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Climate change, wine and sustainability: a quantitative discourse analysis of the international scientific literature

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Abstract

The paper analyses the evolution and potential future trend of research debate related to climate change impacts on the wine chain. A particular emphasis was given to the evaluation of sustainability in the examined literature. From a methodological point of view, sets of text analysis techniques were combined for the investigation of those selected scientific papers. Results highlight that the detailed and in-depth examination of the subject is quite recent. Furthermore, the analysis of climate change on wine production sustainability is primarily focused on the environmental aspects and not to the socio-economic ones. Lastly, future potential research issues and aims for the examined topic were suggested.

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Keywords: climatic change impact; intervention strategies; wine making; sustainable development; text mining; multidimensional scaling; research trend.

1. Introduction

The analysis of climate change (CC) impact on environment and, specifically, on agro-forestry and rural sectors has been widely discussed and examined in last decades from different points of view. The three dimensions of sustainability (i.e. social, environmental and economic ones) have been analysed for different contexts and by means of several methodologies in scientific literature. In particular, for the topic "wine", it is possible to highlight the

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increased interest on it, in case of CC occurrence, in terms of his potential trends and impact analysis for both the production chain and its products (Mozell and Thach, 2014). As a matter of fact, literature points out how the term "wine" is associated to CC for the evaluation of the different steps of the production chain, thus from vine cultivation to market analysis. Among the most significant researches focused on environmental aspects, it is possible to mention the potential variation in cultivar distribution (Schultz and Jones, 2010; Fraga et al., 2012; Ruml et al., 2012), the variation of vine productivity (Bindi et al., 1996; Holland and Smit, 2010; Schultz and Jones, 2010), the potential spread of pests and plant infections (Jones et al., 2005; Stock et al., 2005; Caffarra et al., 2012), or the impact on phenological activity (Schultz, 2000; Webb et al., 2007). Other studies are concentrated on specific intervention strategies able to cope with negative effects of CC (Hadarits et al., 2010; Keller, 2010) or on economic damage (Bernetti et al., 2012; De Salvo et al., 2013). The social dimension of CC affecting the wine chain was mainly provided by the evaluation of perception of local stakeholders (Hadarits et al., 2010; Alonso and O'Neill, 2011), as well as through the so-called socio-ecological approach (Battaglini et al., 2009). More insights about the influence of CC on wine systems were proposed in Lereboullet et al. (2013), through the application of mixed-methods. In this last paper the authors combine different methodologies to model the wine sector as a complex system in an integrated perspective.

The above-mentioned literature shows the high variability of potentially evaluable issues deriving from the combination of CC and wine issues. Within these premises, it can be of interest to depict the time trend of that co-occurrence as well as to identify a technique able to analyse the main topics associated to the words "climate change" and "wine". By doing so, both focuses and gaps in current CC-wine research might be highlighted by means of a quantitative method.

The methodology used to attain the above-mentioned aim is a text mining approach based on discourse analysis of a sample of international scientific papers (Aureli Cutillo and Bolasco, 2004). In general, text mining allows compressing the information of large texts, which turns out to an easier analysis and understanding of complex data (Benzécri, 1992; Ogiela, 2013).

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 (MDS), a technique used to analyse similarity matrix (Jolliffe, 2002). Since the 60s-70s, interest in text analysis has been widening and it now includes not only stylometric studies on books, but also linguistic data analysis from different sources (Bolasco, 2005): structured interviews (Nicolini et al., 2010; Rollero and De Piccoli, 2010), semi-structured interviews (Parr et al, 2011; Bories et al., 2014), narratives (Sauvageot et al., 2006; Cunsolo Willox at al., 2012), focus groups (Debucquet et al., 2012; Mazzonetto and Fiates, 2014), documents (Capone and Petrillo, 2013), scientific discourses (Tonta and Darvish, 2010; Plumecocq, 2014), news articles (Schultz et al., 2012; Rivera et al., 2014), media discourses (Sengers et al., 2010) with a particular emphasis on web pages (White, 2013) and blogs (Flottum et al., 2014).

