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Advanced computation of nutrients flows in river catchments as decision support for development of programs of measures in Austria

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Introduction
In Austria water pollution with organic carbon and nutrients from municipalities and industries has been reduced significantly during the last decades. This was mainly achieved by a best available technology (BAT) driven waste water treatment with enhanced nitrogen and phosphorus removal. Nevertheless, nutrient loadings (mainly phosphorus) are still relevant pressures for about 18 % of the Austrian surface water bodies. Additionally, nutrient discharges via River Danube are still seen as major pressure for the Black Sea ecosystem.
Any further measures to reduce nutrient pollution of surface waters have to focus on diffuse sources of pollution or have to go beyond the already implemented BAT–requirements in waste water treatment. The selection of efficient measures considering the protection of different types of water bodies (ambient surface waters and receiving seas) has to be based on reliable quantifications of pathways and sources of nutrient emissions and the effectiveness of measures for emission reduction.

Material and Methods
Emission modeling based on a lumped sum, empirical modeling approach has been performed to the Austrian territory subdivided into 367 sub-catchments of 50 to 400 km2 size for calculation of nitrogen and phosphorus emissions and retention and losses of nutrients in the river network. 102 of the considered sub-catchments have appropriate water quality measurements at their outlet in order to calibrate and validate model calculations. From the beginning it became clear that special attention had to be paid to the specific alpine character of many Austrian sub catchments.
Environmental quality standards (EQS) for nutrient parameters as part of the general physical-chemical description of a water body differ depending on reference conditions and are defined as 90 % percentiles for concentrations of PO4-P and NO3-N in Austria. Therefore, the model had to be enhanced for calculations of 90 % percentiles in stream concentrations in order to relate model calculations to EQS of ambient waters. After validation of model results against measurements, scenarios have been calculated and measures have been compared in respect to their effectiveness in respect to achievement of EQS in local rivers and in respect the reduction of transported loads towards the receiving sea.

Result and Discussion
Results of scenario calculations show that a set of measures with increased requirements for waste water treatment (effluent concentrations < 0,5 mgTP/l for all wwtp with more than 1000 p.e.) may still reduce the total P loads exported via river systems by about 18 %, while its effectiveness on improvement of local water quality in respect to PO4-P concentrations is relevant only in exceptional cases. In contrast, a set of measures with erosion abatement to reduce 90 % of soil loss form all arable areas contributing to erosion inputs into rivers, results in significantly less than 15 % reduction of total TP export via the Austrian river system, but it is effective in many of the local rivers with actual exceedance of the EQS. Implementation of both scenarios would reduce total exports of P by about 30 % and the percentage of rivers exceeding local EQS could be reduced from almost 20 % of all rivers to less than 10 %. While in the actually released Austrian program of measures for achieving good water quality status in all river bodies such quantitative assessments are not implemented yet, actually performed investigations will deliver an enhanced decision support for development of the next program of measures for implementation of EU water framework directive.