The University of Tehran Press

Pollution

https://jpoll.ut.ac.ir/

Print ISSN: 2383-451X
Online ISSN: 2383-4501

Optimizing the Location of Finsk Dam through an Environmental Approach in Alignment with Sustainable Development Goals

Yousef Nikfard | Gholamreza Nabi Bidhendi✉ | Alireza Pardakhti

Graduate Faculty of Environment, University of Tehran, P. O. Box 14155-6135, Tehran, Iran.

Article Info

Article type:
Research Article

Article history:
Received: 2 May 2023
Revised: 5 July 2023
Accepted: 7 December 2023

Keywords:
Finsk Dam
ICOLD matrix
Sefidroud River
Semnan

ABSTRACT

Water is vital for human survival and has been instrumental in the development of ancient civilizations worldwide. However, in the modern era, humanity grapples with the pressing issues of environmental crisis and the depletion of natural resources. To address these challenges, it is crucial to embrace sustainable practices in land and resource management, ensuring the responsible use of natural resources while safeguarding the needs of future generations. The Finsk Dam, situated on the Sefidroud River, fulfills the vital purpose of providing potable water to the cities of Semnan, Mahdishahr, Sorkheh, and Shahmirzad. Moreover, it also caters to the requirements of downstream aquifers and environmental needs concerning drinking water development. As the Finsk Dam exceeds a height of 15 meters, it qualifies as a large dam according to the International Committee on Large Dams (ICOLD). Consequently, a comprehensive evaluation of its diverse environmental aspects assumes paramount importance. Despite the projections of regional development, the construction of the dam possesses the potential to yield adverse environmental effects within the region. To address this concern, the evaluation matrix method, as endorsed by ICOLD, was employed to scrutinize the various stages of the dam's construction and operation while assessing its environmental aspects. Following technical reviews, the third option emerged as the most suitable location for the dam's construction among the four available alternatives. Additionally, three distinct pipeline routes were identified and evaluated for the transportation of water from the dam to the Semnan province, with the second option being deemed the most appropriate choice.

Cite this article: Nikfard, Y., Nabi Bidhendi, Gh., & Pardakhti, A. (2024). Optimizing the Location of Finsk Dam through an Environmental Approach in Alignment with Sustainable Development Goals. *Pollution*, 10 (1), 17-31. https://doi.org/10.22059/poll.2023.359001.1906

DOI: https://doi.org/10.22059/poll.2023.359001.1906

INTRODUCTION

The ever-increasing growth of the global population has led to a significant increase in water demand, particularly in regions that experience frequent droughts (Bagheri et al., 2021). The surge in water demand, coupled with a reduction in available water resources, has placed an enormous strain on surface fresh water resources in countries located in arid regions. As a case in point, Semnan province, with a land area of approximately 97,000 square kilometers, is located in a desert region, with 45% of its landmass characterized as desert and 30% as highlands. Moreover, the annual rainfall in this province falls below the world average (Hassinzadeh Fard, 2019). It is worth noting that water supply, allocation, and utilization for various purposes, including agriculture and drinking water supply, are vital components of the country's development programs (Amirenjad et al., 2019). To this end, water authorities have embarked on various projects such as dam construction and irrigation projects to maximize the use of water resources for human development and well-being (Morsali et al., 2017).

*Corresponding Author Email: *ghhendi@ut.ac.ir*

Against the backdrop of the rapidly growing population in Semnan, it is evident that the demand for drinking water will continue to rise, posing a significant challenge to water authorities in the region. To mitigate this challenge, water authorities have examined alternative water sources in the region, and Finesk dam construction has been identified as a sustainable option for meeting the increasing drinking water needs of Semnan's population (Hosseinzadeh Fard, 2019). The project's implementation, within its intended scope, has the potential to optimize the use of the region's limited water resources while stimulating economic and cultural growth in surrounding areas through job creation and poverty alleviation. Currently, the shortage of suitable drinking water is among the top priorities of the water transmission system implementation in the study area. It is projected that by 1410, the population of Semnan will reach 256,623 people, more than double its population in 2005, and consequently exacerbate the already existing water shortage. For instance, the city of Semnan is expected to experience a water shortage of 13.09 million cubic meters by 1410 (Madah and Saif Olian, 2018). The construction of the Finsk dam in the Peror region has been proposed to address the issue of over-extraction of underground water resources and their negative consequences (Sadeghi et al., 2021). Semnan province, which relies significantly on underground water sources, currently extracts 1.1 billion cubic meters of water, with an estimated excess of 0.17 billion cubic meters from these sources. In addition, the quality of underground water sources in Semnan province is not favorable, and excessive harvesting has led to a decrease in land surface in the Semnan Plain. Given that the northern regions of the province receive higher levels of snow-bearing heights and precipitation, and most of these precipitations flow on the surface, building the Finsk dam has become crucial. (Hosseinzadeh Fard, 2019).

The looming water scarcity crisis has prompted scientists to devise methods for conserving water and preventing wastage (Balist et al., 2022a). Dam engineering has emerged as one of the best ways of regulating fresh water supply, and currently, running water is the most accessible, renewable, and cleanest source for electricity generation (Mike Coutant, 2014). However, the construction of new dams has faced significant opposition in many regions, with many social and economic arguments presented against dams. Large dams, in particular, have been found to cause significant changes in river ecosystems (Cartney, 2001). As a vital natural resource, the management of fresh water resources requires a balanced approach that considers environmental (Balist et al., 2022b), social, and economic impacts. Dams have significant effects on both upstream and downstream ecosystems by disrupting natural processes and creating barriers to longitudinal exchange along rivers. The construction of dams can cause permanent damage to terrestrial ecosystems and the disappearance of plants and animals in submerged areas (Balist et al., 2019). Additionally, changes in water flow, temperature, and quality downstream can have long-term consequences for aquatic species and ecosystems. Despite the historical abundance of fresh water in Mesopotamia, freshwater scarcity has become a critical problem in the region, with the development of large dams having significant impacts on the flow regime of rivers. In the face of increasing demand for food and freshwater resources due to population growth and changing consumption patterns, it is essential to pay attention to water and soil resources as the foundation of agricultural production. The need for water resource management has become increasingly pressing in recent times, with some predicting that the next century will be a century of struggle for ownership of these resources. (Bremer, 2016; Gleick & Ajami, 2014; Mehta et al., 2013; Soleymanipor & Bagheri, 2007).

