

Methodological Agility for Doing Transformative Transdisciplinary Research on Sustainability Transitions in the Context of the Anthropocene

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Abstract: Undertaking sustainability transitions during the Anthropocene entails complex processes, since it implies co-producing transformative knowledge for many different kinds of socio-ecological contexts that are not just different in degree, but different in kind – i.e. ontologically different. Transformative knowledge is not only about co-producing strategic knowledge of how to navigate different future scenarios practically, taking us from where we are to where we want to be in future. Inextricably linked to this are ethical questions and choices related to the many different ways to act appropriately, fairly and justly on the journey (processes) of transitioning. Inaction in the Anthropocene is arguably the most unethical response imaginable. From a methodological perspective, this is a truly trans-disciplinary challenge. However, trans-disciplinarity is by no means as a methodological panacea. It is much better to imagine trans-disciplinarity as one amongst a number of context- or domain-relevant methodological responses – including mono-, multi- and inter-disciplinarity – on the understanding that trans-disciplinarity is much more specifically focused on and interested in tackling societal challenges that are considered too complex to be addressed strictly from within discrete boundaries of the single disciplines. The methodological agility implied by this should not, however, be confused with the much more onerous Kuhnian notion of ‘paradigm switching’, which is simply too arduous an undertaking for the nimbleness required when facing ever-changing problem situations in the Anthropocene today. In view of the above, the fundamental focus of this paper is on developing such an agile transdisciplinary methodology – with an explicit interest in contributing to the understanding of ways of facilitating the sustainability transitions in the context of the Anthropocene today.

Keywords: Trans-disciplinarity, Methodology, Methodological Agility, Complexity, Sustainability Transitions, Anthropocene

1. Introduction

“The time is upon us to recognize that the new frontier is the interface, wherever it remains unexplored...In the years to come, innovators will need to jettison the security of familiar tools, and specialties as they forge new partnerships” [34].

Humankind is now living in a new geological epoch of the Anthropocene [19]. This development brings with it pressures

which force us to consider how human activity has impacted on, and is in turn impacted by, the natural and the geophysical domains. In this regard, Chandler explains in his book *Ontopolitics in the Anthropocene* that we are required to rethink the fundamental philosophical paradigm that science is about humankind’s knowledge and mastery over Nature [12]. The traditional paradigm of scientific enquiry has

contributed greatly to this mastery; Thomas Kuhn's notion of *scientific paradigms* [37] with its particular focus on the development of individual disciplines in specialist fields of study.

This paradigm, however, has created an artificial bifurcation between the physical and social sciences, as well as divisions within these schools in the form of more sub-disciplinary silos such as physics, chemistry, biology, sociology, anthropology, psychology etc. Whilst this paradigm has contributed to developing comprehensive understandings *within* their specialist foci, on their own the individual disciplines do not lend themselves well to tackling the complex dynamics involved in the connections and interactions *between* Nature and Society. Challenges which are posed by complex dynamics in the problems of social-ecological systems (SES) such as climate change and extreme weather conditions are good examples¹ of current events compelling us to recognize Nature as an *active agent* that *interacts with social systems* and vice versa. In other words, Nature and Society can no longer be seen merely as *static backgrounds*² *against which things happen*, nor can they be systematically analyzed and explained *within* the strict boundaries of individual disciplines *alone*. In the Anthropocene such mono-disciplinary approaches and practices will no longer suffice. Instead, what is needed are radically new different approaches that, amongst other things, as Chandler suggests, involve new forms of governance and intervention, enabling on-going *interaction with* the systems in the form of mapping, sensing and hacking, because systems and the interactions between them are in consistent flux [12]. For academia to keep abreast of and contribute to societal improvement, the scientific paradigms have to shift. Responding to the challenge of real-world problems, and contributing to sustainability transitions, interdisciplinary and cross-disciplinary collaboration are even more critical than before [44]. Academic actors are compelled to engage *across* silos, and *beyond* the institution to *work with* relevant societal agents in an on-going transformative feedback loop.

The Sustainable Development Goals³ (SDGs) call for mobilization across global and local levels, and involves academic actors and societal agents in an emergency response to the planetary challenges facing us in the context of the

Anthropocene. Never before in human history have we been required to mobilize ourselves globally around a common set of goals, whilst facing the consequences of our own human actions on a truly planetary scale.

This ambition requires us to situate our work at the interfaces of discrete disciplines and other forms of knowledge creation. The trajectories of actual sustainability transitions are, however, occurring *asymmetrically* across different countries, societies, and continents – the African continent in particular. Socio-political-ecological contexts and constraints impact on capacities to respond and therefore necessitate the adoption of different transitioning strategies at different rates and paces. In this context of emergent and ever-changing conditions, the fundamental challenge facing science and academia is that we can no longer be satisfied with merely producing knowledge *on or about* Nature and Society, nor can we remain concerned *only* with our *understanding* (*Verstehen*) and *explaining* (*Erklärung*) of the anthropogenic causes of the Anthropocene. To explore different sustainability transitions (pathways) in practice, academia needs to also produce practical-strategic knowledge that can contribute to *changing* (*Verändern*) our thinking and actions.

This, in turn, implies working through a different scientific paradigm that can better support the co-production of *transformative knowledge* capable of undertaking context-sensitive sustainability transitions. This need for acknowledging and working with contextual specificity when engaging with sustainability transitions is discussed in depth by Swilling in his book *The Age of Sustainability* [58]. The core of Swilling's argument is that not only are there different kinds of transitions happening in many different parts of the world today, but that there are also significant differences *within* these different contextual settings and specific kinds of sustainability transitions. For example, when dealing with *urban transitions* specifically, it is not surprising that “in the absence of an alternative generally applicable urban imaginary due to the diversity of urban contexts, the International Resource Panel (IRP)⁴ report recommends the proliferation of *urban experiments as the catalysts of context-specific urban transitions*”.

