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Comparison of Two Approaches for Pasture Inventory in Albania

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Abstract

Abstract section. This study presents the evaluation of two approaches (field and remote sensing - GIS) applied for inventorying pasture condition in Albania. The field inventory was carried out by trained experts in the context of the latest Albanian National Forest Inventory (ANFI), based on 162 sample plots chosen randomly over the pasture areas. At each sample plotit was collected detailed data about pasture condition which were made available for this study. The second approachwe applied, consisted of a combination of Remote Sensing and GIS algorithms to derive several variable maps(classified into a number of classes): cover components of pastures,slope, aspect, elevation, erosion, distance from the hydrologic network, road network and the location of villages. The results indicated significant differences between both methodologies, especially for the cover components of pastures, where a difference of 14% was found regarding the evaluation of herbaceous species. Environmental and pasture use variables appeared to be evaluated differently too, especially the erosion level and distances of pastures from thevillages, networks of roads and water sources.We conclude that the main reason for such discrepancy should bethe low coverage of pasture area in terms of number of sample plots as well as their distribution.Based on the findings of this study, it is recommended that in the future, inventory of pasture condition should be done as much as possible using Remote Sensing and GIS technology because it guarantees full coverage of the study area, reduces the field work which is expensive and time consuming, and provides more reliable evaluation of pasture condition.

Keywords: Inventory, pastures, sample plots, Remote Sensing, GIS.

1. Introduction

Over the centuries, scientists have continuously endeavored to inventor the natural resources. Inventories typically aim at estimating the entire resource by either a complete mapping or a statistically valid sampling procedure[7, 15]. In this way, they can provide a significant basis for decision making and management planning of renewable resources. Early methods of inventory were based on field surveys of the area which was the object of the study, extrapolating the data on the basis of sample plots and generalizing the results for the whole area. The drawback of this method is that, for large areas, it is time consuming, costly and requires qualified personnel. Nowadays, these problems are avoided by the use of an advanced technology such as remote sensing which makes possible the observation of large and inaccessible areas systematically in a very short period of time [9]. However, good field data and suitable resource classifications must be developed within the study area before the remote sensing imagery can be adequately interpreted [7]. Remote sensing data are useful to identify what is growing but when combined with a GIS component we can further analyze the position on the earth, measure area etc, providing in this way a complete record of the site [4]. Due to the advantage that offers over the traditional methods, remote sensing and GIS have found a wide application in environmental studies including pasture inventories as well. In pasture inventory, remote sensing data have been used primarily as a tool to map various pasture ecosystems or plant communities, as well as to estimate forage production (increase of new biomass over time) during a growing season [18]. This is particularly important for developing countries like Albania where satellite imagery visually interpreted can offer the best option to evaluate the condition and extent of the natural resources, and to monitor the progress in management of pasture resources [3].

The proper management of pasture resources can be accomplished based onreliableestimation of their exact location, evaluation of productive potential

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and the capacity for livestock production [12]. Therefore, the objective of this study was to compare two approaches applied for inventorying the pastoral resources in Albania, discuss their advantages and drawbacks with the purpose to provide useful information for the improvement of pasture inventory methodologies in the future, so more reliable result can be obtained.

