Abstract

Sediment source fingerprinting applications continue to increase globally as a tool for information to support improved soil and sediment management problems persisting in river-reservoir-catchment systems. Despite its wider acceptance, interpretations from sediment fingerprinting face significant challenges due to disparities in sampling methodologies, sediment source variability, and the complex interactions of environmental processes, uncertainties in tracer selection and different analytical approaches etc. that can obscure accurate source tracing hampering scientific or management objectives. To quantify and reduce such uncertainties, this thesis proposes a *multiple sampling-tracer-model* framework for Konar river catchment, India and which analyses the combined effects of (i) three sampling strategies (grid, zone and confluence), (ii) three tracer selections (spectral, mineralogical and geochemical) and (iii) two modelling approaches (partial least square regression (PLSR) and Bayesian modelling) in the field of sediment fingerprinting. Further, physically based models such as WEPP and INVEST-SDR were used to validate outcomes from this fingerprinting framework and two novel indices (the erosion susceptibility index, or ESI and source sensitivity index or SSI) were proposed combining results of both the modelling philosophies. In this thesis, Bayesian modelling was employed to analyse geochemical and mineralogical tracers, employing the innovative MixSIAR technique in (i) *no prior* and (ii) *with informative prior* conditions (e.g. areal coverage, particle size distribution, and slope).

The *multiple sampling-tracer-model* frameworks could quantitatively describe the capabilities and deficiencies of tested combinations for Konar catchment. All the sediment fingerprinting techniques have identified agricultural lands as the major contributor of sediments in Konar but varying seasonally (~5% to ~85%). Application of sediment fingerprinting with physically based modelling results presented in this thesis has the potential to bring to light the often overlooked significance of sediment generation in barren

lands and human settlement areas (~22% to ~29% and ~14% to ~23% sediment release respectively from 14% and 12% areal coverage). Newly proposed temporal index (i.e. ESI) revealed the barren lands and human settlements as most crucial land use classes (with highest ESI value of 1.31 and 1.08 respectively) in terms of conservation urgency. The newly proposed informative prior based Bayesian model derived SSI spatial maps helped to prioritize sub-catchments in terms of spatial sediment source contributions and these results were in good agreement (> ~78%) with INVEST-SDR model. Overall, this thesis made a synergic combination of sediment fingerprinting and physically based sediment modelling results for environmental conservation in river-reservoir-catchment systems avoiding limitations inherent to each methods when applied alone.