Schriftenreihe
Soziale Ökologie

Band 45

National Material Flow Analysis for Austria 1992

Society's Metabolism and Sustainable Development

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Vienna, 1997

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Abteilung Soziale Ökologie

Impressum
Medieninhaber, Verleger, Herausgeber:
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The Contribution of Material Flow Analyses to Environmental Policy

National material flow analyses and materials balances are indispensable sources of information with respect to the operationalization of sustainable development. Both of these instruments are already employed in official statistics in Germany and Japan, and other countries – especially member states of the European Union – are likely to follow suit. Because of the preparatory stages of work that have already been carried out, Austria is in an excellent position to assume a leading role in international concerted action.

Whereas the **growth critique** of the 1970s perceived continuous economic growth as the decisive cause of progressive environmental destruction, the contemporary discussion concerning ecologically sustainable forms of social development focuses upon the possibilities of delinking growth with respect to the use of materials from economic (monetary) growth. This is based upon the realization that increases in income as such are unlikely to be detrimental to the environment, whereas permanent increases in resource flows between society and nature certainly do have negative effects. The issue, then, is not just to use resources more efficiently, but to reduce current levels of resource consumption in absolute terms.

Interpreted in this way, **abandoning the materials-intensive model of welfare** implies fundamental social changes which will not only affect the technologies currently employed in production as well as processing or the prevailing structures of demand. Rather, this transformation will particularly affect established organizational patterns with respect to work processes, patterns of human settlement, established habits of food consumption, traffic and leisure. With reference to the industrialized countries, one of the **central demands articulated in the discussion of sustainable development** is that the depletion and use of non-renewable resources needs to be reduced absolutely, and the use of renewable resources must not exceed their capacity of regeneration.

To **operationalize** ecologically sustainable development, therefore, it is mandatory to develop adequate monitoring systems providing comprehensive and regular **information** with respect to current social use and depletion of resources. For some areas of concern, it is possible to use already established information systems and adapt them in ways that respond to the new demands. This is primarily true for national energy balances, despite the fact that their origins go back to policy considerations related to supply.

There is much less information available, however, when it comes to the dimension and structurural composition of the material turnover of societies as well as the development of the process over time. Systematic observations of socially induced material flows are lacking, and existing accounts of the turnover of materials are neither structured as yet according to uniform criteria, nor do they monitor changes over time. National materials balances must be comparable internationally and need to be structured in a way that permits global aggregation. Some countries have already started attempts at establishing **national material flow analyses**, with **Germany, Japan and Austria** currently holding the lead. Endeavours currently under way to improve existing accounting procedures seek to improve **precision** (especially with respect to establishing the conceptual boundaries of materials balances, the classification of material flows and the adaptation of primary statistics) and to achieve a greater degree of international **harmonization**. So far, it is only Germany and Japan that have already implemented these endeavours in the official statistics. It is very likely, however, that institutionalized material flow analyses will also be carried out for other industrial countries over the next couple of years, as well as for some developing countries currently in transition to industrialization.

National materials balances promote ecologically oriented policy-making with respect to resources: Politics, the media and the scientific establishment no longer focus exclusively upon wastes and emissions as the final outcomes of a problematic chain of effects, but upon the **total physical transformation process** – and here, especially, on the initial stages of this process, in which decisions are made which determine the scale and structure of resource use and depletion. The rationale for this new concern is that „materials and substances entering into the industrial process of transformation do not disappear somehow, but have ecological effects, and these effects are becoming more obvious every year“ (Jänicke 1995b).

National materials balances show that it is not only absolute risks that are ecologically relevant, but also the sheer quantities of resources consumed. Strains on the environment, therefore, regularly have two dimensions – the toxicity and dangerousness of the substances involved, on one hand, and the quantity of throughput, on the other. In order to prevent and avoid strains on the environment, both dimensions need to be observed if potential problems are to be addressed adequately. That the perspective of the dominant paradigm, exclusively concerned with poisoning, is reductionist becomes obvious when one considers the massive material turnover associated with construction activities.

One may expect that the completeness and validity of emissions monitoring will gain from the availability of periodically updated materials balances. To a large extent, the existing gaps in documentation and the insecurities involved in monitoring annual movements of wastes and emissions are the result of deficient knowledge with respect to the order of magnitude of the materials entering various processes and their whereabouts. Material flow analyses are crucial for an improved understanding of the connection between raw materials use and the formation of residuals and wastes.

National material flow analyses and materials balances constitute an essential element of environmental economic accounting in Austria.

Beside substance flow analyses as well as energy-, emissions- and waste balances, materials balances are an essential element of **„Physical Accounting“** within the framework of aggregate ecological accounting. At the moment, the broadest conception of a system fully integrated into the system of national accounts used in aggregate economic analysis is developed in the SEFA-Handbook of the United Nations, *Integrated Environmental and Economic Accounting* (United Nations 1993). The Austrian Statistical Central Office (ÖSTAT) has taken up this concept and, for several years now, has been working to develop a **System of Ecological Accounts for Austria** on the basis of a resolution ratified by the Austrian parliament in 1987. This is closely bound up with national resource accounting and the economic valuation of these resources. Currently, the development of national material flow analyses is of outstanding importance for the establishment of joint environmental statistics on behalf of the member states of the European Union. There are plans to elaborate a classification system for activities as well as goods (PRODCOM and NACE) which is expected to tie in with the system of national accounts.

In Germany, material- and energy flow analyses have already been integrated into environmental economic accounting. The methodological concepts required to establish these accounts were developed jointly with the Wuppertal Institute for Climate, Environment and Energy.

In order to integrate national material flow analysis and materials balances into official statistics three preliminary conditions must be satisfied: (1) An appropriate accounting framework is required which permits linking environmental data with the established framework of economic statistics, (2) relevant data must be available and (3) a socially accepted organization must exist which is in charge of carrying out statistical analyses.

The results of the study in hand prove that these conditions are fulfilled to a sufficient extent. Therefore, it is feasible to carry out a national material flow analysis for Austria which is to be updated annually and integrated with existing official statistical accounts.

Certainly, it is conceptualization that has proceeded farthest. The conceptions that have been developed as well as the empirical studies carried out so far have reached a point where it is possible to begin with implementation. The results of the report in hand and, especially, the empirical part of our study corroborate this. There is no doubt that **precision** – especially with respect to the **demand side** of the process – needs to be improved and that both results and methodological procedures call for efforts to strengthen **international harmonization**. This, however, can be reasonably achieved only within the framework of regular reporting procedures taken over from official statistical publications. Without taking this step, all further endeavours to update Austrian materials balances would retain their current status as research results. National materials balances on the basis of research projects, however, are far from commanding the degree of acceptance which is required for policy makers aspiring to use them as a key instrument within the framework of environmental policy-making. The necessity of continuous periodic updating of the accounts, likewise, can only be guaranteed if the process is integrated with official statistical procedures.

The next steps which need to be taken with respect to the statistical implementation of a national materials balance, therefore, will concern the actual data which are available as well as the organizations functioning as the main actors. In short, it is necessary to **improve the generation of primary data** and **establish the preliminary institutional framework.**

Methodological Foundations for Material Flow Analyses

It was possible, within the framework of the study submitted here, to develop a detailed conception of the accounting framework required. Accordingly, standardized procedures are available now for investigations which can be updated in the future. It is indispensable to harmonize these reporting procedures internationally. Further measures designed to elaborate this methodological framework, therefore, should be coordinated with relevant expert work that is currently under way abroad. At the moment, the most important institutions working in this field are EUROSTAT, the *Statistisches Bundesamt Wiesbaden*, the Wuppertal Institute for Climate, the Environment and Energy, and the Environmental Agency in Japan.

First, it is necessary to clearly distinguish analyses concerned with *materials* from analyses of *substances*. Substances are chemical elements and their combinations, whereas materials are all natural as well as produced mixtures of substances, products, wastes, emissions and dissipative losses. Accordingly, the literature distinguishes substance flow analysis (SFA) from material flow analysis (MFA).

Apart from distinguishing material- and substance flow analysis, it is possible to differentiate between functionally oriented analytic approaches and those concerned with spatial entities. Functional approaches are concerned with institutions, activities and products. Research designs oriented towards spatial entities may differentiate politically defined units from those characterized by specific natural conditions. Applied research, however, is typically characterized by combinations of and intersections among various approaches.

The material flow analyses carried out within the framework of this study are based upon the territory of the Republic of Austria and differentiate, with respect to inputs, between

- material extraction from domestic nature
- material imports from abroad (imports in the form of raw materials and products)

Output, in turn, is structured according to

- exports of materials abroad
- discharge of materials into nature (emissions, waste, discharge on purpose, dissipative losses)

Discharge of material on purpose mainly refers to agriculture (dung, compost, sludges, mineral fertilizers), whereas dissipative losses were estimated in this study as abrasives of rubber on roads as well as losses of agricultural products due to drying, dehydration and shrinkage.

For the establishment of materials balances, it is essential to register the increase in material stocks („inventory account“) that are accumulated within the society in the long run by way of infrastructure investment (especially for housing, traffic and communication) and in the form of durable products. In terms of balancing techniques, every materials input which remains in the system for more than one year is considered a stock.

Quantifying and and describing material flows invariably is bound up with the necessity to classify and structure them according to specific criteria. We suggest to distinguish three approaches which, respectively, differentiate material flows by the economic areas in which they occur, according to functional considerations, or via specific groups of raw materials.

With respect to **functional criteria**, the social system is structured according to

- primary extraction (extraction of materials from nature, e.g., by mining, harvests, etc.)
- processing (transformation of primary extracts into products as well as their reutilization and disposal)
- final demand (utilization and consumption of products)

Since the accounting period for which material flows are balanced does not exceed one year at a time, materials that are used for periods longer than one year are registered in a separate inventory account.

Analysis in terms of **economic areas** differentiates between domestic raw materials extraction and exchange of materials with foreign countries (imports and exports).

This implies registration of the total turnover of solid, liquid and gaseous materials which are either extracted from nature on domestic territory or imported across the border, and which are then transformed, used up, exported or immediately returned to nature within the span of one year. The estimation of imports and exports in material flow analyses, therefore, includes semi-finished as well as finished goods. Services and forms of utilizing the environment which do not have any material effects upon it, however, are not registered at all („intrinsic value," e.g., its aesthetic value or its value for recreation).

With respect to raw materials extraction, accounting procedures focus upon those primary inputs extracted from nature which are processed and utilized subsequently within a particular economic system.

Finally, material flows are differentiated further by air, water and other materials, according to the material composition of raw materials (biotic, abiotic), and according to the period or date in which currently available combinations originated (fossil vs. recent). Based upon this basic scheme for the classification of material flows, therefore, the following **partial analyses** may be carried out:

- coal, oil, natural gas
- mineral materials
- biomass
- air
- water

These are ideal-type classifications which permit the largely unanimous attribution of raw material inputs. However, these classifications become ever more fuzzy when it comes to analysing socially induced anthropogenic material flows which, subsequently, are associated with various processes ranging from production and distribution via final demand all the way to final disposal.

Empirical Results

The socially induced materials turnover of Austria was calculated for the years 1990 and 1992. Aggregate results for both reference years do not show significant quantitative differences, and the material requirements of the Austrian economy have hardly changed over the period observed. Data required to update the material flow analysis for Austria for 1993 and 1994 are also largely available already.

With respect to some particular sectors, quantitative differences for the two reference years are more conspicuous. These differences, however, result from methodological adaptations of the accounting framework as well as from improved sources of primary data. It became obvious that, by and large, input-related aspects of social metabolism are better documented than material flows related to output use, since the number of raw materials procured for subsequent processing is rather limited in most cases. At the same time, raw materials are more closely monitored as far as they command a price and enter calculations as costs. Wherever **primary material** is **extraxted directly** from nature (e.g., in the extraction of gravel) on the basis of existing property rights or rights of disposal, however, quantitative information and exact data with respect to extraction are deficient most of the time. When materials passing through the system are being processed in an increasing number of stages, available data may become too sketchy or too intricate to permit an accurate description which differentiates among various material flows. Hence, with increasing depth of processing, there is a tendency to add up these divergent material flows and represent them as total aggregates rather than to differentiate among them. It is only the reporting systems employed by waste management that permit, once again, a more detailed analysis of material flows in certain subsectors.

If total anthropogenic material input is differentiated according to the three main groups of water, air, and other materials, it turns out that throughput of water accounts for by far the largest share of materials required socially: Water accounts for 87% of total material turnover, with 8% left for air and 5% for other materials.

The results for 1992 show a primary extraction of 138 million tons of mineral materials compared to an extraction of 58 million tons of biomass and imports of approximately 25 million tons of oil, coal and natural gas. Taken together, this amounts to a total annual input of materials of 221 million tons which amounts to **an average per capita use of approximately 29 tons per year**. Close to one third of this total involves mineral materials, one quarter is reserved for biomass, and roughly 12% for fossil materials.

Table 1

Material Flow Austria 1992 – Total Turnover

	Domestic Extraction [in Mio t]	Imports [in Mio t]	Total Materials Input [in Mio t]	Share in total Turnover [in %]	Turnover per Capita [in t/EW]
Water	3888		3888	87%	504
Air	330		330	8%	43
Other materials	174	47	221	5%	29
Sum			4439		576

Table 2

Material Flow Austria 1992 – Input of Other Materials (excluding Water and Air)

	Domestic Extraction			Imports			Total Input		
	[Mio t]	[%]	[t/EW]	[Mio t]	[%]	[t/EW]	[Mio t	[%]	[t/EW
Coal, oil, natural gas	4,3	2	0,6	20,9	45	2,7	25,2	12	3,3
Mineral materials (excl. soil excavation)	123	71	15,9	14,5	31	1,9	138	62	17,8
Biomass	47	27	6,1	11,2	24	1,5	58	26	7,5
Sum, rounded	174		22,5	46,6		6,0	221		28,6
Share in %	79			21			100		

Table 3

Output of Other Materials (excluding Water and Air)

	Fossil Material [Mio t]	Minerals [Mio t]	Biotic Material [Mio t]	Total [Mio t]
Wastes	2,2	10,5	11,3	24,0
Emissions	19,4	0,04	11,8	31,3
Discharges on Purpose		1,0	20,7	21,7
Exports	2,4	10,1	9,7	22,2
Dissipative Losses		3,0	0,9	3,9
Total Output to Nature	24,0	24,6	54,4	103,1
Quantity Processed		3,2	4,4	7,6
Inventory Gains (including statistical difference and changes in inventories)	1,2	113,2	3,8	118,2
Total Output and Inventory Gains, rounded	25	138	58	221

Source: Internal Calculations, ÖSTAT, Various Sources.

Austrian material needs are largely satisfied by the extraction of domestic resources. 20% of total materials input are imported, whereas, by and large, **80% are extracted domestically**. More than 50% of materials imported are fossil raw materials. Approximately two thirds of domestic extraction, on the other hand, consist of abiotic raw materials, with biotic raw materials coming close to one third of domestic extraction. Exports of materials amount to 22 million tons or approximately 10% of total material throughput and are mainly composed of minerals and wood, as well as semi-finished and final goods. In terms of value, exports of goods amount to 22% of GDP compared to the sum total of imports estimated at 27% of GDP.

