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ANALYSIS OF THE FACTORS AFFECTING CHANGES IN LAND COVER PATTERNS IN RURAL DISTRICTS IN EAST OF GUILAN PROVINCE (IRAN) FOR FORESIGHT

Mostafa Taleshi[1]
Hassan Afrakhteh[2]
Mohammad Ali Rahimipour Sheikhani Nejad[3+]

[1,3]*Department of Geography, Payam Noor University, Tehran, Iran*
[2]*Department of Geography, Kharazmi University, Tehran, Iran*

(+ Corresponding author)

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ABSTRACT

Foresight is among the key topics in natural resource protection for sustainability of rural settlement system. In foresight of land cover evolutions, identification of factors affecting the evolutions is of paramount importance. In the present research, in order to undertake foresight and sustainable land planning in rural districts in East of Guilan as a special ecologic zone encompassing 744 villages, principle variables were collected via a questionnaire using Delphi method with the help pf experts, followed by calculation of significance factors. A total of 93 variables were found to affect the changes in land cover within the study area at local, regional and national scales. Among these, key variables were identified utilizing MIC-MAC Software. In order to develop scenarios by a 20-member expert panel, 19 key drivers of the changes in land cover were homogenized and 9 primary descriptor were defined. For each descriptor, three variant qualitative component were prepared, which described all possible cases from the most critical case to the most desired one. In the next stage, with the help of cross-impact balance matrix and Monte Carlo simulations in Scenario Wizard Software, a total of three scenarios with 15-year horizons were obtained based on maximum consistency. Finally, based on the maximal effectiveness on protection of natural land cover and continuation of sustainability, the obtained scenarios were designated as balanced ecologic changes, relatively balanced ecologic changes, and imbalanced ecologic changes.

1. INTRODUCTION

Results of recent research show that, changes in land cover/use in the future are caused by numerous drivers. Natural environment conditions, demographic changes, activities resulted from economic growth, attitudes of society and government, and surveillance patterns are among the fundamental factors and key drivers of such changes [1]. Biophysical drivers and socks (e.g. morphological earth processes, climate changes at local and global scales, etc.) are also among the factors contributing into changes in land use and, ultimately, land cover [2]. Today, identification of changing factors and the relationships among them is performed with the help of foresight techniques, and preparation of different scenarios is a well-accepted approach to achieve future trends. Because the scenarios present a systematic framework for exploring future trends [3]. The main advantage of such scenarios is that, they are not limited to the description of one future only, but tend to describe multiple possible futures or even the desired one [4]. The future, however, is impossible to be recognized perfectly or comprehensively. As such, the

aim of futurology is to systematically investigate and search, create and test both possible and desired future to improve decision-making [5].

As of now, numerous studies have been performed in the scope of spatial and physical planning. Among those, Goodarzi, et al. [6] used a hybrid method to propose a processing framework for implementing foresight studies in logistics development document of Yazd Province, Iran [6]. In 2014, Rahnama and Maroufi [7] performed a study in the city of Bookan where they used Delphi method for data collection [7]. The acquired data was analyzed using MIC-MAC Software, with scenarios formulated via Schwartz method. Moreover, Beheshti and Zali [8] conducted a study in East Azerbaijan Province where key factors were identified to formulate scenarios for the coming 10 years [8].

In a study published in 2015, Fierro [9] analyzed internal and external statuses with the help of SWOT model and used MIC-MAC model to analyze strategic variables while using MACTOR model to identify the role of respective stakeholders. He further used SMIC method to generate probable, possible, and desired scenarios [9] . In 2011, Banuls and Turoff [10] used Delphi method and cross-impact analysis for scenario development. In a study on the drivers of rural development [10]. in 2010, Delgado-Serrano, et al. [11] used MIC-MAC Software to undertake prospective structural analysis and graphically demonstrate the relationships among affecting and influenced factors [11]. In 2009, Ahmed, et al. [12] performed a study in Egypt to develop scenarios, where they used MIC-MAC method to identify primary actuators and analyze objectives and positions of key stakeholders via Mactor technique [12]. In 2007, Asan and Asan [13] proposed a complementary technique for cross-impact analysis method, wherein time-modified coefficients were applied [13]. In a study by Godet [14] identification of key drivers using MIC-MAC method, and trend analysis, player identification with the help of retrospective study methods and Mactor, attenuation of uncertainty about key factors using Delphi techniques and cross-impact analysis, and the choice of the most probable scenario using MORPHOL and SMIC PROB-EXPERT methods were proposed [14].

The studies performed by the authors within the study area during the past 26 years indicate that, ecologic and environmentally friendly land covers have followed decreasing trend and suffered from fundamental damages and changes, with the urban coverage being the only land cover experiencing a strictly increasing growth during these years. It is obvious that, continuation of this flow at current rate of changes and ever increasing tendency to undertake constructions will put environmental, economic, and social sustainability at risk. This is because of continuous damaging changes and modification of natural covers and farming without considering suitable alternatives for its use, with the trend of dominating natural and ecologic land forms being even more accelerated with technological developments and population growth. Although evolutions in human environment are indispensable, yet the current ever increasing rate of pervasiveness indicates lack of planning, control and surveillance on or failure to implement existing plans. In the study area, numerous events and states are observable, indicating isolated changes in land cover. These events are caused by key drivers of change. Deconstructive changes by farming land uses, abandoning rice fields and gardens, irregular constructions which are inconsistent with the environment, occupation of natural resources, change of stream and water canal paths, environmental pollution, unleased use of limited natural resources, elimination of natural land features, deforestation, and feeling ponds which may change ecologic land cover can be caused by factoristic, managerial, technological and even discriminating factors raised by the villagers who failed to establish a link between family livelihood and farming. Indeed, observed in the effects and results of the key drivers of changes in land cover. Therefore, it is necessary to identify this factors and drivers with the help of scenario development techniques as far as configuration of possible futures is concerned. In such a case, one can follow a sustainable path to a desired future by taking the required control measures. Nowadays, scenario-based planning techniques have gained large deals of attention in spatial planning, because of the advantages such techniques provide under uncertain conditions and complicated interactions between driving forces. Scenario based planning encourage strategic thinking and dominates

limitations of human thinking by constructing numerous futures. In this way, it can lay down the future considering social values and tendencies.

