DETERMINATION OF THE ENVIRONMENTAL FOOTPRINT OF THE ANTHROPIC WATER CYCLE USING LCA

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Introduction

In its Regional Policy Statement for 2009-2014, the Walloon Government (Belgium) undertakes to make Wallonia a model of good governance. Applying this principle in the field of the environment needs to be based on a continuous, objective and strict evaluation of the evolution of the state of environmental components (air, water, soil, biodiversity, etc.), the pressures to which they are subjected, the resultant impacts and the measures taken to improve living conditions within our Region. Within this framework, the General Operational Direction of Agriculture, Natural Resources and Environment (DGARNE) realizes reports on the state of the environment in Wallonia, in close collaboration with universities and research centers. A chapter is dedicated to the efficient use of water resources, including a **life cycle assessment of anthropic water**.

Materials and Methods

Goal definition

The aim of this study is to assess environmental impacts of anthropic water consumed by Walloon citizens, from its collection to its discharge and treatment. The study also includes the collection and consumption of 7% of rainwater in addition of the tap water.

Methods

The environmental impacts of anthropic water is assessed using the Life Cycle Assessment methodology, ILDC 2011 [2] and ReCiPe 2008 methods (European hierarchist version, update 2014) [3]. This study is done in accordance with the ISO standards 14040 [4] and 14044 [5]. Figure 1 presents common steps of the water cycle. The different impacts are compared with the European reference. The functional unit is 1 m^3 of water for the Walloon citizen's consumption (including both tap water and rainwater). Time reference is year 2010.

A model for the whole water cycle is elaborated in order to assess the impact of the different steps of the process, and to emphasize the importance of the different elements in each step. The model includes seven essential phases: 1/ collection and treatment of surface and ground water, 2/ water mains, distribution and connections, 3/ rainwater harvest, 4/ sewers, 5/ municipal wastewater treatment plants, 6/ compact domestic wastewater treatment plants, and 7/ water elimination without any treatment. Inventory includes construction materials, chemicals consumption, energy consumption, output water streams (liquid discharge and sludges). Construction, earthwork, transport of materials and chemicals, and direct land use, are not included in LCI.

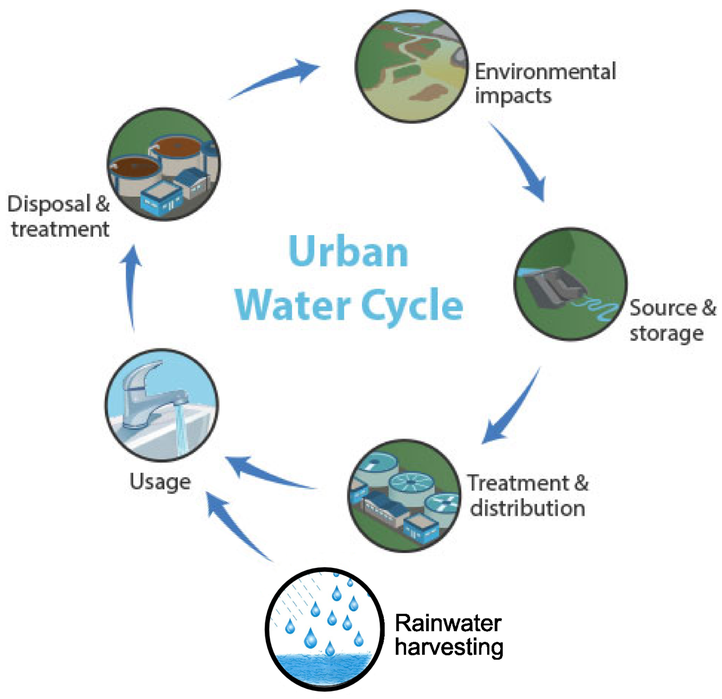

Figure 1. Water Cycle Stages [1]

Results and Discussion

Main results

Results of this study are presented in Figure 2 and 3, and permit to highlight which steps of the anthropic water cycle reach the most impact in each category. The commercial Ecoinvent database [6] is used for generic data needed of the model. Electricity corresponds to the Walloon regional mix as it was in 2010.

Main results of this study are summarized below:

- **Most impacting phases of the cycle are:** (Figure 2)
  - municipal wastewater treatment plant,
  - collection and treatment,
  - distribution,
  - discharge without treatment
- **Most impacted categories are:** (Figure 3)
  - eutrophication,
  - human toxicity,
  - ecotoxicity,
  - natural land transformation

