Sustainable use of natural resources in Italy: measuring effectiveness of policies through decoupling indicators

Carmela Cascone, Sirio Carnevalino, Lorenzo Ciccarese, M. Giunta
APAT - **Italy's Agency for Environmental Protection and Technical Services**
Sustainable Use of Natural Resources
Via V. Brancati 48, 00144 Rome (Italy)
Tel.: 0039 06 50074541, fax: 0039 06 50074618
E-mail: carmela.cascone@apat.it

Abstract

Sustainable use of natural resources is a sound topic in sectorial policies of both EU and all industrialised countries.
Since 1987, when the Brundtland Commission defined the concept of sustainable development, the need of efficient strategies became essential for developing effective resource policies to guaranty decoupling of "economic goods" from "environmental bads".
In 2000, with the Lisbon strategy, European leaders agreed to stimulate economic growth and employment and make European Union (EU) economy the most competitive in the world.
In 2001 EU adopted sustainable development strategy and the sixth environment action programme (6EAP) that expressly calls for 'breaking linkages between economic growth and resource use'.
The Thematic Strategy on Sustainable Use of Natural Resources - COM(2005)670 – emphasizes the importance of integration of environmental concerns into policies that affect environmental impacts of natural resources use. Main objective of the strategy is developing a set of indicators to measure efficiency of economic activity in using resources. By 2008, the Commission will develop indicators to measure progress in efficiency and productivity in the use of natural resources (including energy) and resource-specific indicators to evaluate how negative environmental impacts have been decoupled from resource use (eco-efficiency indicator).
Environmental indicators are based on the Driving Force-Pressure-State-Impact-Response (DPSIR) model and Decoupling indicators describe relationships between the first two components of this structure.
In this framework APAT produces the Yearbook of Environmental Data, which also includes eco-efficiency indicators to satisfy needs of information for policy-makers. Eco-efficiency indicators are the basis to construction of decoupling indicators. Examples of such indicators are eco-efficiency in agriculture, energy intensity and energy efficiency in transportation.
In this paper the conceptual approach used to develop decoupling indicators will be described as well as further development of specific indicators, able to measure adequately the progress towards the EU strategy's objective demands and to make information available to policymakers and citizens.

Introduction

During the last 50 years mankind has altered natural resources in a faster and more extensively way than in any other period of its history, above all in order to satisfy its growing need of fibres, freshwater, lumber and fuel due to demographic explosion of the last century. The consequence is a progressive and inexorable growing request of resources like raw materials, energy and lands. The way of using these (renewable and non-renewable) resources and their global consumption rate are eroding our planet capability of regenerated them.

Millenium Ecosystem Assessment 2005 marks that 15 out of 24 of ecosystem services categories, analysed in the report, are over-exploited: their speed of consumption is much faster than they can regenerate. In particular, 20 out of 24 ecosystem services have been selected (using the availability of data for the analysis as a criterion) among the following categories: resources supplying, production of non-material benefits and regulation of processes; changes in human exploitation have been analysed and it has been observed that services use continues to grow. The only ecosystem service that is declining is fishing, since fish availability is reducing because of its past over-exploitation.

According *to UN World Population Prospects* population increase will be 50% in the next 50 years. Above all, this population growth will affect planet areas where the greater reservoirs of natural resources are located, so meaningful increase of pressures and impacts on ecosystem is unavoidable.

Depletion of renewable resources and habitats is of greater concern than scarcity of most non-renewable resources. The way resources are used has to be changed if we want to guarantee our planet ability to regenerate resources and to maintain ecosystem services.

In the ’70, the United Nations Conference on Human Environment stated the need of producing long period strategies to have an economic, cultural and social development compatible with environmental protection and resources conservation.

Since 1987, when the Brundtland Commission defined the concept of sustainable development, the need of efficient strategies became essential for developing effective resource policies to guaranty decoupling of “economic goods” from “environmental bads”. Social equity, economic growth and environmental protection are three essential pillars of Sustainable Development Concept: society depends on economy and economy, in turn, depends on ecosystems efficiency, that is the fundamental base of the first two.

Sustainable use of natural resources has become a sound topic in sectorial policies of both EU and all industrialised countries but to reach concrete action from problem formalization we have to wait until the last few years, so Sustainable Development seemed a rhetorical concept, a “chimera”.

Main problem to solve is measuring Sustainable Development: first indicators developed are MIPS (Material Input Per unit of Service) and Ecological Footprint.

MIPS evaluate environmental impact of goods and services in each phase of their life. Inputs are represented by five categories of materials: abiotic raw materials, agriculture and forestry biotic materials, soil movements, air movements, water movements. MIPS evaluation problems are linked to the amount of materials used in each economic process. However, the relative indicators are useful as a starting point to reduce wastes and maximize production efficiency.

Ecological Footprints assess total quantity of natural resources and ecological services used by a population to live. It calculates total area of terrestrial and aquatic ecosystem that is essential to supply, in a sustainable way, all the employed resources and to take up, in a sustainable way, all the produced outputs. Each unit of consumed material or energy corresponds to a well-defined land extension, belonging to one or many ecosystems that guaranty, by natural services supply, the relative contribution for resources consumption and/or emissions absorption. Unit of measurement is hectare *per capita* (ha/pc). According to an estimation carried out for the year 2001, on a global level, land requirement for each person is 2.2 ha/pc, ranging from 1.5 ha/pc in China to 9.5 ha/pc in the USA; Italy is in an intermediate position with its 3.8 ha/pc.

It’s important to put in relation ecological footprint and another parameter, Biocapacity, that is a whole of services supplied by local ecosystems in the examined regions. This parameter is expressed as ha/pc. Difference between Biocapacity and Ecological Footprint derives economic deficit or surplus of the region considered.

In the last decade a new approach has emerged in measuring sustainable development. It is based on the hypothesis that it’s possible to decouple environmental pressure from economic growth.

In particular decoupling indicators describe relationships between the first two components of the DPSIR structure, since they are expressed as ratio of an Environmental Pressure and a Driving Force.
The realization of decoupling could follow two ways: one “*relative*”, when the Driving Force (DF) grows over time, but with a lower rate confronted to the Economic Variable, and one “*absolute*”, when the DF remains unvaried over time or it does decrease.
Three typologies of indicators can be used to measure progress on decoupling:

– resource productivity for measuring decoupling of resource use from economic growth;
– resource-specific impact for measuring decoupling of environmental impacts from resource use;
– eco-efficiency for measuring decoupling of environmental impacts from economic growth.

Only in 2001 EU adopted sustainable development strategy and the sixth environment action programme that expressly calls for 'breaking linkages between economic growth and resource use'.
The need of efficient strategies for developing effective resource policies is essential to guaranty decoupling of “economic goods” from “environmental bads”.
In its key policies, the EC calls for 'breaking linkages between economic growth and resource use'. This kind of strategy takes the name of *Decoupling*. In particular, the *Thematic Strategy on Sustainable Use of Natural Resources* - COM(2005)670 – emphasizes the importance of integration of environmental concerns into policies that affect environmental impacts of natural resources use. Main objective of the strategy is developing a set of indicators to measure efficiency of economic activity in using resources.
By 2008, the Commission will develop:

– indicators to measure progress in efficiency and productivity in the use of natural resources (including energy);
– resource-specific indicators to evaluate how negative environmental impacts have been decoupled from resource use;
– an overall indicator to measure progress in reducing the ecological stress of resource use by the EU (eco-efficiency/decoupling indicator).

