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A GIS-Based Study of The Natural Bed of Malfe and Andargoli Villages Rural Complex

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Abstract

In this study, topographic as well as rural texture parameters were analyzed in the form of spatial layers. For this purpose, a Digital Elevation Model (DEM) was first prepared and then, based on the classification of the land form parameters and overlaying them with the land use/land cover layer, the relationship of the physical parameters with the structural context of Malfe and Andargoli villages was analyzed. Finally, both compatible and non-compatible forms of exploitation of the natural bed of the two villages were identified. Furthermore, the results of this study suggest that GIS with the possibility of developing data can be an efficient tool in the process of rural and urban planning.

Keywords: Village, Natural bed, GIS, Malfe and Andargoli villages.

بررسی بستر طبیعی مجموعه روستایی اندارگلی و ملفه با استفاده از سامانه اطلاعات جغرافیایی (GIS)

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چکیده

در این پژوهش که با هدف شناخت و بررسی بستر طبیعی مجموعه روستایی ملفه و اندارگلی واقع در شهرستان سوادکوه انجام شده است، با استفاده از سامانه اطلاعات جغرافیایی(GIS)[1]، پارامترهای طبیعی و کالبدی روستاهای مورد مطالعه در غالب لایه‌های مکانی متفاوت، مورد تجزیه و تحلیل قرار گرفته است. در این راستا، ابتدا مدل رقومی ارتفاعی منطقه در سامانه اطلاعات جغرافیایی تهیه گردید. سپس با طبقه‌بندی لایه‌های شکل زمین و رویهم قرار دادن آن با لایه پوشش و کاربری اراضی، رابطه پارامترهای طبیعی با بافت کالبدی روستاهای ملفه و اندارگلی مورد تحلیل قرار گرفت و نهایتاً بهره برداری های سازگار و ناسازگار از بستر طبیعی روستاهای مورد مطالعه مشخص گردید. علاوه بر این نتایج گویای این مطلب است، سامانه اطلاعات جغرافیایی با امکان ایجاد پایگاه داده، تجزیه و تحلیل داده های فضایی می تواند به عنوان ابزاری موثر در فرایند برنامه ریزی شهری و روستایی مورد استفاده قرار گیرد.

کلمات کلیدی: روستا، بستر طبیعی، سامانه اطلاعات جغرافیایی، ملفه و اندارگلی.

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Introduction

The role of the natural bed in the formation and development of rural areas has previously been explained (Zargar 1999; Saeedi 2008; Sartipipour, 2009). In this literature it has been noted that such natural factors as topography, an adequate water, suitable land and farmlands along with economic, cultural, communications and safety factors are all basic criteria for site selection and rural development in different parts of the world. Although, nowadays, human activities have played a major role in the formation and development of rural area because of technological power, natural factors continue to affect the rural body, especially in less developed areas.

What makes knowing more about the natural bed of rural areas an urgent and essential issue is the need for sustainable and balanced development, preventing water and soil resource degradation and unpredictable events through observing construction and exploitation of land according to standards for rural areas. Studies carried out in Iran show that, at present, the structure of Iranian villages enjoyed an important impact from Rural Guidelines Planning, although these plans are neither sufficient nor wholly effective. We can give as an example of such plans a survey on the effects of Rural Guidelines Planning on the environment of Iranian village, carried out on the three fields of: natural disasters, environmental issues and the natural characteristics of the villages. The result of these studies indicate that the effects of the proposed projects on the villages environment have been ignored during the design process and also neglected after implementing the plans, despite the fact that the successful performance of the plan is related to a great extent with its environmental impacts. (Torkashvand *et al.,* 2008)

Another study has been undertaken to evaluate the effects of Rural Guidelines Planning on the village environment entitled "Environmental Conservation and Rural Development Planning Considering on Rural Guidelines Panel Assessment" (Motii Langrudi *et al.,* 2010). In this study, which deals with the issues of protection of the environment and its status in the physical development planning, especially in Rural Guidelines Planning, 25 villages in four provinces of Iran were studied. The study showed that Rural Guidelines Planning studies lacked any organized spatial strategy and, in effect, led to a sort of spatial homogeneity, without paying any special attention to natural variations throughout the country. The study suggested the following as important factors for removing the shortcomings of the earlier Rural Guidelines Planning: adjusting the Plan's service description on the basis of the environmental and spatial factors of different places; defining a rural environmental conservation index; defining an Environmental Sensitivity Index for different rural areas; and offering strategies for the improvement of the conditions and quality of the rural environment.

Malfe and Andargoli Rural Complex, comprising two connected villages which have witnessed great changes due to joint rural guidelines planning, are no exception. In this study which has employed GIS, we have tried to focus our investigations more on the natural bed on which the village structure had been formed.

Geographic Information System and rural planning

The general application of GIS to rural development includes preparing maps of land and natural resources, environmental management, natural disaster management and spatial planning (Kumara, 2008). Since the life and development of rural areas depends greatly on natural resources such as water, soil, and vegetation, the use of GIS helps natural resource managers and planners greatly on different levels of performance so that they can get to know the study area more accurately and faster and, accordingly, they will be better enabled in planning and decision making by determining more accurately the role of GIS in village studies.

