

# **SUSTAINABLE DEVELOPMENT: WHICH INDICATORS FOR INVESTMENT PROJECTS CHOICE?**

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## **SUMMARY:**

How can the contribution of investment projects in the achievement of sustainable development be assessed? Indeed, the analysis of the available methods of project evaluation shows that the conventional indicators seek to maximize profit. Despite their scientific appearance, "shadow prices" project evaluating methods are subject to the influence of some arbitrarily selected parameters and, hence, may justify anything. As for the method of effects, it is an effective instrument as it enables the assessment of the economic impacts of a project on the national economy, in terms of integration in the national economy and dependence on foreign countries. All of these project evaluation methods do not take into consideration the effects on environment, but the Life cycle analysis provides a remedy to this omission. This approach, that assumes that inputs and outputs are converted in terms of impact on environment, leads to the conversion of all the elements impacting environment into a common assessment to produce a numerical indicator. This conversion is based on assumptions that are not accepted by all environmental experts. Ultimately, this approach offers a set of non-agreeable indicators that are difficult to perform. Sustainable development is a commendable goal; however, the project selection indicators that contribute to its realization need to be refined.

**Keywords:** Projects, indicators, impacts on economy, environmental impacts, project selection, sustainable development.

## **1. INTRODUCTION**

Developing countries have made many investments to reduce poverty. Unfortunately, these investments have not contributed much to economic progress, but even hindered it for many reasons. One of the factors undermining the benefits of industrialization in developing countries is the inability, because of the lack of knowledge, to build a project that makes it possible to assess its real impacts from the point of view of the entrepreneur and the common interest as well. What should be the assessment indicator (s) for selecting those of the projects the most respectful of environment while contributing to sustainable development?

The purpose of this article is to try to answer this question. To conduct this work, we have categorized these methods into evaluation methods from the company's point of view, evaluation methods from the community's point of view and last, the consideration of environment in these evaluations.

## **2. Traditional methods of evaluating investment projects for economic growth.**

The traditional methods (goodwill, internal rate of return) are designed to promote the valorization of the capital and its reproduction at a larger scale by the company. As such, these methods are adapted to the investments selected by the economic public company. Indeed, the public economic company, urged by the principle of commerciality, has therefore, almost the same objectives as the private company (survival, profitability, growth, etc.). Presently, the economic public company is an independent company, and for this reason, it has to anticipate the future to ensure its survival; so it must set a strategic plan that takes into account its strengths and weaknesses, and also threats and opportunities deriving from environment. Within this framework, investment becomes a means of development for the company, and the decision relevant to investment can be a means of anticipating the future. Thus, investments choice takes another extent and becomes one of the instruments of the policy of the company. In other words, classic criteria, if they strongly intervene in investment choice, they are no longer exclusive. This conception of the investment choice practice assumes, of course, that the company's objectives and policies are clearly defined. In the framework of the company's long-term forecast, the procedure of choice and selection of projects will be more rigorous and more rational.

For each project, an investment and financing plan is drawn up and translated into annual action plans for the company. The universal goal of any enterprise and any human group as well is, first of all, its own survival if not its continuity; it is for both a permanent and immediate concern. Of course, this implies the search for a minimum of profitability, insofar as without profitability, the survival of the company will be undermined in the short term. From this point of view, the classic criteria are interesting profitability indicators and owing to simulation, their development allows to take risk into consideration. If these criteria are good for assessing the financial performance of investments, this is not the case for public investments. Costs and benefits from the community perspective differ from those of the company. Consequently, the definition of a further economic calculation from the community point of view is necessary.

### **3. Price evaluation methods: The decision to invest at the mercy of arbitrariness.**

To make a rational use of rare factors of production, reference price methods suggest to replace the observed prices of production factors by world market prices. The world market is also the filter through which projects will be examined. Under this Ricardian reasoning, used particularly in the OECD method, what makes a country wealthy is the rent it can generate on the marketing and the development of its natural advantages.

However, it is worth noting that the international price of a good or service rarely corresponds to a supply / demand balance. In fact, prices are the result of the existing power relationships. Moreover, the recommended free trade leads developing countries to accept an unequal distribution of wealth, and to specialize in areas where developing countries can be competitive, i.e. exportation of primary goods with little added value. This logic of international specialization is logic of "misery" that leads to lasting underdevelopment.

