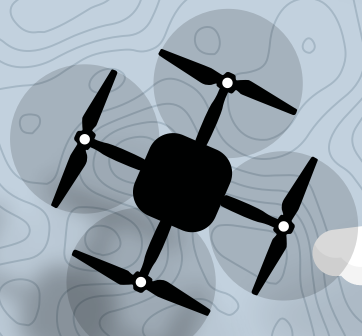
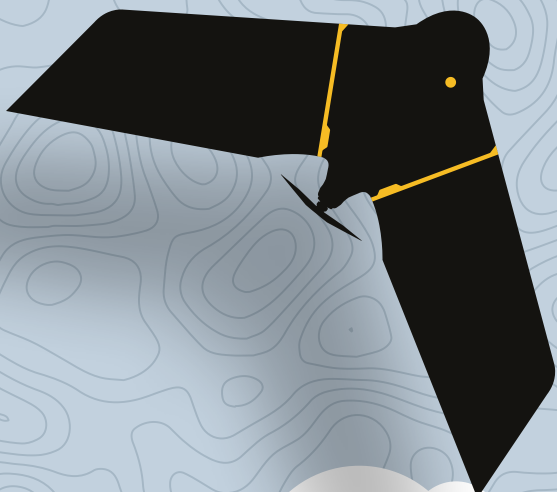
EXPAND YOUR HORIZONS

5 Reasons To Fly A Fixed-Wing Drone

A senseFly eBee X vs. Quadcopter Guide





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5 Reasons To Fly A Fixed-Wing Drone

- Map sites up to **2.6X faster**
- Reduce labour costs by up to **USD $385** per mission
- Complete **2X** more projects per week
- Map remote sites within a **5X larger** flight radius
- Map corridors up to **3X longer**

TABLE OF Contents

1 An overlooked drone decision

When investing in professional drone technology, today's buyer has many options. There are advanced camera payloads to consider, a UAV's flight capabilities, cost and, in the case of mapping drones specifically, high-precision GPS correction options such as real-time kinematics (RTK) and post-processing kinematics (PPK).

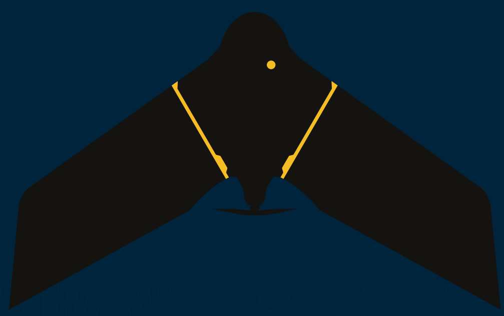
A key factor that some buyers overlook, however, is the type of aircraft itself. It is essential that you understand which type of drone is best suited to your business. Is it a multi-rotor (helicopter-style) drone, such as a four-propeller quadcopter? A fixed-wing drone—sometimes referred to as a flying wing drone, which resembles a traditional airplane. Or both?

This guide does not aim to address every pro and con of each of these platform types. These differences are known and, if not, easily searchable online (see this article: https://tinyurl.com/yyygluw4). Instead, it focusses in on the most commonly known difference: flight times.

While it is widely accepted that fixed-wing drones – like their full-sized aircraft equivalents – can fly significantly longer than multi-rotor drones on a single battery charge, this difference and its potential impact are often overlooked. However, from a business perspective, this is a mistake.

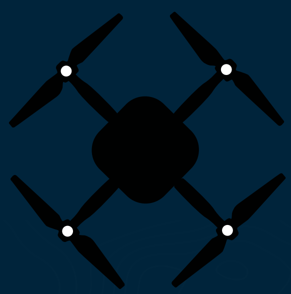
1

The **business impact** that the difference in flight times can have is profound and multi-faceted. It is this difference, the provable efficiency and profit-generating benefits of flying fixed-wing, that this guide sets out to demonstrate. It does this by describing a real-world comparison project, wherein the same exact 100 ha (247 ac) semi-rural site was mapped using both a popular professional quadcopter drone and a senseFly eBee X fixed-wing drone. The results are eye-opening.



- Central body
- 2 wings
- 1 propeller

How it works: the lift generated by the wings allows the drone to compensate for its weight, while the motor drives the aircraft forwards.



- Central body
- 4, 6 or 8 propellers

How it works: the propellers create upward lift, while the drone's direction is controlled by varying the relative speed of each rotor.

