

Report of activities – Phase 2 of the Life Cycle Initiative

Water Use in LCA (WULCA)

Project title:

Assessment of use and depletion of water resources within the LCA Framework

The WULCA working group works as an international working group focusing on water use assessment and water footprinting taking the life cycle perspective. The group was founded in August 2007 within the Phase 2 program under the auspices of the UNEP/Society for Environmental Toxicology and Chemistry (SETAC) Life Cycle Initiative. The working group represents a community of people from academia, various industries (e.g. chemical, food and consumer goods industry, pulp and paper, water treatment, etc.) and public institutions. Constituting a multi-stakeholder group, the group acts globally and cross-sectoral.

The WULCA working group's overall goal focuses on providing practitioners, from both industry and academia, with a coherent framework within which to measure, assess and compare the environmental performance of products and operations regarding freshwater use and their impacts on water. The specific objectives comprise to:

- Develop a general assessment framework for assessing water use including indicators that measure the environmental impacts on human health, ecosystems and freshwater resources;
- Establish adequate water inventory schemes and parameters;
- Establish impact assessment methods for characterizing water use and related environmental impacts;
- Derive recommended practice and guidance for LCA method developers and practitioners.

Objectives 1 and 2 were accomplished with a peer-reviewed publication (Bayart et al. 2010), and objective 3 and 4 have progressed but are have not been completed yet. Preliminary guidance to different stakeholder groups is given in a second publication (Kounina et al. accepted, INT J LCA). Below is the summary of the two main deliverables of the group during Phase 2. More work is required to achieve a consensual method and concrete recommendations to practitioners.

1- A general framework was provided for assessing impacts from water use in Life Cycle Assessment in order to support further quantitative modeling of the cause-effect chain relationships of water use (Bayart et al., 2010). The framework includes recommendations for life cycle inventory (LCI) modeling and provides a description of possible impact pathways for life cycle impact assessment (LCIA), including indicators on midpoint and endpoint levels that reflect different areas of protection (AoP).

2- A review of current methods and approaches addressing freshwater use in life cycle inventory and impact assessment was performed. This work (Kounina et al, accepted, INT J LCA) reviewed several

methodologies describing the inventory and impact assessment of freshwater use potentially applicable in LCA. This review is used as a base to identify the key elements to build a scientific consensus for an operational water characterization method for LCA and can be considered as a complement to the Handbook on good practice released by the JRC which actually fails to represent state-of-the-art description in LCA.

This work, along with training and communication activities has established WULCA as an expert group with about 50 members from four continents. The current project webpage can be found here: <http://wulca-waterlca.com/>.

List of active members:

- **Bayart, Jean-Baptiste**; Quantis, Lausanne, Switzerland and Paris, France / Veolia, Paris, France
- **Berger, Markus**; Technische Universität Berlin, Germany
- **Boulay, Anne-Marie**; CIRAI, École Polytechnique of Montréal, Canada
- **Bulle, Cecile**; CIRAI, École Polytechnique of Montréal, Canada
- **Frischknecht, Rolf**; ESU Service Ltd, Uster, Switzerland
- **Humbert, Sebastien**; Quantis, Lausanne, Switzerland and Paris, France
- **Koehler, Annette**; PE International, Winterthur, Switzerland
- **Kounina, Anna**; Ecole Polytechnique Fédérale de Lausanne, Switzerland / Quantis, Lausanne, Switzerland and Paris, France
- **Margni, Manuele**; Quantis, Lausanne, Switzerland and Paris, France / CIRAI, École Polytechnique of Montréal, Canada
- **Milà i Canals, Llorenç**; Safety and Environmental Assurance Centre, Unilever R&D, Colworth Science Park, Sharnbrook, Bedford, MK44 1LQ, UK
- **Motoshita, Masaharu**; National Institute of Advanced Industrial Science and Technology, Tsukuba, Japan
- **Núñez, Montserrat**; IRTA, Cabrils, Spain
- **Peters, Gregory**; Chalmers University of Technology, Gothenburg, Sweden
- **Pfister, Stephan**; ETH Zurich, Institute of Environmental Engineering, Zurich, Switzerland / Aveny GmbH, Zurich, Switzerland / UC Santa Barbara, United States
- **Ridoutt, Brad**; CSIRO, Clayton South VIC, Australia
- **Verones, Francesca**; ETH Zurich, Institute of Environmental Engineering, Zurich, Switzerland
- **Zelm, Rosalie van**; Radboud University, Nijmegen, Netherlands

Several meetings have been organized for informing the research community and interested people from industry, government and academia on the ongoing activities:

