Chapter 9
Investigation of Environmental Monitoring Designs for Corporate Management Information Systems

Marina G. Erechtchoukova
York University, Canada

Stephen Y. Chen
York University, Canada

Peter A. Khaiter
York University, Canada

ABSTRACT

The evaluation of an organization's environmental performance is an integral part of a corporate environmental management information system. This chapter considers an organization's environmental impact assessment with respect to a water resource. It investigates formal approaches to the development of temporal monitoring designs for producing data sufficient to perform the assessment. In this study, simple random sampling, stratified random sampling, and designs obtained using greedy search have been investigated with respect to their compatibility with a corporate environmental management information system. All three approaches determine temporal monitoring designs with minimal costs and supply data sufficient for estimation of water quality indicators for a given level of uncertainty. It is shown that monitoring designs obtained using the greedy search approach will outperform other designs when the level of uncertainty in the estimate must be low. If high levels of uncertainty are tolerable, simple random designs become preferable due to their simplicity and effectiveness. The proposed approaches lead to automated procedures which can be easily integrated into a corporate environmental management information system.

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INTRODUCTION

There is an increasing awareness that the health and socio-economic well-being of our society are inherently tied to the quality of the environment. Systematic methods to address the adverse environmental impact of business activities on the environment are needed. One such approach has been formulated as a set of protocols underlying environmental management systems. The environmental management systems verify and reduce the impact of an organization's activities on the environment. These systems also help organizations to formulate environmental goals and to evaluate how well they have been achieved through sustainable management. An organization's environmental performance evaluation can be done by measuring 'the interactions between the business activity and the environment' (Bennett & James, 1999). According to ISO 14031 standard, the evaluation of an organization's environmental performance has to be done by using two general categories of indicators which describe the management and operation performance and the environmental condition indicators that reveal the organization's impact on the environment.

The challenge with sustainable management of an environmental resource is to assess the current status, predict future states of the resource under an organization's impact, and determine direct and indirect consequences of the impact on natural systems. The assessment of an environmental resource state and the quantification of an organization's impact on the resource are performed using observations and measurements of environmental parameters that provide information about changes in environmental conditions. Following a systems approach to monitoring and evaluation, the assessment must take into account all major aspects of the resource. Monitoring and assessment are interrelated steps since the first supplies the data for the second, and the assessment step dictates what needs to be measured and/or observed, how it should be implemented, where it needs to be measured and/or observed, and when (i.e., how often) observations and measurements have to be performed.

This chapter considers environmental impact assessment with respect to a water resource, and it investigates formal approaches for temporal monitoring design subject to producing sufficient data for the assessment of an organization's impact on an aquatic environment.

BACKGROUND

An organization's environmental performance evaluation is a multi-step process. There are several frameworks for an environmental management system. European Union's Eco-Management and Audit Scheme (EC, 2001) and EPA's Performance Track and the Code of Environmental Management Principles (US EPA, 1997) are among them. One of the most popular frameworks for an environmental management system was described in ISO 14001 standard (ISO, 2004). This framework requires the development of an environmental policy and the assessment of its fulfillment through four steps: (1) planning, (2) implementation and operation, (3) checking and corrective actions, and (4) management reviews. Monitoring and measurements are critical steps of the process since they supply decision makers with data and information on all steps of the performance evaluation (Stapleton et al., 2001).

Environmental Performance Evaluation

The ISO 14001 standard provides generic recommendations to organizations on how to incorporate environmental management into their operations and governance, but it leaves the details of a particular implementation outside of the document. The details of various implementations have been investigated for case studies (e.g., Lopez-Fernandes & Serrano-Bedia, 2007; Christini et