2. MATERIALS AND METHODS

2.1. Introduction of the Study Area

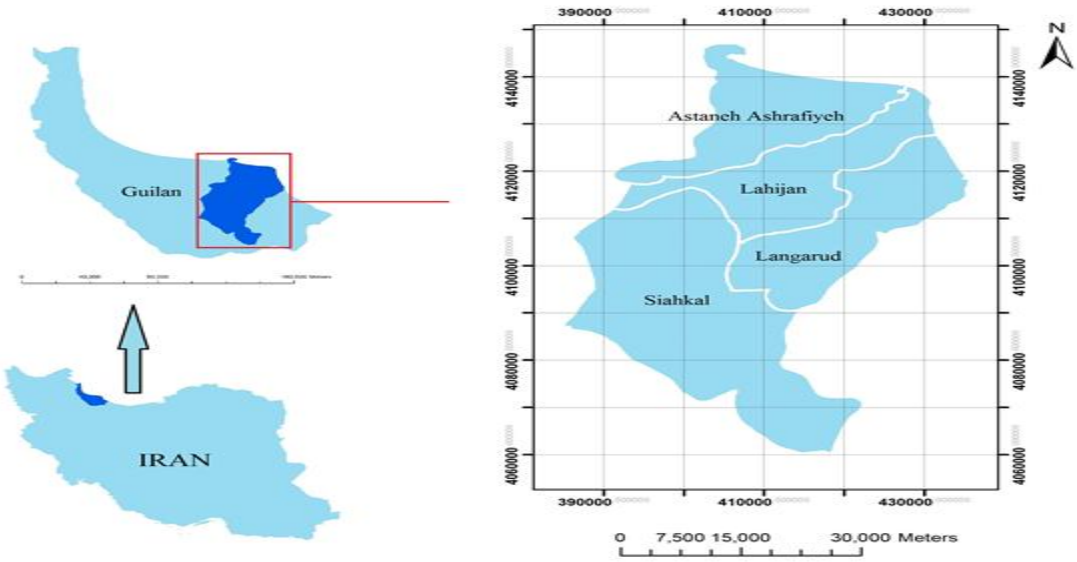

Figure-1. The study area

The area understudy covered Astaneh Ashrafiyeh, Siahkal, Lahijan, and Langarud townships in east of Guilan Province, Iran, covering a total of 2260 km² and accommodating a total of 744 villages (Figure1). Major agricultural products grown in this area include tea, rice, citrus and peanuts. During the recent three decades, the volume of environment-friendly classes of land cover (e.g. forests and rice fields) has followed a decreasing trend, while the area covered by the environment-inconsistent land covers (e.g. urban spaces) have increased.

2.2. Delphi-Cross Impacts Hybrid Method

For the sake of this research, in order to analyze the factors affecting changes in land cover, Delphi method was used. Delphi s obtained by collecting experts' opinions iteratively by successive use of questionnaires. Interaction with anonymous experts and controlled feedback are two integrated features of Delphi technique [15]. These features help avoid numerous limitations of traditional face-to-face panels of experts for foresight, such as undesired leadership and high time cost [16]. Commonly in Delphi method, occurrence or non-occurrence of an event is considered, without regarding its effect on other events. Cross-impact method was originally developed to address this limitation. Cross-impact analysis corrects estimated probabilities of future events based on interactions among events [17]; [18]. It is a flexible scenario analysis technique which can be combined with Delphi method [19]; [20]. Cross-impact analysis uses a cross-impact matrix to systematically describe all possible states of interactions among a set of variables, and evaluates the strength of these interactions [21]. In this regard, MIC-MAC[1] method was proposed by Michel Godet in 1994. MIC-MAC is a structural analysis method which forms a cross-impact matrix and calculates direct and direct relationships among variables. This method manifests latent variables by calculating indirect relationships and feedback loops [22].

[1] Cross-Impact Matrix – Multiplication Applied to Classification

2.2.1. MIC-MAC Analysis

In MIC-MAC method, a set of variables are selected by a panel of experts. This method is performed in three steps: definitions of related variables, identification of relationships among the variables, and identification of key variables among the entire set of variables presented by the experts [22]. Definition of the variables related to a system is a complicated process undertaken upon different experts' ideas, brainstorming and library studies [23]. In identifying the relationship between variables, norm values of 0-3 are assigned. Letting n be the number of defined variables, we may end up forming a $n \times n$ matrix. In the present research, a total of 93 effective factors were identified, so that a 93×93 matrix was formed. Each cell (A_{ij} element) of the matrix indicates how much influence the variable i imposes on the variable j; this is also known as *matrix of direct influence* (MDI). If the variable i is of no influence on variable j, the corresponding element takes zero value, while it will set to 1 should the influence is weak. For strong and very strong influences, norms of 2 and 3 are considered, respectively.

A_{ii} elements in this matrix (diagonal elements) are zero. In a real system, only 30% of the elements of MDI take values other than zero [22].

MDI gives an estimation of general direct influence and direct dependence. This is while, *matrix of indirect influences* (MII) estimates the influence and general dependence of a variable using other variables. When calculating direct influences of the variable k, all values along the kth row of the matrix are summed. Similarly, when calculating the direct dependence level, sum of all values along kth column is obtained. Therefore, there are two different values for each variable, k, as follows:

$$I_k = \sum_{j=1}^{n} m_{kj} (k = 1,2,..,n) \quad (1)$$

$$D_k = \sum_{i=1}^{n} m_{ik} (k = 1,2,..,n) \quad (2)$$

Analysis of indirect maps has more to do with the study of "future" and "strategic prospecting" [24]. MII corresponds to MDI, with its power increased due to frequent repetitions. In the present research, the matrix stabilized after two repetitions.

2.2.2. Influence/Dependence Diagram on MIC-MAC Software

The quadrant and position of elements within that serve as an important criterion. In this method, position of elements on the influence/dependence map, which is developed as a cloud of points, is used. The influence values is read on y axis while the dependence value is presented on x axis (Figure2), Arcode, et al. [25].

