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Geospatial modeling of landscape ecological sustainability level in geo-tourism regions

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Abstract

Identifying various geomorphologic units with ecotourism attraction and determining the high-quality landscape are essential steps to improve quality and protect natural ecosystems. The present study aims to achieve a more appropriate landscape pattern in the framework of ecotourism development in the geo-tourism region of Bishe Waterfall in Iran, taking into account the landscape quality assessment and landscape ecological indicators. Appropriate ways are proposed to develop ecotourism for achieving sustainable ecotourism. For data analysis, Arc GIS, Idrisi, and Fragstats software were used. Also, The area of the study was determined using google earth software, and LAND SAT and NDVI images were used to produce vegetation type and density maps. The development of landforms evaluated the landscape quality units, and then 18 areas were selected as scenic landscapes and verified by using questionnaires. To evaluate the visual aspect, the area was divided into 17 49-hectare cells, and the corresponding metrics were compiled in Fragstats, and the related maps were produced for analyzing and evaluating the landscape pattern using Arc GIS. The results showed three levels of landscape quality assessment, which is distinct, ordinary and, poor, where the landscape quality from the horizontal perspective corresponds to the landscape quality from a vertical standpoint, but the results of the visual assessment of the area with the landform model showed that there is a conflict between the aesthetics and ecology in the region. This issue is determined by calculating the physical and realistic carrying capacity of recreational areas of the tourism zones.

Keywords: Bisheh, Ecological pattern, Fragstats, development of ecotourism, Landscape quality assessment

Introduction

In many countries, tourism has become one of the primary and key elements for economic development and progress. Implementation of conservation plans in advance of sensitive, fragile, and unstable ecological areas and cultural heritage are among the positive environmental benefits of Ecotourism (Santarém *et al.* 2015). The landscape is a dynamic system that changes a lot under the influence of the development process, which sometimes leads to environmental challenges. The environmental design aims to support, rehabilitate, and restore landscapes following an executive response to these challenges (Abdullah and Hezri 2008). Simultaneously, landscape ecology and ecological landscape assessments each have a special View on the landscape observation and provide an image of landscape conditions by evaluating it. These assessments provide an unrivaled opportunity for development designs to emphasize the interdisciplinary approach of their potential step in designing a better ecological landscape(Opdam *et al.* 2001).

Therefore, in this research, it has been attempted to review the thematic literature, based on an interdisciplinary approach, to show how environmental design can be a more appropriate paradigm for landscape intervention and environmental design with the aim of developing ecotourism, using landscape ecology and landscape assessment (Anowar *et al.* 2011).

The environmental design can enable us to provide more appropriate patterns (Bell 2012). So far, research on landscape patterns has focused on landscape, sustainability, and ecological conditions in urban areas and few studies have been conducted on the natural landscape areas. In this study, in addition to assessing landscape visual beauty from a horizontal perspective, the geo-tourism site of Bishe was evaluated for the development of tourism from a vertical perspective with visual criteria of the landscape.

In this regard, while considering the water curbs, the hydrological network, tourism preferences, the calculation of horizontal visibility criteria, the horizontal and vertical visibility matching and the` contrast between aesthetics and ecology were investigated through landscape metrics

Landscape Quality Assessment and Landscape Pattern

Landscape assessment is the classification of options in a range of choices, reflecting people's values and the degree to which they are favorable or need to be protected by the public (Hanley *et al.* 2009) . According to some researchers' viewpoint, there is a close connection between an idealistic landscape, and an ecological landscape, some explicitly believe that there is a close relationship between the visual aesthetics and ecological issues (Tveit 2009, Paul *et al.* 2007). The composition and location of the components of the landscape are the basic characteristics of the landscape pattern (Woon *et al.* 2019). The purpose of the spatial analysis is to discover the systematic order of the seemingly disordered landscape mosaic, and determine the mechanisms and factors important role in the patterns of the landscape. To understand the relationship between the landscape models and ecological processes, on the one hand, and the performance of the landscape, on the other, it is necessary to first determine the pattern of the landscape. Also, Landscape Pattern Analysis (LPA) plays an important role in resource management (Amal Najihah and Saiful 2019).

Landscape Ecological Indicators

Landscape Ecological Indicators are algorithms for quantifying the spatial properties of spots, classes, or mosaics of the whole landscape (McGarigal *et al*. 2009). Landscape Ecological Indicators are the best way to compare the state of Landscape of different lands. Landscape indicators are developed indicators to find the pattern of categorized maps (Renetzedera *et al*. 2010). These indicators can be used as the basis for comparing different landscape scenarios or recognizing changes in the state of the landscape over time. Landscape structure study, based on the ecology principles and landscape indicators, is a suitable tool for mapping and quantifying the spatial characteristics of each user as their constituent parts (Nazren *et al*. 2016).

Study Area

Bisha village in Khorramabad city in Lorestan province of Iran is located at 48 ° 52 minutes east longitude and 33 degrees 20 minutes north latitude. Also, it is located at an altitude of 1200 meters above the sea level. In general, in terms of the topography, the village in question is located in a mountainous region, and it has created a village with the special feature of these types of rural areas (Figure1).

