e-ISSN:2347-7830
p-ISSN:2347-7822

Research & Reviews : Journal of Ecology and Environmental Sciences

Water Quality and Macroinvertebrate Communities Monitoring of Catchment Basin of Debed River in Armenia in Spring in 2015

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Research Article

Received date: 15/08/ 2015
Accepted date: 22/09/ 2015
Published date: 29/09/2015

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Keywords: Biodiversity, Benthic macroinvertebrate, Water quality, Saprobic condition.

ABSTRACT

The research was to complexly assess the quality of water of Debed river. Initial material was monthly monitoring data on Debed river in Spring in 2015.

As result of research a general characteristic of river's biodiversity. We indicated the impact sources of benthic macroinvertebrate numbers reduction and water quality formation factors, assessed the level of water pollution with heavy metal, saprobic level, hydrogeochemical and hydrophysicochemical characteristic.

Several years of experience in investigations with macrozoobenthos in Debed river, a biological assessment system has been developed to indicate pollution levels caused by easily degradable organic substances from sewers. For this purpose, saprobic valences and weights hav been established for 37 taxa of macrozoobenthos.

In order to identify the habitats' saprobic levels, the concentration of chemical indicators for organic load were used the levels of dissolved oxygen after 5 days. The max level was 2.81 in 0.5 km under from Spitak city and min level was 1.65 in Estuary of debed river.

A comparison of heavy metal concentrations in water, as well as the diversity of macroinvertebrate species, was made between sites near the origin of the Debed river, with hardly any mining activities.

The concentration of heavy metals was different.The max concentration of heavy metals was in 2nd , 4th and 7th vantage-grounds of Debed river, and min concentration heavy metals was 1st vantage-ground of Debed river. Analyzed heavy metals were Na, Mg, Ca, Fe, Mn, Co, Ni, Zn, As , Pb, Li.

INTRODUCTION

The article covers a complex research on the quality of catchment basin of Debed River and monitoring data obtained in spring in 2015. In spring is observed abundant flow of the river, which top the vegetation season of macroinvertebrates. The essence of the research consists in the application of the obtained data for scientific interpretation and in the assessment of quality of waters of river.

Hydro ecological and geological circle are connect from regional position and environment. The water resources are important for economic development of RA. But we know that the surface water quality falls along with economic recovery, because from emissions, geological of mining, underground water's radioactive pollution and pollution of chemical residues are influence on the environment.

Primary materials were data on river water quality monitoring conducted on a monthly base for Debed river on monitoring stations.

e-ISSN:2347-7830
p-ISSN:2347-7822

Physical-chemical and hydro-biological samples were taken from 1 sampling sites in each vantage-ground; hydro-morphological assessments is also conducted to identify potentially "high" (reference points) and „good“ ecological status points in the basins.

The monitoring were observed specifically for identifying ecological status in the pilot basins:

- Hydro-biological quality elements: Macro-invertebrates (zoo benthos);
- Hydro-morphological quality elements: Water flows, physical characteristics - channel characteristics, river bank and floodplain characteristics;
- Physical-chemical quality elements: General water quality parameters and specific relevant pollutants - heavy metals.

MATERIALS and METHODS

The sampling protocol of macroinvertebrates we are used by sampling procedure according AQEM Consortium.

The water hardness is determined by titrametric method. The smallest determination level of water hardness was -0,10 K and unit of mesure is equivalent mg/L. the maintained period of samples was 24 hours (GOST 31954-2012).

The elements are determined by application of inductively coupled plasma mass spectrometry (ICP-MS) method and by Elan 9000 ICP-MS equipmant. The samples are conserved by 1% nitric acid. The internal standart is indium (10 mg/L) and the 99,999 % argone is used as ion source (ISO 17294-2:2003).

The total suspended solids sre determined by blue membrane filters and analitical scales “Voyager” equipment (ISO 11923:1997).

The electrical conductivity of water is determined by Cond.340i/SET equipment and unit of measure is mSim/cm2 (ISO 7888:1985).

