
# AN AERIAL VIEW: RPASs FOR FORESTRY OPERATIONS

"A pixel is worth 1024 bits"! Captured from the right perspective, every forest manager now sees aerial images as essential in their toolkit! Converting the data bits from a drone or a Remotely Piloted Aircraft System (RPAS) to actionable information bytes for supporting forest operations had been the journey FPInnovations took over the last 6 years. The objective was to assess whether RPASs represented a suitable platform for forestry operations and whether their use provided added value to various applications. Different types of RPASs and miniaturised sensors have been tested in the forestry environment.

## DEVICES TESTED

The market offers different types of RPASs that vary in functionality, quality and thus cost. They are generally classified into two main categories: multi-rotor and fixed-wing. Multi-rotor RPASs have the advantage of taking off vertically — needing only small spaces such as those found in a forest — can fly close to the canopy but are more demanding in terms of battery life. For the same energy, fixed-wing RPASs tend to cover more surface area but require more landing space and need to be flown at a slightly higher altitude. More recently, a few hybrid models that are relatively expensive became available on the market but have not been tested yet within the context of this research. Miniaturised sensors that can go on these platforms range from simple RGB camera (red, green, blue), multi-spectral (3-7 channels), hyperspectral (over 220 channels) to the survey-grade LiDAR. The choice of a type of RPAS and sensor will depend on the needs of the application in question and on the level of detail desired, of course considering battery endurance, sensor support capacities, and cost.

## TESTS PERFORMED

Research work focused on the feasibility of using RPASs (mostly multi-rotors) for various forestry applications. Data accuracy, substitution or supplement to the land inventory, costs and best practices have been documented. These tests are presented in the table below. For each of them, the type of sensor used is specified as well as an indication of the level of information derived to meet the application (complete or partial). It also states the status of automation of the data analysis and whether such automation is a possibility. This last point is important, since it is this automation that makes the use of RPASs interesting and profitable as opposed to conventional techniques.

The applications tested using a consumer grade easy-to-use RGB camera included situational awareness through simple surveillance for operational safety and road planning in steep terrain, stack burning and heat spot detection; mill yards for volume calculation (logs and chip piles), and surface drainage analysis. Additionally, more detailed 3D assessments included pre-harvest surveys (species identification, canopy height model) and post-harvest compliance (regeneration inventory, stocking, free-growing status and inventory of unused woody material, merchantable waste and potential biomass recovery). Tree vigour in times of stress (drought, insect epidemics) was also measured and led to the development of early intervention strategies. The use of LiDAR sensors made it possible to assess the quality of standing stems (size of crowns, branches, basket of products), the effects of treatments on the growth of residual stems, and finally the characterization of the terrain (risks and trafficability).


*Figure 1 : RPASs and sensors tested during research work at FPInnovations.*

## RESULTS

- The proximity of the target (60 m - 120 m flight altitude with a spatial resolution of 1 to 2 cm) makes it possible to use consumer grade simple RGB camera commonly available in the market to achieve acceptable object and terrain height accuracy for the applications tested; accuracy ranged between 10 cm at 60 m altitude and 21 cm at 120 m flight altitude. Accuracy of a few mm is achievable using a LiDAR sensor, but cost of acquisition is much higher.
- Individual stems of all sizes over 30 cm can be easily identified and their height accurately estimated with photogrammetric models from consumer grade RGB camera.
- Tree species and stand composition is recognisable, several inputs needed for reporting post-harvest compliance requirements are possible, has a good potential to reduce a high component of ground surveys.
- Hot spot detection using non-radiometric thermal imaging is inexpensive and makes it possible to see targets on the ground even under canopy with high positional accuracy.
- The information collected is generally complete and covers most of the applications, and its analysis is either automated or in the process of being automated.
- Costs decrease as the areas assessed increase. For example, for area of 500 ha or more, costs are approximately $10/ha; for areas over 2000 ha, costs can be as low as $2/ha. This can be further reduced if the vendors and providers are locally available.
- The inexpensive multi-rotor RPASs are efficient, and the associated operating costs are lower.
- The challenges include battery endurance, improving sensor quality, managing massive data, automating analyzes, and standardizing practices.

### Applications tested with RPASs

| | Test | Standard camera (1) or LiDAR (2) | Visual | Automation possible | Automated | Complete info | Partial info |
|---|---|---|---|---|---|---|---|
| 1 | Control and safety: identification of potential dangers and documentation | 1 | x | | | | x |
| 2 | Logging roads in steep terrain | 1 | x | | | x | |
| 3 | Stack burning | 1 | | x | | x | |
| 4 | Mill yard Stack and chip inventory | 1 | | | x | x | |
| 5 | Mill yard Surface drainage | 1 | | x | | x | |
| 6 | Pre-harvest survey (orthomosaic, individual tree crown extraction, canopy height model) | 1 | | | x | x | |
| 7 | Species identification | 1 | | x | | x | |
| 8 | Post-harvest compliance: automatic log detection (census and dimensional analysis) FPResidue | 1 | | | x | x | |
| 9 | Biomass recovery zones | 1 | | | x | x | |
| 10 | Regeneration: census and distribution (height, density, stocking, free to grow), FPSilvi | 1 | | | x | x | |
| 11<br>12<br>13 | **Vigour and insects:**<br>• Stress and mortality<br>• TBE — Early intervention strategies<br>• Current and cumulative defoliation in RGB | 1 | | x | | x | |
| 14 | • Healthy versus affected with RGB imaging | 1 | | | x | x | |
| 15<br>16<br>17 | **Quality of standing stems:**<br>• Size of crowns and stems<br>• Branching and knot surface<br>• Basket of standing wood products | 2 | | | x | x | |
| 18 | Treatment effects (multi-temporal LiDAR) | 2 | | x | | x | |
| 19 | **Surface characterization:**<br>• Risk identification and trafficability | 2 | | | x | x | |


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