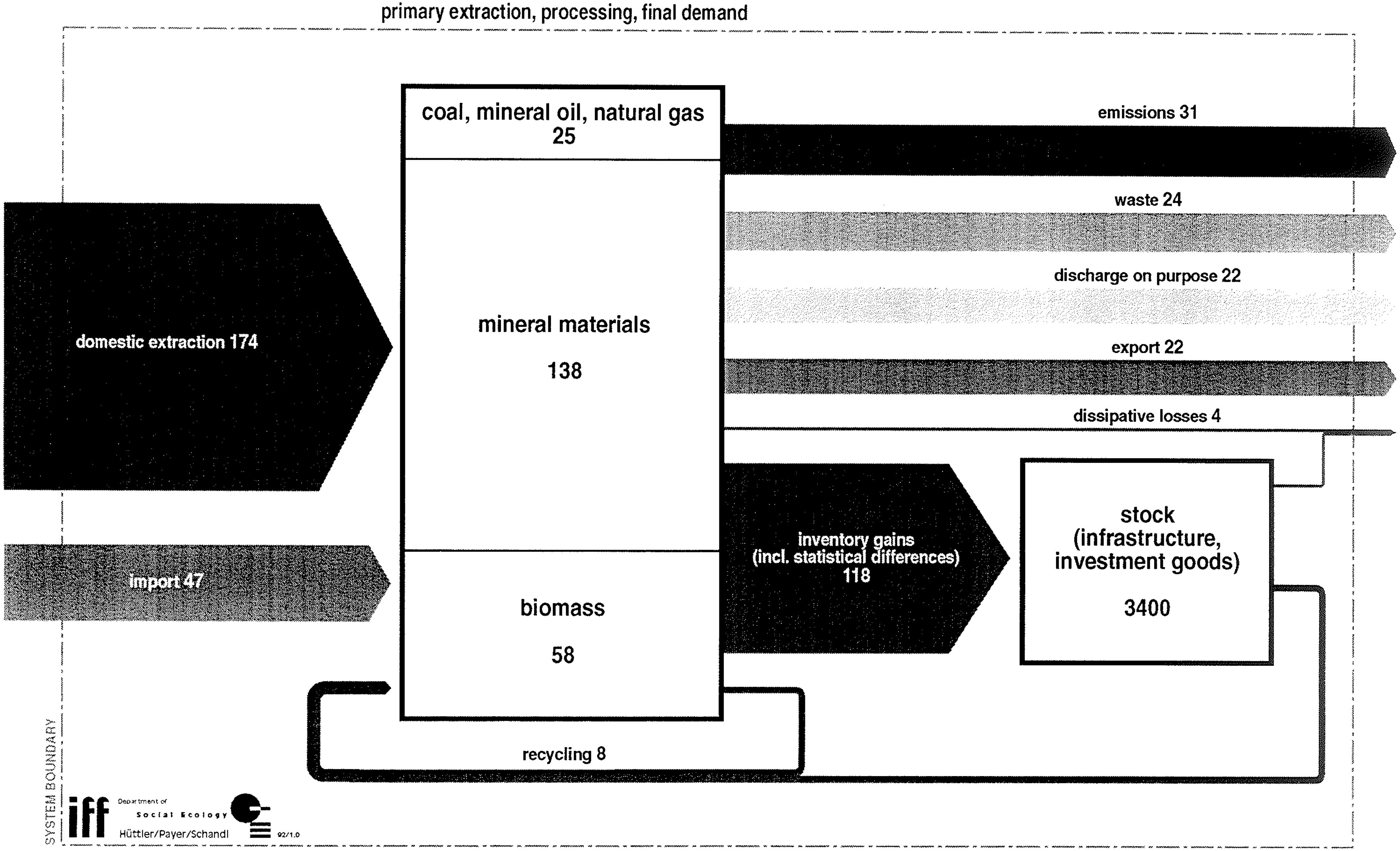
Approximately 50% of material inputs (118 million tons, of which 113 million tons are minerals) are fixed in the long run in the form of constructions, infrastructure and investment goods. This constitutes an annual net increase in material inventories, since material from demolition is already subtracted from these accounts. Two thirds of the total turnover of mineral raw materials are made up of primary products used for construction (crushed stone, gravel, sand, limestone, clay etc.). In particular, the **high intensity of construction** demonstrates that it is not just acute risks, e.g. in the form of toxic substances, but material turnover as such that constitutes an essential criterion for sustainable development.

On the whole, the results confirm that **recycling strategies** which enjoy general favour among the public are only capable of contributing marginally to the solution of the problem. Apart from the quantities that are re-used in agriculture, only a very small part of total material throughput (approximately 3%) is being recycled at the moment. Although it would be feasible technically to recycle a much larger share of materials, this would be dubious on ecological grounds. By far the largest share of materials used (energy carriers, mineral raw materials, composite materials as well as most chemicals) can only be partially recycled. Moreover, if this is possible at all, recycling processes typically require very high energy inputs.

Considering the options involved with respect to sustainable forms of using resources, the relationship between renewable (recent) to non-renewable (fossil) material is of prime concern. If one looks at the share that renewable materials hold with respect to other materials (excluding water and air), non-renewable raw materials (coal, oil, natural gas, mineral materials) hold a share of approximately 75% of total material turnover and, hence, display a striking preponderance over renewable resources (biomass). Even if it is assumed that non-renewable resources can be **substituted** completely, it is impossible to substitute the existing large share of non-renewable resources by means of a forced transition to renewable raw materials. The maximum potential of renewable resources that can be utilized in Austria is limited by the parameters of the natural conditions prevailing in the region and must be considered insufficient. Put differently, this implies that the total area of Austria would have to be several times its current size if the country wanted to supply its raw materials exclusively from renewable sources. A permanent reduction of fossil material throughput, therefore, is impossible unless there

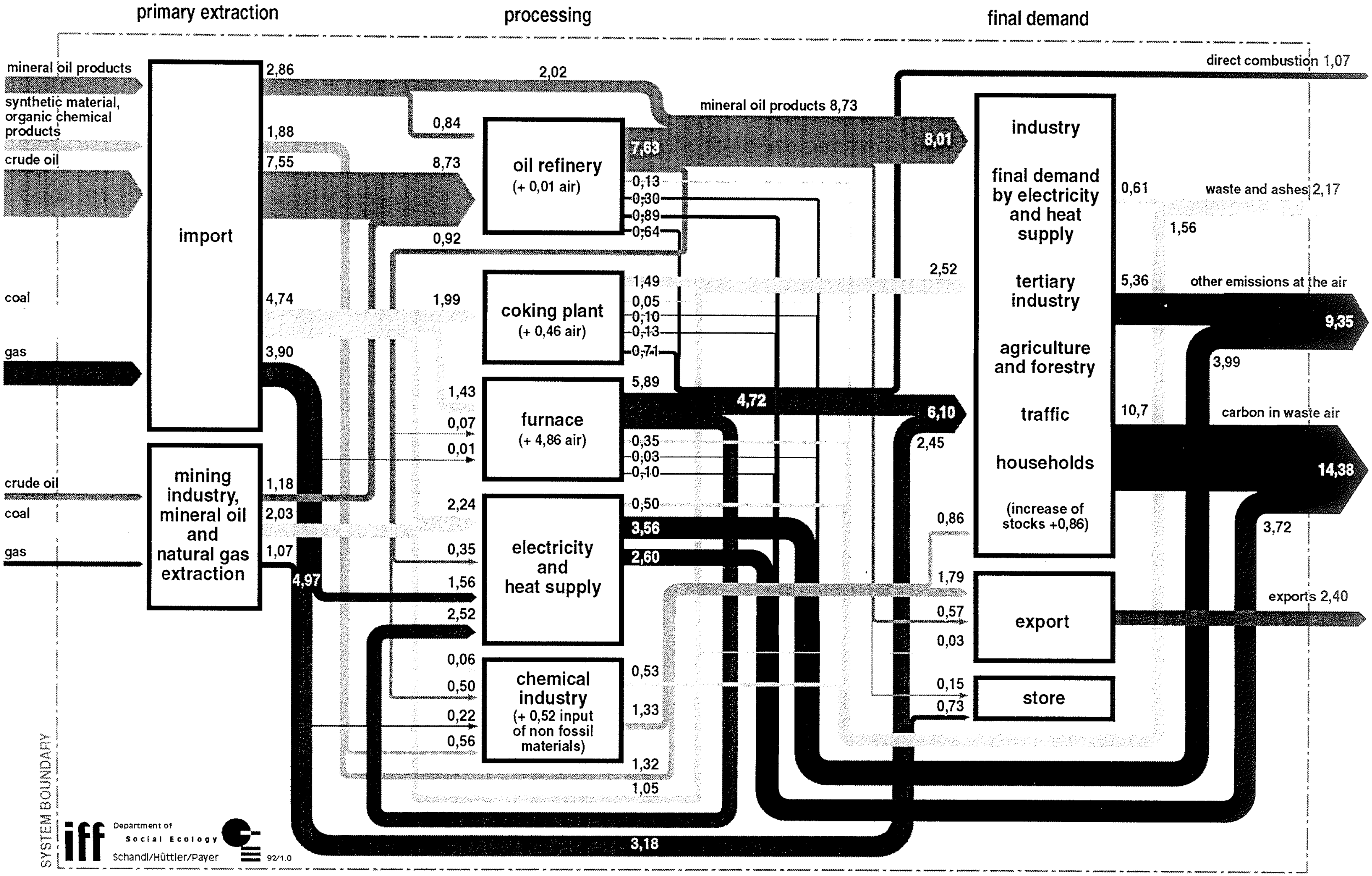
MATERIAL FLOW AUSTRIA 1992 – Total excl. Water and Air

values in mio tons



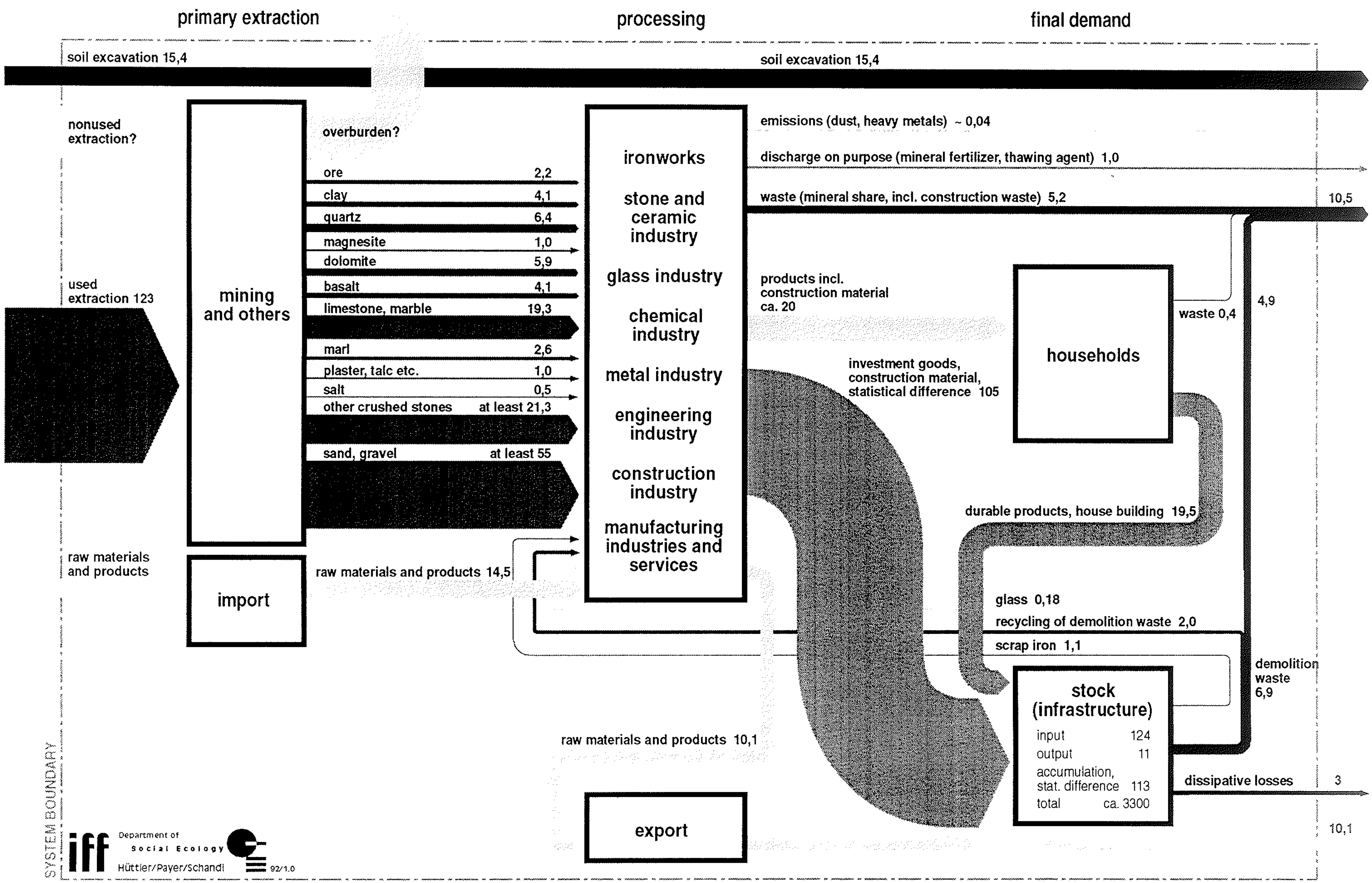
MATERIAL FLOW AUSTRIA 1992 – Coal, Mineral Oil, Natural Gas

values in mio tons



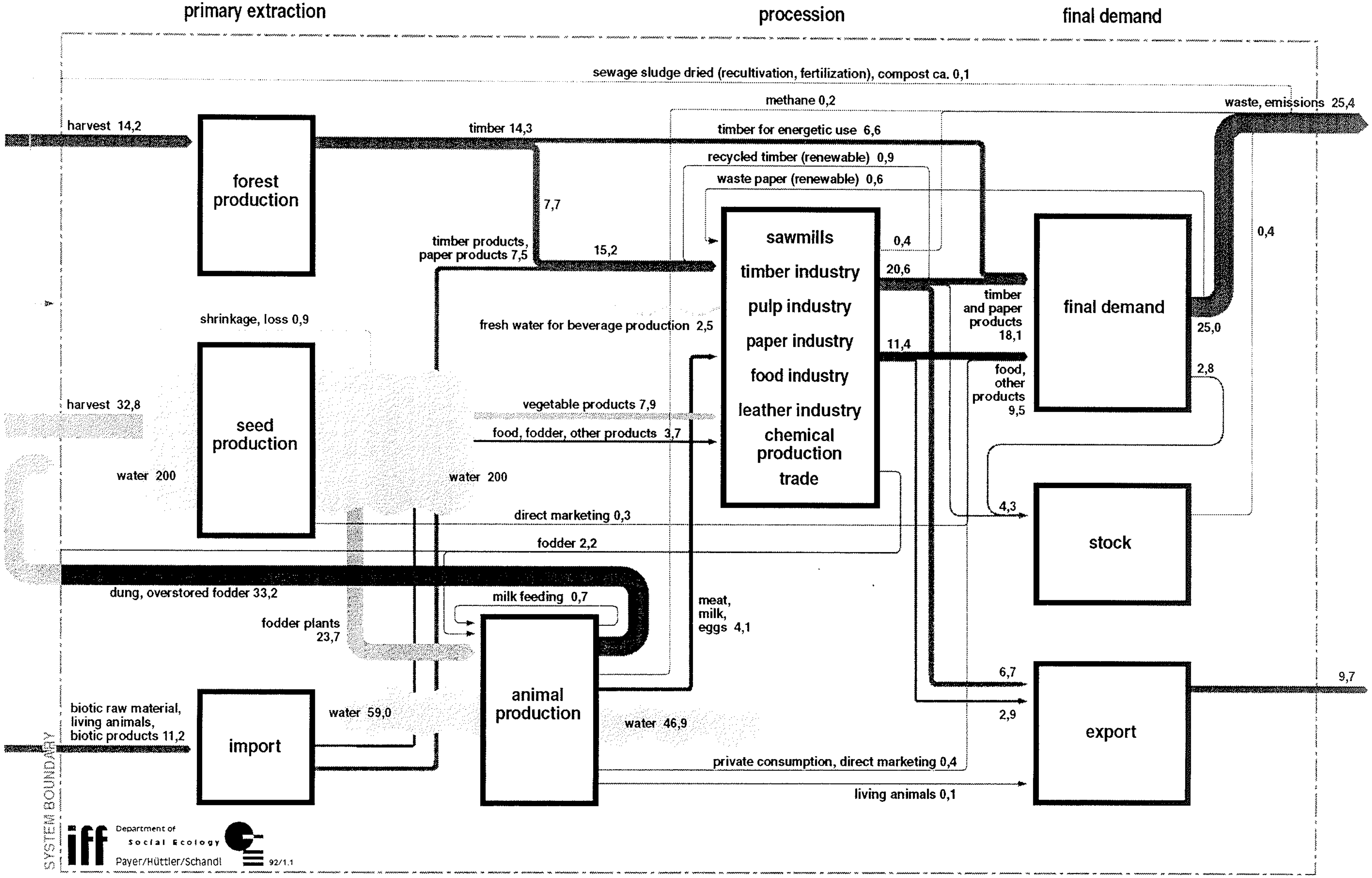
MATERIAL FLOW AUSTRIA 1992 – Mineral Materials

