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Conceptual Approach of Measuring the Professional and Economic Effectiveness of Drone Applications Supporting Forest fire Management

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Abstract

Introduction: Since the operation of manned aircraft at forest fires is expensive, in many cases managers miss the aerial reconnaissance however that would be required for the effective intervention. Drones can give real alternatives against traditional reconnaissance, therefore it is important to study both professional and economic effectiveness of its applications. Methods: Authors used three different approaches to study the effectiveness of drone applications; firstly they used comparison based analysis, then an analysis of indirect way and at last a damage – time function analysis, based on the drone applications at the tactical level. Research used their own experiences in this field, practical experiments, economic analysis and also expert estimation. Results and discussion: The meaning of efficiency for fire managers can be different from the meaning of efficiency for economists. Economic efficiency is more strict than technical effectiveness. Even if drone applications are cheaper than the manned aircraft, it is helpful to analyze its real economic effectiveness. This study points at principle mistakes used often by marketing to overrate the advantages of some product or procedure. Even if it is very difficult to calculate with all circumstances and assumptions found during firefighting process such as aerial patrol for detecting hot spots or fly for reconnaissance but authors show methods that can help us to rate the economic effectiveness more precisely than rated nowadays by the marketing.

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1. Introduction

When anybody assesses efficiency, it is usually the return on investment and the period of time required for such returns to be realized that we take into account. The concept of efficiency is applicable to firefighting as well, but the way it is applied differs from the traditional interpretation. In the case of firefighting and other interventions, efficiency is measured either by the quantity of value saved or by the actual damage, which, of course, should be as small as possible [1]. This article uses three different approaches for measuring the economical based efficiency of using drone at forest fires.

In the first approach the topic focuses on the forest and the economical balance at state level. Method of this chapter based on a relatively simple comparison.

In the second approach a special calculation is used which is based on the method of indirect proof. It is a real calculation for measuring the frame and limits of the real efficiency. Discrete values as an example is given here.

The last approach focuses on the tactical level. Drone applications are thematically separated and the economically based analyses are made at each different use. This method is necessary because different task requires different approach for

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measuring the efficiency. This chapter uses the damage-time function as a basic element of any process measuring the efficiency of firefighting.

2. Comparison based economic analysis

Till starting the intervention the fire spread is out of control. Since the damage that is caused by fire till beginning the intervention is not influenced this part of the forest can be evaluated as an absolute damage. After starting the intervention fire manager can decide on using or not using the drone support. The criterion of the economic efficiency is that the fire management with using drone is more effective [2] and able to save more value forest than the costs of using drone. For supporting the above statement between these two methods of management (management supported by drone or management without drone support) the comparison analysis is required.

2.1. Fire management without drone support

In average cases fire management doesn't use drone, where the time of suppression takes "t₁" and during this term the burnt area means "A₁". The total damage during the intervention is as follows:

$$D_{Absolute} + D_{Suppression1} + \Sigma C_{Tradition1} = \Sigma C_{\Sigma1} \tag{1}$$

- D_{Absolute} - damage, caused by fire till starting intervention;
- D_{Suppression1} - damage, caused by fire during suppression;
- ΣC_{Tradition1} - costs of traditional equipment used for suppression;
- ΣC_{Σ1} - summarized damages and costs of suppression, without using drone.

The saved value of the forest is in the above case means as follows:

$$S_{Forest1} = \Sigma V_{Forest} - (D_{Absolute} + D_{Suppression1}) \tag{2}$$

- S_{Forest1} - saved forest, management without drone;
- ΣV_{Forest} - total value of the forest.

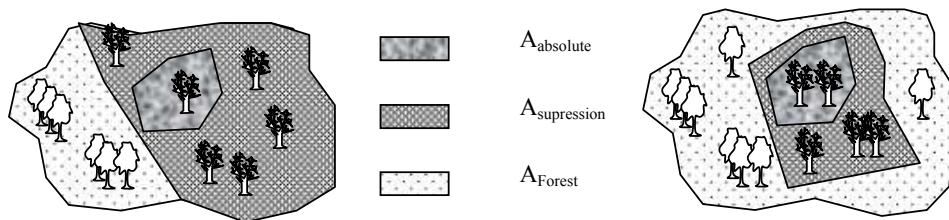


Figure. 1. Burnt area at traditional based (left) and drone supported (right) fire management

For satisfying the criterion of the economic efficiency the next formulas have to be realized:

$$\Sigma C_{Tradition1} < S_{Forest1} \tag{3}$$

The above means:

$$\Sigma C_{Tradition1} = \Sigma V_{Forest} - (D_{Absolute} + D_{Suppression1}) \tag{4}$$

Till the above formulas are valid the criterion of the economically based efficiency is satisfied at traditional fire management.

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