Jun 28th, 10:40 AM - 12:00 PM

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Practical Poststructuralism for Confronting Wicked Problems

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Abstract: This paper discusses an innovative qualitative-quantitative modelling method relevant to two characteristics of wicked problems: they have no definitive formulation, and the choice of how they are defined or explained determines the nature of their resolution. Through projects conceptualizing the human dimensions of climate change, the socio-technical dynamics of the Energiewende (Germany’s low-carbon energy transition), and of water futures of a megacity (Lima), it has been found that the system-theoretic method of cross-impact balances (CIB) reveals fundamental assumptions in interdisciplinary modelling projects and opens them up for investigation. This can democratize modelling exercises while preserving scientific credibility. It can also enhance mutual learning across collaborators and study participants by interrogating the processes, collaborators, methods, or participants that appear to have epistemic authority at different stages of the project and whether such authority is justified. Through these capabilities, CIB gives new practical relevance to deconstructive, critical practices that characterize modes of thought from the humanities and social sciences—namely poststructuralism—and brings new reflexivity to modelling studies.

Keywords: scenarios; qualitative-quantitative methodologies; epistemology; poststructuralism; climate change

1 INTRODUCTION

In their seminal paper on wicked problems, Rittel & Webber (1973) described 10 characteristics. This paper focuses on two that can be confronted through the qualitative-quantitative methodology of cross-impact balances, or CIB (Weimer-Jehle 2006, 2016). First, wicked problems have no definitive formulation, which means there is no objective ‘truth’ regarding what the problem is or what is causing it. Second, the choice of how a wicked problem is defined or explained tends to ‘determine’ the nature of its resolution. This means that the perspective, paradigm, or frame used to make sense of the problem implies only a subset of possible solutions, and they may not be the ‘best’ ones. These particular characteristics of wicked problems pose opportunities and challenges for environmental modelling. Often, models are enlisted because the formulation of the problem is unclear to begin with. However, the process of modelling itself runs the risk of artificially constraining problem definition, and in turn, the creativity needed to find the most effective solutions (Beck 2017). In the sections below, the qualitative-quantitative method of CIB is introduced as well as the concept of poststructuralism. Through three case studies, we summarize our findings that modeling exercises become more reflexive with the application of CIB and thereby more flexible and adaptive. This occurred because CIB enables the disclosure of fundamental assumptions about system structure – not only by modellers but also non-modellers on an interdisciplinary team. CIB is also appropriate to use with stakeholders or study participants. By using CIB to critically investigate what kinds of knowledge components are incorporated in the modelling exercise and to democratize the knowledge inputs to a modelling exercise, mutual learning can be enhanced across collaborators, stakeholders, and study participants.
The method of cross-impact balances (CIB) is used for developing and selecting scenarios among a number of possible factor-combinations. In much environmental change research, scenarios specify particular combinations of input assumptions for model simulation (Carter et al. 2007). Often, such scenarios are elaborated as stories, or narratives (Alcamo 2008). In general, approaches for scenario development range from qualitative to quantitative (e.g. Intuitive Logics versus the Probabilistic Modified Trends school; see Bradfield et al. 2005). CIB is a qualitative-quantitative methodology, as it iterates between qualitative and semi-quantitative analytical steps.

CIB begins first with the qualitative step of specifying relevant variables – so-called “descriptors” – for a scenario. Possible states for each descriptor must also be specified. Descriptors and their states can be qualitative or quantitative. Second, judgments must be articulated for how descriptors are interrelated. This step is similar to specifying an adjacency matrix for a network, and interrelations are recorded as numerical judgments corresponding to a Likert scale. These numerical judgments are used for the third step, which is to evaluate the level of internal consistency of various combinations of descriptor-states (scenarios). A scenario is considered internally consistent when it evokes a self-consistent network of influences, which can be verified mathematically.

CIB can support expert-driven approaches, participatory approaches, or a balance in between. This is because the process of completing CIB opens assumptions for scenario development to inspection. Experts or participants who disagree on the selection of descriptors, their states, or their interrelationships can make note of differences and then explore their implications systematically.

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formulation/definition. The implications of these disagreements can then be systematically investigated to enhance mutual learning across collaborators, stakeholders, and study participants.

