# Modelling and Knowledge Management for Sustainable Development

Antonio Cerone[1] and Alexeis Garcia-Perez[2](✉)

[1] UNU-IIST — International Institute for Software Technology,
United Nations University, Macau SAR, China
ceroneantonio@gmail.com
[2] Faculty of Engineering and Computing, Coventry University, Coventry, UK
ab1258@coventry.ac.uk

**Abstract.** This paper introduces the motivation and aim of the *1st International Symposium on Modelling and Knowledge Management for Sustainable Development (MoKMaSD 2012)*, inspired by the POST-2015 UN Development Agenda. Then the keynote paper and the four contributed papers presented at the Symposium are summarised and related to the POST-2015 UN Development Agenda.

## 1 Introduction

The 2012 Report to the UN Secretary-General "Realizing the Future We Want for All" by the UN System Task Team on the POST-2015 UN Development Agenda [6] identifies and elaborates the four core dimensions "where progress will be needed in coming years and decades in order to build a rights-based, equitable, secure and sustainable world for all people":

1. *inclusive social development*;
2. *environmental sustainability*;
3. *inclusive economic development*;
4. *peace and security.*

*Inclusive social development* aims to ensure people's rights to health and education through preventive, curative and promotional health services, intervention on the environment to provide sanitation and hygienic standards as well as training, childhood education and lifelong learning. Prevention and long-term planning require the ability to manage and integrate rapidly changing information about both natural environment and social development, and create computational models to simulate the implementation of preventive measures, human intervention on the environment and government policies.

The core dimension of *environmental sustainability* is essential in achieving success in inclusive social development. Humans live in a global environment and their survival depends on the sustainability of such global environment, which includes land, water, natural resources, biomass and climate. Damage

A. Cerone et al. (Eds.): SEFM 2012 Satellite Events, LNCS 7991, pp. 149–153, 2014.
DOI: 10.1007/978-3-642-54338-8_12, 

to any component of the global environment affects all other components and, as a consequence, threatens the integrity of the global environment. Therefore "immediate priorities in preserving environmental sustainability include ensuring a stable climate, stopping ocean acidification, preventing land degradation and unsustainable water use, sustainably managing natural resources and protecting the natural resources base, including biodiversity." Furthermore "ecosystem-based approaches to adaptation can provide a win-win opportunity for reducing vulnerabilities, as part of national adaptation strategies" [6].

"Sustainable development involves stable, equitable and inclusive economic growth, based on sustainable patterns of production and consumption." Any modelling approach and policy analysis has to aim to *inclusive economic development*, through sustainable development and better governance, and align "the imperatives of macroeconomic stability and financial sustainability with broader structural development policies enabling adequate generation of productive employment and decent work, reduction of poverty and inequalities, low-carbon as well as resource-and waste-efficient economic growth, and welfare protection" [6].

Better governance also means compliance with and adaptability to international laws and principles of inclusion and participation as prerequisites to maintain *peace and security*.

The *1st International Symposium on Modelling and Knowledge Management for Sustainable Development (MoKMaSD 2012)* was inspired by the POST-2015 UN Development Agenda and originated as a development of the special track on "Modelling for Sustainable Development" of the 9th International Conference on Software Engineering and Formal Methods, held on 14–18 November 2011, in Montevideo, Uruguay. The aim of the Symposium, held on 2 October 2012 in Thessaloniki, Greece, was to bring together practitioners and researchers from academia, industry, government and non-government organisations to present research results and exchange experience, ideas, and solutions for modelling and analysing complex systems and using knowledge management strategies, technology and systems in various domain areas, including economy, governance, health, biology, ecology, climate and poverty reduction, that address problems of sustainable development.

The keynote paper and the four contributed papers presented at *MoKMaSD 2012* show how to use modelling techniques (Sect. 2) or knowledge management frameworks (Sect. 3) to address the core dimensions of the POST-2015 UN Development Agenda.

## 2 Modelling for Sustainable Development

The formalisation of process calculi in both constructive and classical logics, as carried out in recent years, may be combined with other techniques such as concurrency and individual-based modelling, to develop knowledge representation schemes which could help overcome some of the challenges of current knowledge management systems. In their keynote paper, Kahramanoğullar, Lynch

and Priami [5] present an integrated approach to ecosystem modeling from an algorithmic systems biology point of view. They use a modelling interface, called LIME, to provide models written in a narrative style, which are then automatically translated into stochastic programming languages.

Individual-based modelling can be used to model and understand how biological or social systems are organised and governed, but they can also help study individual aspects of population dynamics and their interaction with the surrounding environment, including human beings and their interventions and policy enforcement. Barbuti, Cerone, Maggiolo-Schettini, Milazzo and Setiawan [1] present a new formalism, Grid Systems, aimed at modelling population dynamics, which uses rewrite rules to integrate capabilities of membrane computing, spatiality dynamics and stochasticity. Such integrated approach supports the inclusion in the ecosystem model of aspects of the interaction between the population under analysis (here a mosquito population, vector of fatal diseases) and the human population. This makes the approach suitable not only for analysis of population dynamics but also for epidemiological simulation.

