Using Synergic Methods for Being Methodologically Agile (SM4BMA)

John Van Breda

Centre for Sustainability Transitions (CST), Stellenbosch University (SU), Stellenbosch, South Africa

Email address:

jrvb@sun.ac.za

Abstract: Methodological agility refers to a new meta-level research strategy of *switching between* mono-, multi-, inter- and trans-disciplinarity when facing the global societal challenges in the context of the Anthropocene today. When imagined in complexity terms as a *polycrisis* – consisting of multiple interconnected planetary crises – the Anthropocene cannot be approached in terms of any one of the said four methodologies *only*. This is so for two important reasons: *firstly,* there is not just one dominant crisis to which all the other crises can be reduced, and, *secondly*, not all the planetary crises we are facing today are necessarily complex problems. Some challenges are indeed *complex*; others *complicated*; still others *chaotic*. As a caveat, this new research strategy of methodological agility employs the construct of *synergic methods*, which is related to but different from *synergistic* or using methods *synergistically* in the mixed methods sense of the word when referring to the practice of using many different methods reciprocally. Herein, synergic is taken to mean a one-to-many relationship of using single methods for achieving multiple epistemological ends simultaneously. By combining some of the main features of *action research* and *narrative theory*, narrative action research (NAR) is presented in this paper as an example of how a particular synergic method can be used in transformative transdisciplinary processes (TTDR) for co-producing *systems*, *target,* and *transformation* knowledge – epistemologically speaking three very different kinds of knowledge each with their own (internal) logics, principles, practices, and research questions (epistemic objects).

Keywords: Methodological Agility, Synergic Methods, Mixed Methods, Transdisciplinarity, Complexity, Narrative Action Research

1. Introduction

The main goal in this paper is to further develop the notion of methodological agility (MA) [90] at the methodical level. The need for being *methodologically agile* is rooted in the global challenges we are facing today in the context of the Anthropocene [9, 17, 26, 28] – which has been described as a new human-induced geological epoch introduced / caused by the net effect [60, 61] of multiple socio-technical human actions since the dawn of the Industrial Revolution in the 18th Century in the global north. The Anthropocene does not consist of only single, dominant crises to which all other crises can be reduced, but rather of multiple inextricably connected crises – the '*polycrisis*' is a useful over-arching concept introduced by Edgar Morin [59] for understanding and dealing with the complexity of multiple interconnected planetary crises.

The non-reducibility of the *polycrisis* also means that *not all* the planetary challenges we are facing today are necessarily complex problems. Some are indeed complex; others complicated; others chaotic. Their differences are not merely superficial differences in degree, but rather in kind – i.e. ontologically in that they are being brought about by radically different kinds of causal dynamics. So, for example, complicated problem situations are characterized by linear causal relationships whereas complex problem situations are determined by non-linear / emergent causal relations [60, 61, 68]. This means that we cannot approach every problem situation in the Anthropocene with the same methodological approaches. Doing so would be tantamount to falling into the panacea trap of positing a one-size-fits-all approach for all the ontologically different kinds of problem situations. A better approach to adopt would be opt for any one or different combinations mono-, multi-, inter-, trans-disciplinary approaches. Understanding *when* and *how to*

switch between these different context-sensitive methodologies is at the heart of being methodologically agile. In short, the *polycrisis* and MA go hand in glove.

However, MA does not only mean knowing *when* and *how* to switch both *between* mono-, multi-, inter- and trans-disciplinarity, but also *within* anyone of these different modes of doing research. It is therefore important to distinguish conceptually between the following two types of MA:

1) *Inter-MA* – the agility required for performing the *switching between* mono-, multi-, inter and trans-disciplinarity, and

2) *Intra-MA* – the agility required for the *internal organizing* – structuring and functioning – within any one of the four mentioned methodologies.

In practice, though, this conceptual distinction between these two types of MA is often experienced as two inextricably intertwined aspects of our operational methodological endeavours – two sides of the same coin, as it were. This is particularly the case at the methods level, when having to decide not only *when* to use *what* methods, but also *how* to use them appropriately for different epistemological reasons and social outcomes. To this end, the main concepts, principles, and steps of a particular method – narrative action research (NAR) – will be discussed in this paper as an appropriate research response for *doing* transformative transdisciplinary research (TTDR) for tackling the *polycrisis* in the Anthropocene.

In terms of the above conceptual distinction, NAR will be conceptualised and presented here as a deliberate exercise in intra-MA – when responding to societal challenges which are considered too complex for approaching from mono-, multi- and inter-disciplinary methodological approaches *only* – therefore warranting trans-disciplinary approaches involving social stakeholder engagement in multi-track TTDR processes [91]. This is particularly important, because it is not always possible to engage with 'legitimised' stakeholders [72, 73] mandated to make decisions on behalf of others, but frequently with people (especially in developing world contexts) in their *informal* social networks, without any formal mandates to speak on behalf of others, only themselves. Driven by the principle(s) of *distributed cognition and ethnography* [30, 41, 43], NAR is an appropriate approach for engaging with social actors in such circumstances on a wide range of social-ecological systems issues *affecting* and *being affected* by them in their informal social networks – normally distributed widely across geographic, administrative and institutional settings.

2. Modus Operandi

To achieve the goals set out in the Introduction, this paper will be done the following nested manner: (a) introducing the notion of a multi-ontology methodological decision-making framework for framing the ensuing discussion on working with appropriate methods when facing complex societal challenges, (b) introducing the need for agile 'synergic methods', (c) presenting NAR as an appropriate example of synergic methods, (d) concluding with the need for working with theories of change (ToC) for guiding transformative

research, with particular reference to the notion of vector theory of change (VToC) when working with TTDR processes.

3. The Cynefin Framework: For Multi-ontology Decision-Making and Action-Taking

Making sense of the polycrisis, with its many different problem manifestations in the Anthropocene, can indeed become quite confusing. The multi-ontology decision-making framework – known as the Cynefin framework – has been expressly developed as a useful heuristic for both sense-making and action-taking purposes when facing these radically different kinds of contexts – or domains. "Cynefin" (pronounced phonetically kunev-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 'habitus' [11, 23, 37], and (b) the notion of dynamic formative contexts [6, 18, 24, 34, 88, 89]. When all these concepts are taken together, Cynefin signifies the social places and spaces where people are continuously assembling and re-assembling the 'social' [54] – whilst, in the process of doing so, adopting different roles and identities as social actors.
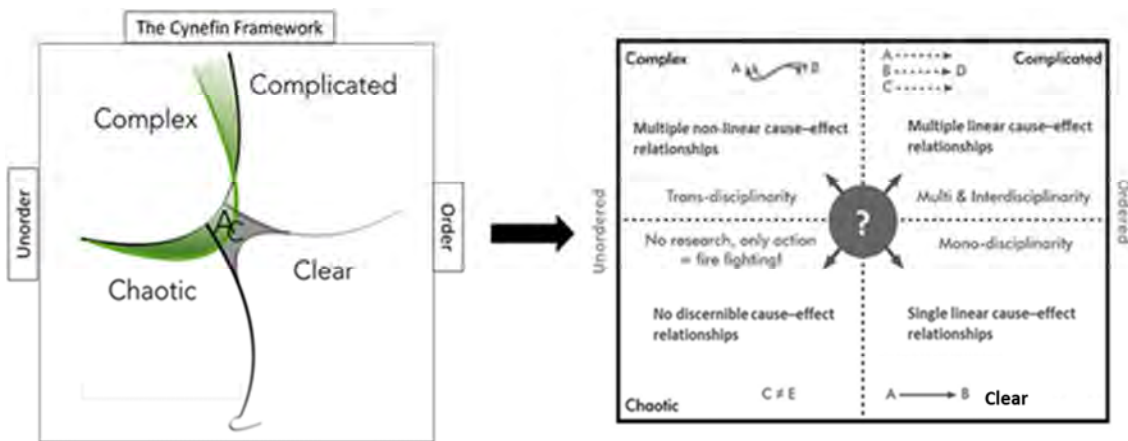
However, and more importantly for our purposes, by positing the notion of the *ontology of context* for exploring different contexts in terms of their fundamentally different kinds of causal dynamics or cause–effect relationships[1], the Cynefin framework can be extended *beyond* the phenomenological level of lived experience. To better understand this, the Cynefin framework distinguishes conceptually among four[2] distinct contexts – also referred to as *domains* – at the following two systems levels: practical systems (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 below is a graphic illustration of the framework:

---

1 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*" [4]. 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.