Materials and Method

Study area

Malfe and Andargoli are two villages both physically and functionally connected to each other, studied here as a rural complex. The two villages are located on the northern slopes of the Alborz Mountains in the North of Iran. The complex is bound to the West by the Tehran-Mazandaran Road, to the North by the Otijoon River and to the East and South by forest and ranges (Fig.1).

Methodology

The natural bed and topography of the Malfe and Andargoli rural complex were studied through GIS since natural bed and topography are effective factors through which rural societies and their activities are determined. In addition to the natural bed, other natural factors such as water and land coverage were also studied in order to map land use and land cover. To analyze the spatial data, GIS and its capabilities were of use in determining the spatial relations of the different layers. Also, software such as Arc GIS10, Auto CAD and Auto Desk Land were of great use in the study for processing data and preparing the required maps. Figure 1 shows the process of study.

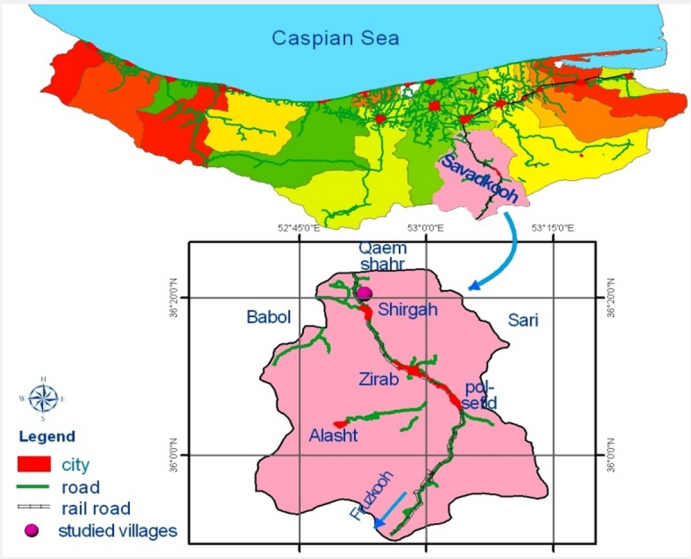

Figure 1. Location of study area.

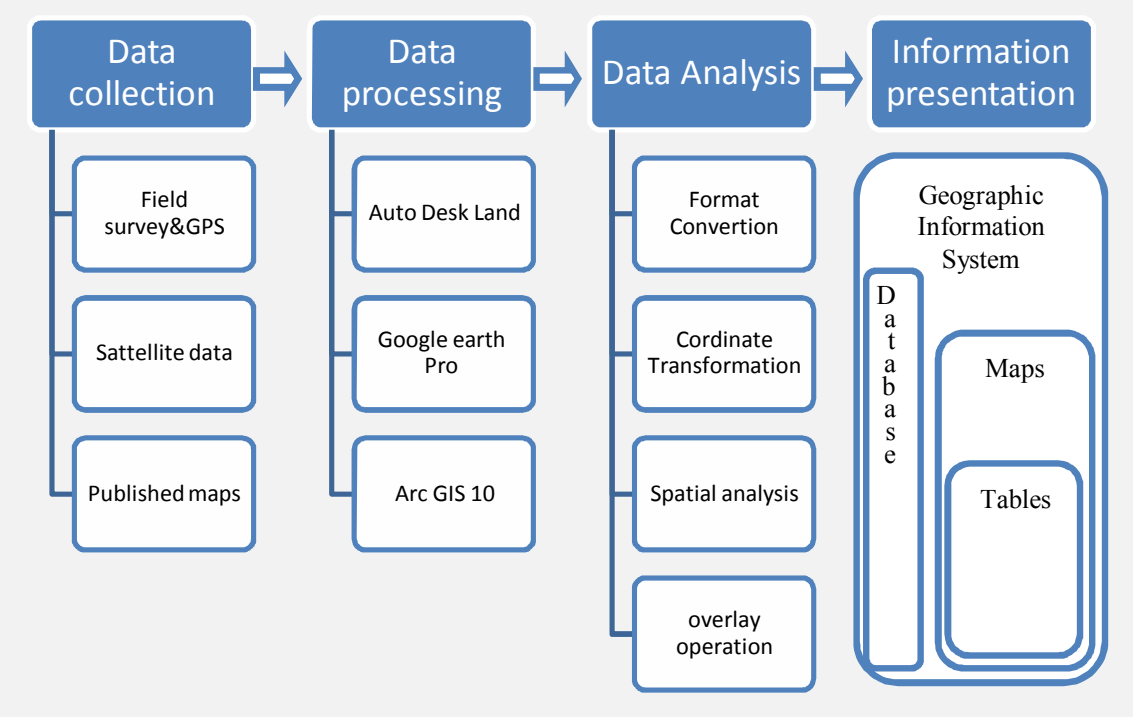

Figure 2. Overview of GIS-based data analysis.

