

1 What prevents the adoption of regenerative agriculture and what 2 can we do about it? Lessons from a behaviorally-attuned 3 Participatory Modelling exercise in Australia

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ABSTRACT

Regenerative agricultural methods (RegenAg) can help farmers attune their agricultural practices to the natural design of earth's cycles and support systems. Their adoption hinges not only on a good understanding of biophysical processes but perhaps more importantly on farmers' values and beliefs, which can become an obstacle for triggering widespread transitions towards synergistic relationships with the land. We conducted a Participatory Modelling exercise with RegenAg stakeholders in Australia—the aim was to provide a blueprint of how challenges and opportunities could be explored in alignment with stakeholders' personal views and perspectives. A participatory Fuzzy Cognitive Mapping exercise was undertaken to unpack stakeholder perspectives into a formal representation or 'mental model' of the barriers and enablers for adoption of RegenAg practices, and to subsequently identify actions that might close the gap between the two. To promote a better understanding and internalization of the outcomes of the engagement, we extracted the dominant narratives which encode the key drivers and pain points in the system. The process relied on a suite of innovative virtual delivery methods that were designed to conduct the stakeholder engagement under COVID-19 lockdown restrictions. For the first time, our Participatory Modelling exercise reveals the key drivers of RegenAg in Australia, highlighting the complex forces at work and the need for coordinated actions at the institutional, social, and individual levels, across long timescales (decades). Such actions are necessary for RegenAg to play a greater role in national economies, to bring balancing relationships to systems currently reliant on conventional agriculture with few internal incentives to change. Our methods and findings are relevant not only for those seeking to promote adoption of RegenAg in Australia, but more broadly for governments and agriculturalists seeking to take a behaviorally-attuned stance to engage with farmers on issues of sustainable and resilient agriculture.

37 1. Introduction

38 In the middle of 2019, the Australian landscape began to burn. By the time the fires ran their course, over 240 days
39 later, more than 30 people had died, 3500 homes had been destroyed, 306 millions tons of carbon dioxide had been
40 released, and costs were approaching 100 billion Lee (2019); Guy (2020); Read and Denniss (2020). The entire country
41 was and, in many places, still is reeling from the devastation. With links to climate change increasing and suggesting
42 the possibility of a repeat in the future Lucas, Hennessy, Mills and Bathols (2007), serious questions confront both
43 policymakers and Australian citizens about how this issue can be dealt with so as not to face this level of devastation
44 ever again. This issue is particularly pertinent for farmers, a group severely affected by the fires, and the drought leading
45 up to it Davey and Sarre (2020); Bell (2020); Flannery (2020). Unfortunately for agriculture, as a system where social

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46 desires do not necessarily align with vested interests, current policy regimes, environmental trends, or market pressures,
47 there are no simple solutions.

48 In the last few decades, Australian farmers have seen enormous changes in their farm systems, but also in the social,
49 economic, and political systems that govern the land across the country Stafford Smith, McKeon, Watson, Henry, Stone,
50 Hall and Howden (2007). Agriculture is inherently exposed to "multiple, simultaneous and inter-connected ecological,
51 economic and social pressures" Feola, Lerner, Jain, Montefrío and Nicholas (2015). The impacts of these pressures are
52 typically seen over long-time periods Oomen, Ewert and Snyman (2016); Hacker, Jessop, Smith and Melville (2010),
53 as the lands on which they farm tend to be governed by 'slow variables' i.e., variables that are crucial to the health
54 of the ecosystem, but whose trends can only be understood in timeframes of decades or longer, despite short-term
55 variations. These variables include climate patterns, (including rainfall), ground coverage of perennial species, local
56 environmental and scientific knowledge, and others Stafford Smith et al. (2007); Hacker et al. (2010). For example,
57 fires are a random and natural occurrence, but the severity and frequency of fires in Australia can be determined by
58 trends (such as fire prevention efforts near populated areas, or a lack of backburning) decades in the making.

59 Farm ecosystems are shaped by these slow variables, which have their own natural trends, but farms are also under
60 increasing and more immediate pressure from human interventions. The complexity of all these interactions make
61 farms a difficult system to manage; there is simultaneously a resilience and a fragility to these tightly linked ecological,
62 economic and social systems Janssen, Anderies and Walker (2004); Quaas, Baumgärtner, Becker, Frank and Müller
63 (2007). For example, fires can carry serious consequences by altering groundcover, changing the physical properties
64 of the soil (including hydrologic properties), altering the composition of soil microbial communities, changing and
65 altering the lands cycles of carbon and nitrogen fixation, and ultimately, reducing the number of plants holding the
66 soil in place Peri, Ladd, Lasagno and Martínez Pastur (2016). This makes erosion more likely, and the land more
67 susceptible to flooding. These chains of impact carry implications for people's livelihoods by ultimately affecting farm
68 productivity Oomen et al. (2016). As such, we need an understanding of both the thresholds and non-linear trends in
69 these complex, socio-environmental systems, and crucially, the role of the individuals within it, as it is their preferences
70 and decisions that shape these farm ecosystems Anderies, Janssen and Walker (2002); Ostrom (2009); Jakoby, Quaas,
71 Müller, Baumgärtner and Frank (2014).

72 Policymakers designed and implemented a wide range of agricultural policies that attempted to solve issues of
73 erosion, water pollution, climate change, and other related issues. These policies however often fail to account for
74 the perceptions and beliefs of individual farmers (who have the final word on whether and how the policies are
75 implemented), and therefore often fail to make a lasting impact Burton (2004). When farmer perceptions are considered,
76 it is often with a simplistic profit driven motive, which has time and time again been shown to be misguided and overly
77 simplistic Borges, Oude Lansink, Marques Ribeiro and Lutke (2014); Ranjan, Church, Floress and Prokopy (2019);
78 Gosnell, Gill and Voyer (2019); Senger, Borges and Machado (2017); Pannell, Marshall, Barr, Curtis, Vanclay and
79 Wilkinson (2006); Leys and Vanclay (2011). Lessons from practice and scholarship show that farmers consider multiple
80 factors in their decision making beyond money, including environmental stewardship, family legacy, and community
81 Feola et al. (2015).

82 As scientists and policymakers seeking to support enduring transitions towards sustainable agriculture, we need to
83 develop a holistic understanding of ecological, environmental, and social factors and how they shape the preferences
84 and motivations of farmers Jakoby et al. (2014); Burton (2004). This is necessary because ultimately farmers are the
85 agents undertaking action and therefore their buy-in or inaction directly determines the success of any sustainability
86 program or policy on the ground Feola et al. (2015). If we understand this, then we can better design incentives,

87 regulations, and institutional reforms, as well as choosing times when it's better not to get involved at all Feola et al.
88 (2015).

89 In this paper, we argue that by focusing on the perceptions and motivations of farmers through increasing our
90 understanding of the stories they tell and the systematic connections within those stories, there is an increased likelihood
91 of creating a more enduring form of bottom-up change in a new social norm, rather than a top-down policy or incentive
92 program that is subject to change with each new election cycle Blackstock, Ingram, Burton, Brown and Slee (2010).
93 This does not mean that existing policies or incentives should be abandoned, but if they come from a ground up
94 understanding of farmer decision-making and motivations, they may be more likely to be adopted by farmers in
95 the first place, and to endure beyond the limits of a given political cycle. To test and demonstrate the potential of
96 adopting this approach, we conducted a participatory Fuzzy Cognitive Mapping exercise which unpacks stakeholder
97 perspectives into a formal representation or 'mental model' of the barriers and enablers for adoption of RegenAg
98 practices. To promote a better understanding and internalization of the outcomes of the engagement, we extracted the
99 dominant narratives which encode the pain points and leverage opportunities in the system. We report on a suite of
100 bespoke virtual delivery methods that were designed to conduct the stakeholder engagement under lockdown and social
101 distancing restrictions due to the COVID-19 pandemic. Our methods and findings are relevant not only for those seeking
102 to promote adoption of RegenAg in Australia, but more broadly for practitioners, for researchers, and for government
103 officials seeking to take a behaviorally-attuned PM stance to engage with their stakeholders in geographically-disperse
104 and value-laden SES contexts.

105 The paper proceeds as follows. Section 2 outlines the conceptual framing and case study. Section 3 describes the
106 participatory engagement process that was undertaken. Section 4 presents a macro, meso, and micro scale analysis of
107 the process and the co-construction of narratives. Section 5 discusses the specific implications for RegenAg in Australia
108 and broader implications for Participatory Modelling practice, limitations, and future research. Section 6 Concludes.