In this framework, APAT produces the Yearbook of Environmental Data, which also includes eco-efficiency indicators to satisfy needs of information for policy-makers. Eco-efficiency indicators are the basis to construction of decoupling indicators. Eco-efficiency represents the amount of “Environment” used per unit of “Economic activity”; in particular eco-efficiency indicators measure the added value per unit of environmental impact and can be derived by dividing resource productivity by resource efficiency.
Examples of such indicators are eco-efficiency in agriculture, the eco-efficiency in energy sector, the eco-efficiency in Forestry and energy efficiency in transportation;
In this paper development of such indicators will be discussed and Italian trends will be shown.

Materials and Methods

Environmental indicators are based on the Driving Force-Pressure-State-Impact-Response (DPSIR) model developed by European Environment Agency (EEA).

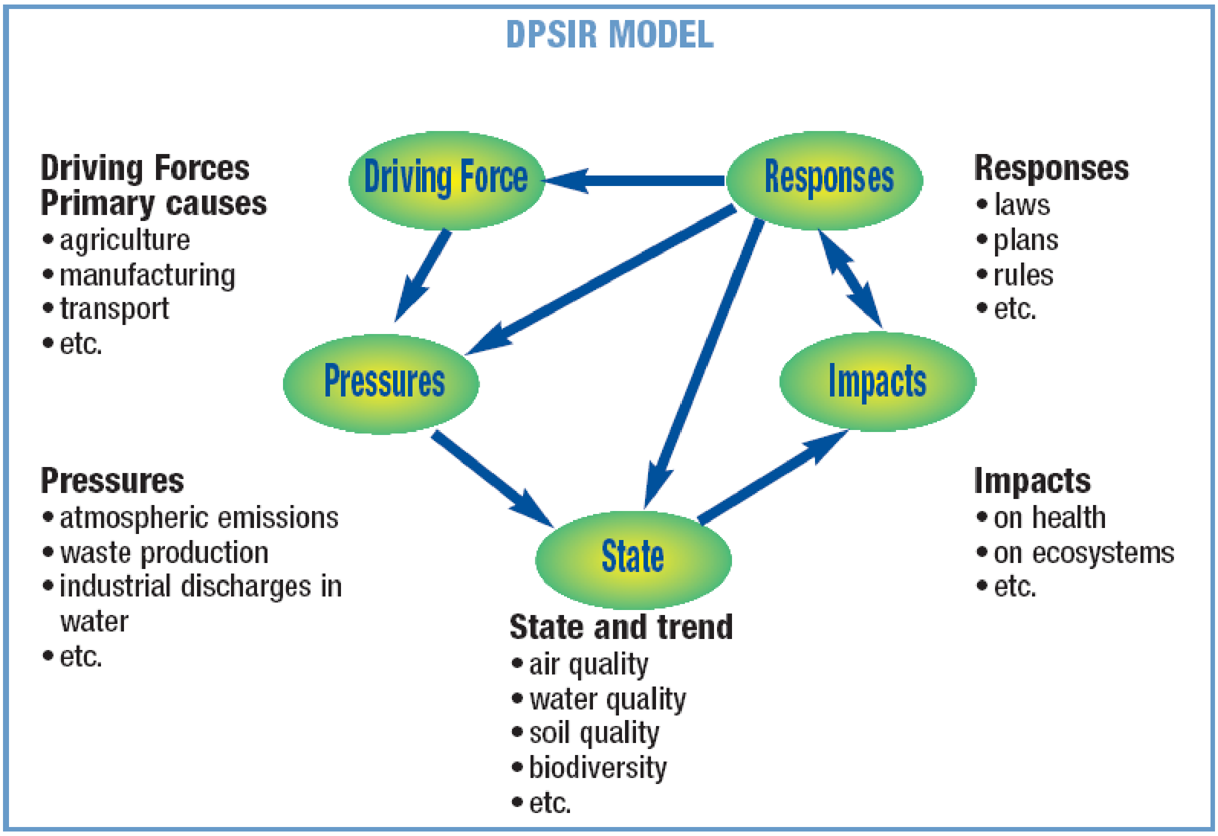

Figure 1. DPSIR Model (Yearbook of Environmental Data, 2004): the *state*, that is the set of physical, chemical and biological qualities of environmental resources (air, water, soil, etc.), is altered by the *pressures*, which comprise everything and anything that tends to deteriorate the environment (air emissions, waste production, industrial discharges, etc.), most of which are caused by human activities (called *driving forces*), such as industry, agriculture, transport, but which can also be caused by natural phenomena. These alterations produce effects (i*mpacts*) on the health of human beings and animals and on the ecosystems, economic damage, etc.. The impacts may be addressed and contrasted by means of *responses*, such as laws and regulations, action plans, aimed at acting on all the other categories.

This model is based on causal relationships that link Driving Forces to Pressures, Pressures to State and so on. Driving Forces are human activities and processes such as transportation and industrial production, Pressures are noise, toxic emissions that cause changes of the natural State (climate, biodiversity), these changes involve Impacts on the anthropic system (health, economy, environment), mankind reacts to these Impacts providing Response (environmental sectorial policies, laws).

Decoupling indicators are generally derived by the ratio of an Environmental Pressure and a Driving Force (even if demographic growth can be used as denominator):

$$\frac{\text{Environmental Pressure}}{\text{Driving Force}}$$

Two parameters can be calculated using indicators numeric value: Decoupling Rate and Decoupling Factor; the first one is obtained by the following formula:

$$\frac{\frac{EP}{DF}\ (\text{at the end of study period})}{\frac{EP}{DF}\ (\text{at the beginning of study period})} = \text{Decoupling Rate}$$

where EP is the Environmental Pressure and DF is the Driving Force; this parameter shows if there is decoupling in a defined interval of time, in fact if obtained value is < 1 then EP/DF ratio has diminished during the examined period, that is there has been decoupling.
Decoupling Factor derives by the following equation:

$$\text{Decoupling Factor} = 1 - \text{Decoupling Rate}$$

It is 0 or negative if there isn't decoupling while it is comprised in the interval]0, 1] when Environmental Pressure is 0.
In some cases it is useful or easy to aggregate two or more indicators: for example when there are several polluting substances that cause the same effects (as the case of the six greenhouse gases), they can be used to build just one indicator (after calculating a specific conversion factor for each gas).

Results and Discussion

Apat Eco-Efficiency Indicators
We had elaborated 8 eco-efficiency indicators that concern about four fundamental socio-economic areas of our country: three of those indicators are about the vehicular transport, one about the agriculture, two concerning the energy sector, and finally two regarding the forestry sector. The trend and the discussion about the results are analysed below here.

Vehicular transport eco-indicators
Three different eco-indicators have been developed. They're based on the same Driving Force (Italian vehicular fleet) related to three different Environmental Pressures: greenhouse gases emissions since 1990 to the 2004 for the first indicator; emissions of some important atmospheric pollutants (like benzene, oxides of azote, plummet, etc.), in the same period, for the second one and, finally, for the third indicator, the energetic consumption of the transport sector since 1990 to the 2002.

Greenhouse gases emissions/Vehicular fleet: between 1990 and 2004 the vehicular fleet shows (tab. 1–fig. 2) a growing trend in vehicles number (+31%), with a little decrease between 2003 and 2004 (-0,29%); in the same period the greenhouse gases emissions (CO_2, CH_4, N_2O) have grown constantly +31% in 2004. This indicator doesn't show any kind of decoupling.
With the emanation of law 120/2002, ratifying the Kyoto Protocol, Italy commits itself to reduce country's green-house gas (GHG) emissions by 6,5% compared to 1990 levels), during the 2008-2012 period.
Size of private vehicular fleet (cars and motorcycles) is an important driving force to state request of road transportation and pressures it determines. Italian motorization rate is one of the highest in OECD countries.
This indicator is useful to verify national target of reducing GHG emissions by 2012.

