Germany's Water Footprint of Transport Fuels

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Introduction

Biofuel Expansion

- Climate
- Energy Security
- Targets set across the globe
- Focus lies mainly still on first-generation biofuels

Water Management

- Agriculture largest water consumer
- Multiple stressors on quantity and quality
- Water footprinting

Background

- Directive 2009/28/EC
  - 10% of all energy used in transport must come from renewable sources
  - Denominator includes petrol, diesel, biofuels, and electricity
- Concerns regarding sustainability of biofuels
  - ILUC contributes to worsened GHG balance (IPCC, 2011; Schroten et al., 2011)
  - Water use requirements present challenge (IPCC, 2011)
  - *Nachhaltigkeitsverordnung* should address these

Research Rationale

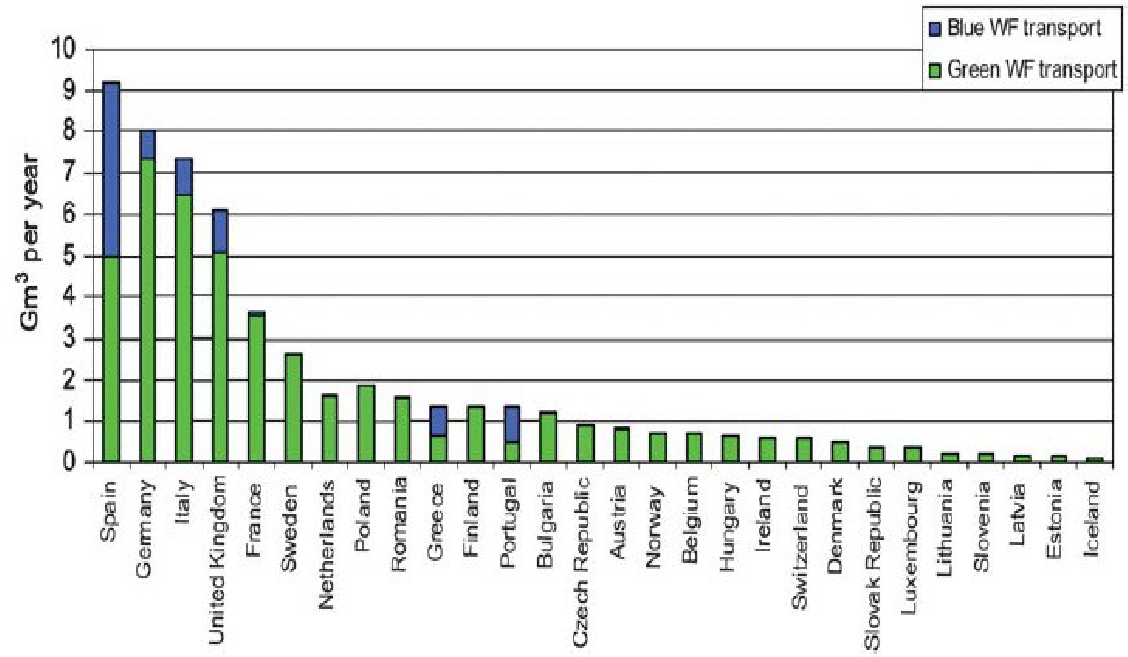

Fig. 1 The WF of the European transport sector if 10 percent of all transport fuels derive from bio-ethanol (first generation biofuel).

Source: Gerbens-Leenes and Hoekstra, 2011

"After consulting the author Hoekstra, it has become clear that the numerical values before the measuring unit Gm^3/yr are meant to designate $km^3/yr = 10^9\ m^3/yr$." (Schubert, 2011)

Research Rationale

- More specific and more accurate data for:
  - Transport fuel demand
  - Feedstock sources
  - Regional production

  Will allow for better picture of water footprint in German transport fuel sector
- Trade sensitivity analysis explores implications of importing biofuels from abroad (Özdemir et al., 2009)

Water Use and Biofuels

- German water withdrawals in 2007: over 20% of renewable resource (FAO, 2011)
  - Water stress by some definitions
  - Transport sector is today relatively water efficient
- Water is a regional resource
  - Effects in and outside of Germany clearly of interest
  - Meeting global biofuel targets could require additional 262 km^3 of freshwater (de Fraiture et al., 2007)
    - Countries like China and India, among others, at risk of increased regional water scarcity