109 **2. Conceptual Framing and Case Study**

110 **2.1. Socio-Ecological Systems and the Importance of Human Learning**

111 Addressing socio-environmental problems in the Anthropocene requires a deeper understanding of the way humans
112 conceive and perceive a given issue or problem situation and how people's knowledge, motivations and behaviors can
113 get in the way of collaboration and policy implementation Ives and Kendal (2014). These problems of SES are, at their
114 core, made 'wicked' by the conflicting values and interests imposed upon them by people Norton (2012). As such, this
115 social component means humans are a key part of the problem, and also a part of the solution Xiang (2013); Conklin
116 and Weil (2007). Ultimately, understanding and transforming human behavior for better management of the system
117 is key to achieving the desired outcomes Reed, Evely, Cundill, Fazey, Glass, Laing, Newig, Parrish, Prell, Raymond
118 and Stringer (2010); van Bruggen, Nikolic and Kwakkel (2019). The inherent uncertainty, conflicting values, and
119 unpredictability of SES means that "it is simply not possible, nor desirable, to understand and manage such complex
120 social and socio-ecological problems through a centralized administration and enforcement of rules, as they tend to
121 over-ride the diverse values and goals underlying these complex issues" Schön and Rein (1994). The 'command and
122 control' model does not work Armitage, Marschke and Plummer (2008); Defries and Nagendra (2017). So, to change
123 behavior, it is better if the issues are "widely understood, discussed and owned by the people whose behavior is being
124 targeted for change" and this is possible through learning (2007) (APS).

125 Learning to manage wicked problems requires a 'deeper' sort of knowledge and learning, the type that helps us to
126 transcend the goals and paradigms of system Meadows and Wright (2008), sometimes referred to as transformative or
127 loop learning Mezirow (2000); Argyris and Schön (1978); Keen, Brown and Dyball (2005). This deeper knowledge

128 must surpass single-loop, limited to the question of: "Are we doing things right?" Yu, Shin, Pérez, Anderies and
129 Janssen (2016), and instead move to the more transformative levels of double and triple loop learning Keen et al.
130 (2005). Double-loop learning examines underlying assumptions and models driving our actions and behavior patterns
131 asking instead: "Are we doing the right things?" Yu et al. (2016). And triple-loop learning helps us to interrogate
132 those values and norms that define our worldview, (i.e. "What do I value? How do I define what is 'right'?"), leading
133 to changes and updates in those "deep-seated beliefs and mental models" that form a key leverage point in changing
134 systems Yu et al. (2016); Pahl-Wostl (2009); Keen et al. (2005).

135 Next, is to understand how individual learning can emerge and endure in larger, social patterns. This can be thought
136 of as changing individuals to change the system Latané (1996). Levin (2002) notes that working with problems
137 of SES requires understanding how individual behaviors within the system both influence and are influenced by
138 collaboration, group dynamics, social networks, institutions and policy; through feedbacks that flow from the bottom-
139 up and from the top-down. Participatory approaches seek to prioritize and strengthen the co-construction of bottom-
140 up feedback, mediated through learning. We, and other researchers, refer to and conceptualize this learning as the
141 transformation of 'mental models' Chi (2008); Henly-Shepard, Gray and Cox (2015). A mental model is a "personal,
142 internal representation of external reality that people use to interact with the world around them" based on an
143 individual's experiences, perceptions, and understandings of the world Jones, Ross, Lynam, Perez and Leitch (2011).
144 Other researchers have also used this approach to engage stakeholders and to elicit their mental models in building
145 better understanding and management of SES Henly-Shepard et al. (2015); Walters and Holling (1990); Reed et al.
146 (2010); Bakken (2019); van Bruggen et al. (2019); Gray, Jordan, Crall, Newman, Hmelo-Silver, Huang, Novak, Mellor,
147 Frensley, Prysby and Singer (2017); Jones, Ross, Lynam and Perez (2014). In these cases, success has been achieved
148 not by reaching 'consensus', but rather by reaching a 'shared understanding', meaning "stakeholders understand each
149 other's positions well enough to have intelligent dialogue about the different interpretations of the problem, and to
150 exercise collective intelligence about how to solve it" Conklin (2006). Because 'wicked' problems are a complex
151 interaction of differing values and perspectives, participatory processes of this nature become a social negotiation to
152 create a more complete understanding of the problem and a more comprehensive response Conklin (2006).

153 **2.2. The Difficulties of Communicating Complexity**

154 Communicating complexity is a challenge in participatory processes seeking to manage SES Castilla-Rho, Rojas,
155 Andersen, Holley and Mariethoz (2017); Ghazoul and McAllister (2003); McLeod and Childs (2013); Meadows and
156 Wright (2008). Despite the best efforts of science, the complex nature of our reality means we can never 'know it'
157 entirely or perfectly Danermark, Ekstrom, Jakobsen, Karlsson and Bhaskar (2001); Edwards, O'Mahoney and Vincent
158 (2014). This is why science has theories, rather than definitive and conclusive 'proof'. While the scientific process of
159 research encourages accepting uncertainty, the design of the human mind struggles to internalise it Beratan (2007);
160 Levine, Chan and Satterfield (2015). Various explanations exist as to why that happens Korteling, Brouwer and Toet
161 (2018) yet the most accepted view centers around our limited ability to process information, the shortcuts our brains
162 use to circumvent complexity, and our preference for black and white answers, as opposed to those that contain some
163 level of ambiguity. The human brain limits the amount of information we can process to conserve energy which leads to
164 'hard and fast' rules and mental models to make decision-making easier and more effective Hutchinson and Gigerenzer
165 (2005); Tversky and Kahneman (1974); Simon (1955); these are our heuristics and cognitive biases Gilovich, Griffin
166 and Kahneman. Efficiency in neurocognitive function therefore pursues a desire for certainty and simplicity.

167 This desire for certainty plays a key role in two tendencies of the human mind: 1) finding patterns, and 2) creating
168 meaning Shermer (2011). Those two tendencies may explain, in part, why narratives are such a powerful way of

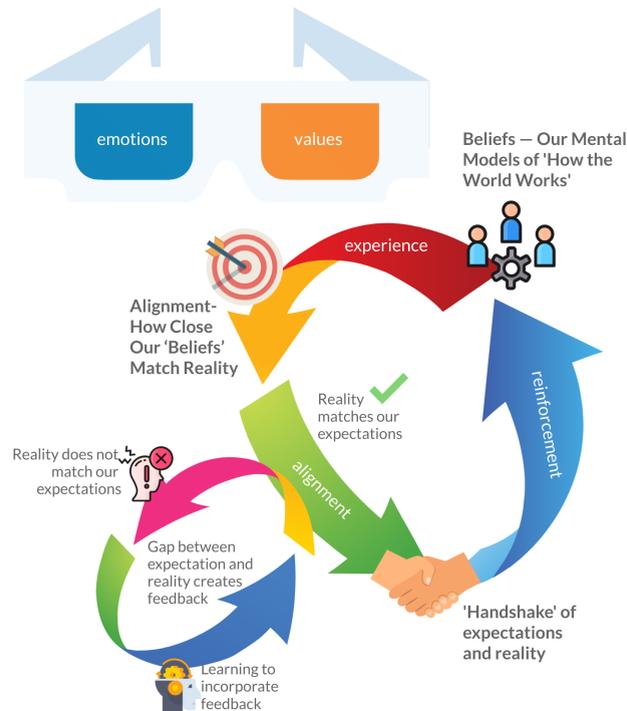


Figure 1: Our beliefs and expectations are based on our mental models of the way the world works. These mental models are constantly being tested to see if our expectations are ‘met’ by reality. When there is a mismatch between the expectations of our mental models and reality, it creates a ‘gap’. We can seek to address that gap by accommodating new information and updating our mental model accordingly, or ignore that information and keep our mental model the same. This entire process was long assumed to be a rational process. Instead, we have learned how our emotions and values ‘colour’ every stage of this process, influencing what we see, what we miss, and what we avoid to maintain our existing mental models. As a result, researchers seeking to work with people, like PM, must understand and align with this process.

169 communicating as a tailor-made way to capture both in a complete ‘story’. The ability to see and understand patterns
170 is compatible with complexity, but it must be trained as the default ‘wiring’ of the brain is to see patterns where none
171 may exist or to confirm information into a pre-existing pattern because it aligns with personal beliefs or values. These
172 tendencies of the mind, left alone, lead to oversimplification. This process by which we form our understanding of the
173 world is that we default to accepting what we ‘see’ to be true until proven otherwise, and it is neurologically easier
174 for us (and probably rewarding) to accept ‘truth’ than it is to disagree or disprove something, or, crucially for complex
175 issues, to think it’s uncertain Harris, Sheth and Cohen (2008); Sacks and Hirsch (2008). Ambiguity and being wrong
176 are neurologically unpleasant. We are often unaware this is happening. In the process, we take cues from our social
177 circles and our environment on ‘proper beliefs’ McAdams and McLean (2013), leading to a multi-level, multi-loop
178 feedback system (Figure 1; synthesized from Levine et al. (2015); Seitz and Angel (2020).

179 **2.3. The Importance of Participatory Modelling (PM)**

180 This difficulty of processing complexity, and the human tendency to bias information makes managing issues of
181 SES, inherently complex, oftentimes a ‘wicked’ problem Defries and Nagendra (2017); Rittel and Webber (1973).
182 Two complementary approaches have been proposed to address the above challenges in the context of SES. The first
183 is systems thinking— understanding that a system is more than the sum of its parts, and that emergence, feedback
184 loops, non-linear behavior, and uncertainty are crucial concepts to understand and to manage complex systems, like

185 SES Checkland (1981); Keen et al. (2005); Meadows and Wright (2008). The second approach is computer simulation
186 modelling, which allows us to explore solutions and scenarios of SES problems in a simplified albeit safe ‘virtual’
187 environment—one that allows us to grapple with the ‘complexity’ of a system without actually intervening and
188 experiencing real-life consequences Luna-Reyes, Black, Ran, Andersen, Jarman, Richardson and Andersen (2019);
189 Epstein (1996).

