Small-scale Mapping with Consumer Drones in **Nepal**

The aims of the project were to provide drone training to locals around Kathmandu and to demonstrate the potential use of drone imagery in disaster response. To this end, relatively affordable consumer drones, together with mapping software and a flight-planning app, were used to achieve similar results to those a professional mapping drone would produce.

Background

One of the main challenges to planning and post-disaster recovery activities in Nepal is that the quality of readily available satellite imagery is too low [1] to really be useful given how dense Kathmandu and other cities are. Among others, the Nepali organization Kathmandu Living Labs [2] has been interested in exploring the possibility of getting imagery at much higher spatial resolution much more frequently without being dependent on an external company that may or may not provide the satellite imagery at a discount.[3] At the same time, Kathmandu University has been experimenting with the use of drones for agricultural purposes and other specific mapping tasks such as mapping of landslides,[4] so there has been an ongoing interest in exploring alternative mapping solutions in Nepal.

Figure 1 Community members are spreading out the printed map of Panga. © Patrick Meier

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1   Low quality is defined as too low-resolution, or lacking visibility due to shading from clouds or cloud coverage.

2   Kathmandu Living Labs (KLL) immediately after the earthquake focused on cultivating and building a community around Humanitarian Open Street Map to produce maps of affected villages and cities. Up to 9 000 volunteers contributed to this work. http://www.kathmanduli-vinglabs.org/

3   Personal communication with Patrick Meier, UAViators on 23 December 2015

4   Personal communication with Uma Shankar Panday, Kathmandu University on 6 January 2016

After the 7.8 earthquake in 2015, the lack of high-resolution and up-to-date imagery became much more acute as communities and non-governmental organizations worked with images of insufficient quality. This case study focuses on the benefits that were derived from a mapping exercise that was conducted in Panga as part of a three-day training organized by UAViators in collaboration with Kathmandu University and Kathmandu Living Labs. Initially, UAViators and their technology partners became involved with the aim of providing training sessions and field missions using mapping drones and to demonstrate the potential of drones for humanitarian use.[5] Following the local advice from Kathmandu University staff, the field activities focused on mapping Panga[6], which was particularly affected by the earthquake. Earthquake damage rendered 578 out of 1 334 buildings uninhabitable, and left 310 families living in corrugated galvanized iron sheet temporary shelters.[7]

Implementation

UAViators had formed a partnership with drone manufacturer DJI and mapping software company Pix4D, both of which donated hardware (drones), software and staff time to conduct training sessions in Kathmandu. Two days were focused on the training of about 32 people in classroom sessions at Kathmandu University and flying practice at the local football field. On the third day, actual locations were to be mapped both in 3D and 2D. Staff at Kathmandu University who had been in contact with the Community Disaster Management Committee (CDMC) in Panga suggested that mapping efforts should also focus on Panga, as it was particularly hard hit by the earthquake and no maps of adequate quality were available.

Figure 2   Excerpt from the ortho-mosaic shows the large degree of detail available

The team of pilots and a number of the students thus went to Panga for the third day of the training to take the aerial imagery of the community. Overall the mapping of the whole area of Panga took 1.5 days[8] of flying 6 drones for a resolution of 3.4 cm.

The imagery was taken and then processed overnight directly by Pix4D staff on laptops. The resulting ortho-mosaic can be seen in Figure 1. (For further information on the detailed workflow and equipment used see the resource section.)

Technology

The training and mapping was done with Phantom 3 Advanced multi-copter drones made by DJI, which were used together with android phones running the mobile app, Pix4Dcapture, which enables the drone to fly and acquire images ideal for mapping.

Regulations

UAViators submitted a formal application to the Civil Aviation Authority of Nepal to map health facilities. These applications could not be granted and the focus then shifted to Panga. Kathmandu University and the CDMC-9 of Kirtipur Municipality filed a joint application for flight permits specifically for Panga and received CAA permission within a week. Since then, regulations have significantly tightened and now obtaining all necessary permissions "may take up to a month" or more.[9]

Information Products

The ortho-mosaics were printed on simple roll-up posters that were then given to the CDMC of Panga who worked directly with the community to utilize these maps. Figure 2 shows the map that was displayed in the streets of Panga to share information concerning the temporary housing locations.

5   Pix4D http://issuu.com/pix4d/docs/nepal_workflow_last/15?e=19759141/31147757
6   Panga is a ward of Kirtipur Municipality which is part of Kathmandu District
7   CDMC Panga

