BeNeLux Chapter Symposium 2021

Wednesday March 10, Virtual event

Systemic analysis of societal challenges

Preliminary program

Welcome

In the year 2020 societies around the world have faced unprecedented challenges. Raging wildfires, social injustice, riots and of course the COVID-19 pandemic. The System Dynamics method and its process support tools offer a valuable resource in understanding such challenges and provide decision makers with systemic insights in policy alternatives.

The Benelux Chapter of the System Dynamics Society aims to further the dissemination and to encourage the advancement of System Dynamics in the Netherlands, Belgium and Luxembourg. Our yearly symposium is a key moment to share, learn and connect. It is our pleasure to welcome you: students, practitioners, and academics, to our chapter's first virtual event. The program consists of two plenary lectures, 4 parallel sessions and a lunch event. We wish you a great day on the 10th of March.

Participants who have registered for the symposium will receive Zoom and Wonder.me details by email before the event.

Kindest regards,

Guido Veldhuis – Chapter president and conference organizer
Program committee: Merel van der Wal, Els van Daalen, Etiënne Rouwette, Mieke Struik
BeNeLux Chapter - System Dynamics Society

Schedule

10.00	**Word of Welcome** (Guido Veldhuis)	
10.10	Parallel 1 **Causal Loop diagrams in Action** Chair: Merel van der Wal	Parallel 2 **Quantitative insights for Policy development** Chair: Guido Veldhuis
11.10	5 minute mini break	
11.15	**Plenary 1:** **Understanding complexity in military operations**	
12.00	**LUNCH**	
12:30	**Informal gathering in wonder.me**	
13.00	Parallel 3 **Systemic insights in and from industries** Chair: Mieke Struik	Parallel 4 **Methodology: Looking back and ahead.** Chair: Els van Daalen
14.00	15 minute break	
14.30	**Plenary 2:** **System Dynamics analysis and scenario development for the safety region Rotterdam-Rijnmond during the Corona pandemic**	
15.00	**Closing words, announcing new President**	
15.15	**End**.	

Click to navigate

Papers and their authors

Parallel 1: Causal loop diagrams in action

Application of remote Group Model Building (rGMB) to support the planning of car sharing system in Bangkok city, Thailand
Peraphan Jittrapirom; Saroch Boonsiripant; Monthira Phamornmongkhon

No food to waste: The dynamic processes that explain food waste in Dutch households
Simone Peters and Inge Bleijenbergh

A systemic perspective on intersecting inequalities in organizations
Inge Bleijenbergh & Mathijs Ambaum

Parallel 2: Quantitative insights for policy development

Supply Chain Dynamics in a digital age: going beyond the traditional usage of honeypot data
Sander Zeijlemaker

A beginner's introduction to Robust Decision Making in System Dynamics
Willem L. Auping

An Exploration of Canadian Energy Policy
Patrick Steinmann; Jason R. Wang.

Parallel 3: Systemic insights in and from industries

The Future of Nickel in a Transitioning World. Exploratory System Dynamics Modelling and Analysis of the Global Nickel Supply Chain and its Nexus with the Energy System
Jessie Bradley, Willem Auping; Benjamin Sprecher

Is the pharmaceutical market structure an obstacle to addressing antimicrobial resistance?
Leon Rohde; Rok Hrzic

Efficiency, the rebound effect, and sustainable development
Andreas Größler

Parallel 4: Methodology: Looking back and ahead

Refining the causal loop diagram: a tutorial for maximizing the contribution of domain expertise in computational system dynamics modeling
Loes Crielaard; Jeroen F Uleman; Bas D L Châtel; Peter M A Sloot; Rick Quax

The behavioural turn in Operational Research and System Dynamics
Etiënne A.J.A. Rouwette

Parallel 1: Causal loop diagrams in action

Application of remote Group Model Building (rGMB) to support the planning of car sharing system in Bangkok city, Thailand

Peraphan Jittrapirom[a,b] Saroch Boonsiripant[c*] Monthira Phamornmongkhonchai[c]

[a]Center for Global Environment Research, National Institute for Environmental Studies, Tsukuba, Japan

[b]Nijmegen School of Management, Radboud University, Nijmegen, the Netherlands

[c]Department of Civil Engineering, Kasetsart University, Bangkok, 10400 Thailand

Urban carsharing has been posited as a solution to address high private car ownership and to promote multimodal travel behavior. However, the operations of such a concept in cities within developing countries, such as Thailand, China, and India, are still limited. Such a novelty can lead to unfamiliarity among policymakers, regulators, and related businesses with the concept and delay its implementations. Given the expected significant growth of private vehicles in these developing cities in the next decades, the urgency to promote the shared mobility concept in these contexts is high.

