Humanitarian Toolbox Project

by

Orest Ropi

A Interactive Qualifying Project

Submitted to the Faculty

of the

WORCESTER POLYTECHNIC INSTITUTE

In partial fulfillment of the requirements for the

Degree of Bachelor of Science

in Computer Science

by

May 2022

APPROVED:

Smith, Therese

Abstract

The goal of this project is to build on existing open mapping using humanitarian software from HOTOSM. I also wanted to learn about humanitarian software while contributing to its progression. This meant comparing HOTOSM with other disaster relief software. Open mapping will contribute to disaster relief in the areas that need mapping. Although most developed areas are mapped, it is crucial that more rural areas are as well. This will allow us to use already existing infrastructure to more efficiently provide aid to those impacted areas.

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Chapter 1

Problem Description

The purpose of this project was to learn about humanitarian software while also contributing to its progression. I like helping people and learning more about how software can be used for humanitarian causes. I wanted to find a project that was currently being worked on and to which I could make a contribution.

Currently, mapping data for humanitarian causes already has a large number of contributions. This is especially seen in developed and urban locations around the world. My goal with this project is to learn the impact of street mapping, while also contributing to its development. I will focus on how street mapping compares to other humanitarian software. [CSVdW07] [ABB17] [PKA+07] [EHRM12] [EMdL+07]

The HOTOSM source-code is hosted publicly on GitHub Pages:

`https://github.com/hotosm`

Link to open source mapping website:

`https://tasks.hotosm.org/`

Chapter 2

Related Work

The existing software for disaster relief includes many fields and platforms. One of the fields that this project will focus on is expanding open map data that enables disaster respondents to reach those in need. I will be doing this by working with HOTOSM software.

2.1 Existing HOTOSM Disaster Relief Software

HOTOSM is an international organization dedicated to humanitarian contributions and the development of communities via open mapping. They work to provide open map data that contribute to disaster management, reducing risks, and achieving sustainable development goals.

When a disaster occurs thousands of volunteers from HOT get together online to construct available map data that allow disaster respondents to reach those in need.

Through the Missing Maps project, the HOT global community completes maps of heightened vulnerability areas where data is lackluster, placing millions of people onto the world map in OpenStreetMap.

HOT helps international organizations, NGOs, and government partners to utilize OpenStreetMap for locally-relevant challenges via the provision of training and equipment.

HOT develops open-source apps and instruments for cooperative mapping and

geospatial data display. The tools are free for all to utilize and leveraged by partners such as Red Cross societies, Médecins Sans Frontières, UN agencies and programs, government agencies, and local NGOs and communities.

Most of this work is done through OpenStreetMap is the community-driven free and editable map of the world, supported by the not-for-profit OpenStreetMap Foundation. HOT works close to the globe to support and increase the use of OpenStreetMap and help build local OpenStreetMap communities.

Three software packages developed by HOT are learnosm, OpenAerialMap, and tasking-manager. Tasking Manager is a mechanism to team up for mapping in OpenStreetMap. OpenAerialMap is an open service to deliver access to a common of openly licensed imagery and map layer services. The learnosm repository is dedicated to helping people learn how to map in OpenStreetMap (OSM) and use many of the software and tools. [SP14]

2.2 Compare to Disaster Relief Software That Exists

Mapping is just one of the many different ways that open-source software can contribute to disaster relief. Another way this could be accomplished is by helping people connect with lost loved ones. Software that helps in the distribution of first-aid, and many others.