This method has a wide number of applications in different fields, ranging from discourse analysis to customer studies (Kang and Park, 2014). Text mining technique can be applied also to explore and predict opinions, attitudes and experiences of people, to achieve information useful for both developing marketing strategies (Singal, 2012) and implementing public policy (Laniak et al., 2013).

A few application of text mining are carried out in the wine sector, mainly concentrated on marketing topics. As an example, Sallis et al. (2008) use a Kohonen self-organising map based on text mining to analyse wine taster comments and their relation with wine sensory data. Maizza et al. (2014) used a text mining approach to create an effective web communication activity calibrated for wine tourism destinations.

2. Methodology

Text analysis was carried out by means of a software package called T-Lab[1].

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

It is a specific software for textual semi-automatic analysis, that uses statistical and lexical techniques, based on the lexicometric approach (Bolasco, 1999). This software develops a word analysis considering the relationships of words within a textual corpus (Della Ratta Rinaldi, 2007).

The paper developed a multidimensional analysis (Bolasco and Cipriani, 1995) of 1,056 scientific abstracts. Abstracts were extracted from the Elsevier database (ScienceDirect platform), setting “climate change” and “wine” as keywords in full-text journals articles. During the elaboration, a particular emphasis was given to the relation of these terms with the sustainability lemma.

Afterwards, the extracted corpus was imported as .txt file and it was subjected to a pre-processing phase, that is the process of cleaning and preparing the text for the subsequent analysis. The following processing steps were performed either by automatic settings or customized ones i.e.: i) lexicalization (some repeated segments were traced back to a single form, e.g. climate_change); ii) lemmatization (some forms with the same root or similar meaning were encoded in a new form that sum occurrences, e.g. sustainable/sustainability, wine producers/wine makers). Furthermore, the corpus of the text was segmented into elementary contexts embodied, in our case, by paragraphs.

Two types of analysis were performed: occurrences and co-occurrences evaluations. Occurrences of a particular lemma (single or lemmatized word) represent the magnitude of that term in the corpus. Co-occurrences analyse the relations among lexical units and elementary contexts. MDS as well as co-word techniques were carried out to perform co-occurrences analyses.

3. Results

The trend of occurrences for the terms “climate change”, “wine” and “sustainability” is shown in Fig. 1.

The first evidence is the prevalent occurrence of “climate change” parameter in respect to the other ones (459 for “climate change”, 355 for “sustainability” and 383 for “wine”). Fig. 1 highlights how this term started to be used from 1999. However, a significant increase of its use in scientific discourse can be highlighted from 2010.

Similar trends are also depicted for the other examined terms (“sustainability” and “wine”).

