

Drones for Good: Mapping Out the SDGs Using Innovative Technology in Malawi

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Abstract

Drones are being used in various industries, focusing on youth involvement and mapping activities as a key component of the multiple initiatives. YouthMappers are creating open-source geospatial data using geospatial technology to address local developmental and humanitarian issues in Malawi and beyond. As the world works to meet the Sustainable Development Goals, this new technology, combined with significant youth involvement, is being used to its full potential because of its sophistication, which allows for more efficient operations in support of industry, innovation and infrastructure (SDG 9) and responsible consumption and production (SDG 12) in the health sector for delivery, precision agriculture and the education sector, to name a few.



Keywords

Innovation · Drone technology · Malaria · Malawi · Geospatial industry · Youth

1 Evolution of an Innovation

The use of unmanned aerial vehicles (UAVs), colloquially referred to as drones, has grown tremendously following the decision by aviation authorities to grant commercial permits to non-military drones in 2006 (Cain Kitonsa and Kruglikov 2018). Since then, the technology has progressed from its traditional applications in security and surveillance to becoming the first line of defence during emergency response, land surveying, construction site inspection and healthcare delivery. Drones are also increasingly being used to aid in promoting development and humanitarian assistance (UNICEF 2018). As a result of the coronavirus (Covid-19) pandemic, drones have gained popularity in the healthcare

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industry. UNICEF is the leading organisation in implementing drone projects in various countries.

Developing countries such as Malawi have benefitted from UNICEF's deployment of drones in the transportation sector, especially for delivering medical samples, which is hindered by the country's inadequate road infrastructure. There have been cases in which drones have been able to transport blood to a remote hospital in a timely manner when a woman was in a life-threatening condition during childbirth. A drone testing corridor has been established in Kasungu, located in Malawi's central region. The purpose of the corridor is to facilitate tests for interested drone companies in the following areas: (i) imagery, generating and analysing aerial images; (ii) connectivity, exploring the possibility for drones to extend telecommunication connectivity across difficult terrain; and (iii) transport, delivery of low-weight supplies such as medicines. Children and marginalised communities will benefit from drones in this corridor because it provides a controlled environment for testing their use. Information gathered from the flights is used to inform the government's plans for the future use of unmanned aerial vehicles/drones (UNICEF 2018).

As a result of this initiative, the idea of establishing an academy dedicated to imparting twenty-first-century skills to the African youth in drone and data technology was conceived, and the concept evolved into what is now known as the African Drone and Data Academy (ADDA).

2 Drones to Promote Inclusion, Empower Youth and Foster Innovation

The goal is to build resilient infrastructure, promote inclusive and sustainable industrialisation and foster innovation. Why? Economic growth and social development are dependent on investments in infrastructure, sustainable industrial development and technological progress. Drones

are a sustainable and energy-efficient alternative for tasks involving other methods of transport or for developing and inspecting infrastructure. In this way, this technology contributes to Sustainable Development Goal 9, sustainable infrastructure.

UNICEF saw the potential for drones in Malawi, with infrastructures such as the humanitarian drone corridor being accessible for interested drone companies, academic institutions (Virginia Tech University) and local Malawian universities willing to spearhead the drone industry in Malawi. With every structure in place, one key component was missing from the mix; the local human resource was lacking. This was when capacity building for drone pilots and data analysts was started through the African Drone and Data Academy.

The African Drone and Data Academy aspires to establish an inclusive and creative environment through its one-of-a-kind curriculum covering drone technology and data analysis. Students from across Africa are given a chance to stay ahead of the curve in the technology sector. It was launched in 2020 and has already made a significant difference in the lives of the youth who participate in the program.

2.1 Youth and Drones

As the only Trusted Operator Program (TOP) training provider outside the USA, the African Drone and Data Academy (ADDA) has contributed to the empowerment of African youth. More than 500 youth across Africa have been in online and in-person drone and data technology courses. Graduates from the academy have gone on to work for a variety of drone companies, each feeling empowered and eager to make a difference in their communities after completing the program. The majority of graduates have been employed in three primary industries, including agriculture, health, and education.

