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RESEARCH PAPER

Assessment of quantitative and qualitative characteristics of rivers in the catchment area of the Salt Lake in Alborz Province of Iran

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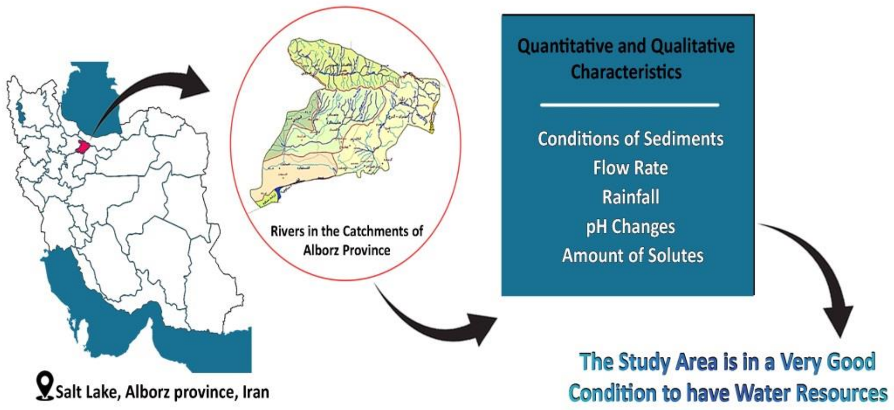
Highlights

- The salt lake catchment in Alborz province has a better water potential situation than similar basins.
- The rivers of the salt lake catchment area in Alborz province have a suitable water capacity due to the climate.
- Management practices in the catchment area of Namak Lake in Alborz province cause the sustainability of water resources.

Graphical Abstract



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Abstract

The characteristics of watersheds are influenced by various factors and parameters that have led them to be considered dynamic and active phenomena in the environmental field. Various criteria and standards have been established for watersheds that provide a suitable approach for controlling watershed conditions. Therefore, the study of watershed characteristics may include different sections. In this study, water resources and potentials in the study area are examined. The quantitative and qualitative characteristics of the salt lake watershed (sediment condition, flow velocity, precipitation, pH changes, amount of dissolved solids) in Alborz province of Iran were studied. For this purpose, the potential of surface waters and their hydraulic and hydrological conditions were evaluated. The results showed that the study area has very good water resources compared to neighboring basins and basins with the same conditions. The basin is mountainous in the northern regions and a plain with a dry climate in the lower regions. Despite the great climatic differences, the rivers have sufficient and stable water flow to satisfy the needs of stakeholders and the riparians, except on certain days of the year. However, there have always been challenges in adjacent or similar watersheds. Clearly, implementing management measures to maintain stability and increase enjoyment should be on the agenda.

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1. Introduction

According to the definition, a watershed or catchment area is a part of land that due to the slope and shape of the land, the water flows there to the lowest place in its area. The area from the beginning of the tributaries of the stream in the streams to the end point leading to the outlet of the basin is located in the catchment area (Sadeghian et al., 2014). In other words, when it rains on the slopes and heights of the earth, the water moves in the direction of the slope of the earth and after joining together, it flows as a river towards the sea, lake and so on. The shape of this river is straight or serpentine based on the slope of the river. If the slope of the river is low, it becomes spiral and if it is steep, it becomes straight (Rohani et al., 2021). According to the explanations provided, the scope of division of catchments from one leaf to large dimensions in the country is included. The basis of evaluations is proportional to the characteristics of the research and is often considered as a case study. Rivers are the most important sources of water supply for various purposes, the proper and efficient use of which requires understanding the conditions and accurate knowledge of their behavior in the region (Nafchi et al., 2021). In this regard, it is necessary to fully understand the different characteristics of catchments as the main bed of rivers and the parameters governing them. The mechanism of the dimensions of the basins has a great impact on this and it is necessary to consider a suitable and practical basis. Existence of sufficient information, recorded data, analyzes performed, beneficiaries of users, etc. are among the items that are prioritized.

The characteristics of watersheds are influenced by various factors and parameters that have led them to be considered dynamic and active phenomena in the environmental field. Various criteria and standards have been defined for watersheds, the result of which is a suitable approach to control the conditions of the watershed. Therefore, the study of the characteristics of the watershed may include different sections (Romanescu et al., 2014). This study is about the study of water resources and potentials in the study area. Azarang et al., (2017) investigated the erosion and sedimentation conditions of the Karkheh River downstream of the reservoir dam. The morphological characteristics of the erosion and sedimentation process between the selected hydrometric stations were evaluated using HEC RAS software. The results showed that the construction of a reservoir dam could not prevent the movement of the central axis of the Karkheh River (Azarang et al., 2017; Nafchi et al., 2021).

Rohani et al., (2021) studied the trend of quantitative and qualitative changes in water resources of Qom watershed. There are two rivers, Qamroud and Qarachai, in the watershed of Qom province. The amount of water entering from these rivers to the watershed of the province, before the construction of 15 Khordad and Ghadir Saveh dams, was equal to 698 million cubic meters, which, including surface currents from rainfall, the total volume of surface water in the province to 750 million meters. The cube has arrived and the volume of water output from this basin, at the site of Kuh-e Sefid station, was 261 million cubic meters before the mentioned dams, while after the construction of two dams, it has been reduced to 66 million cubic meters. With the construction of these two dams, the inflow of water by the Qamroud and Qarachai rivers to the watershed of Qom province has been reduced to a minimum. In terms of quality, in general, the quality of groundwater in the watershed of Qom province is declining. Also, the border of saline water is about 5000 meters and the common season of saline and fresh water is about 3000 meters in Qom plain. In general, the trend of changes in the province's water resources, in terms of quantity and quality, has a sharp decline (Rohani et al., 2021).

Shahryari et al. (2021) analyzed the quantitative components of the catchment and their role in the annual sedimentation rate of 17 catchments in the northeast of the country. In this study, the morphometric indices of the catchment were calculated; Then, using the data of discharge and sediment of the Regional Water Organization, the annual sediment discharge (ss) of each station was determined by multivariate methods of sediment estimation and then the annual sedimentation of basins (tons per year per square kilometer) was calculated. Finally, by calculating the linear relationship and correlation coefficient, the effect of each morphometric index of the catchment on the annual sediment rate was calculated and evaluated. Calculations indicate that the amount of annual sediment in the research basins is not completely affected by morphometric factors and components such as intensity and duration of rainfall, soil type, land use and vegetation should be considered in estimating the annual sediment in the basins to obtain more accurate results (Shahryari et al., 2021; Saha et al., 2022; Shivhare et al., 2022).

Ghaffari et al., (2010) studied urban development on the hydrological status of the catchment area in the Tajrish Basin in the north of Tehran. The results of this study showed that the use of conventional hydrological models to model and predict the hydrological status of watersheds that are subject to severe land use change and urban development, can be associated with many errors (Ghaffari et al., 2010).

Jaberi et al., (2018) analyzed the quantitative and qualitative erosion in the southern catchments overlooking the city of Mashhad and its environmental consequences. The results of this study indicate that firstly, Jagharq catchment has the most erosion and sediment compared to other studied basins. Secondly, the M Psiac model responds well in this area. Because, for example, the estimated amount of sediment in the Jagharq basin with model M psiac was 531 tons per square kilometer per year, while in the sediment measurement station of the relevant basin is 547 tons per hectare per year. Third, the amount of erosion and sediment in the study area is increasing and this is the result of land use changes and human encroachment. This increase in erosion and sedimentation has also had environmental consequences in the region (Jaberi et al., 2018).

