A Summary Report for the Symposium

(Dis)Connections: Exploring the conceptualisation, methodologies and promises of assemblage and systems thinking approaches in food system research

29th and 30th June

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Foreword

This report outlines the outcome of a digital symposium held on 29th and 30th June 2022 to discuss and explore the potential for interconnections, synergies and disjuncture between system thinking and assemblage thinking approaches within food system research. It involved nine speakers and was attended by over 40 participants. The event included a set of presentations from each of the speakers and open plenary discussion involving audience participation.

This report summarises the discussion before concluding by identifying several areas of overlap and disjuncture between system thinking and assemblage thinking approaches.

Acknowledgments

We would like to thank the speakers and audience for the symposium and their contributions to a lively and interesting discussion.

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Contents

Introduction

A digital live event was held on 29th and 30th June 2022 to discuss and explore the potential for interconnections, synergies and disjuncture between system thinking and assemblage thinking approaches within food system research. It involved nine speakers and was attended by over 40 participants. The event included a set of presentations from each of the speakers and open plenary discussion involving audience participation.

Purpose of the workshop

The aim was to discuss and explore the potential for interconnections, synergies and disjuncture between system thinking and assemblage thinking approaches within food system research. The event brought together scholars from North American and Europe to discuss opportunities for further developing our understanding of systems and system analysis through making connections between these different approaches.

Workshop background

Introduction

Food system scholars have oriented themselves towards diverse forms of system analysis to examine change within the context of intertwined and intensifying economic, environmental and climate challenges, alongside a drive for technological transformation and rural social renewal. We seek in this event to continue this theoretical development through examining the interconnections, synergies and disjuncture between systems thinking and assemblage thinking in the context of food system change.

Systems thinking approaches rooted in the work of environmental scientist Donella Meadows (2008) and her efforts to develop a means of practically mapping and modelling system agents, processes and interrelations, have been applied to a range of cases as a means of enhancing our understanding of agriculture, food security and nutrition, and shape policies and strategic interventions for more desirable system outcomes (Borman et al., 2022). The concept of *assemblage* is rooted in the work of social theorists and political philosophers Gilles Deleuze and Pierre-Felix Guattari (1987) and elaborated by Manuel DeLanda (2006). It has been utilised in a growing body of work on rural economies, agricultural governance and food systems (Anderson & McFarlane, 2011; Briassoulis, 2019; Forney et al., 2018) so as to develop our understanding of the shortcomings of existing food system governance practices and identify opportunities for new and more hopeful alternatives. In applying these ideas food systems research in both has drawn attention to the heterogeneous configurations of human, non-human life and material elements, and the non-linear ongoing relational processes that produce diverse and contingent system networks, outcomes and trajectories over space and time.

We encourage theoretically and empirically rooted presentations that addresses the core questions: *how do these approaches theorise and conceptualise systems, what methodologies do they apply, what insights do they generate and what is their underlying aim and promises?* In addressing these questions, we are particularly interested in cases that document how actors are involved in the governance, mobilisation, integration and transformation of social and material relations within food systems.

Speakers

Presenters

- Professor Michael Woods, Aberystwyth University, United Kingdom
- Dr Pytrik Reidsma, Wageningen University, The Netherlands
- Professor emerita Helen Briassoulis, University of the Aegean, Greece
- Dr Erik Mathijs, KU Leuven, Belgium
- Professor Roberta Sonnino, University of Surrey, United Kingdom
- Dr Gary Polhill, James Hutton Institute, United Kingdom
- Dr Hugo Jose Herrera de Leon, University of Bergen, Norway
- Professor Alexandra Hughes, Newcastle University, United Kingdom
- Dr Ben Turner, Texas A&M University, USA

Discussants

- Dr Jérémie Forney, University of Neuchatel, Switzerland
- Dr Hector Menendez III, South Dakota State University, USA
- Professor Birgit Kopainsky, University of Bergen, Norway

Presentation Titles and Abstracts

Wednesday 29th June

Professor Michael Woods

Re-assembling the farm: globalization, China and the New Zealand dairy assemblage

