SCIENCE & GLOBAL SECURITY
2016, VOL. 24, NO. 1, 1–2
http://dx.doi.org/10.1080/08929882.2016.1127029

Routledge
Taylor & Francis Group

Editors' Note

The three articles in this issue of *Science & Global Security* look at various approaches to understanding, anticipating, and mitigating risks. They cover the risks of nuclear weapon proliferation from civilian nuclear fuel cycle facilities, damage to satellites from space debris, and of severe accidents at nuclear power plants. In their own way, each article raises questions about the widespread reliance on probabilistic risk assessment as the standard way to quantify risk in complex systems.

Understanding the risk of a state using its civilian nuclear facilities as part of a nuclear weapons effort, and reliably detecting in a timely way when a state does so, have been central concerns for proliferation analysts, policy makers, and the international community almost since the beginning of the nuclear age. These tasks have been given to the International Atomic Energy Agency (IAEA), which seeks to address them through cooperative inspections intended to reveal if a nuclear facility or material has been diverted from its peaceful purpose.

In "A Game Theoretic Approach to Nuclear Safeguards Selection and Optimization," Rebecca M. Ward and Erich A. Schneider, from the University of Texas at Austin, start from the recognition that a decision by a state to repurpose a civilian facility or material for weapons use would be an outcome of a policy and a strategy and not a matter of chance, and so limits the validity of probabilistic assessment approaches. They also note that in the real world the IAEA has limited resources for its safeguards and inspection system and this constraint is likely to keep growing as inspection costs and the number and size of nuclear facilities increases. Their article applies game theory to consider the problem of how the IAEA could most efficiently allocate inspection resources to detect a range of possible diversion efforts by a host state at a safeguarded gas centrifuge uranium enrichment plant. The model allows for facility-specific assumptions and for choices about the quantity and enrichment of uranium that a state may seek to acquire by a possible diversion. The model may provide a basis for a broader quantifiable assessment of choices between safeguards approaches and instruments for specific sites and how to spread safeguards resources across multiple facilities in a state.

There is a growing problem of risk assessment in space also. There are about 1,000 active satellites in space, with twice as many expected to be launched within the next decade. As with the satellites in orbit today, many of these future satellites may remain in orbit far beyond their active lifetimes—more than a hundred satellites launched after 2002 are inactive and are in orbits with expected lifetimes of more than 25 years. As active and inactive satellites in orbit become more numerous, the risk of damage and destruction of satellites from collisions with other satellites, which produce space debris that can in turn cause further collisions, is expected to grow. Efforts to address these concerns through the Inter-Agency Space Debris Coordination Committee and the guidelines issued by the United Nations Committee on the Peaceful Uses of Outer Space have had limited success so far.

In the article "A Liability and Insurance Regime for Space Debris Mitigation," Ting Wang highlights the problems with the current system to mitigate the risk from space debris and why problems may become more acute with time, and offers a proposal to address some of them using a procedure for determining the liability for the damage to a satellite due to a collision and shows how this can be part of a structure of economic incentives for satellite owners and operators to reduce the risk of collisions.

A perennial concern for the nuclear industry, nuclear regulators and policy makers, and the public has been the risk of catastrophic accidents at nuclear power plants. Traditionally, this is addressed by the industry and regulators using probabilistic risk assessment, which assumes that an accident is the outcome of a discrete series of independent failures in sub-systems and estimating how often each of these events is expected to occur and the possible chains of such events (fault and event trees) that allow them to escalate to a larger failure. Critics note that this approach does not adequately take into account system properties such as indirect, non-linear, and feedback relationships, the impacts of human actions, and of course possibly as yet unknown failure events and paths.

In "Estimating the Frequency of Nuclear Accidents," Suvrat Raju offers a Bayesian approach to compare the predictions of probabilistic risk assessment with empirical data for severe accidents at nuclear power plants. The article highlights the problem in reconciling typical probabilistic risk assessment goals for power reactor core damage events claimed by reactor vendors of less than one in ten million reactor-years and regulatory goals for core damage events of less than one in 10,000 reactor-years and of large radioactivity release events (that is core damage followed by containment failure) of less than one in a million reactor-years, with the fact that there have been eight core-damage accidents in about 15,000 reactor-years of actual operating nuclear power reactor experience. This debate is a central issue in India as part of the debate over nuclear safety and liability, which the article uses as a case study for its analysis.

The article shows that "it is virtually impossible to reconcile the empirical data with the PRA-frequencies," even allowing for regional variations in safety and that accident frequencies have declined rapidly recently because of higher standards and learning. This conclusion challenges the basic reliability of the probabilistic risk assessment method and suggests the nuclear industry and regulators are mistaken to believe that there is a rigorous basis for the claim that the probability of a severe accident is negligible over the lifetime of existing nuclear power reactors.

This issue of the journal also contains a tribute to the life and work of Stanislav Nikolaevich Rodionov, a pioneering Soviet physicist, arms control expert, and an editor and contributor to this journal from its founding in 1989 until his passing in 2014.