Topographical Analysis of the Study Area

Slope and elevation are determining factors for preparing a pattern of activities and establishing a system (Sarvar, 2006). Generally, cities and villages develop to a certain height and, after that, will face limitations. For example, about 54% of all the rural areas in the country are located at a height of 1000-2000 meters, which shows the role height plays in distribution and settlement patterns (Jomehpour, 2006).

The height of study area as shown in Figure 2 is 900 m at the highest point. In practice, because of the 60% slope and density of the forest upward, the settlements of Malfe and Andargoli based on the natural bed and including the rice paddy development around the Otijoon River and the access to roads around Firuzkuh-Sari are located on the lowest part of the area at a maximum height of 250m.

DEM: Digital Elevation Model

To find exact information on the height of the village texture, a Digital Elevation Model (DEM) was prepared. DEM includes an amount introducing the height of the earth's surface. Therefore, in order to prepare a height layer for the village and its surrounds, a topographic map was prepared with a scale of 1:1000 and an index contour line of 5 m and intermediate lines of 1m. After creating the topography in Arc Info software, the DEM of the area was prepared and classified by applying 3D Analysis.

Slope

Slope mapping is a basic explanatory tool since it is important in design and construction and in other applications such as indicating the general condition and topography of the plan and

restrictions on building and environmental hazards, such as erosion and landslides. In this study, the researchers prepared a map of the villages' slope and their surrounds using DEM in Arc Map. Then, the map was classified at the levels of 0-5, 5-10, 10-15, 15-20, and 20-55 percent.

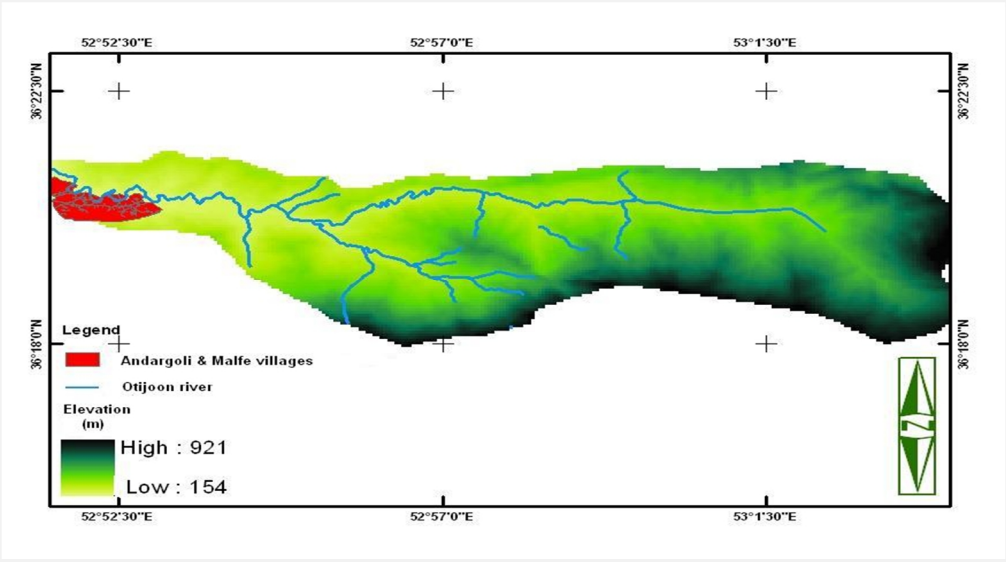

Figure 2. The Otijoon River catchment surrounding Malfe and Andargoli villages.

