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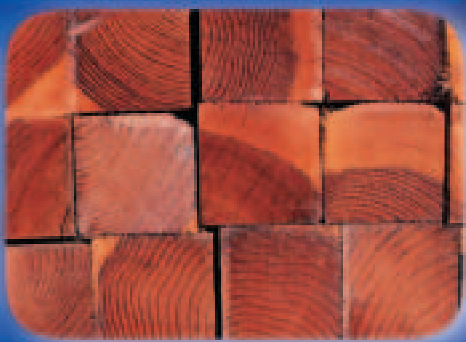
Total Material Requirement of the Basque Country

TMR 2002

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DEPARTAMENTO DE
ORDENACION DEL TERRITORIO
Y MEDIO AMBIENTE

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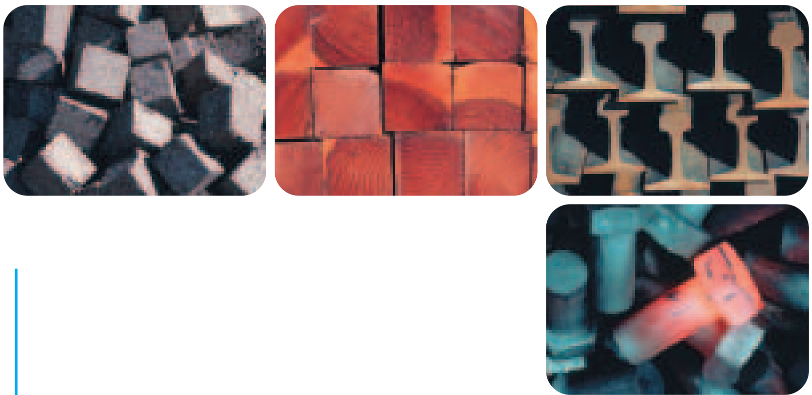

TMR 2002

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Foreword

Sabin Intxaurraga
Basque Government Minister
for Land Use and the Environment

In the coming decade the Basque Country will have a great opportunity to produce more well-being using more human resources and less natural resources. It is essential that economic growth be decoupled from the use of resources and from contamination if sustainable development is to be achieved. A transformation can and must take place which will reduce the use of natural resources and increase productivity, thus generating lower environmental impacts in all sectors of the economy throughout the life cycle of products and services.

This new document has been drawn up under the Environmental Framework Programme to analyse the progress made in this decoupling process. It looks at developments in the use of natural resources in the Basque Country between 1989 and 1998. It also presents a series of indicators which can be used to monitor the pressure exerted by the Basque production system on the environment year by year, to determine the sources of that pressure and to promote action to palliate them. Chief among these indicators is the Total Material Requirement, which indicates the accumulated volume (measured in tonnes per inhabitant per annum) of materials extracted from nature by economic activities.

This study has been drawn up by the Environmental Economy Unit of the University of the Basque Country. This unit was set up jointly by the Basque Government Department of Land Use and the Environment and the Institute for Public Economics of the University of the Basque Country. Its main purpose is to analyse the relationship between economic activity in the Basque Country and the environment.

Acknowledgements

This document was drawn up by Iñaki Arto of the Environmental Economy Unit at the Institute for Public Economics of the University of the Basque Country (UPV) for the publicly-owned environmental management company IHOBE, S.A.

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1 Introduction

Calculating the amount of natural resources consumed and identifying the associated environmental impacts are key points within the sustainability objectives and the strategy of integrating the economy and the environment outlined in the Environmental Framework Programme of the Basque Country 2002-2020. **Material Flow Analysis (MFA)** provides a systematic picture of the physical flows of natural resources from extraction through production, use and recycling to final elimination, taking into account the losses along the way. The technique is based on the desire **to link the consumption of natural resources with the capacity of the environment to provide materials and absorb waste.**

MFA is used to give an overview of the physical basis underlying industrial economies and provide a series of sustainability indicators. **The idea is to account for all the natural resources extracted from the environment (materials processed and/ or displaced) to sustain different economic activities.**

Raw materials enter the economy from agriculture, forestry, fishing, mining and gas/oil drilling. Industry processes those raw materials and converts them into goods and services. Materials are thus passed on to consumers and eventually to their final destination: recycling and re-use, dumping as waste or dispersal into the atmosphere.

Extracting or harvesting primary natural resources often calls for the displacement or processing of considerable amounts of material, which can modify or damage the environment. For instance to get at mineral deposits huge quantities of material sometimes have to be displaced. Then, once the minerals are extracted, the ore must be separated from the gangue minerals and concentrated for processing. All this generates large quantities of waste.

Some agricultural activities heighten erosion by exposing more and more cultivated land to the wind and weather. The construction of buildings and infrastructure involves the excavation of large amounts of materials. All these flows are part of a country's economic activity, but are hardly ever considered as economic goods *per se*. From the viewpoint of material flows a distinction is drawn between materials which enter the economy directly (known as **Direct Material Input or DMI**) and those which do not (known as **Hidden Flows or HF**). The latter are associated with the extraction of primary natural resources. The pressure exerted on the environment by these flows is normally different from that exerted by materials which enter industry directly and are converted into goods and services. A tonne of earth shifted to extract uranium is not the same as a tonne of uranium. But all uses of natural resources have the potential to cause major upsets in the environment.

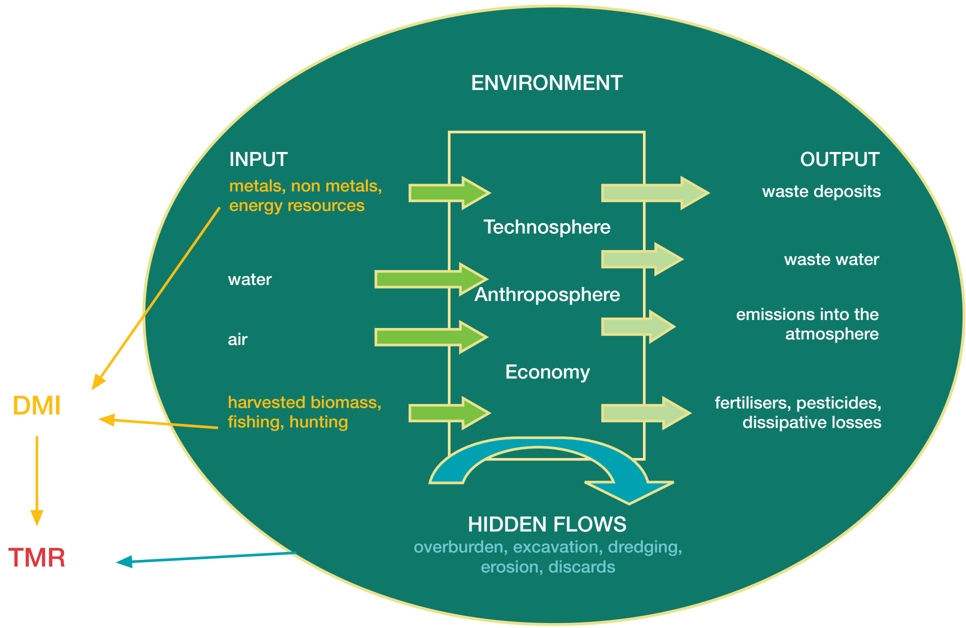
MFA does not enable us to recognise in advance which flows are likely to harm the environment. The harmfulness of flows depends on the point of view of the observer and on the characteristics of the local environment. MFA centres on studying the quantitative aspects of material flows, and takes no account of their qualitative aspects, even though differences in their potential to do harm may be evident. In spite of this, **MFA provides us with a series of figures which, if properly weighted, can give us an overview of the environmental impact (in qualitative terms) of economic activity**. For instance, the flow of oil in an economy can be used to estimate that economy's contribution to acid rain or the greenhouse effect.

Since the market sets no price on hidden flows, they are not generally considered in economic accounting. This results in statistics that underestimate the dependence on natural resources of an economy and provide planners with a distorted image of the physical scale and consequences of their economic decisions.

The primary natural resources and associated hidden flows required for the production of any given product or service comprise the total material requirement associated with it. This requirement is also a measure of the pressure on the environment potentially attributable to that product or service. These flows represent the total amount of natural resources which need to be used to generate the goods and services of an economy.

Separate mention must be made of materials originating in other economies. In the current global economic context materials may originate in one country, be processed in another, turned into end products in a third and consumed in a fourth. This is especially important in MFA's of highly open economies such as the Basque economy. In principle, the hidden flows associated with exported materials could be allocated to the exporting country on the grounds that each country should take responsibility for the environmental damage arising from its exports. In practice, however, this approach fails to take into account the major asymmetries which exist in industrial economies (which import large amounts of raw materials) and developing economies (many of which depend largely on exports of those materials and therefore bear the environmental costs of extracting them). It also fails to consider the current physical basis of most indus-

Figure 1: Material Flow Analysis



trial economies and the importance from a global environmental perspective of using resources more efficiently in those economies. MFA's include an estimate of hidden flows associated with imports.

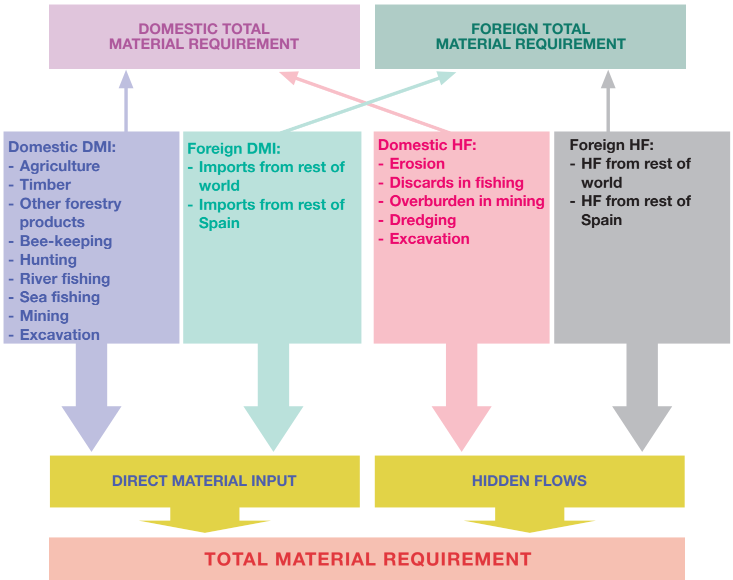
The total physical requirements of an economy (i.e. the sum of domestic and imported materials, excepting air and water, and their associated hidden flows) are known as the Total Material Requirement (TMR) (see Fig. 1). The TMR is a measurement of the physical flows or of the scale of economic activity in physical terms by which an economy is sustained. **The TMR complements other, monetary measurements of a nation's economic activity, such as GDP**. Together, monetary and physical measurements provide a more comprehensive view of the size and scope of industrial economies. The TMR can also be seen as an approximate measurement of the pressure potentially exerted by an economy on the global environment: the accuracy of that measurement will depend on the degree of aggregation of TMR components and their environmental impact. **Material flow accounting is presented in terms of TMR per capita to facilitate comparisons between countries**. The use of raw materials coming from natural resources is also calculated (i.e. the DMI per capita). This is the TMR minus the domestic and foreign hidden flows.

In the short and medium term no changes may be expected in the pattern of consumption and production which could make for a rapid reduction in direct demand and a dematerialisation of the economy. Feasible alternative ways of reducing raw material flows must therefore be considered. One of the most important of those alternatives is provided by TMR, as it enables highly material intensive economic processes to be identified. It is in these processes that ways must be sought of reducing the material flows.

2 Goals & Methods

The main goal of this study is to provide a series of indicators for monitoring the physical basis of the economy of the Basque Country between 1989 and 1998. The set of indicators drawn up enable the degree of dematerialisation of the economy and the level of decoupling between the economy and the environment to be analysed over time

Figure 2: Components of the Total Material Requirement



The main indicator to be calculated is the Total Material Requirement (TMR). This is a macro-indicator developed by the Wüppertal Institute which describes, in terms of total mass, not only the total amount of resources which enter the production processes of an economy directly (direct material input), but also the indirect flows (hidden flows) associated with that production. Material flows of both domestic and foreign origin are taken into account. This breaks down the TMR into a domestic component and a foreign component, thus indicating the geographical location of the pressures exerted on the environment by our economic activities (see Fig. 2). It also indicates the dependency of our economy in terms of resources.

Domestic TMR comprises domestic direct material input plus domestic hidden flows. Domestic DMI covers the domestic extraction of raw materials, both biotic (agriculture, timber, other forestry products, bee-keeping, hunting, river fishing and sea fishing) and abiotic (mining and materials from excavation used in construction). Cattle farming is not included in domestic DMI, as this would amount to accounting twice for the same resources: primary production of feedstuffs for animals and the biomass grazed are counted under agriculture and other forestry products. Furthermore, foreign DMI includes imported cattle feedstuffs, so there is no need to take livestock biomass into account because the inputs needed to sustain it are already accounted for. Domestic hidden flows are materials displaced as a result of the extraction of domestic DMI which do not enter the economy (erosion due to agriculture, discards in sea fishing, displacement of the overburden in mining, surplus materials in excavation for construction of infrastructures/ buildings and dredging operations).