Table 1: Greenhouse Gases Emissions and Vehicular fleet during the period 1990-2004

Year	GHG Emissions ($MtCO_2eq$)	Vehicular fleet (number of vehicles, x 1000)
1990	103,2	33.555
1995	113,8	36.876
2000	125,7	40.744
2001	128,3	41.937
2002	130,6	42.950
2003	133,2	44.080
2004	135,3	43.951

Data sources: APAT; ACI

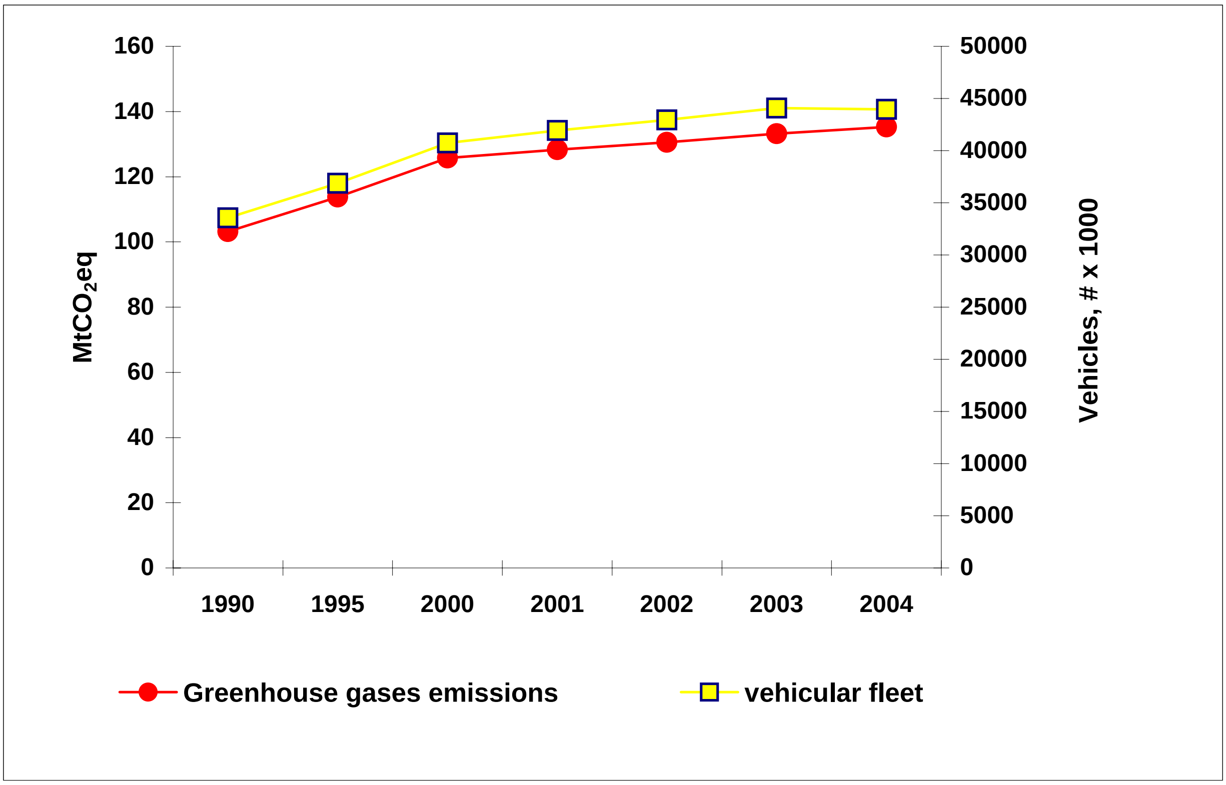

Figure 2. Italian Vehicular Fleet (Driving Force) related to Greenhouse Gases Emissions (Environmental Pressure) during the period 1990-2004

Emissions of some important atmospheric pollutants/Vehicular fleet: between 1990 and 2004 (tab. 2–fig. 3), the emissions of Benzene, Plummet, etc. have significantly decreased (-26%), while, as shown previously, the vehicular fleet has grown (+31%). It means that in this case the parameters have only an absolute decoupling.
The Law 171/2004, actuating the European directive 2001/81/CE, sets national limits in emissions of Sulphur dioxides, Nitrogen oxides, Non-Methane Volatile Organic Compounds and Ammonia.
The improvements achieved in the reduction of the environmental impact of vehicles and infrastructures are currently counterbalanced by the enormous growth in transport demand.
This indicator is useful to evaluate the trends towards the tasks (deriving from international agreements, directives and strategy) of integrating environmental concerns into transport policies and measures.

Table 2: Emissions of the Main Air Pollutants and Vehicular fleet during the period 1990-2004

Year	Emissions of the Main Air Pollutants (kt)	Vehicular fleet (vehicles number x 1000)
1990	976,3	33.555
1995	997,4	36.876
2000	823,5	40.744
2001	799	41.937
2002	747,7	42.950

2003	744,2	44.080
2004	721,5	43.951

Data sources: APAT; ACI

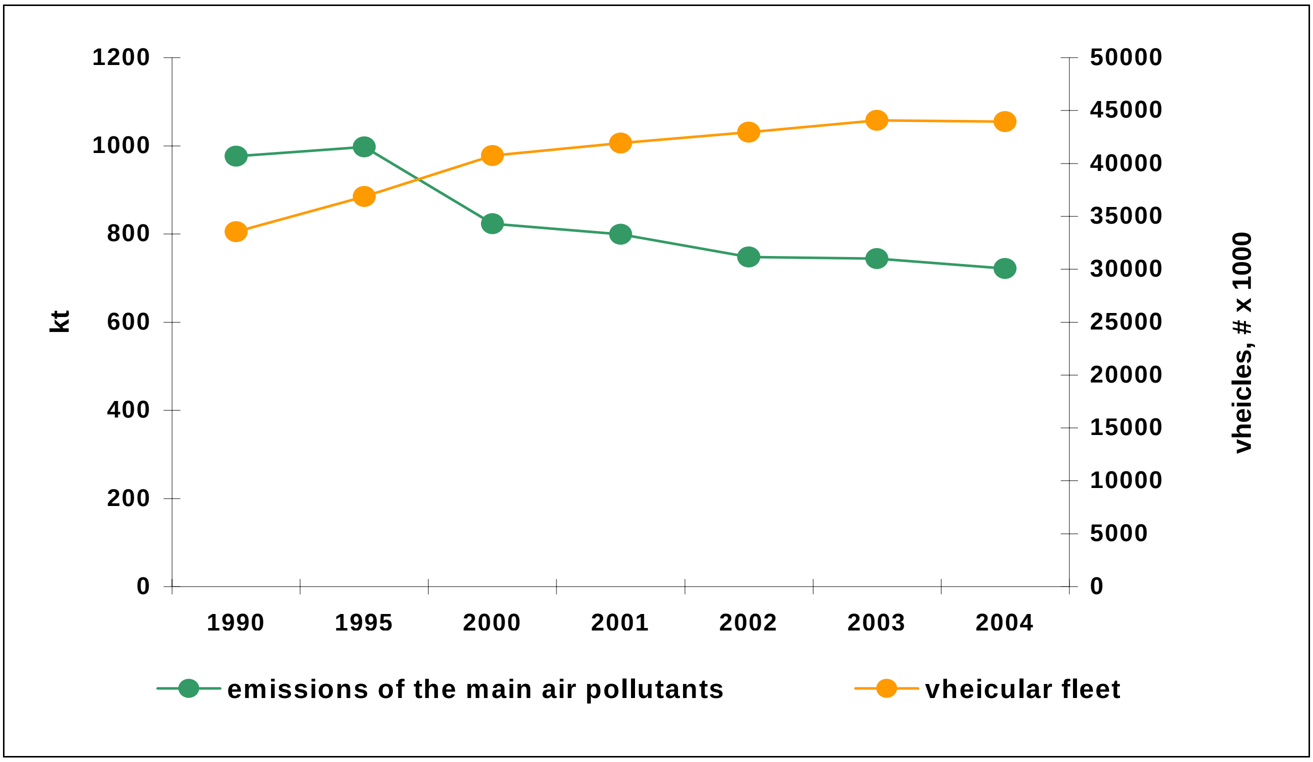

Figure 3. Italian Vehicular Fleet (Driving Force) related to Emissions of the Main Air Pollutants (Environmental Pressure) during the period 1990-2004