This paper considers how assemblage thinking can be employed to analyse how the globalization of agriculture is reproduced through practices of assembling and re-assembling, not only of transnational flows of commodities, capital, labour and material inputs, but also the of physical and organizational structure of individual farms. It starts by briefly outlining some key conceptual attributes of assemblage thinking and how these differ from a systems approach. It then illustrates the application of an assemblage approach through a short case study of the transformation of the New Zealand dairy industry in response to shifting global markets, particularly the growth in demand for milk powder from China. By adopting an 'assemblage' approach that emphasizes relationality, contingency and the combination of human and non-human actants and components, the paper analyses these developments at three levels. Firstly, it traces how the growth of New Zealand dairy trade to China was facilitated by the assembling of diverse technological, financial, transport and representational components, including the coding of New Zealand dairy produce as 'pure' and 'untainted'. Secondly, it examines how the rise in value of dairy products stimulated conversion of sheep and beef farms and forestry land to dairying, with conversions involving the re-assembling of farm systems, including the incorporation of components sourced internationally, such as cattle feed from Australia, hybrid maize seed developed in the US, and irrigation systems manufactured in China. Thirdly, as farms are embedded in rural environments and communities, the paper notes the wider consequential effects of dairy conversions, from watercourse pollution and changes in the appearance of the landscape, to in-migration by Filipino farmworkers and the wear of increased tanker traffic on rural roads.

The presentation was connected with the following paper:

Woods, M, Fois, F, Heley, J, Jones, L, Onyeahialam, AI, Saville, S & Welsh, M 2021, 'Assemblage, place and globalisation', *Transactions of the Institute of British Geographers*, vol. 46, no. 2, pp. 284-298. *https://doi.org/10.1111/tran.12430*

Dr Pytrik Reidsma

Analysing the resilience of an arable farming system in the Veenkoloniën, NLusing system dynamics modelling

Farming systems in Europe are facing economic, social, environmental and institutional challenges. Highly intensive, climate-exposed, arable farming systems like the Veenkoloniën in the north of the Netherlands are particularly vulnerable to many of these challenges. Just in the past twenty years, the Veenkoloniën has lost half of its small and medium sized family farms specialised in cultivating starch potatoes. While starch potato production continues to be stable as the remaining farms are increasing the size of their operation, local stakeholders are concerned that the farming system in the Veenkoloniën is endangered. In this paper we investigate this issue by using a system dynamics simulation model to explore what the potential structures are that could threaten the long term future of starch potato production and to identify leverage points that can enhance the resilience of the system. Our analysis shows that, so far, farmers' active engagement in a processing cooperative has been an important element to their resilience to cope with economic and environmental challenges. In practice, the cooperative has been able to act as a buffer and stabilise prices for farmers in the region by implementing strategies that increase the value of their products, open new markets and increase starch potato production.

The presentation was connected with the following paper:

Herrera, H., L. Schuetz, W. Paas, P. Reidsma, B. Kopainsky, 2022. Understanding resilience of farming systems: insights from system dynamics modelling for an arable farming system in the Veenkoloniën. Ecological Modelling 464, 109848. https://doi.org/10.1016/j.ecolmodel.2021.109848.

Professor Roberta Sonnino

Systems Thinking: Bridging Theory and Practice Through a Place-Based Approach

Responding to growing calls for research that engages with the complexity of food system transformation, in this paper we focus on place as an "active meso-level mediator" between the multiple tensions and contestations that surround processes of change. Drawing on Massey's notion of a "progressive sense of place", we identify, through a critical review of the literature, four main features of this concept that, taken together, have a unique contribution to make to ongoing efforts to conceptualise *and* tackle the interwoven socio-ecological issues that affect the food system, and to position justice at the centre of its transformation. These include: (i) the socio-natural composition of place; (ii) the positive interactions and connections that underpin spatial identity; (iii) the social processes (including power dynamics) that shape everyday spatial practices; and (iv) the flows of ideas, materials, people and resources that cut across space. With special attention given to their interdependence and their implications for the functioning of food systems, these four features provide the basis for the development of an innovative and socio-spatially inclusive place-based framework for food system transformation that integrates ideas of sustainability co-benefits, spatial linkages, social inclusion and sectoral connectivities. This framework, we argue, provides a broader

and more critical academic understanding of food system transformation at both the macro- and the micro-levels. It also enables the formulation of legislative frameworks, policies and practices to deliver such transformation.

