

## TOWARDS UNDERSTANDING THE IMPACT OF MAPATHONS – REFLECTING ON YOUTHMAPPERS EXPERIENCES

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### ABSTRACT:

YouthMappers is a global network of student chapters actively engaged in collaborative mapping efforts, such as OpenStreetMap mapathons. Many questions have been raised about the impact of mapathons on open map data and on the participating mappers. For example, how can the social gathering and event format encourage productivity and quality, while also contributing to community building? Because YouthMappers chapters regularly host mapathons, there are frequent opportunities to investigate the impact of mapathons. In this paper, three universities involved in the YouthMappers network, located in Europe, North America and Africa, describe how mapathons are conducted at their respective universities. Incorporating mapathons into the curriculum encourages students to contribute much-needed open geospatial data for humanitarian projects. At the same time, students get practical experience in data capturing with open source tools and awareness is raised of humanitarian challenges in other parts of the world, thus nurturing socially engaged citizens for the future. The experiences at the three universities are diverse and richly contextual to the specific character of the campus and its students. These differences underscore the challenge of a common means to formally assess the impact of such events in general. Based on this exploratory research, three themes for assessing the impact of mapathons are proposed: the volume and quality of open geographic data produced during mapathons; the social and personal growth of the students attending the mapathons; and the changes in university programs and curricula introduced as a result of the mapathons.

### 1. INTRODUCTION

OpenStreetMap (OSM, [www.openstreetmap.org](http://www.openstreetmap.org)) is an openly-licensed geospatial database created and edited daily by volunteers worldwide, and used by a multitude of actors and for a variety of applications (Mooney and Minghini, 2017). There are three main ways to contribute to OSM: field mapping, which implies a field survey of the area to be mapped (also known as outdoor mapping); remote mapping, which consists in digitizing map objects such as roads and building footprints on top of aerial or satellite imagery (also known as armchair mapping); and bulk import, when external openly-licensed datasets are imported into the OSM database. Depending on the type of data needed, each option has advantages. For instance, when detailed data is needed, field mapping allows for specific attributes to be added by knowledgeable locals. For areas that have little feature data to begin with (e.g. roads and building footprints), remote mapping allows for a large amount of base data to be added quickly.

OSM is used in various humanitarian projects worldwide under the guidance of the Humanitarian OpenStreetMap Team (HOT, [www.hotosm.org](http://www.hotosm.org)) and the Missing Maps project ([www.missingmaps.org](http://www.missingmaps.org)), such as mapping during disaster relief operations or malaria elimination campaigns (Soden and Palen, 2014; Feinmann, 2014). Humanitarian mapping based on OSM happens through the use of the HOT Tasking Manager, a web application (available at [tasks.hotosm.org](http://tasks.hotosm.org)) making it possible to coordinate a collaborative mapping effort, i.e. mapping made by many contributors at the same time on the same area. In some parts of the world, no official map data is available and hence humanitarian mapping based on OSM can play a crucial role.

A mapathon (literally “map marathon”) is a collaborative effort, usually performed by groups of people who meet together (e.g. at a university or a company) aimed at collecting specific map data through remote mapping (typically for humanitarian purposes) in places where OSM data is scarce or non-existent. Mapathons have attracted volunteers all over the world, but what happens to the OSM data and volunteers after the mapathon? Can the data be used for other purposes? Is the data ever updated? Do the volunteers continue to contribute?

Dittus et al., (2016) suggest that the way in which mapathons are conducted may play an important role in future contributor engagement. They identified specific coordination practices which can help build volunteer capacity and cautioned against possible poor data contributions from floods of newcomers attracted to event-centric mapathons (Dittus, 2017). Ebrahim et al., (2016) describe the educational and learning outcomes of a humanitarian mapathon experiment which involved more than 200 10-year old children. Despite children committing the usual mapping errors typical for beginners, the event was extremely positive in terms of stimulating their engagement, enthusiasm and attitude towards geography.

Engagement in OSM mapping is also studied in the case of mapping parties, i.e. social events where a group of people (usually novice and experienced contributors) meet physically to collect OSM data in a specific place. Hristova et al., (2013) study the impact of mapping parties for the OSM community in Greater London and quantify it for different user groups. They observe that newcomers attending mapping parties usually stop

contributing to OSM after the events, while more experienced contributors are retained. This is in line with the findings of Mooney et al., (2015), who share the lessons learnt after a mapping party organized during the FOSS4G Europe 2015 conference. While the overall event was successful, authors recognize that most of the data uploaded to OSM was performed by already experienced contributors. Recruitment and retention of OSM contributors is also studied for bulk imports. As an example, Juhász and Hochmair (2018) analyze spatio-temporal contributions of three target groups to assess the effectiveness of different outreach techniques for a building import task in Miami-Dade County, Florida. Once again, authors highlight that the long-term engagement of OSM newcomers did not succeed, whereas long-term contributors continued to contribute even after the import process.