In this presentation, we will report our effort to support the wide implementation of urban carsharing in Bangkok city, Thailand. We implemented a remote Group Model Building process that brought together relevant stakeholders to build a shared understanding of the carsharing concept, its operations, and how such a service influences the urban transport system among the stakeholders involved. Stakeholders from various backgrounds, such as automakers, policymakers, regulators, carsharing service providers, and user representatives took part in the process.

Through the process, the stakeholders were able to identify the determinants of Bangkok's carsharing system and created a causal loop diagram (CLD) that illustrates the dynamic relationships between entities within the system, thus enhanced their understanding and insights. The GMB process was also innovatively designed to minimize in person-contact, thus reduced the risk of exposure to coronavirus for the participants and the research team.

No food to waste: The dynamic processes that explain food waste in Dutch households

Simone Peters and Inge Bleijenbergh

This research addresses the dynamic processes that explain food waste in Dutch households. Despite a considerable reduction of food waste in Dutch households in the last decade, with 27,6 kilo per person per year the level of food waste continues to be very high (Janssens et al., 2019, p.429). Food waste is food that is or was appropriate for human consumption that is not consumed by humans but discarded by Dutch households. Reducing food waste is important for the environment because it will lead to a lowered demand for food production, which reduces the use of raw materials as water, energy and agriculture land (Natuur&Milieu, 2020). The Minister of Agriculture in the Netherlands therefore adopted the UN objective of halving the amount of food waste by 2030 as a policy goal. This research aims to contribute to this policy goal by developing a dynamic theory about food waste in Dutch households. Based on a literature review and fifteen disconfirmatory interviews with members of Dutch households we developed a causal loop diagram, consisting of six balancing feedback loops and three reinforcing feedback loops. The six balancing feedback loops are the environmental quality loop (B1), the food availability loop (B2), the food production loop (B3), the financial loop (B4), the environmental concerns loop (B5), and the food demand loop (B6). The three reinforcing feedback loops are the knowledge loop (R1), the food norms and values loop (R2), and the perceived environmental quality loop (R3).

In addition, eight nine exogenous variables explain food waste in Dutch households: (1) an increase in household size increases the time spent on food , (2) an increase in time spent on food increases the quality of food management, (3) an increase in the difficulty to empty food packaging decreases the quality of food management, (4 and 5) more good examples regarding food management increase both the norms and values about food waste and the knowledge about food management, (6 and 7) experience with food management and food-related education increase the knowledge about food management, and (8) an increase in the number of people using food banks in the Netherlands increases the awareness about the consequences of food waste, and (9) an increase in the desire to be a good food provider decreases the quality of food management. We advise policy makers to invest in the awareness of Dutch households about the consequences of food waste and the knowledge about food management. Policy makers should not only aim to invest in knowledge, but also in norms and values about food waste in Dutch households and the motivation to do something about it.

References

Janssens, K., Lambrechts, W., Osch, A. van., & Semeijn, J. (2019). How consumer behavior in daily food provisioning affects food waste at household level in The Netherlands. *Foods, 8*(10), 428-446.

Natuur&Milieu. (2020). *Voedselverspilling, hoe erg is dat nu echt?* Retrieved May 5th 2020, from https://www.natuurenmilieu.nl/themas/kenniscentrum/explainer-voedselverspilling/.

A systemic perspective on intersecting inequalities in organizations

Inge Bleijenbergh & Mathijs Ambaum

Radboud University, Nijmegen

Organizations show persistent gender-, class- and ethnicity-based inequalities between employees in terms of well-being, remuneration and representation. Despite decades of diversity scholarship, anti-discrimination legislation and diversity management, gender and ethnic pay gaps and harassment persist, and white male higher-class leaders are overrepresented in the top of organizations. Such inequalities increasingly meet societal resistance.