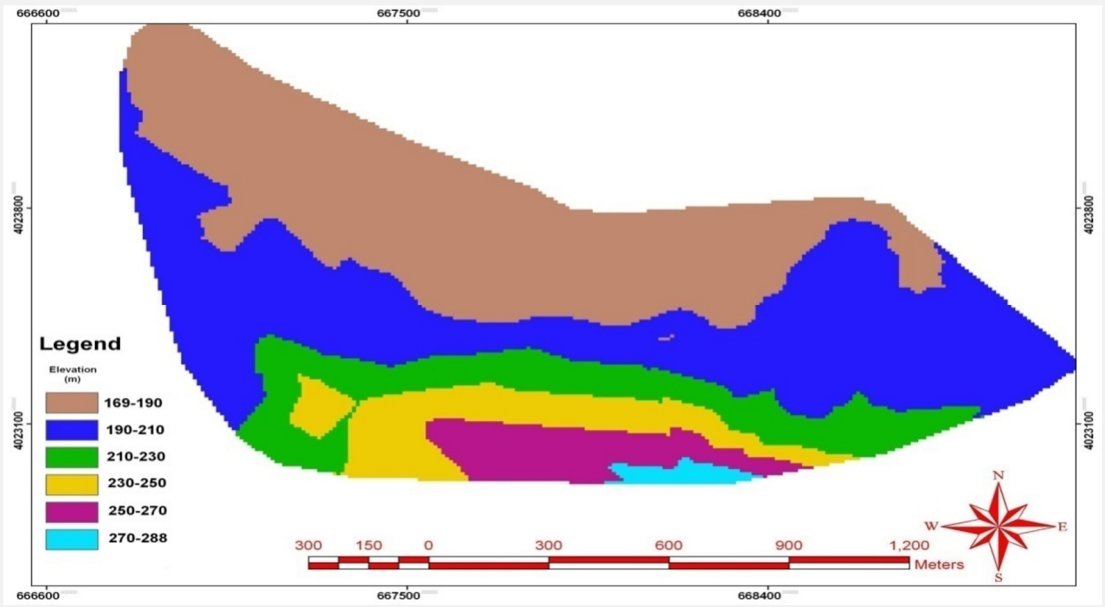

Figure 3. Elevation classes of the study area.

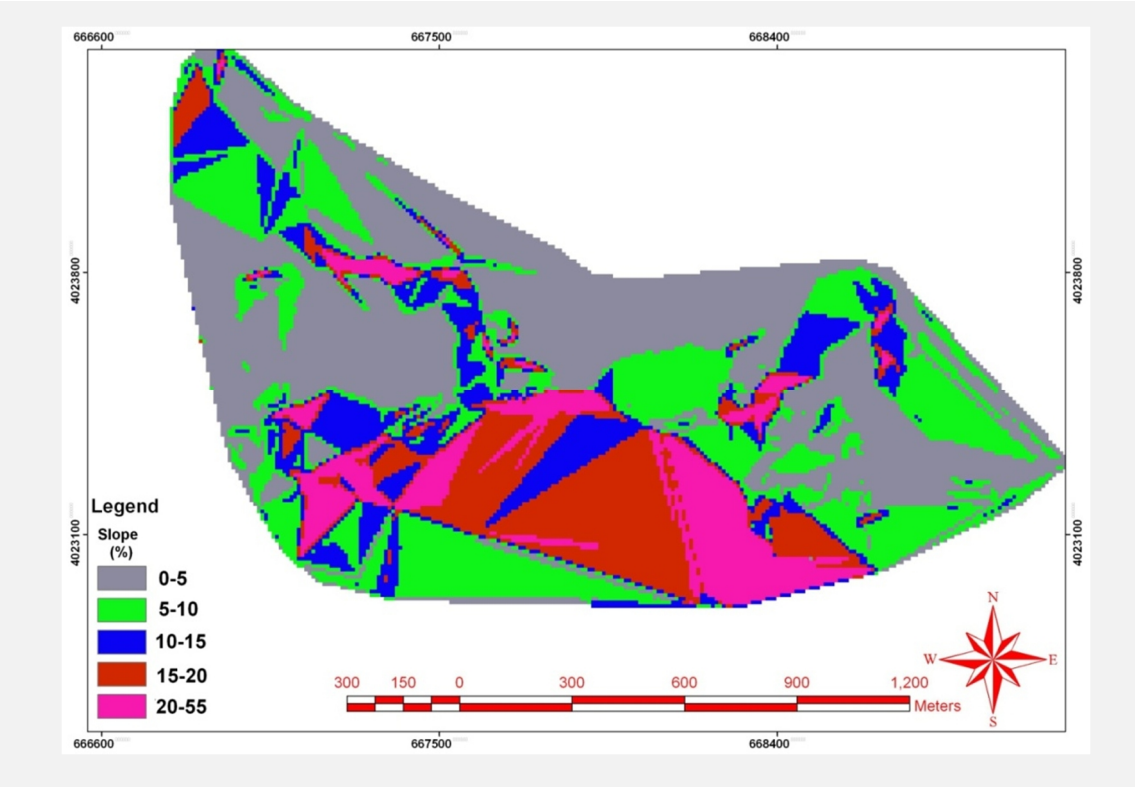

Figure 4. The levels of the slope of the study area.

Preparing Land Use/land Cover Maps

It is possible to trace a variety of factors involved in creating the spatial structure and texture of the village at different levels and on different scales, whether micro or macro (Zargar, 1990). In this study, the scale used is the level of settlement and settlement pattern in the context, farms, gardens, roads and so on. To do this, the researchers prepared land use/land cover of the village and its surrounds, applying a satellite image from Google Earth and IRS PAN with the spatial resolution ability of 5.5 meters. The interpretation of the images and separation of different types of application was conducted through a visual interpretation method. In this step, the researchers also used other published maps of the area.

Table1. Land cover/land use square of the study area.

