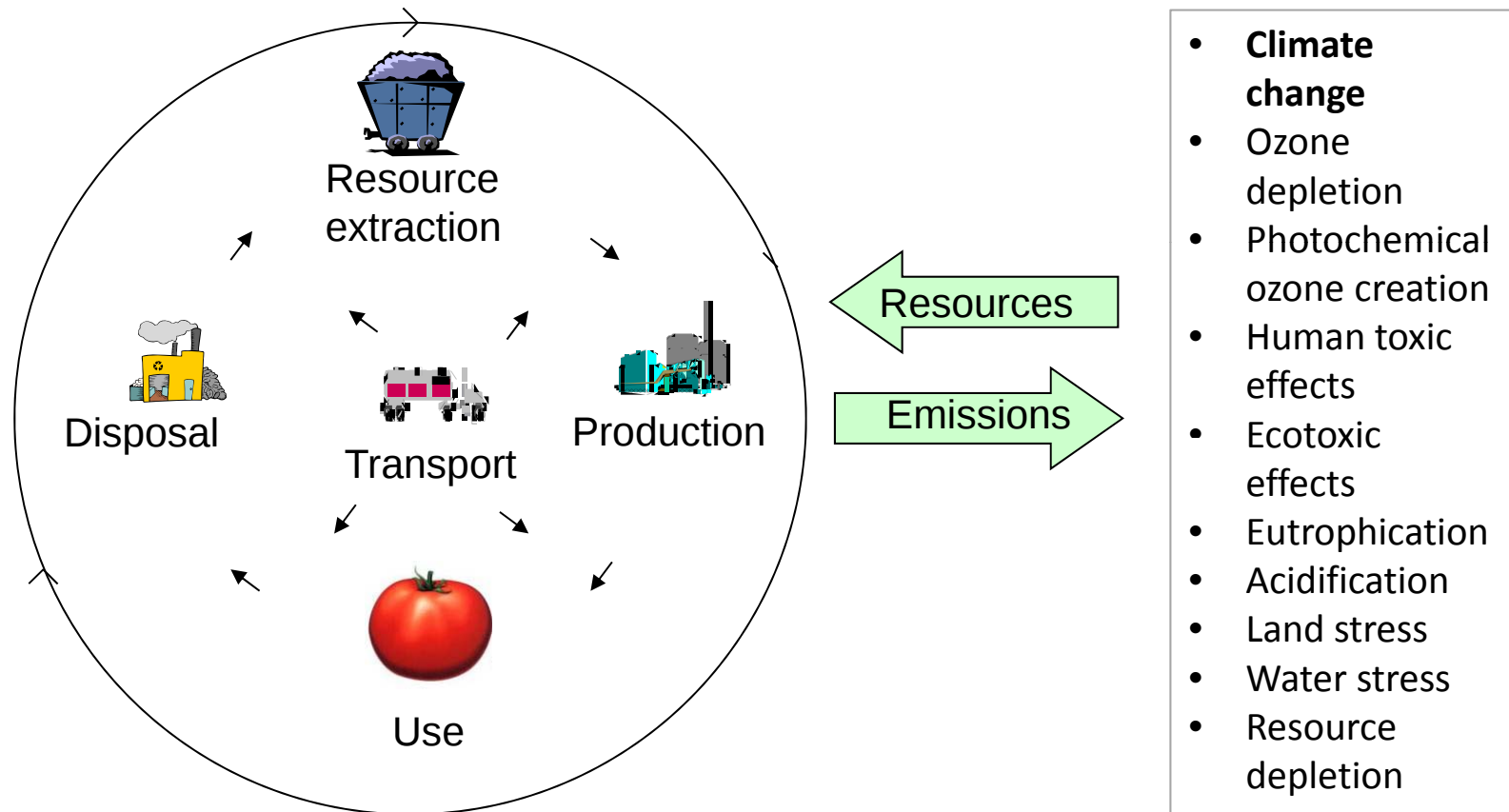


**Swiss Global Change Day  
Bern, 16 April 2013**

# **Consumption and the environment: Driving, eating, and heating ourselves towards a sustainable future**

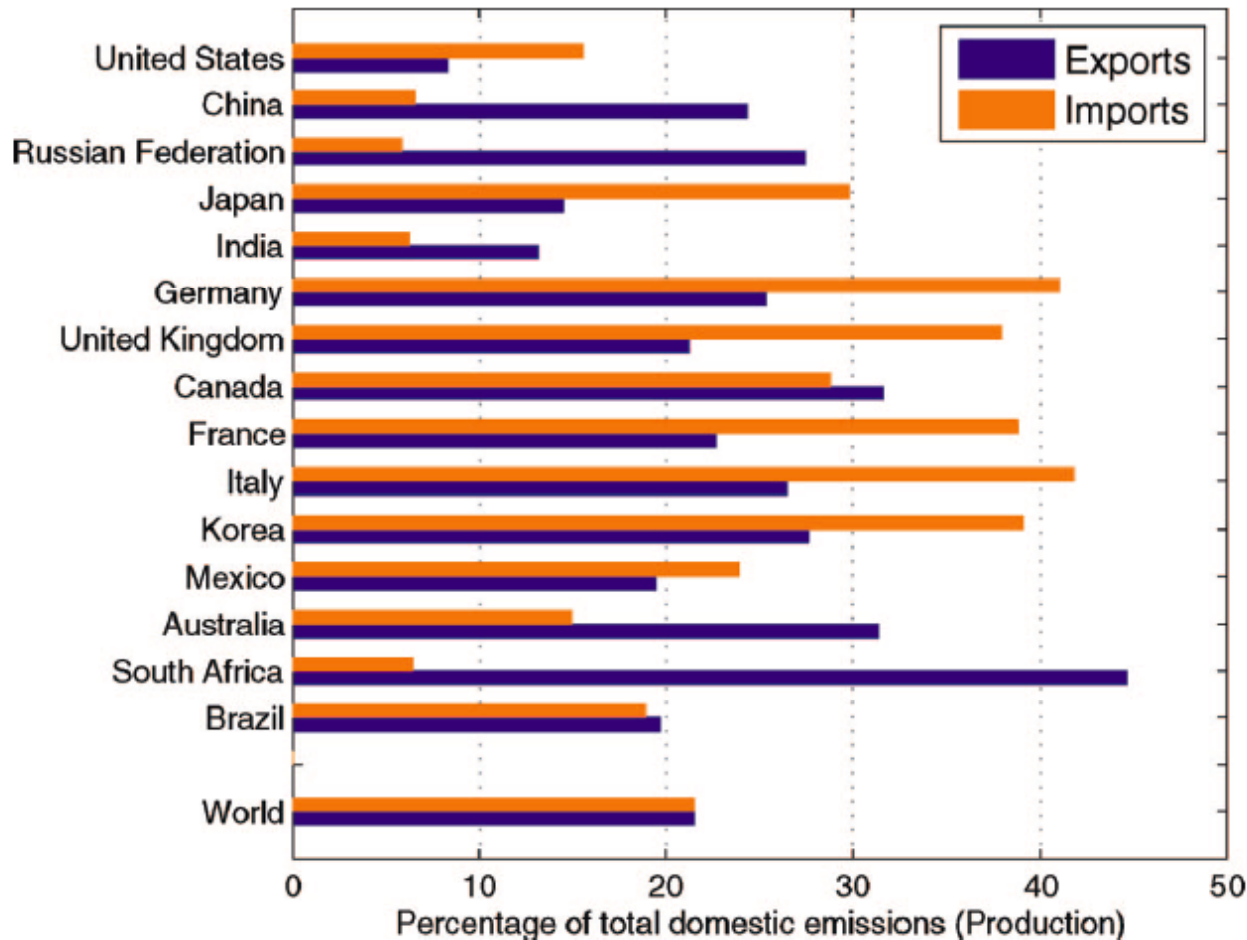
**Stefanie Hellweg  
ETH Zurich  
Institute of Environmental  
Engineering**