Furthermore, because the model underlying the O.E.C.D method binds savings and growth, say that a consumed unit is an immediate and future loss of profit. The objectives of job creation and living conditions improvement are concealed as consumption is discouraged by the relevant recourse to a reference wage rate. Indeed, this savings maximizing policy urges the development of projects using capital-intensive, low-job-creation techniques, which enhances social inequalities by favoring dominant social groups, who have a savings package and can take advantage from international trade.

Finally, the inaccurate determination of some key parameters for the method (national goods, international goods, discount rate, reference wage rate, reference rate, reference exchange rate) is, in some cases, the result of the empirism and subjectivity of the project assessor.

The U.N.I.D.O. method, which was developed after the O.E.C.D. method, tries to rehabilitate planning, and questions part of the mechanisms of the global market decline. This method is based on a price system, which simultaneously refers to world prices and to (competitive) local market price. It also makes use of abstract correcting coefficients intended to artificially impart this method more coherence. This method suffers the same shortcomings as the previous one, because of the incapacity to gather the empirical and statistical data necessary for its implementation, particularly in a developing country. This method is an

academic exercise which leads to arbitrariness and empiricism, providing justification for everything.

#### **4- The method of effects: a performing tool**

The study of the “method of effects” in the view of its implementation within the project planning process in Algeria, calls for a commentary on the foundations, advantages and limits of the project, as it is the case for all the project evaluation methods. By emphasizing the notion of AV, it emphasizes the problem of the national economy integration (the rate of AV included completes the unit of import rate included) and of economic dependence on foreign countries. The effects taken into account in this method are those relating to market production only, and such effects as ecological effects and effects on people’s living conditions are not addressed. As a result, the method seems incomplete, since it does not take into account the impact on environment.

The effects are assessed from the structure of real market prices; the significance of the analysis depends on the significance of prices, because the choices will be oriented by the existing price structure. The comparison of the situation with project and without project being established on the basis of international prices, the gain or loss obtained is significant only if the relationship between domestic and international prices is known. The monetary valuation of the projects’ effects does not give a real opinion on the effects. The inflationary phenomenon of currency acts as a mask.

Land and labor are not taken into account by the method of effects; they are considered to be null. Yet, a paradox exists with the facts in developing countries such as Algeria, where projects are located in agricultural areas which are themselves limited. At this level, it is interesting to have knowledge of the opportunity to implement a project on a given land in comparison with its use for other investments such as agriculture. The assumption of zero work appropriateness is admissible to the limit, because of the relative abundance of labor force and unemployment in these countries. The method of affects does not take time into account, it is static. However, this method allows to obtain a set of indirect evaluation criteria that contribute to the clarification and the preparation of the project choice according to the objectives of the plan; it has the advantage to provide the possibility to be informed about the breakdown of the added value produced locally by category of economic agent, and its use.

The use of national accounts information to assess the effects raises a number of problems; a breakdown of imports by economic branch should be available and imports intended for production should be separated; also the branch

nomenclature must make the difference depending on the traditional or modern nature of the activity. Yet, neither the Algerian accounting system nor the other national accounting systems meet these conditions. The branch nomenclature is at a high level of aggregation, which is inadequate for analyzing the components of the same specific project. The same observation can be made on the nomenclature of economic agents; the use of these data is a rough approximation; an Input - Output table give no information about the existing production capacities; however, this issue is fundamental to know whether the increase in demand can be addressed within the limits of the current capacities (and with a short time of adaptation), where it must lead to an increase in capacity (then, the response of the supply will not be immediate). More generally, the method of effects and the simulation on the TEI do not take time into account; yet, the eventual impetus given by a project depends on the speed and transmissibility of the effects, the greater or lesser spread over time of these effects is not considered. All these limitations to refer to the national accounts information should not lead to a total rejection of their use; the alternative information to be obtained elsewhere should be considered as well as the cost of obtaining this information; perfectionism leads to great loss of money.

It emerges from this presentation that the method of effects is highly interesting in that it aims to analyzing the economy-project as a whole, and is not limited to a close analysis of the project, outside its economic context. However, this method that does not consider all the appropriate aspects of the project evaluation and its results are only partial. This method is supposed to be adapted to underdeveloped countries. Nevertheless, it seems that this effort of adaptation must be reinforced significantly.