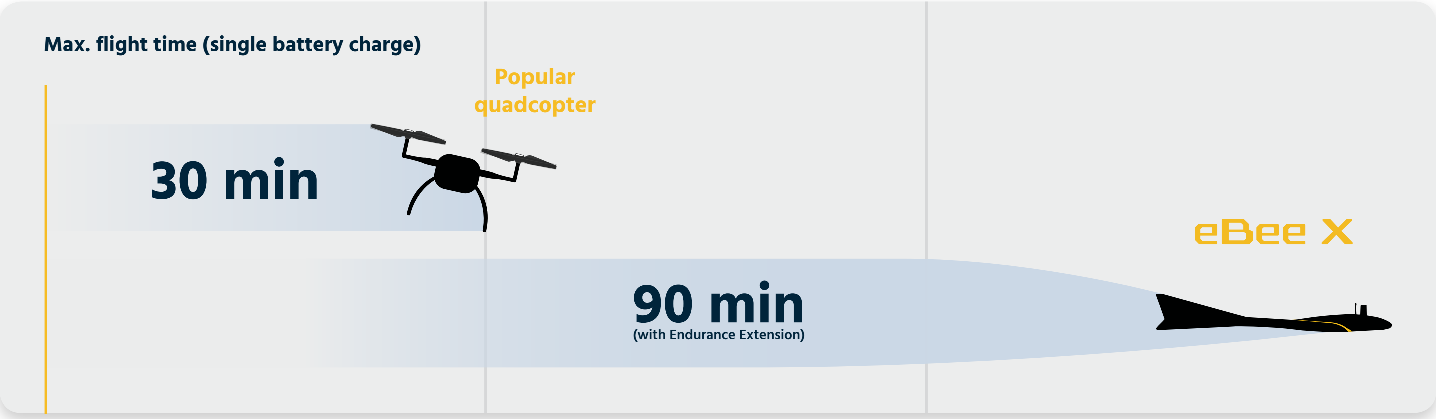
2 Comparison project

The aim of this mapping project was to fly the exact same 100 ha (247 ac) site using a senseFly eBee X fixed-wing mapping drone and a market-leading professional quadcopter drone.

The eBee X was flown over the site twice. Each time a different senseFly photogrammetry camera was used (a senseFly S.O.D.A. and the new senseFly S.O.D.A. 3D respectively) in order to provide a wide range of results and confirm that any fixed-wing benefits derived were not solely attributable to one specific payload.

The key manufacturer-quoted specifications of these two drones are shown below.

	Popular quadcopter	eBee X fixed-wing
Max. flight time (single battery charge)	30 min	90 min (w/Endurance Extension)
Take-off weight (incl. battery & camera)	1.39 kg (3.1 lb)	1.1 kg - 1.4 kg (2.2 - 3.1 lb) depending on camera/battery type
Max. flight speed	50 km/h (31 mph) (P-mode)	110 km/h (68 mph)
RGB sensor	1" CMOS RGB (20 MP)	senseFly S.O.D.A. 3D RGB (1", 3-angle, 20 MP) senseFly S.O.D.A. RGB (1", 20 MP)



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The site mapped with the drones was a mixed-use agricultural area in South-Western Switzerland named Assens (**view in Google Maps**). The full project statistics and default drone and software settings are detailed below:

Site	Mixed-use agricultural area (Assens), Switzerland
Date	February 22, 2019
Weather	Sunny/cloudy
Wind speed	5-6 m/sec (11.2-13.4 mph)
Flight height AGL	122 m (400 ft)

The flight planning settings used for the project were as follows:

Drone	**eBee X fixed-wing**	**Quadcopter**
Mission planning software	senseFly eMotion	DroneDeploy
Front image overlap	75%	75%
Side image overlap	60%	65%
Flight height AGL	122 m (400 ft)	122 m (400 ft)
Ground sampling distance (GSD)	2.9 cm (1.1 in) / pixel	3.6 cm (1.4 in) / pixel

The 100 ha (247 ac) project area, shown within senseFly's eMotion flight software, overlaid onto Google Earth.

3 Reason 1: Spend less time on-site

The key data underpinning this guide's findings are the 'time on-site' data recorded during the 100-ha project. This section outlines the timings recorded during each drone mapping mission (two fixed-wing missions, one quadcopter), in order to calculate a total time on-site for each drone platform. These detailed 100 ha timings are then subsequently used to extrapolate project timings for each platform if it were to be employed to map larger 200 ha (494 ac) and 300 ha (741) projects.

Real-world project: 100 ha (247 ac)

The Assens mapping project outlined on pages 6-7 was flown with both eBee X fixed-wing and quadcopter drones, consecutively, on the same morning in February 2019. During these processes, every separate activity was recorded and carefully timed, including:

- Set-up, battery change & packing time (from opening the box to beginning the drone's take-off procedure, plus the opposite post-mission packing time and any mid-mission battery change times)
- Take-off/landing times (the time taken to fly between the ground and the drone's flight altitude (i.e. Home waypoint) or vice versa. One take-off and landing equals two such operations.)
- Data acquisition times (the time during which images are being captured).
- Transition times (i.e. the time taken for the drone to fly between Home waypoint and first/ next mission waypoint).

