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Article

Assessment of sustainable development models for rural watershed areas with a focus on environmental components

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Abstract: From the point of view of the systemic approach in sustainable rural development programs, all components should be considered concerning each other, but one of the most important components is the environmental index in development programs. Considering that the lack of attention to the environmental components in the development plans of many projects has failed and many challenges have been created in the environmental components. The current research aims to evaluate the role of environmental components in the sustainable development of rural areas. For this purpose, a questionnaire was compiled and using Cochran's formula, a sample size of 100 copies of the questionnaire was completed from household heads, and in addition, 20 copies of the questionnaire were completed to survey the relevant officials. SPSS software was used to classify and analyze data and information, and the AHP model was used to examine the relationship between variables and prioritize them. The studied area was located in the north of Tehran-Mashhad asphalt road and about 50 km east of Garmsar city. The results of the study indicate that there is a significant relationship between the environmental components and the sustainable development of the rural areas of the studied area, which requires the special attention of the officials in this sector. It has the most importance in this region. At the end, suggestions for better planning and sustainable development are given.

Keywords: watershed; water resource management; sustainable development; rural areas; environmental components

1. Introduction

Sustainable development is considered a new idea in the political arena and is another attractive way compared to our current unstable path; Although from the distant past, indigenous peoples around the world have used appropriate methods and measures to harmonize with the requirements of the environment. On a global scale and in the academic and executive fields, intense attention to the concept called sustainable development is increasing [1]. This growing interest has spread to all levels of society and everyone has correctly understood that without this basic need, many efforts will not be able to reach the desired result with full capacity [2]. In achieving sustainable development, economic growth and protection of the environment should be considered as complementary activities at least to some extent. One of the merits of the sustainable development plan is the complementarity of different dimensions of

development, and this is why it is said that "a holistic approach to sustainable development requires an integrated approach to all factors, social, economic and environmental" as well as development indicators, are considered to be the most important criteria for targeting planning and evaluation of rural development plans [3]. By using these criteria, it is possible to evaluate the progress or the impact of rural development plans and projects in reaching the goals [4]. The gap in this field has caused development plans to be carried out far from precise and appropriate indicators, and the targeting of programs and their evaluation has become difficult. On the other hand, one of the issues of the day in the world is the problem of preserving the environment of the village. Protection of the village environment has been accepted and emphasized not only as an inseparable part of sustainable rural development but also as a fundamental value needed by today's generation and future generations. Also, rural settlements have not had a special position in terms of economic function during more than fifty years of planning in the countries [5].

As a result of this lack of identity and the lack of a proper place in the planning system, as well as the acute problems of the villages in terms of the availability of infrastructure and superstructure services and the development of economic activities, employment and living standards, the share of their population has decreased day by day and the demographic pattern of the countries. Now the problem has changed from a village to a city [6]. Therefore, efforts to develop rural environments and eliminate poverty from the face and body of these human settlements became one of the most important national development programs [7]. In Iran, the a need to address the issue of the village and its development by the government; Since several decades ago, feeling has been considered as the axis of development policies in most cases. In this regard, if we consider the main goal of rural development to be able to empower the masses of the rural population who now cannot meet the basic needs of life with their efforts [8].

It can be said that achieving an acceptable state of the process of growth, development and excellence in human societies, both in the city and in the countryside, requires the preparation of planning grounds based on the identification of the environment and the use of the capabilities available in that space [9]. In this regard, the knowledge, examination and analysis of human and natural capabilities in the rural areas of the country can be considered as an important foundation and principle in the process of sustainable development of these human settlements [10]. Considering the importance of the environment and its role in the lives of citizens, in this research, by defining the variables and indicators of sustainable environmental development, the state of environmental sustainability at the level of the villages of the Rameh watershed in Semnan province has been measured.

Sustainable development includes various economic, social, physical, spatial, environmental management, etc. components. In this context, one of the most important elements in the process of sustainable rural development is paying attention to the effective environmental components and indicators in development planning. Examining the structure of the current situation in the world's development programs, especially in the study area, shows that despite the many capabilities we have in rural development programs, there is no attention or less attention to environmental indicators and components in the plan and rural development projects have caused us

to face many challenges in the planning process of sustainable rural development in various components that are effective in sustainable rural development and many projects have either led to failure or have not been provided with a systemic approach to the process of sustainable development. In other words, from the point of view of applied geography, systemic thinking in sustainable rural development planning includes the essential element of the success of programs and plans of rural projects. In this context, all the effective indicators have a systemic effect on each other in a loop-like and chain-like manner, and it should be noted that one of the most important of them is environmental loops, indicators and components.

In reviewing the structure of the current situation of rural development programs and projects, emphasizing the above-mentioned attitude, we notice that despite the great environmental capabilities, less attention has been paid to environmental components and indicators; In this case, other elements of development have also faced fundamental challenges in different components. With this point of view, the direction of the current research is to answer this basic question, what is the role of environmental components in the process of sustainable rural development?

2. Methodology

2.1. Study area

The studied area is located in the north of Tehran-Mashhad asphalt road and about 50 km east of Garmsar city and between longitude 36–52 to 49–52 and latitude 20–35 to 34–35 with an area of 16530 hectares. The minimum height of the outlet opening is 1185 m and the maximum height is 3200 m above sea level [11]. The area in question is one of the mountainous areas, from the north and west to the Habla area of Garmsar, from the northeast to Mount Haft Mil and Khak, from the east to Abdul Abad area, from the southeast to Ab Sark and Khoshab River area, and from the south to It leads to Kezushek mountain and Sarasiyab plain [12]. Its highest height is in Sang Ab Mountain with a height of 3310 m and its lowest height is at the outlet of the basin with a height of 1185 m above the level of the Azad Sea. This area is located in Semnan province, Aradan city and in Aradan section of Kohan Abad district and includes 4 villages named: 1) Chahar Taq, 2) Rameh Bala, 3) Rameh Plain, 4) Qalibaf. It was located in Tehran province and was part of Firozkoh and Poshtekoh districts [13].