In Developing countries investments are made in great numbers. Therefore, the constancy of the technical coefficients is an unreliable assumption because of the significant change of the production capacities of each economic branch. It is therefore essential that the assessment of the indirect effects of a project takes this aspect into account. The possible use of Leontief's dynamic model can be envisaged to improve inter-industrial forecasts by boosting the static model by integrating the stake acquisition factor (equipment).

Moreover, it is noted that the major importance given to direct and indirect foreign exchange earnings, and the distinction between traditional activities and modern activities seem to be insufficient. This work is interesting as it ensues more efficiency and then an improved project planning and an increased reliability, the final objective being an economic and social development in compliance with the choice of the "collectivity". On the plan, the method of effects is about to be used as part of a planning process. Difficulties are statistical only. In fact, the procedure

for using the method is simple. All you have to do is create a computer program for the calculation of the effects to obtain, for all the considered projects, their effects on the economy.

The analyzed project evaluation methods then constitute a means that, although limited, certainly helps to lead any investment policy towards development. All of these methods pass over a whole pan of the economy, i.e. environment.

### **5. Taking into account environment: at what price?**

Can we assess the projects' contribution to sustainable development? Do the proposed indicators allow the selection of projects that contribute to the achievement of this objective, or are it, once again, an experimentation hidden behind advanced calculations whose real purpose is to ensure the continuity of the economic dependence of developing countries and their exploitation through the development of a new ideology inducing long-term underdevelopment?

The Life Cycle Analysis (LCA) is proposed as a tool whose purpose is to present a comprehensive view on the impacts generated by production, and then, to provide indicators of decision support for industrial policies that are concerned about environment.

**Life Cycle Assessment.** Assessment is therefore a decision support tool that identifies and quantifies, throughout the product life cycle, the physical flows of materials and energy associated with human activities; it assesses the potential impacts and then gives an interpretation of the results obtained according to its initial objectives. This approach assumes that inputs and outputs are converted in terms of environmental impact. This leads to the conversion of all the elements involved in an environmental impact into a common measure used to produce a digital indicator. This conversion is based on hypotheses that are not endorsed by all the experts in environment. This is why we find in the literature, several characterization models built on hypotheses and approaches that vary according to the chosen characterization methods. Currently, there are about fifteen variants of life cycle analysis methods. This approach has several limitations and difficulties of use of various kinds:

1-Insufficient inventory data available in the databases:

At the present time, the existing inventory data covers only part of the various fields of the economic activity.

2- Insufficient characterization methods.

“Depletion of scarce resources” Indicator: this indicator is supposed to guide us in the preservation of resources that exist in finite quantity on earth; it is based on antimony as a standard of measurement; the latter is indeed a rare metal doomed to disappear. When comparing the characterization factors proposed in different methods of evaluation of the abiotic resources depletion indicator, it can be seen that each of the existing methods is based on data that are different, for example, on ultimate resources. In the method published by Guinea, the ultimate reserves of uranium are of 62500 billion tons; according to (Heijungs & al, 1992) , they are 1.70 million tons, and 4.3 million tons (IEA, 1998) according to the International Agency of Energy. Choosing Antimony as a reference resource remains very arbitrary as several other resources are being depleted. So the ADP weight coefficients remain questionable and are different from a life cycle assessment method to another. The multiplicity of ADP weight coefficients added to an arbitrary choice of the measurement standard is the main weak point of the sustainability indicator.

GWP<sup>2</sup> global warming: from more than fifteen gases with a global warming potential, only six gases have been selected. To compare the various greenhouse gases, an index is calculated for each substance and for each time frame chosen arbitrarily (100 years). This indicator causes problems as for the uncertainty of the results obtained.

Ozone layer depletion: it is measured by the ODP indicator and so, is not approved by the scientific community as a whole.

One view is that the depletion of stratospheric ozone will become less important in the future (Lindfors, 1996). The proponents of this position recommend to avoid using ODP.

-A second part of the scientists ascertain that gases degrading the ozone layer are declining and recommend the use of the static version of the ODP calculation.

- A last part considers that in view of the measures that have been taken to counteract this impact, it is not necessary to take them into account in the calculations.

Impact of Atmospheric Acidification: Acidification is the increase of acidity in the soil, watercourses or air as the result of the human activities. The Acidification Potential (AP) indicator (Heijungs, R et al., 1992), allows to express the various substances with the same unit, the equivalent kg of SO<sub>2</sub>. LCA methods are calculated for European countries, the United States and Canada. These factors depend on the geographical conditions of each country and are variable in the meantime. This method of calculation has some gaps, since it has no concern for

the mode of emission or the particular environmental conditions that could influence the progress of the phenomenon. The calculation of this indicator did not reach consensus.

