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Analyzing social trust network in human-large carnivores conflict management, Case study: Golestan National Park

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Abstract

Protected areas (PAs) play a vital role in biodiversity conservation. However, human-large carnivore conflict (HCC) is a common problem in PAs and threatens long-term conservation goals. Socioeconomic factors are a significant aspect of HCC, and addressing these factors is crucial for achieving human-large carnivore coexistence. Trust and appropriate communication between all stakeholders are introduced as key factors in the HCC management, but they have remained unclear. The purpose of this study is to investigate stakeholders' social networks in the HCC around the Golestan National Park (GNP), using social network analysis to address this gap. We identified a social trust network in support and information exchange in HCC. The data have been collected through a questionnaire and 292 face-to-face interviews with the residents of 30 villages around the GNP from April to November 2022. Indices of degree centrality, betweenness centrality, and Multi-dimensional scaling (MDS) were analyzed. Our findings show that local communities trust family members the most for receiving support and they trust the most in rangers in information exchange. On the other hand, villagers and village councils have an insignificant role in the social network. The results reveal the significant centrality of rangers in the social network and introduce them as important social capital and key actors in the HCC mitigation strategies. The findings of this research led to the clarification of the interactions in stakeholders' social networks and demonstrated that conflict mitigation strategies require a multidisciplinary approach, and different social aspects of conflicts should be considered in conflict management programs.

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Introduction

Today, protected areas face various types of threats caused by human activities (Ayivor et al., 2020). Considering that the main strategy of managing protected areas is to preserve natural values, prevent the reduction of biodiversity, and maintain the quality and quantity of ecosystem services to humans, trying to reduce possible human-wildlife conflicts is essential (Jepson et al., 2017). Considering that the management of protected areas and surrounding communities are strongly interdependent, managing the interests of all stakeholders and reducing possible conflicts should be a special priority (Von Ruschkowski, 2010). Challenges caused by conflicts in protected areas can cause extensive socio-economic changes, such as the weakening of regulatory institutions, and lead to overexploitation of natural resources (Mendiratta et al., 2021; Negret et al., 2019). Therefore, reducing conflicts will have conservation benefits for the protected area as well as social and economic benefits for all stakeholders related to the protected area (Thorn et al., 2013). Today, among the possible human-wildlife conflicts, the human-large carnivore conflict is one of the main issues in protected areas. In recent years, with the continuous growth of the human population and the existence of common issues between humans and large carnivores, the amount of conflicts between the two has increased significantly (Penteriani et al., 2016). As a result of the conflict, both local people and large carnivores may suffer damage (Kansky and Knight, 2014; Treves & Bruskotter, 2014). Harms to humans mainly occur in the form of livestock losses or threats to the safety of human lives (Srivathsa, 2019). As the conflicts continue, both the fundamental goals of biodiversity of protected areas and the lives of local communities will be affected. Considering that the human-large carnivore conflicts are rooted in complex economic, social, political, and environmental issues (Mosimane et al., 2014; Mutanga et al., 2015), the way and design of conflict reduction activities requires interdisciplinary research in the field of human and environmental sciences (Thorn et al., 2013). Therefore, in the management of human-large carnivore conflicts, accurate knowledge about the social, economic, and cultural dimensions, as well as the relationships between people involved in the conflict, is necessary, and it is obvious that with the participation of all stakeholders, it will be possible to reduce conflicts (Salvatori et al., 2020).

In the past decade, trust between stakeholders is considered as a key factor in natural resource management (Vaske et al., 2007; Stern, 2008). Trust and appropriate communication between all stakeholders are introduced as key factors in the participatory Management of human-carnivore conflict management (Florian, 2019). Research results show that building trust and promoting stakeholder communication is the key to resolving conflicts (Morehouse and Boyce, 2017). In contrast, inadequate and inappropriate information exchange and communication in human-carnivore conflict situations often lead to the failure of conflict mitigation measures and high levels of mistrust between stakeholders (Madden, 2004). The results of the research of Salvatori et al., 2021 show that the lack of trust between stakeholders and relevant authorities, as well as the lack of suitable communication between stakeholders, are key features that characterize social conflicts related to large carnivores (Salvatori et al., 2021). In previous researches on human-wildlife conflicts, socio-ecological dimensions of conflicts, patterns and reasons of human-carnivore conflict, the role of geography in conflicts in protected areas have been discussed; and analyzing the social aspects and how the stakeholders involved in the conflicts communicate is one of the scientific gaps in this field that has been addressed in this research. Studies show that knowing key stakeholders is one of the requirements for the implementation of conservation management plans, and based on the network analysis method, key actors in conservation decisions can be identified (Crona et al., 2011; Bodin and Prell, 2011). In this research, the network of trust in support and trust in the information exchange in the human-large carnivore conflict in Iran's

