

**PROJECT N. 037033**

**EXIOPOL**

**A NEW ENVIRONMENTAL ACCOUNTING  
FRAMEWORK USING EXTERNALITY  
DATA AND INPUT-OUTPUT TOOLS  
FOR POLICY ANALYSIS**



**TECHNICAL REPORT: Full EXIOBASE  
database management system  
including agreed scripts operational**

Deliverable: DIII.4.b-5

Report of the EXIOPOL project

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## Preamble

EXIOPOL (“A New Environmental Accounting Framework Using Externality Data and Input-Output Tools for Policy Analysis”) is an Integrated Project set up by FEEM and TNO with funding from the EU’s 7th Framework Program. It runs between March 2007 and 2011. The main project set-up is in three content clusters, one on externalities modelling (Cluster II), one on a SUT/IO accounting framework with environmental extensions (Cluster III), and one on using the combined result in modelling for decision support (Cluster IV). Furthermore, one overarching cluster is dedicated to keeping the scope of this conceptually complex project focused (Cluster I), one is reserved for management (Cluster VI), and a final one is for dissemination of results (Cluster V).

This technical report reflects the following deliverable, named: DIII.4.b.5: Full EXIOBASE database management system including agreed scripts operational

As can be read from the name of the deliverable, it concerns in fact not deliverables in the form of a report. It indicates that the EXIOPOL Cluster III should have a database management system operational (DIII 4.b.5), and that it has been filled with all data generated in the other WPs in Cluster III (DIII.4.b.4). It hence concerns intangible deliverables, that currently are available as a database program and a dataset available at a computer system of the WP leader, CML- ULeiden in Leiden, the Netherlands. Within the project an exit strategy has been developed and discussed during the June 2010 review meeting with the EU, that implies a business model will be set up that makes the database and related programs available for a modest fee for third parties. The funds generated in this way should allow the consortium to continuously update and expand the database system over time – where without this exit strategy it is foreseeable that the database will be outdated in some time.

Against this background, it was decided to show that the database system is operational and filled with data via this report:

- Describing the structure of the database management system
- Showing screenshots of the functionalities of the data base

The database management system and the data set will be made available if desired to the EU, reviewers and / or advisory board members of the project, where we think it would be appropriate to sign a confidentiality clause beforehand.

## Executive Summary

This technical report reflects the following deliverable, named: DIII.4.b.5: Full EXIOBASE database management system including agreed scripts operational

It concerns an intangible deliverable, that currently is available as a database program and a dataset available at a computer system of the WP leader, CML- ULeiden in Leiden, the Netherlands. With this document the project wants to show that the database system is operational and filled with data via this report:

- Describing the structure of the database management system
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## 1 Introduction

This technical report reflects the following deliverable, named: DIII.4.b.5: Full EXIOBASE database management system including agreed scripts operational

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## 2 Overview of the Exiobase System

The Exiobase system is the database system that transforms the supply – use tables of individual countries into an international input-output table that can be used for the analysis of the environmental impacts associated with the final consumption of product groups. Questions like “how much CO<sub>2</sub> emissions arise in India from steel consumed in the Netherlands” or “which product group has the highest water use in the UK” can be answered by this tool.

Obviously having a world wide input-output model that consists of 44 countries while distinguishing 129 product groups in each country means the handling of a lot of data. Spreadsheets or text files are not suitable anymore when a tool has to be created that is reasonably user friendly. Therefore all the data are stored in a database.

The database plus the applications (or graphical user interface) to manipulate these data and transform them into an international input-output table is the Exiobase system. A conceptual view of the Exiobase system is shown in Figure 1. The data in the Exiobase system are transformed into the international input-output table in three steps and each step requires the storage of data. As can be seen in Figure 1, there is a storage facility for the single country supply-use data, the storage of the international supply-use table (interlinked supply-use table) and the storage of the international input-output table (interlinked country input-output table).

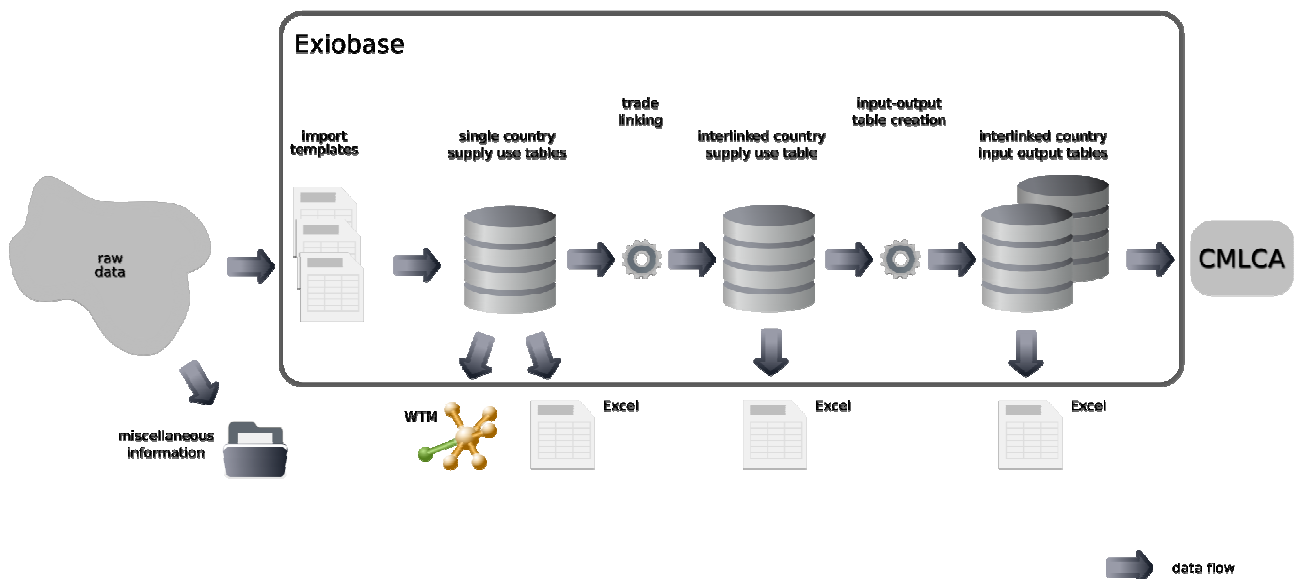


Figure 1. The Exiobase system consisting of three conceptually different storage facilities plus all the transformation steps needed to create the international input-output table



While conceptually the three storage facilities are separate entities, in practice the user of the system only has to deal with one database.

