BALTEX Survey on

Biogeochemical Modelling Activities in the Baltic Sea Basin

Model Name	HBV-NP
Model Description	The HBV-NP simulates nitrogen (N) and phosphorus (P) transport and transformation at the catchment scale (from 1 km^2 to > 1 000 000 km^2). The objectives are usually to estimate transport, retention and source apportionment, to separate human impact from anthropogenic, and to evaluate climate and management scenarios. It is based on the hydrological HBV model, which gradually has been equipped with a N routine (Bergström et al. 1987, Brandt 1990, Arheimer and Wittgren 1994, Arheimer and Brandt, 1998). The P routine was recently been developed (Andersson et al, 2005). HBV-NP is a dynamic mass-balance model, which is run at a daily time-step, including all sources in the catchment coupled to the water balance: $$\frac{d(cV)}{dt} = \sum(c_{in}V_{in}) + D + P - \Phi - cV_{out}$$ where: *c* = concentration of nutrient fraction *V* = water volume of groundwater, river or active part of lake *in* = inflow (e.g. for groundwater: soil leakage from various land uses; for lakes/wetlands: upstream rivers and local discharge, precipitation on the surface) *out* = outflow to river, lake or downstream subbasin, evaporation *D* = atmospheric deposition on water surfaces *P* = emissions from point sources or rural households F = retention (removal or release) The spatial resolution of the model depends on the subbasin division in each application. The HBV-N has been applied in large-scale studies, covering southern Sweden (145 000 km^2 divided into 3700 catchments; Arheimer and Brandt, 1998), the country of Sweden (450 000 km^2 divided into 1000 subbasins; Arheimer, 2003), and the Baltic Sea drainage basin (~1 720 000 km^2 divided into 30 subbasins; Pettersson et al., 2000). The model has also been used for more detailed studies, as for the Genevadsån River (200 km^2 divided into 70 subbasins; Arheimer and Wittgren, 2002; Arheimer et al, 2003) and Rönneå (Arheimer et al., 2005). Additionally, the model has been applied in Matsalu River in Estonia (Lidén et al., 1999), and in Warnow and Neckar Rivers in Germany (Fogelberg, 2003), and in catchments of Norway, Finland, Netherlands, England, Hungary and Italy (Arheimer, 2006). The model

	has also been applied for climate change impact studies on water quality (Arheimer et al. 2005) and is linked to a coastal zone model (Marmefeldt et al, 1998).
State Variables	DIN, organic N, part-P, SRP, ToT-P and ToT-N
On a scale between 1 and 10, please classify your model	1 X Biogeochemical cycling, matter fluxes 2 3 4 5 6 7 8 9 10 Ecosystem functioning
Dimension (0D, 1D, 2D, 3D)	0-2.5 D (?)
Modeled Area (Marine, terrestial, combined)	Terrestrial, Fresh-water
Coupled to hydrological component	Yes
Suited for climate change sensitivity studies	Yes
Publications	Arheimer, B. 2006. Evaluation of water quantity and quality modelling in ungauged European basins. In: Prediction in Ungauged Basins: Promises and Progress. *IAHS Publ. 303:99-107.* Andersson, L. Rosberg, J., Pers, B.C., Olsson, J. and Arheimer, B. 2005. Estimating catchment nutrient flow with the HBV-NP model: sensitivity to input data. *Ambio 34(7)521-532.* Arheimer, B., Andréasson, J., Fogelberg, S., Johnsson, H., Pers, C.B. and Persson, K. 2005. Climate change impact on water quality: model results from southern Sweden. *Ambio 34(7):559-566.* Arheimer, B., Löwgren, M., Pers, B.C. and Rosberg, J. 2005. Integrated catchment modeling for nutrient reduction: scenarios showing impacts, potential and cost of measures. *Ambio 34(7):513-520.* Arheimer, B. and Brandt, M., (1998). Modelling nitrogen transport and retention in the catchments of southern Sweden. Ambio 27(6):471-480. Arheimer, B. and Brandt, M., (2000). Watershed modelling of non-point nitrogen pollution from arable land to the Swedish coast in 1985 and 1994. Ecological Engineering 14:389-404. Arheimer, B. and Wittgren, H. B., (1994). Modelling the effects of wetlands on regional nitrogen transport. Ambio 23(6):378-386. Arheimer, B. and Wittgren, H.B., (2002). Modelling Nitrogen Retention in Potential Wetlands at the Catchment Scale. Ecological

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Remarks