Energy consumption of transport sector/Vehicular fleet: in the thirteen years considered (tab. 3–fig. 4) the vehicular fleet has constantly grown (+16% in 2002), in the same period energy consumption also shows a growing trend even if with a lower rate (+12% in 2002). So this indicator shows a relative decoupling.

The Strategy on Environmental Action for Sustainable Development (CIPE 57/2002) states the task of reduction in consumption of Non-Renewable Natural Resources without compromising actual level of living quality. Revision of Guidelines for politics and national measures on reduction of Greenhouse gases emissions (CIPE 123/2002) has tasks strictly related to reduction in fossil fuels use. Technological innovations can’t solve energetic and emissions problems since energy efficiency of vehicles is not able to balance the enormous growth in transport demand and in vehicles power.

This indicator is useful to verify national target of reducing energy consumption and indirectly fossil fuels use from which energy is almost derived in transportation sector.

Table 3: Energy Consumptions and Vehicular fleet during the period 1995-2002

Year	Energy consumption (Pj)	Vehicular fleet (vehicles number x 1000)
1995	1.623	36.876
1996	1.630	36.693
1997	1.665	37.049
1998	1.713	38.221
1999	1.738	39.627
2000	1.746	40.744
2001	1.765	41.937
2002	1.815	42.950

Data sources: APAT; ACI

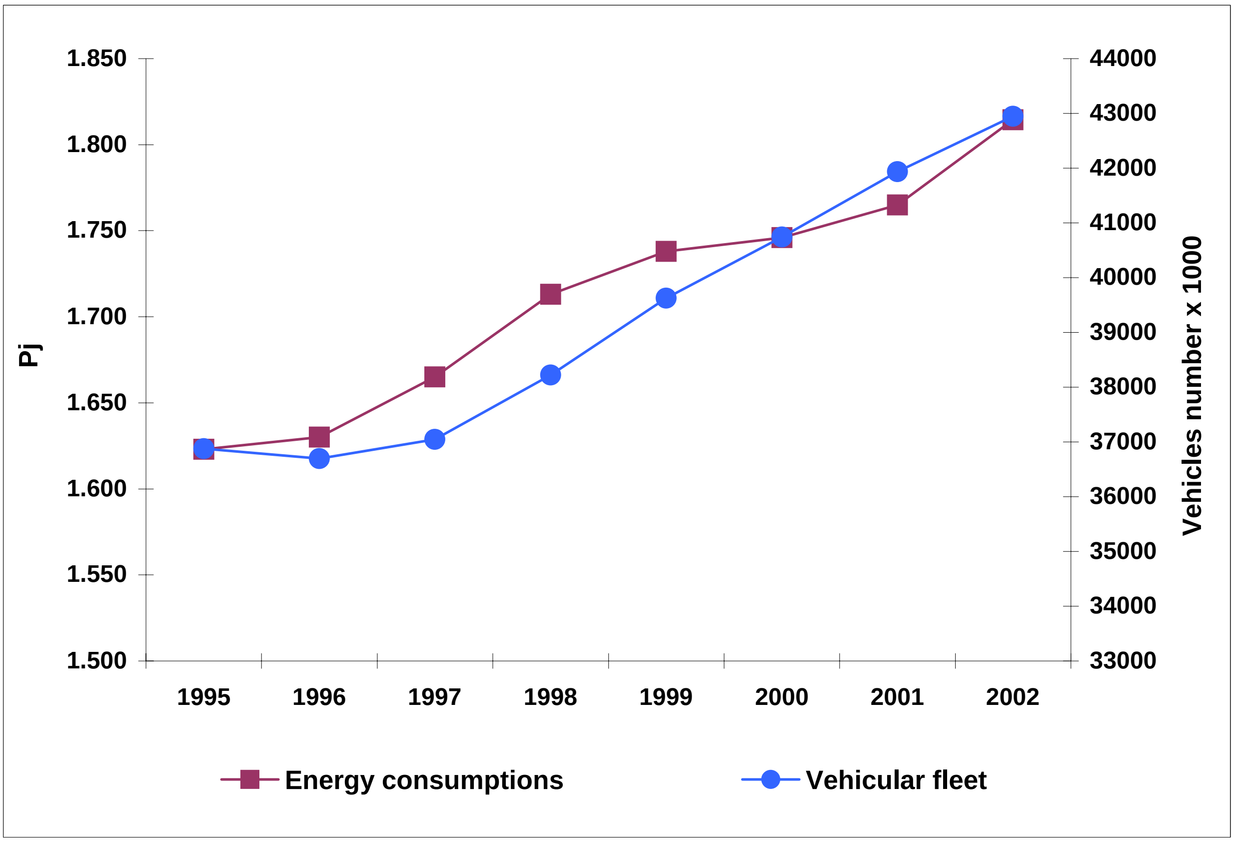

Figure 4. Italian Vehicular Fleet (Driving Force) related to Energy Consumptions (Environmental Pressure) during the period 1995-2002

Energy eco-indicators
Two indicators have been developed in this sector. Primary energy production of the energy sector has been related (as Driving Force) to the greenhouse gases emissions (Environmental Pressure) of this sector in the first indicator, while Primary energy consumption is related to Gross Domestic Product (GDP) in the second one.

Greenhouse gases emissions/Primary energy production: The greenhouse gases emissions show a significant growth since 1998 to 2003, and the total growth in 14 years is 17% (tab. 4–fig. 5); in the same period the production of primary energy has only grown 2%, with a significant loss between 1996 and 2003 (-15%). These results indicate that there isn't any kind of decoupling in this sector. Directives 2003/87/CE assigns to each nation an limiting amount of CO_2 emissions by industry, the law 120/2002, ratifying the Kyoto Protocol compels Italy to reduce its emission to 6,5% (referring to 1990 levels), by 2008-2012 period, CIPE Deliberation 123/2002 defines the task of each economic sector in reducing emissions. Carbon dioxide emissions are primarily due to burning fossil fuels, industrial processes and deforestation.
This indicator is useful to verify national target of reducing greenhouse gases emissions without affecting primary energy production.

