available at www.sciencedirect.com

ScienceDirect

www.elsevier.com/locate/ecolecon

ANALYSIS

The index of sustainable economic welfare (ISEW) for a local authority: A case study in Italy

Federico Maria Pulselli [a,*], *Francesca Ciampalini* [a], *Enzo Tiezzi* [a], *Carlo Zappia* [b]

[a] *Department of Chemical and Biosystems Sciences and Technologies, University of Siena, Via della Diana 2/A, 53100 Siena, Italy*
[b] *Department of Economics, University of Siena, Piazza S. Francesco 7, 53100 Siena, Italy*

ARTICLE INFO

Article history:
Received 12 May 2005
Received in revised form
20 December 2005
Accepted 20 December 2005
Available online 15 February 2006

Keywords:
Local level
Economic welfare
Sustainability
ISEW
Economic policy

ABSTRACT

The Index of Sustainable Economic Welfare (ISEW) has been calculated for many countries, but rarely at the local level. This paper shows how the index has been calculated for the Province of Siena, Central Italy. The whole procedure is illustrated step by step, including the search for the most suitable and precise methods to obtain reliable values for each item composing the index. Application of ISEW at a very local level was found to be feasible. The most general difficulty encountered was the lack of an adequate institutionalised source of statistical information to support the construction of indicators other than purely economic or demographic ones. This is mainly due to the still low interest for a sustainable management of natural resources and land on the part of local authorities, and the related willingness to invest money and human resources on environmental research. The ISEW gives a more realistic representation of the well-being of the population than GDP, since it includes environmental and social items not considered in conventional national accounting. Furthermore, in Italy, the principle of administrative decentralization has been implemented in recent years to such an extent that the central government devolved part of its power to Regions, Provinces and Municipalities. Consequently, local authorities are called to allocate more resources to pursue their policies towards sustainability, an issue which modern electoral campaigns are often based on. The results for the Province of Siena show that there is a large gap between local GDP and ISEW (about 37% of GDP).

1. Introduction

In 1987, the Brundtland Report (World Commission on Environment and Development) expressed the necessity of "meeting the basic needs of all and extending to all the opportunity to satisfy their aspirations for a better life [...] sustainable development requires the promotion of values that encourage consumption standards that are within the bounds of the ecologically possible and to which all people may reasonable aspire [...] at a minimum, sustainable development must not endanger the natural systems that support life on Earth: the atmosphere, the waters, the soil and living beings" (WCED, 1987).

This global dimension of sustainability of human actions needs to be operationalized (Daly, 1990), starting from the local level. Local authorities represent the natural link between population and national or supernational governmental entities. They implement part of the economic, social and environmental policy according to their knowledge of the peculiarities of an area, arguably working in a "co-ordinated

* *Corresponding author*. Fax: +39 0577 232004.
E-mail address: fpulselli@unisi.it (F.M. Pulselli).

0921-8009/$ - see front matter © 2006 Elsevier B.V. All rights reserved.
doi:10.1016/j.ecolecon.2005.12.004

fashion" (Ferrarini et al., 2001) with other authorities at different levels. Some instruments were developed in the last decades, such as the Aalborg Charter of the European Conference on Sustainable Cities and Towns (ICLEI, 1994), in order to regulate this process.

The involvement of local communities towards local sustainability is stimulated by the Agenda 21 (the global action plan for social, economic and environmental development agreed at the Rio Earth Summit in 1992).

Integrating environment and development in decision-making is the subject of Chapter 8 of Agenda 21 (UNCED, 1992a). It notes that the dominant systems for decision-making in many countries tend to separate economic, social and environmental factors at the policy, planning and management levels, influencing the actions of all groups in society and affecting the efficiency and sustainability of development. An adjustment or even a fundamental reshaping of decision-making may be necessary in order to put environment and development at the center of economic and political decision-making. This is the goal of the Local Agenda 21 process, according to which each local authority should seek the participation of citizens, local organizations and private enterprises in order to implement the concept of the Conference of Rio "thinking globally, acting locally". Chapter 28 identifies the role of local authorities (UNCED, 1992b).

The main problem delaying development of local Agenda 21 is the lack of suitable methods for assessing interactions between various environmental, demographic, social and sectoral economic parameters. In Italy, the process of Agenda 21 at the local level is mostly focused on meetings (forums) among all local stakeholders that should theoretically stimulate the participation of people to the decision processes towards a sustainable development. However, the diagnostic phase is often neglected and, nevertheless, it would be simply based on pressure-state–response indicators. Systemic indicators of sustainable development are thus necessary to provide a solid basis for decision-making at all levels and to contribute to self-regulating sustainability of integrated natural and human systems.

Chapter 40 of Agenda 21 (UNCED, 1992c) recognizes this need, stating that commonly used indicators such as GDP and measures of resource and pollution flows do not provide adequate indications of sustainability. This growing need for sustainable development indicators has been widely expressed by many politicians, decision-makers, businessmen and industrialists at national and local level.

In Italy, the Constitution and some laws regulate local government. The most important recent contribution is Constitutional Law n.3/2001 that disciplines the administrative decentralization introduced by the so-called Bassanini laws (n.59 and n.127/1997). These laws actuate the principle of subsidiarity promoted by the Maastricht Treaty of the European Union (art. 3B). According to this principle, national regulations provide that local communities have a certain autonomy and freedom of action together with the correspondent degree of responsibility.

Italy is divided into 20 Regions; each Region is composed of Provinces and Province contains several Municipalities. Regions have legislative power on certain issues and they produce their own Statute and laws (see, for example, the Statute of Tuscany and Tuscan Regional Law n.1/2005 on land management). Provinces and Municipalities have administrative functions and deal with local questions. The Province is a body between the town council (Municipality) and the Region; it represents its community, looks after the interests of the population and fosters local development. It plays an important role in environmental questions because it can grant authorizations and has to monitor and manage the local environment. In order to perform all these functions, a Provincial government needs direct instruments for a continuous knowledge of environmental status and all other local concerns. It is a governmental level close to the citizens and, for this reason, it is responsible for the economic and social development according to local environmental policies (Ferrarini et al., 2001).