3.1 Opportunities for Deep Engagement over the Scope of Relevant Knowledge

Discussions about what knowledge or perspectives are relevant to a wicked problem are multi-layered and often conflictual in respective research projects. Plausible explanations for system behavior (or scenarios) that stakeholders and/or modellers might hold in their minds rest on a series of deeper assumptions. Different perspectives for understanding a system and making knowledge claims can be explained from an epistemological perspective. Epistemology relates to the ways individuals ‘know’ or investigate a future-oriented problem. As such, epistemologies are based on elements such as lived experience, theoretical frameworks, empirical knowledge, and consensus judgments. Different collections of these elements across collaborators or stakeholders give rise to different ‘epistemic lenses’ from which each makes sense of a wicked problem. As Figure 1 suggests, those epistemological considerations matter in modelling, because they drive what data will be considered and what methodological approaches are applied, which speaks to the second characteristic of wicked problems as mentioned above. What stakeholders and/or modellers perceive as ‘legitimate’ knowledge about the problem—i.e. their epistemological commitments—is also informed by deeply rooted ontological assumptions: What is the nature of reality? What is the nature of the problem? What facets and layers of the problem make it a wicked problem? (See Esbjörn-Hargens 2010 for a detailed discussion.) Such ontological assumptions about the nature of reality and the problem itself underlie epistemological and methodological arguments in modelling exercises, which can impede unequivocal and clear problem formulations (i.e., characteristic 1 of wicked problems).

![Figure 1](image-url)

In contrast to popular scenario development methods employing unstructed processes to assemble assumptions about possible future developments (Alcamo 2008), as discussed above in Section 2, cross-impact balances (CIB) demands an explicit account of the assumptions and knowledge components that go into scenario development. This makes it possible to investigate scenario components more deeply and to analyse them in a poststructural manner. As described in the case studies below, with CIB, there are two key opportunities for critical reflection on how collaborators and stakeholders might have different understandings of a system. The first opportunity comes from articulating what variables (as well as their possible states) are believed to be most relevant for study. Second, CIB demands an explicit record of how system elements are believed to directly influence
each other. The latter stage can open discussions to what research activities and modelling approaches might be most relevant, potentially with CIB playing a modelling role itself.

3.2 Examples of Applications of Cross-Impact Balances

3.2.1 IPCC Scenarios

IPCC reports play an important role for organizing research activities of the scientific community. Within IPCC Assessment Reports, scenarios harmonize assumptions across modeling teams so that the results of different studies are comparable (Giord et al. 2009, Hibbard et al. 2007). The IPCC Special Report on Emission Scenarios, or SRES (Nakicenovic et al. 2000), was the first to elaborate harmonizing stories, or narratives, for global socio-economic futures accompanying quantitative emissions profiles. Recently, such narratives (O’Neill et al. 2017), socio-economic futures (Riahi et al. 2017), and emissions profiles (van Vuuren et al. 2011) have been updated.

A CIB study critically examining the SRES found that only a subset of policy relevant futures were featured (Schweizer and Kriegler 2012). Importantly, internally consistent futures with high emissions were left out. This study was timely for the development of new narratives for the next generation of socio-economic scenarios (so-called Shared Socio-economic Pathways, or SSPs). A CIB study was invited to comprehensively explore a range of uncertainties and to provide kernels of SSP narratives (Schweizer and O’Neill 2014). Through expert surveys and workshops, a CIB model was specified that could articulate self-consistent examples of futures combining high challenges for climate adaptation with low challenges for greenhouse gas mitigation and vice versa. This finding was important, as, at the time, it was an open question whether such difficult-to-imagine futures should be entertained as part of the latest set of scenarios for research assessed by the IPCC. Such futures have been adopted and are known as SSP4, “Inequality—A road divided,” and SSP5, “Fossil-fueled development—Taking the highway” (O’Neill et al. 2017).

3.2.2 ENERGY-TRANS Research on the Energiewende

The interdisciplinary project ENERGY-TRANS examined opportunities and challenges for the Energiewende, or Germany’s low-carbon energy transition. CIB was used to organize research activities across several institutions. Three modeling teams with different disciplinary and geographic lenses on the German energy system (e.g. national-level household demands, national-level power engineering, regional-level land use) each used CIB to make the qualitative ‘stories’ about possible societal futures behind their respective modeling activities explicit (Weimer Jehle et al. 2016). Using CIB in this way required collaborators to acknowledge their assumptions, their models’ boundaries, and to consider how they might influence variations across model results.

