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3 **Assessing the role of settlement in the environmental challenges**
4 **of sensitive ecosystems**

5 **A case study in Zrebar wetland (Iran)**

6 ¹Sima Saadi^{1, 2}, Jean-Philippe Antoni²

7 ¹ Faculty of Planning and Environmental Sciences, the University of Tabriz, Tabriz, Iran.

8 ²Laboratory ThéMA, UMR 6049, CNRS and University of Burgundy, Dijon, France

9
10 **Keywords** - Environmental Challenges, Sensitive ecosystems, Wetland, Structural equation
11 modeling, spatial analysis.

12 **Abstract** - The majority of the planet's natural systems, especially sensitive ecosystems, are
13 undergoing rapid change as a result of environmental problems. This issue has been made worse by
14 settlements and their activities. Which has led to environmental issues in the sensitive ecosystem.
15 As a result, the goal of this article is to assess how settlers play a part in the environmental problems
16 sensitive ecosystems face. Zrebar Lake, one of Iran's most significant wetlands, will function as the
17 case study for this analysis. The Required data were collected through a survey conducted from
18 2020 to 2021, among 360 responses in 15 villages and Marivan city in Iran. The statistical analysis
19 was performed using the SPSS and Structural Equation Modeling (SEM) designed with AMOS
20 software. In addition, the probability level (P: 0.0001) is optimum, and Then the spatial analysis
21 was performed in ArcGIS by spatial interpolation with Inverse distance weighted (IDW). The
22 results indicate that in all dimensions examined, settlements have significantly contributed to the
23 occurrence of environmental challenges in the Zrebar wetland ecosystem. And Settlements in close
24 proximity to sensitive ecosystems have a significant impact on these challenges. Finally, the
25 findings of this study demonstrate the problems that a sensitive ecosystem faces, using statistical
26 and spatial analysis to aid in the practical implementation of sustainable management in the

¹Corresponding author:

E-mail addresses: sima_saadi@etu.u-bourgogne.fr & simasadi@yahoo.com (S. Saadi)

27 settlements surrounding the wetland ecosystem, as well as new approaches to launching related
28 policies. Provide long-term ecosystem management in urban and rural areas.

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34 **1. Introduction**

35 **1.1. General context**

36 Many natural processes that directly affect human health, agricultural production, and
37 aquatic systems have become more spatially variable and temporally sensitive because of
38 global environmental change (Cieslik et al., 2018; Anand, 2013). Much of this shift in rural
39 areas is due to the conversion of natural ecosystems to agricultural lands, which is
40 expanding day by day as population expansion, migration, and economic development of
41 settlements rise (Cumming et al., 2014; van Vliet, 2019; Bren d'Amour et al., 2017; Li et
42 al., 2019). This is especially crucial in "sensitive ecosystems" (Lambin and Geist, 2011),
43 which are rare, biologically fragile, or considered "at-risk" environments. Many of these
44 habitats, particularly wetland ecosystems, are complicated due to a variety of
45 environmental variables that are prone to abrupt changes, as well as human actions that
46 result in habitat depletion and other negative implications for organism ecosystems
47 (Denslow et al., 2007; Wang et al., 2022). This is especially true in environmentally
48 sensitive areas like wetlands, where vegetation, biodiversity, aquatic biosystems, plants,
49 and birds are all declining (Khan Yousuf Zai et al., 2005; Li et al., 2022). Every year, like
50 at Zrebar Lake (see part 2), this problem becomes increasingly serious and dangerous.
51 Many plants, aquatic, and animal species are wiped out each year in these vulnerable
52 environments as a result of Zrebar Lake's dryness.

53 These issues are the natural consequence of the development of industrial society, which
54 includes settlements, activities, infrastructures, as well as underlying values, beliefs, and
55 attitudes (Bourdeau, 2004; Stone, 2006; Lomba et al., 2022). Following its own logic,
56 industrial society evolved from a "welfare society" to a "society of universal risk," more
57 unable to regulate the growth of environmental man-made problems. The prolonged
58 survival of such a civilization, based on the accumulation of material commodities at the
59 expense of nature, has become a constant source of economic, social, and environmental
60 peril (Gvozdikova et al., 2019; Neth et al., 2022; Donati et al., 2022; Siddik et al., 2022).
61 Consequently, personal and social issues have a significant part in changing the existing

62 condition. Individual and organizational responsibility, climate change awareness, respect
63 for nature, a sense of belonging, common commitment, and perspective for the living
64 environment should all be encouraged in order to prevent population.

65 As a consequence, these environmental challenges are intimately related to humans and
66 their environments. This relationship can be seen in environmental issues like positive or
67 negative ecosystem effects, economic issues such as business and livelihood dependency,
68 sociocultural issues such as social bonding and sense of belonging, and infrastructure issues
69 such as wetland conservation management policies.

70 **1.2. Issue**

71 Wetlands provide several economic, environmental, and cultural benefits in their natural
72 condition, as well as being crucial environmental components in any terrain. However,
73 human activities such as urbanization, agriculture, and road development can result in
74 significant wetlands loss (Winter et al., 2010). Therefore, people's prejudiced behavior is
75 responsible for the majority of environmental problems and disasters. Consumerism, as
76 well as an overabundance of wealth, power, and land, have most certainly led to the current
77 ecological concerns that humanity faces (Mollison & Slay, 1998). According to studies and
78 research over the last decade, many rivers, lakes, and wetlands around the world have lost
79 their stability and have become sensitive and unstable ecological assemblages, and this
80 process is the foundation for the sustainable development of communities in these basins.
81 The majority of wetlands are currently threatened, and these are the ones that have been
82 harmed the most because of unsustainable human expansion, with the fastest known rate of
83 degradation over time.

84 Therefore, both natural and human forces cause Changes in wetlands. The most serious
85 issue is the tendency of unsustainable wetland community development. Ecosystems and
86 settlement sustainability are linked in a two-way connection. The long-term viability of
87 rural and urban settlements is dependent on ecosystem viability, which is dependent on the
88 pattern of development and living habitats in the surrounding area (Brinson and Malvarez,
89 2002; Euliss et al. 2006; Eftekhari et al., 2016). Understanding and evaluating
90 environmental changes, as well as harmful forces and ecosystem strengths, is a process that
91 leads to a comprehensive understanding of how humans interact with the environment.
92 Given the importance of environmental conservation, the economic dynamics of habitats
93 are represented in the interaction between human societies and the environment in a
94 specific time-space framework (Brinson and Malvarez, 2002; Euliss et al. 2006; Endlicher
95 et al., 2011; Eftekhari et al. 2014; Hasibuan et al., 2014; Fischer et al., 2015).

96 Hence, the balance of ecosystem dynamics and the quality of human environments that
97 contribute positively or negatively to ecosystem functioning are linked to environmental
98 sustainability (Ozgul & Dindaroglu, 2021). To study this equilibrium and its environmental

99 effects, as well as to tackle the challenges in sensitive ecosystems, researchers and
100 stakeholders require sufficient variables and dimensions. Some governments, for example,
101 have created specific variables to measure environmental consequences and promote
102 ecosystem and environmental impact assessments through formal legislation (Heim et al.,
103 2021; Link et al., 2019). In the United States, for instance, variables are an important aspect
104 of the Integrated Regional Environmental Assessment (IEA) (Harvey et al., 2017).
105 Examining and analyzing some of these indications is one of the goals of this paper.

106 **1.3. Objective**

107 In the context of multi-dimensional socio-ecological challenges, this study focuses on the
108 interaction between human (cultural, economic, and social) and natural (biological,
109 physical, and chemical) domains. Its goal is to determine how such a beneficiary might
110 assist managers and stakeholders in making essential decisions in light of changing
111 resource and ecological situations (Jones et al., 2009; Wang et al., 2009). Finally, what
112 effect does urban and rural settlement have on the environmental issues faced by the Zrebar
113 Wetland ecosystem? The purpose of assessing the effects of urban and rural habitats and
114 activities in the Zrebar wetland was to discover more about the role of settlement in
115 sensitive wetlands ecosystems' environmental challenges. The variety of human activities in
116 the lake endangers the health and security of animals, plants, and the lake in the long term,
117 necessitating consideration of social and environmental features to see how settlements
118 affect the environment, with the results assisting developers in determining the necessary
119 next steps to ensure development can continue.

120 Unless individuals adjust their everyday routines, scientific or political solutions will have a
121 limited impact on addressing these concerns (Ardzijauskaitė, 2009). The finest performers
122 and sources of information for such a study are people who live near these ecosystems.
123 Then, using a questionnaire, they must be questioned about their relationship with their
124 sensitive wetland environment. This questionnaire must indicate their distance from this
125 setting in order to analyze the nature and geographical strength of this relationship (Zrebar
126 lake). Because of this, the goal of this study is to examine how settlement affects the
127 environmental problems that sensitive ecosystems face. This study has taken into account
128 the sensitive ecosystem that is the Zrebar Lake. For this reason, Part 2 presents a case study
129 of the Zrebar Lake and its key geographic and demographic characteristics. The
130 questionnaire, as well as the methodology for spatial and statistical analysis, are described
131 in Section 3. The results of the analysis are presented in section 4 and discussed in part 5.
132 Finally, in section 6, the main findings are summarized.

