Rangeland Degredation and Its Impacts on Water Quality in Zayandehroud River Basin

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Abstract

The quality of water in many regions of world are threatened by overuse, misuse and pollution, and it is increasingly recognized that water quality of rivers, streams and wetlands are strongly influenced by landscape characteristics of their watershed including landscape composition (i.e. land use/land cover types and their fractions) in uplands and the spatial configuration of these land use/land cover types. This study focuses on the effects of land cover changes on the water quality of Zayandehroud River. The main goal of this study was to quantify the change in rangelands and forests in Zayandehroud river basin, which suffered intense human interference, in a period of eleven years (1997–2008) and to evaluate how landscape patterns (including Number of Patches, Edge Density, Percentage of Rangelands and Forests) influence on the water quality indices (including BOD5, EC, NO_3, P and TDS) measured in 10 stations along the Zayandehroud river. The results indicated that water quality were significantly correlated with both the proportions and configuration of Rangeland areas. Total edge of range land area had positive effects on water quality, especially on BOD_5 and EC. The proportion of rangeland was negatively correlated with water quality variables. Also PLAND and LPI metrics of range land had positive effect on decreasing nutrient (NO_3, PO_4) of water in this river. However, there was no significant correlation between water quality variables and proportion of Forest in Zayandehroud basin. Because Zayandehroud basin is located in a semi-arid area, where forests are very limited and are occurred only in small patches with low density. It was shown that degradation of range land lead in to degradation of water quality which highlights the importance of rangeland conservation in water quality management at landscape scale.

Keywords: Land cover change, Rangeland, Forest, Landscape metrics, Water quality, Zayanderoud River

1. Introduction

The quality of water in many regions of world are threatened by overuse, misuse and pollution, and it is increasingly recognized that water quality of rivers, streams and wetlands are strongly influenced by landscape characteristics of the watersheds including landscape composition (i.e. land use/land cover types and their fractions) in uplands and the spatial configuration of these land use/land cover types. Many studies have shown that composition and spatial arrangement of landscapes within watersheds can account for the variability of nutrient concentration in

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streams [2,4] Using landscape metrics for quantitative analysis of landscape pattern structure and its change have been widely adopted by landscape ecology researchers.

The main goal of this study was to quantify the change in rangelands and forest areas in Zayandehroud river basin in Isfahan province, Iran, in a period of eleven years (1997–2008) and to evaluate how landscape patterns influence on the Zayandehroud river water quality. Human activities such as urban development and intensification of agriculture, played an important role in the drastic change of rangeland and forest areas in recent decades, particularly in semi-arid areas in Iran. The rapidly increasing of water demand and water pollutions due to population growth, industrial and agricultural development around Zayandehroud river causing Zayanderoud water quality to severely downgrade over the past decades. Therefore, monitoring of Zayandehroud water quality is a critical issue, especially due to the concern that freshwater is a scare resource in this region of Iran. In this study we examined 1)whether there is a significant relationships between land cover changes and surface water quality in Zayandehroud watershed, 2) Whether landscape metrics are good indicators for predicting impacts of landscape structure on surface water quality, 3) which metrics can be more accountable in predicting water quality in the study area.

2. Methods

2.1. Study Area

The Zayandehroud River is the most important river in central Iran which stretches over a length of 400 km, originating in the Zardkouh Mountain and ending in the Gavkhooni swamp after passing through the city of Isfahan. The Zayandehroud River basin has an area of 41,500 square kilometres, and an average rain fall of 130 millimeters. There are 2,700 square kilometres of irrigated land in the Zayandehroud River basin, with water derived from the nine main hydraulic units of the Zayandehroud River, wells, qanat and springs in lateral valleys. The location of the study area is shown in Figure.1 [7].
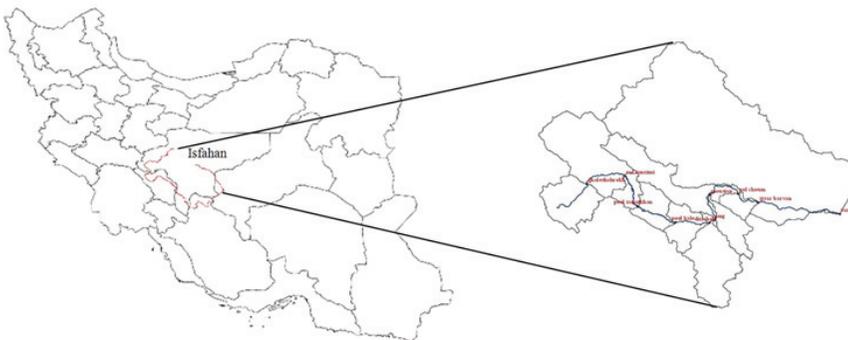

Figure 1. The location of Zayandehroud Basin in Iran

2.2. Data collection and preparation

Water quality such as BOD5, EC, NO_3^- and PO_4 data for 10 sampling stations along Zayanderour river in Ghale shahrokh, Tanzimi Dam, Zama khan bridge, Kalle bridge, Dizicheh, Lenj, Mousi-yan, Choum bridge, Ziyar bridge and Varzaneh. For 1997 and 2008 were obtained from theWater Organization and Environment organization of Iran.