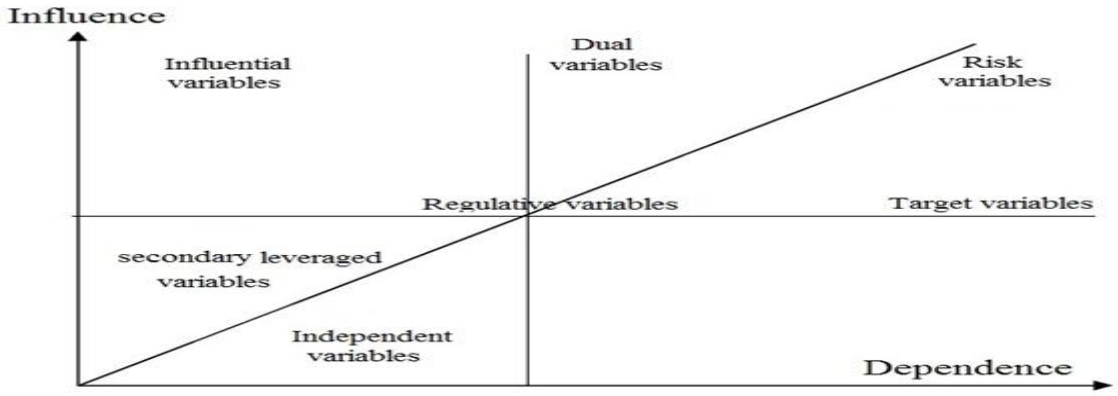

Figure-2. Influence and dependence in MIC-MAC Software [25].

If the cloud of points is extended along the axes (forming a L-shaped geometry), the system state can be evaluated as fully established (stable). This means that, the system response to the behavior of given variables can be foreseen at a particular degree of certainty. On the other hand, when the cloud of points is extended along the bisector of the axes, the system is said to be of unknown (unstable) state. When the point is located in northeast, it is of direct influences and is very largely influenced, playing an ambiguous role in the system; such a position contributes to uncertainty of foreseeing (Figure3).

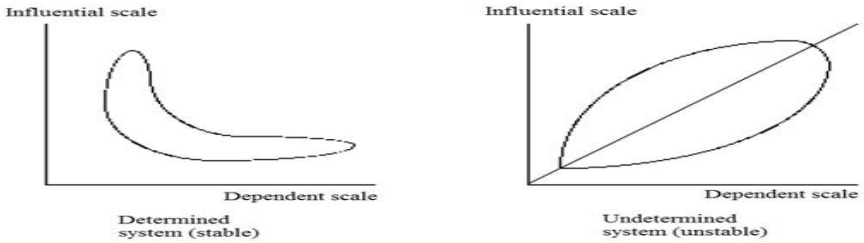

Figure-3. System status [25].

2.3. Foresight

Foresight refers to the set of efforts which use the analysis of resources, patterns and change or stability drivers to visualize potential futures and make plans form them [26]. Trend inference, expert panel, previewing, counselling, objective analysis, scenario development, hindsight, modeling, dependence tree, morphology analysis, visualization, and future cycles are examples of foresight methods [27].

2.3.1. Scenario Development

Among numerous foresight methods designed for foresight, scenario development was selected for the present study. In order to develop scenarios by a 20-memebr expert panel, firstly, 19 key drivers of changes in land use were homogenized based on their influence score and performance similarities. Then, 9 main descriptors where defined. In the next stage, for each descriptor, three variant qualitative components indicating possible states (from the worst case to the best one) were prepared. Subsequently, Cross-impact balance (CIB) matrix was formed. Evaluating the effect of each qualitative component (triple states of the descriptors) toward weakening or strengthening other qualitative component, a score in the range − 3 to + 3 was assigned. Finally, based on maximum internal consistency, we ended up with three scenarios with 15-year horizons. The scenarios were developed in the environment of Scenario Wizard Software. The software has been designed by Dr. Wolfgang Weimer-Jehle from Stuttgart University (Germany). The technique used in this software has its basis on Monte Carlo Simulations. Difference scientific fields employ Monte Carlo methods in widely different ways, yet all of them are common in one aspect: all of them use random number to test and simulate a natural and actual phenomenon. Monte Carlo is a technique for calculating the uncertainty associated with the prediction of a potential event. The tendency toward Monte Carlo methods is boosted when an exact solution is either impossible or infeasible to calculate using deterministic algorithms. Monte Carlo simulation methods are particularly advantageous for studying the systems wherein a large number of variables whose degrees of freedom are related in a pair-wise fashion are dealt [28]. Research process is summarized in Diagram 1.

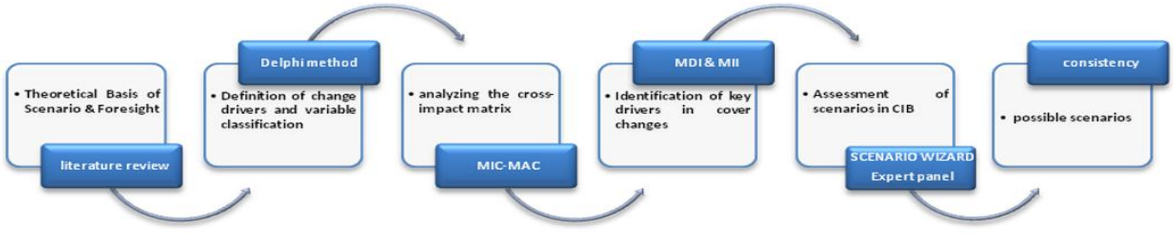

Diagram-1. Research process model

3. FINDINGS

3.1. Definition of Change Drivers and Variable Classification

In order to investigate interactions between effective driving forces on changes in land cover across the study area, 21 sets of change drivers along with 93 variables depended on them, which had contributed to changed land cover classes across the study area during a few last decades, were classified (Table 1). Changes in land cover classes happened in the form of transformations between six classes of land cover: urban, rice field, citrus gardens, frost, water resource, and uncovered.

Table-1. Characteristics of the factors affecting changes in land use/cover across rural districts during the past three decades and their classification