**Ecotoxicity impact:** Ecotoxicity is the ability of a substance to cause adverse effects on living organisms or their physiologies and their functional organisms. Ecotoxicity is the degradation of chemicals (lead, mercury, arsenic, cadmium, etc.). This indicator is calculated with respect to a toxic substance as a standard which is ledichlorobenzene. This indicator is not unanimous in the scientific community.

**Human toxicity:** it reflects the potential damage of the chemical products released to the atmosphere and the environment. For example, arsenic or hydrogen fluoride are potentially dangerous to humans in case of inhalation and / or ingestion and are carcinogenic. The measurement is equivalent to dichlorobenzene, a well-known carcinogen. Human health is marked by the DALY (Disability Adjusted Life Years). This indicator represents the total of years of life lost or lived with a disability (or illness) because of the various impacts related to pollution; it makes a distinction between the years lived with diseases (YLD: Years Lived Disabled) and the years lost by premature mortality (YLL: Years of Life Lost).

DALY measures health gaps as opposed to health expectancies. It measures the difference between a current situation and an ideal situation where everyone lives to the age of standard life expectancy, and in perfect health. On the basis of life tables, the standard of life expectancy at birth is set at 80 years for men and 82.5 for women. The use of a standard life expectancy raises an ethical problem which is to consider that saving the life of a 40 year person in a rich country (significant life expectancy) would be more justified than saving a life of a 40-year-old in a poor country (shorter life expectancy). Moreover, the difference in life between men and women, agreed to be 2.5 years, is not an international biological standard as this difference varies from one country to another. This arbitrary choice affects the calculation of health costs of women relative to men.

One of the calculation parameters of the DALY is the coefficient of severity; for its determination, the period of disability of the individual is weighed according to the severity of the disability. The selection of the coefficients of severity remains arbitrary. Because of the accumulation of the arbitrary hypotheses concerning the characterization methods, the impossibility to have the same result when applying different methods of evaluation of the environmental impacts, the assumptions underlying the computations which sometimes reproduce inequalities (DALY) and the numerous arbitrary choices made, we reach the conclusion that in fact, the indicators of selection of sustainable development projects are to be



developed. What credit can be given to these indicators on which there is no scientific consensus?

Given the many shortcomings mentioned above, sustainable development indicators are far from reaching consensus among experts; sustainable development remains a laudable goal but we still ignore the means of its achievement. Despite the very scientific appearance of the method, it should be noted that the results obtained are to be taken with care. Indeed, many biases and arbitrary selection of coefficients influence the result of the L.C.A. and its interpretation. Attempts to assess environmental impacts are laudable; however, it is worth noting that at the current stage of development of LCA the implementation of these methods remains difficult, and the results obtained by two L.C.A. methods may be different if not contradictory. Therefore, there is some inconsistency, as these methods tend to reflect the results of their sponsors.

Furthermore, these studies are becoming more and more complex, and then, very expensive and out of reach for small investors. Who will invest in such a method if not the most powerful companies with major economic stakes, to consolidate their power?

All the critical remarks we have developed above urge us to have a relative global appreciation of LCAs.

Indeed, LCAs methods have been developed just recently; they still evolve and being an additional tool, they offer new insights.

Moreover, if it is difficult for the indicators provided by the LCAs to be endorsed with the view to internalize environmental impacts in the framework of the project evaluation methods, the respect for the environment remains, nevertheless, a political and moral obligation. In this framework, the LCA tool can be of great contribution in the measurement or in the design of the project, especially when selecting the expected product. At that time, it can be used to select the products with the least impact on environment. Once the products selected, the calculation of the economic profitability of the investment can be made. This two-step approach allows the selection of the most environmentally sound projects. It is clear that during the investment phase, care must be taken to respect environment by choosing the least polluting building materials, equipment, electrical energy and water recycling, until the monetary valuation of the impacts allowing the use of a synthetic indicator of selection of environmentally sound projects.

## **5. CONCLUSION**

Neither development nor sustainable development will result from these academic debates. On the contrary long-term underdevelopment is expanding because beyond the definitions of concepts, the development is measured on the ground. Poverty, diseases, exclusion and exodus are in constant increase. Facing these evils, economic growth although it paves the way for the creation of wealth, is still insufficient. Growth is not a problem in itself, it is the modes of distribution of wealth and the modes of exploitation and transfer of this wealth which are the cause of these evils.

