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Study of the Phosphorus Losses from Different Watersheds in Guilan Province

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ABSTRACT: Phosphorus is one of the essential nutrients for plants which is major pollutants originating from non-point sources such as urban run-off, residential, industrial and agricultural areas. Run-off movement and erosion result in phosphorus loss from watershed and entering the water body. The aim of this study was to investigate the phosphorus release from sub-watersheds under different land-use in Guilan province. These sub-watersheds included Divshel, Komsar, Jokolbandan, Sangar and Saravan. Samples were taken monthly from the run-off of these sub-watersheds during one year. Then, some properties of run-off including electrical conductivity and acidity of run-off, total solids, total suspended solids and total dissolved solids were measured by weighing method; moreover, three types of phosphorus, total phosphorus, water-soluble phosphorus and particulate phosphorus were determined as well. The results showed that the highest loss of total phosphorus was relevant to Sangar with forest and agricultural land uses in February (0.228 mg/l). Phosphorus variations in these sub-watersheds were dependent on the amount of monthly precipitation and phosphorus loss was increased with augmenting rainfall. The maximum mean of water-soluble phosphorus losses were related to Jokolbandan with the dominant land use of forest (0.36 mg/l) and Saravan with land uses of forest and industrial activities (0.33 mg/l), respectively. Furthermore, the highest loss of particulate phosphorus was from Sangar in April (0.192 mg/l). The level of phosphorous losses from the studied sub-watersheds was high enough to result in eutrophication of water bodies and consequently water quality decline.

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1- Introduction

Due to water erosion soil particles are separated and transferred to another place and finally they're settled. Most of the nutrients are also transferred with these particles and reduce the quality of the water resources in the region. When sediment load is increased, the increment of nutrients (nitrogen and phosphorus) decreases water quality. Nitrogen and phosphorus transported from soil through sediments and come into streams due to erosion and run-off [1]. Phosphorus is one of the major pollutants with non-point sources that originate from residential and industrial areas, farming fields and urban run-offs [2]. The released run-off from these watersheds include particles enriched in phosphorus because of the applying of too much chemical fertilizers in agricultural fields which absorbed by soil particles [3]. Fine particles including silt and clay components and soil aggregates are separated and transported by run-off due to soil erosion, and they also carry a large amount of nutrition with them [4]. The high amount of sediments in rivers and lakes disrupt lives of aquatic plants and reduces photosynthesis; also this corruption causes aquatic organisms death [5]. It is hard to estimate the precise release of sediments and nutrition due to temporal and spatial changes [6]. In the water systems, phosphorus is considered as nutrient for algal growth [7]. So, high concentration of phosphorus in surface waters causes eutrophication, its result is inappropriate growth of algae's that limits water usage for industrial, domestic, etc. usages [5]. The aims of this study were to; (1) measure the amount and type of phosphorus release from sub-watersheds under different land-use in Guilan province including Sangar, Saravan, Jokalbandan sub-watersheds and also Divshel and Komsar sub-watersheds, and (2) evaluate the monthly changes of phosphorus release.

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2- Material and Methods

This research was carried out in Guilan province, located in North of Iran and southern margin of the Caspian Sea. Five sub-watersheds were chosen with mostly different land uses in the province including Saravan, Jokalbandan, Sangar and Divshel and Komsar sub-watersheds. Water sampling of the main rivers was performed monthly at the end of each month during one year. Phosphorus exists in different forms in the nature but it can only be measured in its phosphate and orthophosphate forms, therefore different forms of phosphorus in any sample should be transformed to phosphate and orthophosphate in order to be measured. To measure total phosphorous, the sample should be digested first. Potassium persulfate acid method was used for digestion in this study. After digestion, the amount of phosphorus was determined by Ascorbic Acid method [8]. Dissolved phosphorus was measured like total phosphorus with the difference that samples were filtered with Whatman filter paper No.44 before digestion [8]. The particulate phosphorus resulted from the difference between total phosphorus and dissolved phosphorus. Total solids were determined by oven drying the samples. For determining the total dissolved solids, the samples were filtered by three layers of Whatman filter paper No.42 and then were oven dried. The total suspended solids were resulted from the difference of total solids and total dissolved solids [9].