According to the resolution of the Islamic Revolutionary Council, it was removed from Tehran province and placed in the field of Semnan province. In 1999, because the city of Aradan became a district, this watershed is one of the northern areas of Aradan, one of the functions of Kohanabad district, and it was approved in 2013 based on the resolution of the Board of Ministers of Aradan city [14].

The research method in the present study is descriptive-analytical according to the nature and objectives of the subject (assessing the sustainability of rural areas in watersheds) and in connection with the test of research hypotheses. Therefore, to explain the hypotheses, first of all, the descriptive research method is used with the aim of objective, realistic and systematic description. Properties means what is used. Then, in the next step, which includes hypothesis testing, an analytical method has been used. In order to evaluate the role of environmental components in the process of sustainable development of the studied area, a questionnaire was compiled and

using Cochran's formula, the sample size was determined, and the sample size was 100 questionnaires from household heads and in addition to surveying 20 copies of questionnaire were completed by the relevant officials of the provincial agricultural Jihad officials of the General Department of Natural Resources and Watershed Management of Semnan Province and the Organization of Forests, Ranges and Watershed Management of the country. Also, Excel and SPSS software were used to classify and analyze data and information, and AHP model was used to examine the relationship between variables and prioritize them.

2.2. Theoretical

Generally, the need for a new development model was widely recognized until the mid-1980s and environmental policies were considered the dominant discourse in the development literature and policy-making field at the international level [15]. The publication of Holden et al. [16] entitled "Our Common Future" has been a turning point and acceleration in this process.

The philosophical foundations of sustainable development are rooted in the idealistic views of older writers such as Dante, Kant, Rousseau, Neu, William Tell, and even Wilson. It is also possible to understand the logical links between the conceptual roots of sustainable development and the customs, lifestyles and activities of native and local communities in many regions of the world. This general concept was widely discussed with the global conservation strategy to manage the protection of natural resources and the environment to play a role in improving human well-being [17]. In this study, the protection of ecological processes, genetic diversity and sustainable productivity were highlighted. **Figure 1** shows the conceptual composition of the term sustainable development.

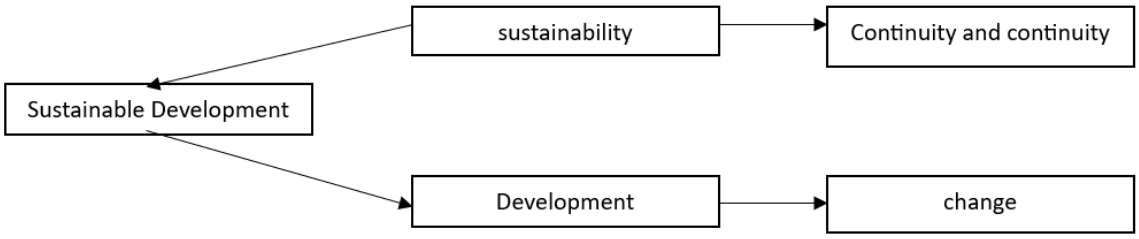

Figure 1. Conceptual composition of the term sustainable development.

2.3. AHP method

The Analytic Hierarchy Process (AHP) is a structured, multi-criteria decision-making method that helps break down complex decision-making problems into a hierarchy of more manageable parts. Developed by Thomas Saaty, AHP enables decision-makers to assign weights to various criteria and alternatives, facilitating a comprehensive analysis of their relative importance [18]. The process begins with defining the main objective and then identifying relevant criteria and sub-criteria, which are arranged in a hierarchical structure. Pairwise comparisons are conducted among these elements to establish their relative priorities. Through these comparisons, AHP synthesizes data and produces a weighted ranking that reflects the preferences of decision-makers, providing a clear basis for selecting the best alternative. This method

is widely used across fields such as engineering, management, and environmental science due to its ability to quantify subjective judgments and incorporate both qualitative and quantitative factors [19].

The AHP method was selected for this study because it allows for a systematic evaluation of various criteria and alternatives, which is crucial in complex decision-making situations. Unlike other decision-making techniques, AHP provides a transparent process where judgments are carefully documented and structured, helping to minimize bias and improve the reliability of the results [20]. Additionally, AHP is particularly useful in cases where subjective criteria play a significant role, as it captures expert opinions and translates them into numerical values that can be analyzed. Given the nature of this study, which involves multiple criteria with varying degrees of importance, AHP's hierarchical framework and its ability to handle both quantitative and qualitative data make it an ideal tool. The use of AHP ensures that all relevant factors are considered systematically, leading to a well-supported and justifiable decision [21].