2. Material and Methods

2.1 Field inventory

A field inventory of pastures was carried out in the framework of the Albanian National Forest Inventory [1]. The sample plots were randomly selected from a grid of 1 x 1 km, built within the pasture area of the whole country.A total of 162 points were randomly chosen from this grid and inventoried in the field using a GPS. Each point-sample plot comprised two subplots: an external subplot of 900 m² (30 x 30 m) within which the dominant plant species were evaluated and their height was also recorded, and an internal subplot of 9 m² (3 x 3 m) within which species composition and the vegetation cover were evaluated. The area sampled was very low, only 14.5 ha out of a total of 480800 ha covered by pastures[1]. At each sample plot were recorded environmental and pasture use variables.Environmental variables included: altitude above sea level,total annual precipitation and mean minimum temperatures of the coldest month based on climatic data of the nearest meteorological station to the sample plots, parent rock categories from geological maps, namely limestone, ultra basic, flysch and clay, the type of soil according to the Albanian soil classification [19], namely grey brown, brown, grey dark and meadow, the soil depth classified as deep (>30 cm), medium (15-30 cm), shallow (< 15cm) and no soil, the slope, classified as undulating (< 15%), steep (15-30%) and very steep (>30%), the erosion status, evaluated and classified as having no signs of erosion, sheet erosion (no marks in depth), rills (lines with a depth smaller than 5 cm) and gullies (lines with a depth bigger than 5 cm), the terrain relief, classified as level, hilly and mountainous, the micro relief, classified as flat, lower slope, middle slope and upper slope, the aspect measured with a compass and classified as flat, north, northeast, east, southeast, south, southwest, west and northwest and the cover with surface movable stones evaluated visually in the field and classified as absent, low (<0.30 of the area), medium (0.31-0.60 of the area) and high (>0.60), andground cover, estimated as percentage of the total area in each plot covered by herbs, woody species (shrubs and trees), rocks and bare soil, as well as plant species composition and height, both of which were determined for the three main cover groups (herbs, shrubs and trees) in each sample plot.Pasture use variables included: ownership, i.e. whether they were state-owned, community or privately owned areas, season of use, i.e. whether they were grazed in summer or in winter, grazing intensity determined on the basis of the traces of livestock excreta and classified as no grazing (no animal excreta), light grazing (excreta evident in less than 0.30 of the plot), medium grazing (excreta present in 0.31-0.60 of the plot) and overgrazing (excreta present in >0.60 of the plot), the status of burning evaluated from the evidence of wildfires and classified as no evidence of burning, evidence of past burning and evidence of recent burning and the distance of sample plots from the nearest road, village and watering point estimated and classified as close (less than 1 km), medium (1-3 km) and far (over 3 km).

2.2 Remote sensing and GIS inventory

2.2.1 Satellite and ancillary data

The remote sensing imagery consisted of four Landsat Enhanced Thematic Mapper (ETM+) images (spectral imagery at 30m resolution) covering the whole area of Albania. The images were already geo-referenced and geo-corrected by using topographic maps of the Albanian Military Geographic Institute (map-to-image) at the scale of 1:100,000 [8]. The ancillary dataset consisted of a Digital Elevation Model (DEM) of Albania, soil types, village locations, hydrologic and road networks. Both datasets were prepared in the framework of ANFI project and used in this study.

2.2.2 Image pre-processing and analysis

Pre-processing included image mosaicking, atmospheric correction and clipping of pasture areas from the images. Mosaicking was necessary in order to provide full coverage of Albania. The atmospheric correction consisted of haze removal from the images because a considerable area of them (especially in the western part) was affected by this component. Clipping of pastures on the images was done by using the polygons of the pasture areas extracted from the land cover /use map produced in 2002 [8].

Subsequently, pixel-based image analysis was applied to the imagery. The images were analysed spectrally by using a combination of Normalised Difference Vegetation Index (NDVI), Principal Component Analysis (PCA) and Supervised Classification (SC). The NDVI was measured automatically based on the ratio between the reflectance of the red (R) and near infrared (NIR) spectral bands [13].It was computed in order to differentiate among vegetation and non-vegetation areas (presented by a range of positive and negative values respectively). Four classes of NDVI were produced: < -0.5 (class 1), -0.5 – 0.0 (class 2), 0.01 – 0.5 (class 3), 0.51 – 1.0 (class 4) and used as an additional layer for further spectral analysis.PCA was applied on 6 bands (five spectral bands of the image + NDVI) in order to improve data interpretability and enhance several features on pastures[9]. In order to identify which colours that were clearly discriminated on the image were represented on the ground, points with known cover determined from the field inventory were used. Groups of pixels similar in their reflectance characteristics were identified and used for the SC analysis. Four different classes (components) were clearly detected over the whole area of pastures: herbaceous species, woody species, bare soil and rocks.The overall accuracy of image classification was estimated to be 75.7%. All the image pre-processing, analysis and accuracy assessment were done in Erdas Imagine 9.1 (Erdas, Atlanta, GA).

