



Looking into Pandora's Box: Ecosystem disservices assessment and correlations with ecosystem services

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ABSTRACT

The concept of ecosystem disservices (EDS) has received much less attention than the concept of ecosystem services (ES). Using an expert-based matrix approach, we assessed the capacity of ecosystem types of the Scarpe-Escaut Regional Natural Park (France) to both provide ES and generate EDS. The matrix is a look-up table that provide for each ecosystem types a score expressing its ES capacity. Our results point to a lower capacity of the considered ecosystems to provide EDS than ES. On average the EDS scores were 60% lower than the ES scores. Of EDS, those linked to human health are the most critical, with higher capacity scores and higher expert' confidence scores than other EDS than those linked with economic or ecological impacts. We analysed correlations between ES and EDS, the presence of strong and significant positive correlations suggests that the same ecosystem characteristics, ecological functions or species groups may generate both ES and EDS. We emphasise that it is important to evaluate both EDS and ES to implement management of the ecosystems, while respecting the functioning of the ecosystems, to develop positive effects while limiting negative ones.

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1. Introduction

The positive contributions of ecosystems to human life and well-being are well-attested, but we cannot ignore negative effects arising from characteristics of ecosystems that are economically or socially harmful, or that endanger health or are even life-threatening (Dunn 2010; Lele et al., 2013; Stoll et al., 2015). Although the use of the ecosystem services concept has expanded considerably over the last decade, it is generally not combined with actual consideration of the negative aspects of the natural environment (Schaubroeck, 2017). Although some authors even advocate that the current ecosystem service consideration equilibrate the age-old practice that nature is accounted only for costs (Shapiro and Baldi, 2014). A quick search on Scopus (in July 2017) returned 126 papers on EDS ("article and review", "all year", "ecosystem* disservice") and 21,248 papers on ES ("article and review", "all year", "ecosystem service"), this means that only 0.6% of published studies focused on EDS. However, there has been an increase in the

Abbreviations: ES, ecosystem service; ET, ecosystem types; EDS, ecosystem disservices; RNP, Regional Natural Park; SE-RNP, Scarpe-Escaut RNP; Conf. Score, Confidence scores.

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number of papers since 2009 on the adverse effects of ecosystems, reflecting its increasing recognition (Von Döhren and Haase, 2015). Negative or dangerous effects of ecosystems are recognised (Kareiva et al., 2007).

The concept of ecosystem disservices (hereafter EDS) has generated debate in the last few years (Barot et al., 2017; Lyytimäki, 2014a; Lyytimäki et al., 2008; Schaubroeck, 2017; Shapiro and Baldi, 2014; Villa et al., 2014). The EDS concept and its assessment have been challenged because they may be perceived as sending a "wrong message", and so may hamper conservation efforts through induced misconceptions (Villa et al., 2014). As discussed by Lyytimäki (2014a), Von Döhren and Haase (2015) and Shackleton et al. (2016), the concept of EDS has varied over time, and so there is a wide range of other definitions, such as "functions or properties of ecosystems that cause effects that are perceived as harmful, unpleasant or unwanted" (Lyytimäki, 2014b), or "negative ecological effects or impacts have been described as harmful consequences of ecological change or as deficient ecosystem services caused, for example, by the loss of biodiversity" (Von Döhren and Haase, 2015). The disservices were also considered under different names related to their impacts (plagues, pests, floods, diseases...) since the dawn of civilization (Shapiro and Baldi, 2014).

Mirroring the definition of ecosystem services (ES), "the goods or services provided by ecosystems that directly or indirectly benefit humans" (MEA, 2005), ecosystem disservices (EDS) can be

defined as “the ecosystem-generated functions, processes and attributes that result in perceived or actual negative impacts on human well-being” (Shackleton et al., 2016).

In the papers published on EDS, several characteristics of the concept can be set out. For present purposes, we will first make a non-exhaustive description of the EDS concept. As presented in Fig. 1,

- An EDS can be triggered as an indirect effect of management (orange dotted arrow) by impaired ecosystem functioning. Nuisances resulting from side effects of management practices are considered as negative externalities, but the response of ecosystems to management practices can induce negative effects on the human well-being, and so are considered as EDS (Barot et al., 2017; Lyytimäki, 2014b; Shackleton et al., 2016). For example, health problems resulting from pesticide spraying are negative externalities of agricultural ecosystems management (direct effect of management), whereas resistant weed invasion following pesticide spraying is a management-induced EDS (indirect effect of management, Barot et al., 2017; Lyytimäki, 2014b).
- An EDS can be the reverse of an ES, i.e. a “negative provision” (green box). It is the opposite of an existing ES, as it is negatively perceived and/or can generate costs (mainly concerning regulation services). For example, greenhouse gas sequestration is an ES in the CICES (Common International Classification of Ecosystem Services, Haines-Young and Potschin, 2013; Hof et al., 2011), yet some ecosystems generate net emissions of greenhouse gases such as CO₂, CH₄ or N₂O (Burgin et al., 2013): it is thus the balance between the production and sequestration of greenhouse gases that ultimately defines whether the ecosystem provides an ES or an EDS.
- An EDS can be directly related to ecological characteristics or functions (red dashed arrow). Some EDS are linked to

specific species, such as species that harm human health (pathogens, parasites), species that cause pest damage (Lele et al., 2013) or animal attacks (Dunn, 2010).

