# Environmental semantics for sustainable development in an interconnected biosphere

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**Please Note: This is an extended abstract for a 15 minute talk during the plenary session.**

***Abstract*— Development unavoidably impacts the ecosystems constituting Earth's biosphere, often producing complex outcomes across a range of spatial and temporal scales. The interconnectivity of global ecosystems and their varied responses to disturbance necessitate great caution when using or encountering terms such as "sustainable" and "sustainability". The Environment Ontology (ENVO; www.environmentontology.org) is coordinating with the Sustainable Development Goals Interface Ontology (SDGIO) to improve semantic representation of environments in the context of global development. In this talk, we will present progress towards this goal, emphasising the potential of ecosystem semantics in bridging and seeding new domain ontologies.**

***Keywords—sustainable development; environment; biosphere; ontology; semantics***

## I. INTRODUCTION

The United Nations Sustainable Development Goals (SDGs; [1], [2]) specify a transformative global agenda for harmonising anthropocentric development and the preservation of ecosystem integrity across multiple scales. In addressing some of the greatest challenges of our time – including eradicating diverse forms of poverty, hunger, and lack of access to basic services – the agenda articulates the need to prevent degradation of the ecosystems which support human societies and constitute humanity's natural heritage [3]. Measuring progress towards the SDGs is complicated by ambiguity in the terminology used to refer to entities of interest in local, national, regional, and international contexts and the difficulties in revealing their interconnectivity. Hence, work has begun to create an ontology which will assist multiple stakeholders in more clearly associating their efforts, data, and knowledge to the wide range of entities participating in the SDG process. Following the fruitful experience of ontologists operating in the biomedical and biological domain, the best practices of the OBO Foundry and Library [4] are being leveraged to create the Sustainable Development Goals Interface Ontology (SDGIO; [5]), in collaboration with the United Nations Environment Programme (UNEP). In this talk, we will discuss our efforts to represent environmental entities in SDGIO through coordination with the Environment Ontology (ENVO; [6]).

## II. REPRESENTING THE ENVIRONMENTAL ASPECT OF SUSTAINABLE DEVELOPMENT IN AN ANTHROPISED BIOSPHERE

Earth's anthropised biosphere [7] sets the stage for the realisation of the SDGs. Accounting for and responsibly managing the integrity of the planet's constituent ecosystems is central to the global development agenda for 2030 [3]. Clearly representing environmental entities – which are often only loosely defined – is key to revealing the interconnectivity of development and conservation activities with undirected or emergent ecosystem processes. With improved environmental semantics, researchers may better coordinate data and information about the processes through which natural, semi-natural, and strongly anthropised environmental systems regenerate the inputs of and/or remediate and recycle the outputs of human activity. These dynamics, considered at different spatiotemporal scales, are at the centre of understanding whether or not a given activity is, in fact, sustainable. The Environment Ontology (ENVO), which represents a broad range of environmental systems, has been adopted and imported into SDGIO to address these issues. Its content is being extended to accommodate entities referenced by the SDGs (Buttigieg et al., in review) and to better represent entities such as "ecosystem services" and "natural capital". As a motivating example, we will present the challenges of representing the preservation of ecosystem services on a parcel of land: issues with spatial and temporal boundaries, classification of environment types, and human-environment interactions will be explored.

## III. The Environment Ontology as a semantic staging ground

In addition to handling ecosystems, the inclusive nature of environmental semantics offers a means to accelerate the development of semantic resources for sustainable development. Representing the large collection of domains referenced by the SDGs is a formidable task, which requires the creation of more ontologies in domains such as urban infrastructure and trade networks. However, creating new ontologies without sufficient community engagement and dedicated teams of domain experts and developers would be premature. Nonetheless, implementation partners have pressing needs and are often unable to wait for such a consortium to be assembled. Thus, in the interim, the broad scope of environmental semantics may readily serve as a 'staging ground' for nascent ontologies. As environmental systems can include most entities as parts, ENVO has been used to represent entities from stars to zebra milk and umbrellas. Once a more focused ontology has been sufficiently developed and stabilised, ENVO will import its classes (as needed) and obsolete any redundant content in aid of coordinated development. Such an approach is being implemented with classes pertaining to food products and agronomic entities (these proceedings), which will be imported into SDGIO.

## IV. Outlook and Conclusions

Environmental considerations are central to sustainable development, and coordination between ontologies such as ENVO and SDGIO is creating a semantic layer capable of supporting the implementation of the Sustainable Development Agenda. In the near future, we hope to expand our sphere of collaboration with other existing or planned ontologies and implementation partners to represent their work and enhance their informatics resources.

## References


[1] United Nations Department of Economic and Social Affairs, "Transitioning from the MDGs to the SDGs : accountability for the post-2015 era," no. ST/ESA/2015/CDP/25. New York, New York, USA, 2015.

[2] United Nations, "Transforming our world: the 2030 agenda for sustainable development." p. A/RES/70/1, 2015.

[3] UNEP, *Embedding the Environment in Sustainable Development Goals. UNEP Post-2015 Discussion Paper 1*, no. July 2013. Nairobi: United Nations Environment Programme (UNEP), 2013.

[4] B. Smith, M. Ashburner, C. Rosse, J. Bard, W. Bug, W. Ceusters, L. J. Goldberg, K. Eilbeck, A. Ireland, C. J. Mungall, N. Leontis, P. Rocca-Serra, A. Ruttenberg, S.-A. Sansone, R. H. Scheuermann, N. Shah, P. L. Whetzel, and S. Lewis, "The OBO Foundry: coordinated evolution of ontologies to support biomedical data integration.," *Nat Biotechnol*, vol. 25, no. 11, pp. 1251–5, Nov. 2007.

[5] "The Sustainable Development Goals Interface Ontology (SDGIO) Code Repository." [Online]. Available: https://github.com/SDG-InterfaceOntology/sdgio.

[6] P. L. Buttigieg, N. Morrison, B. Smith, C. J. Mungall, and S. E. Lewis, "The environment ontology: contextualising biological and biomedical entities.," *J Biomed Semant*, vol. 4, no. 1, p. 43, Jan. 2013.

[7] S. L. Lewis and M. A. Maslin, "Defining the Anthropocene," *Nature*, vol. 519, no. 7542, pp. 171–180, Mar. 2015.