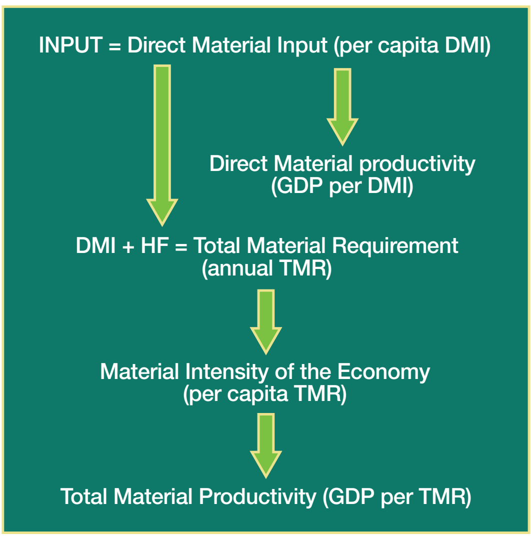
Foreign TMR is divided into foreign DMI and foreign hidden flows. Foreign DMI comprises imports into the Basque Country from the rest of the world and from the rest of Spain. This covers raw and semi-manufactured materials and products of biotic and abiotic origin. The hidden flows associated with imports are those materials displaced elsewhere to obtain the material imported.

The TMR of the Basque Country is therefore made up of the domestic and foreign DMI plus the domestic and foreign hidden flows:

$$TMR = DMI + HF = \underbrace{DMI^{domestic} + HF^{domestic}}_{TMR^{domestic}} + \underbrace{DMI^{foreign} + HF^{foreign}}_{TMR^{foreign}}$$

From the various components of the TMR a series of indicators can be obtained (see Fig. 3) which relate physical variables (DMI, hidden flows and TMR) to economic and social variables (GDP and population levels) .

Figure 3: Main Indicators



The TMR of the Basque Country has been calculated using the method laid down by the European Environment Agency in technical reports nº 55 *Total Material Requirement of the European Union* and 56 *Total Material Requirement of the European Union: Technical Part*. However, it has proved necessary to adapt this method to the specific characteristics of the Basque Country. The main changes made are:

- Use of specific coefficients in calculating **erosion** due to agriculture;
- Introduction of a new method for calculating **excavation** due to the construction of infrastructure and buildings; and
- Estimation of **imports from the rest of Spain**.

Although these changes in methods make the study somewhat more complicated, they lead to significant improvements in the accuracy of the results. Those improvements mean that the indicators are closer to the reality of the Basque economy.

3 Sources of Information

The process of obtaining data to calculate the TMR of the Basque Country was a laborious one, as the data were widely dispersed. In some cases data were expressed in non conventional weight units, and conversion factors had to be applied before they could be processed. In other cases a lack of data made it necessary to draw up estimates.
The main sources of information for calculating the Basque TMR are shown in Table 1, broken down by sectors and types of flow.

Table 1: Main sources of information for calculating the TMR

DOMESTIC SECTOR	
Direct Material Input	**Source**
Agriculture	Nekazal Ikerketa eta Teknologia S.A. (IKT) Ministry of Agriculture, Fisheries and Food (MAFF)
Bee-keeping	IKT, MAFF
Timber	IKT, MAFF
Hunting	IKT, MAFF
Sea fishing	IKT, MAFF
Mining	Spanish Geological and Mining Institute (SGMI)
Excavation used	Own estimates
Hidden Flows	**Source**
Erosion	Own estimates
Discards in fishing	Greenpeace
Overburden in mining	Wüppertal Institute
Excavation not used	Own estimates
Dredging	Port authorities at the ports of Pasajes and Bilbao

FOREIGN SECTOR	
Direct Material Input	**Source**
Imports from rest of world (RW)	ICEX (Institute for Foreign Trade)
	EUSTAT (Basque Institute of Statistics)
Imports from rest of Spain (RS)	Own estimates
	EVE (Basque Energy Organisation)
Hidden flows	**Source**
Hidden flows in imports from RW	Wüppertal Institute
Hidden flows in imports from RS	Wüppertal Institute

4 Analysis of Results

The results of this study are presented below. First the domestic components are given, then the foreign components and finally the totals for DMI, HF and TMR.

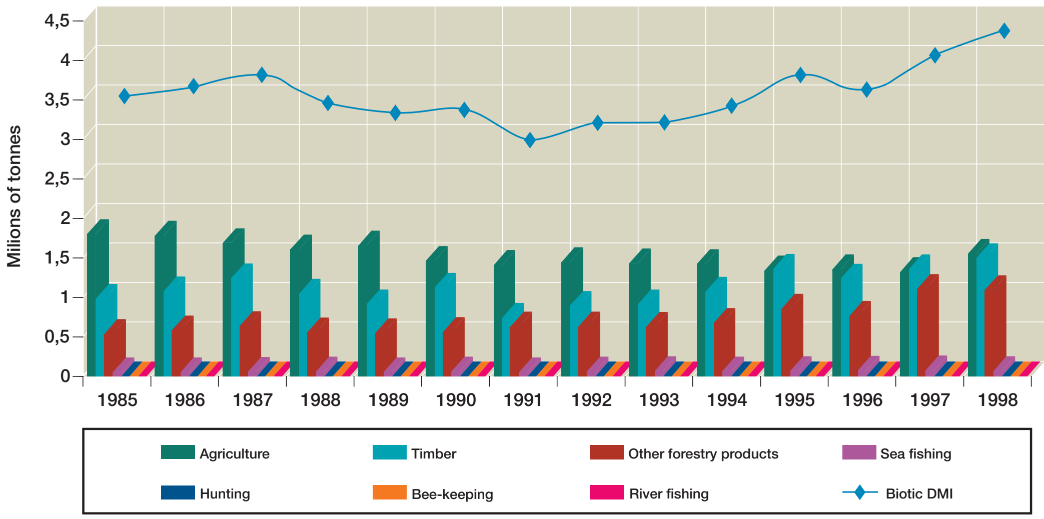
4.1 DOMESTIC RESOURCE EXTRACTION

This comprises all direct appropriations of raw materials within the Basque Country, plus the displaced material that does not enter the economy as an input *per se*, i.e. the domestic DMI and domestic HF, which between them make up the domestic TMR.

4.1.1 Domestic Biomass Extraction and Associated Hidden Flows

In 1998 4.81 MT of biotic materials were extracted in the Basque Country. That same year the biggest flow of biomass directly entering the economy was that of extraction of agricultural resources. This includes the production of cereals, legumes, tubers for human consumption, industrial crops, forage crops (harvested and grazed), vegetables, fresh fruit, nuts, vineyard, olives and other woody plants. In 1998 these categories accounted for 36.88% (1.55 MT) of the total biomass extracted.

Figure 4: Biotic domestic DMI



The second biggest input flow in terms of biomass was that of extraction of forestry products. Timber accounted for 35.61% (1.5 MT) of the total biotic domestic DMI and other forestry products, comprising mainly the mowing and grazing of natural meadowland, grazing land, etc. accounted for 25.97% (1.09 MT).

The remaining domestic biomass extraction categories were sea fishing (1.53%), bee-keeping (0.007%), hunting (0.004%) and river fishing (0.001%).

Figure 4 shows the changes in domestic DMI between 1985 and 1998. The steady increase caused by the growth of forestry production (timber and other forestry products) from 1991 onwards is noteworthy. A comparison of the figures for 1985 and 1998 reveals major increases in other forestry products and timber (104.24% and 53.08% respectively). The 13.95% drop in agricultural production is also worthy of mention. Overall, the biotic domestic DMI increased by 24.55% (0.84 MT) between 1985 and 1998.

The second component of domestic extraction of biotic material is that of hidden flows, i.e. the materials disturbed as a result of the process to obtain the biotic DMI. Two types of HF associated with domestic biomass extraction can be distinguished: erosion and discards in sea fishing.

Erosion due to the extraction of plant biomass (except for timber) is counted in the TMR. Certain agricultural activities propitiate erosion because cultivated land is more exposed to wind and rain. These erosion processes displace huge amounts of material, reduce the fertility of the soil, increase salt levels in water, propitiate eutrophication and accelerate the growth of deltas and estuaries.

Discards are catches thrown back into the sea because they are below authorised or marketable sizes, and catches of species not wanted because they are of little or no economic value. Discards result in economic losses in terms of future biomass, and upset the trophic chain.

In terms of the volume of material displaced, erosion is the more significant of the two factors. It is estimated that between 1985 and 1998 erosion due to agriculture displaced 4.52 MT of soil per annum in the Basque Country, distributed between the three provinces or "Historical Territories" as follows: 88.2% in Araba, 7% in Bizkaia and 4.8% in Gipuzkoa (see Figure 5).

Figure 5: 1985-1998. Distribution by territories of erosion due to agriculture

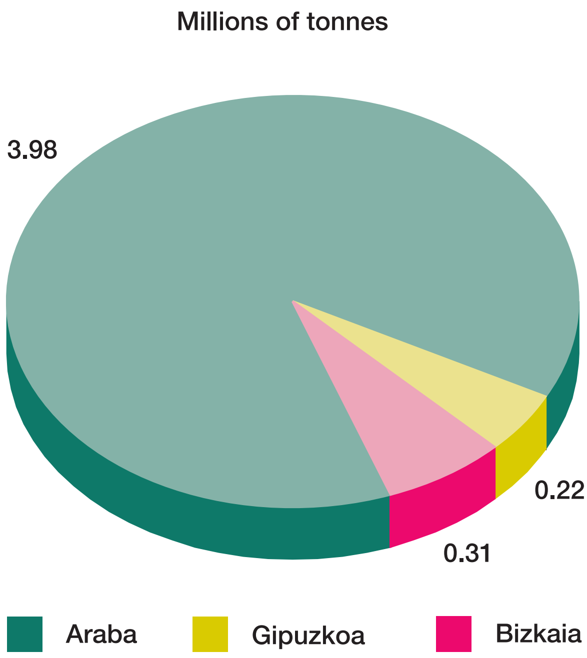


Table 2: 1985-1998. Mean distribution of agricultural land and erosion ratios

	Araba		Bizkaia		Gipuzkoa	
	Land area	Ratio	Land area	Ratio	Land area	Ratio
Dry farmed herbaceous crops	59,015.6	36.523	8,792.4	14.360	4,590.8	14.360
Dry farmed vines & trees	10,697.9	34.435	453.7	13.419	436.5	13.419
Permanent grazing land	39,681.2	10.336	45,601.5	0.297	42,436.6	0.297
Irrigated crops	6,677.4	4.441	335	0.393	90	0.393

Land area given over to agriculture in hectares and erosion ratio in tonnes per hectare per annum

The big difference in erosion in the three territories is due to two things: on the one hand the erosion ratios per type of crop in Araba exceed those in Bizkaia and Gipuzkoa, and on the other hand the land area given over to crops liable to erosion (dry-farmed herbaceous crops and vinyards) is much greater in Araba. Table 2 shows the mean distribution of the main areas of agricultural land according to the erosion which they cause.

A comparison of the figures for 1985 and 1998 shows a decrease of 14.62% in the total material displaced in the Basque Country. This good performance of erosion is a direct result of the decrease in the amount of land given over to dry farming of herbaceous crops.

The map in Figure 6 shows the location of the main focal points for erosion. Most erosion is located in Llanada Alavesa, Valles Alaveses and in Rioja Alavesa areas, as a result of the large areas given over to dry farming of herbaceous crops and vineyards there.

4.1.2 Domestic extraction of abiotic material & associated hidden flows

Mining and Overburden

Material originating from the extraction of metals, non metals, energy resources and quarry products is the biggest component in abiotic domestic DMI. In the case of metals the direct material input is considered to comprise both the ore and the gangue.