values in mio tons



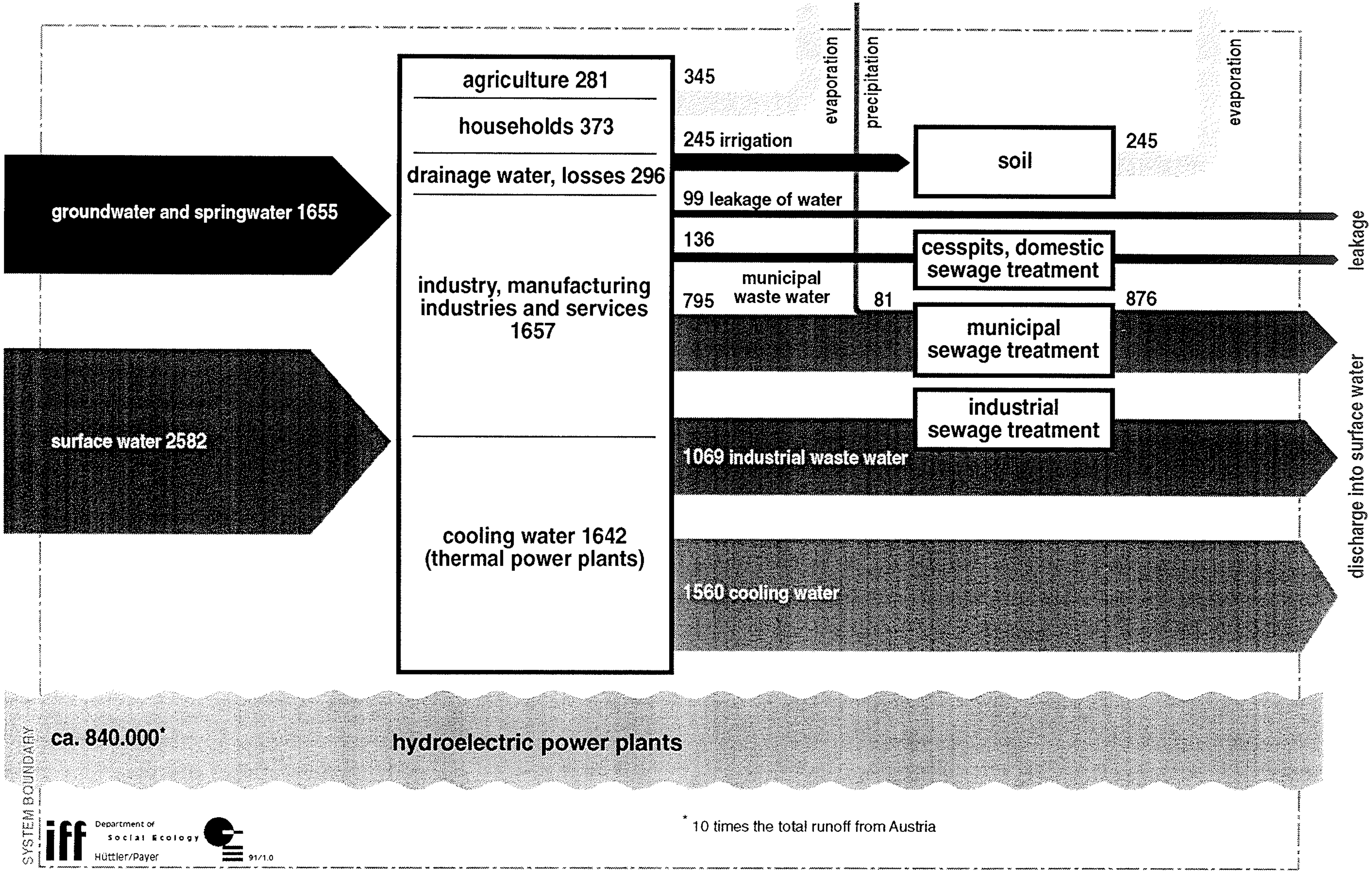
MATERIAL FLOW AUSTRIA 1992 – *Biomass*

values in mio tons



MATERIAL FLOW AUSTRIA 1991 – Water Balance

values in mio cubicmeters



* 10 times the total runoff from Austria

is a concomitant reduction in the quantity of materials required – especially with respect to construction activities and energy supply, with food supply ranking third.

Finally, the results clearly show that the current high level of consumption of materials – so typical for an industrial country like Austria – cannot be generalized worldwide. Apart from the distributional conflicts that would ensue, it is simply impossible to conceive of 6 billion people on earth consuming, on average, 29 tons of materials per capita and year. For simplicity´s sake, one may start from the assumption that each inhabitant of the earth is granted the same amount of „environmental space," i.e. the same range of utilizing raw materials as well as natural absorption capacities for emissions, for a medium-term period. Under these circumstances, the developed industrial countries would have to reduce their raw materials consumption, depending on the material flows in question, by rates ranging from a minimum of 20% to a maximum of 80%.

Recommendations for Statistical Implementation

Empirical investigations carried out within the framework of this study have shown that the data required for annually updated national material flow analyses are largely available. There are some sectors, however, in which relevant material flows are underrepresented in official statistics – essentially, this concerns the turnover of materials in the small trades and in trade, the self-extraction (so-called *Inneneinsätze*) of materials in the processing sector as well as some material turnovers which do not enter official statistics since this would violate certain principles of attribution: According to current statistical convention, material flows are only registered if they can be attributed to the predominant activities of a firm. In particular, total material flows are underrepresented statistically when it comes to the extraction of mineral raw materials and green fodder.

Most of the statistical problems related to underrepresentation may be solved by means of plausible estimates for selected reference years. However, such estimates are too unreliable to serve as a regular data base, and the estimation procedures used are suboptimal for the regular updating of national material balances. Instead, it would be necessary to set up reporting systems for the areas concerned which guarantee that the necessary primary data are available annually or, at least, periodically.

The way in which official statistics deals with the **underrepresentations** observed should not be underestimated when it comes to the acceptance of the reporting system envisaged. Essentially, we see **two options** to handle this problem:

(1) The claim to a comprehensive and largely complete registration of material flows is given up, especially since the objective to be attained is international harmonization. In this case, periodic estimates would regularly be biased towards certain underrepresentations which, however, might be quantified fairly exactly by carrying out a detailed investigation once. Also in favour of this mode of proceeding is the fact that it permits sufficient documentation of the relative changes and tendencies in anthropogenic material flows over time. Wherever it is possible to extrapolate material turnovers on the basis of periodically available data, however, estimates should be carried out even if they tend towards underrepresentation. This is true, e.g., for projections of material extraction based on data available with respect to value added in production (e.g. sand, gravel, crushed stone used by the small trades) or based on stock accounts (e.g. heavy livestock units - *Großvieheinheiten* - used to estimate extraction of green fodder). It is also true for projections with respect to consumption and use on the basis of strategic materials used (e.g., cement input used to produce concrete, bitumen for asphalt), for estimates based upon alternative sources of data (duties charged for the protection of landscape) and for reporting systems installed on the level of federal states (raw materials extraction register of the *Länder*).

(2) For future inquiries the traditional domain documented by official statistics is extended by integrating adequate criteria into statistical procedures. This is certainly the optimal variant if anthropogenic material flows are to be documented as exactly as possible.

If one considers the temporal constraints and financial bottlenecks that this variant would run into, however, it seems to be more advantageous to proceed in a step-by-step fashion. Accordingly, one may start with option 1 and, given available personal and financial resources, successively approach option 2. This implies, first of all, to start with data which are available already, and subsequently to close information gaps which are underrepresented in statistical documentation by means of adequate projection techniques. At the same time, areas which are underrepresented should be listed by priority and gradually integrated into the domain documented by official statistics.

As a matter of principle, it is recommended that a periodic materials balance be established on the basis of ÖNACE 1995. When Austria joined the European Union, the future necessity to register raw- and auxiliary materials was discussed as well. In the future, it is very likely that the registration of **raw and auxiliary materials** will proceed according to ÖNACE, which will also facilitate linking the use of materials with **production data**. So far, raw- and auxiliary materials are documented statistically only according to the systematics used by the trade associations (*Fachverbandsgliederung*) which, for the reasons mentioned above, must be considered as a second-best solution only.

In the future, **data on foreign trade** will be documented in conformity with procedures followed in the European Union. This will improve the **possibilities to link these data with domestic production and demand**. The possibilities to generate corresponding information from detailed **input-output tables** should be evaluated.

We suggest that the Austrian Statistical Central Office (ÖSTAT) use a largely standardized procedure to identify and document **double-counting**, i.e. intermediary deliveries within certain economic sectors or branches. During the implementation phase appropriate statistical procedures should be designed in cooperation with experts from ÖSTAT and, if necessary, involving experts from the respective branches. In this respect, the results taken from updated **input-output tables** are viable sources of information.

Specific efforts should be made to close information gaps still existing with respect to primary data. Available data on the domestic extraction of resources are deficient in the following areas:

- Primary extractions which, due to existing property rights, are used as raw materials free of cost and, therefore, do not enter the statistics of raw- and auxiliary materials. In terms of quantity, this concerns especially mineral raw materials used in the construction sector.
- Primary extractions which do not occur as part of the main activities of a firm, e.g., the extraction of gravel by firms primarily involved in hauling (*Fuhrwerksunternehmen*).

Since this affects only a limited number of distinct raw materials, it does not seem unreasonable to add them to the list of **raw- and working materials** which firms are requested to document in their **statistical accounts**. It is necessary, however, to establish the legal framework for this move beforehand by way of adequate amendments to the Law of Statistics.

Trade constitutes a particular problem, since there are hardly any quantitative data available at all with reference to this sector. We suggest that plausible information might be gained if available information on turnover is matched with expert knowledge concerning this branch and, possibly, with relevant information from market research institutes.

Information on the use of raw materials as well as products is deficient wherever data concerning demand for them are lacking completely or are recorded by way of cumulated values. This is true for **private final demand** as well as for the important sphere of public procurement. Since information with respect to both areas may be gained from **input-output tables**, it seems promising to invite experts familiar with the relevant analytical statistical techniques. Moreover, available deficient primary data on certain sectors of private final demand may be compensated to a certain extent by findings derived from **market research** which may provide valuable information if surveys are carried out periodically.

Construction- and civil engineering are not considered branches which procure material goods in the narrow sense of the term. When it comes to data on materials, therefore, construction statistics only show the amount of raw- and auxiliary materials used. In this case, it would be desirable to amend the available economic data concerning the volume of construction (gross production value, net production value, turnover, revenue, etc.) by a quantitative approximation of the **„products" of construction activities** with respect to the following parameters:

- Constructions: Cubature (m^3) and area (m^2) built up,
- Traffic routes (rail, road): km per defined standard cross-sections (*Normquerschnitte*).

Especially when it comes to construction activities, it is recommended to look at inventory increases. Accordingly, official material flow analysis should develop a separate module documenting the extent and composition of the annual increases in inventories. Housing statistics as well as the periodic counts of houses and apartments carried out by ÖSTAT may be used as starting points.

Assigning firms institutionally to particular economic activities is done according to the „main fields of activity" that they are involved in. This, in turn, is inevitably bound up with fuzzy data in statistical documentation. As far as this has dramatic implications with respect to the material flows documented (as is presumed with reference to construction activities), it is recommended to carry out crude estimates of the masses and volumes involved in periodic intervals.

With respect to the physical dimension of certain sectors of the economy, e.g. the **small trades** as well as the **service sector**, statistical accounts hardly exist at all. Under these circumstances, alternative procedures to generate relevant data should be considered. There exists a wide variety of reports, studies and concepts related to particular branches which frequently provide important information concerning material flows. For some parts of the small trades and service-sector, therefore, it should be possible to establish relationships between economic and physical data which are substantiated reasonably well. There are other subfields, e.g. raw materials extraction, for which reporting systems differ across the Austrian federal states: Whereas Vorarlberg collects duties on landscape use (*Landschaftsabgabe*) which are calculated with reference to the quantity of raw materials extracted, Lower Austria runs a cadastral survey of raw materials extraction which is updated periodically.

Data on bulk mineral raw materials used for construction are based upon several years of observation at the beginning of the 1990s. The findings, therefore, represent an average value from which it is **impossible to derive time series**. As long as available primary data are incomplete, there are two possibilities to update them annually: As long as data are not updated, one may proceed from the results of single inquiries that are more exact than others and project data for subsequent years by means of linear extrapolation, as the *Geologische Bundesanstalt* is wont to do. Another procedure might be to annually update total primary extraction by way of projecting select indicator materials, e.g. cement or bitumen, for which there are data on total annual consumption in the official statistics.

Detailed data on disposal activities are collected within the framework of the Federal Waste Management Plan which is updated every three years. To structure this reporting system, however, a system of key numbers is used for certain categories of waste which largely disregards the origin of these wastes and documents only exceptional cases. When primary data on waste disposal are recorded, therefore, they should be structured not only by assigning key numbers to them. Apart from that, it should be clarified in cooperation with the Federal Environmental Agency (*Umweltbundesamt*) to what extent it is possible to disaggregate primary data with respect to the **quantities of wastes recorded according to ÖNACE 1995**.

Establishing periodic material flow analysis for Austria should be connected, moreover, with establishing appropriate **interfaces permitting substance flow analyses**. Under normal circumstances, substance flow analyses are based upon the flow of goods and utilize additional information concerning the (chemical) substances that raw materials and goods are composed of. Thus, it is possible to follow the flow of certain chemicals and their combinations through a particular system and, if necessary, to balance it. If possible, therefore, available information concerning the composite substances of materials should be integrated in standardized form into the reporting system which is to be established. Subsequently, statistical experts and scientists specializing in material- and substance flow analysis should be invited to discuss problems of implementation and potential requirements concerning the protection of data.

In addition to that, emphasis should be put on improving the possibilities to carry out **regionalized** material flow analyses, e.g. on the level of the federal states (*Bundesländer*), and to improve international harmonization. Austria has gained a lead in this field, and there is no doubt that regular cooperation between ÖSTAT and EUROSTAT as well as the *Statistisches Bundesamt Wiesbaden* has played a very important role in this process. It is recommended, therefore, to further intensify cooperative efforts.

Parallel to the implementation of a periodic materials balance for Austria **a separate „environmental statistics“ division should be opened in ISIS** (Integrated Statistical

Information System), one of the databanks run by ÖSTAT. At any rate, this would be justified by the multiple activities already pursued by ÖSTAT in this rapidly developing field and as a response to permanently increasing demand for statistical information with respect to the environment on behalf of policy-making and science. This main databank within ISIS would exclusively be reserved for environmental statistics and might be structured, in principle, according to the modules used in aggregate environmental economic accounting. Initially, it should contain the following elements:

- periodic material flow accounts at the national level
- select material flow analyses of particular branches
- National Emissions Monitoring (NEMO) for air, water and waste
- select data from the publication *Umwelt in Österreich – Daten und Trends*
- investment in environmental protection

It would be an important first step into this direction if a segment were added to ISIS which shows the material goods production of trade and industry according to ÖNACE 1995.

In addition to that, technical facilities should be examined which are capable of storing primary data for a period of more than 10 years, so that it is possible to retrieve them for evaluation according to certain criteria at a later date.

We recommend that the Federal Ministry of the Environment in cooperation with the Austrian Statistical Central Office (ÖSTAT) are awarded the task of establishing, regularly updating and periodically publishing the materials balance of Austria. ÖSTAT has a large part of the primary data, the relevant know-how and the infrastructure required to meet these objectives readily at hand and, even more important, it is an institution which is socially accepted and given credit for its capacity to establish such periodic information systems. In order to eliminate systematic underrepresentation and achieve international harmonization, the periodization and institutionalization of national materials balances seems to be the most efficient solution.

Experience gained from this study has shown that this will require an increase in staff by an additional full position. Given the current financial constraints which public administrations are facing everywhere, it seems reasonable to consider alternative forms of appointing and financing the personnel in question.

Delinking of Economic Growth and Materials Turnover

From 1970 to 1990 total materials flow through Austrian society has approximately increased by one third. As can be seen from changes in the amount of primary energy used during this period, economic growth in physical terms and value added in production decoupled slightly, and the same is true for the use of materials. Since 1970, materials input per unit of GDP (material intensity) decreased by 25%. This implies that relative gains in efficiency are compensated by the annual increases in the use of materials which, by and large, are caused by few yet massive „strategic" material flows of steel, cement, wood, paper/pulp, sand, gravel and crushed stone.

The empirical findings suggest that delinking of economic growth from the metabolism of human society should be discussed more carefully. The concept of „delinking" involves two alternative perspectives of development differing from each other with respect their ecological effects. The analysis may either focus upon absolute changes in materials throughput or on the relative changes of materials throughput per unit of output. It is strongly recommended, therefore, to distinguish clearly between relative and absolute productivity of resources.

Branch analyses confirmed, once again, that the information contained in material indicators related to value-added concepts is relatively insignificant when it comes to evaluation of the social „pressures upon the environment."

