Management Zones delineation in olive grove using an Unmanned Aerial Vehicle (UAV)

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Abstract. The use of aerial photos taken in a low altitude with UAVs (Unmmaned Aerial Vehicles) is recently becoming a common practice in many areas. The use for agricultural related applications is applied in this study, using a common vegetation index, namely NDVI, to identify areas of large differences in crops grown in order to delineate Management Zones to be eventually used for Precision Agriculture applications. A UAV equipped with an infrared camera was used to develop maps of NDVI in an olive grove along with ground measurements of NDVI, to provide ground truthing information. The results were used to identify areas of small or large differences and to establish Management Zones (MZs) for further evaluation and application of precision agriculture inputs.

Keywords: UAV (Unmanned Aerial Vehicle), NDVI (Normalized Difference Vegetation Index, Management Zones (MZs), remote sensing, ground truthing, olive grove, vineyard, Precision Agriculture

1 Introduction

The first step in application of Precision Agriculture's (PA)methods is to evaluate if any significant "spatial" and "temporal" variability exists in the farmer's field. This results to establishment of digital maps and delineation of Management Zones (MZs) for important soil and crop properties affecting growth and productivity. The technologies developed and become commercially available in the in the last ca.20 years, provided tools to achieve this evaluation. In addition and in the recent years, a new tool became available, the use of unmanned aerial vehicles (UAVs) which has extended to many applications such as agricultural management, civilian applications, homeland security, forest fire monitoring, quick response surveillance for emergency disasters et al. This preliminary study attempts to combine "aerial sensors" to facilitate delineation of MZ in a recently established olive grove.

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2 Materials & Methods

The study area is located at the premises of the American Farm School, Thessaloniki Greece and includes a recently established olive grove, where high and super-high density systems adapted for mechanical harvesting are evaluated in a long-term assessment. A UAV (Figure 1) equipped with a camera with R-G-B-NIR filters and a GPS for georeferencing the pictures, was used to obtain the NDVI (Normalized Difference Vegetation Index) data. In addition a hand help NDVI sensor (Trimble® GreenSeeker) was used to measure NDVI at ground level, to provide similar "ground" data for correlation with the "aerial" values.

Fig 1. The UAV used for the study to obtain "aerial" NDVI data.

Fig 2. The hand held sensor use to obtain NDVI data at "ground" level.