This call for a proliferation of urban experiments as the catalysts of context-specific urban transitions poses fundamental challenges not only to academia, but more specifically to the way that methodological decision-making processes are undertaken when engaging with context-specific sustainability transitions. Just as there are no generally applicable urban imaginaries for undertaking urban transitioning processes, there are no methodological panaceas available for researching context-specific transitions. In all instances, situating the problem in context will provide us with a way to develop the right methodological response.

To this end, this paper presents and develops the notion of *methodological agility* as a means for understanding and navigating the *switching between* different research

¹ To this list of extreme natural events, we can certainly also add the current global pandemic of the Coronavirus – as yet another good example of reaffirming the inextricable interconnectedness of Nature and Society, rather than their forced detachment as two completely separate (ontological) realities in terms of the old Cartesian two-world theory.

² The fundamental differences between Newton & Einstein's conceptions of space, time and gravity can also be quite helpful to illustrate this important point even further. For Newton space, time and gravity were not only separate realities, but they were also fixed. Gravity, in particular, was for Newton like a static stage upon which actors interact with each other, but not with the stage *itself*. All of this, of course, changed radically in Einstein's revolutionary idea of dynamic curved space time (CST). In his general theory of relativity, the actors (celestial bodies) interact with CST, and vice versa. It is this dynamic conception of mutually constitutive interactions that is critical for understanding and engaging – especially when facing complex phenomena / events in the Complex Domain (as will be explained in more detail below).

³ See: <https://www.un.org/sustainabledevelopment/>

⁴ For more information on the UN IRP Weight of Cities report, please visit this website here: <https://www.resourcepanel.org/reports/weight-cities>

methodologies when facing radically different kinds of real-world problem situations (contexts). This paper discusses the adoption and adaptation of the multi-ontology Cynefin sense-making and decision-making framework to develop contextually specific methodological responses. Where context specificity is important for exploring different sustainability transitions in practice, this paper introduces the notion of methodological agility as an innovative response to the call for integration at the meta-theoretical level – in short, the need for deep integration [6]. In so doing, the integrative work undertaken in this paper is about providing a methodological decision-making framework for *working with* and *switching between* four equally valid/context-relevant methodologies: mono-, multi-, inter- and trans-disciplinarity.⁵ This fundamentally implies the notion of methodological agility, for which, we argue, there is a need to be conceptualized as an integrative concept at the meta-theoretical level.

We introduce Cynefin as a methodological decision-making framework, that is designed to account for the practical implications of the tensions and contradictions when engaging in real-life trans-disciplinary research processes. We suggest a framework for sense-making in addressing these tensions, whilst recognising that they may not be resolvable. Such an approach allows us to work with the creative tensions in ways that will continue to refine the practice and discipline of trans-disciplinarity.

2. The Cynefin Framework: For Multi-Ontology Decision-Making

“Cynefin” (pronounced phonetically ku-nev-in) is a Welsh word denoting a place of multiple belongings, in the sense of a cultural holding space where people continuously negotiate their different identities. This definition is also close in meaning to two other important concepts, namely: (a) Bourdieu’s use of the notion of ‘habitus’ [8, 17, 27, 28] and (b) the notion of dynamic formative contexts [4, 13, 25, 18, 59, 60]. When all these concepts are taken together, Cynefin signifies the social places and spaces where people are continuously assembling and re-assembling the ‘social’ [40], whilst, in the process of doing so, adopting different roles and identities as social actors.

However, and more importantly for our purposes, the Cynefin framework goes *beyond* the phenomenological level of lived experience, by positing the notion of the *ontology of context* for exploring different contexts in terms of their fundamentally different kinds of causal dynamics or cause–effect relationships.⁶ To better understand the latter, the

Cynefin framework distinguishes conceptually among four⁷ distinct contexts – also referred to as *domains* – at the following two levels: practical (Clear, Complicated, Complex and Chaotic domains) and abstract (meta-theoretical Ordered and Unordered) systems. Taken together, this framework facilitates performing research *within* the Clear and Complicated domains as concrete examples/manifestations of Ordered systems, and the Complex and Chaotic domains as examples/manifestations of Unordered systems. Figure 1 is a graphic illustration of the framework:

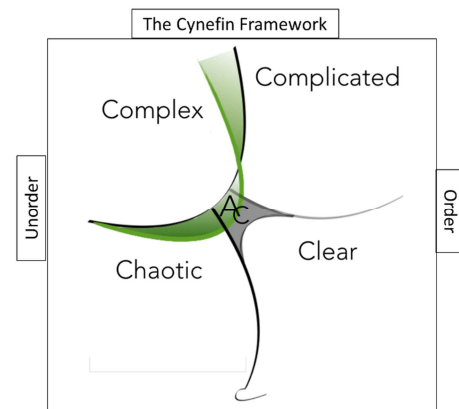


Figure 1. The Clear and Complicated domains are illustrated in this graphic as examples of the more meta-level Ordered domain, and the Complex and Chaotic domains as examples of the Unordered domain.

3. The Adopted / Adapted Cynefin Framework for Agile Methodological Decision-Making

The Cynefin framework, as mentioned, has been developed [54] as a dynamic multi-ontology decision-making heuristic which can be, and has been, used for many different purposes. For our methodological purposes, however, we have explicitly adopted and adapted this framework for navigating methodological appropriateness in an agile manner – as depicted in Figure 2 below.

This transposition of the Cynefin framework into a framework for making methodological decisions allows us to utilise Cynefin as a meta-methodology decision-making framework that can facilitate context-appropriate research to be conducted and improve operationalisation of research. In the following sections this paper expands on each domain in more detail and discusses the methodologies that correspond with each domain.