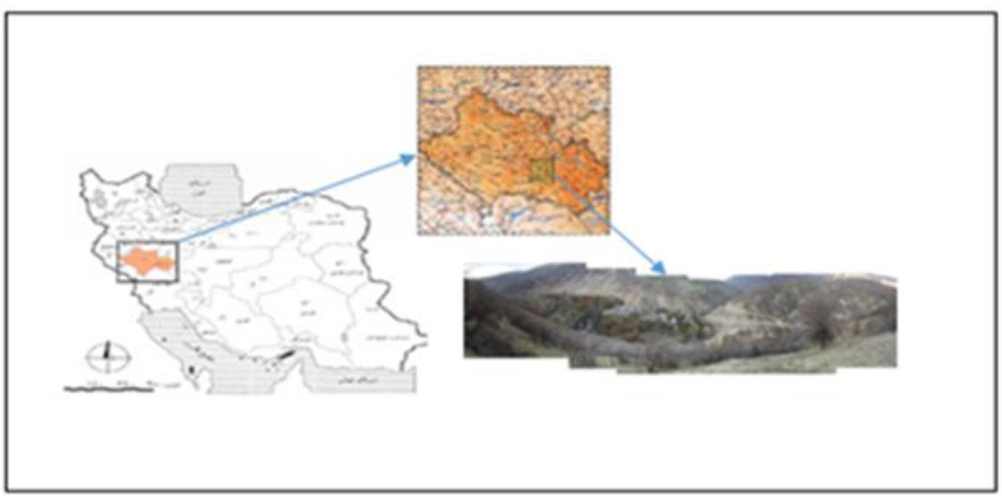


Figure1: Geographic situation of Bisheh village

Ecological Capability Assessment

Establishing a link between the land ecology, the landscape assessment, and the environmental design is possible in many different ways, but one of these methods is to use the results of the evaluations. Related indicators to the structure of performance and evolution are affected by goals and values. These indicators are used to clarify the current status and the favorable environmental status (Caro *et al*. 2020). In the same framework, the initial point is the commonality between the evaluation of the two dimensions of landscape ecology and landscape assessment, and it forms the basis for the environmental design activities (Cassatella and Peano 2011). In each case, the main goal is to achieve a kind of coherence and integrity in which there is a conservation of sites and resources and a level of continuity of ecological processes that can somehow increase the environmental issues such as richness and biodiversity, while reducing ecological disturbances. Therefore, the stages of this research are:

1. Creating homogeneous environmental units Using GIS 10.1 software,
2. Determination of the visual quality of the landscape according to the environmental capability and identification points with the appropriate perspective (as an important element in tourism).
3. Estimation of the carrying capacity of the scenery zones

After preparing the units of the regional environment units, units from the highest to the least variety and diversity (in terms of environmental characteristics, including slope percentage, the altitude from the sea level, geographic location, type of soil, vegetation type and mass, and the type of waterway network) were categorized as privileged, ordinary, and poorly, respectively. Then, by studying the field between the first class (privileged image), the landscapes and azimuths of each of these regions were prepared and Its quality was checked. Also, the carrying capacity of the appropriate areas for the development of tourism was calculated using the guidelines (IUCN 2018).

Determination of Carrying Capacity

To assess the tourism carrying capacity, the area of the region's susceptible tourism was calculated through the map of homogeneous ecological units (Winter *et al*. 2019) and Arc GIS software.
The physical carrying capacity for the susceptible zones is calculated by this formula:

$$\text{Pcc} = \text{A} \times \text{Rf} \times \text{Va}$$

where:
A= Privileged zones area (m^2)
Va = Number of people for outdoor recreation per square meter
Rf = Number of visits per day
Therefore, the physical carrying capacity for the susceptible tourism zone (privileged class) is as follows:
Pcc =2493584×1×1/2=1246792 person

To determine the actual carrying capacity, elevation, soil depth, vegetation cover, and rock mass resistance and soil erosion were classified as ecological factors.
The principle of threshold values in ecology was used to determine the ecological vulnerability. Accordingly, the vulnerability level of each class of ecological factors was determined based on numbers

1 to 4, where number 1 means the least vulnerability and 4 the highest vulnerability levels. In the next step, based on the Two-way comparison method, other weights were calculated. Then, by combining the relative weights, the final weight of each characteristic was calculated. Accordingly, the weight of ecological factors was obtained from table 1.

Table 1: weight of ecological factors

Ecological Factor	Weight(W)
Rock mass Resistance	0.173
Soil Erosion	0.242
Vegetation Cover	0.156
Elevation	0.290
Soil Depth	0.139

Then, the ecological vulnerability of each class was calculated:

$$\mathrm{Hi} = \mathrm{Wi} \times \mathrm{Si}$$

Where:
Hi= ecological vulnerability of each class
Wi= weight of each class
Si= ecological vulnerability code of each class

Percentage of ecological limitations of each class also was calculated by this formula:

$$\mathrm{Cf_i} = \left\lfloor 100 \times \frac{(\mathrm{Ai} \times \mathrm{Hi})}{(\sum \mathrm{Ai})} \right\rfloor$$

where:
Hi= Ecological vulnerability of class *i*
Ai= Area with the ecological vulnerability of class *i*
ΣAi= Total suitable area

Finally, the percentage of ecological constraints for the privileged area was calculated for a range of studies on the desired ecological factors. An example is provided for soil depth ecological constraints in Table2

