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Alternative method to trace sediment sources in a subtropical rural catchment of southern Brazil by using near-infrared spectroscopy

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Conventional fingerprinting methods based on geochemical composition still require a time-consuming and critical preliminary sample preparation. Thus, fingerprinting characteristics that can be measured in a rapid and cheap way requiring a minimal sample preparation, such as spectroscopy methods, should be used. The present study aimed to evaluate the sediment sources contribution in a rural catchment by using conventional method based on geochemical composition and on an alternative method based on near-infrared spectroscopy. This study was carried out in a rural catchment with an area of 1,19 km2 located in southern Brazil. The sediment sources evaluated were crop fields (n=20), unpaved roads (n=10) and stream channels (n=10). Thirty suspended sediment samples were collected from eight significant storm runoff events between 2009 and 2011. Sources and sediment samples were dried at 50oC and sieved at 63 μm. The total concentration of Ag, As, B, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, K, La, Li, Mg, Mn, Mo, Na, Ni, P, Pb, Sb, Se, Sr, Ti, Tl, V and Zn were estimated by ICP-OES after microwave assisted digestion with concentrated HNO_3 and HCl. Total organic carbon (TOC) was estimated by wet oxidation with K2Cr2O7 and H2SO4. The near-infrared spectra scan range was 4000 to 10000 cm-1 at a resolution of 2 cm-1, with 100 co added scans per spectrum. The steps used in the conventional method were: i) tracer selection based on Kruskal-Wallis test, ii) selection of the best set of tracers using discriminant analyses and finally iii) the use of a mixed linear model to calculate the sediment sources contribution. The steps used in the alternative method were i) principal component analyses to reduce the number of variables, ii) discriminant analyses to determine the tracer potential of the near-infrared spectroscopy, and finally iii) the use of past least square based on 48 mixtures of the sediment sources in various weight proportions to calculate the sediment sources contribution. Both conventional and alternative methods were capable to discriminate 100% of the sediment sources. Conventional fingerprinting method provided a sediment sources contribution of 33$\pm$19% by crop fields, 25$\pm$13% by unpaved roads and 42$\pm$19% by stream channels. The contribution of sediment sources obtained by alternative fingerprinting method using near-infrared spectroscopy was 71$\pm$22% of crop fields, 21$\pm$12% of unpaved roads and 14$\pm$19% of stream channels. No correlation was observed between source contribution assessed by the two methods. Notwithstanding, the average contribution of the unpaved roads was similar by both methods. The highest difference in the average contribution of crop fields and stream channels estimated by the two methods was due to similar organic matter content of these two sediment sources which hampers their discrimination by assessing the near-infrared spectra, where much of the bands are highly correlated with the TOC levels. Efforts should be taken to try to combine both the geochemical composition and near-infrared spectroscopy information on a single estimative of the sediment sources contribution.