Figure 6: 1996. Map showing the location of erosion caused by agriculture

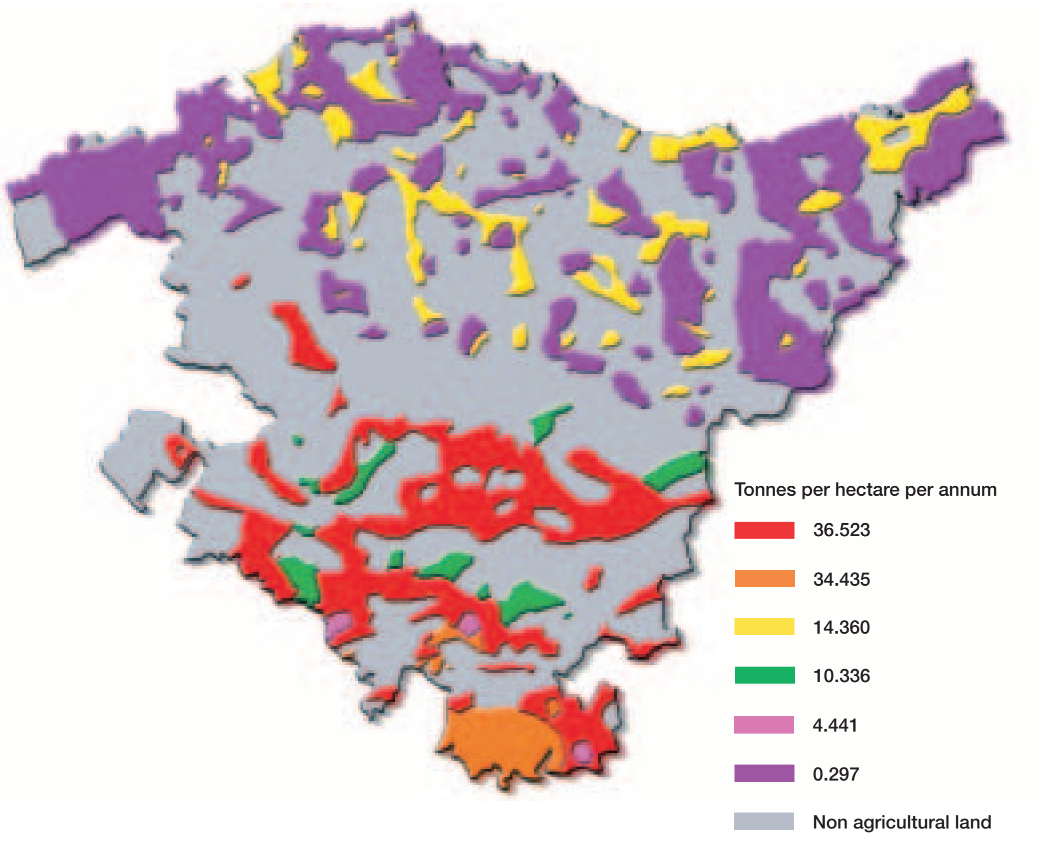
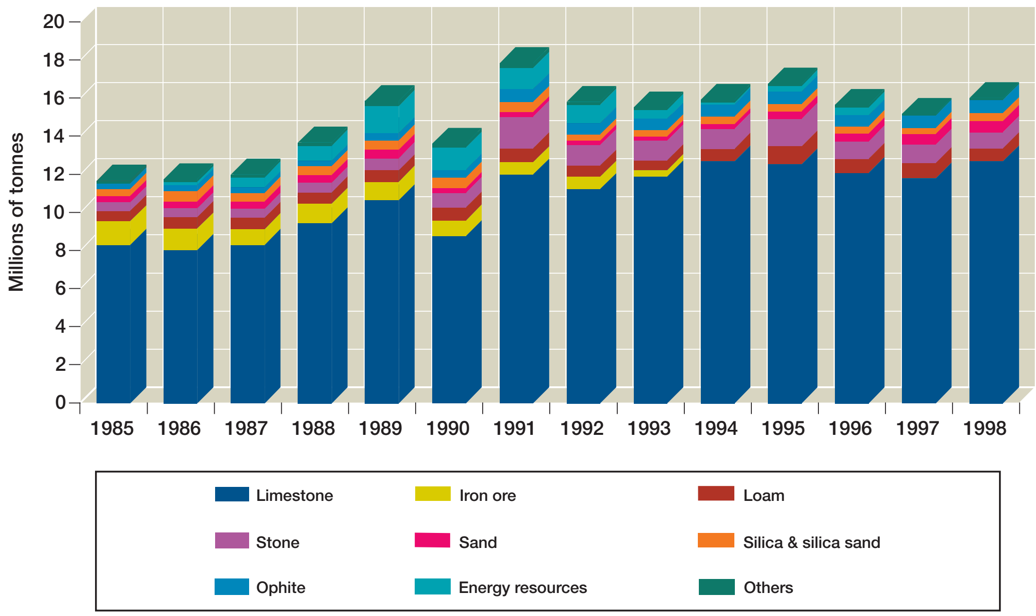


Figure 7: DMI originating from mining



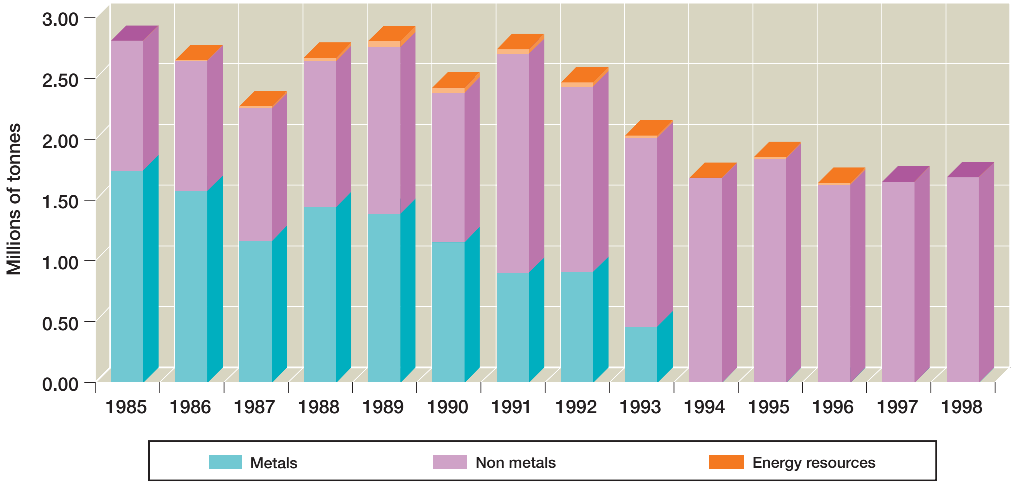
Between 1985 and 1998 domestic mineral extraction increased by 37.06% from 11.68 MT to 16.02 MT (see Figure 7). Most of this increase is due to limestone extraction, where output grew from 8.32 MT in 1985 to 12.7 MT in 1998.

During this period iron and natural gas deposits ceased to be worked.

The hidden flows associated with mining are made up of the material which must be displaced to obtain the DMI. To gain access to a mineral deposit the overburden covering it must normally be removed. This overburden is not normally used, but is dumped as waste on waste heaps near mines. In environmental terms this may be harmful: damage to flora and fauna may ensue, as well as erosion, changes in water courses, leaching, deterioration of the landscape, etc. The material flow originating from the overburden must therefore be taken into account.

Natural gas extraction gives rise to two hidden flows which must be considered: on the one hand the waste from drilling and on the other the quantity of gas flared and/ or reinjected.

Figure 8: Hidden flows associated with mining



Between 1985 and 1998 the hidden flows associated with mining in the Basque Country decreased from 2.81 MT to 1.69 MT (see Figure 8). This drop is closely linked to the cessation of iron mining, which generated hidden flows of 1.38 tonnes per tonne of usable ore. This is much higher than the figure for limestone (the biggest item under the heading of mining & extraction), for which the hidden flows are 0.085 tonnes of material not used per tonne of material used.

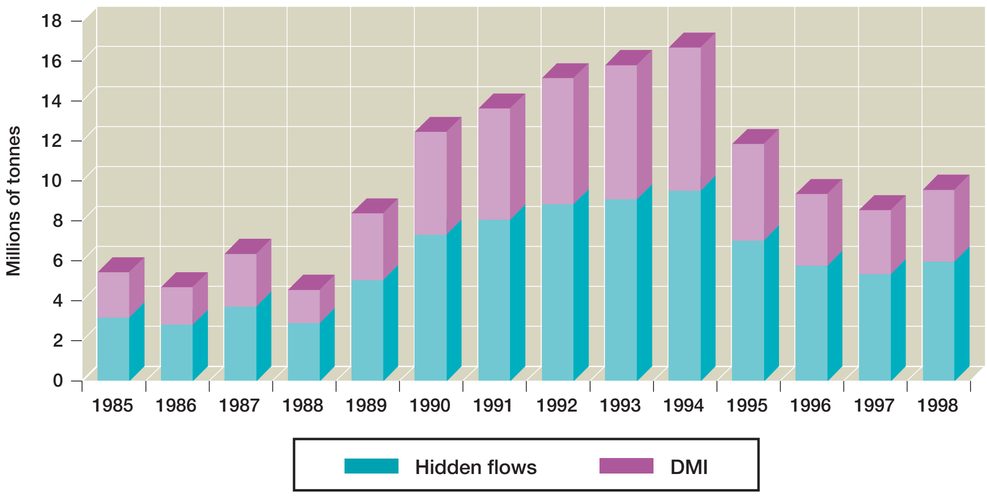
Excavation

Excavation for the construction of infrastructure and buildings generates one of the biggest domestic material flows. The main environmental aspects to be considered in regard to earth removal are noise, emission of dust and particles, generation of waste (oils), high energy consumption, damage to plant life and compacting of the soil, waste dumping, impact on the landscape, effects on archaeological heritage sites, upsetting of natural drainage and the barrier effect.

Excavated material can also be divided into DMI and hidden flows. The former is the material used as filler and to form embankments, etc. The latter is the material dumped on waste tips. Between 1985 and 1998 on average 40% of the material excavated was used, and 60% ended up on waste tips (see Figure 9).

In 1998 excavation for the construction of buildings and infrastructure totalled 9.58 MT, an increase of 75.70% on 1985. This is a direct result of increased activity in the construction of both buildings and infrastructures. Heavy investment in highways in Gipuzkoa and Bizkaia took excavation to more than 12 MT in 1990-1994.

Figure 9: Excavation



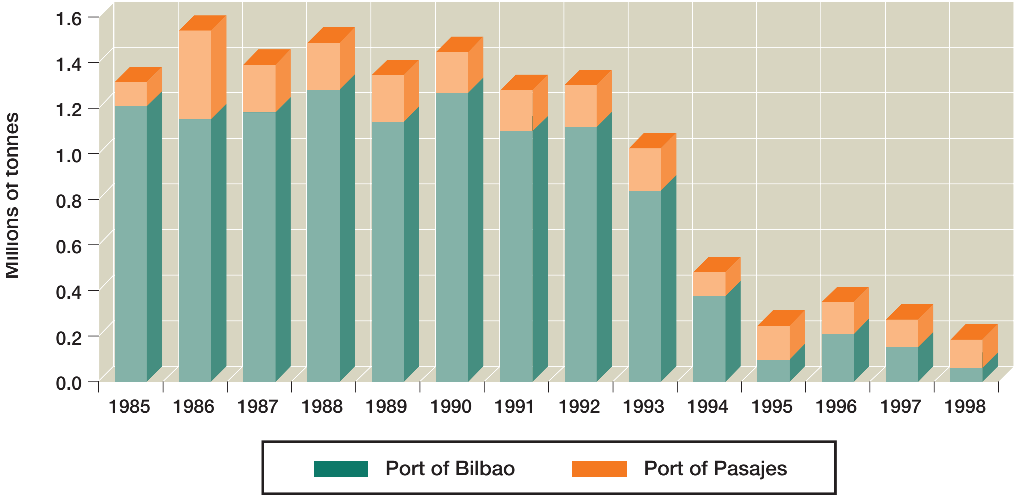
Dredging

Dredging generates a material flow which is not strictly connected to the extraction of resources, but which is necessary for the construction of maritime transport infrastructures and for the maintenance of water depth in ports and river courses. The main sources of this flow are the dredging operations at the ports of Bilbao and Pasajes. Dredged material is usually considered as a hidden flow, as it normally remains outside the economy.

Dredging has negative effects on the marine environment in that it releases contaminants, has a negative impact on trophic chains (especially in the marine benthos), increases salinity in river courses, etc.

Figure 10 shows how the volume of material displaced in dredging operations changed from 1985 to 1998. Between 1985 and 1993 the figure was over 1 MT per annum, but from 1994 onwards it dropped to less than half that amount. This is because considerable extension work was carried out at the port of Bilbao between 1985 and 1993 which required the dredging of huge amounts of material (construction of the Punta Lucero breakwater and several quays and jetties).

Figure 10: Dredging



4.1.3 Domestic Total Material Requirement

In 1998 the domestic TMR was 17.20 tonnes per head of population. Domestic resource extraction was up by 21.05% from 29.91 MT in 1985 to 36.21 MT in 1998. The TMR rose sharply between 1989 and 1994 due to an increase in abiotic material extraction, mainly in excavation (see Figure 11).

