



Full length article

# Decoupling municipal solid waste generation and economic growth in the canton of Vaud, Switzerland

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## ABSTRACT

Switzerland is one of the largest producers of municipal solid waste (MSW) per capita. The principle of decoupling attempts to evaluate the relationship between consumption and production, and to measure the relationship between an activity and its impact on the environment. This paper uses the Environmental Kuznets Curve (EKC) hypothesis to understand the impact of three socio-economic drivers on MSW generation in the canton of Vaud in Switzerland. Vaud is a French-speaking canton that recently implemented several measures to limit MSW generation. We used time series of indicators for income, urbanisation and policy implementation in ten of the canton's districts, which were set as independent variables, between 1996 and 2015. A panel data analysis was performed using a generalized least squares procedure to test for an EKC. Evidence shows that urbanization was slightly negatively associated with MSW generation, but without statistical significance. However, a direct policy mechanism such as the waste bag tax was significantly correlated with a decrease in waste generation. Overall, the presence of an EKC cannot be confirmed in the canton of Vaud, as waste generation tends to stabilize as income increases. It would be useful to perform a similar assessment in other cantons to fully inform decision-makers.

## 1. Introduction

In recent decades, cities have been affected by a growing amount of municipal solid waste (MSW), which puts a strain on waste disposal capacities and on the environment (Cointreau, 2006). The total municipal solid waste (MSW) generated worldwide in 2012 was approximately 1.3 billion tonnes (Hoornweg and Bhada-Tata, 2012). Were all countries to continue to generate waste at the current rate of high income countries, total waste generation could reach 5.9 billion tonnes by 2025 (Scheinberg et al., 2010). The positive correlation between waste generation and income level is often demonstrated in the literature; as disposable income and living standards increase, consumption of goods tends to follow, and waste generation increases accordingly (Hoornweg and Bhada-Tata, 2012; Irwan et al., 2013; Keser et al., 2012; Wilson et al., 2012). Therefore, it is urgent to take appropriate measures to decouple economic growth from waste generation (Sjöström and Östblom, 2010; Unnisa and Rav, 2013).

## 1.1. The concept of decoupling

The concept of decoupling, or delinking, has become a focus in economic studies, in order to understand the relationship between

consumption and production, and to measure the relationship between an activity and its impact on the environment. Is the elasticity of an environmental indicator relative to certain socio-economic drivers. This occurs when the value of the environmental indicator increases, but relatively less than the indicator of the driver (Mazzanti et al., 2008).

Economist Simon Kuznets originally identified an inverted U-shaped relationship between income levels and inequality (Kuznets, 1955). He posited that income inequality would increase and then decrease as income grew within a country. Kuznets (1955) used time-series data from the United States, the UK and Germany for his analysis.

The Environmental Kuznets Curve (EKC) hypothesis attempts to represent the decoupling of behaviours and to model a potential, inverted U-shaped relationship between an environmental indicator and indicators of socio-economic development. Household income's impact on environmental degradation often has an inverted-U shape when plotted (Grossman and Krueger, 1995). A large body of literature focuses on the relationship between income and air pollution (Galeotti et al., 2006; Jalil and Mahmud, 2009; Selden and Song, 1994), whereas the impacts of municipal solid waste are less investigated (Arbulú et al., 2015). Some studies do not support the inverted U-shaped relationship (Chen, 2010; Johnstone and Labonne, 2004; Karousakis, 2006), while others find some evidence of a turning point for MSW generation

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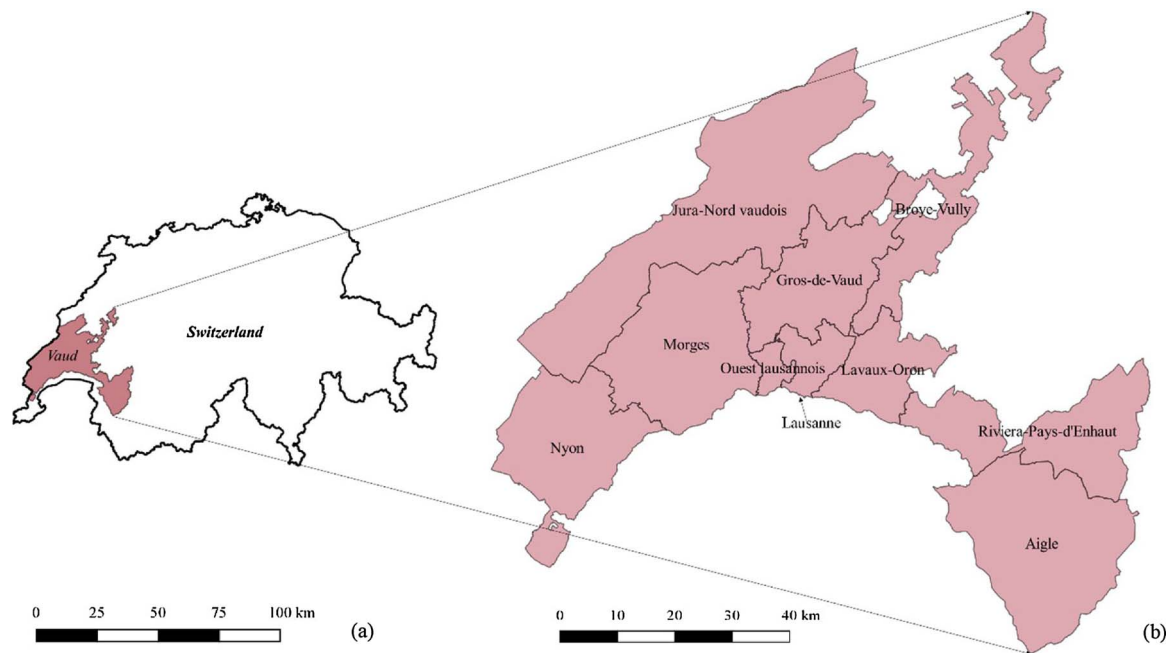