first biosphere reserve, Golestan National Park has been evaluated, weak points of the network were identified, key actors were introduced, and the relationships of local actors were quantitatively and visually analyzed using the social network analysis approach. This study sheds lights on power of social network analysis approach in human-large carnivore conflict management.

Social network analysis is a methodological approach that uses quantitative techniques to analyze social structures (Romero, 2018). This method is one of the latest methods proposed and as a useful tool, it provides the possibility of understanding the relations, interactions, and effects of stakeholders through communication networks (Calvet-Mir et al., 2015). By analyzing the communication network of stakeholders, it is possible to identify the level of cooperation, communication, and inclusiveness within the network (Feng et al., 2022). Focusing on patterns of relationships distinguishes social network analysis from other analysis techniques (Bodin et al., 2020). In this study, three large carnivores of the GNP, Persian leopard (*Panthera pardus tulliana*), brown bear (*Ursus arctos*), and gray wolf (*Canis lupus*), were considered as the species to be considered in conflicts.

Materials and methods

Study area

Golestan National Park, the first national park and biosphere reserve of Iran, with an area of 91,895,000, is located on the border of Golestan, northern Khorasan, and Semnan provinces (Darvish Sefat, 1385Golestan National Park was introduced as a national park in 1957 and registered as a Biosphere Reserve of Iran in UNESCO in 1976 (Zehzad et al., 2002). local communities and residents of the villages surrounding the Golestan National Park are composed of different Iranian ethnic groups, including the Turkmen, Fars, Baloch and Sistani, Kermanj, and Tat. Agriculture, horticulture, animal husbandry, beekeeping, and tourism constitute the main economic activities of indigenous communities (Soofi et al., 2016; Ghoddousi et al., 2017; Soofi et al., 2018). This research was conducted in 30 villages around the Golestan National Park. 2 villages are located in Semnan province, 4 villages are located in northern Khorasan province, and 24 villages are located in Golestan province. Given that large carnivores are distributed up to 5 km from their home range (Ghoddousi et al., 2020; Soofi et al., 2018), villages were selected within 5 km from the border of the national park. The population of the villages, according to the report of the Iran Statistics Center (general census and housing population of 2015), is 17,684 people.

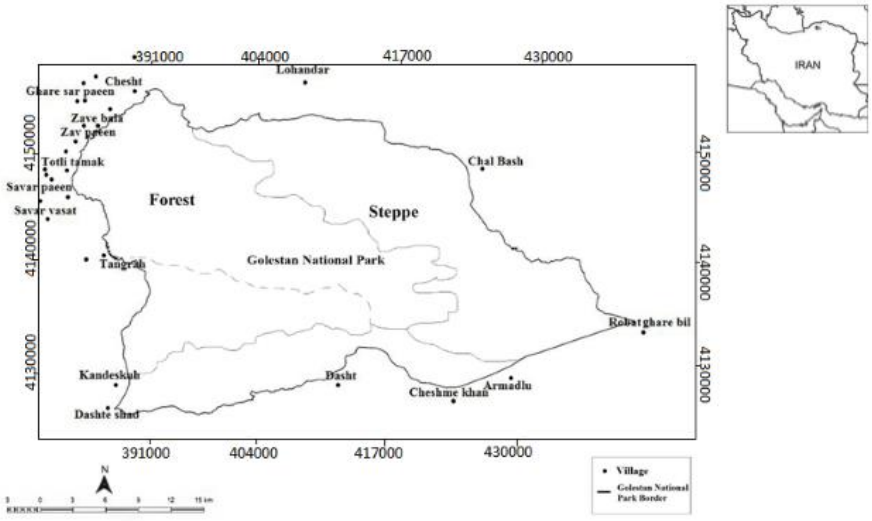

Figure 1. The map represents the study area, the Golestan National Park, and the distribution of the villages around the park where the interview surveys were administered. The map also shows the two dominant vegetation communities (i.e., forest and steppe) in area.

