Integrated Assessment and GCAM

We hear daily about “systems” and how they affect everything in our daily lives: our government, energy supply and consumption, local and global economies, school and health systems, the global climate, watersheds and rivers, water treatment and distribution systems, food production and processing, social welfare, and so on. Systems are everywhere! But what are they, and how do they work?

A not-very-exciting and rather vague definition is that a system “is a set of interconnected components that work together to perform a task or set of tasks”. From a “bird’s eye view”, this description covers our whole world: energy, agriculture, water resources, mining and forestry, manufacturing, climate, buildings, transportation, population, economic activities, and so on all interact to create the world we live in. More locally, we see the same system components interacting in our cities, provinces and countries. These systems are both very complicated and very complex. We can understand them by studying different system “pieces” or “components”, which has been the most common approach (physics, economics, biology, political science, language and culture, chemistry, engineering, medicine, and so on). We can also try to understand how they interact, which is a newer area of research called “systems sciences” or the “systems approach”. A common approach to achieve this greater understanding is computer simulation.

Integrated assessment models (IAM) are “systems simulation models” that support sustainable resource development and infrastructure planning, which requires reliable long-term projections of both resource supply and demand variables. Such projections rest in turn on a clear understanding both of the problem and potential trade-offs, as well as the comprehensive, “big picture” effects of alternative solutions. The IAM proposed for use here, the “Global Change Assessment Model” (GCAM), represents both the behaviour of and interactions between primary and secondary energy supply and demand, the economy, water supply and demand, agricultural production, land use, and the climate – a system-wide perspective that includes both these intersectoral connections, as well as a consistent representation of international trading and policy linkages and their evolution over 100 years under various scenarios. Canada lacks a comprehensive IAM that integrates our country with global systems, and that can simulate broader effects – on energy systems, the climate, land use and water resources – of policy decisions.

In each simulation run, GCAM takes as input a set of scenario assumptions to produce outputs in terms of prices, energy production and transformations, and commodity and other flows across regions and times. Of particular interest for the Future Energy Systems initiative, GCAM represents sources of primary energy supply, modes of energy transformation, and energy service demands – including transportation, industrial energy use, and residential and commercial energy service demands. Supplies and demands for primary and secondary energy forms are simulated, as well as emissions of greenhouse and other gases, and bioenergy demands connect to agriculture and land systems, as well as to the water system. GCAM is a community model and an important international tool for scientific inquiry; hundreds of academic papers using GCAM have been published in peer-reviewed academic journals over the last 30 years (JGCRI, http://jgcri.github.io/gcam-doc/overview.html).