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Applying an improved rapid impact assessment matrix method to strategic environmental assessment of urban planning in China

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ABSTRACT

Strategic environmental assessment (SEA) has become an increasingly important decision-support tool for providing information on the environmental implications of a policy, plan, or program. The goal is to safeguard the environment and promote sustainable development at the strategic level. Despite major progress in implementing SEA practices internationally, developing countries, such as China, often lag behind in applying SEA methodology. Lack of available data and time constraints arising from tight schedules create problems. The rapid impact assessment matrix (RIAM) is a potential resource for breaking through such difficulties. Our analysis of RIAM applications suggested that it could become a tool for evaluating strategic alternatives because of its applicability in interdisciplinary settings, its transparency, and its short implementation timeframe. To make it more suitable for the SEA context, we have developed two major improvements to the conventional RIAM process: assignment of weights to assessment indicators and the development of an integrated environmental assessment score (IES). The improved RIAM process was employed in an SEA of the development plan for the Nansha District in Guangzhou, the capital city of Guangdong Province in China. It was used to assess five alternatives for development in Wanqingsha (WQS), a subunit of Nansha, where important ecological resources are located and where industrial development could impact the air quality in the neighboring Hong Kong Special Administrative Region (HKSAR). The evaluation identified WQS-A04 as the preferred alternative. This alternative involved a minimal amount of industrial development – 10% compared with the most intense development alternative – and included important wetland preservation plans. The assessment results have been incorporated into the officially approved development plan for Nansha. The improved RIAM methodology is well adapted to the technical aims of SEA and decision-making structures in China. It offers the potential for delivering timely and quality results to decision-making processes. To achieve the desired efficiency, it is recommended that an SEA procedure take into account findings acquired from an improved RIAM application at an early stage, then, at a later stage, results from more comprehensive assessments conducted using more sophisticated methods should be added, if time and data are available.

1. Introduction

Strategic environmental assessment (SEA) is a formalized, systematic and comprehensive process for evaluating the environmental impacts of a policy, plan, or program (PPP). The process includes the identification of alternatives for the proposed PPP and requires the preparation of a written report on the findings of the evaluation and an incorporation of the findings in a publicly accountable decision-making process (Thérivel and Partidário, 1996; Thérivel et al., 1992). In recent decades, SEA has been applied throughout the world in a variety of sectors and in various ways to predict and evaluate the potential environmental impacts of policies, plans or programs, as well as to identify and evaluate alternatives to avoid, mitigate or compensate for these impacts (Chaker et al., 2006; Lemos et al., 2012; Thérivel, 2004; Wang et al., 2009; Zhu and Ru, 2008).

1.1. EIA and SEA in China

Environmental Impact Assessment (EIA) was launched in China in 1979 with the enactment of the Environmental Protection Act of the People's Republic of China. The EIA procedures described in this law focused principally on projects and initially the law was applied primarily to capital construction projects. Over time it became apparent that this project focus failed to adequately address environmental and sustainability concerns at the early stages of policy formulation. As a result, Chinese researchers and government officials turned to ideas associated with the emerging SEA process. After intensive development, especially at the strategic levels of planning and programming, SEA procedures and the Ordinance for Plan Environmental Impact Assessment (PEIA) were the centerpiece of the EIA Act of the People's Republic of China that became operational in 2003 (Li et al., 2012; Wu et al., 2011). An

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updated version of the Ordinance for PEIA was promulgated in 2009. At the present time, the Chinese SEA or PEIA system is applied to ten types of specific plans, among which urban planning is a special focus of both SEA research and practice (Wu et al., 2011). By incorporating ecologically friendly, low carbon emission and least waste principles into urban planning processes, the PEIAs have made large contributions to China's rapid and enormous urbanization and re-building program, an effort that includes the goal of moving the country in a sustainable direction.

Experiences in China and in other countries have shown that the benefits of SEA applications are closely related to the timely consideration of appropriate issues and alternatives (Fischer, 2007). Alternatives are options, choices, or courses of action that provide the means for accomplishing specific goals (Steinemann, 2001). Explicitly, they are the means by which the central aim of SEA – providing high-level environmental protection and integrating environmental considerations into the decision-making process – can be achieved. To identify and evaluate alternatives for a PPP in a systematic way, SEA researchers and users have developed diversified tools and methods, including life-cycle assessment (Finnveden et al., 2009), cost-benefit analysis (Abaza et al., 2004; OECD, 2006), fore- and back-casting modeling (Fischer, 2007), carrying capacity analysis (Zhao et al., 2008), and Monte Carlo techniques (Liu et al., 2010). While these methods have contributed to the evaluation of alternatives, problems and challenges remain in the implementation of the SEA process.

