ARTICLE IN PRESS
STOTEN-24370; No of Pages 8
Science of the Total Environment xxx (2017) xxx–xxx
Contents lists available at ScienceDirect
Science of the Total Environment
journal homepage: www.elsevier.com/locate/scitotenv

The economic impact of agricultural pollutions in Iran, spatial distance function approach

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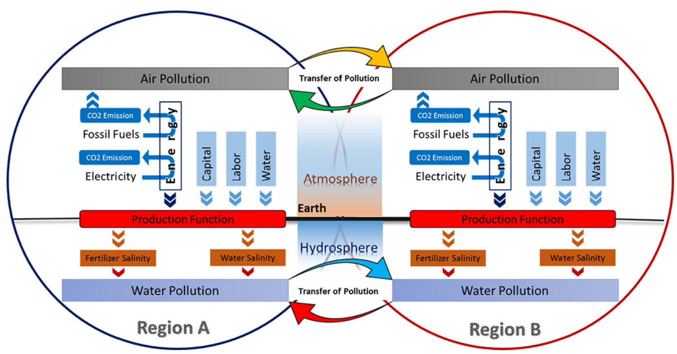
HIGHLIGHTS

- Pollution due to agricultural activities in Iran has increased during the last two decades.
- This spatial output distance function can be used as a new method in estimating the value of externalities.
- This finding refers to the importance of considering the spatial dimension in analyzing the shadow price of pollutions.

GRAPHICAL ABSTRACT



ARTICLE INFO

Article history:
Received 5 July 2017
Received in revised form 14 October 2017
Accepted 14 October 2017
Available online xxxx

Editor: D. Barcelo

Keywords:
Agricultural pollutions
CO_2 emission
Spatial distance function
Water salinity

ABSTRACT

Pollution has increased in Iran in the last two decades due to agricultural activities. Pollutions are released into the atmosphere and thereafter pollute water and soil resources. Therefore, it is important to develop models that can estimate the economic value of these Pollutions. For this purpose, a Spatial Output Distance Function was used in the present study to estimate the shadow price of carbon dioxide emission and water salinity in spatial and temporal dimensions. This method can be used as a new method to estimate the value of externalities. In this study, the data of provinces in Iran during 1995–2014 were used. The results showed that the total shadow price of agricultural Pollutions was equal to 42.54 dollars per unit. In addition, the effects due to the adjacency of regions to each other led to the transfer of pollution and its externalities were equal to 26.3 dollars per unit of pollution. This finding refers to the importance of considering the spatial dimension when analyzing the shadow price of pollutions caused by production. Thus, internalizing the damage caused by pollutions based on the adjacency of regions to each other can increase the efficiency of the production environment.

1. Introduction

Studies on environmental effects caused by agricultural activities in water, soil, and weather sectors have increased in recent years (Yaqubi et al., 2016). The growth of agriculture (Mosavi and Esmaeili, 2012) with excessive water consumption in Iran (Najafi Alamdarlo et al., 2016) and more use of fertilizers (Lepistö et al., 2001) have polluted water resources (Maillard and Santos, 2008; Salehi et al., 2017). The subject of pollution due to agricultural activities in Iran is one of the important challenges of the agricultural sector and has increased in the last two decades. This condition can affect the environment of Iran and cause challenges for sustainable agriculture (Bijani et al., 2017).

Undesirable (bad) outputs were produced with desirable (good) products simultaneously (Zhou et al., 2014), which is often due to the inputs used in the production process. Therefore, energy consumption

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https://doi.org/10.1016/j.scitotenv.2017.10.146
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in the agricultural sector led to the emission of CO_2 in the atmosphere (Najafi Alamdarlo, 2016a, 2016b; Mosavi, 2016). Thus, the pollutions caused by agriculture is emitted into the atmosphere and transferred to water and soil resources. A certain strategy should be defined for beneficiaries based on the emission of environmental pollutions (Rong et al., 2017). Also, these pollutions move both on the ground and under the ground leading to the transfer of pollutions in adjacent regions. As shown in Fig. 1, agricultural activities in region A were produced by using water and other inputs. Using such inputs leads to the emission of pollution on the ground and under the ground. For example, the groundwater salinity occurs as a result of water extraction and use of fertilizers. The created pollution in region A spreads to the adjacent regions. Thus, region B can be polluted as a result of the agricultural activities in another region. Due to the importance of this subject (pollution), models that can analyze such pollutions are needed. Thus, because the main objective of this study was to estimate the economic value of pollutions caused by agricultural activities, the contribution of this study is in estimating the economic effects of environmental pollutions due to proximity to another polluted region.

Many studies have shown that shadow prices are the best instruments for applying environmental control. One way of estimating the undesirable output of shadow price is to use the distance function (Zhou et al., 2014). The studies of Färe et al. (1993), Coggins and Swinton (1996), and Swinton (1998) are among the early studies that used the Translog distance function to estimate the shadow price of Pollutions. This approach was also used to estimate the shadow price of pollutions caused by agricultural activities in various studies. Studies on agricultural Pollutions are divided into two parts. The first part is comprised of studies conducted to estimate the shadow value of Pollutions in the hydrosphere while the second consists of studies that estimated the shadow value of Pollutions released in the atmosphere.