Water transfer from dams and lakes has been the subject of many studies conducted in Iran and worldwide, investigating the environmental effects of such projects. This research has utilized various multi-criteria decision-making approaches and mathematical models to evaluate the environmental impact of dam construction, identify effective criteria, and determine the optimal location for construction. In this context, Amani and Najafinejad conducted a study in 1993, titled “Locating Short Earth Dams Using Elimination Criteria and Hierarchical Analysis

(Case Study: Kal Aji Watershed, Golestan Province),” where they identified indicators based on regional analysis, including qualitative and quantitative criteria. They used satellite data, hydrological, and geomorphological data and prioritized remaining locations using pairwise comparisons and weighting in the Expert Choice software. They found that the 24th and 42nd regions had the highest priority for building short earthen dams. In another case study in 1990, Yaser Minator presented “Optimal Location of Dam Construction Using Multi-Criteria Decision-Making Approach and Fuzzy Logic” for Harsin Dam in Kermanshah Province. The study used extensive library research and experts’ opinions to determine the most important criteria and investigated different types of methods and analyses of multi-criteria decision making, combining two methods, i.e., ideal option of phase and hierarchical analysis of phase, to present the ideal option for optimal selection of the construction site. Jangjoo’s research in 2021 presented a method based on matrices and multi-criteria decision-making approaches to assess the environmental effects of dams, using the ICOLD matrix and the hierarchical analysis process method to analyze the effects of the Zarrajabad dam project. The study showed negative effects (45%) of the implementation of the dam compared to the main method implemented in the project, which suggested implementing the dam project. Additionally, Roozbahani et al. (2020) investigated the planning of water transfer in the catchment area of the Central Plateau of Iran using COPRAS and fuzzy techniques, where the results showed that technical risks and the cost of each cubic meter of water were the most important criteria. The eighth scenario, including water transfer from Beheshtabad basin to Isfahan province and from Khorsan basin to Yazd and Kerman provinces, was found to be the most superior scenario. The primary objective of this study revolves around assessing the environmental viability associated with the construction of the Finsk dam through the utilization of the International Commission on Large Dams (ICOLD) matrix. Additionally, the research endeavors to identify the optimal approach and pathway for the transfer and storage of water within the Finsk dam’s framework. Finally, this study can assist decision-makers in evaluating water transfer projects between basins in uncertain conditions. Since the Finsk dam built on the Sefidroud River aims to provide drinking water to cities, Semnan, Mahdishahr, Sorkheh, and Shahmirzad, and part of the industrial needs of Semnan city, it is necessary to identify its environmental aspects, as its construction may cause adverse effects on the region’s environment.

MATERIALS AND METHODS

The Finsk Dam construction project is located approximately 70 kilometers northeast of Semnan city in Mahdishahr province, Iran (Fig. 2). The objective of this project is to provide 7.5 million cubic meters of drinking and sanitary water to Semnan, Mahdishahr, and Sorkheh cities. The Finsk Dam is an earthen dam with a Russian core, and its construction was initiated in 2006 and completed in 2019. The dam received environmental approval from Iran’s Environmental Protection Organization in 2009, and its construction was approved by the Islamic Council in 2019.

The studied region exhibits a semi-arid and cold climatic profile. Based on the average elevation above sea level, the estimated annual precipitation in the area amounts to 327 mm. The mean temperature recorded within the studied locale is approximately 7.5 degrees Celsius. The frost period spans four months, encompassing the months of December, January, and February. Spring stands out as the wettest season, accounting for 43.8% of the total rainfall, while summer assumes the driest season, representing merely 10.9% of the precipitation. Winter receives 28.96% of the rainfall, while autumn receives 16.4%.

The villages of Finsk, Tem, Talajim, and Maladeh are located near the Finsk Dam. However, with the construction of the dam, the village of Tem will be submerged, and the village of Telajim will be relocated based on operational considerations. The preparation for relocating

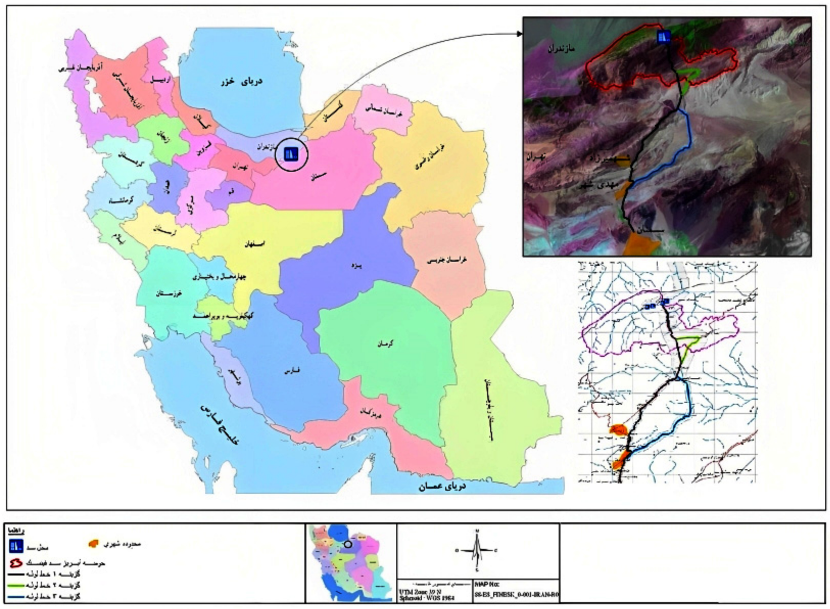

Fig. 1. Study area

these two villages is currently underway.

