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Bioassessment of Macrobenthic Fauna of the Cheshmeh Kileh River, Northern Iran

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Abstract: Cheshmeh Kileh River located in southern part of Caspian Sea is of high importance due to a significant and valuable habitat for migration and spawning of valuable fisheries species such as *Salmo trutta caspius* and *Rutilus frisii kutum.* The present study aims to explore the Cheshmeh kileh River's water quality using demographic indicators of Macrobenthic invertebrates during 2010-2011 in four stations and during twelve times sampling of surber levels in three replicates. The results shows that the maximum annual mean frequency of Macrobenthic invertebrate orders at stations 1 and 2 are related to Diptera, Ephemeroptera and Trichoptera orders, respectively and Diptera, Ephemeroptera orders and Oligochaeta categories (Haplotaxida, Tubificida, Lumbricida, Lumbericulida orders) at stations 3 and 4. So, station 1 with 9.07 g/m^2 has the highest amount of Macrobenthic biomass and station 4 with mean weight of 1.11g/m^2 has the lowest amount of Macrobenthic biomass during the entire year. According to the obtained results, changes and stresses existing in the direction of the river, especially residential waste matters has made changes in the composition of Macrobenthic community and the frequency of resistant and filtering groups and the percent of sensitive groups has been relatively reduced.

Key words: Iran Rivers · Cheshmeh Kileh River · Macrobenthic · Biomass

INTRODUCTION

Having a brief look at the distribution of water resources in the world which is inaccessible for the human to use, the utilization of current and subterraneous surface water such as lakes and wells is associated with several limitations [1]. One way is to discover water quality through the measurement of physical and chemical factors such as DO, pH, TSS, BOD, etc [1]. The other one, which has been focused on its performance in recent decades and is considered one of the most practical and economical methods for determining the ecological health of water and to determine whether human activity has any impact on reduced water quality or not, is biological monitoring and evaluation [2]. Macrobenthic invertebrates are considered good indicators for showing changes in aquatic habitats, because they are highly sensitive to physical changes (depth, velocity, substrate size, water quality). In other words, they are indicators of the structure and function of an aquatic ecosystem [3, 4]. Having specific properties, these organisms have been focused on in the ecological assessment of aquatic ecosystem more than other aquatic organisms (fish and algae). The following ones can be named among these features [5]:

- They have a high species richness which shows different reactions towards the environmental factors.
- They are static; therefore, it is possible to determine the range of inconsistencies according to their presence or absence.
- They have a long life cycle, which makes it possible to study the time effects of factors causing confusion.

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- Environmental changes are displayed periodically; that is, unlike physical and chemical measurements, Macrobenthic invertebrates are not juts indicative of the time of sampling.

The application of these indicators in water quality assessment is based on the fact that Macrobenthic community structure may be changed after the environmental disturbances [5]. Due to the sensitivity and relationship of Macrobenthic to their Environmental conditions, numerous researchers around the word focused their attention since a few decades ago to use this group of organisms to qualitatively water [6-8]. Cheshmeh kileh River of Tonekabon, Iran and its branches are considered a strategic and sensitive area of fisheries over the past half century and the cause of this attention and legal considerations to protection rule and environmental improvement is due to existing valuable subspecies named salmon of Caspian Sea with scientific name *Salmo trutta caspius*. Multiple aquaculture production activities and human activities for excessive harvesting of sand, urban pollution, industrial pollution, agriculture and rural pollution made some changes in natural conditions of Cheshmeh kileh River. Therefore, the objective of the present study consists several purposes, these include: (1) present an overall view of the macroinvertebrate communities along the Cheshmeh kileh River, (2) determine the biological water quality based on benthic communities.

