and worthwhile opportunity window for connecting volunteered and official spatial data.

Before our case study, IGN had not considered integrating crowdsourced data into their official geospatial database. From our interviews, it was obvious that many OSM volunteers had perceptions of the government as being uncommunicative and uninterested. No framework or platform to encourage government and community discussion and collaboration yet existed. YouthMappers interns and facilitators thus held an initial scoping and exploration meeting where members of the IGN and experienced OSM mappers developed a shared vision for integrating OSM into official government datasets. Despite that there are still challenges to overcome to realize this goal, we were able to ignite these connections through a focused dialogue between two previously detached sets of actors of Costa Rica's mapping landscape.

2.4 Dominican Republic

The one country without an existing NSDI, the Dominican Republic, was developing a spatial data information network when the pandemic hit, and had to put these efforts on hold. Furthermore, there is no YouthMappers chapter in the country, although there are students at universities who are eligible to establish them. Nevertheless, the Instituto Geográfico Nacional José Joaquín Hungría Morell (IGN-JJHM) hosted an internship with our project to continue to progress their thinking about the role of volunteered information in this process.

NGOs in the Dominican Republic have created environmental datasets and vulnerable population data, yet there is no general repository for government or public access to these datasets. So we had to work from the ground up on ideas for simultaneously developing VGI and NSDI in parallel tracks. The relatively recent launching of the IGN-JJHM in 2014 was a challenge but also the fact that the institution is in the early stages offers an incredible chance to introduce awareness of open mapping for both government officials and university students just as this information could be incorporated into institutional strategies and activities. We thus offered four workshops (virtually, and in

Spanish) to various government and academic geographers around: Información Geográfica Voluntaria (VGI), YouthMappers: Usos y Beneficios, YouthMappers: Como Usar OSM, and lastly, YouthMappers: Cómo Realizar un Mapatón. These presentations aimed to inform individuals and groups and provide a set of reference resources specifically tailored to the Dominican Republic, including videos, scripts, instructions, and other necessary material to properly convey information and provide the institution with materials they can easily understand and use in future workshops. Eventually, developing a YouthMappers chapter at a prominent university will complement these efforts to broaden awareness on the topics, including the uses, benefits, and limitations of VGI, crowdsourcing, and OSM, for the upcoming careers of geographers, both in academia and government agencies. This experience showcases how in locations where these ideas are only emerging, the network of youth can support this emergence, and ultimately demonstrate the power of involving local youth in national efforts at open data that could improve official cartographies even from their starting points.

2.5 Mexico

The Instituto Nacional de Estadística y Geografía (INEGI) in Mexico allows free and open access to official geographic spatial information. Collaboration among government agencies, geospatial research centers, and VGI communities have produced an abundance of crowd-sourced applications. As a host to our project, we focused together to prepare a detailed report of recommendations to improve and expand the volunteer mapping programs to include greater participation of women, stronger ties to the YouthMappers chapter at the Universidad Autónoma del Estado de México (UAEM) and leveraging a special connection to GeoChicas, an international women's mapping community within OSM that is exclusively active in Latin America.

We began with an information gathering component, including conducting research and interviews with key INEGI personnel and then various actors in the volunteer mapping landscape. This led us to conclude that there exist three different pathways where VGI could expand relative to official cartographies in the country.

First, a top-down approach is possible in a place like Mexico, because several high-level leaders at INEGI expressed an interest in VGI data, and they already operate in a relatively open environment in terms of their NSDI. They have a vision to implement new projects and can serve as champions within the public government agency. They know what specific integration avenues could ensure that the efforts directly speak to official cartographic needs and thus shortcut to success. Direct links to youth and students through mechanisms such as internships could be facilitated.

Another approach to expansion is through a topical focus on inclusion, namely centered on women and on feminist issues. INEGI incorporated a consultant position with GeoChicas. This opportunity to expand participation, representation, and activity is a rich source of ideas on the public utility of INEGI's data. Female students and youth will be among the important communities to engage in through this approach.

A third path that represents a significant opportunity for the growth of YouthMappers chapters across Mexico is through place-based science that merges official data and participatory cartography. The current Director of Geography at INEGI originally founded the CentroGeo scientific think tank which focuses on the need for integrating geographic knowledge and communication in the country at the community scale by applying contextualized science and public participation at the core of nearly every project. One example, in its sixth year, invites the public to suggest updates to place data. This may include updating official names or changing their use designations. While these efforts have had challenges, especially meeting coverage goals, they have expanded their reach by utilizing students in universities. Students are rewarded with community service hours, and have become the

largest citizen contributor group to the project. Participatory Cartography's INEGI-university relationship was replicated in INEGI state offices to build collaboration with locally qualified universities. The process includes state offices reviewing and transferring approved data to headquarters. The goal is to identify areas of activity where INEGI data does not exist, which state personnel can field-verify. In the future, the network and structure of more YouthMappers chapters could accelerate these kinds of programs.

2.6 Panama

Panama hosted an intern with the Instituto Nacional Geográfico Tommy Guardia, in the Autoridad Nacional de Administración de Tierras (IGN-TG). Panama does have an NSDI framework and geoportal. IGN-TG allows public downloads of topographic maps in pdf format, but does not make the geospatial data public in GIS format. In Panama, crowdsourced data is present within a small community of independent OSM mappers and mostly by the very active University of Panama's student chapter of YouthMappers. YouthMappers UP generates volunteer data through collaborative projects that are geared toward academic and research projects that have multiple users and stakeholders, and the support of both public and private sectors. As one of the first international chapters of the YouthMappers network, UP has ample experience driving new data campaigns that have important end uses. However, initiatives from the other direction: from government agencies outward to incorporate VGI have not been happening.