The Finsk Dam is a gravel reservoir dam with a clay core and has a reservoir volume of 11.78 million cubic meters. The height of the dam from the river bed is 57 meters, and the length of the dam crest is 411 meters. The dam will be constructed near the village of Tolajim on the Sefid Roud River, which is one of the main tributaries of Tejn. Sefid Roud is one of the most significant flowing rivers in this region, with a flow rate of 16 million cubic meters per year, and the dam's construction is estimated to affect less than 5% of the flow rate of Tejn (Figure 1).

This research employs the International Committee on Large Dams (ICOLD) matrix method to evaluate the environmental impact of the dam. In this method, environmental activities and components are selected based on the form and instructions provided by the International Commission on Large Dams. One of the benefits of using the ICOLD matrix is that it enables the expression of the characteristics of each environmental effect, with the symbols and numbers used in the matrix describing the status and features of the effect (Tu et al., 2017). The purpose of utilizing the ICOLD matrix in this study is to demonstrate the qualitative characteristics and attributes of the environmental impact on the environmental components, which is achieved through the symbols mentioned above. The ICOLD matrix comprises several rows and columns, with the rows containing two primary components. The first component comprises activities of the water transfer system for dam construction, while the second component includes corrective and control measures to mitigate negative effects. The columns, on the other hand, are related to environmental components, including physical, biological, socio-economic environmental factors, and environmental pollution (Wilson et al., 2017). The ICOLD method is utilized in such a way that the interaction of activity components and environmental components (if there is an effect), and the type of effect characteristics, are expressed in each cell of the matrix, using the descriptors defined as follows (Zeng et al., 2015; Zhou et al., 2017).

ICOLD Methodology

The International Commission on Large Dams (ICOLD) offers a matrix method to evaluate the potential effects of water structures, particularly large dams, on the environment. The method involves preparing a list of effective factors that may be expressed quantitatively or qualitatively to assess their effects on different components of the environment. These effects are then analyzed in a number of possible options, and the option that poses the least environmental risks or the option that designers can address by providing new solutions to its environmental issues is recommended. The ICOLD guidelines are applicable to dams that are in the stages of design, construction, or operation. However, it is possible that some inappropriate environmental issues in already built dams cannot be mitigated or that the costs of controlling or reducing such effects are excessively high and unsustainable (Najamai, 2008).

The ICOLD matrix is organized into several rows and columns. The columns are associated with the existing environmental factors of the region, which include physical, chemical, biological, and socio-economic and cultural environments. The rows, on the other hand, are related to the characteristics of the project. In the ICOLD method, in a cell of the matrix where there is a possibility of an effect, the type and characteristics of the effect are expressed using the following descriptors.

The IQOLD method utilizes a marking system to assess the impact of a project on the environment. The marking system consists of several criteria that determine the nature, intensity, certainty, persistence, occurrence time, and specificity of the effect. Each criterion is represented by a symbol that is displayed in the IQOLD matrix.

The nature of the effect is denoted by either a positive (+) or negative (-) sign, indicating favorable and unfavorable effects, respectively.

The intensity of the effect is determined by a numerical symbol, 1, 2, or 3, based on the type of effect, the effective environmental parameter, and the characteristics of the desired activity. Major effects, which cause significant changes to the status quo, are displayed with the numerical symbol 3. Moderate effects, which result in less significant changes than major effects, but more than low effects, are represented by the numerical symbol 2. Minor effects are included in the descriptive group of low effects and result in smaller changes compared to the previous two groups. The symbol for displaying minor effects is the number 1. (ICOLD, 1982).

The certainty of the effect is indicated by different symbols, which represent the degree of certainty that the effect will occur. Certain effects, which are proven to occur according to the existing situation and similar cases, are represented by the symbol (C). Probable effects, which have a possibility of occurrence but are not certain, are displayed with the symbol (P). Improbable effects, which have a very low probability of occurrence, are represented by the symbol (I). Non-probable effects, which have an uncertain probability of occurrence, are displayed with the symbol (n), (Ghods Consulting Engineers, 2004).

The persistence of the effect is determined by whether the effect is temporary or permanent. The symbol (T) is used to represent temporary effects, which occur at a certain point and do not continue. The symbol (P) is used to represent permanent effects, which exist periodically or continuously in the long term.

The occurrence time of the effect is indicated by the symbols L, M, and I, which represent the long-term, medium-term, and immediate occurrence of the effect, respectively (ICOLD, 1980).

The specificity of the effect is represented by the symbols N and Y, which indicate whether the impact of the activities on the environmental components is specific or not.

In summary, the marking system of the IQOLD method provides a comprehensive approach to assess the impact of a project on the environment. However, to maintain the clarity of the problem, a maximum of three criteria are suggested for each work (National Irrigation and Drainage Committee, 1999).

The symbols Y and N represent the presence or absence of an effect, respectively, within a plan. The dynamic progression of effects may also be expressed through symbols, but this is not essential for a complete and successful matrix (Najmaei, 2002).

Once the activities, components, and environmental parameters affected by the plan have

Table 1. Impact criteria in the IQOLD method (Jozi, booklet of the specialized training course on environmental impact assessment (EIA)

Abbreviated score/sign	kinds of effects	Effect criteria
3	(Major)	(Intensity of Impact)
2	(Moderate)	
1	(Minor)	
(+)	(Positive)	(Nature of Impact)
(-)	(Negative)	
C	(Certain)	(Certainty of Impact)
P	(Probable)	
I	(Improbable)	
N	(non-probable)	
T	(Temperate)	(Continuance of Impact)
P	(Permanent)	
I	(Immediate term)	(Duration of Impact)
M	(Moderate term)	
L	(Long term)	
Y	(Yes)	(Specificity of Impact)
N	(No)	

Table 2. Values of the effect criterion (EIA)

Impact factor	effect characteristics	Symbol
1	Immediate or primary effect	**I**
5.1	Chronic or secondary effect	**L**
7	Transient or temporary	**T**
5.1	Long lasting or permanent	**P**
2	definitive	**C**
5	probable or mid-term	**M**

been specified and organized into a matrix, the relevant effects are determined and loaded into each corresponding cell. In addition to the type and intensity of the effect, which are denoted by numerical values, the time of onset, permanence, and certainty or probability of the effect are also considered and represented by corresponding letters (Mahab Quds Consulting Engineers, 2008).

