'EXTERNALITIES IN AN INPUT-OUTPUT FRAMEWORK'

Workshop of the FP6 project EXIOPOL

Friday 5 March, Centre of Environmental Sciences, Leiden University
Einsteinweg 2, Leiden, Netherlands

Draft program 1.0, 8 February 2010

Workshop is free of charge but participants must pay own travel and subsistence. For planning purposes (lunches, coffee, badges), participants including presenters are kindly asked to register via
www.score-network.org

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1 Workshop background

EXIOPOL is an Integrated Project under the EU's 6th Framework Program of 5 Million Euro, lead by FEEM and TNO, consisting of 36 other partners, and running between 2007 and 2011. The project has two main goals. First, the project aims to develop and/or improve external cost data for a great number of societal processes, such as agriculture, forestry, and industry. Second, the project develops a global, multi-regional economic input output database with environmental extensions (MR EE IO).

The project wants to link these two bodies of work, but historically and conceptually they come from very different backgrounds. Externality research is a 'bottom-up' type of impact assessment. Spatial and temporal variability in emissions, disperson, background concentrations, exposed objects, etc., play a key role in assessing the external costs (usually damage costs) of an activity. EE IO on the other hand gives insight in economic relations between industry sectors at (usually) country level. It hence inherently has a meso/macro character. Traditionally, EE IO is hence linked to 'top-down' impact assessment methods such as life cycle impact assessment (LCIA). Examples are the Eco-indicator 99 method, the CML LCA manual, and the Danish EDIP method. All these methods calculate a time- and space averaged 'potential impact' related to emissions and resource use, expressed in mid-point indicators like Global Warming Potential, Acidification, or end-point indicators like Disability Adjusted Life Years lost (DALY's).

Conceptually, various approaches can be thought of to bridge this gap and to develop externality values that fit in an EE IO framework. Examples include:

- calculate end point indicators like DALYs and multiply with a generic externality cost value for this end point
- calculate mid point indicators, where possible using novel LCIA methods that to some extent indicate temporal and spatial variabilty, and multiply with externality cost data for such indicators (e.g. GWP or acidification)
- calculate average externality values per type of emission and industry in a country, and apply these directly on the EE IO table.

All these approaches have their pro's and con's, and consistency across sectors, emissions, and type of impacts is an important issue. The workshop will see presentations of papers on the following issues:

- conceptual and methodological deliberations on linking externalities and EE IO;
- practical examples for specific emissions and impacts of how externalities can be linked to EE IO
- analyses of which externalities are most relevant from a macro/meso perspective, and for which emissions and sectors the issue of spatial and temporal variability is so relevant that it truly can have an impact on this macro/meso perspective.

The workshop aims to refine the results of an EXIOPOL internal discussion on linking externality values to EE IO (Annex 2). It is limited to about 30 participants. The workshop is free of charge but participants need to cover their own travel and subsistence. Participants are likely to have a background in externalities, Life cycle impact assessment, and other impact assessment methods such as ecological footprinting, material flow analysis, etc. The workshop consists of two parts:

- a block of presentations
- a block in which a moderated, conceptual discussions take place.

The abstract deadline was 14 January 2010, and only in exceptional cases additional presentations can be added (contact for this dr. Arnold Tukker at arnold.tukker@tno.nl).

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2 Workshop program (Draft 8 February 2010)