Table2: Determination of percentage of soil ecological constraints

Soil Depth	S	W	H	Ai	$\mathrm{Cf_i}$
Very low	4	0.139	0.556	324217.8	7.29
low	3	0.139	0.417	956315	15.99

Low to medium	2	0.139	0.287	710397	0.12
high	1.5	0.139	0.209	428209	3.58
very high	-	0.139	0.139	74445	0.41
sum	-	-	-	2493584	27.33

Climatic constraints such as rainy and snowy days, freezing days, and the mean of cloudy weather were 45.08% concerning reported days and hours. Therefore, this actual range capacity is calculated for suitable areas of privileged outing as follows:

$$\mathrm{Rcc} = \mathrm{Pcc} \times \left\lfloor \frac{(100-\mathrm{cf1})}{100} \right\rfloor \times \left\lfloor \frac{(100-\mathrm{cf2})}{100} \right\rfloor \times \ldots \times \left\lfloor \frac{(100-\mathrm{cfx})}{100} \right\rfloor$$

$$\mathrm{Rcc}=1246792\times\frac{100-0/5492}{100}=1239944.62$$

It should be mentioned that: Premium recreation area includes private gardens and can be accessed by removing specific gardens from a privileged recreation area.

Landscape Assessment

Fragstats software was used to quantify the indices to study the spatial structure and spatial analysis of different land-use indices. Before data entry into Fragstats software, data preparation operations were carried out on the Iidrisi software based on the data quality on the vegetation maps of the study area, and finally, the vegetation raster map was used for statistical analysis. In this regard, the classification of the maps according to the types of land-uses in the present study was again performed. For example, in the case of forest land use type which had a single-floor organization map using field studies Land sat satellite imagery, the vegetation type map of the forest was prepared in three classes and was used as the baseline map. The grid of intersections was combined with the vegetation layer of the area and the Intersect off-limits. Also, 17 maps of the same area were obtained as Landscape mosaics. The maps were then converted to Raster and then to Ascii to access Idrisi software. All maps were imported into Idrisi respectively and converted from Real to Integer and finally for Fragstats.

Diversity indicators

This group includes a set of metrics that describe the composition of the landscape. The metrics are completely non-spatial and deal with the number and area of the patches on the landscape. In this study, 4 metrics SHDI, SHEI, SIEI, and RPR were used to evaluate the aesthetics of the area; each of them is described in the Landscape evaluation from a tourism perspective.

Valuing the area's perspective from a tourism perspective

At this stage, to compare the areas designated for tourism development from a landscape perspective and landscape quality with the areas used for tourism in the study area, a questionnaire was prepared and the results of landscaped privileged areas were studied. The results of comparing the privileged areas in terms of landscape with the privileged areas of tourism were examined from the perspective of regional tourism. For an initial introduction to the place, first, a 24-hour voyage was made in early spring to the

Bisheh waterfall area. The questionnaires were reproduced and distributed to tourists during two seasons. The study was conducted for six months and the data obtained from the questionnaire and other information was, then, analyzed. Birds and plants were sampled and photographed during the visit. After collecting the completed questionnaires, the questionnaire questions were classified as statistical tables.

Ecological Assessment of Landscape

In this part of the study, four landscape metrics were used to interpret the composition and spatial distribution of the structural elements inland landscape acording to Table 3. For the ecological evaluation of the area, all 17 cells were inserted into the FRAGSTAST software, as required, and metrics were selected, and the results were calculated:

Table 3: Applied Lanscape Metrices for Interpreting of Elements Spatial Distribution

Scope of Changes	**Unit**	**Abbreviation**	**metrics**
NP>0	-	NP	Number of Patches
0<PLAND<100	%	PLAND	Cover Precentage
MNN>0	meter	MNN	Medium distances to the Nearest Neighbor
MPS>0	hectare	MPS	Medium patch Size
CA>0	hectare	CA	Category Area

Results

Visual quality assessment results

The combination of elevation, slope, orientation, soil, vegetation type, and forest type maps of the environmental units (units) was obtained with 5 environmental units. Diversity was selected and mapped as privileged (1), average (2) and poor (3) areas, respectively. Scenic landscapes were identified among the first-class or field-preferred landscape.