2.4. Sustainable rural development

The expansion of urbanization and the excessive growth of cities along with the decrease in the importance of villages, especially in developing countries, have caused far-reaching changes in the living conditions of rural and urban dwellers [22]. So, the reduction of the rural population, the abandonment of many agricultural lands, the lowering of the standard of living of the villagers and the inadequate provision of public and welfare services in rural settlements compared to urban centers, the increase of urban-rural inequalities, class differences and many problems that take cities and villages and is directly rooted in rural problems and inadequacies [23]. Therefore, efforts to develop rural environments and eliminate poverty from the face and body of these human settlements became one of the most important national development programs [24]. In Iran, the government has felt the need to address the issue of rural areas and its development since several decades ago, and in most cases, it has been considered as the focus of development policies. Sustainability in rural development was defined by the World Bank as improving living conditions in rural areas and reducing poverty. Rural development will be based on sustainable development based on the three main dimensions and axes of equality, economic growth and environmental sustainability [25]. In this way, sustainable rural development is a process that emphasizes the all-round improvement of the rural yard through the establishment and encouragement of activities compatible with environmental capabilities and bottlenecks. In this regard, the most important goal of sustainable rural development will be: making the living areas livable for the future and current generation with special emphasis on the continuous improvement of human-environmental relations and also increasing the social welfare of the village residents.

2.5. Environmental sustainability

From an ecological point of view, sustainability should include limitations on consumption and population levels. These limits are applied to all ecological systems, while mankind may be evasive of it, but ultimately must accept the limitations and

boundaries of a limited planet [26]. Environmental experts focus on the impact of human activities on the environment and are concerned about the limitations caused by these effects. They are concerned with preserving what economists call natural capital. One of the most important characteristics of natural capital that must be preserved is the diversity of biological systems. Preservation of diversity is important because it provides potential existing or unknown human resources and also because biological diversity is the basis of stability and flexibility of ecological systems and their ability to deal with pressures and tensions [27]. Diversity increases ecosystem resilience, and resilience is the fluctuating capacity that enables a system to respond to disturbances and damage. The response pattern will vary widely, but the essential integrity of the ecosystem will be preserved. The key element of resilience is the existence of a wide variety of species that interact with each other and provide a reserve of different genetic forms that provide the potential to adapt and adapt to changing conditions. Although the meaning of sustainability varies in practice, there is a general agreement that people should learn how to sustain their environmental resources [28]. The remarkable issue and importance of reaching a concept of sustainability is that it provides a holistic approach to decision-making and equally pays attention and respect to people and to the development of the ecosystem of which everyone is a part.

2.6. Sustainable development and watersheds

Sustainable development is a comprehensive approach to improving the quality of human life in order to realize the economic, social and environmental well-being of human settlements. Sustainable development is realized if there is overlap between ecological, economic and social layers [29]. Watersheds are no exception to this rule. The concept of watershed management is to provide the possibility of exploitation based on the principles and patterns of sustainable development [30]. In order to achieve sustainable development, it is necessary to describe and evaluate the state of the environment and resources before any planning. On the other hand, evaluation of ecological capacity is a process that tries to provide appropriate development and harmony with nature through regulating the relationship between man and nature [31]. In fact, this assessment is an effective step towards obtaining a plan for sustainable development, because by identifying and evaluating the ecological characteristics in each region, development programs can be planned in sync with nature, and nature itself determines the talents of the land for development [32]. Therefore, it will be inevitable to evaluate the ecological capacity as the basis of land development or environmental planning for countries that seek to achieve sustainable development along with preserving the interests of future generations. Undoubtedly, the goals of watershed management will be realized when a comprehensive and correct management is applied to the resources of watersheds and this management should be able to reduce the destructive processes in the system and strengthen the constructive processes [33]. In general, the comprehensive management of watersheds should have a general and systematic view of watersheds and be done by acquiring goods needed by the society and optimal services without adversely affecting the resources and the environment as well as the lives of the watershed residents.

3. Results and discussion

To investigate the pattern of sustainable development of rural areas in the watershed with emphasis on environmental components in the Rameh watershed of Semnan province, two standard and comparative library and field methods have been used. The present section includes two sections, firstly, in the descriptive section, descriptive statistics were used to present the results of the questionnaire findings, and in the analytical section, statistical tests were used. A questionnaire was prepared for the villagers and officials and used in the analysis, finally, the data analysis was done in the form of descriptive analysis, statistical analysis of SPSS software and AHP hierarchical analysis model, and the results are given below.

3.1. Descriptive findings

In this part, the descriptive findings from the questionnaire are presented. In other words, these findings indicate the demographic characteristics and socio-economic characteristics of the statistical sample of the research. **Tables 1** and **2** show the descriptive findings related to villagers and officials respectively.

The data in **Table 1** provides an overview of the demographic and occupational distribution among villagers. The majority of villagers are men (92.9%) and are predominantly older, with 40% aged 46 and above and 32% aged between 36 and 45. In terms of marital status, 91% of villagers are married, indicating a largely family-oriented community. Farming and ranching are the primary occupations, representing 52% of the villagers, followed by manual labor at 16%. This distribution reflects a rural, agriculture-based economy. Regarding education, 51% of villagers have no formal education or only elementary schooling, while only 1% have a bachelor's degree or higher. This low level of formal education among villagers likely influences the types of occupations available to them, limiting opportunities outside of manual and agricultural work.

Table 1. Descriptive findings related to villagers.