2.2.3 GIS analysis

The thematic map of cover components of pastures was imported into a GIS system for calculating the area covered by each of them for the whole country.In addition, several thematic maps were produced in Arc Map based on the ancillary data provided by the ANFI project. The DEM was processed to automatically derive maps of slope, aspect and altitude classes; the ‘calculate distances’ tool was used to derive the distance maps showing the distance of pastures from the road network, the hydrologic network (streams and rivers), and the location of villages. These maps were classified into a number of classes by using the ‘classify’ tool. The following were derived: three classes for slope, i.e. undulating (<15%), steep (16-30%) and very steep (>30%); nine classes for aspect, i.e. flat, north, north-east, east, south-east, south, south-west, north and north-west; and six classes for altitude, i.e. 0-400 m, 401-800 m, 801-1200 m, 1201-1600 m, 1601-2000 m and >2000 m. The ‘distance maps’ were classified into three classes, i.e. close (<1 km), medium (1-3 km) and far (>3 km). An erosion map was derived by implementing a methodology that processed DEM as well as the soil types, precipitation and cover components maps [6, 10]. For the production of the erosion map, the component maps were classified into four classes (with respect to erosion level) varying in a range from 0-1.For slope, for example, slopes lower than 15% were assigned with 0-0.2 values (class 1), slopes 15-30% with 0.21-0.4 values (class 2), slopes 31-60% with 0.41-0.7 values (class 3) and slopes>60% were assigned with 0.71-1values (class 4). For aspect, north aspects and flat areas were assigned with values varying from 0-0.2 (class 1); north-west, north-east and west areas with values 0.21-0.4 (class 2); south-east, south-west and east with values 0.41-0.7 (class 3); and south aspects were assigned with values 0.71-1 (class 4). As there was no map available for precipitation, a regression equation was run between precipitation (from the field inventory) and altitude as follow:

$Y= 0.54 X + 725.1$; $R^2 = 0.81$.

where:

Y= precipitation (dependant variable);

X=altitude (independent variable);

This equation was applied in Arc Map to produce a precipitation map for the whole pastures area as a function of altitude. Subsequently, areas characterized by a precipitation less than 1000 mm $year^{-1}$ were assigned with values varying from 0-0.2 (class 1); areas with precipitation 1000-1500 mm $year^{-1}$ with values varying from 0.21- 0.4 (class 2); areas with precipitation 1500-2000 mm $year^{-1}$ with values 0.41-0.7 (class 3); and areas with precipitation higher than 2000 mm $year^{-1}$ were assigned with values 0.71-1 (class 4). For soil type, areas covered by brown soils were assigned values 0-0.2 (class 1); grey dark soils with values 0.21-0.4 (class 2); grey brown soils with values 0.41-0.7 (class 3); and meadow soils with values 0.71-1(class 4). For cover components, areas covered by woody species were assigned with values 0-0.2 (class 1); by herbaceous species with values varying 0.21-0.4 (class 2); by rocks with values 0.41-0.7 (class 3); and by bare soil were assigned with values 0.71-1 (class 4). All the above maps (rated with respect to erosion level) were then integrated into a single representative map (by multiplying them) with values varying from 0-1. The final erosion map was classified into four classes by putting the thresholds 0-

0.2 (no erosion), 0.21-0.5 (low erosion), 0.51-0.7 (moderate erosion) and 0.71-1 (high erosion). In addition, grazing pressure was analyzed by using the data about stocking rate for each district of Albania and grazing capacity of Albanian pastures [12,2]. Stocking rate was calculated for each district by using the formula: Stocking rate = Number of animals / Pasture area (SEU/ha/year). In calculating stocking rate, the total number of animals was considered because there were no data on how the grazing resources are allocated among the different kinds of animals. Moreover, the concept of Sheep Equivalent Unit (SEU) was used, where one cattle was taken equivalent to 5 sheep and one goat to one sheep. Grazing capacity (SEUM/ha) was calculated by the formula: Grazing capacity for one month (MGC) (SEU/ha) = Annual biomass (kg Dry Matter(DM)/ ha) / Monthly feed needs (kgDM/SEU). Dry matter production was calculated as an average value for the whole pastures (winter and summer) and was considered to be 1000 kg/ha. The monthly requirement of a SEU was considered 42 kg DM and the grazing period up to 6 months. Grazing capacity was calculated as an average value for the whole pasture areas because no data were available on above ground biomass of pastures in each district of the country. Three classes of grazing pressure were produced and presented graphically based on the comparison between grazing capacity of pastures and stocking rates of each district. Districts characterized by a stocking rate lower than grazing capacity of pastures were classified as “lightly grazed”; districts where stocking rate was approximately the same as grazing capacity were classified as “moderately grazed”; and districts where stocking rate was higher than grazing capacity were classified as ” heavily grazed”.