133 **2. Case study: Lake Zrebar**

134 In Kurdistan, Iran, Zrebar is one of the most significant wetlands. And with remarkable
135 environmental values as well as re-enacted economic values, the lake stands out among a

136 diversity of cultural and commercial activities. Forests from the Zagros Mountains surround
 137 the wetland. Freshwater is obtained from a variety of springs on the lake's bottom and in the
 138 surrounding area, as well as from climatic precipitation. Wetland water levels might vary
 139 from month to month since the volume of water changes throughout the year (Khoram and
 140 Hoshmand, 2012). Despite its geographical seclusion from Iran's busy demographic and
 141 economic centers, the Zrebar Wetland has not been immune to the effects of pollution,
 142 touristic centers, and activity. After all, during the last three decades, regional development
 143 has wreaked havoc on the lake's ecological system and watershed. The long-term viability
 144 of the region depends on the lake's revival (Hosseini et al. 2017). The major reasons that
 145 this wetland has become more sensitive and fragile in recent decades are unsustainable
 146 agricultural activities in the areas around the lake, the entry of industrial, urban, and rural
 147 wastewater, forest degradation, eutrophication, and fires around the lake.

148 Mariwan's villages were divided into three groups to better understand the role of
 149 settlements in environmental concerns. Villages in close proximity to Zrebar Lake (3-0
 150 km), villages in the middle distance (3-6 km), and villages in the far distance (6-9 km) from
 151 the lake were selected at random from each category (Figure 1). Zrebar Lake is 3 km far
 152 from Mariwan. The Mariwan urban community was also investigated because it has an
 153 impact on the lake's and surrounding ecology's environmental issues. As a result, the
 154 villages and towns under inquiry are shown in Table 1 and Figure 1.

155

Table 1. Information of the settlements studied

Distance from the lake	Name of the village/city	Whole population	Number of answered questionnaires
	Kanisanan	660	9
	Yangijeh	362	5
	Daratefy	924	12
	Kolan	252	27
	Ney	2560	43
	Mariwan City	151,188	190
	Barghala	14	2
	Bayela	29	2
	Valajer	1655	27
	Marane	66	2
	SaadAbad	412	6
	MirAbad	265	3
	Bayava	127	2
	Siyonav	818	12
	Darziyan	441	6
	LanjAbad	1052	12
Total	15	9788,188	360



157

158

Figure 1- Map of the Case study

159 3. Methodology

160 This section describes how appropriate data was gathered through a questionnaire, as well
 161 as the dimensions and variables used to assess the public's perceptions of local
 162 environmental implications. It also explains how their responses are statistically and
 163 spatially analyzed.

164 3.1. The questionnaire

165 To collect the required data, a questionnaire was designed with closed questions based on
 166 the Likert spectrum. Given that non-standard and technical meanings may cause differences
 167 in people's perceptions of certain terms in surveys, ignoring this inconsistency may result in
 168 serious misunderstandings and, as a result, incorrect responses. Hence, for survey data to be
 169 accurate, respondents must understand the questions as authored. Allowing respondents to
 170 gain clarity about the intended meaning of survey questions can improve response accuracy
 171 dramatically. Therefore, before distributing the questionnaire to the respondents, the
 172 researcher clarified and explained the difficult questions and concepts to the locals in
 173 straightforward terms. It should be noted that this questionnaire was created in the local
 174 language. The full questionnaire can be seen in Appendix A. First, the questionnaire
 175 contains 5 questions of general information about surveyed people and one question about

176 their location and their living distance from Zrebar Lake (Figure 1). As shown in Table 2
177 and Table 3, the 45 following variables concern environmental challenges within five
178 dimensions. The purpose of using these dimensions is to comprehensively discuss the
179 wetland's environmental problems. In other words, environmental factors such as water
180 pollution and the extinction of aquatic animals and plants are not the only ones influencing
181 this wetland's challenges. Rather, other factors such as infrastructure, such as a lack of
182 proper waste management, social factors such as a lack of awareness, population growth,
183 and a lack of a sense of belonging, economic factors such as unsustainable and destructive
184 tourism in the region, and finally cultural activities aimed at wetland protection, all play a
185 role. These tables were built via research review and shows the indicators used in the field
186 of environmental situations of sensitive ecosystems:

- 187 • ECL (Ecology): Loss of vegetation around the wetland, Lack of suitable cultivation
188 pattern in agricultural lands around the wetland, Danger of oil contaminants
189 entering the lake, Air and noise pollution, The loss of biodiversity, Soil erosion in
190 the watershed and the entry of eroded soils into the wetland, Loss of aquatic animals
191 and plants, Pollution of lake water, Use of fertilizers and chemical pesticides in
192 agriculture near the wetland, Fires around the lake, Lack of attention to the
193 aesthetics of the landscape, Bird hunting, and Expansion of agricultural fields near
194 the wetland.
- 195 • INF (Infrastructure): Entry of urban-rural sewage, Lack of waste management, The
196 lack of pollution control, Lack of sustainable management, Lack of protection
197 restriction for wetlands, Unauthorized use of lake water for agriculture, Lack of
198 careful policy and planning, Lack of government investment in the ecosystem, Lack
199 of private sector investment, and Discharge and Repulsion of waste.
- 200 • CUL (Culture): Sharing creativity, art, and cultural activities, Lack of cultural
201 background, Look at the wetland as a cultural heritage, and Lack of cultural
202 activities related to the protection of the wetland.
- 203 • ECN (Economics): Perform sensitive business activities, Construction of restaurants
204 and entertainment venues around the lagoon, Increase tourism activities, The
205 existence of too many docks and boats, Irregular grazing of livestock around the
206 ecosystem, Unstable tourism, Construction of factories and poultry farms near the
207 lake, Private ownership of lands around the ecosystem, and Unauthorized and
208 excessive fishing.
- 209 • SOC (Society): Responsible people and organizations, Lack of awareness of climate
210 change, Lack of public information and awareness about wetlands, Lack of
211 participatory approach in comprehensive wetland management, Population growth,
212 Disrespect for nature, Lack of sense of belonging, Common commitment and

213 perspective on the living environment, and NGOs and environmental protection
214 organizations.

215 Cochran's formula was used to determine the sample size, and 360 questionnaires were
216 randomly selected among the sample villages. The survey was conducted during the 2020-
217 2021 year. Among the 360 answers, 52% were females and 47% were men, 43.1% were
218 married, 45,8% were single and 11.1% other, whose ages were 30.8% between [15-24],
219 37.8% between [25-34], 18.3% between [35-44], 8.9% between [45-54], 4.2% [55 and
220 more].

221 When using a structural equation model, a variable with several ordered Likert categories is
222 treated as numerical data, and the related and calculated coefficients show the differential
223 effects of this characteristic on each variable's base value.

224 **3.2. Statistical and spatial analysis**

225 The statistical analysis was carried out with SPSS and the Structural Equation Modeling
226 (SEM) was created with the AMOS (Analysis of Moment Structures) software. Since
227 notions such as "culture" and "ecology" are not directly observable and must be deduced
228 from a sequence of measurable factors, the SEM model with latent variables has been
229 employed. This model can be used to investigate a collection of relationships between one
230 or more independent variables, whether they are continuous or discrete. It devises a method
231 for dismantling the correlations found in a set of equations that explain their causal
232 assumptions. The SEM model investigates causal linkages between directly observable
233 data, assuming that any existing relationships are linear.

234 SEM provides three significant advantages over traditional multivariate techniques: (1)
235 explicit measurement error evaluation; (2) estimation of latent (unobserved) variables via
236 observable variables; and (3) model testing, in which a structure can be imposed and data
237 fit assessed. By not explicitly addressing measurement error, most multivariate techniques
238 accidentally disregard it, whereas SEM models estimate these error variance parameters for
239 both independent and dependent variables (Novikova et al., 2011).

240 To measure the questionnaire's reliability, Cronbach's alpha method was used, the value of
241 which is equal to 0.701. In this study, to determine the validity of the questionnaires, the
242 face validity method and the opinion of relevant experts, and the fact of the structure and
243 confirmatory factor analysis, have been used as shown in Table 4. Finally, to show the role
244 of each settlement individually in environmental challenges, a method of Inverse distance
245 weighted (IDW) interpolation was used for spatial analysis in ArcGIS software. IDW
246 indeed allows determining cellular values using a linearly weighted combination of a set of
247 sample points (city and villages understudy). The weight is a function of inverse distance
248 (distance from Zrebar Lake). This method assumes that the variable being mapped
249 decreases in influence with distance from its sampled location (Figures 3 and 4).

250 Concretely, Table 5 shows the percentage (%) and the mean of the respondent's views on
251 the role of settlements (urban and rural) in the environmental challenges of Zrebar Lake,
252 which was designed in the form of a Likert scale (“strongly agree”, “somewhat agree”,
253 “moderate”, “somewhat disagree” or “strongly disagree”). The third column of the Table
254 shows the question numbers of the survey included in the SPSS database. Thus, for
255 example, Q8 (Question 8) refers to question number 26 in the Ecological dimension and so
256 on.