- An effect can be regarded as either an ES or an EDS depending on the point of view of the individuals or societal groups considered, but also depending on space and time (blue double line, Rasmussen et al., 2017, Saunders & Luck, 2016; Shackleton et al., 2016; Vaz et al., 2017). The same function or species can even be perceived as providing simultaneously both ecosystem services and disservices by the same individual or different ones (Lele et al., 2013). For example, hedges can be used to block out a view: some individuals will consider this positive, while others will consider it a nuisance.

The diversity of methods that can be used for assessing EDS is as broad as those used to assess ES. They include EDS assessments based on interviews and discourse analysis (Fischer & Eastwood, 2016), with newspaper text analyses (Lyytimäki, 2014b; Kopperoinen et al., 2014), with a quantitative evaluation (Dobbs et al., 2014) and with monetary valuation (Schaubroeck et al., 2016). EDS and ES are mostly assessed separately on specific ecosystems, e.g., on urban ecosystems (Lyytimäki et al., 2008), on urban forests (Dobbs et al., 2014; Escobedo et al., 2011), on agroecosystems (Sabatier et al., 2013), or on ranch lands (Swain et al., 2013). Kopperoinen et al. (2014) assess “according to how favourable or harmful the areas represented by them are in potentially providing each ES” with a scale from “3 = Very favourable” to “−3 = Very harmful”, and so assess an EDS as a negatively provided ES.

In our study, to use the metaphor of Shackleton et al. (2016), we unpacked and looked into the Pandora’s Box of EDS: we set out to evaluate the capacity of ecosystems to provide ES and generate EDS using an expert-based scoring approach (Campagne et al., 2017), the capacity matrix approach (explained in the next section).

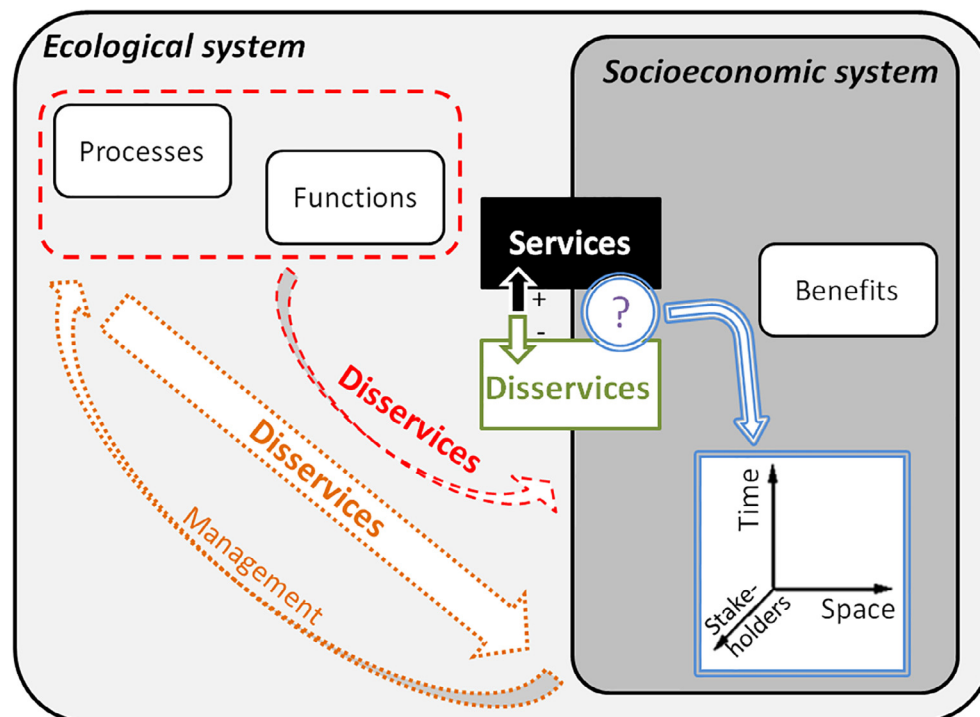


Fig. 1. Distinction between EDS resulting from the ecosystems management (orange dotted arrow); EDS from ecological processes and/or functions (red dashed arrow); EDS as a “negative provision” of ES (green box) and depending on the point of view of individual or societal groups, space and time, effects of the same ecosystem can be considered as either ES or EDS (blue double line).

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