Figure 11: Domestic DMI & HF

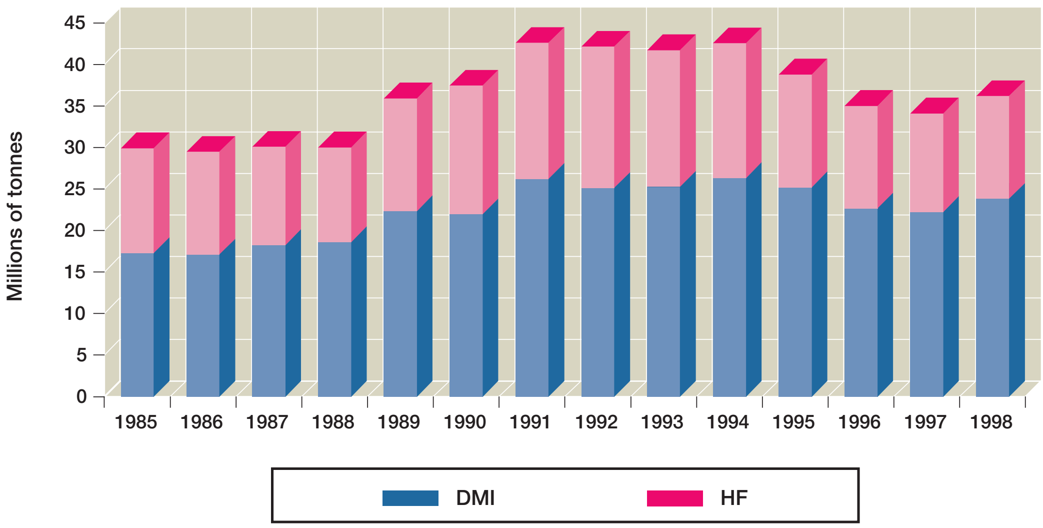


Figure 12: Domestic TMR

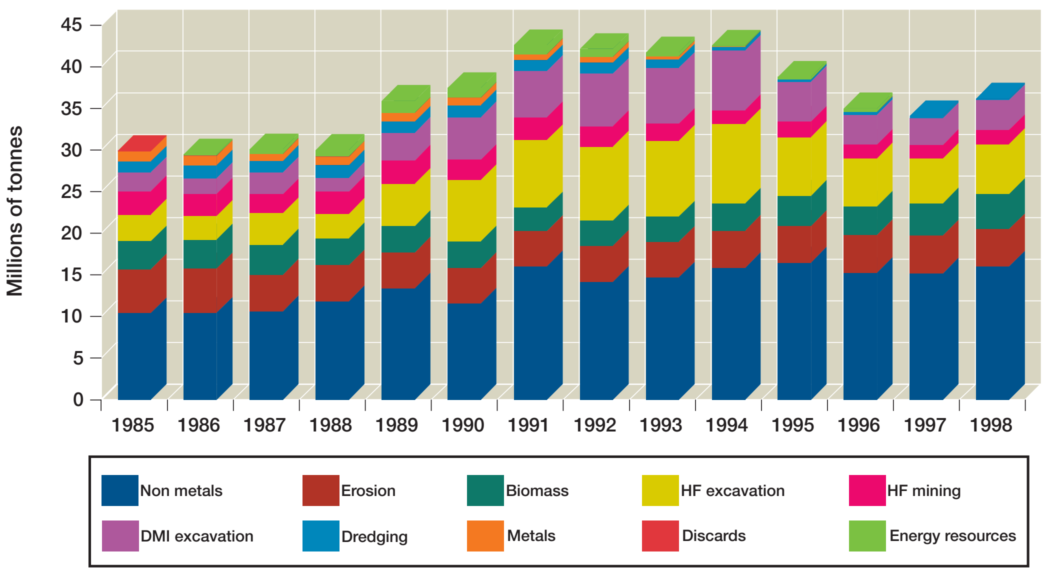


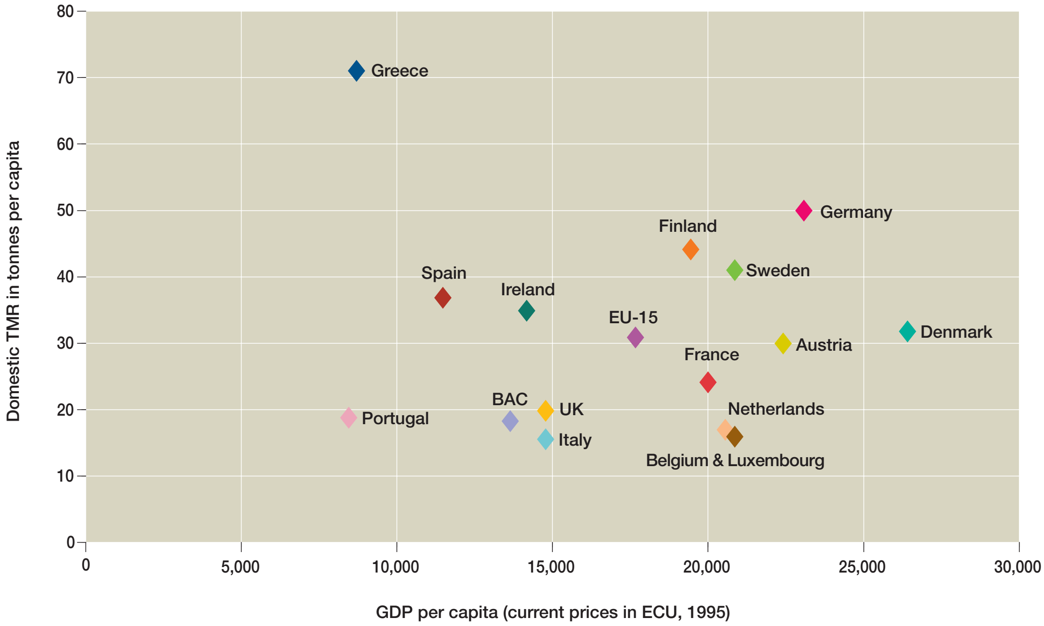
Table 3: **1985 and 1998 Composition of Domestic TMR**

	1985		1998		Variation 1985-1998	
	MT	%	MT	%	MT	%
Non metals	10.41	34.80	16.02	44.24	5.61	53.89
Erosion	5.27	17.62	4.50	12.43	-0.77	-14.61
Biomass	3.37	11.27	4.21	11.63	0.84	24.93
HF excavation	3.21	10.73	5.99	16.54	2.78	86.60
HF mining	2.81	9.39	1.69	4.67	-1.12	-39.86
DMI excavation	2.24	7.49	3.59	9.91	1.35	60.27
Dredging	1.31	4.28	0.18	0.50	-1.13	-86.26
Metals	1.27	4.25	0.00	0.00	-1.27	-100
Discards	0.01	0.03	0.02	0.06	0.01	100
Energy resources	0.00	0.00	0.00	0.00	0.00	0.00
Domestic DMI	**17.29**	**57.81**	**23.83**	**65.81**	**6.54**	**37.83**
Domestic HF	**12.62**	**42.19**	**12.38**	**34.19**	**-0.24**	**-1.90**
Domestic TMR	**29.91**		**36.21**		**6.30**	**21.06**

The most significant events in the development of domestic TMR were the following (see Fig. 12 and Table 3):

- Increase in the part of domestic TMR accounted for by DMI in absolute terms (from 17.29 MT to 23.83 MT) and relative terms (from 57.81% to 65.81%), due to:
  – increases in the extraction of biomass (timber & other forestry products);
  – increases in limestone extraction.
- Decreases in hidden flows in both absolute terms (from 12.62 MT to 12.38 MT) and relative terms (from 42.19% to 34.19%) due to:
  – reduced erosion as a result of a drop in dry farming of herbaceous crops in Araba;
  – the disappearance of the hidden flows associated with metal mining;
  – the decrease in dredging at the port of Bilbao.

Figure 13: Domestic TMR and GDP in EU-15 and the Basque Country in 1995

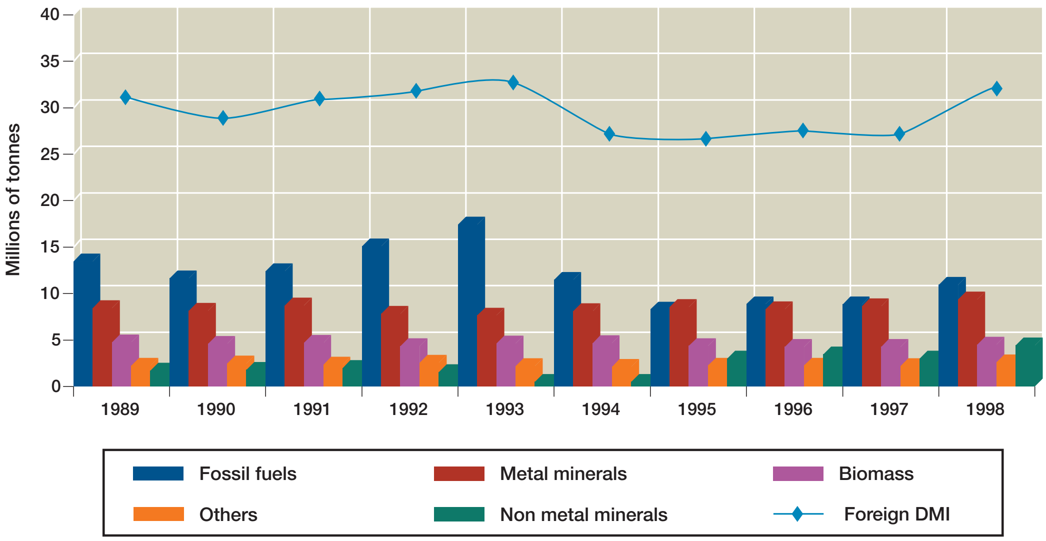


Source: Wüppertal Institute and own data

Figure 13 reveals that there is no correlation between domestic resource extraction and GDP. Some countries obtain far greater wealth in terms of GDP than others with the same quantity of domestic resources. Examples are The Netherlands, Belgium and Luxembourg, Denmark and Austria. In the Basque Country neither domestic resources extraction nor GDP is particularly high. Domestic material productivity in 1995 was on the order of 733 ECU per tonne of material extracted in the Basque Country. This figure is considerably higher than the overall EU figure of 568 euros per tonne, and higher than those of Sweden (507 ECU/t) and Germany (460 ECU/t). However there are also countries, such as Belgium & Luxembourg (1,300 ECU/t) and The Netherlands (1,207 ECU/t), whose domestic material productivity is far higher than that of the Basque Country.

The Basque Country, like other small countries such as Belgium & Luxembourg, makes up for its low domestic resource extraction by means of very high imports. Our analysis must therefore be extended to imported resource requirements.

Figure 14: DMI from imports



4.2 FOREIGN RESOURCE REQUIREMENTS

These include materials imported by the Basque Country from the rest of the world and from the rest of Spain to meet its material requirements, plus the hidden flows associated with those imports.

4.2.1 Foreign DMI

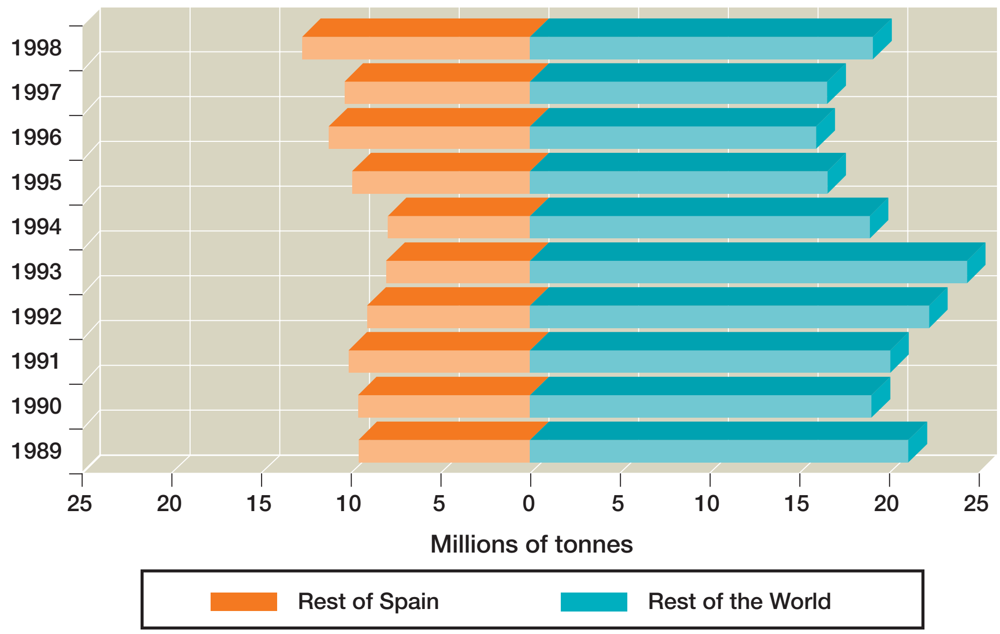
Foreign DMI totalled 15.12 tonnes per capita in 1998, up 0.63 tonnes per capita (4.33%) on 1989. In absolute terms foreign DMI increased over this period by 1.16 MT (3.8%). This difference in DMI growth rates is due to the fact that the population of the Basque Country was smaller in 1998. Materials classed as biomass, metal minerals, non metal minerals and “others” increased. The only decrease was in fossil fuels (see Figure 14).

The main component of imported used material flows is fossil fuels. Although imports of these fuels decreased by 18.72% from 1989, in 1998 they still accounted for 34.4% of total imports (10.95 MT of a total of 31.81 MT). Within fossil fuels the biggest imports were crude oils and petroleum oils.

The large amount of fossil fuels imported is linked closely to the petrochemical industry and to the energy dependency of the Basque Country. In the period under study a change in the production structure of the metal industry in the Basque Country is reflected in the drop in coal imports (from 1.57 MT in 1989 to 0.30 MT in 1998). From an environmental viewpoint the decrease in the fossil fuel flow is significant, as these fuels are one of the main causes of global warming and acid rain.

The second biggest imported material flow is that of metal minerals at 29.39%. This figure rose in absolute terms from 8.45 MT in 1989 to 9.35 MT in 1998, though the type of material imported changed towards more highly processed materials: there were increases in imports of semi-manufactured products and end products and drops in raw materials. These changes are linked to changes in the Basque metal industry (e.g. the dismantling of the Altos Hornos de Vizcaya blast furnaces and the setting up of the Acería Compacta de Bizkaia compact steel mill).

Figure 15: Origins of foreign DMI



Imports of biotic material remained practically constant at around 4.5 MT, which in 1998 accounted for 14.16% of the total material imported into the Basque Country.

The flow of non metal minerals deserves special mention, as it increased by 156.94% (2.7 MT) from 5.61% of foreign DMI in 1989 to 13.88% in 1998. This was due mainly to minerals for construction.

In 1989 68.76% of imports came from the rest of the world. In 1998 the figure was 60.06%. In absolute terms, imports from the rest of Spain increased by 3.13 MT (32.68%) while those from the rest of the world dropped by 1.96 MT (9.32%) (see Figure 15).