Detailed tables of all these timings are available in Appendix 1.

Below are the statistics of the first quadcopter mission:

Site	Flights	Total flight time			Set-up, battery change & packing	Total time on-site
100 ha (247 ac)	2	40 min			9 min	49 min
		Data acquisition	Take-off/landing	Transitions		
		33 min	4 min	3 min		

Below are the statistics of the first eBee X mission, with the drone carrying the senseFly S.O.D.A. photogrammetry camera:

Site	Flights	Total flight time			Set-up, battery change & packing	Total time on-site
100 ha (247 ac)	1	31 min			4 min	35 min
		Data acquisition	Take-off/landing	Transitions		
		26 min	4 min	1 min		

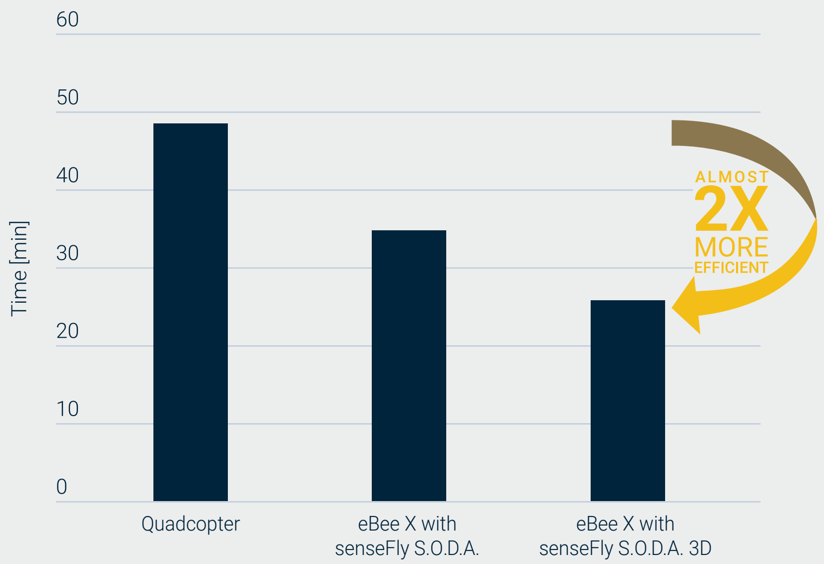
Below are the statistics of the second eBee X mission, featuring the drone carrying senseFly's latest 3-angle S.O.D.A. 3D photogrammetry camera

Site	Flights	Total flight time			Set-up, battery change & packing	Total time on-site
100 ha (247 ac)	1	23 min			4 min	27 min
		Data acquisition	Take-off/landing	Transitions		
		18 min	4 min	1 min		

The difference between these 100 ha (247 ha) mapping timings can be summarised as follows:

	Flights	Total time on-site	Difference
Quadcopter	2	49 min	--
eBee X w/senseFly S.O.D.A.	1	35 min	14 min saved / **1.4X quicker**
eBee X w/senseFly S.O.D.A. 3D	1	27 min	22 min saved / **1.8X quicker**

