Work Package 3.1.

Material input data for the GINFORS model

Technical Report

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Contents

1. Methodological foundations

The compilation of material input data in Work Package 3.1. of the MOSUS project followed the nomenclature and categorisation of materials listed in the handbook for economy-wide material flow accounting published by the Statistical Office of the European Union (EUROSTAT, 2001).

As the modelling approach applied in MOSUS only requires material input models containing data on domestic material extraction, no import or export data in physical units was collected.

Data was compiled on the national level in separate Excel spread sheets for 188 countries (number for the year 2002) and then aggregated to the country/regional coverage of the GINFORS model in a second step. A complete list of countries and world regions represented as single models in GINFORS can be found in Annex 1. For each country, data was collected in a time series from 1980 to 2002, taking into account changes due to the splitting up of the former USSR, of former Yugoslavia and former Czechoslovakia.

The Excel spread sheet for each country contains sub-sheets for the following material groups. The number of material categories within each group is given in brackets.

- Fossil fuels (6)
- Metal ores (37)
- Industrial minerals (41)
- Construction minerals (9)
- Industrial and construction minerals (15)
- Agriculture (139)
- By-products of agriculture (3)
- Grazing (1)
- Forestry (2)
- Fisheries (3)
- Other biomass (4)

Each sub-sheet contains

- primary data (in the unit as in the original source, e.g. tons, kilograms, cubic meters, carat, etc.),
- factors converting primary data into 1000 tons of used extraction
- used extraction (in 1000 tons),
- factors to calculate unused domestic extraction through multiplication with data of used extraction,
- total unused extraction (in 1000 tons) and
- total extraction (in 1000 tons), summing up used and unused extraction.

Each country spread sheet also contains two summary and one indicator sub-sheet. The MFA summary sheet presents 11 main material categories, while the summary sheet for MOSUS aggregates all data into the 6 material groups separated in the GINFORS model: biomass, coal, crude oil, natural gas, metal ores, other mining and

quarrying. All calculated MFA data in the summary sheets is also presented in the unit of 1000 tons. The final sub-sheet contains socio-economic data (population, GDP, GDP per capita) and presents indicators of domestic extraction (used and/or unused) per capita and per GDP.

2. Used extraction: description of data sources and calculation methods

This chapter provides a detailed description of the sources for primary data and factors to calculate used domestic extraction for the main categories of fossil fuels, metal ores, industrial minerals, construction minerals and biomass.

Fossil fuels

The category of fossil fuels contains hard coal, brown coal/lignite, crude oil, natural gas, natural gas liquids and peat for energy use.

Primary data for used extraction of fossil fuels was taken from the following sources:

- Industrial Commodity Statistics Yearbook by the United Nations (http://unstats.un.org/unsd/industry/yearbook/default.htm)
- US Energy Information Administration Statistics (www.eia.doe.gov)
- British Petrol Statistical Review of World Energy (www.bp.com/centres/energy)
- World Mining Data by the Austrian Ministry of Economics and Labour (www.bergis.at/wmd)[1]

As primary data is reported in number of different units, factors had to be applied to convert the original units into 1000 tons (see Table 1).

Table 1: Conversion factors for fossil fuels

Original unit	Factor	Source of factor
hard coal		
1000 short tons	0,91	
crude oil		
1000 barrels per day	49,8	BP Statistical Review of World Energy
natural gas		
billion m^3	850	EUROSTAT (2002)
trillion cubic feet	23800	BP Statistical Review of World Energy
1 TJ	0,02	Ferreira & Ferreira (1994), APE (1992)

[1] The 2004 edition of World Mining Data can be downloaded as a pdf document from www.bmwa.gv.at/NR/rdonlyres/1D55F98F-B0E5-4352-AB5B-4E455DA26579/15776/WMD2004.pdf

Metal ores

38 different metal ores are listed in the EUROSTAT guidebook. We excluded the category of “pyrite” from this list, as the industrial minerals groups also contains a category “sulphur from pyrites”, to which we allocated respective data.