Ndapile Mkuwu and Alexander DC Mtambo are graduates from the first cohort of the African

Drone and Data Academy (ADDA). The two are currently working as senior instructors at the academy. Sharing her experience, Ndapile Mkuwu stated that the program alters one's perspective and significantly increases one's self-worth. Initially, she was interested in the data analysis aspect of the program. However, as time went on, Ndapile developed a growing interest in learning how to build a drone and design fundamentals. It became even more exciting when she discovered that drones can be constructed from locally sourced materials and still perform the same functions as a \$10,000 drone. "You get to learn how to think outside the box, while still thinking of local solutions to local problems", she shared. One of the activities involved building a fixed-wing drone out of foam board and 3D-printed components. It was fascinating to see how what appeared to be poster boards transformed into a drone that could save lives or collect imagery, depending on the type of payload integrated into the craft. Some students took up the idea of utilising low-cost materials and constructed a quadcopter entirely out of plywood, a material abundant in Malawi.

After their graduation, Ndapile and Alexander participated in a mapping activity at Dzaleka Refugee Camp in Malawi which was headed by their instructors at that point. The goal of this project was to acquire high-resolution imagery in order to create a flood model of the area. This was the beginning of their journal as young drone pilots in Malawi. Having joined the academy's task force as national instructors, they are at the forefront of teaching twenty-first-century skills. It has been an exciting experience. However, there are also challenges with difficulties ranging from increasing the number of women engaged in an academy to trying to complete a jam-packed curriculum in a short period of time (5 weeks). Speaking in this, Ndapile said that the only way to withstand the intense nature of both providing the program and receiving the program is to have a strong sense of enthusiasm and passion. In order to boost participation in the tech industry, strategies such as outreach programs have been used.

2.2 An Innovation Region

YouthMappers currently has four chapters based at universities located in Malawi's southern and central regions. The ADDA has so far trained 6 female YouthMappers alumni from these different universities. Having undergone the program and appreciated the technology and its applicability in OpenStreetMap (OSM), we advocated for the training of student members from the LUANAR YouthMappers chapter at Lilongwe University of Agriculture and Natural Resources. Ndapile conducted this training over two days, and it familiarised a group of people who knew nothing about drones and drone flights with the fundamentals of the technology. It was designed so that individuals who participated in the training would have an advantage in any future programs that may need participants to have a basic understanding of drones and other related technologies.

Being a YouthMappers volunteer affiliated with the Chanco chapter is the starting point of the narrative. I began as a volunteer mapper in 2018 and was chosen to be a YouthMappers leadership fellow not long after. As a leadership fellow, I received training in the soft skills that are necessary for managing a chapter and was given the opportunity to network with other youth from across the world. The next year, after the conclusion of the fellowship, I was introduced to a person in Malawi who was involved in drone research, which was relatively fresh knowledge at the time. We connected and were introduced to the academy and what it does; since then, I have progressed from being a student to later being a member of the task force (Fig. 14.1).

3 Drones to Promote Good Health and Well-Being

The introduction of drone technology to the youth in Malawi is already showing positive impacts. Various youth-led initiatives that address multiple issues in different communities have used drone technology.



Fig. 14.1 YouthMappers alumni serving as instructor for the African Drone & Data Academy works with a student during a drone flight

3.1 Dzaleka Mapping Project

MapMalawi is an organisation that was founded by two Malawian females, Ndapile Mkuwu and Zola Manyungwa. The two are former YouthMappers leadership fellows and graduates of the African Drone and Data Academy (ADDA).

It was established to create, engage and work with youth-based communities to create open-source geospatial data using geospatial technology as one of the means of contributing to addressing local developmental and humanitarian issues in Malawi.

The Dzaleka Mapping Project was the first project under the organisation, and it was funded by the Humanitarian OpenStreetMap Team (HOT) community impact grant. Dzaleka Refugee Camp is the largest camp in Malawi, located 50 km just outside the capital city, Lilongwe. It was established in 1994 by UNHCR in response to a surge of forcibly displaced people fleeing genocide, violence and wars in Burundi, Rwanda and the Democratic Republic of Congo. It was meant to house 10,000 people but has reached its maximum absorption and now has 52,000 registered refugees and asylum seekers (There Is Hope 2018). This increase means that the resources in the camp barely cater to the needs of the already vulnerable population.

The Dzaleka Mapping Project generated geospatial data that will show the provision of basic needs at the refugee camp by integrating drones, OpenStreetMap and other geospatial technologies. Centres within or around the refugee camp that allow the refugees to access the different basic needs were mapped out. These include education, healthcare, water/sanitation and buildings/housing. The relevant statistics of the mapped amenities present a picture of how people living in the camp have access to the different amenities.