The two works above provide modelling frameworks that address the core dimension of *inclusive social development*. System dynamics is an interdisciplinary method to enhance learning about dynamic complexity and sources of policy resistance in complex systems. Because system dynamics draws on cognitive and social psychology, organisation theory, economics and other social sciences, studying system dynamics may help the Knowledge Management community understand and influence change in organisations. In this sense, the use of system dynamics yields models that aim to address *environmental sustainability*. Bernardo and D'Alessandro [2] analyse various policies that may promote the transition to sustainability, with a particular focus on the energy sector, and present a dynamic simulation model where three strategies for sustainability are identified (eduction in GHG emissions, improvements in energy efficiency and the development of the renewable energy sector) and the dynamics they may produce in the economy is evaluated.

## 3 Knowledge Management for Sustainable Development

Knowledge management includes important dynamic aspects, such as knowledge transfer and adaptivity, which requires a synergistic approach that incorporates modelling.

Bolisani, et al. [3] consider knowledge transfer between distant organizations and explore recent literature with the purpose to highlight relevant formal approaches that can help model and analyse the processes of inter-organisational knowledge transfer for sustainable development. In this context, modelling and simulation may help investigate

- the effectiveness of knowledge transfer mechanisms that can be adopted in the light of potentially conflicting stakeholders goals;
- how beneficial protective mechanisms may be for economic development;

– the role of co-operation where companies with complementary competencies can fruitfully share and integrate their knowledge, and can benefit of mutual learning.

This analysis represents a first step towards a synergistic approach to modelling and knowledge management. In addition, it addresses the first three core dimension of the POST-2015 UN Development Agenda described in Sect. 1.

Adapting to and complying with frequently changing legislation quickly against low costs is an important pre-requisite to guarantee *peace and security* in governance. Moreover, this requires organizations to adapt their business processes automatically. Gong and Janssen [4] use semantic representation of legal knowledge and present a modelling framework that enables the automatic creation of business process by invoking Semantic Web Services (SWS).

## 4 Conclusion

The works presented at the *1st International Symposium on Modelling and Knowledge Management for Sustainable Development* show that development of synergistic approaches to modelling and knowledge management can be very effective in supporting Sustainable Development.

However, there are other important aspects of Development, both in science and society, that go beyond Sustainability and generally benefit of such synergistic approaches. In biology and medicine, large amounts of data are analysed, often using data mining techniques, to extract pattern and organise and manage knowledge to be then used, for instance, as a basis for the selection of optimal genetic engineering techniques and drug dosages. At the same time, but in separate studies, modelling techniques are used for similar purposes. Analogously, behaviour and interaction within societies are investigated through sentiment analysis to extract moods, learning attitudes as well as various indicators of social processes such as collaboration, while in alternative studies evolution and adaptation within societies are investigated through modelling and simulation. Therefore, in the future, we would like to enlarge the scope of the MoKMaSD symposia towards such more general directions.

## References

1. Barbuti, R., Cerone, A., Maggiolo-Schettini, A., Milazzo, P., Setiawan, S.: Modelling population dynamics using Grid Systems. In: Cerone, A., et al. (eds.) SEFM 2012 Satellite Events, LNCS, vol. 7991, pp. 172–189. Springer, Heidelberg (2012)
2. Bernardo, G., D'Alessandro, S.: Transition to sustainability: Italian scenarios towards a low-carbon economy. In: Cerone, A., et al. (eds.) SEFM 2012 Satellite Evens, LNCS, vol. 7991, pp. 190–197. Springer, Heidelberg (2014)
3. Bolisani, E., Scramoncin, F., Shaikh, S.A.: Models of knowledge transfer for sustainable development. In: Cerone, A., et al. (eds.) SEFM 2012 Satellite Events, LNCS, vol. 7991, pp. 198–203. Springer, Heidelberg (2014)

4. Gong, Y., Janssen, M.: A framework for translating legal knowledge into administrative processes: dynamic adaption of business processes. In: Cerone, A., et al. (eds.) SEFM 2012 Satellite Events, LNCS, vol. 7991, pp. 204–211. Springer, Heidelberg (2014)
5. Kahramanoğulları, O., Lynch, J.F., Priami, C.: Algorithmic systems ecology: experiments on multiple interaction types and patches. In: Cerone, A., et al. (eds.) SEFM 2012 Satellite Events. LNCS, vol. 7991, pp. 154–171. Springer, Heidelberg (2014)
6. UN System Task Team on the POST-2015 UN Development Agenda. Realizing the future we want for all - report to the secretary-general. Technical report. United Nations, New York, June 2012