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A tiered, system-of-systems architecture to assess and enhance sustainability

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Abstract: Although the concept of sustainability has long been recognized as essential for the future of humanity and the integrity of the resources and ecosystems on which we depend, developing and implementing a comprehensive approach to achieving sustainability remains a major challenge. In particular, sustainability needs to be assessed and enhanced across many societal systems, informing the design of solutions that take into account the complex and uncertain nature of the individual systems and their interrelationships. To meet this challenge, we propose a novel tiered architecture for assessing and enhancing sustainability with the following critical attributes: a comprehensive definition of sustainability that meets the essential needs of human and ecological systems; a component-based, systems-level conceptual framework that can couple a wide range of relevant systems using a causal, modular, system-of-systems approach; a tiered structure with different levels of abstraction combined with down-scaled orientors and up-scaled indicators that establish a systematic connection among the tiers; the ability to make robust decisions in the face of deep uncertainty; and the systematic integration of multiple knowledge domains and disciplines. The implementation of the proposed unifying architecture represents a daunting challenge that may take decades to fully accomplish, but the goal of achieving sustainability will itself play out over similar timeframes, and much can be gained by working toward a tiered, system-of-systems architecture for assessing and enhancing sustainability. Indeed, many societal problems could be approached in a similar fashion including resilience, the food/energy/water nexus and the problem of interdependent infrastructure systems.

Keywords: *Deep uncertainty; Integrated assessment; Resilience; Societal problems; Stakeholders*