Journal of Young Scientist, Volume VII, 2019
ISSN 2344 - 1283; ISSN CD-ROM 2344 - 1291; ISSN Online 2344 - 1305; ISSN-L 2344 – 1283

ASSESSMENT OF ECONOMIC FLOOD DAMAGE: A CASE STUDY IN SWITZERLAND

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Abstract

Floods remain one of the major causes of natural disasters affecting society. The consequences of floods to man on a world wide scale have been well documented. Damage assessments of natural hazards supply crucial information to decision support and policy development in the fields of natural hazard management and adaptation planning to climate change. Thus, in this paper we want to bring to the forefront the modern monitoring tools, such as drones for image acquisition and data processing software to possible flood-affected areas, and an economic assessment of the losses due to them.

***Keywords**: economic evaluation, flood damage, Pix4D Software, UAV.*

INTRODUCTION

Worldwide, there is a need to enhance our understanding of vulnerability and to develop methodologies and tools to assess vulnerability. One of the most important goals of assessing coastal flood vulnerability is to create a readily understandable link between the theoretical concepts of flood vulnerability and the day-to-day decision-making process and to encapsulate this link in an easily accessible tool.

Damage assessments of natural hazards supply crucial information to decision support and policy development in the fields of natural hazard management and adaptation planning to climate change. Specifically, the estimation of economic flood damage is gaining greater importance as flood risk management is becoming the dominant approach of flood control policies throughout Europe (Merz et al,. 2010).

This study deals with an assessment of flood vulnerability zones in the West part of Switzerland by using a hydrological technique based on some measurable physical characteristics of flooding and vulnerability factors. This area is predisposed to floods, due to leakage from the slopes in case of torrential rain or appearance of a break of the river La Glanefrom the vicinity of city La Pierraz and Romont. An image from that area can be observed in figure 1, when a main road between Vaulruz and Romont was closed because of flooding and several smaller residential roads were also impassable, on the 12 December 2017, according to National News, worldradio.ch.

Figure1. The main road between Vaulruz and Romont

MATERIALS AND METHODS

In order to acquire the images an eBee Classic drone was used (Figure 2) with a SenseFly S.O.D.A sensor. The SenseFly S.O.D.A. is the first camera to be built for professional drone photogrammetry work. It captures amazingly sharp aerial images, across a range of light conditions, allowing you to produce detailed, orthophotomaps and ultra-accurate 3D digital surface models (Figure 3).

Figure 2. SenseFly eBee Classic

Figure 3. SenseFly S.O.D.A.

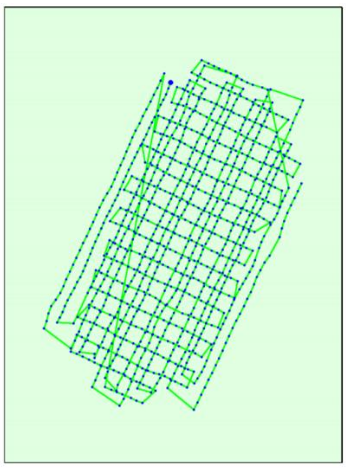

Figure 4. Top view of the initial image position.

The fly was made on the 20 November 2018. The surface targeted it was about1.335 km2 / 133.4981 ha. 1075 images were taken, the average Ground Sampling Distance (GSD) was 3.77 cm, and the time of the fly was 45 m and 21 s. So, according to the flight plan, the drone route it can be analyse in fig. 4. The green line follows the position of the images in time starting from the large blue dot.

The pre-flight plan it was made in Pix4Dcapture application, where it's set all the parameters of fly.

After taking all the pictures, the orthophotomap and the digital field model was drafted with the help of the software Pix4D in cloud. These images are available on the official site of SenseFly in educational purpose. When the orthophotomap is ready, we create 3D model, the elevation and the surfaces.

This software enables data processing online, precisely to be as user-friendly as possible due to the needs of the PC and a dedicated video card that is not so affordable. Pix4D is an image processing software from drones and UAVsand allows to plot orthophotomaps and digital terrain models in on-line cloud with Cloud and local processing. Pix4D offers a 15-day trial of the product after which it can be purchased as a subscription.

RESULTS AND DISCUSSIONS

In the next figure it can be seen the digital model of the field in 3D version and with the determination of the elevation. So, we can see a level difference of 269 m between higher point, which was positioned on the hill at 1123 m, and the lowest point of 854 m altitude. This lowest point was positioned at the level of house construction and this is the reason of the lightly flooded area. This level differences put in danger approximate 85 houses and historical buildings from Romont, Switzerland (Figure 5).

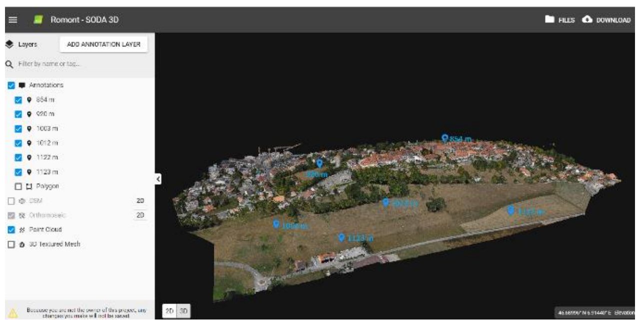

Figure 5. Digital Terrain Model (DTM)

According to plan 2D shown in figure 6, it can made determination of the real estate vulnerable to floods. With the orthophotomap and 3D model of fields it can be observed the houses, public buildings, historical monuments, roads, electricity network, agricultural areas which belong to the landscape. So, according determinations of altitude, it's confirmed that this city is into a valley and it is vulnerable in case of torrential rain.

