Science of the Total Environment 635 (2018) 60–69

Contents lists available at ScienceDirect

Science of the Total Environment

journal homepage: www.elsevier.com/locate/scitotenv

Corporate carbon footprint for country Climate Change mitigation: A case study of a tannery in Turkey

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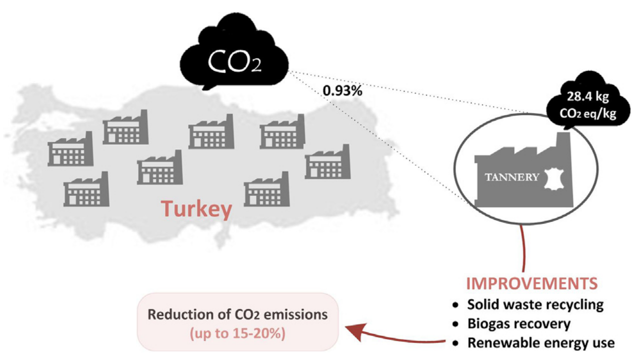
HIGHLIGHTS

- Inventory data for Turkish tannery published for the first time.
- Carbon footprint of tanneries and options for improvement presented
- Contribution of corporate carbon footprint (CCF) to Turkey's GHG mitigation strategy
- Turkish emission factors need to be published for wider CCF calculations.
- Findings important for Turkish companies to compete in international green markets

GRAPHICAL ABSTRACT



ARTICLE INFO

Article history:
Received 16 March 2018
Received in revised form 7 April 2018
Accepted 7 April 2018
Available online xxxx

Editor: Frederic Coulon

Keywords:
Sustainable production
Greenhouse gases (GHG) emissions
Turkish leather industry
Electricity mix
Waste recycling

ABSTRACT

Assessment of carbon emissions and environmental impact of production is indispensable to achieve a sustainable industrial production in Turkey, especially for those companies willing to compete in new international green markets. In this case study, corporate carbon footprint of a representative Turkish tanning company was analyzed. Inventory and impact data are presented to help in the environmental decision-making process. The results indicate that significant environmental impacts were caused during the landfilling of solid wastes as well as the production of the electricity and fuel required in the tannery. Turkish tannery inventory data presented here for the first time will be useful for leather tanning company managers to calculate sustainability key indicators.

Improving alternatives at country level were identified (increasing the renewable sources on electricity production and promote energy recovery in landfills) which would be useful not only to decrease greenhouse gas (GHG) emissions of tanning sector but also of other industries requiring electricity and producing organic wastes. Considering the substantial contribution of industrial processes to the Turkish carbon emissions (15.7%) (TUIK, 2013), work done on those areas would provide a sound improvement in environmental profile of Turkey. The importance to promote a national strategy to reduce GHG emissions in Turkey was discussed here, as well as its relation to corporate carbon footprint assessments.

One of the significant points revealed from the case study is the lack of published country specific emission factors for Turkey, which is a fundamental prerequisite to promote corporate carbon footprint assessment within the country.

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https://doi.org/10.1016/j.scitotenv.2018.04.111
0048-9697/

1. Introduction

1.1. Leather industry and climate change in Turkey

Turkey is considered as a newly industrialized country with a background of rapid economic growth. Industry is one of the three major contributors to CO_2 emissions Turkish economy (OECD/IEA, 2016). Although Turkey's greenhouse gas emissions (GHGs) as carbon dioxide equivalent (CO_2-eq) (6.02 t CO_2/capita) is below OECD[1] Europe average of 8.31 t CO_2/capita (Akbostancı et al., 2011; OECD/IEA, 2016) the shares of CO_2 emissions have increased by 118% in 2014 compared to the emissions in 1990 and reflects its rapid industrial growth and increase in energy consumption associated with increasing demand (TUIK, 2016). Furthermore in line with Turkey's development targets the level of CO_2 emission is foreseen to rise six-fold by 2025 with respect to the level of emissions in 1990 (Lise, 2006).

Leather and leather product industry is one of the foremost traditional sectors of Turkey, with an annual export value around US$ 1.3 million in 2015, and footwear is the most important item (51% of total leather goods exports) (Leather Wear Report, 2016). Over the past decade the evolution of climate change into a global concern and increasing awareness on the environmental impact of production processes has enforced leather manufacturers to provide more information and to meet higher environmental standards.

1.2. Leather processes and life cycle assessment

Life cycle assessment (LCA) is a widely accepted methodology that has proven its efficiency as a good decision-making tool for the assessment of the environmental burdens associated with production processes to move towards sustainable production practices. There are a number of applications of LCA methodology in the field of leather production at different geographical locations such as Spain, India, Chile etc.(Joseph and Nithya, 2009; Puig et al., 2007; Rivela et al., 2004) with various system boundaries comprising all system or only one process step (Castiello et al., 2008; Kiliç et al., 2011) and different flow references referring to the delivery of a leather surface area or to the tanning of a certain weight of raw hide (Milà et al., 1998; Notarnicola et al., 2011).