Time	Subject
From 9.00	**Reception and registration with coffee**
9.30-9.45	**Opening and Welcome** Reinout Heijungs (CML), Arnold Tukker (TNO), Chiara Travisi (FEEM)
9.45-10.15	**1. Externalities in an Input-Output Framework – an Overview** Arnold Tukker (TNO)
10.15-10.45	2. **Integrating judgments on environmental impacts: three views from the cathedral.** Gjalt Huppes (CML)
10.45-11.15	**3. Regionalisation and site dependency in LCA** José Potting, Wageningen University
	Coffee Break
11.30-12.00	**4. Reviewing data and methods for water footprint accunting in a multi-regional input-output framework** Stephan Lutter (SERI), Troy Hawkins (NTNU), Ertug Encin (University of Twente), Tommy Wiedmann (SEI)
12.00-12.30	**5. Integrating Ecological and Water Footprints in a Multi-Regional Input-Output Framework** Troy R. Hawkins, A. Ertug Ercin, Alessandro Galli, Brad R. Ewing, and Tommy O. Wiedmann
12.30-13.00	**6. Bottom-up and Top Down Information to complete the agroalimentary system in Input Output (IO) Tables** Ignacio Cazcarro, Rosa Duarte, Julio Sánches-Chóliz (University of Zaragoza)
	Lunch
14.00-14.30	**7. A consumption based indicator of external costs of electricity** Jan Weinzettel, Miroslav Havránek, Milan Ščasný, Charles University
14.30-15.00	**8. Extrenal cost values for environmentally extended supply and use tables** Wolf Müller, Volker Klotz, Philipp Preiss, Rainer Friedrich (Institute of Energy Economics and the Rational Use of Energy – IER)
	Coffee
15.15-16.30	**Moderated discussion on lessons learned for integrating externality values in EE IO** (in breakout groups if more than 15 people participate)
16.30-16.45	**Concluding remarks and end of workshop** Arnold Tukker

Annex 1: Abstracts

Externalities in an Input-Output Framework – an Overview
Arnold Tukker (TNO)

Abstract: see Annex 2

Integrating judgments on environmental impacts: three views from the cathedral.
Dr. Gjalt Huppes, CML

There now exist two fundamentally opposed approaches to impact modelling and evaluation, from an economic and from an LCA-relalated environmental modelling background (midpoint), and with different views on how to support decision making. The third is a mixture of both, with LCA endpoint modelling, easily transferred into monetary terms. Getting the analytics of this complex field right is the start for improved decision support.

Regionalisation and site dependency in LCA
Dr. José Potting, Wageningen University

[Abstract to follow]

Reviewing data and methods for water footprint accunting in a multi-regional input-output framework
Stephan Lutter (SERI), Troy Hawkins (NTNU), Ertug Encin (University of Twente), Tommy Wiedmann (SEI)

Keywords: water use, water footprint, water account, multi-regional input-output model, virtual water

Abstract: Integrating economic and environmental water data within a single framework allows for modelling of the interaction between the economy and the environment in order to quantify the relative benefits of mitigation measures. Multi-regional input-output models can track the distribution of water use within countries and across countries, but they require appropriate water accounts. With the help of such models the direct and indirect water consumption as well as water pollution of specific economic sectors or whole countries can be calculated, resulting in the sectoral or national 'water footprint'.
The present paper reviews water use data and methods for water footprint accounting in a multi-regional input-output framework. Starting with a short overview of existing databases and accounting systems on water consumption, the strengths and weaknesses of different methods for estimating water use on different levels are analysed, and the most important next steps towards an evidence-based water policy are identified.

Integrating Ecological and Water Footprints in a Multi-Regional Input-Output Framework
Troy R. Hawkins, A. Ertug Ercin, Alessandro Galli, Brad R. Ewing, and Tommy O. Wiedmann

Ecological and water footprints are indicators which can be used to understand the connection between consumption activities and environmental consequences in terms of land and water. These two indicators have been gaining acceptance, especially within the European community, but are not harmonized with one another and are lacking in their representation of product supply chains. Here we integrate existing methods for calculating ecological and water footprints within a multi-regional input-output model which improves tracking along supply chains. Methods for calculating ecological and water footprints are presented and a method for linking with the MRIO model is developed. Alternatives for the connection between the MRIO model and the UNFAO dataset underlying the footprint accounts and their implications for results are discussed. The model presented here offers significant improvements in harmonizing the water and ecological footprint accounts and integrating them with the MRIO model. The matrix organization of the model presented here improves transparency and provides a structure upon which further improvements in footprint calculation can be built.

