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# The Prospect of drone applications

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**Abstract.** As drones' technology matures, it will be used in more and more applications in multiple fields. This paper focuses on the evaluation of the prospects for the application of drones. The evaluation is based on three criteria: the environment, engineering, and disaster management. Through analysis, this paper shows that drones have unique advantages in these three areas. Given the use of ground-based sensors for air and water quality testing, drones have a great positive effect on environmental management. It can also be used for large-scale engineering project management and disaster tracking with its HD video and numerous high-resolution aerial photos. However, drones need improved regulatory controls to address risks to safety, privacy, and security. Overall, this article describes the status of drone applications, which will become more popular with the enhancement of the regulatory environment.

**Keywords:** drone, environment management, engineering, disaster management.

## 1. Introduction

Drone use has grown significantly in the fields of agriculture, law enforcement, the media (news and entertainment), and energy. The global market for civilian drones is sizable and expanding. Currently, each month in the US, more than 15,000 copies are sold [1]. However, drones' flexible mobility and their high-definition sensors may constitute a danger to security, privacy, and public safety. Thus, how to improve restrictions on the illegal operation of drones could be an important factor in limiting further market expansion. As drones have good prospects for application, but are limited by safety hazards, this paper will evaluate the application of drones by 3 criteria and argue for the safety hazards can be relatively well addressed by the relevant regulatory restrictions. The first part of the paper will focus on the environment, and the second part will be concerned with engineering. The third part will concentrate on disaster management. Finally, the safety of drones and the associated restrictions will be discussed.

## 2. The environmental application of drones

Although the potential application of drones in populated areas is becoming increasingly limited for safety and privacy reasons, it can be argued that they have a wide range of environmental applications. It has been claimed that drones have unique advantages in urban environments with their drone-based sensors. The collection of water samples by drones is being studied, and the oil sector might also use this to help them comply with environmental rules [2]. Also, in lakes, drones are better than boats for sampling, not only to save time as well as the fact that repeat sampling at the same location may be done with accuracy down to the millimeter and with no disruption to the site [3]. In the field of air pollution monitoring, China's micro-drones move from experimental to large scale and large number of sensors,

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which is distributed to produce geographically based real-time air quality [4]. However, compared to the main alternatives, satellites, and IoT technology, privacy concerns for drones gain more traction because mobile sensors are more likely to attract attention than fixed ones [5]. Additionally, because they pose a significant risk to both the general public and the payload and need specialized equipment for maintenance, drone solutions are not cost-effective in communities with basic IoT infrastructure. Therefore, how to weigh up the benefits of drones against the risks they pose is crucial. Given the above points, drones have unique advantages in the urban environment, but more investigation needs to be conducted to find out the balance between benefits and risk.

Apart from the application in urban environments, drones are also being applied to visual pollution. Visual pollution was originally defined by researchers as the 'visual quality' of areas being degraded by signs and advertising, but the phrase was later expanded to cover any feature of the landscape that is out of place and creates an offensive or repulsive sight [6]. There are studies arguing that visual pollution encompasses a very wide range and is highly subjective in nature [6]. Its subjective nature leads to the persistent problem of inefficient identification of visual pollutants. Moreover, manual data collection techniques that are costly and time-consuming are used to be the only option for visual pollution studies [7]. However, UAVs with visual contaminant classifiers can be utilized with drones to both take pictures of visual contaminants and use GPS to acquire geographic coordinates [7]. Once the location of visual contaminants is obtained through drones, The control and elimination of visual pollutants in the built environment and natural environment can be done more effectively by human intervention. The approach, for instance, can be used to identify street trash that has to be cleared away to support solid waste management [6]. Overall, the drone's efficient localization of visual pollution effectively solves its diversity issues and promotes the management of visual pollution.

## 3. The application of drones engineering

Apart from the issue of the environment, drones offer a wider range of applications and better prospects for engineering. In civil engineering, the engineering team can save money and gain vital assistance from the drone's ability to monitor a variety of inaccessible and challenging-to-navigate regions while pointing out the best overhead views and relaying the situation in real time [8]. Therefore, drones are applied to building surveys to acquire visibility of the building's roof and other inaccessible places to save time, cost, reduce safety and health risks. Also, It has been asserted that drones can construct digital terrain models (DTMs) or digital surface models (DSMs) from the high-quality aerial photographs generated by their drone-based sensors [9]. With this ability to gather a substantial volume of data in a very brief period of time, drones are used extensively in topographic mapping and land surveys to produce topographic maps. Additionally, in the area of construction site inspections, drones are used to track site progress precisely with virtually no delay to help construction companies manage their time and resources more effectively [10]. In general, drones have generally been utilized extensively in the construction sector due to their easy agility and quick access to vast amounts of data.

In addition, the application in the construction industry, it is argued that drone can also be applied to transportation engineering and traffic engineering. Before constructing and building an infrastructure project, the land on which it is situated must be surveyed to gather dimensions, topographical data, and general site information. Data collected by drones is more economical and faster than using 3D scanners, which is because it has a high viewing angle and can be loaded with real-time transmission sensor [11]. Additionally, the drone can also be used to solve traffic engineering problems. The studies pointed out that traffic flow modelling requires the explanation of the connections between the fundamental flow characteristics, namely, flow intensity, density, and velocity. The drone has a few advantages over typical traffic monitoring equipment in that it can cover a continuous stretch of road while collecting traffic parameters at fixed and discontinuous places, requiring more sensors to monitor a stretch of road [12]. In other words, drones have the advantage of overhead viewing angles and real-time information transmission. Therefore, drones can be applied to transportation engineering and traffic engineering to acquire data for developing an infrastructure project and modelling traffic flows.

