

Comparing Two Models of UAVs (drones) as a Monitoring Tool for Freshwater Turtles

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Abstract. Nowadays, drone models are becoming more and more diverse with many different shapes and features. Some of them are more compact in shape, others are more stable in flight and with different camera qualities. In our study, we compare two drone models – “Phantom 4 Pro + v2.0” and “Mavic Pro Platinum” as a monitoring tool for freshwater turtles. Total flight covered area is approximately 114 decares (11.4 ha) above two rivers in Strandzha Mts. – Veleka River and Silistar River. The current study has shown that “Phantom 4 Pro + v2.0” is very suitable for wide rivers, where there are no overhanging trees over the riverbed and “Mavic Pro Platinum” is more suitable for narrow riverbeds with overhanging crowns of trees above them.

Key words: drones, freshwater turtles, Phantom 4 Pro + v2.0, Mavic Pro Platinum.

Introduction

The slow but effective entry of unmanned aerial vehicles (UAVs) and especially so-called drones into environmental research is starting to become an increasingly important and effective method that opens new horizons in scientific research. In a relatively short time, it has become an affordable and cost-effective tool with many emerging applications. Remote sensing technology is increasingly used to assess changes in forest cover, species distribution and carbon stocks (Koh & Wich, 2012). Both in the field of agriculture, for monitoring and evaluation of crops, orchards and forests, and in the field of environmental monitoring and biodiversity maintenance. Many institutions, such as non-governmental organizations and universities working in the

field of environmental protection, are starting to use more and more different types of UAVs (drones), as their possibilities are growing. UAVs can cover a large distance, to reach remote areas that can be inaccessible to researchers for monitoring of target species (Bevan et al., 2016). Nowadays, using drones as a remote monitoring method in the area of biodiversity is becoming more common. They are used mainly in studies of birds and mammals (Hodgson et al., 2013; Vermeulen et al., 2013; Wilson et al., 2017), also of plant species (Cruzan et al., 2016). Herpetofauna studies including common methods can be quite difficult due to reptile-specific and environmental variables, also a differing capture probability for capture techniques (Vogt and Hine, 1982; MacKenzie et al., 2002; Williams

& Berkson, 2004). The use of UAVs for monitoring herpetofauna along roads and small paths can be a passive and suitable method of determining the presence of herpetofauna species in an area, causing much less disturbance (Chabot & Bird, 2015) in comparison to the traditional methods. However, the success rate of the study, depends on the studied species (size, peculiarities of its biology, etc.) and the technical characteristics of the drones used for monitoring.

Our goal is to establish what are the advantages and disadvantages of two types of drones: “Phantom 4 Pro + v2.0” and

“Mavic Pro Platinum”, and to determine which of the two models of drones is more suitable as a tool for monitoring of freshwater turtles. What flight characteristics are suitable to be performed without disturbing the individuals and to determine whether capturing video or photos is more effective for subsequent analysis.

Materials and Methods

In the present study, we used two different models of drones “Phantom 4 Pro + v2.0” and “Mavic Pro Platinum”. Drone specifications are given in Table 1.

Table 1. Drone specifications of “Phantom 4 Pro + v2.0” and “Mavic Pro Platinum”.