Scholars mainly explain inequalities based on the demographic characteristics of hiring panels, workforce and management, assuming linear causality between these characteristics and the observed unequal outcomes. However, inequalities are more complex. This paper conceptualizes a dynamic perspective on intersecting inequalities in organizations to further the theoretical understanding of inequalities. A dynamic perspective reveals how elements of inequalities interact in such a way that they reinforce or balance each other. Such a perspective helps us to understand why inequalities co-occur rather than appear in isolation, why addressing a single demographic cause is often not effective, and what the potential effects are of interventions that address multiple inequalities simultaneously.

Based upon a literature review, we integrate knowledge about inequality processes at different organization levels in a generic model of intersectional inequalities in organizations. This generic model consists of five reinforcing feedback loops and two balancing feedback loops. Reinforcing feedbacks R1 and R2 consist of a process where the ingroup and the outgroup are increasingly segregated because of an inequality in privilege. Due to a bias for the ingroup over the outgroup, fuelled by being segregated from each other, the ingroup will allocate privilege to individuals with similar characteristics. The more segregated a group becomes the stronger the bias will be. Hence, the privileged become increasingly privileged. When equality levels in the organisation fall short of the desired level of organisational equality, organisation members become aware of the existing inequalities, becoming less biased against the outgroup. Balancing feedback loop B1 shows how this could balance unequal allocation of privilege. B2 shows how awareness of inequality also directly affects the allocation of privilege as sign of positive discrimination to balance privilege allocation. These two balancing feedbacks are reinforced by feedback loop R3, representing how diversity programs reinforce awareness. Such programmes aimed at becoming and maintaining awareness of inequality in order to establish organisational equality. The saliency of categories of identity influences the extent to which the ingroup accepts outgroup characteristics. Feedback loop R4 represent how increasing privileged ingroup members set ingroup characteristics as the norm in the organisation. This results in a less accepting attitude towards outgroup characteristics. Hence, segregation will increase and, as seen previously, the ingroup will be allocated more privilege. Feedback loop R5 shows how a privileged ingroup establishes ingroup characteristics as the norm in the organisation, directly leading to more allocation of privilege to ingroup individuals. Hence, the ingroup will acquire more and more privilege. This generic model may help to conceptualize more specific inequalities in wellbeing, remuneration and social safety and help predicting the potential effect of policies.

Parallel 2: Quantitative insights for policy development

Supply Chain Dynamics in a digital age: going beyond the traditional usage of honeypot data

Sander Zeijlemaker,

PhD student Radboud University, IMR Faculty Nijmegen Postbus 9108, 6500 HK Nijmegen, +31 6 29 46 84 89, s.zeijlemaker@fm.ru.nl

The beer game provides (Sterman 1992 and 1989) us with a lot of knowledge about the drivers for the bullwhip effect: human behaviour (Coppini, Rossignoli, Rossi and Strozzi 2010; Nienhaus, Ziegenbein and Schoensleben 2007; Sterman 1992; Sterman 1989), structure of the value chain (Domingueza, Cannellaa and Framinan 2015; Sterman 1992; Sterman 1989), and ordering & production strategies (Hussain and Drake 2011). We know this effect can be reduced by various levers including information sharing (Giard and Sali 2013; Hussain and Drake 2011; Crosona and Donohu 2005). and lead time (De Trevillea, Shapirob and Hamer 2004), reduction as well as specific strategies for ordering, production, service and pricing (Giard and Sali 2013; Hussain and Drake 2011; Davidsson and Wernstedt 2002).

In the current day and age of digital transformation value chain participants, depend more on information technology (IT). It dependency introduces new risks (Boyens, Paulsen, Moorthy and Bartol 2015). The participants are susceptible for cyber-attacks by their actors. The raise of cyberspace introduces new game theory-like dilemmas with their own systemic structure of affecting the value chain and bullwhip effect (Zeijlemaker and Jasarevic 2019). These dilemmas are orientated around the trust that participants maintain the value chain secure and the sharing relevant and timely security information between the participants. Following group model building approach we built a system dynamics model about these supply chain security-oriented dynamics.

