“Sustainability in the Digital Age I: Resilience facing Global Changes”

Tuesday, May 21, 2019

CIRANO
1130, Sherbrooke West, suite 1400, Montreal, Quebec (Canada) H3A 2M8

Organized by CIRANO, CRM, Future Earth, Ouranos, RCM2, RMA,

Scientific description:

This workshop is the first of a series on the theme “Sustainability in the Digital Age”, organized under the leadership of Future Earth. The purpose of the workshop is to seed a global initiative around sustainability in the digital age.

The Earth is a complex system of systems, ecosystems, socio-ecosystems, where multiple components and stakeholders interact often through feedback loops at different scales thus inducing numerous nonlinearities and uncertainties. As the world population is projected to increase to 9.8 billion by 2050 and we have already crossed four of the nine planetary safe boundaries (Rockstrom et al 2009) including climate and biodiversity ones as a result of human activity, we are increasing our risk of large-scale disruption of nature and driving the Earth system and Mankind into new and non viable states and trajectories. Achieving the UN Sustainable Development Goals will require systems change and adaptation: major shifts in how we produce and consume goods, on how we account for climate, biodiversity or ecosystem services in the public policies and assessments, on how we balance present and future and in how we build societal resilience. In particular, to transform a system, we must identify what systems scientists call, “leverage or tipping points.” These are places within a complex system where a small shift in one thing can produce big changes in everything. The digital age is opening new opportunities for identifying leverage points, management and governance promoting sustainability of planet Earth and Mankind.

The workshop will focus on listing some problems worth solving and some transformative opportunities that can lead to systems change for addressing climate change, biodiversity erosion and global sustainability more broadly.

Themes of the working groups:

(i) **Operationalize the ecosystem approach in the Digital Age**: Big Data, machine learning and IA for the calibration of complex and systemic models induced by environmental challenges and sustainability (climate change, biodiversity erosion, water management, etc.) and integrating multi-dimensional dynamics, non-linear, spatially explicit, multi-drivers (anthropic pressures, public policies, climate, ...) and uncertainties.

(ii) **Operationalizing sustainability and resilience in the Digital Age**: Which numerical and machine learning, IA methods for multi-criteria normative approaches, balancing ecological, economic, and social goals, promoting intergenerational equity (reconciling transients and asymptotics) as well as robustness and adaptation to cope with uncertainties, shocks and risks.

(iii) **Which governance for Sustainability in the Digital Age?** Big Data, machine learning and AI at the service of strategic interactions, participative methods and cooperation via game theory and multi-agent theory.

Schedule:

8:00-8:50: Inscription and coffee

8:50-9:00: Welcoming

9:00-9:40: First presentation
Amy Luers, Executive Director of Future Earth, "Resilience in the Digital Age"

9:45-10:25: Second presentation
Carla P. Gomes, Professor of Computer Science and the director of the Institute for Computational Sustainability at Cornell University, "Computational Sustainability"

10:30-11:00: Coffee break

11:00-11:40: Third presentation
Alexis Hannart, Principal Research Scientist in Climate Science at Ouranos, "Quantifying the impacts and risks of a changing climate: several cases where machine learning represents a big potential"

11:45-12:25: Fourth presentation
Luc Doyen, President of Resource Modelling Association (RMA) and CNRS Researcher at Université de Bordeaux (France), "Mathematics and Numerics for Scenarios of Biodiversity and Ecosystem Services"

12:30-13:30: Lunch on site

13:30-15:30: Working groups
Three working groups in parallel in three small rooms on three themes: the working groups have to work on producing a list of research questions with descriptions.

15:30-16:00: Coffee break

16:00-17:00: Wrap-up

17:00-18:30: Reception on site

Presenters:

1. **Amy Luers, Executive Director of Future Earth**
   "*Resilience in the Digital Age*"
   Resilience has emerged as a central organizing principle for management and policy under the increasing pressures and uncertainty of rapid global change. The new tools of Big Data and artificial intelligence offer us the opportunity to build operational approaches to characterizing resilience, establishing guidelines for building resilient societies and evaluating if societies are resilient to stresses and shocks. This is an invitation to the global scientific community to join forces with decision makers.

2. **Carla P. Gomes, Professor of Computer Science and the director of the Institute for Computational Sustainability at Cornell University**
   "*Computational Sustainability*"
   Computational sustainability is a new interdisciplinary research field with the overarching goal of developing computational models, methods, and tools to help manage environmental, economic, and societal needs for a sustainable future. Artificial Intelligence (AI) is a rapidly advancing field with novel machine learning methods combined with reasoning and search techniques leading to new milestones: from computer vision, machine translation, and Go and Chess world-champion level play using pure self-training strategies, to self-driving cars. These ever-expanding AI capabilities open up new exciting avenues for advances in new domains. I will provide an overview of our research in AI and Computational Sustainability, with examples ranging from wildlife conservation and biodiversity, to poverty mitigation and materials discovery for renewable energy materials. I will highlight cross-cutting computational themes, opportunities, and challenges in Artificial Intelligence to address sustainability problems.

3. **Alexis Hannart, Principal Research Scientist in Climate Science at Ouranos**
   "Quantifying the impacts and risks of a changing climate: several cases where machine learning represents a big potential"
   A distinctive characteristic of climate change, as a challenge faced by humanity, consists in the ubiquity, diversity and potential severity of its impacts. For instance, we already observe – and often also attribute – increases in the frequency of many environmental risks (e.g. heatwaves, storms, droughts, wildfires, flooding …) as well as significant socioeconomic impacts across many sectors (e.g. health, energy, tourism, agriculture …). Research on quantifying and adapting to the latter impacts and risks is thus booming.
   On the other hand, the capacity to collect and analyze massive amounts of data – whether geophysical or societal – and to relate one to the other, has the potential to transform research on these topics. Many applied researchers in the machine learning community do identify this potential and are willing to contribute, but sometimes lack specific, well-posed problems that are amenable to their tools and skills.
   Based on Ouranos experience, my own research and a review of some recent contributions, I will intend to illustrate a few practical problems related to the quantification of climate impacts and risks as well as to adaptation, which are arguably amenable to machine learning.

4. **Luc Doyen, President of Resource Modelling Association (RMA) and CNRS Researcher at Université de Bordeaux (France)**
   "Mathematics and Numerics for Scenarios of Biodiversity and Ecosystem Services"
   Balancing biodiversity conservation with food security and the preservation of a broader set of ecosystem services is among the greatest challenges of the century. The creation of the International Panel for Biodiversity and Ecosystem Services (IPBES), at the interface between decision support and scientific knowledge, is clearly in line with this ecological-economic perspective. IPBES particularly puts forward the development of model-based scenarios that make sense economically, ecologically and promoting sustainability. The presentation will provide generic modeling methods and tools to address such challenges. In particular, we argue that the framework of controlled dynamic systems under uncertainty together with ecoviability metrics are especially well-suited. These general ideas are exemplified with scenarios relating to two applied fields: (i) fisheries and marine biodiversity, (ii) land-use and avifauna.

Local organizers: Christiane Rousseau (CRM) and Bernard Sinclair-Desgagné (CIRANO)