4.2.2 Hidden flows associated with foreign direct material input

This refers to the amount of material which needs to be displaced outside the Basque Country to obtain the material imported. The main hidden flows accounted for here are erosion (as a result of arable and livestock farming), feedstuff inputs associated with imported animal products, overburden and gangue in mining, hidden flows associated with electricity imports and discards in fishing.

The following aspects of foreign DMI were taken into account in calculating these hidden flows:

- composition;
- degree of processing (raw material, semi-manufactured, end product);

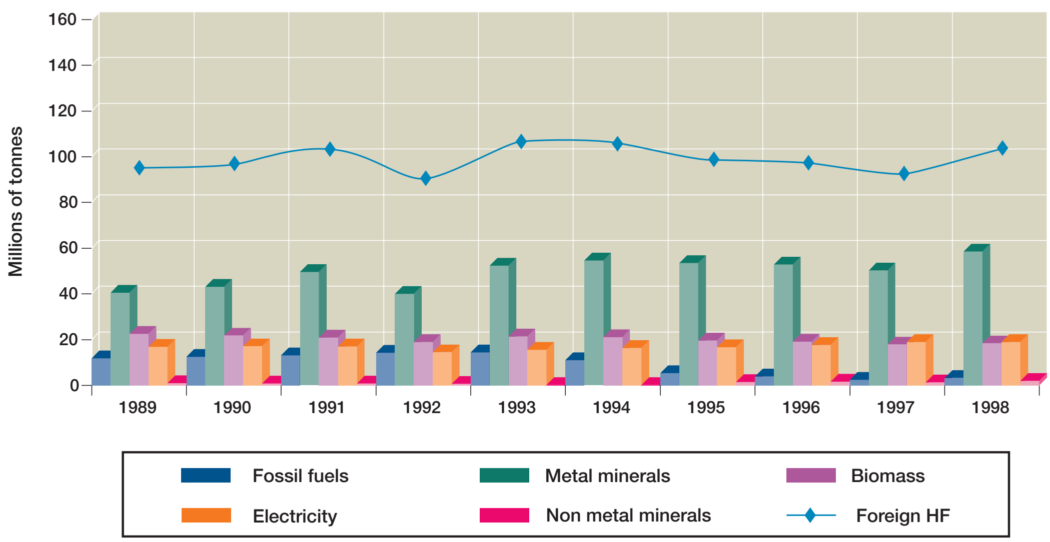
- geographical origin of imports;
- year of importation.

In 1998 the hidden flows associated with imports into the Basque Country totalled 101.15 MT, up from 8.28 MT (8.92%) in 1989 (see Figure 16).

In 1998 57.88% of the hidden flows abroad (58.55 MT) resulted from imports of metal minerals. This flow was up 44.22% from 1989 figures for two reasons:

- increased imports of metal minerals (0.9 MT)

Figure 16: Composition of hidden flows associated with imports

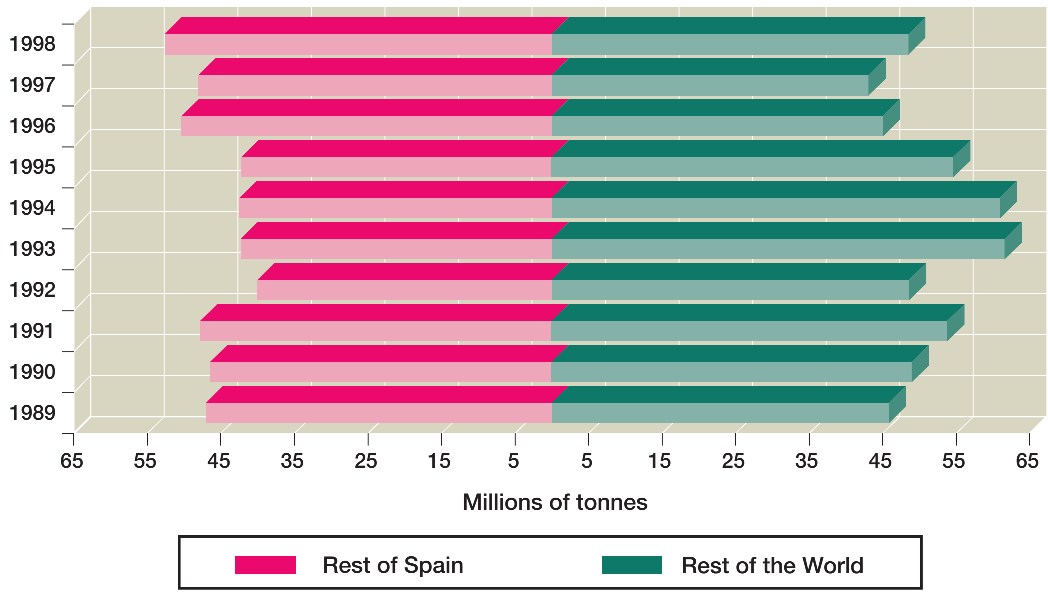


- An increase in the coefficients of hidden flows (in 1989 4.81 tonnes of material were displaced abroad to obtain one tonne of metal material, while in 1998 the figure was 6.26 tonnes per tonne). This increase in hidden flow ratios is due to the higher degree of processing of imported materials (decrease in iron ore imports and increase of imports of iron and steel) and to the increase in imports of metals with higher hidden flow ratios (unrefined tin and refined copper).

The hidden flows associated with imports of materials from arable and livestock farming totalled 18.44 MT in 1998. This was 18.3% down on the 1989 figure of 22.57 MT. The drop is due mainly to reductions in the erosion caused by soya imports from the rest of the world.

Foreign hidden flows also include the material required to produce electricity imports. In 1998 this amounted to 18.96 MT, up 12.15% from 1989. This increase in electricity imports is accompanied by a geographical shift in environmental impact. The overall effect on climate change may remain the same (if output and total consumption remain constant), but the burden of extracting energy resources is borne only by the exporting country.

Figure 17: **Location of hidden flows associated with imports**



The hidden flows that increased most in percentage terms from 1989 were those resulting from non metal minerals, which were up by 107% (by 1.03 MT in absolute terms).

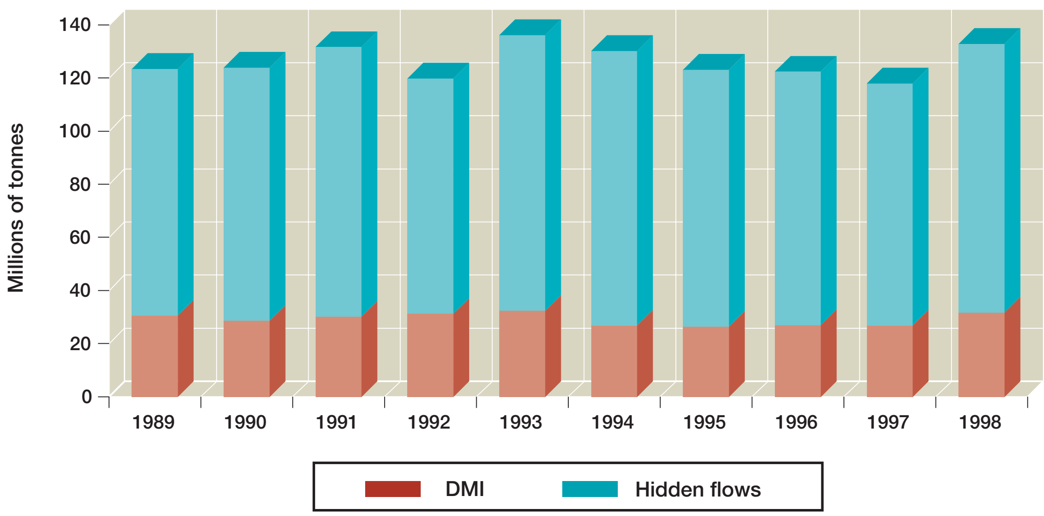
Hidden flows associated with imports of fossil fuels were down by 72.88% from 11.83 MT in 1989 to 3.21 MT in 1998 as a direct result of the drop in coal imports which followed the restructuring of the Basque metal industry in the mid nineteen nineties.

In 1989 50.64% of the hidden flows associated with imports originated in the rest of Spain (see Fig. 17). In 1998 the figure was 52.05%. In absolute terms hidden flows associated with imports from the rest of Spain were up by 5.62 MT (11.95%), and those from the rest of the world were up by 2.66 MT (5.81%).

4.2.3 Foreign TMR

Foreign TMR comprises foreign DMI plus foreign HF. **In 1998 resources originating outside the borders of the Basque Country totalled 63.17 tonnes per head of population (as compared to 58.39 in 1989). Dependence on foreign materials increased by 7.65% (9.45 MT) between 1989 and 1998**.

Figure 18: Foreign DMI and hidden flows



In 1998 hidden flows accounted for 76.07% of foreign TMR, and DMI for 23.93%, as compared to 75.19% and 24.81% in 1989. This implies that for each tonne of material imported into the Basque Country from the rest of the world or the rest of Spain in 1998 3.18 tonnes of material were displaced (as compared to 3.03 in 1989) (See Fig. 18 and Table 4).

The most significant aspect of the changes in foreign TMR is the increase in both absolute (17.96 MT) and relative (44.25%) terms of the hidden flows associated with metal mineral imports (Fig. 19). This is the result of a combination of three circumstances:

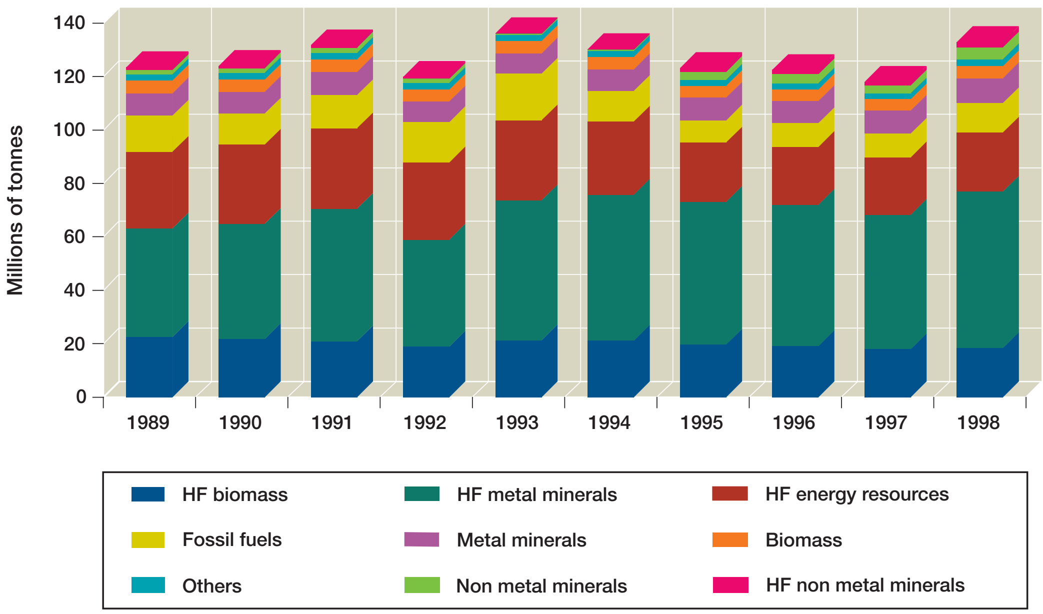
- increased metal material imports;
- imports of more highly processed materials: one tonne of iron ore has an associated HF of 2.11 tonnes, while for one tonne of unrefined iron or scrap the figure is 3.66 tonnes;
- increased imports of unrefined tin and refined copper, which have HF's of 6,791.26 and 300.6 tonnes per tonne respectively.

Table 4: 1985 and 1998 Composition of Foreign TMR

	1985		1998		Variation 1985-1998	
	MT	%	MT	%	MT	%
HF biomass	22.57	18.27	18.44	13.87	-4.13	-18.30
HF metal minerals	40.59	32.86	58.55	44.03	17.96	44.25
HF energy resources	28.74	23.27	22.17	16.67	-6.57	-22.86
Energy resources	13.47	10.91	10.95	8.23	-2.52	-18.71
Metal minerals	8.45	6.84	9.35	7.03	0.9	10.65
Biomass	4.76	3.85	4.51	3.39	0.25	-5.25
Others	2.25	1.82	2.60	1.96	0.35	15.56
Non metal minerals	1.72	1.39	4.42	3.32	2.7	156.98
HF non metal minerals	0.96	0.78	2.00	1.50	1.04	108.33
Direct material input	**30.65**	**24.82**	**31.83**	**23.93**	**1.18**	**3.85**
Hidden flows	**92.86**	**75.18**	**101.16**	**76.07**	**8.3**	**8.94**
Foreign TMR	**123.51**		**132.99**		**9.48**	**7.68**

Another interesting result is the figure for energy resources. On the one hand a drop of 18.71% (2.52 MT) can be observed in DMI for energy resources, due mainly to the decrease in oil imports. On the other hand there is a 22.86% drop (6.57 MT) in hidden flows associated with energy resources. This big drop in HF is the result of an 8.62 MT decrease in HF associated with coal imports, offset to some extent by an increase in HF associated with electricity imports.

19: Foreign TMR



4.3 TOTAL MATERIAL REQUIREMENT OF THE BASQUE COUNTRY

Now that the domestic and foreign components of the TMR have been calculated, we are in a position to work out the total DMI, HF and TMR of the Basque Country.