No.	Change drivers	Variable classification
1	Demographic evolutions	High population density, Youth migration, The population of aged farmers, Population growth
2	Economic factors	Lack of employment, private investment, economic inefficiency of agricultural sector (tea and rice)
3	Social factors	Life style (consumption patterns), cultural values, and folk tradition
4	Settlements	Construction, developing seismic-resisting houses in quake-hit country side, abandoned and worn out rural houses
5	Technologic evolutions	Modern technology, agricultural mechanization, modern instruments, modern varieties and new cultivars
6	Production	Competition in the production of agricultural products, livestock and poultry, agricultural production diversification, market demand for agricultural production, trading agricultural products, establishment of new industries, industrial activity, high cost of agricultural production, lack of processing and packaging industries, high cost of agricultural labor force, small farming lands in the agricultural sector
7	Natural factors	Protected natural resources, ground slope, altitude, soil type, water resources, self-growing trees in abandoned lands, fluctuations of coast line, flooding, soil erosion
8	Infrastructural networks	Roads network, energy network, communication network and information technology
9	Development plans and civil projects	Hadi Plan [2](planning), development plans and civil projects (plan execution)
10	Governmental regulations	Lack of packages supporting agricultural productions (guaranteed purchase, inputs procurement, etc.), and failure to ban unleashed imports, national plan for displacing foresters, regulations on protection of agricultural and ecologic land uses, sea protection boundary, land use change law
11	Tourism	Construction of villas and secondary houses, tourism-depended services, tourism residents and passenger areas, recreation centers and tourism parks, telecabin, the presence of tourism attractions (hirstorical, recreational, natural and cultural)
12	Managerial factors	Weakness of surveilling authorities, rural administration
13	Trans-regional factors	Geopolitical position of the province, trans-regional function, Anzali Free Zone, production of strategic products
14	City and village connection	Extension of urban territory, urban creep and corrosion, urban territory, long distance to cities, transformation of large villages to cities
15	Land cover damaging factors	Excavation for mining, landfilling, industrial leachates, wastes, and sewage, filling of ponds, deforestation for feeding livestock, unleashed and illegal extraction of forests, dam construction, construction debris
16	Land cover rehabilitation factors	Coastal forestation, mountainous forestation, Farming medicine herbs in bare country sides
17	Land exchange	Brokerage, land acquisition, legal and illegal land change of land use/cover and constructional infringement, added value of the land, increased price of land, land trading
18	Human factors	Stakeholders' personal interest (economic and social), influence of influential figures and profiteers (import of goods, extraction of resources, mines, river sands, land use changes and constructional infringement, creating new activities, polluting activities, incompatible activities, cutting trees, etc.), private ownership
19	Services	Hygiene-health services, sports services, training services, emergency rescue centers, commercial services
20	Land loss	Abandoning rice fields and gardens, decomposition of land as a result of inheritance laws, anti-ecological use of the land
21	Change of crop	Change of crop to kiwi, change from farming to spruce planting, change of crop to aquaculture, and change of crop from strategic products to any non-strategic product

3.2. Direct Influences

Once finished with applying pair-wise influence factors on the 93 principle variables affecting changes in land cover across rural districts in east of Guilan, direct effect map was obtained by analyzing the cross-impact matrix in MIC-MAC Software.

[2] The Hadi plan is a plan with a 10-year horizon, Which is designed to guide physical development in the villages of Iran

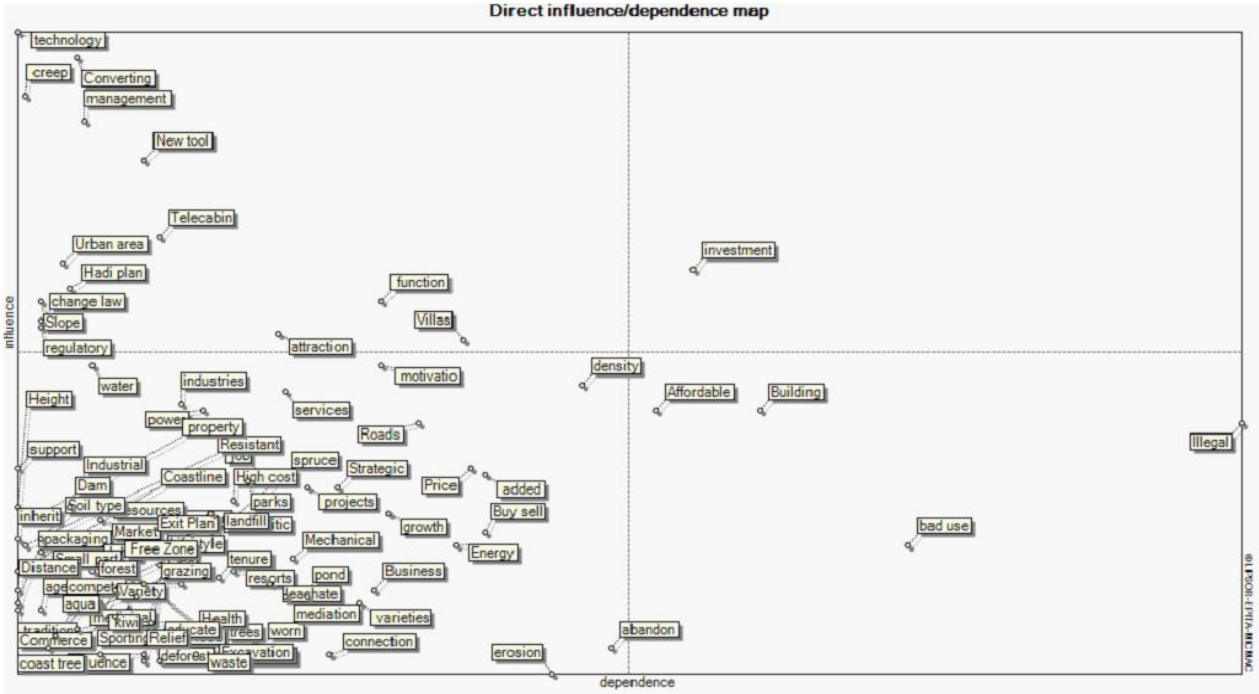

Figure-4. Direct influence/dependence map

Considering Figure 4, even though system state does not imply neither stability nor unstability explicitly, but comparing distribution of the points against L-shaped and bisector-around cases, the system state is seen to be more similar to the L-shaped case, where effective variables on northwest of the plot are well close to the *y* axis. On this basis, modern technology (technology), urbanization of large villages (converting), urban creep and corrosion (creep), rural administration (management) and modern instruments (new tool) had the largest contributions into changes in land cover (named in decreasing order of significance). Furthermore, major influenced variables appeared on southeast of the area. That is, legal and illegal changes of land use (illegal), non-ecologic use of the land (bad use), constructions (building) and economic inefficiency of farming (affordable) were the most influenced variables by changes in land cover across the study area (named in decreasing order of significance). Meanwhile, private investment (investment) indicated an ambiguous role as it both influenced and was influenced largely by the changes in land cover.

