TOURISMOS: AN INTERNATIONAL MULTIDISCIPLINARY JOURNAL OF TOURISM
Volume 11, Number 5, pp. 153-163
UDC: 338.48+640(050)

REFUGEE ROUTES AND COMMON RESOURCE POOLS IN TOURISM AREAS: THE CASE OF LESVOS ISLAND, GREECE

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Lesvos is a Greek island that during 2015 experienced the largest refugee crisis the country has ever witnessed. Refugees arriving to the island in groups totalling over 1.000.000 passed through the island. The current project using a UAV sought to identify the routes of refugees passing through tourism areas of the island and the possible impact these routes had on the development of these areas. Furthermore, the preservation of the common pool resources of these areas is a vital issue for the well being of local communities and the enchancement of their spirit of welcoming the refugees. An automated system used to inform local authorities about areas polluted by the mass movement of people is presented in this paper.

Keywords: *UAV, CPR, Tourism, Refugee Crisis, Sustainable Tourism*

INTRODUCTION

"*To be rooted is perhaps the most important and least recognized need of the human soul.*" (Weil, 2001) Ever since the beginning of mankind, populations moved around the globe either intentionally or under violence (Malkki, 1992) whose (violence) cause does not vary extensively but is rather limited to war zones and military regimes (Loescher, 1993). These populations while on the move need all the resources a person might need to survive and cover Maslow's basic needs.

Water resources, air resources, flora and fauna as well as irrigation systems consist the conventional types of Common Pool Resources (CPRs) used both by locals, tourists (Briassoulis, 2002) and nowadays refugees. CPRs, within the framework of sustainable development, need to be used with caution in order to preserve availability for future generations (Bromley, 1991).

The human pressure as defined by Helbing et al., (2007) involving factors like spatial location, time, estimated density and motion can be critical regarding the over exploitation of CPRs and automated systems need to be employed to alert local authorities and prompt them to take actions to prevent further surcharge.

The need to investigate whether the recent refugee crisis in Greece and particularly Lesvos, which was the main gate for refugees in European Union, burden island' s CPRs, led to the design of an automated system. This system, once given UAV data, proceeds with counting objects (people in particular), follows their route and identifies environmental and human pressure on the areas in the route.

LITERATURE REVIEW

Refugee Crisis

Greece is highly linked with refugees ever since the 19th century as the country was an attractive destination for them. However, 2015 was the peak year for the refugee crisis, since the war in the former Yugoslavia, as over 1.000.000 refugees and migrants wishing to survive war, passed by sea to Europe, mainly Greece and Italy. More than 3000 people were drowned, whereas in October 2015 alone (Fig. 1), more than 135.000 people reached Lesvos (Gkionakis, 2016; Clayton et al., 2015).

Refugees fleeting from Syria negatively affected the country in politics, economy and environment. Soil degradation, liquid pollution and litter are some of the main consequences an area faces when dealing with a refugee crisis (Francis, 2015; Clayton et al. 2015; Gomez, 2010).

Unmanned Aerial Vehicles (UAV)

Unmanned Aerial Vehicles (UAV) have been used within the last decade in a plethora of applications thus making them cutting edge equipment for several sciences. Some of their advantages include covering areas with limited access, covering larger areas, identifying objects in areas where access is impossible (i.e., bottom of a river) etc. Lately, they have been used for agricultural purposes, gathering meteorogical data or monitoring natural disasters, post - disaster assessment, environmental management (Oluibukun et al., 2017; Ezequiel et al., 2014).

Lesvos Island

Lesvos island is a destination that never managed to create a branding despite the fact that it is suitable for the development of Special Interest Tourism (SIT) (Chatzigeorgiou et al., 2009). The large numbers of refugees created several environmental consequences. Just the number of life jackets made from non recycling material reached a volume of 16.000 m^3 in April 2016. Refugees are accommodated either in camps or hotels and there are no longer water supplies available at the area (Chtouris, 2017).

RESEARCH METHODOLOGY

Focus Area

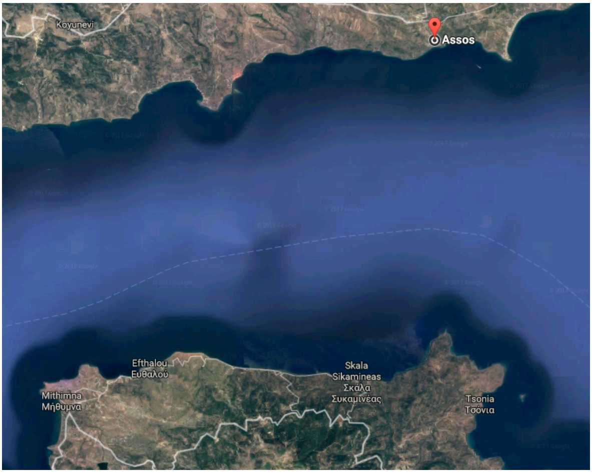
Research focus area included Mythimna, Eftalou, Skala Sikamineas, well-known tourism areas of Lesvos island. The specific spots were used as the main gates to Europe due to their proximity to Turkey. They are across Assos area of Turkey, the main gathering point of the biggest percentage of refugees (see Figure 1). A UAV was used to cover this area and images were collected from beaches where large numbers of refugees would arrive daily with boats. A second set of flights took place from Skala Sikamineas towards the port of Mytilene. The UAV covered several parts of the route capturing images divided every 7 to 10 kilometers.

