Title MSc project:
Reducing the Grey Water Footprint of Pharmaceuticals: Strategies for the agricultural sector

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Assignment number: 05.19   **Internal project**

Head graduation committee   **Daily supervision**
Prof.dr.ir. Arjen Y. Hoekstra   Lara Wöhler

Required courses: Water Footprint Assessment course; interest in working interdisciplinary

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Involved organisations: **Start of the project:** flexible

Short description project aim and motive:
Pharmaceutical residues are emerging pollutants in freshwater ecosystems. There is concern regarding the eco-toxicological effects on flora and fauna as well as the antibiotic resistance resulting from antibiotic pharmaceutical use. Moreover, several pharmaceutical substances have been traced in drinking water (WHO 2012). There is detected evidence of over 600 substances in the environment which result from human as well as veterinary pharmaceutical use (aus der Beek et al. 2015).
In agriculture, pharmaceutical substances such as antibiotics or antiparasites are used in the livestock farming (Aarestrup 2012). Kools et al. estimated the total use of veterinary substances in the EU with 6051 tons per year (Kools 2008). After application, treated animals excrete a fraction of the substance, which then enters the environment as a diffuse emission via manure (Kümmerer 2008).
To prevent pharmaceutical emissions from reaching the water cycle, different measures and strategies exist (e.g. applying less pharmaceuticals, manure storage and composting prior to manure application on land, manure treatment). In this project, the effect of these measures and strategies should be evaluated alongside considering feasibility, costs, trade-offs etc..

Research objective
The research objective of this project is to understand, analyse and evaluate potentials of different strategies to reduce the Grey Water Footprint of pharmaceuticals from the agricultural sector.

Method
As a method it is suggested to use the grey water footprint as an index to evaluate the effectiveness of different measures and strategies that reduce pharmaceutical emissions from agriculture. 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).

Expected result
The project should result in a final report that compares the influence of different measures on the Grey Water Footprint of pharmaceuticals used in agriculture.

Background material
Aarestrup, F. (2012): Get pigs off antibiotics. Nature, 486.
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.
Hoekstra, A.Y., Chapagain, A.K., Aldaya, M.M. & Mekonnen, M.M. (2011): The Water Footprint Assessment Manual: Setting the Global Standard, London, Earthscan.
Kools, S., Moltmann, J.F., Knacker, T. (2008): Estimating the use of veterinary medicines in the European union. Regulatory Toxicology and Pharmacology, 50, 59–65.
Kümmerer, K. (2008). Pharmaceuticals in the Environment – A Brief Summary. In K. Kümmerer (Ed.), Pharmaceuticals in the environment: Sources, fate, effects and risks (Third, revised and enlarged edition ed., pp. 3-21). Heidelberg: Springer.
WHO 2012. Pharmaceuticals in drinking water. Geneva.