# Life Cycle Assessment (LCA)



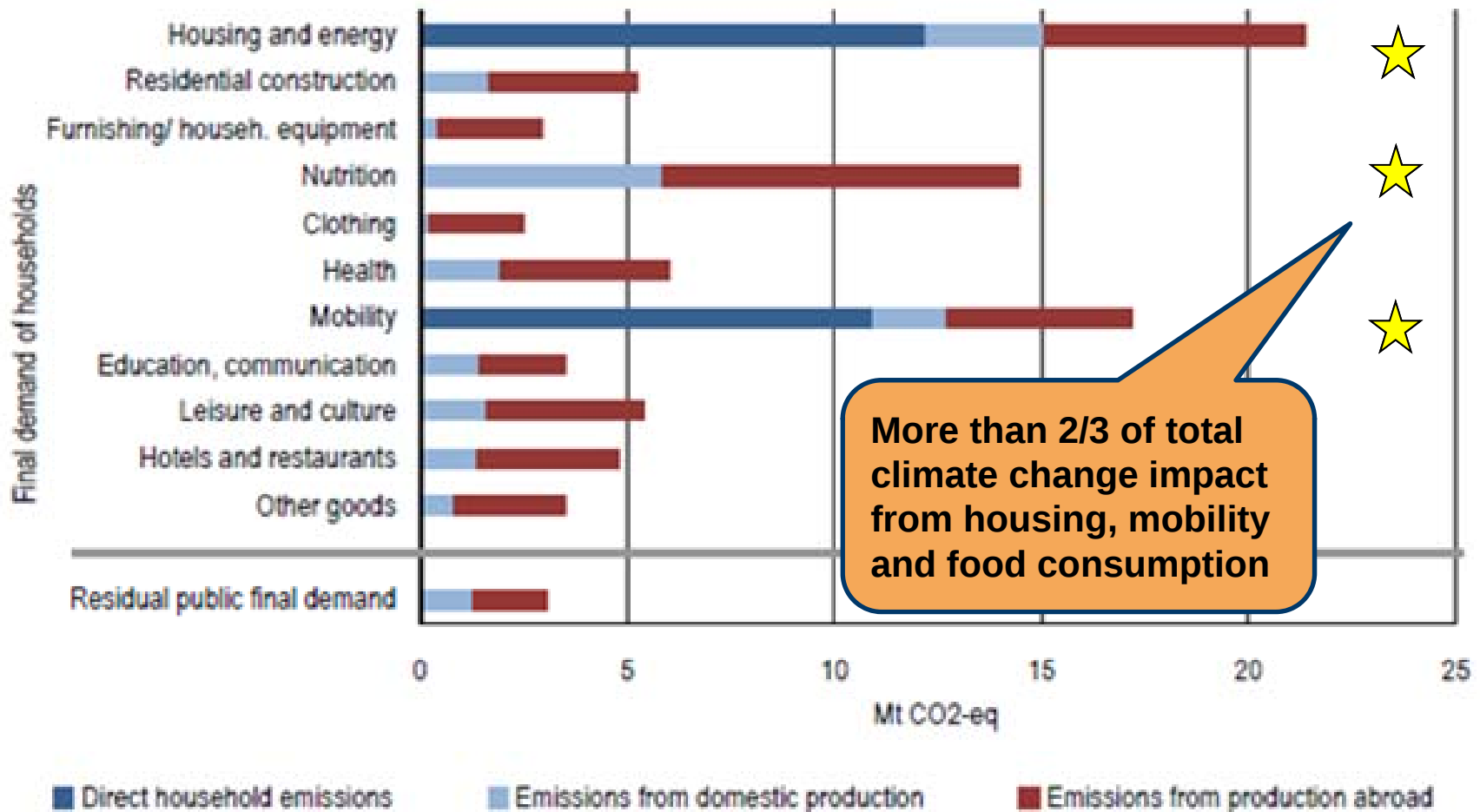
# LCA of consumption

Example: CO<sub>2</sub> embodied in international trade (Peters & Hertwich, ES&T 42 (5), 2008)