Romanescu et al., (2014) analyzed the Quantitative and Qualitative Assessments of Groundwater into the Catchment of Vaslui River. The study of groundwaters in the Vaslui hydrographic basin, in the context of a relief unit with extremely scarce natural resources, reveals a relatively modest hydrogeologic potential, partially exploited and not entirely identified. A proper exploitation of the underground water resources may by done if authorities join efforts and with proper financial support to stimulate economic growth and an enhanced quality of life in that basin (Romanescu et al., 2014).

Ahmadi et al., (2022) analyzed the Evaluation of Heavy Metals Pollution in the Surface Sediments of Mahabadchai Rive. According to the results obtained from upstream and downstream samples, it can be said that the concentration of elements in the upstream was in terms of natural factors, and downstream, heavy metal pollution has increased by increasing human activity. The research is based on evaluating the characteristics of a catchment in terms of quantity or quality or based on a specific approach to investigate the quantitative and qualitative characteristics of catchments located in the political area of Alborz province (Ahmadi et al., 2022).

2. Materials and Methods

2.1. Study area

Alborz province is located in the middle of the western and central Alborz mountain range and in an almost mountainous area in the coordinates of 35 degrees and 28 minutes to 36 degrees and 30 minutes north latitude and 50 degrees and 10 minutes to 51 degrees and 30 minutes east longitude. Fig. 1 shows an limit of Alborz province and the political division of its cities. In general, in Alborz province, the climate is mountainous and semi-arid desert. in The Table 1 shows the characteristics of climatic parameters in this province.

Table 1. of average temperature and precipitation in Alborz province.

Zone name	Type of climate	Propertise					
		Number of sunny days	Average Annual Temprature (C)	Minimum Annual Temprature (C)	Maximum Annual Temprature (C)	Annual Precipitation (mm)	Above sea level
Karaj	Semi arid	342	14.9	-10.8	40.6	387.2	1292.2
Payam	Cold Mediterranean	346	13.8	-15	42.6	339.2	1184
Hashtgerd	Dry Cold	334	12.7	-12.6	38	427	1613
Taleghan	Semi Dry Cold	347	10.1	-16.2	36.4	644.7	1857

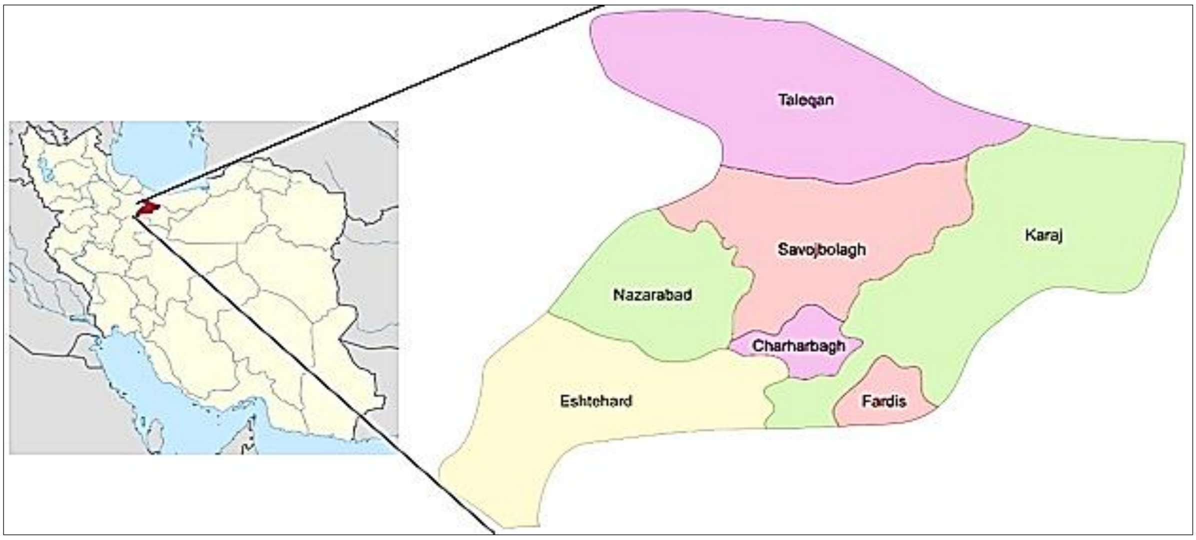

Fig. 1. Scheme of Alborz province and the scope of its political divisions.

Alborz province from a hydrological point of view is located in the two clouds of the Caspian Basin and the Central Plateau of Iran. The province is drained by three large river systems and supplies its surface and groundwater resources in this way. Karaj river basin with all its branches and tributaries along with a number of rivers and tributaries of Shoor river make large parts of this province drink. These two river basins with their study areas (hydrological units) are considered as sub-basins of Salt Lake, which is a small part of the central plateau of the Central Plateau of Iran. Also, the Taleghan river basin, which is one of the sub-basins of Sefidrood, originates from this province and joins the Shahroud river (Al-Mutroud), is a part of Sefidrood river that flows into the Caspian Sea. Fig. 2 shows a diagram of the interference of first and second degree catchments with Alborz province.