Gender		**Age**		**Marital status**		**Job**		**Level of Education**	
Man	Female	Exemplary people		Single	91%	Farmer and rancher	52%	Illiterate and elementary school	51%
92.9%	7.1%	0-25	8%	married	8%	Employee	6%	guidance	21%
-	-	26-35	20%	unanswered	1%	Tradesman	6%	High school	7%
-	-	36-45	32%	-	-	manual worker	16%	diploma	6%
-	-	+46	40%	-	-	Driver	8%	Associate Degree	4%
-	-	-	-	-	-	housewife	11%	Bachelor's degree and higher	1%
-	-	-	-	-	-	unanswered	1%	unanswered	4%

In contrast to villagers, **Table 2** shows that officials have significantly different demographic characteristics. The gender distribution is more balanced, with 75% men and 25% women. Unlike the villagers, officials tend to be younger, with none below the age of 25 and the majority aged 26 and above. Interestingly, only 30% of officials are single, with a significant 60% of responses in the marital status category marked as unanswered. Occupations among officials are primarily in administrative roles, with 40% employed and none in manual or agricultural jobs. Educational levels are notably

higher among officials; 90% hold a bachelor's degree or higher, indicating that higher education is a critical factor in attaining official positions. This contrast in educational levels highlights a disparity between villagers and officials in terms of professional and educational attainment.

Table 2. Descriptive findings related to officials.

Gender		**Age**		**Marital status**		**Job**		**Level of Education**	
Man	Female	Exemplary people		Single	30%	Farmer and rancher	0%	Illiterate and elementary school	0%
75%	25%	0–25	0%	married	10%	Employee	40%	guidance	0%
-	-	26–35	5%	unanswered	60%	Tradesman	0%	High school	0%
-	-	36–45	10%	-	-	manual worker	0%	diploma	0%
-	-	+46	20%	-	-	Driver	0%	Associate Degree	5%
-	-	-	-	-	-	housewife	0%	Bachelor's degree and higher	90%
-	-	-	-	-	-	unanswered	60%	unanswered	5%

3.2. Analytical findings

Firstly, to investigate the relationship between the environmental components of watersheds and the sustainable development of rural areas in the study area, in order to achieve the purpose of the research, according to the types of indicators in the environmental component, statistical tests have been used. It should be noted that to achieve better results, these tests are taken at the two levels of officials and local people. **Table 3** shows the *T*-test to investigate the impact of environmental factors on the sustainable development of rural areas from the perspective of people and officials

Table 3. *T*-test (single sample) to investigate the impact of environmental factors on the sustainable development of rural areas from the perspective of people and officials.

Indicator	**Evaluating people's opinions**				**Evaluation of officials' opinions**			
	Sample size	**Degrees of freedom**	**The value of the *T* test statistic**	**Significance level**	**Sample size**	**Degrees of freedom**	**The value of the *T* test statistic**	**Significance level**
Is there a factor in the region to increase sustainable and balanced productivity of environmental resources?	100	99	46.48	0.000*	20	19	33.18	0.000*
Has Rameh region been able to improve environmental health?	100	99	45.89	0.000*	20	19	25.41	0.000*
Rameh watershed has reduced vulnerability	100	99	40.08	0.000*	20	19	20.98	0.000*
What is the relationship between the watershed and the improvement of institutional sophistication for environmental management?	100	99	32.90	0.000*	20	19	16.80	0.000*
To what extent environmental education in the surrounding villages can be involved in the preservation of the watershed	100	99	40.33	0.000*	20	19	39.14	0.000*
What is the relationship of the villagers in relation to environmental issues?	100	99	20.36	0.000*	20	19	18.68	0.000*

Table 3. (*Continued*)

Indicator	Evaluating people's opinions				Evaluation of officials' opinions			
	Sample size	Degrees of freedom	The value of the *T* test statistic	Significance level	Sample size	Degrees of freedom	The value of the *T* test statistic	Significance level
Can the Rameh watershed have an environmental impact on the livelihood of the villagers?	100	99	40.51	0.000*	20	19	29.94	0.000*
To what extent Rameh watershed can be involved in preserving the ecosystem and environment of villages	100	99	46.07	0.000*	20	19	29	0.000*
In your opinion, to what extent realizing the economic value and environmental importance of the region can be important in the restoration and preservation of the Rameh watershed.	100	99	51.37	0.000*	20	19	29.76	0.000*
In your opinion, to what extent the Rameh watershed has been able to prevent environmental pollution	100	99	87.22	0.000*	20	19	23.65	0.000*
In your opinion, how effective is the implementation of the watershed project in the region?	100	99	93.33	0.000*	20	19	29	0.000*

Significance level up to 99% (*) Significance level up to 95% (**) Non-significance (NS).

According to the above table, which was taken through a one-sample *T*-test to measure the opinions of local people and officials regarding the impact of environmental components on the sustainable development of rural areas, it can be said that according to the results of this test, which are in two levels The people and the officials argued that from the point of view of these two groups, these components have been able to provide the reasons for rural environmental development in such a way that this test is similar to the previous test to complete the performance of those results at a significant level. This shows the validity of these two tests. Finally, according to the significance level allocated for all components in both levels, which shows 99%, it can be stated that environmental components have been able to cause sustainable development of rural areas, but the effect of each component is different. It has been such that in the evaluation of the people's opinions, to what extent do you think the implementation of the watershed project in the region has been effective, with the test statistic of 93.23, it has had the most impact from the people's point of view in the development of these areas, and the component of the relationship between the villagers is related To what extent is it related to environmental issues? With a test score of 20.36, it has played the least role in the sustainable development of the rural areas under study, and in the evaluation of the officials' opinions, the component of environmental education in the surrounding villages has the greatest impact on development. What can be involved in the preservation of the watershed with the test statistic value of 39.14 and the least amount of positive influence in the development of these areas is attributed to the component of the connection between the watershed and the improvement of the institutional finesse for environmental management with the test statistic value of 16.80 has given that this is affected by the difference in the views of officials and local people about development and its definitions in rural areas. Therefore, in order to complete this category and to know the level of development

and the level of effectiveness of the desired sustainable development components, through Spearman's test, we measure the level of influence of the environmental component on the components of sustainable development at the same two levels in order to get a clear picture of the level and manner. To show the impact of the environmental category on the sustainable development of the considered rural areas. **Table 4** shows the Spearman's test to measure the impact of the environmental component on the desired sustainable development components on the studied villages.