MATERIALS AND METHODS

Study Area: Cheshmeh kileh River located in southern part of Caspian Sea (North of Iran) is of high significance due to an important and valuable habitat for migration and spawning of valuable fisheries species such as *Salmo trutta caspius* and *Rutilus frisii kutum*. This river is considered one of the significant one in the catchment area in Caspian Sea located in Iran (Table 1). Its two main branches are Dohezar and Sehezar Rivers (Figure 1). Sehezar River is one of the great and fertile rivers that created Cheshmeh kileh River after the confluence with Dohezar and Valamroud Rivers. This river has permanent water and its bed has a steep and rocky slope along near the sea. The river is 80 Km long and the ambit of its catchment area is approximately 1350 m^2.

Benthic Macroinvertebrates Sampling: Water and benthic macroinvertebrate samples at each site were collected monthly from October 2010 to September 2011 in four stations and three replicates at random from the edge and middle of the river. At each site, water samples were collected from the top 30cm of the water column at the middle of the river by means of an acid-washed plastic bucket, rinsed with water from the site. Macroinvertebrate communities along the stream were sampled monthly using Surber net samplers (475 µm mesh, area of base 0.09 m^2). All the animals collected were immediately fixed in formaldehyde (4%) in the field and then transferred to 95% ethyl alcohol. The macroinvertebrates were sorted, identified to the lowest possible Taxon (Order and families) and counted under a stereomicroscope [9] Criteria of the Macrobenthic biomass in study stations based on their weight and the samples related to each station was placed on a dryer paper in a laboratory environment for a few minutes [10]. Then the weights associated to each family were weighted using a sensitive balance of 1 mg. The benthic macroinvertebrate identification was done to the lowest possible taxonomic level in the laboratory based on keys presented [11-18].

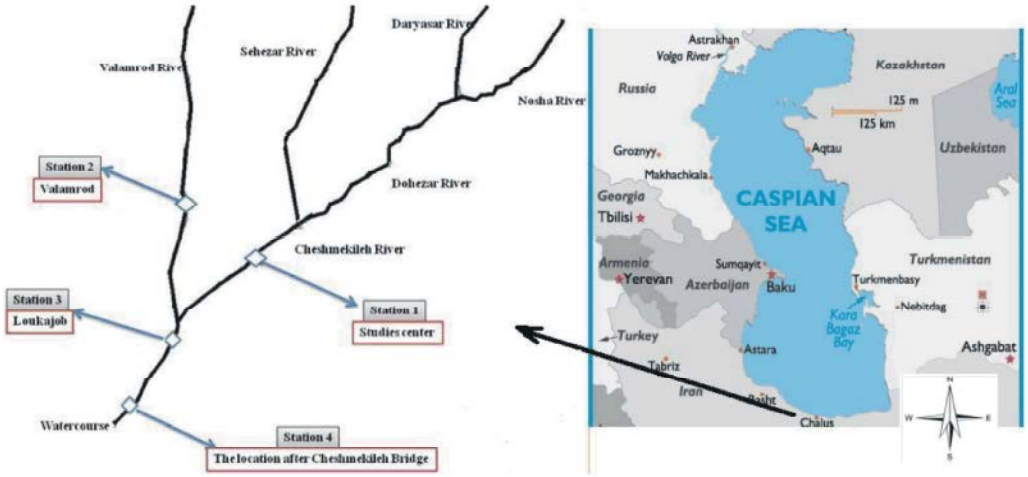


Fig. 1: Station of study locations of Cheshmekileh river of Iran on the map

Table 1: Station of Study Locations

Station NO	Name of Station	The Height above the Sea Level (m)	Longitude	Latitude	The Kind of Bed	Altitude M
1	Confluence	352	050° 50′ 05.5½	36° 41′ 18.9½	Rocky	352
2	Valamroud	174	050° 51′ 0.3½	36° 44′ 36.5½	Clay-Sandy	174
3	Loukajoub	97	050° 49′ 30.6½	36° 46′ 07.6½	Rocky-Sandy	97
4	The location after Cheshmekileh Bridge	-10	050° 52′ 45.7½	36° 49′ 05.8½	Sandy	-10

The normality of data was tested using the Kolmogorov Smirnov test. One- way analysis of variance (ANOVA) followed by Duncan multiple comparison tests was conducted to test the significant differences of biotic indices, physicochemical parameters, frequency and biomass between sites [19]. All statistical analysis was performed using the SPSS software (version 16).