The work described in this paper is borne from the efforts of YouthMappers ([www.youthmappers.org](http://www.youthmappers.org)), a global initiative where university students from all over the world are actively engaged in OSM-based collaborative mapping efforts, such as mapathons. The YouthMappers network relies on open source geospatial software, which provides mature solutions to address the challenges of our society (Brovelli et al., 2017) and is key to empowering students to work with OSM and geospatial data. YouthMappers currently has 113 chapters in 35 countries with over 5000 students that have mapped 2,776,167 buildings, 422,334 roads and over 20,000 other features in OSM from April 2016 to April 2018<sup>(1)</sup>. This represents a total of more than 24 million map changes in 2 years, or an average of a million per month.

Even though HOT has a validation process for map data that YouthMappers adheres to, questions around data quality are often discussed. The same questions are raised for mapathons where newcomers contribute to map areas unfamiliar to them. Because YouthMappers chapters regularly host mapathons, there are frequent opportunities to investigate the impact of mapathons. There should be a healthy balance between productivity and the quality of data produced during a mapathon, while at the same time the opportunity to sensitize young students about humanitarian and other issues should be embraced. How can the social gathering and event format help to establish and maintain attention to productivity and quality, as well as community building itself? And how can we assess this given the wide variance of how mapathons are conducted?

In this paper, we present results of exploratory research about the impact of mapathons. In the next section, three universities involved in the YouthMappers network and located on different continents (Europe, North America and Africa) describe how mapathons are conducted at their respective universities. Based on this, Section 3 reflects on the impact of the mapathons and proposes three themes for assessing the impact of mapathons: the volume and quality of open geographic data produced during mapathons; the social and personal growth of the students attending the mapathons; and the changes in university programs and curricula introduced as a result of the mapathons. Section 4 concludes the paper by summarizing the main findings of the work and providing directions for future work.

## 2. MAPATHON EXPERIENCES

### 2.1 Politecnico di Milano (Italy)

PoliMappers ([polimappers.github.io](http://polimappers.github.io)), the YouthMappers chapter at Politecnico di Milano, Italy, was formed in late 2016 as the first European chapter of the network. In agreement with the YouthMappers requirements, the association has its own board of officers composed of a President, a Vice President, a Secretary, a Treasurer, a Technical Responsible and two Social Media Responsibles. All the activities are performed under the guidance of two Faculty Advisors from the university. The main objective of PoliMappers is to form a voluntary, stable and competent community of mappers at Politecnico di Milano based on OSM, open data and open source software (Kilsedar et al., 2017).

PoliMappers organize mapping activities almost once every two months. These activities are relevant to both field mapping and remote mapping and make use of a wide variety of technologies. Examples include field mapping of the university campus using Field Papers ([fieldpapers.org](http://fieldpapers.org)); outdoor trips in the mountains while mapping with tools like Mapillary ([www.mapillary.com](http://www.mapillary.com)) to collect georeferenced photos and MAPS.ME ([maps.me](http://maps.me)) to map POIs; mapping parties based on the Geopaparazzi app ([geopaparazzi.github.io/geopaparazzi](http://geopaparazzi.github.io/geopaparazzi)) to collect POIs; remote and humanitarian mapping using the iD editor ([wiki.openstreetmap.org/wiki/iD](http://wiki.openstreetmap.org/wiki/iD)) and the JOSM editor ([josm.openstreetmap.de](http://josm.openstreetmap.de)); teaching sessions on OSM humanitarian mapping at elementary schools (children aged 10 to 12 years); and participation and organization of external OSM-related events such as MapTime Milan, OSM mapping parties, conferences and workshops on OSM.

Humanitarian mapathons are held periodically as they represent the easiest way to attract new contributors to PoliMappers and, more generally, to OSM (see Figure 1). These events are open to all students from Politecnico di Milano, from Bachelor students to Master and even PhD students. Students are invited to participate in the mapathon in multiple ways. First, short presentations about PoliMappers and humanitarian mapathons are given during classes taught by professors in the Department and by PoliMappers Faculty Advisors, with the purpose of raising awareness about the association and stimulating the students' interest. In addition, an invitation e-mail is sent by the Secretary of the Computer Engineering School of Politecnico di Milano to all the students enrolled in this school (about 30,000 students). Finally, all the students who attended a previous event organized by PoliMappers and agreed to leave their contact information are informed of upcoming events through the PoliMappers mailing list. Humanitarian mapathons are held in the late afternoon (starting from 4 or 5 pm), so that students can attend them after the end of their lectures, and usually last for a couple of hours.