Table 4. Spearman's test to measure the impact of the environmental component on the desired sustainable development components on the studied villages.

The main change	The dependent variables	Evaluating people's opinions			Evaluation of officials' opinions		
		Sample size	Spearman test statistic	Significance level	Sample size	Spearman test statistic	Significance level
Environmental component	What is the rational use of water in the Rameh watershed in relation to the surrounding villages?	100	0.374	0.000*	20	0.541	0.014**
	To what extent is the rational exploitation of the soil of the Rameh watershed in relation to the surrounding villages	100	0.443	0.000*	20	0.526	0.017**
	To what extent the implementation of environmental programs can contribute to sustainable development in the region	100	0.115	0.253(ns)	20	0.131	0.581(ns)
	Has the Rameh watershed created a pristine landscape and atmosphere in the region?	100	0.294	0.003*	20	0.600	0.005*
	Has the Rameh watershed caused population density in connection with sustainable development in the region?	100	0.770	0.000*	20	0.611	0.004*
	In your opinion, to what extent the Rameh watershed can be involved in maintaining the balance of the environment for the future	100	0.645	0.000*	20	0.465	0.039**
	In your opinion, to what extent does the studied area contribute to economic stability in the studied villages	100	0.422	0.000*	20	0.221	0.350(ns)
	In your opinion, to what extent does the studied area contribute to social stability in the studied villages?	100	0.299	0.003*	20	0.152	0.552(ns)
	In your opinion, to what extent does the studied area contribute to the institutional and spatial stability of the studied villages?	100	0.411	0.000*	20	0.404	0.077**
	Can the studied area contribute to a sustainable livelihood in the villages and prevent the migration of villagers?	100	0.442	0.000*	20	0.492	0.027**

Significance level up to 99% (*) Significance level up to 95% (**) Non-significance (NS).

According to the above table, which has been attempted to measure the impact of the environmental component on the sustainable development of the rural areas of the

watershed through Spearman's correlation test, there are differences in the output from both the authorities and the people, so that the amount The impact of the environmental component on sustainable development from the perspective of the local people in all the components of sustainable development that are affected by the watershed have a significance of 99%, so that only one component of all the existing components shows a lack of significance, that is the component (implementation of the program) to what extent can the environment contribute to sustainable development in the region) shows no significance.

Of course, it should be noted that the effectiveness of the components of sustainable development is different from the environmental sector, so that the Rameh watershed component has the highest impact on population density in connection with sustainable development in the region with a Spearman value of 0.770 and the lowest impact on the same component that shows lack of significance is assigned with a significance value of 0.115, but in the analysis of the opinions of the officials about the influence of the environmental component on sustainable development, it is approximately 95% in the majority of the components with significance, except for two components that have significance. 99% that the component of the Rameh watershed has created a pristine landscape and space in the region, and the Rameh watershed has caused population density in connection with sustainable development in the region, and the three components are less effective than the environmental component from the point of view of the authorities. The components have not been able to reach a significant level and their significance level shows the lack of significance of how far these components can contribute to sustainable development in the region. It helps economically in the studied villages and how much do you think the studied area contributes to social stability in the studied villages [34]. Of course, the effectiveness of each component is different between the components that are significant at 95%, which can be seen in the amount of test statistics assigned to these components. To what extent is the Rameh watershed in relation to the surrounding villages with the value of the test statistic of 0.541 and the least amount of the test statistic is the component in the opinion of the study to what extent it contributes to the institutional and spatial stability in the studied villages with the value of 0.077 It is considered that this is a sign of the different effectiveness of these components.

In the following, in order to investigate the existing capabilities in the region and in order to achieve the goal of the research, according to the type of indicators that determine the most important capability, we use the AHP hierarchical analysis model, which is one of the most famous multi-indicator decision making techniques. It was first invented by Thomas al-Saati of Iraqi origin in the 1970s. AHP can be said that the performance evaluation process can be easily modeled in a hierarchical way. In this model, the first level represents the determination and explanation of the purpose or performance of the device, and the last level includes the operational indicators of performance evaluation, and with the help of intermediate levels, the performance of the device is its constituent dimensions, and each of these dimensions, in turn, is divided into factors. Other subsections are divided. One of the strengths of AHP modeling is that by increasing the number of decision tree levels, more details and peripheral issues can be considered. In other words, increasing the levels of the

decision tree means increasing the model and considering more factors and sub-elements affecting the decision-making problem.

3.3. Environmental capabilities affecting the sustainable development of rural areas

According to the existing conditions and the results of filling out the questionnaire, out of the 12 considered capabilities, according to the ranking averages and the expert opinions of the officials and experts, the 12 considered capabilities have been merged into seven capabilities, and this integration is based on the proximity of these capabilities. have been carried out, which are as follows:

a) The existence of a unique perspective

b) The existence of agricultural and animal husbandry potential

c) Plant and animal diversity

d) Having the ability to grow medicinal plants

e) The existence of tourism potentials

f) Managers' planning to manage the development of employment creation, management of water resources, energy resources, waste and preservation of the ecosystem and natural environment

g) sustainable livelihood and prevent migration of villagers; This area has been selected as the rural development capabilities and the amount of these indicators has been examined in two options: A) the optimal scenario from the perspective of rural development and B) the current situation.