Data collection

The research was conducted based on field study and face-to-face interviews with local communities around the Golestan National Park. To collect field data, face-to-face interviews were conducted with 292 people in 30 villages around Golestan National Park, using a structured questionnaire between April and November 2022. Interviews were conducted in Turkman language (71%, n = 210) and Farsi language (n=82). Therefore, our survey team included one trained Turkmen researcher and a ranger. The official language in Iran is Farsi, which was familiar to all participants. Before the main interview survey, we conducted a pilot study on a subset of the population (n = 15, after obtaining ethical clearance) in the selected villages. The study was carried out under the official permission of the Golestan Province Environment Department. To respect the rights of the interviewees, they were assured that the questionnaire would be anonymous and the answers would be used only for scientific purposes.

Data analysis

In this research, the social network analysis (SNA) method is used to analyze the network of trust in support and network of trust in information exchange in human-large carnivore conflict. UCINET software is used for data analysis in the social network analysis method. The degree centrality, betweenness centrality, and MDS index were used to analyze the network. Data analysis and diagramming were done using UCINET 6 and NetDraw software after forming and entering the data matrix.

The network analysis indicators used in this research are:

Degree centrality: Degree centrality is a fundamental metric in social network analysis, quantifying the importance of nodes based on their direct connections. It measures the number of links a node has, indicating its prominence within the network. Various centrality metrics, including degree centrality, are crucial for identifying key actors in social networks (Mohammadi Kangarani and Mohammadi, 2014; Khaje Naieni *et al*., 2021).

Betweenness centrality: This centrality measure is derived by evaluating individuals' positions within a network and their role in connecting pairs of individuals through the shortest path. Consequently, an individual exhibiting the greatest betweenness centrality is positioned among numerous others, facilitating communication pathways for the rest (Mohammadi Kangarani *et al*., 2011).

MDS: Multidimensional Scaling (MDS) in Social Network Analysis is a technique used to visualize and analyze social interactions or relational data by mapping them into a lower-dimensional space while preserving the original relationships between data points. MDS is particularly valuable in localizing nodes or tags based on their distances from known anchor nodes (Jäckle *et al*., 2015).

Results

In 7 months, face-to-face interviews were conducted with 292 people (48 women and 244 men) in 30 villages around Golestan National Park, using a structured questionnaire. Table 1 shows the demographic variables of the interviewees.

Network of trust in support in the human-large carnivore conflict

A question was raised in the social network analysis section to analyze the network of trust in support: "If large carnivores attack your livestock or damage your farm, which of the people would you ask for help?"

a) Ranger b) Family members c) Village council d) Villager

The results show that men with 72% (n=176) and women with 77% (n=37) trust in “family members” the most to receive support in conflicts. After “family members”, the most trust to receive support is in “ranger”. On the other hand, trust in the “village council” and the “villager”, with the lowest selection in both groups, is the last choice in the support network. Trust in “villager” and the “village council” is seen more among women than men.

Table 1. Frequency percentage of demographic variables of interviewees

Demographic Variables		Frequency	Percentage
Gender	Female	48	%16
	Male	244	%84
Education	Illiterate	55	%19
	Primary school	112	%38
	Elementary school	94	%32
	academic	31	%11
Age	18-29	37	%13
	30-39	77	%26
	40-49	85	%29
	50-59	50	%17
	≥60	43	%15
Ethnicity	Balouch	5	%2
	Turk	6	%2
	Turkman	210	%72
	Fars	58	%20
	Kord	13	%4

The analysis of the betweenness centrality graph showed that “ranger” was the most chosen by Turkmen people at 65% followed by the Fars people at 57%. Turk, Kurd, and Baloch people selected “ranger” the least in the network of trust in support, respectively. On the other hand, the highest level of trust in the “villager” belongs to Turk and Kurd people, and the lowest level of trust in this group is seen in the Turkmen people. For all age groups, the most trust in receiving support is in “family members”. The age group of 50-59 and over 60 years old mostly chose “family members”. After that, the "ranger" is the most trusted group to receive support in all age groups. The most trust in the “ranger” is seen in the younger age groups, and the least trust in the “ranger” in the age groups of 50-59 and over 60 years.

