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Sustainability and food: a text analysis of the scientific literature

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Abstract

The paper analyses the evolution of the research debate related to sustainability and to the relation between food and sustainability. A number of text analysis techniques were combined for the investigation of scientific papers. The results stress how discourse analysis of sustainability in the pre-Rio period is mostly associated with agriculture and with a vision where the ecological and environmental aspects are dominant. In the post-Rio phase, the discussion about sustainability, though still strongly linked to environmental issues, enters a holistic dimension that includes social elements. The themes of energy and the sustainability of urban areas become central, and the scientific debate stresses the importance of indicators within an assessment approach linked to the relevance of planning and intervention aspects. The focus on the role of food within the debate on sustainability highlights a food security oriented approach in the pre-Rio phase, with a particular attention towards agriculture and third world Countries. In the post-Rio period, the focus of the analysis moves towards developed Countries. Even though food security remains a strongly significant element of the debate, the attention shifts towards consumers and food choices.

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Keywords: Sustainability; Food; Rio Conference; Text analysis; Co-occurrence analysis; Comparative analysis

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1. Introduction

The terminology in the field of sustainability is growing in both the number of terms and diversification of fields of study. The fields of study have increased parallel with the increasing awareness of the importance of the paradigm of sustainability (Lukman and Glavic, 2007). Society is increasingly sensitive towards issues related to sustainability (Lozano et al., 2013) and the scientific community itself has experienced an exponential growth of the articles that have sustainability as a key issue. The percentage of articles related to sustainability on the total number of the articles published up to 2014, in various scientific areas, according to the classification of Science-Direct research platform, is as follows:

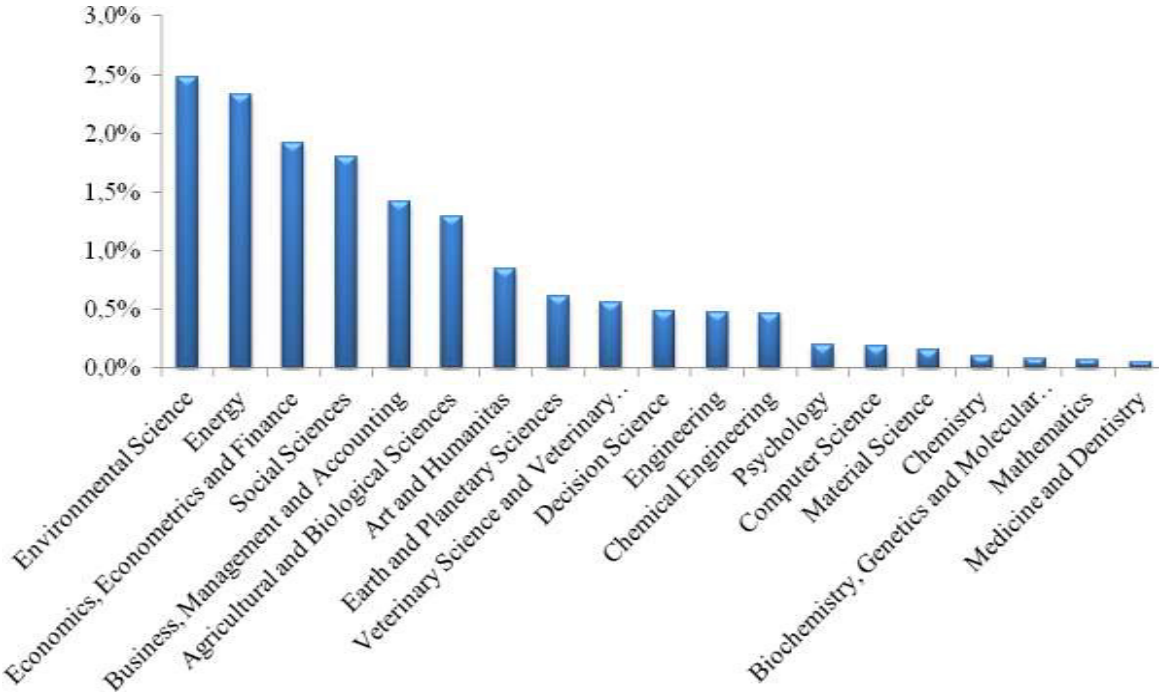

Fig.1: Percentage of articles about sustainability on the total number of articles published up to 2014 in various scientific areas.