⁵ The metaphor used by Nicolescu to describe disciplinarity, multidisciplinarity, interdisciplinarity and transdisciplinarity is that they are like four arrows shot from a single bow: knowledge also resonates well here [45].

⁶ Acknowledging that the fundamental differences between the four domains are in fact ontological due to the differences in their (underlying) causal dynamics is to agree with Aristotle’s fundamental point about the link between knowledge and understanding the causality of things: “We do not have knowledge of a thing until we have grasped its *why*, that is to say, its *cause*” [2]. In other words, understanding and explaining some of the salient features of the fundamentally different kinds of

causality between the four domains is critical for our purposes here in the sense that we will be dealing with these as ontological differences first, before proceeding with a discussion of their epistemological and methodological implications and strategies.

⁷ As depicted in Figure 1, there is also a fifth domain – Aporetic / Confused (A/C) – but this is strictly speaking not a separate ontological domain with its own discernible cause–effect relationships. Rather, this denotes more of an in-between epistemological space, or vantage point, as it were, from where the sense-making of the other said domains takes place.

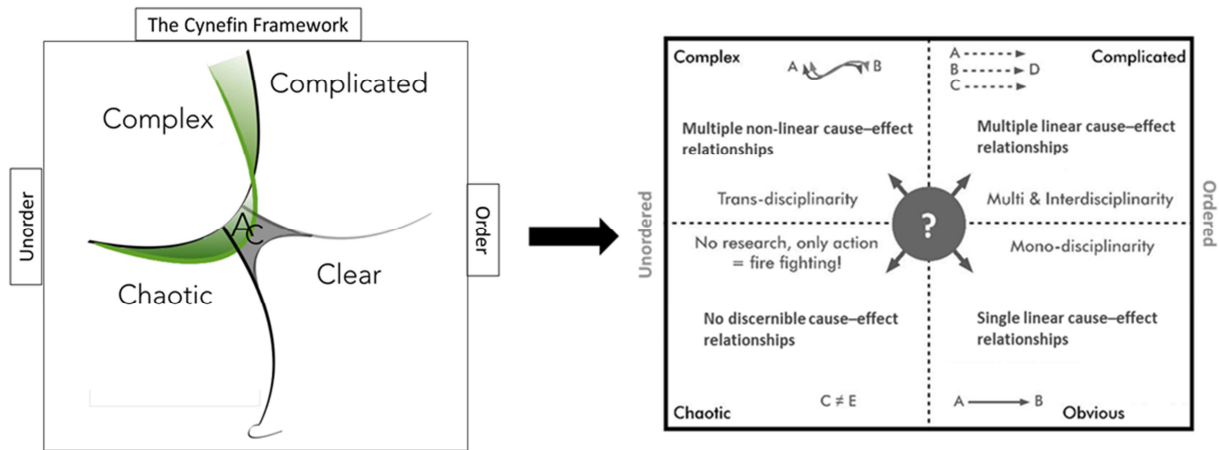


Figure 2. The arrow signifies the process of adopting and adapting the Cynefin framework for the purposes of situating / contextualising mono-, multi-, inter- and trans-disciplinarity as four equally valid domain-relevant research methodologies.

4. Mono-Disciplinarity for Problematics in/for the Clear Domain

In the Cynefin framework the Clear Domain is characterised by self-evident systems where *linear causality* is straightforward. In this domain there are clear-cut epistemic objects [11, 35, 36] which can be described as ‘known knowns’ [54] presenting high levels of certainty and predictability. In other words, there is very little doubt that an effect (the manifest problem) has a very particular cause – i.e. the nature of things can only be explained in this particular way and in no other way(s). In such cases an appropriate epistemological strategy is through *categorisation* of the different types of knowledge(s) produced by the individual disciplines, by classifying them according to well-established disciplinary concepts, theories, principles, practices and methods; such as the consistent application of the principle of parsimony, also known as Occam’s Razor [41, 52], dictating that ‘entities should not be multiplied unnecessarily’, or put differently, ‘when there are two competing theories that make exactly the same predictions, the simpler one (with the fewest assumptions) is the better one.’

Problematics in the Clear Domain are normally characterized by linear causality, or linearity for short. This means that events/occurrences that are caused by single, clear-cut and repeatable cause-effect relationships in which, if conditions are held consistent, action/interaction A will cause B, and the same action or combination in A will *always* cause B. This causality is repeatable and self-evident through simple measurement and observation.

In this domain, *mono-disciplinarity* is a domain-relevant methodological and institutional approach. The nature of the problem might lend itself well to *disaggregation* and categorization into parts of the whole problem. This allows different disciplines to work on each part separately and to arrive at suitable insights through a single disciplinary lens. It also helps if the challenges are seen as *unconnected* problems, and where there are no complex interrelationships around and

between the phenomena. In this mono-disciplinary mode of doing research, the individual disciplines therefore do not see any need for knowledge *co-production* – by crossing disciplinary boundaries – to come up with integrated perspectives for the *explaining* (*Erklärung*) and *understanding* (*Verstehen*) of the clear-cut issues at hand. See Figures 3 and 4 below for a more detailed graphic illustration of this.