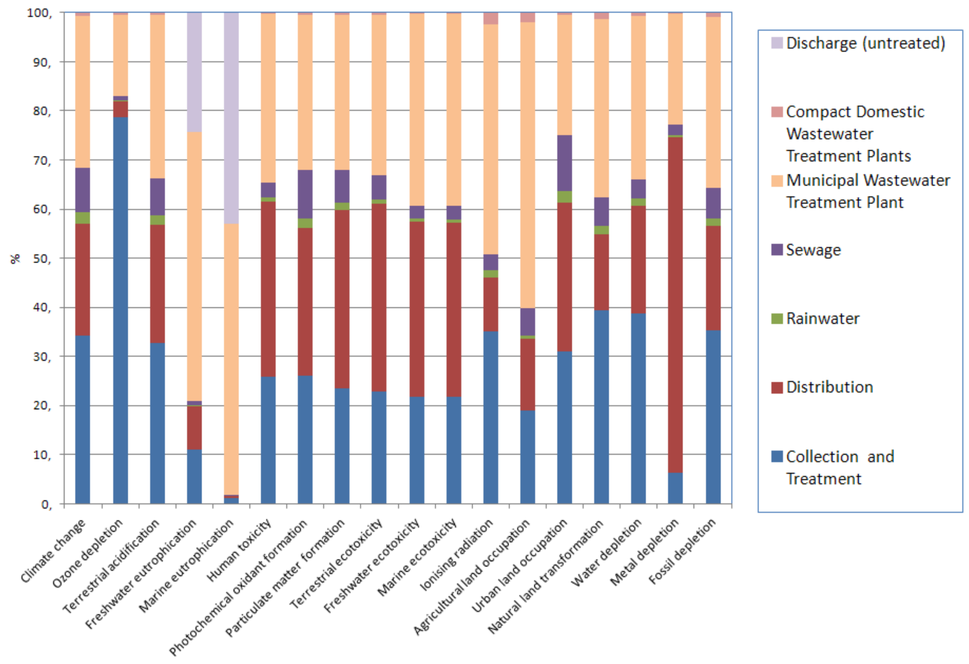

Figure 2: Relative contribution of each step of anthropic water

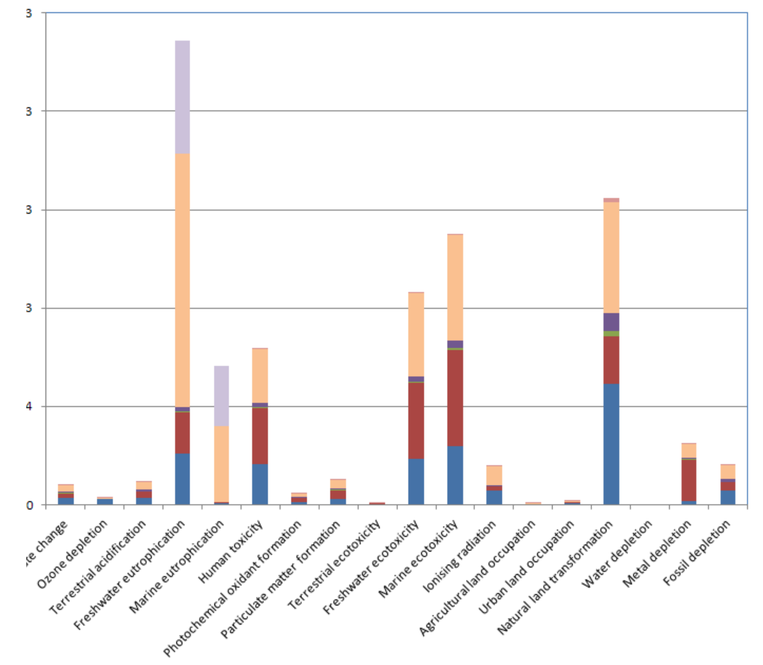

Figure 3: Normalisation of impact of anthropic water

Conclusions

Life cycle assessment of anthropic water points up the way that water consumption by Walloon citizens affects globally the environment. The most impacting steps of the process are highlighted as well as the most affected impact categories. The survey of the way each step influences negatively ecosystems provides some approaches to improve the global environmental impact of human water consumption in the future.

Remark: the environmental impact related to the daily consumption of water by one person (100 L) corresponds globally to a 700 m journey by car!

References

[1] http://www.usaus-h2o.org/modules/source-and-storage/

[2] European Commission - Joint Research Centre - Institute for Environment and Sustainability (2010). International Reference Life Cycle Data System (ILCD) Handbook - General guide for Life Cycle Assessment - Detailed guidance. First edition March 2010. EUR 24708 EN. Luxembourg., Publications Office of the European Union.

[3] Goedkoop, M., et al., ReCiPe 2008 - A life cycle impact assessment method which comprises harmonised category indicators at the midpoint and the endpoint level, Ruimte en Milieu, Editor 2009.

[4] ISO, ISO 14040 : Management environnemental - Analyse du cycle de vie - Principes et cadre, 2006, ISO.

[5] ISO, ISO 14044 : Management environnemental - Analyse du cycle de vie - Exigences et lignes directrices, 2006, ISO

[6] Ecoinvent Centre, The life cycle inventory data version 3.01, 2014. Swiss Center for Life Cycle Inventories.