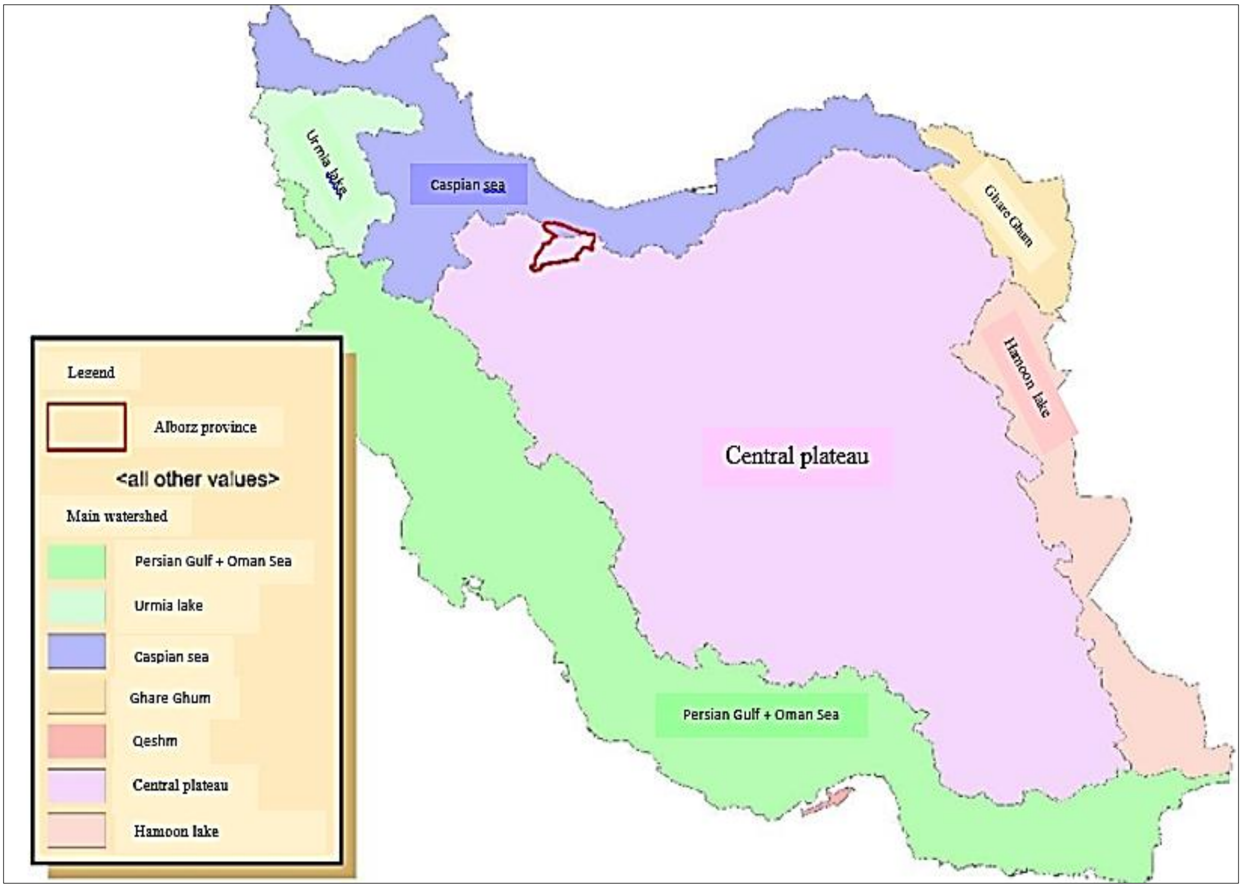

Fig. 2. Scheme of the overlap of the main catchments of the country with Alborz province.

2.2. Water potentials of Alborz province

Alborz province with a volume of renewable water resources of over 2 billion cubic meters per year, the existence of suitable surface currents and suitable aquifers, similar to other parts of the country in terms of quantity and quality suffers from problems and water crisis, so that more 85% of the surface water potential of the province is exploited and a volume equivalent to 700 million cubic meters is transferred to the neighboring provinces through dams. The amount of groundwater abstraction in Alborz province is beyond the renewable capacity and more than 830 million cubic meters per year.

2.3. Characteristics of catchments in Alborz province

According to the hydrological divisions of the Office of Basic Studies of Water Resources of Iran Water Resources Management Company, the country's water resources are divided into six main catchments called the Caspian Sea, Persian Gulf and Oman Sea, Lake Urmia, Central Falt, Eastern and Qaraqoom. The sub-catchment is divided. The main catchment area of the Caspian Sea to the sub-basins of Aras river, Talesh-Anzali swamp rivers, Sefidrood, rivers between Sefidrood and Haraz, Haraz river and rivers between Haraz and Qarah Su, Qarah Su, and Gorgan rivers The Atrak River is also divided. The main catchments of the Persian Gulf and the Sea of Oman include the sub-basins of the western border rivers, Karkheh River, Karun Bozorg River, Jarahi and Zohreh rivers, Hillah river and small canals on both sides, Mand river and catchment areas. Pak Karian and Khanj are the rivers of Kol and Mehran and the southern canals and islands, the rivers between Bandar Abbas and Sadij and also the rivers of South Baluchistan between Sadij and the border of Pakistan. The main catchment area of Lake Urmia includes a sub-catchment of the same name. The main catchment area of the Central Plateau also includes the catchments of Namak Lake, Gavkhoni, Tashk-Bakhtegan and Maharloo Lakes, Abargo-Sirjan Desert, Hamoon Jazmourian Desert, Lut Desert, Central Desert, Ardestan Deserts, Zarrin and Siahkuh Deserts, as well as Daranjir Deserts. And Saghand is divided. The main watershed of the eastern border includes the sub-watersheds of Daq Petregan - Namakzar Khaf, Hamoon Helmand (Goodzreh) and Hamoon Meshkil. The Qaraqoom catchment area also includes a sub-basin of the same name. Figs. 3 and 4 show an outline of the first and second degree basins.

Fig. 3. Scheme of the six main (first Order) watersheds of the country.

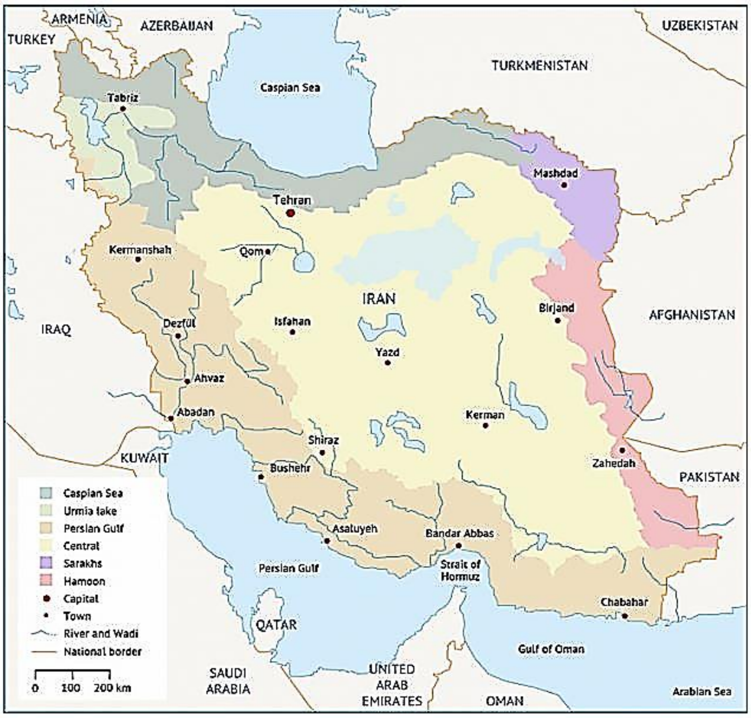

Fig. 4. Scheme of quadratic catchments and its overlap with the location of different provinces.

2.4. Salt Lake catchment

In terms of general hydrological division of Iran, the catchment area of Namak Lake is part of the catchment area of the Central Plateau and is limited to the catchments of Sefidrood and the Caspian Sea from the north, Karkheh and Dez from the west, Zayandehrood from the south and the desert and The salt desert is from the east. The salt lake catchment area is located in the highlands and is located between Central Alborz and Zagros. The basin is located between the geographical coordinates of 48 ° 08 ′ to 52 ° 30 east longitudeLocated at 33 ° 00 ′ to 36 ° 22 ′ north latitude. The area of this basin is about 92561 square kilometers, of which about 42233 square kilometers are mountainous areas and the rest 47930 square kilometers are plains and foothills. 2400 square kilometers are made up of salt marshes and deserts. The cities of Abhar, Takestan, Qazvin, Abik, Hashtgerd, Karaj, Tehran and Varamin in the northern basin, ie the catchment of the rivers Shoor-Karaj-Jajrud and the cities of Hamedan, Shazand, Arak, Khomein, Golpayegan, Khansar, Mahallat, Meymeh, Delijan, Ashtian, Tafresh, Saveh, Qom and Kashan are located in the southern basin, ie the catchment area of Qom, Qarachai and Arak and Kashan deserts. Fig. 5 shows the position of the salt lake catchment relative to the central plateau catchment.

Fig. 5. Relative position of the salt valve catchment relative to the main catchment of the Central Plateau.

