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Water quality dynamics in temporary streams and implications for water management strategies in semi arid regions

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Temporary waters are wide spread in the Mediterranean basin, and in most catchments, some or all tributaries are temporary, that is either intermittent or ephemeral. The EU Water Framework Directive requires the establishment of Basin Management Plans for all European river basins with improvement in the ecological status where necessary. For the more humid catchments of central and north Europe where rivers are perennial, a number of modelling tools exists but, for temporary waters, a number of obstacles prevent the straightforward implementation of the directive, requiring additional effort and significantly different models.

The problem is in general related to data scarcity, absence of extended knowledge on ecosystem dynamics and limited applicability of catchment models to support water management planning. For eight study sites in South and South East Europe, detailed field and model studies have been performed in the EU-project tempQsim (EVK1-CT2002-00112). A number of perceptual models for the study sites have been established and results are being used to improve selected catchment models and provide a more adequate description of pollution dynamics.

Water quality dynamics in terms of concentrations and loadings in temporary waters are mainly determined by the characteristically sequence of dry periods and the following flood events. Field data indicate, that two phenomena are particularly important and have to be distinguished, a) variability of seasonal pollution loads (importance of first flood) and b) extreme increase of pollution loads during the early stages of an individual flood (occurrence of first flush) The variability of seasonal pollution is visible at all sites. In some cases it is not the first run-off event that bears the highest concentrations and loadings. In particular if the first run-off event has only a small discharge and the following run-off event is much bigger, the concentrations and loadings are much higher on the second event. After a longer interval with non significant flood, some data sets show a second important flood (spring flood) at the end of the winter.

Similar, although less distinct differences in sediment concentration can be detected during the first flood. Suspended solids and ash free dry mass may reach comparable high values during the first moment. Patterns for both sediment and solutes are mainly determined by the previous accumulation of mass and the following re-suspension effects. This has important consequences for monitoring the ecological status (in particular the chemical water quality) as required by the EU WFD and for the modelling. Where karstic springs are present, the seasonal patterns are much more complex. Field studies demonstrate a clear difference between small first run-off events, resulting in a remobilisation of pollutants from the stream bed and urban areas, medium events, where the catchment surface contributes to a significant mass input, and finally the big flood events, where water quality is predominantly determined by the outflow from karstic springs. The impact of erosion controlling the inflow of particulate material differs widely according to local vegetation cover and soil erodibility. A particular difference from humid catchments, is that nutrient leaching to groundwater will be interrupted during the dry season (in the absence of irrigation). This contributes to a further accumulation of mass and also affects the water quality of the first significant floods.

Transmission losses by infiltration into the stream bed are also important, in many cases leading to interruption of continuous channel flow with re-deposition of transported suspended matter. Finally, due to the brief duration of flood events and resulting translation times, the available time for self-purification processes can be very small in comparison to more humid catchments. As a conclusion, the higher spatial and temporal variability both for run-off and pollution, clearly require a higher model complexity. Model tests indicate that the most important areas for future modelling lie in the improved simulation of mass accumulation processes and better hydrological simulation during the flow period. Where both types of flow occur, it is also important to achieve a more reliable differentiation of overland-flow and subsurface flow, with their different impacts on water quality.

Water management and improvements in water quality must take these factors into account. Catchment management, modified irrigation schemes and/or check dams may help to reduce the high particulate and nutrient loadings during the first flood events. Sedimentation ponds or flood areas can be used to reduce the high suspended matter concentrations during first flood and first flush events and also provide a relevant option for post pollution treatment.