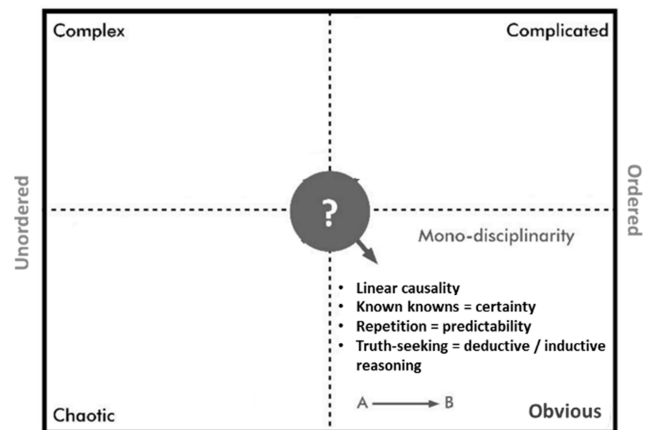


Figure 3. Focusing only on the Clear Domain, characterized in the main by single, repeatable linear cause-effect relationships (A causes B) which can be successfully theorized by the individual disciplines concerned by using the well-established deductive / inductive logics and principles for developing discipline-specific epistemic objects – i.e. problem statements, research questions, hypotheses etc. – without any interaction and collaboration between the individual disciplines or any relevant social actors.

When problems are identified as situated in the Clear Domain, we will experience single-discipline experts, with very limited, or even no, interaction with other disciplines, and/or any societal stakeholders outside of academia. Bringing the perspectives of social actors/stakeholders *into* the research process is generally considered (amongst the disciplinary experts) as redundant or counter-productive to the research process; it is felt that so can only lead to ‘contaminating’ the ‘objectivity’ of the knowledge [46, 47] produced in the research process, thereby making the problem situations at hand unnecessarily ‘complicated’ or ‘complex’.

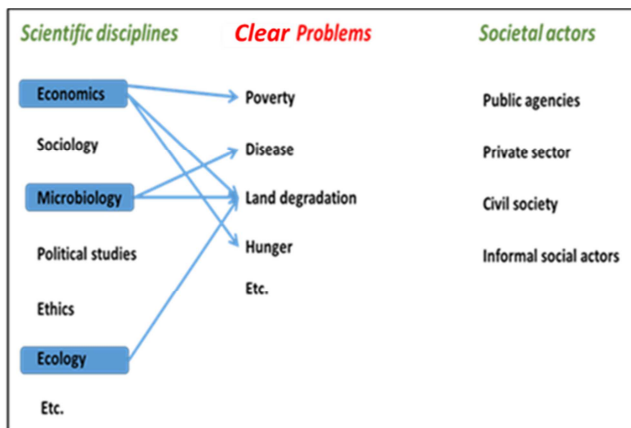


Figure 4. The blue arrows linking the three disciplines concerned (highlighted in small blue boxes) with the different problems/issues here, signify the gist of the mono-disciplinary approach in the Clear Domain, where the individual disciplines are not only working on separate issues, but also working separately from each other – without any form of interaction and collaboration between them or with any of the relevant societal actors.

5. Multi- and Inter-Disciplinarity for Problematics in/for the Complicated Domain

The difference between the Clear and Complicated domains is one of degree and not of kind. Linear causality is applicable in both cases. However, where the Clear Domain is characterized by *single* linear cause–effect relationships, the Complicated Domain is characterized by *multiple* linear cause–effect relations, as well as strong assumptions about the conditions around those causal relationships. For example, that water boils at 100 degrees Celsius is an accepted truth; however, there is also an assumption of the atmospheric conditions being held consistent at sea-level. This ‘truth’ changes in lower atmospheric pressures as the environmental conditions alter the causal relationship. These linear causal relationships are illustrated in Figure 5 below, indicating that any one cause or combination of A, B or C can be the cause of effect D. In other words, there is a shift from one-to-one linear causal relationships in the Clear Domain to many-to-one⁸ or even one-to-many linear causal relationships in the Complicated Domain. The linear relationships of causality are traceable and repeatable, but given the multivariate nature [3] of the Complicated Domain, it is not always immediately clear which of the many different causal relationships are actually the most significant in any given situation. This gives rise to

epistemic objects which can be described as ‘known unknowns’ [54] – with less certainty and predictability than in the case of ‘known knowns’ in the Clear Domain, but certainly not as unpredictable and uncertain as in the case of the Complex and Chaotic domains. Experts, therefore, undertake an epistemological strategy of *analysis* to test and identify which of the multiple linear causal relationships are the more significant ones, and to understand how they are significant. In practice, this means that the complicated nature of the problem situation at hand can be thoroughly revealed through sufficient, in-depth analysis of the multiple linear causal relationships at work. This can be done through hypothesis testing and hypothesis elimination or validation.

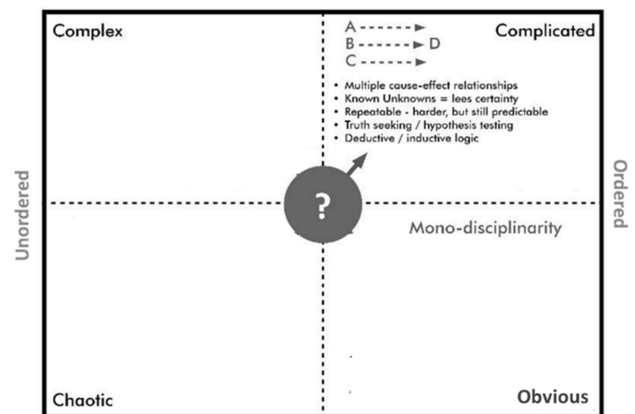


Figure 5. Focuses only on the salient dynamics of the Complicated Domain, characterized mainly by the multiple, repeatable linear cause–effect relationships (A, B, C cause D). Of these different causal relationships, it is not immediately clear what the degree of significance is of each. This is something that can be successfully theorized by the individual disciplines if allowed to work separately, using the well-established deductive/inductive logics and principles for developing discipline-specific problem statements, research questions, hypotheses etc. – without any interaction and collaboration between the individual disciplines or any relevant social actors.