An example of this is American Red Cross. They share a mission of preventing and relieving suffering, here in the U.S. and around the world. American Red Cross is a non-profit humanitarian organization that focuses on disaster relief, disaster relief education, and emergency assistance mainly in the United States. This is an organization that has a broader scope of focus compared to HOTOSM. [Pai19]

OneBlood, approved by the U.S. Food and Drug Administration, is a software application that is highly intuitive, user-friendly, and allows each unit of donated blood to be tracked from collection to transfusion and every step in between. RSA also enables donors to move through the system faster, allowing for increased blood collections and improved donor satisfaction. With both OneBlood and the Red Cross operating on RSA, the software platform will be used to manage more than half of the nation's blood supply. This software can be used in conjunction with HOTOSM software to improve disaster relief. [Pai19]

VEOCI is a virtual emergency operations tool that is being used in more than 180 facilities such as educational centers, airports, and government entities throughout the U.S. and internationally. It was described by the Director of Emergency Management as the "Facebook for Emergency Management." The software is useful for managing and informing large personnel during a time of crisis. The software can also be used to simulate events such as natural disasters. For example, a wildfire approaching a school can be simulated using the software. VEOCI is integrated with google maps and provides a visual representation of the wildfire. The software will also provide other information such as resource supply, evacuation locations, etc. . This will improve education on disaster relief, while also making sure to product is equipped to handle a specific situation. This software tool can also be used in conjunction with HOTOSM, but is mainly useful for large-scale disasters. [HOI19]

Lastly, social media has become a useful software tool for disaster relief. This software is useful for broadcasting the needs of individuals during a disaster. It is the most effective system for this, as it is common for someone to have access to the software during a crisis. Although it is easy to use and most people have access to it, the software is not meant to be solely used for disaster relief. Anyone can restate already known information or propagate rumors. This can lead to issues such as data

cluttering and misinformation. These issues require third-party software to parse the data, so information on social media can be more easily processed. Parsing the data will result in some useful messages being lost, making this tool slightly inconsistent and/or resource-consuming to use. Even if other software might be more effective for the broadcasting needs of individuals, it is important that we continue to use social media due to its broad reach in society. [LC14]

2.3 How this Project Builds upon Existing Work

This project uses existing HOTOSM software to expand existing map data. In the future, I am hoping to be more involved in the development of the software, as I gain more experience with it. As of now, HOTOSM has over 300,000 community mappers that help expand their map data, with hundreds of millions of mapping contributions from them. [PSAB15]

Chapter 3

Methodology

3.1 Looking For Project

My first goal was to research as many projects, as I could and attempt to find one that was interesting and could be contributed by me. My primary tools for searching for projects were google, GitHub, and GitLab. I wanted to look for projects that used programming languages that I was familiar with. I also wanted to look for projects where I could contribute in other ways, apart from software development, as well. These factors maximized my flexibility to start working on the project right away. Being familiar with the programming languages allowed me to quickly start helping contribute to development. Also, having other ways to build on the software outside of programming would allow me to contribute even if I did not get to directly make changes. Lastly, I also looked for a project that was being actively updated and used. This made it more likely that I could contribute to it efficiently.

Here is a list of the projects I looked at in order:

1. "2 Weeks Ready"
    - An application for disaster preparedness. An easy place to store and share emergency information.
    - I reached out to the developers on twitter to try and ask how I could contribute.

- Link to Project Here

2. Carbon Footprint

    - I reached out to the developers on twitter to try and ask how I could contribute.
    - Link to Project Here

3. SugarLabs

    - Attempted to make pull request to contribute to github repository.
    - Link to Project Here

4. crisischeckin

    - Project updates seemed 2 years and older, so I was not able to make contact with the developers.
    - Link to Project Here

5. MobileKidsIdAppBuild

    - Attempted to make pull request to contribute to github repo.
    - Link to Project Here

6. HOTOSM

    - Reached out to developers and staff through slack and email.
    - Link to Project Here

3.2 Training

I decided to contribute by using the software to build on the already existing mapping data. Initially I had to get familiar with how to use their software. This is how I trained:

1. Watched Introductory Videos

Figure 3.1: One of the youtube videos I used to learn the software

2. Asked Questions in Slack

3. Attending Meeting

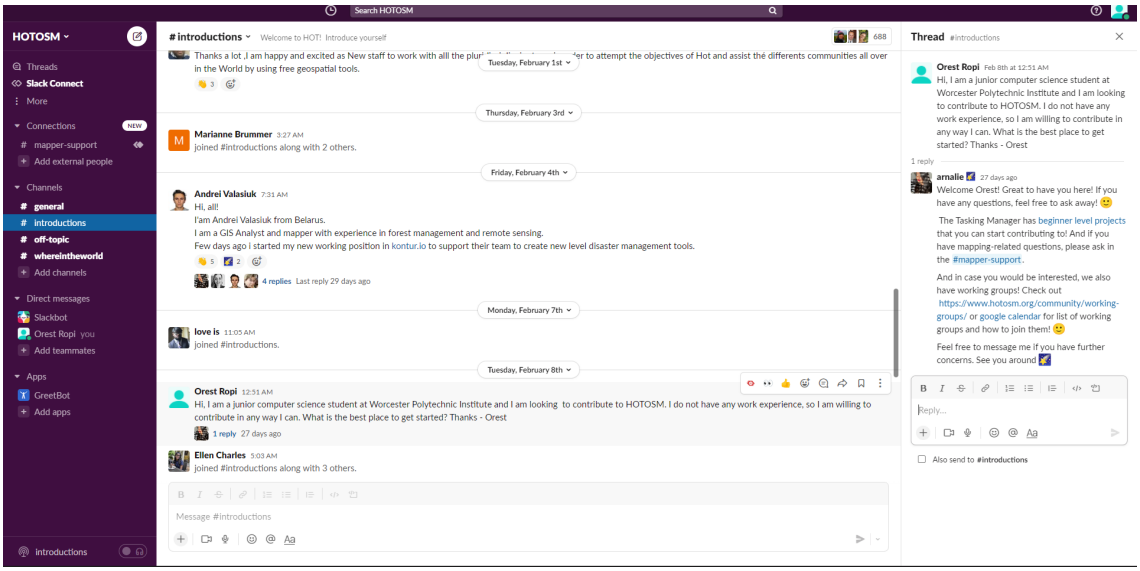

Figure 3.2: I asked slack questions that were related to mapping and HOTOSM

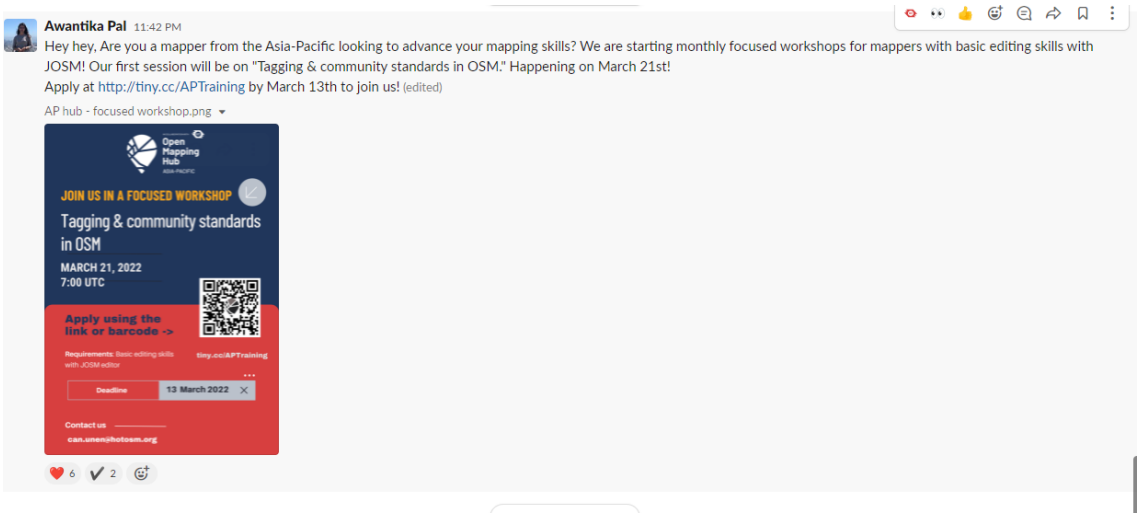

Figure 3.3: I attended meetings such as this one

3.3 What Would Have I Done Differently?

When searching for a project to contribute to, I would start by making sure that it is actively being worked on. Reaching out to a lot of projects by contacting the people who work on them is a good idea. Then I recommend doing more research if the project is right for you. This will save a lot of time, as some projects are inactive and/or difficult to contribute to. I would ask questions as early as possible, this could be done through the slack for HOTOSM. Make sure to look at all available resources to find some that best help you contribute. This could be a readme in a GitHub repository or an instructional youtube video.