The main ridge of the Alborz mountain range, which in many places is more than 3000 meters, is the boundary between the Caspian Basin and the central plateau of Iran. This mountain range plays the role of a large and unique climatic wall in the hydro-climatic conditions of Iran's watersheds. The Karaj River, originating from the southern slopes of this mountain range and moving to the south, has dug a deep and relatively wide valley in the heart of the mountain. The Tehran-Chalous mountain route passes through this valley in most parts and is very active. Human settlements and settlements can also be found in the vicinity of this valley. This valley is the largest and most watery river basin that originates from the southern slopes of Alborz and ends in the salt lake. The Shoor river basin system starts from the neighboring province (Qazvin) and after entering this province, it receives the Kordan river. The Kordan River or several branches and tributaries in the south of the Karaj-Hashtgerd plain join the Shoor River with a circle around the heights of the ring. Based on the divisions of the basin and hydrological areas, this province has nine hydrological units (study areas), which are: Taleghan Alamut, Ramsar Chalous, Zarand saveh, Zone 4 Saveh, Eshtehard, Hashtgerd, Qazvin, Tehran Karaj, Lavasanat.

Although the political borders and dividing lines of the province cover nine study areas, but in terms of water resources and its importance for the province, the areas of Taleghan, Hashtgerd, Tehran, Karaj, Qazvin and Eshtehard are important for this province and The other 4 areas, including Ramsar Chalous, Zarand Saveh, section 4 of Saveh and Lavasanat, are not important for this province. In fact, the non-compliance of the border of the country with the border of the basin divisions has led to the annexation of limited parts of the study units adjacent to this province, while the water resources of these units have flowed to the neighboring provinces and have no benefit for this province. Table 2 shows the general characteristics of hydrological units in Alborz province at the level of main and sub-catchments and its sub-basins.

Table 2. General characteristics of hydrological units in Alborz province at the level of main watersheds and its sub-basins.

Basin	Sub basin	Main river	Area name	Area (km²)	Relative area (%)	Other rivers
Caspian sea	Sefid Rood	Taleghan rood	Taleghan Alamut	1101	21.3	Jostan - Orazan - Behranrood - Narian - Herodorod
	Chalous	Chalous	Ramsar Chalous	6	0.1	This area in Alborz province has no river and surface flow and the initial sources of Chalous river start from Kandovan pass from this part.
Central Plateau	Salt lake	Shoor	Zarand saveh	62	1.2	This area in Alborz province has no river and surface flow
	Salt lake	Shoor	Zone 4 Saveh	25	0.5	This area in Alborz province has no river and surface flow
	Salt lake	Shoor	Eshtehard	715	13.8	Shoor River
	Salt lake	Kordan	Hashtgerd	1279	24.7	Darvan - Aghasht - Barghan - Valian - Siroud - Glinrood - Fashand
	Salt lake	Shoor	Qazvin	333	6.4	This area in Alborz province includes the desert plains of Shoor river and the only important seasonal route is Hugh-Shalmzar river.
	Salt lake	Karaj	Tehran Karaj	1638	31.7	Velayat Rood - Warang-e-Rood - Sierra - Shahrestanak - Gajreh - Arang-e-Kandrood
	Salt lake	Jajrood	Lavasanat	17	0.3	This area in Alborz province has no river and surface flow and the initial sources of Chalous river start from Kandovan pass from this part.

2.5. Surface water

Alborz province has important surface currents. Karaj river is the most important surface flow of the province. Kordan and Taleghan rivers are also considered as other river basins of this province, whose annual flow is also significant. The surface water potential of the province is 1262.96 million cubic meters, of which 171.5 million cubic meters naturally and 705.8 million cubic meters of dam water leave Alborz province. Of this volume, about 385 million cubic meters per year is used for various purposes within the province. It is specified in the form of catchments of Alborz province (Fig. 6).

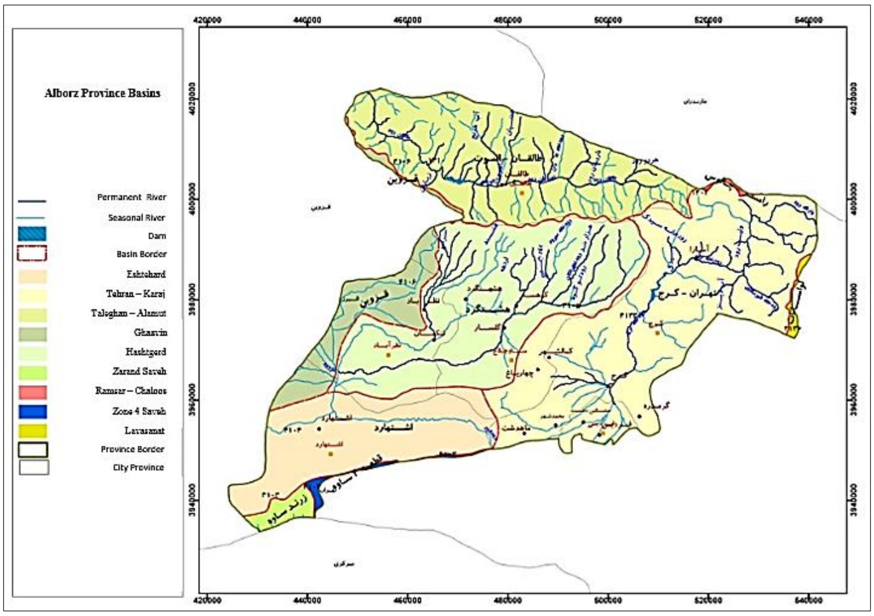

Fig. 6. Scheme of a river in the catchments of Alborz province.

Estimation of hydraulic properties and surface flow sediments has been done through hydrometric stations in the province. With the exception of the Karaj River, whose hydrometric stations have been used for a long time, there are hydrometric stations in other rivers, so that the number of hydrometric stations in the province is about 30, of which Eight stations are closed and inactive, and the rest are recording data on surface currents, sediments, and sometimes climatic parameters. Fig. 7 shows the most important hydrometric stations and also Table 3 shows the characteristics of the stations.

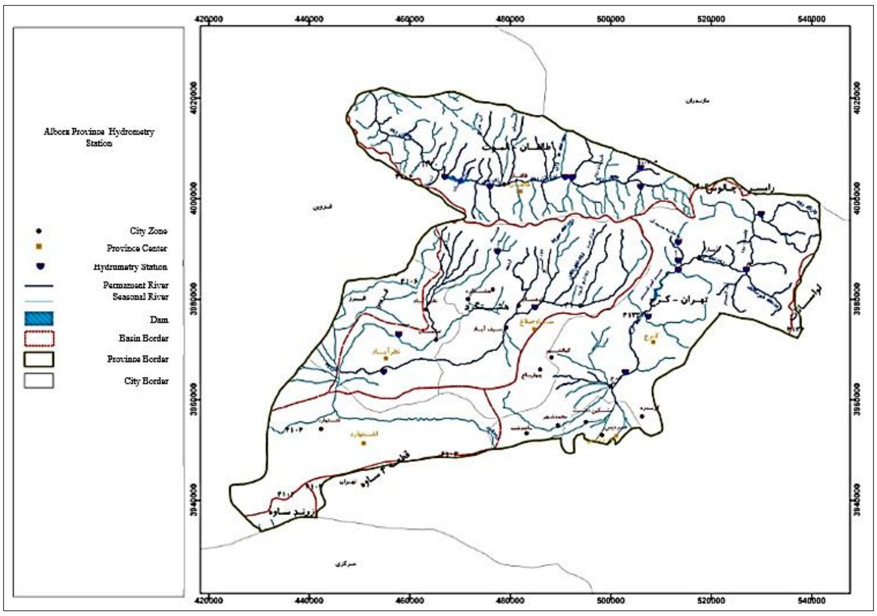

Fig. 7. Distribution of hydrometric stations of rivers in Alborz province.