The biochemical oxigen demand is determined by after 5 days (BOD5) method. The sample is estimated in advance and after 5 days in 200C incubated sample of water. The difference between the content of the decision (ISO 5815-2:2003).

Study Area

The Debed River is the biggest river of the Kur River watershed and the deeper mountain river in Armenia. It is the confluent of the Zoraget and the Pambak Rivers, which join at 2 km northward from Tumanyan Railway Station, and then flows into the Kharam River. The Debed length, starting from the Pambak River head, makes up 178 km, 152 km of which is on the territory of Armenia, the rest of it is on Georgia area. The watershed surface area is 4080 km^2, 3790 km^2 of which is on the territory of Armenia. It has mixed feeding, unsteady regime, rises in spring up to 1 m. The Debed is of great importance considering its hydro energy and irrigation water potential [1-3] **(Figure 1 and Table 1)**.

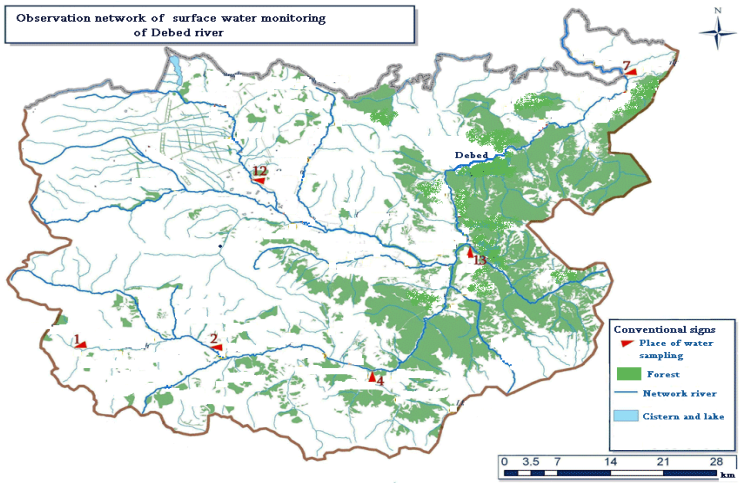

Figure 1. Map of observation network of surface water monitoring of Debed River.

Table 1. The sampling observation network of Debed river

Number of vantage-ground	Location of vantage-ground
1	Khnkoyan village
2	0.5 km under from Spitak city
12	Estuary
4	0.5 km under from Vanadzor city
13	Estuary
7	Near border

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Calculation Methods

The value of Biotic Index (BI) is determined all taxonomic groups and families to the amount. The importance of this method lies in the fact that the state is determined by water pollution.

The pointer of BI:

$$\text{Biotic Index (BI)} = \sum \frac{(n)(a)}{N}$$

Where: N = number of individuals in the sample

n = number of individuals of each taxon

a = pollution-tolerance value assigned to that taxon.

The mathematical calculation method is also included, which will be implemented as follows:

- The benthic invertebrates are important for classification (Order-Family-Genus-Species),
- The taxonomic groups to the count and added together,
- The results are registering to the chart.

RESULTS

Results of Physiochemical Analysis

The response of macrozoobenthic organisms to oxygen concentration is relatively unidirectional as their distribution is never limited by increasing oxygen saturation and, only rarely is oxygen supersaturation considered injurious to organisms. Organisms that are the most sensitive to oxygen deficiencies are those with thick skins and no gills (many plecopteran larvae) or immovable gills (Ephemeroptera larvae). Benthic organisms which live independently from a water's oxygen content are those which, have respiratory tubes (e.g. rat-tail maggots), exchange gases at the water's surface (water bugs and pulmonate molluscs), or live within their own oxygen filled webs (water spiders) [4].

The average level of BOD5 was 2,26 mg/l, the average level of pH was 7,47, the average concentration of Total suspended solids were 57,0 mg/L **(Table 2)** [5].