In retrospective, the period from 1970 to 1990 shows that **changes in total material use are similar to changes in total energy use**. Both of them grow continuously, albeit less than GDP. At the beginning of the 1990s the turnover of materials was reduced by one third compared to 1970. Apart from a substantial reduction in energy consumption per unit of GDP in the period after the second oil price hike, empirical studies show that there is **no trend- reversion towards an absolute reduction of total materials use on behalf of society**. Construction materials (sand, gravel, crushed stone, pebbles) constitute by far the most rapidly growing fraction and, therefore, are mainly responsible for the increase in total materials use. In the wake of the economic downturn at the beginning of the 1990s the growth rates of energy use dropped for a short period. The updated materials balance for 1992 shows that total material use remains fairly constant, at least.

In material terms the development of the Austrian economy is determined by a small number of crucial flows of **steel, cement, fertilizers, wood, paper/pulp, sand, gravel and crushed stone.** These may be defined as strategic materials which may be used as indicators to document the pressures which society exerts upon the environment. Essentially, they desribe the development of some basic industrial sectors which are particularly materials-intensive. In aggregate analyses these strategic materials may be used very much like another indicator, viz. the total aggregate of materials used, in order to operationalize the concept of „sustainable development." They are, however, much better suited for empirical investigations since data are more readily available. The growth rates in total materials use for the period from 1970 to 1990 can largely be explained by increases in the use of these strategic materials. During the period in question, sand-, gravel- and crushed stone throughput increased by 63%, which corresponds to an average annual rate of increase of 3%. During the same period, throughput of all other strategic materials (including chlorine, aluminum and pesticides) increased by a total of 55% or by an annual average rate of 2.6%. It is only the use of fertilizers which saw any reductions between 1970 and 1990. In contrast to this, the throughput of all other materials increased by a mere 0.3% on average or by a total of only 6.8%.

Water use has remained constant, by and large. Short-term peaks of demand (1977, 1991) were due to extraordinary requirements of caloric power plants for cooling water in the extremely cold winters of these years.

With respect to most strategic materials **delinking** has occurred to a smaller or larger extent, and rates of increase in material inputs fell behind the growth rates of GDP. This has had the effect that the amount of materials entering the process of production did in fact drop per unit of value added. Delinking with respect to sand, gravel, crushed stone and cement, however, is only valid with respect to aggregate economic analysis. Set in relation to the development of value added in the construction industries in which the said materials are used as inputs, the material intensity of sand, gravel, crushed stone and cement has in fact increased. The results of sectoral analyses, therefore, may differ radically from findings derived from the analysis of total aggregates. No delinking has taken place with reference to chlorine and wood, and increases in their use largely correspond to increases in GDP. Increases in the use of paper, pulp, aluminum and pesticides, on the other hand, exceed increases in GDP.

Over the whole period in question **resource productivity** – i.e. the economic value added per unit of material or energy used – **has increased substantially**: The productivity of water has increased by 72%, the productivity of materials by 33% and the productivity of energy by 30%. Nevertheless, the persistent increase in the absolute throughput of resources suggests that, despite numerous undisputed successes in the past, pressures put upon nature, on the whole, have not declined yet. Relative gains in efficiency are compensated by the annual increases in consumption, and there is no absolute reduction of the amount of materials being used. What has indeed changed are stress patterns, frequently by way of shifts from emission freights to waste flows. At the moment, increases in material inventories with respect to the built environment as well as infrastructure are still receiving too little attention. This, however, is where environmental problems of the future are lurking in store, viz. problems of waste disposal (since only a small part of debris may be recycled) and the diminution of land due to its alienation for various construction activities.

It was impossible within the framework of this study to carry out a systematic estimate of existing **potentials to reduce socially induced materials throughput**. Options available to reduce the use of non-renewable resources, however, have been discussed with reference to the construction sector, and more detailed analyses of other fields of activities are recommended.

In developing strategies to reduce resource use for the whole of society, the relevant actors, their present needs and wants as well as the options they have with respect to their future wants and perspectives of development should be integrated more strongly. The question to be answered in this case is how it will be possible to integrate core actors like construction contractors or canteens, which primarily want to stay in business and need to be involved in policies of sustainable resource management without threatening their very existence in the long run.

Intermediate Material Flow Analysis – Fields of Activities

Disaggregating material flow analyses and carrying out investigations on an intermediate rather than a macro-level seems be particularly interesting, since this permits more detailed investigation of structural changes in resource use. One of the core objectives of this study, therefore, was to develop and test feasible conceptions for the establishment of branch-related material flow analysis.

The concept of „activity fields" (*Aktivitätsfelder*) serves as a framework within which material- and substance flow analyses may be carried out on an intermediate level. Activity fields consist of a network of social activities which can be attributed to specific actors. These actors are largely defined according to institutional criteria (e.g. branches) and, therefore, known also with respect to their economic dimensions. Acitivity field analysis is concerned with a comprehensive description of the structure of material flows (their material composition, linkages, etc.) and, at the same time, takes into account the economic relevance of the respective economic actors. In contrast to isolated branch analyses concerned with the investigation of select core branches involved in production and distribution, activity field analysis provides the possibility of integrating forward and backward linkages among the relevant actors, e.g. primary extraction, trade, services, households, disposal et al..

A need or want is defined as a human (basic) need for food, housing, clothing, communication, etc.. It is well understood that these wants or needs are subject to temporal as well as social changes and do not stay constant over time. Activities, in turn, are defined as social activities undertaken to satisfy these very needs and wants.

This study investigates the core material flows, i.e. those which cover the whole activity field in question. Material advances which are preliminary for these activities – e.g., the production of machines, transport equipment and auxiliary substances used – are not included in the analysis. The concept of activity fields, however, does not exclude consideration of these advances on principle – instead, it depends on the specific problem to be analyzed whether they are considered or not.

The definition of activity fields is primarily motivated by the consideration that it is not (human) needs and wants that are at the centre of the discussion when it comes to develop modes of economic behaviour which are sustainable in the long run. Instead, what is of central importance is the way in which these wants are satisfied. The analysis is concerned with the exchange relations between societies and their natural environments – relations which vary with respect to time and space. The analysis follows **supply lines** from beginning to end, from the extraction of raw materials all the way to their disposal.

At any rate, the ultimate definition of activity fields should closely follow the established **systematics of economic activities** in order to permit an integrative synthesis of pertinent branch analyses and additional activity field analyses. Once the relevant actors within a particular activity field are described in a way which is compatible with the systematics of economic activities, material flows and the units of value added which are associated with them can be related to each other. This fulfills one of the essential conditions that must be satisfied if economic development is to be evaluated with respect to its resource productivity.

This study has also investigated the extent to which material flow analyses are feasible on an intermediate level on the basis of existing reporting systems, i.e. without having to take recourse to additional statistical inquiries. This concerns especially branch-related reporting systems, i.e. by and large statistics of trade and industry as well as the construction statistics kept by ÖSTAT. The study also identifies the areas for which data are still deficient. Central to the analysis was the development of material flows over time and its relation to the economic dynamics of the respective sectors.

The Activity Field of Food Supply

Total domestic production (primary extraction) of biotic material for food supply (excluding material used as inputs for the non-food sector) amounts to 31.9 million tons annually. This corresponds roughly to one third (69%) of the total annual domestic extraction of biomass or approximately 18% of total domestic extraction of materials. The amount of biotic material used is primarily determined by the 23.7 million tons of fodder plants (including green fodder) consumed annually, since these hold a share of almost three quarters (74%) of total primary extraction required for food production. 8.2 million tons of biotic material are harvested annually as vegetable products for immediate consumption („vegetarian share“).

Compared to these data, the share which the activity field „food supply“ contributes to value added in the production of GDP is between 11 and 12%. From the mid-1970s to the end of the 1980s the contribution of food supply to value added has remained fairly constant. At the same time, the relative importance of the food trade and of gastronomy has risen in comparison with the value added in production by agriculture as well as by the trades. The material intensity of the activity field (biotic material turnover relative to cumulated value added) is approximately 2.3 tons per 1.000.- ATS value added, which is approximately twice as much as the material intensity of the economy at large.

A long-run comparison of the results of agricultural production shows strong fluctuations of yield which, for most of the products in question, largely depend on weather conditions. These fluctuations are largely compensated by increasing or reducing inventories as well as by import substitutions. 1992 saw a very hot and dry summer in Austria which resulted in comparatively low harvest yields. For the following two years, total yields increased by 9.2% in 1993 and 13.4% in 1994.

Food imports (including fodder) amount to approximately 2.8 million tons. Total input of material flow with respect to food supply (domestic primary extraction plus imports), accordingly, amounts to roughly 34.7 million tons. This corresponds to 60% of total biotic input used to maintain the metabolism of Austrian society, or 16% of the input of all materials (excluding water and air). The amount of food consumed by Austrians, therefore, slightly **exceeds one sixth of the total annual use of materials**.

The quantity of **fodder used** substantially influences total social material throughput. In 1992 fodder constituted approximately 50% of total domestic biomass extraction (including wood) or roughly 14% of total domestic materials extraction. Some three quarters of total fodder provided are consumed by cattle, approximately 18% are consumed by pigs, 5% by poultry, 2% by horses and 1% by sheep and goats. The use of fodder types which are not destined for sale (especially green fodder) is almost completey restricted to cattle farming.

The input of materials in food supply is estimated at approximately 14.3 million tons, with an additional minimum of 2.5 million tons of drinking water used for the production of drinks. It was impossible to gain a complete picture of how material inputs are distributed among their various forms of use, i.e. either as inputs in trade and industry as well as in the small trades which are to be processed subsequently, or as merchandize which is acquired directly and resold subsequently. The total biotic input into food processing on behalf of industry, the wholesale trades, dairies and cheese-dairies is estimated at approximately 9.8 million tons. As a result of the estimation procedure employed to compensate for double-counting, this sum total is systematically biased towards underestimation by approximately 5%. Total biotic output amounts to a good 9.5 million tons composed of approximately 8.5 million tons (89%) of products and some 1.0 million tons (11%) of wastes. These wastes, in turn, are variously used as fodder and fertilizers, or as substances which are either processed materially or thermically. With respect to output, estimates are biased towards systematic underrepresentation for the same reasons that were adduced for input estimates, and the same is true for the quantity of wastes reported which is probably too low as a result of underestimation in the trades sector. In the end, the materials balance for output underrepresents the main line of food processing by a total of 0.3 million tons, which corresponds to a good 3% of total materials throughput documented.

No records exist with respect to material flows involved in the small trades as well as in trade and commerce. Due to the results mentioned above, the materials input of both sectors probably is in a dimension ranging from 4.5 to 5 million tons.

Assuming an average rate of consumption of 80%, one may calculate a total of 9.4 million tons of food which are consumed annually. Accordingly, there are some 1.9 million tons of wastes (kitchen refuse, leftovers, spoilage) which are generated annually as well. The total quantity of food consumed, therefore, corresponds to some 29% of the total primary extraction used for food supply. Hence, one kilogram of food consumed requires 4.3 kilograms of biomass which need to be harvested. If people are to be supplied with meat and meat products, of course, material input increases by a corresponding amount. More than two thirds of primary extraction are being recycled into the agricultural system of production even before they are consumed by humans – mainly in the form of harvest residuals, dung and other forms of home-produced fertilizers as well as fodder.

As a result of the increased importance of eating out, ready-made food holds a minimum share of 15% today. With respect to Austria, this yields an annual quantity consumed of 1.4 million tons, of which some 1.1 million tons are actually consumed by humans if one assumes a rate of consumption of 80%.

There are no systematic accounts of the quantity of wastes from food (wastes resulting from processing, refuse and spoilage). Volumes and origins of these waste flows as well as their distribution could not be analyzed systematically within the framework of this study, and the results of the analysis, therefore, are preliminary. First, it is assumed that biotic wastes account for a minimum share of 25% of total wastes. Accordingly, 0.6 million tons of waste may be assumed to be related to municipal food wastes. Another

0.3 million tons or so are assumed to be generated by canteens as well as restaurants. However, part of the residuals generated by trade and industry are disposed via municipal waste disposal, which may cause overlapping to a degree. The quantity of food wastes may be calculated, instead, on the basis of available statistical data and evidence from the relevant literature concerning food consumption as well as consumption quotas: In this case, the quantity of wastes generated is estimated at some 1.9 million tons, which differs from the erstwhile projection by 1 million tons. It is impossible to clarify the origin and composition of these 1 million tons – in part, they contain food residuals which are composted at their place of origin and are impossible to quantify, meat as well as meat products fed to domestic animals, as well as certain quantities of kitchen refuse originating from commerical food preparation, canteens and the like which are larger than initially assumed. Moreover, the available quantitative estimates, while documenting identical material flows, are very likely to differ from each other because of differentials in water content.

Besides, there are other spontaneous side-effects resulting from food consumption as well: It is possible to estimate, by means of adequate material flow coefficients linked with population figures for Austria, that the total output of feces in 1992 was 0.4 million tons. In addition to the stink thus generated, the total quantity of urine excreted amounted to 4.3 million tons, the quantity of water transpiring in the form of sweat came to 1.1 million tons, and carbon output as a result of metabolic processes ran into 1.7 million tons. Taken together, this sums up to a total of some 7.5 million tons of material output resulting from food consumption.

In updating the National Environment Plan, food supply should be given more attention in the future and should, in fact, become a focal concern. This also implies that concrete strategies as well as objectives should be developed which promote modes of economic behaviour that take greater care of resources. With respect to the activity field of food supply, therefore, sustainable development should be based upon interdisciplinary strategies.

The Activity Field of Construction

It is already the results of material flow analysis at the macro-level which suggest that construction activities may be expected to hold the largest shares in material turnover on behalf of Austrian society. Accordingly, it was quite natural to investigate the dimension of the material flows and stocks as well as the shares of various fractions of materials involved in construction activities. It was the bulk of mineral raw materials which took pride of place in the investigation, since no detailed analysis for this fraction exists so far which covers the whole field of construction activities. With respect to the core branches in the activity field „construction“ (i.e., extraction of stones and earths, production of goods from stones and earths, construction) it was possible to analyze the structure as well as the development of material flows over time which are relevant for construction.

With a material turnover of more than 100 million tons annually, construction activities are responsible for approximately half of the material turnover of society. In contrast to this, the share that construction activities hold with respect to the total value added in production is less than 10%.

From 1970 to 1992 the development of construction activities was extremely dynamic, with an increase in total material inputs by some 50%. The increase in material inputs (domestic extraction plus imports) in Austria between 1970 and 1990, therefore, can largely be explained by the increases that took place in construction.

Economic growth in the construction sector averaged 3.9% annually from 1987 to 1992. With an average annual rate of 5.4%, however, growth in physical terms surpassed this increase in value by far. From 1976 to 1992 value added in construction construction and civil engineering in real terms increased by 17%, whereas raw and auxiliary materials input has increased by no less than 47% over the same period. Delinking of growth in physical terms and economic growth, therefore, has occurred in the sense that the turnover of materials has increased much more than the value added in their production.

Compared to the material intensity of the economy at large, the quantity of physical goods produced in relation to value added (material intensity) is ten times larger in the production of goods from stones and earths. In addition to that, material intensity in the construction sector shows a strong tendency to increase.

The data available with respect to trade in wood, construction materials and flat glass between 1976 and 1988 show an increase of approximately 50% in value added.

Compared to the domestic extraction of raw materials, foreign trade in materials relevant for construction plays a subordinate role.

Approximately 50% of all construction materials are filling materials and natural stones. Ready-mixed concrete and products made of concrete hold a share of roughly one third, followed by asphalt (6%) and recycled construction materials (2%) which are largely used in road construction. The remaining construction materials sum up to a total of some 9%, with bricks, limestone, gypsum, wood and iron holding the largest shares. Mineral bulk raw materials are either used directly for fillings or as aggregates in concrete and asphalt. They hold a share of approximately 85% in the total turnover of materials involved in construction activities at large. Strategies designed to reduce materials consumption by society, therefore, must keep a close look at this fraction of materials.

With respect to the specific uses that construction materials are put to, road construction plays a prominent role with 40% of materials used on construction reserved for road-bound traffic networks. Some 8% are used on line construction, and 1% each go into rail construction and hydraulic engineering. The remaining half of the turnover of construction materials is largely used in construction engineering (housing and constructions for economic use or so-called *Wirtschaftsbau*) and civil engineering projects like power generation plants, sewage purification plants, waste deposits and the like.