2. Methodological backgrounds

One of the most ambitious efforts to reform the calculation of an indicator of economic welfare sprang from the partnership of an economist, Herman Daly, and a theologian, John Cobb. Daly and Cobb (1989) named their proposed substitute for the GDP, the Index of Sustainable Economic Welfare (ISEW). This is not the first index proposed: others include the Measure of Economic Welfare (MEW) by Nordhaus and Tobin (1972), the Human Development Index (HDI) by UNDP (1990), the Genuine Progress Indicator (GPI) by Cobb et al. (1995) and the Sustainable Net Benefit Index (SNBI) (see Lawn and Sanders, 1999; Lawn, 2003).

Certain similar analyses were used as methodological sources for ISEW. ISEW was recently calculated for several countries: for example, Great Britain (Jackson and Marks, 1994), Sweden (Jackson and Stymne, 1996), Austria (Stockhammer et al., 1997), The Netherlands (Rosenberg and Oegema, 1995), Italy (Guenno and Tiezzi, 1998), Chile (Castañeda, 1999) and Poland (Gil and Sleszynski, 2003).

Consistent with the necessity of adjusted measures of welfare with respect to GDP (Leipert, 1986), Daly and Cobb (1989) proposed the ISEW for the USA. ISEW is an integrated index of economic development composed of a list of economic values. It enables the integration of the traditional measures of macroeconomic performance, that usually drive local policies, with information on the social (i.e. distribution inequality), institutional (i.e. local policy) and environmental (i.e. air and water pollution) aspects of the presence of a population on a territory, according to a shared vision of sustainability and its dimensions (Valentin and Spangenberg, 2000). In fact, those who propose the ISEW believe that it gives a broader and clearer picture of welfare since it addresses crucial issues such as income distribution, environmental damage and loss of environmental quality. In brief, welfare is affected by the flow of services to humankind rather than by the current output of marketable goods and services (England, 1998).

For this reason, ISEW accounting starts with the value of private consumption which is also the starting point for GDP calculations. Since an additional income of a thousand

dollars is more beneficial to the welfare of a poor family than a rich one (Daly and Cobb, 1994), private consumption has to be adjusted according to the Gini index of income distribution. Stockhammer et al. (1997) consider distribution as an integral part of welfare itself and social welfare is only possible if society as a whole can take part in this welfare. Items that increase economic welfare are considered to be positive values and those which decrease economic welfare are negative ones. For example, some positive benefits are services deriving from domestic labour, durable goods and the transport network; negative items are health and education costs (because they are considered defensive expenditures[1]), the cost of durable goods, commuting and road accidents. Other costs are related to environmental questions: air, water and noise pollution, loss of farmland and wetlands, long-term environmental damage and the depletion of non-renewable resources. The latter is a cost which future generations will have to shoulder and should be subtracted from estimates of the capital of the present generation.

The ISEW is not perfect, as pointed out by Eric Neumayer (1999, 2000). The arbitrary selection of certain variables to be included or excluded from the index, the method of calculation and the concept that the GDP is not an indicator of economic welfare but rather an indicator of total economic productive output have been criticized. Neumayer also draws attention to some contradictions in the methodology.

Contrary to the opinion of Daly and Cobb, ISEW cannot be an indicator of the real level of economic welfare and at the same time an indicator of "sustainability" because it is composed of or should only be composed of a list of items which indicate economic welfare or "sustainability". Neumayer therefore suggests that two distinct indices should be calculated and the relationship between them determined.

The second issue is that ISEW does not really achieve its aims. It was originally compiled by "ecological economists" concerned with the concept of strong sustainability, as distinct from weak sustainability, according to which natural capital can be substituted by man made capital. What surprised Neumayer was that ISEW does not make a clear distinction between these two forms of capital (national capital and natural capital) and it does not make a distinction between the various forms of natural capital (renewable and non-renewable resources).

Actually, Daly and Cobb admitted that many of their own calculations were preliminary and based on highly abstract assumptions, but as Daly said, "ISEW is like putting a filter on a cigarette. It's better than nothing" (England, 1998).

[1] Defensive expenditures are "expenditures that have actually occurred and are classified as not welfare-bearing due to a systematic bias in the economic social system. The typical example of defensive costs are filters, which would not be necessary if production did not cause pollution in the first place. [...]. Defensive costs are merely the monetary equivalent of the reaction to environmental, overpopulation and other kinds of damage" (Stockhammer et al., 1997, p. 21). For the concept of defensive expenditures, see also Leipert (1989).

3. The case study: ISEW for the Province of Siena

3.1. *The territorial system*

The Province of Siena is located in Tuscany, central Italy. It is the second largest Province in Tuscany and is composed of 36 municipalities with a total population of 252,972 (in 1999). The Province's main economic activities are linked to tourism, trade, banking and agriculture; the level of industrial activity is low, except in the crystal, building materials and furniture sectors. The principal commercial products are food including regional specialities such as wine (Brunello di Montalcino, Chianti, Vino Nobile di Montepulciano and Vernaccia di San Gimignano), cheese (pecorino di Pienza) and olive oil. In 1999, the GDP per capita was 17,836. In a survey published by the most authoritative Italian financial and economic newspaper, Il Sole 24 ore (1999), Siena was ranked 9th among 103 Italian Provinces for quality of life. Four UNESCO World Heritage sites are in the Province of Siena: San Gimignano, Siena historical centre, Pienza and, recently, Val d'Orcia. They are much more than tourist attractions because they call for a special policy to preserve and sustain their natural and historical integrity (OECD, 2002).

3.2. *Methods*

The ISEW calculation is divided into items. Item A is the reference year; items *B* and *D* are row and adjusted consumption, respectively. The latter is calculated on the basis of the Gini index of income distribution (item *C*). Items *E*, *F*, *G* and *H* are positive values, corresponding to services that contribute to welfare but are not considered in conventional national accounting. Items *I* to *Q* are negative because they correct the overestimation of economic welfare with respect to the private level of consumption. Items *R*, *S*, *T* and *U* are usually negative since they are estimates of the consumption of structural fractions of Natural Capital without any real counterpart in terms of welfare.

The following sections are devoted to the step-by-step description of the whole procedure, indicating the most important local data sources that prevented from scaling down the national data to the local level, thus avoiding arbitrary estimates. All monetary values were expressed in Italian Lira in 1999, then converted into Euro by multiplying by the fixed exchange rate of 1936.27 Lira per Euro.

3.2.1. *Item A: year*

This ISEW application was based upon figures for 1999.