Among the above indicators, the amount of two indicators (d) and (f) has been calculated through questionnaire techniques. In this way, these two indicators have been given a score of 10 in the "optimal scenario" and in the "existing situation" option, the villagers have been asked to give a score from 0 to 10 to the state of organizing the sale of medicinal plants and the managers' plans. Other indicators also in the "optimal scenario" option, based on the predictions and the table below, which is also known as the evaluation matrix, shows the value of each of the options in relation to each of the indicators. **Table 5** shows the capability evaluation matrix.

Table 5. Capability evaluation matrix.

Option index	***a***	***b***	***c***	***d***	***e***	***f***	***g***
Desirable scenario A	2.74	7.186	4.09	10	5	10	8
Current status B	0.33	6.6	3.02	5.25	1	4.08	4.6

3.4. Pairwise comparison matrix for AHP

The AHP method involves comparing the criteria pairwise based on their relative importance. Pairwise Comparison Matrix for AHP is shown in **Table 6**. Below is the pairwise comparison matrix for the seven criteria:

Criteria:

a) The existence of a unique perspective

b) The existence of agricultural and animal husbandry potential

c) Plant and animal diversity

d) Having the ability to grow medicinal plants

e) The existence of tourism potential

f) Management of job-creating development, management of water resources, energy resources, waste, and preservation of the ecosystem and natural environment

g) Sustainable livelihood and prevent migration of villagers

Table 6. Pairwise Comparison Matrix for AHP.

Criteria	a	b	c	d	e	f	g
a	1	5.348	0.517	0.211	1.838	0.291	0.344
b	0.188	1	0.158	0.143	0.220	0.258	0.163
c	1.934	6.329	1	0.803	2.766	1.108	1
d	4.739	6.993	1.245	1	5.720	1.476	0.654
e	0.544	4.545	0.362	0.175	1	0.263	0.2
f	3.436	3.876	0.903	0.678	3.802	1	0.903
g	2.907	6.135	1	1.529	5	1.107	1

The consistency index (CI) was calculated as follows:

- **CI**: 0.059
- **Random Index (RI)** for \(n = 7\): 1.32
- **Consistency Ratio (CR)**: 0.045 (which is less than the threshold of 0.1, indicating acceptable consistency).

3.5. Evaluation of the performance of each feature on the development using the AHP method

In order to evaluate the performance of each capability on rural development using the hierarchical analysis process evaluation method, the following steps are followed:

- Creating a hierarchical structure

First, the investigated problem has become a "hierarchical structure" that includes a three-level hierarchy, i.e., goal, criteria, and options. In the diagram below, the hierarchical structure for evaluating the performance of capabilities is depicted:

- Determining the importance of indicators

Expert opinions of 20 officials have been used to determine the importance of indicators. To determine the binary comparison matrix of indicators, the geometric mean of the components of the experts' opinion matrices was calculated and the binary comparison matrix was obtained as follows:

a
b
c
d
e
f
g

$$\begin{pmatrix} 1 & 5.348 & 0.517 & 0.211 & 1.838 & 0.291 & 0.344 \\ 0.188 & 1 & 0.158 & 0.143 & 0.220 & 0.258 & 0.163 \\ 1.934 & 6.329 & 1 & 0.803 & 2.766 & 1.108 & 1 \\ 4.739 & 6.993 & 1.245 & 1 & 5.720 & 1.476 & 0.654 \\ 0.544 & 4.545 & 0.362 & 0.175 & 1 & 0.263 & 0.2 \\ 3.436 & 3.876 & 0.903 & 0.678 & 3.802 & 1 & 0.903 \\ 2.907 & 6.135 & 1 & 1.529 & 5 & 1.107 & 1 \end{pmatrix}$$

Environmental capabilities on the rural

a) The existence of a unique perspective

b) The existence of agricultural and animal husbandry potential

c) plant and animal diversity

d) Having the ability to grow medicinal plants

e) The existence of tourism potentials

f) Management of job-creating development, management of water resources, energy resources, waste and preservation of ecosystem and natural environment

g) sustainable livelihood and prevent migration of villagers

In order to determine the importance coefficient of the criteria, first the geometric mean of the rows of the matrix A (dividing each number by their sum) is calculated and then normalized. In this way, the coefficient of importance of the indicators is as follows:

Index importance coefficient (A):

$$W_1 = \frac{0.727}{8.922} = 0.081$$

$$W_2 = 0.026, W_3 = 0.182, W_4 = 0.244, W_5 = 0.056, W_6 = 0.181, W_7 = 0.230$$

- Checking consistency in judgments

To check the consistency in judgments, it is necessary to calculate the consistency coefficient. The compatibility coefficient is calculated as follows:

a) Calculate the value of *L*:

$$L = \frac{1}{n}\left[\sum_{i=1}^{n}(AW_i)/W_i\right]$$

$$\begin{pmatrix} 1 & 5.348 & 0.517 & 0.211 & 1.838 & 0.291 & 0.344 \\ 0.188 & 1 & 0.158 & 0.143 & 0.220 & 0.258 & 0.163 \\ 1.934 & 6.329 & 1 & 0.803 & 2.766 & 1.108 & 1 \\ 4.739 & 6.993 & 1.245 & 1 & 5.720 & 1.476 & 0.654 \\ 0.544 & 4.545 & 0.362 & 0.175 & 1 & 0.263 & 0.2 \\ 3.436 & 3.876 & 0.903 & 0.678 & 3.802 & 1 & 0.903 \\ 2.907 & 6.135 & 1 & 1.529 & 5 & 1.107 & 1 \end{pmatrix} \times \begin{bmatrix} 0.081 \\ 1.026 \\ 0.128 \\ 0.244 \\ 0.056 \\ 0.181 \\ 0.230 \end{bmatrix} = \begin{bmatrix} 0.601 \\ 0.202 \\ 1.285 \\ 1.775 \\ 0.421 \\ 1.31 \\ 1.661 \end{bmatrix}$$