4.3.1 Direct material input of the Basque Country

The DMI is the component of the TMR that covers the materials used for processing in an economy. It comprises the domestic DMI and the foreign DMI (physical flow of material imports).

Most of the DMI of the Basque Country originates from imports. In 1989 the figure was 57.82, and in 1998 it had dropped slightly to 57.18%. The Basque Country is therefore highly dependent on foreign resources. This contrasts with the situation in the USA, the EU, Germany and Japan, where foreign resources account for 11, 20, 23 and 33% respectively. The Netherlands is also fairly dependent on foreign resources, having a foreign DMI of 53%. The conclusion may be drawn that a country's dependence on foreign DMI is correlated with its size: smaller countries tend to import more materials to offset their lack of primary output.

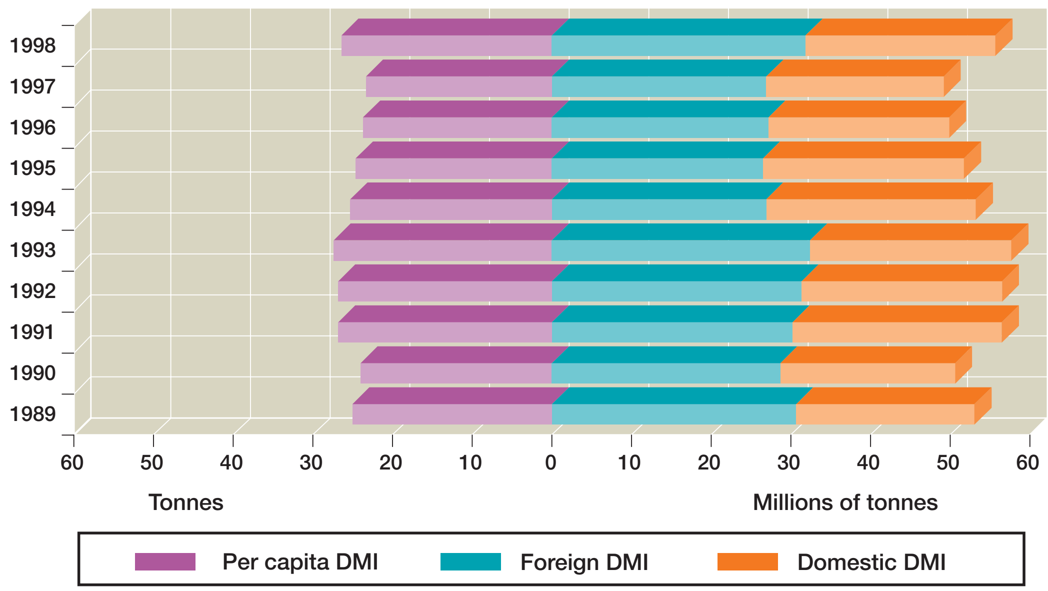
Four periods can be distinguished in the development of the DMI of the Basque Country:

- 1989-1990: DMI dropped by 2.42 MT (4.56%) as a result of reductions in imports of fossil fuels and metal minerals from the rest of the world and lower domestic extraction of limestone.
- 1990-1993: DMI grew steadily, bringing 7.06 MT (13.95%) more material into the economy, as a result of three factors: steady growth in fossil fuel imports from the rest of the world, increased domestic limestone extraction and increases in DMI from excavation for construction.
- 1993-1997: DMI dropped by 8.5 MT due to a fall in fossil fuel imports from the rest of the world and in materials from excavation.
- 1997-1998: DMI increased again, rising by 6.49 MT (13.21%) in this short period as a result of increased fossil fuel imports from the rest of the world, increased non metal mineral imports from the rest of Spain and higher domestic limestone extraction.

In quantitative terms the component of DMI which fluctuated most was fossil fuels, comprising crude oil and petroleum oils imported to meet the energy requirements of the Basque Country, and especially the needs of its petrochemical industry. **The conclusion can be drawn that the main cause of fluctuation in the DMI of the Basque Country lies in oil imports from the rest of the world**.

The DMI of the Basque Country decreased in absolute terms by 7.28% between 1989 and 1997. The decrease in the EU between 1988 and 1997 was 5%. In per capita terms the drop was 6.81% (as compared to 8% in the EU) from 25.06 to 23.35 tonnes (EU: 21.2 to 19.5 tonnes). **A trend towards dematerialisation can be seen in DMI between 1993 and 1997**, following an increase of 7.06 MT between 1990 and 1993. A look at the data for 1998 seems to indicate that this trend was reversed: DMI increased that year by 13.21% on 1997 figures (see Fig. 20). This was due to:

Figure 20: Total DMI



- an increase of 2.55 million tonnes in imports from the rest of the world;
- an increase of 2.35 million tonnes in imports from the rest of Spain;
- an increase of 1.59 million tonnes in domestic resource extraction.

A comparison of the data for the Basque Country and those for EU member States reveals various points worthy of mention (see Table 5):

- Finland, Sweden, Italy, Germany and France have achieved slight reductions in their DMI (between 1 and 3%)
- There is a second group of countries where DMI has increased by more than the EU average, comprising Ireland (36%), Belgium/ Luxembourg (24%), Greece (19%), Denmark (17%) and Spain (12%).
- The Basque Country has reduced its DMI by 6.81%, a considerably higher figure than in the member States of the EU.
- In per capita terms Finland, Ireland, Sweden, Belgium/ Luxembourg, Denmark and The Netherlands had DMI's higher than the EU average in 1997. The remaining countries, including the Basque Country, were below the EU average.

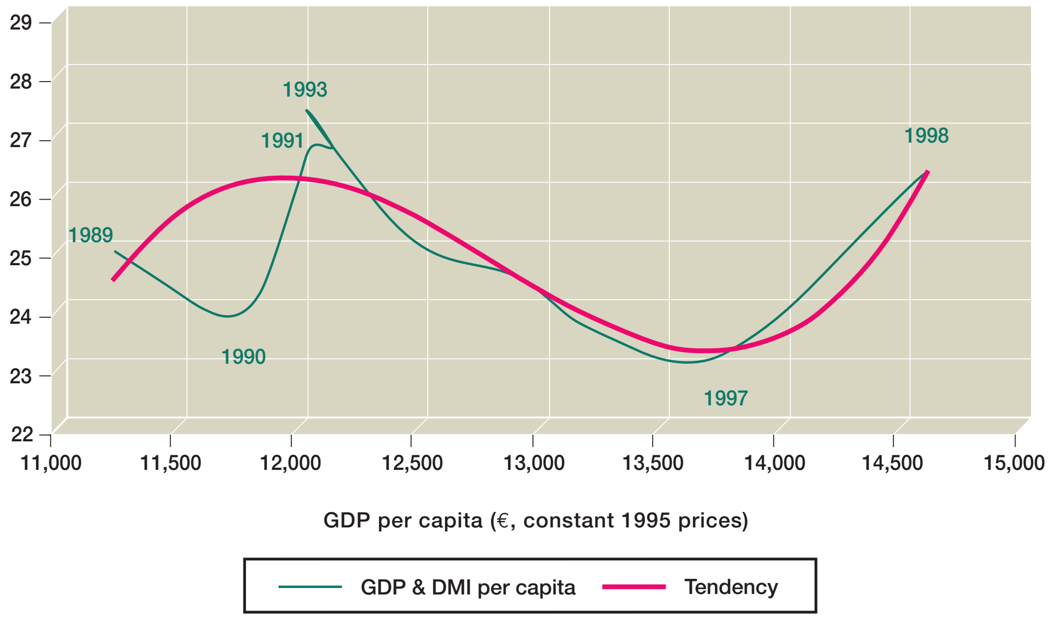
Table 5: **1988 and 1997 – DMI of EU countries and the Basque Country**

	Tonnes per capita 1997	% variation in tonnes per capita 1988-1997
Finland	39	-3
Ireland	35	3
Sweden	34	-3
Belgium	34	24
Denmark	33	17
The Netherlands	29	4
EU-15 average	26,07	7,5
Austria	24	2
Germany	24	-2
Basque Country	**23,35**	**-6,81**
Spain	22	12
France	22	-1
Greece	20	19
EU-15	20	-8
UK	19	0
Portugal	15	36
Italy	15	-3

Source: Wüppertal Institute and own data.
The EU-15 average is the mean of the results obtained for each of the 15 member States.
As from 1990 figures represent the combined results for the FRG and the GDR.
The variation in DMI for the Basque Country refers to the period from 1989 to 1997.
Data on member States include trade within and outside the Community, while the DMI for EU-15 does not include intra-Community trade or the DMI of countries prior to their joining the EU.

1993-1997 saw the absolute decoupling of the Basque economy in terms of DMI. The trend in the Basque Country is towards increased wealth in terms of GDP per capita, with ever decreasing quantities of materials (DMI) being used. A change in this trend seems to have occurred in 1998, though data on subsequent years must be awaited before this can be confirmed (see Figure 21).

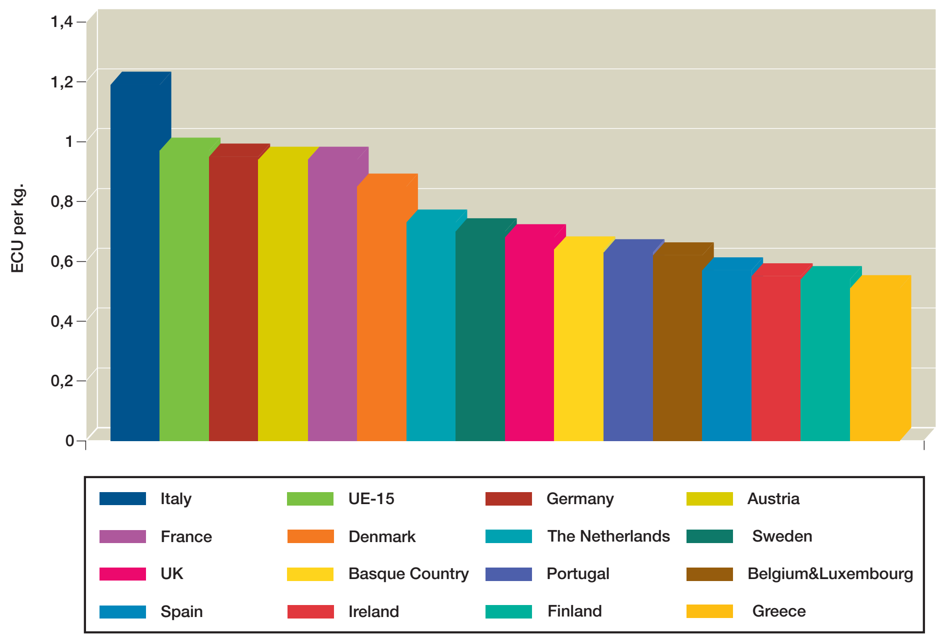
Figure 21: GDP and DMI per capita in the Basque Country between 1989 and 1998



The direct material productivity of resources (actual GDP per DMI) increased by 23.07% from 1989 to 1998. Finland, France, Italy, Sweden and the UK experienced a similar situation, while in the rest of the EU economic growth was associated with greater resource use. In the Basque Country this decoupling is associated with an absolute increase in direct material productivity in 1993-1997 (positive growth rates for GDP and negative for DMI).

In spite of these good results the situation in the Basque Country does not compare well with that of EU member States. Direct material productivity in the Basque Country in 1997 was 0.64 ECU per kg. of DMI. Only Portugal, Belgium/ Luxembourg, Spain, Ireland, Finland and Greece have lower figures. The figure for the EU as a whole is clearly higher (see Fig. 22).

Figure 22: Direct material productivity – GDP/ DMI



Source: Wüppertal Institute
GDP in ECU, current prices, 1995

4.3.2 Hidden flows in the Basque Country

Hidden flows (HF) indicate the amount of material which is displaced to obtain the DMI but which does not enter the economy. **In 1998 HF in the Basque Country totalled 113.53 MT (53.94 tonnes per capita)**. 91.12% of these HF's are from foreign sources, and result from three basic aspects of the Basque economy:

- The importance of the metal industry, the inputs to which are associated with high hidden flows. In 1997 the joint output of the steel making, foundry, forging and drop-forging industries was close to 7 MT. Assuming 100% efficiency in the use of metal inputs, the HF associated with this output would be around 41 MT. If the energy consumption of these industries is taken into account the figure for HF increases to around 7.2 MT.
- High dependency in foodstuffs: this results in high levels of HF as a result of the crop and livestock farming needed to meet import requirements.
- Energy dependency: HF associated with electricity production totalled 18.96 MT in 1998.