Covering these areas produced the routes the refugees followed to arrive from the point the boat left them to the port of Mytilene.

The imagery gathered was used to identify boats on the beaches, groups of people moving from point A to point B and potential impact on CPRs of the area or environmental pollution.

At the end stage of data delivery, image downloaded were used to train a machine where the imagery was uploaded to identify potential arrival of refugees or overexploitation of CPRs to inform the local authorities and urge them to take action so as to prevent further negative consequence on the areas studied.

Figure 1. Focus Area



Aerial imaging workflow requires the following stages (Ezequiel et al.)

Flight Planning and Data Acquisition

To digitally map the focus area, an ultra lightweight (1.28kg) Unmanned Aerial Vehicle was used, powered by four brushless motors, with arm span of 0.5m, equipped with 12 megapixel, length of f/2.8 mm and 4K camera, GPS/GLONASS (see Table 1, Figure 2).

A flight plan was initially designed in order to automate the route the UAV would follow and calculate the required flight time as well as the total number of aerial images taken. Open source code was used (Mission Planner) to implement the flight plan.

Targets with known coordinates were used as monitor points for the quality control of the delivered data.

Table 1. UAV Characteristics

Aircraft	Specs
Weight (Battery & Propellers Included)	1280 g
Diagonal Size (Propellers Excluded)	350 mm
Max Ascent Speed	5 m/s
Max Descent Speed	3 m/s
Max Speed	16 m/s (ATTI mode)
Max Tilt Angle	35°
Max Angular Speed	150°/s
Max Service Ceiling Above Sea Level	19685 feet (6000 m)
Max Flight Time	Approx. 23 minutes
Operating Temperature Range	32° to 104°F (0° to 40°C)
Satellite Positioning Systems	GPS/GLONASS
Hover Accuracy Range	Vertical: ±0.1 m (with Vision Positioning) ±0.5 m (with GPS Positioning) Horizontal: ±0.3 m (with Vision Positioning) ±1.5 m (with GPS Positioning)
Camera	

Lens	FOV 94° 20 mm (35 mm format equivalent) f/2.8 focus at ∞
Image Size	4000×3000
Photo	JPEG, DNG (RAW)
Video	MP4, MOV (MPEG-4 AVC/H.264)

Source: http://www.dji.com/phantom-3-pro

Figure 2. UAV - Phantom 3

Data post Processing and Data Delivery

Aerial imagery was collected upon landing and downloaded on GCS. Imagery processing involves definition of image scale, image cropping, image conversion to 8-bit grayscale, filter application, background removal and conversion from pixels to SI scale. An optimised algorithm Random Decision Forest (RDF) was used to identify life vests, boats and people (Park, et al., 2016).

The process to identify vests and boats included the following stages: To begin with, UAV data were acquired and preprocessed to identify the objects on the imagery downloaded from the camera. The second stage was devoted to feature selection followed by the classification of the imagery and finally the assessment of the accuracy.

Samples taken from the imagery were used to train the Random Forest algorithm and use it to classify the objects. Breiman (2001) proposed Random Forest as an efficient learning method comprising of different classification and regression (CART) classifiers.

A percentage of 2/3 of the total training sample will be designed according to Bootstrap strategy with replacement aiming at reducing the generalization error. Out-of-bag (OOB) data is the remaining 1/3 of the sample used to cross validate and evaluate the RDF. The classes chosen for the classification were life vests, boats, sand, water, vegetation and human.

According to classification results, RDF's performance reached an accuracy percentage of 89.6%.

RDF Technique was also used to identify the boats on the beach, people moving in groups from one point to another and spots of pollution.

RESULTS AND DISCUSSION

Unmanned Aerial Vehicles (UAV) are intensively used to acquire aerial imagery aiming at monitoring, protecting, managing or assessing a vast range of issues. In this present study images acquired were used to identify both people and objects and in particular life vests and spots of pollution on refugee routes on Lesvos island.

Imagery acquired where then used to train a machine and assess the data uploaded so as to inform the local authorities for a potential arrival of refugees on the spot or over exploitation of Common Resource Pools or even the creation of pollution and urge them to take action and prevent further damage.

The AGS technique used to identify the boats, the vests and the people in combination with RDF algorithm provided valuable and reliable products useful for risk assessment and management particularly in areas with tourism development where the environment is of crucial importance for the destination and the local communities.

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