| Camera | Phantom 4 Pro+ v2.0 | Mavic Pro Platinum |
|--|--|--|
| Sensor | 1-inch 20-megapixel Sony Exmor R CMOS | 1/2.3" (CMOS), effective pixels: 12.35 M (Total pixels:12.71M) |
| Lens | FOV (Field of View) 84 °, 8.8 mm / 24 mm (35 mm equivalent), f / 2.8 - f / 11 | FOV 78.8° 26 mm (35 mm format equivalent) f/2.2 distortion < 1.5%, focus from 0.5 m to ∞ ISO |
| Mechanical Shutter Speed | 8 - 1/2000 s | |
| Electronic Shutter Speed | 8-1/8000 s | 8s -1/8000 s |
| Maximum Image Resolution | 16: 9 - 5472 × 3078 | 4000×3000 |
| Video Recording | 4K, 30 / fps with H.265 compression | 4K: 4096×2160 24p |
| Max Video Bitrate | 100 Mbps | 60 Mbps |
| Remote Controller | | |
| Operating Frequency | 2.400 - 2.483 GHz and 5.725 - 5.825 GHz | 2.4 GHz to 2.483 GHz |
| Max Transmission Distance | FCC: 10000 m CE: 6000 m SRRC: 6000 m MIC: 6000 m (Unobstructed, free of interference) | FCC - 4.3 mi (7 km) CE - 2.5 mi (4 km) SRRC - 2.5mi (4 km) MIC - 2.5 mi (4 km) (Unobstructed, free of interference) |
| Remote Controller Screen | LCD 5.5-inch 1080p (1920×1080) | |
| Battery | LiPo 4S, 5870 mAh / 15.2 V / 89.2 | liPo 3S 3830 mAh / 11.4 V / 43.6 Wh |
| Max Flight Time | 30 minutes (no wind at a consistent) | 30 minutes (no wind at a consistent) |
| Maximum Lifting Speed | S-mode - 6 m / s P-mode: 5 m / s | S-mode - 5 m / s |
| Maximum Lowering Speed | S-mode - 4 m / s P-mode: 3 m / s | S-mode - 3 m / s |
| Maximum Speed | 72 km / h (S-mode) 58 km / h (A-mode) 50 km / h (P-mode) | 65 km / h (s-mode) |
| Maximum Take-off Height Altitude (a.s.l.) | 6000 m | 5000 m |
| Satellite Positioning Systems | GPS / GLONASS | GPS / GLONASS |
| Hover Accuracy Range | Vertical: ±0.1 m (with Vision Positioning) ±0.5 m (with GPS Positioning) Horizontal: ±0.3 m (with Vision Positioning) ±1.5 m (with GPS Positioning) | Vertical: +/- 0.1 m (when Vision Positioning is active) or +/-0.5 m Horizontal: +/- 0.3 m (when Vision Positioning is active) or +/-1.5 m |

The flights with both models of drones were performed in the period June-August 2021 in a territory of “Strandzha” Nature Park. The territory of the park overlaps with NATURA 2000 protected area “1007 Strandzha” (EEA, 2022). The flights were executed above the mouths of the rivers Silistar (Fig. 1) and Veleka (Fig. 2). The total area of the covered territory is approximately 114 decares (11.4 ha) respectively: Veleka River - 98.8 dca (9.8 ha) and Silistar River - 15.1 dca (1.5 ha). The flights were performed in two periods: the beginning of July (13.07.2021) and in the end of July and the beginning of August (30.07 - 01.08.2021), in good meteorological conditions for the purpose (e.g. gentle breeze/no rain and good visibility). In total of 11 flights, 6 were made between 13:00 and 16:00, three in the morning between 8:00 and 10:10 and two in the evening at 18:35 and 19:25. The flights are performed over the water surface near the shore, so that turtles can be photographed coming out on fallen trees and branches in the water, basking in the sun, also sinking and floating turtles on the surface of the water. The riverbed of the Silistar River is narrow, the width in the surveyed areas varies between

10m to 20m and in the most part the banks are covered with dense trees and shrubs. A significant part of the crowns of the riparian trees overhangs the riverbed, occupying a significant part of it, which is why drone flights in these places were made with avoid obstacles sensors turned off (Enable Obstacle Avoidance / off). The Veleka River has a wide riverbed - in the places of overflights it is between 76m-40m, where it is not necessary to turn off the sensors for obstacles (Enable Obstacle Avoidance / on). The average flight altitude is 4.18m (SD=3.2), with a maximum of 12m and a minimum of 0.5m. In this case, there is no adherence to a certain height, as the purpose is to check what is the lowest height the drone can descend without disturbing the turtles and other river dwellers. After finishing the field work, all recordings (photos and videos) were reviewed on a computer to account for individuals who were not seen during the flight, and to establish whether capturing video or photos is more effective for subsequent analysis. The screen of the “Phantom 4 Pro + v2.0” remote is 5.5 inches (DJI, 2022a), due to the small size of the screen on the remote control, the probability of missing objects at the time of flight is very high.