3.2.2. *Item B: private consumption*

Private Consumption is the basic variable directly affecting economic welfare because large household expenditures on goods and services are considered to be an indicator of a healthy economy and a wealthy society. Data for this variable were obtained from the statistical report for the Province of Siena by Istituto Guglielmo Tagliacarne (1999).

3.2.3. *Item C: index of income distribution*

In general, private consumption does not really indicate the economic welfare of a population and must be adjusted to reflect more realistic conditions. Daly and Cobb (1994) proposed an index of income distribution to adjust the level of private consumption. In order to estimate the adjusted consumption, an investigation was conducted. Two alternative methods for assessing income distribution inequality are the Gini index and the Atkinson index. The former has been used by Daly and Cobb (1994), Guenno and Tiezzi (1998), Castañeda (1999) and by Costanza et al. (2004) in a recent study on Genuine Progress Indicator (GPI). The latter was adopted by Jackson et al. (1997), because, according to many economists, Atkinson's index is more accurate being based on the utility function. Gini index was used here since certain statisticians consider it to contain elements of the utility function and to be more precise and realistic. The range of variation of this index is between 0 and 1, where 0 means perfect income distribution and 1 means maximum inequality. The value of Gini index was computed from data in Betti et al. (2003) for Tuscany.

3.2.4. *Item D: calculation of adjusted private consumption*

The Adjusted Private Consumption[2] is the basis on which all other positive and negative modifications are applied. Daly and Cobb (1994) used it to calculate the degree of economic welfare because they maintain that there is a degree of inequality of income distribution in all economic systems throughout the world.

3.2.5. *Item E: services — domestic labour*

Domestic labour for cleaning, cooking and childminding, for example, contributes directly to economic welfare, even if it does not involve money. The number of housewives, unemployed persons and students was obtained (data from Provincia di Siena, 2000, 2001). It was assumed that a housewife spends 8 h/day in housework, an unemployed person 4 h/day and a student 2 h/day. The income per hour generated by domestic labour (market wages — ISTAT, 1999a) was multiplied by the hours spent at home by people over 14 years of age, as suggested by Guenno and Tiezzi (1998).

3.2.6. *Item F: services — consumer durables*

Expenditure on consumer durables such as cars and household appliances does not reflect the real welfare of consumers related to these goods because it is necessary to consider the utilization period of these goods. In ISEW calculations, the services connected with these goods are benefits, while the initial capital (item *I*) is a cost that is subtracted from private consumption. Domestic appliances tend to wear out faster than they should and this causes an increase in private consumption that does not really contribute to economic welfare. According to the method of Daly and Cobb (1994), services are only 10% of the total stock because they estimate that such goods have a life span of 10 years.

The services from a variety of goods (houses, household appliances, personal computers, mobile phones and cars) were calculated on the basis of data from the Bank of Italy (D'Alessio and Faiella, 2000 and a personal estimation of their medium prices).

3.2.7. *Item G: services from public infrastructure*

Daly and Cobb (1994) consider that public costs should not be a component of economic welfare because they are part of defensive costs, with the exception of services from public infrastructure (item *G*) and health and education costs (item *H*). Indeed, the growth of administration costs does not contribute to net economic welfare because it keeps economic welfare from declining, thus guaranteeing security, a healthy environment and conditions conducive to trade and commerce.

In general, people use infrastructure without paying a direct monetary contribution. This item is the sum of the value of services of the road system (equal to the cost of their maintenance) and the value of current public expenses in urban development, water distribution, urban health, without which these services would be unavailable. All data are from the Provincial Office of Roads for 1999 (Provincial Office of Roads. Province of Siena, 2003) and Regione Toscana (1999a).

3.2.8. *Item H: public health care and education costs*

It is generally accepted that public health care and education costs should be included in the GDP because they are part of public expenses. This issue, however, is much more complex than it seems. It is not easy to link an increase in public expenditure to an increase in economic welfare because of the inherent difficulty of measuring the demand for the types of services offered by the public administration. According to Daly and Cobb (1994), there is a fraction of health care and education expenditure that contributes to economic welfare and it should be added to private consumption. While Daly and Cobb (1994) consider that 50% of this expenditure is a defensive cost and should not be added to the index calculations, Guenno and Tiezzi (1998) believe that only 50% of health care costs are defensive. Hence, 100% of the public education costs and 50% of health care costs are added. Data are from Progetto Aspis (2002) and Provincia di Siena (2000).

3.2.9. *Item I: costs — consumer durables*

Expenditure for consumer durables reflects a negative adjustment of private consumption because this item has already been included in item F on services for private consumption. All data were from Regione Toscana (1999b), Tomat (2002), ISTAT (1999b) and Provincia di Siena (2001).

3.2.10. *Item J: private defensive expenditure for education and health care*

A fraction of public health care and education expenditure was considered in item *H* as a nondefensive cost that increases economic welfare. In order to get a clearer picture of overall health care and education costs, private defensive costs were subtracted from total consumption. 50% of private health care costs and 50% of private education costs were considered as defensive costs and subtracted from private consumption. Data were from ISTAT (1999c) and Provincia di Siena (2000).

[2] Adjusted Private Consumption = Private Consumption/(1 + Gini's index).

3.2.11. *Item K: local advertising costs*

National advertising costs are mostly aimed at stimulating or maintaining the demand for a certain product, without a real counterpart in terms of collective welfare; on the contrary, at local level, advertising also plays a social rule by broadcasting information, hence a portion of local advertising costs should be added (Daly and Cobb, 1994). However, since no data on local advertising costs were available, this item was omitted.

3.2.12. *Item L: costs of commuting*

Like Daly and Cobb (1994) and Guenno and Tiezzi (1998), we consider that 30% of the costs related to private cars and public means of transport together with 30% of the costs for public and private vehicle maintenance (the sources for these data are ACI-CENSIS, 2003 and Regione Toscana, 1999b) are directly related to commuting costs, according to the following formula:

$$C = 0.3(A - 0.3A) + 0.3B + 0.3C_1 \quad (1)$$

where:

C	the direct cost of commuting
A	automobile and other private vehicle costs
$0.3A$	the estimated amortization costs for private cars; in this case, we excluded it because it was already included in item *F*
0.3	the estimated portion of the use of non-commercial vehicle and the estimated portion of passenger miles on local public transport related to commuting
B	expenditure for tickets on public transport
C_1	costs for public and private vehicle maintenance.