Except for the category of bauxite as the raw material for aluminium production, metal ores are in most statistics reported as net metal content, e.g. concentrated metal produced from primary ores. However, the international MFA convention follows the “run-of-mine” approach, indicating that all crude (metal containing) ore is accounted as “used extraction”. This implies that primary data reported as net metal contents has to be multiplied by a factor reflecting the concentration of the metal in crude ores, in order to obtain numbers for the amount of run-of-mine. Information on concentrations of metals in crude ores was obtained through interviews with experts[2] and a literature survey of more than 300 publications, in particular country and metal reports from the German Federal Geological Institute and the US Geological Survey (a more detailed list is provided in Annex II). All country-specific metal concentrations as well as average concentrations for different world regions were summarised in a separate Excel sheet, from which data was extracted for the MOSUS MFA sheets.

With regard to the calculation of crude ore based on statistics, which report net metal production, a particular problem stems from the fact that crude metal ores in many cases contain several metals, entailing problems of possible double counting. The following metals frequently occur as by-products of other ores and therefore were not considered by factors of metal concentration: Arsenic, Beryllium, Bismuth, Cadmium, Cobalt, Gallium, Germanium, Indium and Thallium, Niobium and Tantalum, Selenium, Titanium, Vanadium, Zirconium and Hafnium.

Lead and zinc almost exclusively occur in the same crude ore, so concentration factors have only been applied to one of the two in order to avoid double counting.

In addition, in some countries, also gold, mercury, molybdenum, nickel and silver occur as by-products of other ores, in particular, copper and lead/zinc ores. In the respective countries, no factor of concentration was applied.

Industrial minerals

In addition to the categories listed in the EUROSTAT guidebook, we introduced the categories of zeolite, vermiculite, wollastonite and tuff, for which data was found in official statistics for some countries.

Industrial minerals are in general reported in the unit of tons, thus no particular conversion factor is needed. Exceptions are the categories of silica sand (often reported in cubic meters), where we applied a factor of 1,22 tons per m^3 (see Reade Advanced Materials, www.reade.com) and the category of diamonds (reported in

[2] Interview with Prof. Leopold Weber, Ministry of Economics and Labour, Austria (publisher of data set “World Mining Data”) on 4th of March 2004.

carat), where we applied a factor of 0,0002 tons per 1000 carat (see World Mining Data, www.bergis.at/wmd).

Construction minerals

In general, coverage of construction minerals in official statistics is still unsatisfactory, even in industrialised countries (see also Bringezu and Schütz, 2001b; EUROSTAT, 2002), but in particular with regard to non-OECD countries, where huge data gaps were identified (in many cases, no data at all was available from published statistics).

We therefore applied an estimation procedure in all country spreadsheets, in order to obtain a level of per capita extraction of construction minerals, which – according to interviewed experts in this field and information from other sources, such as geological institutes – can be assumed as realistic in different world regions. The following information sources were used to establish the per capita levels of construction minerals extraction:

- In industrialised countries, numbers are estimated to range between 10 and 15 tons per capita and year, for transition countries between 4 and 8 tons and for least developed countries between 1 and 2 tons (Weber, 2004, personal communication, see footnote 2)
- In their calculation on global resource extraction, Schandl and Eisenmenger (2004) assume an average of around 1 ton per capita in least developed countries, 2 to 3 tons for developing countries and 7-8 tons for industrialised countries.
- The Austrian Federal Geological Institute states on their website (www.geolba.ac.at): “According to own surveys and international comparisons, you have to calculate a consumption of construction minerals of 12 to 15 tons per capita and year in Austria”.

For our estimation procedure, we included additional lines in the sub-sheet for construction minerals, where we calculated total numbers of extraction of construction minerals according to the estimation scheme (see Table 2). In a second additional line we summed up all extraction reported in official statistics. The difference between these two numbers is listed as “construction minerals nec”. If numbers reported were higher than the numbers obtained from the estimation procedure, original numbers remained unchanged.