The number of participants typically ranges between 30-40 and a maximum of 70-80. This relatively small number (compared to the total number of students invited) can be mainly explained by the fact that the mapathons do not give students any additional credit or official recognition by the university; on the contrary, participation is totally voluntary. Thus, students decide to attend mapathons especially because of the wish to contribute to a humanitarian cause or because they are attracted or curious about

<sup>(1)</sup> Data compiled from <http://resultmaps.neis-one.org/osm-changesets> on the hashtag #YouthMappers<sup>®</sup> by Patricia Solis and Nwasi Menkiti, 4/2016-4/2018.

the mapping activity. In addition, the number of attendees is limited since many students at Politecnico di Milano do not live in Milan and therefore they prefer to come back home just after the end of their lectures.



Figure 1. A picture taken during a humanitarian mapathon at Politecnico di Milano organized by PoliMappers.

Humanitarian mapathons are attended by a mix of novice and experienced OSM contributors. The former are the new students of Politecnico di Milano targeted by the awareness campaigns on PoliMappers described above. Experienced contributors are represented by the 10-15 long-time members of PoliMappers, having a 30% female component. All participants are required to bring their own laptop, since the mapathons take place in standard university lecture rooms with no computers available. There is not a standard way to run mapathons, as this depends on the number and level of experience of attendees which may greatly vary from time to time. When many new students are present, a preliminary presentation about YouthMappers, HOT and Missing Maps is given, followed by a hands-on tutorial on how to use the iD editor. This tutorial particularly stresses the need of digitizing high quality data, e.g. building footprints which require to carefully detect the footprint corners, square the footprint and add the right tag (see e.g. the documentation available at <http://learnosm.org/en/coordination/remote-tracing>). After this tutorial is given, participants are invited to map and ask for assistance to the more experienced students in case of need. After the mapathon, the slides or training materials used during the event are published online on the PoliMappers website. In contrast, when a limited number of new students are present, the mapathons are run by immediately starting to map, with new students working together with long-time members of PoliMappers to be guided on the mapping activities. This allows to make better use of the available time and maximize the mapping results.

When finding a date for a mapathon which is suitable to the majority of students is hard (e.g. during exam periods), a different strategy is adopted. A humanitarian mapping project is selected on the HOT Tasking Manager and the PoliMappers members are invited to contribute map data for that project within a whole week. In this way, everyone is aware about the chosen humanitarian project but is free to find the preferred time to contribute to it. In 2017, the humanitarian mapping activity of PoliMappers was awarded in the frame of the second mapping campaign for malaria eradication in Africa, organized by HOT and Missing Maps and promoted as a challenge among all YouthMappers chapters. PoliMappers have established a good interaction with other YouthMappers chapters as well as other OSM communities. As an example, during an event in 2017, three short talks were given remotely by members of the OSM

community in Sri Lanka, the OSM community in Albania, and Geochicas ([geochicas.org](http://geochicas.org)).

All the OSM changesets performed by PoliMappers are marked with the #polimappers hashtag in the changeset comments, plus a second hashtag identifying the specific event, for example #polimappers03. The number of OSM map changes performed and OSM map objects created clearly depends on the number of people attending the mapathon. However, in general a single mapathon generates some hundreds of changesets, some tens of thousands of map changes, and some thousands of building footprints created. On average, these correspond to one or two thousand map changes, around 20 changesets and around 200 buildings per participant.

The mapathons organized by PoliMappers place attention on the quality of data contributed to OSM mainly during the pre-contribution phase. In other words, attendees (specially students not or little familiar with OSM) are carefully trained by more experienced users before they start making edits to OSM, in order to ensure that they produce OSM data having the highest possible quality. Conversely, less focus is placed on the quality assessment during the post-contribution phase, which is mainly limited to the validation of OSM mapping performed by the members of PoliMappers who are long-term OSM contributors through the corresponding function on the Tasking Manager. The limited focus on the quality of contributed data is justified by the following reasons: a) the mapping tasks required by the humanitarian projects (e.g. mapping building footprints and roads) are pretty easy; b) the mapathons last for a short time, which makes it difficult to include a data validation exercise; c) the main purpose of mapathons organized by PoliMappers is to empower the students (and young people in general) with the knowledge on OSM and open data and the skills in creating and updating map data using open source geospatial software.