The matrix cells are divided into four sections, which are completed in a left-to-right order. The first section denotes the type and intensity of the effect; the second section denotes whether the effect is immediate or secondary, indicated by (I) or (L), respectively; the third section denotes the duration of the effect, indicated by (T) or (P) for temporary or permanent effects, respectively; and the fourth section denotes the level of certainty or probability of the effect, indicated by (C) or (M), respectively (Mahab Quds Consulting Engineers, 2008).

Once the nature and intensity of the effect have been determined, the effect characteristics are multiplied by specific coefficients that correspond to the nature and intensity of the effect. The resulting value is then rounded to the nearest whole number, with a value of 3 indicating the most severe or strongest effect, 1 indicating the weakest effect, and 2 indicating an average effect. Values of 4 and 5 are reserved for highly severe and critical effects, respectively (Mahab Quds Consulting Engineers, 2003).

It is important to note that in this study, the modified version of the ICOLD matrix was utilized. The modified version was deemed appropriate due to its focus on only the environmental parameters impacted by the Barzo dam project, whereas other elements outlined in the ICOLD environmental impact assessment guidelines for dams that were not relevant to the project were removed (Jafari et al., 2019).

The impact analysis and decision-making process involved several steps, including assessing the environmental effects of each option, determining the optimal location for dam construction, and identifying the pipeline routes. Based on the results obtained from these analyses, separate evaluations were performed, and conclusions were drawn (Jafari et al., 2019).

RESULTS & DISCUSSION

This study utilized the ICOLD (International Commission on Large Dams) matrix method to assess environmental activities and components. The selection and preparation of these components were based on the guidelines provided by the International Commission on Large Dams. One of the key benefits of the ICOLD matrix is its ability to express the characteristics of each environmental effect. The matrix utilizes symbols and numbers to describe the condition and features of each effect. The purpose of using the matrix in this report is to demonstrate the qualitative characteristics of the environmental impact of the project components. The ICOLD matrix comprises several rows and columns, with the rows consisting of two main parts. The first part pertains to dam construction activities, while the second part covers corrective and control measures to reduce negative impacts. The columns of the matrix correspond to the environmental components, which include physical, biological, socio-economic environments, and environmental pollution factors (Table 3). The ICOLD method assesses the interference of activity and environmental components in each cell of the matrix. If there is an effect, the type and characteristics of the effect are expressed using defined descriptors.

Based on the results of the environmental assessment matrix and the information presented

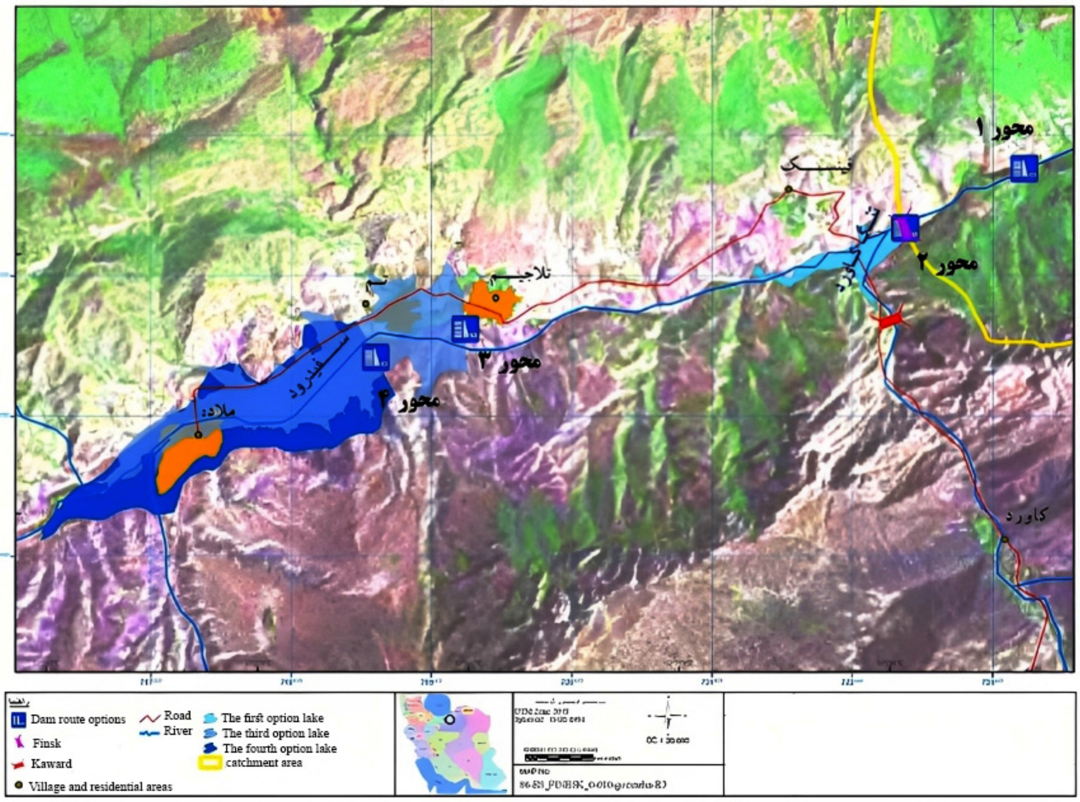

Fig. 2. Location Options for the Finsk Dam

Table 3. Effects identification table

Nature of the Effect	Effect	Receptive Environment	Phase
CTI-3 CTI-2 CTI-2 CTI-4	water resources Soil air pollution noise pollution	physical and Biologically	Construction
CPI-5	induced earthquake Terrain Deformation	Social economic	
PPL-1 CTI-1 1-CTI CPI-1	water resources Soil air pollution noise pollution	physical and Biologically	operation
CPL+2 PTL-1	induced earthquake Terrain Deformation	Social economic	

in the tables and diagrams above, the following conclusions can be drawn:

• All four technical options without environmental remedial measures (such as an environmental management program and impact reduction methods) have a ratio of negative values to total values higher than 45%, which is not recommended from an environmental point of view.