Table 3. Specifications of hydrometric stations in Alborz province.

Properties								**Type of assessment**				
Row	River	Station	Code	longitude	latitude	Elv (m)	Area (km^2)	Discharge	Sediment	Quality	Precipitation	Evaporation
1	Shahrood	Galinak	035-17	44-50	10-36	1770	848	✓	✓	✓	✓	✓
2	Taleghan	Kamakan	037-17	38-50	11-36	1700	---	✓	With the construction of Taleghan Dam, it has gone under water			
3	Shahrood	Gatedeh	050-17	04-51	10-36	2600	84	✓	✓	✓	✓	
4	Dehdar	Dehdar	874-17	04-51	12-36	2800	41	✓	✓	✓	✓	
5	Shahrood	Mehran	965-17	55-50	11-36	2000	98	✓	✓	✓		
6	Shahrood	Justan	966-17	54-50	11-36	1990	428	✓	✓	✓	✓	✓
7	Fashand	Darband	093-41	54-50	03-36	1780	34	✓	✓	✓	✓	
8	Kordan	Deh Sume	095-41	50-50	57-35	1410	360	✓	✓	✓	✓	
9	Kordan	Najabad	097-41	30-50	50-35	1190	940	✓	✓	✓	✓	
10	Shoor	Asefoldole	099-41	45-50	41-35	1122	16400	✓	✓	✓	✓	
11	Karaj	Sira	101-41	09-51	03-36	1790	725	✓	✓	✓	✓	
12	Karaj	Bileghan	103-41	02-51	50-35	1360	1120	✓	✓	✓	✓	
13	Kordan canal	Deh Sume	243-41	50-50	57-35	1425	---	✓		✓		
14	Gajereh	Gachsar	253-41	20-51	07-36	2200	211	✓	✓	✓		
15	Shahrestanak	Doab	255-41	18-51	01-36	2020	151	✓	✓	✓		
16	Kordan	Chardange	275-41	50-50	57-35	---	---	✓		✓		
17	Haft cheshme	Aderan	932-41	05-51	56-35	1600	88	✓	✓	✓		
18	Kordan	Khoram Abad	933-41	32-50	54-35	1172	---	✓		✓		
19	Morood	Pol Khab	935-41	09-51	02-36	1790	25	✓	✓	✓		
20	Kolvan	Sira	936-41	09-51	01-36	1790	74	✓	✓	✓		
21	Neshtarood	Pol Khab	987-41	09-51	04-36	1795	25	✓	✓	✓		
22	Shahrood	Taleghan dam Downstream		37-50	11-36	1690	---					
23	Taleghan	Narian		59-50	10-36	2120	---					

2.6. Surface current potentials of the Saline River Basin

The Shoor River and its catchment area are one of the most important sub-basins of the Salt Lake, and although it receives a lot of water from different places, it is dry most of the year (Fig. 8). On the other hand, due to salinity, its water is unsuitable for agriculture. The water of Shoor river is from the surplus water of Khorrood river which originates from Avaj region and Kharqan mountains, crosses with Abhar river and enters Qazvin plain. The Abharrud River, another tributary of the Abharrud River, originates from the northern slopes of the Goi Qazai Mountains, west of Abhar and to the left of the Abhar Valley to Zanjan. It flows inside the valley to the east and in the Qazvin plain it connects with Khorrood and forms the Shoor river. The presence of salt flats in this area causes salinization of river water. The basin of this river is about 16,400 square kilometers from the source to the exit point of Eshtehard city and in this region the southern streams of Alborz heights and Taleghan mountains join it and a large network of small tributaries between Qazvin and Karaj creates. These seasonal drains and small tributaries are generally used by the villages located in the foothills of the Alborz and its sewage or flood waters enter the salt field and then the saline river. The length of the Shoor River is about 500 km and its catchment area, which is covered by the provinces of Zanjan, Qazvin, Markazi and Alborz, is about 22,768 square kilometers. This river is generally classified as a seasonal river, but in heavy rains it floods and in non-rainy areas it acts as a drainage area. The river has small and large tributaries, numbering up to 66 rivers. The western and southwestern parts of the province are located in the Shoor River basin. The catchment area of the Kordan River, which drains the Hashtgerd study area of Savojbolagh city, is part of the Shoor River basin system. The cities of Savojbolagh, Nazarabad and Eshtehard are located in the Shur River basin. This basin in Alborz province is about 2412 square kilometers and includes 5 study areas. Thus, the Shoor River basin covers 47% of the total area of the province. In the form of the hydrographic network of the catchment area of the Shoor River, it is specified separately for study areas.