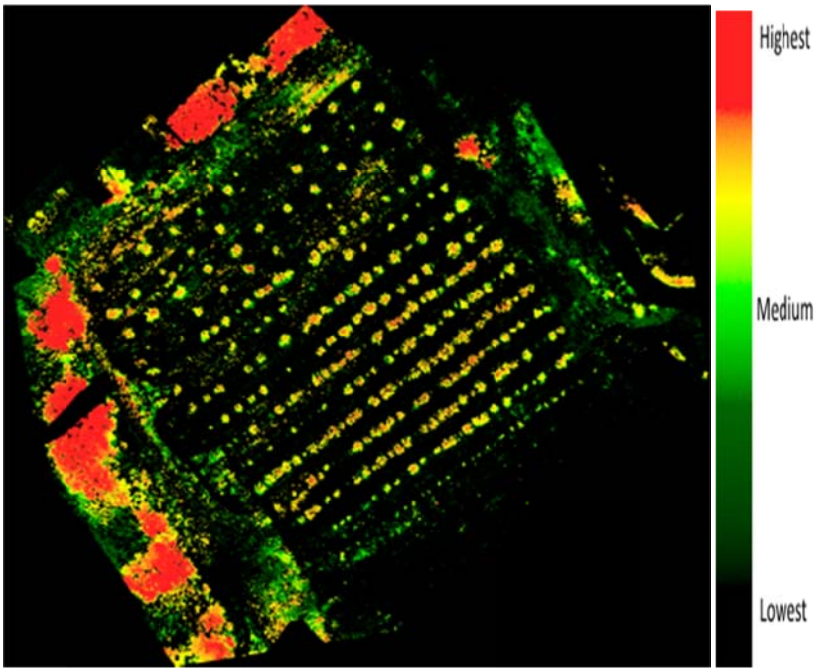

Fig. 3. The NDVI range of the entire olive grove- data by UAV's camera

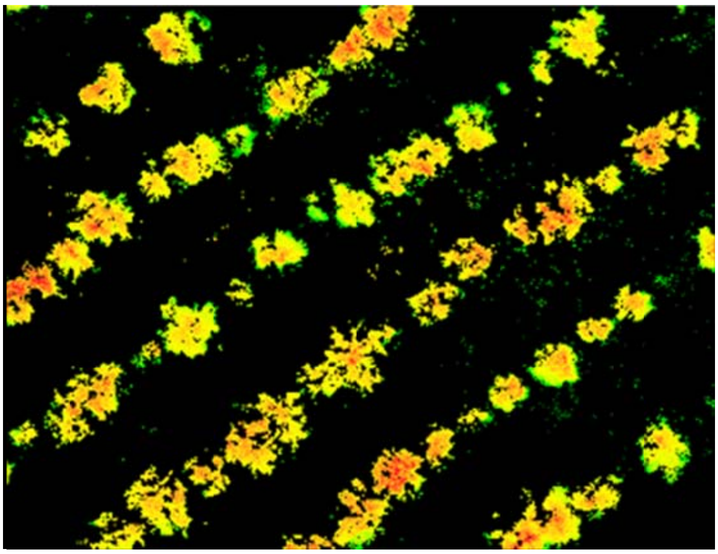

Fig. 4. A selected portion of NVDI from olive trees – data by UAV's camera

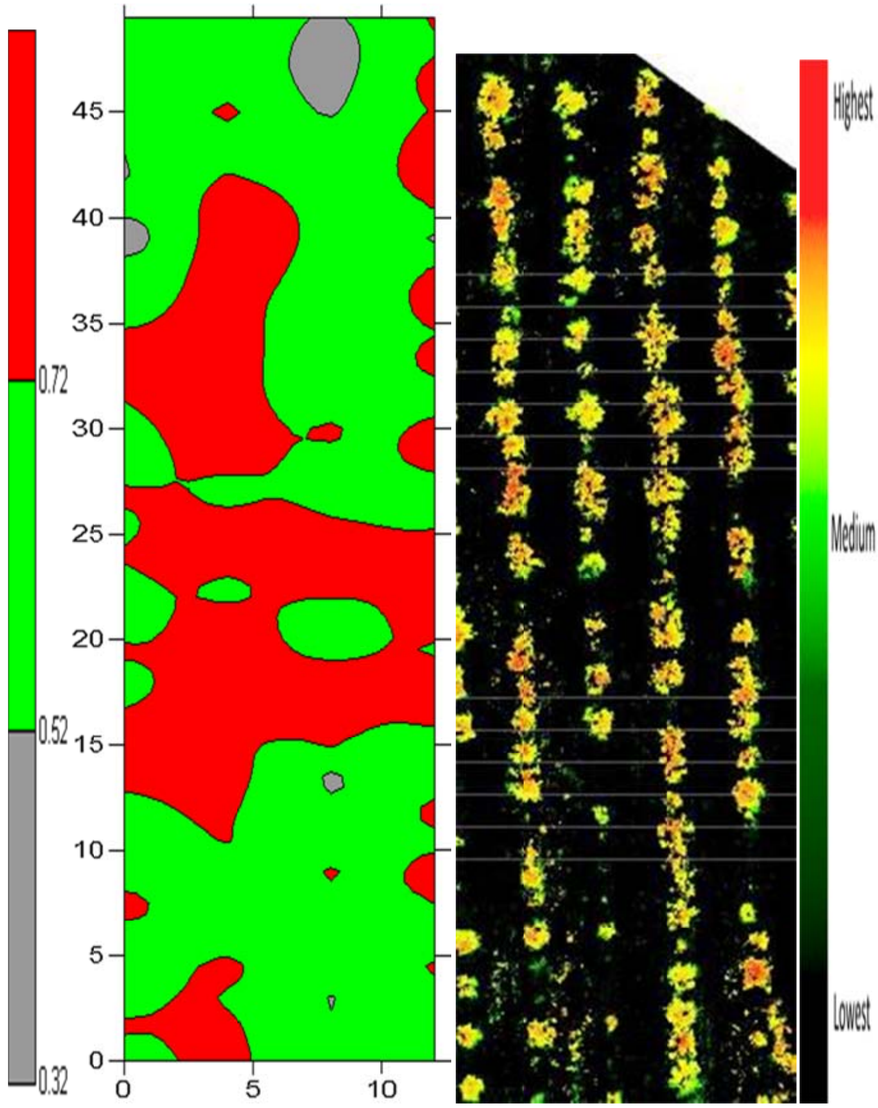

Fig. 5. The NDVI of the selected area shown in Fig.4 in the olive grove, measured using the ground NDVI sensor.

3 Results & Discussion

The aerial data are shown for the entire olive grove in Fig. 3 and for a small selected section, magnified, in Fig. 4. The ground measured NDVI of the selected area is

shown in Fig.5, where two distinct areas are visualized. These two areas appear to be similar with the more detailed NDVI values obtained from the UAV's camera. Further analysis of data will provide more close evaluation of the two MZ's established. The results from a general approach used – to facilitate extrapolation for farmer's use- to delineate MZ indicated that a combination of aerial and ground data can be used to provide a "manageable" size MZ. It is important to "think at the farmer's level" when designing MZ, especially considering the small size farm area at which most farmers exercise cultivations and other management practices. This study presents preliminary data, to evaluate "spatial variability". More data are in progress to further validate the "temporal variability" needed, in order to conclude the delineation of MZs on a time basis. The correlation was good for the olive grove section- partial data section used only in this report-, while there is no consistent correlation in the vineyard, due to inadequate database. Note: Data analysis of new datasets for both crop species, is under evaluation but not presented in this report, due to time constraints.
The ground data provided also in previous year measurement from the olive grove, indicated two very distinct areas of NDVI (Gertsis et al. 2013). Candiago et al. (2015) demonstrated he great potential in terms of speed, cost and reliability, of high resolution UAV data, combined with additional photogrammetric methods. Bendig et al. (2014) used UAV for estimating crop biomass, another area of important application. However, none of these studies had the aerial NDVI to be correlated with ground NDVI data, to provide a means of comparison. In general, there is a gap in validation studies for remote and ground data; therefore, more work is required on this subject, to provide simple and reliable means of delineating MZs at farmer's field level with either aerial or ground sensors.

4 Conclusions

The use of UAV's is currently applied in many areas of interst with a exponential increase of uses. Particularly the applications in agricultural production and environmental studies indicates a high prospect of significant contribution; however, the use of data provided by UAV's should be coupled and validated in most cases, by related data taken at ground level (soil-crop) in order to expand and verify the "extrapolation" to potential beneficial uses. This study is an example of such a "relational" verification. The study is in progress and more data are collected for further and more accurate validation data sets.

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