Bottom-up and Top Down Information to complete the agroalimentary system in Input Output (IO) Tables
Ignacio Cazcarro, Rosa Duarte, Julio Sánches-Chóliz (University of Zaragoza)

As explicitly explained in projects such as GTAP or EXIOPOL, disaggregation of environmentally relevant sectors, not usually highly broken down in IO Tables, is desirable to improve the models results. In order to have relatively homogenous intensities both at regional and country level for each subsector, especially explained to address the water uses analysis, but being important for emissions and other impacts, different forms of introducing information of the agroalimentary system are explained in the paper. The possibilities range from reproducing the construction methods of the National Agrarian Accounts, using the Commodity Balances of the FAO, or including detailed process analysis at the level of specific agricultural and animal products transformation, following the methodologies and sources used in Chapagain and Hoekstra (2003, 2004). The background to be moving between Physical IO tables and Monetary ones is found in well-known works such as Nakamura and Kondo (2002), Suh (2004), Weisz and Duchin (2006), Dietzenbacher et al. (2009), Lenzen (2009), etc.

A consumption based indicator of external costs of electricity
Jan Weinzettel, Miroslav Havránek, Milan Ščasný, Charles University

[Abstract to follow]

Extrenal cost values for environmentally extended supply and use tables
Wolf Müller, Volker Klotz, Philipp Preiss, Rainer Friedrich (Institute of Energy Economics and the Rational Use of Energy – IER)

The development of supply and use tables (SUT) and their extension for environmental effects is the major task of the current EU funded project EXIOPOL. For about 40 European and non-European countries, these SUT will provide valuable information on 130 sectors with respect to their economic activities and the emissions of pollutants into different environmental medias caused by these sectors. However, while the economic activities will be presented in monetary values, the environmental extensions will be provided in satellite accounts using physical units. To overcome this difference in the units and to allow a comparison of economic, ecological and social parameter values, the main objective of the present study is to derive country-specific damage factors that allow for a monetary valuation of the impacts resulting from the sector-specific emissions. The monetary valuation of non-monetised impacts (e.g. human health) should and will be based on contingent valuation, i.e. the ‘willingness to pay’ to avoid a certain impact. The extent of damages resulting from emissions of different pollutants is highly dependant on the location of the emitting source, the height of the release of substances as well as the density of the affected population around the source. In order to account for these factors, the sectors of the SUT have been allocated into different categories with respect to the location of the source in an urban or rural area as well as with respect to the height of the stack releasing the emissions. This differentiation allows for a precise assessment of sector-specific impacts. The monetary character of these damage factors will further enable a comparison of the economic activities and the environmental effects for each sector in each of the 40 countries.
The damage factors for a certain number of substances, all released into the air, have been derived applying two different methodologies. First, results of the EcoSenseWeb model have been applied to a number of classical airborne pollutants and heavy metals. In total, country-specific cost values for 31 countries are available. For those substances not included in the

estimations of EcoSenseWeb, the life cycle impact assessment database of IMPACT2002+ has been used to estimate potential damage factors. These damage factors have been valued by monetary factors for human health, the ecosystem and climate change. In addition to the differentiation of emissions with respect to the height of their release, additional factors for the damages caused by primary particulate matter (PPM2.5 and PPMcoarse) from emission in urban (highly populated) and rural (low populated) areas were estimated applying the EcoSenseWeb model. And finally, damage factors with respect to emissions from transport activities have been derived, especially focussing on emissions of primary particulate matter from road transport.
A first outcome of the study is a classification of sectors of the SUT developed in EXIOPOL with respect to the height of stacks and the location in urban or rural areas. As a second result, monetary damage factors for impacts on human health, the ecosystem and climate change for 41 airborne pollutants have been estimated. These damage factors differ between low, medium and high heights of release, emissions from transport activities and between urban and rural sources of emission. All damage factors have been estimated in Euros per tonne of emission of the respective pollutant. The monetary values have been derived for the 43 countries of the EE SUT including the EU-27 Member States and 16 non-Member countries, namely the Australia, Brazil, Canada, China, India, Indonesia, Japan, Mexico, Norway, Russia, South Africa, South Korea, Switzerland, Taiwan, Turkey and the U.S. The results for the external cost values and the sector classification are available in an MS-Excel document.