On the other hand, the results show the higher level of education (Elementary school and academic), the higher trust in “ranger” to receive support in conflict. On the contrary, people with levels of primary school and illiterate had the most trust in “family members”.

Figure 2 shows the degree centrality graph of the network of trust in support. First, the “family members” and then the “ranger” have the highest centrality in the network with the degree of centrality of 21 and 178, respectively. The “villager” and the “village council” are in the last place with a degree of centrality of 45 and 63.

Figure 3, the betweenness centrality graph created by a one-way matrix of rows, shows a representation of the grouping of the respondents. This graph shows that despite the higher degree of centrality of "family members" with a slight difference compared to "ranger", people who only trust "ranger" are more numerous in the network and are displayed as a group in the center of the graph. This result highlights the importance of the ranger in the network. The group formed at the top of the graph, which is shown in orange, and the small group in yellow has chosen the “village council” and “villager” as trusted people to receive support in conflicts and it shows the lack of centrality of the “villager” and “village council” in the network of trust in support and we found them potentially vulnerable areas in this network. Generally, the betweenness centrality graph analysis emphasizes the importance of the “family members” and the “ranger” with a betweenness centrality of 27133 and 20975 respectively in the network of trust in support in human-large carnivore conflict. The results of the analysis of the degree centrality and betweenness centrality indices of the network of trust in support are presented in Table 2.

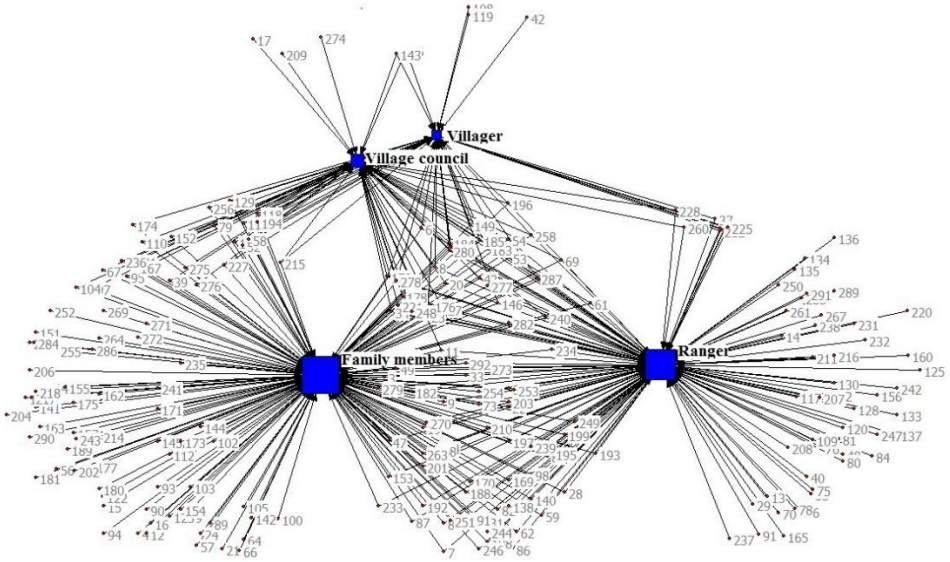

Figure 2. Network of trust in support in the human-large carnivore conflict - Degree centrality

