Exploring Traditional Routes of Seasonal Transhumance Movements with the Help of GIS. The Case Study of a Mountainous Village in Southwest Macedonia, Greece

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Abstract: Transhumance is a traditional livestock system with the historical origin of many centuries. The seasonal migrations of flocks and people, in Greece and elsewhere, were held at predetermined paths and area-specific tactics. This paper explores the traditional transhumance routes between highlands of southwestern Macedonia, Greece and lowlands of either Macedonia or Thessaly, by adopting modern geo-informatics-tools, such as GIS. The adopted technology provides a powerful tool to visualize the traditional routes, to analyze the characteristic elements of each route, and to determine the criteria involved in the selection. The ultimate goal of this work is to bring out the traditional way of transhumance, not as a historical–museum piece of information but as an efficient farming system that (with the proper technological assistance) can be explored and applied by modern farmers, towards establishing an efficient and sustainable animal husbandry system.

Keywords: Geoinformation systems, GIS, transhumant farming system, seasonal movements, transhumance, moving-livestock routes

1 Introduction

Transhumance is a common practice of animal farming operating in Greece and other European countries for several centuries (Ruiz and Ruiz 1986, Olea and Mateo-Tomás, P, 2009, Pardini and Nori, 2011). This system dictates the movement of flocks twice a year (spring and autumn) in order to find food (grazing areas) and get protected from harsh, seasonal weather conditions, such as cold winters and hot summers for the mountainous and lowland pastures respectively. This is part of the so-called "extensive farming", which is structured around free grazing animals and the use of natural pastures towards managing their annual and seasonal variation in productivity (Gomez Sal, 2000, Laga et al, 2003, Aryal, 2010). The historic paths of movements of both flock and people are used even today with much less intensity in

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terms of number of animals and flocks. The overnight positions (stops) or rest areas of these routes, already defined from the past, known as "Konakia" (singular: konaki, plural: konakia) reflect the nutritional needs of the livestock and the climatic and landscape particularities of the broader geographic area (Ntassiou, 2014). The animal walking paths as well as the stop areas should have to assure grazing (i.e. adequate forage production) and additional livestock activities such as milking, cheese-making etc.

The duration of the journey was estimated in number of "konakia" (stops, a kind of outdoor lodging), and not as a daily, walking distance. Konakia were usually located on open – non-forested areas (to eliminate wolf attacks), far from agricultural land (to avoid possible damage to cultivated areas) that as pointed out earlier assure food abundance and access to water. Apparently, there were several factors that were considered for establishing the temporal shelters of Konakia, that follow the rules of a well organized community, that might have been assessed over the years through a trial and error manner before assuming their current historic configuration (Ntassiou, 2014). Recent views consider maintenance of transhumance "on foot" as the most important factor, which can contribute to enhancing the adaptive capacity of agrarian societies to cope with global environmental change (Oteros-Rozas et al. 2013).

The current paper aimed to present the seasonal transhumance routes and define their characteristic elements in a broader geographical area as well as to explore the criteria used for the selection of both the route and the temporal overnight stop (rest) areas. To accomplish the above target we used a Geographical Information System that employs spatial analysis tools to collect, store and analyze information dealing with the geophysical variability of the environment.

As a case study we defined a transhumant route from a mountainous village of Southwest Macedonia to a lowland winter settlement in Thessaly. Specifically, we selected the mountain settlement Perivoli of the current Regional area Grevena, as a starting point for seasonal migrant flocks and farmers family and Argyropouli, Regional area of Larissa, as a winter destination. The route coincides with an important historical section of its path, which used to connect the wider region of Tyrnavos with Grevena and Vlachochoria of North Pindos (Wace and Thomson, 2009), throughout the period of the Turkish occupation Greece. Nowadays, some seasonal-moving flocks with their farmers do follow the same customary ('traditional') route. Thus, it is interesting to analyze the route both in terms of the axis and in terms of other characteristics (such as the location of konakia, vegetation and ecosystem types, etc.).

2 Data and Method

2.1 Oral Testimonies of Stock Breeders and Participant Observations

To reveal information regarding traditional transhumance routes, we developed a balanced questionnaire that was used to interview farmers who have systematically experienced the traditional practice of flocks' movement (Ntassiou and Tsotsos, 2014). Data were tape-recorded and additional information included by sources they were proposed by farmers.

In addition, to document a specific route we followed a flock during its fall transition from the highland area (Perivoli, Grevena) in the winter shelter (lowland area; Argyropouli, Larisa). During the tracking of this route, several representative positions of it were recorded (i.e. their corresponding coordinates) with the help of a GPS (Global Satellite Positioning System)-device (Series eTrex, of GARMIN™).