8   Part of the reason it took about 1.5 days of flights is because the decision was made to only take off from rooftops, and getting permission from individuals living in those buildings took time. In addition, radio wave interference had the effect that the pilot on the ground had to stay closer to the flying drone, also increasing the time it took to cover the area with flights.
9   Personal communication with Uma Shankar Panday, Kathmandu University on 6 January 2016
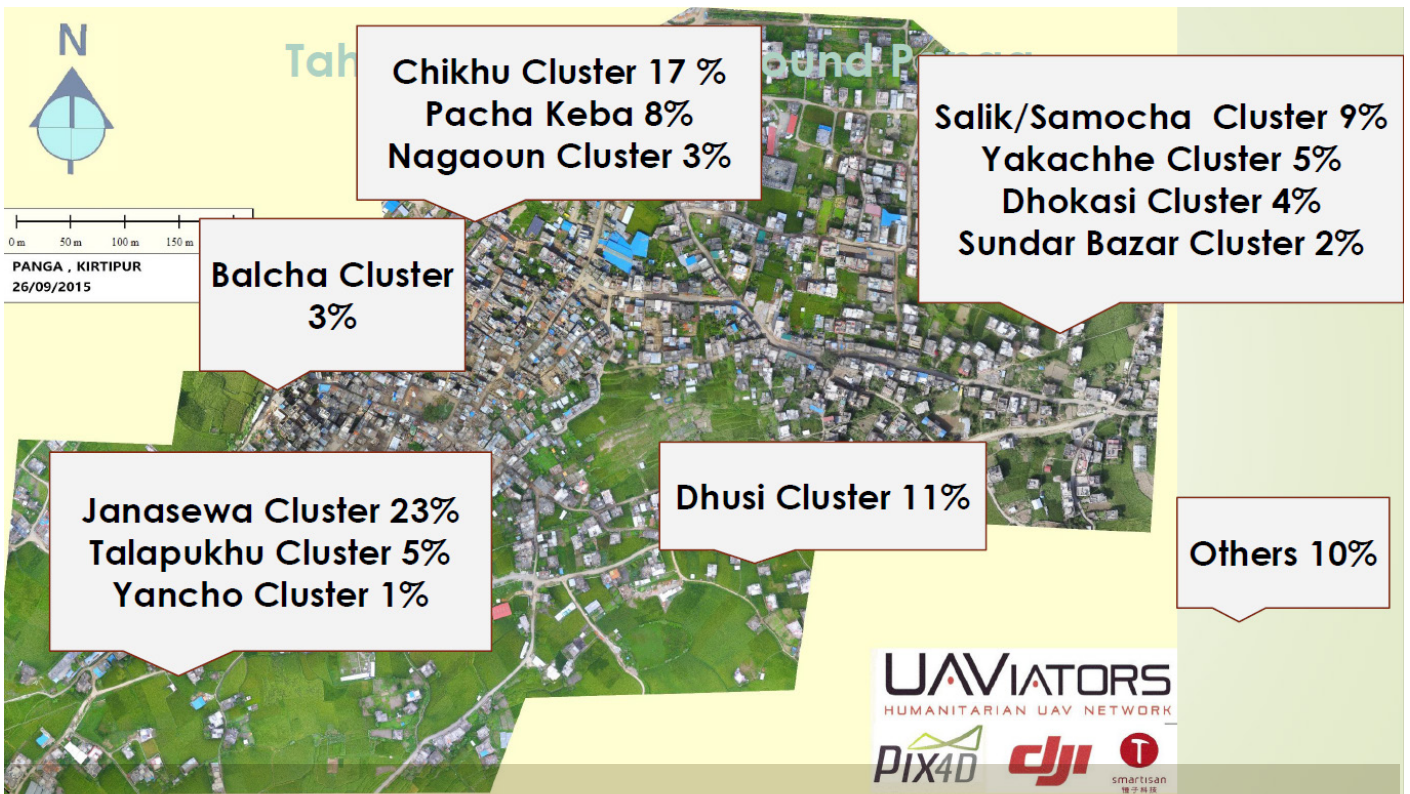
Figure 3   The resulting ortho-mosaic of Panga has a resolution of 3.4 cm and was printed and published by the CDMC of Panga as the map seen above. The map was displayed in public to show the locations of displaced families in the respective temporary housing clusters and the percentage of the total displaced population living there. Credit: CDMC Panga

Figure 4   Ortho-mosaic of Panga Credit: Pix4D

Figure 5   Community mapping. Working with the hardcopy map. © Patrick Meier

Evaluation

The main output, in this case an ortho-mosaic printed onto poster paper (Figure 2), was relatively simple. The CDMC invited community members to annotate the map directly with additional relevant features such as the location of debris, safe drinking water and health facilities. "We had displayed that map on the street of Panga for two weeks to show local people and outsiders about present conditions" and later it was used to demonstrate the location of temporary shelters and what percentage of displaced families lived in which section of town.[10] According to Patrick Meier, who was representing UAViators during the mission, the hard copy maps catalyzed conversations between community members on the strategies and priorities vis-à-vis both the recovery efforts and the preparedness activities that were ongoing in the community. The community of Panga was able to work off the same dataset for the first time. Initially, the CDMC focused on winterization efforts and providing blankets and other necessities, after which they planned to digitize the map and make it available for OpenStreetMap.

