Environmental Informatics for Sustainable Development

Carlos Granell
European Commission - Joint Research Centre, Institute for Environment and Sustainability, Italy

Sven Schade
European Environment Agency, Shared Environmental Information System (SEIS) Support Programme, Denmark

INTRODUCTION

The targets of sustainable consumption and development require strong contributions across the economic, social and environmental sector. Amongst others, research activities on impact assessment, integrated modelling, simulations and policy analysis related to the environment put high demands on the information science community. The large amounts of data sets require data–intensive technologies to enable data access, processing, analysis and visualization. Due to the high degree of spatial, temporal and semantic heterogeneity between data sets – but also of simulation, analyses and processing algorithms – the requested high quality scientific contributions to software tools and applications for grand environmental challenges can rarely be provided in a timely manner nor reused in further scenarios with similar needs and requirements. Policy makers, modelers and environmentalists still miss maintainable implementations from the environmental informatics community to address challenges, such as sustainable use of natural resources, and biodiversity loss.

This article briefly explores the notion of *Sustainable Development* in general and then focuses on the demands for software applications and related Information and Communication Technologies (ICT) in the environmental sector in particular. It provides a detailed description of *Environmental Informatics* and its possible contributions to the sustainable development arena. Finally, it identifies opportunities for subsequent development steps based on relevant and evolving ICT technologies. This particularly addresses how the potential range of ICT technologies can be combined, used, and re-used to promote scalable, evolutionary, and easy maintainable environmental software products. The Internet and its future evolvement are identified as fundamental enabling technologies.

BACKGROUND

In this section we focus on the notion of sustainable development and its demands to the environmental sector. The role of environmental informatics is defined in this context.

Sustainable Consumption and Sustainable Development

The terms –consumption and development– reflect two sides of the same coin. Both terms give priority to the integration of our planet and environment from complementary perspectives. Understanding *sustainable consumption* is needed to identify the essential patterns that define everyday life consumption behaviour of our today's society that unavoidably has environmental impacts (Spaargaren & Oosterveer, 2010). Sustainable consumption practices involve necessarily a sum of interrelated factors such as economic and political settings, technological invocations as well as cultural and social behaviours, which must be analysed as a whole (Mont & Power, 2010). *Sustainable development* on the other hand is primarily focused on development and economic growth taking into account environmental implications (Wass et al., 2011). In the literature sustainable development and sustainability terms have slightly connotations but we treat here as interchangeably terms. In the following we focus on the latter term: sustainable development.

The term sustainability or sustainable development, as understood today, can be traced back to the early 1970s (Du Pisani, 2006). A milestone in the adaptation of the concept of sustainability was the publication of 'The limits to Growth' (Meadows, 1972). This book concluded that the growth of the human population together with a constant increase in prosperity and wealth would cause an ecological collapse within the fifty years. The publication propelled the awareness of ecological problems, and progress and economic growth embraced the concept of sustainable development as a compromise between development and conservation, which were disconnected issues within nations' economic and political agenda. The 1987 report from the UN World Commission on Environment and Development (UN, 1987) defined sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." The Brundtland report uses the terms "sustainable development," "sustainable," and "sustainability" interchangeably, emphasizing the three pillars in which sustainable development sits: economic, social and environmental (Figure 1)

Sustainability is increasingly becoming a concern to government, industry, academic institutions, and citizen in general and needs to be addressed from a trans-disciplinary, integrated and collaborative ap-

proach. In this context, Griggs et al. (2013) refined the UN vision of sustainable development to shift from the traditional three independent pillars (Figure 1) into a unified framework that aggregates these three dimensions (Figure 2). This way, economic productivity and growth influence our society which in turn lies with the Earth's life support systems. In such a new context, safeguarding the Earth and environmental systems becomes a priority for current and future generations (Griggs et al., 2013).

Sustainability in the Environmental Sector

Looking into the environmental sector, sustainability is rapidly gaining a great importance. The need to continuously align policies, resource management strategies, and implementation directives to current environmental and ecology challenges is critical to support environmental sustainability. For instance, Audsley et al. (2006) conducted a study on agriculture land use that helps us to figure out the crucial role of sustainability in Earth and environmental sciences. The authors described how the elaboration of future scenarios for agricultural land use that considered distinct variables such as climate and socio-economic

Figure 1. Economic, social and environmental pillars that frame the UN view for sustainable development (adapted from the Brundtland report)
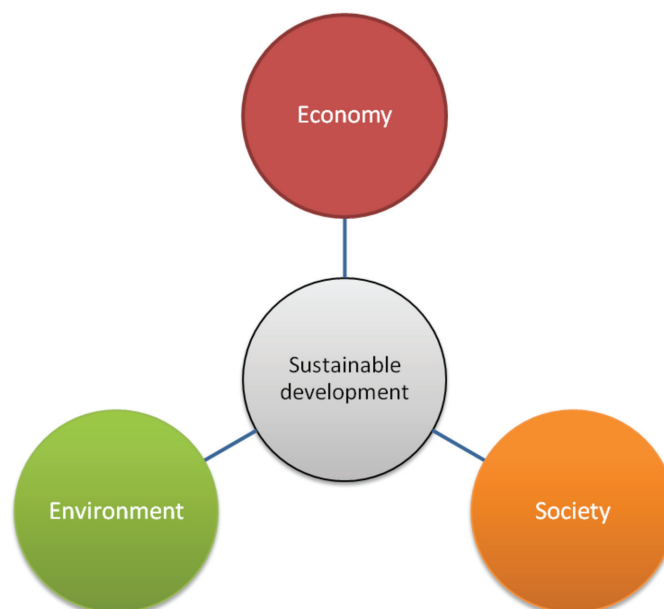
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