2 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 (see dialogue box below) or vantage point, as it were, from where the sense-making of the other said domains takes place.
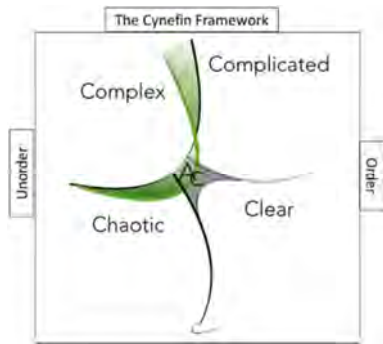
Figure 1. *The Clear and Complicated domains are illustrated in this graphic as examples of the more meta-level Ordered domain and the Complex and Chaotic domains as examples of the Unordered domain. The acronym "A/C" signifies the double meaning of this domain in the sense that it deals with the tensions caused by unclear matters. "C" indicates the state of being confused caused by apparent **c**onflicting or **c**ontradicting perspectives and "A" the aporetic approach seeking to work with the tensions caused by the latter, rather than trying come up with final / definitive solutions.*

In summary, Figure 2 below is a visual representation of the full conversion of the Cynefin heuristic into as a multi-ontology framework for the purposes of agile methodological decision-making and action-taking:

The methodological implications of dealing with problem situations embedded in these ontologically different kinds of domains (contexts) are indeed far-reaching, ruling out any notions of methodological panaceas for tackling *all* the problem situations we encounter in the world today. Instead, a better approach to adopt is learning how and when *to switch between* and *within* said four equally valid / context-relevant methodologies of mono-, multi-, inter-, and trans-disciplinarity – in short, adopting said approach of *methodological agility* [90].

The four domains, each with their domain-relevant methodologies, will now be discussed in some more detail below.

Figure 2. *Signifies the process of adopting and adapting the Cynefin framework as methodological decision-making framework.*

4. Methodological Challenge: Positing Four Domain-Relevant Methodologies

4.1. Mono-Disciplinarity for Problematics in the Clear Domain

In the Cynefin framework, events in the Clear Domain are characterised by their straightforward *linear causality*. This means that problematics in the Clear Domain are caused by single, clear-cut cause–effect relationships (see Figure 2 above), 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. In other words, this causality is repeatable, and self-evident through tried and tested measurement and observation.

In this domain, there are also clear-cut epistemic objects [16, 49, 50] which can be described as 'known knowns' [83], presenting high levels of certainty and predictability. An appropriate *epistemological strategy* for working with such cases with no doubt that the nature of things can *only* be explained in this particular way and in no other way(s) is that

of the *categorisation* of different types of knowledge(s) produced by the individual disciplines. In essence, this means classifying things according to well-established disciplinary concepts, theories, practices and methods – appropriately assisted by the consistent application of the principles such as in/deductive reasoning and parsimony, also known as Occam's Razor [55, 84], 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 least assumptions) is the best explanation.

In this domain, *mono-disciplinarity* (see Figures 3 & 4 below) is a domain-relevant methodological and institutional approach. The nature of the problem might lend itself well to *dis*aggregation 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 discipline lens. It also helps if the challenges are seen as *unconnected* problems, and where there do not exist 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 hereof:
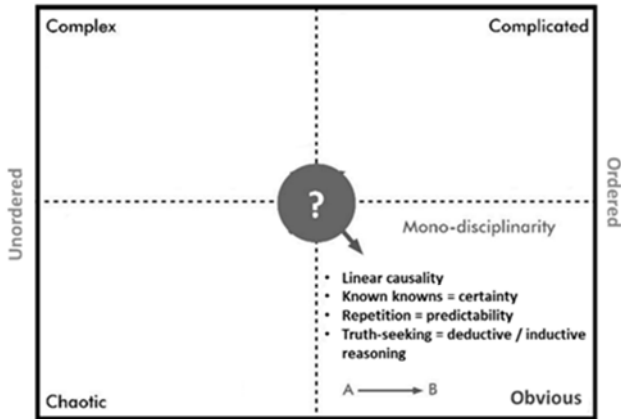
Figure 3. Focuses specifically on the Clear Domain characterized by single, repeatable linear cause–effect relationships (A causes B).
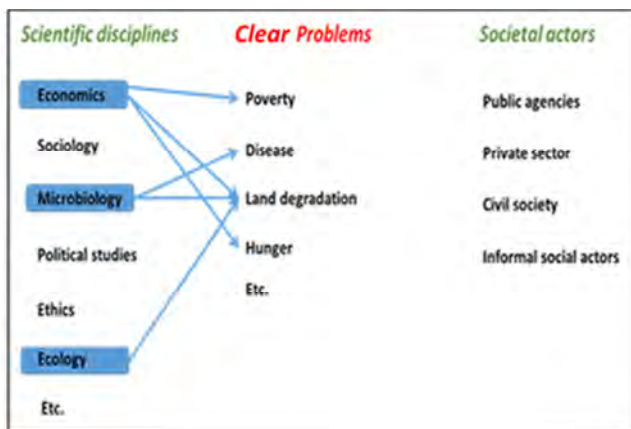
Figure 4. Signifies examples of mono-disciplinary approaches tackling separate issues in the Clear Domain.

When problems are identified as situated in the Clear Domain, single-discipline experts play a dominant role, with very limited, or no interaction with other disciplines, and no contact with 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 – for doing so can only lead to 'contaminating' the 'objectivity' of the knowledge [64, 65] produced in the research process – thereby making the problem situations at hand unnecessarily 'complicated' or 'complex'.

4.2. Multi- and Inter-Disciplinarity for Problematics in 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. However, where the Clear Domain is characterized by *single* linear cause–effect relationships, the Complicated Domain is characterized by *multiple* linear cause–effect relations, and 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, 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-one[3] or even one-to-many linear causal relationships in the Complicated Domain – the linear relationships of causality are traceable, and repeatable.

Given the multivariate nature [5] 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' [83] – 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 more significant ones, and to understand how these 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.

