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## Life cycle assessment for highlighting environmental hotspots in the Sicilian traditional ceramic sector: the case of ornamental ceramic plates

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### ABSTRACT

An environmental assessment of Sicilian traditional ceramics was developed. The study was conducted in accordance with the ISO standards ISO 14040:2006 and 14044:2006 choosing, as the functional unit, 1 kg of ornamental ceramic plates and, as the impact assessment method, Impact 2002+. The system boundaries included the phases of plates' production, all the way to disposal. All primary data needed for the assessment was collected on site in collaboration with a firm involved in the production of ceramic plates. The study showed that the highest environmental impact is due to the consumption of electricity linked to heat treatment during the production phase. Most of the environmental impact damages can be attributed to the damage category *Climate Change*, whilst the most significant impact categories are *Global Warming*; *Respiratory Inorganics* and *Non-Renewable Energy* use. All that considered efforts for reducing the environmental impacts and, consequently, for improving environmental performance should concentrate on reduction of energy consumption or on the use of renewable energy. This life cycle assessment study represents a building block for a possible future proposal of using environmental labels, for example Environmental Product Declarations, as a tool for exploiting, promoting, and differentiating Sicilian traditional ceramic products in the national and international market.

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### 1. Introduction

The production of ceramics is an important element of European economic, artistic and cultural heritage, with a great variety of products linked with the geographical, historical and cultural environment in which they are manufactured. The ceramic art-craft, in particular, can be seen as a medium for enhancing the local economy and the culture of the territories that are closely related to it. In 2012 the "European Union (EU)-TRACE project (TRACE-Net European Traditional Ceramic Network)" was launched, based on a partnership of 21 European cities (from five European nations: Italy, Spain, France, Slovenia, and Croatia). These

have a strong and ancient tradition in artisanal ceramics production. This project was designed to address the decline in volumes and quality of traditional ceramics and to help preserving their characteristics by building upon the common heritage with the aim of promoting sustainable development of the traditional ceramics sector (EU TRACE, 2014).

Furthermore, the artistic, traditional, and quality ceramics and other "non-agricultural products" captured the attention of the European Commission (EC) in 2004. It launched a Green Paper consultation on a possible extension of geographical indication (GI) protection to "non-agricultural products". As reported by the Commission Vice-President for Internal Market and Services, M. Barnier "[...] The EU is rich in products based on traditional knowledge and production methods, which are often rooted in the cultural and social heritage of a particular geographical location. These products form not only part of Europe's knowledge and skills but they also have

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considerable economic potential, which is not fully exploited (COM (2014) 469 final)". This extension proposal was based on the consideration that currently, due to globalisation, consumers are increasingly interested in having suitable tools for identifying authentic and original products; they also expect that quality and specific features advertised actually correspond to reality. This critical issue was highlighted by the EC, in 2011, in its communication on "a single market for intellectual property right" proposing also the development of an analysis of the existing legal framework for GI of non-agricultural products in the Member States and its implication for the internal market (COM (2011) 287 final). Consequently, in 2012 the "Study on geographical indications protection for non-agricultural products in the internal market" was commissioned and the related results were published in 2013: one of the most studied products was ceramics (Insight Consulting, Origin, and Redd, 2013).

Italy has a huge and long ceramics tradition widespread among all its regions, mostly characterised by handmade artefacts manufactured on a small/very small-scale production or as single pieces. In 1999 the Italian Association "Towns of Ceramics" (AiCC) was established specifically for creating a national network of "ceramics producing towns" and for protecting and enhancing their art-crafts. Two towns represent Sicily within this association: Caltagirone (in the province of Catania) and Sciacca (in the province of Agrigento) (AiCC, 2014). In terms of number of active enterprises the most important regions are Sicily, Campania, Veneto, Tuscany, Emilia Romagna, and Umbria. During the "First National conference on ceramics" held in Rome in 2008, on the basis of the data provided by the Italian Revenue Agency, it was highlighted that in 2006 about 2700 enterprises could be, officially, identified in this sector with a total of almost 10,000 employees; a total turnover of about 700 million euros; and a mostly local market with 7% of the income deriving from exports. From 2004 to 2006, the sector went through a dramatic structural and economic decline involving a contraction in the number of enterprises and of employees: the number of operating enterprises diminished by about 200 units, whilst the number of employees decreased by 1700 (Calamandrei, 2009). In the specific case of the Sicilian traditional ceramic sector, this decline can be related to many different issues including: entrepreneurs' difficulties in developing and using effective distribution channels; their attitudes with respect to effective collaboration; the growing competition, due to widespread imitations from emerging countries like China (Schilirò, 2010). This has continued to be a challenge to date.