Annex 2: Results of EXIOPOL internal discussion on methods and problems related to inclusion of externalities in EE IO in EXIOPOL

	Drivers	**Pressures**	**State and Impact**		**Comments**
	Sector activity	Emissions Prim. Res. Use	Mid point ind. GWP,ODP, etc.	End point ind. DALY, PAFF	
Forestry		M3 or ton wood harvesting or Euro wood harversting	IFR has a model that calculates externalities in the next 50 years of a 'shock' in wood production against a background scenario. Cluster III gets data of a 'shock' of 1 tonne/year against various background scenarios. Externalities will be given as a multiplication factor of a M3 produced per country, specified by type of externality: • Recreation • Groundwater replenishing • CO2 sequestration (may e.g. double with CO2 emissions already inventoried)		Cluster III has ton wood harvesting as extension. IFR will provide "a" factor per country in the EU27 IFR will discuss with Cluster III how the 16 non EU countries can be compared with EU27 country data IFR will provide kg CO2 sequestration per unit wood harvested
Abiotic and biotic resource use, land use					Not relevant; in the neoclassical approach it can be assumed that scarcity of resources is already factored in in the price. The Externality community has no values for external costs. This is also true for biotic resources; protective measures (e.g. for fish) make them scarcer and hence externalities get internalized.
Water use					Is probably an issue, but no method available
Emissions A		17 in Ecosense, including CO2	Use Ecosense with info on - country of emission - Estimated stack hight (high/low/traffic), relevant for PM10 only IER has models (both for Europe as the World) that allows for calculating effects of		Provides hence externalities that are pollutant and country specific. We will not discern type of externalities. We further discern 3 forms of PM10 and PM2.5 (high/low stack and traffic)

	Drivers	Pressures	State and Impact	Comments
			emissions within certain countries specifically	
Emissions B		39 not in Ecosense	GHG other than CO2: calculate GWP, multiply with NEEDS values per kg GWP Other: Calculate DALY/PAFF with Eco-indicator 99 to and multiply with external costs per DALY or PAFF	Spatial and temporal variability will hence not be factored in for this group of emissions. It is likely that the total externalities of this group is much less relevant as for Group A. If this assumption appears not justified, this cannot be solved in EXIOPOL but needs a new project.
Agriculture	Manure and fertilizer use Pesticide use		NERI and partners estimate externalities of agriculture by starting with manure, fertilizer and pesticide use, from this losses to soil and groundwater is calculated, these end up in surface water in 6 example catchment areas in Europe; this goes to sea, having influence (for N and P) in water visibility, which in turn has impact on values of houses.	Cluster III has no driver data in its standardized database, only emissions. Cluster III has trouble with emissions to water. Cluster II cannot show emissions as a separate step in their model. A fundamental problem will remain that NERI has absolutely no data for non EU countries, and does not cover all EU27 countries but focuses on some catchment areas.
Accidents		Number of traffic death	**Rainer** sees if he can provide Cluster III with traffic and other accident deaths per annum per country	Fundamental: Cluster III never promised to include accidents. Only to be included if it can be easily done by using data readily available by Cluster II experts
Congestion				Cannot be included in EE IO due to lack of data, and was not promised
Odor				Cannot be included in EE IO due to lack of data, and was not promised
Noise				Cannot be included in EE IO due to lack of data, and was not promised
Industry				Already covered via the emission approach discussed earlier
Waste				Incineration, landfill etc. largely already covered via the emission approach discussed earlier.
Biodiversity				Will be included via end points of emission; unlikely that this Cluster II WP can contribute directly to Cluster III.

Annex 3: Logistical and hotel information

Workshop is free of charge but participants must pay own travel and subsistence.
For planning purposes (lunches, coffee, badges), participants <u>including presenters</u> are kindly asked to register via
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<u>Venue</u>
The workshop is held at the Centre of Environmental Sciences, Leiden University, Einsteinweg 2 in Leiden, Netherlands.