The percentage of articles related to sustainability on the total number of articles published appears to be almost zero until the 90s and then it develops an upward trend increasing over the years, reaching in 2014 a percentage of 5,9% in the area of environmental science, 5,3% in energy, 3,8% in social science and 3,4% in economics. The various political stages of the sustainability path have fueled the scientific discourse and the social debate where there has been an awareness of how commitments of the international community didn't convert into actions, so that talks of "Politics of unsustainability" have started (Bludhorn and Welsh, 2007). There is the need to go beyond symbolic politics, as sub-national policies have a high political-strategic effectiveness, but a low impact effectiveness, having no material effects in reality (Newig, 2007; Szerszynsky, 2007).

The multifaceted theme of sustainable development, that comprises many themes (food, energy, construction, environment, health, right, well-being, etc.), makes this concept perceived as "meta-policy", which is an organizing principle that guides the development strategies of the various sectors (Happaerts, 2012). However, such policies do not offer tangible results and concrete measures in specific sectors, threatening to turn into empty rhetoric (Death, 2011). In fact, there are many qualitative definition of sustainable development, but few quantitative ones, that tend to measure sustainability in terms of holistic dimension (Udo and Jansson, 2009). Given the multifaceted issue of

sustainability and transdisciplinarity of the issue due to interplay between ecological, social and economic dimensions, sustainability is a highly complex task (Kotter and Balsiger, 1999). Since sustainability remains an elusive concept, hard to define (White, 2013), in this paper we want to depict the evolution of scientific discourse about this issue.

With these premises, we depict the trend of such co-occurrence over time as well as the appropriate techniques to analyse the main subjects associated to these words. To achieve these objectives we applied the text mining approach based on discourse analysis of a sample of international scientific papers (Aureli Cutillo and Bolasco, 2004). The method of textual statistics allows to compress the information of large texts in such a way that it can be more easily understood (Benzecri, 1992) and it is used to analyze and understand complex data (Ogiela, 2013). So, in this work statistics has been applied as a means of analysis of the scientific literature. Text mining techniques are applied to obtain automated information from textual data sources (Berry and Kogan, 2010) and they are mostly based on multidimensional scaling (Jolliffe, 2002). This type of analysis allows to investigate the latent semantic dimension and to summarize the information in semantic dimensions through which we can interpret textual data (Bolasco, 1999). Text analysis has seen over the years an increase in application fields, ranging from the analysis of literary texts to the analysis of different sources (Bolasco, 2005; Losito, 2007): interviews, focus groups, documents, scientific discourses, web pages, blogs, news articles.

2. Methodology

In this paper text analysis is carried out by means of a software package called T-Lab[1].

It is a software for textual semi-automatic analysis, that uses statistical and lexical techniques, based on the lexicometric approach (Bolasco, 1999). This software is based on multidimensional analysis and it improves the analysis of the words and of their relationships within textual corpus (della Ratta Rinaldi, 2007). This type of software allows the analysis of large corpus as is the case of the present research that has seen text mining of about 40000 abstracts. Abstracts were extracted from the Elsevier database (ScienceDirect platform), setting "sustainability" or "sustainable" as keywords in journals title, abstract, keywords. The 1992 Rio Conference has been considered as a watershed event in the literature, as it is in that precise time that we can assist to the official awareness of the relationship between economy and environment (La Camera, 2003). So, the concept of sustainable development becomes the organizing principle for the society all over the world (Annan, 2002). Then the extracted corpus has been imported as a .txt file and it has been subjected to a pre-processing phase that is the process of cleaning and preparing the text for the analysis. Furthermore the corpus has been segmented into elementary contexts, in our case represented by paragraphs.