The presentation was connected with the following paper:

Sonnino, R. & Paul Milbourne, P., 2022. Food system transformation: a progressive place-based approach, Local Environment, 27:7, 915-926, DOI: 10.1080/13549839.2022.2084723

Dr Benjamin Turner

Systems thinking to augment applied assemblage thinking

Systems thinking grounded in dynamic feedback information systems provides an unambiguous language to describe and experiment with complex systems. Assemblage thinking grounded philosophy and dynamical systems theory provides a framework for describing the arrangement and connectivity of elements that produce complex social systems and behaviors. Through a variety of agricultural and natural resource management case studies, it is proposed that systems thinking can augment applications of assemblage thinking by providing explicit means of operationalization and visualization of complex systems. Illustration of the case studies reveal that there are several points of strength or convergence between the two approaches as well as important points of departure.

Thursday 30th June

Professor emerita Helen Briassoulis

Assemblage Thinking: Following an alternative path for the study of socio-material issues

The presentation primarily offers a concise account of Assemblage Thinking with a view to studying real world socio-material issues. Secondarily, it provides a broad-brush comparison of Assemblage with Systems Thinking in the way of exploring potential ways to combine, or even synthesize, them in empirical applications.

The study of any problem situation needs to first address the question of ontology, "what is the object of study", which critically judges the choice of epistemology, theory and methodology and, importantly, the practical recommendations offered. Two main paths to the study of socio-material issues are broadly distinguished. The *conventional/mainstream path* – reductionist/essentialist approaches – adopts a *system ontology*, positivist/post-positivist epistemology, general theories, formal/quantitative methodologies and offers OSFA (One-Size-Fits-All) recommendations. The *alternative path* – non-reductionist/relational approaches – adopts *relational, flat ontologies*, non-positivist epistemologies, representational and nonrepresentational theories, mixed quantitative/qualitative methodologies and offers situated recommendations. Systems and Assemblage Thinking belong to the first and the second path respectively.

The system and the flat (e.g. assemblage, actor-network) ontology are roughly sketched. Assemblage Thinking is introduced and the assemblage ontology/analytic is detailed: definition, components, relationships and linkages among them, processes of assembly, multiplicities, properties, agency, identity, power, causality. A broad-brush comparison of Assemblage with Systems Thinking suggests their *commonalities* (against disciplinary and linear thinking, purpose-driven, inclusiveness,

integrated/integrating, underlining adaptation and transformation) and main *difference*, their ontological assumptions (system vs. assemblage).

The implications of adopting Assemblage Thinking to conceptualize, analyze and govern socio-material issues/problems are discussed. The assemblage-based conceptualization underlines desire, purpose, context and process and foregrounds the materiality, multiplicity, complexity, contextuality and processuality of socio-material issues/problems. The assemblage-based analysis is immanent, focusing on issue-related assemblages, *not the system generally*. It foregrounds the particular and the unique of a problem situation, *not system regularities*. Consequently, situated, provisional and open to modification, *not OSFA*, recommendations are offered. Selected open issues are, finally, indicated.

Dr Hugo Jose Herrera de Leon

Using microworlds for policymaking in the context of resilient farming systems

Resilience management of farming systems requires building an understanding of the underlying drivers of the adaptive capacity of the system. In this paper, we use the concept of resilience as a framework to understand how bovine livestock farming systems may adjust to challenging environmental, social, and political conditions. Using an interactive simulation model (microworld), we explored potential developments for livestock farmers in Bourbonnais, France, to the effect of simultaneous changes in the socioeconomic landscape and unpredictable weather conditions resulting from climate change. The results offer insights into the potential trade-offs between systems scale and long-term sustainability by suggesting that sacrificing socioeconomic performance in the short and medium term may increase long-term sustainability and resilience.

Professor Alexandra Hughes

Food supply chains and the antimicrobial resistance challenge: On the framing, accomplishments and limitations of corporate responsibility

This paper presents a critique of supply chain responses to a particular global wicked problem – antimicrobial resistance (AMR). It evaluates the understanding of AMR (and drug-resistant infections) as a food system challenge and critically explores how responsibility for addressing it is framed and implemented. We place the spotlight on the AMR strategies applied in UK retailers' domestic poultry and pork supply chains. This provides a timely analysis of corporate engagement with AMR in light of the 2016 O'Neill report on *Tackling Drug Resistant Infections Globally*, which positioned supermarket chains, processors, and regulators as holding key responsibilities. Research included interviews with retailers, industry bodies, policy makers, farmers, processors, consultants and campaigners. We evaluate how strategy for tackling AMR in the food system is focused on antimicrobial stewardship, particularly targets for reducing antibiotic use in domestic food production. The global value chain notion of multipolar governance, where influence derives from multiple nodes both inside and outside the supply chain, is blended with more-than-human assemblage perspectives to capture the implementation of targets. This conceptual fusion grasps how supply chain responsibility and influence works through both a distributed group of stakeholders and the ecological complexity of the AMR challenge. The paper demonstrates in turn: how the targets for reducing antibiotic use in domestic meat production represent a particular and narrowly defined strategic focus; how those

targets have been met through distributed agency in the UK supply chain; and the geographical and biological limitations of the targets in tackling AMR as a wicked problem.