List of meetings (on-site meetings only) :

- **Kick-off meeting, 30 August, 2007; LCM 2007 Conference; Zurich, Switzerland.**

- **Annual Meeting, 25 May, 2008; SETAC Europe Annual Meeting; Warsaw, Poland.**
- **Annual Meeting, 31 May, 2009; SETAC Europe Annual Meeting; Göteborg, Sweden.**
- **Annual Meeting, 24 May, 2010; SETAC Europe Annual Meeting; Seville, Spain.**
- **Annual Meeting, 15 May, 2011; WULCA Working Group Meeting, SETAC Annual Meeting; Milano, Italy.**
- **Annual Meeting, 20 May, 2012; WULCA Annual Meeting, SETAC World; Berlin, Germany.**

WULCA harmonized the efforts to efficiently close the most important gaps in LCI and LCIA regarding water use and also facilitated cooperation among research groups. This resulted in several papers by participants of the working group:

List of papers benefitting from WULCA:

- All papers documenting methods being analyzed and compared in the review of methodologies by Kounina et al (2012). Extensive list of papers can be found at the end of this document.

Furthermore WULCA presented the work on many conferences:

List of WULCA presentations:

- **Review of methods addressing freshwater use in life cycle inventory and impact assessment; Kounina et al..**
- **Water footprint: Stand alone method or impact category within life cycle assessment?; Berger, Humbert.**
- **Water in life cycle assessment: Review of methods; Kounina et al. 2009; 01 October, 2009; LCA IX, Boston MA; Boston, USA.**
- **Qualitative characterization of available assessment methods assessing human water use. Review of methods addressing water in LCA; Humbert et al. 2010; 24 May, 2010; WULCA, SETAC Sevilla; Sevilla, Spain.**
- **Assessment and responses strategies of water footprints: specific product categories; Pfister 2012; 14 March, 2012; 6th World Water Forum; Marseille, France.**
- **Review of methods addressing freshwater use in life cycle inventory and impact assessment; Kounina et al. 2012; 20 May, 2012; SETAC Berlin - WULCA meeting; Berlin, Germany.**
- **Water use in life cycle assessment and water footprinting: outputs and prospects of the working group WULCA; Pfister et al. 2012; 21 May, 2012; SETAC World Congress 2012; Berlin, Germany.**
- **Review of methods addressing freshwater use in life cycle inventory and impact assessment; Humbert et al. 2012; 25 September, 2012; LCAXII, Tacoma; Tacoma, USA.**

WULCA was actively outreaching to other initiatives dealing with water use assessments and water footprinting, such as WBCSD and WRI, WFN, WWF, and the standardization process of the new ISO standard 14046 on water footprinting. Partly these outreach activities were intensified in closer collaborations (e.g. ISO standardization and WFN).

Also WULCA was contributing to the goals at the World Water Forum and actively participating in dissemination through UNEP's related water programs.

List of papers benefitting from WULCA:

Bayart J-B, Bulle C, Deschênes L, Margni M, Pfister S, Vince F, Koehler A (2010) A framework for assessing off-stream freshwater use in LCA. *The International Journal of Life Cycle Assessment* 15 (5):439-453

Bayart J, Grimaud J, E A (2011) The Water Impact Index: a simplified single-indicator approach for water footprinting. *The International Journal of Life Cycle Assessment* (submitted)

Boesch M, Hellweg S, Huijbregts M, Frischknecht R (2007) Applying cumulative exergy demand (CExD) indicators to the ecoinvent database. *The International Journal of Life Cycle Assessment* 12 (3):181-190

Boulay A-M, Bouchard C, Bulle C, Deschênes L, Margni M (2011a) Categorizing water for LCA inventory. *The International Journal of Life Cycle Assessment* 16 (7):639-651

Boulay A-M, Bulle C, Bayart J-B, Deschênes L, Margni M (2011b) Regional characterization of freshwater use in LCA: modeling direct impacts on human health. *Environmental Science and Technology*

Falkenmark M, Lundqvist J, Widstrand C (1989) Macro-scale water scarcity requires micro-scale approaches. *Aspects of vulnerability in semi-arid development. Natural Resources Forum* 13 (4):258-267

Frischknecht R, Steiner R, Braunschweig A, Egli N, Hildesheimer G (2006) *Swiss Ecological Scarcity Method: The New Version 2006*. Swiss Federal Office for the Environment (FOEN), Zurich and Bern, Switzerland