# Example: Swiss consumption

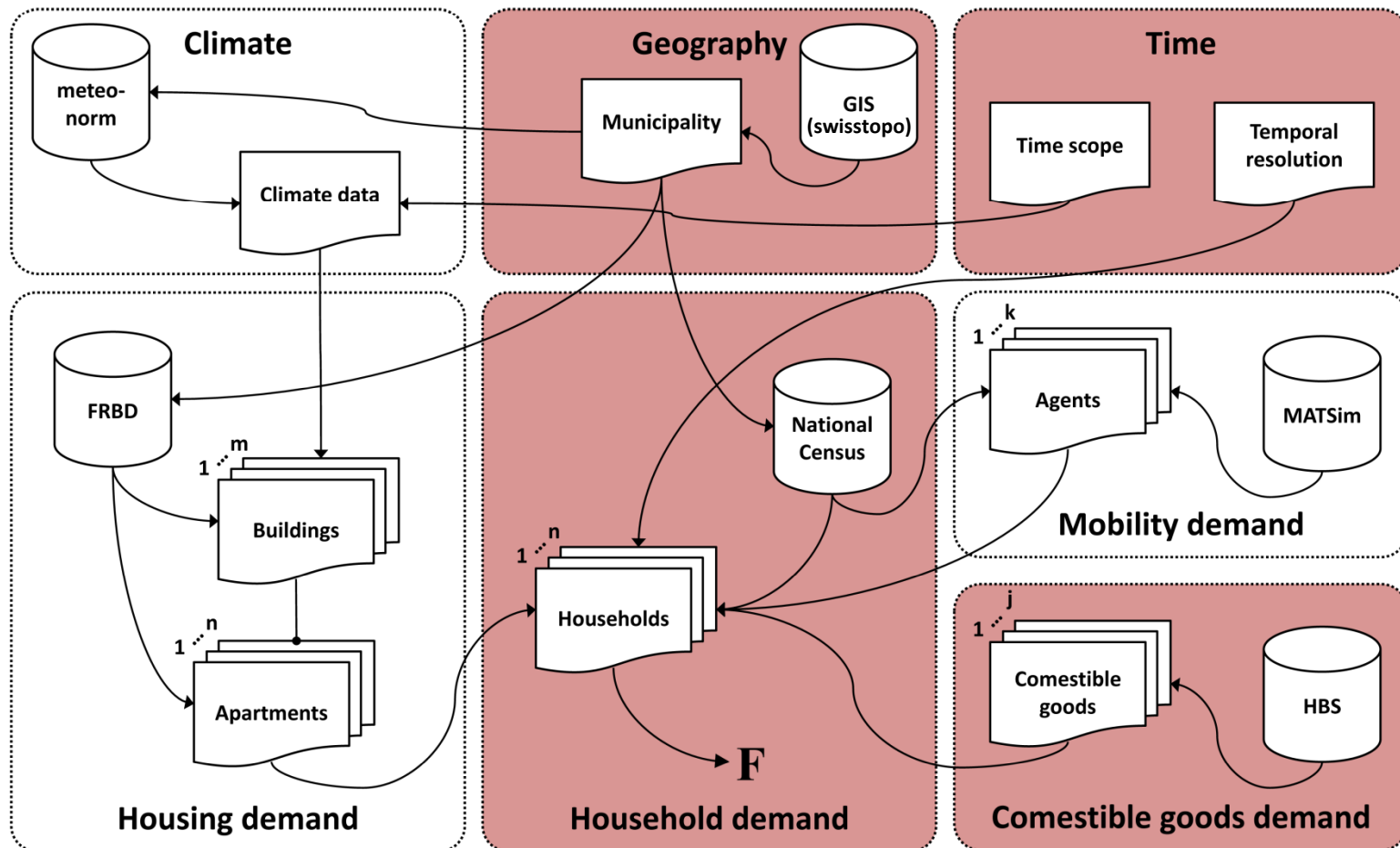
- On average 12 t CO<sub>2</sub>-eq. per capita and year (Jungbluth et al. 2011)



