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Application of GIS in the study examining the utilization of natural vegetation as forage material, during a traditional transhumance route: The case of a route from the highlands of SW Macedonia to the lowlands of Thessaly, Greece

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ABSTRACT

Transhumance is an animal husbandry system based on the seasonal relocation of herds with the purpose of ensuring access to food across the seasons. In Greece, seasonal relocation of herds and people was taking place along particular routes that meet certain conditions pertaining to the convenience and safety of people and animals on route. Nowadays, this traditional type of relocation is no longer so prevalent and whilst its cultural character has been investigated and documented, there still remains the question whether nowadays it can sustain the stockbreeders and their herd in their relocation. To answer this question, this paper tracks the movement of a herd in the geographical space and correlates its progression with the natural energy (vegetation) contained therein. GIS (Geographic Information System), orthophotographs, observations and narrative interviews are used for the collection and verification of data. Data-analysis based on simple formulas of range science with the objective of calculating the natural energy available along the route (i.e. forage material) has been carried out, and conclusions are reached regarding the ability of the route to sustain herders and their flocks in their seasonal movement. The paper aims at showcasing the traditional seasonal relocation practice (transhumance) not as a historic and (quite possibly) outdated ('archaic') method but as part of a modern and efficient husbandry system that utilizes another green source of energy with many benefits for the stockbreeders, the herd and the environment.

1. Introduction

Transhumance constitutes a husbandry system based on the seasonal movement of livestock that permits optimum exploitation of existing resources by distributing grazing between winter pastures (lowlands, more southerly latitudes) and summer pastures (highlands, northerly latitudes) (Ruiz & Ruiz, 1986). It is practiced in many countries, adjusted to the climate conditions of each area and the cultural identity of the relocating populations. A great number of studies described transhumance in Europe (p.e. Davies, 1935; Evans, 1940; Edwards, 1942; Matley, 1970) and the specific area of Mediterranean (p.e. Aitken, 1945; Ruiz & Ruiz, 1986; Cleary, 1988; Pardini & Nori, 2011; Laga et al., 2012; Oteros-Rozas et al., 2013; Ntassiou, 2014), in Africa (p.e. Adriansen, 2008; Nyssen et al., 2009; Sulieman, 2013; Shittu, Galtima, & Yakubu, 2016), Asia (p.e. Coughenour, Behnke, Lomas, & Price, 2008; Aryal, 2010), America (p.e. Huntsinger, Forero, & Sulak, 2010; de Abreu, McManus, & Santos, 2010) and Australia (p.e. O'Connor, 2004; Cameron & Spooner, 2010). In Greece, herds that are reared this way are moved from lowland pastures to highland grazing areas and vice versa each year (in spring and autumn, respectively) so as to utilize different grazing areas across the seasons (Chang & Tourtellotte, 1993; Sivignon, 1968).

From the end of the 20th century, transhumance has been in decline in the Mediterranean mountains (Ruiz & Ruiz, 1986; Cleary, 1988; O'Flanagan, Lasanta, & Paz Errea Abad, 2011), including Greece (Karamanes, 2011), and seems to be both misunderstood and deprived of its intrinsic historical interest (Cleary, 1988). This decline has resulted in the loss of traditional management practices (Morán-Ordóñez, Suárez-Seoane, Calvo, & De Luis, 2011) and other elements connected with these practices such as the traditional manner of relocation of transhumant flocks and men, on foot. This method of transportation tends to become a characteristic of a bygone era and is seen as an

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element of the intangible cultural heritage (O'Connor, 2004; O'Flanagan et al., 2011; Meini, Adducchio, Ciliberti, & Di Felice, 2014; Ntassiou & Doukas, 2016). Most herds are currently transported by trucks, in an effort to save time. However, transhumance has been proven a remarkable method for preserving forage, increasing biodiversity, and improving the quality and structure of the landscape (Ruiz & Ruiz, 1986). Consequently, efforts are made for it to be restored in the preferences of modern herders (O'Flanagan et al., 2011).

Indeed, so far, research into the effect of transhumance on pastoral ecosystems has yielded useful conclusions on the effect of animal grazing on plant species richness (Aryal, 2010) and the foraging behavior of animals (Papachristou, Platis, & Nastis, 2005). There remains the question whether the transhumant route can provide enough forage material to sustain the herd.

To answer the question, this paper looks into one of the traditional transhumant routes, calculates the available forage material across its length, and compares it to the volume of forage necessary to feed an average herd of 1000 animals. Based on the findings, a discussion is held on the efficiency of the transhumant route to meet the needs of one (or more) herds. Limitations and future research ideas are also discussed.

The investigation is carried out with the help of simple rules of range science in combination with an (appropriately adjusted to the case) Geographic Information System (GIS) that is equipped with spatial analysis and data management tools. From the perspective of range ecology, the spatial distribution of stock is interesting because a high spatio-temporal variability in natural resources can be exploited by moving livestock around in the landscape (Adriansen, 2008). However, since the purpose of the study is limited to a general assessment of the situation, the methodology applied is simplified and in no case can it replace the experiments and field work methods used by range science.