Subsequently we have done a further extraction of abstracts related to sustainability that has segmented the period 1975-2014 in terms of five years, subjected to pre-processing phase and to segmentation into elementary contexts. In addition, a third extraction of textual data has been carried out, including in Science-Direct research platform the combination of "food" and "sustainability" or "food" and "sustainable" as keywords in the title, abstract and keywords. Approximately 2500 abstracts have been extracted, also systematized into two main sub-categories, pre-Rio and post-Rio, and subjected to pre-processing phase and segmentation into elementary contexts, also represented here by paragraphs. Databases are ready to explore the relationships between lexical units and context units.

The analysis carried out on the corpus is the following: word associations and specificity analysis. Word associations have been conducted for both corpus: that of "sustainability" and that of "food and sustainability", with sub-categories pre-Rio and post-Rio. Word associations allow to verify co-occurrence and similarity relationships that define the local meaning of selected key-words: in the first corpus "sustainability", in the second one "food". The selection of associated words is carried out by the computation of association index used to analyze the co-occurrences of the lexical units inside the elementary contexts.

The graphical output is a radial diagram, where the lemma selected is in the center and the others are around it,

[1] http://www.tlab.it

each at a distance proportional to its degree of association. On the corpus relating to sustainability in the time period 1975-2014 a diachronic analysis of the literature has been done. This period has been divided into eight five years subset. Every period has been analyzed through the specificity analysis, bringing to the identification of typical words of each subset of the corpus. Specificity analysis has compared the vocabulary of each subset with the global vocabulary of the corpus, extracting the typical lexical units for each relevant period by means of the chi-square.

3. Results and discussion

Word associations concerning the sustainability pre-Rio and post-Rio show the following radial diagrams:

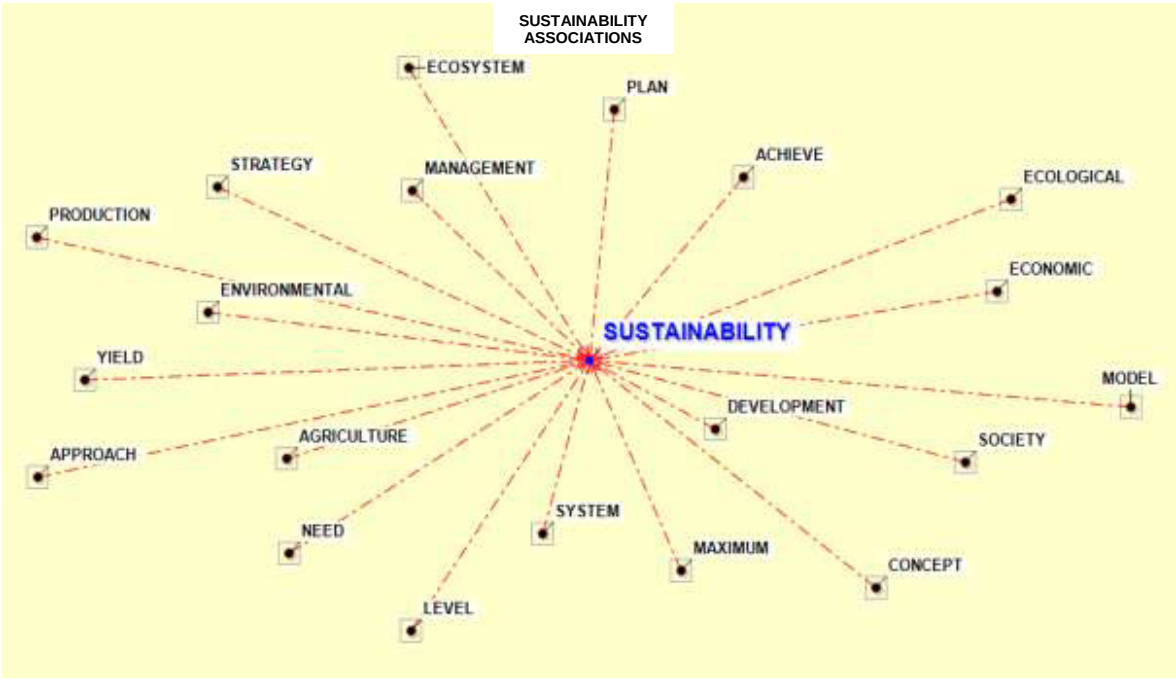

Fig. 2: Word associations “sustainability” Pre-Rio

SUSTAINABILITY ASSOCIATIONS

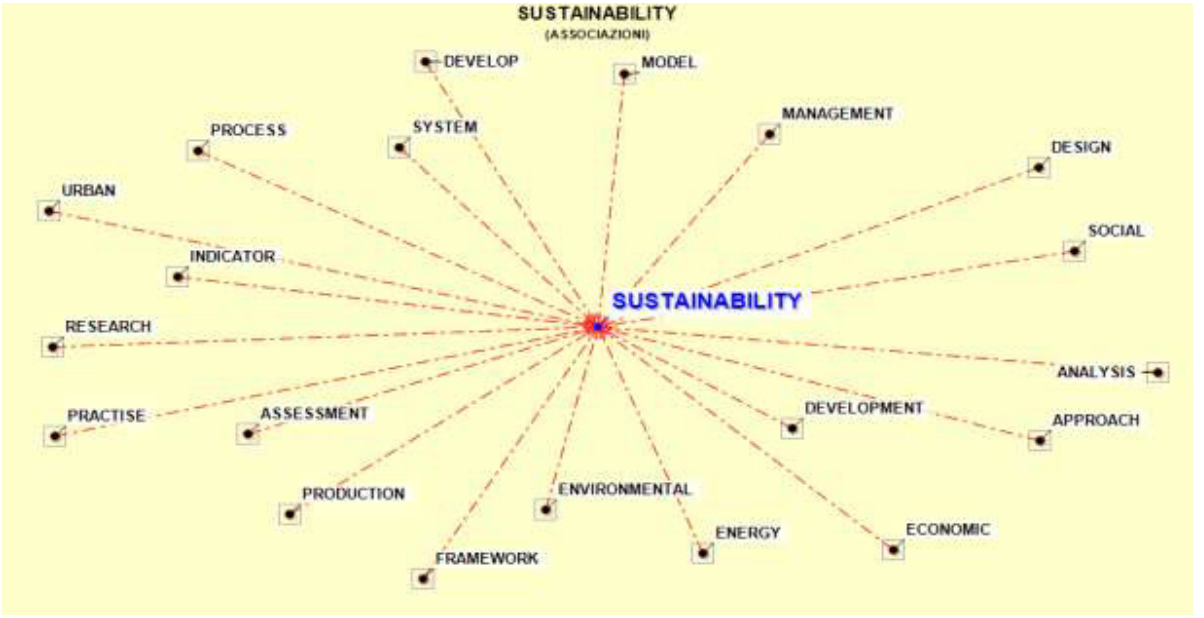

Fig. 3: Word associations "sustainability" Post-Rio

Both graphs show the top twenty most significant words, ordered according to the index of association with the word sustainability. The graphical output of the association of words shows that in both periods the word most associated with sustainability is development. However the differences of scientific discourse between these two macro-periods can be found in the fact that the pre-Rio period is more connected to agriculture and to a vision of sustainability linked mainly to the ecological-environmental aspect. In the post-Rio period, the discussion of sustainability, while remaining anchored to a predominantly environmental vision, acquires a holistic dimension that also encompasses a social vision. Issues relating to energy and sustainability of urban areas become central into the scientific debate that evidences the importance of the indicators for a concrete approach of evaluation which also connects to terms related to planning strategies intervention.

The diachronic analysis of the literature was performed through the analysis of specificity, that is the identification of typical words of each subset of the corpus, which specifically are the eight periods of five years in which has been segmented the time from 1975 to 2014.