Table 2. The variables used in the field of environmental situations of sensitive ecosystems by researchers (Ecological and Infrastructure dimensions)

Dimensions	Variables	Weichenthal et al, 2019	Ortega-García et al, 2019	Radwanina Taruc et al, 2019	Schulz et al, 2019	Xu et al, 2019	Borgwardt et al, 2019	Pedersen, 2019	Wondie, 2018	Tan et al, 2018	Ashford et al, 2018	Tonini et al, 2018	Murray et al, 2018	Zaheri & Saadi, 2018	Larios et al, 2017	Sieben et al, 2016
	Loss of vegetation around the wetland									*		*				
	Lack of suitable cultivation pattern in agricultural lands around the wetland										*					*
	Danger of oil contaminants entering the lake										*					*
	Air and noise pollution	*								*						
	The loss of biodiversity			*		*									*	
	Soil erosion in the watershed and the entry of eroded soils into the wetland															*
	Loss of aquatic animals and plants						*			*						
	Pollution of lake water	*	*	*		*									*	
	Use of fertilizers and chemical pesticides in agriculture near the wetland		*		*	*										
	Fires around the lake										*					
	Lack of attention to the aesthetics of the landscape							*						*		
	Bird hunting								*							
	Expansion of agricultural fields near the wetland															*
	Entry of urban-rural sewage						*									*
	Lack of waste management											*				
	The lack of pollution control			*								*				
	Lack of sustainable management				*											
	Lack of protection restriction for wetlands													*		
	Unauthorized use of lake water for agriculture								*							
	Lack of careful policy and planning								*							
	Lack of government investment in the ecosystem	*				*							*			
	Lack of private sector investment							*								
	Discharge and Repulsion of waste									*		*				

260 Table 3. The variables used in the field of environmental situations of sensitive ecosystems by researchers (Social, Economic, and Cultural
 261 dimensions)

Dimensions	Variables	Weichenhal et al, 2019	Ortega-García et al, 2019	Radwamina Taruc et al, 2019	Schulz et al, 2019	Xu et al, 2019	Borgwardt et al, 2019	Pedersen, 2019	Wondie, 2018	Tan et al, 2018	Ashford et al, 2018	Tonini et al, 2018	Murray et al, 2018	Zaheri & Saadi, 2018	Larios et al, 2017	Sieben et al, 2016
	Responsible people and organizations												*			
	Lack of awareness of climate change				*											
	Lack of public information and awareness about wetlands				*									*		
	Lack of participatory approach in comprehensive wetland management													*		
	Population growth								*							
	Disrespect for nature							*								
	Lack of sense of belonging							*								
	Common commitment and perspective on the living environment												*			
	NGOs and environmental protection organizations									*				*		
	Perform sensitive business activities		*					*								
	Construction of restaurants and entertainment venues around the lagoon								*							
	Increase tourism activities						*									
	The existence of too many docks and boats						*									
	Irregular grazing of livestock around the ecosystem						*		*							
	Unstable tourism								*							
	Construction of factories and poultry farms near the lake								*							
	Private ownership of lands around the ecosystem								*							
	Unauthorized and excessive fishing											*				
	Sharing creativity, art, cultural activities												*			
	Lack of cultural background												*			
	Look at the wetland as a cultural heritage								*							
	Lack of cultural activities related to the protection of the wetland													*		

Table 4. Results of confirmatory factor analysis (construct validity)

Sig	Sig number	standard error	Non-standard estimates	The relationship between variables		
***	4.919	.156	.769	Ecological	←-	Environmental Challenges
***	7.267	.133	.964	Infrastructure	←-	Environmental Challenges
***	6.672	.110	.735	Cultural	←-	Environmental Challenges
***	.418	.135	.056	Economic	←-	Environmental Challenges
***	8.491	.156	1.325	Social	←-	Environmental Challenges
			1.000	Loss of vegetation around the wetland	←-	Ecological
***	3.995	.343	1.958	Lack of suitable cultivation pattern in agricultural lands around the wetland	←-	Ecological
***	3.193	.232	1.369	The danger of oil contaminants entering the lake	←-	Ecological
***	3.315	.241	.740	Air and noise pollution	←-	Ecological
***	2.351	.220	.797	The loss of biodiversity	←-	Ecological
***	3.812	.295	.517	Soil erosion in the watershed and the entry of eroded soils into the wetland	←-	Ecological
***	3.910	.259	1.125	Loss of aquatic animals and plants	←-	Ecological
***	4.405	.372	1.014	Pollution of lake water	←-	Ecological
***	4.325	.282	1.638	Use of fertilizers and chemical pesticides in agriculture near the wetland	←-	Ecological
***	4.508	.434	1.221	Fires around the lake	←-	Ecological
			1.000	Entry of urban-rural sewage	←-	Infrastructure
***	5.426	.210	1.140	Lack of waste management	←-	Infrastructure
***	5.429	.167	.909	The lack of pollution control	←-	Infrastructure
***	6.644	.271	1.800	Lack of sustainable management	←-	Infrastructure
***	6.272	.262	1.643	Lack of protection restriction for wetlands	←-	Infrastructure
***	5.830	.185	1.078	Unauthorized use of lake water for agriculture	←-	Infrastructure
***	4.464	.161	.717	Lack of care policy and planning	←-	Infrastructure
***	5.503	.224	1.232	Lack of government investment in the ecosystem	←-	Infrastructure
***	5.909	.260	1.535	Lack of private sector investment	←-	Infrastructure
***	4.926	.167	.820	Discharge and Repulsion of waste	←-	Infrastructure
			1.000	The irresponsibility of individuals and organizations	←-	Social
***	5.156	.131	.677	Lack of awareness of climate change	←-	Social
***	5.912	.164	.967	Lack of public information and awareness about wetlands	←-	Social
***	5.369	.145	.779	Lack of participatory approach in comprehensive wetland management	←-	Social
***	5.514	.147	.811	Population growth	←-	Social
***	5.277	.119	.628	Disrespect for nature	←-	Social
***	7.062	.163	1.154	Lack of sense of belonging	←-	Social
***	7.369	.171	1.257	Common commitment and perspective on the living environment	←-	Social
***	7.402	.205	1.520	Lack of NGO activity and environmental protection organizations	←-	Social
			1.000	Perform sensitive business activities	←-	Economic
***	.416	22.848	9.503	Construction of restaurants and entertainment venues	←-	Economic
***	.416	29.275	12.188	Increase tourism activities	←-	Economic
***	.417	28.996	12.079	The existence of too many docks and boats	←-	Economic
***	.417	37.126	15.474	Irregular grazing of livestock around the	←-	Economic

Sig	Sig number	standard error	Non-standard estimates	The relationship between variables		
				ecosystem		
***	.417	45.611	19.029	Unstable tourism	←-	Economic
***	-.296	2.893	-.856	Construction of factories and poultry farms near the lake	←-	Economic
***	.416	30.000	12.489	Private ownership of lands around the ecosystem	←-	Economic
***	.353	4.386	1.547	Unauthorized and excessive fishing	←-	Economic
			1.000	Lack of Sharing creativity, art, cultural activities	←-	Cultural
***	5.256	.299	1.573	Lack of culture-building	←-	Cultural
***	5.669	.403	2.283	Lack of looking at the Wetland as a cultural heritage	←-	Cultural
***	5.177	.226	1.170	Lack of cultural activities related to the protection of the wetland	←-	Cultural

264

265 4. Results and Discussion

266 This section included three sub-sections of respondents' views on the role of settlements in
 267 environmental challenges. It finally presents a model of analysis developed by combining SPSS
 268 and SEM, and shows how this model fits in SEM.

269 4.1. Respondents' opinion

270 According to the results shown in Table 5, people living near Zrebar Lake consider that:

- 271 • For ECL, variables like “Fire around the lake” (3.96%), “Use of fertilizers and chemical
 272 pesticides in agriculture near the wetland” (3.85%), “Pollution of lake water” (3.76%),
 273 and “Air and noise pollution” (3.70%) had the most important impact on the occurrence
 274 of environmental challenges. The conditions for the occurrence of such issues have been
 275 made possible by the growth of people in the lake's surroundings. The loss of vegetation
 276 surrounding the wetland habitat is a result of both intentional and incidental burning by
 277 visitors and locals. Additionally, the use of poisons and artificial fertilizers, as well as the
 278 entry of urban, industrial, and rural sewage, have all caused contamination in this
 279 sensitive ecosystem that will have an irreversible impact on it (Myers et al., 2012;
 280 Eddudottir et al., 2016; Anne Beryl Vogt, 2021; Liu et al., 2022; Long et al., 2022).
- 281 • For INF, variables like “Entry of urban-rural sewage” (3.98%), “Lack of government
 282 investment in the ecosystem” (3.83%), “Lack of protection restriction for wetlands”
 283 (3.78%), and “Lack of care policy and planning” (3.73%) had the most impact on the
 284 occurrence of environmental challenges. Despite these difficulties, the sensitive
 285 ecosystem cannot be adequately protected if there is no efficient sewage management to
 286 stop additional lake pollution and if the government lacks essential collaboration (Jia et
 287 al., 2021; Desta, 2021).
- 288 • For SOC, “Lack of participatory approach in comprehensive wetland management”
 289 (3.79%), “Lack of awareness of climate change” (3.73%), and “Lack of public
 290 information and awareness about wetlands” (3.69%) had the most impact on the
 291 occurrence of environmental challenges. Such environmental social issues significantly

292 contribute to an increase in human effects on sensitive ecosystems. Because of this, it's
 293 essential to have knowledge of the ecosystem and how the climate is changing, as well as
 294 local participation, good management, and capacity building in such communities (Kemp
 295 & Palinkas, 2015; Kovalenko & Kovalenko, 2018; Desta, 2021).