Where in the Clear Domain, single-discipline expertise would be the appropriate methodological approach, in the Complicated Domain there is a need for either multi- and inter-disciplinary expertise, or both. 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. If taking a *multi-disciplinary* approach (see Figures 5 & 6 below), individual disciplines are no longer working on separate issues as in the Clear Domain, but on the same issues. However, they are no working together / collaborating (as in inter-disciplinarity), but rather still working *independently* from each other with each discipline still using

---

3 In this regard, with the necessary changes, the notion of 'over-determination' as used, for example, by Louis Althusser [2] 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 what 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 (over-determination) can always be found / located in the contradictions (material causes) of the economic system of the capitalist mode of production.

its own stock of ideas, concepts, frameworks and methods 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 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.

integrated hypotheses at different stages *during* the research process, allowing them 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 / multifaceted / integrated inter-disciplinary *understanding* (*Verstehen*) and *explanation* (*Erklärung*) of the complicated causal dynamics of the problem situation at hand – in many cases contributing to positing new theories in the field. However, in both approaches, there is no significant engagement and inputs sought from social actors or stakeholders. As in the Clear Domain, any contact with the latter is still seen as redundant and should therefore be deliberately excluded from the research process.
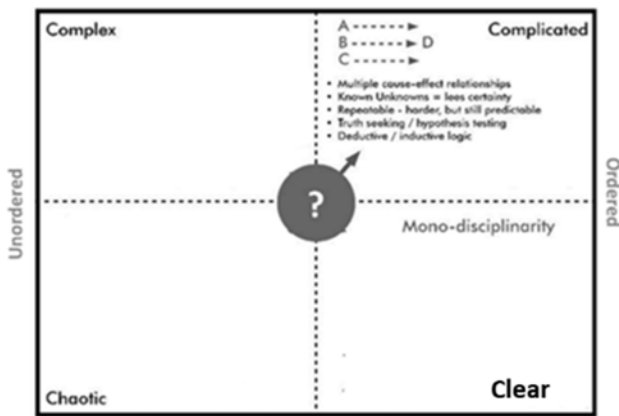

Figure 5. *Focuses specifically on the Complicated Domain, charaterised by multiple, repeatable linear cause–effect relationships (A, B, C causes D).*
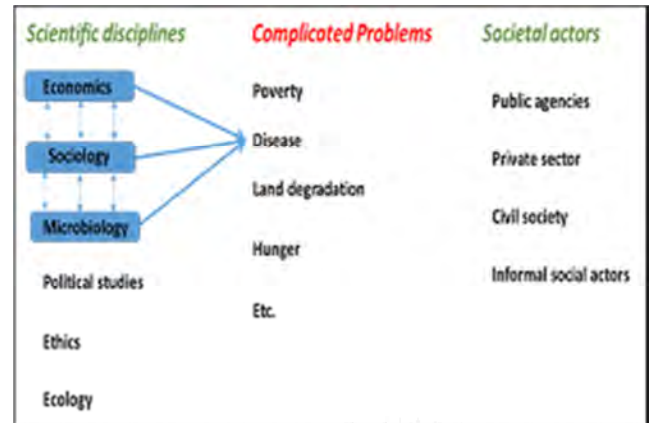

Figure 7. *Signifies examples of inter-disciplinarity where disciplinary experts tackling the same issues and starting to collaborate with each other.*
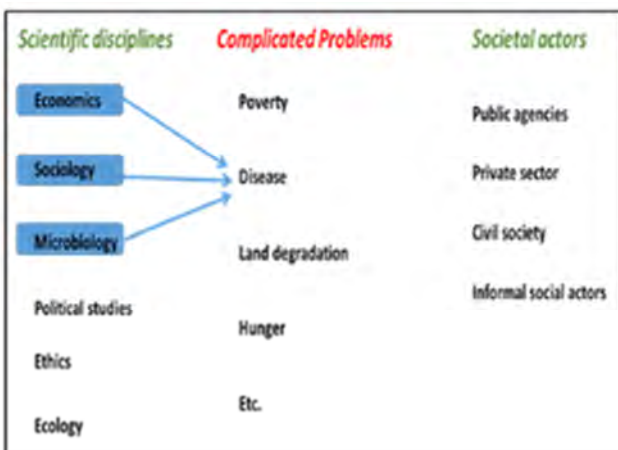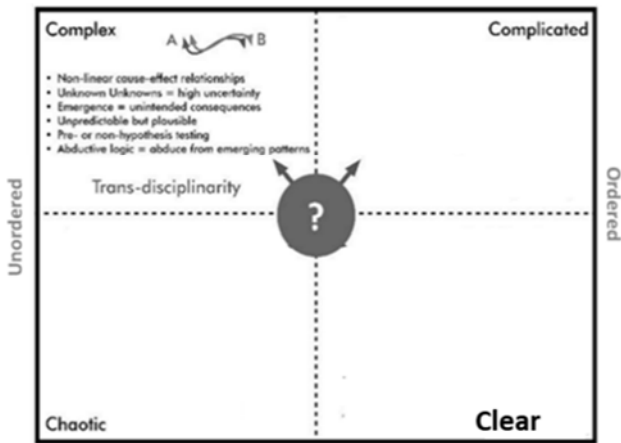
4.3. Trans-Disciplinarity for Problematics in the Complex Domain

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 [22].

It is also important to be mindful that the nature of A and B are not static, and that A or B might become something completely different as it becomes embedded in this, as well as multiple other feedback loops. 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 8 and 9 below for some simple graphic depictions of this:

Figure 6. *Signifies examples of multi-disciplinarity where disciplinary experts are tackling the same issues, but still working separately.*

However, where *inter-disciplinarity* (see Figure 7 below) is adopted, individual disciplinarians start to realise that working strictly *within* their own disciplinary boundaries presents limitations for dealing with the multivariate dynamics at play in the Complicated Domain. Collaboration with each other provides more opportunity for developing

Figure 8. *Focuses specifically on the Complex Domain, charaterised by multiple, bi-directional, non-linear cause–effect relationships (A causes B and B causes A).*
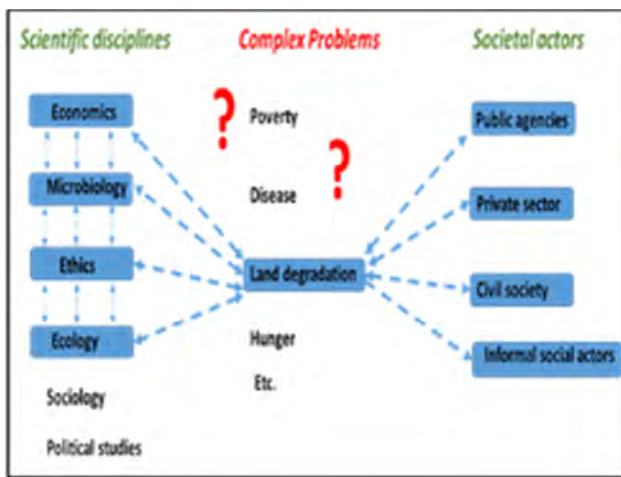
Figure 9. *Signifies examples of trans-disciplinarity disciplinary experts are collaborating with each other and societal actors to tackle the same complex issues.*

In complex systems everything is seen as irreducibly connected [10, 19, 21] – making it more useful to think about the nature of things *relationally* rather than focus on the things *in and of themselves*. In the Complex Domain, causality can never be reduced to some or other ultimate cause [33], 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[4]. 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 property of complex adaptive systems [45-47]. Or, put differently: *the system itself* is characterized by non-linear causality [69]; seeking causality might become futile, as the system can better be described as one of dynamic correlation [7, 17, 52, 53].