Below, the table shows the top twenty typical words, sorted by the decreasing value of the chi-square[2], an index which identifies the relevance of each element analyzed.

1975-1979	1980-1984	1985-1989	1990-1994	1995-1999	2000-2004	2005-2009	2010-2014
whale	Inuit	third_world	tillage	soil	forest	sustainability	sustainability
creep	Quebec	low-input	agriculture	nutrient	fruit	indicator	chain
crack	environment	fisherman	environment	crop	disturbance	innovation	performance
contraction	deposit	weave	vaccination	water	groundwater	nanotechnology	supply
post-industrial	Indian	flock	dryland	ecosystem	assurance	socio-technical	assessment
assignment	rate	fatigue	conservation	quality	harvest	hydrogen	concrete
biosciences	private_sector	agriculture	problem	productivity	management	fleet	university

[2] Chi square value wasn't reported in the table for readability.

rigor	duty	mariculture	straw	wastewater	soil	fermentation	manufacture
maximum	substrate	fauna	cadmium	farm	Philippines	evaluation	biofuels
stretch	corporation	competitive	crop	leaching	water	assessment	indicator
fatigue	wear	visual	immunization	landscape	simulation	degrowth	stakeholder
blue	steady-state	himalayan	biological	drainage	dam	foresight	education
steady_state	society	park	adjustment	injury	ruminant	ore	build
kinetic	continental	agroecosystems	soil	restoration	catchment	multi-level	cleaner
molecular	salmon	fuelwood	international	tax	saline	local	company
child	constant	foreign	epidemiology	ecological	age	education	student
unstable	tonne	export	infection	land	plot	stakeholder	governance
propagation	worldwatch	firm	loam	forest	financial	network	social
arbitrary	ocean	agroecology	fertilizer	wheat	kiln	migration	green
population	organism	tillage	maize	fertiliser	plantation	regional	urban

Table 1: Specificity analysis 1975-2014

In the first two periods taken into account, that are until the mid-80s, discourse analysis on sustainability has been concentrated mainly on specific studies relating to particular criticality such as the studies on whales, on specific populations, on the seas and oceans . Driven by the theories of Georgescu-Roegen and Herman Daly (Daly and Georgescu-Roegen, 1977), studies on sustainability focused on steady state economy in which the physical components of an economic system are closely bound to the laws of physics and the ecological relationships. Then, the scientific debate on sustainability closely tied to the natural environment has shifted on issues related to the Third World, with agriculture that begins to represent a particularly relevant topic that will take on a connotation prevalent in the '90s.

Awareness brought by Rio Summit refer to the complementary relationship between the fight against poverty and against the environmental degradation means that the issues related to third world, such as the problems of hunger and health, come in light in the scientific debate, seeing emerge as significant issues agriculture, agricultural practices and their impacts, vaccinations, water, environment and ecosystems. The scientific discourse about sustainability in the first five years of 2000 relates mainly to the problems of forest, water and disturbance, substantially on elements linked to the sphere of environmental and natural resource management. For the first time the word management appears, presumably in line with the spirit of the Johannesburg summit that wanted to be a summit of actions and results rather than a theoretical debate about difficult challenges (Carr and Norman, 2008).

In the next five years, the very word sustainability becomes the pivot of scientific discourse with the role of the indicators that become increasingly important, according to an evaluation approach of environmental impact and of measurement of sustainability indexes. The importance of indicators over time derives by the fact that they can play a crucial role in the continuous process of concepts' redefinition, becoming a tool to assessment for policy makers (Rinne et al., 2013). The energy theme becomes central in academic debate with technological innovation that takes on a relevant. Moreover, it becomes increasingly necessary to offer measuring instruments to "evaluate" and "assess" phenomena to be managed politically by "multi-level" scales, starting with the "local" through participatory approaches involving the various "stakeholders". The importance of the concept of "local" in the scientific treatment may have been stimulated by the European Conference on Sustainable Cities and Towns, Aalborg +10, in which emphasis is given to the actions of local sustainability, while the theme of clean energy is the first challenge of the European Sustainable Development Strategy, presented in Bruxelles in 2006.