3. Results

3.1Environmental variables

The results of both inventories related to the cover components of pastures revealed that there exist only slight differences for the pasture area covered by woody species (Table 1). However, the discrepancy is high for the other components of pastures, especially for herbaceous species (overestimated by ANFI project) and bare soil (underestimated by ANFI project). Considering the elevation and aspect classes, it is obvious that there exist only slight differences. The variables that show high discrepanciesare those ofslope, soil type and erosion level. Referring to the slope, there is an overestimation by the ANFI project of the pasture area distributed on steep slopes, and, an underestimation of the one located on very steep slopes. This might be related to the limited number of points inventoried in very steep slopes which makes those areas not to be represented equally by the sample plots with respect to the pastures located in undulating and steep slopes.

The pasture area by soil type, in general, appears to be evaluated quite well by the ANFI project with the exception of grey dark soils where a difference of 12 % between the results derived from the field data and the GIS analysis was found. According to the GIS analysis, grey dark soils cover a larger area than the one found by ANFI. Small differences also exist in the estimation of pasture area occupied by grey brown, brown and meadow soils. For the erosion level, it appears to be a high discrepancy in the results, especially for the classes characterized by low level of erosion.

3.2Pasture use variables

Regarding the variables of pasture use, the discrepancies of the results are very high in the case of pasture distance from the villages (Table 2). The highest differences exist in the evaluation of pasture areas located in a distance close and far away from the villages. It appears that the data collected in the field were taken mainly in a medium distance from the villages, while in the areas close and far from the villages, the number of sample plots was deficient and sufficient respectively. In other words, according to the ANFI results, pasture areas located close to villages were underestimated while those distributed far away from villages appear to have been overestimated. Referring to the pasture distance from the roads and the water sources, it is evident that there is a high discrepancy of the results, especially for the pasture area classified to be close to the roads and water sources. Considering grazing use, it seems that ANFI project has evaluated well pasture area characterized by a proper grazing, but there is a high discrepancy regarding the other two classes, light and heavy grazing respectively.

Table 1. Inventory results related to the environmental variables

Variable comparison	ANFI results		R. S. &GIS results		Differences
Cover components	Area(ha)	%	Area (ha)	%	Area(ha)
Woody species	84140.0	17.5	93275.2	19.4	-9135.2
Herbaceous species	231745.6	48.2	164433.6	34.2	67312
Bare soil	75004.8	15.6	110103.2	22.9	-35098.4
Rocks	89909.6	18.7	112988.0	23.5	-23078.4
Total	480800	100	480800	100	
Altitude					
0-400 m	106737.6	22.2	122393	25.46	-15655.4
401-800 m	82986.08	17.26	110334	22.95	-27347.92
801-1200 m	100968	21	111898	23.27	-10930
1201-1600 m	107122.2	22.28	77048	16.02	30074.2
1601-2000 m	65292.64	13.58	46083	9.58	19209.64
>2000 m	17790	3.7	13128	2.73	4662
Total	480800	100	480800	100	
Slope					
Undulating (<15%)	103853	21.6	102796	21.38	1057
Steep (16-30%)	201840	41.98	173211	36.03	28629
Very steep (>30%)	175107	36.42	204793	42.59	-29686
Total	480800	100	480800	100	
Aspects					
Flat	2981	0.62	578	0.12	2403
North	20770	4.32	40777	8.48	-20007
North-east	71206	14.81	56640	11.78	14566
East	59379	12.35	58570	12.18	809
South-east	47503	9.88	56479	11.75	-8976
South	53417	11.11	66138	13.76	-12721
South-west	103853	21.6	84348	17.54	19505
West	74187	15.43	71556	14.88	2631
North-west	47503	9.88	45637	9.49	1866
Total	480800	100	480800	100	
Soil type					
Grey brown	175107	36.42	163472	34	11635
Brown	97939	20.37	76928	16	21011
Grey dark	89044	18.52	149048	31	-60004
Meadow	118710	24.69	91352	19	27358
Total	480800	100	480800	100	
Erosion level					
No erosion	76928	16	76928	16	0
Low erosion	86544	18	139432	29	-52888
Moderate erosion	149048	31	120200	25	28848
High erosion	168280	35	144240	30	24040
Total	480800	100	480800	100	

