Research article

# Satisfaction of Human Needs as a Tool for the Evaluation of Sustainability through Indicators

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**Abstract** Inside the current worldwide framework of climate change, economic globalization and population growth, irrigation agriculture faces a series of problems which have to be approached as a challenge to sustainability. To speak about sustainability in irrigation it must be stated that irrigation agriculture is a system of production of goods with the objective of satisfying human needs. From this definition, the concept of sustainable development as meeting the needs of the present without compromising the ability of future generations to meet their own needs achieves full meaning. Developing a methodology of evaluation of sustainability, focused through checking the level of satisfaction of human needs of local populations, may allow for a more complete vision of reality than a mere economic evaluation. In this paper, Maslow's hierarchy of needs is proposed as the structural basis of a methodology of evaluation of sustainability through indicators. Through a survey of farmers in the irrigation area of Terra Cha province of Lugo, northwestern Spain, indicators are developed to monitor the sustainability of their production system. Those indicators are included as ecological factors in a specially-designed algorithm to compare social achievements with the resources used for those achievements. Such a comparison is useful in assessing sustainability through the use of indicators.

**Keywords** sustainability, irrigation, satisfaction, human needs

## INTRODUCTION

During the twentieth century economic growth took countries that already were worldwide economic powers, and some other emerging countries, to a wealth level never before seen in history, the so-called "State of well-being" (Stecher, 2007; Galbraith, 1999). A significant contribution to this economic evolution was the parallel agricultural evolution of the Green Revolution. The Green Revolution required a high level of inputs coming in one way or another from the availability of cheap oil (Gutierrez, 1996). This agricultural evolution allowed substantial cheap food produced by means of worldwide industrial agriculture. This system was able to compensate, through economic mechanisms, periods of shortage in some zones by surpluses from others, to improve the stability of individual diets.

This supply of food needs to the world population had collateral effects. The plowing of new farming land meant deforestation; the overexploitation of soil, its exhaustion; the intensive handling and the lack of protective measures, erosion; the monoculture, increase of plagues; the high level of inputs, salinity and pollution of several kinds; the badly planned extension of irrigation, exhaustion of water courses and aquifers; the wider spread of species and varieties "of high performance", and loss of genetic diversity (Shiva, 1991). And on the other hand, the economic mechanisms that should have ensured full supply have actually produced strong imbalances between different areas of the planet.

Thus, the cheap availability of food, at least for a percentage of the world population, entailed damage to the environment, to natural resources and to life quality for many people. And there is an implicit threat to the life quality of future generations by the reduction of the productive is the basis for agriculture. Since the global production of a sufficient volume of food has not been translated into satisfying the world population nourishment needs, the present model of food production may be interpreted as an example of private benefit related to public damage. Even more, not even the supply of cheap food (constituting the central argument of industrial agriculture) is happening. Global economic factors such as the rise of biofuel and speculation with commodities doubled the price of basic food in three years, equaling to a backward movement of seven years in the fight against poverty (Daboub, 2008).

Therefore, if there is enough food in the planet for feeding the population but the nourishment needs of that population are not satisfied, and the ability to satisfy them in the future is threatened, why should we go on using that model of production and distribution? If sustainability consists of satisfying the needs of present generations without jeopardizing the capacity of future generations to satisfy theirs (Brundtland, 1987), it would be more suitable, more stable and more lasting, more sustainable in fact, trying to satisfy the nourishment needs of the population sustainably. This is especially so in rural communities, where development is a tactically important issue for their survival (Tolon et al., 2006). By extension, analysis of the level of satisfaction of human needs would be a suitable approach for an evaluation of the sustainability of an agricultural system.

The use of indicators as a tool for sustainability evaluations is widely recognized (Manteiga, 2000). In this paper Maslow's hierarchy of needs (Maslow 1943) is proposed as the basis of a methodology for evaluating sustainability through indicators. Through a survey of farmers in the irrigation area of Terra Cha province of Lugo, northwestern Spain, indicators are developed to measure the sustainability of their production systems. The values of these indicators are used as a way of including ecological aspects in the evaluation. Once implemented in a specific algorithm the results provide a comparison of achievements in the social environment and the resources used. Such information is shown to be a useful methodology.

