

The use of unmanned aerial vehicles for forecasting and preventing floods

Dmitry Gura^{1,*}, *Polina Malimonenko*¹, *Nelli Dyakova*¹, and *Alexander Solodunov*^{1,2}

¹Kuban State Technological University, 2, Moskovskaya str., Krasnodar, Russia

²Kuban State Agrarian University, 13, Kalinina str., Krasnodar, Russia

Abstract. The paper considers possible aspects of unmanned aerial vehicles (UAVs) to predict and prevent dangerous situations associated with floods, waterlogging, and stream rise in the territories of settlements in modern conditions. Besides, a historical analysis of such cataclysms was carried out for the period from 2019 to 2020, which deserves the special attention of scientists. The relevance of the paper is undoubted, since the symbiosis of nature and man gives rise to destructive phenomena against the background of an incorrect interaction of these two units. The paper is divided into 5 main sections, which include: introduction, history of floods, possible use of UAVs in water accidents, and further actions after the work of UAVs is done and the conclusions.

1 Introduction

In modern realities, society tries to model its life most comfortably every day, which inevitably leads to the acceleration of technical progress. Over the past decades, the existence of man in the world has changed dramatically: the number of production facilities has increased, science is learning more boundaries of previously unexplored areas, social ways of striving are changing, etc. Due to these factors, human needs increased and came to the fore of the coexistence of nature and man. The lack of balance in these natural relationships leads to terrible disasters for many reasons. Some of these are lack of control and environmental protection. A person cannot program a certain setting in the natural environment, but he can control the existing indicators of natural phenomena, predict their further development, and introduce ways and methods to prevent them. By 2021, there are technologies in the world that make it possible to remotely monitor the areas of the territory and objects within these boundaries. The technology discussed in scientific work is related to unmanned aerial vehicles their use for forecasting and preventing such a negative phenomenon as floods.

Flood is a significant difference in the coordinate marks of the water level on the ground between the design (admissible) and real ones (exceeding the admissible level). Floods can be caused by seasonal melting of snow, heavy rainfall, strong winds, ice and surges, anthropogenic interference, and much more [1].

* Corresponding author: gda-kuban@mail.ru

At the end of the 20th century, a classification of destructive natural phenomena was introduced in Russia, consisting of a six-point typification, according to which one point is awarded to a slightly dangerous phenomenon, and six points to a dangerous type. Most foreign countries also have their classification of natural disasters according to damage caused.

2 Flood history from 2019 to 2020 and their causes

Let us consider the historical examples of the world's most famous floods over the past 3 years.

One example of catastrophic floods, in the one of Naples, Italy, in October 2020. The reason for the sharp rise in water in the village was heavy rains with a storm. Naples was not ready for such a cataclysm due to the lack of necessary engineering structures, such as channel regulating structures and structures for regulating and diverting surface runoff, drainage systems, and individual drainages, and other protective structures, which caused the flood itself.

Another similar example is the flood caused by heavy rainfall in Paris (France), because of which the Seine River overflowed its banks, flooding the embankments in the center of the metropolis. In four days, from January 21 to 25, the water level rose by 1 meter. This disaster occurred on January 25, 2021. The main reason is also the lack of necessary engineering structures if heavy rainfall occurs.

Rains also flooded the territory of Malaysia at the end of January 2021. Many regions were affected by floods, and their residents were evacuated to safe areas at the time of the disaster [2].

The cataclysms of the coming years do not end here.

In Russia, at the end of June 2019, in the city of Tulun (Irkutsk region), there was one of the most destructive floods for the country, which was also associated with heavy torrential rains that coincided with melting snow in the Eastern Sayan mountains, and stream rise also started. An emergency regime was introduced in the city on June 28. The dam on the Iya River was not ready for such a pressure of water, which contributed to the overflow of water through it. Many residents were not warned in time. Most had to evacuate their homes on their own. The exact number of casualties and deaths varies from source to source. Over 80% of the city's territory was damaged [3].