Table 2. Pasture use variables

Variable comparison	ANFI results		R. S.&GIS results		Differences
Grazing use	Area(ha)	%	Area (ha)	%	Area(ha)
Light grazing	130008	27.04	105600	22	24408
Moderate grazing	241890	50.31	225600	47	16290
Heavy grazing	108853	22.64	148800	31	-39947
Total	480800	100	480800	100	
Distance from villages					
Close (<1km)	78130	16.25	182704	38	-104574
Medium (1-3km)	204340	42.5	245208	51	-40868
Far (>3km)	198330	41.25	52888	11	145442
Total	480800	100	480800	100	
Distance from roads					
Close (<1km)	131403	27.33	322136	67	-190733
Medium (1-3km)	191118	39.75	120200	25	70918
Far (>3km)	158279	32.92	38464	8	119815
Total	480800	100	480800	100	
Distance from water					
Close (<1km)	121017	25.17	346176	72	-225159
Medium (1-3km)	229245	47.68	110584	23	118661
Far (>3km)	130537	27.15	24040	5	106497
Total	480800	100	480800	100	

4. Discussion

ANFI pasture inventory determined the condition of pastures by using a methodology based on field data. Pastures were analyzed by studying their state in the selected plots chosen randomly all over the country and therefore guaranteed equal probability of representation for the whole pastures of Albania. Moreover, variables recorded in the field allowed a complete evaluation of pasture condition in sample plots by considering all the important aspects for evaluation of pasture condition. However the inventory of pastures at the national level based on field sampling is influenced by many factors including the time required by teams for field data collection, the funds available, vegetation type, management objectives, etc. Therefore, although the ANFI pasture inventory provided an idea about the state of Albanian pastures, it can be considered rough since it evaluated pasture condition in a very small area (14.5ha) while the total pasture area amounts to 480000ha. There is no doubt that the ANFI inventory provided a lot of information about pasture condition in selected plots but it is uncertain if these data can be used as a good estimator of the whole pasture area. It is essential to stress the fact that the sample information is of little value unless it can be used as a reliable description of the area as a whole [11].

The new inventory performed in this study covered all the pastures of Albania. It analyzed most of the variables recorded in the field by the ANFI teams for the whole pastures of the country by using remote sensing and GIS. In this way, it provided data for a more consistent evaluation of pasture condition. An important point to be stressed here is that pasture condition was evaluated quantitatively based on the inventoryof several variables which are considered essential in determining the state of pastures. An additional advantage can be considered the use of a methodology based on remote sensing and GIS that reduces to minimum the field work which is expensive, time consuming and requires a lot of qualified people. Moreover, this methodology made possible mapping of the whole pastures providing an idea about the cover components and plant structure all over the country. However, it should be mentioned the fact that this methodology could not provide the level of details of the ANFI field inventory for the plots studied because there are variables which are difficult to be assessed remotely and therefore require their measurement in the field. Moreover, even the use of a methodology based on remote sensing algorithms requires field trips for the definition of the spectral characteristics of various land cover types which are used in the process of image classification and accuracy assessment[7]. For this purpose, we used the data collected in the field by the ANFI teams because no other data were available for the whole pasture area. Therefore, the level of accuracy achieved in classifying cover components of pastures is affected by the reliability of the ANFI data. In addition, the remote sensing methodology relies on the pixel as the smallest entity; therefore it cannot detect cover variability within the size of the pixel. It is clear that the smaller the pixel size is, the higher the variability captured in the plot is expected. Taking into account the peculiarities of Albanian pastures which are characterized, in general, by homogeneity [12] that exceeds the magnitude of the pixel, it can be stated that the pixel based methodology applied for mapping of pastures can be considered adequate. Moreover, the inaccuracies were minimized by the use of spectral analysis algorithms based on PCAwhich highlights the areas that show differences in terms of land cover[5]. In addition, GIS analysis was very important because it provided information about environmental variables that influence pasture condition all over the country. This information constitutes an advantage over the ANFI methodology because it was used for analyzing pasture state allowing conclusions to be drawn and actions to be proposed regarding proper management of pastures in the future.