2.2 Cartographic Material and Geographic Background

The cartographic base which is used consists of 14 historical maps of the US Army (1953-1955 period). Features of this map-series are: (a). The sharpness of roads, trails, streams, rivers and water sources, either for the period to which they relate (aerial photographs, 1945) or for earlier years (b). The analytical names which often coincide with registered locations of «konakia» (Doukas et. al., 2015).

The software package ArcGis10™ was selected for the entry and processing of the available cartographic material, with the use of the Greek Geodetic Reference System GGRS 87 (EGSA 87) as the reference system for this research. The method of ground control points and the affine transformation was chosen for the georeference. Finally, map sheets were organized in directories (Raster Catalogs), so it is easier to use and edit them than each one separately.

For visualization needs of the geomorphology of the area, was considered necessary to create a digital terrain model (DTM). The 'Greek area' was downloaded from a NASAs website (ASTER GDEM[1]). This downloaded raster file underpins the creation of soil shading model, which sets the three-dimensional view of both, space and soil-slope maps.

The map-sheets and the digital terrain model are a part of a much bigger dynamic geodatabase which includes data network of moving farmers of the wider southwestern Macedonia-area (Ntassiou, 2014). The entities to be created and placed on the background are stored in the geodatabase in order to inform and enrich it with new data, whenever are available.

Finally, after the creation of the geodatabase in the software environment of ArcMap™ , there was the import of orthophoto-maps background (imagery) of the basemaps-collection, which enables the observation of objects in the contemporary geophysical space. In this way, a traditional route is provided in the contemporary space (with its effects emerging therein), while it is possible to observe the comparative data shown in historical American charts.

[1] http://asterweb.jpl.nasa.gov/gdem.asp

3 Results and Discussion

3.1 Recording of route and its overnight stay-positions (konakia)

Initially, the transhumant route and its konakia were recorded according to data derived from the oral testimonies of farmers. One of the narrators who experienced seasonal movement before the Second World War contributed to understand that the route path is not changed in time, but based on a tradition from which there was no possibility of deviation. In interviews attributed the detailed description of the routes and the toponyms of overnight stay-positions. Such information helped the final setting up of the route onto the geographical area (Table 1). The route was computed in time, based on the number of days that lasted an average movement.

Table 1. Route of transhumance and related 'konakia', from Perivoli to Argyropouli (duration 10 days)

Kiatra Lai (Perivoli area) - Tista (Ziakas) - Mavranaioi - Ag. Theodori (Vranes area) - Fountain Mustafa - Sioutsa - Lai - Kefalovriso - Aradosivia (Stefanovouno) - Argyropouli			
α/α	*konakia*	*α/α*	*konakia*
1	Fountain Exarchou	6	Lai
2	Tista (Ziakas) (Ag. Athanassios area)	7	Kefalovriso
3	Ag. Theodori (Vranes area)	8	Aradosivia (Stefanovouno)
4	Fountain Mustafa	9	Katatzol (Argyropouli)
5	Sioutsa		

3.2 Digital mapping of the route and konakia

The stopping-points (konakia) be identified on the map-background and digitized. Then, we proceeded with the tracking of the course and its setting up, according both to the roads (footpaths, etc.) shown in the older maps and the contemporary course, as well. The digitizing of the entire route resulted into an overall length about 135km. Thus, the length is an additional parameter to be taken into consideration, apart the duration (10 days). In order to provide spatial and descriptive information, the data formed properly, which obviously is important for the mapping and documentation of the route (Figure 1).

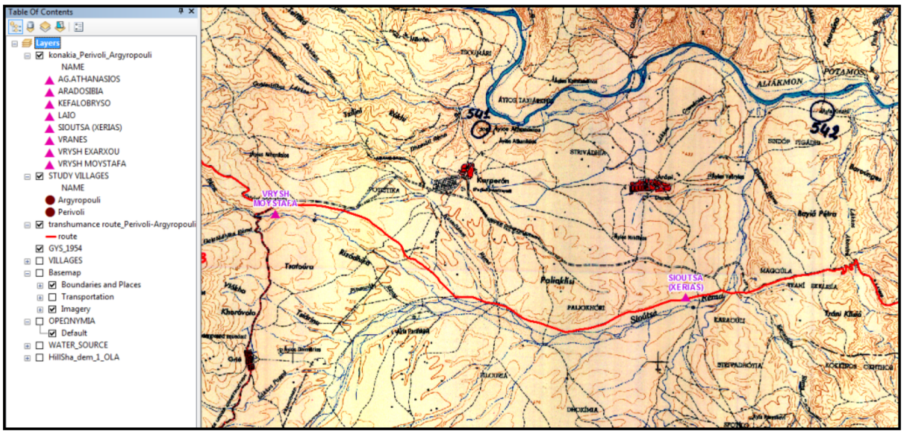

Fig. 1. The digitization of data in the cartographic base maps of the US Army (period 1953-1955).