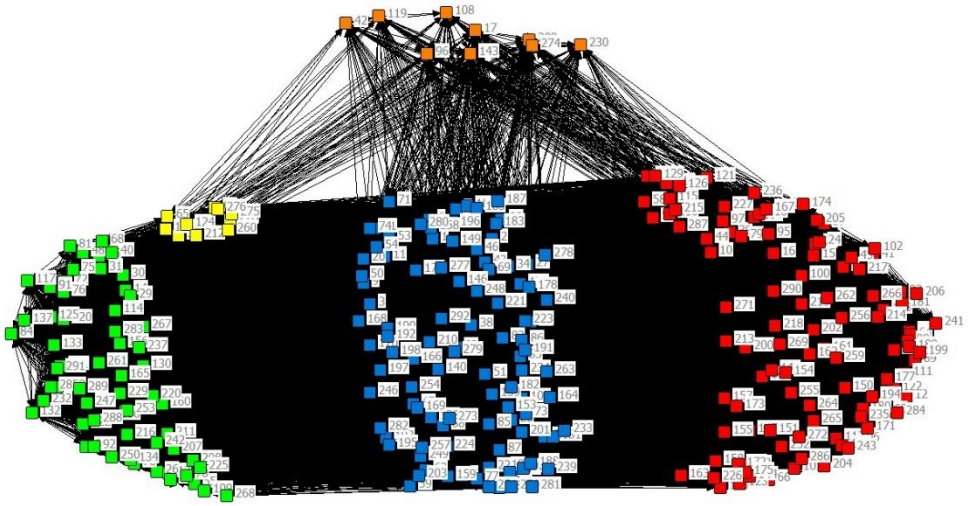

Figure 3. Network of trust in support in human-large carnivore conflict - Betweenness centrality

Table 2. Numerical results of the betweenness centrality and the degree centrality analysis of network of trust in support in human-large carnivore conflict

Indicators	Ranger	Family members	Village councils	Villager
Betweenness centrality	20975	27133	2744	1757
Degree centrality	178	211	63	45

The analysis of the MDS index is shown in Figure 4. In the analysis of the MDS graph, participants are grouped according to the selection pattern into multiple choice groups. The group that chose the “family member” and the “ranger” are placed in the center of the graph, and it emphasizes the high centrality of the “family member” and the “ranger” in the network of trust in support in human-large carnivore conflict. The group formed on the margin of the graph, with less centrality, had an insignificant role in the network and included people who chose “villager” and “village council” as a trusted group for receiving support in human-large carnivore conflict. The graph of the network of trust in support in the MDS analysis is a re-emphasis on the lack of centrality of

"villager" and "village council" and the high centrality of "ranger" and family in this network.

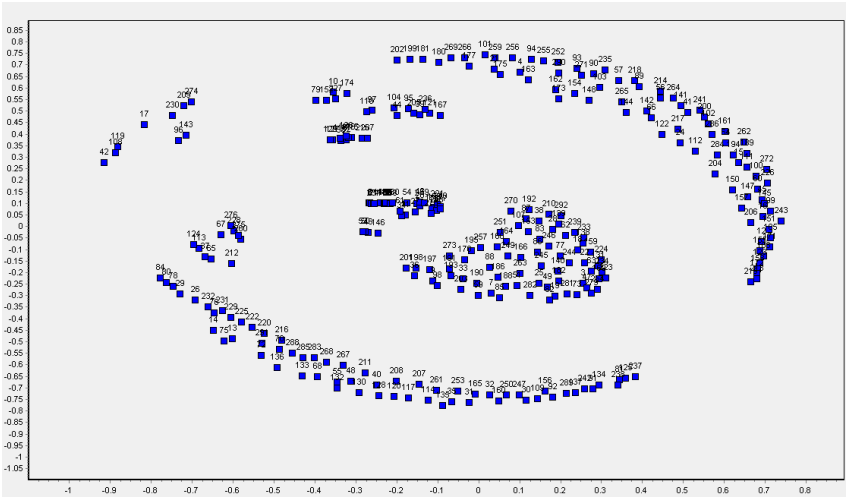

Figure 4. MDS index analysis of the network of trust in support in human-large carnivore conflicts

Trust network in information exchange in human-large carnivore conflict

A question was raised in the social network analysis section to analyze the trust network in the information exchange: "If you need to get information about large carnivores and conflicts, which of the people do you refer to?" a) Ranger b) Family members c) Village council d) Villager

The findings from the analysis of this network show that there is no isolated group in the network and in total, the highest number of choices is the "ranger" with 65% (n=190), "family members" with 40% (n=117), the "village council" with 7% (n=19), and the farmer with 4% (n=9). The results show that men with 66% (n=162) and women with 58% (and=28) have the most trust in "ranger" to receive information. After the "ranger", the most trust among both gender groups (women with 46% and men with 39%) is towards "family members". In contrast, trusting "villager" and "village council" are the least in the trust network in information exchange. The Turkmen, Fars, and then the Baluoch people trust "ranger" the most, and the Turk and Kurd people trust "family members" the most.