Underdevelopment is a consequence, among others, of the deterioration of the terms of trade resulting from the exploitation of the resources of the South by the Center. It is time to change exchange and cooperation relationships from a domination relationship into a relationship based on the sharing of natural resources in exchange for technology transfer. The answer is clear, we very often refuse the rule of participation in the capital when starting businesses in proportion to (51/49), because we do not content with half of the wealth produced; we reject the equitable sharing and the sovereignty of the decision. We want to maximize profit, to have the autonomy of the decision and to ensure the transfer of the created profits in full. The degradation of the environment and the transfer of technology are someone else business. The equitable sharing of wealth is not the concern of the investor; on the contrary, we are more and more demanding towards under-developed countries they are offered “tax disarmament” as a solution to improve attractiveness by gaining points in the scale of Doing Business.

This is why it is high time to have indicators capable of determining, in an investment of one hundred units, the share that is due to us and the part that will be transferred (including the impact on environment). A foreign investment that creates an added value which will be almost completely transferred is not interesting, because the indirect costs generated by negative externalities are not taken into account. This investment is not profitable from the point of view of the community. The rule of equity participation in proportion to 51/49 at least has the merit of preserving sovereignty over the decisions made. This allows to take part in the strategic decisions taken in the company, to ensure the transfer of technology, to ensure the recruitment, the training of the local work force and its promotion especially to the positions of conception and decision-making, to ensure some integration into the national economy through the substitution of local by-products or intermediate inputs for imported products and to guarantee the sharing of wealth created with the partner.

Any investment whose objective is the maximization of profit fully transferable abroad, taking advantage of cheap production factors, (such as electricity, water, telephone charges, employing a workforce of foreign origin in its entirety, using the products of foreign subcontracting, having no responsibility for

the environment, enjoying all the local tax advantages), is of no contribution to the national economy. On the contrary, it generates negative impacts on the economy: economic dependence, destruction of the environment, enslavement of an untrained workforce, in short, economic impoverishment.

In developing countries, the importance of the institutional environment, far more than the natural environment is well established. Easing the investment procedures must focus on the administrative and fiscal aspect to favor attractiveness of investments. Many efforts are being made to this end by the developing countries; it is the case of Algeria because we can create a company in symbolic dinar and online; the administration has to make efforts from its side: reduction of the time to obtain bank credit, building permit, connection to the telephone network, electricity, water, acquisition of real estate and obtaining various exemptions.

The time allocated to certain procedures is not defined, but time is the main factor in the success of an investment transaction. Time is a parameter that has an economic counterpart: reducing time is reducing costs. We must fight against the waste of time. It is therefore necessary to remedy this situation and to develop the institutional environment and to preserve the natural environment.

Considering that investment generates growth in a deterministic way is totally wrong. This assumption has been demonstrated; massive investment does not automatically lead to technical progress; only judicious entrepreneurship developed under specific institutional conditions, favorable to investment and innovation, can be a source of wealth.

The generalization of sustainable development cannot be done at any price. Renewable energy (solar, wind) is more expensive than fossil energy. Paradoxically, we encourage the substitution of conventional energy by clean energy on the grounds that we seek the preservation of fossil energy resources in the long term. Yet, the alignment of fossil fuel prices on solar energies is simpler and faster and has an immediate global impact. This will save fossil resources while promoting the development of renewable energies. Of course, this option is of no interest for all.

One wonders then if sustainable development is not, in fact, a strategy of energy independence, which allows the creation of new opportunities of investment and technologies on the grounds that we worry about the degradation of the fauna and the flora. Because how can we understand that at the time when thousands of humans are dying of disease, hunger, war or drowned in the sea, the human being who suffers these impacts, does not reach the same ecological status than the rest of the animals and plants?

We invest billions "blindly" without knowing beforehand what will be the return of the sums invested, what are the consequences of this investment in terms of direct and indirect job creation, what are the consequences for economic independence, what are the consequences on human health, on the natural environment and what are the consequences on our sovereignty. It is high time to invest in research and in the creation of information as without the latter, no planning work is possible. Without these two prerequisites we will continue to be consumers of pseudo-scientific methods "produced by hand" to manage our resources and dream of a sustainable development designed for us.