3.2.13. *Item M: urbanisation costs*

In general, growing population density in urban areas implies that land and house prices and rents rise without a compensating increase in economic welfare. Buying a house provides a high level of satisfaction and the monetary value of the investment tends to be maintained with rare contingent exceptions. The concentration of people in urban areas also stimulates an increase in the supply of houses that partially offsets the increase in prices due to the overcrowding and is regulated by multiyear urban plans approved by local authorities. Hence this figure has not been subtracted from private consumption.

3.2.14. *Item N: costs of road accidents*

In the ISEW calculation, unlike GDP, these costs are a negative item because they decrease economic welfare. The cost of road accidents was calculated from total payments of insurance premiums as a result of car accidents. We used the same method as Guenno and Tiezzi (1998) to calculate national figures. Data were from ISTAT (1999d).

3.2.15. *Item O: cost of water pollution*

As in the case of Italy, we used total costs for water purification. Water quality is usually determined on the basis of parameters such as BOD (biological oxygen demand) and COD (chemical oxygen demand) and the cost of pollution is calculated on the costs of abatement of organic pollution levels. In this paper an estimate of the total amount of costs necessary to purify the water supply is obtained from data on a standard purification plant. The cost is 14.56 Euro in 2001 and it is referred to the equivalent inhabitants (E.I.) of the area (see http://www.wasserfeld.it/Italienisch/depuratore_1.html). The number of E.I. of the Province of Siena was obtained by summing resident population (252,972), E.I. of industrial sector (261,000) and E.I. of agricultural and zootechnic sector (772,396) (Regione Toscana, 2000a).

3.2.16. *Item P: cost of air pollution*

Daly and Cobb (1994) divided their estimate of this cost into 6 categories: 1) damage to agricultural production; 2) material damage; 3) cost of cleaning implement; 4) damage caused by acid rain; 5) urban degradation; 6) damage to buildings and surroundings. Like Guenno and Tiezzi (1998), we considered types of emissions and their cost per ton of emission abatement (data from IRSE, 2000):

SO_x	2324 Euro/ton
NO_x	904 Euro/ton
TSP (total suspended particles)	130 Euro/ton
CO_2	10 Euro/ton.

Costs were multiplied by the quantity of emissions (Regione Toscana, 2000a), to obtain the cost of air pollution for these four pollutants in a year.

3.2.17. *Item Q: costs of noise pollution*

Noise pollution is not a substantial problem in the Province of Siena. A project for measuring and reducing noise pollution in urban centres has been undertaken but the results are negligible.

3.2.18. *Item R: loss of wetlands*

Wetlands host some of the most biologically productive habitats in the world. Their value has not been included in economic accounting because they are considered part of natural capital and difficult to monetize. The ISEW addresses this issue by estimating the value of services lost when wetlands are converted to other uses. In 1999, there was an increase in wetlands in the Province of Siena because local authorities have implemented a project to refill part of the Montepulciano Lake basin.

It seems reasonable to assign a positive value to an increase in wetlands because it increases economic welfare. A value of 1033 Euro/ha was used (Guenno and Tiezzi, 1998).

3.2.19. *Item S: loss of agricultural land*

Agricultural land productivity is fundamental for every society and has been progressively reducing for a long time due to two destructive processes. Urban expansion and bad land management (allowing erosion, intensive agricultural practices, decomposition of organic material) have led to the depletion of agricultural land and a reduction in yields. Assigning a monetary value to this loss is an arduous and controversial task.

Figures for the area of depleted agricultural land were taken from the fourth and fifth agricultural censuses of 1990 and 2000, respectively (ISTAT, 1990, 2000), and represent definitive loss of available bioproductive land due to the change in use. The difference between the values of 1990 and 2000 was divided by 10 to give annual depletion. The monetary value of agricultural land (12,900 Euro/ha) was obtained from the Provincial Office of Agriculture (personal communication).

3.2.20. *Item T: depletion of non-renewable resources*

As in Daly and Cobb (1994) and Guenno and Tiezzi (1998), we used Salah El Serafy's (1988) method to calculate depletion of non-renewable resources.

According to El Serafy, a portion of the economic profits of resource extraction should be reinvested to preserve the capacity of the economic system to produce a durable income for future generations.

El Serafy's formula as presented by Guenno and Tiezzi (1998) is:

$$R–X = R[1/(1+r)^{n+1}] \quad (2)$$

where:

X	annual income;
R	revenue from extraction net of extraction costs;
r	discount rate;
n	residual life-time of the stock of resources.

Dealing with the concept of sustainable income, Santos and Zaratan (1997) describe an income component ($X \leq R$) that can be consumed, and a capital component ($R-X$) that must be invested to ensure a future flow of income. Since discounting the utility of future generations is morally unacceptable, Daly and Cobb (1994) assumed a discount rate of 0 that implies $X=0$. Therefore, the value of total net returns from the sale of non-renewable resources is counted as depreciation.

Depletion of non-renewable resources was calculated by considering resources extracted in the Province of Siena: sand, clay, gravel, limestone, marble and travertine (Regione Toscana, 2000b). Unit prices of each product extraction costs were obtained by interviewing local quarry owners.

3.2.21. *Item U: long-term environmental damage*

A major factor contributing to economic welfare in the long run is the conservation and protection of natural ecosystems which represent a source of biological production. Modern society and the economic system engage in myopic commercial practices and produce technological devices which ignore the physical rules and the inability of ecosystems to cope. The production of toxic wastes, carbon-dioxide, nuclear wastes and chlorofluorocarbons, with their long-term deleterious effects, is a real cost to be recognised which will fall on future generations.

In order to calculate long-term environmental damage we used the method of Daly and Cobb (1994) and considered four main pollutants — CO_2, NO_x, CH_4, and CFC. Long-term environmental damage is directly proportional to consumption of fossil fuels and energy. Hence, petrol, diesel fuel, fuel oil, methane and electricity consumption time series were considered.[3]

As proposed by Guenno and Tiezzi (1998) we used a tax of 1.276 per equivalent barrel of oil (Anielski and Rowe, 1999). It was multiplied by the time series (1979–1999) of non-renewable energy consumption (data sources: DGERM, 1999; GRTN, 1999; personal communications by local methane providers, 2003) to represent the persistence of environmental damage in the medium–long-term due to emission of combustion gases.

