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EDITORIAL: DEPENDENCE OF OBSERVATION-BASED CONCLUSIONS ON THE THERMODYNAMICS AND KINETICS OF ENVIRONMENTAL PROCESSES

Environmental processes that have significant impacts on human health and ecological systems occur at timescales that range from nanoseconds to millennia. Approaches to investigation of such processes include experimental studies of real and analogous systems, theoretical simulations of driving factors of environmental systems and their components using physical and other laws, and combinations of these two approaches. As evident in the persistent public debate about radioactive waste disposal and impact mitigation measures for global climate change, attainment of consensus on the meaning of research results depends not only on the plausibility of the scenarios predicted but on the confidence that can be placed on the method of analysis used to obtain the results. Analyses involve measurements and/or observations, the results of which are often used in predictive models to support public policy making. In turn, public policies have significant and diverse manifestations on every country's sustainable development and quality of life. Thus, the possibility of occurrence of the environmental processes and phenomena that are considered in public policies is an important issue.

Conceptual, physical, and quantitative models have been configured and applied to make predictions for real systems. Public confidence in such predictions is often enhanced when it is known that such models have been validated and/or verified. Definitions and differences between model validation and verification have attracted controversy among analysts for decades and remain largely unresolved. Taking the defensible argument that verification of an environmental model should involve data acquisition on the essential features of the environmental system studied or its analog, then the capacity to acquire precise and accurate data by measurement is exceedingly important. Essentially, the conclusion that a phenomenon has occurred or can occur is dependent on whether

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the analyst has measured or can successfully measure or observe the phenomenon and/or indicators of its occurrence. Thermodynamics points to the possibility of occurrence of such phenomena but kinetics addresses the rate at which they occur. If the rates are slow and immeasurable with current technologies, the erroneous conclusion that such phenomena have not occurred or cannot occur can be easily made. Thus, advances in metrology constitute a huge determinant of the breadth of environmental phenomena that technical analysts and policymakers consider in constructing environmental management systems. Interestingly, in a purely physical, experimental approach, conclusions about whether an environmental process has occurred are usually reached on the basis of the kinetics of accumulation of the yield products of the process. This is tantamount to an override of thermodynamics by kinetics in the consideration of analysts and happens quite frequently. In such circumstances, acknowledgment of the viability of a process is linked to both the sensitivity of the instrument of its measurement, and the time it takes for measurable results to emerge. Then, could it be that given sufficient time, any process will occur? This is doubtful because the occurrence of unlikely processes can be dispelled on the basis of theoretical considerations that are rooted in system composition and thermodynamics. For example, a system that contains carbon needs a source of oxygen and favorable conditions to generate carbon dioxide. Indeed, theoretical and observation-based assessments are necessary for making conclusions on observable and prospective environmental phenomena so that rational public policies can be developed and implemented.

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