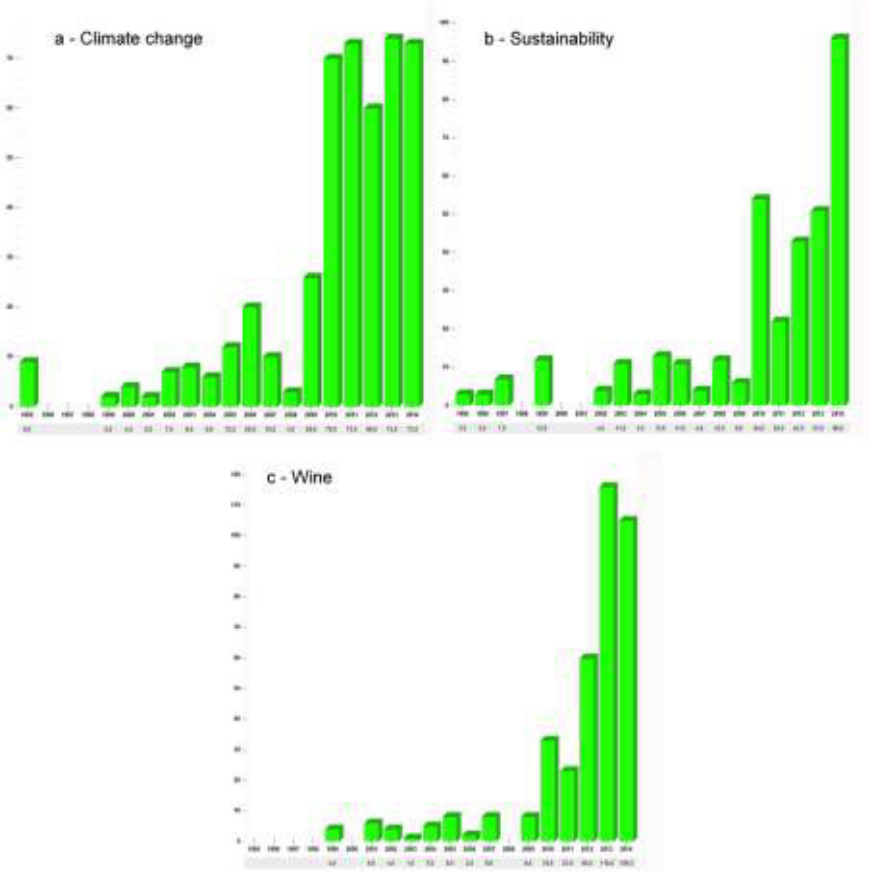

Fig. 1. (a) “Climate change” occurrences; (b) “sustainability” occurrences; (c) “wine” occurrences.

Concept mapping among single keywords (lemmas) was based on multidimensional scaling (MDS). In our study, due to best performances in respect to other indexes, the Mutual Information association index was applied in MDS procedure. The test was defined for the whole corpus and results are shown in Fig. 2.

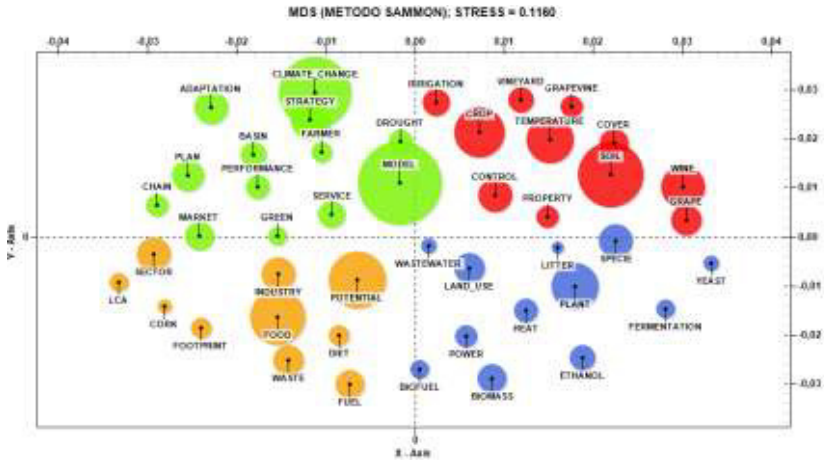

Fig. 2. Multidimensional scaling representation of corpus' lemmas.

Stress value shows a fair goodness of fit (Wickelmaier 2003) between input matrix and Sammon's map. Fig. 2 shows four main potential categorizations of words and research interests in the examined literature. The right sections (both first and fourth quadrant) of the graphic seem to refer to analysis of impacts at farm level. In the first quadrant a field evaluation is reported due to terms such as "soil", "crop", "wine", "temperature", "vineyard", "property". In this context an evaluation of impact on *terroir* is evident. The fourth quadrant highlights terms specifically related to winemaking and winery activity; however, the dimension of these terms explains a fewer occurrence and importance in respect to previous ones. The second quadrant focuses on adaptation and mitigation strategies at chain and market level (see e.g. "adaptation", "strategy", "plan", "market", "chain" lemmas). It is important to highlight the centrality and magnitude of the "model" lemma for both general as well as farm analysis. Lastly, in the third quadrant the main attention is given to the potential consequences of CC on wine chain (see "industry", "food" and "waste" words), as well as on environmental assessment by means of carbon footprint and Life Cycle Assessment (LCA) approaches.

The analysis of co-occurrences is shown for the combination of wine-climate change (Fig. 3) and wine-sustainability (Fig. 4) terms.