In our quantification efforts we have applied a very novel approach by using honeypot data[1] for quantification. Normally, defenders use this data to learn from actors (Dowling, Schukat, Barrett 2019). Actors use external data, usually scans, to learn from observed weaknesses and blocking measures in the outer layers of the defender's technical infrastructure (Chatterjee, Datta, Abri, Namin and Jones 2020). We used honeypot data in our model to get insights about the security state of one supply chain participant. The

[1] A honeypot is a computer system that is deliberately made weak and placed in a network with the purpose to capture threat actors' activities, malicious software and other cyber relevant signals with the purpose to get information for futher analysis.

nature of security dynamics required us to use equations with probabilistic and random number generating features. Nevertheless, we received meaningful output.

One of the validation procedures involves the comparison of the model output with the reference mode. In our research we compared the simulated range of expected occurred security incidents based our model with honeypot data with the reported security incidents that occurred over a 12-month period. The reported incidents fit within the simulated range of incidents.

Our contribution is twofold: (1) we were able to get insights on the status of an organisational from solely external data sources and (2) we identified that specific participants' actions in these dilemmas may evoke better-before-worse or, the other way around, worse-before-better behavior in this value chain.

A beginner's introduction to Robust Decision Making in System Dynamics

Willem L. Auping, TU Delft

System Dynamics (SD) research is frequently characterised by the use of models sensitive to input parameter values. As a consequence, it is common practice in the SD field to perform sensitivity analyses on models. When a model is behaviourally sensitive to model inputs, it is not common practice, however, to test policies designed with these models over a broad set of scenarios (i.e., different combinations of uncertain input parameters), but rather just on a base case. Testing policies on a broad range of input scenarios is common practice in the Decision Making under Deep Uncertainty (DMDU) field, for example, by making use of the Robust Decision Making approach. The use of DMDU tools for SD research is rather successful in literature, but for some SD researchers it proves too hard to incorporate the use of these tools in their research. This paper presents a beginner's introduction to systematically testing policies over a broad range of scenarios. By doing so, it tries to bridge the gap between common practice in consolidative SD modelling and fully exploratory SD modelling.

An Exploration of Canadian Energy Policy

Patrick Steinmann, Wageningen University & Research, Wageningen, the Netherlands, mail@patricksteinmann.com

Jason R. Wang, Independent Researcher, Edmonton, Canada, jason@jrwang.ca

Introduction

Within the next decades, our planet will have to switch from using mainly fossil fuels for energy to sustainable and low-carbon fuel sources. It is unclear how this grand societal challenge can be achieved. In this study, we systematically explore the behavior of an integrated energy-climate-economy simulation model. From this exploration, we identify both the importance of factors behind reducing greenhouse gas emissions, and policy alternatives for reaching specific climate goals.

Methods

We connect a validated and widely recognized energy-climate-economy simulation model, the Pembina Institute/Energy Innovations Energy Policy Simulator, to a workbench for exploratory modelling. Using this workbench, we perform both global sensitivity analysis and scenario discovery (a policy design algorithm) on the model, parametrized for Canada. In total, we study 184 input parameters, and 34 outcomes of interest from the environmental, social, and economic domains. For scenario discovery, we consider one climate-based, and one economy-based threshold of policy success: 152 MtCO2e emissions per year, a representation of the Canadian Long Term Strategy for decarbonization compatible with the Paris Agreement, and little negative economic impact.

Results

Based on a combined metric considering both individual and total sensitivity indices, we identify that a substantial carbon tax, especially on industry at $240 CAD/tCO2e, is unavoidable. Additionally important are achieving afforestation and reforestation while also capturing at least 27% of methane are also important. Beyond these, pathways to success contain many combinations of the other parameters without a clear boundary for any specific parameter. For instance, a carbon tax on consumer transportation is not important, which is contrary to some Canadian policy system designs.

Discussion

The necessity of carbon taxation is, at this point, almost beyond dispute in the climate policy literature. However, the value of the carbon price is disputed. The further most important input parameters are all connected to Canada's most substantial greenhouse gas emitters and carbon sinks, validating the model's behavior.

