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Life Cycle Assessment in spatial planning – A procedure for addressing systemic impacts

Morten Bidstrup*, Massimo Pizzol, Jannick Højrup Schmidt

Aalborg University, Department of Development and Planning, Denmark

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ABSTRACT

Spatial planning establishes conditions for societal patterns of production and consumption. However, the assigned Strategic Environmental Assessments (SEA) tend to have a too narrow focus. In particular, there is a need for applying a system perspective in SEA, extending assessment beyond the spatial boundaries of a plan to further focus on global, indirect and cumulative impacts. These impacts are referred to as "systemic impacts". This study proposes a Life Cycle Assessment (LCA) procedure which can be adopted in SEAs of various types of planning. The procedure represents a first step towards operationalising LCA in SEA by adjusting LCA methodology to focus on the ways planners and planning processes can influence the environmental impacts of interconnected activities. The proposed procedure was tested on a case study of Danish extraction planning, and it was found to generate new knowledge for decision support. The procedure enabled identification of key systemic impacts, as well as it enabled formulation of recommendations for how to address these impacts in planning processes. On a more general level, this article demonstrates an application of LCA which until now has received little attention, and it highlights the role of spatial planners in facilitating cleaner production.

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1. Introduction

Patterns of traffic, industry, production and resource supply form the backbone of local and regional development. However, they also generate unwanted environmental impacts, and environmental assessment has thus for decades been an integrated part of preparing the spatial plans regulating these activities. In particular, the Strategic Environmental Assessment (SEA) is highlighted as a tool which can facilitate sustainable development (Fischer, 2007; Partidário, 2012; Therivel, 2010) by introducing sustainability principles in planning processes and generating transparency about alternatives (Stinchcombe and Gibson, 2001). Because SEA is performed at the plan level[1] (or higher), it allows influence on the combination and the characteristics of project proposals from a wider perspective. In doing that, it enables a consideration of development alternatives where cumulative and synergistic impacts can be considered (Johnson et al., 2011; Therivel, 2010). This is an important characteristic of SEA since a strategic viewpoint can provide an alternative perspective on the rationale of decisions. A projected wastewater discharge from a proposed project may e.g. seem negligible when viewed upon independently, while it could represent a contribution to a cumulative wastewater overload on a local recipient when viewed upon strategically. A new resource intensive industry may reversely seem polluting locally, while it may represent an opportunity for industrial ecology and cleaner production from a strategic viewpoint.

Yet, experiences from various international studies conclude that current SEA practice has major shortcomings in this regard. Studies from both Europe (Bragagnolo et al., 2012; Stoeglehner, 2010; Söderman and Kallio, 2009), North America (Noble, 2004) and Asia (Zhou and Sheate, 2011) all conclude that SEAs tend to have a too narrow scope and that they do not address cumulative impacts. Tetlow and Hanusch (2012) emphasise that such SEA improvement is generally needed. Yet, such improvement entails assessing impacts which extend beyond the geographical boarders of the region in scope and beyond the timeframe of the plan in scope, changing the assessment paradigm from a plan/project focus towards a system focus (Gunn and Noble, 2011).

SEA must, in addition to assessment of direct and onsight impacts, thus also focus on how a plan's embedded activities influence

* Corresponding author. Tel.: +45 99407200.
[1] SEA is a tool applicable to plans, programmes and policies (often referred to as PPP). This article solely deals with SEA in planning.

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and interact in systems. This, however, is a difficult task since impacts exist on diverse scales of space (local, regional, national and global) and time (short-term vs long-term), often appearing indirectly (a consequential action sparked elsewhere). With an outset in the assessment scope currently lacking in SEA practice, this article proposes the term "systemic impacts" to cover the global and long-term impacts (induced both directly and indirectly) of proposed plan activities.

Introduction of Life Cycle Assessment (LCA) in SEA practice has since the late 1990's been advocated as a potential means for addressing such systemic impacts in spatial planning (Owens, 1997; Tukker, 2000). LCA is the study of impacts assigned to societal products or services, and it is defined as a "*compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product system throughout its life cycle*" (ISO, 2006). The ability to predict global, long-term and indirect impacts across the life cycle of products and services makes LCA an analytical tool which can complement SEA (Bjorklund, 2012; Finnveden and Moberg, 2005; Fischer, 2007; Jeswani et al., 2010; Loiseau et al., 2012; Manuilova et al., 2009). Yet, the communities of scientists and practitioners working with respectively SEA and LCA remain rather segregated despite their common focus of supporting environmentally sound decisions. A standard is currently in development on how to apply LCA to policy proposals (WRI, 2014), but there exist little consensus on how to apply the tool in planning.