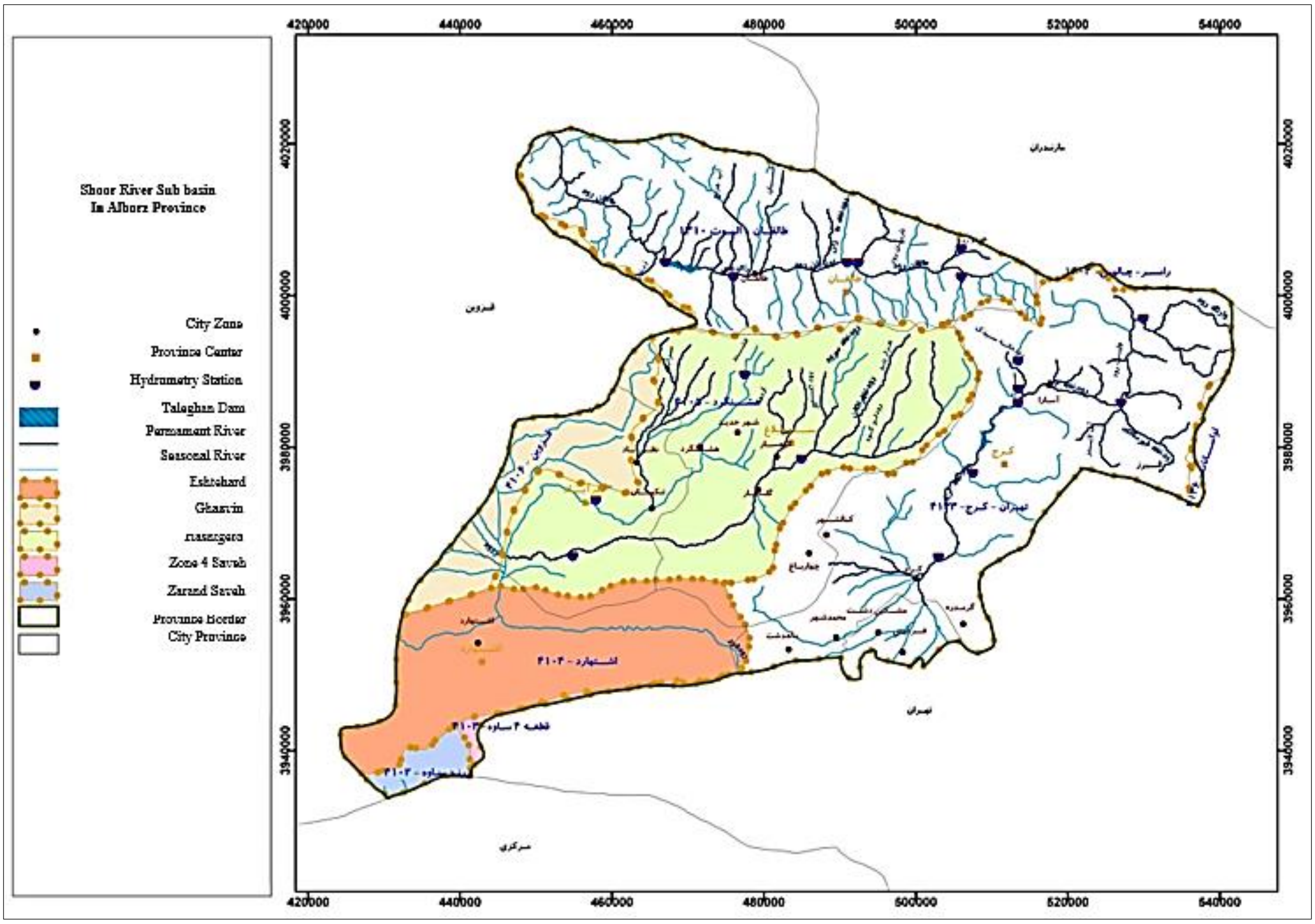

Fig. 8. Hydrographic network of Shoor River catchment area.

According to the information received from the regional waters of Alborz province, the total annual surface volume of Hashtgerd basin in Deh Soomeh, which is the outlet of Kordan to the plain, is about 111 million cubic meters. Most of the surface flows of the Kordan basin are controlled and consumed in the plain, so that the outlet of this basin to the Shoor River is estimated at 8.5 million cubic meters. In the table4 of statistical indicators, the maximum, average and minimum average flow of the Shoor River basin at the location of hydrometric stations in the province are specified (Tables 4 and 5). This statistic is related to the data measured during the period 1998-2019.

Table 4. Long-term statistical indicators of river flow coefficient of Shoor catchment in cubic meters per second.

River	Station	S.I.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Ann.
Fashand	Darband Fashand	Max	0.5	0.8	1.9	3.9	2.5	1.3	0.4	0.3	0.2	0.3	0.7	1.3	0.6
		Ave	0.1	0.2	0.5	1	0.7	0.4	0.2	0.1	0.1	0.1	0.3	0.2	0.3
		Min	0	0	0.1	0.2	0.1	0.1	0.1	0	0	0	0	0	0.1
Kordan	Deh Soume	Max	13.4	7.7	18.6	26.7	30.8	13.9	4.8	2.5	2.1	2.6	6.4	17.2	9
		Ave	1.8	2.5	5.7	11.6	11	3.3	1.3	0.5	0.3	0.5	1.3	1.7	3.5
		Min	0	0	0	0	0	0	0	0	0	0	0	0	0
Kordan	Najm Abad	Max	3.2	1.6	4.9	5.8	9.1	2.9	0	0	0.3	0	5.2	6.8	1.3
		Ave	0.2	0.1	0.5	1.3	1.1	0.1	0	0	0	0	0.6	0.6	0.4
		Min	0	0	0	0	0	0	0	0	0	0	0	0	0
Shoor	Pol Asefoldole	Max	6.9	16.4	14.3	45.5	44.7	5.5	1.4	0.7	1.9	8.7	8.6	4.4	8.4
		Ave	0.6	1.3	2.3	4.7	3.4	0.5	0.1	0	0.1	0.3	0.7	0.6	1.3
		Min	0	0	0	0	0	0	0	0	0	0	0	0	0
Kordan creek	Kordan	Max	0.6	0.6	0.9	1.3	2.1	2	1.5	1.2	1.1	1.1	2.6	1	0.9
		Ave	0.2	0.2	0.3	0.4	0.9	1	0.7	0.5	0.4	0.4	0.4	0.3	0.5
		Min	0	0	0	0	0	0.1	0.1	0.1	0	0	0	0	0.1

S.I: Statistical Index, Ann: Annual.

Table 5. Long-term statistical indicators of river flow coefficient of Shoor catchment in cubic meters per second.

River	Station	S.I.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Ann.
Karaj	Sira	Max	10.5	12.9	24.2	50.5	74	64.4	39.7	20.1	17.9	7.7	25.3	19	26.4
		Ave	4.7	5	9.1	21.1	34.3	28.3	16.2	8.8	6.1	4.8	5.8	5.1	12.5
		Min	2.8	2.4	4	7.9	9.4	7.8	4.6	3.2	2.7	0	0	1	5.2
Karaj	Bileghan	Max	16.1	13.6	44.4	72.4	108	73.6	46.2	31.3	0.22	19.6	16.3	18.7	34.4
		Ave	7.9	7.5	11	19.2	34.5	31.8	20.1	15.3	12.9	10.6	9.5	8.6	15.7
		Min	2.8	1.8	3.1	5.5	7.9	8.1	7.3	4.7	4	0	3.1	3.2	7.4
Velayat Rood	Gachsar	Max	2	1.8	2.6	5.3	22.6	21.8	13.2	6.3	3.6	2.7	3.4	3	6.7
		Ave	1.4	1.3	1.4	3.3	9.5	11.1	7.8	2.2	3.6	3	1.7	1.5	4
		Min	0.9	0.8	1	1.4	3	3.8	2.9	2	1.4	0	0	0.6	1.8
Aderan	Haft Cheshmeh	Max	1.1	0.9	4.3	5	8.5	5.6	0.9	0.5	0.4	0.3	1.2	2.2	1.7
		Ave	0.3	0.3	1	3	3.8	1.2	0.4	0.2	0.2	0.1	0.3	0.3	0.9
		Min	0.1	0.1	0.2	0.9	0.4	0.2	0.1	0.1	0	0	0	0.1	0.2
Murd	Pol Khab	Max	0.3	0.2	1	1.5	3.1	1.9	0.5	0.1	0.1	0.1	0.8	0.7	0.5
		Ave	0.1	0.1	0.2	0.9	1.4	0.5	0.1	0	0	0	0.1	0.1	0.3
		Min	0	0	0	0.3	0.3	0.1	0	0	0	0	0	0	0.1
Kolvan	Sira	Max	1.7	2.4	3.6	8.5	13.1	7.4	4.8	1.9	1.2	1.3	3.6	2.6	3.2
		Ave	0.8	0.9	1.7	3.7	1.7	3.4	1.7	0.9	0.6	0.6	1	0.9	1.7
		Min	0.3	0.4	0.7	1.6	1	0.8	0.5	0.3	0.2	0.3	0.5	0.5	0.7
Neshta Rood	Pol Khab	Max	0.5	0.5	1.5	2.4	3.3	1.7	0.3	0.1	0.1	0.2	0.8	0.8	0.7
		Ave	0.1	0.2	0.5	1.4	1.5	0.4	0.1	0.1	0.1	0.1	0.2	0.2	0.4
		Min	0	0	0	0.5	0.3	0.1	0	0	0	0	0	0	0.2

S.I: Statistical Index, Ann: Annual.

2.7. Surface current potentials of Karaj river basin

Karaj river basin is the most important river system in Alborz province. Most of the urban areas and large and populous villages of Alborz province are located in the Karaj river basin. Therefore, the role and activities of humans in the vicinity of rivers in this region is significant and important. The Karaj River, as the most abundant and strongest natural flow that flows in the southern slopes of Alborz, is stronger and stronger than several of its neighboring and adjacent river basins that drain the southern slopes of Alborz. It is more watery. The volume of surface currents in this basin is slightly more than twice the flow of Jajroud basin and more than 5 times the Kordan river basin. The most important surface currents of this basin are Varangehrood, Velayatroud, Doab and Shahrestanak, Sefidak or Sierra and Arangehroud. It is specified in the shape of the hydrographic network of Karaj river basin.