First applications of LCA on leather industry took place in the nineties at European tanneries. Milà et al. (1998) conducted a life cycle study in the Spanish leather industry on a cradle-to-grave basis in order to identify the environmental 'hot spots' in the footwear life cycle. These authors further applied LCA in order to detect the environmental 'hot spots' of chrome-tanned bovine leather industry and provide environmental information to The Autonomous Government of Catalonia for the establishment of environmental criteria in the Catalan eco-label. In both studies detailed inventory data was not provided. Only environmental results for chrome-tanned leather were presented for different impact categories (Milà et al., 2002).

Rivela et al. (2004) carried out a LCA by studying a representative leather tannery industry in Chile. Authors included both technical and economic analysis to quantify and evaluate the impacts of the chromium tanning process and further improvement actions were proposed. Joseph and Nithya (2009) made an attempt to investigate the material flows of Indian leather by applying a life cycle analysis approach in order to get an idea about the environmental burdens of leather products.

A number of life cycle assessment case studies were conducted to evaluate the environmental performance of alternative technologies in order to investigate the feasibility of applying cleaner production principles as a tool for improving the environmental and economical quality in the leather tanning industry. Within this context the soaking, unhairing and liming processes were evaluated under the LCA perspective and comparative environmental performances of the alternative methods were presented by various researchers (Castiello et al., 2008; Nazer et al., 2006). Nazer et al. (2006) applied LCA as a decision support tool to evaluate the net environmental benefits of using unhairing-liming liquids several times after being recharged with reduced quantities of chemicals and results were expressed in eco-points. Castiello et al. (2008) made another attempt to evaluate the actual reduction of the environmental impact of conventional unhairing process, by applying an alternative oxidative unhairing process that eliminates the use of sulphides. Another comparative LCA was carried out to analyze the environmental performance of chemical and enzyme-assisted soaking and unhairing/liming processes in a Chinese tannery. Environmental impacts of producing and delivering the enzymes to the tannery, chemicals and electricity savings have been evaluated in terms of energy consumption and contribution to global warming (Nielsen, 2006; Notarnicola et al., 2011) put some effort to analyze Spanish and Italian product-systems regarding bovine leather manufacturing, and carried out LCA to find out if the different technologies and management solutions adopted led to significant environmental differences in the two system analyzed. It is one of the detailed comparative LCA studies in European tannery systems with available inventory data regarding each phase of tanning process.

Waste minimization in tannery sludge management was another issue that has been evaluated under LCA perspective for environmental comparison of alternative processes. Kiliç et al. (2011) made some efforts to evaluate three tannery waste treatment scenarios: direct landfilling of sludge, chromium recovery prior to landfilling, and anaerobic digestion followed by oxidative chromium recovery and landfilling to investigate whether recovering chromium from tannery sludge reduce environmental impact of tanning. Bacardit et al. (2015) used LCA methodology to evaluate a patented alternative bovine leather processing system and compared to the existing traditional processes.

1.3. Leather processes and carbon footprint

Although LCA has proven its usefulness as a good environmental tool in quantifying the environmental burdens associated within life cycle stages of production processes, due to its wide scope and multiple impact categories, a higher worldwide trend of simplification (Baitz et al., 2013; Bala et al., 2010) focusing on a single indicator, carbon footprint, relevant to global warming (one of the impact categories evaluated through a LCA study) is gaining increasing interest. Carbon footprint (CF) of a product or service can be assessed at product level, following the LCA methodology for only this one impact category and following standards such as: PAS 2050 (2011), ISO 14067 (ISO 14067, 2013) or GHG Protocol for products (WBCSD, 2011b). It can also be assessed at corporate level, following standards such as: ISO 14064 (2006) or GHG corporate protocol (2004). Only a few studies have adopted a carbon footprint approach for the analysis of environmental burdens associated with leather production system. Chen et al. (2014) quantified the carbon footprints of the finished bovine leather in different thicknesses tanned in Taiwan through use of PAS 2050 (BSI PAS 2050, 2011). Some other studies focused on comparison of carbon footprint of alternative processes considering only the process under study. Kılıç et al. (2014) made some attempts and calculated greenhouse gas emissions and energy consumption associated with biodiesel production from tannery fleshings and further comparative assessment with rapeseed vegetable oil was also performed by the same authors (Kılıç et al., 2013). In another study carbon footprint of using a plant-derived biosurfactants in stead of conventional degreasing chemicals was reported by a preliminary work conducted by Kılıç et al. (2015b)

Xu et al. (2015) analyzed the environmental performance of a newly developed chromium-free tanning process compared to the conventional one in China. More recently GHG emissions derived from vegetable and chromium tanned leather processing technologies was

[1] Organisation for Economic Co-operation and Development.