• Options 2, 3, and 4 have relatively similar negative physical effects during the construction stage, but options 3 and 4 have more negative economic and social effects due to the drowning of rural settlements.

• Option 2 is not recommended due to its overwhelming negative effects on the environment and protected area, even with corrective measures.

• Options 3 and 4 are biologically similar, but option 3 is more suitable from an economic and social point of view and is recommended if it does not have specific subsurface problems.

• Constructing a diversion dam on the Kaward branch and using it simultaneously with axis 3 can supply Semnan city's drinking water needs.

• The evaluation matrix results show that if the ratio of negative values to total values is less than 45% in an option, it is recommended by observing the relevant conditions.

• The recommendations also take into account the strict observance of all environmental principles and standards and all the recommendations of the Environmental Protection Organization.

Moreover, among the available alternatives for water transmission lines, option 2, which runs in close proximity to the road, has been deemed the optimal choice for water transfer. As such, the implementation of the Finsk dam can be achieved through the following strategies:

• Refraining from utilizing borrowed resources in the immediate vicinity of the dam and adhering to the environmental water base requirement.

• Establishing the transmission system route within the Paror protected area near the existing road.

• Executing remedial measures and implementing solutions to mitigate the impact of the project on the environment, particularly by creating an environmental structure and prioritizing environmental concerns during the design, construction, and operational phases.

• Allocating sufficient funds to the environmental department and restoring and reviving vegetation in the area.

• Ensuring that the regional water company commits to environmental protection organizations regarding the excavated areas in the Paror protected area.

• Carrying out monthly monitoring and inspection programs by the Environmental Protection

Table 4. Summary of the results of the assessment matrix of Finsk dam's environmental effects for all options using the ICOLD method in implementation and non-implementation options

	first option			second option			third option			fourth option		
	Positive	**negative**	**total**	**Positive**	**negative**	**total**	**Positive**	**negative**	**total**	**Positive**	**negative**	**total**
Implementation	25.2	-91	-65.8	12.3	-110	-97.7	25.2	-91	-65.8	45.3	-91	-45.7
	4.55	-64	-59.45	2.4	-64.5	-62.1	4.55	-30.45	-25.9	5.22	-56	-50.78
	180	-63	117	193.6	-75.6	118	427.5	-63	364.5	311	-63	248
	12	-120	-108	14.3	-130.4	-116.1	12	-120	-108	12.6	-87.3	-74.7
	58	-95	-37	196.4	-76.3	120.1	198	-40.5	157.5	91	-58	33
	0.75	-9.75	-9	30.2	-30.1	0.1	0.75	-9.75	-9	9.45	-23.1	-13.65
	6.3	-20	-13.7	41.6	-16.5	25.1	6.3	0	6.3	14	-13	1
	3.15	-7.875	-4.725	29.6	-24.6	5	3.15	-7.875	-4.725	7	-7.875	-0.875
	289.95	-470.6	-180.6	520.4	-528	-7.6	677.45	-362.5	314.875	495.57	-399.2	96.29
	first option			**second option**			**third option**			**fourth option**		
	Positive	**negative**	**total**	**Positive**	**negative**	**total**	**Positive**	**negative**	**total**	**Positive**	**negative**	**total**
non-implementation	5.5	-1.2	4.3	2.4	-2.6	-0.2	0	0	0	11	-45.4	-34.4
	34	-5.25	28.75	47	-24.5	22.5	0.7	-5.25	-4.55	23.4	-5.25	18.15
	42	-13	29	24.3	-12.3	12	0	-139.5	-139.5	8.5	-97.3	-88.8
	36	-2.3	33.7	8	-1.3	6.7	6	0	6	16.4	0	16.4
	68	-17.56	50.44	86	-99.7	-13.7	0	-176.62	-176.62	0	-51.2	-51.2
	0	0	0	14	-16.5	-2.5	0	0	0	18.4	0	18.4
	14	-3.4	10.6	0	0	0	0	0	0	0	0	0
	0	-4.2	-4.2	0	-14.9	-14.9	0	-4.2	-4.2	26.5	-4.2	22.3
	199.5	-46.91	152.59	181.7	-171.8	9.9	6.7	-325.57	-318.87	104.2	-203.35	-99.15

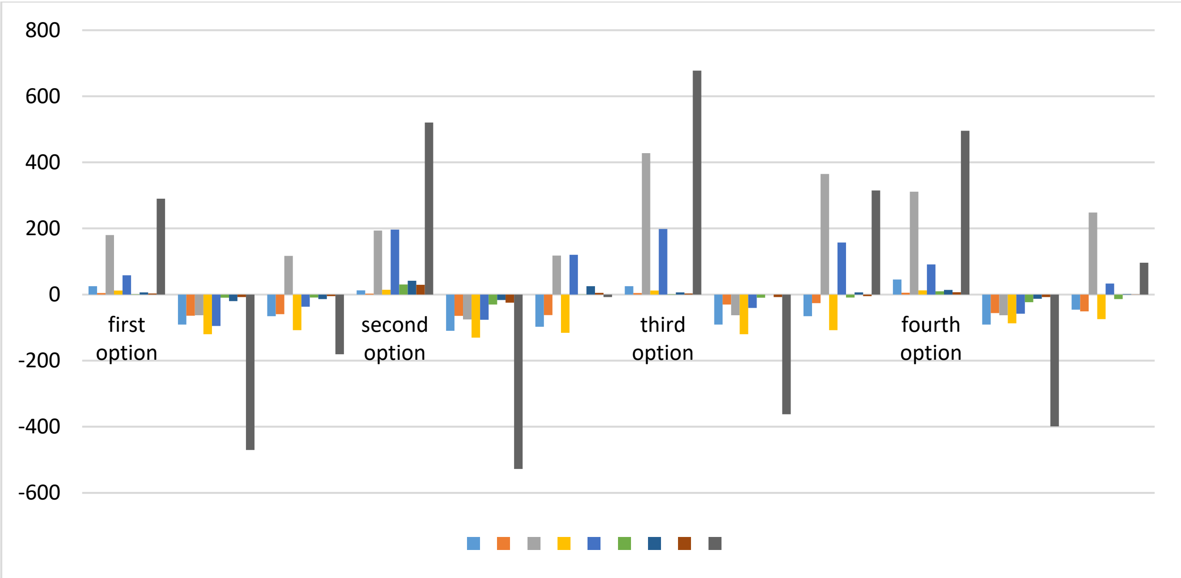

Fig. 3. Diagram of results of Finsk dam environmental impact assessment matrix for all options using ICOLD method in implementation and non-implementation options

