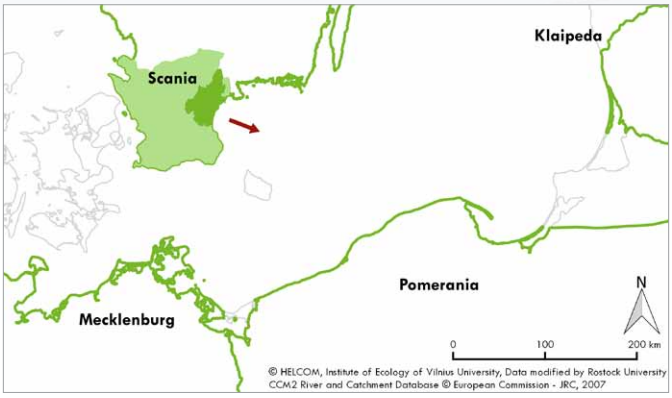
Estimating the local chemical pharmaceutical burden using chemical analysis of wastewater and surface water – The example of Diclofenac in Kristianstad Municipality, Region Skåne



In the MORPHEUS project we estimated the occurrence and load of pharmaceuticals in four areas of the South Baltic Sea. This included the released loads from selected WWTPs as well as the environmental occurrence of pharmaceutical substances downstream of the WWTPs in the coastal regions Skåne (Sweden), Mecklenburg (Germany), Pomerania (Poland) and Klaipėda (Lithuania).

In this article, we report on some of the findings from the Swedish model area Skåne and Kristianstad Municipality in the north east part of Skåne (Scania) as an example of a local assessment.

Figure 1. Sampling points of treated wastewater at the outlet of Kristianstad WWTP (1a, left) and Tollarp WWTP (1b, right).

In total 15 pharmaceuticals were evaluated in MORPHEUS, and here we present data for one of these which is much used in Sweden; Diclofenac.

In Kristianstad municipality there are several WWTPs. Here we focus on two, which both release their treated wastewater from the two cities Kristianstad and Tollarp into the Helge Å river system. The two WWTPs differ in size with the largest being Kristianstad WWTP (Figure 1a) treating a yearly wastewater volume of 8,186,000 m^3 from roughly 52,000 people and large food industries, while Tollarp WWTP (Figure 1b) treats 361,000 m^3 from 4,790 people and food industries.

Samples were taken in the outlet water of both WWTPs and the Diclofenac concentrations obtained were 579 ng/l and 646 ng/l for Kristianstad and Tollarp WWTP, respectively (average of a summer and a winter sample). By multiplying this concentration by the yearly volume of treated wastewater, the total released burden of Diclofenac was calculated to be 4.7 kg from Kristianstad WWTP and 0.23 kg from Tollarp WWTP (Figure 2).

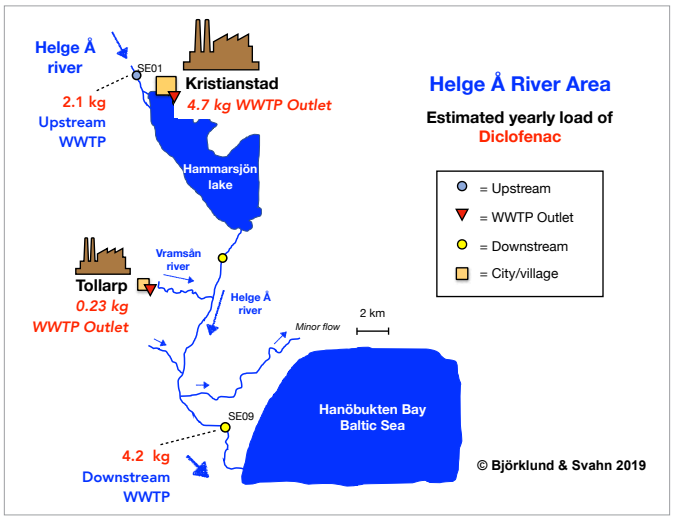


Figure 2. Schematic overview of the Helge Å river area within the UNESCO Biosphere Reserve "Vattenriket". In the picture, four sampling points are indicated; the upstream sampling in Helge Å river (SE01, Fig. 3), Kristianstad WWTP outlet (Figure 1a), Tollarp WWTP outlet (Fig. 1b) and the downstream sampling point in Helge Å river. (SE09, Header).

