

QANAT'S ENVIRONMENTAL IMPACT ASSESSMENT IN ARID AND SEMI-ARID AREAS

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ABSTRACT

Today, Environmental problems are considered as one of the most important challenges for industrial projects that are harmful for the life of plants and animals. There has been a lot of attempt to decrease the negative impact of operating and maintenance projects and to avoid running conducting projects with high negative impact. This study is an attempt to analyze the effects of qanat - a technique exploiting groundwater used in Iran and most of Middle Eastern countries - on the environment.

Hydrology, pollution, ecology and socio-economical challenges are important parameters in environmental assessment. Because of simplicity and applicability, checklist method was selected for assessing the environmental effect of qanats. In this method of assessment, extended domain of design parameters are considered too. The result obtained from this assessment and data analysis, indicate that qanat has positive environmental effect on soil sediment, soil erosion, ecology and social economy, including income, resettlement and user contribution.

The result of the study shows that the only negative effect of qanat on environment is water pollution, especially with toxic substances, chemical fertilizers and waste water.

Keyword: Assessment – Checklist – Environment – Methodology – Qanat

INTRODUCTION:

Qanats are one of the most important ways for water harvesting that are used from past in Iran. Agriculture and production are influenced and improved by this technique. So, it is necessary to keep this way of water harvesting by scientific and executive approaches for sustainable development. Nowadays, most of institutes and organizations analyze environmental impact assessment for new projects.

Identification of environmental impact, their importance and approaches for decreasing negative impacts are important goals for EIA.

First step at environmental impact assessment is determination of domain and limitation that has done simultaneously by planning. Primary techniques for domain determination are included: Baseline studies, Checklists, Matrices, Network diagrams and Layout.

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Between five appointed methods for environmental impact assessment, checklist is selected because of simple usage, applicable for non-specialists, using extended domain of design parameters, specify the relationship between questions and information in a matrices and representation of results in a table.

This method as an organized procedure with stable framework is utilizable for introduction of projects and their environmental impacts.

In this paper, qanat's environmental effects on hydrology, pollution, soil, sediment, ecology, socio-economic problems are analyzed.

METHODS AND MATERIALS:

ASSESSMENT METHODOLOGY

1-HYDROLOGY

In this part consequence of water flow regime, water table variations and water resources operations during a year are analyzed. According to geographical situation and topography, qanats are recharged in different ways. Some qanats witches are located in highlands and steep valleys recharge from subsurface flows and qanats witches are located in mountainside recharge from groundwater flows. In all cases, cognition of relation between kind of flow and qanat's recharge is important in environmental impact assessment.

1-1-Water shortage regime

Water harvesting from groundwater resources causes water table decline and breaking off relation between plant and aquifer. So, these plants can not supply water with capillary phenomena.

Qanats can prevent from this problem because of its special structure. As qanat's tunnel has constant elevation with decreasing of water table, discharge will be decreased and finally will be stopped. By this technique intensive water table decreasing at upstream of qanats will not be occurred. This subject can decline environmental impact of water table deduction.

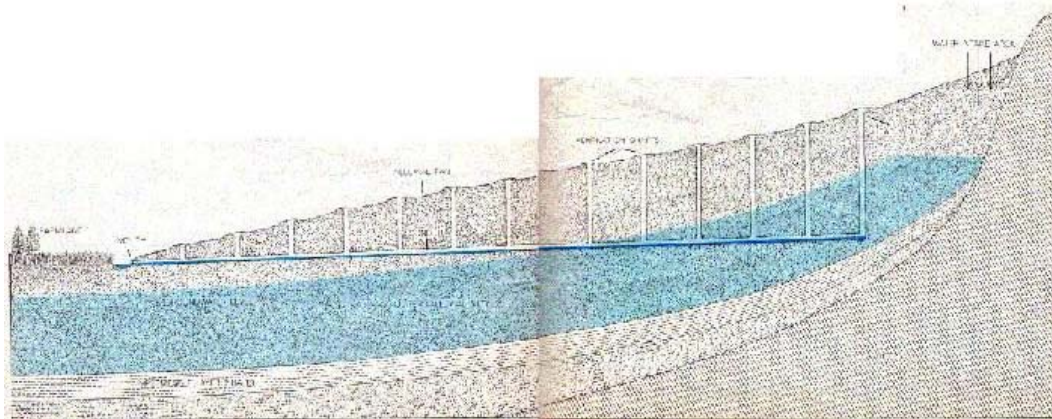


Figure (1) wet tunnel and dry tunnel

1-2- Flood regime

One of the other advantages of this technique is prevention of flood. Since other methods of water harvesting regardless to reservoir volume are only based on water requirement without any limitations, aquifers would be offloaded at draught period. So with appropriate condition for aquifer recharging in wet periods, because of aquifer compaction and macro and micro media deduction, it can not absorb surface water. This problem increases flood occurrence.