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## 4. The application of drones in disaster management

Despite the concerns about engineering applications, the drone can also be used for disaster management. It can be seen in Figure 1 that drones have a wide range of applications in flood management. Before flooding, Drones can be used to examine riverbeds in an effort to prevent floods. This will give decision-makers a bird's-eye perspective of the affected area and objective, pertinent data while the flooding is happening. Also, after the flooding, Drones can be used by professionals to quickly analyze the flood damage by mapping or re-mapping the impacted areas. It has been claimed that drones are used for quick fire detection in the prevention of water-related disasters such as forest fires [13]. Quick detection of a fire means that the fire is relatively small, so the fire service can contain or control it more easily and efficiently. Based on Figure 2, a reduction in Δt in any period will result in a significant reduction in damage caused by fire. Overall, drones play an important role in flood prevention, decision-making, and disaster recovery, and their use in rapid fire detection can significantly reduce fire risk.

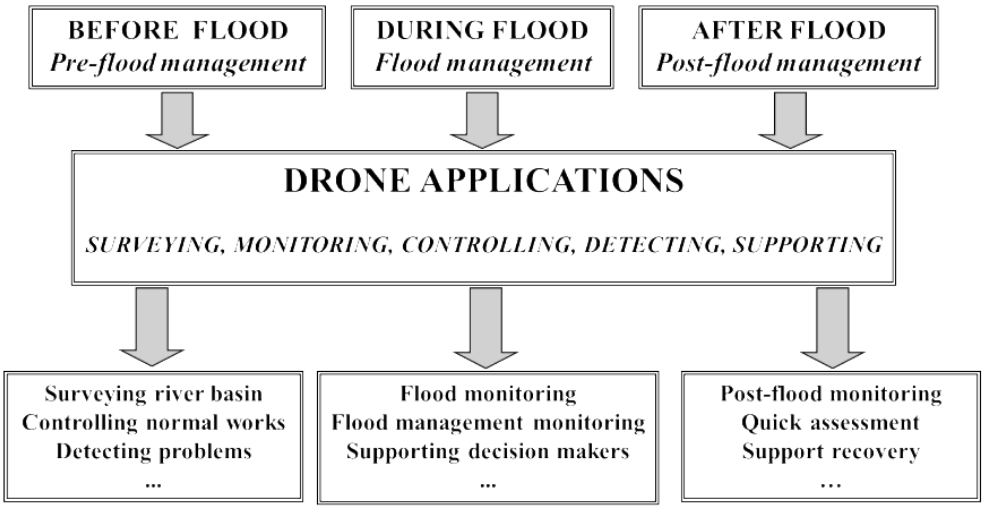



**Figure 1.** Time sectioning of drone application in case of flood management [13].

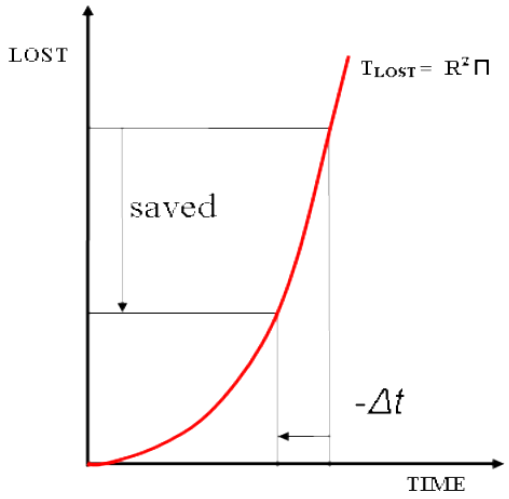



**Figure 2.** Damage-time function. It is a basic shape at uncontrolled forest fire [13].

## 5. Advantages and disadvantages of drone applications

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In terms of environmental management, drones are better than boats to sample, which is not only more efficient but also more accurate since Repeat sampling at the same location is possible with sub-meter precision. Moreover, given the capacity to accumulate massive amounts of data in a brief length of time, drones are widely used for topographic mapping and land surveying to produce topographic maps. Moreover, drones are widely used to acquire visibility of inaccessible places during building surveys. It can also cover a continuous stretch of road to acquire data for the traffic flow model. In terms of disaster management, drones can be used to quickly spot a fire, which is conducive to controlling the fire efficiently and reduce the loss effectively. However, drones pose a risk to privacy, public safety, and security. It gets more traction on privacy concerns than its competitors, namely, satellites, and IoT technology [5]. Whereas, studies point out that through IoT, the drone can be supervised in real-time with a large amount of data collected by many fixed points and vehicles [5]. When drones' GPS is positioned in urban areas or high-risk areas, drone movements will be controlled, for example by limiting altitude, which will facilitate the safe management of drone flights. Therefore, drones can be effectively controlled, and their unique advantages far outweigh their potential hazards.

## 6. Conclusion

In conclusion, the drone is evaluated as having a wide range of application potential, considering 3 criteria: the environment, engineering, and disaster management. Firstly, data shows that drones have higher accuracy in collecting water samples and have the ability to access data more quickly with high vision compared to the ground-based sensor. Also, the high maneuverability and real-time data transmission capabilities of drone make it widely used in engineering to investigate hard-to-access areas and acquire data for traffic flow models. In addition, its ability to detect can be applied in disaster management to reduce the loss. Finally, the limitation of drones' risk to privacy, public safety, and security has been evaluated, and solutions to rely on IoT to control drones have also been proposed. However, this paper lacks an analysis of specific use cases for safety restrictions on consumer grade drones, for instance, practical implementation of IoT. Additionally, more research is needed to assess the potential risks associated with drones.

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