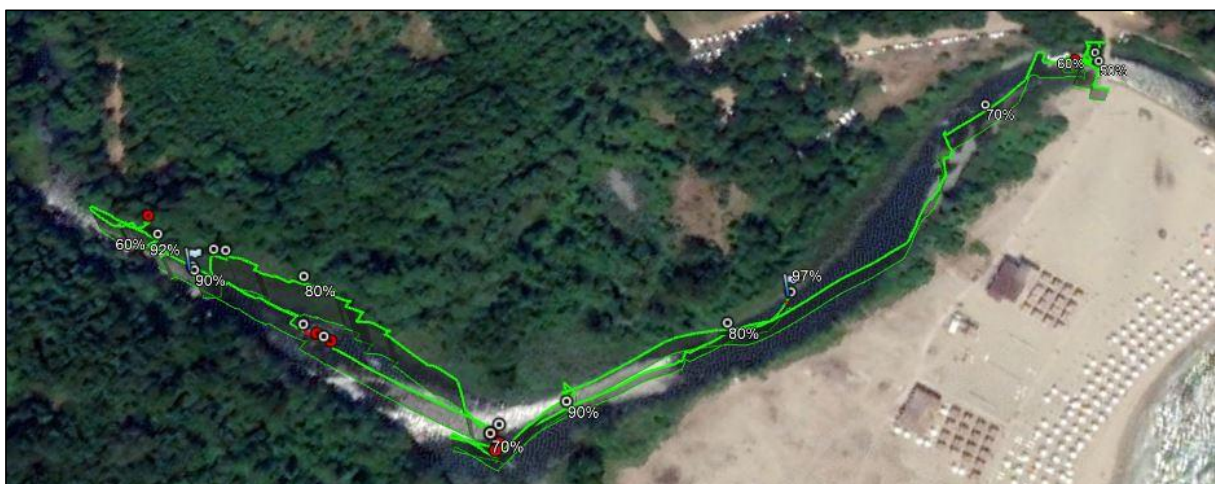


Fig. 1. Flights above Silistar River with “Phantom 4 Pro + v2.0”.



Fig. 2. Flights above Veleka river with “Mavic Pro Platinum”.

Results and Discussion

During the flights we found out both types of drones are resistant to air currents, the drones are very stable in the air when they hang, the cameras of the drones are suitable for the purposes of the methodology.

During the flights, 9 aquatic turtles (*Emys orbicularis*) were recorded: 8 in Silistar River and 1 in Veleka River. The reason we observed only one aquatic turtle in the Veleka River is the all-day flow of tourists in July and August. There was not much opportunity to get very close to the water surface, as well as to operate calmly with the drone, in a way which avoids collision with tourists on kayaks. After reviewing the photos and videos, 5 more aquatic turtles from the Silistar River and two aquatic snakes (*Natrix sp.*) were found. At a height of 6 meters above the water surface and with the drone positioned above the turtles, they are not disturbed, but between 6 and 4 meters the probability of disturbing increases progressively, while below 4 meters it is certain that they will jump back in the water. The results show that photos are much more effective than videos. There is much more detail in the photos than in the videos. When reviewing the photos, there is an option to zoom in, you can accurately identify species of the herpetofauna hidden among the aquatic

vegetation or swimming underwater up to a depth of 10 to 20 cm.