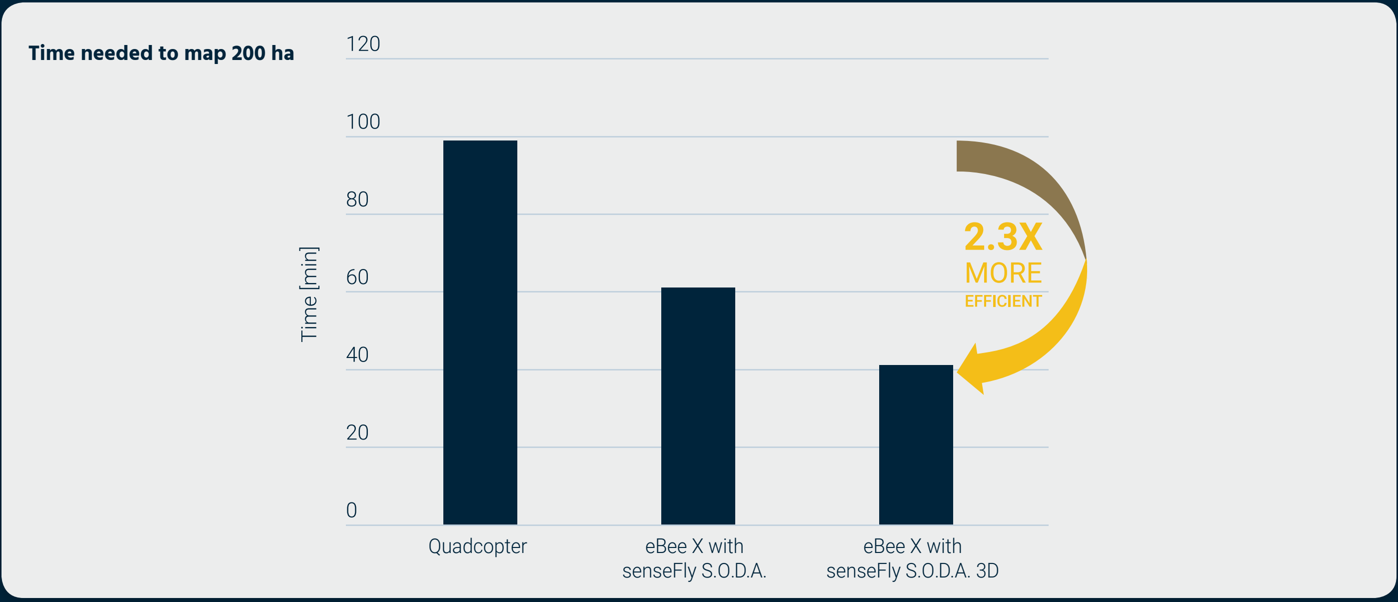
Time needed to map 100 ha



Theoretical larger project: 200 ha (494 ac)

To view the detailed timings underpinning the results below, please see Appendix 1.

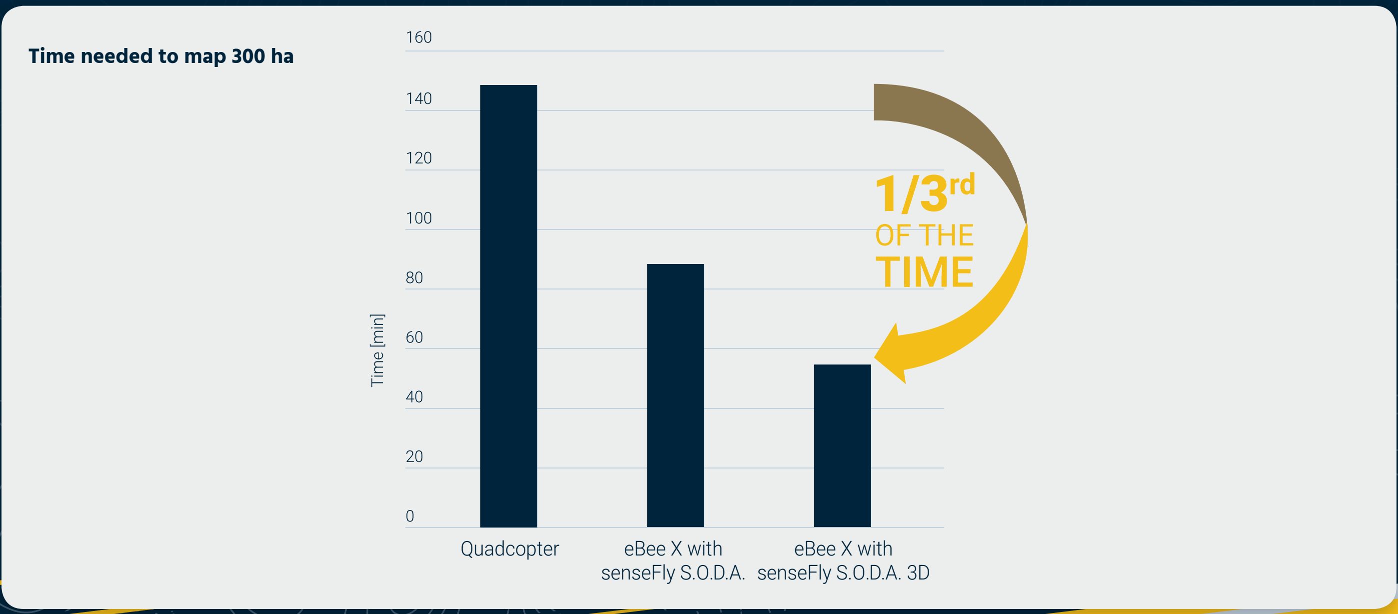
	Flights	Total time on-site	Difference
Quadcopter	4	98 min	--
eBee X w/senseFly S.O.D.A.	1	62 min	36 min saved / **1.6X quicker**
eBee X w/senseFly S.O.D.A. 3D	1	42 min	56 min saved / **2.3X quicker**



Theoretical larger project: 300 ha (741 ac)

To view the detailed timings underpinning the results below, please see Appendix 1.