- 296 • For ECN, “Increase tourism activities” with 3.71%, “Construction of factories and
 297 poultry farms near the lake” with 3.56%, and “Private ownership of lands around the
 298 ecosystem” with 3.56% had the most impact on the occurrence of environmental
 299 challenges. The wetland ecosystem can benefit the local population economically and
 300 materially and encourage the growth of new enterprises in the area (de Juan et al., 2017).
 301 According to Diaz et al. (2018), ecosystems’ contributions to people are categorized into
 302 three broad partially overlapping groups – material, non-material, and regulating
 303 contributions. However, if the locals misuse these financial advantages and act contrary
 304 to conserving the lake's ecosystem, for instance by boosting tourism without taking into
 305 account the lake's health and pollution (noise pollution, dumping trash, etc.), it will have
 306 irreversible consequences.
- 307 • For CUL, “Lack of cultural activities related to the protection of the wetland” (3.88%)
 308 and “Lack of Sharing creativity, art, cultural activities” (3.68%) had the most important
 309 impact on the occurrence of environmental challenges. These difficulties may have a
 310 variety of repercussions on the wetland ecosystem, making it impossible for the locals to
 311 view the lake as a cultural treasure and to be vigilant in its protection if they do not have
 312 a feeling of connection to the ecosystem. As a result, the lake environment is crucial for
 313 sustaining, providing for, regulating, and feeding the cultural ecosystem, the locals' sense
 314 of community, and their cultural legacy. (Zoderer et al., 2016; Sterner et al., 2020; Desta,
 315 2021).

316 Table5. Frequency of variables from the respondents' point of view

Dimension s	Variables	Symbol In SPSS	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree	Mean
	Loss of vegetation around the wetland	Q1	11.9	21.3	13.3	26.2	26.8	3.35
	Lack of suitable cultivation pattern in agricultural lands around the wetland	Q2	6.1	21.0	18.0	30.1	24.3	3.46
	Danger of oil contaminants entering the lake	Q3	13.0	21.3	10.8	30.9	23.5	3.31
	Air and noise pollution	Q4	6.9	9.1	23.8	27.1	32.6	3.70
	The loss of biodiversity	Q5	5.8	22.4	21.5	27.9	21.8	3.38
	Soil erosion in the watershed and the entry of eroded soils into the wetland	Q6	13.0	20.7	20.2	25.7	19.9	3.19
	Pollution of lake water	Q7	8.3	19.3	13.8	31.5	26.5	3.49
	Use of fertilizers and chemical pesticides in agriculture near the wetland	Q8	2.5	13.8	17.1	38.1	27.9	3.76
	Fires around the lake	Q9	4.4	9.9	16.6	33.4	35.1	3.85
	Lack of attention to the aesthetics of the landscape	Q10	0.0	11.0	14.6	40.6	33.1	3.96
	Bird hunting	Q11	8.6	20.2	14.4	30.1	26.2	3.46
	Failure to address rare and endangered species	Q12	5.8	14.9	13.3	33.1	32.3	3.72
	Loss of aquatic animals and plants	Q13	9.1	18.2	16.6	34.0	21.5	3.41
	Entry of urban-rural sewage	Q14	2.5	10.2	14.1	32.9	39.8	3.98
	Lack of waste management	Q15	8.6	19.3	10.5	32.9	28.2	3.53

Dimension s	Variables	Symbol In SPSS	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree	Mean
	The lack of pollution control	Q16	11.3	17.7	18.2	30.9	21.3	3.33
	Lack of sustainable management	Q17	2.8	19.1	15.7	38.7	23.2	3.61
	Lack of protection restriction for wetlands	Q18	0.0	13.0	22.4	37.8	26.2	3.78
	Unauthorized use of lake water for agriculture	Q19	4.7	18.2	18.0	34.3	24.3	3.56
	Lack of careful policy and planning	Q20	1.1	14.6	20.7	37.0	26.0	3.73
	Lack of government investment in the ecosystem	Q21	0.3	11.9	19.9	40.3	27.1	3.83
	Lack of private sector investment	Q22	7.2	12.7	15.7	37.3	26.5	3.64
	Discharge and Repulsion of waste	Q23	5.2	15.2	16.9	35.6	26.5	3.63
	Irresponsibility of individuals and organizations	Q24	9.4	19.3	16.6	29.6	24.6	3.41
	Lack of awareness of climate change	Q25	3.0	13.3	19.1	35.9	28.2	3.73
	Lack of public information and awareness about wetlands	Q26	2.8	18.2	13.8	36.7	27.9	3.69
	Lack of participatory approach in comprehensive wetland management	Q27	2.5	14.1	14.1	40.1	28.7	3.79
	Population growth	Q28	11.3	23.8	13.8	30.4	20.2	3.24
	Disrespect for nature	Q29	11.0	20.2	14.6	27.6	26.0	3.38
	Lack of sense of belonging	Q30	17.4	26.5	11.6	24.0	19.9	3.03
	Common commitment and perspective on the living environment	Q31	8.6	19.9	19.9	29.3	21.8	3.36
	Lack of NGO activity and environmental protection organizations	Q32	23.2	31.5	9.4	18.0	17.4	2.75
	Perform sensitive business activities	Q33	6.1	16.0	21.0	32.3	24.0	3.53
	Construction of restaurants and entertainment venues	Q34	9.7	22.9	17.7	28.5	20.7	3.28
	Increase tourism activities	Q35	0.3	16.0	22.4	34.8	26.0	3.71
	The existence of too many docks and boats	Q36	10.8	19.3	21.8	26.2	21.3	3.28
	Irregular grazing of livestock around the ecosystem	Q37	12.2	20.4	17.1	30.4	19.3	3.24
	Unstable tourism	Q38	5.2	15.2	25.1	33.4	20.4	3.49
	Construction of factories and poultry farms near the lake	Q39	6.1	18.5	15.5	30.7	28.7	3.58
	Private ownership of lands around the ecosystem	Q40	2.5	20.2	18.0	37.3	21.5	3.56
	Unauthorized and excessive fishing	Q41	6.4	15.5	15.5	37.0	25.1	3.59
	Lack of Sharing creativity, art, cultural activities	Q42	0.3	15.5	22.7	38.4	22.7	3.68
	Lack of cultural background	Q43	8.3	18.2	18.5	31.8	22.7	3.43
	Lack of looking at the Wetland as a cultural heritage	Q44	23.2	26.0	9.4	23.5	17.4	2.86
	Lack of cultural activities related to the protection of the wetland	Q45	0.3	10.8	18.8	40.6	29.0	3.88

317

318 4.2. Latent variables

319 Figure 2 shows the representation of the model developed by combining SPSS and SEM. All
320 factor loads are positive in this diagram. In this figure, Oval shapes represent the error term (e) of
321 each variable. Also, the names of observed variables are displayed based on the abbreviation of
322 hidden variables. For example, observed variables of the ecological variable are named ECO1,
323 ECO2, ECO3, etc. The Structural Equation Model allows measuring a “hidden variable” using
324 several observed variables and specifying, estimating, evaluating, and presenting graphics to
325 show the hypothetical relationships between the variables. It also determines to what extent the
326 number of variables observed for a “hidden variable” is affected by the desired hidden variable
327 and to what extent it is affected by the error variable. The combination of SEM and factor
328 analysis used in this study provides a framework for better understanding the interaction between
329 settlements and environmental concerns that affect sensitive ecosystems. Indeed, settlements
330 near wetland ecosystems have large areas, high internal heterogeneity, a major central population
331 center, strong radial directionality inflows and movements, and a variety of contrasting change

332 patterns (Forman, 2008), all of which contribute to the complexity of the relationship between
333 landscape patterns and ecological processes. For a better understanding of ecological structure
334 and function, SEM was used to simplify heterogeneity and characterize latent variables and
335 interactions (Sutton-Grier et al., 2010; Moeinaddini et al., 2020; Xie et al., 2020; Wang et al.,
336 2022). In this model, Ecological (ECL), Infrastructure (INF), Cultural (CUL), Economic (ECN),
337 and Social (SOC) are the hidden (or latent) variables represented by five ovals. Each of these
338 latent variables is linked to several observed variables:

- 339 • ECL is related to 13 observed variables: “Loss of vegetation around the wetland”, “Lack
340 of suitable cultivation pattern in agricultural lands around the wetland”, “Danger of oil
341 contaminants entering the lake”, “Air and noise pollution”, “The loss of biodiversity”,
342 “Soil erosion in the watershed and the entry of eroded soils into the wetland”, “Loss of
343 aquatic animals and plants”, “Pollution of lake water”, “Use of fertilizers and chemical
344 pesticides in agriculture near the wetland”, “Fires around the lake”, “Lack of attention to
345 the aesthetics of the landscape”, “Bird hunting and Failure to address rare and endangered
346 species”. Note that because the structural equation models do not respond to more than
347 10 variables for each hidden variable, we had to remove 3 variables from this dimension
348 in this section to fit the model.
- 349 • INF is related to 10 observed variables: “Entry of urban-rural sewage”, “Lack of waste
350 management”, “Lack of pollution control”, “Lack of sustainable management”, “Lack of
351 protection restriction for wetlands”, “Unauthorized use of lake water for agriculture”,
352 “Lack of care policy and planning”, “Lack of government investment in the ecosystem”,
353 “Lack of private sector investment and Discharge and Repulsion of waste”.
- 354 • SOC is related to 9 observed variables: “Irresponsibility of individuals and
355 organizations”, “Lack of awareness of climate change”, “Lack of public information and
356 awareness about wetlands”, “Lack of participatory approach in comprehensive wetland
357 management”, “Population growth”, “Disrespect for nature”, “Lack of sense of
358 belonging”, “Common commitment and perspective on the living environment” and
359 “Lack of NGO activity and environmental protection organizations”.
- 360 • ECN is related to 9 observed variables: “Perform sensitive business activities”,
361 “Construction of restaurants and entertainment venues”, “Increase tourism activities”,
362 “Existence of too many docks and boats”, “Irregular grazing of livestock around the
363 ecosystem”, “Unstable tourism”, “Construction of factories and poultry farms near the
364 lake”, “Private ownership of lands around the ecosystem and Unauthorized and excessive
365 fishing”.
- 366 • CUL is related to 4 observed variables: “Lack of Sharing creativity, art, cultural
367 activities”, “Lack of culture-building”, “Lack of looking at the Wetland as a cultural
368 heritage” and “Lack of cultural activities related to the protection of the wetland”.