Both types of drones are suitable for monitoring of freshwater turtles and even other representatives of freshwater herpetofauna that emerge on the water surface to breathe, such as aquatic snakes and frogs. “Phantom 4 Pro + v2.0” has more powerful rotors than “Mavic Pro Platinum”, which makes it very stable in sudden and strong changes in air currents. Therefore, longer distance can be covered in a shorter time and it is very stable when it is necessary to hang on one place in windy conditions. Due to its larger size and bulky shape “Phantom 4 Pro + v2.0” is very suitable for wide riverbeds such as the Veleka River, where there are no overhanging trees over the entire riverbed. Due to the greater stability when hanging in the air, there is better visibility (no shaking or other camera interference) even when there is a strong wind. On the Veleka River the remote control of “Phantom 4 Pro + v2.0” started to lose signal with the drone at a distance of more than 500 m. Between the drone and the remote control there were tall trees and a small river bend. On the Silistar River, the loss of signal appeared at a distance of about 300m, but there was very dense bush vegetation between the remote control and the drone, trees with overhanging crowns, covering part of the

riverbed. The quality of the “Phantom 4 Pro + v2.0” camera is very good, the pictures are with more detail, wherefore in the subsequent review of the photos many more details could be found in them. That

allows taking photos from a greater height - 7-8 m (Fig. 3a,b, 4) and the pictures will be detailed enough to detect not only freshwater turtles, but other freshwater inhabitants.



Fig. 3a. Three freshwater turtle and one water snake captured with “Phantom 4 Pro + v2.0” in Silistar River from a distance of 7 m.

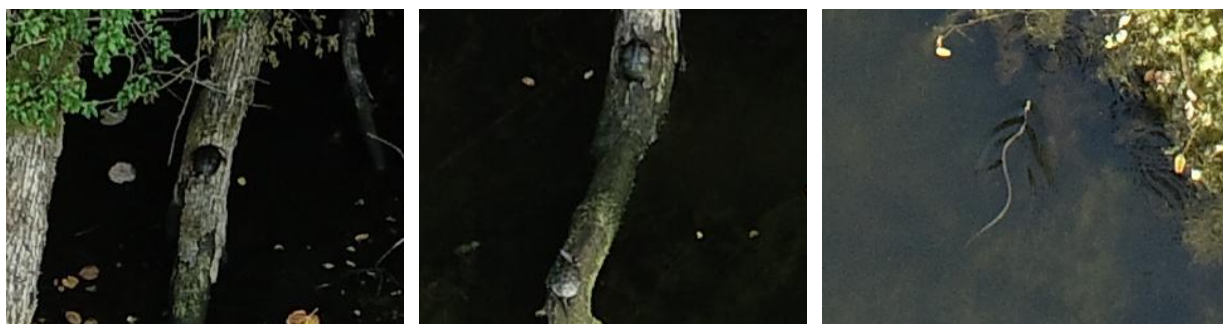


Fig. 3b. Zoomed and cropped parts of Fig. 3a with clearly visible freshwater inhabitants (*Emys orbicularis* - 3 ind. and *Natrix natrix* - 1 ind.).



Fig. 4. Juvenile freshwater turtle captured in the water with “Phantom 4 Pro + v2.0” in Silistar River from a distance of 5 m.

“Mavic Pro Platinum” is a smaller, more compact, drone than the “Phantom 4 Pro + v2.0”. Due to its compactness and aerodynamic shape, it is much more maneuverable, it can effectively avoid obstacles and it can pass through quite narrow spaces which makes it very suitable for narrow riverbeds with overhanging crowns of trees above them, such as Silistar River. However, this also depends to a large extent on the pilot's skills. “Mavic Pro Platinum” is much more susceptible to stronger air currents, especially if they are sudden. It is relatively stable in the air, but in narrow riverbeds it should be borne in mind that strong and sudden gusts of wind can displace the drone and it can crash in overhanging branches from the treetops or in tall riparian vegetation.

With the “avoid obstacles” sensors on, the drone detects everything in distance of 10 m around it as an obstacle, and when the drone is 3 m away from the obstacle, it stops in one place and does not allow you to continue your flight. This type of flying requires a lot of experience, as in a significant part of the flights there is no visual contact with the drone and the orientation is only based on the camera.