3.3 Data processing and spatial analysis

By using the right tools of the GIS, there are feasible geo-processing and spatial analysis procedures that lead to miscellaneous conclusions on the traditional tactics of a move. For example, in certain zones of influence (buffer), that are created within the network of routes of flocks and stock farmers families (konakia-lodgings, route axes), the data contained in the respective surfaces can be analytically observed, whether they are digitized entities (settlements, founts, etc.) or part of the satellite image. Furthermore, the processing of data (concerning soil-surfaces, slopes, etc.), leads to the computation/creation of 'cost surfaces' used in finding optimal solutions for choosing routes or critical positions, in which an activity is under development.

3.3.1 Zones of influence

The course of a transhumance flock, by using the 'traditional' method, entails covering the nutritional needs, i.e. its appropriate grazing. The type of vegetation on both sides of the route-axis shows how apt is the path for food security, and accordingly determines the duration of the trip. In particular, good quality grazing at different points of the route decelerates the movement of the flock, as the optimum exploitation is desired. Conversely, the lack of appropriate vegetation or the existence of cropland is both acceleration factors for the movement of the flock. By defining appropriate 'zones of influence' in the GIS, conclusions are drawn about the effect of the movement of the flock in the landscape, as about the impact of the landscape on the efficient grazing for the flock. A zone-width of 300 meters either side of the route-axis demarcate the grazing area of the moving flock, a fact that allows the observation of vegetation and its interaction with the flock (Figure 2).

Around the konakia, areas of influence are formed, which include settlements, water founts or other points of interest. The number or type of items included in these areas of influence, determine the position of makeshift camps and of the grazing-areas for the flock during the stay. Also in the background of orthophoto-maps (Imagery) the natural features of the area around the konaki (such as vegetation cover, vegetation type and other factors affecting the choice of location for the night) are spotted. Demarcated areas (buffer) with a radius of 500 m to 1000 m, allow a more meaningful and detailed observation of these elements of the natural terrain (Figure 3). For example, the settlements located in a small distance around the konakia are characterized by a greater degree of interaction with the moving stock-farmer families. In the past, dairy products being manufactured in temporary camps from farmers were channeled in such settlements. Moreover, the intra-day stay of the latter in the area offered ample scope for developing relationships with the populations of these settlements (Ntassiou, 2014).

Fig. 2. Areas of influence around the axes of the routes, in zones of 600 m-width.

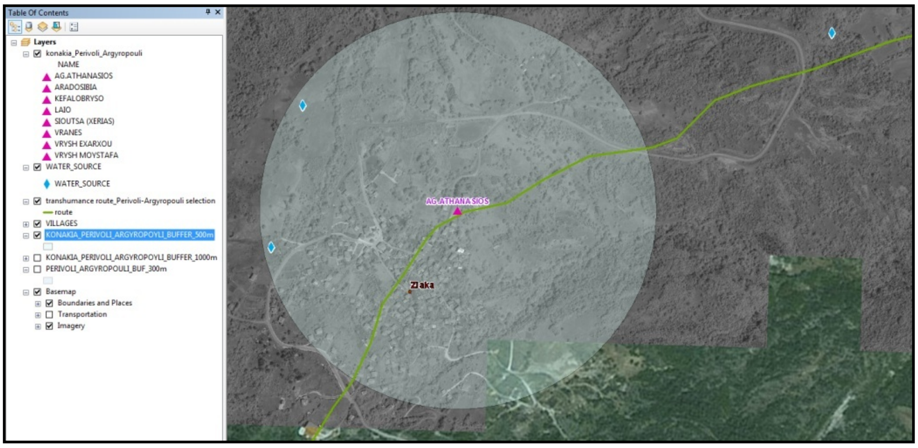

Fig. 3. An influence-area with radius of 500m, around the konakia near the village Ziakas where: water sources, the settlement and the land use that affects grazing, are mapped.