Land use	Square (m^{2})	Square percentage (%)
Residential	275128.51	16.17
Garden and farmland	789231.92	46.40
Forest	265304.65	15.60
Range	10655.46	0.63
Rice paddies	331609.03	19.49
Sports ground	19288.74	1.13
Graveyard	9828.91	0.58
Total	1701047.20	100

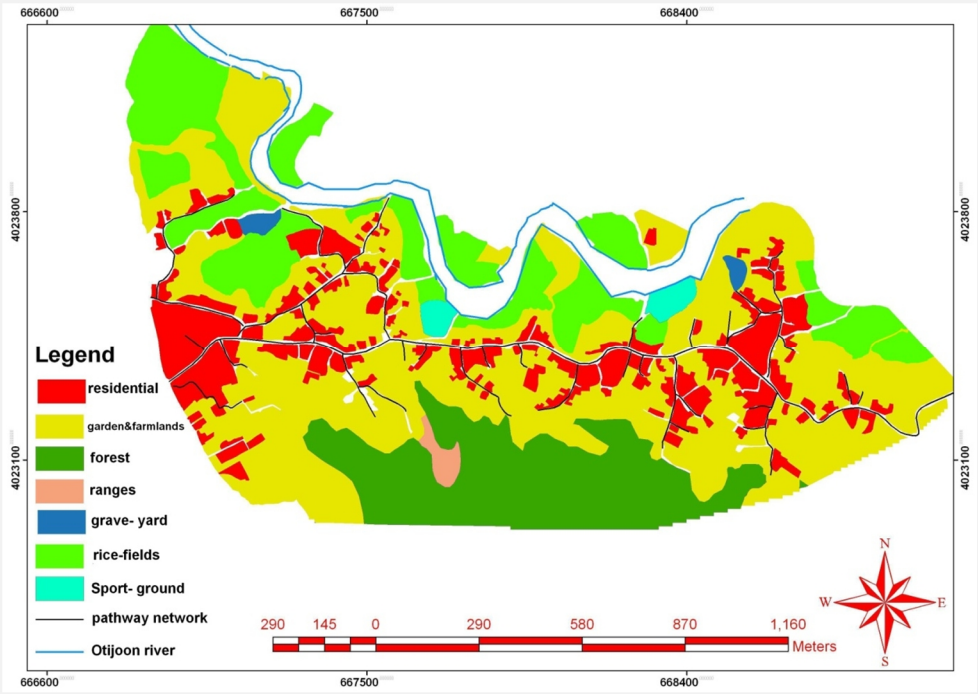

Figure 5. Land cover/ land use in the study area.

With reference to this, it should be mentioned that the study area comprises two land units of low-lying mountainous land with the relatively high range of the Alborz Mountains in the upper part and slope plains with rivers in the lower part (Soil and Water Research Institute, 1995).

Based on this, the land use\land cover of the villages can be considered in proportion to the water, soil, and topography of the area. In other words, the deep soil with a heavy texture and a mild slope on the bank of Otijoon River helps the use of the land of this area for water –related activities, namely cultivating plants and rice. The damp climate and semi-deep soil of the sloped area is the location for small pockets of citrus gardens and farmland which, in the southern and eastern parts, spreads to the dense forest coverage.

From this figure it is evident that the physical development of the villages to the South and Southwest has been halted by forests to the North with the river and to the West by the road and the physical mass of the villages, along with the village pathways network laid between the farmlands and rice paddies.

Given the fact that the maximum height of the studied villages and their surrounds is 300 meters, elevation itself does not cause any limiting conditions for the settlement and development of the villages. Also, the factor of aspect had no effective role in this study in the context of the villages' formation; the variety of different geographical aspects is, however, as important in rural housing and farmland usage as is the quantity of humidity, light reception, temperature and