Non-linearity gives rise to epistemic objects which can be described as 'unknown unknowns' [83] – 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 / ad hoc events as in the Chaotic Domain. They certainly do produce some patterns[5] which can only be detected *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 by disciplinary experts, with their theoretical knowledge systems, *only*. It requires epistemic engagement with the social actors, so-called 'ordinary' or 'lay' people to incorporate their practical / embodied / tacit / 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 / understanding things in the Complex Domain. This means working collaboratively in the trans-disciplinary mode by bringing such pre-theoretical knowledge and ways of knowing *into* the research process – from the very outset of defining / 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 [72, 73] into 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 which case, different and more appropriate approaches are warranted, capable of working with individuals in many different places and spaces – at the same and/or different times. Such approaches are known in the literature as *distributed cognition / ethnography* [30, 43, 76, 77]. When adopted and adapted for the purposes of dealing with

---

4 In the Complex domain, the abovementioned overly abstract concept of 'over-determination' as theorized by Althusser [2] 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.
5 The characteristics of which can 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) [12, 27, 35, 51].

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 in academia, *only*.

4.4. Chaotic Domain – No Research, Only Action

The Chaotic Domain (see Figure 10 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 complete *un*-ordered and randomness. It is in the absence of *any* causal relations that things manifest themselves in a completely random manner.

In this domain, we are facing epistemic objects known as 'unknowable unknowns' [83], basically rendering any form of systematic / substantive research in this domain impossible – at least in terms of the said four methodologies. Chaos is also, ontologically speaking, a very temporary state, as complete randomness requires massive energy to create, and are impossible to maintain [66]. 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.
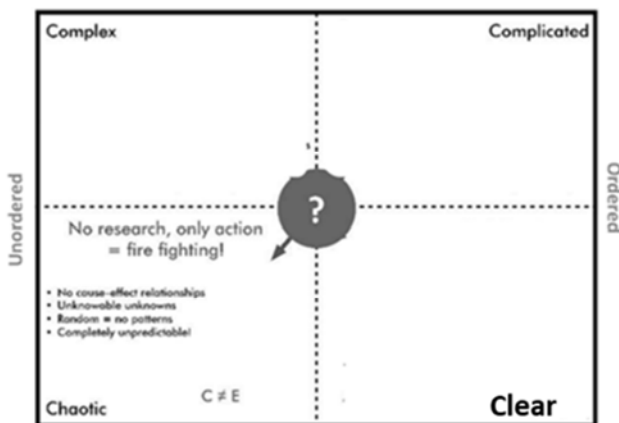
***Figure 10.** Focuses specifically on the Chaotic Domain with no discernable cause–effect relations – producing completely random / ad hoc events – rendering any form of conduct systematic research impossible.*

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

Our discussions above have provided a typological discussion of how research in the Clear, Complicated,

Complex and Chaotic domains present 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 (see Figure 11 below) provides us with 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 and impacts upon social and human worlds, and by that very nature needs to factor 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'…" [15]. In Strathern's [85] contemplation of how relations and relationality is 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." [36]. 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" [56]. Aristotle also emphasized that the undoing of this "knot"[6] can only be done by those who are aware of

---

6 This notion of undoing the knot is different to that of 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 of avoiding premature convergence [82] and with a sense of anticipatory awareness [82],

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 to his deconstructive approach [94]. He subscribed to a very purist definition of what qualifies as a decision arguing 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" [3].

This final domain in the Cynefin framework can, therefore, be seen as the learning space(s) opening 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 of being 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 critically to be considered. Beginning first with this aporetic contemplation will contribute to more effective methodological agility.
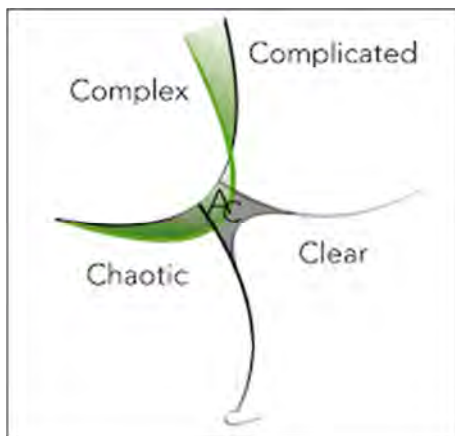
Figure 11. *The acronym "A/C" signifies the double meaning of this domain in the sense that it deals with the tensions caused by unclear matters. "C" indicates the state of being confused caused by apparent conflicting or contradicting perspectives and "A" the aporetic approach seeking to work with the tensions caused by the latter, rather than trying to absolve them.*

When said aporetic reflection and contemplation results in the building of sufficient consensus around the complexity of the real-world challenges at hand, and the methodological decision-making supports pursuing transdisciplinary approaches, then the following methods question(s) certainly

come into play: *how* and *which* methods to use, under *what* circumstances and for *what* purposes. To be sure, when facing complexity, there are no methodical short cuts to be taken. This but can only be figured out in the context of the actual emergent / non-linear real-world dynamics at hand. However, this does not translate into a position of anything goes or, even worse, *against methods* per se [32]. On the contrary, when facing the polycrisis the challenge is one of trans-disciplinary co-production of systems, target and transformation knowledge [40, 63]. Applied to the challenge of working with *unknown epistemic objects* in the Complex Domain, these can be briefly defined as follows:

1) *Systems knowledge* – is descriptive knowledge about the complexity of the current situation; why 'is' it complex vs. complicated vs. chaotic.
2) *Target knowledge* – is normative knowledge of what is more desirable than the current complex problem situation[7].
3) *Transformation knowledge* – is practical-strategic knowledge of *how to change* complex situations and transition *from* the current problematic situation *to* a more desirable situation.

5. Synergic Methods

Epistemologically speaking systems, target and transformation knowledge are three different kinds of knowledge, each with their own epistemic objects [15, 16, 49, 50]. The implications of facing unknown epistemic objects in the Complex Domain is that there are no methodical quick fixes with automatic guarantees for producing said systems, target and transformation knowledge. It means methods which can be co-designed during TTDR processes in and for the specific real-world contexts in which TTDR processes are embedded. In other words, we need agile methods that are flexible enough to be co-constructed by the researchers and stakeholders involved in TTDR processes in pursuit of systems, target and transformation knowledge(s) via exploring said unknown epistemic objects in the Complex Domain.

A useful concept with which to describe such agile / flexible / dynamic methods is that of 'synergic methods', deduced from the key concept of 'synergic satisfiers' posited in Human Scale Development [58]. An example of synergic satisfiers is of a mother breastfeeding her baby; thereby satisfying the baby's needs of subsistence, affection and identity – in short, one action (breastfeeding) satisfying more than one fundamental human need at the same time. Similarly, following this logic of one-to-many relations, synergic methods can be seen as research approaches capable of co-producing *during* transdisciplinary research processes said systems, target and transformative knowledge from exploring unknown epistemic objects.

---

namely that our decisions and actions are always provisional as they may very well produce unexpected consequences / challenges.

7 In other words, complexity is not necessarily a desirable situation; on the contrary, as the notion of the polycrisis (mentioned in the Introduction) suggests it may very well be at the core of what is problematic, undesirable, or unsustainable – and, therefore, in need *to be changed* (the focus of transformation knowledge).

