Effect factors for marine eutrophication in LCIA based on species sensitivity to hypoxia - DTU Orbit (09/11/2017)

Effect factors for marine eutrophication in LCIA based on species sensitivity to hypoxia

Hypoxia is an important environmental stressor to marine species, especially in benthic coastal waters. Increasing anthropogenic emissions of nutrients and organic matter contribute to the depletion of dissolved oxygen (DO). Biotic sensitivity to low levels of DO is determined by the organisms' ability to use DO as a respiratory gas, a process depending on oxygen partial pressure. A method is proposed to estimate an indicator of the intensity of the effects caused by hypoxia on exposed marine species. Sensitivity thresholds to hypoxia of an exposed ecological community, modelled as lowest-observed-effect-concentrations (LOEC), were compiled from literature for 91 demersal species of fish, crustaceans, molluscs, echinoderms, annelids, and cnidarians, and converted to temperature-specific benthic (100 m depth) LOEC values. Species distribution and LOEC values were combined using a species sensitivity distribution (SSD) methodology to estimate the DO concentration at which the potentially affected fraction (PAF) of the community's species having their LOEC exceeded is 50% (HC50LOEC). For the purpose of effect modelling in Life Cycle Impact Assessment (LCIA), effect factors (EF, [(PAF) m3 kgO2 -1]) were derived for five climate zones (CZ) to represent the change in effect due to a variation of the stressor intensity, or EF = ΔPAF/ΔDO = 0.5/$HC50_{LOEC}$. Results range from 218 (PAF) m^3 kgO_2^{-1} (polar CZ) to 306 (PAF) m^3 kgO_2^{-1} (tropical CZ). Variation between CZs was modest so a site-generic global EF of 264 (PAF) m^3 kgO_2^{-1} was also estimated and may be used to represent the average impact on a global ecological community of marine species exposed to hypoxia. The EF indicator is not significantly affected by the major sources of uncertainty in the underlying data suggesting valid applicability in characterisation modelling of marine eutrophication in LCIA.

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