	Flights	Total time on-site	Difference
Quadcopter	6	148 min	--
eBee X w/senseFly S.O.D.A.	1	88 min	60 min saved / **1.7X quicker**
eBee X w/senseFly S.O.D.A. 3D	1	56 min	92 min saved / **2.6X quicker**



4 Reason 2: Reduce your labour costs

'Time on-site' information is a solid starter metric. However, for a business manager, the effect of this time on direct labour costs is potentially more interesting (especially if an external drone operator is being employed). This section explores the effect on labour costs of each drone's mission mission's timings. It does this by assuming typical Western hemisphere staffing costs and using these—alongside the previous section's on-site timings—to calculate the financial benefits associated with using a fixed-wing drone.

Labour cost assumptions

To calculate the labour costs associated with the three project sizes described in the previous section, the following assumptions were made:

No. of staff required	2
Labour cost / hr (USD)	$125
Combined labour cost / hr (USD)	$250
Combined labour cost / min (USD)	$4.17

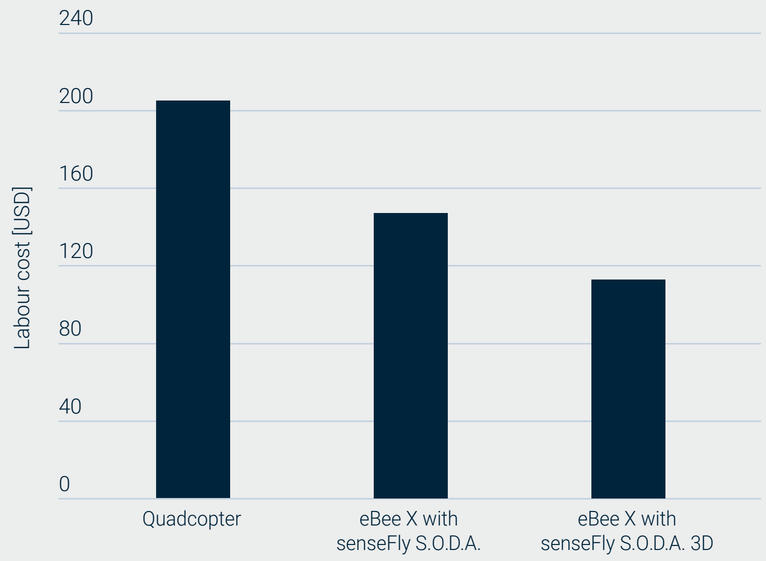
The requirement for two drone staff to be present on-site is typical in many countries, where commercial UAV/UAS regulations require both an operator and a second observer to be present at every job.

NB: The calculations that follow account for on-site drone operations only. They do not account for post-flight in-office tasks such as image processing and data analysis, nor do they take into account costs associated with staff travel to and from the job site.

Real-world project: 100 ha (247 ac)

	Flights	Total time on-site	Labour cost (USD)	Time saved	Savings per mission (USD)
Quadcopter	2	49 min	$204	--	--
eBee X w/senseFly S.O.D.A.	1	35 min	$147	14 min	$56
eBee X w/senseFly S.O.D.A. 3D	1	27 min	$114	22 min	$90

Labor cost per project to map 100 ha



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Theoretical larger project: 200 ha (494 ac)

	Flights	Total time on-site	Labour cost (USD)	Time saved	Savings per mission (USD)
Quadcopter	4	98 min	$406	--	--
eBee X w/senseFly S.O.D.A.	1	62 min	$258	36 min	$149
eBee X w/senseFly S.O.D.A. 3D	1	42 min	$173	56 min	$233

Theoretical larger project: 300 ha (741 ac)

	Flights	Total time on-site	Labour cost (USD)	Time saved	Savings per mission (USD)
Quadcopter	6	148 min	$617	--	--
eBee X w/senseFly S.O.D.A.	1	88 min	$368	60 min	$249
eBee X w/senseFly S.O.D.A. 3D	1	56 min	$232	92 min	$385

Labour cost per drone platform

5 Reason 3: Increase your project capacity

In addition to the cost benefit of spending less time on-site, for professional drone service providers and in-company operators alike, this time savings means more mapping projects can be completed over a specific period.

In this section we calculate the potential increase in the number of drone projects an organisation can complete—its so-called 'project capacity'—over the course of a week, because of the time saved by operating a fixed-wing drone in place of a quadcopter.

Flight condition assumptions

To calculate the project capacities achievable with the three drones platform, the following assumptions were made:

Avg. no. flying days per week	2
Flying hours per day	8
Flying hours per week	16
Flying minutes per week	960
Avg. travel time between projects	30 min

These parameters were chosen with the aim of identifying a realistic average flight capacity that applies, as much as possible, across regions and across the changing weather (and therefore flight) conditions throughout the course of a year.

To view the formula to which the above assumptions were applied, please see Appendix 2 .