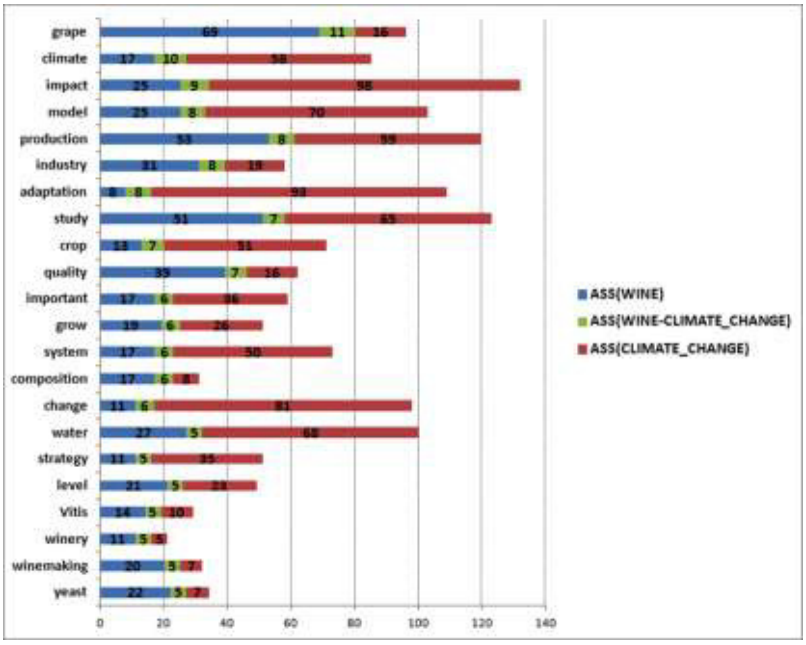

Fig. 3. Co-occurrences of “climate change” and “wine” lemmas.

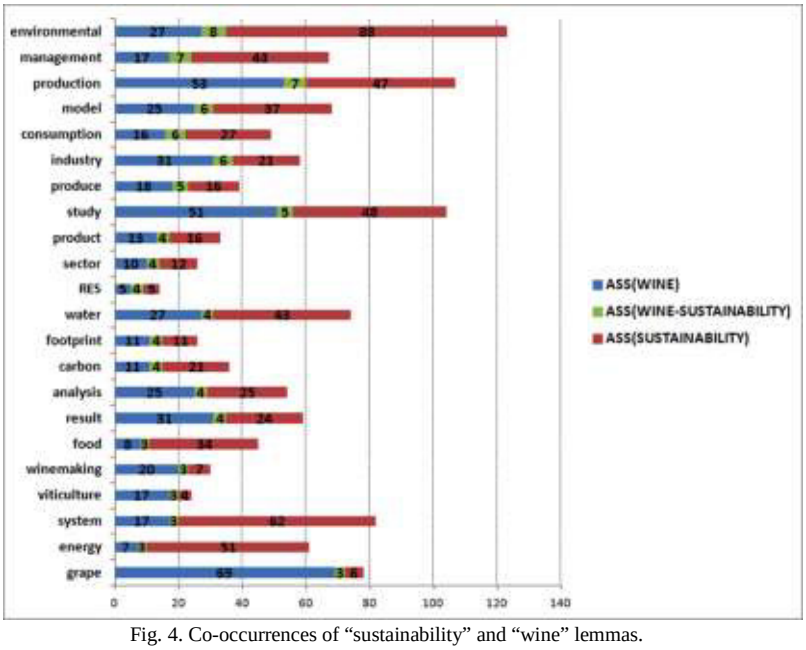

Fig. 4. Co-occurrences of “sustainability” and “wine” lemmas.

The results of Fig. 3, confirming the results of Fig. 1, show the presence of climate change term in a more general framework in respect to wine association. The most relevant co-occurrences for the two terms seem to be related to modelling and research activities about potential effect due to CC on wine production. Parameters such as “impact”, “model” as well as “study” have, as matter of fact, a good relevance in the evaluated combination.

Those variables are followed by organizational and economic factors, i.e "production", "industry", "winery" and "winemaking". Additional insights can be revealed considering the need of the wine farms to cope with negative effect due to CC; in this sense some papers introduce "adaptation" and "strategy" co-occurrences. Some environmental and field-related terms seem to have a strong importance in the scientific discourse as revealed by the co-occurrences "grape", "crop", "grow", "water" as well as "yeast".