The basic assumption behind the estimation procedure is that extraction of construction minerals per capita is related to population and GDP. Extraction increases, when population grows and the absolute level is determined by GDP/capita levels. The scheme presented in Table 2 is oriented at the World Bank Classification of per capita income and assumes a saturation effect, e.g. as countries get richer, growth in construction minerals extraction per capita slows down and comes to an end above 20.000 US$/capita. However, note that also in the highest category (10 tons per capita), numbers increase in absolute terms, if population grows. Note also that the assumed maximum value of 10 tons per capita reflects a defensive estimation according to the estimated numbers given by other information sources (see list above).

Table 2: Estimation scheme for construction minerals in the MOSUS project

Income/capita (constant 1995 US $)	Extraction of construction minerals in tons/year/capita	World Bank country classification	Growth in extraction in tons per capita per 1000 $
0-1000	1	Low income and lower middle income	1
1001-2000	2		
2001-3000	3		
3001-4000	4		
4001-6000	5	Upper middle income	0,5
6001-8000	6		
8001-10000	7		
10001-15000	8	High income	0,2
15001-20000	9		
More than 20001	10		0

Some categories in the sub-sheet construction minerals and industrial & construction minerals were reported in m^3. In order to transform data into tons, we used the following densities (tons per m^3).

Table 3: Density factors for selected industrial and construction minerals

Material	Density (t/m3)	Source
Marble	2,55	Mininglife (www.mininglife.com/Miner/general/Density.htm)
Silica sand (quartzsand)	1,22	Reade Advanced Materials (www.reade.com/Particle_Briefings/spec_gra2.html)
Clay	1,8	Reade Advanced Materials (www.reade.com/Particle_Briefings/spec_gra2.html)
Slate	2,75	Mininglife (www.mininglife.com/Miner/general/Density.htm)
Granite	2,65	Mininglife (www.mininglife.com/Miner/general/Density.htm)
Limestone	2,5	Mininglife (www.mininglife.com/Miner/general/Density.htm)
Sand and gravel	1,83	Reade Advanced Materials (www.reade.com/Particle_Briefings/spec_gra2.html)

Biomass

In accordance with most MFA studies on the national level, the statistical database of the Food and Agricultural Organisation (FAO) of the United Nations was used as the main data source for used biomass extraction.

FAO directly provides data for the following categories:

- Agricultural harvest
- Forestry
- Fish catch (including aquatic mammals)
- Aquatic plants

Furthermore, the following categories were calculated based on FAO data:

- By-products from harvest
- Biomass uptake from grazing

No data was available for the categories of hunting, private gathering of mushrooms and berries as well as production of herbs and vegetables in gardens.

Agriculture

Classification of agricultural products also followed the EUROSTAT classification. However, some products, for which FAO data was available, were not classified in the handbook, but included in our calculations. These categories were in general agricultural products from sub-tropical and tropical areas.

The following Table 4 summarises the modifications used in MOSUS in comparison to the EUROSTAT categorisation:

Table 4: Comparison of agricultural product categories

EUROSTAT Handbook	MOSUS Worksheets
Cereals	
Cereals nec	Cereals nec (including Pop Corn, Fonio and Quinoa)
Roots and tubers	
Roots and tubers nec	Roots and tubers nec (including Cassava, Yautia, Taro)
Pulses	
Beans	Beans (including Dry Beans, Dry Broad Beans, Green Beans, Green Broad Beans, Bambara Beans, String Beans)
Peas (Chick-Peas and Peas, Dry)	Peas (including Chick-Peas, Dry Peas, Dry Cow Peas, Pigeon Peas)
Oilcrops	
Oilseeds nec	Oilseeds nec (including Castor Beans, Kapokseed in Shell, Karite Nuts /Sheanuts/,Tung Nuts, Coconuts)
Vegetables and Melons	
Melons	Melons (including Watermelons, Cantaloupes and other Melons)
Onions	Onions (including Onions and Shallots, Green Onions, Dry Onions)
Vegetables Fresh nec	Vegetables Fresh nec (including Okra)
Fruit excluding melons	
Bananas	Bananas (including Plantains)
	Oil Palm Fruit

