Evaluation of the measures to reduce sediments and nitrogen inputs to the Mar Menor coastal lagoon (Spain)

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In the past few decades, the Mar Menor lagoon has experienced an environmental deterioration, caused mainly by intensive agriculture and past open-pit mining activities. This leads to elevated nitrate concentrations in the superficial aquifer, which is connected to the lagoon, and high soil erosion rates. For this reason, the present study aims to estimate the actual inputs of nitrogen and sediments to the lagoon as well as to propose and evaluate pollution reduction measures.

The study is focused on the South basins (100 km2) with a total of 87 semi-arid basins (66 coastal microbasins). Major land uses are intensive production of horticultural and citrus crops, hence, 45% of the area is irrigated and fertilised. The hydrological distributed TETIS model was employed. It was important to employ a distributed model because there are 6 disconnected areas and it allows to obtain results at any point. Due to the lack of actual monitorization, the calibration was carried out in a non-traditional way. The runoff calibration was based on previous floods studies and the groundwater calibration on an annual balance of a previous hydrogeological study. The sediment cycle was calibrated based on the annual erosion rate (USLE equation). The nitrogen parameters were calibrated in order to accomplish the potential demand of the vegetation. The observed nitrate concentrations in the aquifer, although scarce, were used to validate the model.

Once the model was calibrated, the annual balances were obtained using rainfall series (1951-2016). The erosion rate was 37 t/ha, while the sediment yield was 6 t/ha, mainly coming from the mineral extraction zone. In the case of the nitrogen, almost all of the nitrogen input is removed by plant uptake. Yet, 2 kgN/ha reach the lagoon in the runoff flux, and a value between 0.2 and 10, through the aquifer connexion.

Consequently, pollution reduction measures are needed and the model was used to evaluate them. Several alternatives were evaluated. The first measure evaluated was the reforestation with coniferous of the mineral extraction zone. The results showed a high reduction of the erosion rate and a still important reduction of the sediment yield. Accordingly, a reduction in the transport of the nitrogen fixed to the clay fraction was achieved. The second measure evaluated was to employ better support practices, like hedgerows and contouring. These results were not significant, primarily because the erosion from the mineral extraction zone is elevated. In addition, there are 17 check dams that are not in use. Therefore, the rehabilitation and use of them was also considered. These results were appropriate in the case of sediment retention, nevertheless, as nitrogen is fixed to the clay fraction, the nitrogen reduction was low. Moreover, the adjustment of the fertiliser rates to the nitrogen potential demand was taken into account. In this case, a reduction in the nitrogen input, showed a reduction in the nitrate concentration in the percolation flux. Finally, the transformation of the horticultural crops into natural vegetation at different distances from the coastal line diminishesed pollution charges.