GIS plays an important role in this research, as transhumance develops in the geographical space and is described using geo-spatial data. GIS has proved useful in the investigation of routes (Ntassiou, 2014; Shittu et al., 2016) and the identification of their cultural-historical character (Meini et al., 2014; Ntassiou & Doukas, 2016). In combination with remote sensing, GIS is a powerful tool in evaluating the effects of grazing on forage quantity and quality in a free ranging area (Kawamura & Akiyama, 2010). This paper uses GIS to assess the available quantity of forage material -but not the quality thereof-along a typical traditional transhumant route so as to conclude whether it can sustain the herd.

2. Reasoning, methods and data

2.1. Generally

The type and availability of forage on opposite sides of the transhumance route axis is an important – if not the most important - factor in the stockbreeders' decision to follow a route and may also determine the duration of the journey (Ntassiou, 2014; Ruiz & Ruiz, 1986). As the herd is fed by grazing, good quality forage material at different locations of the route may keep the herd at that location. On the contrary, lack of appropriate vegetation and/or the existence of agricultural plots may accelerate the movement of the livestock (Ntassiou, 2014).

The herd must also be watered and the herders must be able to sell their products or buy provisions. This means that the herd takes advantage of springs or rivers and that it stays close to villages along the way. Characteristic for the traditional Greek transhumance, are the predetermined traditional axes of the routes and the overnight stay or resting places known as “konakia” (Wace & Thompson, 1989). A konaki[1] was established at locations along the route that meet the conditions relating to the availability of spring water and wood (to start and keep a fire) and offered safety.

Using an appropriately adjusted GIS that utilizes descriptive and spatial information for a particular transhumant route, in combination with range science principles, this paper examines a traditional transhumant route that is still followed by herds today. Its historical and contemporary character is documented by witness accounts (interviews) and personal observations made by an author of this paper, when she accompanied a herd in its full journey from the summer to the winter pastures. During this journey, the route that the herd takes and the width of the area where it forages (buffer zone) are recorded. The surprising width of these routes is not due so much to the technical difficulties involved in controlling livestock, but rather to provide sufficient pasturage during the long migrations (Aitken, 1945). By appropriately determining the width of the buffer zones, conclusions can be reached regarding both the impact of the herd's movement on the landscape and the impact of the landscape on the herd's efficient grazing. The data are inserted in the GIS, thereafter the surfaces from where the herd passes and the forage material contained therein are calculated.

Based on the forage material that is available in the zone of transport, conclusions are reached regarding the number of herds that can be fed from this particular route.

2.2. Study area

The paper examines the ‘Perivoli – Argyropoili’ transhumant route (see Fig. 1).

The starting point (latitude: 39°56′20″, longitude: 21°5′41″, altitude: 1860m) is a peak of the Pindos Mountain Range (the “Augo” area), in the Perivoli land district, South-Western Macedonia (Fig. 1). It is a forested area, rich in exploitable coniferous wood (mainly black pine), and deciduous trees (beech and oak trees). The climate of the area is transitional from Mediterranean to continental, with high rain frequency, cold winters and relatively warm summers.

The destination (latitude: 39°49′50″, longitude: 22°18′26″, altitude 200 m) belongs to the land district of Argyropouli (Fig. 1). It is a village of Thessaly, a fertile plain area that constitutes the winter pasture of choice for many herds of the mountainous Western Macedonia (Chang & Tourtellotte, 1993; Sivignon, 1968).

This is one of the many different transhumant routes followed by the herds of the wider area of SW Macedonia to winter pastures, as recorded in a recent study (Ntassiou, 2014).

The ‘Perivoli (“Augo” area) - Argyropouli’ route coincides with the historical route that connects the wider Tyrnavos area (in Thessaly) with Grevena and the Northern Pindos mountain range, throughout the period of the Turkish occupation in Greece (Wace & Thompson, 1989). Nowadays, some seasonal-moving livestock and their breeders follow the same traditional route either for reasons of tradition or for financial reasons, to save on the truck transportation expenses and the cost of feeding.

2.3. Cartographic material and geographic background

The software package used for the creation and operation of the GIS is ArcGIS 10™. This application was used for all data analysis and processing, producing a geo-database.

The cartographic and geographic background consists of:

- 12 historical maps of the US Army (from the 1953–1955 period) at a scale of 1:50,000. These maps are characterized for the sharpness of

[1] konaki” (plural: konakia) means: a location where the breeders choose to establish a makeshift camp for overnight stay or for resting during the seasonal relocation of their livestock and families. It is suitable for carrying out all duties relating to the management of the herd (milking, cheese making, etc.) (Ntassiou, 2014).