Source: calculation ESU-services Ltd. and Rütter+Partner

# Modeling consumption impacts of individuals

## housing, mobility, food



FRBD: Federal Register of Buildings and Dwellings  
HBS: Household Budget Survey

MATSim: Multi-Agent Transport Simulation  
GIS: Geographic information system

Source: Ph.D. thesis Dominik Saner, ETH Zurich, 2013

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# Housing

- Heat, warm water, electricity, infrastructure
- Heat balance for every apartment (based on SIA norm)

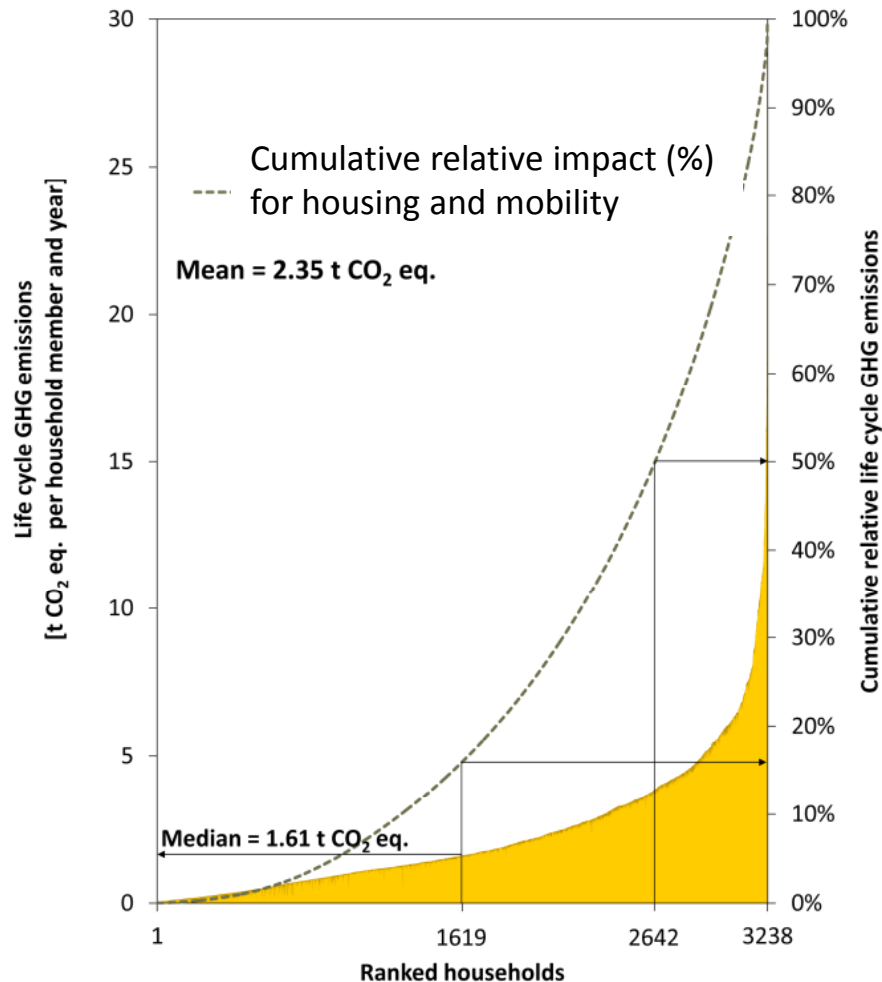
$$Q_h = \sum_{t=t_{begin}}^{t_{end}} (Q_{T,t} + Q_{V,t}) - \eta_g \cdot (Q_{s,t} + Q_{iP,t} + Q_{iEl,t})$$

Diagram illustrating the heat balance equation for a building, with labels and arrows indicating the components:

- Heat demand** points to  $Q_h$ .
- Transmission losses** points to  $Q_{T,t}$ .
- Ventilation losses** points to  $Q_{V,t}$ .
- Solar gains** points to  $Q_{s,t}$ .
- Internal gains** points to  $Q_{iP,t}$ .
- Waste heat electricity use** points to  $Q_{iEl,t}$ .
- Heat storage capacity of building** points to the efficiency factor  $\eta_g$ .

Source: Ph.D. thesis Dominik Saner, ETH Zurich, 2013

# Results: Per-capita climate change impact of housing (example of the municipality of Wattwil)



Source: Ph.D. thesis Dominik Saner, ETH Zurich, 2013

# Mobility (only land-based transport)

## Model:

- MATSim: agent based transport model
- Car, public transportation, bikes, walking
- Travel distance and used vehicle for all inhabitant