## 2.2 Texas Tech University (United States)

The YouthMappers at Texas Tech University approach mapathons in both formal and informal learning environments. The student-led chapter is one of the three co-founding chapters, along with The George Washington University and West Virginia University (WVU). The YouthMappers student-led chapter meets once each month and organizes mapathons several times per year for their members who come from dozens of majors across several colleges, from geography, GIS, geophysics, landscape architecture, wind energy, engineering, education, history and language degree programs. A handful of faculty regularly offer ad-hoc extra credit points to encourage students to participate in workshop and mapathon events. Especially at the end of the semester, when students are looking to improve their grades, this gesture boosts attendance.

Among their varied activities, the chapter organizes special training workshops (such as story mapping, a “MapShop” on JOSM, etc.); symposia featuring external visitors and campus researchers to showcase open data; Map-Offs with other universities, especially sports rivals in the same week as football and basketball match-ups between TTU and WVU; local campus mapping and a “Map your way Home” mapathon party to add detailed attribute data to OSM in Texas. The chapter is active, interacting not only with other chapters within the USA, but also with chapters in other countries. Their members have submitted blogs to the YouthMappers webpage, and received local television and campus news magazine coverage of activities. Several have participated in the virtual internship program for

YouthMappers that USAID GeoCenter offers to US and Canadian students.

The chapter is officially recognized by the TTU Student Organization governance process in the Center for Campus Life, affording it formal status and eligibility to request funding for activities and space for events. Funding resources generated internally have allowed the chapter to invite external visitors, travel to conferences, and purchase mapathon supplies for copies, flyers, pizza, and drinks.

The YouthMappers at Texas Tech chapter has been led by two Presidents since founding, both female undergraduates, along with a Vice President, Treasurer and Secretary. Other positions that members serve include communications team, a mapathon committee, and a student technical expert who assists with validation or other specialized needs. The chapter membership fluctuates between 35 and 50 active members, who are 40% female, but the mapathons attract many more participants, about 70 to 75 on average from Bachelor's, Master's and doctoral level students.

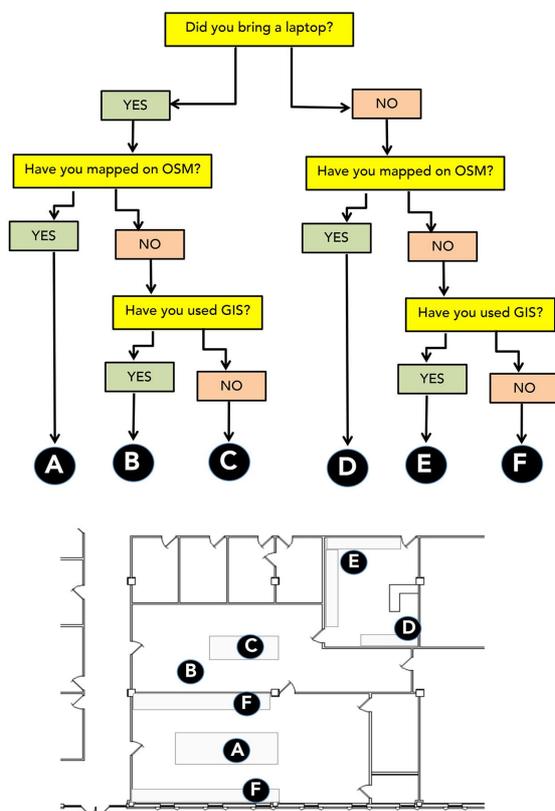


Figure 2. TTU's triage approach to organizing newcomers.

Because the mapathon events tend to attract students who are not regular members, whether they are motivated by extra credit, curiosity, or the opportunity to contribute to a major newsworthy humanitarian need, the need to manage newcomers and continue to engage ongoing volunteers presents a unique challenge. In addition, the space in any single computer laboratory is insufficient to accommodate more than 30 at a time. Typically mapathons on campus thus utilize the whole suite of labs, including the GIS lab, the Remote Sensing lab, sometimes the Physical Geography lab, and the Map Room, which does not have computers, but can accommodate students bringing their own laptops. Chapter officers help to train and validate during the mapathons to catch early mistakes, wearing a ball cap with the

YouthMappers logo so they can be easily identified by those looking for help. We have developed a triage in-take system to direct attendees to specific locations depending on what experience level they may have. For example, beginners without laptops occupy the perimeter of the GIS lab (group F), while veteran OSM users with laptops are stationed in the center of the same room so they can assist new mappers overflow (group A, see Figure 2). An orientation presentation is offered to the group as a whole, then training guidance presentations are provided separately at various depths of explanation at each location according to the abilities of the particular group.