Many LCA studies have to date dealt with topics typically covered by SEA, such as urban water management (Lemos et al., 2013; Niero et al., 2014), forest management (Berg and Lindholm, 2005; Valente et al., 2011) and waste management (Prapaspongsa et al., 2010; Quek and Balasubramanian, 2014). Yet, such studies are typically limited to concluding on a preferred technical option, after which it is assumed that someone somewhere will be supported by these LCA results when making a decision. Some authors have described how LCA can support decisions in regard to a proposed plan (Bjorklund, 2012; Lundie et al., 2004; Nilsson et al., 2005), while recent work propose "territorial LCA" for baseline analysis of the functions on a given territory (Loiseau et al., 2013). However, little LCA research has until now focussed on what happens in between baseline studies and finished plan proposals – the process of planning. This research builds on the idea that LCA knowledge must add value within planning processes in order to be influential in practice. SEA is the established tool through which such support can be provided.

Integrating LCA as an analytical tool in SEA is ultimately an act of operationalising LCA in spatial planning processes. However, this requires research on how to adapt LCA methodology to fit SEA and spatial planning processes as well as research on how to use such LCA application to support better decision-making in practice. The research of this article primarily focuses on adapting LCA methodology by proposing and testing an LCA procedure which can be adopted in the analytical phase of SEA. The research is interdisciplinary and it represents a first step towards bridging the research communities working with environmental analysis through respectively LCA and SEA.

The article opens with a brief description of how LCA could fit within the framework of SEA, after which the proposed LCA procedure is presented. The procedure is then tested on a case study of Danish extraction planning, which is taken as a starting point for discussion and reflection on the performance and limitations of the procedure. The article concludes by summing up the experiences gained from the test.

2. The proposed procedure for LCA in SEA

2.1. Ensuring better planning with SEA

SEAs (or SEA-like processes) are required for plans likely to generate substantial environmental impacts in the European Union (The European Parliament, 2001), USA (USEPA, 2000), Australia, China, Korea (Fischer, 2007), South Africa and several other countries (OECD, 2006). Many definitions of SEA exist; however, Fischer (2007) describes it as a "systematic decision support process, aiming to ensure that environmental and possibly other sustainability aspects are considered" when e.g. preparing spatial plans. SEA processes can vary, but frameworks typically include:

a) screening for the necessity of SEA,
b) scoping of the issues that need to be addressed,
c) assessment of planning alternatives, and
d) environmental reporting.

The basic purpose of planning is to determine a suitable course of action (a plan) for reaching desirable development objectives. A planning process will typically yield a plan proposal (based on initial prioritisations), which then subsequently is adjusted and approved in cooperation with key stakeholders. Decision-making theory and decision processes are broad research topics which go beyond the scope of this present article. However, it is widely recognised that integration of SEA in the planning process (as opposed to using SEA solely for plan approval) is a key element in producing effective and influential decision support (Partidário, 2012; Therivel, 2010; van Doren et al., 2013). When integrated, SEA generates knowledge on how to avoid, minimise or compensate environmental burdens while planners are considering the alternatives way of reaching planning objectives (Fischer, 2007).

2.2. Fitting LCA in SEA

As recommended by Fischer (2007), this study proposes to introduce LCA as a "*technique*" in the assessment of planning alternatives within the SEA framework (bullet **c** in Section 2.1). This, however, can be challenging due to the very same differences which make the tools complementary.

SEAs typically focus on alternative ways of reaching the development objectives of the plan in scope, considering alternative configurations of activities and/or applications of technology within the spatial boundaries of the region in scope. Yet, this focus on the development of and the impacts on a specific region (producing a plan) contrasts with the product-oriented paradigm of LCA, which focuses on the total impacts assigned to a Functional Unit (FU). Hence, the merge of these two tools for environmental analysis depends on the extent to which the spatially delimited development objectives of SEA (and the available alternatives) influence a quantifiable flow of products or services which can be expressed as an FU and modelled with LCA. In essence, LCA can only add value in SEAs which change the demand for products and services or which influence the ways by which these are supplied.

The proposed procedure of Section 2.3 therefore focuses on how planning choices can influence production and service systems. Planning is, quite simply, established as a model variable which through regulation of activities within a region generates differences in the demand for, or the supply of, products and services. The proposed procedure should be perceived as a supplementary analysis, which can be applied in SEAs where the scoping phase (bullet **b** in Section 2.1) reveals a concern for systemic impacts

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