## METHODOLOGY

The irrigation area in Terra Cha Province of Lugo, northwestern Spain (Fig. 1) was chosen for the research because of physical proximity, agricultural relevance and data availability.

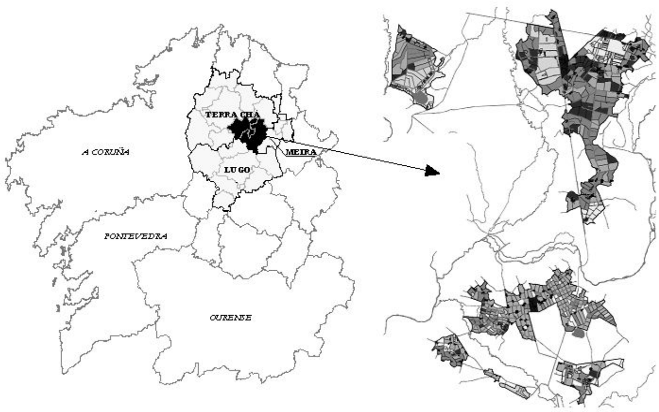


**Fig. 1 Map of research zone (Cancela, 2003)**

The Terra Cha irrigation area covers 2892 ha divided into three sectors (A Espiñeira, Arneiro, Matodoso). During the fourth quarter of 2009, a survey was conducted of the 192 farmers who live and produce there. The survey included 62 questions with 130 items, gathered in the following groups: ownership and entitlement, farm description, village and farm evolution, factors restricting production, associations, quality and origin of products, attitude towards structural modification, attitude towards change, job and life quality, and attitude and aptitude towards agriculture (Alvarez, 2010).

As a structural basis for the methodology, the hierarchy of Maslow (1943) was adopted. This is shown in Table 1.

**Table 1 Hierarchy of needs (Maslow, 1943)**

| Needs | Description | Elements |
|---|---|---|
| Physiological (basic) | Physiological needs, essential to maintain homeostasis (related to the health of the individual) | Breathing<br>Drinking<br>Eating<br>Sleeping<br>Eliminating residues |
| Safety | Born from the desire of the individual to feel safe and protected | Physical safety<br>Security of employment<br>Security of income and resources |
| Social recognition | Related to the emotional development of the individual | Association<br>Participation<br>Acceptance |
| Self-esteem | Related to the way in which the occupation of the individual is recognized | Recognition from others in terms of respect, status, prestige and power |
| Self-fulfillment | Morality, creativity, spontaneity, problem solving, lack of prejudice, acceptance of facts | The individual arrives to this category when all the other levels have been reached and completed |

For these categories the development of significant indicators for each was established by the questions in the survey, with the kind and number of answers indicating their value. Then two concepts are considered: on one side, ecological footprint, described as "a measure of the load imposed by a given population on nature. It represents the area of the Earth's surface necessary to sustain levels of resource consumption and waste discharge by that population" (Wackernagel and Rees, 1996); on the other side, carrying capacity, described as "the amount of productive land required to support a region's population indefinitely at a given material standard" (Rees, 1992). Regional and global values of both concepts are used to develop a further pondering factor applied to the indicators. Also, an algorithm was constructed according to Maslow's hierarchy to provide a tool to interpret the results (Fig. 2).