369 According to Figure 2, all factor loads are positive. As a result, all model fit indices have been
370 evaluated at an appropriate level, which indicates a complete fit of the global model. According
371 to Table 6, it can be said that all observed variables have positive and significant impact
372 coefficients within their scales. In other words, all the dimensions mentioned—namely, the
373 infrastructure dimension with a factor load of 1.82, the social dimension with a factor load of
374 1.51, the ecological dimension with a factor load of 1.34, the economic dimension with a factor

375 load of 1.22, and finally the cultural dimension with a factor load of 1.—show that settlements
376 have significantly contributed to the emergence of environmental challenges.

377 As reviewed above, human actions are changing many environmental constraints simultaneously.
378 The high dimensionality of these changes may lead to much greater impacts on ecosystem
379 communities than anticipated from a consideration of only one or a few of these variables
380 (Tilman & Lehman, 2001).

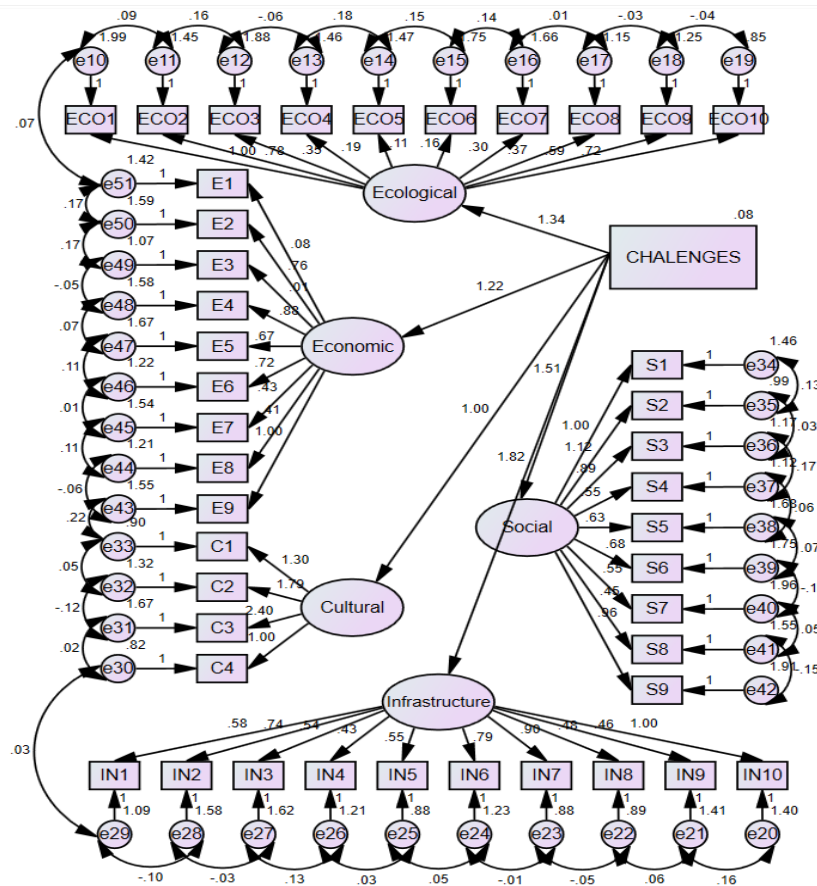
381 Research on the interactions between human behavior and ecological systems tends to focus on
382 the direct effects of human activities on ecosystems, such as biodiversity loss. There is also
383 increasing research effort directed towards ecosystem services. However, interventions to control
384 people's use of the environment alter the incentives that natural resource users face, and therefore
385 their decisions about resource use (Milner-Gulland, 2012). As a result, the relationship between
386 humans and the Zrebar wetland ecosystem, which has turned into a sensitive and fragile
387 ecosystem over the past ten years, is crucial in terms of both the ecological and other dimensions
388 of infrastructure, social interaction, economics, and culture (Reyahi-Khoram and Hoshmand,
389 2012; Nhu et al., 2020).

390 Finally, the causes of environmental changes in Zrebar wetland are divided into two categories,
391 one is climatic and ecological changes and the other is derived from human activities.

392 The transformation of Zrebar Wetland in terms of climate changes due to the decrease in the
393 amount of rainfall, decrease in relative humidity, increase in the number of winds and dust in the
394 catchment area of Zrebar Wetland, the influx of sediments and flowing sand, excessive growth of
395 reeds and increase in the volume of its sediments. The amount of nitrate in the water and
396 endangers the life of the animal and plant species of the lake (Javidi Deljavan & Hosseini, 2019)
397 and reduces the water supply of the bubbling springs supplying the water resources the lake
398 (Barari et al., 2018). So that during the past 13 years, the depth of the wetland has decreased by
399 100 cm, and its depth decreases by about 7.6 cm every year (Halabian & Ismaili, 2018).

400 In terms of changes caused by human activities, we can mention the entry of human sewage and
401 solid waste in 15 villages on the edge of the lagoon. In general, the proximity of human
402 settlements to the Zrebar wetland, especially against the environmental stress caused by human
403 activities, has intensified the ecological transformations caused by climate change. For example,
404 until the last two decades, the communities around the lagoon were engaged in fishing,
405 agriculture for daily needs. But today, the increase in economic activities, villa construction,
406 tourism, demographic changes, land use and urban sprawl have intensified this transformation. In
407 other words, climate changes on the one hand and changes caused by the activities and behaviors
408 of local communities on the other hand have caused environmental challenges that Zrebar
409 Wetland is facing today (Nhu et al., 2020; Salimi et al., 2021).

410



411

412

Figure 2. The pattern of structural equations of research

413

414

Table 6. Results of confirmatory factor analysis (construct validity)

Sig	Standard regression weight	The relationship between variables		
***	.143	Loss of vegetation around the wetland	←-	Ecological
***	.314	Lack of suitable cultivation pattern in agricultural lands around the wetland	←-	Ecological
***	.197	The danger of oil contaminants entering the lake	←-	Ecological
***	.122	Air and noise pollution	←-	Ecological
***	.131	The loss of biodiversity	←-	Ecological
***	.078	Soil erosion in the watershed and the entry of eroded soils into the wetland	←-	Ecological
***	.174	Loss of aquatic animals and plants	←-	Ecological
***	.186	Pollution of lake water	←-	Ecological
***	.279	Use of fertilizers and chemical pesticides in agriculture near the wetland	←-	Ecological
***	.258	Fires around the lake	←-	Ecological
***	.193	Entry of urban-rural sewage	←-	Infrastructure
***	.286	Lack of waste management	←-	Infrastructure
***	.240	The lack of pollution control	←-	Infrastructure

Sig	Standard regression weight	The relationship between variables		
***	.164	Lack of sustainable management	←-	Infrastructure
***	.276	Lack of protection restriction for wetlands	←-	Infrastructure
***	.343	Unauthorized use of lake water for agriculture	←-	Infrastructure
***	.434	Lack of care policy and planning	←-	Infrastructure
***	.233	Lack of government investment in the ecosystem	←-	Infrastructure
***	.233	Lack of private sector investment	←-	Infrastructure
***	.209.	Discharge and Repulsion of waste	←-	Infrastructure
***	.406.	The irresponsibility of individuals and organizations	←-	Social
***	.399.	Lack of awareness of climate change	←-	Social
***	.350.	Lack of public information and awareness about wetlands	←-	Social
***	.194.	Lack of participatory approach in comprehensive wetland management	←-	Social
***	.208	Population growth	←-	Social
***	.199	Disrespect for nature	←-	Social
***	.235	Lack of sense of belonging	←-	Social
***	.187	Common commitment and perspective on the living environment	←-	Social
***	.242	Lack of NGO activity and environmental protection organizations	←-	Social
***	.019	Perform sensitive business activities	←-	Economic
***	.142	Construction of restaurants and entertainment venues	←-	Economic
***	-.012	Increase tourism activities	←-	Economic
***	.218	The existence of too many docks and boats	←-	Economic
***	.171	Irregular grazing of livestock around the ecosystem	←-	Economic
***	.158	Unstable tourism	←-	Economic
***	.144	Construction of factories and poultry farms near the lake	←-	Economic
***	.127	Private ownership of lands around the ecosystem	←-	Economic
***	.012	Unauthorized and excessive fishing	←-	Economic
***	.192	Sharing creativity, art, and cultural activities	←-	Cultural
***	.243	Lack of culture-building	←-	Cultural
***	.301	Lack of looking at the Wetland as a cultural heritage	←-	Cultural
***	.234	Lack of cultural activities related to the protection of the wetland	←-	Cultural

415

416 As regards the error variables (which capture the variance that is not considered in the model),
417 variables are closely interrelated. All the variables were estimated through the maximum
418 likelihood estimation. All the results obtained are considered adequate, and therefore, the model
419 has a good fit.

420

421 4.3. Model fits

422 The chi-square (χ^2) goodness-of-fit test is one of the most widely used nonparametric tests to
423 determine the discrepancy between an observed dataset and an expected dataset. This test and its
424 limiting probability (p) are the only goodness-of-fit test associated with significance testing; the
425 other measures and indices are merely descriptive. In this regard, the result obtained with the
426 (χ^2) is very good: 1502.970 with 812 degrees of freedom (DF). Likewise, the probability level
427 (0.000) is excellent. This means that the variables are significantly different.