Gaston-Gilles Granger underlines that "Science is a factor of reproduction of society; it is not neutral; it is not only an epistemological problem but a common place of political struggle".

Apart from the methods of project evaluation by reference prices (shadows prices), which are the subject of a consensus as to their partiality, the rest of the project evaluation methods are focused on the indicators that contribute to the maximization of the project. profit, hence economic growth. Some of them are very useful to measure the impact of any investment operation on the national economy, upstream and downstream impacts of projects to assess the overall economic contribution and choose the most successful programs. Nevertheless, these methods are demanding in terms of statistical information, which information is insufficient, missing or not very elaborated in developing countries. Last, all these methods do not take the negative externalities into account.

New approaches are being explored; we need to be part of the race, and to participate in the search for improved methods of assessment of environmental impacts and project evaluation methods in general, including inventory data bases. Despite all the shortcomings mentioned above, the consideration of the environmental impacts has become an obligation in Western countries, particularly in the field of product labeling through a standard that would be imposed on any product intended for the international market. Any delay in this field will make it necessary to call for foreign consulting firms to formalize impact studies; otherwise our products will be exposed to the risk of exclusion from the international market.

Consequently, and especially because the existing evaluation methods cannot objectively address **all** our concerns, it is therefore necessary to participate by ourselves in this reflection and to define the outlines of a project evaluation procedure that would be in line with our future vision of the economic development of our country. In the field of research, we need to develop our methods for assessing environmental impacts, to create our inventory databases and to formalize our software.

## BIBLIOGRAPHY

- 1-CMED, Commission Mondiale sur l'Environnement et le Développement. 1988. Notre avenir à tous. Montréal : Éditions du Fleuve .Les publications du Québec.
- 2-MEDDTL : Site internet du Ministère de l'écologie, du Développement Durable, des Transports et du Logement. Disponible sur: <http://www.developpementdurable>. Consulté le 30 mai 2011.
- 3-ANAND, S. And HANSON (1997) :Disability-adjusted life years: a critical review. Journal of Heath Economic 16 (1997) 685–702. St. Catherine College, Oxford, UK.
- 4-BELIR,R(1990)..Thèse de magistère soutenue à l’Institut National de la Planification et de la Statistique –Alger, intitulée « Le choix des investissements en Algérie ».
- 5-BELLIR, R. (1978). Mémoire de D.E.S.S. soutenu à l’Université de Montpellier I « Elaboration et évaluation de projets en rapport avec le processus de planification en Algérie ».
- 6-DALY, H. 1990: Toward operational principles of sustainable development. In Ecological Economics, Vol 2. Issue 1, 1-6
- 7-GOEDKOOPT M et SPRIENSMA. (2000). The eco indicator 99: A damage oriented method for Life Cycle Impact Assessment .Amersfoort: Pré Consultants. [https://www.pre-sustainability.com/download/EI99\\_annexe\\_v3.pdf](https://www.pre-sustainability.com/download/EI99_annexe_v3.pdf)
- 8-GRANGER, G.-G. (1974). Science pratique et pratique de la science,. Saint-Louis à Bruxelles : Facultés Universitaires.
- 9-GUINEE J ET HEIJUNGS R (1995): A proposal for the définition of resource equivalency factors for use in product life cycle assessment Centre of Environmental Science, Leiden University,
- 10-HEIJUNGS,R et al – (1992): environnemental Life Cycle Assessment of Product : Guide, ed.CML,Leiden ,Centre de Sciences de l'environnement.
- 11-IPCC,2007 : IPCC AR4 SYR (2007), Core Writing Team; Pachauri, R.K; and Reisinger, A., ed., Climate Change 2007: Synthesis Report, Contribution of

Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, IPCC, ISBN 92-9169-122-4

12-JOLLIET et al. (2010) Analyse du cycle de vie. Comprendre et réaliser un écobilan (2eme édition. Suisse : EPFL-Lausanne-Suisse: Presses Polytechniques et universitaires romandes, 2010.

13 LITTLE ET MIRLEES. (1969). Manuel d'analyse des projets industriels dans les pays en voie de développement. Vol. II : L'analyse coûts-avantages du point de vue de la collectivité,. Etudes du Centre de Développement de l'O.C.D.E.

14 MURRAY, C.J., and ACHARYA, A.K. (1997). Understanding DALYs (disability-adjusted life years). Journal of Health Economics 16: 703-730.