In the age groups, the trust in the "ranger" in information exchange in conflict with carnivores was the most in all age groups. The noteworthy point in this network is the lack of trust of the youngest (18-29 years) in the "villager" and the "village council" to receive information. On the other hand, the results show that with the increase in education level (elementary school and academic education), the trust of local communities in the "ranger" in the information exchange about large carnivores and conflicts with them increases and educated people trust in the "ranger" the most compared to low-educated and illiterate people. Another noteworthy point in the results of this network is that only uneducated people trust "villagers" and "village council" to get information about large carnivores and conflicts with them.

Figure 5, show the degree of centrality of the trust network in information exchange. According to this graph, the "ranger" and then the "family members", with centrality degrees of 189 and 116, have the most importance in this network, and local communities trust them the most in information exchange. The "villager" and "village council", with the lowest degree centrality, are displayed on the margin of the graph.

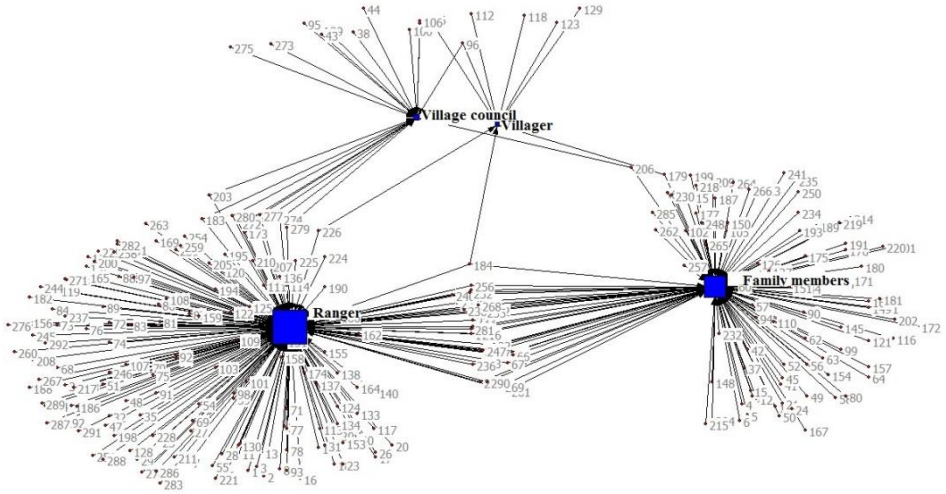

Figure 5. Trust network in information exchange in human-large carnivore conflict - Degree centrality

Figure 6 shows the betweenness centrality graph. The group created on the left side, shown by red squares, is the group of "ranger" selectors. The group in green has more than one choice and chooses the "ranger" and "family members" as trusted people to receive information. The analysis of this chart also helped to understand the influence of "ranger" with a betweenness centrality of 34720 and then "family members" with a betweenness centrality of 22078 in the trust network in information exchange and shows the control power of the "ranger" in this network. The numerical results of the analysis of the degree centrality and betweenness centrality indices of the trust network in information exchange are presented in Table 3.

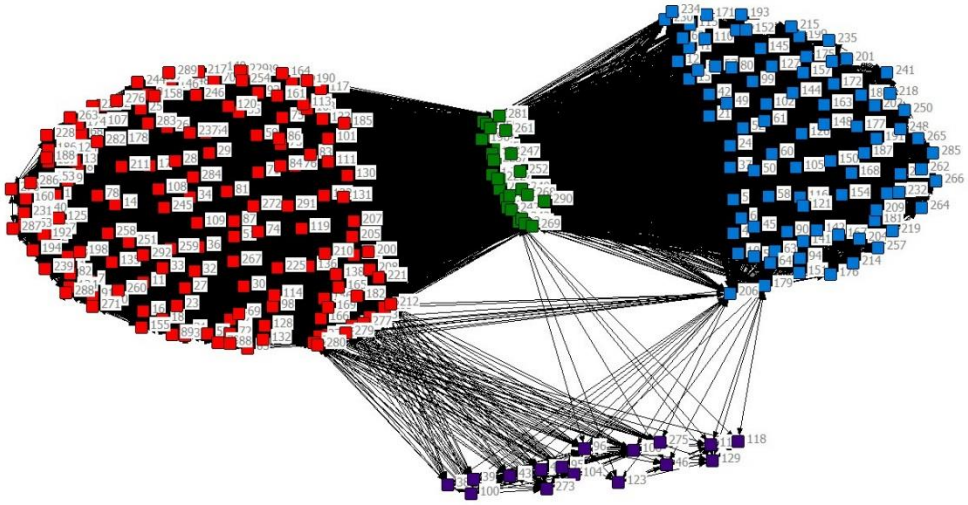

Figure 6. Trust network in information exchange in human-large carnivore conflict - Betweenness centrality