So:

$$L = \frac{1}{7}\left[\frac{0.601}{0.081} + \frac{0.202}{0.026} + \frac{1.285}{0.182} + \frac{1.775}{0.244} + \frac{0.421}{0.056} + \frac{1.310}{0.181} + \frac{1.661}{0.230}\right]$$

$$\mathrm{L} = \frac{1}{7}[51.488] = 7.355$$

b) Calculation of the compatibility index (CI):

$$\mathrm{CI} = \frac{L - n}{n - 1}$$

$$\mathrm{CI} = \frac{7.355 - 7}{7 - 1} \rightarrow \mathrm{CI} = \frac{0.355}{6} = 0.059$$

c) Calculation of compatibility coefficient (CR)

The random index (CR) can be extracted from the previous table since the number of indices (*n*) is equal to seven so RI will be equal to 1.32. So:

$$\mathrm{CR} = \frac{\mathrm{CI}}{\mathrm{RI}}$$

$$\mathrm{CR} = \frac{0.059}{1.32} \rightarrow \mathrm{CR} = 0.045 < 0.1 \rightarrow \mathrm{ok}$$

Because CR is smaller than 0.1, therefore consistency in judgments is acceptable, so it is taken for the next step. Randomness indices is shown in **Table 7**.

Table 7. Randomness indices (RI).

N	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
RI	0	0.58	0.9	1.12	1.24	1.22	1.41	1.45	1.49	1.51	1.48	1.56	1.57	1.59

- Determining the importance of options

Using the hourly 9-quantity scale (**Table 8**) and the evaluation matrix (**Table 9**), the preference of each option over the other option is judged in relation to each of the indicators in the following order:

Table 8. Hourly 9-quantity scale for binary comparison of capabilities.

score (severity of preference)	**1**	**3**	**5**	**7**	**9**	**2,4,6,8**
Definition	Same preference	slightly preferred	More preferred	Much more preferred	Absolutely preferred	Intermediate preferences (when intermediate states exist)

$$\begin{bmatrix} 1 & 9 \\ \frac{1}{9} & 1 \end{bmatrix} \begin{bmatrix} 1 & \frac{1}{9} \\ 9 & 1 \end{bmatrix} \begin{bmatrix} 1 & S \\ \frac{1}{S} & 1 \end{bmatrix} \begin{bmatrix} 1 & 3 \\ \frac{1}{3} & 1 \end{bmatrix} \begin{bmatrix} 1 & 7 \\ \frac{1}{7} & 1 \end{bmatrix} \begin{bmatrix} 1 & 6 \\ \frac{1}{6} & 1 \end{bmatrix} \begin{bmatrix} 1 & 5 \\ \frac{1}{5} & 1 \end{bmatrix}$$

Now, the geometric mean of each row of the binary comparison matrices of the options (the above matrices) is calculated, then by normalizing them (dividing each number by their sum), the importance coefficients of the options are determined. The next table shows the importance coefficient of each option compared to the other option in relation to each of the investigated indicators.

Table 9. The coefficient of importance of each of the options compared to the other option in relation to each of the capabilities.

Capabilities	**a**		**b**		**c**		**d**		**e**		**f**		**g**	
option	A	B	A	B	A	B	A	B	A	B	A	B	A	B
Importance factor	0.9	0.1	0.1	0.9	0.83	0.16	0.75	0.25	0.87	0.12	0.85	0.14	0.83	0.16

- Determining the final score of capabilities

At this stage, by combining the coefficients of the importance of indicators and options, the final score of each option is determined using the following formula (principle of hourly hierarchical composition).

$$\text{The final score of option } X = \sum_{i=1}^{n} W_i(g_{ix})$$

$$(W_i = \text{The coefficient of importance of index } I\text{ ,}$$

$$g_{ix} = \text{The score of option } x \text{ is related to sub} - \text{index } i)$$

Table 10 shows the coefficients of the importance of indicators and the score of capabilities in relation to each of the indicators:

Table 10. The coefficients of the importance of indicators.