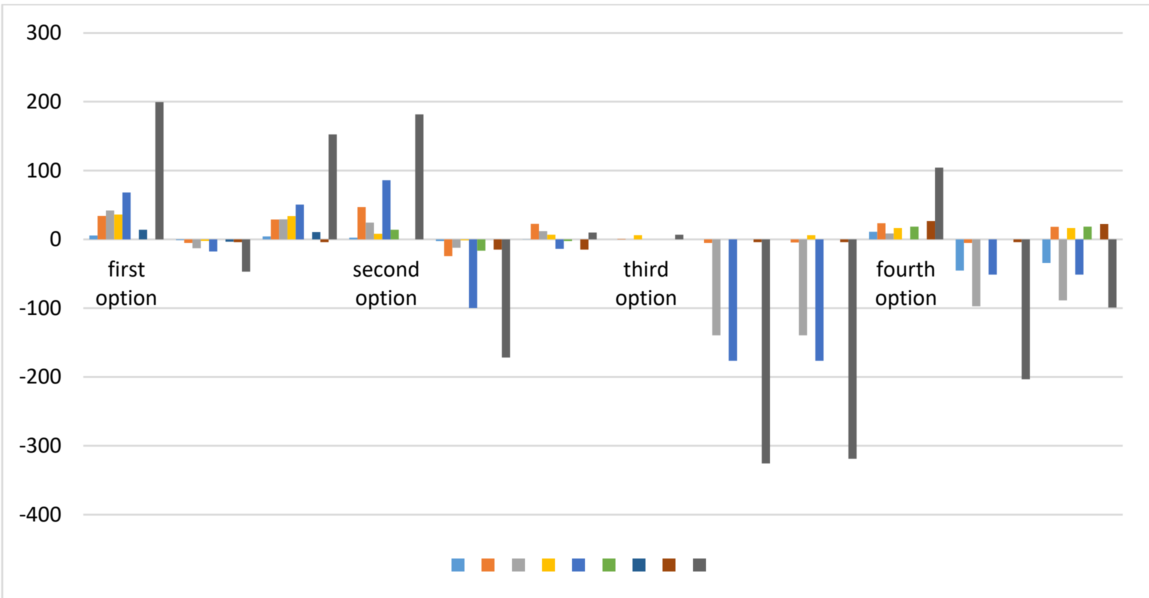

Fig. 4. Diagram of results of Finsk dam environmental impact assessment matrix for all options using ICOLD method in non-implementation options

Organization to regulate the activities of the project.

• Enforcing additional measures outlined in the environmental management plan that significantly contribute to moderating adverse effects and enhancing positive impacts of the plan on the environment.

This study evaluated the environmental impacts of constructing the Finsk dam on the Sefidroud river (Fig. 2) and transferring its water to Semnan province. Four construction options were identified and evaluated using the iCold matrix, and option 3 was deemed the most suitable location for the dam. Three pipeline routes were also evaluated, and option 2 was selected as the best option. The study determined the required number of pumping stations, their technical specifications, and their locations using optimization methods. The findings of this study indicate that despite the detrimental and negative environmental consequences associated with the construction of a dam on the Sefidroud River, which serves as a significant tributary within the Tajen watershed, the project offers more advantages when compared to alternative scenarios. By carefully selecting the appropriate implementation option for the dam, it is suggested that the results of this study align with the research conducted by Jangjoo in 2021. Jangjoo developed a methodology based on matrices and multi-criteria decision-making approaches to facilitate the environmental assessment of dams, utilizing the Hierarchical Analysis Process method for analyzing the effects of the Zarrajabad Dam project.

Human activities have always had an impact on the environment and ecosystems. Dams are no exception and have been constructed without complete knowledge of climate, hydrology, and hydraulics. Although dams have several benefits, including flood control, providing water for agriculture and urban use (Hajizadeh et al., 2018), and energy production, their construction and water storage have significant physical, chemical, and ecological impacts on the ecosystem.

CONCLUSION

The construction of dams can affect meteorology, biology, culture, and historical sites, and it is necessary to consider both positive and negative impacts to achieve sustainable development. Unfortunately, discussions about environmental effects play a limited role in the design and performance of most existing dams. However, increasing awareness about environmental impacts has led to efforts to develop less environmentally damaging perspectives in dam construction projects. Despite varying success in developing criteria and measurements, this approach is crucial for preserving the environment.

Environmental impact assessment is a systematic and official process of evaluating and predicting the potential impacts of a project on the environment, human health, and social welfare (Chehrazar et al., 2022). It involves the identification and evaluation of the physical, chemical, biological, cultural, and socio-economic components of the environment in order to determine the positive and negative effects of a project. Environmental impact assessment serves as a valuable planning tool for ensuring that a project is operated in a manner that minimizes its negative impacts on the environment.

With regards to water resources, the Semnan province faces significant challenges due to its location in a dry region and the excessive exploitation of its water resources. The lack of adequate water sources, poor quality of surface and underground water, long-term droughts, absence of permanent rivers, and the declining size of underground water are major obstacles that threaten the development of the province. The hydrology of Semnan province is mainly associated with the Dasht Kavir watershed, with a few parts within the Caspian Sea watershed. The province does not have any inter-district water transfer facilities, and water is transferred within the province through canals. There are nine earthen dams with clay cores in Semnan province, with a greater concentration in the eastern half of the province. The capacity of these dams is 157 million cubic meters, and the estimated annual storage of surface water is 3.282 cubic meters.