Where in the Clear Domain applying single-discipline expertise would be the appropriate methodological approach, in the Complicated Domain there is a need for multi- and/or inter-disciplinary expertise. In other words, in the Complicated Domain there are two domain-relevant methodological approaches possible, with varying degrees of collaboration and interactions between individual disciplines. When adopting a *multi-disciplinary* approach (see Figure 6 below), individual disciplines are no longer working on separate issues as in the Clear Domain, but on the same issues. However, they are still working *independently* from each other, with each discipline still using its own stock of ideas, concepts and frameworks etc. with which to develop hypotheses for unravelling the complicated nature of the problem situation at hand. This mode of working *independently* on the same issues, without the need for collaboration, is made possible by the linearity of the causal relationships, enabling individual disciplines to theorize and hypothesize on the predominance of multiple causal relations in this domain, but always as determined by the disciplinary perspectives of independent disciplines. In this mode, the expert analysis of the complicated situation at hand will be provided

⁸ In this regard, with the necessary changes, the notion of ‘over-determination’ as used by Louis Althusser [1], for example, could be employed successfully. From this perspective, problems (effects) in the complicated domain are determined (caused) by multiple causes, any one of which alone would be sufficient to ‘determine’ (cause) the effect. This, in effect, means that there is a surplus of causes, more than are necessary to cause the effect – and this, in turn, means searching for the ‘ultimate’ or ‘final’ causal factor amongst all the ‘competing’ possibilities. Because of his ideological and intellectual commitment to Marxism, Althusser posited that ‘in the final analysis’ such ‘ultimate’ causes can always be found/located in the contradictions (material causes) of the economic system of the capitalist mode of production.

by the principal investigator of the research project, charged with the responsibility of coming up with some or other *integrated perspective* and *explanation* of the multiple causal dynamics at work – normally at the end of the research, when all the participating disciplines have had a fair chance to complete and submit their own discrete research findings.

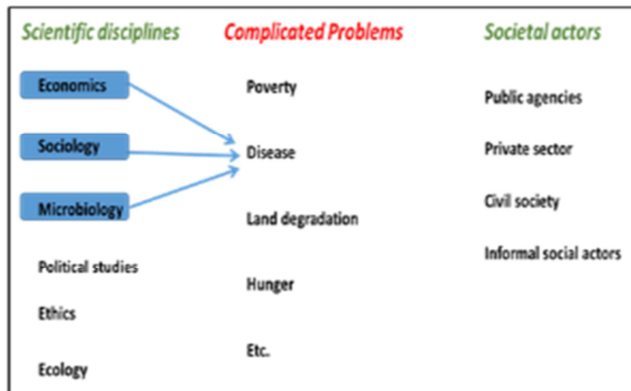


Figure 6. The blue arrows in this figure denote two important aspects of multi-disciplinarity: (a) the different disciplines now focusing their efforts on the same issues in the complicated problem situation at hand, and (b) the disciplinary certainty that comes with this, on the assumption that sufficient analysis of the repeatability in the same problems at hand will produce sufficient understanding/insight into the predominant causal relations to be focused on. The listed disciplines, highlighted in small blue boxes, signify the fact that they are still working separately from each other, with no interaction/cooperation between them or any of the relevant social actors listed here.

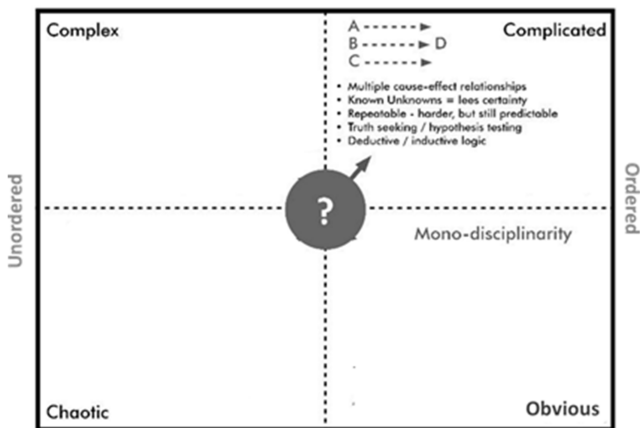


Figure 7. Focuses only on the salient dynamics of the complicated domain, characterized mainly by the multiple, repeatable linear cause–effect relationships (A, B, C cause D). Of these different causal relationships, it is not immediately clear what the degree of significance is of each. This is something which can be successfully theorized by the disciplines working together and cross-pollinating ideas, theories, concepts, data and frameworks. There is a process of collaborative hypothesis development and testing. This is, however, done without any interaction with social actors who might be a part of the problematic.

However, where *inter-disciplinarity* (see Figure 8 below) is adopted, individuals working in the single disciplines start to realise that working strictly *within* their own disciplinary boundaries creates limitations for dealing with the multivariate dynamics at play in the Complicated Domain. Collaboration with each other provides more opportunity for

developing *integrated hypotheses* at different stages *during* the research process, allowing the proponents to better investigate these multivariate dynamics. This collaboration can take many different forms, but normally entails some form of exchange of information and methods amongst the relevant disciplines – i.e. borrowing concepts, perspectives and practices etc. from another discipline in order to come up with a more enriched and/or multifaceted and/or integrated inter-disciplinary *understanding* (*Verstehen*) and *explanation* (*Erklärung*) of the complicated causal dynamics of the problem situation at hand – something which cannot be achieved by the individual disciplinary proponents working in isolation from each other. However, in both approaches, there is limited, or even no, engagement and inputs sought from social actors or stakeholders. The subject matter at hand is seen as being separable from the environment and context.