190 One method that combines both of these approaches is participatory modelling (PM). Participatory Modeling
191 (PM) is an umbrella term for tools and methods to place people at the center of a scientific modelling process. In PM,
192 stakeholders (i.e., members of the system of interest) build the model with researchers Kenny (2017); Metcalf, Wheeler,
193 BenDor, Lubinski and Hannon (2010); van den Belt, Kenyan, Krueger, Maynard, Roy and Raphael (2010). Regardless
194 of the particular method chosen (system dynamics, agent-based modelling, causal loop diagrams, etc), PM seeks to
195 bring researchers and stakeholders together on (at least) close to equal footing, in pursuit of ‘shared understanding’
196 of a problem, the system(s) within and around that problem, and the key components and relationships that combine
197 to build those systems Kenny (2017); Voinov and Bousquet (2010). For this paper, we define PM as: “a purposeful
198 learning process for action that engages the implicit and explicit knowledge of stakeholders to create formalized and
199 shared representations of reality” Jordan, Gray, Zellner, Glynn, Voinov, Hedelin, Sterling, Leong, Olabisi, Hubacek,
200 Bommel, BenDor, Jetter, Laursen, Singer, Giabbanelli, Kolagani, Carrera, Jenni and Prell (2018). In effective PM
201 exercises, participants are empowered to ask questions, find answers, and make key decisions in the model-building
202 process, in consultation and collaboration with researchers Lynam, Jong, Sheil, Kusumanto and Evans (2007); Cuellar-
203 Padilla and Calle-Collado (2011). When dealing with SES, this style of participation can become a vehicle to elicit
204 both tacit knowledge (qualitative and hard to verbalise) and scientific expertise. When combined, these two types of
205 knowledge can substantially improve and inform both the model and process used to develop that model Wood, Stillman
206 and Goss-Custard (2015).

207 One of the challenges still remaining within PM centers around the use of any model as a ‘boundary object’
208 Carlile (2002); Star and Griesemer (1989)—a device that, if successful, can act as a bridge between various groups “to
209 facilitate mutual understanding and cooperation” Falconi and Palmer (2017); Huvila, Anderson, Jansen, McKenzie,
210 Westbrook and Worrall (2014); Luna-Reyes et al. (2019); Fischer and Riechers (2019) by making people’s perceptions
211 and worldviews, i.e. mental models, explicit. For example, Knapp et al. (2011) recognized the need for integration
212 of local knowledge and the challenges that qualitative data poses to a traditional (quantitative) modelling process and
213 they incorporated meeting notes, comments on models from local ranchers and agency representatives, and workshop
214 evaluation questionnaires into the quantitative state and transition model they built around rangeland watersheds
215 in western Colorado. They too found benefits from stakeholder participation, calling for professionals to “think
216 systematically” about the integration of data with existing, experiential knowledge to overcome the conflict that
217 can arise between researchers and stakeholders actually living in the system. However, even within the participating
218 stakeholders, differing values and perspectives, particularly when dealing with SES issues, are often complicated and
219 “deeply embedded in the minds, hearts, and practices of society” Etienne, Du Toit and Pollard (2011), making any kind
220 of resolution extremely difficult. For example, Squires and Renn (2011) note “that the interaction between modellers
221 and stakeholders cannot be reduced to the communication of technical data and analytical results from modellers to
222 stakeholders.” Hare (2011) recognizes that learning may be more important than building and using a model to support
223 decision-making; while Luna-Reyes et al. (2019) identify ‘cognitive boundaries’ as a challenge, pointing out “there is
224 no agreed-on process for bridging these boundaries” or clarity on what or how to communicate with stakeholders past
225 these issues. These and other studies reveal how the patterns of the human mind pose a significant barrier to the sort

226 of systemic change sought by PM practitioners seeking to address problems of SES Hamalainen (2015); Voinov and
227 Gaddis (2017).

228 The bottom line is that although the model produced during a PM process is useful, there is also increasing interest
229 in the social engagement, negotiation, learning, and mediation that occurs ‘around’ the modelling effort. To do so, we
230 build on much of the literature that explores and calls for an integration of local experience and scientific data, the
231 mix of qualitative and quantitative data that emerges from a PM workshop, and a combination of theory and relevant,
232 applicable practice for users. Our interest, and the question this paper seeks to address, is in how a model can effectively
233 become the boundary object around which a socio-environmental issue can be ‘mediated’, to use this combination of
234 quantitative and qualitative approaches that occur within PM to drive behavioral change in stakeholders and in the
235 system Schmitt Olabisi, Adebisi, Traoré and Kakwera (2016); Voinov, Jenni, Gray, Kolagani, Glynn, Bommel, Prell,
236 Zellner, Paolisso, Jordan, Sterling, Schmitt Olabisi, Giabbanelli, Sun, Le Page, Elsworth, BenDor, Hubacek, Laursen,
237 Jetter, Basco-Carrera, Singer, Young, Brunacini and Smajgl (2018); Zellner (2008); Hamalainen (2015); LaMere, M,
238 Vanhatalo and Haapasaari (2020). Different approaches have been suggested to better assimilate and communicate
239 complexity in a PM process, of the SES and the socio-emotional dynamics of the people involved, including a greater
240 integration of social sciences Amazonas, Kawa, Zanetti, Linke and Sinisgalli (2019), explicit and implicit mental
241 modelling LaMere et al. (2020), even gamification of the PM process Bakhanova, Garcia, Raffe and Voinov (2020). In
242 this paper we explore the use of narratives, as one way to address the challenge of communicating complexity Eakin,
243 Siqueiros-García, Hernández-Aguilar, Shelton and Bojórquez-Tapia (2019); Moezzi, Janda and Rotmann (2017); Gray
244 (2018); Jordan et al. (2018) in the hopes of improving SES management, specifically focused on adoption of RegenAg
245 practices.

246 **2.4. Case Study: The Mulloon Institute and Regenerative Agriculture**

247 The Mulloon Creek Catchment is located in the Southern Highlands of New South Wales and is part of the
248 traditional country of the Yuin people, covering an area of 23,000 hectares and comprising more than fifty kilometres
249 of creeks and tributaries, and four floodplains (2). Mulloon Creek Catchment feeds into the Shoalhaven River, which
250 forms a vital source for Sydney’s drinking water. The landscape of the catchment has historically been associated with
251 pasture production, for both sheep and cattle Thackway (2019).

252 The Mulloon Rehydration Initiative, run by the Mulloon Institute, is a catchment-scale land management project.
253 The project is a collaboration of 20 private landholders, comprising both production and amenity landholders. It
254 aims to rebuild the natural landscape function of the entire Mulloon catchment to boost its resilience to climatic
255 extremes through more reliable stream flows, improved ecosystem functioning and enhanced agricultural productivity.
256 It does so through an approach called ‘Natural Sequence Farming’ (NSF), which falls under the larger umbrella
257 of RegenAg approaches. In contrast to conventional agricultural techniques which may focus on a mechanistic and
258 reductionist approach to maximal production, RegenAg methods instead focus on aligning with landscape function,
259 regenerating biodiversity, and partnering with animals, microbes, and pollinators for a more holistic and resilient
260 approach (Chapman, 2019; Gordon, 2020; Murphy, 2021). While there are many techniques, practices, traditions,
261 and definitions Newton, Civita, Frankel-Goldwater, Bartel and Johns (2020) within RegenAg, for this paper, we define
262 RegenAg broadly as an “alternative form of food and fiber production, concern[ed] with enhancing and restoring
263 resilient systems supported by functional ecosystem processes and healthy, organic soils capable of producing a full
264 suite of ecosystem services, among them soil carbon sequestration and improved soil water retention” Gosnell et al.
265 (2019).

266 Within RegenAg, NSF focuses on the vegetation, the daily water cycle, and the hydrology of the area as these are
267 the three critical areas controlling the landscape. Among other things, practitioners of NSF use vegetation, namely
268 deep rooted perennials to draw and store water deep within the land Andrews (2008). Mulloon Creek has trialled NSF
269 since 2005. There were significant challenges in garnering support, both from the local community, and government
270 agencies, but eventually, the Mulloon Rehydration Initiative was formed in 2016. The Project and TMI employ a
271 number of RegenAg practices, including NSF, while also drawing on indigenous expertise and scientific research
272 to measure the biophysical, economic and social impacts of its practices, including the implementation of formal
273 scientific instrumentation and monitoring Institute (2016). The Project has received enough attention that the United
274 Nations Sustainable Development Solutions Network chose Mulloon as one of five global demonstration projects for
275 sustainable and productive farming Institute (2016), and they were recently awarded a \$3.8 million dollar grant by the
276 federal government to demonstrate the effectiveness of rehydration activities and train and educate land managers in
277 holistic management, NSF, and regenerative agricultural practices The Mulloon Institute (TMI) (2021).