The three steps necessary to create the international input – output table are also represented by the three applications that are part of the Exiobase system:

1. The administration module - This module can be used to set-up a new database, import new data and manipulate data
2. The country supply-use viewer module - This module can be used to view the country supply-use tables, automatically check the data and calculate the international supply – use table.
3. The international supply-use viewer module - This module can be used to view the international supply- use tables and calculate the international input – output table

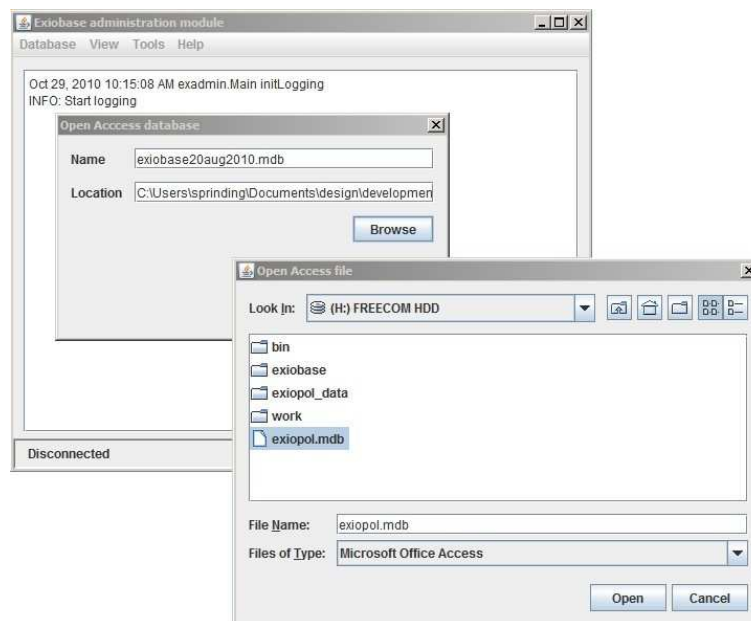
For each of the modules a short visual guide is given below which shows the key-capabilities of the modules.



### 3 The administration module

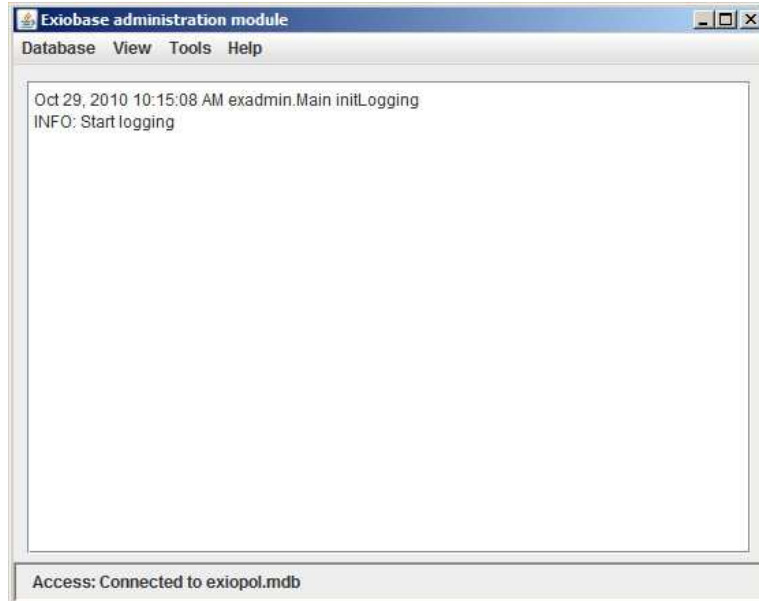
#### 3.1 Setting-up a new database

Starting from a completely empty (without any tables or any data) Access 2000 file a new Exiopol database can be created. This is done by opening the empty Access file by selecting **Database >> Open** from the menu. The user is then asked to locate the file, as shown in Figure 2. Opening a file is just as easy as opening any type of file.



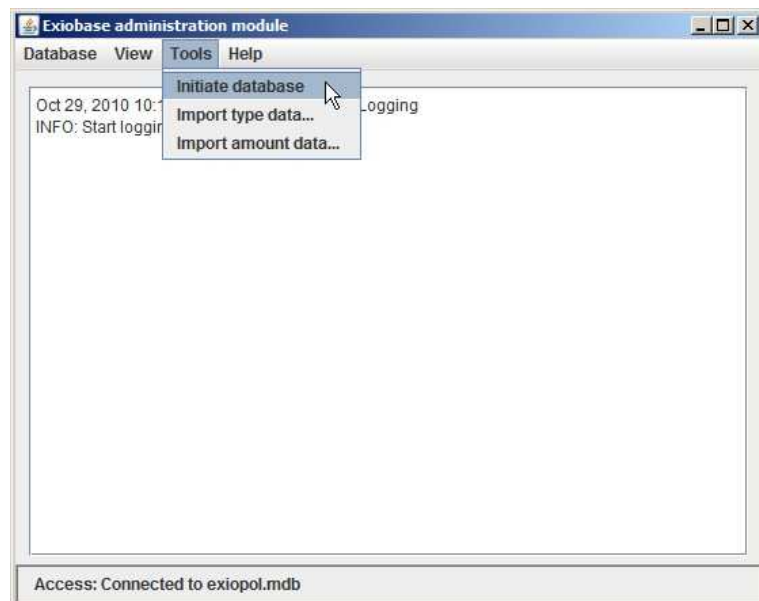
**Figure 2: Opening an Access file.**

After the Access file has been opened, as indicated on the statusbar, see Figure 3, the database can be initiated, using the Tools menu.



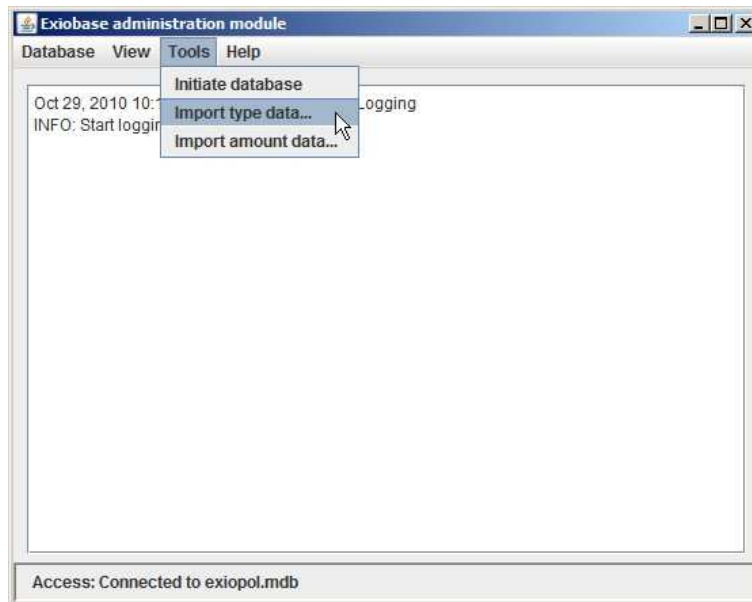
**Figure 3: The empty Access file has been opened**

Initiating Exiobase is done in two steps. First all the database tables need to be created. That is done by selecting the menu **Tools >> Initiate database**.