Chapter 4

Results and Conclusions

I ended up using the HOTOSM software to map some areas that needed mapping. The areas in which I contributed to mapping included the countries of Libya, Brazil, and Mauritania. The mapping included identifying roads, structures, and geological features. I used google translate frequently so I could understand the different languages that were used. I learned more about how the software was constructed by using it as well.

As more areas are mapped it is easier to conduct relief operations. Identifying the fastest routes to an area will lead to supplies arriving faster. An example of this could be identifying the location of roads and what type of road they are, using the HOTOSM software. Mapping will allow us to know which areas have residents. An example of this is labeling structures as a home rather than ruble, using the HOTOSM software. This will make search efforts for missing people easier because the relief operations will know which areas to search. The mapping also allows relief operations to find the fastest path to a hospital from a certain location. [dDS12] [LC14]

The mapping can also have economic and educational benefits for the mapped areas. For example, it can help local leaders make sure that residents have access to educational centers. Local businesses can also use the map data for more efficient travel. It can also help with identifying where possible customers are located. The map data can allow charity organizations to identify problems such as poor road

construction. This will allow mapped areas to have a higher chance to receive funding from these charities or their governments.[Pai19] [dDS12] [LC14]

Here are images of the mapping software:

1. Mapped Areas in Nouadhibou, Mauritania
2. Mapped Areas in SÃO Francisco River, Brazil
3. Mapped Areas in Benghazi, Libya