The lower part of Helge Å river, including the Hammarsjön Lake, is a unique wetland and was given the status of a UNESCO Biosphere Reserve in 2005 with the name "Vattenriket". The area holds a great variety of species of which many are red listed. The Helge Å river has a length of almost 200 km and an average yearly flow of around 37 m^3/s (2016). The Helge Å river enters Lake Hammarsjön in the northwest corner and flows through the lake to the south. Kristianstad WWTP releases its wastewater into the northeast corner of Lake Hammarsjön.

The Vramsån river is a tributary of the main Helge Å river and is one of Europe's finest places for a number of bivalves. The Vramsån river has a length of 55 km and an average flow of 3.4 m^3/s (2016), and enters the Helge Å river downstream from Tollarp WWTP which releases its wastewater into the Vramsån river. All together the Helge Å river and the Vramsån river represent very different types of dilution scenarios. Additionally, the UNESCO Biosphere reserve, including the two rivers and Lake Hammarsjön, is a great example of an area with high ecological value and sensitivity.

In order to study the presence of pharmaceuticals in the UNESCO Biosphere Reserve "Vattenriket", as a consequence of the release of pharmaceuticals from WWTPs in the area, two sampling points were chosen. One of these was a sampling point called SE01 upstream from Kristianstad WWTP (Figure 2 and Figure 3). Here the background concentration of Diclofenac was ca. 1 ng/l. By multiplying this value by the average yearly flow of the Helge Å river, it shows that roughly 2.1 kg of Diclofenac enters the UNESCO Biosphere Reserve "Vattenriket" yearly. This load comes from upstream WWTPs. There are more than 30 WWTPs that discharge along the Helge Å river, which are a major source of pharmaceuticals entering the UNESCO Biosphere Reserve "Vattenriket".

Figure 3. Sampling point SE01 in Helge Å river, upstream of Kristianstad wastewater treatment plant, see Figure 2.

If the purpose is to decrease the total amount of pharmaceuticals that enter the entire river system, Kristianstad WWTP should be equipped with advanced treatment technologies to remove 4.7 kg of Diclofenac. The next step would be to contact adjacent municipalities, upstream from the Helge Å river system, to ask them to take actions to reduce the extra 2 kg of Diclofenac that is entering at the upstream point of Lake Hammarsjön. Thirdly, Tollarp WWTP should implement advanced treatment technology to take out 0.23 kg of Diclofenac.

From a concentration perspective, Kristianstad WWTP should once again be equipped with advanced treatment technology, since the concentration of Diclofenac in the north-eastern bay of Lake Hammarsjön is almost 400 ng/l. This is 4 times higher than the concentration stated by the Swedish Agency for Marine and Water Management of 100 ng/l which must not be exceeded to classify the environmental status of the surface water as good. The reason for this high concentration is poor dilution since the Helge Å river does not pass directly through this more stagnant part of the lake. Secondly Tollarp WWTP should be upgraded since the concentration here is roughly 10 ng/l which is relatively high compared to the upstream point in Helge Å river which is in the order of 1 ng/l.

Finally, a point downstream of all WWTPs, called SE09 (Figure 2), was analysed and shown to contain ca 2 ng/l of Diclofenac. This showed that roughly 4.2 kg of Diclofenac will enter the Baltic Sea annually from the Helge Å river system.

All together the work conducted in Kristianstad municipality and the UNESCO Biosphere Reserve "Vattenriket" is an example of how the monitoring of released pharmaceuticals in a specific area can be used to make better-informed and knowledge-based decisions on where to take action to start reducing the chemical burden on the South Baltic Sea.

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