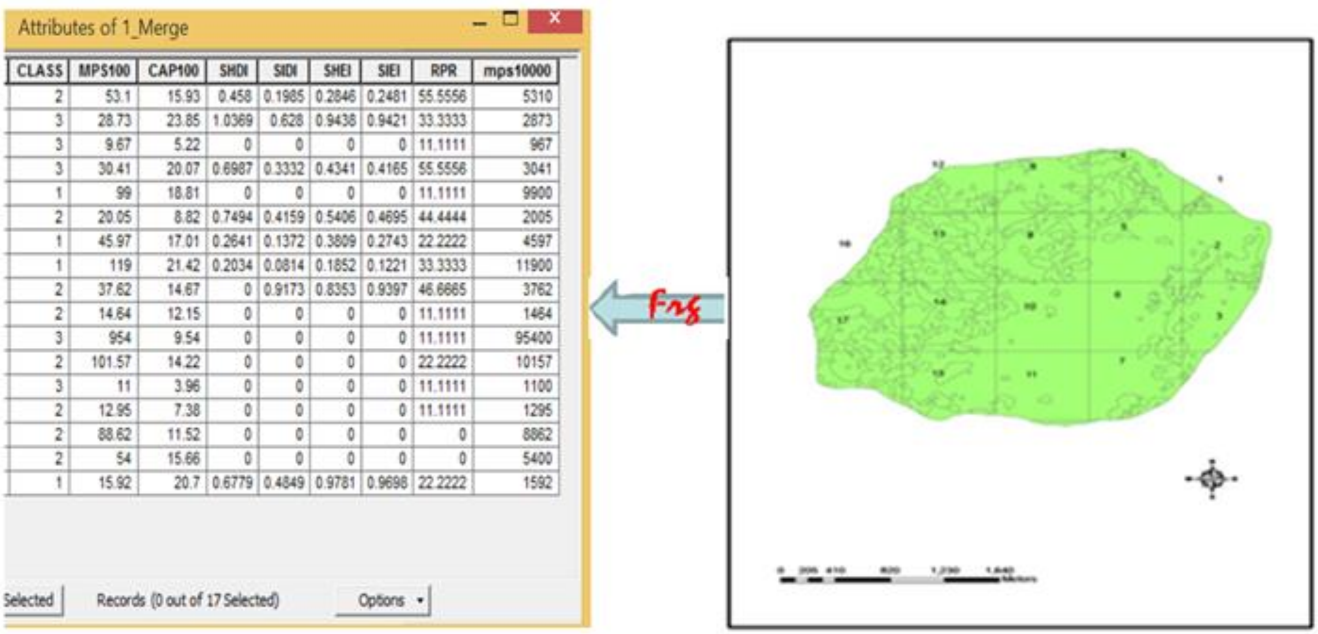
Since the number of scenic areas for development on the first level (privileged landscape) was sufficient due to the forest area, the quality of the scenic landscapes was selected for the selected locations. The scenic spots are shown in Numbers Map (Figure 2).

Estimated Range Capacity Results

The comparison of the calculated quantities shows that considering the ecological constraints in the study area including altitude, soil depth, vegetation, and base rock resistance lead to a reduction by 95 % of physical carrying capacity in areas that are prone to tourism development. Despite the lack of reliable information, this estimate does not consider other limitations such as expectations, psychology, the culture of visitors, and management goals; thus, it does not indicate effective indicators of carrying capacity. However, a considerable reduction in the number of permitted tourists has a highly significant impact on the sake of the environmental planning process for the intended area. It should be considered that the development of the tourism industry underlines the native inhabitant's participation in Tourism corresponding occupations.

Landscape Assessment Result

The squared zoning method is used in the metric mapping. The shape of the geometric unit and its area depends on the variety of use or land cover, the total extent of the study area, the map scale, the quality and scale of the image, the accuracy and purpose of the study. Four metric values were calculated for each of these 17 squares, which were entered to the GIS (Figure 2). For each of these metrics, the maps are provided (Figure3).



CLASS	MPS100	CAP100	SHDI	SIDI	SHEI	SIEI	RPR	mps10000
2	53.1	15.93	0.458	0.1985	0.2846	0.2481	55.5556	5310
3	28.73	23.85	1.0369	0.628	0.9438	0.9421	33.3333	2873
3	9.67	5.22	0	0	0	0	11.1111	967
3	30.41	20.07	0.6987	0.3332	0.4341	0.4165	55.5556	3041
1	99	18.81	0	0	0	0	11.1111	9900
2	20.05	8.82	0.7494	0.4159	0.5406	0.4695	44.4444	2005
1	45.97	17.01	0.2641	0.1372	0.3809	0.2743	22.2222	4597
1	119	21.42	0.2034	0.0814	0.1852	0.1221	33.3333	11900
2	37.62	14.67	0	0.9173	0.8353	0.9397	46.6665	3762
2	14.64	12.15	0	0	0	0	11.1111	1464
3	954	9.54	0	0	0	0	11.1111	95400
2	101.57	14.22	0	0	0	0	22.2222	10157
3	11	3.96	0	0	0	0	11.1111	1100
2	12.95	7.38	0	0	0	0	11.1111	1295
2	88.62	11.52	0	0	0	0	0	8862
2	54	15.66	0	0	0	0	0	5400
1	15.92	20.7	0.6779	0.4849	0.9781	0.9698	22.2222	1592

Figure 2: Maps of Network and Metric Quantities of Landscape

Individual Analysis of Landscape Metrics in the Area

According to the RPR index, the relative richness of patches is changeable from 0 to 55.55 per cell. Also, the large part of the relative richness has existence in the cells of 1, 4, 6 and 9, indicating a prominent region from the landscape perspective. Additionally, there is the lowest part in sections of 3, 5, 10, 13 and 14, demonstrating areas that not only have a shortage in the amount and variation (diversity) of patches, but also it contains weak landscape. Based on the area distribution amongst different patches driven from dividing the level of variation by the maximum diversity, and when the area is distributed equally amongst the patches, it will be equal to 1. The SHEI and SIEI metrics demonstrate vegetation in the area at which the highest SHEI values range is from 0.185 to 0.978, and consist of cells 1, 4, 6, 7, 2, 9 and 17. The aforementioned cells are located in river. From the tourists' outlook, these areas lie in the high level of landscape. Besides that, the lowest levels are discovered in cells of 5, 3, 11, and 15 indicating imperfect landscape. The highest SIEI values differ from 0.1221 to 0.96 which includes cells of 1, 2, 4, 6, 7, 9 and 17 which is perfectly consistent with the Shannon uniformity index.