Whenever possible, the mapathons include a skype call with another chapter or with a practitioner from the agency requesting the data to provide context. A single sheet with "quick start" instructions is available on the desks. The map room serves as a common area where all attendees can mix and enjoy pizza. The venue often includes one computer with speakers playing music from the region where the task is being mapped (e.g. salsa when mapping Puerto Rico, kizomba music when mapping Angola, etc.). Also, the large screen is set to "Show Me The Way" which displays real time mapping of OSM users (<http://osmlab.github.io/show-me-the-way>) which encourages new mappers when they see their name displayed, or the Missing Maps Leaderboards in case of a competition with another university (<http://www.missingmaps.org/leaderboards>). Typically events last for about 3 hours and the average amount of edits created range from 25,000 to 30,000 map changes depending on the tasks and the mix of beginner versus experienced mappers. After any events that relate to USAID tasks, we prepare a brief update to the GeoCenter on basic metrics and general action (see Figure 3).



Figure 3. Texas Tech University students, attending an orientation to a mapathon, talk to Chad Blevins, USAID GeoCenter by Skype to understand the context of the task.

Texas Tech students can also take a dedicated service-learning course for 3 credit hours where they work on teams with other students in YouthMappers chapters around the world to map the same areas and research the humanitarian or development issue affecting the region. A total of 62 students have completed the course in the past three semesters, primarily undergraduates with a handful of graduate students. Teams are formed by students' preferences for USAID-requested project themes hosted on the HOT Tasking Manager, and an adaptive design enabled a balance of independent study and group work.

For the first half of the course, each week the class consider a discussion topic responding to an article or reference provided the week before. The main discussion topics include: the role of geographic technologies in use by international aid actors in general and USAID in particular; resilience as a development concept; the trajectory of the open geospatial data movement, particularly with respect to Volunteered Geographic Information (VGI) and the OpenStreetMap (OSM) platform. Students also search for additional relevant literature and jointly prepare an online “wiki” annotated bibliographic entry. Each student also creates country/site profiles about the locations needing geospatial data and briefing documents about the particular development or humanitarian issues in question for which data is needed.

Each team is responsible for contacting and communicating by internet video conference and emails with the local YouthMappers chapter in the locations where the remote mapping takes place. When it is not possible to locate or communicate with local students, some teams are able to interview humanitarian practitioners such as from USAID, USGS, etc. Other geographic subjects and themes of the place of study are added as they became relevant to the respective student projects as they unfold. In addition to the subject matter, content about how to plan and execute a mapping project is integral to the learning objectives.

The main activity of this course is to create new, quality, localized geospatial data in unmapped places of the world where USAID works, ensuring that the new data is open and accessible to the public via OSM. An average of about 5,000 changesets per student can be created, although some students create far more, up to 60,000 and even 80,000 edits. Quality of edits is controlled through an early benchmark, where student mapping is evaluated after the first 500 edits using Overpass Turbo (<https://overpass-turbo.eu>) and visual inspection of the sites. Tailored feedback is provided to individual students for improvement. One week during the semester, the class hosts a public mapathon to invite other mappers to contribute to these same projects, including attendance by resident international students who help provide a local point of view and contextualize the purpose of mapping.

A final project presentation exports the edits, summarizes the work in the format of a story map, and shares the learning trajectory of the student teams. A list of topics and locations covered to date in this course include the following:

- Refugee Camps and Displaced Persons in Bidi Bidi Camp, Uganda
- Illegal Dumping and Waste Mapping (with Federal University of Akure chapter), Nigeria
- Volcano Preparedness and Evacuation Planning near Nevado del Ruiz, Colombia
- Flooding Preparedness in rainy Cebu, Philippines
- Peace, Land Use and Environment in La Guajira, Colombia
- Food Security in Northern Ghana
- Hazard Management near Mount Sinabung, Indonesia
- Development Planning and Open Data, Angola
- Poverty and Food Insecurity in Khulna, Bangladesh
- Disaster Response near Mount Cotopaxi, Ecuador
- Malaria Prevention, Mozambique

This course promotes learning outcomes with respect to civic engagement, creating thinking, critical thinking, and global learning. In addition, students demonstrate skills in written and oral communication and teamwork. Learning outcomes are

evaluated using the VALUE (Valid Assessment of Learning in Undergraduate Education) rubrics produced by the American Association of Colleges and Universities (AACU). Student learning is also assessed by written self-reflection at the end of course. Some students have enjoyed the experience so much that they retook the course, even though they had passed with high marks! The bibliography and syllabi are available openly at the course wiki for adaptation by faculty anywhere ([sites.google.com/site/youthmappers](https://sites.google.com/site/youthmappers)).