All the above-mentioned disasters associated with the flooding of the urban area could be neutralized or, at least, the damage they caused could be reduced. Unmanned aerial vehicles (UAVs) of a modern design are considered one of the possible measures to prevent floods.

3 Using UAVs to predict and prevent floods and other destructive phenomena associated with water

The specificity of using UAVs is the possibility of remote observation and timely anthropogenic intervention against the background of the device data analysis.

Modern UAV equipment includes various detectors for a person in all spheres of his life, such as a video recording with the automatic approach of necessary objects (zoom is available as on the latest photography devices), video recording, aerial photography, obstacle sensor, GPS coordinates, thermal imager, and much more. They allow the use of UAVs for a different spectrum of actions [4-6].

First, the remote sensing system is used by units of the Ministry of Emergency Situations. In their interests, UAVs solve several tasks, such as precise identification of objects in a territory with their coordinates and existing borders, monitoring a territory, maintaining

photo and video recording in disaster areas, creating cellular base stations in hard-to-reach areas, guiding employees to search groups and their information support, search for victims, search for underwater objects.

Thus, with thermal imager, it becomes possible to track the heating of large volumes of snow, which can affect the flooding of the urban environment. This will help to avoid the minimum risks during snow melting. With these sensors, it is possible to track the approach of groundwater, which also often leads to territory flooding. Several other methods of using a thermal imager for similar purposes can be identified [7].

Considering the possibility of high-quality zooming of the camera as a special addition to the aerial vehicle, we can talk about the likelihood of flood prevention. Here, the UAV is configured with a specific route and the time when it should fly. During the flight, you can use video recording or direct monitoring. This makes it possible to quickly notice an increase in the water level in reservoirs and other water bodies due to the snow melting, heavy rainfall, or other external factors, which makes it possible to take timely action to neutralize the situation.

Talking about the sensors responsible for aerial photography and GPS navigation, their use for territory analysis is considered a priority. With UAVs, it is possible to trace areas that require special attention due to the high probability of floods, stream rise, and waterlogging, focusing on the boundaries of water bodies that already exist and are just forming in a natural or anthropogenic way [8].

Besides the listed above, there is another way to remotely draw up topographic maps of the area using UAVs - the method of laser scanning (Fig. 1, 2).

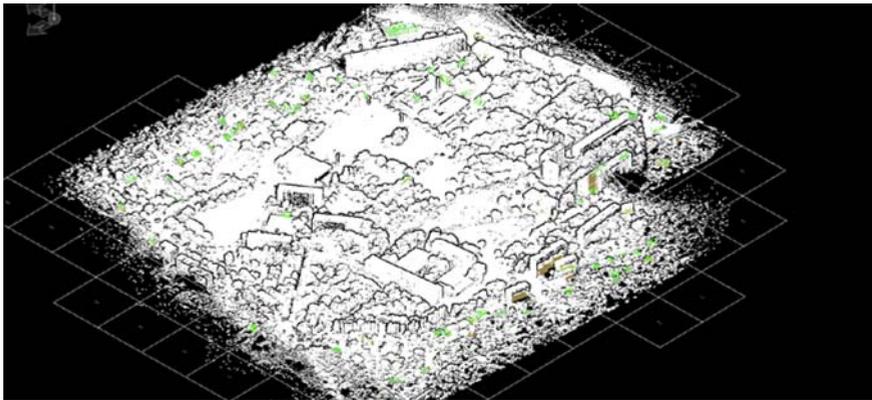


Fig. 1. An example of laser scanning of the terrain relief in black and white format.