Figure 4.1: An area I mapped in Nouadhibou, Mauritania

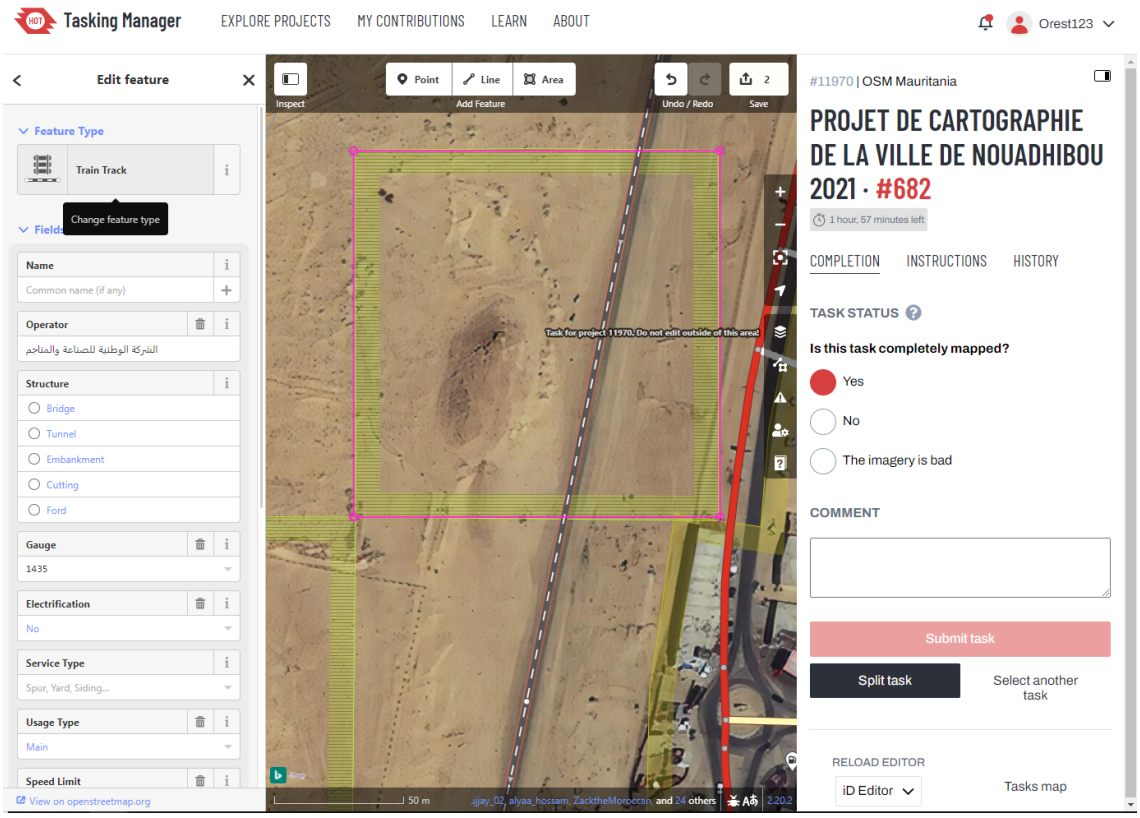

Figure 4.2: Another area I mapped in Nouadhibou, Mauritania

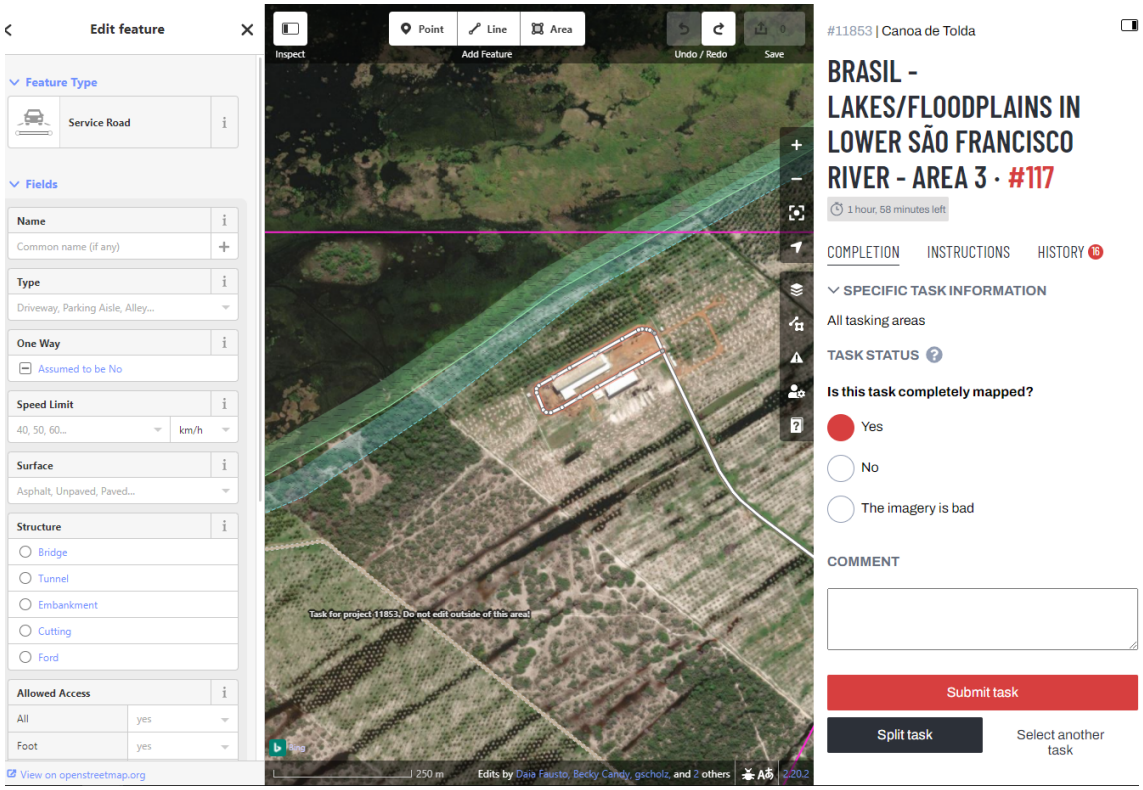

Figure 4.3: An area I mapped in SÃO Francisco River, Brazil

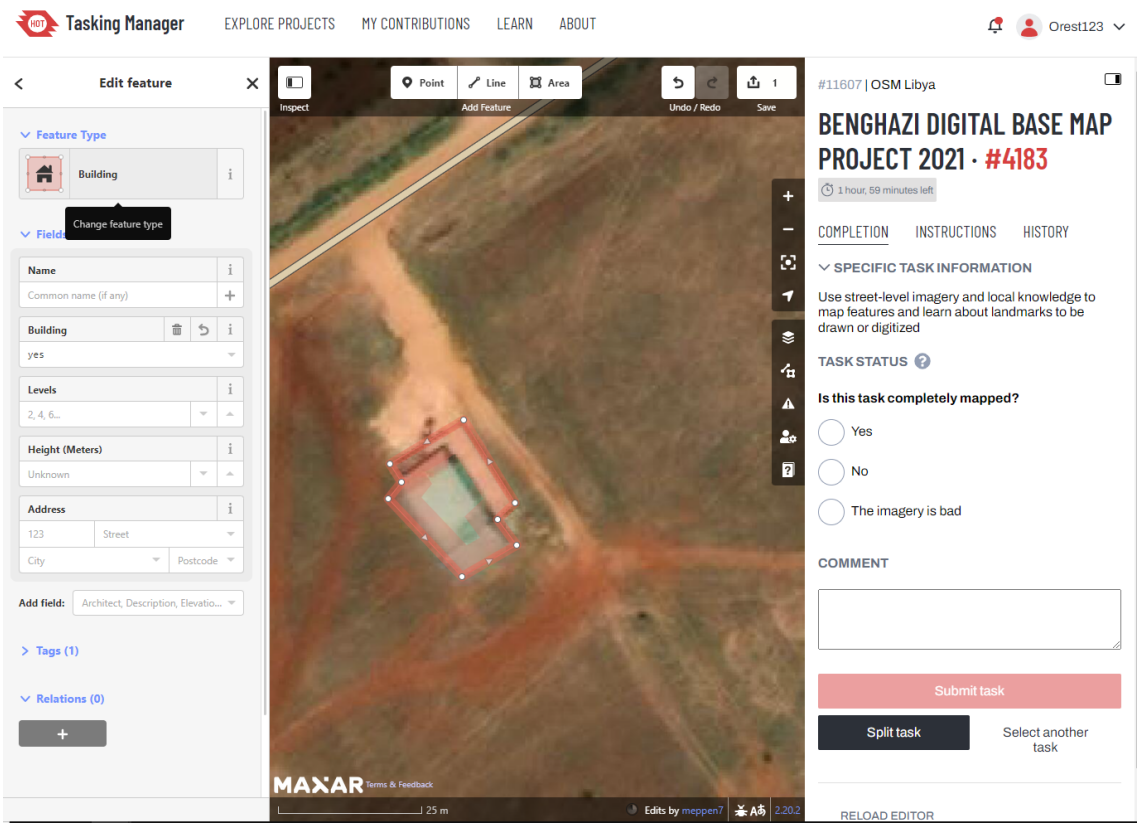

Figure 4.4: An area I mapped in Benghazi, Libya

Chapter 5

Limitations and Future Work

Although the software is abstract, it can help extract more benefits from material things that already exist such as roads. This makes the software a powerful tool in the real world for collecting, representing, and sharing data. The software allows us to interact with people worldwide. Although this can help us get data quickly, as it does for HOTOSM, it also leads to data cluttering. This requires new features to be implemented in the software to make sure the data is parsed and utilized effectively. [dDS12] [LC14] [SP14]

In the future, I plan on continuing to use HOTOSM software to contribute with map data in locations of need. As I begin to gain more experience I hope to eventually contribute to the development of their software. Donating is another future option to help support HOTOSM software.