Due to the drought and the limited capacity of the dams, the province has the potential to store more than 125 million cubic meters of water. There is a surplus of 362 million cubic meters of excess surface water in the province, some of which flows like untimely floods. It is possible to plan for nearly 300,200 million cubic meters of this excess water. However, 10 surface water aquifers in the province have an annual storage deficit that needs to be addressed and managed for improvement. Other areas either cannot be exploited due to poor quality or have the characteristic of alignment with optimism. Thus, not only is there no excess capacity in the aquifers, but at least 160 million cubic meters of surface water resources should be used to replenish the aquifers.

The surface water resources in the province that can be planned for improvement and development are estimated to be between (40-140) million cubic meters, and when combined with the available underground water resources, the total usable water in the province amounts to 1.470 million cubic meters. However, the negative balance of the province's plains due to the lack of rainfall and permanent daily groundwater has resulted in a large part of the province's water consumption coming from the aquifers (Sadeghi et al., 2018). This has caused an annual drop in the groundwater level by 70 meters and a deficit of the reservoir equal to 180 million cubic meters. The agricultural sector accounts for all surface water and 940 million cubic meters of underground water, which highlights the urgent need for effective management and sustainable use of water resources in the province.

GRANT SUPPORT DETAILS

The present research did not receive any financial support.

CONFLICT OF INTEREST

The authors declare that there is not any conflict of interests regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/ or falsification, double publication and/or submission, and redundancy has been completely observed by the authors.

LIFE SCIENCE REPORTING

No life science threat was practiced in this research.

REFERENCES

Amirenjad, H., Saadati, H., Farhangi, H., & Fallah-Mehdipour, E. (2019). Groundwater resources vulnerability assessment using GIS-based DRASTIC model in the northwest of Semnan province, Iran. Journal of African Earth Sciences, 159, 103614.

Arekhi, S., Niazi, Y., & Kalteh, A. M. (2010). Soil erosion and sediment yield modeling using RS and GIS techniques: a case study, Iran. Arabian Journal of Geosciences, 5, 285–296.

Babanouri, N., Kiani, F., & Jafari, M. (2015). Sedimentation estimation in reservoirs using a numerical model: a case study of the Finsk dam, Iran. Environmental Earth Sciences, 73, 7257–7270.

Bagheri, A., Saghafian, B., Faridzad, M., & Emamgholizadeh, S. (2021). A new drought vulnerability index based on fuzzy clustering and multi-criteria decision-making methods. Natural Hazards, 107(1), 263-283.

Balist, J., Chehrazar, F., & Jafari, H. R. J. (2022). Spatial-Quantitative Environmental Assessment of Three SHIRAZ Alternatives Railway with Enhanced YAPP-FAHP Method. Human & Environment, 20(1), 299-311.

Balist, J., Malekmohammadi, B., Jafari, H. R., Nohegar, A., & Geneletti, D. (2022). Detecting land use and climate impacts on water yield ecosystem service in arid and semi-arid areas. A study in Sirvan River Basin-Iran. *Applied Water Science*, *12*, 1-14. https://doi.org/10.1007/s13201-021-01545-8

Bremer, L. L. (2016). The water-energy nexus: the nexus of the nexus. Environmental Law Reporter, 46(5), 10641-10658.

Cartney, E. A. (2001). River and dam: or, why a river can't be a dam. Environmental Ethics, 23(1), 41-57.

Gleick, P. H., & Ajami, N. K. (2014). Reducing the vulnerabilities of interdependent systems: the California drought and the water-energy nexus. Environmental Research Letters, 9(8), 080201.

Hajizade vadeghani, B., balist, J., & karimi, S. (2018). Urban development locating with Fuzzy Logic, weighted linear combination and FANP Decision-Making Technique - Case study: Kashan

