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Suspended sediments – associated water quality elements

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INTRODUCTION

The detrimental impact of sediment and associated pollutants on water quality is widely acknowledged for many water sources (Rickson 2014). There is increasing recognition that fine sediment represents an important diffuse source pollutant in waters surface (Walling and Collins 2008). In many cases, toxic substances can be absorbed by sediment particles and then transported to other areas. Studying the quantity, quality, and characteristics of sediments in the stream helps scientists and engineers to determine the sources and evaluate the impact of the pollutants on the aquatic environment. Recognizing the role of suspended sediment (SS) in the transportation of major elements from land to rivers is necessary (Chau 2006). In this study we tried to evaluate the role of SS in transportation of calcium, magnesium, nitrogen and phosphorus to the river. We also estimated the percentages of each of the above mentioned elements which carried on SS to the total amounts transported as dissolved and particulate forms. The results therefore help managers and decision makers to properly designate control strategies in the study area.

MATERIALS AND METHODS

The study area was the main river of the Educational and Research Forest of Tarbiat Modares University located in the north of Iran. The study watershed comprises around some 50 000 ha extending between longitudes 51°48′8″ to 59°49′40″East and latitudes 36°24′4″ to 36°32′33″ North. The polyethylene vessels selected for sample collection were washedby acid to eliminate any potential pollution (Ahearn*et al*. 2005) and the 2litre-samples were obtained through depth integration (Hsu *et al*. 2007). The samples were collected semi-weekly under different hydrological conditions. One litre of sample was then filtered through a 0.45 lm Watmann filter (42) for measuring SS. The weights of the particulate and dissolved parameters were measured by scales with an accuracy of 1:1000 by standard methods (Kiteca and Jai 2005, Mitchell *et al.*2005). The percentage of each element transferred in dissolved or particulate form was calculated and consequent comparisons were analysed by using SPSS16 software.

RESULTS AND CONCLUSION

The results of the statistical analyses of the study variables are shown in Table 1. The maximum contents of Ca, P and Mg were carried contemporary with the mine exploitation period and flood occurrence. This finding agrees with Zhang *et al*. (2007) and Hunter and Walton (2008) who believed in the high effectiveness of hydrological condition on the transportation rates of water pollutants with suspended sediment. However, variation of N did not follow the SS trend in the study area which verified the high potential of N for transport in dissolved form that has been reported for forest areas. Although the potential for N loss in overland and subsurface flow increases with soil nutrient concentration, it also depends on many other factors (McDowell *et al*. 2004). Considering the result of this study has showed that SS is the most important factor for the transfer of phosphorus which is the most significant water quality parameter in sea plants nutrition. This result is confirmed by Drewry *et al*. (2005) in the Moruya and Tuross River watershed in Australia. We found that the greatest amount of phosphorus was transferred in particulate form during flood events. This is due to accumulation of phosphorus on the soil surface and its dependency on soil erosion and sedimentation. It is confirmed by the results of Zhang *et al.* (2007) in Japan on increase of phosphorus during flood events. It was concluded that the device used in this study could not identify particulate Nitrogen; this result concurs with Esberg *et al.* (2004).

This is due to the presence of forest which caused transformation of Nitrogen to nitrate salt and transfer of Nitrogen in dissolved form as reported by Walling (2005) for transfer of large amounts of Nitrogen in solution. Soil erosion with transfer of SS from the soil surface to rivers can lead toincrease of the dissipation of nutrients from the soil and also enhance water pollution. Somura *et al.* (2012) confirmed the relationship between phosphate and SS in the Hii River basin in Japan, and Hsu *et al*. (2009) emphasized that during flood, the concentration of pollution increased rapidly. According to Table 2, transfer of the elements by SS during the mining period is of secondary importance. The results of the present study have revealed the importance of proper environmental management to control soil erosion and transfer of SS as a carrier of pollutants into the rivers.

Table 1 Mean concentrations (mg L^{-1}) of elements transferred to the river as dissolved and suspension under different hydrological conditions.

Elements	Transportation form	Base flow	Flood	Mine exploitation
Phosphorus	Dissolved	0.09 ± 0.05	0.25 ± 0.03	0.15 ± 0.03
	Particulate	0.7 ± 0.21	51.95 ± 21.4	17.82 ± 11.46
Calcium	Dissolved	44.14 ± 1.07	47.97 ± 4.2	51.00 ± 5.04
	Particulate	5.21 ± 0.91	833.5 ± 481.5	146.65 ± 119.15
Magnesium	Dissolved	30.97 ± 1.30	37.63 ± 3.50	35.63 ± 3.10
	Particulate	3.90 ± 0.92	318.24 ± 179.57	141.76 ± 103.99
Nitrogen	Dissolved	0.33 ± 0.34	0.34 ± 0.10	0.19 ± 0.05
	Particulate	No data	No data	No data

Table 2 Percentages of qualitative parameters transferred as particular form to the river under different hydrological conditions.

Variable	State	Maximum	Minimum	Mean
Nitrate (mg L^{-1})	Natural	34.00	0.36	8.32
	Flood	98.02	0.47	39.75
	Mine exploitation	92.00	9.37	37.29
Magnesium (mg L^{-1})	Natural	47.20	0.03	9.35
	Flood	97.10	13.51	35.11
	Mine exploitation	96.80	5.66	44.47
Phosphorus (mg L^{-1})	Natural	99.13	10.25	69.58
	Flood	99.8	98.00	99.12
	Mine exploitation	99.6	71.40	90.58
Calcium (mg L^{-1})	Natural	34.00	0.36	8.32
	Flood	98.02	0.47	39.75
	Mine exploitation	92.00	9.37	37.29

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