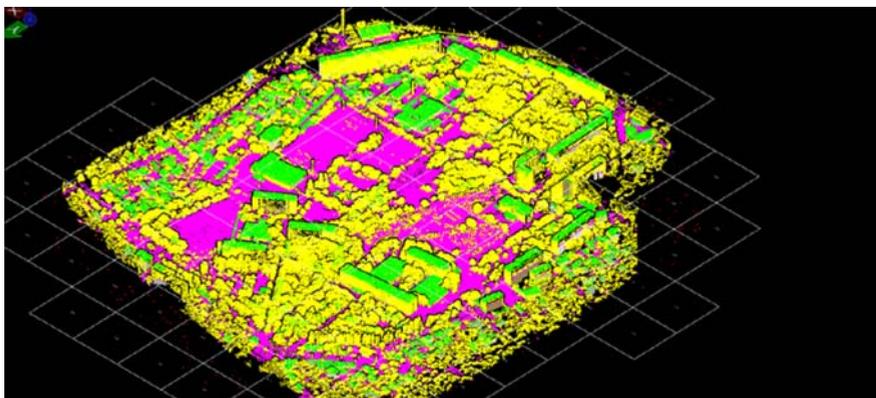


Fig. 2. An example of laser scanning of an area using a thermal imaging camera.

It also includes the function of detecting defects and anomalies in the studied area. This method is considered the most accurate when performing possible work with this sensor because detailing of the laser scanner is carried out using the latest equipment with high-quality characteristics. Thus, the method of laser scanning allows with maximum accuracy to determine the formed from snow hills, hollows, the level of water sources, which makes it possible to notice an increase in the water level in time and, prevent flooding or waterlogging [9].

One of the possible factors of an increase in the water level or tide is a malfunction of the city's utilities, such as storm canals, water towers, industrial and domestic wastewater discharge communications, etc. The human factor plays an important role here, without which I cannot imagine modern reality. Here, the aircraft, using aerial photography sensors, a thermal imager, video recording, etc., can determine defects resulting from wear, damage, or an initial design error. This method is necessary to replace engineering structures to avoid destructive situations that can be caused by the above possible indicators [10].

4 Further actions on the forecast and prevention of floods after the work of UAVs is done

First, it is necessary to mention that according to the town planning code of the Russian Federation, the drainage system is obligatory when designing settlements.

When choosing a drainage system, special attention is paid to areas at risk of flooding, and areas with difficult terrain, dense buildings, and heavy traffic.

The drainage system, arranged in cities, should be individual, based on the indicators of chemical analysis of the soil, the possibility of earthquakes, and the natural conditions of the territory [11].

After a detailed analysis of the required territory using a UAV and identifying the fact of a possible negative phenomenon associated with water resources, timely action must protect these lands [12].

Besides the proposed option for forecasting and preventing floods using aircraft, each country also has hydrological stations and posts, which are the main source of information in destructive processes associated with water bodies. In Russia, this service is represented by the Russian Federal Service for Hydrometeorology and Environmental Monitoring (Roshydromet), where the meteorological service is also located.

A convenient combination of the existing system with the proposed one is obvious. Thus, it is possible to improve the analysis of the required territory and timely warn the population and higher authorities about the emergence of unforeseen danger. The method has a high probability of not only preventing the negative impact of possible disasters but also saving the lives of the population [13-15].

Regarding operational actions to eliminate the alleged flood, there are several ways. For example, if the situation relates to a reservoir and a large pressure on the main structure, then concrete slabs with a strength of at least M-500 are installed, which allows preventing the destruction of the main structural element of the object in a short time. If the rise in the water level is caused by heavy rainfall, which storm sewers cannot cope with, then there is a possibility of drainage using prepared hollows for artificial reservoirs, where special services can organize the flow of excess rainfall [16].

5 Conclusions

Having analyzed such a negative phenomenon as a flood, we can conclude that usually floods occur both through the fault of man and nature. On the one hand, society cannot cope with

nature and control it as a program in a computer system, but people can prepare much for possible destructive factors, having a huge technical potential.

Nowadays, floods are caused by the illiterate design of engineering structures and delayed actions to protect against natural phenomena.

In this paper, several proposals were made for the modernization of the existing system, which is possible for every country in the world.

Society should be in comfortable, and therefore - protected conditions for each person individually. The future life and sustainable development of the entire planet depend on this.

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