3.3.2 Identification of characteristic points on the routes

The digital terrain model created for the study area, through appropriate questions (queries) and the use of appropriate GIS-tools (Toolbox), led to the computation of Slope-surfaces, Aspect-surfaces and Hillshade-surfaces, concerning the soil. The selection of appropriate values for a surface (p.e. the slope or the aspect of the ground) and the application of the data-cut off on the selected surfaces, result into positions with characteristic values along a path.

For example, difficult parts of the route, such as those with a steep grade, can be designated by applying several 'scenarios' with slope-variations (Figure 4). With such experimentation, it is easy to detect and mark avoidable points of routes, where their axis follows p.e. a steep slope or a difficult helical-path or has the form of stairs. Such a difficult part of the route is detected in the location 'Skala Paliouria', near the settlements of 'Paliouria' and 'Friday' of Deskati (Figure 4) (Ntassiou, 2014). The remaining path of the route has no other difficult positions concerning steep slope (Figure 5).

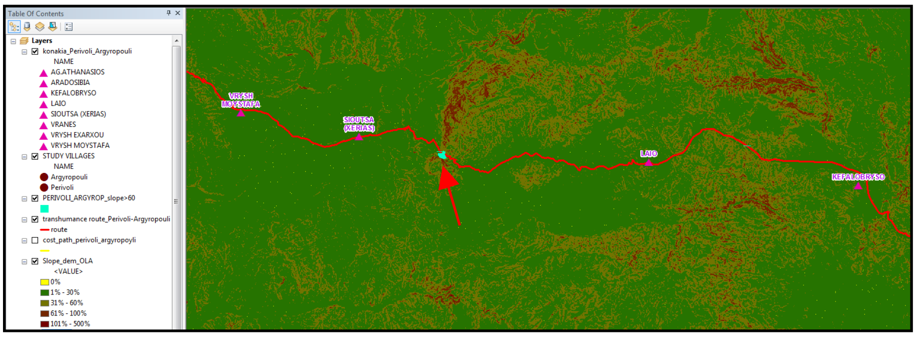

Fig. 4. Detecting points with steep slopes (> 60%) in the map-background. Indicating position 'Skala' which has such characteristics.

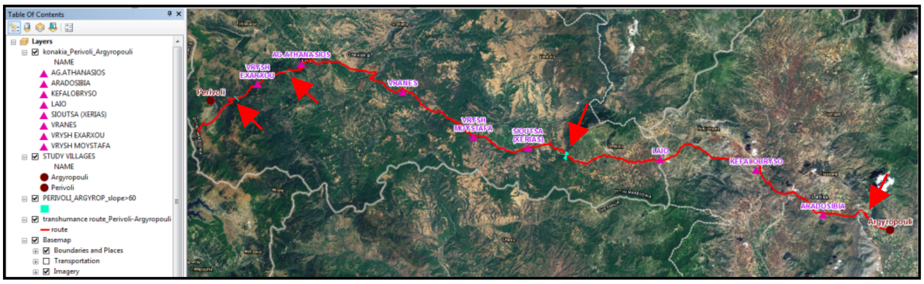

Fig. 5. Marked points with steep slope (> 60%) over the entire length of the route Orchard – Argyropouli

3.3.3 Findings on the relative position of digitized routes in relation to alternative routes (paths of minimum cost)

A cost-surface is the mathematical surface that models the costs of moving, from a specified source location to one or more destination locations (Papadimitriou, 2011). Where the term 'cost' here, means: the 'consumption' of energy or time, when moving in any cell of a raster map and the final 'sum' of this consumption when crossing map segments (Papadimitriou, 2011). By using such GIS-special tools, cost-surfaces are computed and illustrate the relative difficulty (or ease) of movement. Consequently, with their help, the best solutions to travel can be determined.

For the present paper, a model calculating the shortest path created (Figure 6) (Ntassiou, 2014), between two villages. In this model, the slope-surface of soil used as a cost-surface (cost-raster), because the combination of soil-slopes with the shortest possible path sufficiently identifies the optimal route.

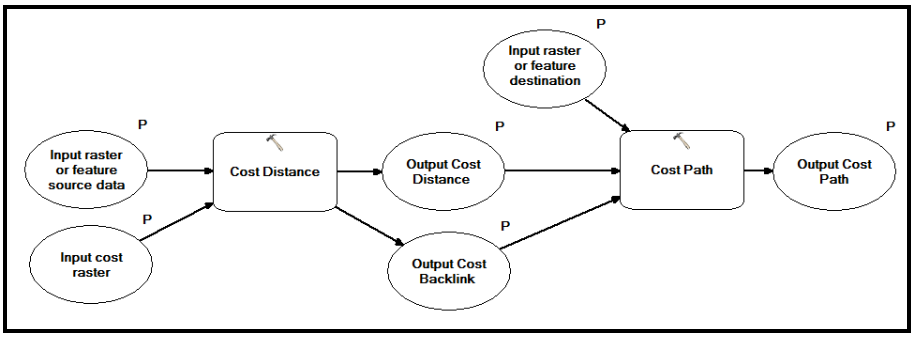

Fig. 6. Model for determining optimal path (cost path)

