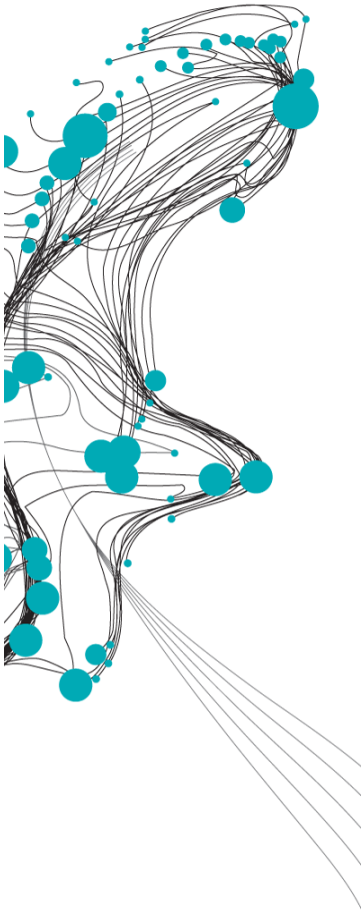
ASSESSING AND QUANTIFYING THE PHARMACEUTICAL SUPPLY CHAIN AND ITS ENVIRONMENTAL IMPACTS



Pharmaceuticals in the environment is a topic that gets increasingly more attention. As of yet, most of the focus has been on urban wastewater as a pathway for pharmaceutical pollution. However, it has been shown that manufacturing effluents can contain considerable amounts of pharmaceutical residues. Impacts of these kinds of local pollution can be extensive, with antimicrobial resistance as the most notable example. Initiatives to tackle pharmaceuticals in the environment are slowly getting traction. Yet, the full extent of the problem is unknown. In order to get a better picture of the problem, this research aims to assess and quantify the environmental impact of pharmaceutical production.

The present study has been divided into three broad stages: 1) assessing the accessibility of the pharmaceutical supply chain by contacting relevant organisations and regulators, 2) visualising the pharmaceutical supply chain using trade data, and 3) quantifying the environmental impact of the pharmaceutical industry for two substantiated example pharmaceuticals (ciprofloxacin and metoprolol) in a specific study area (Patancheru, India). For the quantification of the environmental impact, the grey water footprint (GWF) is used.

Main conclusions from this study are outlined in Figure 1. The pharmaceutical supply chain involves many organizations/actors and stages, but information on these, the production locations and environmental impacts cannot be obtained by the public, nor by researchers. In the majority of cases, confidentiality is cited as the constraining factor. An analysis of trade data demonstrates that the pharmaceutical supply chain for the EU market is not limited to EU's borders, but is spread across the globe. A quantification of the GWFs for metoprolol and ciprofloxacin shows that the environmental impact of pharmaceuticals varies considerably. For the EU consumer, a per capita GWF of 18.8 m^3/year was established for ciprofloxacin, whereas metoprolol resulted in a per capita GWF of 0.0055 m^3/year. This is only 0-3% of the total GWF of pharmaceuticals, which also includes the GWF of pharmaceutical consumption.

Ultimately, this thesis demonstrates that the production-related GWF of pharmaceuticals is relatively small when compared to the consumption-related GWF. However, contamination of the environment is extremely local and consequently, environmental impacts can be severe. A lack of requirements on transparency in the pharmaceutical supply chain does not stimulate environmental stewardship, neither is environmental stewardship demanded through (EU) legislation. For this reason, it is advised to promote transparency in the supply chain and to incorporate environmental criteria in the regulatory framework regarding pharmaceutical manufacturing and market entry.

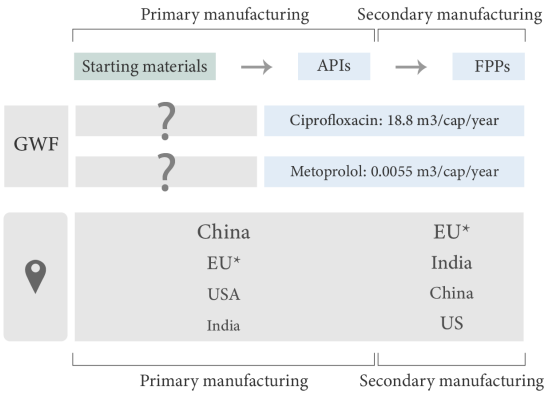


Figure 1: A coarse overview of the pharmaceutical manufacturing supply chain, its GWF and important production locations.

Gidde Tuitert

Graduation Date:
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Graduation committee:
University of Twente
Dr. M.S. Krol
L. Wöhler MSc

UNIVERSITY OF TWENTE.