### 2.3 University of Pretoria (South Africa)

In May 2016, the University of Pretoria’s Centre for Geoinformation Science (CGIS) lab officially became an inaugural YouthMappers chapter and the second chapter in Africa. The CGIS YouthMappers events are coordinated by a postgraduate student (President), a senior undergraduate student (Vice President) and a faculty advisor. Our activities focus on our students and also outreach to the local schools. For the students, monthly events are held, such as remote or field mapping, and other open data events. In addition, final year geoinformatics students complete a semester module for which they use open source tools to map an informal settlement and provide innovative solutions for the community (Coetzee and Rautenbach, 2016). The data captured for this module, specifically the building footprints, are then added to OSM.

Students enrolled for geoinformatics modules are invited through our internal mailing lists. Each mapathon focuses on a different purpose and area. Extra credits for certain modules are offered to encourage mapathon participation. This usually applies to at least 90% of the participants. Participation is rewarded, but contributions are not evaluated.

Mapathons are typically arranged for two hours on a Friday afternoon when students tend to have free space on their timetables. Generally, the first mapathon of the year is the first time that students participate in a mapathon or contribute to OSM. In the past year or two, the number of participants has varied between 10 and 30, depending on the semester. In the first semester, the module for which extra credits can be obtained has just over 100 students from various degree programmes. In the second semester, the additional credits apply only to the geoinformatics students (i.e. ranging from 15 to 20 students). To date, we have not invited students from outside our department.

A mapathon starts with an introductory presentation during which the hosts explain the mapathon purpose to the students and introduce them to the OSM editing tools. Experience has shown that even though OSM tools are user-friendly, students need additional guidance. Therefore, a short training video is shown as part of the introductory presentation. Next, students are encouraged to complete the iD editor tutorial before starting to map. The mapathon hosts walk around among the students to answer any questions or to assist as necessary.

Next, we reflect on the impact of this year’s first mapathon, held in March 2018. TeachOSM was used to create a task for two disadvantaged communities in the City of Tshwane (South Africa), namely Atteridgeville and Soshanguve. The aim of the mapathon was to capture roads and footpaths in these communities to improve the basemap that can be used, e.g. to plan visits to a number of dwellings by community health workers. Only third year students (19 males and 17 females) participated in the mapathon for extra credit in their module. The majority of students study geoinformatics (27%), environmental science (25%) or geography (16%). The remaining students were

from other degree programmes, such as meteorology or geology. This was the first mapathon for all but one student. As a result, the majority of the students completed the iD editor tutorial before starting the given task. The number of mapped features differed significantly from one student to another. On average, students mapped 296 nodes; one student was able to map 1,516 nodes in the two hour time slot. In total, 8,289 nodes were mapped or updated, resulting in 75.12 km of additional roads and footpaths in OSM. Figure 4 shows building footprints added during the mapathon.

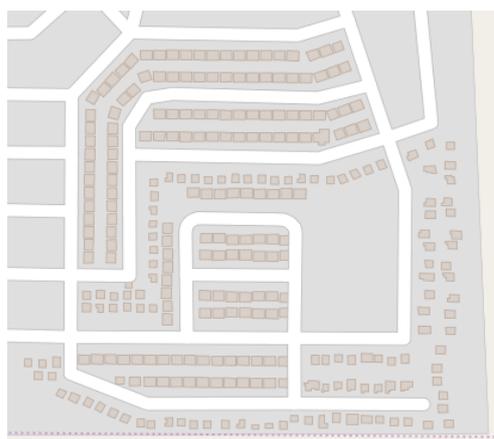


Figure 4. OSM screenshot showing building footprints added during the mapathon (map © OpenStreetMap contributors).

After the mapathon, the students were asked to complete a short survey to record their experiences. 94% of the students felt that they learned something from the mapathon. We also asked them to tell us what they learned. The following were recurring themes: digitizing; that maps could have errors on them and that it is therefore important to map as accurately as possible; and that they can help another community through mapping. Even though all the students participated in the mapathon for extra credits, 88% of the students said that they would consider participating in a mapathon without any incentives being offered. Most students (77%) found iD editor to be intuitive and easy to use. The main challenges indicated were bad imagery or cloud cover (16%); difficulty in identifying roads and footpaths on the satellite image (26%); and also difficulty in identifying the type of road surface (22%). Lastly, 75% of the students indicated that they would use OSM again in the future.

The JOSM Validator ([wiki.openstreetmap.org/wiki/JOSM/Validator](http://wiki.openstreetmap.org/wiki/JOSM/Validator)) was used to validate the quality of the data collected during the mapathon. JOSM Validator raised 364 warnings for the mapathon contributions. This amounts to warnings for 4% of all objects mapped. A warning is not necessarily an error and needs to be verified. The data contributed by our mapathon raised only warnings, not errors. Even though 4% is low, it will take some time to verify all the warnings.