The camera has visibility only forward and downward (in case the drone turns laterally, it is possible to check for obstacles, sideways and behind it), but there is no way to see obstacles upwards, such as hanging branches of trees which is a typical characteristic of this habitat type. The signal loss between the remote control and the “Mavic Pro Platinum” is almost the same like with “Phantom 4 Pro + v2.0”, the difference is insignificant. The camera quality of the “Mavic Pro Platinum” is not so good, it is suitable for the purpose of the study, but the pictures are not so detailed and they have to be taken from lower distance (5 m or lower - Fig. 6), in order not to miss some objects on the water surface (Fig. 7).

According to Biserkov & Lukanov (2017), the optimal height for drone observation is 10 m, and above this height the turtles are not well visible, but they used “Phantom 3 Professional” drone with 12MP camera, which is a quite old model. Also, in their study they mention, that when piloting the UAV below 10 m, the noise from the drone rotors causes disturbance to the turtles and they jump back in the water from their basking sites. In our study, the anxiety of turtles was observed between 7 to 4 m in flight height. The reason

for this difference most likely is because “Phantom 4 Pro + v2.0” features new ESCs, low-noise propellers, “OcuSync”, and a redesigned controller, which makes it less noisy than the “Phantom 3 Professional”, according to DJI’s official website (DJI, 2022a). Also, “Mavic Pro Platinum” is a less noisy than “Phantom 4 Pro + v2.0” (Table 2). That allows us to descend below 10 m without causing disturbance (Fig. 3, 4 and 8). We managed to approach to 4.5 m before causing noticeable disturbance. Due to the good resolution of the “Phantom 4 Pro + v2.0” camera, it is not necessary to go less than 7 m. After analyzing video and photo materials from all flights, we concluded that, photos are much more effective than videos. There is much more detail in the photos than in the videos. When reviewing the photos, there is an option to zoom in, you can see species of the herpetofauna hidden among the aquatic vegetation or swimming underwater up to a depth of 10 cm (it also depends on the transparency of the water surface) (Fig. 4, 6 and 8). In most cases we were able to identify the species of freshwater turtles or at least the genus of aquatic snakes. However, it also

depends on the size of the photo and the height from which it was taken (lower height + higher resolution = more detailed photo). Also, viewing photos is somewhat faster than viewing videos. Even if you capture a photo from a video, the photo will be with much lower quality and zooming is involved, the objects in it, would not be clearly visible (Fig. 4 and 8). When we compare the pictures and the videos from both types of drones it is obvious that “Phantom 4 Pro + v2.0” takes better pictures and videos with much higher quality than the “Mavic Pro Platinum”.

Table 2. The range of acoustic footprints of the DJI drones according to [Airborne Drones](#) (drone noise level, January 13, 2020).

| DJI models | |
|-------------------|--------|
| Mavic Platinum | 70dB |
| Spark | 74dB |
| Phantom 4 Pro 2.0 | 76,5dB |
| Mavic Air | 76dB |
| Mavic Pro | 79dB |
| Phantom 4 Pro | 81dB |



Fig. 5. *Emys orbicularis* captured with “Mavic Pro Platinum” in Silistar River from a distance of 4,5 m.



Fig. 6. Picture taken from a video record from “Mavic Pro Platinum”, on the picture is visible two freshwater turtles and two frogs.



Fig. 7. Picture taken from a video record from “Mavic Pro Platinum”, freshwater turtle Veleka River captured from a distance of 5 m.



Fig. 8. A water snake (*Natrix* sp.) above the water surface captured with “Phantom 4 Pro + v2.0” in Silistar River from a distance of 6 m.

Using “Phantom 4 Pro”, Huerta et al. (2020) conducted an experiment for using UAVs, for detecting herpetofauna species and their results showed that the use of UAVs for monitoring reptiles along roads can be a passive, convenient method with lower disturbance to determine the presence of herpetofauna in an area. The image quality of “Phantom 4 Pro” may not be sufficient to positively identify herpetofauna to the species level, but with the future development of UAVs and camera quality this method could be an essential tool for future detection and monitoring of herpetofauna in open environments.

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