3- Results and Discussion

Figure 1 presents the monthly changes of total, dissolved and suspended solids from the watershed's outlets. The results from the comparison of the average of total solids showed that there is a significant difference between Divshel and Sangar sub-watersheds at P<0.01. Also the difference between Divshel and Saravan was statistically significant. The comparison of average data of dissolved solids showed a significant difference between Komsar watershed with Divshel and Sangar sub-watersheds but there was no significant difference with other sub-watersheds, i.e. Jokalbandan and Saravan. Sangar watershed showed a significant difference with other sub-watersheds in terms of dissolved solids. In overall, the results from Figure 1 show that the amount of suspended solids is more than dissolved solids. This emphasizes on the importance of soil erosion in all sub-watersheds during the year.

Monthly changes in different types of phosphorous are presented in Figure 2 for all sub-watersheds. The results indicated that the highest total phosphorus pollution from Komsar watershed is occurred in January (Bahman) (0.08 mg/L), which is mainly in the form of particulate P. Soil erosion is high in this month because of the poor vegetation cover and high rainfall rates. Therefore, the main cause of phosphorus losses occurred in relation with silt and clay particles [10]. In this watershed, only one third of phosphorus losses is in the form of dissolved phosphorus, and the main phosphorus loss transported by soil particles. In Divshel watershed, the trend of P losses seems to be bimodal with peaks at January and June. The high particulate phosphorus losses are due to road construction during the year of the study. The results indicated that 55 percent of P pollution in this watershed is in form of particulate. As shown in figure 2, most of phosphorus transport from Sangar watershed occurred during January to April with a peak of 0.228 mg/L in January. Phosphorous transport from Sangar was highes among the studied sub-watersheds. Rice fields are the main land use in Sangar watershed. Also, rural area occupied the rest of area. Accordingly, the main cause of P pollution is related to erosion of fine particles during the wet season. The trends of phosphorous losses from Jokalbandan watershed was almost similar to Divshal. But, the rates were almost two times (0.160 mg/L at February and 0.14 mg/L at June). The second difference was the form of P loses. In contrast with Divshal, it was observed that about 60 percent of phosphorus transportation from Jokalbandan watershed is in dissolved form. The reason is the predominance of urban and rural uses in the region. Monthly changes in phosphorous losses were lowest in Saravan watershed in compare to other sub-watersheds. In contrast with all other sub-watersheds, 65 percent of phosphorus transport from Saravan was in dissolved form. The land use of this watershed is mainly forest and therefore soil erosion is low. On the other hand, landfill of Rasht city is located in this watershed which is a source of dissolved P release.

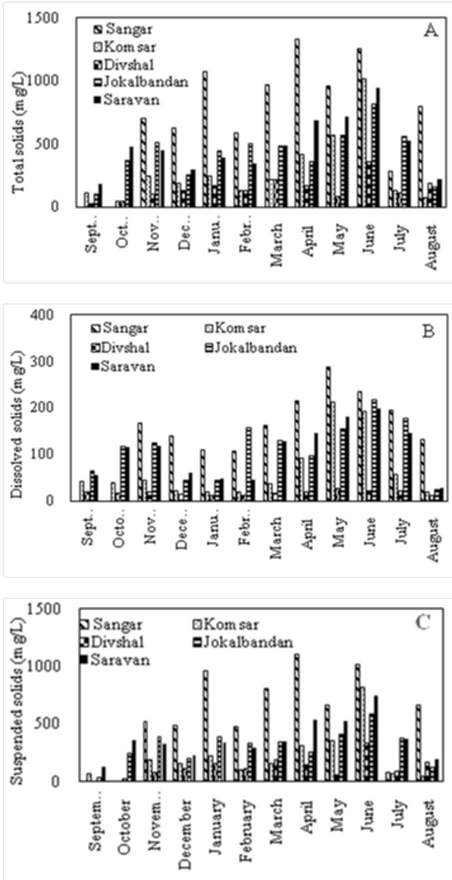

Figure 1. Monthly changes in A) total solids, B) dissolved solids, and C) suspended solids out flow from different sub-watersheds