According to SHDI, the highest and the lowest values are classified in cells of 1, 2, 4, 6, 7, 17 and 3, 5, 9, 10, 11, respectively. In the present study, according to the results of Shannon and Simpson diversity indices, there are three different clusters as following; 1) when the proportion is greater than zero, the cluster distribution is seen, 2) while it equals to 1, it is a random distribution, and 3) if the values are less than one, it will be representative of uniform vegetation.

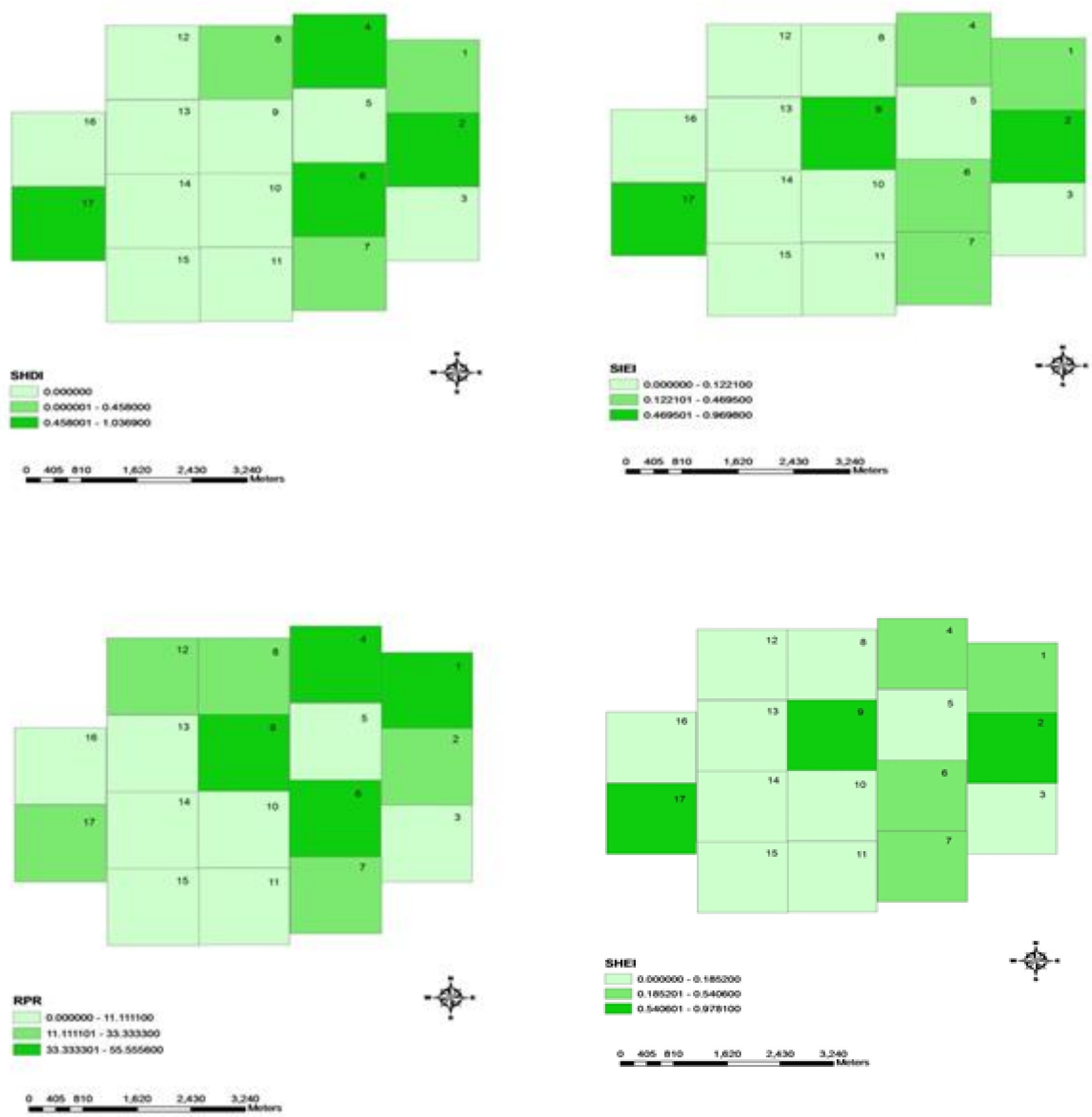


Figure 3: Individual Metric Analyses

Final Analysis of Landscape Quality Assessment

As mentioned earlier, none of the metrics can represent the proper or inappropriate state of the landscape. On this account, every single of the metrics must be considered in the analysis of the landscape. It requires classification on the base of 4 metric values the first class of which is the most prominent in terms of landscape. Besides, it is followed by the 2th and the 3th class where they grouped into the poor and average categories. On the account of this category, in the following map is determined that:

1) ***class 1: SHEI>0.185, SIEI>0.1221 RPR>11.11 ,SHDI>0.0001,***

Class one is observed in cells 1, 2, 4, 6, 7 and 17, where diversity and richness are at their best. It comprises of the areas around the waterfall. As per tourist's points of view, these areas have a higher value of beauty and quality of landscape than the other forests.