The identified carbon tax minimum of $240 CAD/tCO2e broadly aligns with estimates from other research, and current government policy plans. The model exploration approach provides more robust results than optimization models focused on social cost of carbon, and also highlighted limitations with the model, such as integration errors.

The high alignment regarding policy relevance of input parameters between global sensitivity analysis and scenario discovery indicates the findings from these analysis methods is robust.

Conclusions

Using a simulation model of energy and climate, we show through exploratory modelling that carbon tax is the most important policy lever for achieving long-term decarbonization. Further levers for consideration are within the land use sector and avoiding methane leaks.

Future work might consider the effects of energy policy on employment and GDP, or study how energy policies might be structured in time to provide adaptive and robust policy alternatives.

Plenary 1

Understanding complexity in military operations

Maj Doeke Broersen[a]

[a]*Royal Netherlands Army*

In this session, we will discuss the causes of complexity in military operations and show some system dynamics analysis examples that are derived from practice, in which the software tool MARVEL was used.

Contemporary military conflicts are characterized by a high level of complexity. Often due to the multitude of state and non-state actors, and not least because of the speed at which information spreads through societies. System dynamics analysis helps to understand the complexity in military operations and helps to identify the root underlying causes of (military) conflict. At some point, the connectivity and ripple effects of military actions within the operational environment become too high for the human mind to comprehend. The software tool MARVEL is able to connect both the science and art of understanding a conflict environment. The aim is to improve interventions and reduce negative side effects that may otherwise prolong a conflict.

Parallel 3: Systemic insights in and from industries

The Future of Nickel in a Transitioning World. Exploratory System Dynamics Modelling and Analysis of the Global Nickel Supply Chain and its Nexus with the Energy System

Jessie Bradley, Willem Auping (TU Delft), Benjamin Sprecher (Leiden University)

Acceleration of the energy transition requires increased mining of metals. One of these metals is nickel, used in stainless steel required for all energy infrastructure, and an important component for both stationary batteries and batteries used in electric vehicles. Previous research has been done on the global nickel requirements for the energy transition at a high level of aggregation. However, we use an exploratory system dynamics model to assess the resilience of the nickel supply chain and its nexus with the energy system at the level of individual mines. We modelled the development of the global nickel supply chain, and its energy requirements and GHG emissions and explored different disruption scenarios, sustainability policies, and uncertainties between 2015 and 2060. Nickel demand seems to grow in a bandwidth between 7 and 35 million tonnes per year by 2060. The main contributors to the demand size are electric vehicle batteries. The nickel system is conditionally resilient to the energy transition, given sufficient exploration and annual capacity increase. To increase the resilience of the nickel system, policies that support innovation in battery lifetime and good end-of-life waste management of batteries can play an important role. The most important contribution of this research is not in the data and assumptions, but in the model itself, which can be adapted and refined in further research to make the outcomes more robust and useful for decision making. Other important avenues for further research include determining how much exploration is possible and how quickly mining capacity can be increased.

Is the pharmaceutical market structure an obstacle to addressing antimicrobial resistance?

Authors: Leon Rohde[1*], Rok Hrzic[2]

1.Healthcare Policy, Innovation and Management program, Faculty of Health, Medicine and Life Sciences, Maastricht University

2.Department of International Health, Faculty of Health, Medicine and Life Sciences, Maastricht University

*Corresponding author: l.rohde@student.maastrichtuniversity.nl

Introduction: The next health crisis is one of antimicrobial resistance (AMR). Approximately 700,000 people annually die from antimicrobial-resistant pathogens worldwide and it is predicted that this will increase to 10-50 million annual deaths by 2050, surpassing cancer-related deaths. One solution to AMR is the development of novel antimicrobial agents. However, pharmaceutical companies have increasingly been suspending antimicrobial development, leaving the pipeline of novel antimicrobials insufficient. This paper investigates why there is a lack of investment in the development of antimicrobials in pharmaceutical companies by using a system dynamics approach.

Method: A systematic literature review was performed, which included peer-reviewed literature and industry publications. The literature was used to identify and categorize the relevant variables, perceived relationships between these variables, and their role in the development of antimicrobials. This information was then used to construct a causal loop diagram.