The comparison between the relative position of the digitized route and the corresponding minimum cost-path (cost path), shows that the course does not follow the total length of the best solution, for the shortest distance and smoother gradients (Figure 7). Specifically, the points of divergence identified in Section Orchard - foot of mountain Orliakas (village Ziakas) and in a part of position Sioutsa - Aradosivia (Stefanovouno).

In the first of these divergent sections, the existence of historical old path passing mountain Orliakas justifies the development of the traditional route, which corresponds to the path. Also in the second part of these divergent sections, the deviation is explained by the existence of a basic road that linked Grevena with Elassona (since the Turkish occupation). The traditional route of seasonal migrant flocks and livestock families follows alongside this old basic road (Figure 8). It is obvious that the traditional route followed by the flocks during their transhumance (from the mountainous settlement to lowlands and vice versa), does not deviate from the roads and some points deviate minimally, just to exploit grazing.

In the past (even before the Second World War) in Greece, the mild lands and the shortening of travel were not important criteria in defining a route. Crucial role in choosing routes played additional factors such as the vegetation type, the accessibility of rivers, the crossing of important settlements, the climatic conditions.

Moreover, for the choice of a path axis the existence of appropriate grazing was a determinative factor to a significant degree. In particular, during the autumn migration to lowland places (which in most cases were extended in time), the distance-criterion was not of importance (Ntassiou, 2014).

Fig. 7. The position of the route Perivoli-Argyropouli (red line), length: approx. 135km, in relation with the 'least cost-path' (yellow line), length: approx. 120km.

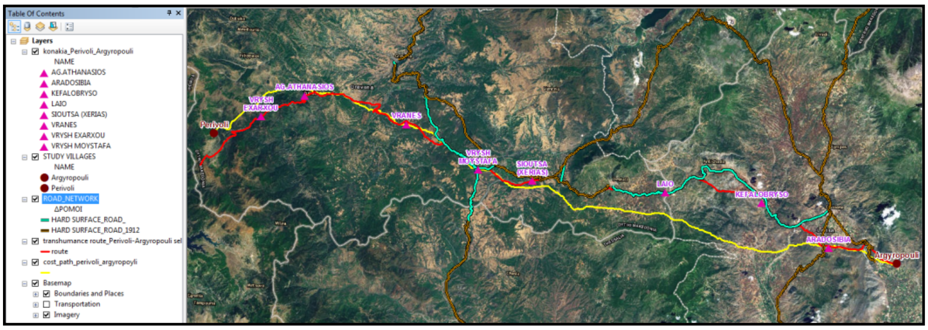

Fig. 8. The position of the route Perivoli-Argyropouli (red line), in relation with the 'least cost-path' (yellow line). Also, the historical roads of the period 1912-1940 are illustrated (with green and brown line, respectively).

4 Conclusions

The GIS developed for this research, contributes to the detailed visualization and strong promotion of a traditional transhumance route. Even more, it provides 'functional' results useful for younger, novice farmers. Concerning the oral tradition, the data organized with the help of appropriate historical cartographic material and stored in the corresponding geodatabase, making it available to future generations, even for historical studies of transhumance flocks. The dynamic character of the geodatabase allows continuous data stream (in-out), which makes it possible to extend the boundaries of the geographic study area and of course, the easy conformation and adaptation of geodatabase to any world region.

Apart from the historical and cultural value of the method, the credit of the technical characteristics of a traditional route as well as their proper processing and analysis, makes more understandable the 'technical part' of the traditional movement. The new moving farmer can form a 'criterion-picture'. With these criteria, he/she will be able to identify both, an appropriate path and how he/she will move on this path. Thus, GIS can be a way of learning a part of the customary ('traditional') way of movement for the novice farmer, who does not know the details of this tactic.

With the addition of extra data in the geodatabase system (e.g. climatic and meteorological data, land use maps, geological maps, etc.), the developed methodology can lead to the reasonable enrichment of the conclusions.

Within the nowaday standards, this method has a strong potential for development and expansion, especially from the 'decision-making' and 'management' points-of-view, while maintaining vibrant its historic and cultural character.

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