According to the Federal Waste Management Plan (*Bundesabfallwirtschaftsplan*) approximately 7 million tons of construction residuals are produced annually. 2 million tons of these residuals originate from construction sites, the rest is debris from the demolition of houses and infrastructure (roads et al.). Residuals of construction materials, therefore, hold a share of some 6% in the total turnover of materials used in construction. Close to one third of construction residuals, i.e. an annual total of some 2 million tons, is processed and recycled. Although processing capacities have been substantially expanded in recent years, the total volume of materials processed stagnates.

Increases in stocks by some 104 million tons annually are balanced by outputs of construction residuals summing up to a total of approximately 5 million tons, as well as by dissipative losses in the form of road abrasion amounting to an estimated 3 million tons. Increases in stocks, therefore, are 13 times larger than output. It is no surprise, then, that construction activities result in a gigantic build-up of material stocks amounting to an annual total of some 96 million tons or some 12 tons annually per capita. Total material stocks are estimated at some 300 million tons per capita, with traffic- and other forms of construction related to infrastructure (line construction, hydraulic engineering, etc.) holding a share of approximately two thirds, and housing as well as construction and construction for economic use (*Wirtschaftsbau*) accounting for 1/6 each.

Statistics on trade and industry as well as the construction statistics run by ÖSTAT underrepresent sand, gravel and crushed stone by some 60%. If one extrapolates the quantities of sand and gravel produced by the small trades on the basis of value added, underrepresentation is reduced to some 25% which, incidentally, corresponds to the amount of underrepresentation of employees in the construction statistics run by ÖSTAT.

Total value added in construction activities in 1988 (in constant prices of 1983) came to 114 billion ATS. Since data for the small trades are deficient, value added for 1992 can only be adduced and, hence, is estimated at some 128 billion ATS. Set in relation to the turnover of 104 million tons of materials (including extractions plus imports) in 1992, value added per ton was 1234.- ATS.

Empirical findings with respect to material turnover in construction show that this field of activities will be crucial when it comes to designing strategies for the future on condition that societies need to develop sustainable forms of relating to nature. In recent years, the extraordinary rate of economic growth of the construction sector has been overshadowed by still higher growth rates with respect to the physical inputs involved in construction. The need to develop modes of organization and ways of acting which protect resources, therefore, is particularly pressing within the whole field of construction activities.

Availability of raw materials is a critical bottleneck. Whereas Switzerland, e.g., has already been forced to face natural constraints with respect to raw materials availability, the situation in Austria is characterized by conflicting interests as to how nature should be used: Concerns to extract raw materials or expand human settlements, on one hand, are counteracted by claims to environmental protection and the establishment of natural reserves, on the other. Regional planning, therefore, plays a crucial role in balancing and coordinating these contradictory claims to use the natural resources available.

The current annual turnover of 14 tons of materials per capita in the construction sector alone is certainly unsustainable in the long run and can neither be maintained on that scale globally. Hence, it is impossible at the moment to answer how supply can be ensured in the long run if current levels of consumption are maintained. Instead, it is necessary to develop scenarios for substantial reductions in materials turnover with respect to the whole field of activities related to construction. We have already mentioned some of the options to be discussed as well as their potential contribution to reduce resource consumption.

Given the ways in which construction materials are used at the moment, the increasing use of wood in construction can reduce the amount of non-renewable raw materials and resources only in a few sectors (mainly in housing as well as in construction for economic use); on the whole, the effects this will have on the total reduction of the consumption of non-renewable resources will be negligible. Even if the amount of debris and refuse from constructions and from construction were recycled completely, this would reduce consumption of primary raw materials only by an additional 2-3%.

In the foreseeable future, substitution of mineral raw materials (by wood) and recycling (of construction refuse) will facilitate a reduction of mineral raw materials consumption by approximately 5-7%. Hence, one may conclude that none of the options mentioned, taken by itself, can contribute decisively to solve the problem of resources with respect to construction. Apart from having to consider the technical and organizational measures mentioned before, strategies for sustainable development in the field of construction activities will have to integrate a complex set of additional considerations –

duration, intensity and flexibility of use, construction methods, employment effects, etc.. At the same time, it seems to make sense to keep in mind the demand structures in various sectors (housing, trade and industry, public construction, roads, infrastructure, communication lines, etc.) and their respective dynamics.

There is a multitude of demographic, economic and social factors on the demand side which affect construction activities: The development of human settlement structures is not only influenced by population dynamics and migration, but also by the increase in the number of households due to the prolongation of life as well as the increase in singles-households and divorces. Additional factors are the general increase in wealth, the concomitant boom in the construction of second homes as well as holiday homes, and an increase in the average amount of space used per workplace.

It is not least important to look at construction activities with a view towards employment effects. In this respect, the state must be considered the most important agency for the commissioning of construction contracts, whereas politics is in charge of defining the framework for construction activities. It is recommended to promote employment-intensive branches which, at the same time, tend to be relatively effcient with respect to the use of resources: Therefore, construction construction as well as the redevelopment and renovation of constructions should be favoured *vis-a-vis* those branches that are more material-intensive. Changes in value added in construction construction and civil engineering already show a marked tendency in this direction, since adaptations have almost doubled their share from 6% in the mid-1970s to 11% in 1994. Comprehensive redevelopment and renovation of the existing stock of constructions, including heat insulation as well, is employment-intensive, reduces the consumption of energy required to operate the constructions in question, and has a dampening effect on the amount of space required for new constructions.

The following list of measures and steering options should be suggestive of the subsequent steps which need to be taken to approach that objective:

Construction Construction

- Types of (especially compact) construction which save on energy, materials and area used
- Renovation and redevelopment (heat insulation, etc., also with a view towards employment effects)
- Increase intensity of use (e.g., by developing adequate legal and tax-incentives with respect to second homes, holiday homes and unused housing facilities
- Extend average duration of use by way of more flexible types of construction.
- Substitute mineral raw materials by renewable resources
- Re-use of structural elements and recycling

Road Construction and other Infrastructure

- Extend duration of use by conserving, as far as possible, existing infrastructure (i.e., mainly by transferring goods transported by road to rail-bound forms of transport)
- Promote types of construction which save on resources (road widths, dimensions of infrastructure, use of recycled construction materials, etc.)
- Use of infrastructure in sparsely populated areas which is independent of pipelines and other carriers (Waste water, telephone)
- Reduction of investment in material-intensive construction activities with little effects upon employment in favour of renovation, redevelopment and modernization in construction construction.

In updating the National Environment Plan, construction activities should be made an area of focal concern. Also, strategies as well as objectives should be developed with respect to this field which reduce pressures upon the environment. Sustainable development in the field of construction activities will not just be achieved by singular or merely technical measures; instead, what is needed is a comprehensive approach which also integrates professional expertise from public authorities serving as builders, from experts in traffic planning, regional planning, architecture, and urban planning.

The Importance of Intermediate Material Flow Analyses for Implementation of Periodic Material Flow Accounting

The material flow analyses carried out for the two activity fields of food supply and construction have demonstrated that material flow analyses at an intermediate level are feasible, in principle, on the basis of data currently available. A decisive preliminary condition to describe the economic and physical developments in construction is the possibility to link various sets of data. Institutions like ÖSTAT which generate and analyze these data according to a largely uniform systematic classification should be able to carry out material flow analyses fairly easily.

In addition to that, the material flow analyses carried out for the two activity fields have resulted in further specification of the empirical findings and have clarified methodological questions posed on the macro-level. It is recommended, therefore, to carry out additional material flow analyses related to activity fields.

For detailed analyses, e.g. by way of research accompanying the updating and realization of the National Environment Plan, at least the following activity fields are of prime importance:

- Construction
- Food Supply
- Energy Supply
- Water Supply
- Transport

An estimation of **double counts** (i.e. intermediary deliveries within a specified economic activity) is impossible due to the data available at the moment. An improvement of the situation with respect to primary data may be expected from a survey of data referring to production, raw and auxiliary materials. This should conform to EU standards and follow uniform nomenclatures with respect to goods as well as activities. A statistical survey of internal inputs (material inputs not invoiced, or so-called *Inneneinsätze*) would markedly increase the exactitude and expressiveness of branch-related material flow analyses.

With reference to disposal, the Federal Waste Management Plan serves as the central database. Although it is updated only once every three years, it is sufficiently exact to serve as a basis for periodic material flow analyses of Austria. It is a problem, however, that data can be linked only insufficiently as a result of differing systematics. Since it is only possible in part to link waste flows to production sectors according to individual branches, measures should be taken that, in the future, will enhance the possibility to **link data on waste with their respective branch codes according to ÖNACE**.

Branch-related waste surveys (branch conceptions) may serve as a valuable source of information for material flow analyses but, instead of just recording wastes, should take account of material as well as substance flows in general. It is recommended that they follow the systematic classification compatible with ÖNACE and be updated regularly. In turn, these updated surveys might serve as the basis which can be used to update the Federal Waste Management Plan.

From the results gained so far it is possible to draw the following recommendations with respect to the implementation of a periodic material flow analysis:

- The survey of raw materials extraction should become an integral part of production statistics. The **share held by the small trades** should be calculated periodically **by means of their contribution to value added** in production.
- **Survey of the inputs of raw and auxiliary materials according to the systematics used to assign material goods in production statistics**. This will largely prevent the overlapping of records and facilitate linkages between production statistics and the list of raw and auxiliary materials. Also, so-called **internal inputs** (material inputs

not invoiced, *Inneneinsätze*) should be surveyed, since these data are essential prerequisites for carrying out consistent material flow analyses.

- Integration of periodically available data from **market research** with respect to trade as well as private final demand.
- Estimation of materials use outside of those units which are surveyed statistically (contractors' yards, highway maintenance depots, energy suppliers, private construction of homes, etc.)

Detailed survey of strategically important materials like cement and bitumen as well as estimation of the consumption of aggregates induced by these products by means of technology coefficients. Thus, data on cement consumption may be used, by approximation, as indicators for the production of concrete, with bitumen analoguously serving as indicator for the production of cement. On this basis it is possible to follow the development of almost 50% of the amount of mineral bulk raw materials over time and arrive, very efficiently as well as fairly exactly, at reasonable quantitative estimates of these changes.

References

Alder, Robert (1992): Energieaufkommen und -verwendung in der österreichischen Volkswirtschaft 1988. Endgültige Energiebilanz 1988. In: Statistische Nachrichten 6/1992. S. 498-511.

Alder, R., Kvapil, B. (1995): Energieaufkommen und -verwendung in der österreichischen Volkswirtschaft 1992. Endgültige Energiebilanz 1992. In: Statistische Nachrichten 8/1995, S.618-629.

Altner, G., Mettler-Meibom, B., Simonis, U.,E., Weizsäcker, E., U., von (1994): Jahrbuch Ökologie 1995. München.

Altner, G., Mettler-Meibom, B., Simonis, U.,E., Weizsäcker, E., U., von (1995): Jahrbuch Ökologie 1996. München.

Ayres, R. U. (1994): Industrial metabolism: Theory and policy. In: Ayres, R. U. und Simonis, U. E. (1994): Industrial metabolism. Restructuring for Sustainable Development. Tokyo, New York, Paris. S. 3-20.

Ayres, R., Ayres, L., Tarr, J. (1994): A historical reconstruction of carbon monoxide and methane emissions in the United States, 1880-1980. In: Ayres, R. und Simonis, U.E. (1994): Industrial metabolism. Restructuring for Sustainable Development. Tokyo, New York, Paris. S. 194-238.

Ayres, R. U., Simonis, U. E. (1994): Industrial metabolism. Restructuring for Sustainable Development. Tokyo, New York, Paris. S. 3-20.

Baccini, P., Brunner, P.H. (1991): Metabolism of the Anthroposphere, Berlin, Heidelberg, New York, London, Paris, Tokyo, Hong Kong, Barcelona, Budapest.

Baccini, P., Daxbeck, H., Glenck, E., Henseler, G. (1993): Metapolis. Güterumsatz und Stoffwechselprozesse in den Privathaushalten einer Stadt. Bericht 34A des Nationalen Forschungsprogramms des Schweizerischen Nationalfonds zur Förderung der wissenschaftlichen Forschung. Zürich.

Barlösius, E. (1993): Anthropologische Perspektiven einer Kultursoziologie des Essens und Trinkens, in: Wierlacher, A., Neumann, G., Teuteberg, H.J. (Hg.): Kulturthema Essen. Ansichten und Problemfelder.Berlin.

Bayer, K., Puwein, W. (1986): Umweltschutzaktivitäten der österreichischen Industrie, in: Schriftenreihe der Bundeswirtschaftskammer Heft 53/1986, Wien.

Bäck, S. (1990): Entwicklungstendenzen bei der Futterversorgung Österreichs. Diplomarbeit an der Universität für Bodenkultur, Wien.

Behrensmeier, R., Bringezu, S. (1995): Zur Methodik der volkswirtschaftlichen Material-Intensitäts-Analyse: Ein quantitativer Vergleich des Umweltverbrauchs der bundesdeutschen Produktionssektoren, in: Wuppertal Papers Nr. 34/1995.

Belz, F. (1994): Ökologischer Strukturwandel in der Schweizer Lebensmittelbranche, in: IWÖ-Diskussionsbeitrag Nr. 9. St. Gallen.

Berger, W. (1993): Begrenzung und Entgrenzung. Menschliche Bedürfnisse als ethisches Problem, in: Berger, W., Pellert, A. (Hg. 1993): Der verlorene Glanz der Ökonomie. Kritik und Orientierung. Wien. S.237-248.

Binder, A., Konrad, W., Heyke, C. (1992): Abfallarme Großküche. Studie des Österreichischen Ökologie-Instituts im Auftrag des Magistrates der Stadt Wien, MA 48. Wien.

Binswanger, M. (1992): Information und Entropie. Ökologische Perspektiven des Übergangs zu einer Informationswirtschaft. Frankfurt, New York.

Binswanger, M. (1993): Gibt es eine Entkopplung des Wirtschaftswachstums von Naturverbrauch und Umweltbelastungen? Daten zu ökologischen Auswirkungen wirtschaftlicher Aktivitäten in der Schweiz von 1970 bis 1990. Diskussionsbeitrag Nr. 12 am Institut für Wirtschaft und Ökologie an der Hochschule St. Gallen (IWÖ).

Bittermann, W. (1991): Umweltrelevante Aspekte der Landwirtschaft, 2.Teil, in: Statistische Nachrichten 8/1991, S.750ff

Bittermann, W. (1994): Sektorale Ökobilanzen (auf regionaler Ebene), in: Statistische Nachrichten 7/1994, Wien. S.590-593.

Bittermann, W. (1995): Von der Landschaftsnutzung zum Landschaftsverbrauch, in: Sieder, R., Steinert, H., Talos, E. (1995): Österreich 1945-1995, Verlag für Gesellschaftskritik, Wien

Blum, W.E.H. (1993): Abfallwirtschaftliche Aspekte in der Landwirtschaft in Zusammenhang mit dem Bundes-Abfallwirtschaftsplan, in: Bundesministerium für Umwelt, Jugend und Familie, Schriftenreihe der Sektion V, Bd. 9. Wien.

Braun, R. (1992): Verwertung und Entsorgung organischer Nebenprodukte und Reststoffe der Industrie, in: Müll und Abfall 12/1992.

Breuer, G. (1994): Düngemittel. In: Gattermayer, F. *et al* (Hg.): Agrarvermarktung in Österreich. S. 199-207.

Bringezu, S. (1993): Where does the cradle really stand? Fresenius Environmental Bulletin 2:419-424 (1993).

Bringezu, S. (1994): Strategien einer Stoffpolitik. Vorstoß zu den Quellen anthropogener Stoffströme. Paper Nr. 14. Wuppertal.

Bruckner, W., Fellinger, R., Fischer-Kowalski, M., Grundwald, H., Haberl, H., Hüttler, W., Jorde, T., Konrad, W., Payer, H. (1995): Entwicklungsprogramm für ein nationales Emissionsmonitoring – NEMO. 1. und 2. Zwischenbericht. Studie im Auftrag des Bundesministeriums für Wissenschaft, Forschung und Kunst und des Bundesministeriums für Umwelt. Wien.

Brunner, P. H. (1991): Das Lager Anthroposphäre. Herausforderung für die Entsorgung von morgen. Waste Magazin 4/1991. Wien.

Brunner, P. H., Daxbeck, H., Baccini, P. (1994): Industrial metabolism at the regional and local level: A case study on a Swiss region. In: Ayres, R. U., Simonis, U. E. (1994): Industrial metabolism. Restructuring for Sustainable Development. Tokyo, New York, Paris. S. 163-193.

