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## Shaping eco-hydrologic flow regimes at regional scale

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The EU Water Framework Directive WFD (60/2000) asks the achievement of a good ecological status of water bodies and requires the definition of ecological flows in Water Management Plans. Ecological flow definition goes beyond the minimum low-flow discharge and is defined as a hydrologic regime suitable for the aquatic ecosystem and preservation of biodiversity. Ecological status is monitored by environmental agencies and is based on the worst among the selected biological indicators (e.g., macroinvertebrate-based indices, nutrients and dissolved oxygen, macrophytes indices etc.). This work examines the hydrologic regimes of water bodies based on (i) monitored ecological status, (ii) water quality/quantity stressors and (iii) water balance computed with a distributed hydrologic model validated against recorded river discharge data. As water stressors climate, morphological alterations, land use, and water management indicators are accounted for in each river catchment. Machine learning classifiers are compared in their capability of predicting a good ecological status based on stressors. The hydrologic model is used to determine flow duration curves and to extract seasonal patterns and characteristic discharges of river which currently satisfy the WFD requirements. The method is applied to the rivers of the Tuscany region (central Italy), which is part of the Hydrographic District of the Northern Apennines. The results show a significant role of climate and land use parameters in determining a less than good ecological status with a consequent need of dilution of pollutants and higher specific discharges. The different hydrologic regimes in different ecological status conditions highlight the capability of advanced eco-hydrologic modelling to overcome the limitations of the commonly adopted purely hydrologic approaches at district scale.