The last five years continue to have as central themes the assessment and the indicators, based on an approach towards sustainability more concrete and less theoretical. In this period discourses on alternative energy, such as

"biofuels"[3], and on buildings become very important. Themes of the green and urban design become relevant as that of education and of awareness of sustainability that can involve students, university, corporate companies in a process of governance. With regard to the scientific debate on integrated urban planning as an essential condition for sustainable development, the Leipzig Charter on Sustainable European Cities in 2007 can be considered a starting point. Regarding the specific issue of alternative energy, the input of the scientific debate can be given by the Copenhagen Conference on climate in 2009. In reference to the Education, we underline as at its 57th session in December 2002 the United Nations General Assembly declared the time period between 2005 and 2014 as the United Nations Decade of Education for Sustainable Development (DESD) in order to stress the crucial role of education in moving towards more sustainable world (UNESCO, 2007). Finally, with regard to the green economy and the system of governance, Rio+20 Conference, in 2012, may have been a catalyst for scientific debate since the Conference focused on two main themes (Tukker, 2013):

-"A Green Economy in the context of sustainable development and poverty eradication", intended as a transition towards a green economy that is not just considered an environmental improvement, but a new paradigm that seeks to mitigate global threats;

-"Institutional framework for sustainable development": to be understood as a reference to the global governance system for sustainable development, which will develop, monitor and implement sustainable development policies.

Finally, a particular focus was done about how the theme of food is related to sustainability in the scientific debate. Specifically, taking also in this case as a watershed date to analyze the literature the event of Rio, we see how the keyword “food” is associated with different words, whose first twenty are represented by the following graphics:

Fig. 4: Word associations “food” Pre-Rio

FOOD ASSOCIATIONS

[3] Bioenergy and biogas are not included in the top twenty terms, but they are however present as specific terms in this time frame