## Validation:

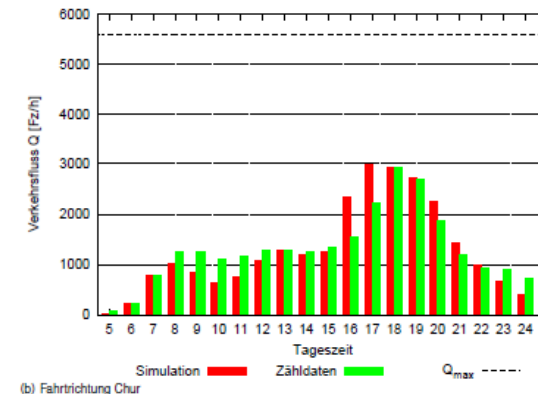
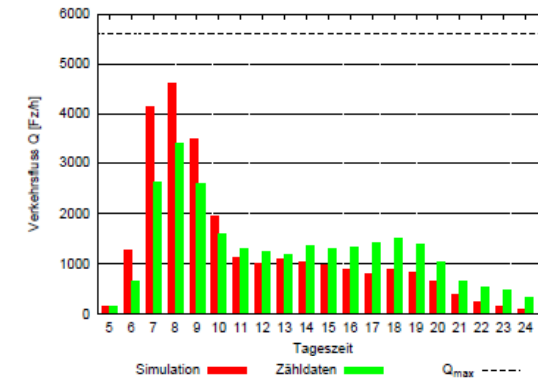
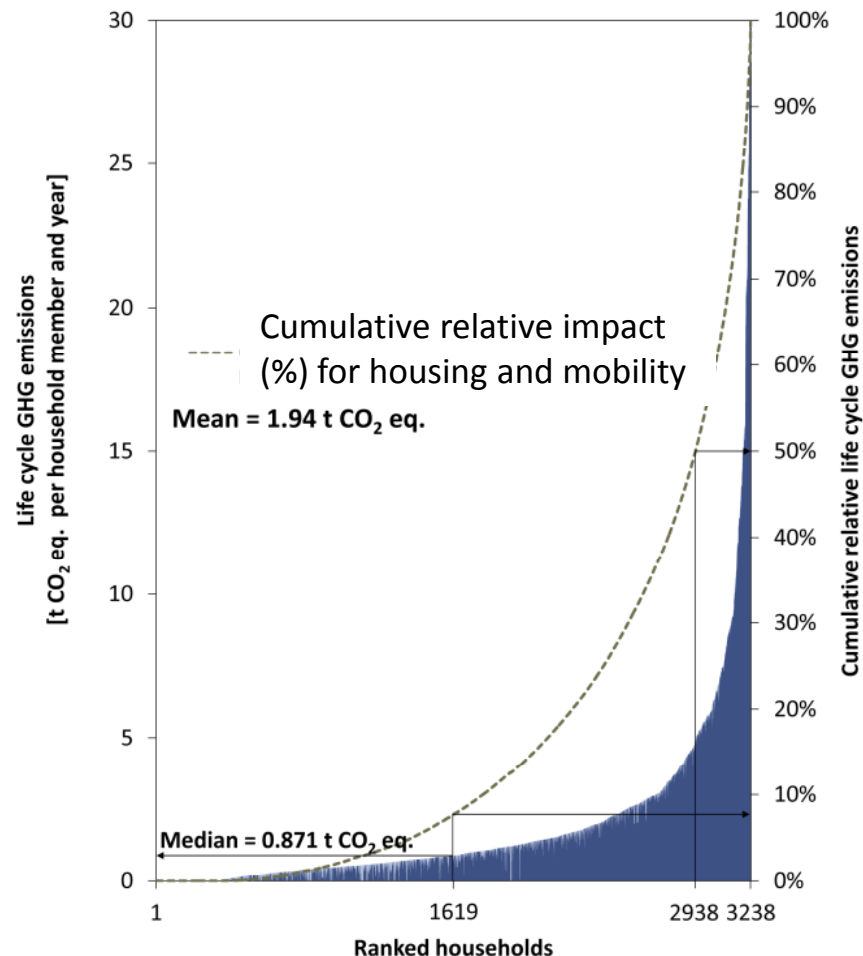


Abbildung 7: Vergleich Simulation - Zählstelle: Autobahn A3, Höhe Adliswil

Meister et al. (2008)