3.2.22. *Item V: net capital growth*

In order to sustain long-term economic welfare, there should be an increasing or constant supply of capital per worker. ISEW calculates net capital growth (NCG) by adding the stock of new capital (ΔK) and subtracting the capital requirement (CR: amount needed to sustain the stock of capital and, thus, the amount needed to sustain the same level of capital per worker). The CR is obtained multiplying the percentage variation in labour force ($\Delta L/L$) by the stock of capital of the preceding year (K_{-1}) (Guenno and Tiezzi, 1998).

$$\mathrm{NCG} = \Delta K – \mathrm{CR} \quad (3)$$

where $\Delta K = K - K_{-1}$ and $\mathrm{CR} = (\Delta L/L)K_{-1}$

Data were from IRPET (2001) and Provincia di Siena (2000, 2001).

3.2.23. *Items W–X–Y–Z: index of sustainable economic welfare and local GDP*

ISEW is obtained by the algebraic sum of all the items, depending on their positive or negative contribution to welfare, as previously indicated. The main features of ISEW, as a measure of sustainable economic welfare, with respect to GDP, as a measure of economic performance, are:

- Inclusion of changes in the distribution of income, reflecting the fact that an additional Euro means more to the poor than to the rich;
- Inclusion of household labour;
- Exclusion of expenses to offset social and environmental costs (defensive expenditure)
- Inclusion of long-term environmental damage and depreciation of natural capital;
- Inclusion of net production of man-made capital (i.e. investment).

[3] This procedure leads to an overestimate of long-term environmental damage (and a consequent underestimate of ISEW) because in the Province of Siena, local geothermal electricity production has been meeting the 90% of provincial demand at least for ten years, implying a change in the emission inventory. For the calculation of this item (with a final value of 47,151,341 Euro as shown in Table 1, item U), the Province of Siena has been considered within the national context where the demand of electricity is mostly met by thermoelectric production (non-renewable). On the contrary, long-term environmental damage in case of local renewable production (geothermoelectricity) would be equal to 36,368,379 Euro, implying an increase in ISEW equal to 0.38%.

Data for GDP and GDP per capita in 1999 are from the Statistic Compendium of the Province of Siena, by Istituto Guglielmo Tagliacarne (2001).

The method used in this paper is largely in line with that of Guenno and Tiezzi (1998) with some exceptions: public maintenance costs of urban development, water distribution and urban health were added to private consumption; the urbanization costs, as described by Daly and Cobb (1994), were not subtracted, because they are directly related to welfare; the cost of water pollution was calculated on the basis of the total purification costs of water (instead of an estimate based on a parameter such as biological oxygen demand, BOD); loss of agricultural land was computed by comparing the results of two censuses (1990 and 2000) to have a picture of irreversible changes in land use.

4. Results and discussion

As originally proposed by Daly and Cobb (1994), many elements, directly or indirectly affecting economic welfare, were evaluated at local level. After taking adjusted private consumption (*D*) as the starting point, positive and negative items (as previously indicated) were added or subtracted. Table 1 shows all the items concurring to the final result and a comparison of ISEW and GDP. Adjusted private consumption in the Province of Siena was 2,676,060,404 Euro. The positive components of welfare added 2,650,938,146 Euro and their percentage weights are shown in Fig. 1. Two main items represented more than 95% of total positive market and non-market value contributing to ISEW, namely household labour (*E*) and services from the stock of durable goods (*F*). The former contributes to the welfare of society but has no monetary counterpart. It is not only related to the number of housewives/househusbands, but represents hours dedicated to maintaining a given standard of living. The latter (*F*) tends to correct the overestimate inherent in the GDP. Fig. 2 shows negative elements (a value of 2,485,876,614) to be subtracted from consumption. The principal elements are non-renewable resource depreciation (*T*), expenditure on consumer durables

Table 1 – Items and values used to calculate ISEW for the Province of Siena in 1999 and comparison with local GDP

A		Year	1999
B		Personal consumption expenditure	3,492,258,828
C		Index of distribution inequality	0.305
D		Weighted personal consumption expenditure	2,676,060,404
E	+	Services of household labour	931,977,688
F	+	Consumer durables services	1,604,156,791
G	+	Services from public infrastructure	32,351,376
H	+	Public expenditure on health and education	82,392,693
I	–	Expenditure on consumer durables	676,984,208
J	–	Defensive private expenditure on health and education	115,129,206
K	–	Local advertising expenditure	Not available
L	–	Cost of commuting	578,603,706
M	–	Cost of urbanisation	Not computed
N	–	Cost of car accidents	2,944,063
O	–	Cost of water pollution	18,729,518
P	–	Cost of air pollution	531,166
Q	–	Cost of noise pollution	Not computed
R[a]	+	Loss of wetlands	7224
S	–	Loss of agricultural land	11,089,879
T	–	Exhaustible resources depreciation	1,034,711,527
U	–	Long-term environmental damage	47,151,341
V	+	Net capital growth	52,374
W		ISEW = sum of all positive and negative items	2,841,123,936
X		ISEW per capita	11,231
Y		GDP	4,508,466,984
Z		GDP per capita	17,822

a In 1999 an increase in wetlands was recorded by the Provincial Offices.

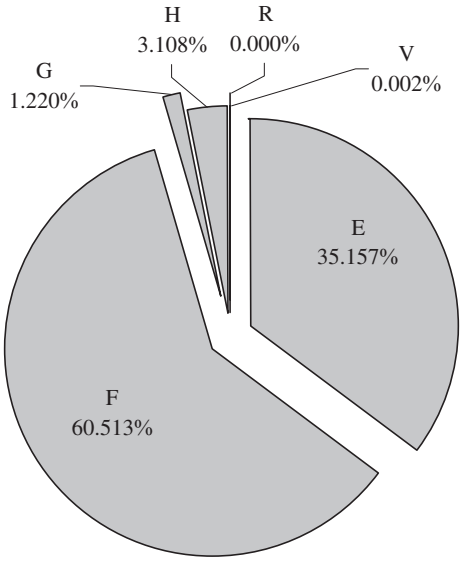

Fig. 1 – Positive items concurring to the calculation of ISEW.