Table 4: Greenhouse gases emissions and Primary Energy Production during the period 1990-2003

Year	**Greenhouse gases emissions (MtC02eq)**	**Primary Energy Production (Quadrillion Btu)**
1990	147,2	1,219
1991	141,5	1,315
1992	141,2	1,354
1993	135,9	1,386
1994	137,1	1,457
1995	151,2	1,395
1996	146	1,467
1997	147,2	1,463
1998	157,4	1,451
1999	153,4	1,393
2000	160,9	1,377
2001	163,5	1,341
2002	169,4	1,264
2003	171,5	1,248

Data sources: APAT; EIA

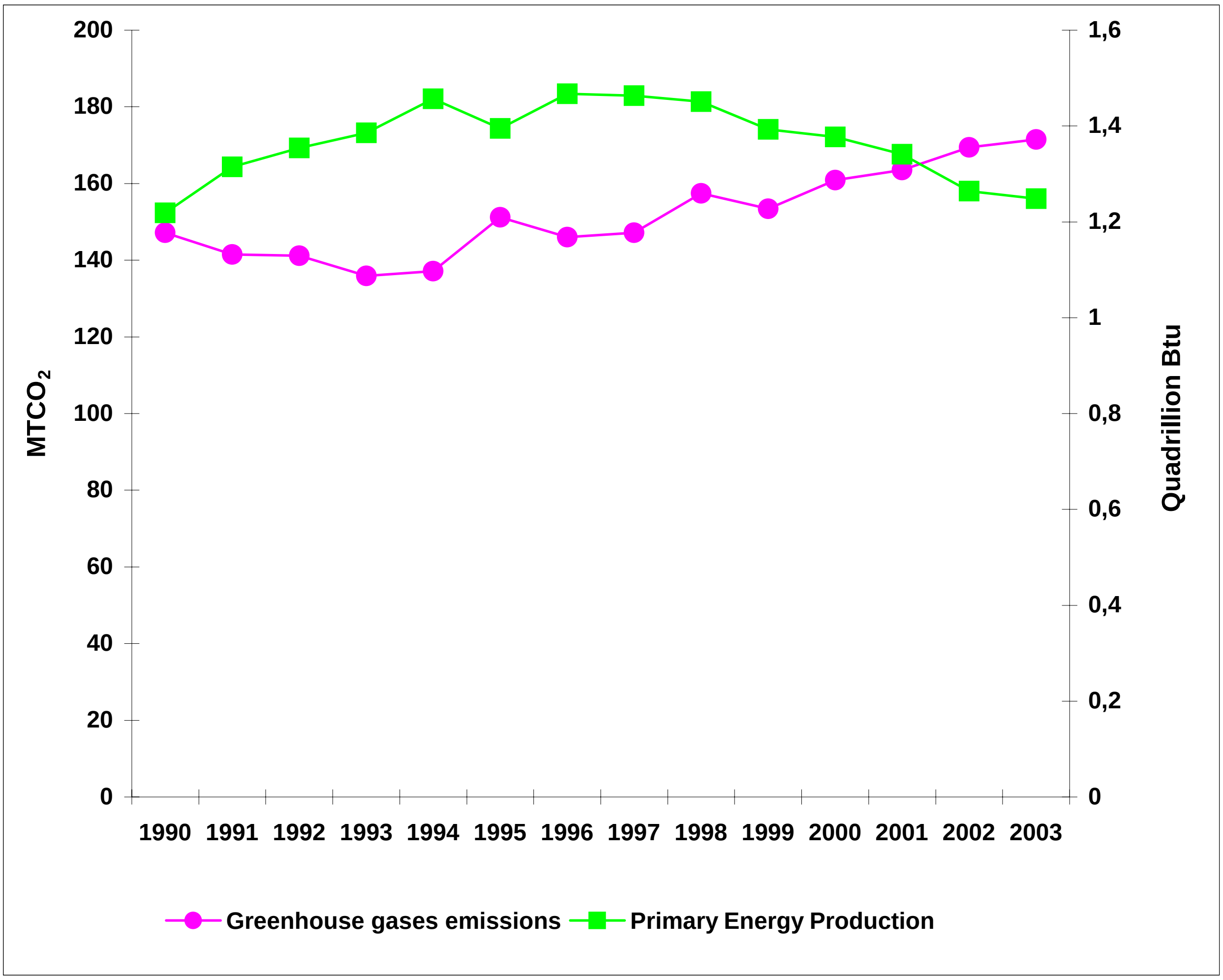

Figure 5. Primary Energy Production (Driving Force) related to Greenhouse gases emissions (Environmental Pressure) during the period 1990-2003

Energy intensity: Primary energy consumption is related to Gross Domestic Product (GDP).
This indicator has an irregular trend. First a decreasing between 1995 and 1997 followed by an equivalent increasing in 1998-1999, then a strong decline until 2002 and a faster improvement in 2003 (tab. 5–fig. 6). Taking into account the period 1995-2003 the overall energy intensity is constant (0,14%) so also in this case there is no decoupling.
The report "*Energy and Environment in the European Union*", prepared by the European Environmental Agency, aims to provide policymakers with the information needed to verify how environmental policy are integrated in energetic policy, following the process begun in 1998 with the meeting of European Committee in Lisbon.
This indicator is useful to verify improving in public richness respect to energy consumption in order to reduce last one.

Table 5: Annual withdrawal of wood and Gross Value Added during the period 1980-2004

Year	Energy Intensità (Btu per unit of GDP)
1995	7.245
1996	7.198
1997	7.163
1998	7.235
1999	7.243
2000	7.103
2001	7.021
2002	7.011
2003	7.235

Data sources: EIA

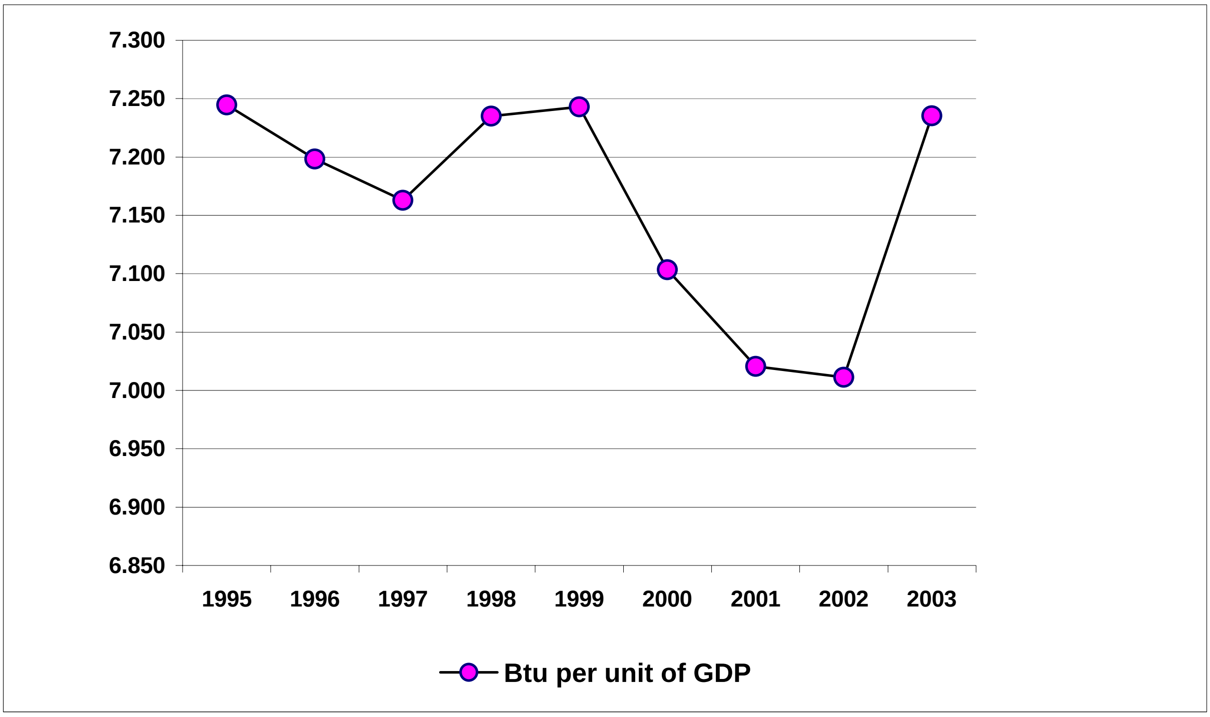

Figure 6. Energy Intensity: Primary Energy Consumption (Environmental pressure) related to Gross Domestic Product (Driving Force) during the period 1995-2003.

