Plastic dispersion and accumulation in the environment using a mass flow analysis approach

Anna Schwarz*[1]

[1]TNO – Princetonlaan 6, Netherlands

Abstract

Plastic material is rapidly accumulating in the environment. In this study, a Material flow analysis (MFA) approach was used including potential losses of plastics from the full life cycle of the product. The MFA includes yearly emissions to the environment on a global level, per country, sector, polymer, life cycle stage and environmental compartment. The yearly MFA was extended to a global accumulation and dispersion model untill 2050. Degradation of macroplastics was included to simulate global accumulation of plastics in the environment until 2050, and transport pathways over land and water were included. Quantities of plastic production in the future were modelled as 'business as usual' with a growth of 4% per year, a reduction scenario with -1% plastic production, and a zero production policy where no plastics were produced. The yearly MFA results on plastic losses to the environment show losses per sector, per country based on income class, and environmental compartment. Globally, the contribution of rubber microplastics from car tyres contribute over 60% of microplastics. These plastics accumulate mainly along roadsides and in subsurface waters. Most macroplastics in the environment originate from lower middle income countries, of which the packaging sector is the largest contributor. Most of the plastics end up on residential soils and in surface waters. Accumulation and dispersion of microplastic in the environment in the future results from the packaging sector, rubber from tyres and textiles. Quick degradation of macroplastics for specific polymers will significantly increase the number of microplastics, for example LDPE materials on land (with high UV exposure). For human and biota exposure, increased intake depends mostly on indoor air and intake through surface water microplastics. The developed accumulation and dispersion model can be used to calculate the effect of mitigations, such as material replacements, alternative policies and clean-up efforts.

Keywords: MFA, environment, microplastics, accumulation, degradation, transport

*Speaker