RESULTS

47 families, 15 orders and six categories of Macrobenthic invertebrates and sampling of Macrobenthic fauna mainly formed by aquatic insect's larvae were identified during 12 months study (Table 2). Average monthly percentage of the Macrobenthic invertebrate population in four stations indicated that in station 1 the highest frequency percentage was in February with 23%, in station 2, in November with 24%, in station 3, in February with 17%, in station 4, in April with 18%. Frequency percentage annual of Macrobenthic invertebrate orders at four stations studies are shown in Figure 2. The maximum Frequency percentage annual of Macrobenthic invertebrate orders at stations 1 and 2 were related to Diptera, Ephemeroptera and Trichoptera orders, respectively and Diptera, Ephemeroptera orders and Oligochaeta classes (Haplotaxida, Tubificida, Lumbricidae, Lumbericulida orders) at stations 3 and 4 (Figure 2). The maximum Frequency percentage annual of Macrobenthic invertebrate family at stations 1 were related to Hydropsychidae, Baetidae and Chironomidae with 22%, 21% and 20% respectively, at station 2 were related to Chironomidae, Baetidae and Hydropsychidae with 45%, 16% and 10% respectively, at station 3 were related to Chironomidae, Baetidae and Hydropsychidae with 37%, 27% and 7% respectively, at station 4 were related to Chironomidae, Baetidae and Naididae with 62%, 17%and 4% respectively. The annual average percentage of Macrobenthic invertebrates in Cheshmeh kileh River to 4 stations showed that Diptera order with 46%, Ephemeroptera order with 27% and Trichoptera order with

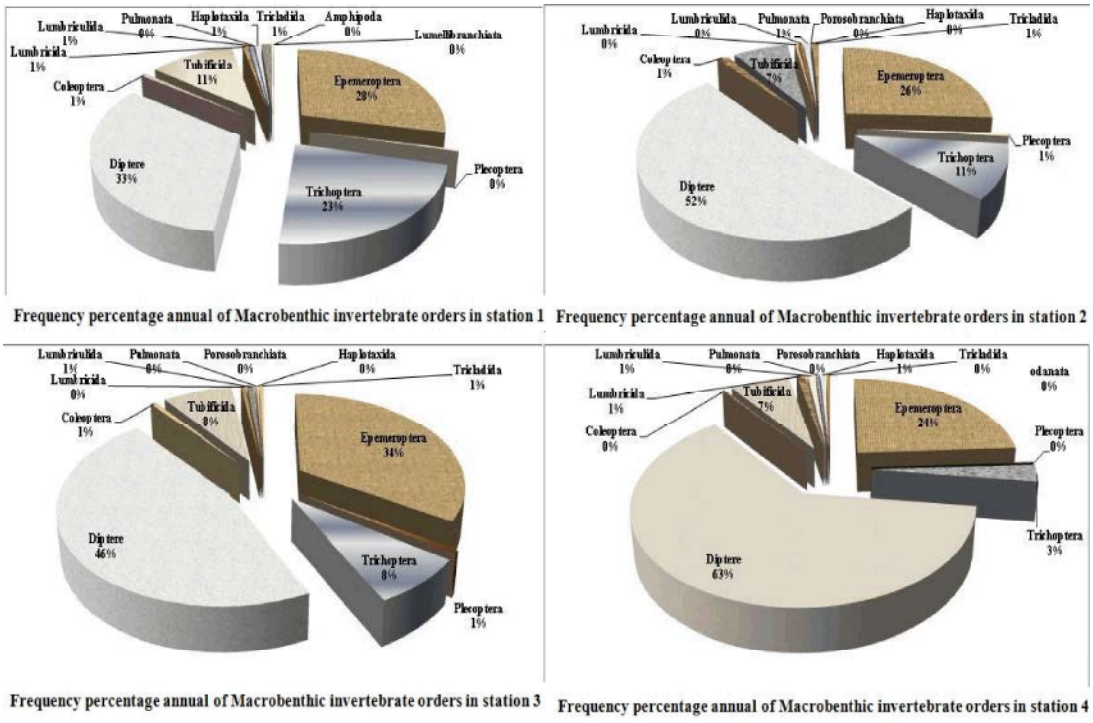


Fig. 2: Frequency percentage annual of Macrobenthic invertebrate orders in four stations