With its strong focus on using quantitative and qualitative methods in complementary ways, the 'mixed methods' [8, 25] approach (see Figure 12 below) is a good example of synergic methods. However, its strong point is also its weak point because it tends to omit transformative methods from its repertoire of methods. For example, (participatory) action research approaches are either completely absent from mixed methods, or if mentioned, relegated into the background by said quant-qual methods. This results in yielding valuable insights into the *understanding* and *explaining* of problem situations, but not necessarily into *changing* them.
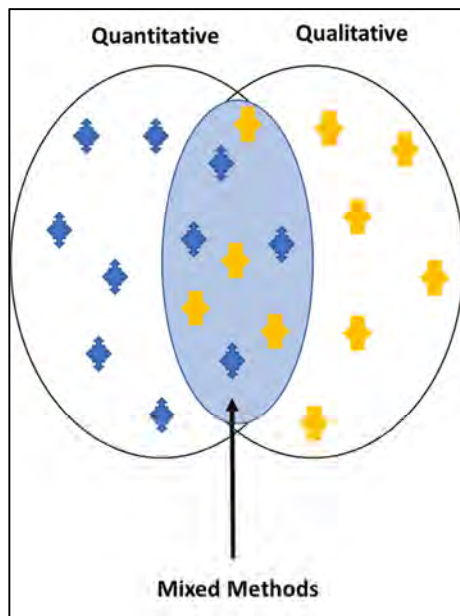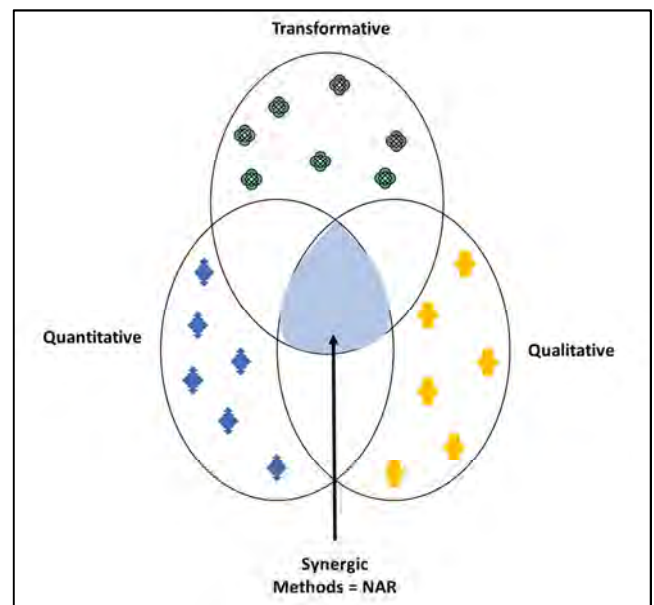

Figure 12. Depicting the 'Mixed Methods' approach with its focus on using quantitative and qualitative methods in complementary ways, but, importantly, excluding transformative approaches from its repertoire of methods.

Another good example of synergic methods is what will be referred to and described in more detail below as 'narrative action research' (NAR). Although NAR shares the quant-qual orientation of mixed methods by working with multiple lived experiences (as human narratives / stories), it also goes beyond mixed methods by filling the transformative gap in latter via deliberately importing the transformative logic / reasoning of action research approaches (e.g. participatory action research) to become a driving force of the research process. In other words, NAR combines the key concepts, principles, practices and logics of both quantitative, qualitative and transformative research approaches for doing transformative transdisciplinary research (TTDR) on complex issues in the Complex Domain. In short, this translates into developing better / deeper insights and understandings of the complex situations at hand via sense-making of emerging patterns of peoples' lived realities in order to figure out *what* and *how* to bring about necessary social change in complex problem situations (polycrisis).

6. Narrative Action Research (NAR)

NAR has been deliberately developed over the last couple of years (since 2014), as an appropriate approach for conducting TTDR processes, facing wide a variety of complex social-ecological challenges [8]. The appropriateness of NAR is that it is intentionally transformative, purposely seeking, as mentioned, not only better understanding (*Verstehen*), explaining (*Erklärung*) of complex problem situations, but also, very importantly changing (*Verändern*) them. In this regard, NAR differs from mixed methods approaches, which can be visualized as follows (see Figure 13):

Figure 13. Depicting the methodological space (signified by the light blue triangular area) left vacant, as it were, by the Mixed Methods approach, to be filled by synergic methods, such as NAR.

6.1. NAR Processes

When dealing with methodology it is critically important not to adopt an instrumentalist approach which reduces methodology to methods *only*, but rather a more process-oriented approach [20, 67, 74, 92]. In this regard, NAR processes essentially consist of six phases I. Preparation, II. Designing, III. Collecting, IV. Analysis & Sense-making, V. Returning, and VI. Implementing / Vector Monitoring & Evaluating (VME) – each with their own steps, practices and tools – which can be depicted as multi-phased iterative and linear processes as follows (see Figures 14 and 15 below):

6.1.1. Iterative NAR Process

A useful way to visualize the iterative nature of the six phases of NAR is in the following non-linear circular manner:

---

8 For some NAR case studies / projects, please see: https://ttdr.net/pre-2020-projects/ and https://ttdr.net/post-2020-projects/
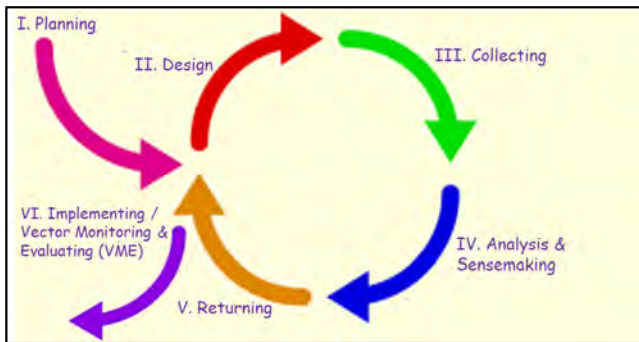
Figure 14. *Illustrates iterative NAR processes, consisting of six phases: I. Preparing II. Designing, III. Collecting, IV. Analysis & Sense-making, V. Returning, and VI. Implementing / Vector Monitoring & Evaluating (VME).*

6.1.2. Linear NAR Process

It is also possible to depict the above iterative process as a more linear process with distinct phases and steps. This is akin to presenting the more familiar flat / two-dimensional double helix version of the real 3-dimensional structure of the DNA molecule. A useful way of doing this is by embedding the six phased NAR process into the Jahn TDR framework [44], visualized as follows (see Figure 15 below):
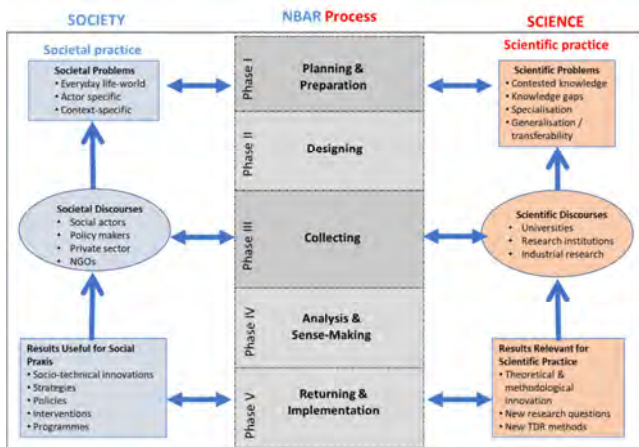

Figure 15. *Signifies the linear version of the iterative process by incorporating it into the Jahn TDR framework.*

Making this move has the advantage of explicating some of key steps to be taken during each of the phases:

(i). Preparation
1) Developing rich contextual descriptions of the complex problem situation at hand (systems knowledge).
2) Doing stakeholder analysis using various mapping tools [30, 41, 70, 71, 93] (systems knowledge).
3) Developing provisional guiding problem statements and research questions for unknown epistemic objects in the Complex Domain (systems knowledge).

(ii). Design
1) Using understandings and insights gained during preparation phase for co-designing context-relevant signification frameworks [9] (questionnaires) with enumerators (co-researchers).
2) Making co-designed signification frameworks available online using appropriately designed software tools.
3) Deciding on narrative capturing strategies for engaging with stakeholders / social actors in their formal and informal social settings and networks; with specific attention to role of gatekeepers).