Forestry eco-indicators

Two different indicators have been developed for this sector, both with the same Driving Force (Gross Value Added, that is the difference between the value of goods and services achieved in the forestry sector and the value of goods and services consumed in the same period); in the first case the Environmental Pressure is the annual withdrawal of wood, for the second one it's the annual rate of withdrawal (calculated as cubic meters)

Annual withdrawal of wood/Gross Value Added to basic Forestry prices: Gross Value Added to basic Forestry prices has a constant growth in the period 1980-1995 (tab. 6–fig. 7), but it declines in the last decade; between 1980 and 2004 there has been a considerable increase (53%). Annual withdrawal has increased in the 1980-2000 period, but has declined noteworthy until 2004; on the whole, in 25 years total increase has been of 22%, then in the examined period there has been a relative decoupling.

Under both the Kyoto Protocol and European Burden Sharing Agreement Italy could comply with its reduction targets only by resorting to the carbon absorption by forests. The Ministerial Conference on the Protection of Forests in Europe (MCPFE) aims to develop a dynamic process oriented towards forest protection and their sustainable management in Europe.

This indicator is useful to verify improving in wood value and without affecting resource consumption.

Table 6: Annual withdrawal of wood and Gross Value Added during the period 1980-2004

Year	Gross Value Added to base prices (euro x 1000)	Annual withdrawal (cubic meters)
1980	223.392	7.362
1985	279.779	8.189
1990	296.465	7.319
1995	393.385	9.736
2000	386.829	11.801
2004	342.048	8.986

Data sources: APAT

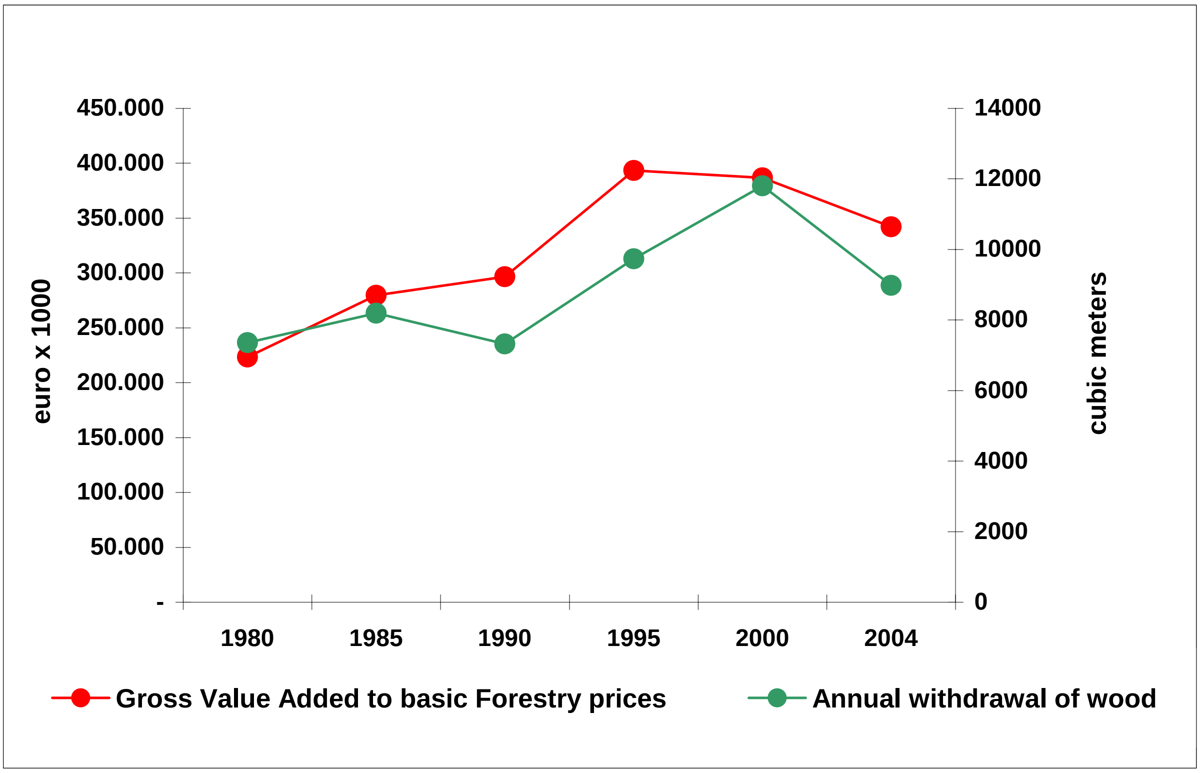

Figure 7. Gross Value Added to basis Forestry prices (Driving Force) related to withdrawal of wood (Environmental Pressure) during the period 1980-2004

Annual rate of wood withdrawal/Gross Value Added to basic Forestry prices: Gross Value Added to basic Forestry prices, as shown previously, has a constant growth in the period 1980-1995 (tab. 7–fig. 8), but it declines in the last decade; between 1980 and 2004 there has been a considerable increase (53%). In the same period annual rate of withdrawal has increased 8%, then also in this case there has been a relative decoupling.

Recently, the consumption of timber has primarily increased for energy production purposes, besides it means that there is a reverse trends in the abandonment of forests and an improving in their management with positive effects on their preservation.

For several decades rural development policies have been shifting the focus of forestry and agriculture from the simple increasing of productivity to the capacity of integrating productivity itself and the protection of natural areas and resources by developing ecological sustainable forestry techniques.

This indicator is useful to verify economic value of forestry and its efficiency in sustainable management of the natural resource.

Table 7: Annual rate of withdrawal of wood and Gross Value Added during the period 1980-2004

Year	Gross Value Added to basic Forestry prices (euro x 1000)	Annual rate of withdrawal (cubic meters/ha)
1980	223.392	1,2
1985	279.779	1,2
1990	296.465	1,1
1995	393.385	1,4
2000	386.829	1,7
2004	342.048	1,3