Project capacities

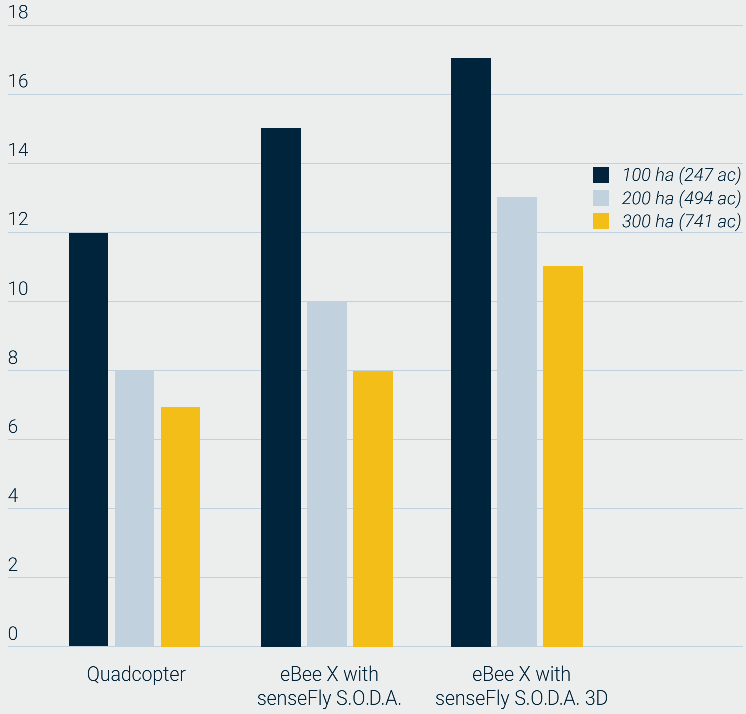
Flying a fixed-wing drone in place of a slower quadcopter was found to boost a team's potential capacity by several projects per week.

In the case of this guide's sample 100 ha project, based on the assumptions above, up to five more such projects could be completed each week. In the case of larger 300 ha projects, this number increases to more than double the number of projects (11 projects versus five).

5

Size of site	No. of projects per week		
	Quadcopter	eBee X w/ senseFly S.O.D.A.	eBee X w/ senseFly S.O.D.A. 3D
100 ha (247 ac)	12	+3	+5
200 ha (494 ac)	8	+2	+5
300 ha (741 ac)	5	+3	+6

Number of projects achievable per week

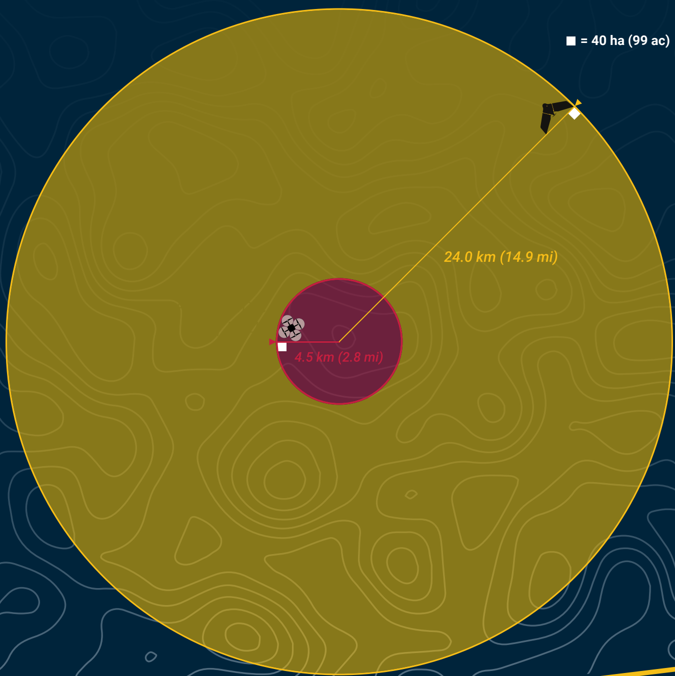


6 Reason 4: Expand your remote mapping capabilities

As any experienced geospatial professional knows, accessing the site you want to map is not always possible. For example, security concerns, environmental hazards, and natural events such as flooding or landslides might all prevent access. Therefore, it is crucial to employ a mapping platform that can reach virtually any site, map it and return home — without the risk of running out of battery charge. This section explores the abilities of the different drone platforms to achieve this goal.

While these are challenges, aerial data still needs to be acquired. Therefore, it is crucial to employ a mapping platform that can reach virtually any target site, map it effectively, and return home — without the risk of running out of battery charge.

The graphic below highlights the difference in achievable mapping radiuses between our example quadcopter and the fixed-wing eBee X carrying a senseFly S.O.D.A. camera. The goal in this example is to reach, map and return safely from a small 40 ha (99 ac) site, in a single flight. The figures below are based on the drone returning home to land with 10% battery remaining.