The presentation was connected with the following paper:

Hughes A, Roe E. & Hocknell S. 2021. Food supply chains and the antimicrobial resistance challenge: On the framing, accomplishments and limitations of corporate responsibility. *Environment and Planning A: Economy & Space*, 53 (6), 1373-1390 https://doi.org/10.1177/0308518X211015255

Professor Erik Mathijs

Mutual adaption in scaling up niche farming through mainstream food systems

The purpose of this presentation is to explore what changes are needed in both niche and regime assemblages in order to facilitate the marketing of niche products (local, organic, agro-ecology) through mainstream food processing and retailing systems. Practices, routines and performances of both systems are described and compared, as well as efforts to reconfigure current systems. The analysis is based on an empirical analysis of 32 semi-structured interviews with actors in both alternative and mainstream systems in Belgium.

The presentation was connected with the following paper:

Ionara Costa, I., Bui, S., De Schutter, O. & Dedeurwaerdere, T. 2022. A network perspective to niche-regime interactions and learning at the regime level, *Environmental Innovation and Societal Transitions,* 43, 62-79 https://doi.org/10.1016/j.eist.2022.03.001.

Dr Gary Polhill

Simulation and systems thinking: the birth of the ecocyborg

It is an assumption that human cognition, whether individually or collectively, is adequate to the task of governing complex adaptive systems such as food production systems. Yet we now find ourselves with the need to do so to avert various anticipated social and environmental disasters. Computer simulations increasingly play a role in assisting decisions in complex adaptive systems, with the consequence that they are becoming embedded in socio-environmental systems. The ramifications of this could be conceptualized as an 'ecocyborg' – the augmentation of ecosystems with machine intelligence and technological automation. This talk will briefly discuss some of the issues that this raises, particularly the question of how far simulation-assisted decision-making in complex adaptive systems can be pushed.

The presentation was connected with the following paper:

Polhill, G.J. & Edmonds, B. (2023) Cognition and hypocognition: Discursive and simulation-supported decision-making within complex systems. *Futures.* 148, 103121. https://doi.org/10.1016/j.futures.2023.103121

First Open Plenary Discussion

Presenters: Michael Woods, Ben Turner, Roberta Sonnino & Pytrik Reidsma

Discussants: Dr Jérémie Forney & Dr Hector Menendez III

Key points from the plenary discussion

- There are re-occurring systemic problems that have not gone away, and we need to develop holistic understandings of the system of concern if we are to address them appropriately. This requires us to move away from narrow understandings. System thinking provides you with a framework for doing that.
- Systems thinking provides us with the means of developing quantitative and mental models of food and farming systems. These are complex systems with different components that interact and system thinking provides you with a means of understanding those connections so as to address key challenges.
- This aim is shared with assemblage where researchers are also trying to make sense of, understand and uncover relationships. Some go further and try to change and reconfigure those relations. At the core there is a desire to imagine and contribute to bringing about a different future.
- Broadly speaking both require similar types of data. The divergence is what each approach does with the data and the resulting end product. For example, assemblage doesn't seek to quantify the assemblage, but it can and does draw on quantitative data. These approaches therefore lend themselves to answering different types of questions.
- Quantification is key to system dynamics modelling. We want to quantify systems and then use that as a basis for simulations that enable us to generate different possible future scenarios to see the effects. These scenarios can be used as a tool for planning. One of the aims of system thinking is to produce quantitative models that can be used as tools in this fashion.
- Simulation, the act of 'peaking' into different possible futures is a main goal of system analysis. Humans are naturally poor at inferring how changes in structure and behaviour are interlinked and system modelling is a tool for examining those dynamics that extends natural human capacities in this respect.
- Developing simple models is not a corollary for development of small models. Simple models are conceptually and practically embedded with complex dynamics.
- An open question about whether assemblages and systems are the same 'object' of study. All the presentations stressed interconnection, relationality, interaction. But the approaches frame the object differently and ask different types of questions.
- Although there are similarities and correspondences assemblages and systems are not the same things. An assemblage is not a system. The research questions are different. Assemblage is interested in how things come together, how they are held together and how transformations happen in those contexts. This contrasts with system thinking that often poses questions about resilience of existing systems that explicitly and implicitly seeks to preserve current system functionalities. Assemblage doesn't necessarily make those commitments.
- Assemblage provides a means of moving between different assemblages that might operate on different spatial and temporal scales by treating them symmetrically. For example, you can examine how what is happening at the global level (e.g. a trans-local assemblage) and

