World Academy of Science, Engineering and Technology
International Journal of Agricultural and Biosystems Engineering
Vol:17, No:07, 2023

Tracing Sources of Sediment in an Arid River, Southern Iran

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Abstract : Elevated suspended sediment loads in riverine systems resulting from accelerated erosion due to human activities are a serious threat to the sustainable management of watersheds and ecosystem services therein worldwide. Therefore, mitigation of deleterious sediment effects as a distributed or non-point pollution source in the catchments requires reliable provenance information. Sediment tracing or sediment fingerprinting, as a combined process consisting of sampling, laboratory measurements, different statistical tests, and the application of mixing or unmixing models, is a useful technique for discriminating the sources of sediments. From 1996 to the present, different aspects of this technique, such as grouping the sources (spatial and individual sources), discriminating the potential sources by different statistical techniques, and modification of mixing and unmixing models, have been introduced and modified by many researchers worldwide, and have been applied to identify the provenance of fine materials in agricultural, rural, mountainous, and coastal catchments, and in large catchments with numerous lakes and reservoirs. In the last two decades, efforts exploring the uncertainties associated with sediment fingerprinting results have attracted increasing attention. The frameworks used to quantify the uncertainty associated with fingerprinting estimates can be divided into three groups comprising Monte Carlo simulation, Bayesian approaches and generalized likelihood uncertainty estimation (GLUE). Given the above background, the primary goal of this study was to apply geochemical fingerprinting within the GLUE framework in the estimation of sub-basin spatial sediment source contributions in the arid Mehran River catchment in southern Iran, which drains into the Persian Gulf. The accuracy of GLUE predictions generated using four different sets of statistical tests for discriminating three sub-basin spatial sources was evaluated using 10 virtual sediments (VS) samples with known source contributions using the root mean square error (RMSE) and mean absolute error (MAE). Based on the results, the contributions modeled by GLUE for the western, central and eastern sub-basins are 1-42% (overall mean 20%), 0.5-30% (overall mean 12%) and 55-84% (overall mean 68%), respectively. According to the mean absolute fit (MAF; ≥ 95% for all target sediment samples) and goodness-of-fit (GOF; ≥ 99% for all samples), our suggested modeling approach is an accurate technique to quantify the source of sediments in the catchments. Overall, the estimated source proportions can help watershed engineers plan the targeting of conservation programs for soil and water resources.

Keywords : sediment source tracing, generalized likelihood uncertainty estimation, virtual sediment mixtures, Iran
Conference Title : ICOACWM 2023 : International Conference on Organic Agriculture Crops and Water Management
Conference Location : Berlin, Germany
Conference Dates : July 17-18, 2023

Open Science Index, Agricultural and Biosystems Engineering Vol:17, No:07, 2023 publications.waset.org/abstracts/166240.pdf