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On ranking the hazard of pharmaceuticals for the environment: a methodology accounting for uncertainties and tradeoffs

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Massive amounts of pharmaceuticals are produced for human needs each year and numbers keep increasing. Adverse effects of the occurrence of these substances in the environment have been reported in various ecotoxicological studies and even potential adverse effects on human health are currently investigated. For all these reasons politics and environmental agencies seek to limit their presence in the environment. But to tackle the issue of pharmaceuticals in the environment at the source –consumption- is not an easy challenge as human health is and must remain the. In order not to make any tradeoff between human health and environmental protection, it is important to be able to estimate the hazard of pharmaceuticals to limit the concentration of most harmful substances in the environment. Indeed with information on the relative hazard of pharmaceuticals, it becomes possible, for example, to substitute some substances with others presenting fewer hazards for the environment but similar therapeutic effects. This study focuses on the evaluation of the relative hazard of pharmaceuticals. Hazard is computed from the aggregation of different physical-chemical and toxic criteria defining the drugs. The aggregation is done by using a designed utility function. Uncertainties on criteria and weights are accounted by considering them as stochastic variables. The probability density function defining the criteria considered in this study is a uniform distribution whose mean is the measured value of the criteria. The probability density function defining the weights is extrapolated by converting the judgment of an expert committee into a continuous non parametric distribution. Assigning weights is a nowadays accepted approach and is necessary to introduce the concept of subjectivity in some specific field of water management or hazardous substance ranking. It is here used to account for the relative impact of each criteria in the hazard evaluation process. Weights reflect what decision makers consider important and what they are willing to trade off. The flexibility of the method renders possible to adjust the classification depending on the priority of the decision maker, which can be directed to either the protection of the environment or to human health. The methodology allows an ordinal ranking for the hazard of a list of pharmaceuticals highly consumed in Switzerland and who may impact the local environment in the long run. Ordinal ranking is fundamental to obtain a restricted prioritization list of substances to study into details that fits laboratories capacities, time available, and budget constraints. Results show that the ranking of prior hazardous substances can be greatly influenced by the priority of the stakeholders. If priority is given to evaluate the effects of pharmaceuticals on the aquatic environment, specific substances of interest have been identified to be fenofibrate, tiagabine, fluvastatine, simvastatine or diclofenac. On the other hand, for a study concerning the effects of traces of drugs in drinkable water on human health, efforts of investigation shall go to cortisone, sulfamethoxazole, amoxiciline or ciprofloxacin. A cluster analysis of available dataset allows a systematic identification of these groups of substances. But because they present specific toxic characteristics hormones ethinylestradiol and testosterone, along with antibiotic erythromycin A should be in all cases included in risk assessment methodologies, environmental concentration estimation and regular measurement campaigns.