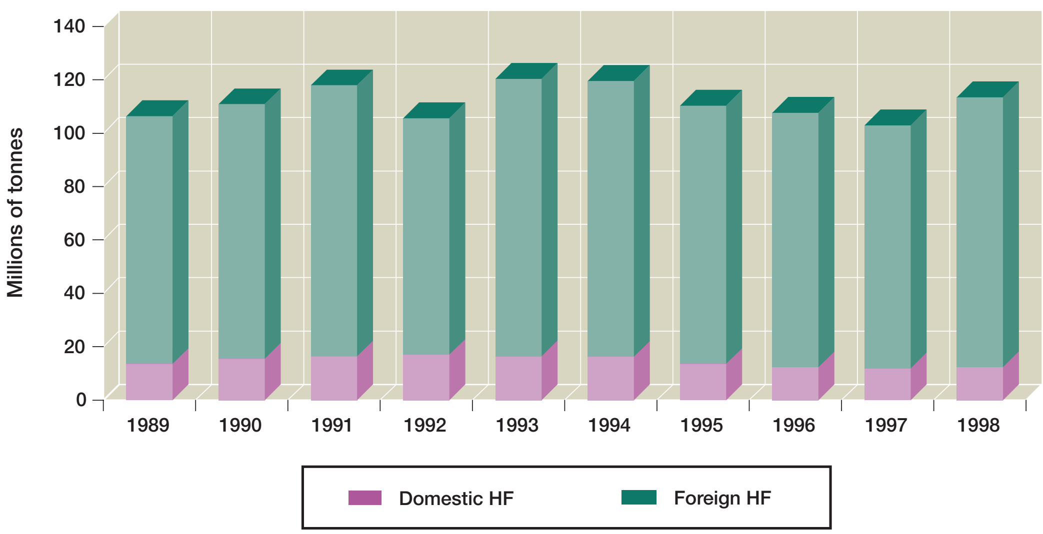
The trends in hidden flows over time can be broken down as follows:

- 1989-1991. HF increased by 11.54 MT (10.84%) as a result of increased imports of metals with high HF coefficients (silver, tin, refined copper and unrefined copper) and of iron and tin ore. There was also an increase in HF associated with coal imports. This coincided with increases in HF associated with excavation for construction of housing and infrastructure.
- 1991-1992. HF fell by 12.33 MT (10.45%) as some components reversed the tendency evidenced in the previous period. There were drops in HF associated with imports

from the rest of the world of silver, tin, refined copper and unrefined copper. HF associated with imports from the rest of Spain of biomass, metal minerals and electricity also dropped.

- 1992-1993. HF increased by 14.73 MT (13.95%), mainly as a result of HF associated with metal imports from the rest of the world (iron and steel, tin, refined copper and unrefined copper). HF associated with imports of biomass and electricity from the rest of Spain also rose during this period. From 1992 onwards HF associated with coal imports gradually decreased.
- 1993-1997. HF dropped by 17.37 MT (14.43%). There were decreases in HF associated with imports from the rest of the world of iron ore (offset by the increase in HF associated with iron and steel imports from the rest of the world and the rest of Spain), unrefined copper and unprocessed tin. There was a sharp drop in HF associated with coal imports, and HF associated with biomass imports from the rest of Spain also decreased. Much of this decrease in HF can be explained in terms of the reduction in HF associated with excavation for construction.
- 1997-1998. HF increased by 10.53 MT (10.22%), mainly as a result of increases in HF associated with imports from the rest of the world of refined copper and unprocessed tin, and with imports of metal minerals from the rest of Spain. HF associated with coal also increased as a result of operations at the Pasajes power station.

Figure 23: Location of total hidden flows



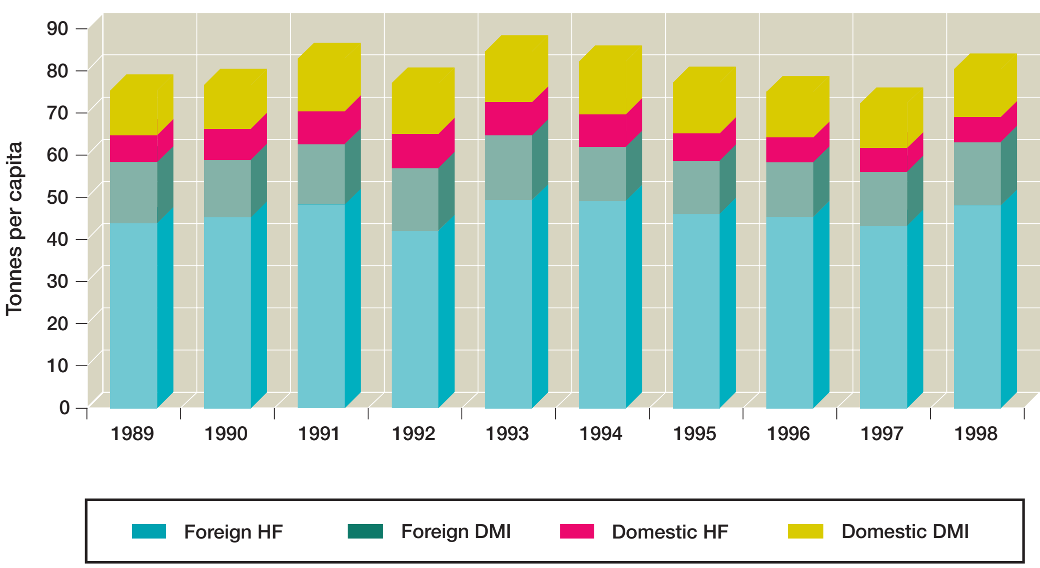
An analysis of the fluctuations in the various components of hidden flows reveals that their behaviour can be explained to a large extent by the behaviour of HF associated with imports of metal minerals and coal.

Since 1989 HF have increased by 6.68%. Foreign HF have increased by 8.92% while domestic HF have decreased by 8.7% (see Figure 23).

4.3.3 Total Material requirement of the Basque Country

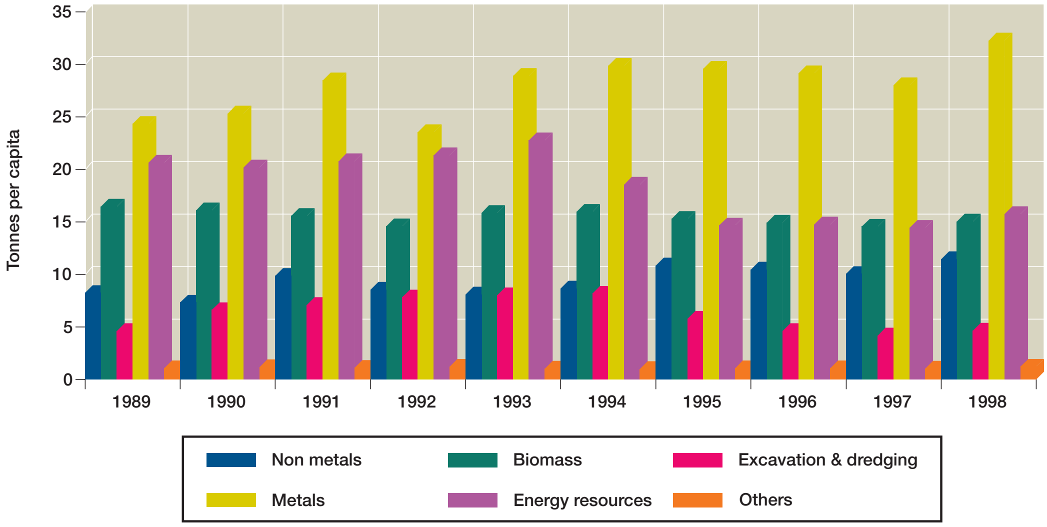
The TMR covers all the material needs of the economy of the Basque Country, including materials entering the economy as direct inputs and those which must be displaced within the environment in order to obtain resources. **In 1997 the TMR of the Basque Country was 72.29 tonnes per capita. This figure is considerably higher than the overall EU figure of 50 tonnes per capita for the same year**. This difference between the Basque and European TMR's was due mainly to metal minerals: in the EU they accounted for 10 tonnes per capita, and in the Basque Country 23.01 tonnes.

Figure 24: TMR of the Basque Country in tonnes per capita



In 1998 the Basque TMR was 80.37 tonnes per capita, up 6.65% from the 1989 figure. The biggest component was foreign HF, i.e. materials displaced abroad to obtain those imported into the Basque Country, which accounted for 59.79% of the total (48.06 tonnes per capita). Foreign DMI at 18.81% (15.12 tonnes per capita) was the second biggest component, followed by domestic DMI and domestic HF at 14.08% and 7.21% (11.32 and 5.88 tonnes per capita) respectively. The foreign component of the per capita TMR in the Basque Country in 1998 therefore accounted for 78.6% of the total (compared to 77.47% in 1989) (see Figure 24). **In other words, of every 10 tonnes of materials needed by the Basque economy in 1998, 7.86 came from outside the Basque Country**.

Figure 25: Composition of the per capita TMR of the Basque Country



The biggest material flow (DMI + HF) of the Basque Country in 1998 was that of metal minerals at 32.26 tonnes per capita (40.14% of the TMR). This figure was up by 7.92 tonnes (32.55%) from 1989. In the same year the energy sources component of the TMR (fossil fuels plus their HF and electricity) totalled 15.73 tonnes per capita (19.58%), 4.91 tonnes less than in 1989. Another major material flow was that of biomass (and its HF), which accounted for 15.04 tonnes per capita (18.72%), down 1.42 tonnes from 1989. 14.72% of the per capita TMR of the Basque Country was accounted for by non metal minerals and the HF associated with their extraction (11.42 tonnes). This figure was up 3.22 tonnes (38.99%) from 1989. The remaining components of the per capita TMR were excavation with 4.64 tonnes and "others" (miscellaneous imports) with 1.23 tonnes. The trends for each component are indicated in earlier sections of this study.

Table 6: 1989 and 1998 – Ratios of hidden flows per type of DMI

	Domestic		Foreign	
	1989	1998	1989	1998
Biomass	1.37	1.07	4.74	4.09
Fossil fuels	0.03	No DMI	0.88	0.29
Metal minerals	1.32	No DMI	4.81	6.26
Non metal minerals	0.27	0,57	0.56	0.45
Total	0.61	0.52	3.03	3.18

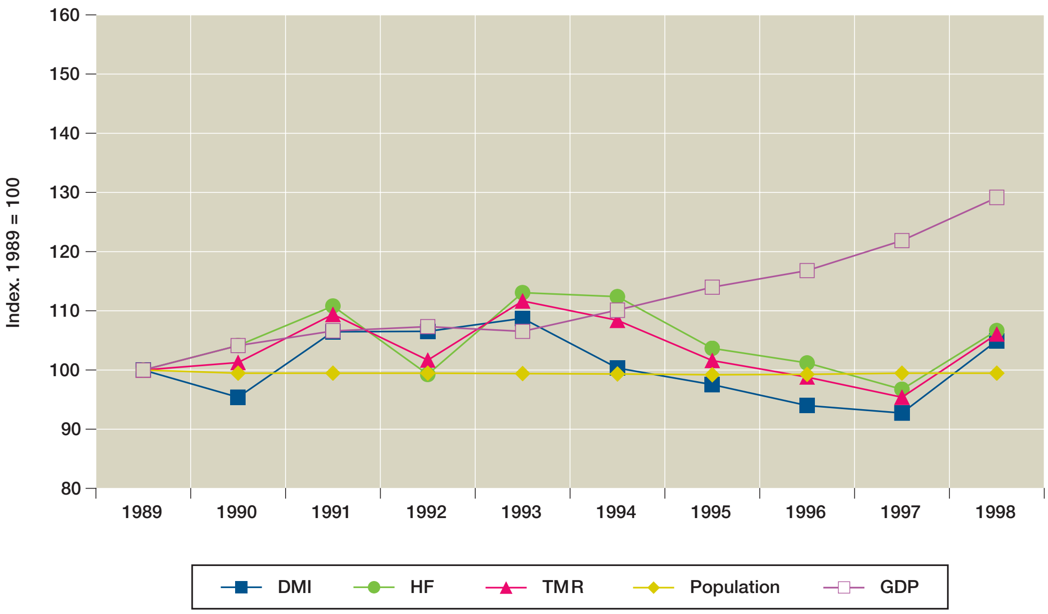
Ratios in tonnes of HF per tonne of DMI

A comparison of foreign DMI and HF reveals that 3.18 tonnes of material were displaced for each tonne of material imported in 1998 (Table 6). However for domestic resource extraction the figure was around 0.52 tonnes of material displaced per tonne of material used. A comparison by types of goods shows that domestic extraction entails less

HF than foreign extraction (except for non metal minerals in 1998). The reasons are as follows:

- Imported biomass includes a large percentage of semi-manufactured and end products, which have higher ratios of hidden flows than raw materials (NB: in domestic DMI, only raw material extraction is considered).
- The same applies to metal minerals, but an additional factor also comes into play: metal mineral extraction in the Basque Country was restricted to iron ore, while imports included other metals with higher hidden flows than iron (especially copper and tin).
- The only sources of fossil fuel extraction in the Basque Country were the Gaviota and Albatros natural gas deposits (the former exhausted in 1995 and the latter operational in 1995 and 1996), for which the hidden flows were 0.03 tonnes per tonne. However, imported fossil fuels include coal, which has higher associated HF than natural gas.
- The flow of non metal minerals was greater in the Basque Country in 1998 because excavation for construction (with HF of 0.60 tonnes per tonne) was included under this category, in which it outweighed other items.