how that is impacting a specific local setting (e.g. place-based assemblage). Both are treated as assemblages.

- Assemblage isn't trying to describe a 'complete' or bounded system, it is a framework for identifying and analysing different dynamics (e.g. globalisation) within a specific setting where those situated dynamics can be identified through the empirical endeavour. In contrast to system modelling where model boundaries are identified as an early starting point from which the model is detailed.
- A key principle of assemblage is that it recognises that we can never completely map out all the components and that each small change in a specific assemblage opens-up different possible futures which are innumerable and can never be completely anticipated.
- Place-based relational thinking provides a means through which fragmentations, which might be between research disciplines, policy fields or amongst key actors can be bypassed and/or bridged to facilitate transformation towards different, more sustainable, and equitable futures.
- System thinking requires there to be some kind of logic and coherence to the food system but that is not typical of the food system in reality.
- Good analysis from system and assemblage is not restricted to the easily visible, tangible or quantifiable but is able to identify visible and hidden dynamics, decision making actors, and actors that face the consequences. This is achieved by assembling stakeholders who can both inform the system model and analysis but also allow you to think in terms of power dynamics and power relationships.
- System thinking models aim to be as simple as possible and also capture the key variables that are influencing the system through sensitivity analysis. This means system thinking is able to identify the important variables from which scenarios can be run. This process provides opportunities to identify levers of change whilst omitting the dynamics that are less significant. It is therefore also a tool of prioritisation. But this does involve reducing and deciding what is kept and what isn't.
- System dynamics modelling is motivated by a desire to problem solve and ideas of resilience that suggest maintaining functionalities of the existing system. It requires a concrete problem to be identified and assessed. This potentially results in narrowness and fragmentation of focus. Assemblage does not necessarily require this level of reduction. However, it does need to reduce its analysis to a set of dynamics, processes and/or outcomes of interest which it can then analyse through the application of assemblage concepts.
- Fluidity of terms in assemblage. This contrasts with system thinking which has defined terms and concepts through which it constructs models. For example, stocks and flows, feedback loops and so one. In contrast assemblage concepts, such as coding, encompasses a lot of potential 'things' and has dynamic implications. For example, coding includes laws, regulations, even genetic coding, but also representation, pricing and so on. Coding, and changes to coding, impact the assemblage in fluid, non-linear ways. A change in price, shows up in business account books, which might result in a change in the sustainability of a business model and reassessment of possible changes, which might lead to a sector being represented as in decline.
- Framing the question/problem is important to both approaches and the parameters of the system/assemblage of interest. The boundaries of assemblage will always be less clearly defined than system thinking. In system thinking defining the system boundaries will shape the types of dynamics, relations, and agencies that are determined as important. Failing to draw the boundaries in the right place might result in a failure to account for key dynamics,

such as power, that are external to the modelled system. For assemblage it is about where to stop the cycles of rich description so that the important dynamics and processes been adequately identified and described.

- Time is a boundary that needs to be considered. Assemblage, although anticipatory and able to generation imagined futures has more limited time horizons than system modelling which is able to extend significantly into the future. Systems modelling aims to calibrate a model through a long historical time series of data to the present, and from this basis extrapolate multiple simulations well into the future. These scenarios are less limited by the human capacities of imagination but are limited by the vocabulary of the model which is set in the present.
- Assemblage isn't about simulation or prediction no matter how provisional or contingent those claims of prediction might be. However, assemblage is a means of thinking through different futures and planning in response to that.