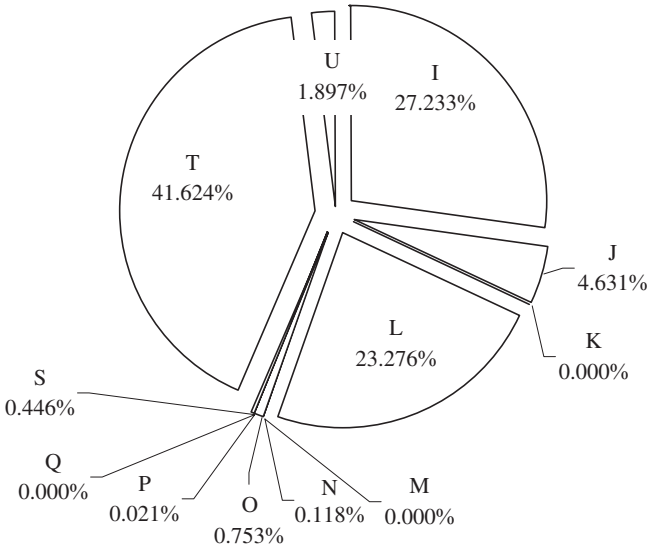

Fig. 2 – Negative items concurring to the calculation of ISEW.

(*I*) and commuting costs (*L*). They represent 92.1% of the total negative elements. In particular, the problem of the exploitation of local non-renewable resources is fundamental from the point of view of sustainability. Normally no intrinsic value is attributed to extracted materials: only the costs of extraction (goods, services, energy, labour, etc.) are accounted for. The proposal of Daly and Cobb (1994) refers to El Serafy's method, representing the difference between the flow of money derived from the sale of exhaustible products and the stock of materials derived from geological processes. In the Province of Siena, many materials are extracted, such as travertine, a precious yellow marble, gravel and sand. If this difference between a flow and a stock is not taken into account, extractive activity will never be considered a sustainable activity.

Cost of commuting depends on two elements: overcrowding of roads and urban areas and the need to own one or more private cars in a consumer society. Among negative items, there is non negligible defensive expenditure (*J*) and environmental damage (*U* — related to combustion of fossil fuels).

Positive and negative items coincide quite well so that the value of ISEW is very similar to the value of private consumption. The final result (2,841,123,936) is only 63% of the local GDP. The difference is important, corroborating the trend shown by several authors in western countries.

Guenno and Tiezzi (1998) described the trend of ISEW for Italy. The gap between Italy's ISEW and GDP is high (more than 60% in 1990) and seems consistent with the results presented in this paper. Although all data are from 1999, the trends of ISEW and GDP show a similar growth rate, after a decline in ISEW in the 1970s.

The main differences with respect to the conclusions by Guenno and Tiezzi (1998) concern pollution and exhaustible resources. The low impact of air, water and noise pollution in the Province of Siena reflects the characteristics of the area, where production is in the sectors of agriculture, tourism, services, etc. rather than industrial, towns are small and the population density is only 66 persons per km^2. On the other hand, exploitation of non-renewable resources is also a typical activity of the area due to quarrying of ornamental stone, gravel and sand for construction. The Province of Siena is already beyond the "threshold" (Max-Neef, 1995), though with a prosperous economy based on the tertiary sector and good environmental conditions due to the absence of invasive urbanism and heavy industry. The use of this holistic indicator demonstrates that a set of good economic indicators and good environmental status are not sufficient for sustainability of human activity, if applied separately.

Sustainability calls for an overall view of the world with multidimensional indicators that reflect the links between the economy, environment and society. The much abused GDP is often reported as a measure of a country's economic welfare: the more money spent for market products, the higher the GDP and the better overall economic welfare is supposed to be. The ISEW provides a more complete view that seems consistent with the necessity of managing environmental problems together with the economic ones and implementing technical instruments for local sustainability policies according to the role of peripheral institutions. In fact, the ISEW methodology integrates the fundamental dimensions of sustainability, namely economic, environmental, social and institutional, enabling to address the policy-making to sustainable development and it measures the critical elements that affect well-being, awakening public opinion to certain problems and stimulating participation.

However, the difficulties in implementing an adequate time series analysis at local level and the need to make estimates and assumptions due to the lack of data revealed the inadequacy of the institutional basis, in terms of statistical information, that would be necessary for calculating indicators other than purely economic or demographic ones. The main information gap regards environmental components (pollution levels, water and air quality), the energy sector (local energy producers are unwilling to provide data on their production and local public authorities lack basic information about energy sources, consumption and distribution) and land and resources use (for example, evolution of towns and suburbs in terms of land consumption and the dynamics of the quarry sector in terms of extracted materials). Such a condition causes difficulties in practicing integrated policies towards sustainable development because it prevents authorities from systematically monitoring the real state of the territorial system. A common purpose should be pursued by local authorities in order to realize a real local Agenda: stimulating a deeper knowledge of the characteristics and peculiarities of each area, shifting the environmental consciousness to medium–long run questions rather than emergent, and thus seemingly more urgent issues.

5. A tool for a local environmental policy

The concept of a sustainable system is different from that of an environmentally clean one. Local variables of sustainability must take more than just traditional environmental issues into account. Sustainability indicators should go beyond the reductionist approach with its separate compartments of environment, economy and society and reflect the interactions between them. In order to make progress and offer more practical methods of monitoring, an index of local sustainability, an approach which reflects the synergy between environmental, social and economic variables, is needed. ISEW methodology seems suitable for studying the real welfare of a population in a region. It seems consistent with main aims and precepts of modern strategic planning models that local authorities are implementing in Italy. These programs are characterized by some of the following elements, taken from a local agenda experience in Italy (Bollini, 2000):

- Equal opportunity in society and social integration — equal access to all fundamental services like education, employment, energy, health care, housing, job training and transport;
- Local government/decentralization/democratic practises — common access and participation in local planning and decision-making;

- Relationships between local and global issues — satisfy local needs, from production to consumption and waste management, and make them more sustainable;
- Local economy — combine objectives and local needs with available jobs and other services in order to minimise damage to natural resources and the environment;
- Environmental protection — decrease depletion of land and natural resources, control waste accumulation and toxic emissions and increase biodiversity;
- Cultural heritage environmental quality in towns — protect, conserve and restore works of historical, cultural, architectural importance including buildings, monuments and local cultural events; protect the aesthetic and functional qualities of urban space and buildings.