Table 2. Results of phisicochemical analysis of water sample

Number of vantage-ground	Location of vantage-ground	Total suspended solids mg/L	pH value	Water hardness eq mg/L	BOD5. mg/L	Electrical Conductivity mSim/cm2
1	Khnkoyan village	77,1	6,77	1,112	2,37	112
2	0.5 km under from Spitak city	79,4	7,51	2,286	2,81	218
12	Estuary	49,6	7,57	1,742	1,65	163
4	0.5 km under from Vanadzor city	72,3	7,71	2,189	2,06	223
13	Estuary	28,3	7,71	1,612	2,69	149
7	Near border	76,2	7,78	2,259	1,69	193

Heavy Metals in Water of Debed River

Arsenic (As) is attributed to conditionally essential immunotoxic elements. Long-term administration of small doses of arsenic favors occurrence of cancer [2,6].

Zinc (Zn) nickel (Ni) are necessary microelements for normal functioning of the organism. But above-standard concentrations of those metals in food favor disorders in functions including reproductive and genetic ones [6].

Lead (Pb) is carcinogen and teratogen; has a property to substitute calcium in the skeleton. With age, the contents of Pb in the organism heighten **(Table 3)** [2,6].

Table 3. The dynamics of HMs contents on Debed river's water sample

Number of vantage-ground	Na mg/L	Mg mg/L	Ca mg/L	Fe mg/L	Mn mg/L	Co mg/L	Ni mg/L	Zn mg/L	As mg/L	Pb mg/L	Li mg/L
1	4,982	3,015	17,219	1,628	0,023	0,001	0,007	0,014	0,001	0,001	0,001
2	8,635	7,420	33,344	3,237	0,128	0,001	0,003	0,015	0,001	0,002	0,001
12	5,385	5,424	25,790	0,449	0,011	0,000	0,002	0,006	0,001	0,001	0,001
4	9,304	7,136	31,881	3,617	0,124	0,001	0,003	0,013	0,002	0,002	0,001
13	4,354	5,103	23,740	0,323	0,008	0,000	0,001	0,002	0,001	0,000	0,000
7	8,256	7,577	32,557	3,649	0,126	0,001	0,003	0,019	0,001	0,002	0,001

e-ISSN:2347-7830
p-ISSN:2347-7822

Results of Biological Research

At least 2489 benthic macroinvertebrate taxa have been recorded from Debed river **(Table 4)**. As a Family, Gammaridae were numerically dominant in all substrates and accounted for the majority of the biomass. Of the 4 most abundant taxa were insects and one was oligochaete **(Table 4)**.

Table 4. Taxonomic Identification of Benthic Macroinvertebrates in Debed river

Class	Order	Family	Genus	Number
Insect	Diptera	Chironomidae larvae		196
Insect	Diptera	Chironomidae pupa		9
Insect	Diptera	Tabanidae		19
Insect	Diptera	Tipulidae		10
Insect	Diptera	Simullidae	Simulium	135
Insect	Diptera	Ceratopogonidae		4
Insect	Diptera	Dixidae		26
Insect	Diptera	Aterecidae		15
Insect	Diptera	Syrphidae		1
Insect	Diptera	Sciomyzidae		5
Insect	Ephemeroptera	Baetidae	Baetis	338
Insect	Ephemeroptera	Heptageniidae		28
Insect	Ephemeroptera	Ephemeridae		57
Insect	Ephemeroptera	Caenidae		22
Insect	Coleoptera	Elmidae	Limnius	28
Insect	Coleoptera	Hydrophilidae		6
Insect	Trichoptera	Hydropsichidae	Hydropsyche	192
Insect	Trichoptera	Polycentropodidae		1
Insect	Trichoptera	Limnephilidae		51
Insect	Trichoptera	Phryganeidae	Oligostomis	57
Insect	Trichoptera	Rhyacophilidae		38
Insect	Trichoptera	Molannidae		1
Insect	Trichoptera	Lepidostomatidae		12
Sgmented worms	Oligochaeta	Naididae		76
Sgmented worms	Hirudunae	Glossiphoniidae		29
Malacostraca	Amphipoda	Gammaridae	Gammarus	1044
Insect	Plecoptera	Perlidae		27
Mollusca	Gastropoda	Planorbidae		13
Mollusca	Gastropoda	Ancilidae		49

Natural rivers have a different and often much more abundant benthic fauna than do reservoirs. The differences are reflected in the oligochaete, chironomid, ephemeroptera, trichoptera and amphipod species present [7,8].