Table 3. Numerical results of betweenness centrality and degree centrality analysis of trust network in information exchange in human-large carnivore conflict

Indicators	Ranger	Family members	Village councils	Villager
Betweenness centrality	34720	22078	1581	3186
Degree centrality	189	116	9	21

The analysis of MDS index are shown in Figure 7. Participants are grouped into family member selection, "ranger" selection, "village" and "village council" selection, and

a multi-choice group including "family members" and "ranger". The group that chose the family member and the "ranger" are placed in the center of the graph, so it emphasizes the high centrality of the family and the "ranger" in the network of trust in information exchange. The group in the margin of the graph has a minor role in the network and included people who chose "villager" and "village council" as the trusted people for information exchange in the human-large carnivore conflict. Analyzing the MDS index, re-emphasizes the lack of centrality of "villager" and "village council" and the high centrality of the "ranger" and family in this network.

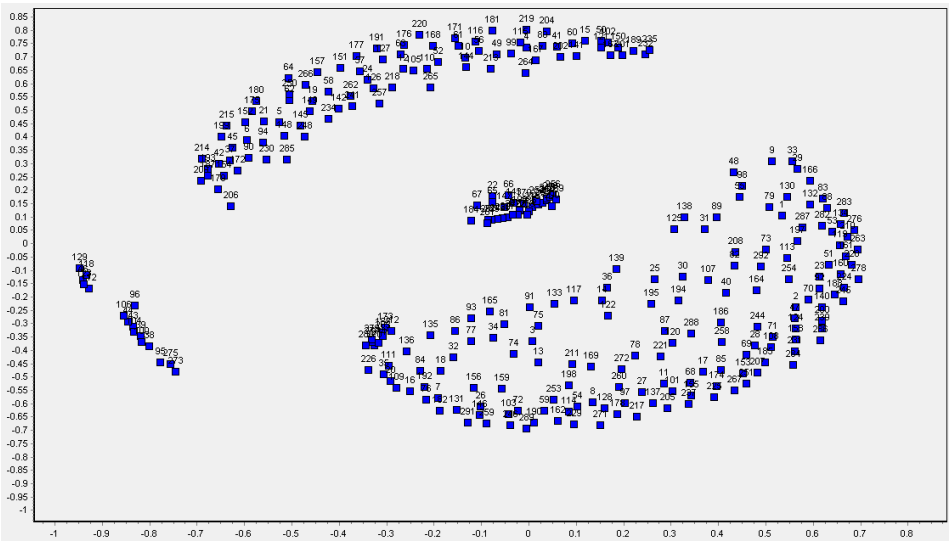

Figure 7. MDS index analysis of the trust network in information index in the human-large carnivore conflicts

The comparison of centrality indices in both networks of trust in support and trust in information exchange is shown in Table 4. In the network of trust in support, the group of "family members", and in the network of trust in information exchange, the "ranger" has the most centrality.

Table 4. Comparison of social networks in the human-large carnivore conflicts

Maximum betweenness centrality	Maximum degree centrality	Social network in the human-large carnivore conflict
Family members	Family members	Network of trust in support
Ranger	Ranger	Network of trust in information exchange

Conclusion

The analysis of stakeholder networks leads to the design of management strategies to reduce the human-large carnivore conflict and helps to increase the population of large carnivores (Grossmann et al., 2020). The size of the stakeholder network and the quality of relationships within the network play an important role in advancing conflict management and the effectiveness of protected areas (Jacobsen and Linnell, 2016; Manolache et al., 2018; Hartel et al., 2019). In this research, using the social network analysis approach, the network of trust in information exchange and trust in support was analyzed in the human-large carnivore conflict in Golestan National Park.