Gleick PH (1996) Basic Water Requirements for Human Activities: Meeting Basic Needs. *Water International* 21 (2): 83-92

Hanafiah M, Xenopoulos M, Pfister S, Leuven RS, Huijbregts M (2011) Characterization factors for water consumption and greenhouse gas emissions based on freshwater fish species extinction. *Environment Science and Technology* 45 (12):5272–5278

Hoekstra AY, Chapagain AK, Aldaya MM, Mekonnen MM (2011) *The water footprint assessment manual: setting the global standard*. Water Footprint Network. Enschede, the Netherlands

Jolliet O, Müller-Wenk R, Bare J, Brent A, Goedkoop M, Heijungs R, Itsubo N, Pena C, Pennington D, Potting J, Rebitzer G, Stewart M, de Haes H, Weidema B (2004) The LCIA midpoint-damage framework of the UNEP/SETAC life cycle initiative. *The International Journal of Life Cycle Assessment* 9 (6):394-404

Maendly R, Humbert S (2011) Empirical characterization model and factors assessing aquatic biodiversity damages of hydropower water use *The International Journal of Life Cycle Assessment*, Submitted

Milà i Canals L, Chenoweth J, Chapagain A, Orr S, Antón A, Clift R (2009) Assessing freshwater use impacts in LCA: Part I — inventory modelling and characterisation factors for the main impact pathways. *The International Journal of Life Cycle Assessment* 14 (1):28-42

Motoshita M, Itsubo N, Inaba A (2010a) Damage assessment of water scarcity for agricultural use. *Proceedings of 9th international conference on EcoBalance*. D1-1410. National Institute of Advanced Industrial Science and Technology (AIST)

Motoshita M, Itsubo N, Inaba A (2010b) Development of impact factors on damage to health by infectious diseases caused by domestic water scarcity. *The International Journal of Life Cycle Assessment* 16 (1):65-73

Ohlsson L (2000) Water conflicts and social resource scarcity. *Physics and Chemistry of the Earth, Part B: Hydrology, Oceans and Atmosphere* 25 (3):213-220

Owens JW (2001) Water Resources in Life-Cycle Impact Assessment: Considerations in Choosing Category Indicators. *Journal of Industrial Ecology* 5 (2):37-54

Pfister S, Bayer P, Koehler A, Hellweg S (2011) Environmental Impacts of Water Use in Global Crop Production: Hotspots and Trade-Offs with Land Use. *Environmental Science and Technology* 45 (13):5761-5768

Pfister S, Koehler A, Hellweg S (2009) Assessing the Environmental Impacts of Freshwater Consumption in LCA. *Environmental Science and Technology* 43 (11):4098-4104

Raskin P, Gleick P, Kirshen P, Pontius G, Strzepek K (1997) *Water Futures: Assessment of Long-range Patterns and Prospects*. Stockholm, Sweden

Ridoutt BG, Pfister S (2010a) Reducing humanity's water footprint. *Environmental Science and Technology* 44 (16):6019-6021

Ridoutt BG, Pfister S (2010b) A revised approach to water footprinting to make transparent the impacts of consumption and production on global freshwater scarcity. *Global Environmental Change* 20 (1):113-120

Ridoutt BG, Williams SRO, Baud S, Fraval S, Marks N (2010) Short communication: The water footprint of dairy products: Case study involving skim milk powder. *Journal of Dairy Science* 93 (11):5114-5117

Seckler D, Amarasinghe U, Molden DJ, de Silva R, Barker R (1998) World Water Demand and Supply, 1990 to 2025: Scenarios and Issues. IWMI Research Report vol 19. IWMI, Colombo, Sri Lanka

Smakhtin V, Revenga C, Döll P (2004) A Pilot Global Assessment of Environmental Water Requirements and Scarcity. *Water International* 29 (3):307-317

Sullivan C, Meigh J, Giacomello A (2003) The Water Poverty Index: Development and application at the community scale. *Natural Resources Forum* 27 (3):189-199

van Zelm R, Schipper AM, Rombouts M, Snepvangers J, Huijbregts MAJ (2011) Implementing Groundwater Extraction in Life Cycle Impact Assessment: Characterization Factors Based on Plant Species Richness for the Netherlands. *Environmental Science and Technology* 45 (2):629-635

WBCSD (2010) The global water tool. Accessible at: <http://www.wbcd.org>. Geneva, Switzerland

World

Xenopoulos MA, Lodge DM, Alcamo J, Märker M, Schulze K, Van Vuuren DP (2005) Scenarios of freshwater fish extinctions from climate change and water withdrawal. *Global Change Biology*