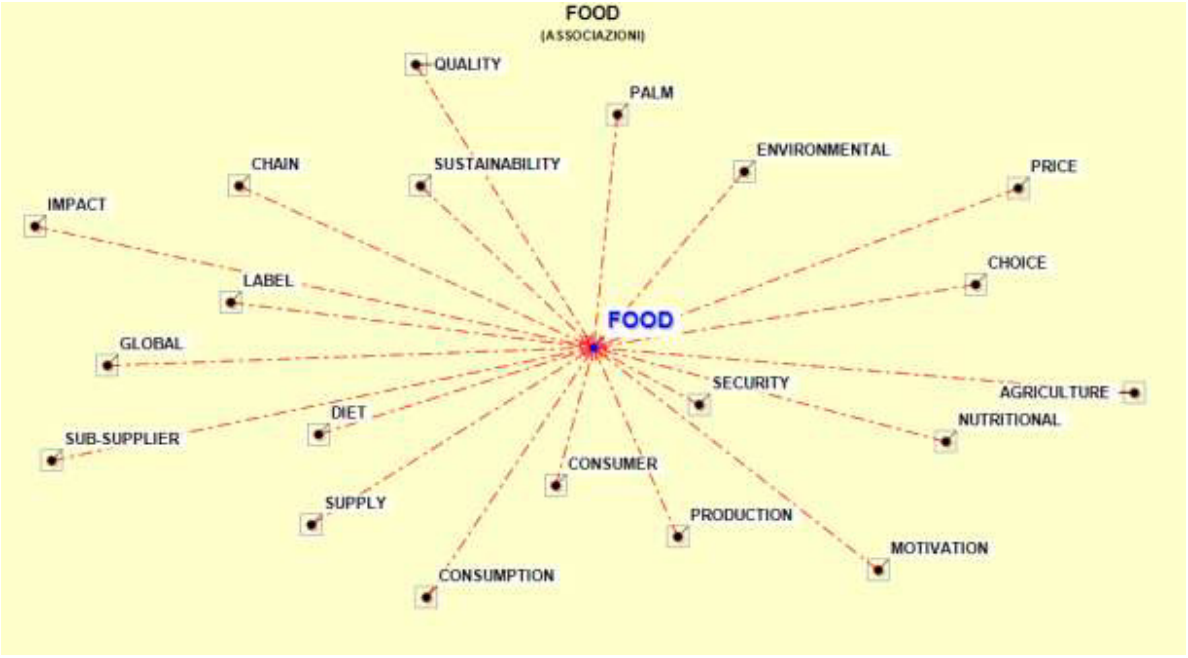

Fig.5: Word associations “food” Post-Rio

The comparison between the two radial representations expresses a difference of content about the relations of co-occurrence and similarity that, within both the corpus subsets, determine the meaning of the keyword “food”. In Pre-Rio period, the scientific literature, related to food and sustainability, highlights an approach primarily oriented on food security, with a focus on agriculture and problems of developing countries, especially Africa, on how to increase agricultural productivity and manage price volatility to ensure that everyone has access to food. In the post-Rio period, the focus of the scientific debate is extended to developed countries. While food security remains a strongly significant element, the discussion moves on to the consumer and on food choices, taking into account the whole food chain. In the post-Rio, the scientific discourse on food is also linked to the environmental aspects. Finally, from one aspect it arises the problem of guaranteeing food to everybody in an equal way, strengthening global governance mechanisms, from another aspect it arises the problem of eating habits and of quality in terms of food safety.

4. Conclusions

In this work the application of the quantitative tools to literature review facilitated the interpretation and the analysis of the scientific discourse. Furthermore, this methodology allows results to be replicable (Dafoe, 2014). The present analysis focused on literature about "sustainability" and about "sustainability and food". The scientific interest of the combination of food-sustainability is becoming increasingly important that differs in various areas of research and fields of study. If on one hand food production causes environmental stress, on the other hand it raises ethical issues. Food consumption guidance may provide benefits for the environmental, economic and social point of views, so dietary habits can be considered important factor in the evolution of sustainable lifestyles (Vinnari and Tapio, 2012). This work is a starting point to understand where the scientific part is directing as regards the sustainability (White, 2013). Sustainability remains an elusive concept, largely hard to define. Hence the issue of indicators for measurable and concrete goals becomes relevant, especially in the last years of the scientific debate. However, problems related to the use of indicators derive from the broad definition of sustainability and multidisciplinary approach and from the lack of standard classification and selection methods to define them,

particularly at local level (Tanguay et al. 2010). Future development of this research could be to see how the indicators have evolved in the scientific debate and how these are selected in order to develop reliable and operative method for assessment indicator (Hak et al., 2012). In recent years studies on indicators of sustainable development emphasize the role of indicators as learning tool. The development of indicators, in fact, can promote learning about the system and co-creation of knowledge among the various stakeholders of the community, in order to develop and coordinate shared action plans (Oldenhuizing et al., 2013). It could be interesting to compare the results of the scientific literature with what emerges from the media and public, in order to build a shared vision from which to achieve positive progress, related to defined miserable and tangible objectives. Understanding which indicators and parameters people consider important to measure sustainability through text mining of blogs or Facebook groups could provide useful information, enabling to better programmes and plans aligned with the concerns of the community (Rivera et al., 2014; Souza et al., 2014). Future developments of this research could be focused on understanding the perceptions and values of stakeholders on the relevant issue of sustainability (Rivera et al., 2014), using new media, observing their hopes and perceived risks (Fløttum et al., 2014). It is important developing adequate policies and action strategies shared by the community (Laniak et al., 2013). Indeed, a shared, concerted and collective vision on sustainability issues allows us to explore the common objectives to express an effective collective action for the government of public goods (Bass et al., 2014). Furthermore, this shared vision could promote governance that would make the citizen co-responsible in a path of "cooperative development".

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