Brunner, P.H., Daxbeck, H., Obernosterer, R., Schachermayer, E. (1995): Machbarkeitsstudie Stoffbuchhaltung Österreich. UBA-BE-027. Bundesministerium für Umwelt, Wien.

Brugger (1994): Wien Strom, pers. Auskunft.

Buitenkamp, Maria; Venner, Henk; Wams, Ted (Eds.) (1993): Action Plan Sustainable Netherlands, Milieudefensie (Friends of the Earth, Netherlands). Amsterdam. Deutsche Ausgabe (1994): Aktionsplan für eine nachhaltige Entwicklung der Niederlande. Frankfurt a. Main: Institut für sozial-ökologische Forschung (ISOE).

BUND/Misereor (Hrsg.) (1996): Zukunftsfähiges Deutschland. Ein Beitrag zu einer global nachhaltigen Entwicklung. Studie des Wuppertal Institutes für Klima, Umwelt, Energie. Basel, Boston, Berlin.

Bundesgesundheitsamt (1991): BLS, Bundeslebensmittelschlüssel, Version 2.1, Berlin.

Bundesamt für Umwelt, Wald und Landschaft (BUWAL 1995): Stoffbilanzen Schweiz. Eine kurze Übersicht. Bern.

Bundesministerium für Land- und Forstwirtschaft (BMLF 1992): Kommunale Kläranlagen in Österreich. Stand 1991. Wien.

Bundesministerium für Land- und Forstwirtschaft (BMLF 1993): Gewässerschutzbericht 1993. Wien.

Bundesministerium für Land- und Forstwirtschaft (BMLF 1993): Bericht über die Lage der österreichischen Landwirtschaft 1992. Wien.

Bundesministerium für Umwelt, Jugend und Familie (BMUJF 1991): Fachgrundlagen zur Beurteilung der Deponiefähigkeit von Bauschutt. Schriftenreihe der Sektion V.

Bundesministerium für Umwelt (BMU 1992): Bundes-Abfallwirtschaftsplan 1992, Wien.

Bundesministerium für Umwelt, Jugend und Familie (BMUJF 1993): Ökologische Gesamtrechnung. Ergebnisse des Forschungsprojektes „Neue Wege zur Messung des Sozialproduktes“, Wien.

Bundesministerium für Umwelt (BMU 1994): Branchenkonzept Holz. Erstellt vom Institut für Verfahrens-, Brennstoff- und Umwelttechnik der TU Wien unter Mitarbeit des Österreichischen Holzforschungsinstitutes. Wien.

Bundesministerium für Umwelt (BMU 1995a): Bundes-Abfallwirtschaftsplan – Bundesabfallbericht 1995, Wien.

Bundesministerium für Umwelt (BMU 1995b): Nationaler Umwelt Plan Österreich, Wien.

Bundesministerium für Umwelt (BMU 1995c): Leitfaden Klimaschutz auf kommunaler Ebene, Wien.

Bundesministerium für wirtschaftliche Angelegenheiten – Bundeslastverteiler (BMwA 1992): Betriebsstatistik 1991. Erzeugung und Verbrauch elektrischer Energie in Österreich. Wien.

Bundesministerium für wirtschaftliche Angelegenheiten (BMwA)- Oberste Bergbehörde (Hg.) (lfd. Jg.): Österreichisches Montan-Handbuch.

BMWFK, BKA, BMLF, BMU (1995): Forschungsschwerpunkt Kulturlandschaft. Forschungskonzept 1995. Wien.

Czerny, M. (1995a): Baukonjunktur in Europa erholt sich langsam. In: WIFO Monatsberichte 2/95, S. 88-93.

Czerny, M. (1995b): Wirtschaft und Infrastruktur. In: Czerny, M., Kramer, H., Kratena, K., Lehner, G., Puwein, W., Schebeck, F. (1995): Gesamtwirtschaftliche Bedeutung der Infrastruktur für Österreich. Studie des Österreichischen Instituts für Wirtschaftsforschung im Auftrag des Bundesministeriums für wirtschaftliche Angelegenheiten. Wien.

Daly, H.E. (1992): Steady-State Economics, London.

Daxbeck, H., Merl, A., Obernosterer, R., Brunner, P.H. (1994): Die Stoffflußanalyse als Instrument für eine nachhaltige urbane Entwicklung. Studie zur Wiener Internationalen Zukunftskonferenz – WIZK. Institut für Wassergüte und Abfallwirtschaft, Abteilung Abfallwirtschaft TU Wien.

Der Standard (1995a): Budgetprobleme und politische Krise gefährden Wirtschaftswachstum. WIFO-Expertin schlägt Konjunkturalarm. Der Standard. 28./29. Oktober 1995. Wien.

Der Standard (1995b): Krise am Bau verschärft sich. Der Standard. 17. November 1995. Wien.

Der Standard (1995c): Große Baustofflösung in Sicht – Der Handel will sich neu formieren. Der Standard. 17. November 1995. Wien.

Deutsche Gesellschaft für Ernährung (DGE 1988): Ernährungsbericht 1988. Frankfurt a.M.

Deutsche Gesellschaft für Ernährung (DGE 1992): Ernährungsbericht 1992. Frankfurt a.M.

Dieren, W. van (1995): Mit der Natur rechnen: Der neue Club-of-Rome-Bericht, Basel, Boston, Berlin.

Dobler, F. (1995): Holzrahmenbau in Oberösterreich. In: Aktivum 4/95, S. 13.

Döcker, U., Kloimüller, I., Landsteiner, G., Nohel, C., Payer, H., Rützler, H., Sieder, R., Stocker, K. (1994): Fetter, schwerer, schneller, mehr. Mythen und Fakten vom Essen und Trinken, in: IKUS-Lectures Nr. 20 + 21/1994.

Doubek, C., Winkler, P. (1995): Siedlungsentwicklung in Österreich. Band I: Trends 1971 – 1991. Expertengutachten des Österreichischen Instituts für Raumplanung (ÖIR). Österreichische Raumordnungskonferenz (ÖROK) Schriftenreihe Nr. 121. Wien.

Doubek, C., Birner, A,. Deoapina, F., Zeiser, W. (1995): Siedlungsentwicklung in Österreich. Band II: Szenarien 1991-2011. Expertengutachten des Österreichischen Instituts für Raumplanung (ÖIR) im Auftrag der ÖROK und des BMwA. Wien.

Dreier, P., *et al.* (1995): Nicht gefährliche Abfälle. Teil A: Abfälle aus Haushalten und ähnlichen Einrichtungen. Materialien zum Bundes-Abfallwirtschaftsplan 1995, in: Umweltbundesamt Monographien, Bd. 64. Klagenfurt.

Dreier, P., Lassnig, D., *et al.* (1995): Nicht gefährliche Abfälle. Teil B: Baurestmassen, Klärsclamm, Holzabfälle, u.a.. Materialien zum Bundes-Abfallwirtschaftsplan 1995, in: Umweltbundesamt Monographien, Bd.65. Klagenfurt.

Drnek, T. (1994): Die wirtschaftliche Bedeutung der Steine- und Erdengewinnung in Österreich. Diplomarbeit am Institut für Bergbaukunde, Bergtechnik und Bergwirtschaft der Montanuniversität Leoben.

Drumel, B. (1995): Gemeinsam Handeln – Das WWF-Programm für den Naturschutz in Österreich 1995-2000. WWF Studie 24. Wien.

Dworschak, H., Elsigan, G., Gründler, N.I., Leodolter, K. Pesendorfer, C. (1995): Gesundheitsförderung im Betrieb – Gemeinschaftsverpflegung. Endbericht. Linz.

Eder, M. (1994): Der agrarische Außenhandel Österreichs, in: Gattermayer *et al.* (Hg.): Agrarvermarktung in Österreich, 2.Aufl., Wien, S.121-129.

Enquete-Kommission (1993): Verantwortung für die Zukunft. Wege zum nachhaltigen Umgang mit Stoff- und Materialströmen.

Enquete-Kommission (1994): Die Industriegesellschaft gestalten. Perspektiven für einen nachhaltigen Umgang mit Stoff- und Materialströmen. Bonn.

Environmental Agency (1994): Unveröffentlichte Daten der japanischen Umweltbehörde. Tokyo.

Environment Agency (1995): Unveröffentlichte Daten der japanischen Regierung. Tokio.

Erard, M., Dick, R., Zimmerli, B. (1986): Studie zum Lebensmittel-Pro-Kopf-Verzehr der Schweizer Bevölkerung, Mitt.Gebiete Lebensm.Hyg. 77, S.88-130.

Energieverwertungsagentur (E.V.A. 1995): Berechnungen auf Basis der ÖSTAT Energiebilanzen. Wien

Fachverband der Bauindustrie Österreichs (lfd. Jg.): Kenndaten der Österreichischen Bauindustrie.

Fachverband der Nahrungs- und Genußmittelindustrie (lfd. Jg.): Die Lebensmittelindustrie. Jahresbericht. Wien.

Fachverband der Stein- und keramischen Industrie Östrerreichs (lfd. Jg.): Die Stein- und keramische Industrie Österreichs. Jahresbericht. Wien.

Fachverband der Stein- und keramischen Industrie (o.J.): Steinbruch – Wir alle brauchen ihn! Informationsbroschüre. Wien.

Fellinger, Rupert (1991): Versuch einer Chlor-Stoffstrom-Bilanz für Österreich. Wien: Ökologie-Institut.

Fenz, R. (1985): Die Laufwasserkraft in Österreich. Österreichische Zeitschrift für Elektrizitätswirtschaft ÖZE 5/1985, S.178.

Fiala, M., Nommsen, T. (1995): Die europäische Bau- und Baustoffindustrie. Branchen Report Creditanstalt.

Fischer, E. (1994): Waren- und Verwertungsgenossenschaften in der Agrarvermarktung, in: Gattermayer *et al.* (Hg.): Agrarvermarktung in Österreich, 2.Aufl., Wien, S.79-88.

Fischer-Kowalski, M. (1994): Ökologie und Sozialpolitik. IFF Schriftenreihe Soziale Ökologie Bd. 36. Wien.

Fischer-Kowalski, M., Haberl, H. (1992): Purposive Interventions into Life Processes: A Neglected „Environmental" Dimension of the Society-Nature Relationship, Paper to the 1. European Conference of Sociology, Vienna 1992, IFF Schriftenreihe Soziale Ökologie, Band 24, Wien.

Fischer-Kowalski, M., Haberl, H. (1993): Metabolism and Colonisation. Modes of Production and the Physical Exchange between Societies and Nature, IFF Schriftenreihe Soziale Ökologie, Band 32, Wien.

Fischer-Kowalski, M., Haberl, H. (1994): On the Cultural Evolution of Social Metabolism with Nature. Sustainability Problems Quantified, IFF Schriftenreihe Soziale Ökologie, Band 40, Wien.

Fischer-Kowalski, M., Haberl, H., Payer, H. (1994): A Plethora of Paradigms: Outlining an Information system on Physical Exchanges between the Economy and Nature, in: Simonis, U.E., Ayres, R.U. (Eds.), Industrial Metabolism. Restructuring for Sustainable Development, Tokyo, New York, Paris.

Fischer-Kowalski, M., Haberl, H., Payer, H., Steurer, A., Zangerl-Weisz, H. (1991): Verursacher-bezogene Umweltindikatoren – Kurzfassung. IFF Schriftenreihe Soziale Ökologie Bd. 10. Wien.

Fischer-Kowalski, M., Madlener, R., Payer, H., Pfeffer, T., Schandl, H. (1995): Soziale Anforderungen an eine nachhaltige Entwicklung, Gutachten zum Nationalen Umweltplan (NUP) im Auftrag des BMUJF, IFF-Schriftenreihe Soziale Ökologie, Band 42, Wien.

Fischer-Kowalski, M., Payer, H. (1995): Fünfzig Jahre Umgang mit Natur, in: Sieder, R., Steinert, H., Talos, E. (1995): Österreich 1945-1995, Verlag für Gesellschaftskritik, Wien.

Fischer-Kowalski, M., Haberl, H., Hüttler, W., Payer, H., Schandl, H., Winiwarter, V., Zangerl-Weisz, H (Hrsg.) (1996): Gesellschaftlicher Stoffwechsel und Kolonisierung von Natur. Berlin: G&B Facultas (im Erscheinen).

Friends of the Earth Europe (FOE) (1995): Towards Sustainable Europe. The Study. Vorbereitet vom Wuppertal Institut für Klima, Umwelt, Energie.

Galler, J. (1994): Güllegrubenbau – worauf ist zu achten? In: Blick ins Land 5/1994, S. 26.

Gattermayer *et al.* (Hg. 1994): Agrarvermarktung in Österreich, 2.Aufl., Wien.

Gerhold, S. (1990): Stoffstromrechnung: Verpackungsmittel, in: Statistische Nachrichten 5/1990, Wien. S.308-312.

Gerhold, S. (1990): Stoffstromrechnung: Pestizide, inStatistische Nachrichten 7/1990, Wien. S.453-461.

Gerhold, S. (1992): Stoffstromrechnung Schwermetalle. In: ÖSTAT, Statistische Nachrichten 4/1992. Wien. S. 321-329.

Gerhold, S. (1992): Stoffstromrechnung: Holzbilanz 1955 bis 1991, in: Statistische Nachrichten 8/1992, Wien. S.651-656.

Gerhold, S. (1994): Stoffstromrechnung: Asbest – Aktualisierung bis 1992, in: Statistische Nachrichten 1/1994, Wien. S.48-51.

Gerhold, S. (1994): Stoffstromrechnung: Wasch- und Reinigungsmittel – Aktualisierung bis 1992, in: Statistische nachrichten 3/1994, Wien. S.236-239.

Gerhold, S. (1994): Problemorientierte Umweltindikatoren – Diskussion eines Konzeptes, in: Statistische Nachrichten 7/1994, Wien. S.594-602.

Gerhold, S. (1994): Stoffstromrechnung: Holzbilanz 1991 bis 1993, in: Statistische Nachrichten 12/1994, 1009-1012.

Gerhold, S. (1995): Problemorientierte Umweltindikatoren – ein Erfahrungsbericht. In: Statistische Nachrichten 5/1995. Wien. S.376-393.

Gerhold, S. (1995): Bericht über die Arbeitsgruppe Umweltstatistik, Unterarbeitsgruppe „Green Accounting", 23. und 24. März 1995, interner Bericht.

Gerhold, S. (o.J.): Versuch einer Einordnung der ÖSTAT-Arbeiten an der Ökologischen Gesamtrechnung in vorhandene Konzepte, unveröff. Manuskript.

Gerhold, S., Bittermann, W. (1994): Ökologische Gesamtrechnung: Sektorale Ökobilanzen und problemorientierte Umweltindikatoren, in: Statistische Nachrichten 7/1994, Wien. S.586-589.

Gerhold, S., Steurer, A. (1993): Ökologische Gesamtrechnungen: Stoffstromrechnung Düngemittel; Düngemittelabgabe. In: ÖSTAT, Statistische Nachrichten 4/1993. Wien. S. 285-289.

Gerschlager, C. (1993): Konturen der „Entgrenzung". Zu Fortschritt und Knappheit, in: Berger, W., Pellert, A. (Hg. 1993): Der verlorene Glanz der Ökonomie. Kritik und Orientierung. Wien. S.249- 280.

Gesellschaft für Stadtentwicklung (GSE) (1991): Recycling-Projekt BauElementeLager. Informationsbroschüre. Berlin.

Gesundheits- und Wirtschaftsamt (1992): Umweltbericht der Stadt Zürich 1991/1992. Umweltschutzfachstelle der Stadt Zürich, Gesundheits- und Wirtschaftsamt.

Goldbrunner, J. (1993): Tiefengrundwässer in Österreich. In: Wasserreserven in Österreich. Schutz und Nutzung in Gegenwart und Zukunft. Wiener Mitteilungen Bd. 111 – 1993, S. 157.

Grüne Bildungswerkstatt (GRÜBI 1995): Essen mit Genuß. Ernährungspolitik aus grüner Sicht. Wien.

Guggenberger, T. (1994): Bundesanstalt für alpenländische Landwirschaft. Pers. Mitteilung.

Haberl, H. (1991): Gezielte Eingriffe in Lebensprozesse. Vorschlag für verursacherbezogene Umweltindikatoren. In: Schriftenreihe Soziale Ökologie Bd.11. Wien.

Haberl, H. (1993): Theoretische Überlegungen zur ökologischen Bedeutung der menschlichen Aneignung von Nettoprimärproduktion, IFF Schriftenreihe Soziale Ökologie, Band 33, Wien.

