ASA Research

Research Agenda. Systems analysis treats the coupled human-environment as a hierarchical system of interacting systems. A particular research question employs one of the three possible levels of consideration, illustrated in Diagram 1.

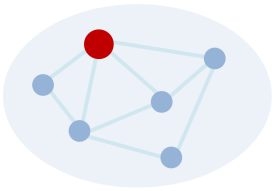
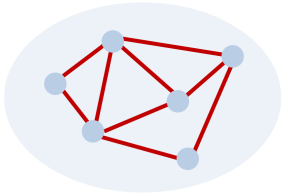
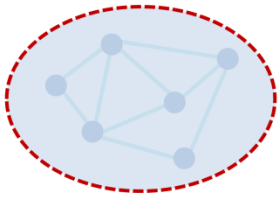
Level of analysis	 **Particular system:** focus on decisions taken by a system within a larger system	 **Interactions between systems:** focus on (dynamic) connectivity between systems	 **System of systems:** focus on the state and dynamics of the entire complex system
Research domain	**Domain 1: Optimal behavior of systems**	**Domain 2: Interactions within systems**	**Domain 3: System transitions and resilience of systems**

Diagram 3: Three levels of systems analysis and three corresponding ASA Research Domains.

Correspondingly, ASA's research is organized around three mutually complementing and cross-fertilizing research domains. Within **Domain 1 Optimal behavior of systems** ASA research focuses on how making decisions that govern systems' behavior can be formalized in models, notably, under uncertainty and risks, and what consequences different decisions yield. Decision support tools and applications are developed, which are traditionally based on the optimization of a utility describing decision-maker's preferences. In this domain, ASA researchers employ and advance methods of optimization theory, control theory, theory of dynamic systems, and other related fields. Applications mostly focus on economic models, notably, long-term economic growth (also under environmental constraints) and resource management models.

ASA research within **Domain 2 Interactions within systems** focuses on the role of indirect links and connectivity between individual systems within a larger networked system. Graph theory, information theory, network analysis and other related fields are employed, and network-based modeling and assessment frameworks are developed. ASA research in this domain focuses on ecological and social applications; some methodologies are also being transferred to other

disciplinary areas, for example, to economics, energy policy, and resource management.

Within **Domain 3 System transitions and resilience of systems** ASA research focuses on systems of systems, characterized by complex dynamics, decentralized decision-making, and significant uncertainties with the aim to study system's resilience. The behavior of such systems is too complex to be modelled by traditional tools; therefore, ASA experiments with qualitative (e.g., soft systems mapping) and quantitative (e.g., agent-based modeling) methods and approaches. The aim of these is to evaluate possible consequences of extreme shocks affecting the system under study and, based on that, system resilience. Novel methods of data analysis aiming to identify precursors of system flips and general patterns via learning from the past are developed. ASA research in this domain is currently emerging.