278 TMI is a leader in this space, and outreach and education is a huge part of their portfolio. However, TMI and other
279 RegenAg groups and leaders still face an uphill battle when it comes to adoption. Books like Charlie Massy's *The Call*
280 *of the Reed Warbler* point out the urgent need to make this transition, and details some of the barriers to doing so,
281 based on nearly 80 interviews with farmers around Australia who had made the transition to RegenAg Massy (2017).
282 However, as the adoption of RegenAg has increased, and the evidence base continues to grow, the question has started
283 to move from "Is RegenAg good?" to "How do we convince more people to do it?" Which is a horse of an entirely
284 different colour, but one that holds serious implications for the future of farming in Australia.

285 **3. Materials and Methods**

286 **3.1. PM and Fuzzy Cognitive Maps**

287 Within PM, Fuzzy Cognitive Mapping (FCM) is a tool commonly used Christen, Kjeldsen, Dalgaard and Martin-
288 Ortega (2015); Giabbanelli, Gray and Aminpour (2017); Gray, Hilsberg, McFall and Arlinghaus (2015); Henly-Shepard
289 et al. (2015); Halbrendt, Gray, Crow, Radovich, Kimura and Tamang (2014); Hester (2015); Ozesmi and Ozesmi
290 (2003); Nyaki, Gray, Lepczyk, Skibins and Rentsch (2014). FCM arose from the work of Axelrod (1976), who
291 introduced the idea of having stakeholders create 'cognitive maps' of a system for the purposes of social science
292 research, which was later built upon by Kosko (1986) who added fuzzy logic as a quantitative means to handle "vague
293 and qualitative knowledge" van Vliet, Kok and Veldkamp (2010); Hester (2015); Christen et al. (2015). FCM is a semi-
294 quantitative knowledge elicitation technique used to represent the 'mental model' of an individual or a group—this
295 takes the form of a qualitative 'map' of how someone believes a given system functions, by identifying the variables
296 or concepts of the system and relationships between them ?van Winsen, de Mey, Lauwers, Van Passel, Vancauteran
297 and Wauters (2013). The quantitative element of the knowledge elicitation process comes from the way relationships
298 are encoded, which can be either positive (>0) indicating an increase in A increases B, or negative ($0<$) indicating an
299 increase in A results in a decrease in B Hester (2015). The weights given to those relationships indicate the 'strength'
300 of the causal relationships Vergini and Groumpos (2016). Overall, the focus of the FCM exercise is on identifying key
301 feedbacks of the system, to illustrate what variables are present in the system and how they affect each other van Vliet
302 et al. (2010). The FCM can be created by an expert or a stakeholder, as an individual or as a group, and once the maps
303 are drawn, the structure can be quantitatively analyzed using graph theory Ozesmi and Ozesmi (2003).

304 FCM can have different uses, different purposes, and be appropriate for a few different situations. It can be used
305 as a model of a particular system, an the end goal in itself to gain insight into the system of study; it can be used to
306 drive communication and reduce conflict between stakeholders or different interest groups (policymakers, scientists,



Figure 2: The Mulloon Creek catchment and land stewardship activities conducted by the Mulloon Institute (TMI), located near Braidwood in New South Wales. TMI focus on landscape rehydration activities, using Natural Sequence Farming. Activities include building leaky weirs, contour banks, embankments, and vegetation plantings, among others and have been linked to raising the water table, improving biodiversity, decreasing erosion, and building drought resilience.

307 stakeholders, etc.); or it can serve as an initial participatory step in the building of a formal simulation model Özkesmi
 308 and Özkesmi (2004); Vanwindekens, Stilmant and Baret (2013). FCMs can be exploratory, as an attempt to understand
 309 the reasoning behind human behavior and actions or the wants and needs of stakeholders Papageorgiou and Salmeron
 310 (2013); Fairweather (2010); Christen et al. (2015). FCMs can also be used to create a portrayal of the system and to
 311 test how that system might act under different scenarios, which is particularly useful for testing different policy options
 312 and developing strategy Özkesmi and Özkesmi (2004). FCM is generally an adequate engagement tool “(i) when dealing
 313 with complex problems; (ii) in situations where human behavior is important but hard to quantify; (iii) in situations
 314 where personal knowledge is available while scientific knowledge is incomplete; (iv) in situations where problems
 315 are wicked, involving many parties and with no easy solutions;” (v) when the problem requires public involvement
 316 (possibly mandated by law) Özkesmi and Özkesmi (2004).

317 When it comes to SES as complex adaptive systems, FCMs can be useful and effective in guiding communication,
 318 comprehension, and problem solving, without the use of complex mathematics van Winsen et al. (2013); Vergini and
 319 Groumpos (2016). However, they are not without their challenges and shortcomings, among them arguably the main
 320 one are the difficulties humans face in trying to share their perspective on the system that is distorted by their own biases

321 and values Özesmi and Özesmi (2004), and the limits of human knowledge Fairweather (2010). These challenges can
322 somewhat be addressed by combining the cognitive maps of individuals and by cross-checking with other sources of
323 information and methodologies (interviews, surveys, etc.) to improve the accuracy of any ‘map’ or model Özesmi and
324 Özesmi (2004). FCM also cannot include aspects of time (including delayed feedbacks) Papageorgiou and Salmeron
325 (2013), cannot handle Boolean expressions Hobbs, Ludsin, Knight, Ryan, Biberhofer, Hobbs, Ludsin, Knight, Ryan,
326 Biberhofer and Ciborowski (2002), struggle to provide insight behind the ‘why’ agents perceive the system as they
327 have drawn it Vanwindekens, Baret and Stilmant (2014), and the nature of a causal relationships between variables can
328 be positive or negative but not both Hobbs et al. (2002).

329 Despite these challenges, FCMs offer advantages that make them well suited for tackling the complex socio-
330 environmental problems Australian farmers face. FCMs are easy to teach, easy to use, they offer a systematic way to
331 incorporate qualitative concepts into modeling a system and provide a clear representation of system feedbacks with a
332 short turnaround Özesmi and Özesmi (2004); van Vliet et al. (2010); van Winsen et al. (2013). FCM also works well
333 with data that might be missing, is not well-defined, or might be uncertain Özesmi and Özesmi (2004). The flexibility
334 of the method allows for input from any number of stakeholders and experts, thus encouraging communication between
335 and across diverse areas of knowledge van Vliet et al. (2010), which can in turn stimulate a productive environment to
336 test interventions and policy scenarios in the aims of seeking better management van Winsen et al. (2013); Papageorgiou
337 and Salmeron (2013). To summarize, FCM provides an efficient and useful methodology that can handle complex,
338 uncertain systems that cross various fields of knowledge, which is precisely the type of problems Australian farmers
339 face in their socio-environmental landscapes.

340 **3.2. Stakeholder Participation: Virtual Workshop in a Pandemic**

341 While we originally planned for our FCM workshops to be face-to-face, COVID-19 and NSW government
342 regulations on social distancing in mid-2020 made this impossible. At the time, the restrictions limited the number
343 of people gathering in one place, closed gyms, reduced availability of public transit, and restricted seating in cafes
344 and restaurants (NSW Government: Health, 2021). After some deliberation, the research team decided to pivot to
345 an entirely virtual workshop. Due to the widespread availability of free team collaboration and video conferencing
346 software, we were able to hold the workshop in an entirely digital format using a combination of Zoom and MURAL
347 (a digital workspace and ‘virtual whiteboard’ for collaboration Tippin, Kalbach and Chin (2018)). We used Zoom
348 videoconferencing to hold the call with everyone, and then used MURAL (www.mural.co) Tippin et al. (2018) for the
349 FCM exercise. The benefit of this virtual approach was that it allowed us to engage with our stakeholders during a time
350 of lockdowns and social distancing, but there were disadvantages as well, largely due to technical problems of unstable
351 internet.