Despite the decline and the marginal role that this sector has compared with the mainstream industrial sectors,<sup>1</sup> it is significant to underline the importance that the traditional ceramic industry has for the local economy of the aforementioned Italian regions, thus making it worthy of attention and requiring commitment of the involved stakeholders. Furthermore this crisis can be transformed into a large opportunity for re-launching this sector focussing on the exploitation of the quality and excellence of the products and on expanding attention on more sustainable and cleaner ways of manufacturing. This is already being done by the industrial ceramic sector. The latter sector has shown, in recent years, a growing interest towards environmental and sustainable production issues related to its production chains, mostly in the ceramic tiles sector. This is because tiles, as cladding systems for

walls and floors, are one of the most used materials in building construction applications, causing huge environmental impacts throughout their life-cycles due to: the high consumption of resources, water, and energy; the related emission to air and water; waste; and noise (Almeida et al., 2011; Huang et al., 2013; Pini et al., 2014). As a result, in the last decade many Life Cycle Assessment (LCA) studies have been performed in the industrial ceramic sector with the aim of realising environmentally sustainable production systems. In particular, several studies have been developed on topics such as the following ones:

- Comparative LCAs of flooring materials;
- Evaluation of the environmental performances of ceramic tiles and improvement proposals.

Regarding the first topic, it is possible to highlight the papers by Nicoletti et al. (2002), Bribián et al. (2011), and Mahalle (2011). In the first one, ceramic and marble tiles were compared with the aim of identifying the one with the best environmental profile and the linked hotspots. In the second one, the authors presented a comparative analysis of energy and environmental impacts and evaluated the eco-efficiency improvement potential for the most commonly used building materials (bricks and tiles; insulation materials; cement and concrete; wood products). Finally, the last paper developed a cradle-to-gate environmental profile for pre-finished hardwood flooring and comparisons with alternative flooring products such as carpets, ceramic tiles, vinyl cork, and linoleum flooring. Regarding the second topic, it is possible to highlight the papers by Corradini et al. (2008), Bovea et al. (2010), Ibáñez-Forés and Bovea (2011), and Pini et al. (2014). In particular, Corradini et al. (2008) focussed on the whole supply chain, from raw materials extraction through to finished product packaging; the study highlighted that the environmental impact is mostly due to non-renewable resources consumption (mostly fossil fuels) during the firing and (to a lesser extent) transport steps. As regards possible improvements, the authors focussed mostly on the logistics optimising. Bovea et al. (2010) covered all the steps from mining the red clay and atomising it, to the glaze manufacture, to the ceramic tiles production and deliver to customers. Their study highlighted that the biggest contribution to all the impact categories (except for destruction of the ozone layer and the indicator noise) is again the firing stage. Regarding possible improvement solutions, the authors focussed on two main processes: firing and pressing. Ibáñez-Forés and Bovea (2011) performed an environmental statistical analysis of ceramic tiles, taking into account the stages from the mining of the raw materials to the management of the tiles as construction and demolition waste at the end of their useful life. The greatest environmental impact for all the impact categories was the tile manufacturing process, followed by clay atomisation and product distribution. Finally Pini et al. (2014) analysed the life cycle of an innovative ceramic product, porcelain stoneware. This involved identifying environmental impacts, energy consumption and CO<sub>2</sub>e emissions that occur starting from the extraction of raw materials to production, distribution and to end-of-life stages, within a cradle to grave perspective.

Others studies were also performed focussing on the preparation of the sectorial Product Categories Rules (PCRs). Examples are the studies by Benveniste et al. (2010a, 2010b) and the development of a full Environmental Product Declaration (EPD) study by Almeida et al. (2013). The phase that caused the most environmental impacts is manufacturing. Global warming (GW) was also found to be one of the categories with the most environmental impacts, mainly due to the CO<sub>2</sub> emission in the firing stage. The ozone layer depletion impact category was far less significant. All

<sup>1</sup> In 2014, the Italian ceramic industry (which includes ceramic tiles, ceramic sanitary ware, refractory materials, and ceramic tableware) was comprised of 223 companies, which employed 26,000 employees, and had a turnover of 5.7 billion euros/year (75% of which was generated by exports) (Confindustria Ceramica, 2014).

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