By public transport

Leiden is just 20 minutes by train from Schiphol airport; trains leave about every 15 minutes. CML is located near Central Station Leiden. Walking distance: 20 minutes (not a very scenic route).
Buses from Central Station to CML:

- Bus 232 direction Leiden Transferium, to bus stop 'Plesmanlaan'
- Bus 17 direction Stevensof to bus stop 'Cruquiuslaan'
- Bus 32 direction Katwijk, to bus stop 'Verbeekstraat'
- Bus 35 direction Katwijk, to bus stop 'Verbeekstraat'
- Bus 43 direction Den Haag, to bus stop 'Universiteitsterrein'

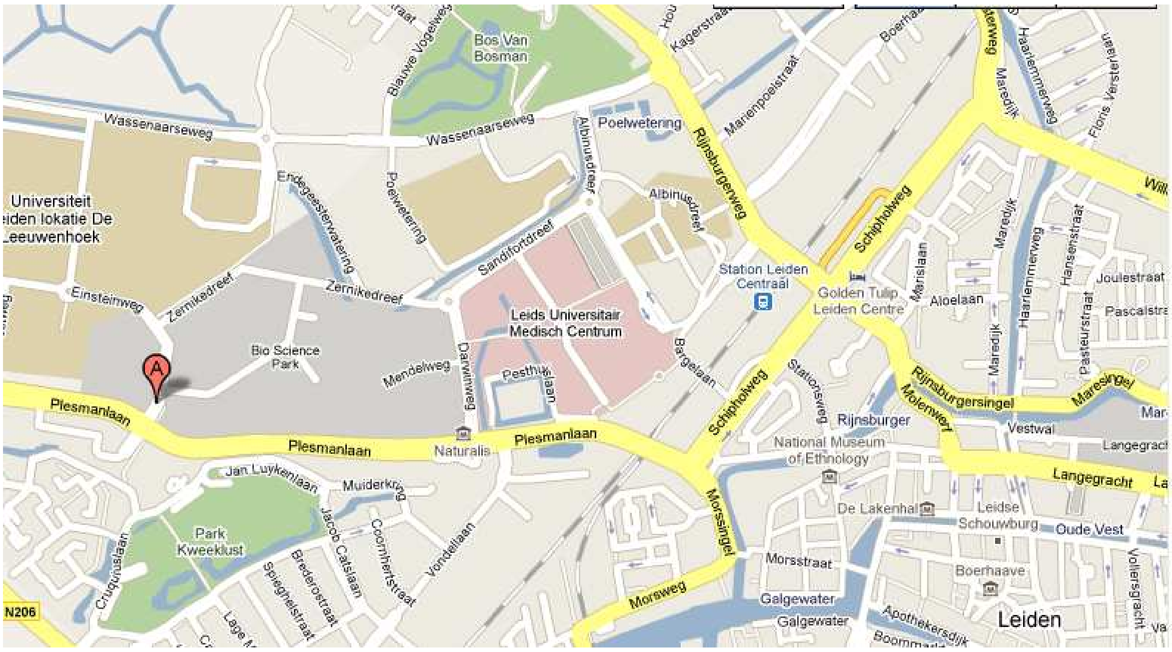

Figure 1: Location of CML (A) and Leiden Central Station (centre map). The historic city of Leiden is at the bottom right of the figure

By car from A44
Take exit 'Leiden, Katwijk', follow direction Leiden, turn left at the sign 'Bio-Sciencepark'. The first building on your left hand side is 'Van Steenisgebouw'.

By car from A4
Take exit 'Zoeterwoude Dorp', follow the signs 'Leiden-Zuid' until you are on the Churchill-laan/Dr. Lelylaan, follow this road to the end. Turn right, take a second right, and then turn left at the sign 'Bio-Sciencepark'. The first building on your left hand side is 'Van Steenisgebouw'.

Hotel suggestions

De Doelen ***, Rapenburg 2, http://www.hoteldedoelen.com/, centrally located in the historic city, 25 minutes walk from CML

Golden Tulip ****, Schipholweg 3,
http://www.goldentulipleidencentre.nl/?Language=EN, opposite the railway station (connecting to Schiphol airport), 20 minutes walk from CML

Tulip Inn ***, Schipholweg 3,
http://www.goldentulipleidencentre.nl/?Language=EN, opposite the railway station (connecting to Schiphol airport), 20 minutes walk from CML

Holiday Inn ****, Haagse Schouwweg 10, http://www.holiday-inn-leiden.nl/en, near the highway, 10 minutes walk from CML

Other hotels can be found via

- www.booking.com
- www.hotelclub.com