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| **Location:** | Port Moresby and selected Provinces in PNG |
| **Type of Contract:** | Professional Service Contract with a Firm (Request for Proposals) |
| **Project:** | Strengthening the Management Effectiveness of the National System of Protected Areas |
| **Languages Required:** | English |
| **Starting Date:** | December 2018 |
| **Duration of Initial Contract:** | Approximately 100 person days over the period December 2018 to June 2020 |

**Report to the UNDP**

**Re: Trip to various locations: 15 Aug – 3 Sep 2019**

# Introduction

At various occasions between April, 2018 and May, 2019, personnel from various government and non-governmental organisations received drones (DJI Phantom 4 Pro) and associated equipment. At the time of this report, staff of Michon Enterprises (‘Camzilla’) had provided formal theory and practical training to these personnel. The objectives of the training were that the attendees would be competent and confident in the use of the drones for mapping, observation and surveillance operations and basic photography / videography.

From 15 August to 3 September 2019, I (Justin Hechinger) – accompanied by James Sabi (CEPA) – travelled to multiple sites throughout Papua New Guinea, in order to perform basic maintenance checks and to provide supplementary training, support and advice to recipients of the drones. It was anticipated that drone pilots would have been using the drones for various purposes, and that on this mission, we would identify and address gaps in skills and/or knowledge, and build upon previous training.

This report summarises the activities undertaken, observations made and my recommendations going forward.

## Site 1: Port Moresby (15-18 Aug)

During this segment, I visited with staff of CEPA and the UNDP, and performed a basic test of two Phantom 4 Pros which were being held at CEPA’s Port Moresby offices. During this time, it was discovered that one drone battery had failed. This is likely the result of the battery not having been periodically discharged and charged in the time since the battery was supplied. The remaining five batteries were found to be still in a serviceable condition. Personnel were reminded of battery care procedures.

James and I travelled to Varirata National Park to perform some testing of a thermal camera and drone that I brought with me. We attempted to spot feral deer during the night, but spotted some native macropods, instead.

## Site 2: Wewak (19, 20 Aug)

We were scheduled to meet and work with Derek Warakai (East Sepik Provincial Administration). I have been told that the PNG Prime Minister’s visit to Wewak disrupted this plan, as Derek was tied up with preparations for the visit and activities related to it. Therefore, I am unaware whether the drone has been used, if so, for what purposes it has been used. Essentially, no knowledge was gained from this segment of the trip.

## Site 3: Lumi (21 – 23 Aug)

TCA at Lumi was provided one drone and one individual from from TCA (Matthew Akon) attended drone training in May of this year. Matthew was not in Lumi during my visit, but I have been told that the drone has not yet been used at TCA. Matthew had taken the drone’s iPad with him, meaning an incomplete kit was left on-site (see recommendations below). I had brought my own iPad, so we were able to test the drone and fly mapping missions.

Matthew had not trained any of his colleagues, therefore in his absence there were no trained pilots at TCA. I demonstrated the drone’s capabilities to the people present, and mapped two areas of approximately 1 km2. The mapped area covered some of the local village’s land.

The mapping operation was significantly-constrained by the number of batteries on hand. Mapping missions were interrupted for several hours while batteries were charged. This limited flight operations to just two maps (1 km2) per day. If sufficient batteries were on hand, flight operations could continue all day, enabling a much larger area to be mapped.

Aside from the one pilot who was not present, nobody had received formal drone training. So, three individuals were selected for basic training, and I conducted an ad-hoc four hour drone session. Training consisted of theory, followed up by basic flight training and a mapping mission.

## Site 4: Lae (24 – 27 Aug)

We met with staff of the TKCP and the Provincial Administration. It is understood that neither organisations’ drones had yet been utilised for mapping, and it was unclear whether they had been used for any official purposes. Staff of the TKCP had provided some training to a second individual, and we built-upon that training by conducting theory and practical sessions, and by demonstrating a mapping mission (Lae Botanical Gardens).

## Site 5: Kokopo (28 – 31 Aug)

During this leg of the mission, we worked with staff from the UNDP, Provincial Administration and OISCA. This group was skilled at flying, and had used the drones (in a limited capacity) for various purposes. We conducted several mapping missions of coastal areas, and spent time installing orthomosaic software (Pix4D) and the free GIS software program QGIS onto several computers. Participants then proceeded to use Pix4D to generate orthomosaics and 3D models. *This was the first time that a mapping mission and map generation has been conducted – start to finish – by recipients of the drones, and is a significant milestone.*

Observations and recommendations:

It seems that none of the recipient organisations have thus-far used the drones much, despite some of them having received the drones as far back as April 2018. All of the underlying reasons are unclear, but the following list is my observations and recommendations.

1. **Unclear objectives for drone utilisation:** It is possible that there is confusion among the pilots and their supervisors over how best to employ the drones.

**Recommendation:** **Define organisational objectives.** I suggest that each organisation define (in-writing) its objectives regarding drone-use. Doing so will improve the ability of the organisations to work towards those objectives. Once these objectives are identified, we can work with pilots and management to meet them. This would ideally occur on-site, where mission planning and execution could take place.

1. **Lack of confidence among pilots:** We have observed in some pilots a lack of confidence regarding how to operate the drones. Each pilot we have worked with has been quite capable, but a lack of confidence or concerns over causing damage to the drone may be one factor in the underutilisation of the drones.