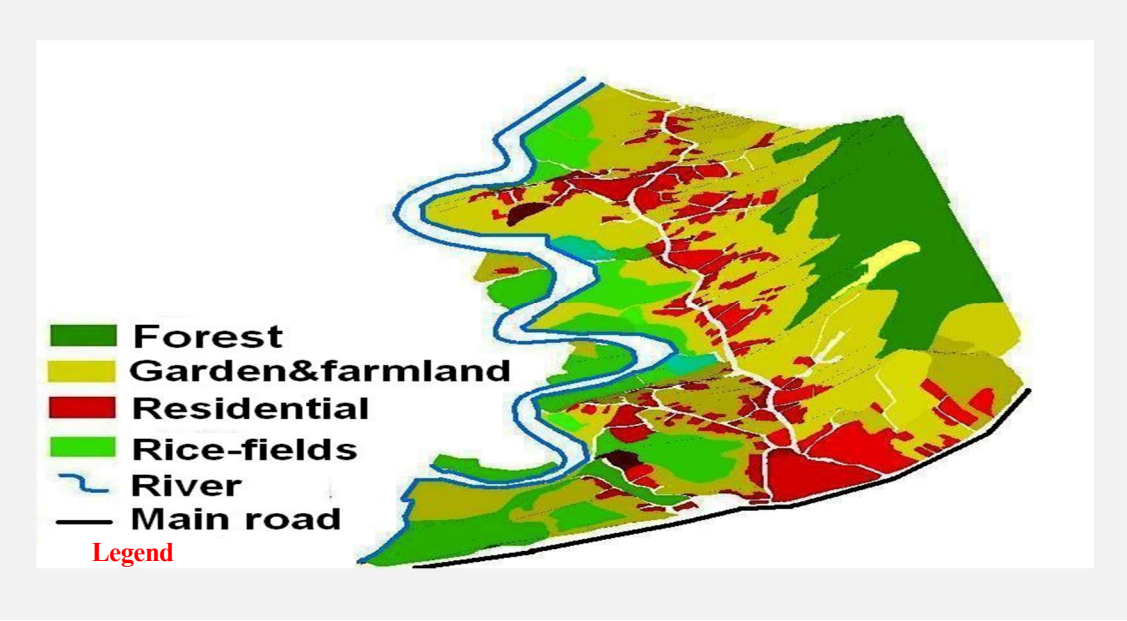

Figure 6. A 3D view of Andargoli and Malfe settlements.

evaporation amount. As a result, among various parameters of land form, slopes enjoy a more important role in the way the land is used in the villages studied. The slopes and steep surfaces of the rural areas are mainly used for such activities as farming, communicating paths, electrical transfer lines, water piping projects and housing. Each of these mentioned activities requires a certain amount of slope (Zomorrodian, 1994). So, by continuing with the overlay of slope layer and land use/cover layer, we can observe the critical threshold slope for construction, agriculture and roads network.

Overlapping slope layer with land cover/ land use layer

In this step, first the classified slope layer and land use\land cover in the GIS were laid over each other and it was decided which different land use areas and ranges are located on what degree of slope. Table 2 shows the slope areas of this region and the percentage of the square for each level use, applying GIS. In a second step, construction conditions, farmland and the village pathways network with its allowable limits were studied and the allowable slope threshold identified.

Table 2. Percentage of land use square on different slope levels of the study area.

Slope (percent) / Land use\cover	0-5	5-10	10-15	15-20	20-55
Residential	46.41	21.99	15.66	9.50	6.45
Garden and farmlands	30.66	26.56	16.48	15.07	11.24
Forest	50.57	34.48	10.58	3.06	1.29
Ranges	4.58	26.96	8.13	33.99	26.34
Rice-fields	7.95	9.42	17.09	51.30	14.24
sport - ground	62.36	21.38	16.26	-	-
Grave-yard	49.32	14.04	36.64	-	-

According to studies and the literature, residential zones must be located on areas with a maximum slope of 10 percent (DHV consultant Engineers of Holland – date? reference list?) and the costs of construction in areas with more than a 10 percent slope rises remarkably steeply. Thus, in Arc map software, structures located above 10 percent were identified and the results are given in the map in Figure 7. Also, slopes above 20 percent must be excluded from any residential development plans and should remain in their natural condition. According to Table 2, some land with a slope of more than 20 percent include landforms and gardens which, until recently, were covered with forest. Hence, considering the negative effects of farming on high slope areas, the researchers also present here farmlands of more than a 20 percent slope in Figure 8.

As Figure 7 shows, most structures located on the southern slopes of the village are built on slopes higher than the standard measures. This leads not only to an increase in the costs of construction and services, but also to a higher risk of vulnerability of the areas in the case of earthquakes and landslides. This is also true in the agricultural sector where, with an increasing slope, productivity is reduced as a result of the increase costs of agricultural activities and potential for erosion.

The results of the statistical analyses on Central Idaho southern farmland support the idea that there is a negative correlation between the degree of slope and price of products (Vasquez, 2002).