428 Table 7 shows the model fit indices. The goodness variables of the model show the number
 429 0.828, which indicates a favorable situation. In addition, Tucker fit indices show an adaptive fit
 430 of 0.706 and 0.736, respectively, for the model. The economic fit index and the economic
 431 adaptive fit index are 0.899 and 0.653, respectively. The Root Mean Square Error of
 432 Approximation (RMSEA) measures the goodness-of-fit for statistical models, with the goal for
 433 the population to have an approximate or close fit with the model, rather than an exact fit, which
 434 is often not practical for large populations. Values below 0.05 indicate a good fit of the model.
 435 Therefore, the result of 0.049 also indicates a fit of the model.

436

Table 7. Status of fitting variables

The value of the index in the desired pattern	Indicator
134	NPAR
1502.970	CMIN
812	DF
000.	P
828.	GFI
1.851	CMIN/D F
049.	RMSEA
706.	TLI
736 .	CFI
899.	PNFI
653.	PCFI

437

438 The results of the one-way analysis of variance of the role of settlements in the environmental
 439 challenges of the Zrebar Lake ecosystem (Table 8), which is based on its distance from the lake,
 440 is that according to the value of GIS in the Ecological, infrastructure, social, variables Economic,
 441 and cultural, on average, these variables differ significantly in villages with different distances.
 442 In other words, this table shows, there is a statistically significant difference between the means
 443 of our groups. We can see that the significant value is 0.000 which is below 0.05. Therefore,
 444 there is a statistically significant difference between different periods in the studied dimensions.
 445 To see which of the two groups is different, Table 9 provides a comparison table of several
 446 Tukey tests for all three different groups' combinations.

447

Table 8. Results of one-way analysis of variance in the test ANOVA

Variables	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	15.389	3	5.130		
Within Groups	48.563	356			
Total	63.952	359			
Between Groups	10.441	3	3.480		
Within Groups	65.841	356			
Total	76.282	359			
Between Groups	12.116	3	4.039		

	Within Groups	84.358	356	0.237		
	Total	96.474	359			0.000
	Between Groups	15.299	3	5.100		
	Within Groups	65.213	356			
	Total	80.512	359			
	Between Groups	25.054	3	8.351		
	Within Groups	139.944	356			
	Total	164.998	359			

448

449 The role of human settlements in each of the rural groups and the city of Mariwan has been
450 calculated separately for Ecological, Infrastructural, Social, Economic, and Cultural dimensions
451 at different distances. Considering the average between these groups, we see that in all of the
452 dimensions the villages of part C (6-9 km from the lake), which are far from the lake, have the
453 most differences from the other groups. These results show that settlements located further away
454 from Zrebar Wetland have far less impact on the environmental challenges of this data
455 ecosystem. These findings are consistent with previous research (Zaheri and Saadi, 2019;
456 Eftekhari et al., 2016). As a result, towns positioned further away from the Zrebar wetland
457 appear to have a much lower environmental impact. This implies that communities located this
458 far away play a less role in the incidence of these difficulties than adjacent villages like Marivan,
459 owing to their lack of connection to the wetland ecology. Particularly about appropriate
460 development patterns in agricultural regions surrounding the wetland, lake water pollution,
461 wetlands privacy restrictions, attentive policy, and planning, or climate change awareness (Nhu
462 et al., 2020; Dong et al., 2022; Molla Sitotaw et al., 2022).

463

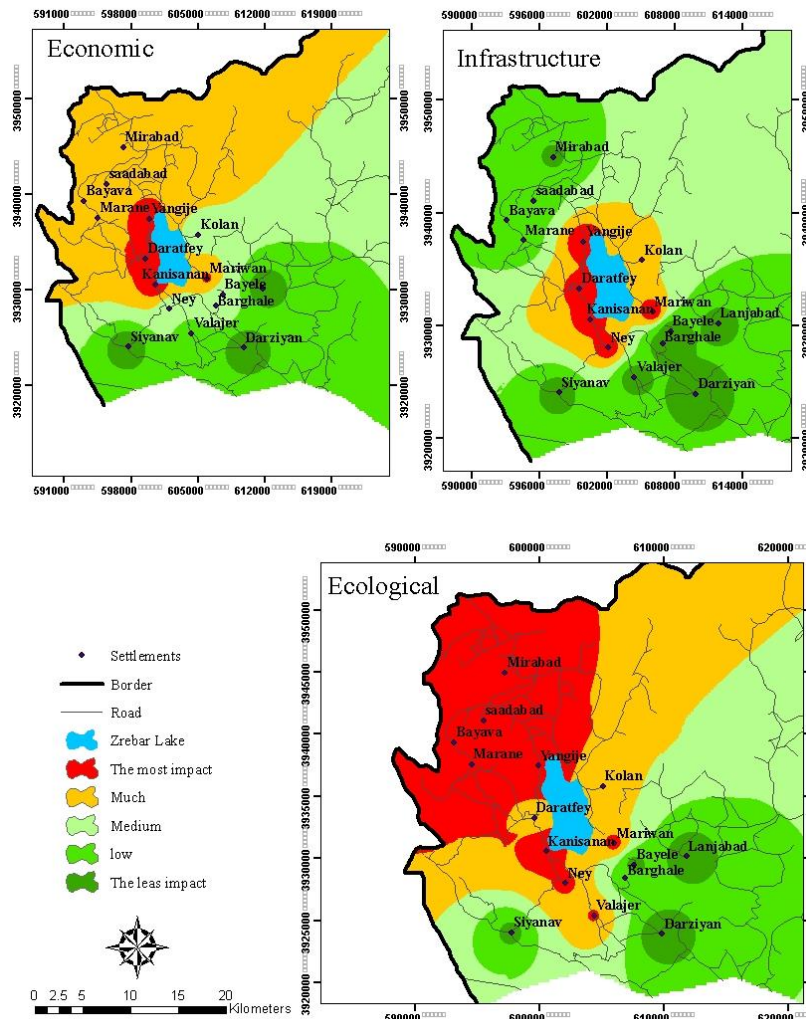
Table9. Multiple comparisons in the test ANOVA

Variables	Distance of villages from Zrebar Lake	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
	the villages of Part A (0-3 km from the lake)	96	3.5136	0.33137	0.03382	3.4465	3.5808	2.77	4.38
	the villages of Part B (3-6 km from the lake)	39	3.5444	0.33455	0.05357	3.4359	3.6528	2.92	4.38
	the villages of Part C (6-9 km from the lake)	35	4.1582	0.46490	0.07858	3.9985	4.3179	2.92	4.85
	Mariwan City (0-3 km from the lake)	190	3.4389	0.37466	0.02718	3.3853	3.4925	2.46	4.77
	Total	360	3.5402	0.42206	0.02224	3.4964	3.5839	2.46	4.85
	the villages of Part A (0-3 km from the lake)	96	3.4323	0.57647	0.05884	3.3155	3.5491	2.00	4.70
	the villages of Part B (3-6 km from the lake)	39	3.9564	0.37683	0.06034	3.8343	4.0786	3.00	4.60
	the villages of Part C (6-9 km from the lake)	35	3.9000	0.36942	0.06244	3.7731	4.0269	3.10	4.60
	Mariwan City (0-3 km from the lake)	190	3.6705	0.35809	0.02598	3.6193	3.7218	2.60	4.60
	Total	360	3.6603	0.46096	0.02429	3.6125	3.7081	2.00	4.70
	the villages of Part A (0-3 km from the lake)	96	3.2083	0.61331	0.06260	3.0841	3.3326	2.00	4.89
	the villages of Part B (3-6 km from the lake)	39	3.4473	0.47585	0.07620	3.2930	3.6015	2.44	4.33
	the villages of Part C (6-9 km from the lake)	35	3.8857	0.44402	0.07505	3.7332	4.0382	2.78	4.67
	Mariwan City (0-3 km from the lake)	190	3.3503	0.41985	0.03046	3.2902	3.4104	1.89	4.56
	Total	360	3.3750	0.51839	0.02732	3.3213	3.4287	1.89	4.89
	the villages of Part A (0-3 km from the lake)	96	3.5521	0.46960	0.04793	3.4569	3.6472	2.44	4.56
	the villages of Part B (3-6 km from the lake)	39	3.1823	0.38699	0.06197	3.0569	3.3078	2.33	3.89
	the villages of Part C (6-9 km from the lake)	35	2.9651	0.33849	0.05722	2.8488	3.0814	2.33	3.67
	Mariwan City (0-3 km from the lake)	190	3.5848	0.42834	0.03108	3.5235	3.6461	2.11	4.44
	Total	360	3.4722	0.47357	0.02496	3.4231	3.5213	2.11	4.56

Economic	the villages of Part A (0-3 km from the lake)	96	3.1745	0.71738	0.07322	3.0291	3.3198	1.50	4.75
	the villages of Part B (3-6 km from the lake)	39	3.5192	0.60258	0.09649	3.3239	3.7146	2.25	4.50
	the villages of Part C (6-9 km from the lake)	35	2.9857	0.52139	0.08813	2.8066	3.1648	1.75	4.00
	Mariwan City (0-3 km from the lake)	190	3.6803	0.59988	0.04352	3.5944	3.7661	1.25	4.75
	Total	360	3.4604	0.67794	0.03573	3.3901	3.5307	1.25	4.75

464

465 The IDW approach was then utilized in ArcGIS software to spatially examine the data and
 466 observe how each of the villages and cities is related to the researched dimensions.



