Probabilistic risk assessment of the environmental impacts of pesticides in the Crocodile (west) Marico catchment, North-West Province

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Abstract

External agricultural inputs, such as pesticides, may pose risks to aquatic ecosystems and affect aquatic populations, communities and ecosystems. To predict these risks, a tiered approach was followed, incorporating both the PRIMET and PERPEST models. The first-tier PRIMET model is designed to yield a relatively worst-case risk assessment requiring a minimum of input data, after which the effects of the risks can be refined using a higher tier PERPEST model. The risk assessment initially depends on data supplied from local landowners, pesticide characteristic, application scheme and physical scenario of the environment under question. Preliminary results are presented, together with ecotoxicological data on several frequently-used pesticides in a section of the Crocodile (west) Marico Water Management Area (WMA) in South Africa. This area is historically known to have a high pesticide usage, with deltamethrin, aldicarb, parathion, cypermethrin and dichlorvos being the main pesticides used. Deltamethrin was indicated as having the highest probability of risks to aquatic organisms occurring in the study area. Cypermethrin, parathion, dichlorvos, carbaryl, bromoxynil, linuron, methomyl and aldicarb were all indicated as having possible risks (ETR 1-100) to the aquatic environment. Pesticides posing no risk included fenamiphos, abamectin, pendimethalin, captan, endosulfan, alachlor, bentazone and cyromazine (ETR<1). The pesticides posing a possible risk to the aquatic ecosystem were evaluated further to determine their effects on 8 grouped endpoints using the PERPEST effect model. Deltamethrin and cypermethrin were again noted as posing the greatest risk and clear effects were eminent for aquatic insects and macro-crustaceans, followed by micro-crustaceans and rotifers. High percentages of clear effects on insects were also observed for carbaryl, parathion and dichlorvos. Linuron was indicated as having minimal clear effects on community metabolism, macrophytes and phytoplankton classes, while lesser clear effects of bromoxynil occurred on periphyton communities. Application of both the lower-tier PRIMET and higher-tier PERPEST models showed similar trends in that they both ranked the top 5 pesticides in the same order of risk. This approach offers a significant improvement over the presently-used simulation models or use of safety factors. It is therefore especially useful in developing countries such as South Africa, where pesticide environmental risk information is scarce. Although these models were effectively used in this study, it still has to be validated further under South African conditions

Keywords: risk-assessment model, pesticides, aquatic ecosystem