**Figure 4: Initiating the empty database.**

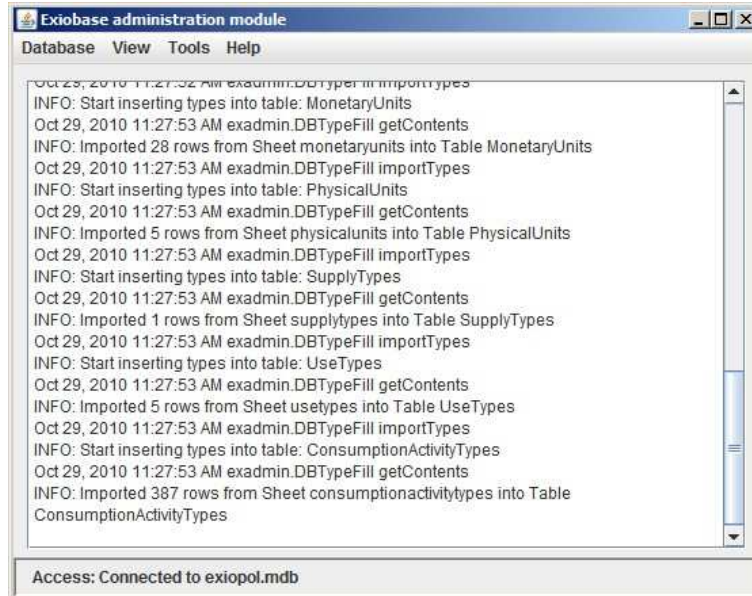
After the database has been initiated all the classifications (industry sectors, commodities etc.) as being used in the supply – use tables are imported. This is done by selecting **Tools >> Import type data**



**Figure 5: Importing all the classifications that are needed to store the supply-use tables**

The type data are read from an Excel file that is supplied together with the Exiobase system. It contains the classifications as are now being used with in the Exiopol project. If in another project it is desirable to work with a different classification system for the industries, commodities etc. (e.g. a switch from NACE 1.1 to NACE 2.0), is very easy to adapt these classifications import them and use the Exiobase system with the new classification system. No adaptations at all are needed in the Exiobase system.

While importing data, messages containing information about the status of the import are logged in the main window area, see Figure 6.

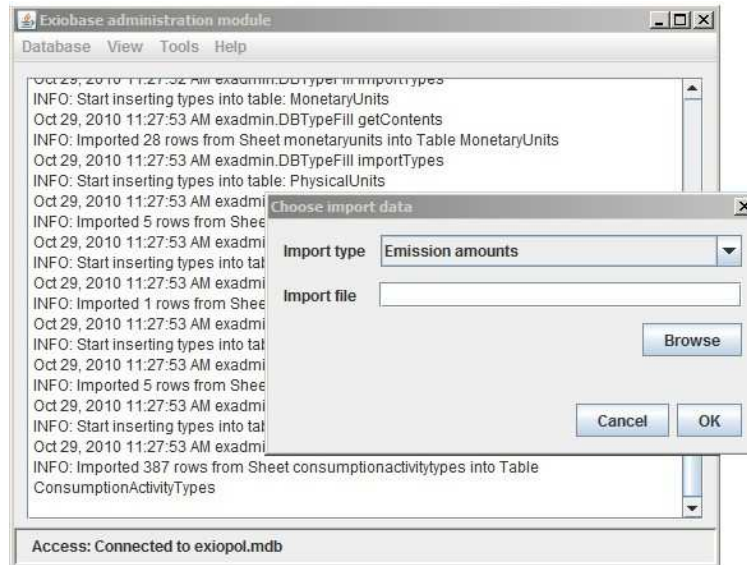


**Figure 6: Messages logged when importing the type data.**

### 3.2 Importing new data

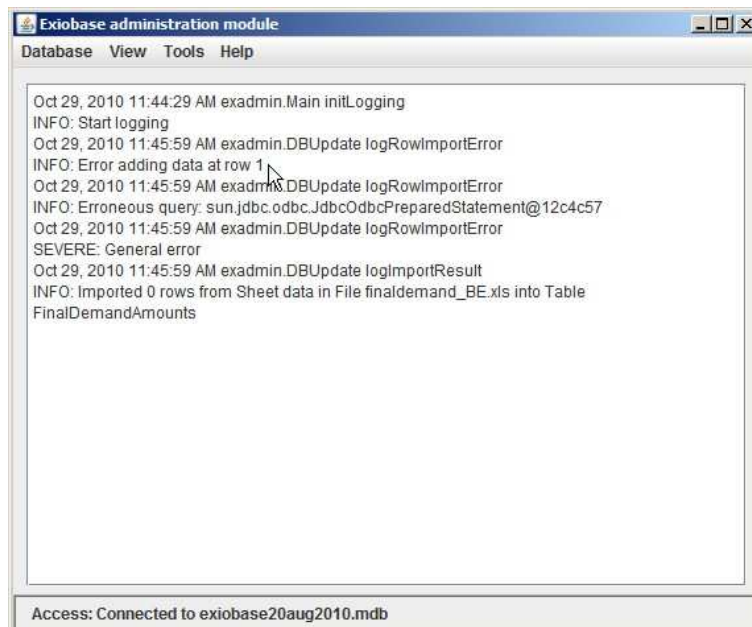
After initiating the database and importing the classifications all supply – use tables, extensions, consumer and trade data can be imported. For each kind of data that need to be imported a specific Excel file format has been defined that can be read by the Exiobase system. It is a very flexible, yet robust format that allows for the delivery of data in any type of statistical classification (NACE 1.1 or NACE2.0) .

Importing of data is started by selecting from the menu **Tools >> Import amount data**. The user is then asked which kind of data need to be imported and the user can browse and select the files that need to be imported, see Figure 7.