The overexploitation of the environment damages the quality of life, especially in relation to health, services and the ecosystem. These aspects of life are fundamental for economic activity. The complex dynamic processes which link the natural world and the economy to quality of life are the central focus of sustainability studies. Since environmental issues and economic and sector-specific policy overlap, decision-makers and the public need to be informed about threats to the natural foundations which support quality of life. Exhaustive regional studies, that shed light on environmental, socio-demographic and economic conditions, can be carried out using these new methods. ISEW assigns a monetary value to certain regional characteristics and to "nature" used for productive, tourist or residential purposes, the location of businesses and public services and the extent of industries and trades and their types, the road network and the flux of transportation vehicles, allowing decision/policy-makers to have a wide set of information to drive the improvement of local welfare. The gap between ISEW and GDP is the real indicator that should corroborate the efforts of those who are implementing environmental programs and researches, and condemn the policy of economic growth as unsustainable.

6. Conclusions

Several applications of ISEW have been recently presented for different countries (at the national level). This paper shows the feasibility of ISEW at the very local level, and describes it as a synthetic instrument useful to design local policies devoted to sustainable development. The application of ISEW, like other indicators, meets the needs of diagnostic instruments expressed by local authorities in order to implement their sustainable plans and programs, such as Agenda 21. This item-by-item analysis demonstrates that ISEW could compliment the GDP in a society where environmental and social problems are becoming relevant. The calculation of ISEW we have presented in this paper shows the monetary relevance of items like depletion of resources, production of air, noise and water pollution, long-term environmental damage in the economic welfare of the Province of Siena. The results of the analysis are consistent with the results for Italy. The gap between ISEW and GDP was confirmed, though the main items influencing the final result at local level play a different role relative to the national level. For example, the scattered presence of industrial activities and the low population density in the Province of Siena make the effect of pollution lighter than in Italy and in western countries, in general. At the same time, both energy and resource consumption and the exploitation of local stocks of non-renewable resources are substantial inputs and greatly affect the results.

The assessment of the sustainability of economic and social activities at the local level is certainly a great challenge for local authorities. Their power to take decisions, though regulated by laws, should be put into action on the basis of accurate and comprehensive information. Any decision, plan or project to be implemented should be evaluated both in economic terms and considering social and environmental aspects.

Acknowledgements

The authors would like to thank Achille Lemmi and Silvia Tiezzi of the University of Siena, as well as two anonymous referees, for insightful suggestions.

REFERENCES

ACI-CENSIS, 2003. XIII Rapporto Automobili. Available at http://www.tmcrew.org/eco/bike/xiii_rapporto_auto.htm.

Anielski, M., Rowe, J., 1999. The Genuine Progress Indicator-1998 Update, Executive Summary. Redefining Progress, One Kearny Street, Fourth Floor, San Francisco. Available online at http://www.rprogress.org/newpubs/1999/gpi1998_data.pdf.

Betti, G., Cheli, B., Lemmi, A., Scivolone, N., 2003. Misure convenzionali e non convenzionali della poverta'. Il caso della Toscana. Societa' italiana di economia pubblica. Dipartimento di economia pubblica e territoriale–Universita' di Pavia, Italy.

Bollini, G., 2000. Gli indicatori ambientali e di sostenibilità. Comune di Alghero. http://www.comune.alghero.ss.it/agenda_locale/documenti/indicatori.pdf.

Castañeda, B.E., 1999. An index of sustainable economic welfare (ISEW) for Chile. Ecological Economics 28, 231–244.

Cobb, C., Halstead, T., Rowe, J., 1995. The Genuine Progress Indicator. Summary of Data and Methodology. Redefining Progress, One Kearny Street, Fourth Floor, San Francisco.

Costanza, R., Erickson, J., Fligger, K., Adams, A., Adams, C., Altschuler, B., Balter, S., Fisher, B., Hike, J., Kelly, J., Kerr, T., McCauley, M., Montone, K., Rauch, M., Schmiedeskamp, K., Saxton, D., Sparacino, L., Tusinski, W., Williams, L., 2004. Estimates of the genuine progress indicator (GPI) for Vermont, Chittenden County and Burlington, from 1950 to 2000. Ecological Economics 51 (1–2), 139–155.

D'Alessio, G., Faiella, I., 2000. I bilanci delle famiglie italiane nell'anno 1998. Supplemento al bollettino statistico, nuova serie, X. Banca d'Italia, Roma, Italy.

Daly, H.E., 1990. Toward some operational principles of sustainable development. Ecological Economics 2, 1–6.

Daly, H.E., Cobb, J.B., 1989. For the Common Good: Redirecting the Economy Towards Community, the Environment, and a Sustainable Future. Beacon Press, Boston. 482 pp.

Daly, H.E., Cobb, J.B., 1994. Un'economia per il bene comune. Il nuovo paradigma economico orientato verso la comunità,