Berries nec	Berries nec (including Cranberries)
Fruit Tropical Fresh nec	Fruit Tropical Fresh nec (including Cashewapple, Mangoes, Papayas)
Treenuts	
Nuts nec	Nuts nec (including Areca Nuts,Kolanuts,Cashew Nuts,Brazil Nuts)
Fibre crops	
	Abaca (Manila Hemp)
	Agave Fibres nes
	Coir
	Fibre Crops nes
	Ramie
	Sisal
	Kapok Fibre
	Jute and Jute-like Fibres
Other crops	
	Cocoa beans
	Green oilseeds for fodder
	Mate
	Mixed Grasses and Legumes
	Natural Gums
	Natural Rubber
	Sugar Crops nes

In the FAO database, all primary crop categories concerning grass harvest is reported in fresh weight (approximately 80% water content, wc). In order to avoid inconsistencies when comparing MOSUS MFA data with existing national MFAs, these categories were transformed to a standard of 15% water content, using the formula given in EUROSTAT (2002, p. 56):

Yield (fresh weight: 80% water content) * 0.2 * 100 / 85 = yield (hay weight: 15% wc).

Table 5 lists the relevant categories and the related FAO product code.

Table 5: Agricultural products with 80% water content in primary data

Product name	**FAO product code**
Rye Grass, Forage and Silage	638
Grasses nec for Forage and Silage	639
Clover for Forage and Silage	640
Alfalfa for Forage and Silage	641
Leguminous nec for Forage and Silage	643
Mixed Grasses and Legumes	645

By-products of harvest

Based on FAO data on agricultural harvest, by-products from harvest (in particular, crop residues used as fodder), were calculated using factors listed in the EUROSTAT study on EU-15 countries (EUROSTAT, 2002, p. 56).

Concerning straw used for economic purposes, the basis for the calculation were all cereals except maize. The relation of corn to straw is given as 1 and the relation of used straw to total production of straw as 0,5. Thus, 50% (or 0,5) of the weight of the used cereals (except maize) is assumed to be used as straw.[3]

Concerning fodder beet leaves, the relation between beet and leave is given as 0,33, of which 80% (or 0,8) are used as fodder. Thus, 26,4% (or 0,264) of the weight of fodder beet harvest is accounted as used fodder beet leaves.

Concerning sugar beet leaves, the relation between beet and leave is given as 0,8, of which 25% are used as fodder. Thus, 20% (or 0,2) of the weight of sugar beet harvest is accounted as used sugar beet leaves.

Grazing

Biomass uptake from grazing can be estimated applying two different approaches:

(A) the “supply approach” multiplies areas of permanent pastures (as given by the FAO database) with annual yield coefficients. Thus, primary data is the area of permanent pastures (in 1000 hectares) and yield data for pasture (in hectogram per hectare). If available, yield data was taken from category “Grasses nes, Forage and Silage” (FAO code 639). If not available, data was taken from categories “Mixed grasses and legumes” (FAO code 645) or “Forage products nes” (FAO code 651).

[3] This procedure is consistent with the calculation of unused biomass from cereal harvest, where we assumed that 50% of straw remains unused (see chapter on unused extraction below).

Data is then transformed into hay weight of 15% water content using the formula as listed above and finally a share of 15% is substracted, in order to account for the fact that (1) productivity of permanent pastures is considered to be lower than productivity on arable land and (2) the actual amount of fodder uptake is below total productivity. Thus, according to the supply approach, biomass uptake from grazing is calculated by the following equation:

Biomass from grazing = yield*pasture area* 0,0001*0,2*100/85*0,85

(B) The „demand approach“ multiplies annual livestock data with estimations of yearly fodder demand by different grazing animals (see EUROSTAT, 2002 for details). In MOSUS, we assumed the following per capita demands (Table 6).