Qanats with annual auto control of water harvesting, can prevent fundamental changes in soil media.

1-3- Operation

Continuous flow is one of the disadvantages of qanat's operation. Of course planning for water usage in arid and semi-arid region has solved this problem. There are very different procedures for keeping water, but we can classify all of procedures by two major categories:

Structural preservation:

Ab-anbar and Yakhchal are two important structures that gathering water at un-demanded seasons like winter.

Managerial experience:

Water spreading recharge projects and water diversion toward dessert for irrigation of trees are the most important programs for water usage at winter. Irrigation of trees and plains aquifer recharging will prevent dessert development.

1-4- water table fall

One of the advantages of water table fall before precipitation season is water reservation possibility. Decreasing of water table in waterlogged lands by drainage is useful for agriculture.

Nowadays, non-structural drainage is a compatible strategy for environment. For example Biodrainage that is performed by some trees and plants species. In this context, qanats in addition to water harvesting can perform as a subsurface drain and decrease water table.

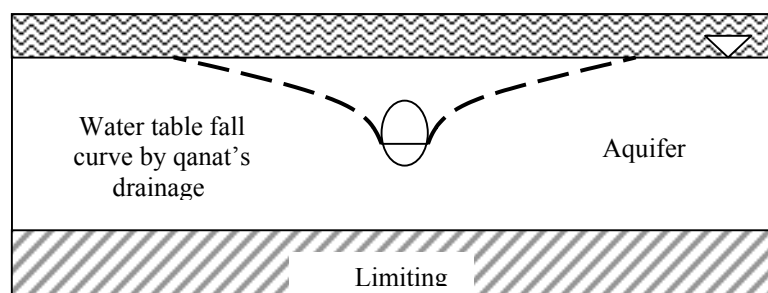


Figure (2) qanat's drainage

In general, wet tunnel in qanats that supply maximum water, perform drainage activity in two parts:

In portion of wet tunnel which is lied in subsurface, qanat's conduit operate as subsurface drainage pipes.

In another portion of wet tunnel which is lied in subsurface not completely, qanat's conduit operate as surface drains.

Table (1) Hydrology assessment by ICID checklist

F	E	D	C	B	A	Environmental Impact		
+						Shortage Regime	1-1	Hydrology
+						Flood Regime	1-2	
				+		Operation	1-3	
				+		Water Table Fall	1-4	
					+	Water Table Rise	1-5	

2- POLLUTION

Today, due to rural development, increasing of agricultural fields and industrial centers and swage entrance to ground waters, qanats are exposed to pollution. Pollution is included three categories:

2-1- Toxic material pollution

This kind of pollution is prompted by factories sewage (in Yazd and Ardekan qanats) and industrial waste water entrance to qanat's conduit. These materials like Arsenic, cadmium and cobalt which are usually used in textile and dyeing industries and leavening agents and plastics factories. Depletion of these swages in qanat's feeding privacy cause water and soil pollution.

2-2- agricultural pollution

In some areas qanats are installed consecutively. In these cases, swage of upstream qanat transfer dissolution of fertilizers and pesticides to downstream qanats and it can damage water quality and environment.

2-3- Urban swage pollution

Rural and urban development, increase in population and lack of management result in urban swage pollution. So, qanats which are located in these areas have environmental problems. As a result, for prevention of negative environmental impact, infrastructures are needed for gathering urban swage in qanat's privacy.

Table (2) Pollution assessment by ICID checklist

F	E	D	C	B	A	Environmental Impact		
	+					Toxic Material Pollution	2-1	Pollution
	+					Agricultural Pollution	2-2	
	+					Urban Wastewater Pollution	2-3	

3-SOILS

One of the most important points in qanat's excavation is soil properties. In case that qanat's conduit pass through gypsy or salty soils, water quality will be unsuitable, qanat's conduit will be deformed and finally it will be destroyed (Kalshour qanat in Neishabur). Ground waters in central part of plains are stagnate and they have abundant dissolved solids but ground waters in mountainsides are fresh and without any dissolved solids.

As a result, water passing through different lands creates two kinds of water: male and female (heavy and light). So, with appropriate route selection for qanat's conduit and transmission of high quality water toward arid and semi-arid region, it will be possible to improve agricultural condition.