**Figure 7: Importing the supply - use tables. Selecting the type and file that need to be imported.**

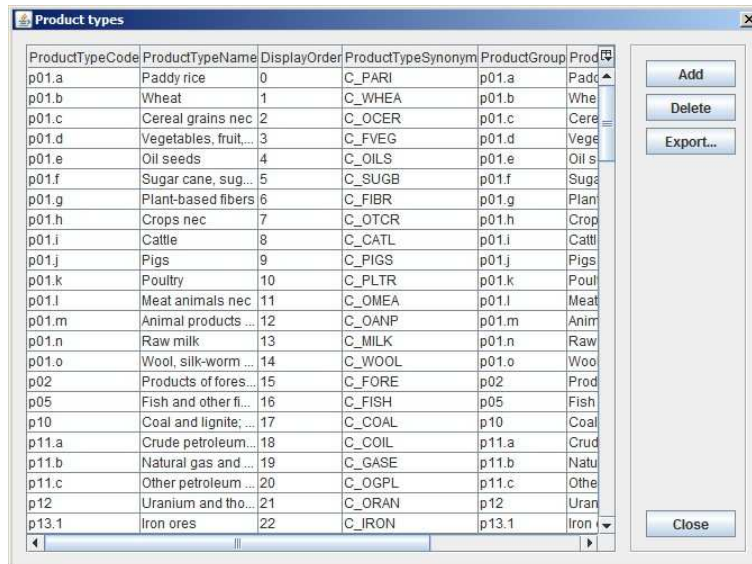
When importing data these data are checked if they conform to the expected format. Any problems are logged into the main window. For example in Figure 8 we show what happens when we try to import the same value for final demand twice. The row is given where this happens and depending on the type of error, more information on that error is given. When the import file has been imported the total number of items imported and the total number of errors are logged in the main window area.



**Figure 8: An error message is logged when the import data are not correct.**

### 3.3 Viewing data

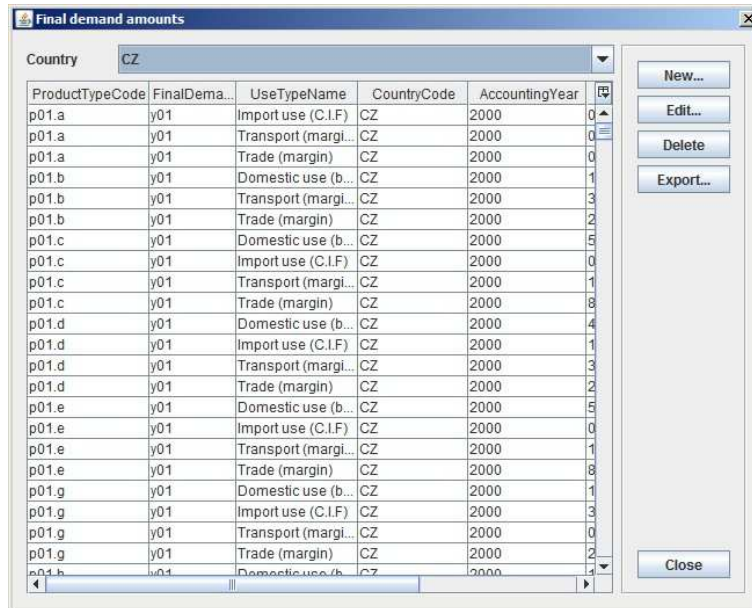
After data have been imported into the Exiobase system, the can have a look at the data that were imported. Data can be viewed by selecting from the menu **View >> View Types** or **View >> View View amounts**. When selecting view types the user can inspect the classifications that are being used in Exiobase. For example, in Figure 9 the view for the product classification is shown.



ProductTypeCode	ProductTypeName	DisplayOrder	ProductTypeSynonym	ProductGroup	ProductCode
p01.a	Paddy rice	0	C_PARI	p01.a	Paddy
p01.b	Wheat	1	C_WHEA	p01.b	Wheat
p01.c	Cereal grains nec	2	C_OCER	p01.c	Cereals
p01.d	Vegetables, fruit,...	3	C_FVEG	p01.d	Vegetables
p01.e	Oil seeds	4	C_OILS	p01.e	Oil seeds
p01.f	Sugar cane, sug...	5	C_SUGB	p01.f	Sugarcane
p01.g	Plant-based fibers	6	C_FIBR	p01.g	Plant-based fibers
p01.h	Crops nec	7	C_OTCR	p01.h	Crops
p01.i	Cattle	8	C_CATL	p01.i	Cattle
p01.j	Pigs	9	C_PIGS	p01.j	Pigs
p01.k	Poultry	10	C_PLTR	p01.k	Poultry
p01.l	Meat animals nec	11	C_OMEA	p01.l	Meat animals
p01.m	Animal products ...	12	C_OANP	p01.m	Animal products
p01.n	Raw milk	13	C_MILK	p01.n	Raw milk
p01.o	Wool, silk-worm ...	14	C_WOOL	p01.o	Wool, silk-worm
p02	Products of fores...	15	C_FORE	p02	Products of forests
p05	Fish and other fi...	16	C_FISH	p05	Fish and other
p10	Coal and lignite; ...	17	C_COAL	p10	Coal and lignite
p11.a	Crude petroleum...	18	C_COIL	p11.a	Crude petroleum
p11.b	Natural gas and ...	19	C_GASE	p11.b	Natural gas
p11.c	Other petroleum ...	20	C_OGPL	p11.c	Other petroleum
p12	Uranium and tho...	21	C_ORAN	p12	Uranium and thorium
p13.1	Iron ores	22	C_IRON	p13.1	Iron ores

**Figure 9: Viewing the product classification being used in the Exiobase system**

In Figure 10, viewing the final demand values is shown. Having all the data in a long list may seem awkward but is actually very practical when particular data have to be looked up because the rows can be sorted quickly by just clicking on the column header.