Suitability of Technology

The drones that were used for mapping are not traditionally considered professional mapping drones, but rather consumer models that are much more affordable than the professional versions. The integration with the flight planning app for mapping[11] allows this common consumer drone to be refashioned into a drone that is able to take imagery that can be used to produce maps of decent quality. The mobile app allows for flight planning and for the camera on the drone to be triggered at the specific intervals and locations necessary to achieve the coverage and overlap for a high quality ortho-mosaic.[12]

The project created very high quality maps that could not have been made via traditional methods such as satellite imagery due to costs and limitations in terms of available resolutions. Some limitations to the use of drones also emerged. The multi-copter drones have a limited battery life of about 20 minutes and are thus not able to fly over and map large areas. This means that mapping the area of 1.5 km^2 required a number of flights and took 1.5 days of mapping.[13]

Another unforeseen problem arose due to radio wave interference between the device that controls the photo trigger on the ground and the receiver on the drone. The flights needed to be shortened, as the drone had to stay within a short radius of the controlling device on the ground, or else the trigger mechanism became blocked due to other radio waves in the area. This issue may occur in locations where radio signals are used in atypical bands or where the use of various bands is not governed or enforced. While this problem would not necessarily be encountered in all countries, it may not be unique to Nepal.

As noted, multi-copter drones are especially useful when the application requires increased vertical control and oblique imagery (of building structures, for example). In addition, the vertical landing and take-off, good manual control and user-friendliness of the drones allows for their use in highly obstructed areas, as was the case in Kathmandu and Panga. The drones are designed for user-friendliness and several of those involved in the training remarked on how easy it is to fly them.

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10   Personal communication with Yogesh Maharjan, CDMC-9 Panga on 3 February 2016

11   Pix4D Mapper Capture app

12   Personal communication with Krista Montgomery, Pix4D on 13. January 2016

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13   Climbing to building tops for take off and landing and radio interference also contributed to this time frame.

Need for Media Strategy and Agreements

The mapping and training could not have taken place without the sponsorship of the partners. DJI, Pix4D and Smartisan donated more than US $50 000 overall towards the Nepal mission through in-kind contributions, technology transfers, professional training and their time. Their participation lent this mission a distinctly corporate flavour. "Public-private partnerships with respect to UAV missions are invaluable and thus need to be managed in such a way that all partners gain from the experience."[14] This need for management and agreements is reinforced by the fact that outsiders often do not understand local dynamics and sensitivities when working in a foreign country.

As part of the commercial sponsorship, the companies hired a film crew and a professional photographer to document the mission. Local partners later expressed concern over the resulting documentary film, which they perceived as promoting commercial products rather than the actual activities and contributions made by locals. Some implementing staff also felt that they had little control or oversight over the filming process, which took place partially in a community that was recovering from a major disaster. A number of people involved in the project reported that the filming was a major challenge. Laying out specific terms of media engagement ahead of the deployment, especially to avoid potential sensitivities in the host communities, might be helpful in fostering positive and frictionless collaborations.

Future Use

Both Kathmandu University and Kathmandu Living Labs will continue to use the drones that had been donated. According to Elizabeth Gilmour at Kathmandu Living Labs, "We definitely plan on using UAVs. Because we are involved in the damage assessments that we are doing on the ground and because I thought they (drones) were a lost cause[15] we have not yet done much. But now we can work on plans on how to use them. Nama Budhathoki [Director and Founder of Kathmandu Living Labs] has more specific plans what we want to do with them -- maybe imagery collection and maybe some other ideas." Ms. Gilmour also noted, however, that the short range of the drones might be a limiting factor. "The big focus (for Kathmandu Living Labs) is on mapping. It is going to be hard to do a lot of mapping with these UAVs because they have a battery life of only 20 minutes, so as what happened in Panga you will have to do flights and flights and flights then wait for the battery to charge and then flights and flights and flights. So what we need to do is find a specific kind of project where a detailed map of a small area is very valuable. For example, in agricultural mapping, like the food security mapping this could be helpful."[16]

Kathmandu University is currently actively using the drones in a number of projects. Among others, parts of Panga that had not been mapped during the initial mission have now been mapped with the donated drones. According to Kathmandu University, a number of building damage assessments under Professor Maskey's leadership are also being conducted with Manekharka and Hindi Village Development Committees of Sindhupalchowk District, which was one of the worst affected districts from the Nepal 2015 earthquake. Further, the University continues to build a local capacity by teaching 3rd year undergraduate Geomantic Engineering students in imagery acquisition and modeling with the software.

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14   Personal communication with Patrick Meier, UAViators on 21 December 2015

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15   Six DJI Phantom 3 drones were donated to Kathmandu Living Labs but remained stuck in customs over several months.

16   Personal communication with Elizabeth Gilmour, Kathmandu Living Labs on19 January 2016.

Resources

An illustrated workflow of the mapping in Panga made by Pix4D
http://issuu.com/pix4d/docs/nepal_workflow_last?e=19759141/31147757

Information video produced by DJI
https://www.youtube.com/watch?v=QXkcvzxBsrY

Acronyms

CDMC   Community Disaster Management Committee
UAV   Unmanned Aerial Vehicle

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Technical Specifications & Credits

Swiss Foundation for Mine Action (FSD)
7bis, Avenue de la Paix - Floor 2
CH-1202 Geneva
Switzerland
drones.fsd.ch

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