A river-load oriented model to evaluate the efficiency of environmental policy measures against phosphorus losses.

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Watersheds losses of phosphorus and suspended matters have large economic and environmental incidences. To evaluate environmental policies or ahead of the implementation of mitigation options, stakeholders concerned by surface water resources sustainability require analytical tools to evaluate the apportionment between point and diffuse sources of nutriments and pollutants. A number of empirical and mass balance modeling approaches have been developed in the recent years to answer to this operational demand (Cassel et al, 2002; Nemery, 2003). Point and diffuse sources were commonly evaluated from loading values or using power functions established between phosphorus concentration and water discharge measured under mid and long-term monitoring programs at watersheds outlets (Burher et Wagner 1982). These models do not explicitly account for the processes that control P concentrations and dynamics in the river system. Quantitative impact on mass balances of In-stream processes has been often neglected although they determine storage and speciation transformations of P inputs (Dorioz et al, 1998).

To differentiate the phosphorus sources, we developed a simple and loaded-oriented model –- that computes retention, settling, re-suspension rates of fine and coarse P fractions and their relation to P concentration of bed-sediments. The model is applied on a long-term database (25 years provided by the International Commission for Geneva lake Protection) of water discharge and chemical flows to evaluate the incidence of agricultural (Policy Measures for Integrated Production and Required Ecological Provisions) and sewage treatment policies (implementation of modern and efficient sewage treatment systems) implemented in the Venoge watershed (240 km²) for the control of Geneva lake pollution. The model predicts adequately observed values of dissolved and particulate phosphorus. It can detect changes occurring in the behavior of the river system, notably the P retention properties that vary with the organic pollution of the river, with two main patterns: retention properties limited by anoxia in conditions of excessive loads, and concentration-dependent properties after restoration of water quality. The model reflects the gradual decrease of point and diffuse inputs over the studied period.

Burher A., Wagner G. 1982. Die leastung des bobensee mit phosphor und strickstoffuerbigunden und orgnischem kolhenstoff in abfluss jarh 1978/1979 Berich n°28 der Internationalen Gewassers Chutzkomission fur Bodensee, 48p.

Cassell A., Kort R..L, Meals D.W., Aschman S.G., Anderson D.P, Rosen B.H. Dorioz J.M. 2002. Use of mass balance modelling to estimate phosphorus and bacteria dynamics in watersheds. Water Sciences and Technology vol 45, N°9 pp157-168

Dorioz J.M., Cassel A., Orand A., Eisenman K. 1998 Phosphorus storage, transport and export dynamics in the Foron river watershed. Hydrol. Processes, vol. 12, 285-309

Nemery J. -2003- Origine et devenir du phosphore dans le continuum aquatique de la Seine des petits bassins amonts à l'estuaire: rôle du Phosphore échangeable sur l'eutrophisation. Thèse Sciences de la Terre. Univ. Paris 6, 259 p

Wang, D. S.N. Levine, D.W. Meals, Jr., J.P. Hoffmann, J.C. Drake, and E.A. Cassell. 1999. Importance of in-stream nutrient storage to P export from a rural eutrophic river of Vermont, USA. pp. 205-223 IN T.O. Manley and P.L. Manley (eds.) Lake Champlain in Transition: From Research Toward Restoration . Water Science and Application. Vol. 1. American Geophysical Union.