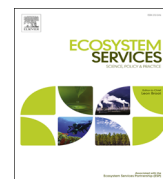




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Are the major imperatives of food security missing in ecosystem services research?



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ABSTRACT

It has been widely recognized that food security depends on the sustainable use and provisioning of ecosystem services. The goal of this paper is to present an overview of the scientific literature on ecosystem services and food security, with a major focus on case studies of farming communities in Africa, Asia, and Latin America, in order to answer the following research questions: (1) does ecosystem services research generate knowledge that helps to address the major imperatives of food security?, and (2) are the multiple linkages between ecosystem services and food security analyzed or assumed in research? The results of the study highlighted that food utilization, access and stability, which are the major food security challenges in the world, remained under-investigated. There is a major bias on food availability in relation to crop production, and most articles assumed that food security would improve by increasing crop productivity, but this hypothesis remained largely untested. Other research blind-spots were co-production, trade-offs and off-site effects of ecosystem services in relation to food security, gender and cultural services. The study concludes that ecosystem services research needs to improve efforts to generate knowledge that helps to address the main imperatives of food security.

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1. Introduction

The ecosystem services framework is broadly applied for assessing the multiple relations between ecosystems and human well-being (Millennium Ecosystem Assessment, 2005). Ecosystem services offer multiple material and non-material benefits to people, which are grouped into four broad categories including provisioning (e.g. wild foods, cooking fuel and fresh water), regulating (e.g. pollination and maintenance of soil fertility), supporting (e.g. habitats for species and maintenance of genetic diversity) and cultural services (e.g. spiritual experience and sense of place) (TEEB, 2015). Human well-being is affected by the flow of ecosystem services, which depends on ecosystem composition and function. Certainly, a major component of well-being is food security, which is not only related to the satisfaction of a basic need but also to human nutrition and health (McMichael et al., 2007). Although ecosystem services from natural and anthropogenic landscapes are critical for the food security of the rural poor in developing countries (Richardson 2010), 60% of the ecosystem services of the world are degraded or used unsustainably (Barbier, 2008).

The World Food Summit defined food security as a condition that exists 'when all people, at all times, have physical and economic access to sufficient safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life' (FAO, 1996). In order to achieve food security it is necessary to simultaneously ensure four complementary pillars: availability, access, utilization and stability. Food availability is related to having sufficient supply of food and is related to the level of food production. The access to food refers to having adequate physical access, entitlements or economic resources to acquire food. Food utilization is related to the nutritional status of a person and is understood as having the energy and nutrients necessary for a healthy life, which involves food preparation, dietary diversity, feeding practices, intra-household distribution of food and access to clean water. Food stability refers to the capacity to ensure that the other three dimensions are fulfilled over time, for instance during lean months and periods of environmental, political or economic instability (FAO, 2008). However, nowadays 805 million people in the world do not have enough food for a healthy and active life, including 226.7 million undernourished people in Africa, 525.6 million in Asia and 37 million in Latin America and the Caribbean (FAO et al., 2014). Despite the fact that food production and agricultural productivity have increased in the world, they are not sufficient to ensure that most vulnerable groups have access to food, and have sufficient food stability, which is the pillar that has made the least progress in the last decades due to volatility of international food prices, political instability (FAO et al., 2014), changes in climate patterns and climate extreme events, incidence of crop and pest diseases and reduction of water availability. In addition, in 2013 about 33% of all stunted children were from Asia and Africa (UNICEF et al., 2014) where undernutrition is widespread (UNICEF, 2015). Certainly, hunger eradication, reduction of child mortality, improvement of maternal health and environmental sustainability are among the Sustainable Development Goals.

It has been widely recognized that food security depends on the sustainable use and provisioning of ecosystem services (Millennium Ecosystem Assessment, 2005; Poppy et al., 2014b; Richardson, 2010). Ecosystem services influence directly and indirectly each one of the pillars of food security (Richardson, 2010), for instance, supporting the production of food and providing wild foods (availability), providing resources that are the basis of rural livelihoods and income generating activities (access to food), bringing resources that are necessary for sanitary food preparation and a diversified diet (utilization), and regulating climate and

water flows (stability). On the other hand, increases in global food production occur to a great extent at the expense of essential ecosystem services and loss of biodiversity through i.e. land use change for agricultural production or unsustainable collection of forest products (Richardson, 2010; UNEP, 2011), as well as at the expense of dietary diversity (Khoury et al., 2014). Food insecurity, hunger and malnutrition are inextricably linked with ecosystem service degradation and scarcity of resources, among other factors. It is certainly necessary to meet the dietary needs of an increasing population in a way that it is socially and environmental sustainable (Godfray et al., 2010; Richardson, 2010).

However, information about the manifold direct and indirect linkages that exist between ecosystem services and food security is really scattered across different journals and disciplines. There are various literature reviews that evaluate the state of the art of ecosystem services. For example: on ecosystem services in general (Seppelt et al., 2011; Vihervaara et al., 2010), with regarding to mapping values (Schägner et al., 2013), agriculture (Tancoigne et al., 2014a), economic valuation (Laurans et al., 2013), or limited to a certain geographical region (e.g. Balvanera et al., 2012 for Latin America). But there are no studies so far that present a detailed bibliographic review of ecosystem services in relation to the four pillars of food security. This is certainly necessary in order to provide beneficial information for designing future ecosystem services research agendas that would be realistically aligned to the major challenges that the world is facing with regard to food security.

The goal of this paper is to present an overview of the scientific literature on ecosystem services and food security, with a major focus on case studies of farming communities in Africa, Asia, and Latin America, given that in developing countries child malnutrition is higher in rural than urban areas (Smith et al., 2004). Does ecosystem services research generate knowledge that helps to address the major imperatives of food security? Are the multiple linkages between ecosystem services and food security analyzed or assumed in research? In order to answer these questions we proposed the following objectives: (1) to analyze the trends in ecosystem services research addressing food security issues (temporally, spatially and topic-wise), (2) to evaluate the occurrence of the different pillars of food security (availability, access, utilization and stability) in relation to ecosystem services research as reflected in case studies from Africa, Asia, and Latin America, (3) to analyze the nature of the links reported between ecosystem services and food security, and the inclusion of issues of co-production of ecosystem services (human enhancement of ecosystem service provision in the anthropogenic landscape), trade-offs and gender as part of the case studies.

2. Methods

Firstly, in order to analyze the trends in ecosystem services research addressing food security issues (objective 1), a literature review was conducted. We started by searching for peer reviewed journal articles published before 2014 including ecosystem services and food security in title, keywords or abstract using the Scopus[®], ScienceDirect[®], Web of Science[™] and EBSCOhost databases. The keywords used were 'ecosystem services' and 'food security', with the Boolean 'AND'. The 'AND' is inclusive, thus it allowed to have a corpus of articles that include both concepts in each article. In Scopus[®] and ScienceDirect[®], the keywords of the query were entered in the 'title-abstract-keywords' field option, where author keywords and indexed keywords are not differentiated (Tancoigne et al., 2014b). The field option used in Web of Science[™] was 'topic' including researching the keywords in title, abstract, author keywords and indexed keywords fields. The query

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