Data sources: APAT

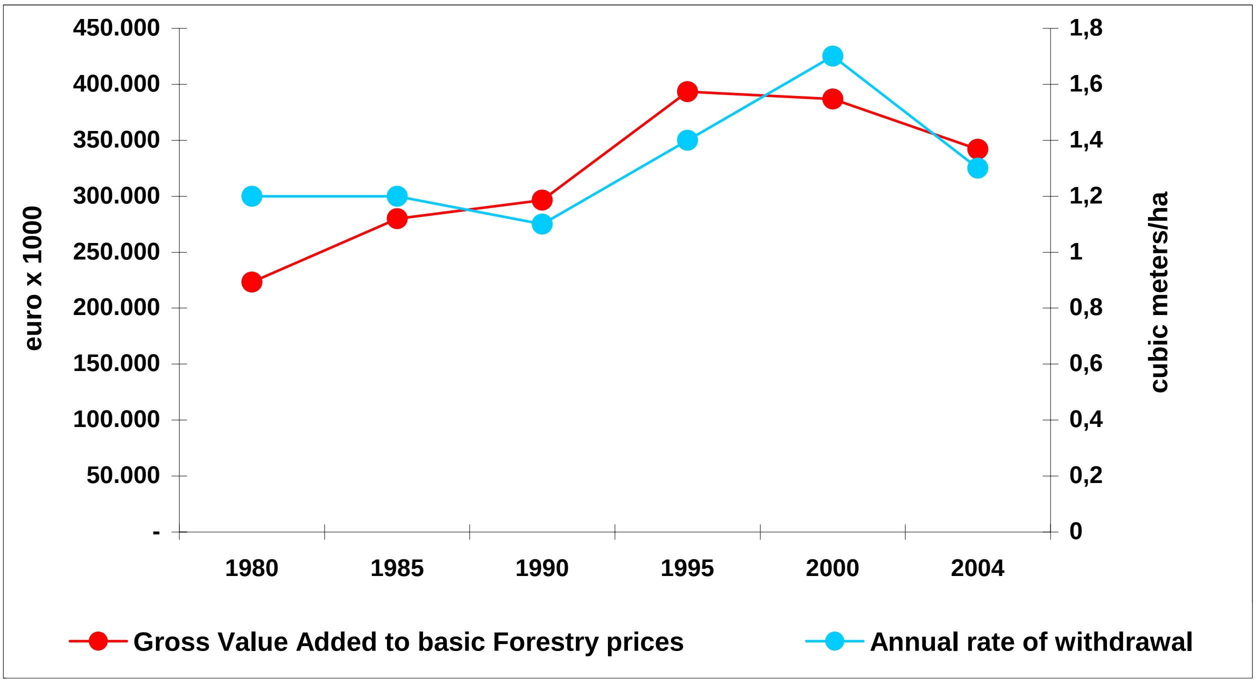

Figure 8. Gross Value Added to basic Forestry prices (Driving Force) related to Annual withdrawal of wood (Environmental Pressure) during the period 1980-2004

Agriculture eco-indicators

Eco-efficiency in agriculture concerns with the efficient and sustainable use of resources in agricultural production. It increases when the required level of production is achieved, whilst reducing inputs and losses to the environment, providing the productive potential for the future is maintained. This can be expressed by comparing Gross Value Added and resources use (such as Utilized Agriculture Area (UAA), irrigated land, pasture, energy use, emissions of Green House Gases, tropospheric ozone precursors and acidifying substances, consumption of fertilizers and pesticides).

All the parameters used in the analysis have been reported as an index by referring their value to 1990 (year the series start) and assuming that this value is 100. The analysis is limited to 2003 for data availability.

In general we can observe an improving in eco-efficiency until the 1999, since the economic indicator (GVA) grows and the impact and pressure indicators decline. In the last four years of the analysis, production decreases while energy use and consumption of fertilizers and pesticides increase. Actual trends of the components aggregated in the indicator testify a general reduction in eco-efficiency (tab. 8–figg. 9,10).

Although fertiliser use declines somewhat in the decade to 2001 (when the minimum value of the series has been reached), nutrient surpluses on agricultural land remains a serious issue giving rise to nitrate pollution and eutrophication of water bodies. Pesticide use also declined slightly, but this is unlikely to have major beneficial effects.

To further reduce environmental risks, the EU sixth environmental action programme encourages low-input or pesticide-free agriculture and the use of integrated pest management (IPM) techniques.

In the same period UAA decreases consistently reaching an extension of 13.207.000 ha in 2003. In particular, irrigated land remains constant until 2001 and in the last period it has increased producing greater exploitation of water resource by agriculture. On the other side there is a reduction of pasture area that has reached the minimum value in 2001 producing pressure on biodiversity characterizing these habitat.

There is a strong tendency towards specialisation within the agricultural sector. Either specialised crop or livestock farms are replacing mixed holdings. This allows for spatial concentration and higher intensity of land use. A further indication of intensification is the increase in cropland at the expense of permanent grassland and pasture. Extensive livestock systems rely to a larger degree on the utilisation of pastures at low stocking densities than modern intensive livestock farms that use arable fodder crops. Thus, the decline of permanent grassland is on the one hand linked to the increasing specialisation in arable production, and on the other to increasing stocking densities in modern livestock systems. The objectives of the agri-environment Regulation 2078/92 included, among others, options to maintain extensive production methods, to extensify livestock production, and to convert arable land into grassland.

Agriculture is not a substantial source of greenhouse gases. Livestock ruminants however, are a significant source of methane, one of the greenhouse gases. The total contribution of agriculture emissions is only 2 % to total national emissions. In the decade to 2000 their level was above the reference value (1990) while since 2001 it declines and in 2003 it’s the 6 % lower than 2002.

Emissions of acidifying substances are significant, above all ammonia emissions, agriculture has been responsible of the 94 % of the total national ammonia emissions and of 5,06 % of the national acidifying emissions. Ammonia can contribute to both acidification and eutrophication and the issue of ammonia emissions is particularly significant. All these values remain constant until 2003 when ammonia emissions decrease to 2 % to 2002

Trends of the components aggregated in the indicator testify a general reduction in eco-efficiency.

Table 8: Gross Value Added compared to Emissions of Greenhouse gases, Acidifyng substances, Tropospheric ozone precursors, UUA and Grassland and Pastures areas, Energy consumption during the period 1990-2003

	Gross Value Added (euro x 1000)	Greenhouse Gases	Acidifying substances (Kt of acid equivalent)	Tropospheric ozone precursors (t/a TOPP)	Grasslands and Pastures (ha)	Utilized Agriculture Area (ha)	Energy use (tep x 1000)
1990	20928074	40339	23382	1874	4106	14947	3112
1991	23523074	41877	24100	1975			2923
1992	23662073	41610	23784	1927			2997
1993	23587614	41929	24224	1879			3252
1994	24677654	41480	23842	1876			3250
1995	26721552	41395	23775	1838	3758	14685	3294
1996	28359587	41191	23346	1884	3747	14753	3270
1997	28641424	42279	24103	1771	3860	14833	3199
1998	28590436	41591	24059	1888	3829	14966	3188
1999	28983930	41875	24422	1856	3727	14120	3137
2000	28441711	40981	23649	1756		13213	3226
2001	29403816	40334	24123	1669			3351
2002	29029487	40176	24204	1795			3297
2003	29278906	38747	23603	1672	3336	13207	3361

Data sources: MAP (energy consumption); ISTAT (AAU, grasslands and pastures areas; fertilisers and pesticides consumption); FAO website (irrigated land); INEA (GVA); APAT (CTN_ACE – greenhouse gases, acidifyng substances and ozone atmospheric precursors emissions)