Results: A total of 24 sources were utilized. The extracted variables were related to three main categories: research & development, regulation, and economics. The causal loop diagram consists of four main loops: return of investment loop, perceived market attractiveness loop, research cost loop and qualified personnel loop. The return-on-investment loop includes factors such as price benchmarking, treatment duration, time to uptake, current number of AMR cases, and sales volume. These variables determine the profits a company expects to make on its investment, which influences the perceived market attractiveness. In the perceived market attractiveness loop, the main variable is the perceived profitability of antimicrobials relative to other pharmaceutical products. This loop influences the qualified personnel loop, which describes attracting and retaining skilled personnel to the field of antimicrobial development. The final main loop is the research cost loop, which includes variables such as degree of complexity of research, time of research, clinical trial failure rate, and clinical trial costs.

Conclusion: The causal loop diagram identified the main cause for the lack of investment in the field of antibiotic development to be the perceived low return of investment. The low return of investment is related to the high research costs and low expected sales volume. These results highlight that the current market structure for antimicrobials no longer promotes research and development and that it is necessary to implement alternative reimbursement strategies. The pharmaceutical market structure can no longer be based on sales volume but needs to convert to a de-linked market between sales and profit. Pull incentives that incentivize outputs, for example subscription-based reimbursement, would have the most impact on the return of investment a company can expect from an antimicrobial. Further research needs to be conducted on how specific pull strategies would impact the antimicrobial development system.

Efficiency, the rebound effect, and sustainable development

Andreas Größler (andreas.groessler@bwi.uni-stuttgart.de)

University of Stuttgart, Germany

Most studies in sustainable management address efficiency gains, like using less material and energy, emitting less hazardous products and waste, and the reusage/recycling of products and components. Such efficiency gains, despite their obvious appeal from an economic perspective, usually lead to an overall increase in economic activity with potentially adverse consequences (i.e., a rebound effect). Thus, making economies truly sustainable might necessarily mean to ramp-down output in certain industries and of material economic activities in total. However, this issue is virtually absent in academic discussions in management research and practice. This exploratory study is mostly conducted as a conceptual and literature-based endeavour, supported by illustrative causal maps.

Keywords: downsizing, efficiency, rebound effect

Most studies in sustainable management address efficiency gains in the broadest sense, like using less material and energy, emitting less hazardous products and waste, and the reusage/recycling of products and components (Kleindorfer et al., 2005). Such efficiency gains, despite their obvious appeal from an economic perspective, usually lead to an overall increase in economic activity with potentially adverse consequences (Ehrenfeld&Hoffman, 2003; see Figure 1). One exemplary reason for such adverse consequences is the rebound effect which “is the reduction in expected gains from new technologies that increase the efficiency of resource use, because of behavioral or other systemic responses. These responses usually tend to offset the beneficial effects of the new technology or other measures taken"; Wikipedia, 2020; cf. also Binswanger, 2001). Note that indirect and economy-wide rebound effects play an important and often neglected role in this regard. Accordingly, many researchers in the broader sustainability science claim that an overall reduction of economic activity is inevitable (see the "degrowth" concept and movement; Kallis, 2011) and is intertwined with cultural and societal transformation (Schneidewind, 2018).

Consequently, making economies and businesses truly sustainable might necessarily mean to ramp-down output in certain industries or even of material economic activities in total (Sterman, 2012; Meadows&Randers, 2012). Despite its potential importance, the issue of operations ramp-down is virtually absent in the academic discussion. For instance, many illustrations and examples from textbooks assume capacity growth when presenting capacity change concepts—usually, the strongest indication of production ramp-down one can find, is a mentioning of this possibility (i.e., capacity decrease) in the beginning of respective textbook chapters.