# Results: Per-capita climate change impact of land-based mobility (example of Wattwil)

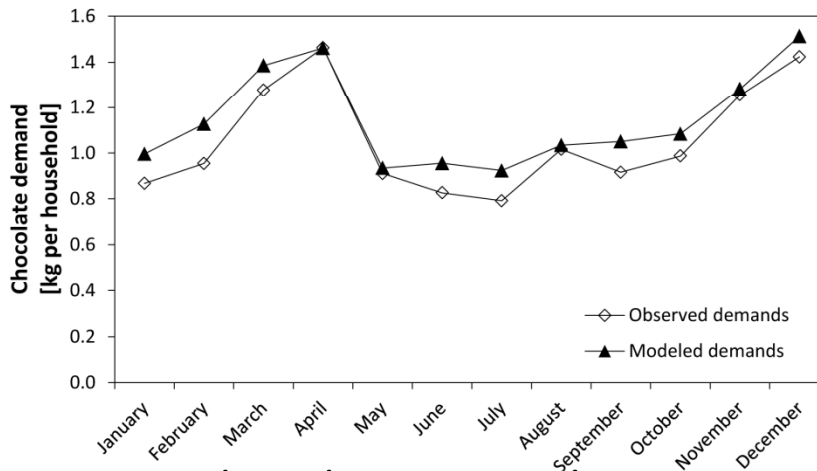


Source: Ph.D. thesis Dominik Saner, ETH Zurich, 2013

# In-house food consumption

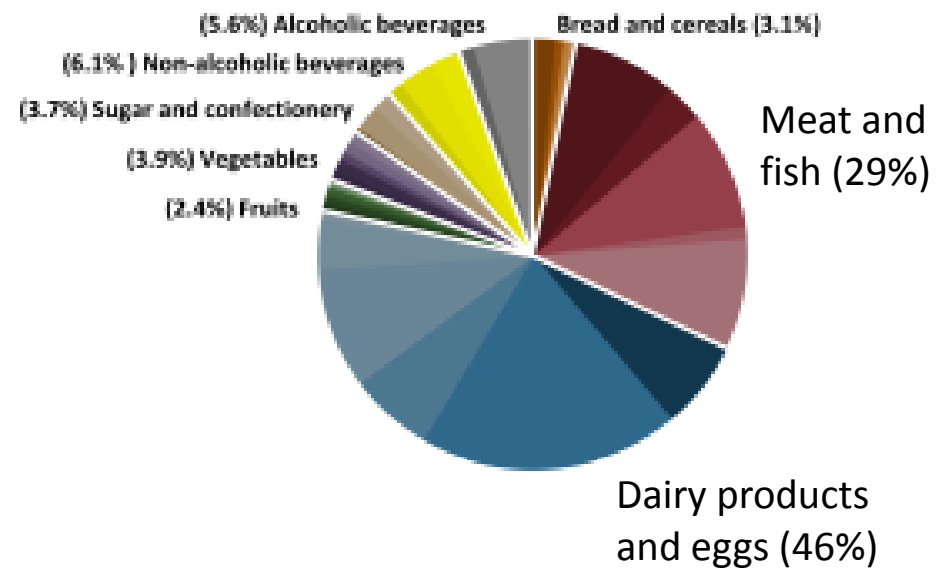
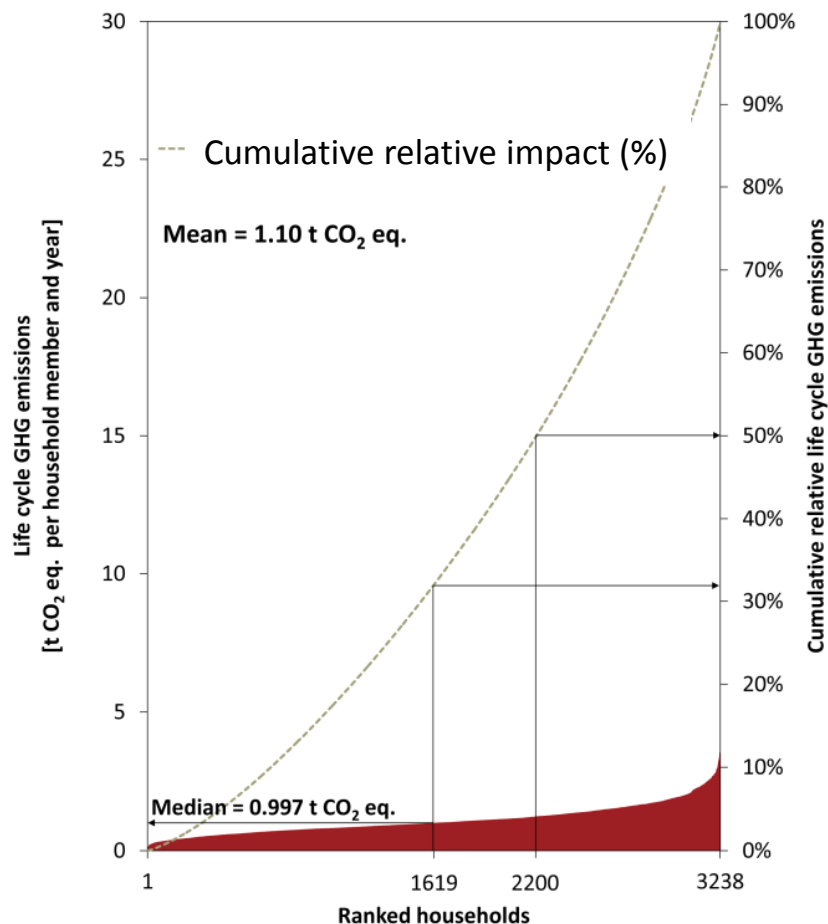
- Based on household budget enquiry («Haushaltsbudgeterhebung»)
- Generalisierter linear models

## Validation:



Source: Ph.D. thesis Dominik Saner, ETH Zurich, 2013

# Results: Per-capita climate change impact of in-house food consumption (example of Wattwil)



Source: Ph.D. thesis Dominik Saner, ETH Zurich, 2013

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# For agriculture, other impacts than climate change also need to be considered (example: water stress)