Second Open Plenary Discussion

Presenters: Helen Briassoulis, Alexandra Hughes, Erik Mathijs, Hugo Herrera & Gary Polhill

Discussants: Dr Jérémie Forney & Professor Birgit Kopainsky

Key points from the plenary discussion

- A major point of difference regarding the ontological assumptions of 'system thinking' and 'relational flat ontological thinking' under which assemblage would be situated.
- System thinking positions systems as composed of discrete categories of objects and actors, which have measurable characteristics and singular roles/memberships. Relationships are fixed, circular, linear or prescribed but it is important to note they reject simple linear thinking in the whole. Vertical and hierarchical scales are usually pre-determined. Processes occur in stages, system behaviour is measured in averages and aggregates and relations are generalisable. Assumes a system, both in general and in part.
- Assemblages on the other hand are composed of no fixed or pre-determined actors and objects. The characteristics and capacities of these human and non-human components are relational and contingent. Not all components are 'equal'. There are some critical or limiting components that regulate the functioning of assemblages (e.g. resources, institutions, norms etc.). Components play material and expressive roles simultaneously and have multiple memberships. Categories are emergent outcomes of assemblage processes and coding. Assemblages are constantly becoming, situated and relational. Agency and power are distributed but uneven. There are no ontological hierarchies, binaries, or dichotomies and boundaries are blurred. Assemblage doesn't assume a system; it assumes a multiplicity composed of assemblages.
- One of the useful elements of thinking with assemblage is with regards to agency and distributed agency and the ways in which in manifests within, and shapes governance efforts. It brings in the agency of humans and non-humans, and how their agencies shape social, economic and supply change responses.
- There is also a difference between the objectives of analysis in that system thinking is often about some form of preservation, so it is inherently conservative, how can we adapt to protect the system. Whereas assemblage as always changing, reproducing and reforming themselves so change is not a problem, it is how things are.

- System thinking and modelling is a tool for helping you organise your thoughts to see the whole of the system, then reflect on the connections between the different parts of the system, how they are linked together and challenge yourself on the causal relationships and influences. If we think of the system as peoples' ontology or worldview formalised in a model.
- Models aren't fixed things necessarily. They are fixed at any one time, but they are also constantly open to tinkering, revision, addition and subtraction which includes data, relations and functions.
- There is not one type of modelling, nor is there just one model there are several annunciations of models and in dialogue we can develop ways to better represent reality in order to be able to experiment, to the extent that reality can be represented. For example, important values like 'sense of place', or 'spirit of place' these are very important but that resist representation in models.
- We need to explore ways to find the proper kinds of modelling and we need to question the fundamental presuppositions of system thinking because the real world is not a system, we impose a system on the world.
- It is not problematic to describe things using the terms of a system as long as you accept that your conceptualisation of the world, the way you have formalised it with respect to a particular issue or problems you are interested in, is transient. It has meaning only in a specific context and at a particular time.
- The real world is totally composed of elements getting in and out and that have multiple memberships. A farmer cannot be categorised as just a farmer, they might be a political representative, a parent, spouse, friend, member of an organisation, own and operate other businesses. Another example is land use classes such as agricultural land use. Agricultural land use includes industries, roads, villages, archaeological sites. Categories are constraining and system modelling constrains actors in this way. But categories are also useful because they are helpful for putting some order in our thoughts, but they are not ordering the world because the world is not categorised.
- Creating these categories and mapping them requires us to make compromises and concessions to aggregate things. But if we want to make recommendations to those who will implement decisions, we cannot categorise and aggregate things. So, assemblage is a logical route to express or represent what exists in the real world as it exists in that world not in the categories. This is difficult because out scientific methods have been modelled after system thinking and breaking this frame is difficult.
- Categories cannot be used and understood outside of the socio-cultural context in which it is being discussed. For example, there was a researcher who collected different definitions of forest. By the time he retired he had collected over 1000 different definitions. In a model you operationalise just one. This is an important problem to be aware of. It is still reasonable to build a model to try and pursue some of the logical consequences of your thinking and knowledge about a system within your framing of it.
- There are some relations that are necessary and some that are contingent and contextual. Explanation has to do with the contextual and the contingent. When you collect data on rainfall or soil moisture, these are interrelated. The soil moisture depends on the temperature, the rainfall and the wind. System thinking treats these as more or less separate and independent variables.
- Assemblage makes a difference because it reveals who did what, when and why. This is why thick description is needed.