Table 2: Macrobenthic invertebrates families identified in study stations at Cheshmekileh River

Order	Family	Feeding Habit	Order	Family	Feeding Habit
	Chironomidae	c-g/prd/shr/c-f/scr		Hydropsychidae	c-f
	Tipulidae	c-g/prd/shr		Hydroptilidae	scr/shr/c-g
	Athericidae	Prd		Rhyacophilidae	Prd
	Simuliidae	c-f		Polycentropodidae	c-f/prd
Diptera	Belphariceridae	Scr	Trichoptera	Sericostomatidae	
	Ceratopogoniidae	Prd		Limnephilidae	shr/scr/c-g
	Dolichopodidae	Prd		Brachycenteridae	shr/c-f
	Tabaniidae	c-g/prd		Glossosomatidae	Scr
	Psychodidae	c-g		Lepidostomatidae	Shr
	Stratiomyidae	c-f			
	Empididae	Prd	Amphipoda	Gammaridae	c-g
	Perlidae	Prd	Porosobranchiata	Valvatidae	
	Scr				
	Choloroperlidae	prd/c-g			
Plecoptera	Perlodidae	Prd		Hydrobiidae	Scr
	Nemouridae	Prd	Pulmonata	Limnaeidae	c-g
	Leucteridae	Shr		Planorbidae	Scr
	Heptageniidae	Scr		Physidae	c-g
	Baetidae	c-g/scr	Lamellibranchiata	Sphaeridae	c-f
Ephemeroptera	Ephemerllidae	c-g/scr	Odanata	Gomphidae	
	Caenidae	c-g	Lumbriculida	Lumbriculidae	
	Leptophlebidae		Lmbricida	Lumbricidae	
	Oligoneuridae		Haplotaxida	Haplotoxidae	
Coleoptera	Hydraenidae		Tubificida	Naidida	
	Elmidae	scr/c-g			
Tubificidae	Tricladida	Planaridae			

Feeding habits:

c-f: collector-filterer	omn: omnivore
c-g: collector-gatherer	pir: piercer
prd: predator	par: parasite
shr:shredder	scr:scraper

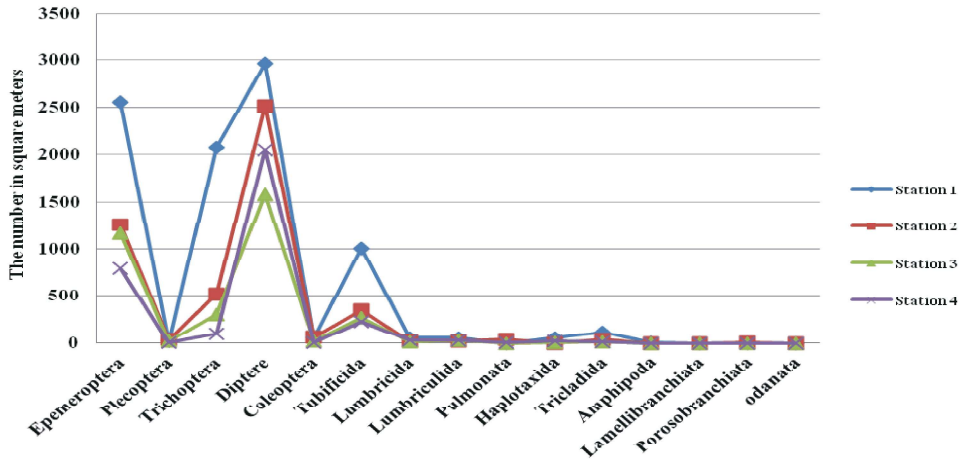
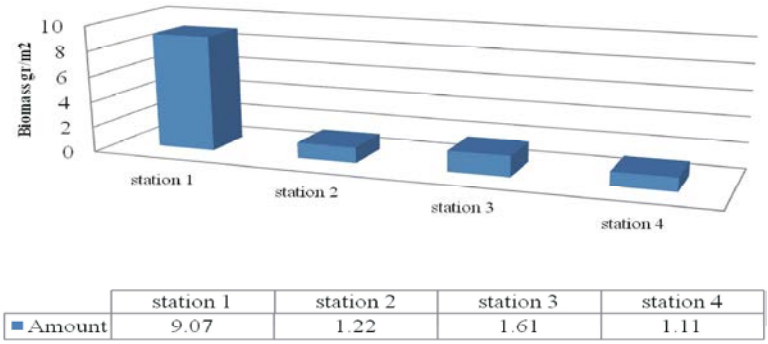