352 For our workshop, we invited fifteen participants and while thirteen accepted, eleven ended up participating with
353 two late withdrawals. Participants were a mix of researchers (6), farmers (6), and educator/trainers (4) of RegenAg,
354 (*not exclusive categories*), identified as male (8) and female (3), ranging in farming experience from none to over
355 30 years, and all based in New South Wales. TMI had 3 representatives and 1 landholder from the Mulloon Creek
356 Catchment also participated. To select the participants, we used purposeful sampling based on their affiliations with
357 RegenAg as we wanted a spectrum of practitioner, trainer, and researchers and educators of RegenAg in the workshop.
358 This was in line with our qualitative approach and our aim to understand the underlying problems and barriers facing
359 the adoption of RegenAg, as those advocates understood it (Bryman 2008; Bussing 2019). We personally contacted
360 each participant and we obtained informed consent from all to participate, agreeing to protect their identities and keep
361 their data confidential. This research was approved by the Human Research Ethics Committee at the University of

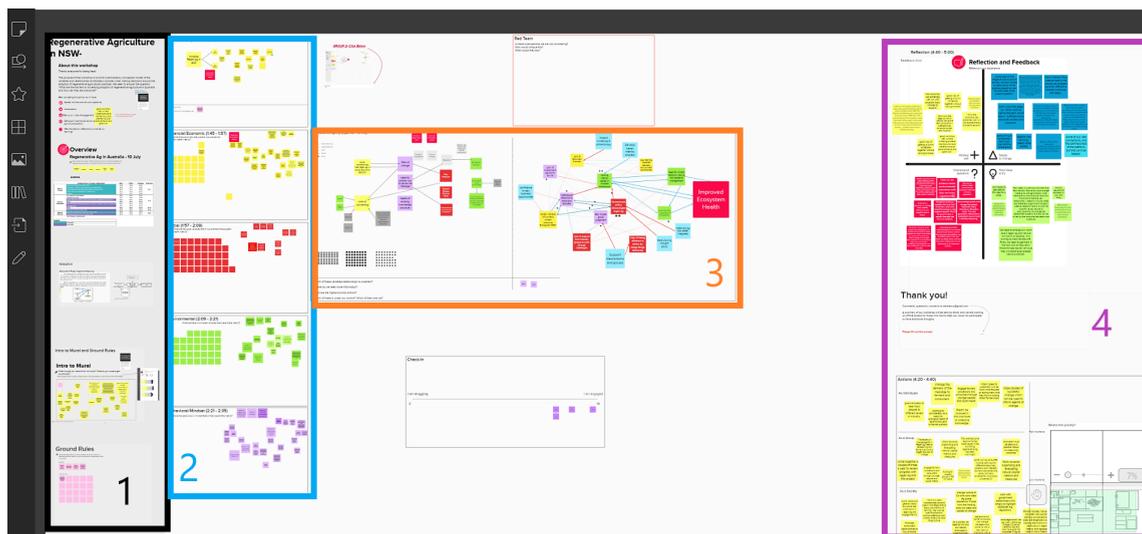


Figure 3: A screenshot of the structure we created on MURAL for each of the four stages of the workshop: (1) plenary, (2) elicitation, (3) modelling, and (4) debrief.

362 Technology Sydney (ETH19-3712). For participating academics, permission was also secured from their respective
 363 universities to participate.

364 The aim of the workshop was to elicit mental models of the barriers facing adoption of regenerative agriculture,
 365 via facilitated stakeholder interaction. To do so, we designed a virtual workshop consisting of four stages: (1) plenary,
 366 (2) elicitation, (3) modelling, and (4) debrief.

367 We put together a facilitation team to work with each stakeholder group (participants were randomly split into
 368 two groups for the elicitation and modelling stages before reconvening for the debrief). Each facilitation ‘team’ had a
 369 facilitator (1 an expert, 1 a PhD student), a modeller (expert), and a support person (student) and the entire workshop
 370 was video-recorded (with the informed consent of participants). The facilitator was in charge of leading participants
 371 through the process of building the FCM, solving any issues as they arose. The modeller was responsible for drawing
 372 on MURAL for the modelling phase (*at the direction of participants*), and creating ‘stickies’ for participants who had
 373 trouble accessing MURAL. The support person kept an eye on the chat and the video to make sure participants had the
 374 chance to participate. They asked clarifying questions when necessary. The research team trialed the process a month
 375 beforehand with a group of postgraduate students and academics to gain familiarity with the virtual methods and to
 376 ‘stress test’ the virtual approach. We also provided participants with tutorial videos on how to use Zoom and MURAL
 377 (see here for an introduction to MURAL and here for navigating MURAL) in the week leading up the workshop to
 378 level-set for digital skills during the workshop.

379 3.2.1. Plenary

380 We developed pre-defined templates in MURAL to provide a sequence of activities for the group to work through.
 381 The plenary session lasted 30 minutes started with introductions from participants and the research team. This included
 382 introductions to the overall research of the lead facilitator, an overview of the work of the Mulloon Institute, a
 383 presentation on the modelling process and the concept of cognitive biases, and a tutorial activity to make sure everyone
 384 felt comfortable using MURAL’s features (e.g., adding a ‘sticky’ note, commenting on other notes, and voting). In the
 385 first activity, we discussed our shared purpose and setting the goal and modelling ‘metric’ that would be the focus

386 of the subsequent elicitation and modelling stages. Considering that the theme of the workshop was on the barriers
387 to adoption of RegenAg, the discussion centered around what ‘metric’ or indicator might best reflect the success or
388 failure of this effort. We set aside 15 minutes for this activity, considering we had already introduced initial ideas for
389 the metric (the number of farmers practicing RegenAg and/or the number of hectares under RegenAg production)
390 over email prior to meeting. As a group, we ended up needing more time for this activity, as many in the group had
391 different ideas about what the metric should be, and, quite understandably in retrospect, more time was needed to
392 explain the purpose of this ‘metric’ in defining the process of the workshop. This initial framing of possible metrics
393 may have also introduced ‘bias’ in pre-determining what was considered; we chose to do so in the interest of time and
394 a desire to engage in the modelling activity. Ultimately, our group decided that ‘*Improved Ecosystem Health*’ was the
395 ultimate ‘metric’ or outcome of interest that RegenAg sought to promote. Participants were then told that the goal of
396 the following activity (the elicitation phase) was to unpack key variables that directly or indirectly contribute to the
397 state of this outcome. Then, during the modelling phase, we would set out to establish how these variables might be
398 interrelated, and to identify a portfolio of levers that could exert a positive effect on key variables within the system.

399 **3.2.2. Elicitation**

400 Armed with the notion of ‘*Improved Ecosystem Health*’ as the outcome of interest for the system, we used Zoom’s
401 breakout room feature to divide participants into two groups (group 1= six participants, group 2= five participants)
402 to build two FCMs. Each group then moved through the process of brainstorming and ranking of causal ‘factors’
403 or ‘variables’ that might contribute to or hinder ‘*Improved Ecosystem Health*’ under four categories that were pre-
404 established by the research team: (1) Economic/Financial, (2) Environmental, (3) Social and (4) Behavioral.

405 Under each category, the group’s participants were given time to write down their thoughts on what the key
406 factors either driving or hindering the adoption of Regen-Ag are, based on their knowledge, experiences, beliefs and
407 perspectives. We did not impose a limit on how many factors each participant should contribute, and they completed this
408 activity on their own—with little to no discussion—to avoid groupthink Janis (1991). We then proceeded to discuss, as
409 a group, what each participants’ factor contributions meant, with the aim of casting a vote on the top three factors. For
410 each category of factors, we allocated 5 minutes to the individual elicitation of factors, 10 minutes to group deliberation,
411 and 5 minutes for a polling activity (participants were allocated 3 votes to allocate to the group’s sticky notes). We
412 repeated the process for each of the four categories, ending with twelve factors after 80 minutes that progressed to the
413 modelling phase.

414 **3.2.3. Modelling**

415 During the modelling phase (which was originally allocated a total of 60 minutes, but we had closer to 45
416 minutes), and taking cues from participants’ views expressed through an open discussion, the facilitating team began
417 to draw connections (*at the direction of participants*) between the top twelve factors, establishing positive and negative
418 relationships and how ‘strong’ these relationships were between the factors—i.e., their polarity. Participants decided
419 how these factors related to each other and how they contributed to our ultimate ‘metric’ of ‘*Improved Ecosystem*
420 *Health*’. The role of the facilitators during this phase of the participatory process was to draw the connections between
421 factors as decided and directed by participants, inquire as to their polarity and strength, and to ask clarifying or
422 prompting questions about why that relationship existed and if there were other factors to consider. One person’s
423 role was to keep the conversation moving, and one of the other facilitators primarily handled the technical aspects of
424 the FCM modelling, primarily in drawing the connections. An additional support person monitored the chat room on
425 Zoom for any nonverbal contributions or if the facilitator missed a participant eager to say something.