Fig. 1. Study Area.

Map (a) shows the location of the canton of Vaud in Switzerland. Map (b) shows the ten districts of interest in the canton of Vaud.

(Abrate and Ferraris, 2010; Arbulú et al., 2015; Khajuria et al., 2012; Mazzanti et al., 2008). An EKC may also arise only when residents show a diminishing marginal utility of consumption, but not when they consume more as their income increases (Swart and Groot, 2015). Economic growth is a recognised driver of urbanisation (Frenken et al., 2007; Moomaw and Shatter, 1996), and consequently a driver of change in terms of land-use. The impact of changes in land-use and the socio-economic variables associated therewith have been the focus of recent studies, wherein a positive statistical relationship was found between changes in land-use and MSW generation (George, 2015; Lei et al., 2016; Xiao et al., 2015), but a negative relationship was found between the density of dwellings and MSW generation (Chamizo-Gonzalez et al., 2016).

## 1.2. Waste management in Switzerland

Switzerland is attempting to implement a strategy of *avoidance, reuse, recycling* similar to that of the European Union with the revised Waste Framework Directive (2008/98/EU), which introduced a new version of the “Waste Hierarchy”. It stipulates that waste prevention, reuse and recycling should be prioritized over other types of recovery and disposal into landfills unless proven otherwise. However, increasing MSW generation is a growing concern in the context of demographic growth and economic development, which trigger high levels of urban sprawl (Jaeger and Schwick, 2014).

MSW generation increased from 603-kg per capita in 1990 to 729-kg per capita in 2014 (Federal Office for Environment (FOE, 2016). This growth is largely associated with consumption habits, higher amounts of organic waste and the limited lifespan of electronic equipment. Despite high recycling rates (approx. 50%) and efficient waste disposal, waste generation reflects natural resource consumption, which is one of the greatest challenges for the country (Federal Office for Environment (FOE, 2016). For example, in order for the entire world population to match Swiss consumption levels, the amount of resources necessary would be equivalent to that of three Earths (Federal Office for Environment (FOE, 2016).

Switzerland is a federation with twenty-six sovereign states called cantons. Each canton has its own government and parliament. Cantons are further divided into districts and municipalities, which results in

decentralized public political power and potential discrepancies with regard to waste management strategies. The canton of Vaud is located in the western French-speaking region of Switzerland. In Vaud, MSW is defined as the “waste produced by households, and those with similar a composition produced by industries, small-businesses, agriculture and tertiary activities” (Directorate General for the Environment (DGE, 2016). Incinerable waste and recyclable waste (i.e. paper, cardboard, glass, organic waste and metals) are MSW. The canton has designated areas for waste management within the canton that roughly corresponds to the district boundaries. Municipalities are required to evaluate the quantities of MSW, separated at source or not, and to communicate the results to the canton. The results are then cross-validated and aggregated by district. In this study, data on MSW generation are preferred to data on waste composition because MSW generation trends are more diverse across districts than is the evolution of waste composition. The canton has established several measures to limit MSW generation, which were applied differently across the various districts. For example, a ‘waste bag tax’ was officially introduced for the entire canton in 2013 to finance the treatment of MSW, but many municipalities in the northern districts had already introduced it as early as 2008.

The aim of this research is to understand the relationship between three socio-economic drivers (i.e. income, urbanisation and policy implementation) and MSW generation in the canton of Vaud using four corresponding indicators (Section 2.2.1). The objectives are (i) to understand MSW generation trends in the canton at the *district* level, (ii) to test for the presence of an EKC, and (iii) to determine whether a correlation exists between MSW generation and important socio-economic drivers.

## 2. Study area and data

### 2.1. Study area

The study area is the canton of Vaud, which, administratively speaking, is divided into ten districts: Aigle, Broye-Vully, Gros-de-Vaud, Jura-Nord Vaudois, Lausanne, Lavaux-Oron, Morges, Nyon, Ovest Lausannois and Riviera-Pays-d'Enhaut (Fig. 1). The canton had a population of 767,497 inhabitants in 2015. The least populated district

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