3.2 UAV Imagery Giving an Essential Perspective

Drones were an essential part of the project. The Dzaleka Refugee Camp is a high-density settlement with clustering buildings. Therefore, there was a need for imagery with high spatial resolution. MapMalawi volunteers, in collaboration with CAGE, used drones to capture images of the refugee camp. The imagery was captured using a Mavic 2 enterprise dual; the mission was flown at the height of 100 m to achieve an image resolution of 3 cm/pixel. Individual images were combined to form an orthomosaic, and the final image was published on openaerialmap.org.

The HOT Tasking Manager was used for organised and coordinated OpenStreetMap mapping. The *Malawi – Mapping for People Living in*

Protracted Crisis – Dzaleka Refugee Camp task was created to manage the project. The high-resolution drone imagery was used as a background image for the project. Volunteers expressed that the clarity of the drone imagery made feature identification and mapping easy. It is with no doubt that the presence of the drones contributed to the success of the mapping activities.

3.3 Collaborations, Youth and Community Involvement

In the words of Hellen Keller, “alone we can do so little; together we can do so much”. Collaborations, youth and community involvement were critical to the project success. Youth that are graduates of the drone academy were recruited as volunteers under MapMalawi. Ndapile and Zola believe that community members should take part in mapping activities. Apart from the fact that their local knowledge is beneficial to the project activities, involving the community empowers them and lets them see themselves in the created maps. Therefore, MapMalawi also collaborated with a local tech lab, TakenoLab, located at Dzaleka Refugee Camp, and works with people living within and around the refugee camp. The MapMalawi volunteers and youth affiliated with TakenoLab were trained to make edits on OpenStreetMap using iD editor. Remote mapping activities using iD editor focused on mapping buildings within and around the refugee camp. The youth at the camp were also trained on how to collect point data using KoBoCollect, and Ndapile also facilitated a class on drone technology at the refugee camp.

Collaborations went beyond Malawian borders. The Malawi OSM community hosted OSM Africa’s monthly mapathon in September 2021. The Dzaleka Mapping Project was the project mapped on this day, with OpenStreetMap users from different parts of Africa contributing towards the generation of the OpenStreetMap-based geospatial data for the refugee camp. The Humanitarian OpenStreetMap Team (HOT) data quality interns validated the mapping. With the



Fig. 14.2 Drone imagery provides an excellent source of high-resolution imagery that enables remote feature mapping onto OpenStreetMap. (Credit: N. Mkuwu)

efforts of the groups mentioned, a total of 16,715 buildings, 23 schools, 11 toilets, 16 waste disposal sites, five health centres, one police station and 47 water points were mapped out (Fig. 14.2).

4 Drones for Innovation in Health Prevention Efforts

4.1 Novel Technology to Control Malaria

According to the World Malaria Report 2018, Malawi is one of the top 20 countries globally in terms of malaria prevalence and fatality rate (2% of global cases and deaths). Malawi accounts for approximately 7.4% of all malaria cases in Eastern and Southern Africa (World Health Organization 2018).

The Malawi Liverpool Wellcome Trust carried out a pilot study in Kasungu, Malawi. According to the preliminary studies, malaria transmission occurs all year round in this area, with parasite prevalence in children between 2 and 10 years old estimated at 19% in 2017. Its transmission is potentially driven by a number of reservoirs (artificial lakes) that provide permanent water sources within which female *Anopheles* can lay their eggs (Stanton et al. 2021). The project's

goal was to perform field research inside the UNICEF humanitarian drone testing corridor in Kasungu district, Central Malawi, to see whether mosquito breeding areas could be detected pragmatically using drones and to provide a framework for the National Malaria Control Program to adopt this technology (MESA 2021).

In addition to the production of orthomosaics, the Malawi Liverpool Wellcome Trust team uses additional geospatial methods, such as machine learning, to quickly identify tiny ponds of water that may be a possible breeding location for the mosquito. Because of the geotagging feature of drones, identifying locations where breeding sites are likely to be found is very simple, this reduces the amount of effort required for humans to find the potential sites for water sample collection to have some lab work done to determine the presence of mosquito larvae that causes malaria.

4.2 Mosquito Breeding Sites in Kasungu

Mwase is a village in Kasungu with a dam that goes by the same name. Mwase village is surrounded by two other villages (Chiponde and Chinkhobwe) with high malaria cases (Fig. 14.3).



Fig. 14.3 Mwase village in Kasungu has a dam and reservoir which needs monitoring to control malaria

While on site, Ndapile Mkuwu and Alexander Mtambo were struck by how important the initiative is since they were able to see first-hand how bad malaria is in the area. They randomly went to two different houses to introduce themselves, and the first house had two people suffering from malaria, and the other had four people. Sharing her experience, Ndapile said, “I must say that this gave us more motivation as we knew that the work we are doing is something that will actually impact real people with real problems”.