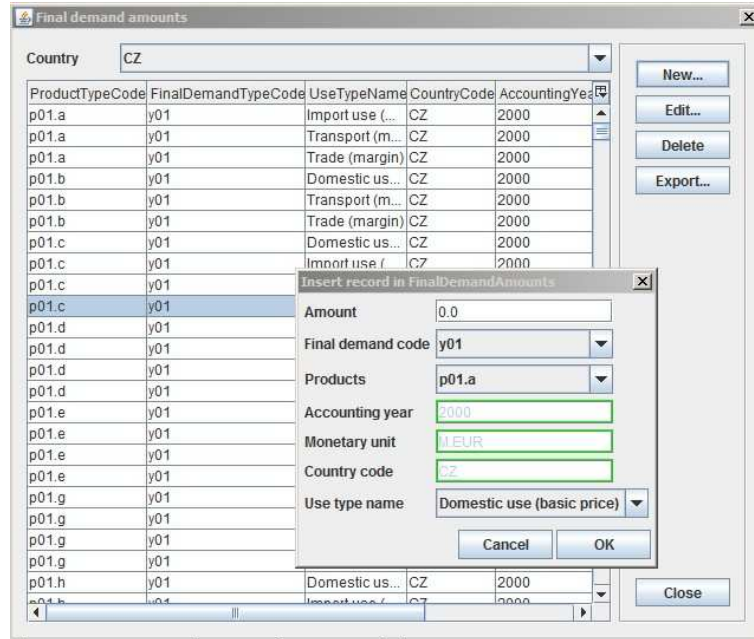


ProductTypeCode	FinalDema...	UseTypeName	CountryCode	AccountingYear	
p01.a	y01	Import use (C.I.F)	CZ	2000	0
p01.a	y01	Transport (margi...	CZ	2000	0
p01.a	y01	Trade (margin)	CZ	2000	0
p01.b	y01	Domestic use (b...	CZ	2000	1
p01.b	y01	Transport (margi...	CZ	2000	3
p01.b	y01	Trade (margin)	CZ	2000	2
p01.c	y01	Domestic use (b...	CZ	2000	5
p01.c	y01	Import use (C.I.F)	CZ	2000	0
p01.c	y01	Transport (margi...	CZ	2000	1
p01.c	y01	Trade (margin)	CZ	2000	8
p01.d	y01	Domestic use (b...	CZ	2000	4
p01.d	y01	Import use (C.I.F)	CZ	2000	1
p01.d	y01	Transport (margi...	CZ	2000	3
p01.d	y01	Trade (margin)	CZ	2000	2
p01.e	y01	Domestic use (b...	CZ	2000	9
p01.e	y01	Import use (C.I.F)	CZ	2000	0
p01.e	y01	Transport (margi...	CZ	2000	1
p01.e	y01	Trade (margin)	CZ	2000	8
p01.g	y01	Domestic use (b...	CZ	2000	1
p01.g	y01	Import use (C.I.F)	CZ	2000	3
p01.g	y01	Transport (margi...	CZ	2000	0
p01.g	y01	Trade (margin)	CZ	2000	2
p01.h	y01	Domestic use (b...	CZ	2000	3

**Figure 10: Viewing the final demand values in Exiobase for the Czech Republic.**

### 3.4 Adding, changing and deleting data

When the user is viewing the data as explained above there is the possibility to add, change or delete individual values. By clicking on the **New...** button an dialog is opened that allows to insert a new value. By selecting a row first and clicking on the **Edit...** button an existing value can be changed. By selecting 1 or more rows and clicking on the **Delete...** button these values will be deleted from the database. In Figure 11 it is shown how a new value is inserted.



**Figure 11: Inserting a new final demand value.**

When it comes to bulk updating or inserting data into the Exiobase system one should use its file import capabilities as explained in Section 3.2.

### 3.5 Exporting data

In the administration module it is possible to export data when the user is viewing the data by clicking on the **Export...** button. This export function exports the current data that are shown in the window.. This function is particularly useful if a small part of the data needs to be inspected.

Bulk export of the complete country supply – use tables including extensions to Excel or other format can be done in the country supply- use viewer module, see Section 4.4.



## 4 The country supply-use viewer module

### 4.1 Viewing data

#### 4.1.1 By industry sector

After starting the country supply-use application and opening the Access file with the data in the same way as described in Section 3.1, the user can start viewing the data in Exiobase. Two different ways of browsing through the data are provided. One particular ‘slice’ through the data is by industry sector. The user can select a country and an industry sector in that country and see all the data that associated with that industry sector. For the industry sector selected, the products consumed by the industry sector, the products manufactured, the direct emissions for the industry sector, raw materials used by the industry sector etc. are all shown in one window. This particular ‘slice’ through the data is unfamiliar in Input-Output analysis but is very familiar for Life Cycle Assessment practitioners. An example of such a view for the industry sector i01.d in BE is shown in Figure 12. This view is opened from the menu **View >> Activities >> Industry**.

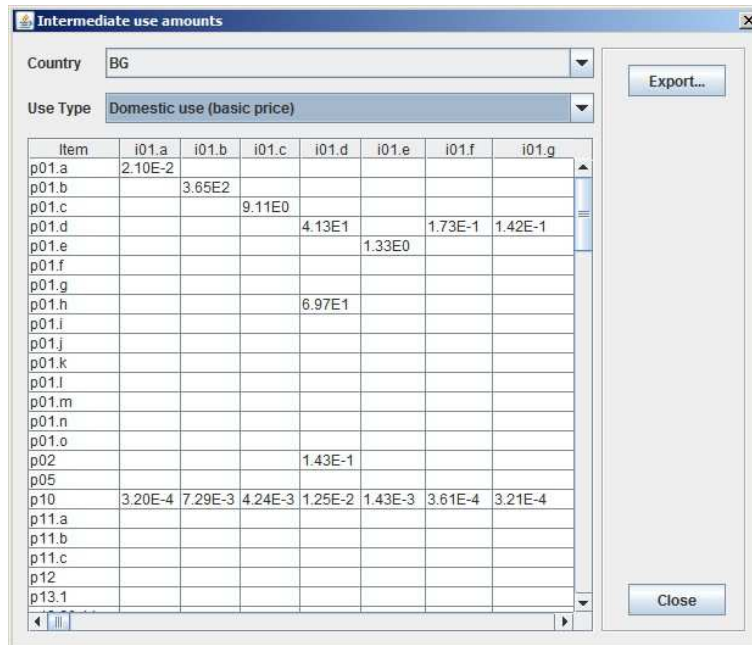
	Domestic u...	Import use (...)	Transport (...)	Trade (marg...	Taxes less...	
p01.d	8.34E0	1.53E-4	4.20E-5	8.86E0	1.41E-1	MEUR
p01.h	6.80E-5	1.06E-4	4.20E-5	5.11E-4	1.86E-4	MEUR
p23.20.a	7.94E-3	4.81E-4	6.40E-5	7.08E-3	2.65E-3	MEUR
p23.20.b	1.01E-1	4.64E-4	6.40E-5	8.26E-2	2.55E-2	MEUR
p23.20.c	1.29E1	4.61E-4	6.40E-5	1.05E1	3.15E0	MEUR
p23.20.d	2.49E-3	5.26E-4	6.40E-5	2.67E-3	1.25E-3	MEUR
p23.20.e		5.16E-4	6.40E-5	6.84E-4	4.58E-4	MEUR
p23.20.f	4.14E-3	4.42E-4	6.40E-5	3.97E-3	1.68E-3	MEUR
p24	4.60E1	1.78E1	6.40E-5	4.36E1	1.08E0	MEUR
p29	2.32E1	6.06E1	4.00E-5	4.66E1	1.58E0	MEUR
p40.11.a	1.14E0	1.27E-4				MEUR
p40.11.b	2.35E0	6.34E-4				MEUR
p40.11.c	3.21E0	8.84E-4				MEUR
p40.11.d	3.45E-2	1.64E-4				MEUR
p40.11.e	1.66E-3	1.30E-5				MEUR
p40.11.f	2.89E0	1.00E-3				MEUR
p41	2.96E0				1.28E0	MEUR
p45	1.14E-1					MEUR
p51	1.25E2	4.70E0		-1.10E2	4.39E-3	MEUR
p60.1	5.40E-5	1.80E-4	-2.00E-4		-1.80E-5	MEUR
p60.2	5.40E-5	1.80E-4	-2.00E-4		-1.80E-5	MEUR
p60.3	4.90E-5	1.59E-4	-1.67E-4		-2.20E-5	MEUR
p61.1	7.20E-5					MEUR
p61.2	7.40E-5					MEUR
p65	5.16E1					MEUR
p66	2.52E0	6.55E-1			8.08E-1	MEUR

Figure 12: Viewing the supply – use data per industry sector.