Table 6: Fodder demand of different grazing animals

Species	Fodder demand (kg per year)
Asses	4015
Buffaloes	3285
Cattle	3285
Goats	365
Horses	4015
Mules	4015
Sheep	365

Source: adapted from EUROSTAT, 2002

In the MOSUS data set, both estimates were performed and the lower number included in the spread sheets as a minimum estimation of biomass uptake from grazing. It has to be mentioned, however, that data on yield of permanent pastures is not available for a number of (in particular, developing) countries. In those cases, only the demand approach could be applied.

Forestry

Domestic extraction of wood was estimated using primary data from the FAO data base. Data was disaggregated into production of coniferous wood and non-coniferous wood, respectively, each comprising four categories of use: sawlogs and veneer logs, pulpwood - round and split, other industrial roundwood, and fuelwood.

FAO forestry data is reported in cubic metres and thus had to be transformed into tons by using density coefficients. Following the EUROSTAT (2002, p. 58) publication for EU-15 countries, the following factors were applied for all countries:

- 0.75 tons per m^3 for coniferous wood, and
- 0.85 tons per m^3 for non-coniferous wood.

These factors comprise the wood density coefficient (to obtain mass dry matter) as well as the water content coefficient (with a water content of 15%).

In line with other MFA studies (for example, EUROSTAT, 2002), we have to remark that wood density is varying significantly across countries and across different species. Therefore, the application of only two conversion factors for all countries represents an inaccuracy, which could be removed by calculating country- and species-specific conversion factors. However, this task was beyond the scope of the MOSUS project.

Fishing

Fishery data was disaggregated into three categories:

- Marine fish catch (FAO category 1821)
- Inland water fish catch (FAO category 1501)
- Other (including [crustaceans, molluscs, cephalopods] FAO category 1851, and aquatic mammals, FAO category 1579)

All categories are listed in tons, except from category 1579, which lists numbers for different types of whales, seals and walruses. The three categories are (a) blue-wales & fin-whales, (b) seals & walruses and (c) sperm-whales and pilot-whales. Based on an internet research on average weight of aquatic mammals, we estimated the average weight of (a) at 100 tons, of (b) at 0,5 tons and of (c) at 15 tons.

Other biomass

Other biomass comprised four categories:

- Honey
- Gathering of mushrooms and berries
- Aquatic plants
- Herbs and vegetables from gardens

FAOSTAT provided data on honey production and extraction of aquatic plants.

3. Unused extraction: description of data sources and calculation methods

In the MFA country spread sheets, data on unused domestic extraction (UDE) was estimated by multiplying used extraction with factors expressing amounts of unused materials per used materials (in ton/ton).

Factors for abiotic minerals (fossils, ores, industrial and construction minerals) were summarised in a separate Excel spread sheet, from which they were extracted for the respective country sheets. Factors for UDE of biomass were derived from a separate literature survey (see Jölli and Giljum, 2005).

Fossil fuels

The following were the most important data sources for UDE factors for fossil fuels:

- **Hard coal**: in the special issue on hard coal of the geological yearbook (Hinrichs, 1999), the German Federal Geological Institute reports a number of country-specific factors for overburden in hard coal mining. In addition, the publications on total material requirement of the European Union prepared by the Wuppertal Institute in Germany (Bringezu and Schütz, 2001a, b) provide numbers on UDE factors for hard coal in selected countries. If no country-specific data was available, the average factor of 0,89 tons of overburden per ton of hard coal was applied (factor taken from Bringezu and Schütz, 2001b).

- **Brown coal / lignite**: data on country-specific UDE factors for brown coal were taken from Bringezu and Schütz (2001b). If no country-specific data was available, the average factor of 3,2 tons of overburden per ton of brown coal was applied (taken from the same publication).