Fig. 3: The annual mean frequency of Macrobenthic invertebrate's orders in four stations

14 and Tubificida order with 9% are the highest frequency percentage, respectively. Kruskal-Wallis test of Macrobenthic invertebrates orders index of Trichoptera, Plecoptera, Ephemeroptera and other orders as the other indicates a significant difference among the stations at 95% confidence level ($P<0.05$) throughout the year; but Chironomidae family at four stations showed no significant difference among the stations throughout the year ($P>0.05$). The annual average frequency of Macrobenthic invertebrate orders at four stations



	station 1	station 2	station 3	station 4
Amount	9.07	1.22	1.61	1.11

Fig. 4: Results of Biomass in four stations

indicates that the maximum frequency at four stations is related to Diptera order (Figure 3). This is one of the largest and most diverse aquatic insect orders which assign 44% of annual frequency. 11 families of this order are identified which Chironimidae and Simuliidae families have the highest share and more than 96% of all members of the order are formed in all stations. Ephemeroptera order is the dominant group in terms of frequency after Diptera order that comprises of 28% of annual frequency. Six families are identified in this order in which Baetidae family had the largest population. Trichoptera family had the largest family which comprised of 15% of annual frequency. The annual average of frequency percentage among Macrobenthic invertebrates shows that station 1 with 44% is of the highest frequency, station 2 with 23%, station 3 with 17% and station 4 with 16% frequency is of the lowest frequency throughout the year. The obtained results showed that the highest amount of biomass among stations was in winter. Station 1 has the highest weight mean, that is 9.07g/m^2 and station 4 has the least weight mean, that is 1.11g/m^2 (Figure 4). According one-sided analysis of variance (ANOVA) with 5% probability level of biomass Macrobenthic invertebrates among the four stations, there is a significant difference at 5% probability level ($P<0.05$).

DISCUSSION AND CONCLUSION

The effective use of these tools requires a better understanding of the organisms that have the greatest influence on biotic index results, as well as of the processes that underlie the distribution and occurrence of bio indicator taxa in the environment. The results showed that aquatic insect's classis were the dominant creatures of Macrobenthic fauna of Cheshmeh kileh River. The same results have been achieved through identifying the demographic structure of Macrobenthic in Chafroud River [20], Garganroud River [21] and Shafaroud River [22]. Those Macrobenthic which have collector and filter feeder nutritional behavior, such as Chironomidae, Baetidae, Tubificidae, Simulidae, Nanidae and Hydropsychidae are increased at downstream field of aquaculture [23, 24]. These results at station 1 is led to an increase in these families and are gradually reduced at downstream due to Dohezar and Sehezar River confluence and also existing aquaculture farms in the upstream station and leftover food and materials resulted from metabolic activity of fish existing as a floating organic matter in water. Reported in studies on fish aquaculture farm of Robotic fish of increasing Baetidae family at downstream stations of fish aquaculture [8] that this study is compatible with the one conducted at station 1. Also, Increase in abundance of Baetidae was also recorded downstream from other fish farms [3, 19, 25]. The cause of dominancy of Diptera order is specifically for Chironomidae and Simuliidae families which these two families are resistant against pollution. It seems that it is related to the kind of nutrition of this group which acts as a filter of organic matters floating in water. The relative increase of resistant groups indicates the environmental pressure on river's ecosystem and consequently a change in the composition of Macrobenthic population for consumption and compensation of disturbance. The changes made in the composition of Macrobenthic population are often in response to environmental factors and stressful conditions in the river to maintain ecological balance [26]. Researcher showed that the groups which are sensitive to pollution (Ephemeroptera, Plecoptera, Trichoptera) in contaminated areas are reduced and vice versa, the resistant groups Diptera (Chironomidae and Simullidae) are increased [27] which this issue can be clearly seen along the Cheshmeh kileh River stations in such a way that changes in the Diptera order is reached from 33% at station 1 to 63% at station 4. The obtained

