Source Fingerprinting of Sediment Deposited in the Dam Reservoir: A Case of Lavar Dam Watershed, Fin, Hormozgan Province

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Extended abstract

1. Introduction

Soil erosion is a major environmental threat worldwide. This three-stage process including detachment, transportation and sedimentation of soil particle by runoff affects natural and agricultural areas of Iran. Soil erosion has many off-site and on-site effects such as sediment deposition in the lake of dam and channels, transportation of nutrients and contaminants including phosphorous, pesticides, heavy metals, pathogens and radionuclides (Horowitz, 2008). Therefore, understanding spatial variations of sediment sources can be useful for managing the supply of sediment and contaminants in river systems. Quantifying sediment sources can be important to target efficient management measures, reducing sediment supply in the catchments. Sediment fingerprinting techniques are therefore increasingly applied to determine sediment sources and pathways in catchments and thus inform management interventions (Walling, 2005). Many scientists applied sediment fingerprinting techniques for quantifying source contribution of fluvial (e.g., Owens et al., 2005; Russell et al., 2001; Walling et al., 1999; Zhang and Liu., 2016; Nosrati et al., 2018; Collin et al., 1997 and 2012) and aeolian sediments (Gholami et al., 2017a,b; Liu et al., 2016). The sediment fingerprinting approach has been used for a variety of different applications including agricultural, forest harvesting, wildfires and urbanization (Koiter et al., 2018).

Fingerprinting techniques have evolved from single-property fingerprints to multi-property composite fingerprints because reliance on a single property of sediment makes it difficult to accurately distinguish sediments from a variety of sources in large fluvial systems, such as catchments (Collins and Walling, 2004). Many different physicochemical properties have been successfully used to discriminate potential sediment sources, including mineralogy (Klages and Hsieh, 1975), geochemical elements (e.g. Martinez-Carreras et al. (2010b); Collins et al. (2013); Pulley et al. (2015); Chen et al. (2016)), elemental composition (e.g. Motha et al. (2003); Devereux et al. (2010)), biomarkers (Chen et al., 2016), and environmental radionuclides (Martínez-Carreras et al. (2010)). Sediment fingerprinting technique is principally based on statistical tests such as Kruskal-Wallis H test and discriminant function analysis; and mathematical mixing models. The main objective of this study is quantifying sub-basins contributions as potential sources for sediments deposited on the back of the dam in the Lavar watershed, Fin, Hormozgan province by fingerprinting technique.

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2. Methodology

2.1.Sampling and Laboratory analysis

In this study, spatially distributed source samples were taken from 23 sites, of which 9, 6 and 8 samples were taken from northern sub-basin, midlle sub-basin and southern sub-basin potential sources, respectively, and seventeen samples were collected from the deposited sediments in the lakes dam, Lavar watershed, Fin, Iran.Samples were collected from the upper 0–5 cm depth of potential sources and deposited sediments on the lake's dam.All sediment samples and potential source samples were dry sieved in the laboratory. Concentration of 56 geochemical elements including Al,Ba,Be,Ca,Ce,Co,Cr, Cs,Cu,Dy,Er,Eu,Fe,Ga,Gd,Hf,Ho,K,La,Li,Lu,Mg,Mn,Mo,Na,Nb,Nd,Ni,P,Pb,Pr,Rb,Sb,Sc,Sm,Sn,Sr,Ta, Tb,Te,Th,Ti,Tl,Tm,U,V,W,Y,Yb,Zn,Ag,Zr,As,Bi, Sand Sbwere determined using ICP-OES and also, eight REE ratios (∑REE, Nd/Yb, Eu/Eu^* (Europium Anomaly), $(La/Lu)_n$, $(La/Sm)_n$, $(Gd/Yb)_n$, $(La/Yb)_n$ and δCe (Cerium Anomaly)) were calculated and assumed as tracers.

2.2. Disrcimination of sources and quantification of their contribution

A stepwise discriminant function analysis (DFA) applied to discriminate sources. A mathematical multivariate mixing model was used in conjunction with the composite fingerprint to quantify the relative contributions of each source type to the sediment samples collected from the back of dam.

3. Results

The results of the stepwise DFA, based on the minimization of Wilk's lambda, for discriminating the three source types, on the basis of the individual geochemical properties, showed that six tracers includingLa/Yb,Nd/Yb, Th, Bi,Pr and Cr were selected as optimum fingerprints. A total of six properties were selected for the optimum composite fingerprint, which correctly discriminated 100% of the source type samples. The minimum and maximum of GOF were calculated 45 and 94%, respectively. The fact that a majority of the GOF values was well above 80% suggested that the mixing model performed well in assessing the sediment sources in our study area (Zhou et al., 2016; Haddadchi et al., 2013).

4. Discussion &Conclusions

Among of six optimum fingerprints for discriminating sources of sediment, three optimum fingerprints (La/Yb,Nd/Yb and Pr) were selected from rare earth elements and their indices. This indicates that rare earth elements (REE) and their indices have great potential to identify the provenance of aeolian sediments and their transport pathways, because they are less fractionated during weathering, transport and sedimentation (e.g. Rao et al. (2011); Hu & Yang, (2016)). According to the results, the contribution mean from northern sub-basin, middle sub-basin and southern sub-basin were estimated 18%, 16% and 66%, respectively. Therefore, southern sub-basin was recognized as the main source to supply material for sediments deposited on the back of the dam.

Key Words: Sediment Fingerprinting, Tracer, Potential Sources, Rare Earth Elements, Lavar Dam.