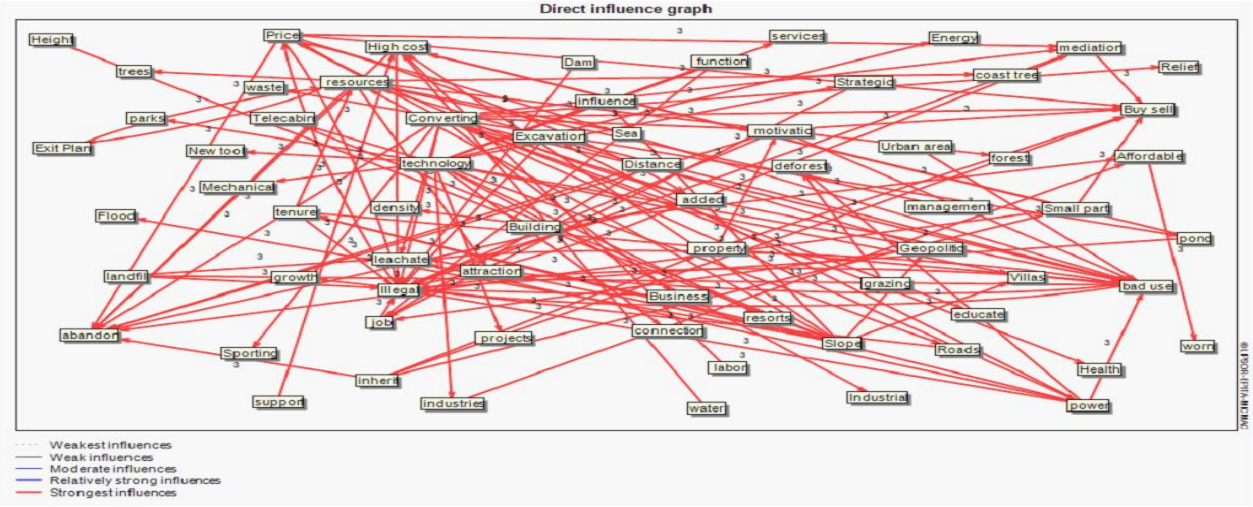

Figure-5. Direct influence graph

Figure 5 shows strong and direct paths between different pairs of variables, most of which are one-way paths with few two-way ones. Some of the paths extend to pass limited number of nodes. These intermediate nodes indicate intermediate variables. Nevertheless, the most significant point in the flow of the paths is the fact that, most of the arrows terminate at particular variables, proving the dependency of these variables and the fact that those are well influenced by the changes in land cover. Of such variables, one may refer to legal and illegal land use changes (illegal), anti-ecologic use of land (bad use), and abandoning gardens and rice fields (abandon).

3.3. Direct Influences

Output of the MIC-MAC Software following the application of matrix multiplication to come with a new classification of the important variables in MDI was the indirect influence map. The MII was formed to identify fundamental latent variables.

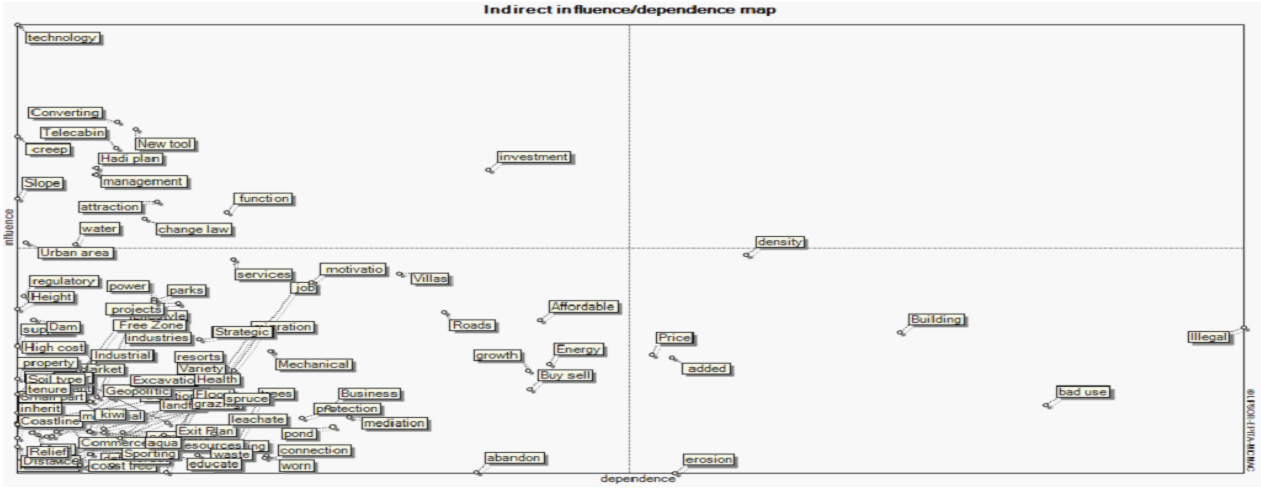

Figure-6. Indirect influence/dependence map

Figure 6 shows that, the indirect influence map is more stable than the direct one, with the most influential variables being modern technology (technology), urbanization of villages (converting), modern instruments (new tool), and urban creep and corrosion (creep) (named in decreasing order of significance). Moreover, the most influenced variables were found to be legal and illegal changes of land use (illegal), anti-ecologic use of land (bad use), construction activities (building), and population density (density) (named in decreasing order of significance).

