Using Ontologies to Relate Resource Management Actions to Environmental Monitoring Data in South East Queensland

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ABSTRACT

The Health-e-Waterways Project is a multi-disciplinary collaboration between the University of Queensland, Microsoft Research and the South East Queensland Healthy Waterways Partnership (SEQ-HWP). This project develops the underlying technological framework and set of services to enable streamlined access to the expanding collection of real-time, near-real-time and static datasets related to water resource management in South East Queensland. More specifically, the system enables water resource managers to access the datasets being captured by the various agencies participating in the SEQ HWP Ecosystem Health Monitoring Program (EHMP). It also provides online access to the statistical data processing tools that enable users to analyse the data and generate online ecosystem report cards dynamically via a Web mapping interface. The authors examine the development of ontologies and semantic querying tools to integrate disparate datasets and relate management actions to water quality indicators for specific regions and periods. This semantic data integration approach enables scientists and resource managers to identify which actions are having an impact on which parameters and adapt the management strategies accordingly. This paper provides an overview of the semantic technologies developed to underpin the adaptive management framework that is the central philosophy behind the SEQ HWP.

Keywords: Adaptive Resource Management, Ecoinformatics, Environmental Monitoring, Ontologies, Semantic Querying

INTRODUCTION

Climate change, urban development and population growth in South East Queensland are applying significant pressure to urban water supplies. Billion dollar investments are being made in new water projects, such as the South East Queensland Water Grid, with the aim to enhance and secure water supply to the region. However the potential benefits of these mas-

sive investments in physical infrastructure will not be fully realized, without the investment in corresponding *cyberinfrastructure*. Scientists, urban planners and policy makers require access to integrated water information management systems that enable them to track water movement, consumption and quality across the "whole-of-water-cycle". They require access to high quality, complete datasets and accurate predictive models on which to base water management decisions. Understanding and satisfying the competing needs of water users, requires the integration of data and models that reflect the behaviour of many systems including: climate, rainfall, catchments, reservoirs, rivers, agricultural demand, industrial demand and urban demand. The linking of models requires a detailed understanding of: the questions being asked, the data that is available and the relationships between the datasets and models being employed. In parallel with the demand for more sophisticated querying and decision support interfaces, there is a trend towards wide-spread deployment of sensors capturing real-time information including volume flows, water quality, images and video. These real-time and near-real-time, temporal and visual data streams require more sophisticated, high speed, data processing, indexing and archival services.

This paper describes the Health-e-Waterways Project – a cross-disciplinary collaboration between information scientists and water resource managers and stakeholders that is developing the knowledge management infrastructure for adaptive whole-of-water-cycle management in South East Queensland. It begins by describing the challenges faced by South East Queensland Healthy Waterways Partnership (SEQ HWP) in managing the data associated with their Adaptive Management Strategy and Ecosystem Health Monitoring Program (EHMP). It goes on to describe the ontology-based knowledge management system developed by Health-e-Waterways to enable the integration and analysis of a wide range of data types. More specifically it describes the ontologies that have been developed, the system architecture and the query, reporting and visualization interfaces – that are enabling scientists and policy makers to identify trends in ecosystem health indicators both geographically and temporally and to understand the impact that water resource management actions are having on water quality.

THE SOUTH EAST QUEENSLAND HEALTHY WATERWAYS PARTNERSHIP

South East Queensland Healthy Waterways Partnership (SEQ HWP) was established in 2002 by government, industry and community stakeholders working in close cooperation to develop a whole-of-government, whole-of-community approach to understanding and managing the region's waterways. The key elements of the SEQ HWP strategy include: the implementation of targeted management actions (ranging from upgrades of sewage treatment plants to rehabilitation of riparian vegetation); a multidisciplinary science, research and monitoring program that underpins the management action program and monitors its effectiveness; and the Healthy Waterways promotional and educational program (Bunn et al., 2007). Moreover the SEQ HWP is underpinned by an "Adaptive Management" approach as illustrated in Figure 1. "This approach recognizes that management intervention can't be postponed until all of the information required to fully understand the situation is available" (Bunn et al., 2007). As a result, monitoring data is continually acquired through a comprehensive Ecosystem Health Monitoring Programme (EHMP) (EHMP, 2010), analysed and assessed to monitor the effectiveness of management actions, that are then adapted as required. The EHMP comprises two sub-programmes – the Estuarine and Marine EHMP and the FreshWater EHMP.

The *Estuarine and Marine EHMP* began in 2000 and includes monthly monitoring of water quality parameters at 260 sites in coastal waterways from Noosa to the New South Wales border. This program monitors a range of physical/chemical and biological indicators

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