Uncertainty in bio-geomorphological assessments of lowland river floodplains resulting from landcover classification errors

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Landcover maps provide essential input data for a sequence of models used to quantify the hydrodynamics and ecology of lowland rivers and their floodplains. Hydrodynamic models provide estimates of peak water levels and sediment deposition while ecological models characterize habitat suitability, biodiversity (Lenders et al., 2001; Schipper et al., 2008) and ecosystem services (Nelson et al., 2009). Such models are routinely used in the environmental impact assessment of landscaping measures that aim to reduce the flood risk and improve the ecological quality of the river area (Van Stokkom et al., 2005; Samuels et al., 2006). In general, however, the impact of landcover classification errors on hydrodynamic and ecological model output has hardly been quantified. Our main objective is to assess the uncertainty in biogeomorphological modeling of a lowland river depending on the classification accuracy of landcover maps.

We quantified this uncertainty for the three distributaries of the river Rhine in The Netherlands with respect to four aspects: (1) flood water levels using WAQUA, (2) annual average suspended sediment deposition using SEDIFLUX (Middelkoop and Van der Perk, 1998), (3) potential biodiversity values using BIOSAFE (De Nooij et al., 2004), and (4) ecotoxicological hazards based on a food web after Schipper et al. (2008). We assessed how the outcomes of these quantitative models depend on the classification error of the input landcover maps in a Monte Carlo analysis. The uncertainty was assessed for two overall classification accuracies:f 69 and 95%. For each classification accuracies, we generated 15 land cover map. Subsequently we ran all four models with the 30 realizations.

The error in the land cover map gave an uncertainty in water levels of up to 20 cm. Overbank sediment deposition varied up to 100% in the area bordering the main channel, which is directly linked to the variations in flow velocity encountered in the same area. However, when aggregated to the whole study area, the 68% confidence interval in sediment deposition was only 0.6%. The ecotoxicological effects, indicated by the fraction of little owl habitat with a daily cadmium intake exceeding a toxicity threshold of 148 µg d^{-1}, varied between 16 and 19% for the Nederrijn-Lek, 39 and 42% for the Waal, between and 54 and 60% for the IJssel. A classification accuracy of 69% in the land cover map resulted in significantly higher potential biodiversity values in comparison with an accuracy of 95%. The magnitude of the overestimation of biodiversity values at low classification accuracies remarkably differed for various protected species and between river distributaries.

Compared to biogemorphological effects of landscaping measures, the effects due to the uncertainty in the land cover map are of the same order of magnitude. Given high financial costs of these landscaping measures, increasing the classification accuracy of landcover maps is a prerequisite for improving the assessment of the effectiveness and efficiency of landscaping measures.

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