Bibliography

[ABB17] Ron Austin, Peter Bull, and Shaun Buffery. A raspberry pi based scalable software defined network infrastructure for disaster relief communication. In *2017 IEEE 5th International Conference on Future Internet of Things and Cloud (FiCloud)*, pages 265–271. IEEE, 2017.

> Disasters, both natural and man-made, can occur at any time or place in the world; aid is then required to support the victims of the disaster and to provide humanitarian support within the disaster zone. The first 24-48 hours after a disaster are a critical time for first responders in administering aid to the victims. This is known as the golden 24 hours [1] where 85effort, a rapidly deployable, scalable, and low-cost communication infrastructure is required. This paper proposes the use of low-cost Single Board Computers, in combination with scalable containerized network services (e.g. VOIP, Web Services, etc.), utilizing Software-Defined Network-based control to allow the centralized management of devices. A Raspberry Pi-based prototype setup is detailed, and initial performance tests are presented as a means of confirming the technological viability of the concept under several different topology configurations.

[CSVdW07] Paul Currion, Chamindra de Silva, and Bartel Van de Walle. Open source software for disaster management. *Communications of the ACM*, 50(3):61–65, 2007.

This paper presents the results of a study of student perceptions of learning related to software engineering knowledge and skills while involved in an HFOSS project. The study involved ten different courses offered at four different academic institutions between the summer 2008 and fall term 2010. The courses ranged from software engineering and software development courses aimed at juniors and seniors as well as an introductory computing course. In these courses, students participated in a range of HFOSS projects ranging from disaster management applications to applications to aid disabled computer users. In addition to reporting on learning, the paper will also discuss the impact of gender on software engineering learning as well as compare results from high versus low programming experience on software engineering learning.

[dDS12] Luis E. de la Torre, Irina S. Dolinskaya, and Karen R. Smilowitz. Disaster relief routing: Integrating research and practice. *Socio-Economic Planning Sciences*, 46(1):88–97, 2012. Special Issue: Disaster Planning and Logistics: Part 1.

Describes a common issue in disaster relief software is that operations often are not as organized as they could be. The paper shows how operations research models have the power to help relief agencies save lives more efficiently. Through interviews with aid organizations, this paper provides an analysis on the models used for operations.

[EHRM12] Heidi J.C. Ellis, Gregory W. Hislop, Josephine Sears Rodriguez, and Ralph Morelli. Student software engineering learning via participation in humanitarian foss projects. In *2012 ASEE Annual Conference & Exposition*, San Antonio, Texas, June 2012. ASEE Conferences. number = 10.18260/1-2–21949, https://peer.asee.org/21949.

This is a source for an article about open-source software as it relates to software engineering students. A study was done where open-source software was integrated into classes for 4 academic institutions. These studies ranged from 2008 to 2010. The article also goes on to talk about the impact of gender in software engineering as well. The study resulted in a determination that students gained significant knowledge by working on software outside the classroom, as reported by the students themselves.

[EMdL+07] Heidi J. C. Ellis, Ralph A. Morelli, Trishan R. de Lanerolle, Jonathan Damon, and Jonathan Raye. Can humanitarian open-source software development draw new students to cs? *SIGCSE Bull.*, 39(1):551–555, mar 2007.

In the paper an example of a humanitarian open-source software project that began deployment in January 2006 at a liberal-arts college as an experiment in CS education. Sahana is a free and open-source disaster management system that was developed in Sri Lanka by a group of IT professionals in response to the 2004 Asian tsunami. It is web-based and addresses the IT coordination problems that typically

occur in trying to recover from a large-scale disaster. The article explores the wider use of Sahana for teaching about open-source software and allowing CS students to make useful contributions. This article includes the benefits for both academia and the industry of open-source software.

[HOI19] Harry Hueston and George K Orton III. Introducing a virtual emergency operations center into a higher education curriculum. *Administrative Issues Journal: Connecting Education, Practice, and Research*, 9(1):48–52, 2019.