**Recommendation**: Increase use of simulator and real world flight. Each course attendee has been instructed on the use of the in-built flight simulator and ‘beginner mode’. This simulator is used indoors, and does not involve actual flight. Nevertheless, it is a valuable tool in building confidence and capability. Beginner mode allows pilots the opportunity to fly the drone with minimal risk of crashing. Management should ensure that pilots are given sufficient time to use the simulator, beginner mode and flight in ‘p’ mode.

1. **Equipment not kept with drone kit:** At one location (Lumi), the sole trained pilot had left the area and took the drone’s iPad, leaving an incomplete kit behind. The result is that the drone was unusable.

**Recommendation**: The equipment provided with the drones should be considered ‘a kit’ – therefore, all items should remain together; items should not be taken for other purposes – either personal or business. Each item is critical to the operation of the drone, therefore, if one piece is missing, the drone may not be able to be utilised.

1. **Intra-organisational training:** At one location (TKCP), limited in-house training has been provided to staff who had not attended formal training. Personnel in East New Britain have now started training at least one new pilot. At other visited locations, however, trained personnel do not appear to have passed their knowledge onto their colleagues. There are likely multiple reasons for this, but regardless, it creates a weakness in the organisations, and reduces the likelihood that the drones will be used.

**Recommendation:** Organisations provide ‘in house’ theory and practical training for new pilots (if personnel are available). This will not only increase the confidence of the trained pilots, but will also increase the likelihood that the drones are effectively employed. Training presentations have been provided to facilitate this knowledge transfer.

1. **Limitations due to low number of batteries:** Each drone was distributed with three batteries (although some have subsequently failed). As described above, this is an insufficient quantity for mapping areas of 1 km2 or greater, as several hours may be required before mapping can resume, and in remote areas where electricity is unavailable, recharging may be impossible.

**Recommendation:** Consideration should be given to purchasing additional batteries. If the specific requirements of each organisation can be determined, then batteries can be effectively-distributed.

1. **Map creation software:** Orthomosaic-generation software is the item that allows maps to be created and shared. Without this, data can be captured but cannot be visualised, analysed or distributed. As previously discussed, we had selected WebODM as the orthomosaic-generations software for drones in PNG. This was because it is relatively-inexpensive when compared to commercial map-generation software.

However, WebODM requires that a large (>3gb) file be downloaded onto each computer, and this has proven to be a challenge in PNG. The program is also resource-intensive, and its use requires a high level of technical ability. Even relatively-powerful computers have problems processing larger maps, and my observation is that most drone pilots have computers that are at best capable of processing only small maps.

**Recommendation: Purchase Pix4d Mapper orthomosaic software and establish processing stations:** Pix4d Mapper is a commercial map/3D model generation program, and costs ~US$5,000. It can be installed on multiple computers, but only one computer can be logged into the program at a time. Pix4D is easier to use and less resource-intensive than WebODM, although it still requires a modern, relatively-powerful computer. An internet connection when the program is opened, as the software confirms that no other computers are currently logged in. Two-dimensional orthomosaics can be generated, as can 3D models. The outputs can be exported into GIS programs (e.g. ARCGIS or the free QGIS) or Google Earth.

Pix4D was demonstrated at each location during this trip, and drone pilots in ENB have successfully conducted mapping missions and generated maps from the captured photos. This is the first time this type of mission has been conducted from start to finish by local drone pilots, and is a notable accomplishment.

I recommend that Pix4D Mapper be purchased and installed on one or two **central processing stations –** with one possibly located at CEPA in Port Moresby, and the second in East New Britain. Having one or several processing stations – and only a few personnel trained in orthomosaic generation – is a more realistic objective than training 40 or 60 people spread throughout the country. I recommend that the software be installed on dedicated machines, as the computers should not be used for other purposes while Pix4D is running. In this scenario, images can be sent to the processing stations on flash drives, the maps can be generated and then returned via the flash drives (the files are too large to e-mail). Camzilla can assist with the purchase of Pix4D licenses.

The suggested specifications for the processing station are:

* 1. 64-bit processor with MMX, SSE, SSE2, SSE3, SSSE3 instruction set support or higher
  2. VT-X support
  3. 60 GB free disk space
  4. At least 32 GB of RAM (more is better)

1. **Fixed wing drone:** Some organisations would like to map large areas (e.g. TCA, with ~180,000 ha of land). However, mapping large areas with the Phantom 4 Pro is impractical. Quadcopters are inefficient in flight, resulting in short flight times and relatively slow speed. Thus, a fixed wing drone may be ideal for mapping larger areas.

**Recommendation:** We would like to discuss options for a fixed wing drone, which can be used to map these larger areas.

Planning for the next trip should commence ASAP. This will reduce the chances that critical personnel will be unavailable during the mission. I suggest that we visit fewer sites but spend more time at each site; this will help mitigate disruptions caused by factors such as transportation delays and unsuitable weather.

We have sent a questionnaire which should be completed by all personnel who have a drone. The answers will help to increase the efficiency of future missions.

In conclusion, it appears that the drones thus far have been underutilised, and although I have attempted to identify issues which have contributed to this underutilisation, there are likely to be other unidentified factors at play. It is clear that there are some barriers to achieving self-sufficiency with drone operations in PNG, but we are making steady progression towards this objective. The above recommendations – if followed – will increase the efficiency and effectiveness of these operations, advancing operators towards self-sufficiency.

We welcome comments in response to this report, and appreciate any feedback you can provide regarding our performance.

Warm regards,

Justin Hechinger

Director, Michon Enterprises / Camzilla