City. Scientific- Research Quarterly of Geographical Data (SEPEHR), 27 (105), 219-232. doi: 10.22131/sepehr.2018.31496
Hassinzadeh Fard, Z. (2019). Identifying the effects of Finsk dam construction on sustainable rural development in Peror area of Semnan province. Journal of Rural Research, 10(4), 1-22.
Hosseinzadeh Fard, Z. (2019). Environmental and socio-economic impacts of Finsk dam construction on sustainable rural development in Semnan province. Journal of Agricultural Science and Sustainable Production, 29(4), 105-124.
ICOLD. (1980). Environmental guidelines for river basin development planning. International Commission on Large Dams.
ICOLD. (1982). Environmental aspects of dams and reservoirs. International Commission on Large Dams.
ICOLD. (2013). Environmental impact assessment for dams: guidelines for consultants. International Commission on Large Dams.
Jangjoo, M.R. (2021). Developing a method based on matrixes and multi-criteria decision-making approaches for environmental assessment of dams (ACase study). Anthropogenic Pollution Journal, 4 (2): 28-34.
Balist, J., Heydarzadeh, H., & Salehi, E. (2019). Modeling,evaluation, and zoning of Marivan county ecotourism potential using fuzzy logic, FAHP, and TOPSIS, Geographica Pannonica, 23 (2019), pp. 47-63
Jafari, H., Rahimi, H., & Zarrabi, A. (2019). Environmental Impact Assessment of Barzo Dam using ICOLD Matrix. Journal of Civil and Environmental Engineering, 49(1), 17-26. doi: 10.22034/JCEE.2019.133571.1014
Jafari, M., Babanouri, N., & Kalantari, N. (2019). Evaluating the water quality of the Finsk dam in Iran using water quality index (WQI) and NSF index. Environmental Earth Sciences, 78, 501.
Balist, J., Malekmohammadi, B., Jafari, H. R., Nohegar, A., & Geneletti, D. (2022). Modeling the supply, demand, and stress of water resources using ecosystem services concept in Sirvan River Basin (Kurdistan-Iran). *Water Supply*, *22*(3), 2816-2831. Doi: https://doi.org/10.2166/ws.2021.436
Lashkari, H., & Kazemi, F. (2019). Numerical modeling of the sedimentation process in Finsk reservoir, Iran. Applied Water Science, 9, 79.
Madah, S. S., & Saif Olian, M. H. (2018). Optimization of water transmission system in the study area of Semnan city using genetic algorithm. Water Resources Management, 32(8), 2691-2706.
Mahab Quds Consulting Engineers. (2008). Environmental impact assessment of Sarbandar gas pipeline project. Mahab Quds Consulting Engineers Report, Tehran.
Mahab Quds Consulting Engineers. (2003). Environmental impact assessment of Shalamcheh dam and power plant project. Mahab Quds Consulting Engineers Report, Tehran.
Mehta, L., Yang, F., & Lobo, A. (2013). The future of the global water system: will climate change alter the linkages among water, food and energy?. In Climate vulnerability (pp. 41-56). Elsevier.
Mike Coutant, C. (2014). Perspectives on hydropower. Wiley Interdisciplinary Reviews: Water, 1(1), 5-17.
Morsali, M., Omid, M. H., & Sherafatmand, H. (2017). Spatiotemporal changes in land use and land cover and their relationship with soil erosion and sediment yield in the Gorganrood watershed, Iran. Journal of African Earth Sciences, 129, 10-20.
Najamai, M. (2008). Environmental Impact Assessment of Dam Construction on River Flow Regime. Water and Wastewater, 67, 30-39.
Najmaei, M. R. (2002). Environmental impact assessment methods (Vol. 1). University of Tehran Press.
National Irrigation and Drainage Committee. (1999). Irrigation and drainage project environmental guidelines. Ministry of Energy, Tehran, Iran.
Quds Consulting Engineers (2005). Environmental impact assessment (EIA) guidelines for road construction projects. Tehran, Iran.
Sadeghi, A., Khaledi, J., & Nyman, P. (2018) Rainfall Variability and Land-Use Change in Arid Basins with Traditional Agricultural Practices; Insight from Ground Water Monitoring in Northwestern Iran. J Earth Sci Clim Change 9: 498. doi:10.4172/2157-7617.1000498
Sadeghi, A., Galalizadeh, S., Zehtabian, G., & Khosravi, H. (2021). Assessing the change of groundwater quality compared with land-use change and precipitation rate (Zrebar Lake's Basin). *Applied Water Science*, *11*, 1-15. https://doi.org/10.1007/s13201-021-01508-z
Soleymanipor, M., & Bagheri, S. (2007). Using the analytic hierarchy process (AHP) for decision making in engineering applications: some challenges. Journal of Computing in Civil Engineering, 21(6), 364-372.
Tu, J. C., Jin, J. Y., Chen, J., Yan, C. J., & Zhou, J. Y. (2017). Application of the ICOLD matrix method for environmental impact assessment of hydropower stations in China. Environmental Earth Sciences, 76, 252.

Wilson, R., Singh, V. P., & Gupta, H. V. (2017). Environmental impact assessment of reservoirs in India: a review of approaches. Environmental Earth Sciences, 76, 507.

Zeng, S., Liu, Y., Fan, Y., & Wu, J. (2015). EIA of dams and reservoirs in China: development and practices. Environmental Earth Sciences, 74, 1489–1501.

Zhou, W., Yang, Z., Lu, X., Wang, S., & Cao, Y. (2017). A review of environmental impact assessment in China: progress, challenges, and recommendations for effective EIA. Journal of Cleaner Production, 166, 1406–1417.

Table. Summary of the results of the evaluation matrix of the environmental effects of the Finsk Dam (option 4) using the ICOLD method in the executive option.

Total effects by applying effect coefficients			The effects of the project on the socio-economic environment				The effects of the project on the biological-ecological environment				The effects of the design on the physical and chemical environment				Intensity of impact	Impact factor	Abbreviation
			result				result				result						
total	negative	positive	negative	positive	negative	positive	negative	positive	negative	positive	negative	positive	negative	positive			
					2	12			3	-			2	-	1		
-45.7	-91	45.3	-2.8	+25.2	-	-	-65.8	-	13	-	-22.4	-	1	-	2	1.4	**ITC**
					-	2			6	-			4	-	3		
					13	5			21	-			41	-	1		
-50.78	-56	5.22	-4.55	+4.55	-	1	-10.15	-	4	-	-15.75	-	2	-	2	0.35	**ITM**
					-	2			-	-			-	-	3		
					-	8			1	6			-	8	1		
248	-63	311	-13.5	+144	-	9	-22.5	+198	1	7	-27	+85.5	2	4	2	4.5	**LPC**
					1	2			1	8			2	1	3		
					-	1			2	-			1	-	1		
-74.4	-87.3	12.6	-	+3	-	-	-105	+9	9	-	-15	-	2	-	2	3	**IPC**
					-	-			5	1			-	-	3		
					4	100			11	4			9	15	1		
33	-58	91	-9	+165.37	2	19	-14.62	+13.5	1	4	-16.87	+19.12	3	1	2	1.12	**LPM**
					-	2			-	-			-	-	3		
					-	1			1	-			10	-	1		
-13,65	-23.1	9.45	-	+0.75	-	-	-.75	-	-	-	-9	-	1	-	2	0.75	**IPM**
					-	-			-	-			-	-	3		
					-	-			-	-			-	-	1		
1	-13	14	-	+6.3	-	-	-	-	-	-	-	-	-	-	2	2.1	**LTC**
					-	1			-	-			-	-	3		
					5	6			5	-			1	-	1		
-0.875	-7.875	7	-2.625	+3.15	-	-	-4.72	-	2	-	-0.53	-	-	-	2	0.52	**LTM**
					-	-			-	-			-	-	3		
96.295	-399.27	495.75	-32.475	+252.32	27	172	-223.55	+220.5	85	30	-106.55	+104.62	81	29			**جمع**