The article discusses the use of virtual emergency operations centers in higher education. They went on to describe how this would help students. The schools, and the police departments responsible for keeping students safe. Virtual Emergency Operations Center, or Veoci, is a high-quality software application designed to aid emergency responders as smoothly and consistently as possible. In an emergency, first responders and authorities must have the resources to care for people who may be injured, dehydrated, fatigued, and possibly lost or confused. Veoci helps emergency management teams keep track of all people involved in a disaster. When police and first responders know who has already received food, water, and medical treatment, it's easier for them to prevent abuse and waste of emergency resources.

[LC14] Peter M. Landwehr and Kathleen M. Carley. *Social Media in Disaster Relief*, pages 225–257. Springer Berlin Heidelberg, Berlin, Heidelberg,

2014.

This book section discusses how social media has become more integrated into peoples' daily lives, its users have begun turning to it in times of distress. People use Twitter, Facebook, YouTube, and other social media platforms to broadcast their needs, propagate rumors and news, and stay abreast of evolving crisis situations. Disaster relief organizations have begun to craft their efforts around pulling data about where aid is needed from social media and broadcasting their own needs and perceptions of the situation. They have begun deploying new software platforms to better analyze incoming data from social media, as well as to deploy new technologies to specifically harvest messages from disaster situations.

[Pai19] William Painter. The disaster relief fund: Overview and issues. *Congressional Research Service: Washington, DC, USA*, 2019.

This report introduces the DRF and provides a brief history of federal disaster relief programs. It goes on to discuss the appropriations that fund the DRF, and provides a funding history from 1964 to the present day, discussing factors that contributed to those changing appropriations levels. It concludes with a discussion of how the budget request for the DRF has been developed and structured, given the unpredictability of the annual budgetary impact of disasters, and

raises some potential issues for congressional consideration. This report is updated on an annual basis.

[PKA+07] Nikos Pogkas, George E Karastergios, Christos P Antonopoulos, Stavros Koubias, and George Papadopoulos. Architecture design and implementation of an ad-hoc network for disaster relief operations. *IEEE Transactions on Industrial Informatics*, 3(1):63–72, 2007.

This paper presents an ad-hoc sensor network especially developed for a disaster relief application that provides the rescue teams with a quickly deployable, cost-effective, and reliable tool to collect information about the presence of people in a collapsed building space and the state of the ruins. The hardware/software architecture of the wireless sensor nodes is developed for low-cost design implementation. Energy efficiency is another objective of this paper, achieved by the combination of a low-power-mode algorithm and a power-aware routing strategy. A selected set of simulation studies indicate a reduction in energy consumption and a significant increase in node lifetime whereas network performance is not affected significantly. Finally, a lightweight management architecture is presented to facilitate autonomous management of ad-hoc sensor networks.

[PSAB15] Leysia Palen, Robert Soden, T. Jennings Anderson, and Mario Barrenechea. Success and scale in a data-producing organization: The socio-technical evolution of openstreetmap in response to humanitarian events. In *Proceedings of the 33rd Annual ACM Conference on*

Human Factors in Computing Systems, CHI '15, page 4113–4122, New York, NY, USA, 2015. Association for Computing Machinery.

The article describes the earthquake that struck Haiti in 2010 and the 2013 Typhoon Yolanda. that catalyzed a set of efforts in the-emergent "volunteer technology communities." This paper describes how an organization that emerged out of the response, the Humanitarian OpenStreetMap Team, formalized their practices with respect to many different needs with the aim of setting a model for how the potential of participatory, community mapping could be realized in Haiti, Yolande, and beyond.

[SP14] Robert Soden and Leysia Palen. From crowdsourced mapping to community mapping: The post-earthquake work of openstreetmap haiti. In Chiara Rossitto, Luigina Ciolfi, David Martin, and Bernard Conein, editors, *COOP 2014 - Proceedings of the 11th International Conference on the Design of Cooperative Systems, 27-30 May 2014, Nice (France)*, pages 311–326, Cham, 2014. Springer International Publishing.

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Note some annotations are partially derived from abstracts of papers.

Appendices

Appendix A

HOTOSM Source Code

This code is shown publicly on GitHub:

`https://github.com/hotosm`