- **Crude oil**: For crude oil, only one average global factor of 0,17 tons of UDE per ton of crude oil was found in the literature (Bringezu and Schütz, 2001a).

- **Natural gas**: in the Wuppertal publications on TMR of EU-15, several country-specific UDE factors are reported. If no country-specific data was available, an average factor of 0,2 tons of unused extraction per ton of natural gas was applied (factor taken from Bringezu and Schütz, 2001b).

No overburden can be observed in the extraction of peat for energetic uses.

Metal ores

For UDE factors of metal ores, we used the same literature sources as described for metal ore concentrations (see also Annex II), from which a large number of country-specific UDE factors could be extracted. If no country-specific information was available, we applied factors from neighbouring countries or continental average factors. Only if no continental information was reported, global average numbers were used.

Industrial minerals

Country-specific data on UDE factors for industrial minerals were only available for Germany and the UK, extracted from several publications of the Wuppertal Institute (Bringezu and Schütz, 2001a, b).
For all other countries, global average numbers were applied, based on the same publications from Bringezu and Schütz.

Construction minerals

Most important data sources for UDE factors of construction minerals were the TMR studies for the EU-15 by Bringezu and Schütz (2001a; 2001b) and a material flow study on the European level by Mündl and Scharnagl (1998).

If no UDE factor was found in the literature, a minimum estimation of 0,05 tons UDE per ton of used construction mineral was applied.[4]

Biomass

As stated above, UDE factors for agriculture, forestry and fishery were derived from a literature survey and all UDE factors applied in MOSUS are summarised in a separate publication (Jölli and Giljum, 2005).[5]

In most material flow studies published so far, the category of unused biomass extractions was disregarded or calculated based on a small number of estimated factors. However, amounts of unused biomass extractions are huge and have to be considered, if the total material extraction of a national economy is assessed. Due to the fact that this issue has only recently gained more attention, only a few publications exist so far which report amounts of residues of agricultural, forestry and fishery activities.

Due to data restrictions, we were only able to provide one set of UDE factors, which we applied to all countries. Clearly, this can only give a very rough estimation of overall UDE in biomass categories, as differences in unused extraction due to different forms of cultivation, differences between social conditions of countries (which are important with regard to use and reuse of biomass residues) and differences in climate and vegetation could not be taken into account.

Agriculture

Unused biomass from agriculture can be divided into two categories: (1) parts of the plant which are retained to the field and (2) losses of parts of the plant due to harvest methods. In MOSUS, we only dealt with the first category of unused extractions of agriculture, as the second one can in general be disregarded due to small amounts of UDE. However, not all residues from agriculture are unused extractions, as unused biomass extractions are reused for a number of purposes, including energy production (biogas), forage and bio-fuels. This share has to be excluded from the calculations, as it enters the economic system for further use (see, for example, the chapter on by-products of harvest above).

For cereals, data for the ratio of the weight of the harvested product to the weight of total biomass extraction was taken from the MFA handbook by EUROSTAT (2001), which is estimated as 1 for all cereal categories except maize (1,4).

[4] Factor based on personal communication with Carlos Costa, geology specialist from the Portuguese Geologic and Mining Institute, Lisbon.
[5] This publication can be downloaded from www.seri.at/studies.

For all other categories, data on ratios were taken from biomass energy flow accounts by Hemstcock and Hall (1995) and Amoo-Gottfried and Hall (1999). Information on unused shares of residues was taken from di Blasi et al. (1997).

Forestry

In the course our search of sources for UDE factors in forestry, we found three main studies calculating forestry residues, focusing on different countries and different years. The first study deals with the US (McKeever and Falk, 2004), the second with China (Cuiping et al., 2004) and the third study (Koopmans and Koppejan, 1997) summarises data from several sources. While the share of woody residues is quite similar in all three publications, the results for the use of residues for other economic purposes, depending to a large extent on environmental, economic and social factors, differ considerably (between 10% and 35%).