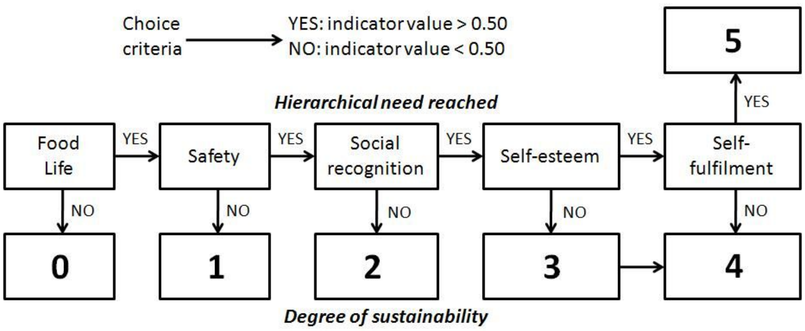


**Fig. 2 Algorithm to evaluate the degree of sustainability**

The algorithm to evaluate the degree of sustainability of the system follows the hierarchy of Maslow through a YES/NO decision path, with the threshold value fixed at 0.50. This number becomes a reference level assuming that reaching the satisfaction of a certain need for at least half the population allows to consider it satisfied enough. Also, the achievement of a higher step in the hierarchy means a higher degree of sustainability. Reaching a level of 5 in the algorithm would mean full sustainability (high achievements with small consumption of resources), while numbers around 2-4 provide relative levels of sustainability (low, medium or high). Values of 0-1 mean full unsustainability (low achievements with big consumption of resources).

## RESULTS AND DISCUSSION

After processing and reviewing the survey, the indicators were obtained according to their representativeness of the given category, and they are shown in Table 2 together with their respective values.

**Table 2 Categories, indicators and values of them**

| Categories (needs) | Indicators | Value (%) |
|---|---|---|
| Physiological (basic) | % of available income not spent in nourishment | 82.32 |
| Safety | % of population actively employed | 93.96 |
| Social recognition | % of participants in associative groups | 16.13 |
| Self-esteem | % of farmers satisfied with their job | 47.36 |
| Self-fulfillment | % of people satisfied with their life and hopes for the future | 40.44 |

The factors which include the ecological aspect into analysis use the following values, obtained from the research of Martin Palmero (2004):

- Ecological footprint (regional): 7.01 ha per capita
- Carrying capacity (regional): 1.25 ha per capita
- Carrying capacity (global): 2.15 ha per capita

With these values we are able to compare the requirements of productive land for the life standard of the population in the region with two different values of available resources per capita: the regional value (which refers to the local availability of resources) and the global value (which considers the possibility of importing matter and energy and exporting waste). To make this comparison, we build the following ratios, obtaining the subsequent pondering values in so much per one:

- Carrying capacity (regional) / ecological footprint (regional): 0.18
- Carrying capacity (global) / ecological footprint (regional): 0.31

**Table 3 Pondered values of indicators and degrees of sustainability reached**

| Categories (needs) | Indicators | Value (unpondered) | Value (regionally pondered by 0.18) | Value (globally pondered, by 0.31) |
|---|---|---|---|---|
| Physiological (basic) | % of available income not spent in nourishment | 0.82 | 0.15 | 0.25 |
| Safety | % of employed people on active population | 0.94 | 0.17 | 0.29 |
| Social recognition | % of participants in associative groups | 0.16 | 0.03 | 0.05 |
| Self-esteem | % of farmers satisfied with their job | 0.47 | 0.08 | 0.15 |
| Self-fulfilment | % of people satisfied with their life and hopes for the future | 0.40 | 0.07 | 0.12 |
| Degree of sustainability (through algorithm) | | 2 | 0 | 0 |

In Table 3, the values of indicators, all of them also transformed to so much per one, are given in three ways: without ecological inputs, and modified by regional and global pondering values. The degree of sustainability obtained using the algorithm in Fig. 2 allows comparison between the results using ecological / sustainability considerations.

As it can be seen in Table 3, the values of indicators decrease greatly once they are pondered considering local and global carrying capacities. Also, following the algorithm in Fig. 2, a degree of sustainability of 2 (low relative sustainability) is achieved by using the unpondered values of indicators; however, once we use the pondered values of indicators, either locally or globally pondered, the degree of sustainability achieved becomes 0.

## CONCLUSION

The hierarchy of Maslow, used as a framework, allows a structured system of sustainability indicators to be developed. The values of these indicators, which include factors that reflect environmental aspects of the system under study, reveal that the achievements of a society may be reached at an unreasonable environmental cost. Sustainability appears very hard to reach once the hidden costs of producing goods and/or services are shown. From this basic methodology, new versions with more sensitivity and features can be developed to obtain an improved methodology of evaluation of sustainability through indicators.

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