In a post-project workshop presentation, Naegler and Pregger (2016) from the integrated assessment modeling team at DLR reported that the CIB discussions were highly beneficial for moderating a process to bring together views of experts—at times diverging—from diverse disciplines ranging from energy modeling to social sciences. However, two limitations were acknowledged. First, a CIB matrix itself can be considered a low-resolution ‘meta’-model. The fact that a higher-resolution model, such as an integrated assessment model, would produce results independent of CIB’s organizing framework raised questions about how to interpret unanticipated results when they arose. In the face of seemingly conflicting results, what should take precedence—results produced by a detailed model (with narrower model boundaries), or those anticipated by the coarse CIB meta-model? Second, in two of the ENERGY-TRANS CIB projects, the collaborators (who were akin to ‘study participants’) were all energy modellers. This suggested that the collaborators were well positioned to develop high literacy with CIB. Although enhanced self-reflexivity was achieved, the modellers appreciated the involvement of “CIB experts” presiding over the CIB discussions. CIB aims to be an accessible methodology and has freely available software tools (see www.cross-impact.de). However, it may still be too technical for study participants—even those who are modelers themselves—to use independently.
3.2.3 Water Futures for Lima Coping With Climate Change

The LiWa Project focused on sustainable water and wastewater management of Lima, Peru. It combined CIB with modeling and simulation of Lima’s entire water supply and sanitation system as well as with hydrological modelling of the catchment areas (Schütze et al. 2018). The qualitative CIB model covered social, political, technical, and environmental aspects, and it provided the modelers with different qualitative scenarios to orient their simulations. The LiWa scenarios drew particular attention to the impacts of climate change and to the impacts of governance on possible future situations of water supply and demand. The CIB model was developed through a series of workshops with a group of local stakeholders, including diverse actors ranging from representatives of the public water company to NGOs.

The participatory approach of CIB revealed ontological cleavages among stakeholders. These manifested in diverging assumptions on impacts between descriptors, e.g. regarding effects of a potential privatization of the water company on the rate of losses of the water network. The decomposition of such worldviews into pairwise relationships made these accessible for discussion and critical reflection (Kosow 2015). The qualitative CIB scenarios have been translated into quantitative input-data sets for simulation runs, jointly by the modellers and the CIB experts. This allowed the water system modelers to reflect upon their context assumptions, which until then had been implicit. In addition, it allowed the non-modelers to gain a better understanding of the interrelations assumed by the numerical water system model (Kosow 2016).

3.3 DISCUSSION

Poststructuralism as a social scientific mode of thought is regularly subject to criticism. Many scholars have used it for critique (Gasché 2007) often advocating relativism (see Weiss 2000 for a review). This has given it a reputation for impracticality in empirical research contexts. However, to generate exploratory scenarios of system behaviour, CIB employs approaches that can be considered poststructural “tools” (Inayatullah 1998). In CIB, system definitions and subsystem interrelations must be deconstructed so that underlying assumptions and potential approaches to the modelling exercise are laid bare. After critical examination and consideration, these elements can then be reconstructed to elucidate new, alternative scenarios. CIB thereby invites poststructuralist inquiries among members of interdisciplinary teams for practical purposes.

The ‘practical’ turn of poststructuralism via CIB features most prominently in the IPCC scenarios case. Investigations into largely unquestioned epistemological commitments—that is, in the way scenario factors were combined to present ‘relevant’ and ‘plausible’ scenarios in the IPCC SRES—did not stop at the analytical level of critique. From such epistemological scrutiny, practical methodological propositions were formulated as additional alternative scenarios that were not previously featured. The critical findings of the CIB method also practically informed development of the next generation of socio-economic scenarios (SSPs).