5. Conclusions

Comparison of the results of both ANFI and remote sensing GIS inventory revealed that their discrepancies are quite high. This suggests that the accuracy of the field inventory carried out by ANFI project was not high apparently due to the limited number of sample plots studied. Therefore, the future inventory of pasture condition should be done as much as possible by using remote sensing technology because field work which is expensive and time consuming can be reduced to a minimum. However, such technology must be associated with field trips to provide data for the proper imagery classification. In other words, in order to have a highly accurate inventory of pastures both the above methods should be combined.

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7. References

1. ANFI:**Albanian National Forest Inventory.**Terms of Reference. Tirana, Albania; 2004.

2. **Agricultural Statistical Yearbook of Albania** 2007.

3. Booth D.T, Tueller P: **Rangeland monitoring using remote sensing.** Arid Land Res. Manag 2003, **17**: 455–478.

4. Buchan P: **Satellite Imagery for Regulatory control**. **Modern Agriculture:**Site-Specific Crop Manag.1997,**1**(2):20-23.

5. ChuviecoE:**Measuring changes in landscape pattern from satellite images: short-term effects of fire on spatial diversity.** Int. J. R. Sens.1999, **20**: 2331–2346.

6. Gatzojannis S, StefanidisP,Kalabokidis K:**An inventory and evaluation methodology for non-timber functions of forests.** Freiburg.Mitteilungen der Abteilung fur ForstlicheBiometrie2001:1–49.

7. Hunt E.R, James J, Everitt H, Ritchie J.C, Moran M.S, Both D.T, Anderson G.L, Clarc P.E,SeyfyiendM.S:**Application and research using remote sensing for rangeland management**. Photog. Eng. Res.2003, **75**: 425–435.

8. Jansen L.J.M, Cerutti P.O, Spisni A, Carrai G. Morandini L: **Analysis of the spatio-temporal and semantic aspects of land-cover / use change dynamics 1991–2001 in Albania at national and district levels**. Env. Mon. Assess. 2006, **119**: 107–136.

9. Lillesand T. M, and Kiefer R. W: **Remote sensing and image interpretation**. John Willey & Sons, New York; 2000:736p.

10. Kola H, Male J, Fierza G:**Effect of damage to forests on soil degradation**. National Conference on Land degradation and protection in Albania. Tirana, Albania2003.

11. Oliver M.A, Webster R: **Kriging: a method of interpolation for geographical information systems**. Int. J. Geog. Inf. Syst.1990, **4**: 313 – 332.

12. Papanastasis V.P:**Special study on grazing impact on wooded lands, including firewood consumption assessment**. ANFI. Tirana2003.

13. PettorelliN, Vik J. O, Mysterud A, Gaillard J.M, Tucker C. J, and Stenseth N. Ch:**Using the satellite-derived NDVI to assess ecological responses to environmental change**Trends Ecol.Evol.2005, **9**: 503-510.

14. Shundi A, Buzi T: **Experimental results in improvement of mountainous pastures in Albania**. Herba 1991, **4**: 50–52.

15. Shundi A: **Country Pasture/Forage Resource Profiles**. Albania 2004. Rome: FAO. http://www.fao.org/ag/AGP/ AGPC/doc/counprof/Albania/albania.htm (accessed 17 September 2010)

16. Smith E.L: **The struggle for a uniform monitoring system**. Arid Land Res Manag 2003, **17**: 347–358.

17. Tueller P.T: **Remote sensing technology for rangeland management applications**. J. Range Manag. 1989, **42**: 442–453.

18. Tueller P.T. Nevada R: Remote sensing of range production and utilization. J Range Manag 2001, **54**: 77–89.

19. Zdruli P: **Soil survey in Albania**. CIHEAM - Mediterranean Agronomic Institute of Bari,Valenzano (BA), Italy, 2003: 39–45.