Drone	Achievable radius for a 40 ha (99 ac) mapping
Quadcopter	4.5 km (2.8 mi)
eBee X w/senseFly S.O.D.A.	24.0 km (14.9 mi)

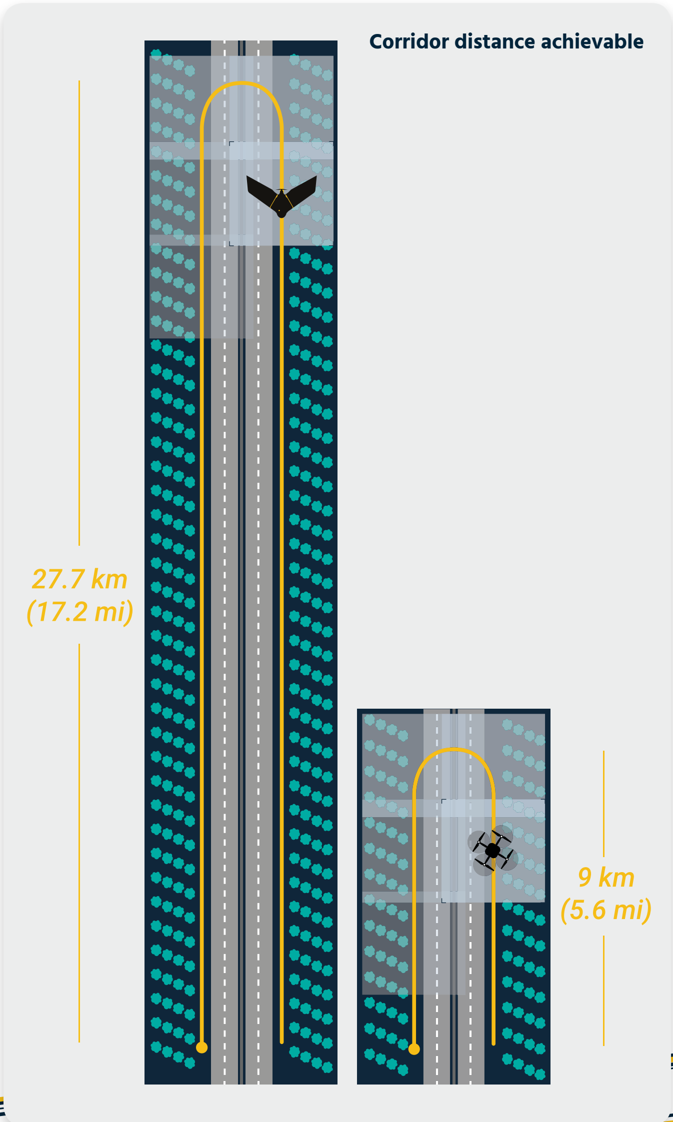
To view the full calculation used, please see Appendix 3.

In summary, the fixed-wing eBee X drone can access a flight radius up to **5.3X larger** than this guide's typical quadcopter drone. This difference could potentially enable a commercial operator to map a much more diverse range of sites.

7 Reason 5: Expand your corridor mapping capabilities

Many geospatial projects are linear in nature, such as road construction surveys, power line inspections and coastal surveys, making corridor mapping a key component of many drone operators' work. A UAV's flight endurance has a direct effect on the length of corridor that can be mapped effectively (and saflely) in just one flight. This section explores this relationship.

The following figures detail the length of corridor that can be mapped with the three different drones platforms. The goal was to map a narrow corridor using two flight lines one (there/back) and, as with remote sites in the previous section, then return home to land with 10% battery.



Drone	Achievable single-flight corridor length
Quadcopter	9 km (5.6 mi)
eBee X w/senseFly S.O.D.A. 3D	27.7 km (17.2 mi)

To view the full calculations used, please see Appendix 3.

With its up to **3X longer flight time**, the fixed-wing eBee X can map up to 18.7 km/11.6 mi (approx. 3X) longer corridors than a typical quadcopter. This difference could potentially enable a commercial operator to engage in a wider range of corridor projects, or to map larger corridors up to **3X more efficiently**.

NB: for corridor mapping projects that involve the drone flying beyond the operator's visual-line-of-sight (A.K.A. BVLOS missions), many countries additional flight permissions and exemptions are required.

8 Appendices

Appendix 1

Detailed 100 ha (247 ac) project timings: quadcopter

Activity	Time	Steps
Set-up	0:00	Unpack & assemble drone Start drone Launch DroneDeploy application Final adjustment of flight settings (manufacturer app)
Flight 1	5:00	Take-off
	6:10	Reach mission altitude
	6:33	Reach 1st mission waypoint
	23:37	Return-to-home triggered (30% battery)
	24:36	Drone reached Home
	25:35	Landed, engine off
Battery change	26:28	Second battery inserted & drone restarted (necessary twice)
Flight 2	28:44	Take-off
	29:37	Reach mission altitude
	31:14	Reach 1st mission waypoint
	44:26	Finish mission, return-to-home
	47:40	Land, engine off
Packing	47:40	Disassemble & repack drone
Total time on-site	**48:40**	

Detailed 100 ha (247 ac) project timings: eBee X w/senseFly S.O.D.A.