The combination of "wine" and "sustainability" parameters (Fig. 4) confirms how, in the scientific debate, these terms have been mainly analysed in the environmental and organizational perspective. Social components appear in some factors but - generally – in an indirect way (see the terms "sector" or "food"). An evident relation is also shown between wine-sustainability and energy issue ("RES", "energy").

4. Discussion and conclusion

The analysis of occurrences, MDS and co-words results reveal the higher presence of environmental and economic terms in respect to social ones. This is particularly evident analysing the wine-sustainability co-occurrences. This result might depend on the mainly adopted approach in scientific evaluations related to the impact of CC on the wine sector. As a matter of fact, despite the need of an integrated assessment of a complex system, during the first phase of the analysis a simplification seems to be necessary. Field-related and environmental consequences of CC (e.g. variation in production, pest and plant diseases, increase in water consumption as well as carbon footprint variation) are followed by the analysis of economic impacts and potential modification of the production chain. A differentiation between a general focus (e.g. satellite activities of the wine chain, wine market, environmental impact) and studies on farm-related impacts are well defined by the text mining approach.

The main findings of the paper can be related to both a research and a practical level.

The application of a statistical tool to the textual data facilitated a quantitative literature analysis, ensuring the replication of the results (Drieger, 2013). A *pro* of this technique in respect to other quantitative methods is the opportunity to express stakeholder's perception in both statistical and natural language (Dahl and Flottum, 2014).

At practical level, since climate change is considered a relevant topic and a big global threat of the 21century, it could be of interest to compare the results of this paper (scientific literature) with the perceptions of different stakeholders. By applying text mining on additional digital media, it could be possible to understand the human and societal perspectives on the future in relation to climate change. In this sense, the comparison of textual analysis revealed through different channels could be implemented. As a matter of fact, blogs, media, interviews, news article, as well as additional scientific discourse, can turn out to be a useful tool able to achieve a "virtual" participative approach, suitable to communication strategies applied to mitigation and adaptation measures.

A perceived inconsistency that arises from the results is the low number of occurrences for the terms "climate change", "sustainability" and "wine" in respect to the analysed papers. However, as described in the methodological section, this aspect depends on a specific issue: to have a significant sample of abstracts, the co-occurrence of the three terms was selected in full-text, but they do not necessarily appear in the elementary contexts evaluated by the software. This aspect, however, facilitates the analysis of the co-occurrences in the scientific debate, due to the specific elementary context adopted in our procedure (paragraph). In addition, in this way more robust results are given.

A future step of this current research might be an in-depth evaluation of the scientific literature on adaptation and mitigation measures. It is important to develop a scientific debate on the different farmers' responses, which will vary according to the different socio-economic contexts and the different climatic impacts (Niles et al., 2014). In literature there is a lack of analysis on adaptation measures among different types of farm systems, despite agricultural adaptation to climate change is very important for community and for global food security (Schmidhuber and Tubiello, 2007). In general, researches on climate change impact on agriculture apply a specific approach, which focus on climatic and economic concerns (Holland and Smit, 2010). This approach is increasingly used to analyse risks, practices and future adaptation planning. Nevertheless, in viticulture this socio-ecological approach has not been widely applied, although it could be useful to identify the adaptive capabilities of the viticultural system (Lereboullet et al., 2013).

The paper focused on literature about climate change, taking into account only the specific "wine" topic. Nevertheless, this could be extended to other sectors of agriculture.

In conclusion, climate change has got an important role in the media and in scientific discourses, but the

response of the public opinion and their relative behaviour has been soft (Li et al., 2011). The role of the scientists in the dissemination process is then crucial (Bentely et al., 2012), since specific linguistic social diffusion models might impact on public opinion and, consequently, on politics (Nerlich et al., 2010). Within these premises, this paper could be a starting point for further researches willing to analyse information-dissemination processes on climate change and wine/agricultural, so as to sensitize politics on those issues.

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