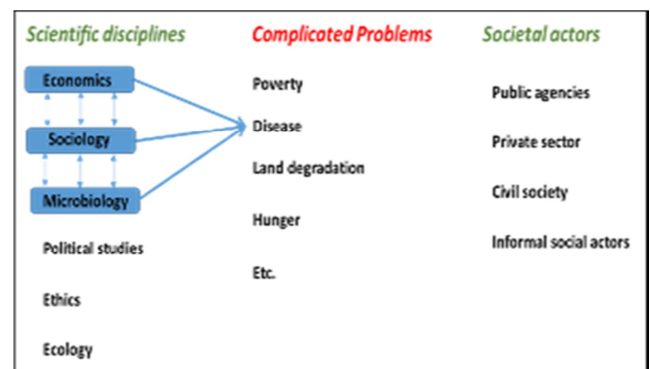


Figure 8. The solid blue arrows in this figure denote the shift taking place in the inter-disciplinary methodology in which the different disciplines are now focusing their efforts on the same problems/issues at hand. The smaller blue arrows (between the highlighted disciplines) signify the second important feature of this approach, namely that there is now some form of interaction/collaboration between the different disciplines mentioned – exchanging some information, insights, practices and methods. However, the absence of any lines or arrows to and from the listed social actors signifies the fact there is still no engagement with them in an attempt to incorporate their embodied understanding of the issues at hand into the research process.

6. Trans-Disciplinarity for Problematics in/for the Complex Domain

In the complex domain we encounter a shift from linear to non-linear causality – meaning that events/occurrences in this domain are no longer caused by direct cause–effect relationships between A (cause) and B (effect), but rather by bi-directional or circular feedback loops occurring between A to B and back from B to A again [16].

It is also important to be mindful of the fact that the nature of A and B is not static, and that A and/or B might become something completely different as they become embedded in this feedback loop, as well as in multiple others. The nature of the connectedness of things in the Complex Domain means that there are multiplicities of ongoing relationships between unknown variables that account for the emergence that is typical of complex systems. As mentioned above, the differences between the Complex (Unordered), and Clear and

Complicated (Ordered) domains are ontological in nature – and thus display differences in system type (Ordered vs. Unordered), and not just in degree. See Figures 9 and 10 below for some simple graphic depictions of this.

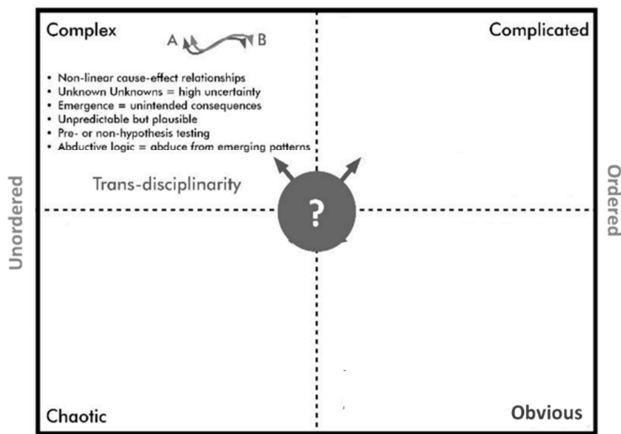


Figure 9. The wave-like arrows between A and B here signify bi-directional non-linear cause-effect relationships producing and/or responsible for emergence/emergent events in the Complex Domain, which are non-repeatable and unpredictable, the limits of which (enabling boundaries) are both driving and guiding our epistemological endeavours in this domain.

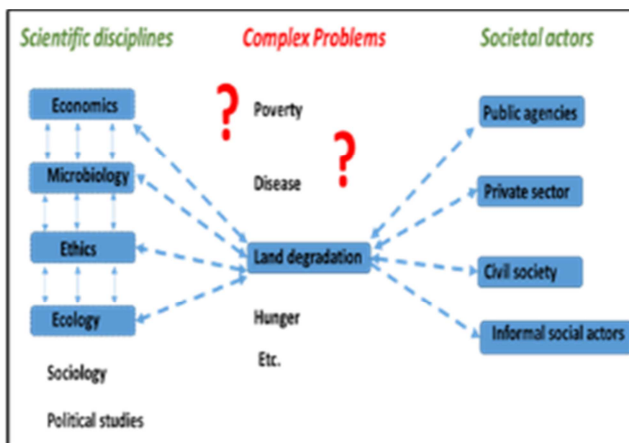


Figure 10. The two red question marks here signify the uncertainty and/or complexity of the complex problems (referred to as unknown unknowns in Figure 9) in the Complex Domain. As a result, the blue dotted lines to the left and right of the complex problems also denote some uncertainty in that it is not immediately clear which disciplines and social actors should be brought into the research process. This may only become clearer during the unfolding research process, which in turn means that the participants will enter and exit at various stages of the dynamic research process.

In complex systems everything is seen as irreducibly connected [7, 8, 14, 15, 55] – making it more useful to think about the nature of things *relationally* rather than focus on the things themselves in isolation. In the Complex Domain, causality can never be reduced to some or other ultimate cause [24], because in complex systems there are no centralized power nodes responsible, as it were, for the ultimate/final causality of things. Instead, it is because of their fundamental *interconnectivity* in emergent complex systems that things always happen *through* a multiplicity of intense local and external interactions. This, as said, rules out the possibility of

reducing causality to just a limited number of sources or locales (nodes) with more concentrated or stronger causal relations and powers than others in the system.⁹ In fact, the very notion of causality – i.e. *what causes what* in space and time – needs to be seen and understood more as a *distributed* phenomenon, something which is part and parcel of the dynamic, emergent properties of complex adaptive systems [31-33]. Or, put differently: *the system itself* is characterized by non-linear causality [49]; seeking causality might become futile, as the system can better be described as one of dynamic correlations [5, 12, 38, 39].

