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Methods and data

Norway has updated the critical loads to fit with the new 0.10°×0.05° longitude-latitude grid, according to the Call for Data 2014/15. Minor modifications have also been made to the calculation method for critical loads of acidity for surface waters. Norway has not developed biodiversity critical loads, and no changes have been done to the dynamic modelling. In connection with the Call, Sweden and Norway have compared the calculation methods for critical loads for surface waters (see separate report under the national report from Sweden).

Critical loads for surface waters

The database for critical loads for surface waters is based on a 0.25°×0.125° longitude-latitude grid (Henriksen 1998). The chemistry of surface water within a grid cell was set by comparing available water chemistry data for lakes and rivers within each grid cell. The water chemistry data were primarily results from the national lake survey conducted in 1986 (Lien et al. 1987). The chemistry of the lake that was judged to be the most typical was chosen to represent the grid cell. If there were wide variations within a grid cell, the most sensitive area was selected, if it amounted to more than 25% of the grid cell area. Sensitivity was evaluated on the basis of water chemistry, topography and bedrock geology. Geology was determined from the geological map of Norway (1:1 million) prepared by the Norwegian Geological Survey (NGU). The critical loads of the original grid were assigned to the new 0.10°×0.05° longitude-latitude grid without further data collection. The mid-point critical loads values of the new grid cells were used as critical load for the entire grid cell. When the mid-point was at the border between two original grid cells or at the corner of four original grids cells, the average critical load of the original grid cells in question was used.

The methodology for Norway was described by Henriksen (1998) and the application later updated in Larssen et al. (2005; 2008). A variable ANClimit as described by Henriksen and Posch (2001) is used, but adjusted for the strong acid anion contribution from organic acids after Lydersen et al. (2004). [BC]0* was originally calculated by the F-factor approach, using the sine function of Brakke et al. (1990), but in recent applications [BC]0* has instead been estimated from MAGIC model (Cosby et al. 1985; Cosby et al. 2001) runs used for calculating target loads (Larssen et al. 2005). Here MAGIC was applied to 131 lakes in Southern Norway, of which 83 lakes were acidified (ANC < the variable ANClimit). A linear regression of MAGIC modelled [BC]0* ([BC]1860*) vs [BC]1986* for these 83 lakes is used to estimate [BC]0* for each grid cell. For the current call, a minor error in the regression was corrected, and potassium was included in BC, which has not traditionally been done.

Nitrogen removal in harvested biomass was estimated by Frogner et al. (1994) and mapped for the entire Norway according to forest cover and productivity. Nitrogen immobilisation was kept constant at 0.5 kg N a^{-1} (CLRTAP 2004). The de-nitrification factor (fde) was kept constant at 0.1 and the fraction of peat in the catchments ignored in the national scale applications. Mass transfer coefficients were kept constant at 5 m a^{-1} and 0.5 m a^{-1} for N and S, respectively and chosen as the mid-value of the ranges proposed by Dillon and Molot (1990) and Baker and Brezonik (1988), respectively. Mean annual runoff data were taken from runoff maps prepared by the Norwegian Water Resources and Energy Directorate (NVE). The lake to catchment area was set constant to 5%.

Dynamic modelling of surface water acidification

Modelling of aquatic ecosystems (lakes) have been carried out for the entire country using the MAGIC model (Cosby et al. 1985; Cosby et al. 2001). The model was calibrated to observational data from 990 of the 1007 statistically selected lakes in the 1995 national lake survey (Skjelkvåle et al. 1996). (17 lakes of the total 1007 lakes in the survey were disregarded due to very high phosphorus concentrations (and ANC) from local pollution, extremely high sea salt concentrations or inconsistencies in the catchment characteristics data available.) The model was calibrated to observed water chemistry for each of the lakes and to soil base saturation from nearest available (or most relevant) sample. In the automatic calibration routine of MAGIC the following switches were set: BC optimizer (weathering calibration): on, sulphate adsorption optimizer: off, soil pH optimizer: on, N dynamics optimizer: off (this means that nitrogen uptake in the catchment was assumed proportional (with a constant proportion) to the input at all times). Atmospheric deposition history was provided by CCE for EMEP grid cells and a sequence for each grid cell assigned to the lakes with each cell.

After calibration, all 14 scenarios were run for all 990 lakes. In order to get a reasonable coverage within each EMEP grid cell, the calibrated lakes were then used to assign scenarios to all grid cells in the Norwegian critical loads database (2304 cells) using a matching routine called "MAGIC library" (IVL 2015) (see also country report for Sweden). The 2304 grid cells were matched to the 990 lakes to which the model was calibrated according to a Eucledian distance routine based on water chemistry and location. Each of the 2304 grid cells was thus assigned a MAGIC modelled lake. Input data and data sources are described in the CCE Status Report 2008 (Hettelingh et al. 2008).

Empirical critical loads for nitrogen
The vegetation map of Norway was updated with the new empirical critical loads from the "Workshop on the review and revision of empirical critical loads and dose-response relationships" (Bobbink and Hettelingh 2011) in 2011 (see CCE Status Report 2011 (Posch et al. 2011)). The empirical critical loads map was overlaid with the new 0.10°×0.05° longitude-latitude grid. In 2011 the mid-point values of the grid cells were used as empirical critical load values for the cells. For the 2014/15 call, empirical critical loads are reported for each ecosystem type within the grid cells (ecords).

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