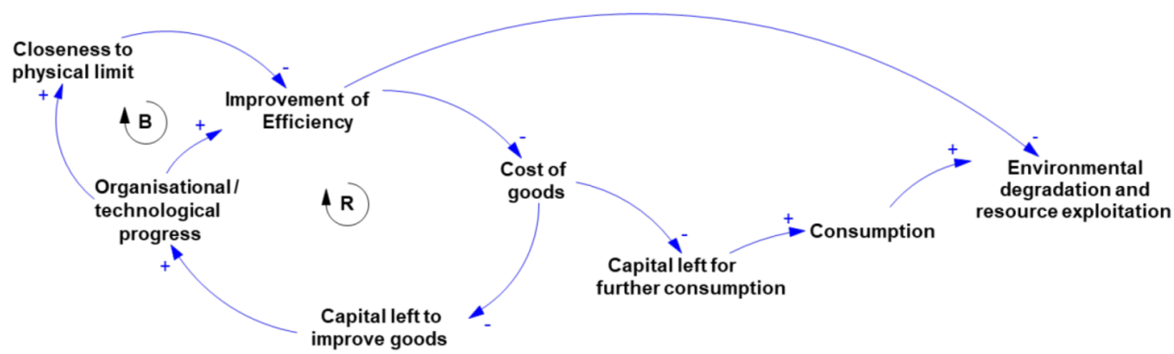

Figure 1 – Causal diagram of rebound effect regarding economic efficiency

Apparently, lowering economic capacity (maybe even to zero) to accommodate for changed contextual or organizational situations seems either to be a topic that does not require much attention or that academics in the field of operations do not like to talk about. However, being good in managing ramp-downs and the transition to highly sustainable production could well be a major strategic advantage within the next decades (Forrester, 2009; Reichel&Seeberg, 2010).

This exploratory study is mostly conducted as a conceptual and literature-based endeavour. Sources from the sustainable operations field (e.g., Kleindorfer et al., 2012; Walker et al., 2014) as well as from operations strategy (e.g., van Miegham, 2008; Slack&Lewis, 2017) are used. The discussion is supported by illustrative causal maps and simulation models (Randers, 2000).

References
Binswanger, M. (2001). Technological progress and sustainable development: what about the rebound effect? Ecological Economics, 36(1), 119-132.
Ehrenfeld, J. R., & Hoffman, A. J. (2013). Flourishing: A frank conversation about sustainability. Stanford University Press.
Forrester, 2009. "The Loop You Can't Get Out Of", Interview by Michael S. Hopkins, MIT Sloan Management Review (Winter 2009), excerpts: GreenBizz.html.
Kallis, G. (2011). In defence of degrowth. Ecological Economics, 70(5), 873-880.
Kleindorfer, P. R., Singhal, K., & Van Wassenhove, L. N. (2005). Sustainable operations management. Production and Operations Management, 14(4), 482-492.
Meadows, D., & Randers, J. (2012). The Limits to Growth: the 30-year update. Routledge.
van Miegham, J. A. (2008). Operations Strategy – Principles and Practice. Dynamic Ideas, Belmont, MA.
Randers, J. (2000). From limits to growth to sustainable development or SD (sustainable development) in a SD (system dynamics) perspective. System Dynamics Review, 16(3), 213-224.
Reichel, A., & Seeberg, B. (2010, October). Rightsizing production: The calculus of" Ecological Allowance" and the need for industrial degrowth. In Proceedings of the IFIP working group (Vol. 5).
Schneidewind, U. (2018). Die große Transformation [The great transformation]. Fischer, Frankfurt a.M.
Slack, N., & Lewis, M. (2017). Operations Strategy, 5th ed. Pearson, Harlow, UK.
Sterman, J. D. (2012). Sustaining sustainability: creating a systems science in a fragmented academy and polarized world. In Sustainability science (pp. 21-58). Springer, New York, NY.
Walker, P. H., Seuring, P. S., Sarkis, P. J., & Klassen, P. R. (2014). Sustainable operations management: recent trends and future directions. International Journal of Operations & Production Management, 34(5).
Wikipedia (2020). Rebound effect, https://en.wikipedia.org/wiki/Rebound_effect_(conservation) [accessed 14/01/2020].

Parallel 4: Methodology: Looking back and ahead

Refining the causal loop diagram: a tutorial for maximizing the contribution of domain expertise in computational system dynamics modeling

Loes Crielaard*[1,2], Jeroen F Uleman*[1,3], Bas D L Châtel*[1,3], Peter M A Sloot[1,4], Rick Quax[1,4]

* Loes Crielaard, Jeroen F Uleman, and Bas D L Châtel contributed equally.