(iii). Narrative / Data Collection
1) Deciding on capturing methods (audio, paper, online, interviews, iPads, Smart phones).
2) Deciding on ways of collection (indirect questions, text, anecdote circles, journaling, naïve interviewing etc.).
3) Doing field work (story collections).

(iv). Analysis & Sense-Making
1) Reading and discussing individual stories.
2) Training enumerators (co-researchers) in using relevant software for detecting and visualising emerging narrative patterns.
3) Doing necessary logistical / practical planning for returning stories to original storytellers; who, when, where and how?

(v). Returning Stories
1) Returning stories to storytellers and do collaborative sense-making with them.
2) Introducing transformative dialogues with storytellers on what needs to change to have fewer negative stories and more positive stories (target knowledge).
3) Developing context-relevant strategies for implementing small safe-to-fail social change experiments (transformation knowledge).

(vi). Implementation
1) Implementing small safe-to-fail social change experiments as 'adjacent possibles' [10] (transformation knowledge).
2) Amplifying what works; dampen what does not work – change direction if necessary (transformation knowledge).
3) Introducing and conducting on-going vector monitoring & evaluation (VME) (see section 7 below).

6.2. Guiding Principles

NAR processes are guided by the following guiding principles (see Figure 16 below):

6.2.1. Co-design
Rather than assuming atomism, NAR takes a

---

9 This means adopting an abductive logic [57, 62, 87] for designing context-sensitive signification frameworks with a view of exploring unknowns in the Complex Domain, which may take on the form of hypothesis-generating vs. hypothesis-confirming kind of research.

10 This means implementing context-sensitive social change interventions which are both embedded within a particular context (to be recognized as *from* that context) as well as being *different from* the context (pointing to what is possible and not necessarily present in current context yet) [48, 79].

communitarian approach. This is, metaphorically speaking, akin to a dynamic interaction between actors and the stage with emergent connections between social agents and their social contexts[11] – in which people – both individuals and groups – are constantly *shaping* and *being shaped* by each other. In other words, co-designing key aspects of the research process – starting with the signification framework – is part and parcel of the dynamic interactions involved in formative contexts [6, 18, 24, 34, 88, 89], making the NAR a thoroughly collaborative, co-creative process. In so doing – taking into consideration the richness of social actors' different and differing experiences and voices – helps to ensure participant engagement throughout the entire research process as they feel like active agents, rather than passive onlookers, in and to the change process.

6.2.2. Self-signification

The idea behind self-signification is that people self-interpret their stories into their own structure; they give further meaning to their experiences by placing their story onto signifiers. As NAR allows for written narratives, audio dictations, or the uploading of pictures, it comes with the advantage that the story always stays in its original form rather than relying on a transcription or algorithm to interpret it later. Epistemological power remains at the subject level, encouraging epistemic justice and the reduction of [80, 81].

6.2.3. Distributed Cognition

A famous study by Simons and Chabris [75] introduced inattentional blindness: the cognitive bias we have where we do not see what we do not expect to see. Scholars often point to the "wisdom of crowds" [86] to overcome these innate biases, where the aggregate of stories coalesce into a more representative collective judgment. This distributed cognition of a wide, diverse group allows wisdom to emerge through voices of real people, living their own unique lives and contexts.

6.2.4. Distributed Ethnography

Traditional ethnography is an anthropological method that consists of long-term participant observation, often in people's day to day environments [34]. It is a deeply contextual, inductive method that is often used to avoid essentialism and scientific reductionism. However, one of the difficulties of this method, as well as others which place contextuality at the center, is their notorious lack of scalability [78] as a way "respondents can contribute stories in their own contexts, in their own time and place" therefore overcoming the hurdle of scalability whilst benefiting from the advantages of ethnography in practice. Snowden [78] calls this distributed ethnography.

6.2.5. Epistemic Justice

Epistemic justice refers to a fairness of knowing, including the need for inclusion in the "knowing process." If there is a lack of representation from one group or an overabundance from another, or if people are excluded based on their socio-cultural-economic status, demographic, or geographical context, then this can be seen as an epistemic injustice as there is an unjust power dynamic [13]. It is not enough to collect more perspectives about an experience or event or situation. To attend to shifting knowledge, and seeing differently, people have to create new knowledge about a system by identifying what their experiences mean and how they are making sense of, and finding meaning, in the world.

However, epistemic justice is not only a moral/ethical concept, seeking *fairness & equality* in co-producing knowledge in unequal knowledge/power relations. It is also a way of ensuring that we avoid falling into the reductionist trap of peddling in 'single stories' [1].
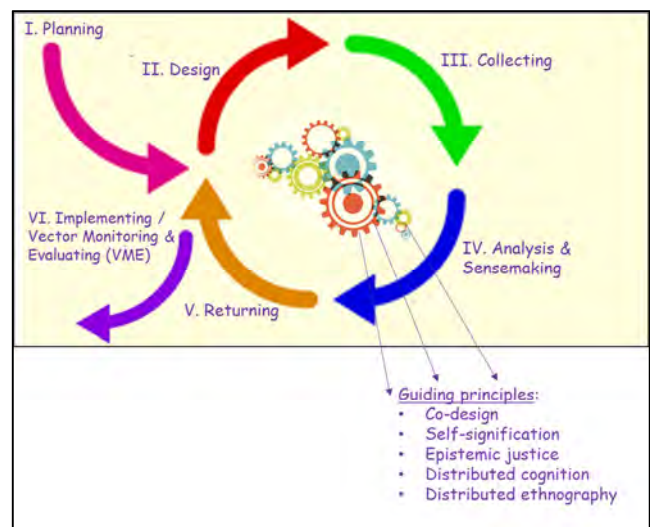

Figure 16. Signifies the guiding principles as being at the core of NAR processes.

7. Vector Theory / Praxis of Change

Vector monitoring and evaluation was already briefly referred to above as one of the important steps in phase VI of the NAR process. However, this should not be seen as just single or once-off step, but can be further developed in theory/praxis of social change, particularly if the notion of 'praxis' is understood and defined in the Freirean sense of the word as *reflection and action directed at the social issues / challenges to be transformed* [32, 42]. In short, this means theory-informed action and action-informed theory, comprising of the following iterative steps (see Figure 17 below for a visual representation hereof):

1) Taking action
2) Considering the impacts / consequences of the action.
3) Analysing the results of the action by reflecting upon it (critical thinking / imagining).
4) Altering and revising conceptions and planning following reflection.
5) Implementing these plans in further actions.

---

11 This metaphor is taken from Einstein's conceptualization of dynamic gravity as curved spacetime (CST) in which celestial bodies (actors) interact with – *shaping* and *being shaped* by – CST [38]. Also see this video by Brian Greene: https://youtu.be/dEWupAFtXGU
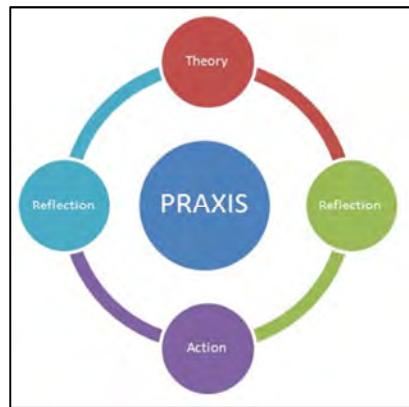
Figure 17. *Depicts the three iterative aspects of praxis: action / doing, critical reflection and theorizing.*

By following these steps in an iterative manner means going beyond merely introducing a monitoring and evaluating tool for the research process, but in effect *becomes* the praxis of a vector theory of change – specifically focused on the direction in the speed of travel through the intensity of the change effort [82][12]. In practice, this means initiating yet another iterative cycle of the NAR process by collecting, analysing and sense-making of peoples' lived experiences of the change interventions with the relevant social actors involved in TTDR processes. In all of this, the role of the researchers remains focused on said *directionality* of the change process by providing as far as practicably possible real-time feedback to the people involved for *their* decision-making on the next steps whether to stay on course or change direction.