Non-linearity gives rise to epistemic objects which can be described as ‘unknown unknowns’ [54] with far less certainty and predictability, when compared to ‘known knowns’ in the Clear Domain and ‘unknown knowns’ in the Complicated Domain. However, non-linear causal relations are not completely random and/or ad hoc events as in the Chaotic Domain. They certainly do produce some patterns,¹⁰ which can be detected only *after* the event, and therefore not predicted in advance. This means that the task of sensing or sense-making of such emerging patterns cannot be conducted *only* by disciplinary experts working on their own, with their discrete theoretical knowledge systems. It requires epistemic engagement with the social actors, so-called ‘ordinary’ or ‘lay’ people, to incorporate their practical, embodied, tacit and experiential knowledge of the complex problem situation at hand as the knowledge developed would be incomplete without it.

Working strictly in mono-, multi- and inter-disciplinary ways in the Complex Domain is, therefore, ontologically inappropriate. Since we can no longer make sense of the complex nature of emerging problem situations *within* the epistemic boundaries of theoretical knowledge *only*, we are compelled to go *beyond* (the ‘trans’ in trans-disciplinarity) and engage *with* non-academic actors and *their* everyday ways and means of knowing and/or understanding things in the Complex Domain. This means working collaboratively in the trans-disciplinary mode by bringing such pre-theoretical knowledge *into* the research process – from the very outset of defining and developing the problem statements and research questions (epistemic objects).

However, working collaboratively does not *ipso facto* imply trying to assemble all the relevant ‘legitimised’ stakeholders [50, 51] in the same room, as it were. The reason for this may be very practical in that such representatives, with a mandate to speak and make decisions on behalf of others, may not always be ready and available for engagement in collaborative research processes; in this case, different and more appropriate approaches are warranted, involving

⁹ In the Complex domain, the abovementioned overly abstract concept of ‘over-determination’ as theorized by Althusser [1] is no longer useful, because in this domain things are determined (caused) by the net effect of their multiple (small / local) non-linear interactions – making it both theoretically and practically impossible to try and locate some or other ‘final’ cause(s) with more concentrated and stronger causal powers than others in the system.

¹⁰ The characteristics of which can be described as rhizomatic-like – as in the case of Bramble bushes which produce a lot of growth (causality) in different directions with patterns, but without central controlling power nodes (e.g. central roots) [9, 20, 26, 54].

participants who are capable of working with individuals in many different places and spaces – at the same time and/or different times. Such approaches are known in the literature as *distributed cognition/ethnography* [23, 30, 56, 57]. When adopted and adapted for the purposes of dealing with complex problem situations in the Complex Domain, this would certainly signal a radical departure from the well-established mono-, multi- and inter-disciplinary practices of developing epistemic objects (including hypothesis testing and integration) by certain disciplinary experts, located exclusively in academia.

7. Chaotic Domain – No Research, Only Action

The Chaotic Domain (see Figure 11 below) is, ontologically speaking, radically different from the other three domains in the sense that things happen in a completely ad hoc manner with no discernable causal relationships. The domain of Chaos can be seen as the extreme end of the spectrum between the Ordered and Unordered systems, with it representing completely un-ordered and random conditions. It is in the absence of any causal relations that things manifest themselves in a completely random manner.

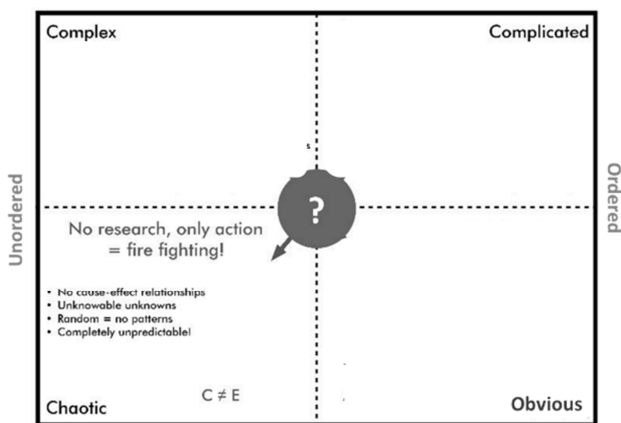


Figure 11. The ' $C \neq E$ ' symbol signifies that in this domain there are no discernable cause-effect relations – meaning that in the Chaotic Domain things happen/occur in a completely random and/or ad hoc manner. This, in turn, makes it basically impossible to conduct systematic research of any kind in this domain. Instead, facing the very urgent consequences of random and or/ ad hoc events, the strategic focus in this domain is squarely on taking appropriate real-time action(s) to bring the situation under control as quickly and effectively as practicably possible.

In this domain, we are facing epistemic objects known as 'unknowable unknowns' [54], basically rendering any form of systematic/substantive research in this domain impossible – at least in terms of the four methodologies mentioned. Chaos is also, ontologically speaking, a very temporary state, as complete randomness requires massive energy to create and is impossible to sustain [48]. In the Chaotic Domain, the main focus is on strategic action-taking, specifically aimed at bringing the chaotic events under beneficial control. When such strategic action-taking proves to be effective, parts of

the system will likely transition into the other domains. Systems that undergo chaos become fundamentally different, and there is an irreversibility to the system-level disruption. All research is therefore likely conducted in retrospect, and the appropriate approaches can be determined by using the framework as a meta-methodological frame.

8. The Confused / Aporetic Domain - Awareness of Methodological Tensions

The discussion above have provided a typological account of how research in the Clear, Complicated, Complex and Chaotic domains raises different methodological considerations. The "causal dynamics" discussed in the sections above, however, are often not always obvious; there are always nested causal dynamics (that is, research often takes place in systems which are nested, and which will display elements across all domains), and domain recognition is not always straightforward. The methodological tensions that arise will come from different and differing perspectives, backgrounds and epistemological politics.

For these tensions, the final domain in Cynefin provides us with a holding space which encourages a state of aporetic contemplation. Creating an aporia allows for researchers to contemplate research methodology in its philosophical underpinnings. It encourages epistemological politics and paradox and, in so doing, encourages us to consider the intra- and extra-disciplinary needs and limitations of knowledge production. Trans-disciplinary research intersects with and impacts upon social and human worlds, and by its very nature needs to factor in the practical overlaps which present themselves as social knowledge in the making.