4- Conclusion

The study of phosphorus release from five sub-watersheds from different parts of Guilan showed the risk of eutrophication. The P concentration reaches to 0.24 mg/L in some parts. The results indicated that phosphorus release was very variable among the studied sub-watersheds and also showed a high monthly changes. The differences among the sub-watersheds seem to be related to differences in land uses in this sub-watersheds. The sub-watersheds with agriculture and urban land uses showed higher rates of phosphorous pollution. There was a peak at January in P concentration at all regions. Another peak was observed at June and/or September. Phosphorous losses form most of the studied sub-watersheds was mainly in the form of particulate P which is related to the transportation of fine soil particles by soil erosion. Phosphorus release from farming fields depends on runoff intensity, farming activities, season and soil conditions. In the wet months that the land is bare, soil is wet and rainfall is high, the rates of runoff and soil erosion were consequently high. Saravan sub-watershed showed a different behavior. Dissolved phosphorus transport was dominant in this sub-watershed because of dominancy of forest land use and the presence of Rasht landfill. In overall, the risk of eutrophication is high in Guilan because of high phosphorous concentration by soil erosion especially from rice fields and constructing site and waste waters from urban area.

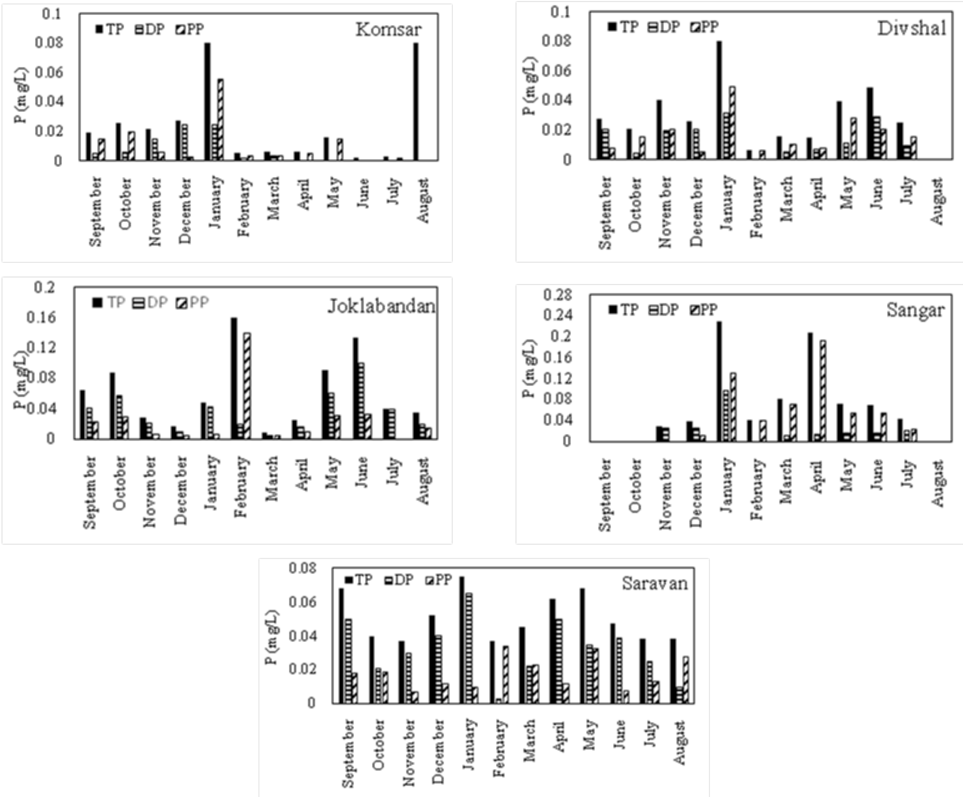

Figure 2. Monthly changes in total, dissolved, and particulate phosphorus in different sub-watersheds

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