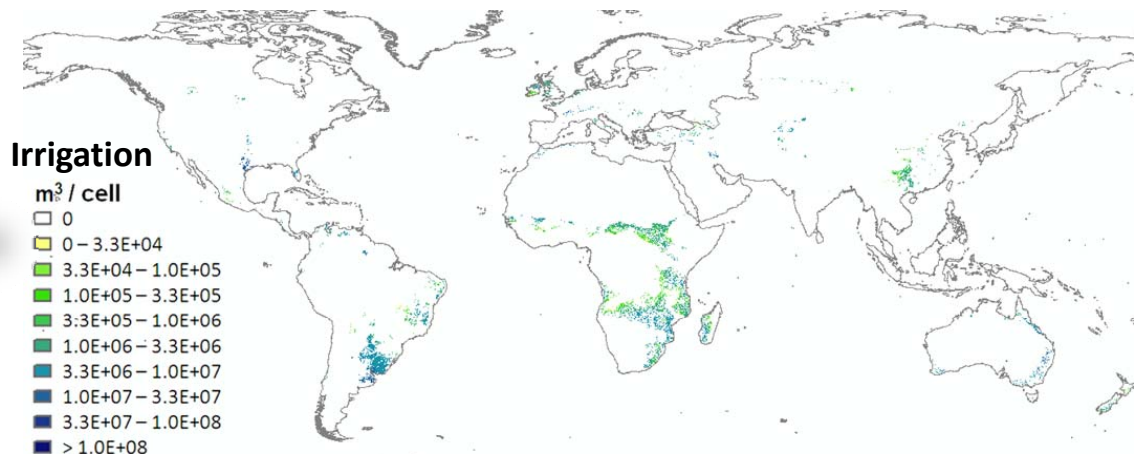
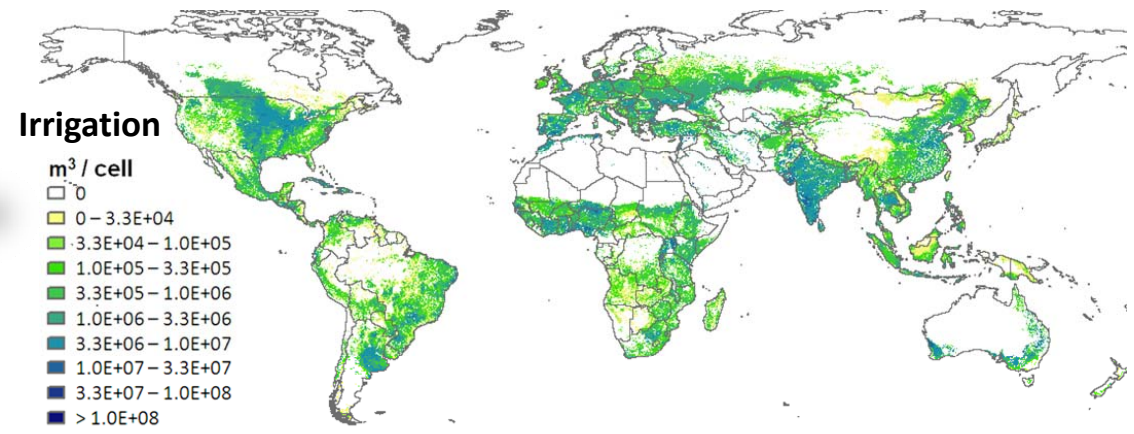
Strategies to feed population in 2050:

- Intensification

Irrigation:  
+ 1125 km<sup>3</sup> (64%)