To investigate whether mapathon data can be used in OSM-based applications, we tried to create a route in the MAPS.ME mobile app ([maps.me](http://maps.me)) in the area that was mapped during the mapathon, see Figure 5. Due to topological errors in the data contributed during the mapathon this was not possible. Additionally, we downloaded the OSM data for the mapathon area and prepared a basemap in QGIS ([www.qgis.org](http://www.qgis.org)) to verify that the data was appropriate for the mapathon's purpose. The contributions from the mapathons improved the base map because, despite the

topological errors, the additional footpaths and roads allow a community health worker to plan visits to a number of dwellings.

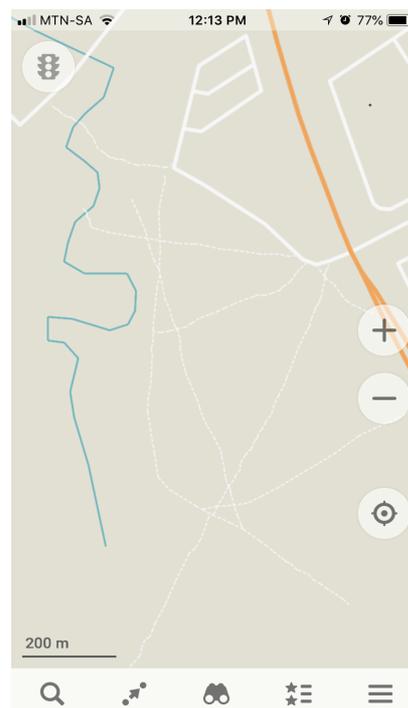


Figure 5. MAPS.ME screenshot showing footpaths added during the mapathon (map © OpenStreetMap contributors).

### 3. TOWARDS UNDERSTANDING THE IMPACT

The mapathon experiences of the three universities described in Section 2 are diverse and richly contextual to the specific character of the campus and its students, as much as they share some approaches, tools, and the humanitarian open data vision. These differences underscore the challenge of a common means to formally evaluate or assess the impact of such events in general. However, reflecting on the common processes lead us to offer at least three ways in which mapathons conducted through the YouthMappers framework in particular could improve our understanding of the impact of mapathons more broadly. We see these impacts as bearing upon the map data (in terms of both productivity and quality), upon the mappers themselves, and upon the institutions who host YouthMappers chapters and mapathons.

Firstly, what is the impact of mapathons on OSM data volume and quality? Do mapathons have an impact in areas where data is scarce or non-existent? Is the quality of mapathon data acceptable? The large number of building footprints, roads and other features mapped through YouthMappers mapathons (i.e. not counting other mapathons) suggests a considerable impact on OSM data in terms of volume. An error analysis performed on YouthMappers edits broadly during the 2016 campaigns for malaria eradication (promoted by USAID and HOT) suggests that student contributions on the whole fare as well as other users in humanitarian tasks (Solis et al., in press).

However, the general challenges of assessing the quality of VGI (Cooper et al., 2011) also apply to mapathon contributions. Spatial data quality assessments typically consider six elements of quality: positional accuracy, completeness, thematic accuracy, temporal quality, logical consistency and usability (ISO

19157:2013). For many of these, automated validity checks can be done, e.g. through the JOSM Validator. However, full validation of the completeness of a mapathon contribution is not possible without a reference dataset (which often does not exist) or validation in the field. Matching mapathons for remote mapping with field mapping trips could contribute to completeness validation. Alternatively, senior students could validate data contributed by junior students, in the way it is done at Texas Tech. In contrast to the a-posteriori quality check, some recent developments in literature stress the need to introduce data collection protocols to guide contributors a-priori in producing data of the highest possible quality (Mooney et al., 2016). This is accomplished in the field of humanitarian mapping through the multitude of training materials and guidelines, see e.g. the Missing Maps archive at [www.missingmaps.org/learn](http://www.missingmaps.org/learn), and the establishment of a Training Working Group within HOT ([wiki.openstreetmap.org/wiki/Humanitarian\\_OSM\\_Team/Working\\_groups/Training](http://wiki.openstreetmap.org/wiki/Humanitarian_OSM_Team/Working_groups/Training)).

Among the quality elements, the usability or fitness for use is the most difficult to validate automatically because it depends on specific user requirements. A mapathon usually collects data for a specific purpose, which dictates the nature (e.g. attributes) and quality (e.g. accuracy and completeness) of the data to be collected. However, OSM data is used in many online and mobile applications for a large variety of purposes. Adding post-mapathon usability checks by using the collected data in some of these online and mobile applications would help students to assess the general usability of the data and - even before (e.g. for routing) - to understand the challenges of assessing usability. Generally, data quality validation is time consuming and one needs to consider whether the experience of mapathon participation could be more important than the map data contribution. For example, some students noted that mapathon participation has taught them about challenges of data quality and maintenance and that the quality of map data should not be accepted at face value. Even if they never return as OSM contributors, these are important lessons that could lead them to understand and contribute to the geospatial data industry at large in their future careers.