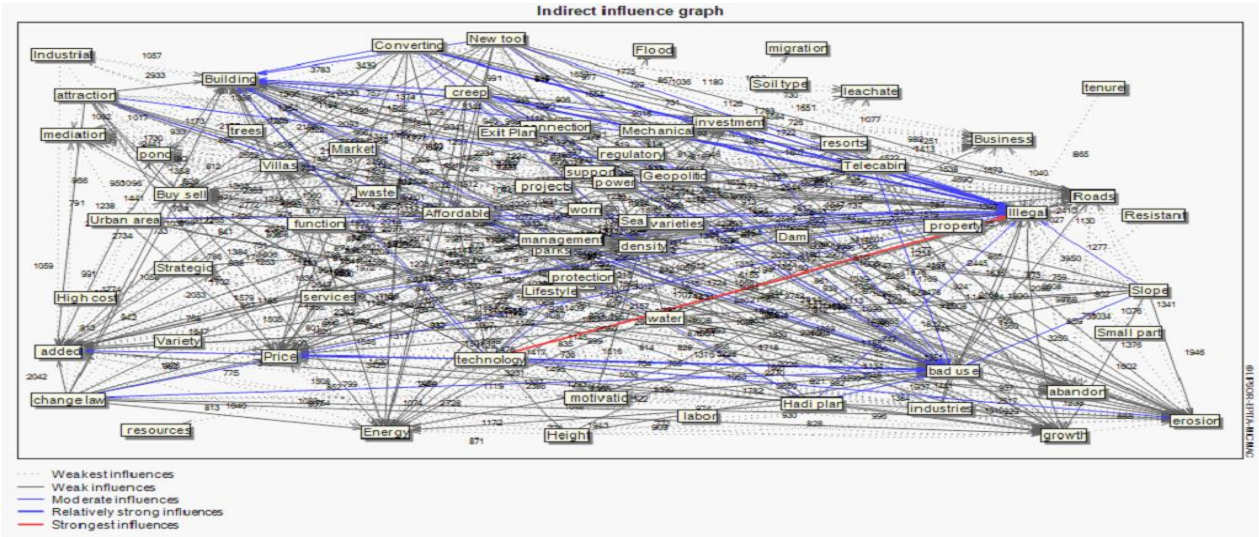

Figure-7. Indirect influence graph

Figure 7 demonstrates possible indirect paths along with the established rings between the variables. The strongest relationship was identified between modern technology (influential) and legal and illegal changes of land use (influenced).

3.4. Key Drivers Of Land Cover Change

Figures 8 and 9 demonstrate the key influential and influenced variables in land cover change, based on the sums of rows and columns of the MDI and MII. Key drivers of land cover change were selected from the variables of highest ranks in both MDI and MII.