2) ***class 2 : 55>RPR>33,0.45>SHDI>0 AND 0.548>SHEI>0 , 0.46>SIEI>0.12***

This classification is a north section of the regions and situated in cells of 8 and 9. The landscape is moderately beautiful, consisting of suburbs of the village, the railway station, residences, and the slopes of the Gaffe Mountains.

3) ***class 3: SHEI<0.185 AND SIEI<0.1221 RPR<33 AND SHDI<0.0001***

The western part of the study area contains poor vegetation such as low density and semi-density Oak. Also, these cells encompass the Gaffe Mountains. However, it is normal that this area attracts fewer tourists owing to the steep slope, distance from the waterfall, and the river.

The comparison of the results of the questionnaire with the results of the evaluations

In response to the questionnaires, the majority of tourists (83%) commented that the summer season would be the best moment to travel to the mountainous area and cold weather rather than winter and autumn. Over half of those surveyed (54%) reported that the purpose of visiting the area is to utilize the landscape. Approximately three-fourth of the participant (76.66%) said that they prefer watching nature to other leisure activities. So, 89.66% of tourists travel to the area to watch the waterfall. Seventy-eight percent of those interviewed showed that unlimited presence of tourists causes damage to Bisheh Waterfall in the lack of proper supervision at the Seasonal tourism. Also, it has not provided appropriate compensation to solve the problem, yet. As stated by tourists, the ultimate landscape assessment maps are in line with classes of 1, 2 and 3 classes with the privileged, ordinary, and weak patches about the desirable region at the present study area. Therefore, the ecological structure of the study area must be examined, especially with regards to the tourism-prone areas.

Ecological Stability Assessment of Landscape

The principal objective of the environmental design aims to protect and preserve the environmental Functions by preserving, reviving, reclaiming, and restoring natural and ecological structures. On the foundation of this goal, either the landscape ecological assessment or the landscape analysis contributes to great and valuable help in achieving the above-mentioned goals. It is vital to utilize ecological landscape metrics. Hence, we analyze the ecological status based on the landscape metrics.

The majority of NP patches are reprehensive of the area's green spaces. The presence of these orchards in these cells along with the crushing phenomenon highlights the importance of paying more attention to this cell for communicating between the green spots and creating a larger patch. Additionally, we have the lowest NP levels in the north and south parts of the region. It should be considered that a high NP level indicates the fragmentation phenomenon and the land is involved in the environmental disturbance. Furthermore, a low NP level denotes stability unless it is fewer than the acceptable range.

As for the CAP, 24 % has been the highest proportion of green spaces. The highest CAP was compared with the rest of the cells. It is found that the lowest amount of CAP is related to the low-density oak vegetation that covers the areas of the Gaffe Mountains.

With regards to MPS, the eastern part of the region and the surrounding river comprise of the least values. Both the number of patches and the related area is small, implying the fragmentation phenomenon. For instance, the highest proportion of green spaces has a smaller area. So, MPS values are both in the low state and are not in a good standing regarding the stability of green spaces. The highest amount of MPS is covered with the low-density oak vegetation. As a result, the large patches rise with low numbers. The MNN metric ranges change from 0 to 71.51 meters with approximately three-fourths cells in the range. The magnitude of this metric has an inverse relation with the stability of green spaces. Generally, it can be told that the MNN metric is in a desirable condition; however, it must not be taken the only procedure for demonstrating the stability of green spaces. Since the cells, in which there are several patches, has a lower MNN, this indicates a fragmentation in the surface of the green patches

The Final analysis of the Ecological Sustainability Level of the Area

As mentioned earlier, none of the metrics values can singly represent the precise ecological status of the area. Therefore, these metrics must be considered simultaneously and taken into account in analyzing the ecological status. Figure 4 presents the details the data on that:

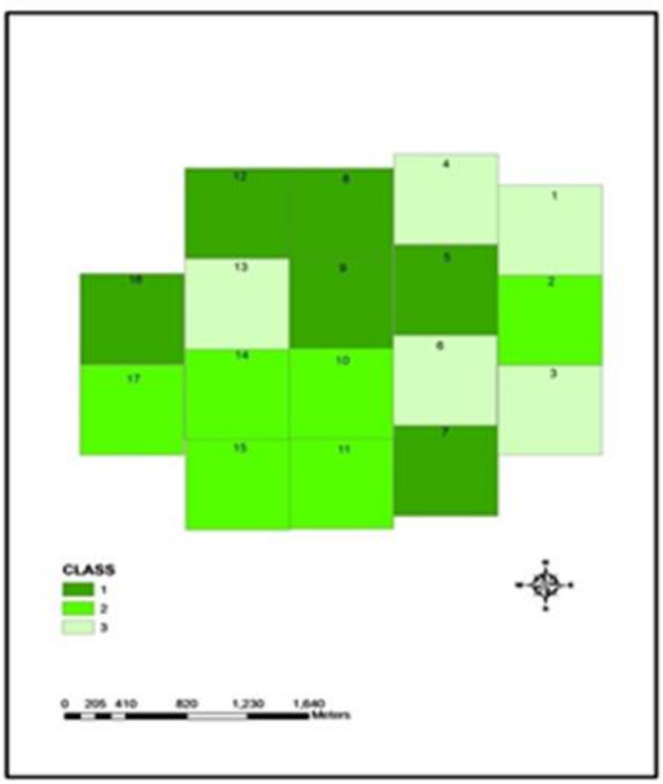


Figure 4: Final Map of Ecological sustainability level

It requires classification based on four metrics in need of providing the maps. The classification is as follows: a) class 1 is the most ecologically sustainable, b) the 2nd class is the most inappropriate and c) the 3rd class sets as the ecologically unstable situation.