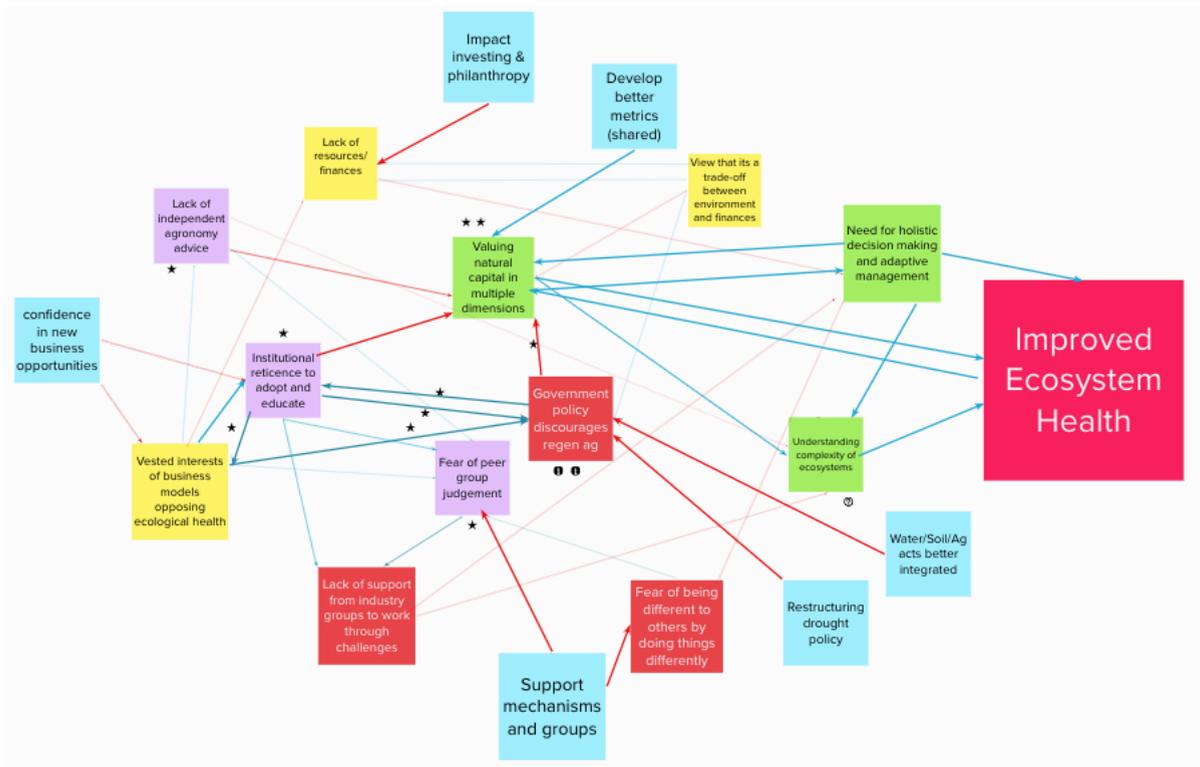


Figure 4: A screenshot of the initial, complete FCM built by Group 2 during the modelling phase in MURAL. Green stickies were environmental, yellow stickies were economic/financial, red stickies were social, purple stickies were behavioral, and blue stickies were 'levers' or actions that could be taken to influence the system. Our metric, 'Improved Ecosystem Health' was the measure we sought to influence and understand, as a broader proxy for the success of RegenAg. Arrows indicated causal relationships, with bold arrows indicating 'strong' relationships, and pale arrows indicating 'weak' relationships. Red arrows were negative or 'balancing' relationships, and blue arrows were positive or 'reinforcing' relationships.

426 In planning the workshop, we set aside time for when the group finished building the mental model map (i.e.,
 427 identified all relevant causal relationships between factors for the four categories, and establish their polarities);
 428 they could also look to identify and add 'levers' to the map, actions or policies that might be capable of shifting
 429 key 'factors' to move towards a better state for the chosen 'metric'. For example, Group 2 identified several levers,
 430 including 'Restructuring Drought Policy' to affect 'Gov't Policy Discouraging Regen Ag' and 'Support Mechanisms
 431 and Groups' to address 'Fear of Peer Group Judgment' and 'Fear of Being Different to Others'. In short, 'levers' were
 432 ways participants identified an ability to 'shift' or 'transform' a factor within the model, and thereby alter the system
 433 in the hopes of moving closer to the metric of 'Improved Ecosystem Health'.

434 One of our groups (Group 2) got through this stage, building a complete 'map', while the other (Group 1) struggled
 435 to complete even drawing connections between the 12 identified factors. In the former, the group did a much better
 436 job of staying on task (possibly due to the experience of the lead facilitator, practiced in leading PM), while the latter
 437 struggled through the initial phase of the exercise in eliciting and ranking factors (possibly due to the inexperience of
 438 the lead facilitator, or greater confusion over the purpose of the exercise, or both).

439 3.2.4. Debrief

440 Time was devoted at the end of the workshop for a 'debrief' session consisting of two parts. In part 1 (20 minutes),
 441 the two groups were brought together to share and to present their 'maps', noting the similarities and differences

442 between each. At this time, we were not seeking to combine the models. After sharing the different models, we set
443 aside 30 minutes for the whole group of participants to reflect on what next actions should be in the attempt to improve
444 adoption of RegenAg (10 minutes), and for the group to reflect on their experience of the process and workshop as
445 a whole (20 minutes). For a discussion on RegenAg, we divided 'Next Actions' into actions that could be taken as
446 individuals, as a group, and as a society, with time given for participants to put down their individual thoughts on their
447 own (no discussion) before coming together to briefly discuss these as a group. Reflection on the process was guided by
448 a template available on MURAL (see figure below), dividing quadrants between "What worked well?", "What needs
449 to change?", "What are new ideas to try (for next time)?", and "What are the unanswered questions?" Participants were
450 given time to put down their thoughts and discuss section by section.

451 **3.2.5. Follow-up**

452 In the aftermath of the workshop, we conducted follow-up interviews with the participants to evaluate their
453 experience of the workshop and to provide space for any feedback, on the model or the process, that they were unable to
454 provide during the workshop. Then, the conceptual model results from the two groups were combined into one model by
455 the facilitator after comparing to find common variables and aggregate them, re-visiting the recordings and transcripts
456 of the workshop, to determine what possible connections could be added, similar to the Rich Elicitation Approach
457 LaMere et al. (2020). This combined model was digitized into Mentalmodeler.org as an FCM online software, and
458 sent to participants via email for approval and feedback LaMere et al. (2020) with a full record of the changes made
459 for the stakeholders to validate.

460 In addition, as a result of this follow-up process, we also identified key 'narratives' present in the FCM using
461 qualitative analysis. As the sample size of stakeholders was small, this limits any statistical inferences we could make
462 from the study; however, there are also advantages to the depth and high quality interactions we could create in this
463 setting (Knapp et al. 2011). Building on the literature of PM (Knapp et al. 2011; Bussing et al. 2019; Denning et al. 2018;
464 Meinherz Videira 2018), we sought to use the combination of quantitative (the model) and qualitative (the discussion
465 around the model) data to "clarify the nature of some specific situations in the social world, to discover what features
466 there are in them and to account, however partially, for those features being as they are" Crouch and McKenzie (2006).
467 In short, we sought to use thematic analysis identify the emergent themes and patterns that arose from the workshop
468 Braun and Clarke (2006), to extend from individual experience and perspective to structural themes and patterns Crouch
469 and McKenzie (2006) in full acknowledgment (and in keeping with the critical realist grounding of this research)
470 that the way individuals find sense and meaning of their lived experience matters, as do the ways social context and
471 biophysical limits can present a different picture of 'reality' Fletcher (2017); Braun and Clarke (2006). These themes
472 and patterns ultimately became our narratives. Narratives have been used before in communicating the results of FCM
473 Eakin et al. (2019), but are not widely used in PM, despite their suitability for communicating complexity Ryan (2019),
474 and their use in working on environmental issues Moezzi et al. (2017). To identify the narratives, we looked for the
475 structural barriers facing the adoption of RegenAg, drawing on several iterations of a synthesis of the model variables
476 and relationships, the audio recordings, transcripts of the workshop discussions, and submissions on the workshop pre
477 and post-questionnaires (Knapp et al. 2011). The objective of the analysis was to present the possible stories present in
478 the system. We followed the approach laid out in Braun and Clarke (2006), first familiarizing with data by reading the
479 transcripts, questionnaire responses, and re-visiting the recordings, before generating initial themes on the transcript,
480 revisiting those themes (in combination with looking at the model for the relevant variables and relationships), and
481 then reviewing those themes, written as narratives, with stakeholders to ensure their validity (Braun Clarke 2006;
482 Vaismoradi, Turunen, Bondas 2013). Our inductive coding did not look at frequency patterns, instead looking for

483 'themes' at the passage level of the transcript and questionnaire responses *and* its respective grounding in the variables
484 and relationships present in the model.

485 As our stakeholders were not experienced modellers, we deliberately used narratives to communicate and interpret
486 the model results for participants, similar to Eakin et al. (2019), but using a template of our own (available in Results:
487 'Meso-scale analysis: FCM Narratives') to highlight the story, the actors, and the implications of the narrative for both
488 the model and the necessary solutions. As mentioned, the outcomes of this post-processing were then presented to
489 participants to validate and/or propose any changes, to the model and to the narratives.

490 3.3. Data Analysis

491 In analyzing fuzzy cognitive maps, Özesmi and Özesmi (2004) lay out the steps to move towards analyzing
492 a social model, which includes determining an adequate sample size, using graph theory to analyze the structure
493 of the models, condensing the models for comparison, and then using neural network computation to analyze
494 outcomes and simulate different policy options. After transcribing the aggregated FCM into the MentalModeler
495 software (www.mentalmodeler.org) we were able to calculate the following statistics Kokkinos, Lakioti, Papageorgiou,
496 Moustakas and Karayannis (2018):

- 497 • Total number of variables
- 498 • Total number of connections
- 499 • The network 'density', as the actual number of connections divided by the number of connections possible in
500 the 'map' (i.e. if all variables were connected to each other, that would be a density of 1).
- 501 • The average connections per variable
- 502 • Complexity score, as the ratio of receiver variables to transmitter variables.
- 503 • Centrality rankings as a proxy for the most 'influential' variables, which depends on the number and strength of
504 the connections attached to a variable. The higher a variable's centrality, the more influence it has on the 'map'
505 when it changes.