Activity	Time	Steps
Set-up	0:00	Unpack & assemble drone Start drone Launch eMotion application Final adjustment of flight settings (eMotion)
Flight	3:00	Take-off
	3:45	Reach mission altitude
	4:41	Reach 1st mission waypoint
	30:41	Finish mission, return-to-home
	31:35	Reach Home waypoint
	32:13	Approach for landing
	33:01	Land, engine off
Battery change	33:01	Disassemble & repack drone
Total time on-site	**34:01**	

Detailed 100 ha (247 ac) project timings: eBee X w/senseFly S.O.D.A. 3D

Activity	Time	Steps
Set-up	0:00	Unpack & assemble drone Start drone Launch eMotion application Final adjustment of flight settings (eMotion)
Flight	3:00	Take-off
	3:40	Reach mission altitude
	5:26	Reach 1st mission waypoint
	23:51	Finish mission, return-to-home
	24:49	Reach Home waypoint
	25:37	Approach for landing
	26:30	Land, engine off
Battery change	26:30	Disassemble & repack drone
Total time on-site	**27:30**	

Appendix 2

Project capacity

Project capacities were calculated based on the following assumptions:

- Weather and other imperatives allow two days per week on-site
- Labour time is eight hours per day
- A travel time of 30 minutes is included between each two consecutive projects

Example: 100 ha (247 ac) mapping with eBee X w/senseFly S.O.D.A.

$$\textit{No. of projects} = \frac{2 \textit{ days} \times (8 \textit{ hr} \times 60 \textit{ min})}{\textit{Time on site + travel time}}$$

$$\textit{No. of projects} = \frac{2 \times (8 \times 60)}{35 \textit{ min} + 30 \textit{ min}} = \textit{15 per week}$$

Appendix 3

Remote mapping / corridor mapping

The maximum possible mapping radius of each drone, and the maximum possible corridor mapping length of each drone, were calculated based on the following parameters:

- Battery charge at landing: 10%
- The drones fly with a ground speed of 12 m/s (26.8 mph).
- The height of the mission's flight line remains constant at 122 m (400 ft) above take-off altitude.

	Max. manufacturer-quoted flight time	Flight time with battery at 10% on landing
Quadcopter	30 min	27 min
eBee X w/senseFly S.O.D.A.	90 min	81 min
eBee X w/senseFly S.O.D.A. 3D	80 min	72 min

Remote mapping example

To calculate the 40 ha (99 ac) achievable mapping radius of the quadcopter drone, the following parameters and calculation were used:

Parameters:

- **Flight time:** 27 min
- **Mission time to cover 40 ha (99 ac):** 16 minutes (incl. take-off/landing times, see Appendix 1)
- **Mission block size:** 40 ha (99 ac) represents a square of 632 m x 632 m (2,073 ft x 2,073 ft)
- **Drone flight speed:** 12 m/s (26.8 mph)

Calculation:

$$\textit{Radius of action} = \frac{\textit{(Flight time − mission time) x drone speed}}{2} + \textit{length of mission block}$$

$$\textit{Radius of action} = \frac{(27 \text{ min} - 16 \text{ min}) \times 12 \text{ m/s}}{2} + 632 \text{ m}$$

$$\textit{Radius of action} = \frac{(27 - 16) \times 60 \times 12}{2} + 632 = 4{,}592 \text{ m}$$

Corridor mapping example

The flight was assumed to be a straight corridor mapping between Point A and Point B, consisting of two flight lines (there and back), starting from the take-off point.

This question was then addressed: what is the maximum distance the drone can cover between Point A and Point B to complete this mapping, while ensuring a safe landing at the take-off point with 10% of battery charge remaining?

To calculate the maximum corridor length achievable with an eBee X w/senseFly S.O.D.A., the following parameters and calculation were used:

Parameters:

- **Mission time:** max. flight time (81 min) – take-off & landing time (4 min) = 77 minutes
- **Drone flight speed:** 12 m/s (26.8 mph)

Calculation:

$$\textit{Max. corridor length} = \frac{\textit{Mission time x drone speed}}{2}$$

$$\textit{Max. corridor length} = \frac{77 \text{ min} \times 12 \text{ m/s}}{2}$$

$$\textit{Max. corridor length} = \frac{77 \times 60 \times 12}{2} = 27{,}720 \text{ m} = 27.7 \text{ km}$$

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