The Water Footprint

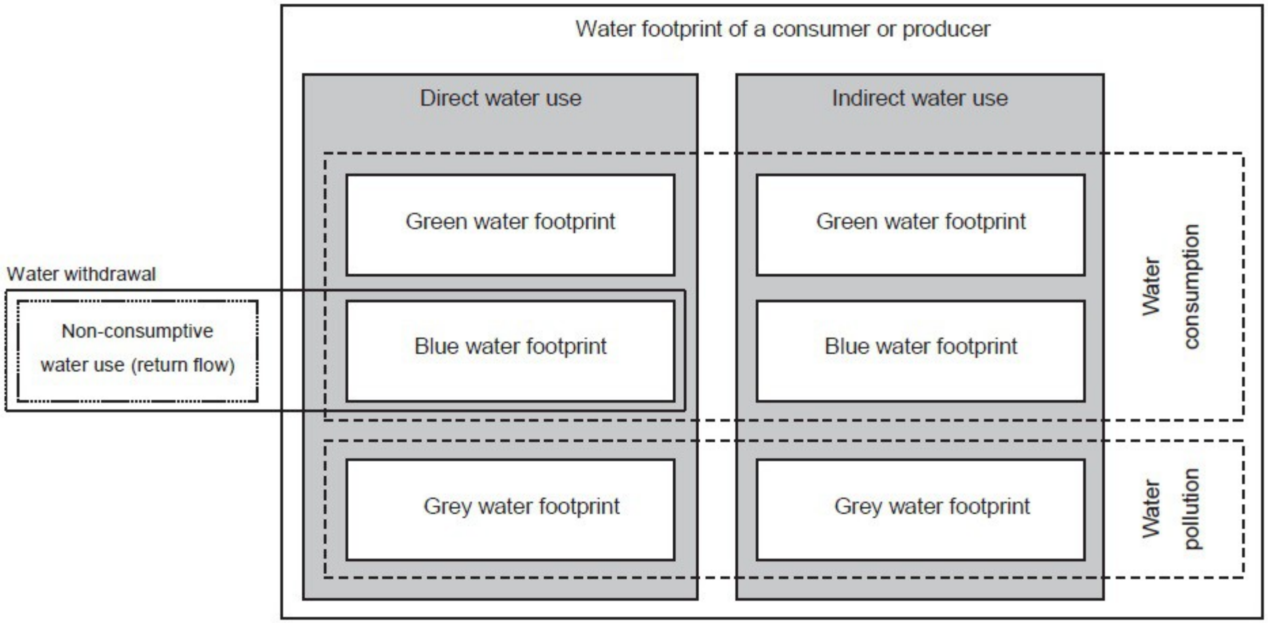

Figure 1.1 Schematic representation of the components of a water footprint. It shows that the non-consumptive part of water withdrawals (the return flow) is not part of the water footprint. It also shows that, contrary to the measure of 'water withdrawal', the 'water footprint' includes green and grey water and the indirect water-use component

Source: WF Assessment Manual (Hoekstra et al., 2011)

The Water Footprint

- Multidimensional indicator for capturing water use in production processes, countries, economic sectors
  - Comparing process efficiency
  - Position relative to consumption boundaries
  - Illuminating international resource distribution
- Lacking, however, as a policy tool
  - No operational definition of sustainability built into tool
  - Dynamically weak
  - Weak across borders
  - Lack of pricing ignores comparative advantage

Methodology

- Transport Demand
  - Projection of German transport energy demand in 2020 (Eichhammer, 2000)
  - Reflects falling trend in German transport fuel demand over last 10 years (Eurostat, 2012)
- Feedstock Sources
  - Domestic weighted by feedstock type (VDB, 2011)
    - Bioethanol: 2/3 Cereals, 1/3 Sugar Beets
    - Biodiesel/Plant Oil: 100% Rapeseed (Canola Oil)
  - Domestic and international footprints from Mekkonen and Hoekstra (2010)
- Regional Production
  - Regional data on feedstock production weights domestic water footprints (from various German government agencies)
  - International export countries (Özdemir et al., 2009)

Methodology

- Production Regions
  - Largest producers not necessarily those with largest WFs

  - Imported sources tend to have higher WFs

Table 2 Water footprints of various biofuels

Biofuel	Water Footprint (m^3/GJ)
Domestic	
Bioethanol	54.15
Biodiesel/Plant Oil	106.19
Imported	
Bioethanol (BR - Sugarcane)	58
Biodiesel/Plant Oil (BR - Soy)	351
Biodiesel/Plant Oil (Malaysia/Indonesia – Oil Palm)	129.5

Results

Table 3 Scenario results

Scenario	Incorporation Rate (%)	Biofuel Import % (by energy content)	Total WF (km^3)	External WF (km^3)	Ratio to Baseline	Ratio to Policy
Baseline	5.73	0	13.74	2.18	-	-
Baseline-Trade	5.73	60	21.24	16.62	1.55	-
Policy	10	0	22.26	2.08	1.62	-
Policy-Trade	10	60	35.35	27.28	2.57	1.59

Results

- Vary significantly from results of Gerbens-Leenes and Hoekstra (2011) [8 vs. 22.26 km^3]
- Policy scenario increase represents 7% of 117.6 km^3 total German water consumption for agriculture
- Trade scenarios show overall increase in footprint, but in different environmental contexts
  - Weakness of WF as indicator
  - Domestic feedstocks tend to have higher grey footprints

Results

- Assumptions of Gerbens-Leenes (2011)
  - Energy use in 2020
    - Equivalent to 2005 values
  - Fuels used
    - Most water efficient feedstocks and fuels available
      - German market currently supplied with 70% biodiesel
  - Footprint of non-biofuel road fuels
    - Ignore petroleum and diesel WFs

Conclusions

- Water footprint can only serve as guidepost in assessing policy
- Scarcity-adjusted management practices are necessary in order to avoid water resource misallocation
- Nonetheless, this analysis confirms that the water requirements of this legislation are significant and calls into question further expansion of first-generation biofuels

Questions, Comments?

THANK YOU FOR YOUR ATTENTION!

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