

## Complex Adaptive Systems Support Synergistic Social, Economic, and Ecological Analyses

### Integrated Analytic Approach

Today's world includes complex interactions among science, environment, culture, politics, and economics. The Complex Adaptive Systems (CAS) Group in the Decision and Information Sciences Division at Argonne National Laboratory is developing approaches and technologies to analyze these complex problems and applying them to address a variety of issues at the local, national, and international level.



Analyzing these issues often involves integrating models from individual processes and then assessing the ensemble of data to make a decision on how to respond. These assessments can be made at an individual person level, at a collective organizational level, or both. In either case, these “agents” respond to external influences and act on them by using either fixed or adjustable rules. In the latter case, agents can “learn” from past situations and develop new criteria on which to base decisions. Adaptation is the key aspect in complex adaptive systems. Models of individual processes can change and adapt in ways that are better suited to their environments.

### Analyses for National Security

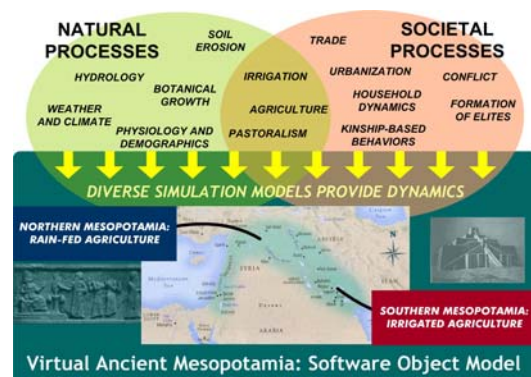
The CAS Group has developed a number of complex adaptive system tools and approaches to support the national security community. Examples include tools to

study drug interdiction strategies, targeting concepts for force architecture analyses (developed for the Joint Staff/J-8). Other efforts involve the study of impacts on national security from emerging societies. An “emerging society” is considered to be a social entity that is undergoing a significant change from one state to another, such as from countries experiencing a new regime, significant economic changes, or those recovering from catastrophic disasters.

The CAS Group is also a cofounder of the Joint Threat Anticipation Center, a joint activity with the University of Chicago. This joint effort aims to study and model terrorist-related issues.

### Sustainability Analyses for Ancient and Developing Societies

The CAS Group has participated in a National Science Foundation Biocomplexity Grand Challenge effort with the Oriental Institute of the University of Chicago to study the evolution and sustainability of the ancient Mesopotamian civilization. This system integrated detailed environmental and agricultural mian villages. The effort used extensive historic data captured on clay tablets to develop the structure of the villages and to provide data with which validation efforts could be performed. The system has also been used to study the agricultural sustainability of a village in modern Thailand. This effort was conducted with researchers at the University of Chicago's Economics Department.



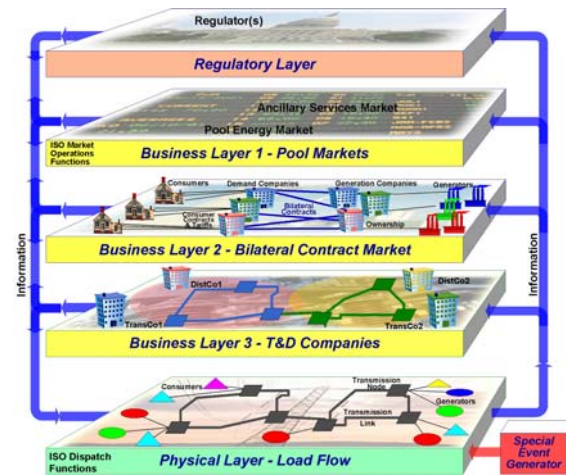
## Modeling Complexities in the Electricity Market

EMCAS (Electricity Market Complex Adaptive System) is an agent-based simulation model of the electric power market designed to investigate market restructuring and deregulation and to understand implications of a competitive market on electricity prices, availability, and reliability. The agents in EMCAS represent the participants in the restructured electricity market.

Different types of agents capture the heterogeneity of restructured markets, including generation companies, demand companies, transmission companies, distribution companies, independent system operators, consumers, and regulators. The agents perform diverse tasks using specialized decision rules. Agents learn about the market response to their bids, infer competitors' strategies and adapt their actions accordingly. Agents continually explore new strategies in response to dynamic supply and demand forces and identify strategies that perform better.

## Training and Outreach

The CAS Group conducts training in the use of agent-based modeling tools with the Santa Fe Institute. CAS also sponsors an annual conference on agent methods, theory and applications in conjunction with the University of Chicago.



**Learn more about Complex Adaptive Systems at:**

<http://www.dis.anl.gov/>

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