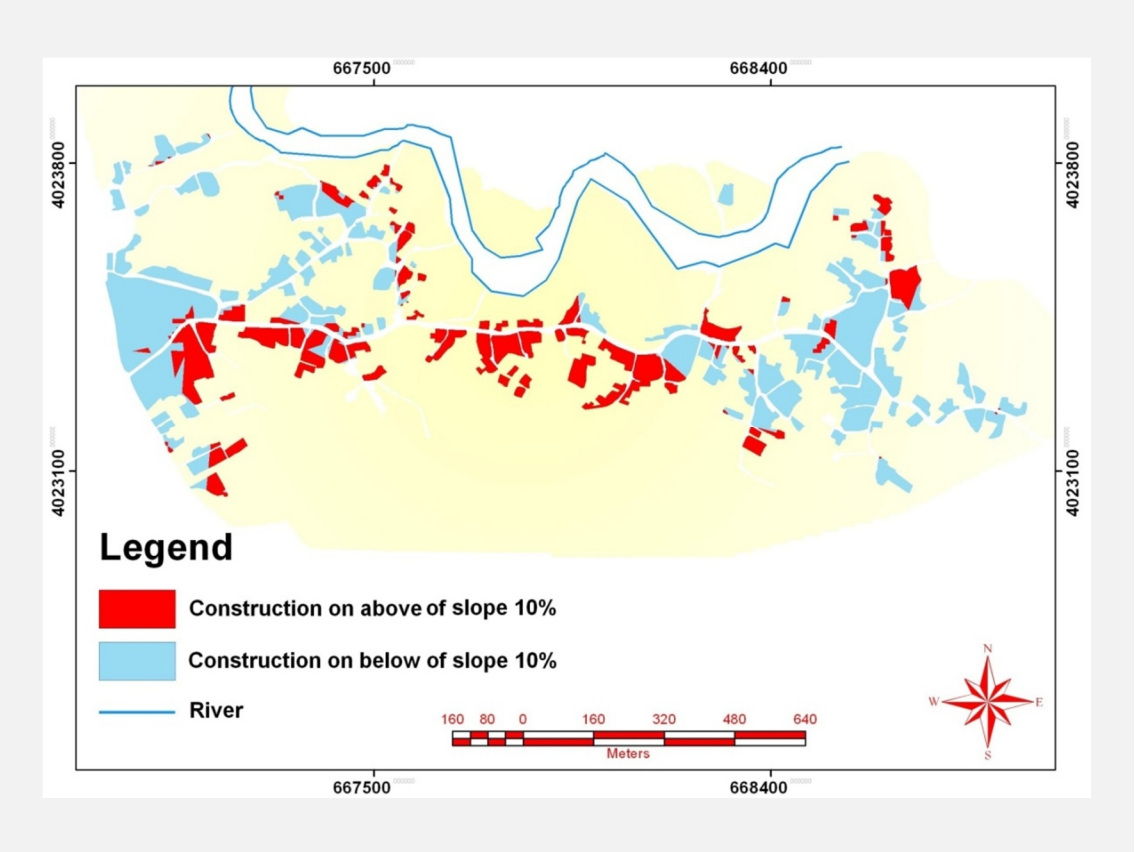

Figure 7. Constructions on an above standard measured slope.

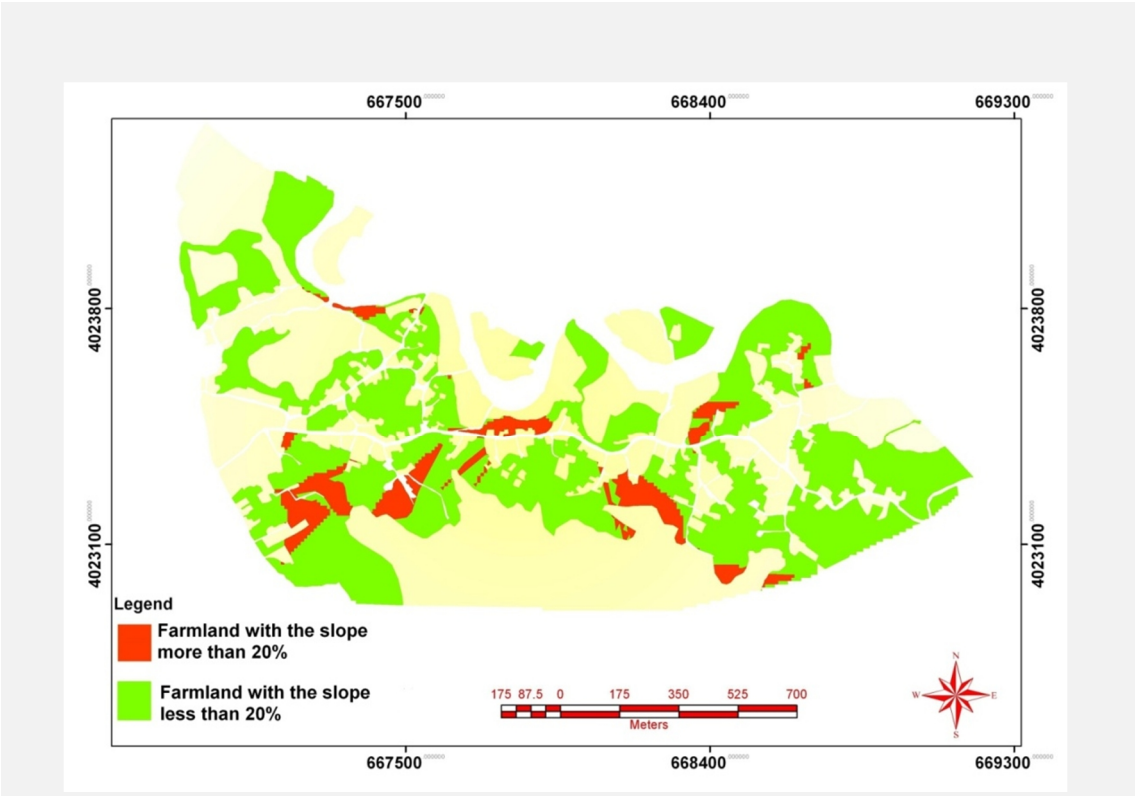

Figure 8. Farmland conditions in proportion to the standard measured slope.

As in the previous step, the correlation between slopes and the pathway network of the villages was studied. According to the available sources, the slope of streets is mainly 5 percent but, according to topographic conditions, it may be necessary to have a 5-6 percent for main streets and one of 10-12 percent for minor streets (Shia, 2006).

