

Assessing the health of coral reef ecosystems using data-driven ontologies and Virtual Earth: a new algorithm and tools

Geoinformatics has been thrust into the spotlight of science. A glimpse of the sublime effects of humankind's omnipresence upon all its inhabitants (including ourselves) has made it imperative that we know more about how the global ecosystem functions. The challenges are tremendous. We must not only rethink how to do science on this scale, but also begin to produce tools to enable such large scale projects to even be feasible. Geoinformatics is a means of moving toward answering both problems. In this work, our contribution is to present both (I) a new algorithm of interpreting vast extant data and (II) tools employing this algorithm that enable scientists to more efficiently and effectively analyze vast amounts of data. It is critical to point out using these (or any technical) tools should not burden scientists--requiring them to waste the invaluable resource of time so crucial to scientific study. Since water covers approximately 70% of the earth's surface, we focus on marine ecosystems. In particular, we are assessing the health of a coral reef ecosystem (CRE), since CREs are (1) among the most threatened ecosystems on the planet; (2) extremely sensitive to subnormal changes in the environment; (3) among the least understood ecosystems on the planet. There exist vast numbers of CRE observational data. Unfortunately, even photographic transects that have been developed yield limited understanding as to how acquired CRE data relate to its overall health. Interpreting enormous corpia of data is not new; bioinformatics has been in forefront of moving to data-driven science (interpreting analytically generated and collected data) where data regularly is on the order of gigabytes and terabytes. Recently, a means of creating data-driven ontologies [Costello et al.] (as opposed to the current hand-curated ontologies) revealed novel, sound ontologies. The first iteration of the software can be found at www.ddont.org (Data-Driven Ontology or DDOnt). The output is a visually accessible tree that indicates significant relationships of properties of the objects under study. In this work we employ a modification of the DDOnt algorithm and Microsoft's Virtual Earth™ (VE) that allows scientists to study disease of CREs, the data used being drawn from (1) coral diseases and (2) observational data associated with selected coral ecosystems. The modified algorithm's inherent adaptability allows researchers to contribute observational data from reefs all over the world creating a dynamic coral disease ontology, while also providing a temporal extent of coral reef ecosystems. The visualization of this ontology is done using photographic transects associated with the observational data and coordinated using VE. The photographic transects associated with the observational data also provide a visualization for researchers to identify and validate possible diseases that exist within coral reef ecosystems, in particular the widespread bleaching of coral reefs based on various known environmental causes. Such an approach emphasizes the importance of building a temporal extent of observational data alongside photographic transect data. Our results demonstrate this approach is successful and likely extensible to not only areas of marine ecosystems, but to other terrestrial ecosystems as well.