l'ambiente e un futuro particolarmente sostenibile. RED edizioni, Como, Italy.
DGERM, 1999. Direzione Generale dell'Energia e delle Risorse Minerarie. Combustibles consumption: time series. Available at https://dgerm.attivitaproduttive.gov.it/dgerm/venditeprovinciali.asp.
El Serafy, S., 1988. The proper calculation of income from depletable natural resources. In: Ahmad, Y.J., Serafy, S.E., Lutz, E. (Eds.), Environmental Accounting for Sustainable Development. An UNDP–World Bank Symposium. World Bank, Washington, DC, pp. 10–18.
England, R.W., 1998. Measurement of social well-being: alternatives to gross domestic product. Ecological Economics 25, 89–103.
Ferrarini, A., Bodini, A., Becchi, M., 2001. Environmental quality and sustainability in the province of Reggio Emilia (Italy): using multi-criteria analysis to assess and compare municipal performance. Journal of Environmental Management 63, 117–131.
Gil, S., Sleszynski, J., 2003. An index of sustainable economic welfare for Poland. Sustainable Development 11, 47–55.
GRTN, 1999. Gestore della Rete di Trasmissione Nazionale. Available at http://www.grtn.it/ita/statistiche/regioni.asp?ANNO=1999 and AREA=SI.
Guenno, G., Tiezzi, S., 1998. The Index of Sustainable Economic Welfare (ISEW) for Italy. Worknote 5.98. Fondazione Enrico Mattei. Milano, Italy.
International Council for Local Environmental Initiatives (ICLEI), 1994. Towards Sustainable Cities and Towns: Report of the First European Conference on Sustainable Cities and Towns. Freiburg, Germany.
Il Sole 24 ore, 1999. Dossier-La qualità della vita. December 27th, p. 25.
IRPET, 2001. Istituto Regionale Programmazione Economica Toscana. La situazione economica della Toscana. Consuntivo anno 2000. Previsioni 2001–2002. Italy.
IRSE, 2000. Inventario Regionale delle Emissioni. Rapporto: Qualità dell'aria, inquinamento acustico, industrie a rischio, inquinamento elettromagnetico. Italy.
ISTAT, 1990. Istituto Nazionale di Statistica. 4° Censimento dell'Agricoltura. Roma, Italy. http://www.regione.toscana.it/cif/pubblica/cen90407/indic407.htm.
ISTAT, 1999a. Istituto Nazionale di Statistica. Lavoro e Retribuzioni. Roma, Italy.
ISTAT, 1999b. Istituto Nazionale di Statistica. Consumi delle famiglie 1997–1999. Roma, Italy.
ISTAT, 1999c. Istituto Nazionale di Statistica. I consumi delle famiglie italiane 2000. Roma, Italy.
ISTAT, 1999d. Istituto Nazionale di Statistica. Statistica degli incidenti stradali. Roma, Italy.
ISTAT, 2000. Istituto Nazionale di Statistica. 5° Censimento dell'Agricoltura. Roma, Italy. http://censagr.istat.it/toscana.pdf.
Istituto Guglielmo Tagliacarne, 1999. Sistema Starter, Data Base, Roma, Italy.
Istituto Guglielmo Tagliacarne, 2001. Osservatorio Economico Provinciale 2000, Siena, Italy.
Jackson, T., Marks, N., 1994. Measuring Sustainable Economic Welfare. A Pilot Index: 1950–1990. Stockholm Environment Institute, the New Economics Foundation. 46 pp.
Jackson, T., Stymne, S., 1996. Sustainable Economic Welfare in Sweden: a Pilot Index 1950–1992. Stockholm Environment Institute, the New Economics Foundation. 46 pp.
Jackson, T., Laing, F., MacGillivary, A., Marks, N., Ralls, J., Stymne, S., 1997. An Index of Sustainable Economic Welfare for the UK 1950–1996. University of Surrey Centre for Environmental Strategy, Guildford, UK.
Lawn, P., 2003. A theoretical foundation to support the index of sustainable economic welfare (ISEW), genuine progress indicator (GPI), and other related indexes. Ecological Economics 44, 105–118.
Lawn, P., Sanders, R., 1999. Has Australia surpassed its optimal macroeconomic scale: finding out with the aid of benefit and cost accounts and a sustainable net benefit index. Ecological Economics 28, 213–229.
Leipert, C., 1986. A critical appraisal of gross national product: the measurement of net national welfare and environmental accounting. Journal of Economic Issue 21, 357–373.
Leipert, C., 1989. National income and economic growth: the conceptual side of defensive expenditures. Journal of Economic Issue 23, 843–856.
Max-Neef, M., 1995. Economic growth and quality of life: a threshold hypothesis. Ecological Economics 15, 115–118.
Neumayer, E., 1999. The ISEW — not an index of sustainable economic welfare. Social Indicators Research 48, 77–101.
Neumayer, E., 2000. On the methodology of ISEW, GPI and related measures: some constructive suggestions and some doubt on the "threshold" hypothesis. Ecological Economics 34, 347–361.
Nordhaus, W., Tobin, J., 1972. Is growth obsolete? Economic Growth. National Bureau of Economic Research, General Series No. 96, New York.
OECD, 2002. Territorial Reviews. Siena Italy. OECD, Paris.
Provincial Office of Roads. Province of Siena, 2003. Personal Communication on Public Infrastructure. Siena Italy.
Progetto Aspis, 2002. Analisi delle spese per l'istruzione pubblica. http://www.cede.it/web-est/aspis/cede.pdf.
Provincia di Siena, 2000. Rapporto Statistico 2000. http://osservatorioeconomico.provincia.siena.it/resources/rapp_stat/rapp_stat2000.htm.
Provincia di Siena, 2001. Rapporto Statistico 2001. http://osservatorioeconomico.provincia.siena.it/resources/rapp_stat/rapp_stat2001.htm.
Regione Toscana, 1999a. Spesa dei Comuni per il territorio e l'ambiente nel 1999. http://www.rete.toscana.it/sett/pta/stato_ambiente/indicatori_ambientali/finanza_verde_ch5.htm.
Regione Toscana, 1999b. Indicatori ambientali. Trasporti e mobilità: autovetture per anno di immatricolazione.
Regione Toscana, 2000a. Rapporto sullo stato dell'ambiente in Toscana. http://www.rete.toscana.it/sett/pta/stato_ambiente/rapporti/2000/frameset.htm.
Regione Toscana, 2000b. PRAE — Piano Regionale per le Attività Estrattive.
Rosenberg, D., Oegema, T., 1995. A Pilot ISEW for the Netherlands 1950–1992. Instituut vor Milieu-En systeemanalyse, Amsterdam.
Santos, T.M., Zaratan, M.L., 1997. Mineral resources accounting: a technique for monitoring the Philippine mining industry for sustainable development. Journal of Asian Earth Sciences 15 (2–3), 155–160.
Stockhammer, E., Hochreiter, H., Hobermayr, B., Steiner, K., 1997. The index of sustainable economic welfare (ISEW) as an alternative to GDP in measuring economic welfare. The result of the Austrian (revised) ISEW calculation, 1955–1992. Ecological Economics 21, 19–34.
Tomat, G.M., 2002. Beni durevoli, indici di prezzo e cambiamenti di qualità: un'applicazione ai prezzi delle automobili in Italia, 1988–1998. Tema di discussione, vol. 439. Banca d'Italia, Roma, Italy.
UNCED, 1992a. Agenda 21, Chapter 8, Integrating Environment and Development in Decision-Making. Rio de Janeiro 3rd–14th June, 1992.
UNCED, 1992b. Agenda 21, Chapter 28, Local Authorities' Initiatives in Support of Agenda 21. Rio de Janeiro 3rd–14th June, 1992.

UNCED, 1992c. Agenda 21, Chapter 40, Information for Decision Making. Rio de Janeiro 3rd–14th June, 1992.
UNDP, 1990–2004. Human Development Report. Oxford University Press, New York.
Valentin, A., Spangenberg, J.H., 2000. A guide to community sustainability indicators. Environmental Impact Assessment Review 20, 381–392.
WCED, World Commission on Environment and Development, 1987. Our Common Future (the Brundtland Report). Oxford University Press, Oxford.