1. Institute for Advanced Study, University of Amsterdam, Amsterdam, The Netherlands
2. Department of Public Health, Amsterdam UMC, University of Amsterdam, Amsterdam Public Health Research Institute, Amsterdam, The Netherlands
3. Department of Geriatric Medicine, Radboud Alzheimer Center, Donders Institute for Brain, Cognition and Behaviour, Radboud University Medical Center, Nijmegen, The Netherlands

4. Computational Science Lab, University of Amsterdam, Amsterdam, The Netherlands

Complexity science is increasingly recognized as a relevant paradigm for studying systems where biology, psychology, and socio-environmental factors interact. The application of complexity science however often only encompasses developing a conceptual model that visualizes the mapping of causal links within a system, e.g., a causal loop diagram (CLD). While this is an important contribution in itself, it is imperative to formulate a computational version of a CLD in order to interpret the dynamics of the modeled system and simulate 'what if' scenarios. We propose to realize this by deriving knowledge from experts' mental models in the biopsychosocial domains. This tutorial paper first describes the steps required for capturing expert knowledge in a CLD such that it may result in a computational system dynamics model (SDM). For this purpose, we introduce several annotations to the CLD that facilitate this intended conversion. This annotated CLD (aCLD) includes sources of evidence, intermediary variables, functional forms of causal links, and the distinction between uncertain and known-to-be-absent causal links. We propose an algorithm for developing an aCLD that includes these annotations. We then describe how to formulate an SDM based on the aCLD. The described steps for this conversion help identify, quantify, and potentially reduce sources of uncertainty and obtain confidence in the results of the SDM's simulations. We utilize a running example that illustrates this conversion process. The approach described in this paper facilitates and advances the application of computational science methods to biopsychosocial systems.

The behavioural turn in Operational Research and System Dynamics

Etiënne A.J.A. Rouwette, Radboud University

Systemic analysis of societal challenges implies both high quality modelling as well as productively working with stakeholders, in order to ensure sensible results as well as implementation of recommendations. This presentation looks at the impact of modelling on behaviour, first from an Operational Research (OR) perspective and then more specifically from a System Dynamics (SD) perspective.

Practitioners and researchers in OR have increasingly realised that in order to make a real difference, focusing on the 'content' of OR work is simply not enough. In addition to technically correct and valid models, OR has long been interested in the process of developing models and its impact on behaviour of decision makers and stakeholders. A recent review on Behavioural OR maps the body of behavioural OR studies that focus on interventions. 'Intervention' here refers to a designed problem-solving system in which individuals or groups engage with OR methods, processes and tools in order to complete a set task or address a real-world problem. The review covers a 30-year period, and develops a typology to organise the corpus of reviewed studies. The typology is comprised of four types of studies, each type representing a distinctive approach in terms of its assumptions about behaviour (determinist or voluntarist) and the research methodologies they use (variance or process), and each type is concerned with different research questions that do not cut across other approaches. On the basis of this categorisation, knowledge themes emerge and suggestions for further developing OR-based interventions.

SD is concerned with capturing the structure behind real-world phenomena in transparent models. With its focus on explanatory models (instead of optimal or ideal) that aim to realistically depict managerial decision making, SD may be said to have an intrinsic behavioural focus. SD models describe decision makers not as strictly rational, but instead as subject to fallacies and prone to errors. SD also has a long tradition of working with decision makers and stakeholders, distinct from process studies in OR. In this presentation we map SD work onto the typology developed for BOR and identify consequences for SD-based interventions.

Plenary 2

System Dynamics analysis and scenario development for the safety region Rotterdam-Rijnmond during the Corona pandemic

Maikel Lenssen[a] & Maartje Schuurmans-Spoelstra[b]

[a]Safety region Rotterdam-Rijnmond

[b]Royal Netherlands Army & TNO

During the first months of the COVID-19 pandemic, the Safety Region of Rotterdam-Rijnmond applied System Dynamics to support scenario development in the developing crisis. In this talk, Maikel Lenssen Maartje Spoelstra will elaborate on the role of the Safety Region in the pandemic, the SD-model that was developed and how modelling contributed to scenario building to support decision making.