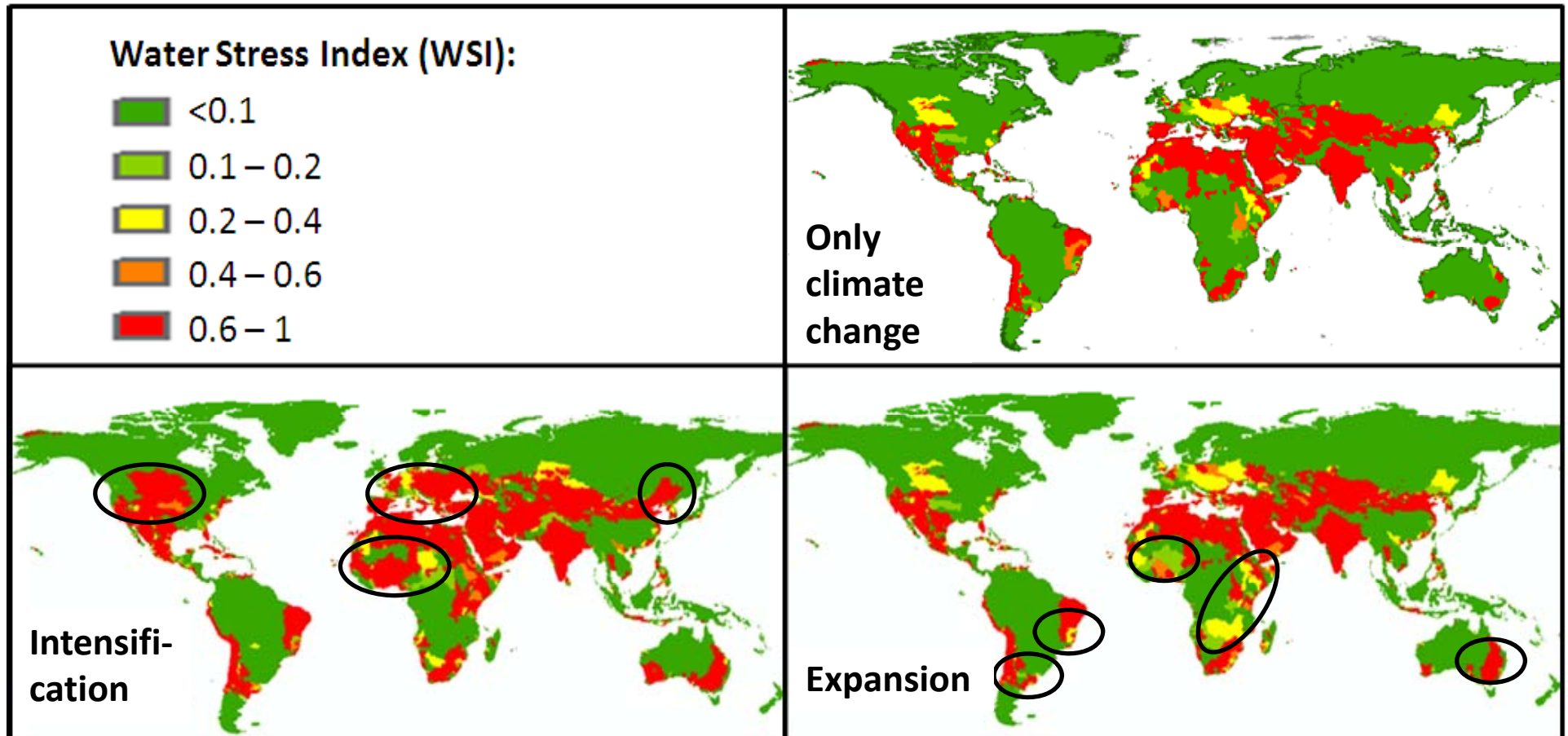
- Expansion on pastures

Irrigation:  
+169 km<sup>3</sup> (10%)



*Pfister S, Bayer P, Koehler A, Hellweg S, Projected water consumption and land use in future global agriculture: Scenarios and related impacts, Science of the Total Environment 409 (20), 4206-4216*

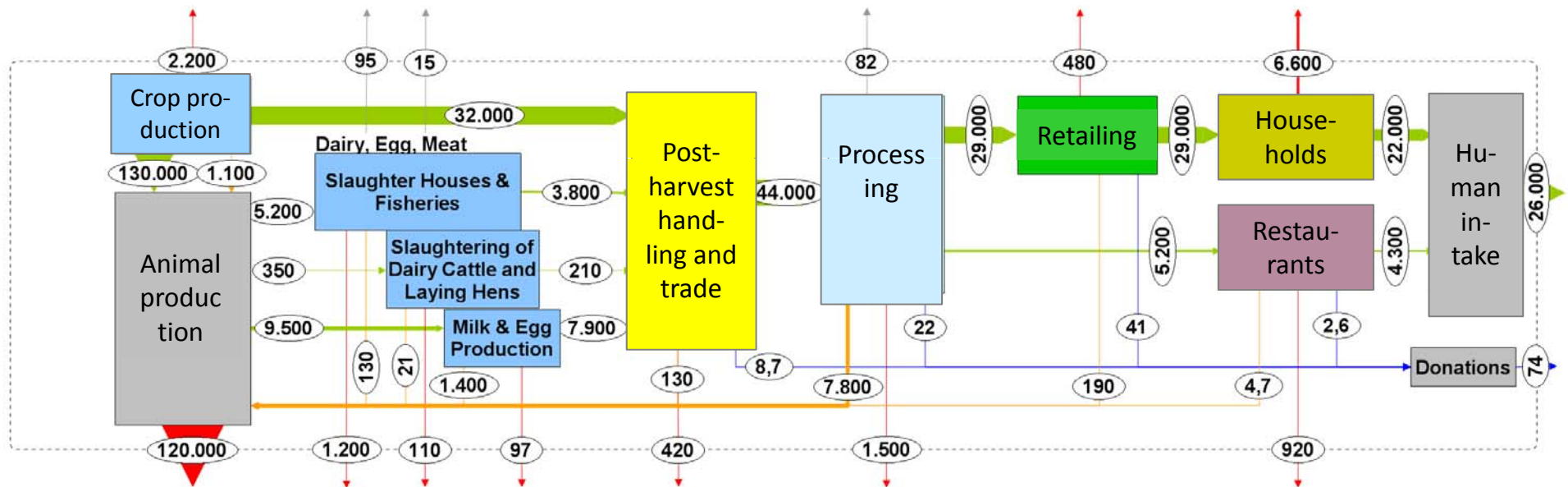
# Water Stress in 2050



*Pfister S, Bayer P, Koehler A, Hellweg S, Projected water consumption and land use in future global agriculture: Scenarios and related impacts, Science of the Total Environment 409 (20), 4206-4216*

# Improvement potentials for food consumption

- Less animal products
- Reduction of food waste



Beretta C, Stössel F, Baier U, Hellweg S, Quantifying food losses and the potential for reduction in Switzerland, Waste Management 33 (3), 2013, 764–773

# Conclusions

- We are not even close to the 1 t CO<sub>2</sub>-eq/capita goal
- **Three consumption areas (housing, mobility, food) responsible for more than 2/3 of total climate change impact**
- **Significant improvement potentials exist**
- **Housing:** renewable energy supply and efficiency gains can cut down greenhouse gas emissions significantly
- **Mobility:** large spread in current impact between different households
- **Food:** reduction in meat consumption and food waste
- Minimizing environmental impacts requires also considering other impacts than climate change

# Thank you