The results of the analysis of the network indicators of trust in information exchange and trust in support in the human-large carnivore conflict show that villagers and village councils are identified as having inadequate positions in social networks, despite their potential influence.The results of the study by Soleimani et al. (1400) show that effective communication between local people and government institutions has led to the exchange of knowledge and information

(Soleimani et al., 1400). Therefore, by trying to highlight the role of these two groups in the social network of stakeholders in the issue of conflicts, they can be introduced to the local communities as trusted and reliable supporters in the villages. The research results of Grossmann et al. (2020) show that the expansion and strengthening of stakeholder networks will be effective in the management of the human-large carnivore conflict. This study also emphasizes the importance of trust and support between stakeholders to reduce conflicts (Grossmann et al., 2020).

In comparison of both networks in the MDS analysis, the large number of multiple choice groups in the trust-in-support network shows the importance of support in conflict situations with large carnivores compared to information exchange in local communities affected by conflicts. By supporting the local communities, we can help reduce conflicts and ensure that humans and carnivores can coexist sustainably. The analysis of the network of trust in support in the human-large carnivore conflict shows that local communities have the most trust in receiving support when conflicts occur, first to "family members" and then to the "ranger". Supporting the local community in conflict with carnivores, while their most important source of livelihood is at risk of damage or loss, is one of the key measures of conflict management in protected areas (Gulte et al., 2023). On the other hand, the analyzing indicators of the trust network in support in human-large carnivore conflict shows that village councils and villagers are in an inappropriate position in the stakeholder's network, and the trust of local communities towards these two institutions in receiving support is insignificant. As results of the research of Young et al. (2016), our results show that low levels of trust and poor communication between stakeholders and local authorities and decision-makers in conflict situations are known as key factors for stopping conflict management processes. On the other hand, the results of Salvatori et al. (2020) research show low levels of trust and communication between stakeholders, as well as challenges such as the need for more knowledge exchange and the lack of capacity of authorities, including the challenges of managing human-large carnivore conflict (Salvatori et al., 2020). Efforts to establish proper communication and cooperation and build trust between stakeholders are known as effective measures to increase the effectiveness of human-carnivore conflict reduction mechanisms (Barker et al., 2023).

One of the strengths of both networks in this research is the remarkable centrality of the "ranger" as an important social capital in the social network of stakeholders. Stakeholders who have high centrality in the network can be considered influential people and important stakeholders in future management planning in protected areas (Prell et al., 2011). According to the results of this research, using the ability of rangers as a trusted authority of the local community, especially in information exchange and support in the human-carnivore conflict, can be considered in conflict reduction measures and the conservation goals of the national park. In another part of the results, the importance of the role of the ranger and the need to increase the number of rangers as a suggested management solution in the human-carnivore conflict has been pointed out. In the research of Rizzolo et al. (2021), rangers are mentioned as cultural mediators in the prevention of conflicts in protected areas. Since the results show that a high level of literacy plays a role in choosing the ranger to receive information about large carnivores and conflicts, planning workshops to increase people's knowledge about conflicts with large carnivores and the importance of the ranger's role in the social network of stakeholders will be essential. One of the effective strategies in the management of endangered species is to increase the knowledge of local communities regarding to coexist with wildlife (Chynoweth et al., 2016; Bautista et al., 2019). Also, the workshops on the human-large carnivore conflicts will be a measure to strengthening communication between local communities and rangers, and this type of communication will provide conditions that a wide range of local communities will more and more support the mission of rangers in the field of reducing and control the human-

large carnivore conflicts. Considering that in the older age groups (50-59 and <60) there is the highest level of trust in the villager and the village council and the lowest level of trust in the ranger, villager and the village council can be placed as mediators to build trust between the older age groups and the ranger. Also, the results show that ethnicity is effective in choosing the ranger in the network of trust in information exchange and trust in support; so the most trust in the ranger can be seen in the Turkmen people. Therefore, it is important to pay attention to the ethnicity in the selection of rangers, to interact as much as possible between the stakeholders in the social network, and to strengthen the foundation of trust between the local communities and the rangers.

Overlay, our research is among the first to analyze the trust networks in human-large carnivore conflict stakeholder network analysis. The trust network analysis in the human-large carnivore conflict was a suitable recognition of some hidden dimensions of social factors in the human-large carnivore conflict. The findings of this research show that strengthening the foundation of trust in local communities can be considered as a strategy in management measures to reduce human-large carnivore conflict. The visual analysis of the trust network led to the clarification of the interactions in the social network of stakeholders and revealed that conflict mitigation strategies require a broad and multifaceted approach and different social aspects of conflicts should be considered in conflicts management programs.

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