506 In examining the maps, it is important to identify transmitter, receiver, and central variables. The 'centrality' of a
507 variable is determined by the number of relationships and the cumulative weight of those relationships coming in and
508 going out; the higher that number is, the more important that variable is to the feedbacks of the system Vanwindekens
509 et al. (2014). Transmitter variables (or forcing functions) have a lot of relationships going out and none coming in,
510 while receiver variables take in the relationships of other variables and send none out Ozesmi and Ozesmi (2003).
511 Identifying and labeling these variables in a FCM can help generate insight into the way agents view their system; for
512 example (taken from Ozesmi and Ozesmi (2003)):

513 *"Local people and hunters have more transmitter variables in their maps than NGO personnel [did in*
514 *their maps]. This indicates that local people and hunters see themselves and the Uluabat Lake ecosystem*
515 *as being under outside control and dependent on outside forces."*

516 In all FCM exercises, it is important to remember that complexity is not the ultimate goal; the aim is for the model
517 to be a useful representation of reality Özesmi and Özesmi (2004), whether there are many variables or a few. Klein
518 and Cooper (1982) discovered that the number of variables in a map does not determine its success, and therefore
519 we encourage the approach of keeping a model as simple as possible to solve a particular problem, and no simpler
520 Vanwindekens et al. (2014), which is in line with the recommendations of the modeling literature.

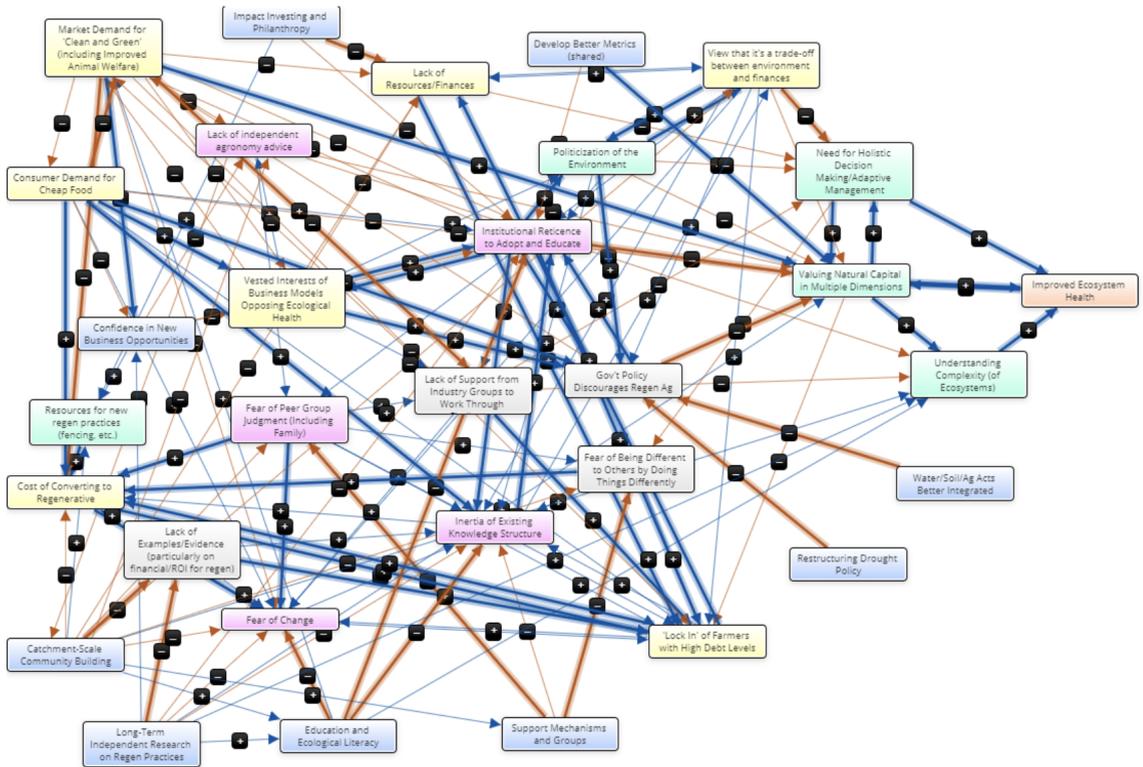


Figure 5: The combined FCM elicited from workshop participants. We used different colors to reflect the different variable categories, similar to what we had used in MURAL (green=environmental, yellow=financial/economic, gray=social, and pink=behavioral), while our 'levers' or actions we could take were in blue. Our metric, 'Improved Ecosystem Health' in orange, was the measure we sought to influence and understand, as a broader proxy for the success of RegenAg. Arrows indicate causal relationships. The color of the arrows indicated their polarity (Red arrows were negative or 'balancing' relationships, and blue arrows were positive or 'reinforcing' relationships) and the width of the arrow indicated the strength of the relationship (thick were 'strong' relationships, thin were 'weak' relationships).

521 4. Results

522 4.1. Macro-, Meso- and Micro-scales of FCM

523 The model created in the aftermath of the workshop reflected a collaboration of individual mental models, and we
 524 devised a process to analyze this at three scales: the macro (a comparison between all of the networks and their global
 525 characteristics), the meso (an analysis of the communities, sub-networks, and narratives present in the model), and the
 526 micro (an analysis of the most relevant 'variables'). With each of these 'lenses', it is possible to extract and condense the
 527 critical information of the 'map' to answer key questions. For example, what is central to each network? How do you
 528 compare between networks in structural and statistical terms? Which 'variables' from each category (financial, social,
 529 environmental, and behavioral) are the most central to the network? Where are the densest 'zones' of the network?
 530 As we show below, using the different scales of the FCM can further illuminate the principal networks, variables, and
 531 narratives present in the system as identified (explicitly or implicitly) by workshop stakeholders.

532 4.1.1. Macro-scale analysis: The System

533 The final, aggregated FCM (Figure 3) comprised 31 concepts, with 141 relationships. This included 5 transmitter
 534 components (levers: 'Impact Investing and Philanthropy', 'Develop Better Metrics', 'Restructuring Drought Policy',

535 'Water/Soil/Ag Acts Better Integrated' and 'Long-Term Independent Research'), and only 1 receiver component (the
536 goal of the system, 'Improved Ecosystem Health'). The five most 'central' variables were (in order) 'Institutional
537 Reticence to Adopt and Educate', 'Valuing Natural Capital in Multiple Dimensions', 'Cost of Converting to
538 Regenerative', 'Gov't Policy Discourages Regen Ag', and 'Lock In of Farmers with High Debt Levels'.

539

540 4.1.2. Micro-scale analysis: Honing in on Variables

541 **Centrality.** 'Centrality' in an FCM serves as a proxy for the most 'influential' variables in a given network. Each
542 variable's centrality score depends on the number and strength of the connections attached to a variable. The higher
543 a variable's centrality, the more influence it has on the 'map' when it changes, a result of the combination of the
544 number of relationships and the cumulative weight of those relationships coming into and going out from that variable
545 Vanwindekens et al. (2014).

546 Measures of 'centrality' can provide insight into key traps and pain points in the system, potentially as areas to focus
547 on and 'leverage points' of opportunity for change Meadows and Wright (2008). For example, institutions, mainly
548 government, play a large role in this system, as the most central variable is 'Institutional Reticence to Adopt and
549 Educate', with 'Govt Policy Discourages Regen Ag', 'Inertia of Existing Knowledge Structure', and 'Politicization of
550 the Environment' all making the top ten. This suggests the dominant paradigm of government policy is one supportive
551 of conventional agriculture, borne out by the role conventional agriculture plays in the Australian economy, and the
552 relatively low percentage of Australian agriculture belonging to RegenAg or other alternative measures. This has
553 the potential to be a reinforcing feedback loop that solidifies lock-in to traditional agricultural practices, particularly
554 considering the influence of the Market ('Consumer Demand for Cheap Food') and Business ('Vested Interests of
555 Business Models'). Without policies or actions to provide a balancing relationship (reflected by the red arrows and
556 largely present from the 'levers' in the map), these variables are all connected by positive relationships, with an increase
557 in one leading to an increase in another, without an obvious incentive to change. This perception among stakeholders
558 is striking, although perhaps not surprising given the number of stakeholders in the workshop who self-identified as
559 'pioneers' or 'mavericks' during the modelling process. Their position on the 'outside' as early adopters and advocates
560 of RegenAg may give them more insight into how the paradigm of conventional agriculture supports and intensifies
561 (through positive relationships) its own structures.

562 According to workshop participants, business and industry is also largely arrayed against RegenAg ('Vested
563 Interests of Business Models', 'Consumer Demand for Cheap Food', 'Lack of Support from Industry Groups'), although
564 they also noted the opportunities within that sector ('Market Demand for Clean and Green'). The connections between
565 'Consumer Demand for Cheap Food', 'Vested Interests of Business Models Opposing Ecological Health', and 'Gov't
566 Policy Discouraging Regen Ag' had strong positive arrows between them, suggesting a reinforcing system that is
567 difficult for RegenAg to 'break into' without serious policy or business investment and intervention.