Haberl, H. (1994a): Menschliche Eingriffe in den natürlichen Energiefluß. In: Kosz, M. (Hrsg.) (1994): Auf dem Weg zu einer nachhaltigen Entwicklung in Österreich. Untersuchung im Auftrag von Friends of the Earth (FOE) Österreich. Nestelbach.

Haberl, H. (1994b): Der Gesamtenergieinput des sozio-ökonomischen Systems in Österreich 1960-1991. Zur Erweiterung des Begriffes „Energieverbrauch", IFF Schriftenreihe Soziale Ökologie, Band 35, Wien.

Haberl, H. (1995): Menschliche Eingriffe in den natürlichen Energiefluß von Ökosystemen. Sozio-ökonomische Aneignung von Nettoprimärproduktion in den Bezirken Österreichs. Dissertation an der Universität Wien, Wien.

Haberl, Helmut (1996): Der Energie-Stoffwechsel. In: Fischer-Kowalski, Marina *et al.*: Stoffwechsel der Gesellschaft und Kolonisierung von Natur. Berlin. S. 81-94.

Hackl, A., Mauschitz, G. (1995): Emissionen aus Anlagen der österreichischen Zementindustrie. Studie im Auftrag der österreichischen Zementindustrie.

Hauk, E., Winkler, N. (1995): Straßen und Wege in den österreichischen Wäldern. Die aktuellen Weginventurdaten der Waldinventur 1986/90. In: Der Förderungsdienst 9/1995, S. 265-272.

Hauptverband der Sozialversicherungsträger (lfd. Jg.): Statistisches Handbuch der österreichischen Sozialversicherung. Wien.

Heinrich, M. (1995): Bundesweite Übersicht zum Forschungsstand der Massenrohstoffe Kies, Kiessand, Brecherprodukte und Bruchsteine für das Bauwesen hinsichtlich der Vorkommen, der Abbaubetriebe und der Produktion sowie des Verbrauches. Berichte der Geologischen Bundesanstalt, Heft 31.

Hildebrandt, E., Kühleis, C. (1995): Ökologischer Wohlstand durch neue Arbeitszeitmodelle?, in: Altner, G., Mettler-Meibom, B., Simonis, U.,E., Weizsäcker, E., U., von (1995): Jahrbuch Ökologie 1996, München, 269-276.

Hinterberger, F., Welfens, M.J. (1994): Stoffpolitik und ökologischer Strukturwandel. In: Wirtschaftsdienst 8. August 1994. Baden-Baden. S.403-408.

Hofmeister, S. (1994): Stoff- und Energiebilanzen. Zur Eignung des physischen Bilanz-Prinzips als Konzeption der Umweltplanung, in: Landschaftsentwicklung und Umweltforschung. Schriftenreihe des Fachbereichs Landschaftsentwicklung der TU Berlin Nr. 58. Berlin 1989 Nachdruck 1994.

Hohenecker, J. (1980): Ernährungswirtschaftsplanung für Krisenzeiten in Österreich. Vierter Teilbericht: Futtermittelbilanzen für Österreich – Schema und Berechnungen für die Wirtschaftsjahre 1972/73 bis 1976/77, Institut für Landwirtschaftliche Betriebswirtschaft und Ernährungswirtschaft, Universität für Bodenkultur Wien, Wien

Hüttler, W., Payer, H. (1994): Wasser und Wirtschaftswachstum. IFF Schriftenreihe Soziale Ökologie Bd. 38.

Hüttler, W., Payer, H. (1995): NEMO – Nationales Emissionsmonitoring: Ein weiterer Schritt zur Integration von Stoff- und Materialbilanzen mit der Volkswirtschaftlichen Gesamtrechnung, in: Umweltbundesamt (UBA 1996): Tagungsbericht zum Workshop „Stoffbilanzen auf nationaler Ebene", Wien (in Vorbereitung).

Hüttler, W., Payer, H., Schandl, H. (1994): Stofffluß Österreichs. Beitrag für den AK VI „Ressourcenmanagement" des Nationalen Umweltplanes und Erster Zwischenbericht zum Forschungsprojekt „Wirtschaftswachstum und Stoffwechsel – Vorstudie für den Aufbau einer Stoffbilanz Österreich", 1994, Wien.

Hüttler, W., Payer, H., Schandl, H. (1995a): Nationale Materialbilanzen als Instrument einer ökologischen Ressourcenpolitik, in: WIFO-Monatsberichte 11/1995, 713-718.

Hüttler, W., Payer, H., Schandl, H. (1995b): Materialfluß Österreich 1990. IFF Schriftenreihe Soziale Ökologie Bd. 44.

Institut für Kulturstudien (IKUS 1994): Ernährungsweisen und Eß- und Trinkkulturen in Österreich. Endbericht des multidisziplinären Forschungsprojektes „Ernährungskultur in Österreich" im Auftrag von Bundesministerium für Wissenschaft und Forschung, Bundesministerium für Land- und Forstwirtschaft, Bundesministerium für Gesundheit, Sport und Konsumentenschutz. Wien.

Institut für sozial-ökologische Forschung (ISOE 1992): Sustainable Netherlands – Aktionsplan für eine nachhaltige Entwicklung der Niederlande.

Jänicke, M. (1994): Vom Nutzen nationaler Stoffbilanzen, in: Altner, G., Mettler-Meibom, B., Simonis, U.,E., Weizsäcker, E., U., von (1994): Jahrbuch Ökologie 1994. München, S.20-28.

Jänicke, M. (1995a): Ökologisch tragfähige Entwicklung: Kriterien und Steuerungsansätze ökologischer Ressourcenpolitik, in: Hamm, B. (Hg.): Globales Überleben. Sozialwissenschaftliche Beiträge zur global nachhaltigen Entwicklung. Schriftenreihe des Zentrum fürs europäische Studien, Trier.

Jänicke, M. (1995b): Tragfähige Entwicklung: Anforderungen an die Umweltberichterstattung aus der Sicht der Politikanalyse, in: Bringezu, S. (Hrsg.): Neue Ansätze der Umweltstatistik. Ein Wuppertaler Werkstattgespräch. Berlin, Basel, Boston.

Jänicke, M., Mönch, H., Binder, M. u.a. (1992): Umweltentlastung durch industriellen Strukturwandel? Eine explorative Studie über 32 Industrieländer (1970 bis 1990). Berlin.

Kaas, T., Fleckseder, H., Brunner, P.H. (1994): Stickstoffbilanz des Kremstales. Institut für Wassergüte und Abfallwirtschaft, Abt. Abfallwirtschaft, TU Wien.

Kaltenegger, C. (1994): Die österreichische Nahrungs- und Genußmittelindustrie, in: CA Quarterly II/94, S.28-31.

Kaltenegger, C. (1994): Die österreichische Bauwirtschaft. In: CA-Quarterly IV/94, S. 15-21.

Kanzian, R., Salhofer, S. (1993): Beurteilung betrieblicher Abfallwirtschaftskonzepte. Studie im Auftrag des Bundesministeriums für Umwelt, Jugend und Familie, Wien.

Karlsson, S., Azar, C., Eriksson, K.-E., Holmberg, J., Lindgren, K., Wirsenius, S. (1994): Material Flows. On the Metabolism of the Industrial Society in a Sustainability Perspective. AFR-Report 38, Swedish Waste Research Council.

Karmasin, H. (1994): Ernährungstrends, in: Gattermayer *et al.* (Hg.): Agrarvermarktung in Österreich, 2.Aufl., Wien, S. 9-16.

Kloimüller, I. (1994): Qualität der Gemeinschaftsverpflegung, in: Institut für Kulturstudien (IKUS 1994): Ernährungsweisen und Eß- und Trinkkulturen in Österreich. Endbericht des multidisziplinären Forschungsprojektes „Ernährungskultur in Österreich" im Auftrag von Bundesministerium für Wissenschaft und Forschung, Bundesministerium für Land- und Forstwirtschaft, Bundesministerium für Gesundheit, Sport und Konsumentenschutz. Wien.

Koller, F. (1994): Ökologischer Branchenstrukturwandel in der Schweizer (Hoch-) Baubranche. IWÖ – Diskussionsbeitrag Nr.4.

Kommission der Europäischen Gemeinschaft (COM 94, 670): Leitlinien der EU über Umweltindikatoren und ein "Grünes" Rechnungssystem – Die Integration von Umwelt und Wirtschaftsinformationssystemen. Mitteilung der Kommission an den rat und das Europäische Parlament. Brüssel.

Konrad, W., Jorde, T. (1994): Abfalleinsatz in der Zementindustrie. Eine kritische Betrachtung der ökologischen Auswirkungen. Studie des Österreichischen Ökologie-Instituts.

Kosz, M. (Hg. 1994): Auf dem Weg zu einer nachhaltigen Entwicklung in Österreich. Studie im Auftrag von Friends of the Earth (FOE) Österreich, Nestelbach.

Kraemer, K. (1994): Was heißt Ressourcenproduktivität?, in: Altner, G., Mettler-Meibom, B., Simonis, U.,E., Weizsäcker, E., U., von (1994): Jahrbuch Ökologie 1994. München, S.29-34.

Krammer, J. (1995): Von „Blut und Boden" zur „Eurofitness". Die Entwicklung der Landwirtschaft seit 1945, in: Sieder, R., Steinert, H., Talos, E. (1995): Österreich 1945-1995, Verlag für Gesellschaftskritik, Wien.

Kratena, K. (1995): Multiplikator- und Beschäftigungswirkungen von Infrastrukturinvestitionen. In: Czerny, M., Kramer, H., Kratena, K., Lehner, G., Puwein, W., Schebeck, F. (1995): Gesamtwirtschaftliche Bedeutung der Infrastruktur für Österreich. Studie des Österreichischen Instituts für Wirtschaftsforschung im Auftrag des Bundesministeriums für wirtschaftliche Angelegenheiten. Wien.

Kuhn, M., Radermacher, W., Stahmer, C. (1994): Umweltökonomische Trends 1960 bis 1990. In: Wirtschaft und Statistik 8/94. Wiesbaden. S. 658-664.

Lahner, T. (1993): Ökologische und volkswirtschaftliche Bedeutung der Bauwirtschaft. In: Handbuch der Umwelttechnik 1994. UTEC.

Lahner, T. (1994): Steine und Erden. Für die ökologische Bewertung des Bauwesens ist eine Stoff- und Güterbilanz notwendig. Müllmagazin 1/1994. S. 9-10.

Lauber, W. (1993): Cadmium in Österreich. Umweltbelastung und Umweltschutz, in: Informationen zur Umweltpolitik 94. Wien.

Lauffer, H. (1983): Die Jahresspeicherwerke Österreichs. Österreichische Zeitschrift für Elektrizitätswirtschaft ÖZE 5/1983, S.127.

Leitner, K. (1995): Innovatives Bauen mit Holz. Geförderte Modellbauvorhaben in Bayern. Unterlagen zur Besichtigungsreise im Juni 1995. Linz.

Liedtke, C., Manstein, C., Bellendorf, H., Kranendonk, S. (1994): Öko-Audit und Ressourcenmanagement. Erste Schritte in Richtung eines EU-weit harmonisierungsfähigen Umweltmanagementsystems, in: Wuppertal Papers Nr.18/1994.

Litzka, J. (1993): Selektiver Abbau von Straßenbaustoffen und deren Wiederverwendung. Vortrag anläßlich der UTEC-Absorga 1993. Wien.

Marihart, J., Gattermayer, F. (1994): Kartoffeln und Kartoffelerzeugnisse, in: Gattermayer *et al.* (Hg.): Agrarvermarktung in Österreich, 2.Aufl., Wien, S.385-392.

Marin, B. (1987): Krise und Innovation in der Bauwirtschaft. In: Marin, B. (Hrsg.) (1987): Verfall und Erneuerung im Bauwesen. Internationale Publikationen. Wien.

Maurer, O. (1994): Marketinggrundlagen für den Direktabsatz landwirtschaftlicher Produkte, in: Gattermayer *et al.* (Hg.): Agrarvermarktung in Österreich, 2.Aufl., Wien, S.79-88.

Meier-Ploeger, A., Vogtmann, H. (1991): Lebensmittelqualität, in: Alternative Konzepte 66, Stiftung Ökologie und Landbau.

Mikinovic, S. (1993): Was ist Agrarmarketing?, in: Der Förderungsdienst, Heft 12/1993, S.75f.

Ministry of Housing, Spatial Planning and the Environment (1994): The Netherlands' National Environmental Policy Plan 2 (NEPP 2). Den Haag.

Moewes, G. (1995): Weder Hütten noch Paläste. Architektur und Ökologie in der Arbeitsgesellschaft. Eine Streitschrift. Basel.

Murawski, H. (1983): Geologisches Wörterbuch. dtv-Enke.

Narodoslawsky, M., Wallner, H.P., Steinmüller, H. (1995): ÖKOFIT – Ökologischer Bezirk Feldbach durch integrierte Technik. Bericht aus Energie- und Umweltforschung 10/95. Bundesministerium für Wissenschaft, Forschung und Kunst. Wien.

Neumann, G. (1993): „Jede Nahrung ist ein Symbol". Umrisse einer Kulturwissenschaft des Essens, in: Wierlacher, A., Neumann, G. und Teuteberg, H.J. (Hg.): Kulturthema Essen. Ansichten und Problemfelder.Berlin.

Obernosterer, R. (1994): Flüchtige Halogenkohlenwasserstoffe (FCKW, CKW, Halone). Stoffflußanalyse Österreich. Diplomarbeit am Institut für Wassergüte und Abfallwirtschaft, Abt. Abfallwirtschaft, TU Wien.

OECD – Organisation for Economic Co-operation and Development (1993a): OECD Environmental Data 1993, Donnés OCDE sur l´environment. Paris: OECD.

Ofner, Hanspeter (1994): Stoff- und Energiebilanzen ausgewählter Fachverbände, Diplomarbeit an der Technischen Universität Graz, Graz.

Organisation for Economic Co-operation and Development (OECD 1993): OECD Environmental Data. Compendium 1993. Paris.

Österreichische Akademie der Wissenschaften, Forschungsstelle für Technikbewertung (1993): Begleitforschung zu den branchenorientierten Umweltschutzaktivitäten in Österreich – Zwischenbericht. Studie im Auftrag des Bundesministeriums für Umwelt, Jugend und Familie, Wien.

Österreichische Mineralölverwaltung (ÖMV 1994): Daten zur österreichischen Energieversorgung, Wien.

Österreichische Raumordnungskonferenz (ÖROK 1993): Siebenter Raumordnungsbericht, Wien.

Österreichische Vereinigung für das Gas- und Wasserfach (ÖVGW 1993): Betriebsergebnisse der Wasserwerke Österreichs 1991. Wien.

Österreichisches Ökologie-Institut (1990): Ausstieg aus der Müllverbrennung – Einstieg in die ökologische Abfallwirtschaft. Studie im Auftrag des Bundesministeriums für Umwelt, Jugend und Familie, Wien.

Österreichisches Ökologie-Institut, Institut für Interdisziplinäre Forschung und Fortbildung (ÖÖI, IFF 1995): NEMO – Entwicklungsprogramm für ein Nationales Emissionsmonitoring. Eine Inititiative des Bundesministeriums für Wissenschaft, Forschung und Kunst und des Bundesministeriums für Umwelt, 1.Zwischenbericht, Wien.

Österreichisches Normungsinstitut (1990): ÖNORM S 2100 Abfallkatalog. Wien

Österreichisches Statistisches Zentralamt (ÖSTAT 1981-93): Industrie- und Gewerbestatistik 1.Teil. Wien.

Österreichisches Statistisches Zentralamt (ÖSTAT 1981-1993): Industriestatistik 2.Teil. Wien.

Österreichisches Statistisches Zentralamt (ÖSTAT 1981-1992): Gewerbestatistik 2.Teil. Wien.

Österreichisches Statistisches Zentralamt (ÖSTAT 1986): Konsumerhebung 1984 – Hauptergebnisse, Wien.

Österreichisches Statistisches Zentralamt (ÖSTAT 1993): Statistisches Jahrbuch für die Republik Österreich. Wien.

Österreichisches Statistisches Zentralamt (ÖSTAT 1993): Umweltdaten Schnellbericht 1993. Wien.

Österreichisches Statistisches Zentralamt (ÖSTAT 1994a): Österreichs Volkseinkommen 1993. Wien.

Österreichisches Statistisches Zentralamt (ÖSTAT 1994b): Energieaufkommen und -verwendung in der österreichischen Volkswirtschaft im Jahr 1991. Endgültige Energiebilanz 1991. In: Statistische Nachrichten. 8/1994. Wien. S. 695-707.