As can be seen in Fig. 9, the Karaj River Basin in the Alborz Mountains covers the eastern half of the province from north to south with a trend from northeast to southwest and mainly includes the cities of Karaj and Ferdis. This catchment covers about 33% of the total area of the province. All the main tributaries of this river have a constant flow pattern and a rainy snow regime. Gradual melting of snow in the high mountain slopes and also the presence of 815 springs with considerable flow in the mountain basin has caused a suitable flow and relatively uniform distribution in the river basin in mountainous areas. Despite the fact that the largest river in this basin is the Karaj River, but other rivers in this area also have a considerable flow and can be evaluated and studied.

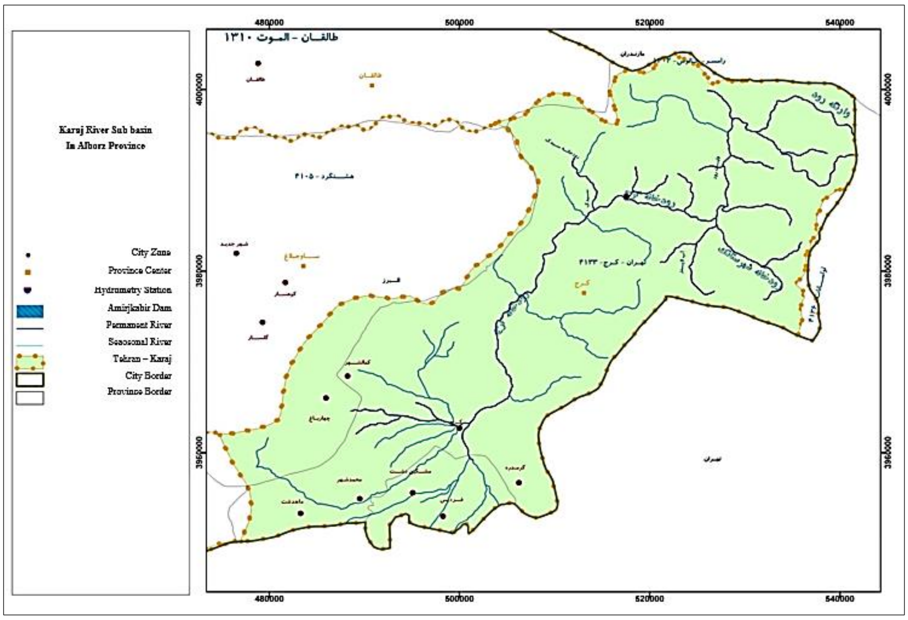

Fig. 9. Hydrographic network of rivers of Karaj catchment.

2.8. Qualitative characteristics

2.8.1. Surface water quality

The quality characteristics of surface water are investigated according to the results of chemical analysis of river water solutes. Sampling of rivers in Alborz province in hydrometric stations includes values related to salinity, electrical conductivity as well as anions and cations in river water. Table 6 indicates the quality parameters in the rivers of Alborz province.

2.8.2. Groundwater

Groundwater resources in Iran and many other countries with similar climates are the most important sources of water used in agriculture and drinking. On the other hand, the risk of less pollution of these resources than other methods of water treatment has led to a boom even in areas where there is no shortage of surface water. The study of groundwater quality in Alborz province is specified in Table 7. Due to the integration of underground resources in this area, the study areas are in the form of plains and in the form of urban and extra-provincial areas.

Table 6. Values of water quality parameters of rivers in Alborz province.

River	Station	Discharge condition	Na^+	Cl^-	pH	EC	TDS	Drink condition
			Meq/l			Mg/l	6*10	
Fashand	Darband	High water	0.45	0.3	7.5	393	230	Good
		Low water	0.33	0.17	7.9	350	210	Good
Kordan	Dehsume	High water	0.73	0.37	7.56	561	300	Good
		Low water	0.25	0.25	7.4	250	140	Good
Kordan	Najmabad	High water	0.36	0.22	7.93	430	233	Good
		Low water	0.62	0.30	7.95	343	174	Good
Shoor	Pol asefoldoleh	High water	285	258	7.3	34250	25670	Useless
		Low water	30	32.8	7.8	4540	2768	Unsuitable
Karaj	Sira	High water	0.36	0.30	8.1	336	202	Good
		Low water	0.34	0.28	7.7	302	154	Good
Karaj	Bileghan	High water	0.42	0.40	8.15	358	186	Good
		Low water	0.34	0.17	7.64	306	192	Good
Gajereh	Gachsar	High water	0.51	0.20	8.1	392	238	Good
		Low water	0.25	0.25	7.35	292	154	Good
Neshtarood	Pol khab	High water	0.45	0.45	8.05	297	182	Good
		Low water	0.45	0.45	8.05	208	106	Good

Table 7. Groundwater quality parameters in the study area of Alborz province.

Study Area	Statistical index	Na^+	Mg^{2+}	Ca^{2+}	Cl^-	pH	EC	TDS (mg/l)
		Meq/l						
Eshtehard	Max.	200	21.1	66.6	223	8.23	24300	14438
	Min.	8.3	0.71	4.53	6.9	6.94	1423	760
	Ave.	52.7	8.29	20.92	62.51	7.8	8015	4825
	Standard Deviation	49.73	5.87	16.69	60.95	0.3	2006262	3885
	Coefficient of variation	94.4	70.8	79.8	97.5	3.8	78.1	80.5
Hashtgerd	Max.	445	3.66	3.38	3	8.28	1572	1034
	Min.	0.47	0.81	0.5	0.2	7.71	328	198
	Ave.	1.8	1.52	1.78	0.77	8.1	571	357
	Standard Deviation	1.28	0.74	0.8	0.72	0.2	348	229
	Coefficient of variation	71.1	48.7	44.9	93.5	25	60.9	64.1
Ghazvin	Max.	31.75	18.89	10	37.86	8.3	6326	3780
	Min.	1.03	0.47	0.73	0.58	6.9	404	252
	Ave.	8.9	4.57	3.8	7.61	7.6	1790	1087
	Standard Dwviation	6.48	3.35	1.88	7.52	0.2	1165	699
	Coefficient of variation	72.8	73.3	49.5	98.8	2.6	65.1	4648
Tehran - Karaj	Max.	53	22	16.31	24.4	9	7170	200
	Min.	0.4	0.23	0.54	0.3	7.01	320	200
	Ave.	5.9	2.74	4.57	3.93	7.9	1281	200
	Standard Deviation	7.18	2.88	3	3.72	0.5	1111	200
	Coefficient of variation	121.7	105.1	65.6	94.7	6.3	86.7	200

3. Results and Discussion

With the exception of the northern part of the country and the northern slopes of the Alborz mountain range, the characteristics of other catchments in the country have been more or less affected by the prevailing weather conditions and have not always been relatively stable. Even in the catchment areas of mountainous areas located in the west and northwest of the country, in times of drought, the surface of the catchment area has been a good indicator of the situation in the region. The enclosed part of the salt lake catchment in Alborz province has special conditions and characteristics that have doubled its importance compared to other similar and adjacent basins. This basin in the northern parts has high altitudes that end in dry desert areas at the exit. The source of all the rivers studied in this study, which are located in this basin in Alborz province, are internal and related to the basin itself and do not enter from other adjacent basins. Therefore, the characteristics of the flow including discharge, sedimentation, water quality, flow regime, number of main and secondary waterways, type of waterways (seasonal and permanent), etc., the flow in rivers completely indicate the status of the basin and Its hydraulic and hydrological conditions (Benito and Thorndycraft, 2005).