Although it is clear that the dam is a mosquito breeding site, there are other smaller water bodies inside the villages that have the potential to be mosquito breeding sites. However, the size of these smaller bodies makes them relatively harder to detect. This is where drone imagery becomes quite useful. After creating an orthomosaic, areas with water that were difficult to identify through manual surveying by simply strolling about the towns on the ground became easier to identify (Fig. 14.4).

4.3 Pre-flight Preparation

Malawi Liverpool Wellcome Trust contracted Alexander Mtambo and Ndapile Mkuwu to conduct mapping activities in the areas of interest and produce maps through GLOBHE, a global crowd droning platform. As per the Malawi regulations, for an individual to pilot a drone, you must have the remote pilot license (RPL). Ndapile and Alexander are certified drone pilots by the Malawi Department of Civil Aviation (DCA) and holders of the Trusted Operator Program Level 2 (TOP 2) issued by Aerial Unmanned Vehicle Systems International (AUVSI). Nonetheless, they were required to obtain authorisation to fly or at the very least notify the DCA of the times and heights at which the drones would be flying to facilitate coordination with other airspace users and to ensure the safety of all airspace users during all operations.

Ndapile and Alexander conduct community sensitisation activities before flying the drones as per standard practice. Drones are very useful and

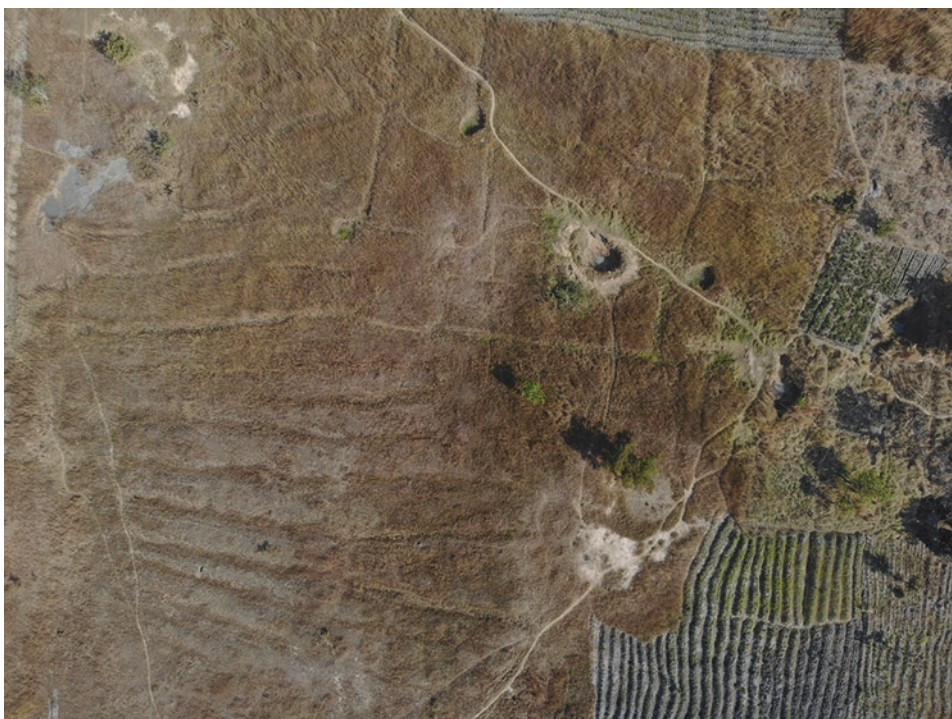


Fig. 14.4 Small ponds of water that may serve as breeding grounds for mosquitos that cause malaria are difficult to identify or locate through manual surveying but easily identifiable via drone imagery

make work simpler in many situations, but they also have some negative effects, such as personal privacy and safety concerns. The community is educated on what the drone is and how it is likely to behave once it takes off. Once individuals are aware that a camera is hovering above their heads, they begin to wonder what the purpose of all the pictures being recorded could be. This is one of the main reasons why community sensitisation is very crucial. The drone pilot duo always strives to make sure that relevant authorities in the community are aware that they are flying and why drones are flying. The case in Kasungu was slightly different for us despite the location being remote; Malawi Liverpool Wellcome Trust had already done much sensitisation, and people had already seen a drone fly. Nonetheless, Ndapile and Alexander avoid working on the assumption that everyone knows what a drone is and that they have seen it before (Fig. 14.5).