Category 1: NP<83, MPS <30.4, MNN>61.34, CAP>12.15

There are flora patches that are more Coarse-grained in comparison with the rest of the classes and have a small distance to one another. Due to CAP zones, the few patches indicate the high consistency and relative integrity of the flora patches in this class. Thereupon, the cells 5, 7, 8, 9, 12 and 16 are in this category, most of which are in the northern part of the region.

Category 2: 24<CAP<7.38,100<MPS<10,50<MNN<62,1<NP<130

The flora patches are very small polygons and their frequency is lower than the first class. It comprises the southern and southwestern zones and cells of the region. These cells mainly are composed of forests.

Category 3: NP<19, MNN<61, MPS<54, CAP<23.85

This class comprises the eastern part of the region and the surrounding zones of the waterfall, the river, and the village. The composition and distribution of the flora reflect the Undesirable status. The flora patches are placed in the distance to each other and the very little area is occupied in comparison to other categories. Much of the flora patches encompasses the green spaces around the Cesar or Sezar riversides. A lot of construction, building and high density have been initiated in these sections. Some gardens are in the southern and northern zones, as well. The development of the tourist instruments threatens the gardens of this area. Therefore, it requires more attention and protection.

Discussion and conclusion

Landscape visual quality assessment is an essential component of the environmental impact assessment and can provide decision-makers with information about the effects of the proposed development activities and land use on the visual quality of the landscape. To evaluate the visual and natural qualities of the Bisheh Wasteful, the classification of units to superior, common, and inferior was prepared by field research amongst the superior spots of each of these areas for the environmental design and planning.

Taken together, seven points were identified in the Bisheh Wasteful. Their range is often the west and north of their range, covering a wide range. Our research has highlighted the importance of these areas that can be developed for hiking, cycling, canoeing, and garden landscapes. Besides, fishing and other ecotourism facilities in the study area should be considered following some of the principles regarding the quantity of visitors' capacity of the recreational facilities for programming and planning. The ultimate map was drawn to distinguish the scenic areas following the definition of the landscape quality from a horizontal perspective. The quality of the landscape was assessed by using the landscape model in the next step.

Land use metrics are widespread, extensive and can be grouped into seven general categories:

1. The use and lack of selection of Landscape Metrics
2. The analysis of habitat and biodiversity
3. The water quality estimation
4. The evaluation of the landscape model and its changes
5. The Landscape Urban pattern, roads, and networks

6. Landscape Aesthetics
7. Management, planning, and monitoring

As reported previously in this paper, the metrics of the Landscape Aesthetics group/department/ category have been used in assessing the quality of the landscape from a vertical perspective. Therefore, the visual quality of the landscape was carried out separately based on the RPR, SHEI, SIEI, SHDI metrics at first. Then, it is analyzed jointly and the results were classified and mapped. The preferred areas of tourism, which are based on the visual quality of the area's landscape, are mainly located in the western part of the bush area. These include the Sezar River, the Pesil River, the Bisheh waterfall, and the gardens. On the other hand, the region dense forests are mainly located in these areas. So, this implies that the visual assessment of the landscape is done correctly.

It should be noted that discrepancies are found in the maps since, as illustrated in the first map, all criteria including slope, elevation, hydrology, etc. are evaluated based on all indicators which are very important in the beauty landscape (such as waterfalls). Ensuring the accuracy of our results, the next steps were evaluating the visual aesthetics in terms of tourists' points of view in the area. Therefore, 150 questionnaires were distributed among the tourists present in the area during the two seasons. The findings of these questionnaires suggested that the tourists' chosen areas are ideally aesthetically pleasing for recreation, and these areas are precisely inconsistent with the superior ones obtaining from the metrics and landform evaluation.

Thus, the region 1, 2, and 3 are superior, weak, and inferior in terms of the landscape quality, respectively. Tourists prefer the river, waterfall, village, gardens, and forests for recreation. The spots are located in the third category referring to the areas which were chosen by tourist owing to higher slope, altitude, and water distance. This region is mainly comprised of the uppermost part of the heights. The related map should be analyzed and examined to determine the discrepancy, difference, or conflicts between the aesthetic ecological sustainability of the study area.

The cells 4, 1, and 6 at which are located as the best category of the area's aesthetics, have very unstable ecological status. To put it simply, the most unstable regions are amongst the most superior and privileged landscape autistics. The riversides and waterfall placed at the 1st and superior class concerning landscape assessing methods (horizontal, vertical, tourist point of view), have unstable ecological conditions.