results showed that the highest amount of biomass among stations was in winter. Station 1 has the highest weight mean, that is 9.07g/m^2 and station 4 has the least weight mean, that is 1.11g/m^2. The highest mean of Macrobenthic biomass at station 1 is related to Naididae, Lumbericulida & Lumbricidae from Oligochaeta order, Diptera order (Chironomidae, Simmulidae) and Trichoptera order which mostly are of Hydropsychidae family. Researcher found out in his study on Tresenjika River that the increased load of organic material resulted from Reiboutic aquaculture sewage is associated with increased biomass amount in Macrobenthic [8]. In the study conducted on Macrobenthic fauna in Madersou River at Golestan National Park, it has been concluded that the great and terrible flood in late autumn and winter causes detachment and loss of these riverbeds and henceforth Macrobenthic are taken away at the points far from the original location [27] that this issue is also proved at the Cheshmeh kileh River. The environmental conditions, especially water flow, have a very large effect on the diversity and density of Macrobenthic existing in Cheshmeh kileh River, which this effect is very high in flood seasons. In current water and the streams in which good environmental conditions and non-chaotic environment are existed, unusual increasing number of Chironomidae in comparison with sensitive creatures, which is resulted in reduced amount of Ephemeroptera, Plecoptera and Trichoptera than Chironomidae, is indicative of environmental stress [28]. In station 2, two distinct branches of benthic communities have been created due to different water regimen in this river. Comparing the Ephemeroptera, Plecoptera and Trichoptera order and other Macrobenthic groups in different stations can be somehow indicative of severity of vulnerability and also created turbulence caused by various factors within them in such a way that Ephemeroptera, Plecoptera and Trichoptera order percentage has been dramatically decreased and Diptera order has been increased at station 4 in downstream of Cheshmeh kileh in downtown. One of the significant stressful factors in the study direction of station 4 is changing water quality of the river after passing by from the city area and entering wastewater and domestic and municipal sewage and also construction of four bridges, (downtown bridge, old Janbazan Bridge and suburban belt in the direction of river, sand factories, authorized and unauthorized removal of sand from the riverbed, carwash manufactures, Fish sales Market and discharging urban waste around the river are among the influencing factors on benthic fauna and water quality which has a significant impact on reducing Ephemeroptera, Plecoptera and Trichoptera orders which is indicative of water quality.

CONCLUSION

The results have shown water quality in upstream and middle stream were very good to average from site No. 1 to site No. 3. But the downstream quality was relatively poor in during the year (site 4). There are several reasons for low water quality in some sites. But pumping of untreated wastewater from urban community seems to be a primary source and Indiscriminate removal of sand from the river and the secondary source would be the untreated waste water from agriculture lands (high amounts of river due to agriculture usage was at minimum level. Therefore, these problems cause direct effect on both water quality and benthic fauna. Thus, changes and stresses existing in the direction of the river, especially residential waste matters has made changes in the composition of Macrobenthic community and the frequency of resistant and filtering groups and the percent of sensitive groups has been relatively reduced.

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