Figure 26: Population, GDP, DMI, HF and TMR



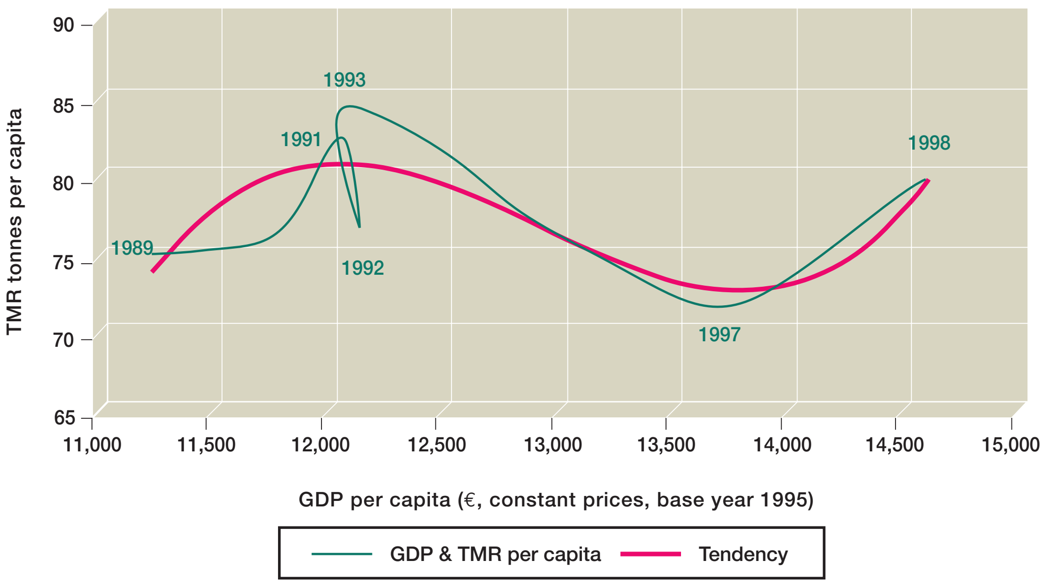
- Two circumstances deserve special mention in terms of trends in foreign HF: firstly the 39.73% increase in HF associated with imported metal minerals (as a result of shifts in imports towards materials with higher HF), and secondly the 18.57% drop in HF associated with fossil fuel imports as a result of decreasing coal imports.

A comparison of the TMR and its components with population data and GDP prompts the following conclusions in regard to the Basque Country (see Fig. 26 and 27):

- **The population dropped slightly from 1989, but material requirements increased as a result of greater hidden flows associated with imports.**
- **Decoupling of the Basque economy from the environment increased in every year except 1991, 1993 and 1998**, with the actual GDP growing at higher rates than the TMR.

- **Decoupling was absolute in every year except 1990, 1991, 1993 and 1998**: wealth in terms of actual GDP increased while less resources were used. In 1990 the actual GDP also grew, but less than the TMR.

Figure 27: GDP and TMR per capita in the Basque Country between 1989 and 1998



- **Between 1993 and 1997 there was a major increase in the material productivity of resources** in terms of actual GDP divided by TMR, from 142.73 euros per tonne (at constant 1995 prices) to 191.03 euros. In terms of material productivity, the economy is dematerialising, i.e. increases in wealth (actual GDP) are being obtained with less and less resources (TMR).
- The trend for efficiency in resource use, measured in terms of actual GDP per TMR breaks down into four different situations (see Table 7):
  - **In 1991-1992 and 1993-1997 there was absolute growth in efficiency of material use**, with a bigger actual GDP being achieved with less resources. In these years decoupling was absolute.
  - **In 1989-1990 there was a relative increase in efficiency**: the actual GDP grew at a higher rate than the use of material. These were years or relative decoupling.
  - **In 1990-1991 and 1997-1998 there was a relative decrease in material efficiency**. Wealth increased, but so did the use of materials.

Table 7: 1989-1998 – Trends in average efficiency in terms of actual GDP per TMR

	Growth rate			Variation in efficiency	
	GDP	TMR	GDP per TMR		
1989-1990	4.13	1.27	2.82	relative	↑
1990-1991	2.41	8.02	-5.19	relative	↓
1991-1992	0.68	-7.05	8.32	absolute	↑
1992-1993	-0.76	9.81	-9.63	absolute	↓
1993-1994	3.35	-2.92	6.46	absolute	↑
1994-1995	3.53	-6.23	10.40	absolute	↑
1995-1996	2.45	-2.78	5.39	absolute	↑
1996-1997	4.36	-3.42	8.06	absolute	↑
1997-1998	5.98	11.19	-4.69	relative	↓

– **Surprisingly, efficiency decreased in absolute terms in 1992-93: the actual GDP decreased in spite of an increase in TMR**. The main cause was an upturn in imports from the rest of the world of refined and unrefined copper, which led to an increase in hidden flows of 10.49 MT. HF associated with imports of tin grew by 4.42 MT in the same period. To all this we must add a 5.61 MT increase in petroleum oil imports. As a result, the TMR of the Basque Country grew by 9.81%, while at the same time the Basque economy shrank by 0.76% (actual GDP).

- **The performance of TMR can be approximated by considering only the metal and energy components**, which between them explain 94.83% of its variation.

5 Conclusions & Actions to Reduce TMR

This section presents the main conclusions of this study. A series of proposals for action to reduce the TMR are also proposed.

5.1 CONCLUSIONS

1 The pressure exerted on the environment by the Basque Country is truly high, and has increased since 1989.

As of 1998 every inhabitant of the Basque Country required 80.37 tonnes of material to meet his/ her needs. This figure was up by 6.65% (5.01 tonnes) from 1989.

2 The Basque Country evidences a high dependency on imported materials. That dependency has increased since 1989.

In 1998 78.6% of the per capita TMR originated outside the Basque Country. This is closely related to the energy and foodstuffs dependency of the Basque Country and to the significance in material terms of the metal and petrochemicals industry. Since 1989, dependency on foreign resources has increased by 8.2% (4.79 tonnes per capita).

3 The origins of the TMR of the Basque Country varied from 1989 to 1998.

In 1989 41.97% of the material requirement of the Basque Country came from the rest of the world, 35.51% from the rest of Spain and 22.53% from within the Basque Country itself. In 1998 the figures were 39.97%, 38.63% and 21.40%, respectively.

4 In 1997 the TMR of the Basque Country totalled 72.29 tonnes per capita, while the figure for the EU as a whole was 50 tonnes.

The big difference between the figure for the Basque Country and the figure for the EU is due mainly to metal minerals, which in the EU account for 10 tonnes per capita and in the Basque Country account for 28.01.

5 Most of the Basque TMR is made up of hidden flows. Both hidden flows and DMI decreased between 1989 and 1997, but increased in 1998.

In 1998 67.11% of the TMR comprised hidden flows, i.e. material displaced in the process of obtaining DMI. Between 1989 and 1997 HF per capita in the Basque Country dropped by 2.73%. DMI dropped by 6.81% (as compared with 8% for the EU).

6 The variables which cause DMI and HF to fluctuate are clearly identified.

Changes in DMI are due mainly to imports of crude oil and petroleum oils, while those in HF are due to variations in imports of tin, unrefined and refined copper, iron and steel, iron ore and coal.

7 There is decoupling and an increase in material productivity over most of the period analysed.

With the exception of 1991, 1993 and 1998, there has been decoupling in the Basque Country, with the actual GDP growing at a higher rate than the TMR. This decoupling is absolute except in 1990, 1991, 1993 and 1998, i.e. greater wealth is produced in terms of actual GDP with less resources. Between 1993 and 1997 there is a 33.84% increase in material productivity measured as actual GDP divided by TMR from 142.73 euros to 191.03 euros per tonne. In terms of material productivity, the economy is dematerialising, i.e. wealth (actual GDP) is being increased with less and less resources (TMR).

8 There is no direct dependency between wealth and use of resources.

The results of this study suggest that there is no direct dependency between the economic cycle of the Basque Country and its material requirement. Changes in the TMR are usually due to one-off fluctuations in the demand for resources in certain material-intensive industries whose contribution to the GDP is not so high in relation to their material requirements (e.g. petrochemicals and the metallurgical industry).

9 Between 1985 and 1998 local pressure on the environment increased.

In 1998 domestic resources extraction in the Basque Country (domestic TMR) was 17.2 tonnes per capita, up 23.19% from 1985 levels. This rise is due to increases in forestry production and quarry product extraction. The main material flows in 1998 were those of extraction of non metal minerals (16.02 MT), surplus material from excavation for construction (5.99 MT), erosion due to agriculture (4.5 MT), biotic material (4.21 MT) and DMI from excavation for construction (3.59 MT).

10 From 1985 to 1998 the share of domestic TMR accounted for by domestic DMI increased, while domestic HF decreased.

This is due to increases in the extraction of forestry products and limestone, a drop in erosion due to agriculture and material dredged at the port of Bilbao, and the disappearance of the hidden flows associated with the extraction of metal minerals.

5.2 ACTIONS TO REDUCE MR

Examples of corrective measures are proposed below which could be adopted to reduce the material flows of the Basque Country.

- In 1998 the energy resources component of the TMR of the Basque Country was 33.12 MT (24.9% of the total). The following actions would reduce this figure:
  - Gradual replacement of current energy sources by other, non material input-intensive sources (e.g. solar & wind power).
  - Increased use of natural gas in detriment to oil and coal: natural gas has a gross calorific value of 11,764.71 therms per tonne (including HF), which is 1.12 times greater than that of crude oil and 10.37 times greater than that of coal (including HF in both cases). In other words, more energy can be obtained with the same amount of material. For instance if coal imports from the rest of the world in 1998 had been replaced by natural gas, a drop of 1.44 MT in TMR would have resulted.
  - Encouragement of energy sources which use waste as an input (e.g. electricity generated from refuse or petroleum waste). One initiative along these lines is the IGCC (Integrated Gas Combined Cycle) plant, which is capable of producing electrical power from crude oil distillation waste.
- In 1998 erosion due to Basque agriculture totalled 4.5 MT. This hidden flow could be reduced by changing the way farms are managed and implementing defensive measures such as terracing and vegetation barriers.
- Excavation for infrastructure and housing construction produces one of the main domestic material flows. In 1998 9.58 MT of material was excavated, of which only 37.5% was used. The authorities could do more to encourage the use of excavated material. Measures in this direction would have a two-fold effect: on the one hand DMI would increase in detriment to hidden flows, and on the other materials from excavation would replace other DMI (and the HF associated with their extraction would diminish accordingly).
- Any action which encourages recycling and/ or re-use of materials will directly help to reduce TMR. Such measures reduce DMI (material entering the economy as DMI is replaced by material already within the economy which does not therefore count as DMI) and indirectly help to reduce hidden flows (the HF associated with the DMI replaced would be avoided).
- New communications technologies provide many opportunities for dematerialising the economy: e-books, advertising on the Internet, e-business, etc.

Basic Bibliography

ADRIAANSE, ALBERT; et. al. Resource Flows: The Material Basis of Industrial Economies. World Resources Institute, Washington, D.C. 1997.

AYRES, ROBERT U.; Ayres, Leslie W. Accounting for Resources, 1: Economy–Wide Applications of Mass–Balance Principles to Materials and Waste. Edward Elgar, Cheltenham (U.K.). 1999.

AYRES, ROBERT U.; Ayres, Leslie W. Accounting for Resources, 2: The Life of Materials. Edward Elgar, Cheltenham (U.K.). 1999.

BRINGEZU, STEFAN; Schütz, Helmut. Total Material Requirement of the European Union. Technical report n.º 55. European Environmental Agency, Copenhagen, 2001.

BRINGEZU, STEFAN; Schütz, Helmut. Total Material Requirement of the European Union: Technical Part. Technical report n.º 56. European Environmental Agency, Copenhagen, 2001.

DE MARCO, OTTILIA; et. al. Appendix to Material Flow Analysis of the Italian Economy. Journal of Industrial Ecology, 4(2). Spring 2000.

Eurostat. Economy-wide Material Flow Accounts and Derived Indicators: A Methodological Guide. European Communities, Luxembourg, 2001.

SPANGENBERG, JOACHIM H.; et. Al. Material Flow-based Indicators in Environmental Reporting. Environmental Issues Series n.º 1. European Environmental Agency, Copenhagen, 1999.

Appendix: Glossary and Abbreviations

- **Absolute decoupling**: an absolute reduction in the use of material.
- **Dematerialisation**: an absolute or relative reduction in the amount of material used per unit of product.
- **Direct Material Input (DMI)**: The flow of natural resources into an industrial economy to be processed. It is calculated as the TMR minus the HF.
- **Direct material productivity**: an indicator of output per unit of material which enters the economy directly.
- **Hidden Flows (HF):** also known as the "ecological rucksack". The quantity of material which is displaced by the process of obtaining DMI and which remains outside the economy.
- **Material Flow Accounting**: a system of accounting used for national economies, based on accounts organised methodologically which reflect the total quantities of material used in the economy. This enables the total consumption of resources to be accounted for, along with the associated indirect flows, and can be used to draw up indicators.
- **Material Flow Analysis (MFA)**: a method of assessment which compares the efficiency with which materials are used, using information from material flow accounting. MFA helps to identify needless waste of natural resources and other materials in the economy which would otherwise go unnoticed in conventional systems of economic accounting.
- **Material productivity:** an indicator of output per unit of material.
- **MT**: millions of tonnes.
- **Relative decoupling:** a process of reducing the amount of material used per unit of product, even though the amount in absolute terms continues to grow.
- **t**: tonne.
- **Total Material Requirement (TMR)**: An indicator developed by the Wüppertal Institute to describe in terms of tonnage not only the quantity of natural resources contained in the goods produced by an economy but also the hidden flows associated with their production. It is used to compare efficiency in the use of resources in an economy.

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