Similar slices are also available for consumer activities and trade. A simple export function is also provided in these view dialogs that export the data as shown on screen to a comma separated text file. This is practical for situation where the user wants to export a small part of the data.

#### 4.1.2 By country

A within the field of Input – Output analysis more traditional ‘slice’ through the data is provided when selecting **View >> Matrices** from the menu. This option shows the user a supply table or use table of a single country as one big table. An example is shown in Figure 13.



Item	i01.a	i01.b	i01.c	i01.d	i01.e	i01.f	i01.g
p01.a	2.10E-2						
p01.b		3.65E2					
p01.c			9.11E0				
p01.d				4.13E1		1.73E-1	1.42E-1
p01.e					1.33E0		
p01.f							
p01.g							
p01.h				6.97E1			
p01.i							
p01.j							
p01.k							
p01.l							
p01.m							
p01.n							
p01.o							
p02				1.43E-1			
p05							
p10	3.20E-4	7.29E-3	4.24E-3	1.25E-2	1.43E-3	3.61E-4	3.21E-4
p11.a							
p11.b							
p11.c							
p12							
p13.1							

**Figure 13: Intermediate use amounts for Bulgaria – domestic use matrix.**

A simple export function is also provided in these view dialogs that export the data as shown on screen to a comma separated text file. This is practical for situation where the user wants to export a small part of the data.

A particular useful feature in Exiobase is the ability to change the presentation of the values in the tables as shown in the previous views. It is possible to highlight negative values, automatically provide column and row sums or show zero values. Changing the appearance of the values can be done by selecting **Tools >> Options** from the menu and selecting the tab **Data presentation** in the dialog.. Here it is possible to turn off or on various presentation features as shown in Figure 14.

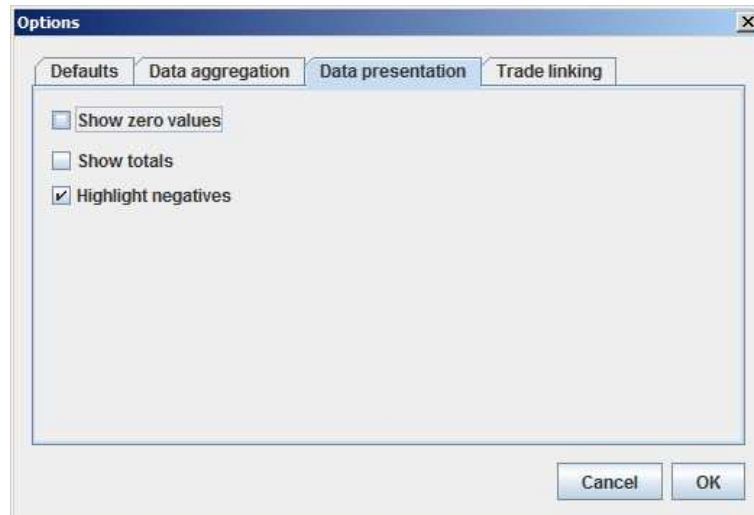


Figure 14: Changing the presentation of data in the tables.

## 4.2 Checking data

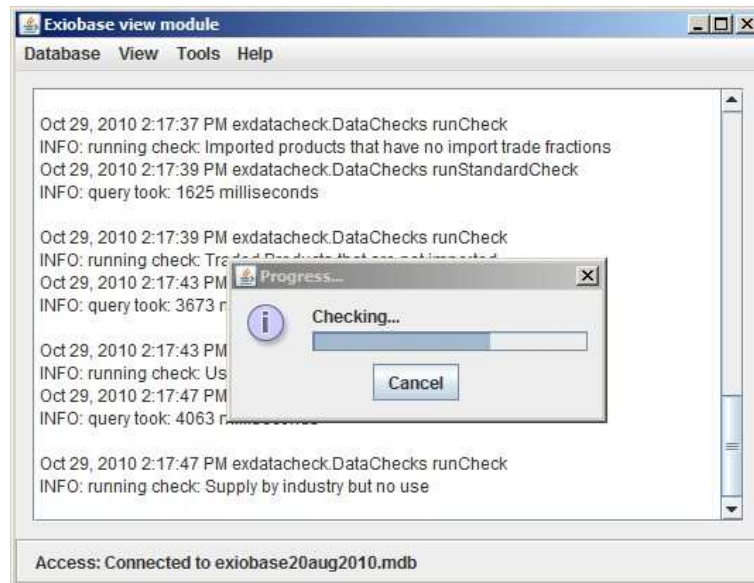
One of the difficulties when working with a large dataset which contains data gathered by different research groups is quality checking. It is impossible to manually check for inconsistencies and implausible values. Exiobase provides routines to check the data automatically. Inconsistencies like industry sectors that do not have any factor inputs, negative values, missing domestic use values etc can all be looked up and reported. The data checking tool is selected from the menu by **Tools >> Check**.

A dialog appears that asks the user which part of the data needs to be checked. After selecting one or more parts clicking on the **Check** button starts the check.



**Figure 15: Selecting which aspect of the data needs to be checked.**

The results of these checks are written to an Excel file. Interpreting the results of the checks needs expert information. Not everything that seems to be inconsistent is a real problem. Checking can take some time in the order of 10 – 20 minutes if all parts of the data have to be checked in one go. An example of what is shown when the checks are run is shown in Figure 16. Notice that each completed check is logged into the main window which gives excellent information about the progress of all checks.