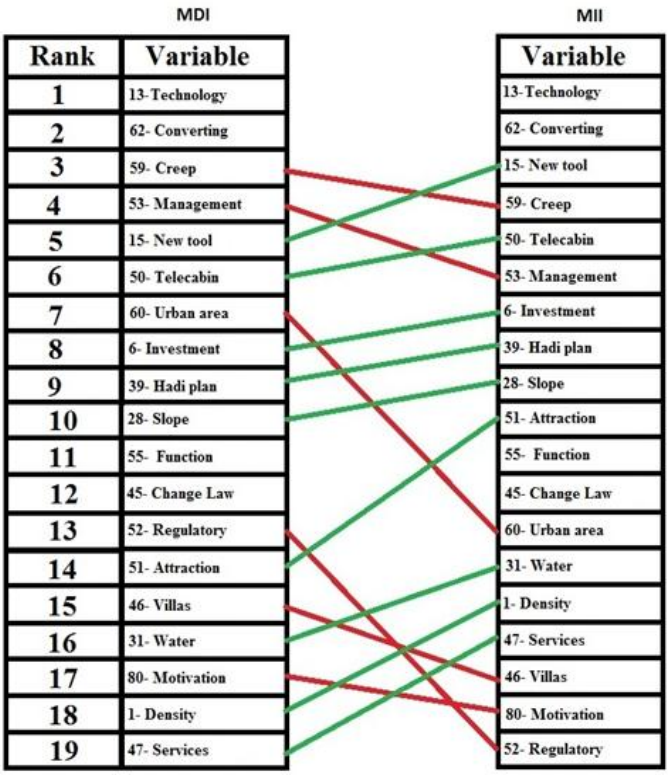

Figure-8. Order of influences of variables in MDI and MII

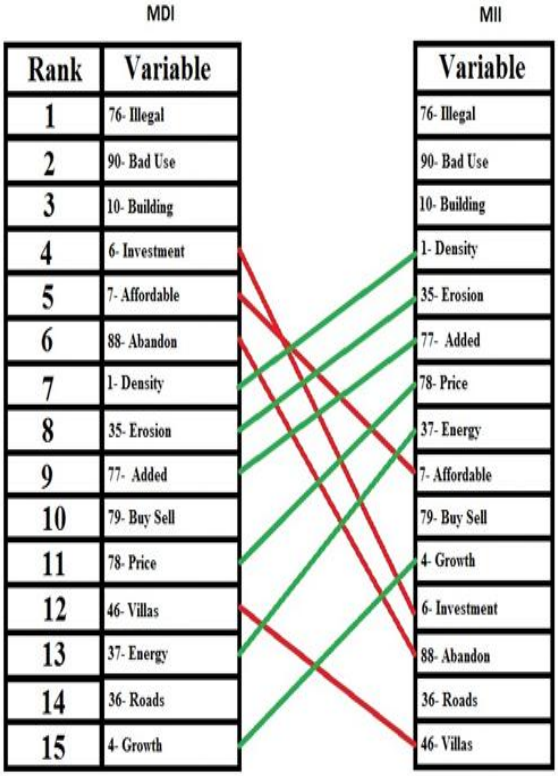

Figure-9. Order of dependence of variables in MID and MII

3.5. Variable Role Displacement in MII

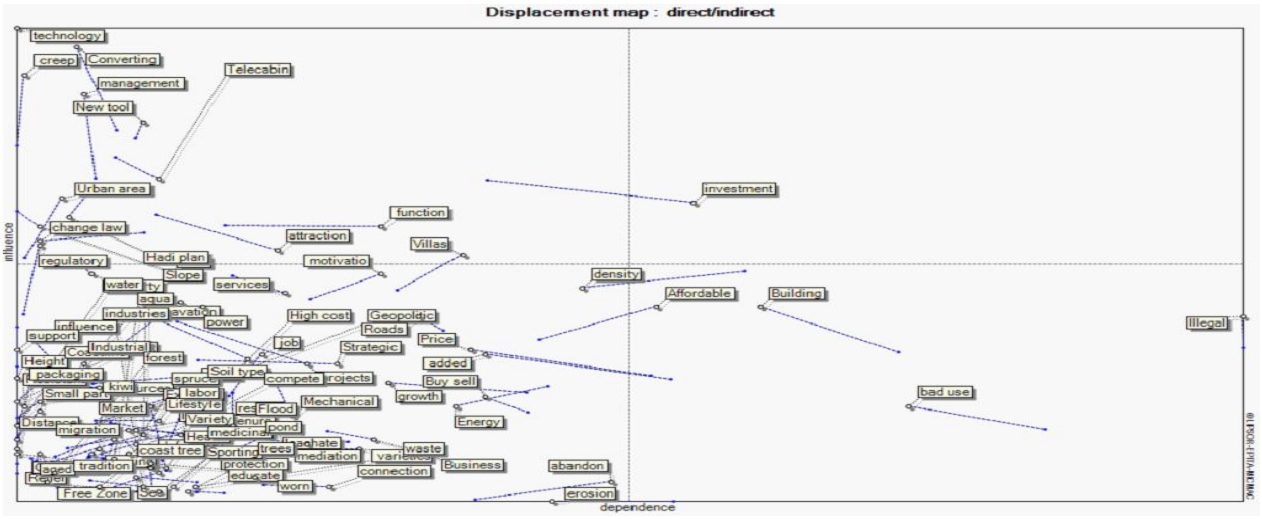

Figure-10. Displacement map

The displacement map compares the states of variables in MDI and MII. The lines indicate displacements and variable motions. The end of each line marked by the variable name is related to MDI, while the other end (unmarked) is related to MII. MII identifies latent variables which can determine relationships in future, as is evident on Figure 10. The variables of added value of land (added), land price (price), erosion and high population density (density) fall within the southeastern quadrant. Therefore, these four variable are likely to be highly influenced by other drivers in future. This is while, the variables legal and illegal change of land use (illegal), anti-ecologic use of land (bad use), and construction activities (building) will be also further influenced in future. Beyond any doubt, this will end up further damaging the land and destruction of its natural capabilities. Moreover, the variable "private investment (investment)" is situated on the northwestern quadrant, so that it will play an influential role in changes in land cover in the future.

3.6. Scenario-Based Foresight

Permutation of the triple components of the 9 descriptors can generate 19,683 scenarios. However, once the strengthening, weakening, or neutralizing weighting factors were applied to the relationships between component pairs, many of unrealistic cases were eliminated. Moreover, the realistic cases were rearranged based on internal consistency of the relationships, so that weak scenarios were omitted. Once finished with calculating the scores in CIB matrix using Monte Carlo method, we ended up with 850 scenarios of weak consistency and three ones of strong consistency. Finally, considering the qualitative components, the three accepted scenarios were designated as balanced ecologic changes, relatively balanced ecologic changes, and imbalanced ecologic changes (Table 2).

Table-2. Possible cases of variant qualitative components, from undesired case to desired case in the system

Variant qualitative components and possible cases			Descriptors
Most desired case	**Intermediate case**	**Most undesired case**	
Limited adoption of technical jobs and modern instruments for changing ecologic land cover	Relative adoption of technical jobs and modern instruments for changing ecologic land cover	Extensive adoption of technical jobs and modern instruments for changing ecologic land cover	Modern technology and instruments
Transformation of villages of populations above 4000 to cities and horizontal expansion of existing urban territories toward the surrounding areas	Transformation of villages of populations above 3000 to cities and moderate horizontal expansion of existing urban territories toward the surrounding areas	Transformation of villages of populations above 2000 to cities and horizontal expansion of existing urban territories toward the surrounding areas	Urban expansion
Accurate institutional control of and surveillance on changes in land cover	Moderate institutional control of and surveillance on changes in land cover	Weak institutional control of and surveillance on changes in land cover	Management and surveillance
Limited investment on anti-ecologic sector and deconstructing changes in land cover	Moderate investment on anti-ecologic sector and deconstructing changes in land cover	Large investment on anti-ecologic sector and deconstructing changes in land cover	Private investment
Limited instrumental use of Hadi Plan and land use change act to change ecologic land uses	Relative instrumental use of Hadi Plan and land use change act to change ecologic land uses	Intensive instrumental use of Hadi Plan and land use change act to change ecologic land uses	Land use transformation rules
Limited tendency toward construction toward areas of slopes beyond 25%	Relative tendency toward construction toward areas of slopes beyond 25%	Intensive tendency toward construction toward areas of slopes beyond 25%	Ground slope
Dominance of agricultural and natural tourism functions on the tourism functions altering the land cover	Relative dominance of agricultural and natural tourism functions on the tourism functions altering the land cover	Full dominance of agricultural and natural tourism functions on the tourism functions altering the land cover	Trans-regional function
Limited changes in ecologic land use around water resources	Relative changes in ecologic land use around water resources	Intense changes in ecologic land use around water resources	Water resources
Limited dependence of ecologic land use changes on socioeconomic drivers in areas of high population density	Relative dependence of ecologic land use changes on socioeconomic drivers in areas of high population density	Intense dependence of ecologic land use changes on socioeconomic drivers in areas of high population density	Population density

Tables 3, 4, and 5 demonstrate the three scenarios obtained, with each scenario presenting 9 probable cases of land cover changes under the effect of the key drivers across the study area during the coming 15 years.

Table-3. Scenario 1: Balanced ecologic changes

Qualitative component	Descriptor
Limited adoption of technical jobs and modern instruments for changing ecologic land cover	Modern technology and instruments
Transformation of villages of populations above 4000 to cities and horizontal expansion of existing urban territories toward the surrounding areas	Urban expansion
Moderate institutional control of and surveillance on changes in land cover	Management and surveillance
Limited investment on anti-ecologic sector and deconstructing changes in land cover	Private investment
Limited instrumental use of Hadi Plan and land use change act to change ecologic land uses	Land use transformation rules
Limited tendency toward construction toward areas of slopes beyond 25%	Ground slope
Relative dominance of agricultural and natural tourism functions on the tourism functions altering the land cover	Trans-regional function
Limited changes in ecologic land use around water resources	Water resources
Limited dependence of ecologic land use changes on socioeconomic drivers in areas of high population density	Population density

Scenario 1

Under the first scenario, which was designated as balanced ecologic changes, technical jobs will found less opportunities for disturbing the environment. Assuming natural rate of population growth, only villages with current populations above 4,000 will reach the population threshold for transforming to cities. Among the 744 villages under investigation, only Baz kia gurab and Leil had populations beyond 4,000. The presence of fair surveillance and appropriate observation of legal regulations and Hadi Plan, limited urban development, limited maneuver space for initiatives by stakeholders, limited influences of human actions on farming lands and forests, specially within areas of high population density, and preservation of water resources are among the characteristics of Scenario 1. Under this scenario, relative dominance of tourism over agricultural activities is probable. Even though the activities which flourish tourism spots while imposing no deconstructive change in land cover and do not interrupt farming do not enjoy acceptance and sectoral development, but those incur no fundamental damage to the environment. Moreover, when covered by natural land cover, hillsides and slopes will be protected against fundamental changes which result in the elimination of natural features, damaged streams, and the invasion of urban constructions.