Secondly, the impact of mapathons on mappers themselves is multifaceted. Surely, the social atmosphere of the gatherings has allowed students to network with peers and enjoy a fun, group setting. These moments of camaraderie are important for academic settings and a sense of belonging among students. In some cases, e.g. the PoliMappers chapters, a group of friends was formed who extended their personal relations far beyond the purely academic ones. Course assessments also revealed that students demonstrate learning in areas of technical skill and subject matter knowledge in many geographic domains, from open data to quality control, to spatial data management, to imagery interpretation; in addition, given the humanitarian and development context, students also learn about places of interest, and people's lives in locations remote from their daily geographies (Solís et al., 2017). It was also found that even beginners merely participating in a humanitarian mapathon significantly increase the level of interest in geospatial careers (Solís and DeLucia, submitted). Beyond these practical impacts, mapathons offer the ability for mappers to directly add to the domain of public knowledge through sharing spatial data, suggesting a mode of empowerment whereby students include themselves and their communities on the map. Furthermore, when the purpose of the mapping is made clear, it may prompt mappers to realize the importance of being a good citizen and think more empathically about others (Solís and DeLucia, submitted), suggesting an affective impact that contributing data

to OSM via mapathons could broadly bring to mappers and in turn to society.

Thirdly, mapathons have an impact on the universities where they are hosted. For example, previous to the introduction of YouthMappers mapathons, Texas Tech only offered GIS courses using proprietary software and did not incorporate an explicit open spatial data component in the curriculum, but now offers such formal educational opportunities. Service learning course credit was added to the Geospatial Information Science and Technology (GIST) program, providing students with the chance to receive formal acknowledgement on their transcripts for contributing to community engagement while earning their degree. As a result of these offerings, a number of students have directly been inspired to focus on open spatial data, OSM, and mapping for resilience in their thesis and dissertations. Faculty as well has begun a new line of research related to different aspects of open mapping, including quality and productivity topics, policy study on the uptake of open data in decision making, and impact on student learning outcomes. A significant impact was also registered at Politecnico di Milano. Thanks to the popularity, both among students and the faculty staff, of humanitarian mapathons and other mapping activities organized by PoliMappers, from the Academic Year 2018-19 mapathons will be officially recognized as “innovative teaching” activities by the university, which will allocate specific funding to support and organize them. As a consequence, students will be able to attend mapathons no longer as an extra (voluntary) activity, but as part of their curriculum. PoliMappers' activities impacted the university also in terms of students' inspiration on topics such as OSM and open data that lead to thesis and specific research works. An example (Minghini et al., in press) is published in the same collection of proceedings of this paper.

#### 4. CONCLUSIONS

In this paper we reported on exploratory research towards a better understanding of the impact of student mapathons. We described the mapathon experiences at three universities involved in the YouthMappers network, describing the purpose of the mapathons, the way students are encouraged to participate, how mapathons are organized and the number of attendees. The experiences of these three universities are very diverse and richly contextual to the specific character of the campus and its students. These differences underscore the challenge of a common means to formally evaluate or assess the impact of such events in general. Nevertheless, we identified three ways in which mapathons conducted through the YouthMappers framework in particular could improve our understanding of the impact of mapathons more broadly.

Firstly, the mapathons impact the map data in terms of both productivity and quality. Measuring the range of data quality elements with replicable methods is time consuming and often requires manual inspection. However, whenever possible it would be good to report a few automated quality measures after a mapathon. This could contribute towards a competitive environment that encourages different YouthMappers chapters to improve the quality of the data that they contribute. It would also be interesting to analyse and profile the contributions by individual mapathon participants. To achieve this, an analysis of the OSM Full History Planet File (<http://planet.osm.org/planet/full-history>), which stores the whole OSM database together with the history of edits, would be required.

Secondly, the mapathons impact the mappers themselves. To better understand this impact, one could develop a questionnaire that is completed after each YouthMappers mapathon. The responses could provide further guidance on how to conduct mapathons that positively impact society in the long run.

Finally, mapathons impact the institutions who host YouthMappers chapters and mapathons. We provide selected examples in this paper but more research is required to gain a better understanding. Now that the YouthMappers chapters have been running for a few years, the time may be opportune for such an investigation.

In conclusion, incorporating mapathons into the curriculum encourages students to contribute much-needed open geospatial data for humanitarian projects. At the same time, students get practical experience in data capturing with open source tools and awareness is raised of humanitarian challenges in other parts of the world, thus nurturing socially engaged citizens for the future.

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