Our internship confirmed that Panama has a wide range of stakeholders in academia and government agencies around spatial data. Many organizations produce geographic data, yet there are many silos, and few collaborate by sharing data or incorporating crowdsourced data. For example, Panama's official geographic institute, Tommy Guardia, has the cartography expertise,

but lacks the resources to collect data extensively and intensively. YouthMappers has experience in mobilizing volunteers to collect data but expressed the need for more training to maintain the quality of data collected and to utilize more advanced tools and techniques.

Through the conversations sparked by our project, we honed in on a fundamental issue to resolve before greater collaboration could unfold. Different government organizations use different data formats, platforms, and even contradicting attributes for the same objects, hampering basic operations like merging across official datasets. However, these problems that are barriers to more integration of VGI are the same as those that collaboration through VGI might be able to solve.

We chose to explore how to begin this process by focusing on street names in Panama. Here, one street might have an official name differing from its actually used name. Official data did not contain names for 272 of the 613 streets in a pilot project zone. Other streets have multiple names. Updating this complex data platform requires money, effort, and personnel to develop concerted efforts to standardize nomenclature (Fig. 26.3).

Due to the pandemic, the government-mandated quarantine prohibited the ability of government officials to accomplish fieldwork to verify geographic names. Our YouthMappers intern demonstrated a Python program that uses volunteer data from Open Data Kit (ODK) to pinpoint inconsistencies in official street data, which was then implemented by geographers at IGN-TG. What started out as a small idea grew to engage the attention and collaboration of the institution's senior members, including the director of the technology department. The University of Panama's YouthMappers were engaged in the project's user workshops which led to collaboration on a VGI-to-official-dataset project framework. Participants expressed interest and capacity to further develop the project, proposing improvements and internalizing the ODK and Python framework through documentation and workshops. The incentives for officials included updat-

ing data at a reduced cost while integrating local knowledge into the geographic names. The incentives for volunteers included the opportunity to focus another category of efforts to respond directly to national official spatial data needs.

3 Challenges and Recommendations

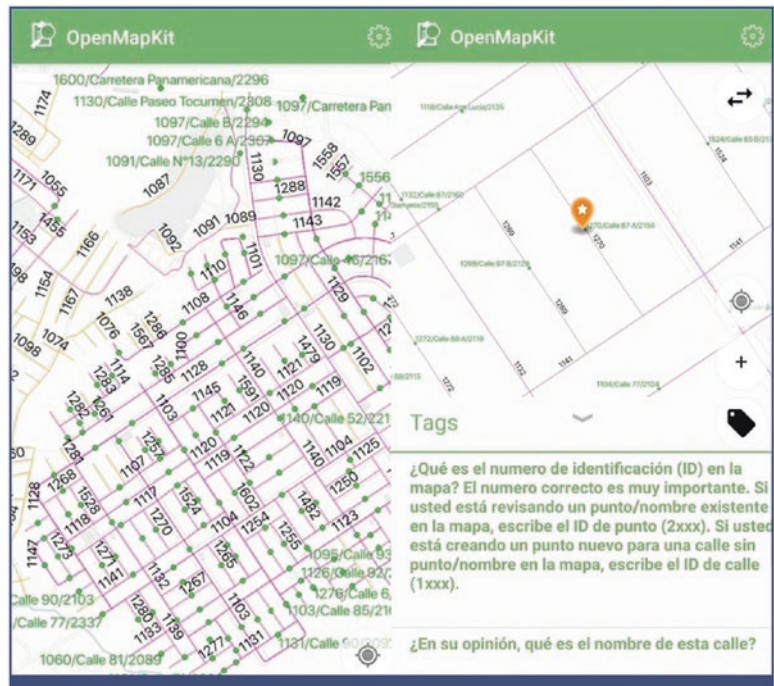
Our case studies showcased a range of starting abilities, awareness, and capacity for incorporating open mapping with official spatial data infrastructures. Through the creativity of our YouthMappers interns, and the graciousness of our hosting institutions, windows of opportunity were discovered across various applications, from responding to health emergencies and natural hazards in Belize and Jamaica, to managing environmental conservation efforts in Colombia; from leveraging tourism assets in Costa Rica, to staging a new national spatial data infrastructure with youth in the Dominican Republic; from promoting gender equity in Mexico, to improving geographic names in Panama. These experiences sum up to a better understanding of both the criti-

cal challenges and the significant opportunities for incorporating VGI geospatial data into official geographic information.

The main recommendations we can derive from the collective experience of these YouthMappers-led case studies, as well as from the results of the larger research project (Wintemute et al. 2021), include the following from the lens of student experiences:

- Successful examples from the region help raise awareness of opportunities for youth and for open mapping, mitigating concerns of quality.
- Place-based knowledge from the field that students can supply can amplify goals for data relevance or completeness coverage that public agencies may need.
- Empowering local champions for official cartographic and VGI collaboration is key, and youth can serve in some of these leadership roles, too.
- Given the diversity of experience and capacity, efforts must be tailored to the individual

Fig. 26.3 An OpenMapKit tool tests how to update or add official geographic names of streets in Panama



needs and opportunities present in each national context.

- Exchanges across countries can accelerate adoption in the region, as well as offer exciting learning opportunities for students.

It is our hope that this work spawns new champions and partnerships between the local OSM communities and government institutions. YouthMappers chapters can provide a supportive framework for efforts to build more effective and accountable institutions via fundamental spatial data, advancing SDG 16. At the same time, these opportunities can represent significant educational innovation for SDG 4, which in turn can build the spatial talent for the future of these same public institutions, advancing SDG 16 again, and indirectly all of the UN Sustainable Development Goals.

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