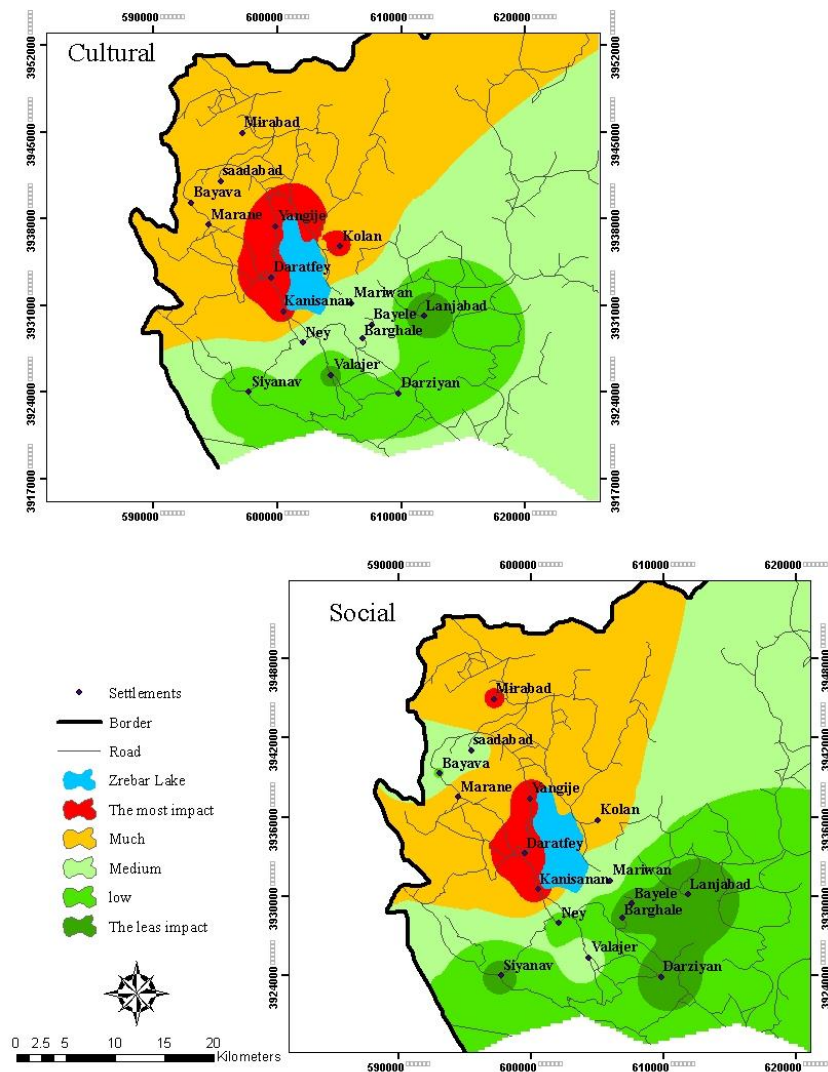
467

468 **Figure 3. Spatial analysis of The Role of Settlements in Environmental Challenges of Zrebar wetland by IDW**
 469 **(Ecological, infrastructural and economic dimensions)**

470 According to Figure 3, Mariwan city and Yangije villages, Daratfey and Kanisanan are among
 471 the settlements that have played the largest part in the wetland ecosystem's environmental
 472 difficulties in terms of economic, infrastructure, and ecological dimensions. Construction of
 473 factories and poultry farms around the lake, rising private ownership of property around the
 474 ecosystem, illegal and excessive fishing, and unsustainable tourism are all possible factors for
 475 the economic dimension. Furthermore, sewage from these communities entering the lake,

476 growing uncontrolled development surrounding the lagoon by urban people, and unauthorized
 477 use of lake water for agriculture are all potential infrastructure issues. However, in terms of
 478 environmental impact, communities in the middle distance and some border villages, in addition
 479 to Mariwan and surrounding villages, have the greatest impact. Because of the border
 480 communities, the lack of adequate agricultural land in these areas, and their daily travel for
 481 hunting and fishing. These findings are consistent with previous research (Jafari Azar, 2015;
 482 Nashenas, 2014).

483 As can be seen, this wetland has a lot of promise in the field of ecotourism, and it's clear that
 484 public and private sector investment will help the wetland achieve its potential and the native
 485 people will benefit from it. As a result, individuals are more likely to be concerned about the
 486 wetland's protection and management (Reyahi-Khoram and Hoshmand, 2012; Nhu et al., 2020).



487
 488 **Figure 4. Spatial analysis of The Role of Settlements in Environmental Challenges of Zrebar wetland by IDW**
 489 **(Cultural and social dimensions)**

490 Villages near and medium distances from the lake have played the most significant role in
 491 environmental concerns, according to Figure 4. The reason for this can be linked to a lower level

492 of climate change knowledge (or a sense of risk) in rural areas compared to Mariwan, as well as
493 population expansion in these communities in recent years.

494 According to the AMOS structural model, the most important role of urban and rural settlements
495 in the occurrence of environmental issues in the wetland ecosystem is infrastructural and social
496 dimensions, followed by ecological, economic, and cultural dimensions, respectively. According
497 to these findings, officials and the government should seriously consider infrastructure issues in
498 the study area, such as waste recycling management, sustainable management, privacy rules for
499 the Zrebar wetland, careful policy and planning, and government investment in the ecosystem, in
500 the first stage, to improve the situation in the study area.

501 The most pressing issue is to raise public awareness about the region's environmental crises. As a
502 result, problems like animal hunting, forest fires, water pollution in the wetland, and plant loss in
503 the area were avoided. This conclusion is in accordance with McCampbell et al. (2018) findings
504 in the African Great Lakes Region, which argue that, in addition to technological and biophysical
505 components, socio-cultural, economic, and institutional factors have a significant role in
506 preventing and managing issues.

507 The theme of tourism, which has grown significantly in recent decades, has increased the
508 region's environmental concerns. As a consequence, the expansion of tourism-related economic
509 and business activities such as rising garbage around the lake, expanding fishing and boating in
510 the area, increasing private ownership and construction of villas around the lake, and eventually,
511 the construction of hotels around the lake. Restaurants and entertainment venues have become
512 more environmentally conscious, thus paying attention to these concerns and attempting to
513 remedy them can help to improve the region's environmental position.

514 Informing people, especially farmers, about the importance of not using chemicals and fertilizers
515 in the lands near the lake, encouraging government agencies to improve waste management and
516 invest in the area, establishing privacy rules for the lake, increasing cultural activities about the
517 importance of the wetland ecosystem and the risk of climate change, and finally improving.
518 These results are consistent with the findings of Cieslik *et al.* 2018 They argue that improved
519 connectivity and digitally-enabled horizontal information sharing have the potential to foster
520 exchange and learning among the local actors in the system.

521

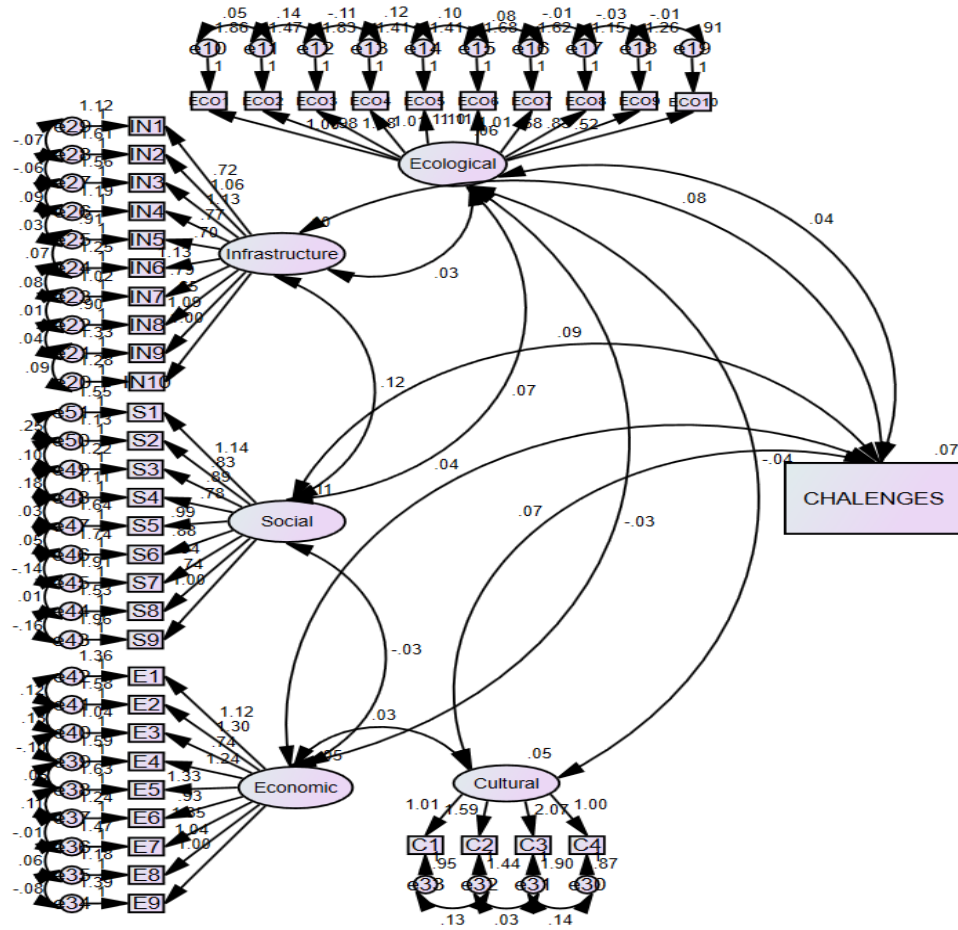


Figure 5. Model for measuring the pattern of structural equations of research

522

523

524 In summary, all the results obtained allow us to affirm that the elaborated model is correct since
 525 it adequately specifies the relationships among the variables.