When sharing how they handle flying drones with people around, Alexander said:

To avoid drawing negative attention to ourselves or our activities, we constantly emphasise safety while using drones, particularly when working around young children. We also make sure that all flight crew members are properly attired, which makes us far more recognisable in the event that someone has a question or requires our assistance with anything related to our operations. We make sure that we have a minimum of three people: one who serves as the chief pilot, another who assists with crowd management, and another who serves as a visual observer.

4.4 Data Collection

After evaluating the terrain, which was mainly flat, Ndapile and Alexander decided to fly at the height of 100 m. The Department of Civil Aviation specifies a limit of 120 m as the maximum height allowed. It should be noted that the resolution that the project managers request also defines the altitude to which the mission will be set. The lower the height at which the drone flies,

Fig. 14.5 Each member of a drone team has specific responsibilities to pilot and manage the operations



the higher the image resolution. Finally, the drone pilot duo makes sure that they are flying higher than the highest building or natural landmark in the region. This is to prevent the drone from crashing, despite the drone having an inbuilt obstacle avoidance system. The overlap percentage for the mission flight was set on 70% frontal and side, which produced approximately 2000+ images for the 600-ha area that was being mapped.

4.5 Working Through Challenges

Batteries are a constant source of frustration during flight activities. This includes batteries for the remote controller and the batteries for the drone itself. Usually, a battery would provide about 20–25 min of flying time for a mission. With the study area being approximately 600 ha in size and to avoid spending a significant amount of time on site, Ndapile and Alexander are obliged to accelerate the procedures while not compromising on quality. Despite all efforts, batteries still prove to be a challenge. Car battery chargers are used to tackle this, and sometimes an uninterrupted power supply (UPS) is utilised. In addition to this, the duo makes sure that the take-off

home point is as close to the trading centres as possible to charge the batteries in the nearby houses and shops within the community.

5 Reflecting on the Potential of Drones for SDGs in the Hands of Youth

With the two activities that we covered in this chapter, it is evident that drone technology is dependable and can be used for a broad range of applications. Drones have the potential to contribute to the achievement of the Sustainable Development Goals more efficiently and sustainably; the fast development of the drone industry is an indicator of the promise that they possess in this regard. Various youth engagement programs have been launched to promote active participation in ticking the boxes of the different Sustainable Development Goals (SDGs). The African Drone and Data Academy is one of the key players in this regard; it trained more than 500 youth across Africa in online and in-person drone and data technology courses. A good number of its graduates are now employed by drone companies that specialise in either health or agriculture. Several others have start-up companies,

with the core activity being the provision of mapping services.

We believe that with the appropriate amount of empowerment, most of the problems that plague our communities would be resolved, and lives would be spared. As of 2019, drones delivered over 27,361 vaccines and 95,011 doses of antibiotics in Malawi; drones are bringing us a step closer to excellent health and well-being. Who better head these initiatives than our African youth?

References

- Cain Kitonsa H, Kruglikov SV (2018) Significance of drone technology for the achievement of the United Nations sustainable development goals. *R-Economy* 4(3):115–120. <https://doi.org/10.15826/recon.2018.4.3.016>
- MESA (2021) Assessing the operational usage of drone imagery for malaria mosquito breeding site mapping in Malawi (Maladrone). Available via Mesa Malaria. <http://mesamalaria.org/mesa-track/assessing-operational-usage-drone-imagery-malaria-mosquito-breeding-site-mapping-malawi>. Cited 29 Jan 2022
- Stanton MC, Kalonde P, Zembere K, Spaans RH, Jones CM (2021) The application of drones for mosquito larval habitat identification in rural environments: a practical approach for malaria control? *Malaria J* 20(1). <https://doi.org/10.1186/s12936-021-03759-2>
- There Is Hope (2018) The situation in Dzaleka Refugee Camp. Available via Dzaleka Refugee Camp – There Is Hope Malawi. <http://thereishopemalawi.org/dzaleka-refugee-camp/>. Cited 29 Jan 2022
- UNICEF Malawi (2018) Drones In Malawi – Factsheet. Available via UNICEF. <https://www.unicef.org/malawi/media/651/file/The%20Drones%20Factsheet%202018.pdf>. Cited 29 Jan 2022
- World Health Organization (2018) World Malaria report 2018. Available via WHO. <http://apps.who.int/iris/bitstream/handle/10665/275867/9789241565653-eng.pdf>. Cited 29 Jan 2022

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