Title MSc project: Grey Water Footprint of Pharmaceutical Production

Assignment number: 16.18	**Internal project**
Head graduation committee Prof.dr.ir. Arjen Y. Hoekstra	**Daily supervision** Lara Wöhler
Required courses: desired is the Water Footprint Assessment course	
Involved organisations	**Start of the project:** flexible

Short description project aim and motive:

Pharmaceutical residues are emerging pollutants in freshwater ecosystems. There is detected evidence of over 600 substances in the environment. This is a global problem occurring in every part of the world (aus der Beek et al. 2015). There is concern over the eco-toxicological effects on flora and fauna as well as the potential impact of antibiotic resistance resulting from antibiotic pharmaceuticals on public health. Moreover, several pharmaceutical substances have been traced in drinking water (WHO 2012).

Research regarding the detection, removal and avoidance of these pollutants mainly focussed on the emissions from human and veterinarian medicine use. However, pollution can also derive from pharmaceutical production (see for example Fick et al. 2009; Larsson 2014; SumOfUs 2015). High concentrations of pharmaceuticals in wastewater treatment effluents have been found and studied in India and China where regional hotspots for pharmaceutical manufacturing are located. Besides these findings, pollution from production plants were also identified in the USA and Europe (Larsson 2014).

The grey water footprint is an indicator of freshwater pollution. It is defined as the load of pollutant divided by the difference between the maximum allowed and the natural background concentration (Hoekstra et al., 2011). The latter is zero for the case of pharmaceuticals. The method described in Franke et al., 2013 could be adapted to estimate the grey water footprint for pharmaceuticals. The GWF is to be estimated individually for each substance of the assessment. The overall GWF is equal to the largest GWF between the examined contaminants.

Research objective

The research objective of this project is to estimate the grey water footprint of pharmaceutical production for a selected number of pharmaceuticals.

Approach

The work will consist of the following steps:

- Draft an overview of pharmaceutical emissions from their manufacturing.
- Analyse global trade patterns for pharmaceuticals (Where are the substances produced and where consumed? Are there steps in between?)
- Estimate the grey water footprint per unit of pharmaceutical.

Background material

Aus der Beek, T., Weber, F.-A., Bergmann, A., Grüttner, G. & Carius, A. (2015): Pharmaceuticals in the environment: Global occurence and potential cooperative action under the strategic approach to international chemicals management (SAICM). IWW Rheinisch-Westfälisches Institut für Wasser Beratungs- und Entwicklungsgesellschaft mbH Umweltbundesamt.

Fick, J., Söderström, H., Lindberg, R. H., Phan, C., Tysklind, M., Larsson, D. G. J. (2009): Contamination of Surface, Ground, and Drinking Water from Pharmaceutical Production. In: Environmental Toxicology and Chemistry, Vol. 28, No. 12, pp. 2522–2527.

Franke, N.A., Boyacioglu, H., Hoekstra, A. Y. (2013): Grey Water Footprint Accounting: Tier 1 supporting guidelines.

Hoekstra, A. Y., Chapagain, A. K., Aldaya, M. M. & Mekonnen, M., M. (2011): The Water Footprint Assessment Manual: Setting global standards, London, Earthscan.

Larsson, D. G. J. (2014): Pollution from drug manufacturing: review and perspectives. Phil. Trans. R. Soc. B 369: 20130571.

SumOfUs (2015): Bad Medicine: How the pharmaceutical industry is contributing to the global rise of antibiotic-resistant superbugs.

WHO 2012. Pharmaceuticals in drinking water. Geneva.