Table-4. Scenario 2: Relatively balanced ecologic changes

Qualitative component	Descriptor
Limited adoption of technical jobs and modern instruments for changing ecologic land cover	Modern technology and instruments
Transformation of villages of populations above 4000 to cities and horizontal expansion of existing urban territories toward the surrounding areas	Urban expansion
Weak institutional control of and surveillance on changes in land cover	Management and surveillance
Limited investment on anti-ecologic sector and deconstructing changes in land cover	Private investment
Limited instrumental use of Hadi Plan and land use change act to change ecologic land uses	Land use transformation rules
Relative tendency toward construction toward areas of slopes beyond 25%	Ground slope
Full dominance of agricultural and natural tourism functions on the tourism functions altering the land cover	Trans-regional function
Relative changes in ecologic land use around water resources	Water resources
Limited dependence of ecologic land use changes on socioeconomic drivers in areas of high population density	Population density

Scenario 2

Called relatively balanced ecologic changes, the second scenario had such features as limited adoption of jobs and technological instruments, appropriate observance of legal regulations and Hadi Plan, limited investment on deconstructive changes in land cover, and weak influences of populations movements in dense population zones, in one hand, while suffering from weak control and surveillance on natural cover preservation, fair tendency toward undertaking constructions on sloped hill sides and villa construction in the vicinity of water resources and beaches, on the other hand. In fact, natural and agricultural ecosystems are faced by fair threats in this scenario. In addition, tourism activities well dominate agricultural ones, developing relatively different spatial – physical consequences, with the villages of more than 4,000 population becoming eligible for transforming into cities. In this scenario, general behaviors in preserving natural resources and observing regulations will be relatively normal, and even though the environment is assumed to be somewhat disturbed, but damaging the land cover consistent with the environment will not be pervasive.

Table-5. Scenario 3: Imbalanced ecologic changes

Qualitative component	Descriptor
Relative adoption of technical jobs and modern instruments for changing ecologic land cover	Modern technology and instruments
Transformation of villages of populations above 3000 to cities and horizontal expansion of existing urban territories toward the surrounding areas	Urban expansion
Weak institutional control of and surveillance on changes in land cover	Management and surveillance
Moderate investment on anti-ecologic sector and deconstructing changes in land cover	Private investment
Relative instrumental use of Hadi Plan and land use change act to change ecologic land uses	Land use transformation rules
Intensive tendency toward construction toward areas of slopes beyond 25%	Ground slope
Full dominance of agricultural and natural tourism functions on the tourism functions altering the land cover	Trans-regional function
Relative changes in ecologic land use around water resources	Water resources
Relative dependence of ecologic land use changes on socioeconomic drivers in areas of high population density	Population density

Scenario 3

The third scenario is called imbalanced ecologic changes. Under this scenario, the state of natural land cover is more severe than those of the other two scenarios as environmental damage risks and loss of farming lands increase. Under this scenario, the adoption of technical jobs will be relatively populated. The villages with current populations beyond 3,000 will reach the threshold for transforming into cities. Three villages have this condition: Baz kia gurab, Leil, and Ahandan in Lahijan Township. Sloped hillside areas will be intensively affected by villa construction. Dominant tourism activities with spatial-physical consequences will leave no opportunity for environment-consistent activities. Land cover changes will be influenced by population density and relatively anti-ecologic activities undertaken by the population. Water resources, beaches, and natural perspectives will be invaded by constructions. Relative tendency to invest on the fields which are inconsistent with natural environment, weak institutional surveillance, and instrumental use of regulations and Hadi Plan to achieve speculative goals will be other features of this scenario.

4. CONCLUSION

In recent years, the use of modern technologic instruments have further complicated the disturbing of natural environment, as compared to previous decades. Maximal extraction of nature and non-renewable resources, accelerated consumption of renewable resources, and pollution generation at rates higher than those at which nature can reproduce the resources or absorb the pollutions are made possible for human only by the honor of the

technologic instruments. In other words, under the name of different titles and activities, technological instruments have served as determinant and influential factors. Examples of this can be seen in mining, excavations, unleashed consumption of forest and pasture resources, cutting the trees, changing paths of streams and rivers, filling ponds and wetlands, generation of debris, landfilling, production of industrial leachates, damaging gardens and rice fields, contracting buildings, unleashed withdrawal of sand and gravel from river beds, displacement of natural features to dominate ground slope, deployment of technologic activities, etc. All of the mentioned activities tend to leave the land with some non-ecologic cover.

In the present research, in order to configure possible futures of land cover, three scenarios were formulated. The first scenario went for balanced ecologic changes in future, where a sustainable balance would be established between urban land cover and other land covers. In the second scenario, relatively balanced ecologic changes were considered across the study area, where the balance between urban land cover and other land covers was somewhat biased towards the urban land cover, so that some unstable impacts would appear at some core centers for tourism. After all, the third scenario was a warning for non-ecologic changes in future, where unleashed changes in land cover toward urban land cover would be faced, so that the high-rate changes would make the land no more suitable for farming and places natural and agricultural perspectives at risk.

Regional planning is indeed some sort of organization across the environment whose natural organization is previously disturbed by human agents. Results of this study show that, human agents play pivotal roles in all of the key drivers of changes in land cover, while natural shocks have never imposed such fundamental changes in the land cover. Beyond any doubt, continuation of the current trend in the coming pair of decades will leave us with a busier, polluter, more wore, more expensive, and more disordered land that the current state. Unless some contexts of anti-ecologic activities are eliminated. Unleashed changes in natural land cover not only disturbs ecologic discipline, but also threats economic and social sustainability as it present no practical alternative for forest, garden crops, and rice fields. Even trying to accept a fundamental change from farming to tourism, the trend motion is yet to be guided toward sustainability. Because a major portion of tourism attractions across the region are dependent on the presence of heights, water resources, undisturbed natural gifts, farming lands, and forests, so that the disturbance of nature-consistent land covers will put at risk the livelihood and social environments of the region because of lost resources and revenue generation contexts, migration of youth, selling lands to non-indigenous residents, abandoning, etc. Therefore, with the help of scientific techniques, foresight develops possible futures, with the help of which one can observe ending points of different paths in a long-term perspective, based on which appropriate managerial, inhibitory, and guiding measures can be taken to stabilize sparse resources and come with sustainable rural settlements. Appropriate human and organizational behaviors in consistency with nature can bring about regional sustainability. Conscious and unconscious actions by humans which can change structural land cover will be controllable and manageable. Of course, modification of regulations and promotion of training will play significant roles in this regard.

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