Österreichisches Statistisches Zentralamt (ÖSTAT 1995): Systematik der Wirtschaftstätigkeiten – ÖNACE 1995, Wien.

Österreichisches Statistisches Zentralamt und Umweltbundesamt (ÖSTAT und UBA 1994): Umwelt in Österreich – Daten und Trends 1994.

Payer, H. (1991): Indikatoren für die Materialintensität der österreichischen Wirtschaft. IFF Schriftenreihe Soziale Ökologie, Band 14, Wien.

Payer, H. (1993): Ökonomische Erfordernisse des Naturschutzes in Österreich. WWF Studie 10, Wien.

Payer, H. (1994): Ernährungsbezogene Gesundheitsaufwendungen in Österreich, in: Institut für Kulturstudien (IKUS 1994): Ernährungsweisen und Eß- und Trinkkulturen in Österreich. Endbericht des multidisziplinären Forschungsprojektes „Ernährungskultur in Österreich" im Auftrag von Bundesministerium für Wissenschaft und Forschung, Bundesministerium für Land- und Forstwirtschaft, Bundesministerium für Gesundheit, Sport und Konsumentenschutz, Wien.

Payer, H. (1995): Vertragsnaturschutz und Landschaftspflege – ein Überblick, in. Raum 20/1995.

Payer, H., Zangerl-Weisz, H. (1991): Die Emissionen der österreichischen Wirtschaft: Systematik und Ermittelbarkeit. IFF Schriftenreihe Soziale Ökologie, Band 15, Wien.

Pirkl, R., Letouzé-Zezula, G., Heinrich, M. (1991): Rohstoffnutzung und Umweltschutz: Wege zur Konfliktminderung. Mitt.österr.geol.Ges., 83 (1990). Wien.

Pospischil, E. (1993): Bauchemie – Gefahrenstoffe in der Bauwirtschaft. Aspekte des Arbeitnehmer- und Umweltschutzes. Bundeskammer für Arbeiter und Angestellte. Informationen zur Umweltpolitik Nr. 95. Wien.

Puwein, W. (1993): Maßnahmen zur Erhaltung der Kulturlandschaft in Österreich, in: WIFO-Monatsberichte 5/1993, S. 290-297.

Raninger, B., (1995): Sammlung und Verwertung kommunaler biogener Abfälle in Österreich, in: Bundesministerium für Umwelt, Schriftenreihe der Sektion III, Bd.21. Wien.

Roodeman, D.M., Lenssen, N. (1995): Bauen für die Zukunft. In: World-Watch Jan/Feb 1995, 24-32.

Rohrböck, G., J. (1991-1994): Ernährungsbilanz 1989/90, 1990/91, 1991/92, 1992/93, in: Statistische Nachrichten, jeweils Heft 2/1991-1994.

Rüprich, W., Strauch, D. (1982): Abfallbehandlung in Intensivtierhaltungen – Einführung in den Problemkreis, in: Müll und Abfall, Heft 9/1982.

Rützler, H. (1994): Mahlzeiten, Lebensmittel, Nährstoffe. Ergebnisse einer repräsentativen Verzehrserhebung, in: Institut für Kulturstudien (IKUS 1994): Ernährungsweisen und Eß- und Trinkkulturen in Österreich. Endbericht des multidisziplinären Forschungsprojektes „Ernährungskultur in Österreich" im

Auftrag von Bundesministerium für Wissenschaft und Forschung, Bundesministerium für Land- und Forstwirtschaft, Bundesministerium für Gesundheit, Sport und Konsumentenschutz, Wien.

Rützler, H. (1995): Bewußt Essen – Gesund Leben. Eine kritische Anleitung zur vollwertigen Ernährung. Wien.

RWI-Berichterstattung (1987): Analyse der strukturellen Entwicklung der deutschen Wirtschaft. Essen.

Schachermayer, E., Bauer, G., Ritter, E., Brunner, P.H. (1994): Messung der Güter- und Stoffbilanz einer Müllverbrennungsanlage. Institut für Wassergüte und Abfallwirtschaft, Abt. Abfallwirtschaft, TU Wien.

Schandl, H., Zangerl-Weisz, H. (1996): Erstellung einer Materialbilanz der Chemieproduktion unter besonderer Berücksichtigung methodischer Fragestellungen in Hinblick auf sektorale Materialbilanzen. Unveröff. Offert an das Bundesministerium für Wissenschaft, Forschung und Kunst, Wien.

Schenkel, W. (Hg. 1992): Recht auf Abfall? Versuch über das Märchen vom süßen Brei. Berlin.

Schenkel, W., Reiche, J. (1992): Abfallwirtschaft als Teil der Stoffflußwirtschaft, in: Schenkel, W. (Hg. 1992): Recht auf Abfall? Versuch über das Märchen vom süßen Brei. Berlin. S. 59-110.

Scherhorn, G. (1994): Pro- und post-materielle Werthaltungen in der Industriegesellschaft, in: Altner, G., Mettler-Meibom, B., Simonis, U.,E., Weizsäcker, E., U., von (1994): Jahrbuch Ökologie 1994. München, S.186-198.

Schiebel, W. (1994): Lebensmittelhandel, in: Gattermayer *et al.* (Hg.): Agrarvermarktung in Österreich, 2.Aufl. Wien, 59-78.

Schima, J. (1994): Wald und Holznutzung in einer nachhaltigen Wirtschaft. In: Kosz, M. (Hrsg.) (1994): Auf dem Weg zu einer nachhaltigen Entwicklung in Österreich. Untersuchung im Auftrag von Friends of the Earth (FOE) Österreich. Nestelbach.

Schmidt-Bleek, F. (1994): Wieviel Umwelt braucht der Mensch? MIPS – Das Maß für ökologisches Wirtschaften, Berlin, Basel, Boston.

Schneeberger, W. (1994): Futtermittel, in: Gattermayer *et al.* (Hg.): Agrarvermarktung in Österreich, 2.Aufl. Wien, 209-226.

Schneeberger, W., Pölzlbauer, A. (1991): Futtergetreide- und Eiweißfuttermittelmarkt, in: Breuer, G. *et al* (Hg.) Agrarvermarktung in Österreich, Wien.

Schneider, W., Fasel, C. (1995): Schöne neue Kunstwelt. Nur mit TV total ist der Planet zu retten, in: Spiegel special Nr.8/1995: TV total. Macht und Magie des Fernsehens. S. 31-33.

Schnitzer, H. (1993): Nachhaltigkeit – Versuch einer Charakterisierung, in: VT-Newsletter 8/1993.

Schnitzer, H., Paula, M., Niederl, K. (1993): The Cleaner Production Approach to Sustainability. In: Proceedings of the International Symposium. Sustainability – Where do we stand? Graz. S. 237-246.

Schönstein, R., Schörner, G., Krempl, M (1991): Schotterbilanz Niederösterreich. Studie im Auftrag des Geologischen Dienstes des Amts der Niederösterreichischen Landesregierung.

Schönstein, R., Schörner, G., Krempl, M (1992): Steinbruchbilanz Niederösterreich. Studie im Auftrag des Geologischen Dienstes des Amts der Niederösterreichischen Landesregierung.

Schramm, W. (1993): Begleitforschung zu den branchenorientierten Umweltschutzaktivitäten in Österreich, Österreichische Akademie der Wissenschaften, Forschungsstelle für Technikbewertung. Studie im Auftrag des Bundesministeriums für Umwelt, Jugend und Familie. Wien.

Schramm, W. (1995): Stoffströme der Branchenkonzepte. Vortrag am 8.2.1995. Krems im Rahmen der Veranstaltung "Stoffströme in der österreichischen Wirtschaft", TU Wien, Forschungsinstitut für Chemie und Umwelt.

Schramm, W. (1995): Operationalisierung des Konzepts Cleaner Production am Beispiel der Ledererzeugung, Österreichische Akademie der Wissenschaften, Forschungsstelle für Technikbewertung. Studie im Auftrag des Bundesministeriums für Umwelt. Wien.

Schütz, H., Bringezu, St. (1993): Major Material Flows in Germany. In: Fresenius Environmental Bulletin, 2: 443-448, 8/1993.

Sieder, R., Steinert, H., Talos, E. (1995): Österreich 1945-1995, Verlag für Gesellschaftskritik, Wien.

Spangenberg, J.H. (1995): Towards Sustainable Europe. Zusammenfassung einer Studie aus dem Wuppertal Institut für Klima, Umwelt, Energie im Auftrag von Friends of the Earth Europe, Wuppertal.

Stahmer, C. (1991): Vom Bruttosozialprodukt zum Ökosozialprodukt? Umweltberichterstattung im Rahmen der Volkswirtschaftlichen Gesamtrechnung. In: Diefenbacher, H./Habicht-Erenler, S. (Hrsg.): Wachstum und Wohlstand. Neuere Konzepte zur Erfassung von Sozial- und Umweltverträglichkeit. Marburg. S.43-60.

Stähelin, H.B., Lüthy, J., Casabianca, A., Monnier, N., Müller, H.-R., Schutz, Y., Sieber, R. (Hg. 1991): Dritter Schweizerischer Ernährungsbericht. Bundesamt für Gesundheitswesen. Bern.

Stalzer, W. (1993): Zukunftsperspektiven für die Wasserversorgungswirtschaft in Österreich, in: Wiener Mitteilungen Bd. 111. S. 241-266.

Statistisches Bundesamt Wiesbaden (StBA 1994): Bericht über das Ergebnis des Koordinierungsgesprächs zum Themenbereich Material- und Energieflußrechnungen am 11. Oktober 1994 in Wiesbaden, unveröff. Manuskript. Wiesbaden.

Statistisches Bundesamt Wiesbaden (StBA 1995): Umweltökonomische Gesamtrechnungen – Material- und Energieflußrechnungen – 1995. Fachserie 19: Umwelt, Reihe 5. Wiesbaden.

Steinlechner, E., *et al* (1993): Möäglichkeiten der Vermeidung und Nutzung anthropogener Methanemissionen. Institut für Umweltgeologie und Ökosystemforschung, Joanneum Research, Graz.

Steurer, A. (1992): Stoffstrombilanz Österreich 1988. Schriftenreihe des IFF-Soziale Ökologie, Band 26. Wien.

Steurer, A. (1994): Stoffstrombilanz Österreich 1970-1990. Schriftenreihe des IFF-Soziale Ökologie, Band 34. Wien.

Stigliani, W. M., Anderberg, S. (1994): Industrial metabolism at the regional level: The Rhine Basin. In: Ayres, R. U. und Simonis, U. E. (1994): Industrial metabolism. Restructuring for Sustainable Development. Tokyo, New York, Paris. S. 119-162.

Streibel, G. (1990): Reproduktion und Nutzung der natürlichen Umwelt, Forschungsstelle für Umweltpolitik/Freie Universität Berlin, FFU rep 90-13. Berlin.

Supersberg, H. und Cepuder, P. (1993): Entwicklung des Wasserbedarfes einer zukunftsorientierten Landwirtschaft. Wiener Mitteilungen Bd. 111.

Sustain – Verein zur Koordination von Forschung über Nachhaltigkeit (1994): Forschungs- und Entwicklungsbedarf für den Übergang zu einer nachhaltigen Wirtschaftsweise in Österreich. Graz.

Swoboda, F. (1990): Strukturerhebung über die Gemeinschaftsverpflegung Österreichs 1990, Arbeitsgemeinschaft Großküchen Österreichs (AGÖ). Wien.

Taibinger, P., Schott R. (1995): Branchenkonzept Nahrungs- und Genußmittelindustrie – Abfälle und Stoffströme. Wien.

Teuteberg, H.J. (1993): Prolegomena zu einer Kulturpsychologie des Geschmacks, in: Wierlacher, A., Neumann, G. und Teuteberg, H.J. (Hg.): Kulturthema Essen. Ansichten und Problemfelder.Berlin.

Tischler, Ferdinand (1994): Mehoden zur Erstellung von Grobbilanzen für Industriebranchen, Diplomarbeit an der Technischen Universität Graz, Graz.

Umweltbundesamt (UBA 1995a): Baurestmassen. Vermeidung, Verwertung, Behandlung. UBA-Report UBA-95-110. Wien.

Umweltbundesamt (UBA 1995b): Materialien zum Bundes-Abfallwirtschaftsplan. Nicht gefährliche Abfälle Teil B: Baurestmassen, Klärschlamm, Holzabfälle, u.a. Monographien Bd. 65. Wien.

Umweltbundesamt (UBA 1995c): Abfallaufkommen in Österreich – Materialien zum Bundes-Abfallwirtschaftsplan 1995. UBA Monographien Bd. 61, Wien.

United Nations Organization (UNO 1993): Integrated Environmental and Economic Accounting. A United Nations Handbook of National Accounting. New York.

Velechovsky, G. (1995): Hoch- und Tiefbau 1994. Statistische Nachrichten 7/1995, S.540-542.

Vereinigung der Österreichischen Zementindustrie (VÖZ 1994): 100 Jahre Vereinigung der Österreichischen Zementindustrie, Wien.

Vereinte Nationen (1994): Integrated Environmental and Economic Accunting. Handbook ?

Vonkeman, G.H., Maxson , P. (1994): Looking back from the Future. Dutch Governmental Programme for Sustainable Technology Development (STD). Institute for European Environmental Policy. Brussels.

Weizsäcker, E. U. von (1992): Erdpolitik. Ökologische Realpolitik an der Schwelle zum Jahrhundert der Umwelt, Darmstadt.

Weizsäcker, Ernst Ulrich von; Lovins, Armory B.; Lovins, L. Hunter (1995): Faktor Vier: doppelter Wohlstand – halbierter Naturverbrauch. Der neue Bericht an den Club of Rome. München: Droemer Knaur.

Weterings, R.A.P.M., Opschoor, J.B. (1992): The Ecocapacity as a Challenge to Technological Development, Publication RMNO Nr. 74a, Rijswijk.

WHO Projekt „Wien – Gesunde Stadt" (WHO 1994): 1. Wiener Ernährungsbericht. Wien.

Wiederstein, T. (1995): Vermeidung und Verwertung von Industrie- und Gewerbeabfällen in Österreich. In: Österreichische Wasser- und Abfallwirtschaft. Heft 1/2, 1995. Wien, New York. S. 1-5.

Wierlacher, A. (1993): Einleitung: Zur Begründung einer interdisziplinären Kulturwissenschaft des Essens, in: Wierlacher, A., Neumann, G. und Teuteberg, H.J. (Hg.): Kulturthema Essen. Ansichten und Problemfelder.Berlin.

WIFO (1993): Energiebilanzen des Österreichischen Instituts für Wirtschaftsforschung. 1955-1990. Wien.

WIFO (1994): Energiebilanzen des Österreichischen Instituts für Wirtschaftsforschung. 1986-1993. Wien.

Willke, H. (1995): Systemtheorie III: Steuerungstheorie. Grundzüge einer Theorie der Steuerung komplexer Sozialsysteme. Stuttgart, Jena.

Willke, H. (1995b): Wissen: Die entscheidende Ressource für die künftige Überlebensfähigkeit von Unternehmen. Impulsreferat auf der Jahrestagung der Österreichischen Gesellschaft für Gruppendynamik und Organisationsentwicklung, 26. bis 29. Oktober 1995 in Wels.

Windisch, G. (1993): Wirtschaftsstruktur. In: Nowotny, E./Schuberth, H. (Hrsg.): Österreichs Wirtschaft im Wandel. Entwicklungstendenzen 1970-2010. Wien. S.75-88.

Winkler-Rieder, W. (1993): Biomasse und Klima. Studie der ÖAR Regionalberatung Ges.m.b.H. im Auftrag des WWF Österreich mit Unterstützung der ABB Österreich. Wien.

Wuppertal Institut für Klima, Umwelt, Energie (WIKUE 1994): Zukunftsfähiges Deutschland, unveröff. Zwischenbericht vom 8.11.1994, Wuppertal.

Wurzian, E. (1994): Grund und Boden – ein nicht vermehrbares Gut. In: Raumordnung 1/1994, S.3-6.

Wytrzens, H. K., Zehetner, R. (1990): Übersicht über das Abfallaufkommen der landwirtschaftlichen Produktion in Österreich, in:. Die Bodenkultur 1/1990, S.67.

Zetinigg, H. (1993): Nutzung und Schutz der Tiefengrundwässer des steirischen Beckens. In: Wasserreserven in Österreich. Schutz und Nutzung in Gegenwart und Zukunft. Wiener Mitteilungen Bd. 111 – 1993, S. 183.