526 In general, the findings will contribute to a better knowledge of the environment and challenges
 527 facing a sensitive ecosystem, as well as a methodological framework for investigating the
 528 regional variability of the relationship between environmental variables and settlements.

529

530 5. Conclusion

531 Lakes are particularly vulnerable while also being extremely important. They only cover a small
 532 portion of the planet, but they are rich in biodiversity and contribute disproportionately to
 533 ecosystem services. Scientists and decision-makers are interested in wetlands because of their
 534 diverse roles and environmental services, as well as their socioeconomic benefits. However,
 535 particularly in terms of government regulation and environmental regulations, they have not
 536 received the attention they need.

537 One of the most significant freshwater lakes in the Middle East and Iran is Lake Zrebar. Over the
 538 past ten years, the lake has undergone several changes that have finally resulted in the loss of
 539 biodiversity and a decrease in the lake's water level. Because of this, the role of settlements in the

540 environmental issues affecting this delicate ecosystem has been examined in this study. A
541 questionnaire, followed by statistical techniques and spatial analysis, were employed to assess
542 these challenges. The findings of the research in this area are as follows.

543 The research's findings show that in all dimensions examined, settlements have significantly
544 contributed to the occurrence of environmental challenges in the Zrebar wetland ecosystem. The
545 structural equations model's findings indicate that the infrastructure, social, ecological,
546 economic, and cultural factors present the greatest challenges respectively.

547 The questionnaire was randomly distributed to three groups of villages near Zrebar Lake (0-3
548 km), villages in the middle distance (3-6 km), and villages in the far distance (6-9 km) from the
549 lakes in order to better understand the role of settlements in environmental challenges. The
550 results of this part show that, in comparison to communities in the middle of the distance and
551 villages near the lake, settlements farther away from Zrebar Wetland have a significantly lower
552 impact on the environmental challenges of this ecosystem.

553 This calls for further preparation and consideration of the environmental issues in the lakeside
554 regions. Since no lake exists in a vacuum from its surroundings, our major argument is that the
555 establishment of the required infrastructure, government funding, and cooperation, as well as
556 increasing local understanding of the importance of the wetland and environmental challenges in
557 the area, should take precedence. For instance, increasing knowledge and providing better
558 resources for farmers that operate near lakes would help them use fewer pesticides and chemical
559 fertilizers, which have led to lake water contamination and the extinction of many plant and
560 animal species. Additionally, wastewater management in the area should be improved to lessen
561 lake water pollution and sustainable tourism should be developed to limit noise pollution and
562 biodiversity loss in wetland ecosystems. Also, raising awareness, engaging in cultural events,
563 and hosting festivals, create the conditions for greater social involvement in the preservation of
564 the wetland and enhancing a sense of community around the lake.

565 In general, Infrastructure concerns, such as waste management, recycling, sustainable
566 management, privacy laws, careful planning, and government investment, should be given
567 serious consideration by authorities in the first phase. The second most important issue is to
568 increase public knowledge of the environmental crises in the area. Animal hunting, forest fires,
569 water pollution in the wetland, and the loss of vegetation in the area must all be addressed in this
570 way. Finally, the challenges found in this study can assist managers and planners in effectively
571 managing the wetland. Additionally, it can help with the practical implementation of identifying
572 the lake's challenges and offer innovative approaches for launching pertinent policies to address
573 these challenges based on the local comprehension of the communities.

574 **Highlights**

- 575 ❖ The significance of settlements in sensitive ecosystems' environmental challenges;
- 576 ❖ Settlements in close proximity to sensitive ecosystems have a significant impact on
577 environmental challenges;
- 578 ❖ The most environmental challenges have been in the infrastructural, social, and
579 ecological dimensions;
- 580 ❖ Understanding the local population is essential for identifying and resolving the
581 challenges.

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821 **Appendix A (the main part of the questionnaire):**

822  *The role of settlements in the Ecological dimension of sensitive ecosystems*

Dimension	Row	Questions (Indicators)	strongly agree	somewhat agree	Neither agree nor disagree	somewhat disagree	strongly disagree
Ecological	1.1	Human settlements contributed to the loss of vegetation around Zarivar Wetland.					
	1.2	The lack of a suitable cultivation pattern in the agricultural lands affected the occurrence of environmental challenges.					
	1.3	The presence of a border road and the passage of oil tankers increased the risk of oil contaminants entering the lake .					
	1.4	Air and noise pollution due to the Ecotourism undermined the preservation of the ecosystem around the Wetland.					
	1.5	The existence of human settlements caused the loss of biodiversity in the region.					
	1.6	Soil erosion in the watershed and the entry of eroded soils into the Wetland affected the occurrence of environmental challenges.					
	1.7	The existence of human settlements polluted the lake water .					
	1.8	The use of chemical fertilizers and pesticides in agriculture endangered the preservation of the wetland ecosystem.					
	1.9	The occurrence of fires near the lake contributed to the occurrence of environmental challenges.					
	1.10	Destruction of aquatic animals and plants affected the occurrence of environmental challenges.					

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824  *The role of settlements in the Infrastructure dimension of sensitive ecosystems*

Dimension	Row	Questions (Indicators)	strongly agree	somewhat agree	Neither agree nor disagree	somewhat disagree	strongly disagree
	2.1	Entry of urban-rural sewage affected of environmental challenges.					
	2.2	The lack of waste management in the region played a role in the emergence of environmental					

Infrastruct		challenges.					
	2.3	The lack of pollution control in the region contributed to endangering the ecosystem.					
	2.4	The lack of sustainable management in the region played a role in the emergence of environmental challenges.					
	2.5	The lack of privacy laws for wetlands affected environmental challenges.					
	2.6	The unauthorized use of lake water for agriculture or other purposes endangered the ecological stability of this wetland.					
	2.7	The lack of care policy and planning by the authorities affected the emergence of environmental challenges?					
	2.8	The government's lack of investment in preserving the wetland ecosystem contributed to environmental challenges.					
	2.9	The lack of private sector investment in the wetland affected the occurrence of environmental challenges.					
	2.10	Discharge and Repulsion of waste in the wetland affected the occurrence of environmental challenges.					

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 *The role of settlements in the Social dimension of sensitive ecosystems*

Dimension	Row	Questions (Indicators)	strongly agree	somewhat agree	Neither agree nor disagree	somewhat disagree	strongly disagree
Social	3.1	The irresponsibility of individuals and organizations in the region played an important role in environmental issues of this wetland.					
	3.2	The lack of awareness of people about climate change and environmental issues contributed to the emergence of environmental challenges.					
	3.3	The lack of information and public awareness about wetlands contributed to the emergence of environmental challenges.					
	3.4	The lack of a participatory approach in the comprehensive management of the wetland endangered the conservation of the wetland.					
	3.5	Population growth in the region contributed to the emergence of environmental challenges.					
	3.6	The lack of respect for nature contributed to the emergence of environmental challenges.					
	3.7	The lack of a sense of belonging to the place (Identity) contributed to the emergence of envi-					

Dimension	Row	Questions (Indicators)	strongly agree	somewhat agree	Neither agree nor disagree	somewhat disagree	strongly disagree
		ronmental challenges.					
	3.8	The lack of common commitment and vision for the environment contributed to the emergence of environmental challenges.					
	3.9	Lack of NGO activity and environmental protection organizations organizations played an important role in environmental issues of this wetland.					

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 *The role of settlements in the Economic dimension of sensitive ecosystems*

Dimension	Row	Questions (Indicators)	strongly agree	somewhat agree	Neither agree nor disagree	somewhat disagree	strongly disagree
<i>Economic</i>	4.1	Carrying out Sensitive business activities around Zarivar Wetland endangered the preservation of this wetland ecosystem.					
	4.2	The construction of restaurants and recreational places around the lagoon played a role in preserving the ecosystem of this lagoon.					
	4.3	The increase in tourism-related activities endangered the conservation of the wetland.					
	4.4	The existence of too many docks and boats endangered the aquatic ecosystem.					
	4.5	Irregular grazing of livestock around the ecosystem endangered the conservation of the wetland.					
	4.6	Unstable tourism in the region influencing the environmental challenge.					
	4.7	The construction of factories and poultry farms near the lake contributed to the emergence of environmental challenges.					
	4.8	Private ownership, in other words privatization, the lands around the wetland ecosystem contributed to the emergence of environmental challenges.					
	4.9	Unauthorized and excessive fishing endangered the aquatic species ecosystem.					

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 *The role of settlements in the Cultural dimension of sensitive ecosystems*

Dimension	Row	Questions (Indicators)	strongly agree	somewhat agree	Neither agree nor disagree	somewhat disagree	strongly disagree
Cultural	5.1	The lack of Sharing creativity, art, cultural activities (in the context of the destruction of Zarivar Lake and its ecosystems) affected the people and the authorities in the face of environmental challenges.					
	5.2	The lack of cultural background regarding the protection of Zarivar Wetland in the region affected the occurrence of environmental challenges.					
	5.3	Looking at the wetland as a cultural heritage played a role in preserving the ecosystem of this wetland.					
	5.4	Lack of cultural activities related to the protection of the wetland played a role in preserving the ecosystem of this wetland.					

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