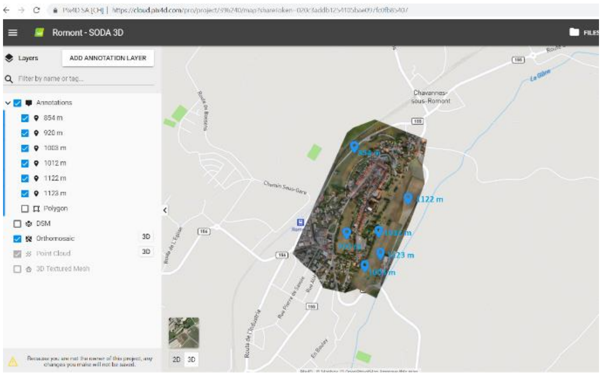

Figure 6. The determination of the quota and surfaces

In the next figure was determinate the limits of the flood areas. The vulnerability area has been divided in three zones with differential economic assessment: the first area of 17,3 ha includes agricultural lands, the second area of 15,33 ha includes historical monuments and public buildings like markets, church, hall and the last one includes houses (Figure 7).

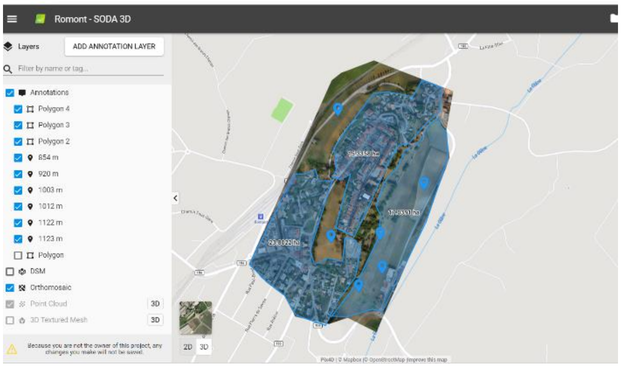

Figure 7. Evidence of the 3 vulnerable areas

Damage assessment and the cost of recovery from floods:
Area I – 17,03 ha: approx. 23.000 euro;
Area II – 15, 33 ha: approx. 120.000.000 euro;
Area III – 23,80 ha: approx. 740.000.000 euro.
The prices are approximative and are based on the work performed in the same situations in Europe. These approximations are made with the help of the contracts from the halls and the mass-media. These works include the drain excess of water, rehabilitation of roads, consolidation of buildings, house painting and other refurbishment works following the withdrawal of water.
UAVs are operationally more versatile and visible compared to land-based approaches or other aerial methods, such as manned aircraft and satellites. Conducting atmospheric measurements in remote locations is one situation where the use of small, lightweight UAVs is of particular benefit (Popescu et al., 2017). In fact, the reduced size, weight and power needs of these flying robots, along with the reduced cost of the platforms and instrumentation, make them highly suitable for these operations (Trif et al., 2018; Villa et al., 2016). So, with the help of them we realized the numeric model of the land and on this based we determinate: quota, surface and we delimited the vulnerable areas for floods, in a simplified way, precise and in a short time with the help of GIS instruments and functions of the program Pix4D.

CONCLUSIONS

The number of hydrological (flood, mass movement), meteorological (tropical storm, extratropical storm, convective storm, local storm), climatological (extreme temperature, drought, wildfire) and geophysical (earthquake, tsunami, volcanic activity) events continue to increase in the last decades at global level (Vîrsta et al., 2007).
The assessment of direct economic damages can be divided into three steps, each having potential for improvement. The classification of elements at risk is mostly based on economic sectors with different detail concerning subclasses within a certain sector. These classifications describe only a rather limited share of the variability that is observed in damage data. Moreover, they are not based on objective and/or statistical classification methods. Expert knowledge and conditions of the damage assessment currently determine the details of classification and the actual derivation of class boundaries. A future research direction is the development of classification schemes which are less subjective. Further, it should be investigated under which conditions classification schemes are advantageous which are more oriented towards damage mechanisms. An open question in the classification step is the use of sectoral versus object-specific approaches.
A single large industrial plant can incur direct damage that exceeds that of nearby dwellings

and other commercial operations by orders of magnitude. Such large variability in industrial damages might suggest the use of synthetic damage functions, using questionnaires or expert opinions for the individual assessment of damage potentials at every industrial plant. However, this approach is not feasible for damage assessments in large areas. Besides, it has been shown that uncertainty in damage modelling decreases with increasing areas and numbers of affected objects, since outliers lose their importance (Merz. et al., 2004).

As a recommendation for the avoiding floods in cities can be cleaning, deepening, or making, where it's not, rainwater collection ditches; creating the basins for the flood water; maintenance of land improvement works; protection of shores and dams.

The Earth Observations data offers the capabilities to monitor the disasters at a large scale, being able to identify areas where the events are not in-situ observed or to monitor large vulnerable areas potentially affected by disasters (Stancalie et al., 2016).

It's recommends applying modern methods of image acquisition and processing the date where are used the drones and software for the determination of the digital land model. On that base we can make a lot of measurements and observations.

ACKNOWLEDGEMENTS

This study represents a part of our license which will be presented next year. Also, we would like to thanks Sense Fly and eBee, for the all free dataset that we downloaded from their official web sites in educational purpose.

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