8. Conclusion

This paper introduced the notion of methodological agility (MA) as the *ability to switch* between different – mono-, multi-, inter- and transdisciplinary – methodologies when facing radically different kinds of societal challenges – clear, complicated, complex, chaotic – embedded in ontologically different contexts or domains. It was argued that performing this switching happens not only *between* said methodologies as inter-MA, but also *within* any one of the methodologies as intra-MA. The latter constituted the main focus of this paper with the introduction of a novel concept of *synergic methods* for dealing with complex – non-linear, emergent – societal challenges in pursuit of co-producing systems, target and transformative knowledge during TTDR processes. In this regard, NAR has been proposed as a good example of such synergic methods, illustrated briefly with reference to key processual aspects – phases and steps – of this approach. However, *when,* and *how* synergic methods should be used is always context-dependent since the contextual conditions in which TTDR are embedded are always in a continuous process of change. How to make

sense of ever-changing, and ontologically different, contexts can indeed be a confusing exercise. To this end, the Cynefin multi-ontology framework was introduced as a useful heuristic for facilitating agile methodological decision-making. Finally, given its overall transformative orientation, this paper introduced a vector theory/praxis of change, the purpose of which is to help steering / nudging TTDR processes in a transformative direction, without the normative-teleological onus of knowing in advance what the ultimate end-goals of our transformative actions *should be* – but rather co-generating these *during* the emerging research process – or, putting it differently, in the poetic words of Antonio Machado: "*making the road by walking it*".

References

[1] Aidichie, C. N., 2009. The Danger of a Single Story [video]. TED Conferences: https://www.youtube.com/watch?v=D9Ihs241zeg&ab_channel=TED

[2] Althusser, L., 2005. For Marx. Verso, London.

[3] Anidjar, G., 2013. Acts of Religion. Routledge.

[4] Aristotle, 1961. Aristotle's Physics. U of Nebraska Press, Lincoln.

[5] Bai, Z., Wong, W.-K., Zhang, B., 2010. Multivariate linear and nonlinear causality tests.

[6] Bateson, G., 1972. Steps to an Ecology of Mind: Collected Essays in Anthropology, Psychiatry, Evolution, and Epistemology. University of Chicago Press, Chicago.

[7] Beck, U., 2015. Emancipatory catastrophism: What does it mean to climate change and risk society? Current Sociology 63, 75–88. https://doi.org/10.1177/001139211455995

[8] Bergman, M. M., 2012. Mixed Methods Research. SAGE Publications, Limited.

[9] Bhaskar, R., 2019. Metatheory for the Anthropocene: Emancipatory Praxis for Planetary Flourishing. Routledge.

[10] Boulton, J. G., Allen, P. M., Bowman, C., 2015. Embracing Complexity: Strategic Perspectives for an Age of Turbulence. Oxford University Press, Oxford.

[11] Bourdieu, P., 2008. Structures, Habitus, Practices.

[12] Braidotti, R., 2005. Rhizomes: Issue 11/12: [WWW Document]. URL http://www.rhizomes.net/issue11/braidotti.html (accessed 10.19.16).

[13] Byskov, M. F., 2020. What Makes Epistemic Injustice an "Injustice"? Journal of Social Philosophy.

[14] Camic, C., Gross, N., Lamont, M., 2012. Social Knowledge in the Making. University of Chicago Press.

[15] Cetina, K. K., 2009. Epistemic Cultures: How the Sciences Make Knowledge. Harvard University Press.

[16] Cetina, K. K., Schatzki, T. R., Savigny, E. von, 2005. The Practice Turn in Contemporary Theory. Routledge.

---

12 Also see this video by Gary Wong: https://www.youtube.com/watch?v=xI4sWoGQ3EM

[17] Chandler, D., 2018. Ontopolitics in the Anthropocene: An Introduction to Mapping, Sensing and Hacking. Routledge.

[18] Ciborra, C. U., Lanzara, G. F., 1994. Formative contexts and information technology: Understanding the dynamics of innovation in organizations. Accounting, management and information technologies 4, 61–86.

[19] Cilliers, P., 2008. 3.1 Knowing Complex Systems: The Limits of Understanding. A Vision of Transdisciplinarity: Laying Foundations for a World Knowledge Dialogue 43.

[20] Code, M., 2007. Process, Reality, and the Power of Symbols: Thinking with A. N. Whitehead. Springer.

[21] Cohen, M. D., Axelrod, R., 2000. Harnessing Complexity: Organizational Implications of a Scientific Frontier. Simon and Schuster, New York City.

[22] Colchester, J., 2016. Nonlinear System. Complexity Labs. URL http://complexitylabs.io/nonlinear-system/ (accessed 5.4.18).

[23] Costa, C., Murphy, M., 2015. Bourdieu, Habitus and Social Research: The Art of Application. Springer, New York City.

[24] Crawford, J. B., Mills, A. J., 2009. The Formative Context of Organizational Hierarchies and Discourse: Implications for Organizational Change and Gender Relations. Gender, Work & Organization. https://doi.org/10.1111/j.1468-0432.2009.00470.x

[25] Creswell, J. W., 2013. Research Design: Qualitative, Quantitative, and Mixed Methods Approaches. SAGE Publications.

[26] Crutzen, P. J., others, 2002. Geology of mankind. Nature 415, 23–23.

[27] Deleuze, G., 2004. Difference and Repetition. A&C Black.

[28] Ehlers, E., Krafft, T., 2006. Earth System Science in the Anthropocene: Emerging Issues and Problems. Springer Science & Business Media.

[29] Elden, S., 2002. Mapping the present: Heidegger, Foucault and the project of a spatial history. A&C Black.

[30] Enfield, N. J., Kockelman, P., 2017. Distributed Agency. Oxford University Press.

[31] Feyerabend, P., 1993. Against Method. Verso.

[32] Freire, P., 2014. Pedagogy of the Oppressed: 30th Anniversary Edition. Bloomsbury Publishing USA.

[33] Funtowicz, S. O., Ravetz, J. R., 1994. Uncertainty, complexity and post-normal science. Environmental Toxicology and Chemistry: An International Journal 13, 1881–1885.

[34] Garfinkel, H., 1991. Studies in Ethnomethodology. Wiley, New Jersey.

[35] Genosko, G., 2001. Deleuze and Guattari: Deleuze and Guattari. Taylor & Francis, Oxfordshire.

[36] Goh, Z., 2020. Aporetic Meditations. Cognitive Edge. URL https://www.cognitive-edge.com/aporetic-meditations/ (accessed 9.22.21).

[37] Goh, Z., 2012. Understanding Cynefin through Social Theory. Gognitive-Edge Vol. 10.

[38] Greene, B., 2005. The Fabric of the Cosmos: Space, Time and the Texture of Reality. Penguin UK.

[39] Hadorn, G. H., Pohl, C., 2008. Handbook of transdisciplinary research. Springer, Dordrecht.