Table (3) Soils assessment by ICID checklist

F	E	D	C	B	A	Environmental Impact		
				+		Soil Characteristics	3-1	Soils
				+		Saline Groundwater	3-2	

4-SEDIMENTS

4-1- Qanat's erosion

Artificial recharge is one of the best techniques for qanat's discharge improvement. For example by constructing small dams in addition to more permeation of precipitation in soil, runoff volume will be decreased. So, usage of this technique at upstream can prevent soil erosion. Other reason for decreasing erosion by qanat is possibility of shrubs and trees irrigation. This parameter causes root accumulation, wind erosion prevention and shifting sand stabilization in deserts.

Qanat's conduit slope is influenced by two parameters: 1) meeting aquifer 2) erosion and sediment.

Annual and perennial dredging is a strategy for qanat's conservation and maintenance, but it is not economical. Nowadays, new procedures are created maintenance costs deduction. For example piscaculture in qanat's tunnel is one of these methods. Fishes movement in qanat's tunnel can control sediments.

4-2- Qanat's morphology

Special morphology of qanat has appropriate compatibility with environment. Always, ground water harvesting comes along with consumption of energy and cost. Qanat, unfashionably uses any energy and cost for pumping water to surface. Furthermore, this technique does not occupy soil surface. As a result, high evaporation in arid and semi-arid region can not influence on transmission efficiency.

Table (4) Sediment assessment by ICID checklist

F	E	D	C	B	A	Environmental Impact		
				+		Erosion	4-1	Sediment
				+		Qanat's Morphology	4-2	
				+		Sedimentation	4-3	

5-ECOLOGY

Most of qanats are installed at dessert edging. Life in these areas is very weak and fragile. So, after qanat's construction in these areas, because of water existence life changed and population increased. Increase in population at dessert edging has beneficial results like prevention of desertification, formation of water habitat and etc.

Also, we can indicate to marine habitats genesis possibility in qanat's conduit. This case can prevent sediment and erosion in qanats and it can be useful for environment.

Table (5) Ecology assessment by ICID checklist

F	E	D	C	B	A	Environmental Impact		
					+	Land Use	5-1	Ecology
				+		Border Lands	5-2	
				+		Plains and Ponds	5-3	
					+	Animals Immigration	5-4	

6- SOCIO-ECONOMIC

Qanat's water in many years with special orderliness has been used by rural people and farmers in arid and semi-arid areas. Today, by installation of deep and semi-deep wells and uncontrolled water harvesting, water table in most plains have been decreased.

So, rural people immigration to big cities will be one of the most important results. This problem will bring large sociological and economical problems in urban management systems.

Table (6) Socio-Economical assessment by ICID checklist

F	E	D	C	B	A	Environmental Impact		
					+	Population changes	6-1	Socio-Economic
					+	Incomes	6-2	
					+	People's emigration	6-3	
					+	Further settling	6-4	
				+		Valuable places	6-5	
					+	User cooperation	6-6	

CONCLUSION:

In this study, ICID checklist is used for environmental impact assessment of qanat in arid and semi- arid areas. This checklist is presented by Irrigation and Drainage Committee for irrigation and drainage networks assessment.

However, surveying of a project's environmental impact assessment should be done according to its regional condition, but in this study environmental impact assessment of qanat in arid and semi- arid areas was generally analyzed.

In this methodology, negative and positive environmental impacts of qanat are discussed according to categorized subjects.

For shortage and flood regimes, there is not correct judgment possibility and more researches are recommended. According to this study, pollution has more negative impacts on environment but other parameters have positive impacts.

Table (7) ICID checklist for environmental impact assessments

Judgment is not possible now	Very negative impact possibility	negative impact possibility	Without any impact	positive impact possibility	Very positive impact possibility	Environmental Impact		
F	E	D	C	B	A			
+						Shortage regime	1-1	Hydrology
+						Flood regime	1-2	
				+		operation	1-3	
				+		Water table fall	1-4	
					+	Water table rise	1-5	
	+					Toxic material	2-1	pollution
	+					Agricultural pollution	2-2	
	+					Urban wastewater	2-3	
				+		Soil salinity	3-1	soils
				+		Soil characteristics	3-2	
				+		Saline groundwater	3-3	
				+		Qanat's erosion	4-1	sediment
				+		Qanat's morphology	4-2	
				+		sedimentation	4-3	
					+	Land use	5-1	Ecology
				+		Border lands	5-2	
				+		Ponds and plains	5-3	
					+	Animals emigration	5-4	Socio-Economic
					+	Population changes	6-1	
					+	incomes	6-2	
					+	People emigration	6-3	
					+	Further settling	6-4	
				+		Valuable places	6-5	
				+		User cooperation	6-6	

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