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Comparing geological and statistical approaches for element selection in sediment tracing research

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Elevated suspended sediment loads reduce reservoir capacity and significantly increase the cost of operating water treatment infrastructure, making the management of sediment supply to reservoirs of increasingly importance. Sediment fingerprinting techniques can be used to determine the relative contributions of different sources of sediment accumulating in reservoirs. The objective of this research is to compare geological and statistical approaches to element selection for sediment fingerprinting modelling. Time-integrated samplers (n=45) were used to obtain source samples from four major subcatchments flowing into the Baroon Pocket Dam in South East Queensland, Australia. The geochemistry of potential sources were compared to the geochemistry of sediment cores (n=12) sampled in the reservoir. The geochemical approach selected elements for modelling that provided expected, observed and statistical discrimination between sediment sources. Two statistical approaches selected elements for modelling with the Kruskal-Wallis H-test and Discriminatory Function Analysis (DFA). In particular, two different significance levels (0.05 & 0.35) for the DFA were included to investigate the importance of element selection on modelling results. A distribution model determined the relative contributions of different sources to sediment sampled in the Baroon Pocket Dam. Elemental discrimination was expected between one subcatchment (Obi Obi Creek) and the remaining subcatchments (Lexys, Falls and Bridge Creek). Six major elements were expected to provide discrimination. Of these six, only Fe_2O_3 and SiO_2 provided expected, observed and statistical discrimination. Modelling results with this geological approach indicated 36% (+/- 9%) of sediment sampled in the reservoir cores were from mafic-derived sources and 64% (+/- 9%) were from felsic-derived sources. The geological and the first statistical approach ($DFA_{0.05}$) differed by only 1% (σ 5%) for 5 out of 6 model groupings with only the Lexys Creek modelling results differing significantly (35%). The statistical model with expanded elemental selection ($DFA_{0.35}$) differed from the geological model by an average of 30% for all 6 models. Elemental selection for sediment fingerprinting therefore has the potential to impact modeling results. Accordingly is important to incorporate both robust geological and statistical approaches when selecting elements for sediment fingerprinting. For the Baroon Pocket Dam, management should focus on reducing the supply of sediments derived from felsic sources in each of the subcatchments.