Maps of forests and range land for study area were prepared using hybrid classification of multi-temporal Landsat5 (ETM) images taken in September 1997 and 2008.

2.3. Watershed delineation

Identification and quantification of nonpoint source pollution in a large basin like Zayanderoud basin are logistically challenging. Therefore, the Zayanderoud basin was divided into 10 distinct sub basins based on elevation and available hydrographical data, using Arc-SWAT extension in ArcGIS 9.3 [1,8].

2.4. Quantifying landscape pattern changes

Changes of landscape pattern can be detected and measured by landscape metrics which quantified and categorized complex landscapes into identifiable patterns. Various metrics, including: Edge Density (ED), Largest Patch Index (LPI) and Percentage of Landscape (PLAND) were calculated using Fragstat 3.3 [9] to quantify the landscape patterns changes in 1997–2008.

2.5. Statistical analysis

Pearson correlation test and regression analysis was applied to assess the relationship between landscape indices and water quality parameters in R 2.7.12(R Development Core Team 2007).

3. Results

Table 1 shows the changes in landscape pattern which is calculated by landscape metrics in two census dates (1997 and 2008).
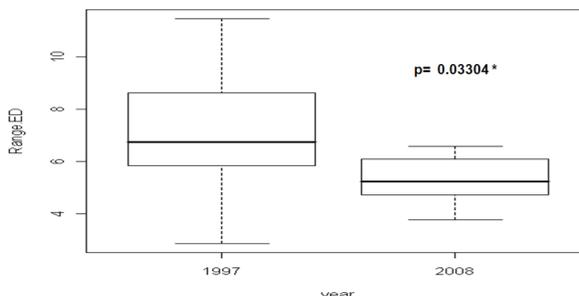

Figure 2. Rangeland Edge Density (ED) in 1997 and 2008. Bold horizontal lines show the median, boxes show the interquartile range, and the whiskers show the maximum and minimum values.

	1997	2008
Rangeland. CA	179678.8	135462.1
Rangeland.ED	7.055	5.266
Range.PLAND	65.703	45.802
Forest.CA	14784.6	13974.11
Forest ED	1.965	1.560
ForestPLAND	14.281	9.216

Table 1. Comparison of landscape metrics in 1997 and 2008 in Zayandehroud river basin

The increase of built-up land and bare land accounted for the most obvious transformation in the study area. This increase was traced to the conversion from rangeland, which experienced the most drastic decrease by 20% in Zayandehroud basin, in a period of eleven years (1997–2008). The results also indicated that water quality were significantly correlated with both the proportions and configuration of Rangeland areas. However, there was no significant correlation between water quality variables and proportion of Forest in Zayandehroud basin. Total edge of range land area had positive effects on water quality, especially on BOD_5 and Ec (p<0.01). In particular, concentrations of BOD_5 and Ec were more likely to be high when range land areas in watersheds were fragmented into smaller patches. These results suggest that unregimented large rangelands in watersheds might reduce the concentrations of BOD_5 and Ec in the river. Lee *et.al* also found a similar result about effect of range lands ED on water quality [4]. PLAND and LPI metrics of range land had also positive effect on decreasing nutrient (NO_3, PO_4) of water in this river (p<0.05). It was shown that degradation of range land lead in to degradation of water quality which indicated the importance of rangeland conservation [4, 11], Thus, human land uses might degrade water quality not only by transforming natural areas into urban or agricultural areas generating pollutants and nutrients, but also by degrading the quality of remnant range land patches in watersheds with fragmented and isolated range land patches.

4. Discussion and conclusion

Many studies have reported that forest and vegetation cover like rangeland and forests play primary roles in protecting water quality in adjacent aquatic systems [4, 11, and 13]. Results of this study also revealed that the degradation of range land lead in to degradation of water quality which highlights the importance of rangeland conservation in water quality management at landscape scale. However, a significant relationship between Forest areas and water quality was not observed in this study, because the Zayanderoud basin is located in a semi-arid area of Iran, where forests are very limited and are occurred only in small patches with low density. Thus, in semi arid areas like Zayanderoud watershed, range lands conservations play more important role for management of water quality. Results of this study can be used in establishing and implementing effective water management at landscape scale, in this region. In addition, the information on the hydrologic effects of land use can provide guidelines, not only for resource

managers in restoring the aquatic ecosystem but also for policy makers in evaluating alternate land management decisions.

5. References

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