In the first part, McClelland and Horowitz (1999) reported the shadow price of water pollution caused by the wood industry and Hernández-Sancho et al. (2010) believed that this value can be effective in choosing the best investment in water treatment. Molinos-Senante et al. (2011) estimated the environmental benefits of improving water quality. Bostian et al. (2015) examined the tradeoff between water quality and agricultural production in Spain. Molinos-Senante et al. (2016) stated that the shadow value for water leakage in Chile was 32% of the water price.

In the second part, more studies have been conducted to estimate the relationship between environment and agriculture using the distance function and they are often classified into three groups. The first group of studies investigated the environmental impacts of the entire agricultural sector at the national or regional level (Ball et al., 2000; Färe et al., 2006; Kiani, 2014; Rosano-Peña and Daher, 2015; Tang et al., 2016a, 2016b, 2016c; Mosavi et al., 2017; Xu and Lin, 2017; Tang et al., 2016a, 2016b, 2016c). The main objective of these studies was to estimate the productivity and environmental efficiency of the agricultural sector. In the second group, studies were conducted to assess the relationship between crop production and its pollution (Rezek and Perrin, 2004; Yaqubi et al., 2016). Here, the target was to obtain a shadow price and use it as an environmental control mechanism. The third group of studies evaluated the pollutions in agricultural-related industries, which in these studies often sought to obtain real prices for agricultural products (Murty et al., 2006; Chakravorty et al., 2007(.

However, in both spheres (atmosphere and hydrosphere), the spatial effects of pollution transfer were disregarded and no study was conducted to estimate the environmental effects caused by the proximity of regions to each other. Thus, the present study was conducted to develop a Spatial Distance Output Function model (SDOF) to obtain the shadow price of pollutions caused by proximity to other polluted regions and estimate the environmental shadow price caused by pollutions in each region. In fact, this model also provides a new approach for estimating the externalities. This study was organized as follows: the next section includes the research methodology and properties of a spatial distance function model; the third section provides the discussion on the research findings and the final section presents the conclusion.

2. Methodology

2.1. Output distance function (ODF)

Parametric and non-parametric methods can be used to estimate the shadow price (Tang et al., 2016a, 2016b, 2016c), but the non-parametric method is not appropriate for estimating the shadow price of Pollutions (Färe et al., 2005). Thus, many studies used parametric method for their estimation (Färe et al., 2006; Du et al., 2015; Tang et al., 2016a, 2016b, 2016c). Distance function is one of the best methods for obtaining the shadow price of environmental Pollutions (Recka, 2011). Output distance function measures the efficiency of the current technology to

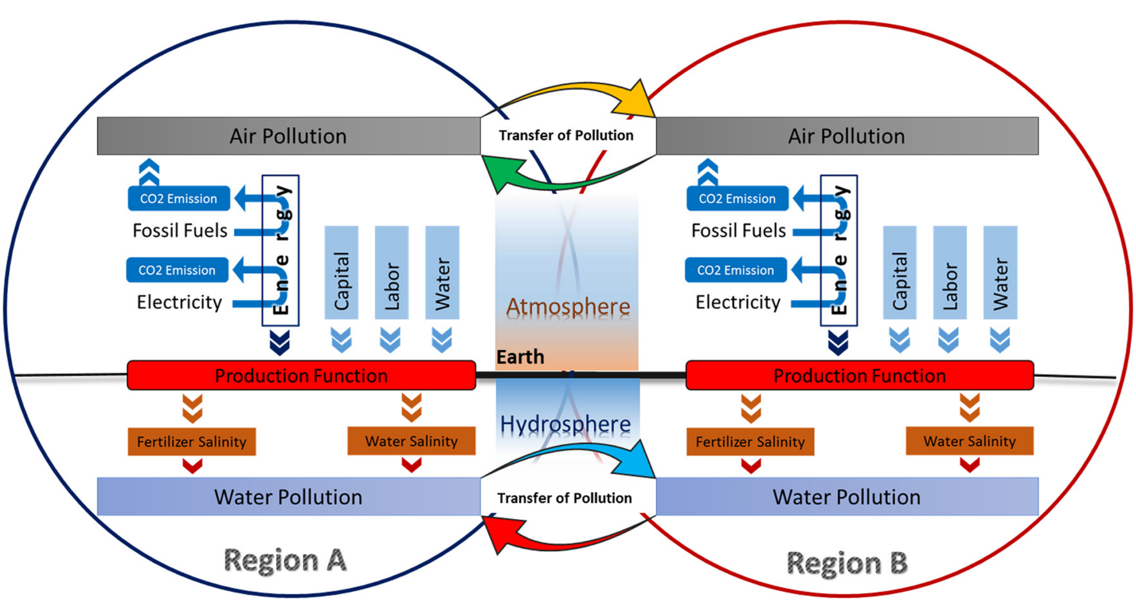

Fig. 1. Agricultural pollutions in three dimension (Atmosphere, Hydrosphere and Adjacency regions).

Please cite this article as: Najafi Alamdarlo, H., The economic impact of agricultural pollutions in Iran, spatial distance function approach, Sci Total Environ (2017), https://doi.org/10.1016/j.scitotenv.2017.10.146