The aporetic domain allows us to contend with the fact that "At site after site, heterogenous social knowledge practices occur in tandem, layered upon one another, looping around and through each other, interweaving and branching, sometimes pulling in the same direction, sometimes in contrary directions. Such practices cannot be circumscribed within traditional disciplinary enclosures, nor even within academia. Together, they appear multiplex, polymorphous, an 'intricate spider web'..." [10]. In Strathern's contemplation [53] of how relations and relationality are an innate part of all social knowledge production, she remarks that the belief that we can unravel or untie the essential knottiness of the self-consciously interventionist act of trans-disciplinary work is nothing more than an epistemological lure. The domain of the aporetic therefore aptly allows us to contend with the tensions that are necessary for engaging with trans-disciplinarity in the face of complexity.

The aporetic domain highlights the importance of reflexivity and awareness of one's state of confusion. Aporia was originally introduced by Aristotle to describe a state of impasse in our thinking. Translating from the Greek root of the word, "'a' not + 'poros', path or passage, aporia means no way through." [29]. In the aporetic domain, we are well aware that we are confused, and we know that we need to adopt

different ways of learning, perceiving, interpreting, and exploring to work our way out.

"The aporia of our thinking points to a knot in the object; for in so far as our thoughts are in aporia... it is impossible to go forward" [43]. Aristotle also emphasized that the undoing of this "knot"¹¹ can only be done by those who are aware of this impasse. In the Aporetic/Confused domain, we place importance on our *awareness* of being in a new type of confusion. This awareness is what shifts the aporetic from domain to methodology.

Derrida has employed aporia or an aporetic ethic [21, 22] to his deconstructive approach [61]. Derrida subscribed to a very purist definition of what qualifies as a decision. He believed that for something to qualify as a "decision", it is defined by the fact that it was "undecidable". That is, where things had worked before, and we did not have to ponder the decision, then they are not in essence "decisions", but part of programming. "Think here of Kierkegaard: the only decision possible is the impossible decision. It is when it is not possible to know what must be done, when knowledge is not and cannot be determining that a decision is possible as such. Otherwise, the decision is an application, one knows what has to be done, it's clear, there is no more decision possible; what one has here is an effect, an application, a programming".

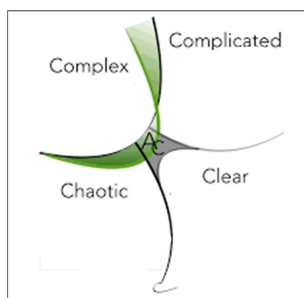


Figure 12. The acronym "A/C" signifies the double meaning of this domain in the sense that it deals with the tensions caused by unclear matters. "C" indicates the state of being confused caused by apparent conflicting or contradictory perspectives and "A" the aporetic approach seeking to work with the tensions caused by the latter rather than trying to absolve them.

In summary, this final domain in Cynefin can be seen as the learning space(s) opening up during emergent research processes, where mono-, multi-, inter- and trans-disciplinary scholars can interact with each other and seek to work with the tensions to create truly transformative work. Methodological tensions are part and parcel, then, of the learning and of be/coming methodologically agile as we seek to work with them, rather than to absolve them. As trans-disciplinary research continues to develop, these emerging and contradictory perspectives need to be considered critically. Beginning with this aporetic contemplation will contribute to

more effective methodological agility.

9. Conclusion

Issues in any of the four domains are both ontologically and epistemologically speaking dynamic. This means, on the one hand, that they can change or be changed when acted upon *during* implementation of any of the four research methodologies. On the other hand, it also means that, even when things do not actually change, it is still possible that our perceptions and understanding of them might change. Either way, what is required is *both* inter- and intra-methodological agility – i.e. the ability to switch methodologies not only *between* the Clear, Complicated, Complex and Chaotic domains, but also to work with different approaches *within* any of the four methodologies of mono-, multi-, inter- and trans-disciplinarity.

When applied to working in the trans-disciplinary mode within the Complex Domain, inter- and intra-methodological agility means, *inter alia*, the ability to work with and switch between formal multi-stakeholder¹² processes [42] and working with individual social actors, in their informal settings¹³. Inter- and intra-methodological agility offers different approaches to respond to Chandler's call to rethink the onto-politics of the Anthropocene. Sustainability transitions take place in complex dynamic systems which are in continuous processes of emergence. Research in these areas cannot be done at a distance – to conduct research in this field is to act in it, and impact on it. This, therefore, calls for methodological strategies that allow us to act more authentically in these real-time and rapidly changing contexts. Developing real-time feedback loops that harness the emergent properties of complex systems will allow for greater domain authenticity and align research in these contexts with the theory and praxis of sustainability transitions. Methodological agility allows us the ability to appropriately flex without forcing a complete paradigm shift, or 'Gestalt switch' (*a la* Thomas Kuhn), when facing the challenge of switching methodologies in the face of radically different and changing real-world contexts.

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¹¹ This notion of undoing the knot is different from that of untying the Gordian knot, which implies producing definitive solutions through bold actions. However, awareness of one's confusion in the Aporetic Domain does not mean avoiding decision-making and action-taking. On the contrary. But this is done in a way to avoid premature convergence [54] and with a sense of anticipatory awareness [54], namely that our decisions and actions are always provisional as they may very well produce unexpected consequences and/or challenges.

¹² In other words, working with so-called 'legitimised' stakeholders with a mandate to make decisions on behalf of others.

¹³ For example, using distributed cognition and learning narrative-based approaches such as the SenseMaker® method (as discussed under the heading Transdisciplinary for Problematics in the Complex Domain above).

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