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Temporary Mediterranean rivers: importance of episodic flow pulses for nutrient dynamics

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Temporary rivers are dominant throughout arid and semiarid regions that cover about 30% of the total land surface (Thornes, 1977). Temporary rivers and streams are also very common in Mediterranean catchments, where the majority of the tributaries fall dry at the surface. Temporary rivers are linked to the problem of water stress in several aspects. The most important ones are water scarcity during summer and the creation of run-off and pollution pulses at the beginning of the rainy period. During the drying period, water quality gradually decreases because evapotranspiration losses "concentrate" pollutants until the river dries up completely. During the drying period, increased water temperature stimulates biogeochemical cycling in wetted sediments ("hot spots"). Heavy rainfall events in autumn create flush floods, which carry high loads of sediments, solutes and pollutants ("hot moments"). Wet-dry cycles may also indirectly influence the activity of soil organisms that control carbon and nitrogen mineralisation, sediment respiration, nitrification, denitrification, and ammonia volatilisation.

Within the framework of the EU-funded project TEMPQSIM (EVK1-CT2002-00112) eight Mediterranean temporary catchments have been investigated over a two year period: Krathis (Greece), Iskar (Bulgaria), Tagliamento and Mulargia (N Italy and

Sardinia, respectively), Vene (France), Can Vila and Albujon (N and S Spain, respectively) and Pardiela (Portugal). A main objective of the project was to study nutrient cycling during drying and rewetting periods. For that purpose, monthly or bimonthly campaigns, combined with automatic monitoring and sampling has been performed. During the rewetting process, special attention was paid to trace the first flush effect on aquatic composition.

The studied rivers represent the wide range in hydrology and chemistry typical for the Mediterranean, from very low nutrient concentrations (Krathis) to very high concentrations (Albujon). Results from episodic events indicate that the water was enriched by dissolved and especially particulate nutrients during the first flush. In the Mulargia and Vene, for example, the bulk of particulate and dissolved nutrients was mobilised during the first flush event. In Krathis, however, suspended matter and associated nutrients were predominately mobilised during a second, more intense flood event. Krathis and Vene showed 17-fold and 10-fold, respectively, sediment enrichment during the events. Concerning dissolved species, highest enrichment during flash floods presented ammonia, ranging between 1.3 (Pardiela) and 7.8 (Krathis) times. Sediments delivered during flush events were enriched with organic matter. For example, in Krathis particulate matter showed a 25, 27 and 58-fold enrichment for P, N and C respectively during the second flood compared to the annual average. In Tagliamento, POM was mainly transported during flood events, while its composition shifted from in-stream algal sources at the rising limb of the hydrograph to soil sources during peak discharge. In addition, there is an increase of N and P dissolved organic fraction during the floods (e.g. in Vene and Krathis). During the events, sediments and associated nutrients reached maximum concentrations preferably at peak runoff (Mulargia, Krathis, Vene, Iskar), but also at the rising limb of the flood (Albujon, Vene) and even at the recession limb (Albujon). Similarly, dissolved nutrients reached maximum levels at peak runoff (Mulargia, Can Vila, Krathis, Vene, Iskar), at the rising limb (Vene, Albujon) and at the recession limb of the hydrograph (Mulargia, Krathis, Iskar, Albujon).

The increase of inorganic N and P during rewetting is attributed to flushing of soil salts, that were accumulated in floodplain and/or aquifer soil pores during the prestorm period (Walling and Foster, 1975). In addition, stimulation of N mineralisation and nitrification (e.g. Cui and Caldwell, 1997; Austin et al., 2004), as indicated in the case of Krathis, explains ammonia and nitrate increases. However, ammonia could also derive from denitrification, since rewetting may create also conditions for denitrifying activity (Groffman and Tiedje, 1988). The increase of particulate and dissolved organic fraction during rewetting is attributed to the contribution of organic matter from leaf litter or microbial biomass, which results in an initial pulse of carbon, nitrogen and phosphorous (Baldwin, 1999) and to the transfer of pollutants (e.g. for Vene and Albujon). Finally, dissolved phosphorous, release from microbial biomass and from anaerobic sediments (Baldwin and Mitchell, 2000; Turner and Haygarth, 2001) additionally supports our findings.

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