Environmental capabilities of sustainable development of rural areas								
Importance of index		a) 0.081	b) 0.026	c) 0.182	d) 0.244	e) 0.056	f) 0.181	g) 0.23
Option score	A	0.9	0.1	0.833	0.750	0.875	0.857	0.833
	B	0.1	0.9	0.167	0.250	0.125	0.143	0.167

Therefore: the final score of option *A*:

$$= (0.081 \times 0.9) + (0.026 \times 0.1) + (0.182 \times 0.833) + (0.244 \times 0.750) + (0.556 \times 0.875) + (0.181 \times 0.857) + (0.23 \times 0.833) = 0.807$$

The final score of option *B*:

$$= (0.081 \times 0.1) + (0.026 \times 0.9) + (0.182 \times 0.167) + (0.244 \times 0.250) + (0.056 \times 0.125) + (0.181 \times 0.143) + (0.23 \times 0.167) = 0.192$$

- Determining the percentage of success of capabilities

According to the above results, it is possible to calculate the success rate of the capabilities compared to the "optimal scenario" of its studies (option A):

$$\text{success rate} = \frac{\text{The final score of the status quo option (B)}}{\text{The final score of the optimal scenario option (A)}} \times 100$$

$$\text{success rate} = \frac{0.192}{0.807} \times 100 = 23.79\%$$

- Summary and conclusion of hierarchical analysis

Index (d) with an importance coefficient of 0.1233 is the most important among the selected evaluation capabilities. Of course, the performance of capabilities in relation to indicators (a), (c), (e), (f) and (g) is far from the predictions made in the ideal scenario of the studies. This distance in relation to capability (a) is very large. Regarding capability (b), it has moved far ahead of the predictions made. This is due to the positive effect of agricultural development and the modernization of animal husbandry, as well as the reduction of negative effects (natural issues due to the growth of science and the use of experts in agriculture and animal husbandry).

The amount of index (c) in the current situation is equal to 5.25 out of 10 (optimal situation), which shows well that the plant diversity of the watershed is as a taffeta separate from the areas outside the watershed. Index (f) of managers' planning to manage job-creating development, manage water resources, energy resources, waste and preserve the ecosystem and natural environment received a score of 4.08 out of a total of 10 points (optimal situation) which shows that Managers and planners have not been able to meet the needs of the villagers in the mentioned administrations and cause progress and reduction of damages in these sectors. The success rate of the evaluated capabilities compared to the desired study option was 23.79%, which indicates a severe weakness in the use of these capabilities.

4. Conclusion

In the current research, the pattern of sustainable development of rural areas in the watershed was discussed with an emphasis on environmental components in the watershed. In this section, while presenting the results of the research findings,

practical solutions are presented to increase the positive impact on the neighboring villages by providing suitable solutions. According to the analysis presented in the research findings section, it can be stated that there is a significant relationship between the environmental components and the sustainable development of the rural areas of the study area. Therefore, the local and national authorities should make more useful use of these components in the direction of rural development in such a way that the use of these components can be considered as a desirable feature and can be considered in the direction of sustainable rural development. Furthermore, according to the findings of the AHP model, there are many capabilities in this region and it has led to the sustainable development of rural areas. The problem in this section is the ability to grow medicinal plants, which can be seen in the results of the tests, which has the most importance among the selected evaluation capabilities with an importance coefficient of 0.1233. Another discussion is that to what extent we have been able to benefit from them in this direction and we have not harmed them, but with these interpretations it is possible to plan in such a way that this potential feature of the region can be used for development. At the end of the research, according to the findings of the research, the following suggestions are made for better planning and for the sustainable development of the villages located in the Rameh watershed area:

- Formation of cooperative cooperatives of villagers in order to better exploit the existing pastures in the basin.
- Planning in line with the development of popular consultation of the villagers in order to use the potential of the basin as best as possible according to the needs of the day.
- Planning in order to reduce the lack of coordination between the executive bodies in order to use the ability of people's participation continuously.
- Formation of private companies in order to create ecotourism residences in order to increase the benefit of the environmental capabilities of the region in attracting tourists.
- Creation of formal and informal trainings in order to make the villagers use as much as possible the ability to grow medicinal plants in the region according to the ecological conditions of the region and the needs of the market.
- Planning for the ease of commuting to the region according to the topographical conditions of the region in order to increase the ease of people's participation for the sustainable development of rural areas.
- Increasing governmental follow-ups with regard to increasing participation and assistance in the direction of implementing watershed management operations in the Rameh basin, considering the lack of success after several years of watershed management operations in the area.
- Planning in order to benefit from the natural potentials and potential production power and suitable capabilities of the region in various dimensions.
- Creating a land improvement plan in line with the prosperity of the region to solve the existing bottlenecks including cultural and livelihood poverty among the villagers and etc.

- Creating a program in order to increase the coordination between the relevant institutions in the correct implementation of the projects foreseen in the direction of the sustainable development of the rural areas of the region.

5. Recommendations

In order to enhance sustainable development in rural areas, particularly in the Rameh watershed region, it is essential to focus on maximizing the use of existing environmental capabilities while minimizing potential harms. The formation of cooperative groups and active participation from local villagers are critical steps in fully leveraging the region's natural resources, such as pastures and medicinal plants. It is recommended that authorities and stakeholders emphasize bottom-up development models, where villagers actively contribute to decision-making processes. Creating ecotourism ventures and facilitating easier access to the region will help attract tourists, benefiting the local economy while ensuring environmental conservation. Additionally, increasing formal and informal training on the sustainable cultivation of medicinal plants in line with ecological conditions can provide both economic and ecological benefits, driving long-term prosperity in the region.

Future studies should explore the integration of more comprehensive environmental data to refine the understanding of the watershed's ecological capabilities and their relationship with sustainable rural development. Expanding the scope of research to include broader regional studies and comparing the effectiveness of various models for rural development in different watersheds could provide valuable insights. Furthermore, long-term monitoring of the implemented strategies, especially concerning watershed management and ecological tourism, is necessary to assess the effectiveness of current interventions and adjust policies accordingly. Future research can also focus on developing innovative financing models for rural development that align with the principles of sustainability, ensuring the resilience of these regions against climate change and socio-economic challenges.

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