[40] Hagan, T., Smail, D., 1997. Power-mapping—I. Background and basic methodology. Journal of Community & Applied Social Psychology 7, 257–267.

[41] Hollan, J., Hutchins, E., Kirsh, D., 2000. Distributed cognition: toward a new foundation for human-computer interaction research. ACM Transactions on Computer-Human Interaction (TOCHI) 7, 174–196.

[42] Horton, M., Freire, P., 1990. We Make the Road by Walking: Conversations on Education and Social Change. Temple University Press.

[43] Hutchins, E., 1991. The social organization of distributed cognition. American Psychological Association 283–307.

[44] Jahn, T., 2008. Transdisciplinarity in the Practice of Research. In: Matthias Bergmann/Engelbert Schramm (Hg.): Transdisziplinäre Forschung. Integrative Forschungsprozesse verstehen und bewerten., German (No English translation yet) 21–37.

[45] Juarrero, 1998. Causality as Constraint, in: Evolutionary Systems. Kluwer Academic Publishers, pp. 233–242.

[46] Juarrero, A., 2010. Complex dynamical systems theory. Cognitive Edge Network.

[47] Juarrero, A., 2002. Dynamics in Action: Intentional Behavior as a Complex System. MIT Press.

[48] Kauffman, S., 2017. The'adjacent Possible'is Relational, in: 43 VISIONS FOR COMPLEXITY. World Scientific, pp. 23–24.

[49] Knorr Cetina, 2001. Objectual practice. Routledge.

[50] Knorr-Cetina, K. D., 2013. The Manufacture of Knowledge: An Essay on the Constructivist and Contextual Nature of Science. Elsevier.

[51] Kurtz, C. F., Snowden, D., 2007. Bramble bushes in a thicket: Narrative and the intangibles of learning networks. Strategic networks: Learning to compete 121.

[52] Latour, B., 2017. Facing Gaia: Eight Lectures on the New Climatic Regime. John Wiley & Sons.

[53] Latour, B., 2012. We Have Never Been Modern. Harvard University Press.

[54] Latour, B., 2007. Reassembling the Social: An Introduction to Actor-Network-Theory. OUP Oxford.

[55] LLC, B., LLC, G. B., 2010. Reductionism: Occam's Razor, Reductionism, Monism, Reduction, Type Physicalism, Dialectical Monism, Separation of Concerns. General Books.

[56] Madigan, A., 1999. Metaphysics: Book B and Book K 1-2. Clarendon Press.

[57] Magnani, L., 2017. The Abductive Structure of Scientific Creativity: An Essay on the Ecology of Cognition. Springer.

[58] Max-Neef, M., Elizalde, A., Hopenhayn, M., 1991. Human Scale Development. The Apex Press.

[59] Morin, E., Kern, A. B., 1999. Homeland Earth: A Manifesto for the New Millennium. Hampton Press, Incorporated.

[60] Pearl, J., 2009. Causality. Cambridge University Press.

[61] Pearl, J., Mackenzie, D., 2018. The Book of Why: The New Science of Cause and Effect. Penguin UK.

[62] Peirce, C. S., 1974. Collected Papers of Charles Sanders Peirce. Harvard University Press.

[63] Pohl, C., Hadorn, G. H., 2007. Principles for Designing Transdisciplinary Research. Oekom.

[64] Popper, K., 2005. The Logic of Scientific Discovery. Routledge.

[65] Popper, K. R., 1979. Objective Knowledge: An Evolutionary Approach. Clarendon Press.

[66] Prigogine, I., Stengers, I., 2018. Order Out of Chaos. Verso Books.

[67] Processual Case Research, 2010. SAGE Publications, Inc., 2455 Teller Road, Thousand Oaks California 91320 United States. https://doi.org/10.4135/9781412957397.n273

[68] Prosser, S., 2012. Emergent causation. Philosophical studies 159, 21–39.

[69] Rosen, R., 2005. Life Itself: A Comprehensive Inquiry Into the Nature, Origin, and Fabrication of Life. Columbia University Press.

[70] Schiffer, E., 2007. The power mapping tool: a method for the empirical research of power relations.

[71] Schiffer, E., Hauck, J., 2010. Net-Map: collecting social network data and facilitating network learning through participatory influence network mapping. Field methods 22, 231–249.

[72] Scholz, R. W., 2011. Environmental Literacy in Science and Society: From Knowledge to Decisions. Cambridge University Press.

[73] Scholz, R. W., Lang, D. J., Wiek, A., Walter, A. I., Stauffacher, M., 2006. Transdisciplinary case studies as a means of sustainability learning: Historical framework and theory. International Journal of Sustainability in Higher Education 7, 226–251.

[74] Seibt, J., 2018. Process Philosophy, in: Zalta, E. N. (Ed.), The Stanford Encyclopedia of Philosophy. Metaphysics Research Lab, Stanford University.

[75] Simons, D. J., Chabris, C. F., 1999. Gorillas in our midst: Sustained inattentional blindness for dynamic events. perception 28, 1059–1074.

[76] Snowden, 2016a. Ethnography Part I [WWW Document]. Cognitive Edge. URL /blog/ethnography-part-i/ (accessed 6.11.18).

[77] Snowden, 2016b. Ethnography Part II [WWW Document]. Cognitive Edge. URL /blog/ethnography-part-ii/ (accessed 6.11.18).

[78] Snowden, 2010. snowden narrative resaearch - Google Search [WWW Document]. URL https://www.google.com/search?q=snowden+narrative+resaea rch&ie=utf-8&oe=utf-8&client=firefox-b (accessed 4.18.18).

[79] Snowden, D., 2016. The adjacent possible [WWW Document]. Cognitive Edge. URL /blog/the-adjacent-possible/ (accessed 6.23.18).

[80] Snowden, D., 2011. Signification [WWW Document]. Cognitive Edge. URL /resources/glossary/ (accessed 2.7.19).

[81] Snowden, D., 2010. Naturalizing sensemaking. Informed by knowledge: Expert performance in complex situations 223–234.

[82] Snowden, D., Blignaut, S., Goh, Z., 2021. Cynefin. Cognitive Edge Pte Ltd, Singapore.

[83] Snowden, D. J., Boone, M. E., 2007. A leader's framework for decision making. Harvard business review 85, 68.

[84] Sober, E., 2015. Ockham's Razors. Cambridge University Press.

[85] Strathern, M., 2020. Relations: An Anthropological Account. Duke University Press.

[86] Surowiecki, J., 2005. The Wisdom of Crowds. Anchor Books.

[87] Thagard, P., 1997. Abductive reasoning [WWW Document]. URL http://cogsci.uwaterloo.ca/Articles/Pages/%7FAbductive.html (accessed 10.30.17).

[88] Unger, R. M., 2014. The Religion of the Future. Harvard University Press.

[89] Unger, R. M., 1998. Democracy Realized: The Progressive Alternative. Verso.

[90] Van Breda, J., Goh, Z., 2022. Methodological agility for sustainability transitions in the Anthropocene. IJSDR.

[91] Van Breda, Swilling, 2018. The guiding logics and principles for designing emergent transdisciplinary research processes: Learning experiences and reflections from a transdisciplinary urban case study in Enkanini informal settlement, South Africa. Sustainability Science.

[92] Whitehead, A. N., 2010. Process and Reality. Simon and Schuster.

[93] Wood, D., 2021. The art of deep mapping, in: Making Deep Maps. Routledge, pp. 17–37.

[94] Zlomislic, M., Zlomislić, M., 2007. Jacques Derrida's Aporetic Ethics. Lexington Books.