While some eastern reservoirs may stratify and range from oligotrophic to eutrophic, assessment of the water quality requirements based on the benthos places most in a mesotrophiclike category. Species introductions and invasions are capable of dramatically altering natural river benthic communities [8,9].

The Debed river is fast flowing in spring, but this not problem that we have done sampling. The sampling was in spring, because this time is vegetation period of macroinvertebrates.

The saprobic conditions **(Figure 2)** it is nevertheless an important factor in discriminating water-quality classes.The saprobic index primarily represents the state of oxygen balance in the system as well as the presence of fine particulate organic matter.

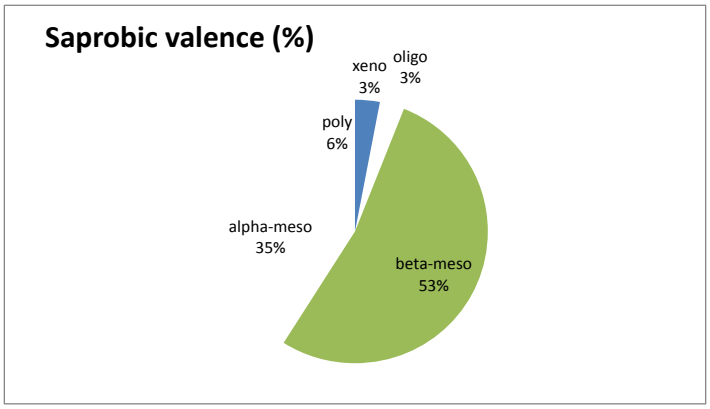

Figure 2. The saprobic conditions of Debed river (the average value of all observation network).

Data collection and treatment methods, as well as the limitations of the biotic index.

The results of data analysis for all samples colected during our studies in the Debed river are presented in **Table 4**, which was sufficient information to determine their saprobic condition.

Within the 37 taxa, insects, represented mainly by the Trichoptera, Diptera and Ephemeroptera, are the most numerous. Among the other macroscopic indicators with valences at the level genus and species are insectsof the orders Plecoptera, Coleoptera. Mollusca, Olichaeta and Hirudinae could be taken as indicators as well. But only Amphipoda was more than Ephemeroptera and Diptera.

Finally, this adaptation of the principles of the saprobic system represents significant progress in the standardization of methodologies for the evaluation of aquatic ecosystems in Armenia, considering that it is already implemented thoroughly and consolidatedly in other countries with proven efficiency in the assessment of organic pollution effects on aquatic life.

CONCLUSIONS

In addition to the key factors - water temperature, flow velocity, oxygen balance and food composition and availability - there are other abiotic and biotic factors which will not be covered within this system, such as climate, geology, topography, physical-chemical conditions, discharge, discharge regime, habitat structure, and competition. Because the fauna depends upon the primary productivity and this productivity in turn depends upon light, the incidence of sunlight must additionally be considered in any monitoring methodology.

The annual monitoring is necessary to develop new indicators and introduce the monitoring system for ecosystems.

The study is based on the quality control of river water, which is caused by the chemical composition of the water as well as aquatic benthic macroinvertebrates. Geological changes of river also had an impact on the development and propagation of invertebrates.

- In conclusion the water quality does have a positive effect on the quantity of macroinvertebrates in the water.
- Aquatic macroinvertebrates can be used as Bioindicators for freshwaters.
- Macroinvertebrate assemblages were dominated by the Amphipoda family Gammaridae at a higher proportion than seen in most other species in our database in Debed river.
- The other dominant characteristic of Debed river assemblages was the relative lack of sensitive and delicate taxa, particularly those in the indicator groups mayflies (Ephemeroptera), flies (Diptera), and caddisflies (Trichoptera).

ACKNOWLEDGEMENTS

This work was undertaken with staff of the Environmental Impact Monitoring Centre of Armenia and Institute of Geological Sciences of National Academy of Sciences of Armenia.

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