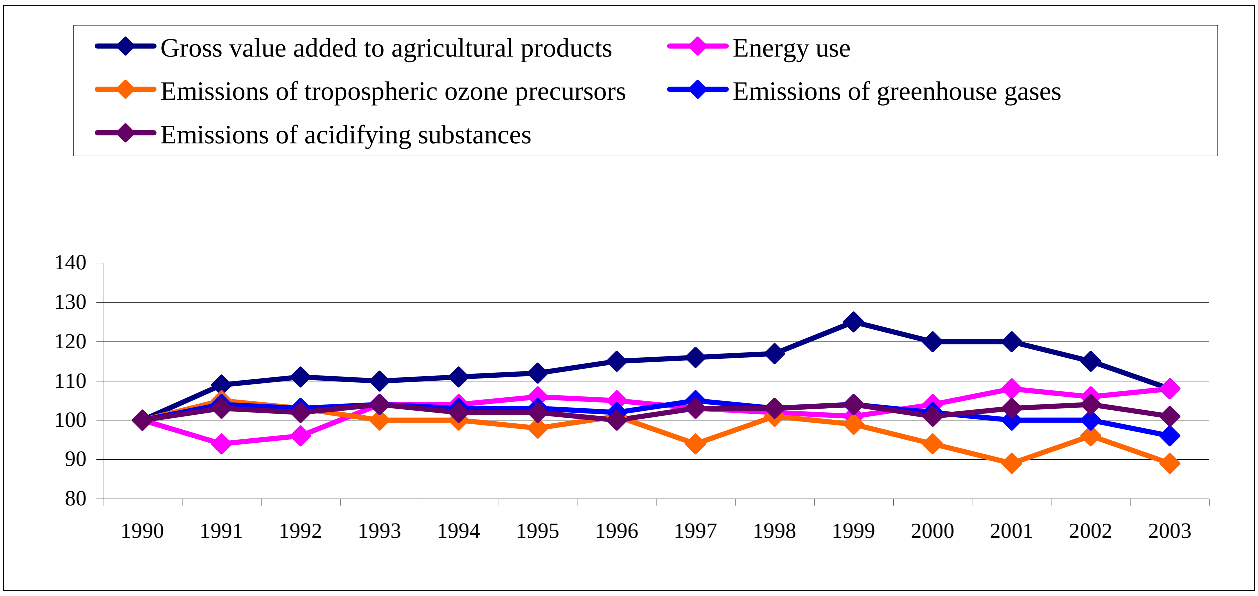

Figure 9. Gross Value Added to basic Agriculture prices (Driving Force) related to Emissions of Greenhouse gases, Acidifyng substances, Tropospheric ozone precursors (environmental pressure) and Energy use (Resource consumption) during the period 1990-2003

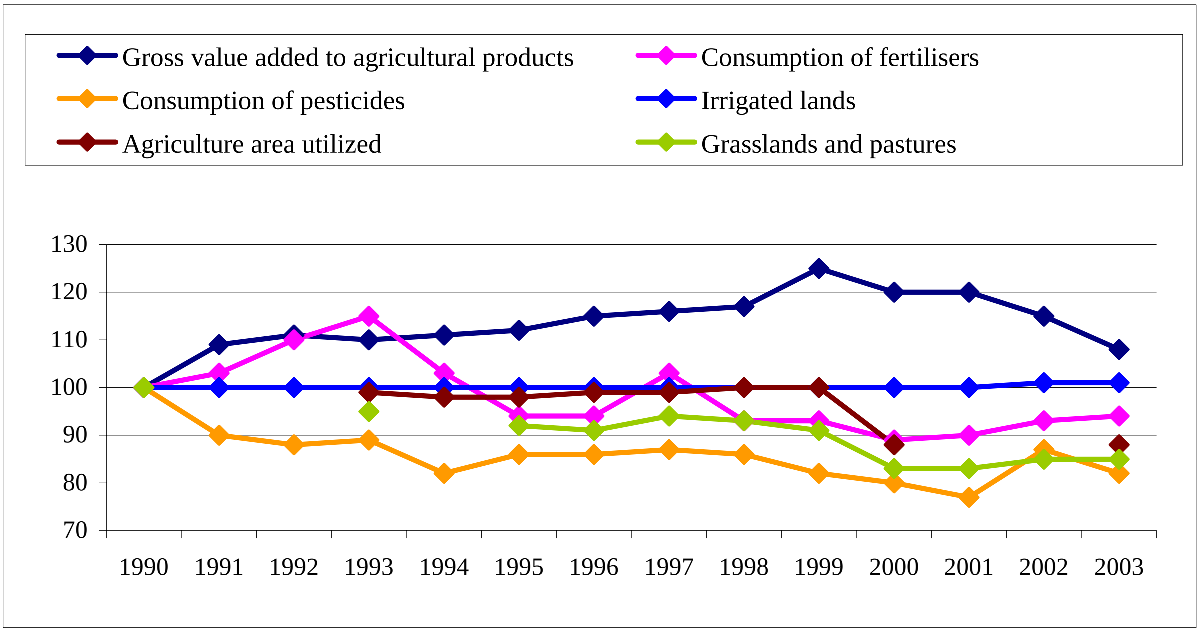

Figure 10. Gross Value Added to basic Agriculture prices (Driving Force) related to UUA, Irrigated land and Grassland and Pastures areas, Pesticides and Fertilisers consumption during the period 1990-2003

Conclusions

Developing decoupling indicators, and eventually applying them, is the best and more actual way to measure sustainable development. Their potential is noteworthy and their scope (improving, as great as possible, efficiency of production and consumption processes to reduce wastes to the least) seems to be a feasible objective. But there is a long way to walk to reach concrete results, above all it's urgent to plan action as two temporal scale, on one hand there is a strategic approach on a long period and on the other hand there is the identification of objectives and action of immediate fulfilment. Both scales have the same basic criteria: dematerialization of economic system (that is quantity of natural resources – renewable and not renewable – used to feed productive system and actual consumption model) and conscious participation of all the protagonists involved in programming and putting into effect processes in progress.

Dematerialization is a carried out process to be accelerated, addressing technological process towards sustaining energy and raw materials saving, all conditions being equal, and towards recycling wastes and imperfect goods of production.

Regarding conscious participation probably there will not be a real and lasting adhesion by a single individual (or just one social category or a population) to objectives and processes if they are not clearly shown, presented and explained in all their basic characteristic, including possible alternatives. Then it is fundamental to promote a meticulous action in this sense, starting from institution vertex to arrive, through nation, regions, municipality and so on to citizens. Carrying on this two actions and improving knowledge on fragile equilibrium between ecosystems and human impact, seems to be the convincing way in order to assure a future as harmonic as possible to the next generations on our planet.

References

APAT, 2004. *Yearbook of Environmental Data*.

COMITATO INTERMINISTERIALE PER LA PROGRAMMAZIONE ECONOMICA (CIPE). Deliberazione 2 agosto 2002 n. 57. *Strategia d'azione ambientale per lo sviluppo sostenibile in Italia.*

COMITATO INTERMINISTERIALE PER LA PROGRAMMAZIONE ECONOMICA (CIPE). Deliberazione 19 dicembre 2002 n. 123. *Revisione delle linee guida per le politiche e le misure nazionali di riduzione delle emissioni dei gas serra (legge 120/2002)* .

Decreto Legislativo 21 maggio 2004, n. 171. *"Attuazione della direttiva 2001/81/CE relativa ai limiti nazionali di emissione di alcuni inquinanti atmosferici"*

Direttiva 2003/87/CE del Parlamento europeo e del Consiglio, del 13 ottobre 2003, *che istituisce un sistema per lo scambio di quote di emissioni dei gas a effetto serra nella Comunità e che modifica la direttiva 96/61/CE del Consiglio (Testo rilevante ai fini del SEE)*

European Environment Agency (EEA) and the Statistical Office of the European Communities (Eurostat), 1995. *Driving Force-Pressure-State-Impact-Response (DPSIR) framework*.

European Environment Agency, 2001. *Report 'Environmental signals 2001'*.

European Environment Agency (EEA) and AEA Technology Environment, 2002. *Energy and environment in the European Union*.

European Union (EU), 2001. *Sixth Environment Action Programme. Environment 2010: Our future, our choice*.

European Union (EU), 2005. *Thematic Strategy on Sustainable Use of Natural Resources - COM(2005)670*.

LEGGE 1 giugno 2002, n.120. *Ratifica ed esecuzione del Protocollo di Kyoto alla Convenzione quadro delle Nazioni Unite sui cambiamenti climatici, fatto a Kyoto l'11 dicembre 1997.*

Millennium Ecosystem Assessment Board, 2005. *Living Beyond Our Means: Natural Assets and Human Well-being*.

OECD Secretariat, 2001. Report on *Indicators to Measure Decoupling of Environmental Pressure from Economic Growth*.

Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, 2004. *Revision of World Population Prospects*.

World Commission on Environment and Development (WCED), 1987. Brundtland Report "*Our Common future*".