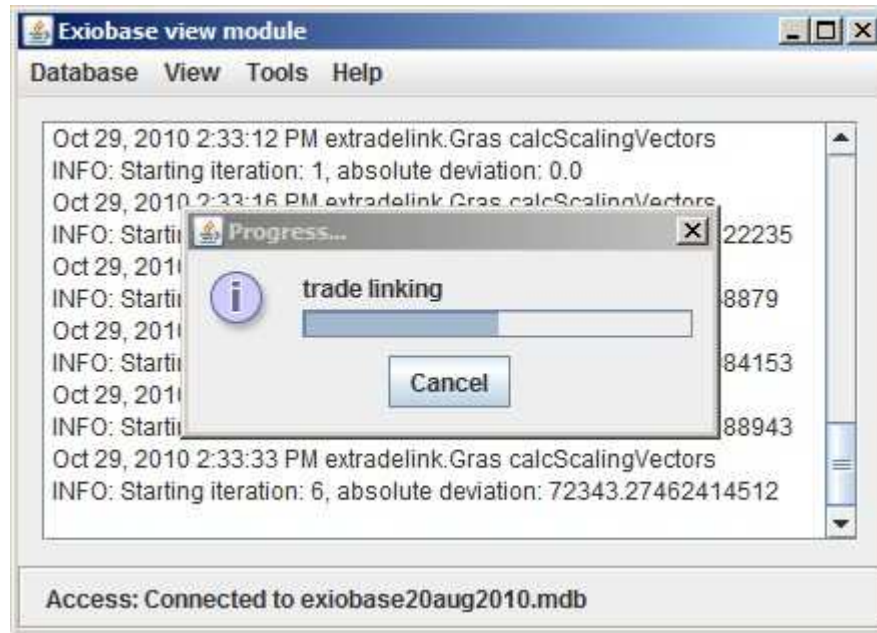
**Figure 16: Running the checks.**

An example of the check report is provided as attachment, see check\_report.xls.

### 4.3 Creating the international use table

An important argument to set-up Exiobase as it is, is the need to create international supply-use and input-output tables. When these tables are created the number of data increases quadratic. When creating the international use tables all single country use tables are connected using trade data, creating one single huge world-wide use table. This is done in the so called trade-linking step which consists of several sub steps. The user does not see any of this complexity. To create the international use table select **Tools >> Trade Linking...** from the menu. A dialog is presented where the user can select the type of trade linking procedure to use. After clicking the **OK** button, the trade – linking procedure starts. Trade linking can take quite some time. A progress dialog is shown and the status messages are logged into the main window area, giving excellent information about the progress and potential problems that might occur during trade-linking.

If trade-linking succeeds, the generated international table is automatically stored in the database.



**Figure 17: Trade linking procedure in progress.**

While the trade-linking takes place, detailed information about the iterative updating of data during the trade-linking is written to an Excel-file (tradelinking\_report.xls). This report is provided as separate attachment. The report can be used by experts to examine and debug any problems that might arise during trade – linking.

While the trade-linking takes place also the supply – use tables for the so called Real Rest of World countries (rRoW) are estimated. Also an excel file is written that contains these estimated tables, see the rRoW\_report.xls file, which has been provided as attachment.

The user can change several options that influence how the trade-linking procedure operates by selecting **Tools >> Options** and selecting the **Tradelinking** tab, see Figure 18.

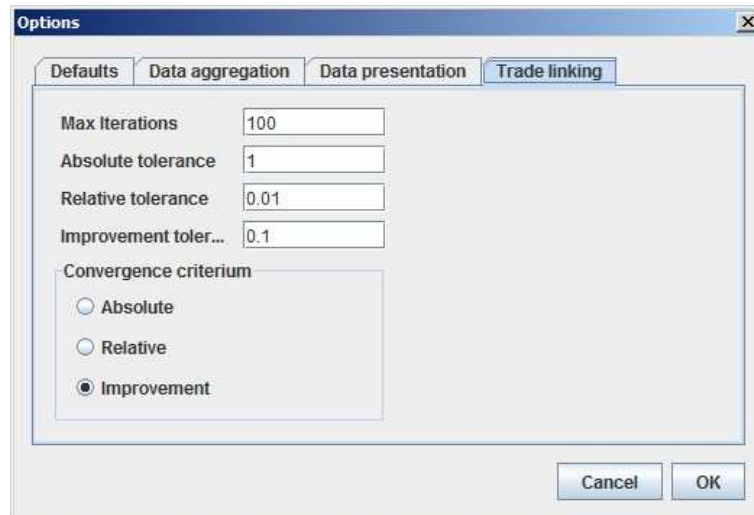
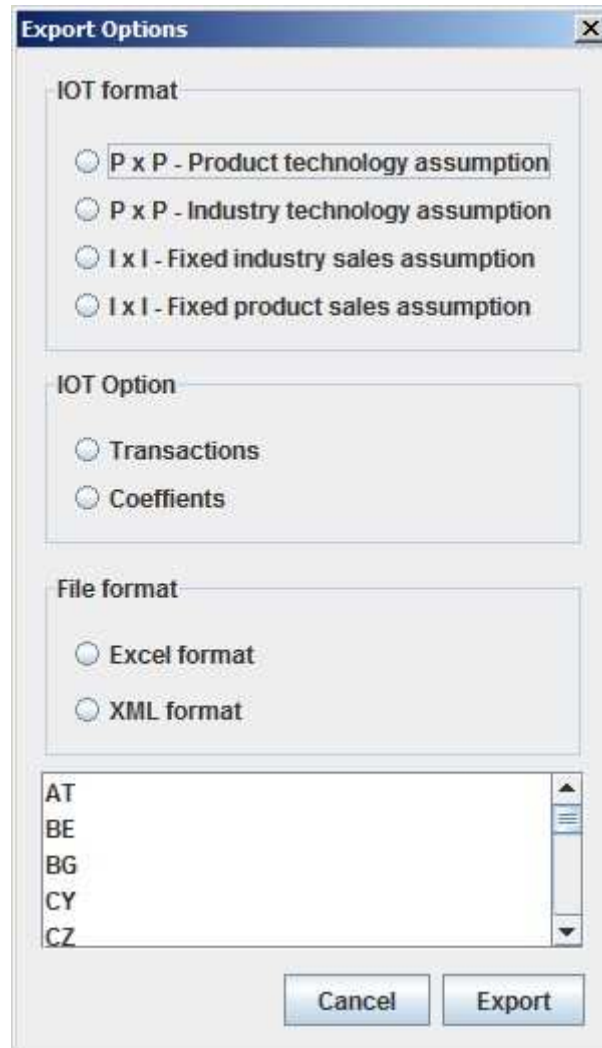


Figure 18: Changing the behavior of the trade-linking procedure.

#### 4.4 Exporting the national supply-use tables

The country supply-use viewer module can also be used to export in Excel or XML format the national supply and use tables or even directly create national input-output tables. From the menu select **Tools >> Export SUT...** or **Tools >> Export IOT...** which pop-ups a dialog where several options can be selected.

In figure 19 the expert options dialog for the export of national input-output tables is shown.



**Figure 19: The options dialog for the export of national input-output tables**

As an example the generated input-output table for Belgium as XML file has been attached.