1.2. Problems with SEA

Among the chief problems are the formidable costs associated with the acquisition of sufficient information for SEA projects that cover large geographical areas or reach across multiple sectors, the excessive time required to train persons to utilize and effectively execute complex models, and the increased difficulties in communicating with stakeholders – decision-makers and public citizens – who usually lack an understanding of the models that are regularly employed in SEA projects (Alshuwaikhat, 2005; Che et al., 2011; Zhou and Sheate, 2011). These problems, resulting in delayed responses, daunting costs, and complicated assessment results, may seriously impede the ability of SEA procedures to improve decision-making. Thus, among other things, the SEA process is sometimes perceived as being too difficult, time consuming, and costly. This is especially true in developing countries where time constraints and limited budgets for the development of SEA projects are the norm (Dalal-Clayton and Sadler, 2005). Therefore, it is imperative that time and cost-saving methods for assessing SEA alternatives be developed which are systematic, objective, transparent, and participatory. For this purpose, the rapid impact assessment matrix (RIAM), a tool that has been widely used in project level EIAs, is deemed to be the preferred method.

1.3. Overview of RIAM

The RIAM, first developed by Christopher M. R. Pastakia in 1998, is a tool that enables the user to compare the impacts of alternatives under consideration in an EIA (K. Jensen, 1998; Pastakia and Jensen, 1998). Essentially, the RIAM process is a grading system that employs a matrix to record quantitative judgments based on pre-defined criteria. The scores in the matrix can be transposed into ranges that describe the degrees of positive and negative impacts ascribed to the alternatives under study (El-Naqa, 2005). The system is suitable for EIAs in which a multi-disciplinary team approach is used because it allows for data from different components and perspectives, recorded in a matrix format, to be analyzed against important assessment criteria (Pastakia, 1998).

Since its development, the RIAM methodology has been used successfully in EIA projects as diverse as sewage disposal (A. Jensen, 1998), thermal power plant optimization (Baba, 2007), and solid waste landfills (El-Naqa, 2005; Iman Momeni, 2011; Mondal and Dasgupta, 2010).

In these applications the RIAM has been shown to be a tool that enables researchers to organize the EIA process and to provide a transparent and permanent record of the analyses that are performed (Mondal and Dasgupta, 2010). Furthermore, when compared with other assessment methods, the simple structure of the RIAM allows the user to perform multiple analytical runs to compare different options on a comparable basis. This can be followed with re-analyses as needed and in-depth investigations of selected environmental components; all of which can be performed in a rapid and precise manner (Mondal and Dasgupta, 2010).

1.4. RIAM and SEA

With the accelerated development of SEA methodology worldwide, increasingly discussions have occurred about the potential for applying the RIAM method, or other similar approaches to SEA processes. Kuitunen et al. (2008) has suggested that the RIAM methodology could be used to compare and rank distinct PPPs based on their negative or positive impacts. A practical application of this method to an SEA type project has occurred in Kuwait, where a study was conducted of the rapid evolution of coastal morphological landscape changes caused by anthropogenic activities (Baby, 2011). However, there have been few examples where the RIAM methodology has been applied in well-defined SEAs. It is clear that some improvements are needed in the conventional application of the RIAM methodology to project-based EIAs in order to adapt it to the features and requirements for assessing PPP alternatives.

The intention of the study reported herein was to develop an improved RIAM process to assess strategic options and alternatives for SEAs in the field of urban planning. In doing so, an objective was to minimize costs and time requirements while, at the same time, ensuring assessment quality. The proposed RIAM methodological improvements were designed to address disadvantageous factors contained in conventional approaches, such as the assignment of equal weights to indicators, a shortcoming that is reported in a number of otherwise relevant studies. Another need is to enhance the technical aims of the SEA process, including the delivery to decision-makers of an integrated assessment of alternatives. The improved RIAM methodology was then applied to the urban planning SEA of the Nansha District, located in Guangzhou, the capital of Guangdong Province in South China. The area of study is situated in the southern tip of mainland China, approximately 60 km north of the Hong Kong Special Administrative Region (HKSAR). As part of the study, consideration was also given to the question of whether the improved RIAM methodology adequately addresses the technical requirements that are specified in China's Ordinance for Plan Environmental Impact Assessment (PEIA); if it does so, an explication of the way in which these requirements are met was also of interest.

2. Improving RIAM procedures for evaluating alternatives

A conventional RIAM matrix is constructed from a set of well-defined assessment criteria and a collection of specific environmental indicators or components. The environmental indicators are carefully chosen for the purpose of evaluating the potential impacts of the alternatives that are being considered (Pastakia and Jensen, 1998). With the assessment criteria typically arrayed as the columns of the matrix and the indicators as the rows, the cells are comprised of numbers which provide a measure of the expected impacts of the indicators when measured against the assessment criteria. Technically, the assessment process is comprised of four steps that must be completed in sequence: Step I — create a set of indicators, Step II — provide numerical values for the indicators, Step III — compute environmental scores and Step IV — evaluate the alternatives. To make this method more adaptable