GIS analysis of the average slope of the pathways network (Fig.9) shows that the western paths enjoy a reasonable slope while the main path of the village has a slope higher than that of the standard one. Slopes are related to access paths the villagers use to reach their homes, gardens and farmlands.

Conclusion

In this study, by applying GIS the natural environment of Andargoli and Malfe villages was studied. GIS application of this area made it possible to achieve a more accurate analysis of the villages' natural environment and different spatial factors so that we could reach both an objective knowledge of the geographical space of the area and an understanding of the relations between the different factors and parameters. The results for the natural environment of the two villages shows that, because of suitable conditions such as a mild climate, fertilized soil, surface water supply, forest vegetation, and convenience to a service centre, the settlement and habitation pattern of the village is both rational and appropriate.

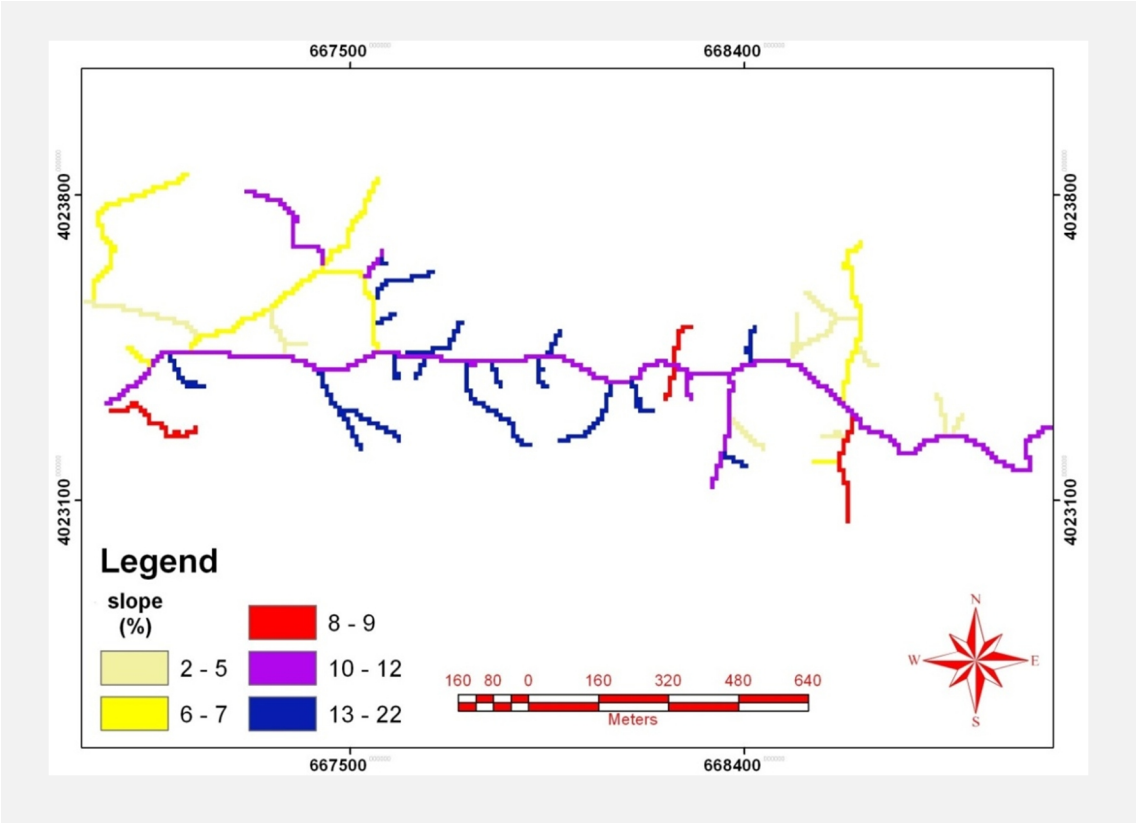

Figure 9. The average slope of pathway of the studied villages.

However, the important issue in this regard is to pay attention to sustainable exploitation of resources and to increasing the quality of life in the villages by observing correct standards of exploitation. In some cases, these standards have not been considered; for example, the extension of farmlands to the high slope slopes of the southern part of the area, once covered with forest, will lead to instability of the land in the long run if it is not changed and, consequently, the probability of landslides and severe land erosion will rise. Farming and gardening activities are of high importance in Andargoli and Malfe villages due to its suitable water supply and soil conditions and farmers can earn a good living. In planning the village bodies and structures, we need to consider the following steps: preventing the felling of trees, reviving the damaged forest, improving soil texture, carrying out basic studies on crop water and nourishment requirements, observing topographic standards in construction of housing and pathways and paying attention to the limits of rivers and territory. Unfortunately, there is no consideration given to observing such issues as vegetation, water and soil in the service description format of the rural guidelines plans. Moreover, as previously mentioned, unlike in urban lifestyles the way of life in rural areas is specifically connected to nature and, so, ignoring the relationship between man and nature in rural planning leads to unwanted cultural and environmental consequences.

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