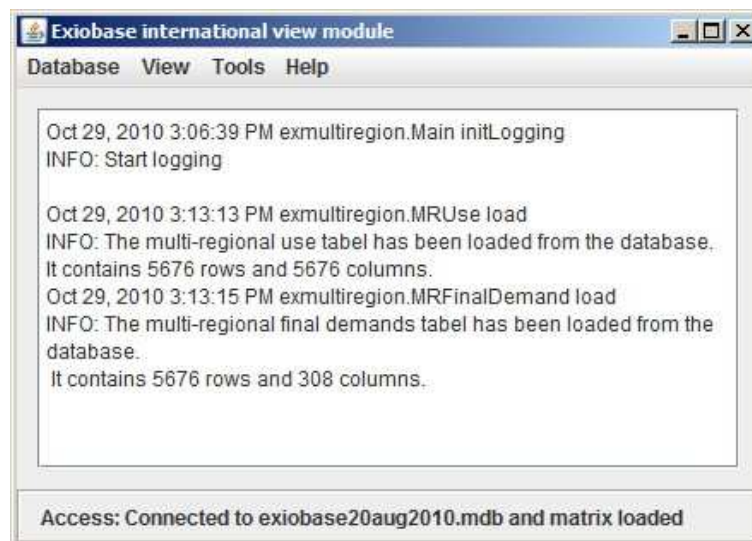
## 5 The international supply-use viewer module

### 5.1 Loading the international supply-use table

The international supply – use viewer is used to inspect and export the international tables. The international use table that was created during the trade – linking procedure has to be loaded from the database first after starting the international supply-use module. Loading the international supply –use table from the database is done by selecting **Database >> Load** from the menu.

The loading of the international supply – use table requires explicit user interaction because automatically loading the international supply – use table from the database at start-up likely takes too much time (it contains  $3.4 \times 10^7$  values). Loading takes about 1 – 2 minutes.

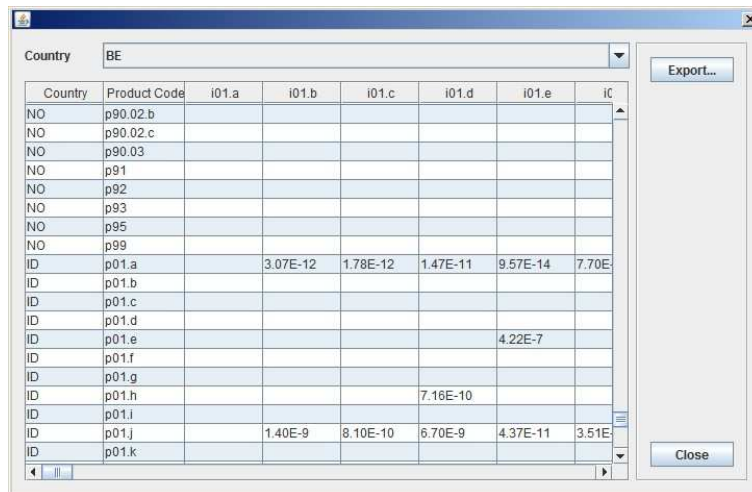
When loading of the international table is ready a status message is logged into the main window area, see Figure 20.



**Figure 20: The international supply - use viewer module after loading the international use table from the database.**

### 5.2 Viewing the international use table

The international use table can be shown by selecting **View >> International use table...** from the menu. Each time a country is selected from the dropdown box a part of the international use table is shown that represents all the import used into the selected country and the domestic use of the selected country.



Country	Product Code	i01.a	i01.b	i01.c	i01.d	i01.e	i01.f
NO	p90.02.b						
NO	p90.02.c						
NO	p90.03						
NO	p91						
NO	p92						
NO	p93						
NO	p95						
NO	p99						
ID	p01.a		3.07E-12	1.78E-12	1.47E-11	9.57E-14	7.70E-14
ID	p01.b						
ID	p01.c						
ID	p01.d						
ID	p01.e					4.22E-7	
ID	p01.f						
ID	p01.g						
ID	p01.h				7.16E-10		
ID	p01.i						
ID	p01.j		1.40E-9	8.10E-10	6.70E-9	4.37E-11	3.51E-11
ID	p01.k						

**Figure 21: Small part of the international use table which shows the imports of agricultural products from Indonesia to agricultural sectors in Belgium.**

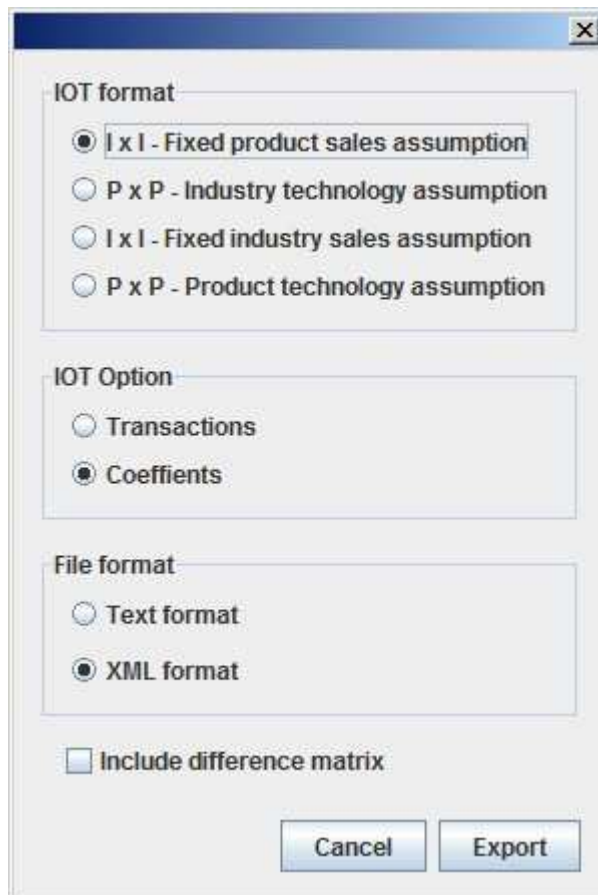
By clicking on the **Export...** button the current view is exported as comma separated text file.

### 5.3 Creating and viewing the international input – output table.

Selecting **Tools >> Create IOT** from the menu will create the international input –output table. The process can take quite some time. While the input – output table is created any status messages and warnings are logged into the main window area.

When the international input-output table has been created to can be viewed by selecting **View >> International input – output table**.





**Figure 23: Export options dialog for export of the international input-output table.**

Clicking on the **Export** button will start the bulk export. The export routine creates the required input – output table plus extensions and writes these to XML files. For each country a separate XML file is written which is compressed “on the fly”. Writing the complete international input – output table as one XML file is not practical because it would be very big indeed.