- An example is when we talk about the effectiveness of a policy measure in a specific place and in a specific time period, we implicitly engage all the components that participated in that place and period to implement that policy. Policy effectiveness is not something abstract; it is very concrete. Similarly, when we talk about the resilience of a place, or of an organisation, we are not talking about abstract concepts, we are talking about the things here and now. A system approach necessarily abstracts and sidesteps some critical details. The devil is in the detail and this is important in assemblage thinking. We don't say that the corporation did this and that; there is a particular person or group which used particular means to achieve particular objectives.
- The assemblage approach does not totally reject system approach, we need the big picture, and we need to embed the microworlds within the big picture. But there is the constant interaction and they co-constitute. If we want to study transformation and transition we have to record the dialectic between changes in one component and changes in the whole system. Assemblage is more integrative and encompassing, it does not reject the whole but sees the whole as co-constituted with its elements.
- The future is an element of both approaches. System modelling has the benefit of allowing for simulation which can explore multiple future possibilities and their consequences, as well as highlighting unintended consequences. If our core assumptions hold over the timeframe that is relevant to the model. These simulations each represent a different possible scenario. Simulations also allows us to test specific scenarios in which we introduce specific policy interventions for example.
- Models are something to help you think through possible futures, it allows you set out your knowledge and assumptions in a coherent, consistent and logical way so as to think about possible developments and futures. It is a glimpse of different things that we might need to anticipate. Therefore, use the model as a tool to consider possible scenarios. One of the caveats is that this is not a prediction.
- In assemblage thinking, the orientation towards the future is inherent to the idea of emergence and becoming, an interest in what might come next. These futures are the possibility space of an assemblage. These possibilities include not only multiple possible futures, but also alternative possible histories and possible presents only one of which is actualised at any one moment.
- There are methodological options in both approaches to use qualitative visioning exercises which aims to imagine a future reassembly. These are both steps in trying to organise and think about the future and these tools can help with that.
- Another caveat in relation to system models and the future is with regards to vocabulary. When you develop a model of a system you give names to variables and relationships between them. Whatever we say about the future will therefore be expressed by the vocabulary of the present that we initially defined and conceptualised the system. The further we run ahead in time the greater probability that we might use a whole new vocabulary to describe the world. That is a clear constrain on the ability to predict. But it is still useful as a tool for collecting and extrapolating our knowledge and expressing the potential consequences of particular decisions in the language of now to help make a decision.
- The question of integration of these approaches is difficult. It is good when two methods and theories don't do the same thing or try to do the same thing because there is value to be created at their conjunction and concurrent use. Assemblage has value in challenging the decisions of system thinking and of the models we make, even when we build the models in

a participatory way, we make choices and some of those might be implicit e.g. what do we understand of the system, what is the purpose, what are the components, what should be included and excluded from the model. Assemblage seems like an approach to challenging those assumptions, opening the box again and in turn provide richness of description and analysis in areas where the system dynamics modelling moves on or is forced to reduce. It creates opportunities to enrich the necessary simplification of system modelling.

- Assemblage is the recognition that something can evolve or die out and it isn't something we are used to talking about with models.

Conclusion

Are assemblages and systems engaging with the same 'object' of analysis?

- System thinking and assemblage thinking are engaging with different objects of analysis.
- Systems thinking provides us with the means of developing a mental model and tool for examining systems. These are complex systems with different components that interact and system thinking provides you with a means of understanding those connections so as to address key challenges.
- Assemblage isn't trying to describe a 'complete' or bounded system, it is a framework for identifying and analysing different dynamics with a specific context specific through the empirical endeavour. A key principle of assemblage is that it recognises that we can never completely map out all the components.
- The ontological differences between assemblage and system are the most significant area of difference. Navigating these differences is a challenging research issue and task.

Both approaches are interested in the future as an important element of analysis but potentially with different objectives.

- Both have an orientation towards examining future possibilities.
- The time boundaries are greater for system thinking due to the capacity of models to run much further into the future.
- Assemblage desires to examine past paths not travelled, present possibilities within the assemblage for re-assembly, and imagine and contribute to bringing about a different future.
- System thinking is potentially more focused on resilience and preserving certain system functionalities in the face of uncertain futures.

Methodologically there is alignment.

- There are significant similarities regarding certain types of data and methods of mapping assemblages/systems. Approaches are likely to be participatory and data can be qualitative and quantitative.
- The differences are what is done with the data. System thinking aims to produce quantified models for the purposes of simulation and scenarios. Assemblage is interested in using rich description to elucidate key dynamics within specific contexts that are shaped transformations.

We need to aim for collaboration not integration

- It is good when two methods and theories don't do the same thing or try to do the same thing because there is value to be created through their differences in approach, emphasis and aim.


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