Field studies indicate that due to the mountainous climate of the upstream areas and the plain conditions of the downstream areas, the type of river water utilization in the two areas is quite different, so that in the upstream areas, the highest consumption of drinking water Villages and a small part of agriculture, while in the downstream areas of the industrial sector around Alborz province, as well as extensive cultivation in the existing plains has led to a change in the type of exploitation of the stream. The climate of the region, soil chemical properties, consumption method and other effective factors in addition to reducing the amount of rainfall in low rainfall years have led to the downstream regions are always in constant challenge with water and the amount of water available in the challenge.

4. Conclusion

The study of the amount and characteristics of the flow by assuming other factors in relation to the adjacent basins has strengthened the fact that the appropriate upstream situation in the study area is a strong point compared to other areas and the possibility of water use Provides. The study of other areas of the salt lake basin indicates that few mountainous areas have been studied as the source of water flow in this area and this issue indicates the high potential of this area. The main feature of other parts of the salt lake basin is the salinity of the soil and low rainfall and unusable water, while in this area, having fresh and drinkable water is one of the main and important features for the province. It becomes. The study of aquifers in the study area indicates that due to the flow and flow regime, it is not possible to build a dam to divert water economically and technically justify, but with proper management can be stored in the usual way in times of flooding. And was used optimally in cases of water shortage and flow reduction. The study of the hydrological characteristics of the basin using the relevant software can provide more comprehensive results in identifying and evaluating this area, which will be done in the next step of the relevant studies.

The third dimension of environmental water security is the pollutant emission factor. In the present study, the pollutant emissions, fertilizer levels and chemical pesticides used in agricultural lands were surveyed by asking the heads of households. Considering the importance of chemical pesticides in the environment, numerous studies have been carried out both inside and outside the country. The results showed that the highest level of nitrogen fertilizer was used in Bilavar, Chaqanarges, Baladarband and Miandarband. The highest levels of phosphorus pesticide have also been reported in Chaqanarges and Miandarband. Furthermore, Bilavar, Chaqanarges and Miandarband had the highest levels of potassium fertilizer consumption. Regarding emissions, the Jalalvand and Sarfirozabad were the most secure and Chaqanarges and Miandarband had the most unsecure conditions among the studied districts. After the overlap of layers, the water environmental security map showed that the Miandarband, Sarfirozabad, Jalalvand, Sanjabi and Haftashian districts were in a very secure condition compared to other rural districts. Parts of Chaqanarges, Bilavar and Dorudfaraman are in a critical condition regarding environmental water security which necessitates special attention from the authorities. Considering the critical condition of water levels in the wells of Chaqanarges, Bilavar and Sanjabi and the warning condition in Dorudfaraman, Jalalvand, Mahidasht and Baladarband, it is recommended to enforce rules to prevent unauthorized use of wells, control drainage and prevent over-drainage of wells through patrol groups and install smart water meters to control the level of operation with greater sensitivity. Research on the transfer of water from one area to another, especially in Haftashian, Baladarband, Chaqanarges and Jalalvand, which had a lower rank in available water quantity, is necessary. Moreover, training programs provided by agricultural promoters to raise farmers' awareness about the amount and manner of using fertilizers and chemical pesticides are necessary.

References

Ahmadi, R.K.S., Nazarnejad, H., Asadzadeh, F., 2022. The Evaluation of Heavy Metals Pollution in the Surface Sediments of Mahabadchai River. *Iran. J. Res. Environ. Health,* **8**(1), 46-58. https://doi.org/10.22038/jreh.2022.62272.1469

Azarang, F., Telvari, A.R., Sedghi, H., Bajestan, M.S., 2017. Large dam effects on flow regime and hydraulic parameters of river (case study: Karkheh river, downstream of reservoir dam). J. Water Soil, **31**(1), 11-27. https://doi.org/10.22067/jsw.v31i1.48743

Benito, G., Thorndycraft, V.R., 2005. Palaeoflood hydrology and its role in applied hydrological sciences. *J. Hydrol.*, **313**(1-2), 3-15. https://doi.org/10.1016/j.jhydrol.2005.02.002

Ghaffari, G., Keesstra, S., Ghodousi, J., Ahmadi, H., 2010. SWAT-simulated hydrological impact of land-use change in the Zanjanrood basin, Northwest Iran. *Hydrol. Proc. Int. J.,* **24**(7), 892-903. https://doi.org/10.1002/hyp.7530

Jaberi, M., Ghassemi, M.R., Shayan, S., Yamani, M., Zamanzadeh, S.M., 2018. Interaction between active tectonics, erosion and diapirism, a case study from Habble-Rud in Southern Central Alborz (Northern Iran). *Geomorphology,* **300**, 77-94. https://doi.org/10.1016/j.geomorph.2017.01.031

Nafchi, R.F., Samadi-Boroujeni, H., Vanani, H.R., Ostad-Ali-Askari, K., Brojeni, M.K., 2021. Laboratory investigation on erosion threshold shear stress of cohesive sediment in Karkheh Dam. *Environ. Earth Sci.*, **80**(19), 1-15. https://doi.org/10.1007/s12665-021-09984-x

Rohani, N., Rajaee, T., Mojaradi, B., Jabbari, E., Shafiei Darabi, S.A., Heidari Bani, M., 2021. Climate Study of Changes of Major Water Resources in Qom Province Using Satellite Data and Remote Sensing Technologies. *Environ. Sci.,* **19**(1), 239-258. [In Persian] https://doi.org/10.52547/envs.33643

Romanescu, G., Paun, E., Sandu, I., Jora, I., Panaitescu, E., Machidon, O., Stoleriu, C., 2014. Quantitative and qualitative assessments of groundwater into the catchment of Vaslui River. *Rev. Chim.,* **65**(4), 401-410.

Sadeghian, M.S., Heydari, M., Noori, M., Ebrahimi, F., ShahiriParsa, A., 2014. Evaluating the suspended sediment of mahabad dam using statistical methods. *J. River Eng.,* **2**(7), 10.

Saha, S., Das, J., Mandal, T., 2022. Investigation of the watershed hydro-morphologic characteristics through the morphometric analysis: a study on Rayeng basin in Darjeeling Himalaya. *Environ. Challenge.,* **7**, 100463. https://doi.org/10.1016/j.envc.2022.100463

Shahryari, A., Farhadian, H., Mahmoudi, M., 2021. Investigating the Factor Structure of Challenges and Strategies of Rapeseed Production Development (Studied Case: Alborz Province). *Rural Develop. Strategy.,* **8**(2), 133-150. https://doi.org/10.22048/rdsj.2021.276316.1922

Shivhare, V., Gupta, C., Mallick, J., Singh, C.K., 2022. Geospatial modelling for sub-watershed prioritization in western Himalayan basin using morphometric parameters. *Nat. Hazards,* **110**(1), pp.545-561. https://doi.org/10.1007/s11069-021-04957-6

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