The number of patches has increased due to the intense usage by the tourists in the areas leading to the ecological breakdown of the region. Also, cells 12, 5, 5 and 16, which have a level of stability of class I, are in the inferior class of the landscape evaluation. Hence, these cells have poor aesthetic value in terms of ecological stability and health. Also, Cells 15, 14, 11, 10 and 17, which have normal ecosystem health status, are classified in two classes of stability, including a third (poor) landscape assessment. Our study have led us to conclude that this region has partly aesthetic and ecological conflicts because of the intensive presence of tourists in the scenic areas.

The evidence from this study suggests the idea that Carrying Capacity includes Real Carrying Capacity and Physical Carrying Capacity for the tourism development industry. The present findings revealed that the Physical Carrying Capacity decreased by up to 95% in the tourism-prone area by considering the ecological constraints in the zone. Moreover, this assessment does not consider other parameters such as expectations, psychology, the culture of visitors, and management objectives due to the lack of reliable information. Hence, the Carrying Capacity indicator is not effective. However, the significant reduction in the permitted visitors can have remarkable and outstanding effects under the impact of the ecological constraints in the estimations for the development of environmental planning in the Bisheh area.

References

Abdullah S.A., Hezri A.A. 2008. From Forest Landscape to Agricultural Landscape in the Developing Tropical Country of Malaysia: Pattern, Process, and Their Significance on Policy. Environmental Management 42; 907–917. https://doi.org/10.1007/s00267-008-9178-3

Amal Najihah M., Saiful A. 2019. Developing Urban Green Space Classification System Using Multi-Criteria: The Case of Kuala Lumpur City, Malaysia. Journal of Landscape Ecology 12(1):16-36. https://doi.org/10.2478/jlecol-2019-0002

Anowar H., Siwar C., Shaharuddin M., Rabiul I.,2011. The Role of Home Stay for Ecotourism Development in East Coast Economic Region. American Journal of Applied Sciences. 8 (6): 540-546. https://doi.org/ 10.3844/ajassp.2011.540.546

Bell Simon. 2012. Landscape: pattern, perception and process. Second Ed. Tylor and Francis group

Caro C., Cunha P., Marques J.C. and Teixeira Z., 2020. Identifying ecosystem services research hotspots to illustrate the importance of site-specific research: an Atlantic coastal region case study. Environmental and Sustainability Indicators. 100031. https://100031. 10.1016/j.indic.2020.100031.

Cassatella C., Peano A. 2011. Landscape indicators: Assessing and monitoring landscape quality. First Ed. Springer Science. doi:10.1007/978-94-007-0366-7.

Hanley N., Ready R., Colombo S., Watson F., Stewart M., Bergmann E. 2009. The impacts of knowledge of the past on preferences for future landscape change. Journal of Environmental Management 90(3):1404-1412. https://doi.org/10.1016/j.jenvman.2008.08.008

IUCN. 2018. Tourism and visitor management in protected areas, Guidelines for sustainability

McGarigal K., Tagil S., Cushman S. 2009. Surface metrics: an alternative to patch metrics for the quantification of landscape structure. Landscape Ecology 24: 433–450. **doi**:10.1007/s10980-009-9327-y

Nazren L., Mohammad Firuz R., Rd Puteri Khairani K. 2016. GIS-based integrated evaluation of environmentally sensitive areas (ESAs) for land use planning in Langkawi, Malaysia, Ecological Indicators 61(2): 293-308. https://doi.org/10.1016/j.ecolind.2015.09.029

Opdam P., Foppen, R., Vos C. 2001. Bridging the gap between ecology and spatial planning in landscape ecology. Landscape Ecology 16: 767–779. https://doi.org/10.1023/A:1014475908949

Paul H., Gobster E., Joan I., Nassauer E., Terry C., Daniel E. 2007. The shared landscape: what does aesthetics have to do with ecology?. Landscape Ecology 22: 959–972. DOI 10.1007/s10980-007-9110-x

Renetzedera C., Schindlera S., Peterseilab J., Prinza M., Mücherc S., Wrbkaa T. 2010. Can we measure ecological sustainability? Landscape pattern as an indicator for naturalness and land use intensity at regional, national and European level. Ecological Indicators 10(1): 39-48 https://doi.org/10.1016/j.ecolind.2009.03.017

Santarém F., Silva R., Santos P ,2015. Assessing ecotourism potential of hiking trails: A framework to incorporate ecological and cultural features and seasonality, Tourism Management Perspectives 16: 190-206. DOI: 10.1016/j.tmp.2015.07.019.

Tveit M. 2009. Indicators of visual scale as predictors of landscape preference; a comparison between groups. Journal of Environmental Management. 90(9): 2882-2888. https://doi.org/10.1016/j.jenvman.2007.12.021

Winter P. L., Selin S., Cerveny L., Bricker K. 2019. Outdoor Recreation, Nature-Based Tourism, and Sustainability. Sustainability 12(1): 81-92. https://doi.org/10.3390/su12010081

Woon H., Saiful A., Shukor N. 2019. Land Use and Landscape Pattern Changes on the Inside and Outside of Protected Areas in Urbanizing Selangor State, Peninsular Malaysia. Journal of Landscape Ecology 12(2): 41-63. https://doi.org/10.2478/jlecol-2019-0009