Even when CIB is not used for a complete ‘practical poststructuralist’ cycle (i.e. reconstruction following deconstruction), the application of CIB in modelling studies can invite reflexivity (and in turn, learning) on three levels. First, on an individual level, reflexivity develops an improved appreciation of how and why particular knowledge components are generated, articulated, and assembled in modelling exercises—paired with a sensitivity towards “the status, validity, basis and authority of knowledge claims” (Alvesson 2016). Second, and related to this, CIB can bring about reflective practice on the project level. ‘Reflective practice’, a term originally coined by Schön (1983), implies that modellers, collaborators, and knowledge users continuously reconsider how they approach wicked problems within modelling (i.e. their methodological choices) and why they are approaching it that way (ontological and epistemological considerations, see Figure 1). Following Schön (1983), an exchange between modellers, non-modellers, and field experts needs to be systematically encouraged to make taken-for-granted assumptions explicit and to enable their critical examination. This is how reflective practice (or reflexivity) happens. The LiWa Project case demonstrates that CIB offered a platform/arena for such inclusiveness of modellers and non-modellers into joint research activities that would have been difficult to realise without CIB as a mediating tool. What the LiWa case also underscores is that CIB is applicable not only for solving problems and mediating inner-project
conflicts; rather it first and formerly lays them out in the open for discussion. This equally applied to reflexivity on a third level—that of model interpretation—as illustrated by the ENERGY-TRANS case.

Reflexivity is important in collaborative research because it enables mutual learning. In interdisciplinary projects where multiple disciplines and their diverse empirical frames and inputs aim to co-produce knowledge about a problem, Phillips et al. (2013) note that conflicts often arise. These are regarding how knowledge is produced, articulated, and integrated. The authors propose a range of reflexive strategies for these challenges, and among them is a proposal for poststructuralist approaches. Such critical analyses not only can reveal “the dominance of certain knowledge interests and forms of knowledge over others” (Phillips et al. 2013: 7) but also make room for exploring alternative approaches to problem definition and resolution.

4 CONCLUSIONS, RECOMMENDATIONS, AND FUTURE WORK

Through three case studies, this paper describes how the method of cross-impact balances (CIB) enables critical inquiries into two key aspects of wicked problems: First, they have no definitive formulation, which means there is no objective ‘truth’ regarding what the problem is or what is causing it. Second, the choice of how the problem is defined or explained tends to ‘determine’ the nature of its resolution. This means that the perspective, paradigm, or frame used to make sense of the problem implies only a subset of possible solutions, and they may not be the ‘best’ ones. These aspects are influenced by the perspectives of investigators, collaborators, stakeholders, and study participants on questions that are ontological (“what is”) and epistemological (“what is/can be known”). In interdisciplinary projects, arguments over ontological and epistemological perspectives can hinder mutual learning, and, at worst, become power plays “of certain knowledge interests and forms of knowledge over others” (Phillips et al. 2013: 7). To guard against this, we propose that early in modelling projects, CIB be used as part of interdisciplinary collaboration to systematically explore conceptions of the system under study. CIB is a qualitative-quantitative method that generates exploratory scenarios of system behaviour through approaches that can be considered poststructural “tools” (Inayatullah 1998). In CIB, system definitions and subsystem interrelations must be deconstructed so that underlying assumptions and potential approaches to the modelling exercise are clearly articulated and laid bare. This enables their critical examination and consideration. After such critical reflection, these scenario/model elements can be reconstructed to elucidate new, alternative scenarios. CIB thereby invites poststructuralist inquiries among members of interdisciplinary teams for practical purposes and can be considered “practical poststructuralism.” From the case studies, such poststructuralist inquiries enhanced reflexivity and learning on three levels: (1) that of individual collaborators and study participants to better appreciate how and why particular knowledge components are generated, articulated, and assembled in models; (2) at the project level, where CIB provides a platform/arena for including the perspectives of modellers and non-modellers jointly in scoping and structuring research activities; and (3) at the level of model interpretation, where a CIB meta-model can help environmental or integrated assessment modelers acknowledge their own model’s assumptions, model boundaries, and how these might influence variations across model results.

Future work could further improve the potential of CIB in the above areas. Limitations remain with whether CIB is truly accessible for interdisciplinary collaborators to use in the absence of a ‘CIB expert’. Additionally, open questions remain with how to handle seemingly conflictual results between a detailed environmental or integrated assessment model and a coarse, but more comprehensive, CIB meta-model.

ACKNOWLEDGMENTS

Travel support for VS to present this paper at the 9th International Congress comes from a University of Waterloo Social Sciences and Humanities Research Council Institutional Grant as well as from the Waterloo Institute for Complexity and Innovation. Research support for HK and for RS regarding the practical poststructuralism of CIB comes from the Cluster of Excellence Simulation Technology (EXC 310/2) at the University of Stuttgart.
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