For all country data sheets in the MOSUS project, we calculated with an average factor of 30% woody residues in total roundwood production, of which 35% were assumed to be unused.

Fishery

With regard to UDE from fishery activities, only one reliable source was identified; a study by the FAO (1994), assessing fisheries by-catch and discards on a global scale.

For marine fish, an average of 19,8 tons of every 100 tons are discarded catch (and only 80,2 tons are used catch). The discarded mortality rate of marine fishes is about 98%, i.e. 98% of the fishes which are retained to the sea do not survive due to catch, handling, etc. Consequently, the average coefficient to calculate unused marine fishes from data on used catches is 0,242.

No data were found with regard to inland fish catch. Therefore, as a first approximation, the same factor as for marine fishes was applied.

The category of “other fisheries” contains a number of very heterogeneous species: cephalopods, molluscs, sharks and marine mammals like whales, seals and other mammals, sea birds and sea turtles. Due to these differences and the lack of data we found no possibility to calculate an aggregated UDE coefficient for this category.

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ANNEX I: The 55 country / regional models within GINFORS

1 Austria
2 Belgium/Lux
3 Denmark
4 Finland
5 France
6 Germany
7 Greece
8 Ireland
9 Italy
10 Netherlands
11 Portugal
12 Spain
13 Sweden
14 United Kingdom
15 Czech Republic
16 Hungary
17 Poland
18 Slovak Republic
19 Turkey
20 Iceland
21 Norway
22 Switzerland
23 Canada
24 Mexico
25 United States
26 Japan
27 Korea
28 Australia
29 New Zealand
30 China
31 Hong Kong
32 Indonesia
33 India
34 Malaysia
35 Philippines
36 Singapore
37 Taiwan
38 Thailand
39 Argentina
40 Brasil
41 OPEC
42 Rest of the world
43 Cyprus
44 Estonia
45 Latvia
46 Lithuania
47 Malta
48 Slovenia
49 Bulgaria
50 Romania
51 Russia
52 Ukraine
53 Chile
54 Peru
55 South Africa

ANNEX II: Sources for information on metal grades and overburden in metal and mineral mining

German Federal Geological Institute (www.bgr.de)

- *Rohstoffwirtschaftliche Länderstudien* (Raw material country studies), covering the following countries: Russia, Ukraine, Turkmenistan, Belarus, Kazakhstan, Turkmenistan, Uzbekistan, Tajikistan, Kyrgyzstan, Bulgaria, Estonia, Latvia, Lithuania, Poland, Rumania, Slovakia, Slovenia, Czech Republic, Hungary, Albania, Bosnia-Herzegovina, Yugoslavia, Croatia, Macedonia, Rumania, Brazil, Argentina, Mexico, Mongolia, China, Zimbabwe, Ethiopia, Mozambique, and New Zealand.

- *Geologisches Jahrbuch – Sonderhefte zu ausgewählten Rohstoffen* (Geological yearbook – special issues on selected raw materials), covering the following raw materials: iron, copper, aluminium, nickel, manganese, chromium, phosphate (and hard coal).

- *Untersuchungen über Angebot und Nachfrage mineralischer Rohstoffe* (Studies on supply and demand of mineral raw materials), covering the following raw materials: potash, lithium, niobium, tantalum, bauxite, zinc, molybdenum, tungsten, cobalt, vanadium, asbestos, germanium, indium, selenium, tellurium, zirconium, chromites, dolomite, diatomite, magnetite, quartzite, andalusite, and vermiculite.

US Geological Survey (www.usgs.gov)

- *Country reports*: country reports are available for download almost all countries world-wide.

- Personal communications with USGS experts

Wuppertal Institute for Climate, Environment and Energy (www.wupperinst.org)

- Technical report for study “Total Material Requirement” of the EU-15” (Bringezu and Schütz, 2001b)
- Technical detailes of national MFA (Inputside) for Germany (Schütz, 1999)