568 Possible ways to intervene in this system were identified by the 'levers', the blue variables, which are either
569 transmitter variables (outgoing connections only), or loosely and weakly influenced by other levers, such as 'Long-Term
570 Independent Research' having an effect on 'Education and Ecological Literacy'. None of these levers, which can also
571 be seen as interventions in the system, rank highly in centrality. This is unsurprising, as they were added last as inputs
572 into the system, limiting their connections and therefore their centrality, but also worth noting as it also may reflect the
573 difficulties of influencing this system with so much 'reticence' and 'inertia' ingrained. This would reiterate the need to
574 find balancing relationships within the system, starting with 'Valuing Natural Capital in Multiple Dimensions'.

575 *'Valuing Natural Capital in Multiple Dimensions'* scores highly on centrality, a reflection of the number of strong
576 connections it primarily receives. This was a key variable of focus for participants, with strong ties to a *'Need for*
577 *Holistic Decision-Making'* and *'Understanding Complexity of Ecosystems'* as environmental variables capable of
578 directly improving the metric of *'Improved Ecosystem Health'*. Others in agriculture, and more broadly in sustainability
579 Costanza and Daly (1992); Costanza, de Groot, Sutton, van der Ploeg, Anderson, Kubiszewski, Farber and Turner
580 (2014), have called for a valuing of natural capital, and it stands to reason this would be a vital issue for stakeholders
581 as they seek to place a financial value on the often ignored positive externalities of RegenAg. *'Valuing Natural Capital*
582 *in Multiple Dimensions'*, as the second most central variable on the map, determining where and how to influence this
583 variable would be a vital first step for those seeking to increase adoption of RegenAg.

584 Such efforts to value natural capital may also help to address two of the closely related variables that also score
585 highly on Centrality: *'Lock-In of Farmers with High Debt Levels'* and the *'Cost of Converting to Regenerative'*.
586 For participants, these variables reflected the difficulties, as one put it, of "going green when you're in the red".
587 Transitioning to RegenAg often requires a high up-front cost either in additional resources (ex; the cost of fencing to
588 move to cell grazing) or in reduced income by shifting away from high-production farming. These additional expenses
589 may or may not reflect reality, particularly when considering the return on investment and resilience offered by many
590 RegenAg practices, but the 'perception' of the expense seems to be important for those considering a transition. As
591 many farmers are already in debt, these remain significant challenges, even when ignoring the additional social costs
592 and mental strains of making such a change while dealing with judgment or pressure from peers and family. The
593 additional variables of the *'Lack of Resources/Finances'* and the *'View that It's a Trade-Off Between Environment*
594 *and Finances'* lend further support to the significance of this barrier facing those seeking to transition to RegenAg.
595 Understanding the variety of factors affecting this particular barrier, while complex, is possible due to the visual and
596 interconnected nature of the FCM.

597 **Complexity.** Over the course of the model iterations, the average number of connections for each variable increased
598 from 2.5 to 4.5, likely due to participants feeling more comfortable expressing how interconnected the system was, and
599 the fact that they were given more time to reflect on and internalise the knowledge captured in the map. These changes
600 in the FCM demonstrated a greater understanding of the connectedness of the system, reflecting the complexity of
601 the issue and showing evidence for social learning Henly-Shepard et al. (2015); Reed et al. (2010); Fazey, Fazey,
602 Fischer, Sherren, Warren, Noss and Dovers (2007). It is possible that given more time, stakeholders would continue
603 to identify new connections, but there is a risk of diminishing returns, as more connections does not always lead to
604 greater understanding.

605 It is also worth noting that despite the increase in the average connections reflecting a greater complexity to the
606 system, this was not reflected in the Complexity Score, defined as a function of transmitters to receivers, which was
607 quite low at 0.2 (on a score ranging from 0-1, with 1 being high complexity) Henly-Shepard et al. (2015). We were
608 not concerned by this result, as this was a product of the process we used, beginning with a singular metric, *'Improved*
609 *Ecosystem Health'*, which was our sole receiver variable and the measure for which we sought the system to work
610 towards improving. Other authors have noted this score might not necessarily negate the complexity of the model, as
611 the lack of receiver components "could in fact be a sign of a complex model that shows significant interlinkages and
612 influences between system components" Henly-Shepard et al. (2015).

613 Furthermore, workshop participants demonstrated an understanding of complexity and systems thinking during
614 the workshops, which may have been self-selected among RegenAg practitioners who have to account for the effects
615 of biodynamic influences on their economic and social activity of agriculture. It is still noteworthy, as they noted the
616 reinforcing nature of a number of institutional barriers and policy barriers that were identified as a part of the workshop.

617 For example, participants noted the policy ‘triangle of death’, a reinforcing loop between ‘*Vested Interests of Business*
618 *Models*’, ‘*Institutional Reticence to Adopt and Educate*’ and ‘*Gov’t Discourages Regen Ag*’.

619 “*In a negative sense, we were focused on a little triangle of interactions between the yellow one on the bottom left,*
620 *the vested interests, linking up to institutional reticence and linking across to government policy. And that little circle*
621 *travels its own kind of thing in a vortex to the bottom and takes us away from what we need to do in valuing natural*
622 *capital and improving ecosystem health. So those vested interests... they were a couple of key factors.*”

623 While not explicitly stated as such, this is evidence of systems thinking in identifying the micro-structures or
624 systems motifs (in this case a moderated effect motif) present in the network, linking causality that accelerated the
625 effect of ‘Vested Interest’ and ‘Gov’t Policy’ both have on ‘Institutional Reticence’ Levy, Lubell and McRoberts
626 (2018); Gray (2018). It is encouraging that RegenAg practitioners were aware of these feedbacks within the system,
627 as previous studies had shown that familiarity with systems thinking among participants was not necessarily reflected
628 in any subsequent ‘model’ Levy et al. (2018); Schmitt Olabisi et al. (2016), and systems thinking has long been linked
629 with positive outcomes in sustainability, and the ability to improve decision making in SES Levy et al. (2018); Gray
630 (2018); Levin (1998); Ison, Maiteny and Carr (1997); Halbrendt et al. (2014); Meadows (1999).

631 4.1.3. *Meso-scale analysis: FCM Narratives*

632 ‘Narratives’ have been used as a part of qualitative research in psychology, anthropology, sociology, health research,
633 and climate and energy research Moezzi et al. (2017); Overcash (2003). It can be defined as “collecting and analyzing
634 the accounts people tell to describe experiences and offer interpretation” Overcash (2003). In the aftermath of the
635 construction of the FCM, we analyzed the initial model results, the recordings of the workshops, and the interviews
636 with participants. As a result of this process we identified five key ‘narratives’ in the FCM, and we used these to
637 communicate the model results to participants, asking them to offer feedback on the validity of the narratives and on
638 their implications. Each narrative consists of:

- 639 • **The Story:** a brief description of what the narrative is.
- 640 • **The Actors:** identifying who the key players might be in such a story.
- 641 • **The Model:** what implications this story has for the model (in our case the representation of the RegenAg system
642 using FCM), both in how it is currently reflected in the model and what might need to change accordingly.
- 643 • **The Solutions:** if this story is true, what solutions or actions are needed to address the narrative in seeking to
644 increase adoption of RegenAg practices.

645 We see these narratives as a means to establish an ongoing conversation between participants, especially as some
646 participants reached out to the research team after the workshop to share their own narratives. The methodologies used
647 to elicit and co-construct narratives from FCM workshops will be the subject of a forthcoming paper by the authors.

648 By focusing on extracting narratives from the FCM—as opposed to the more traditional quantitative analysis—we
649 sought to avoid the criticism and the challenge of the ‘black box’ of modelling (obscuring the workings of the model
650 from stakeholders), by laying out what patterns were present (in the form of stories) and clearly identifying where
651 variables and relationships in the model supported this story, or where it might need to change to better reflect this
652 pattern. Furthermore, the narrative construct identifies key actors and solutions as a way to put this narrative ‘into
653 practice’ and to empower stakeholders to act. It is a similar approach to Scenario Analysis Schmitt Olabisi et al.
654 (2016) that often works hand in hand with PM, but we used these narratives primarily as a communication tool. The

655 iterative nature of moving from narrative to model, and model to narrative, especially with a visual component, allows
656 for elicitation and refinement of implicit mental models made explicit by our PM workshop. Multiple narratives can
657 (and probably should be) present, helping to convey the complexity of these issues without being overwhelming.
658 Anecdotally, after the workshop one participant responded, unprompted, with a narrative of their own (which became
659 Narrative 5), making reference to the model, the variables, and relationships, attesting to the simplicity and efficacy of
660 narratives as a communication device between the research team and participants.

661 *"...I gave some thought to all that you had written and concluded that the most constructive way for me to respond to*
662 *you was to simply create a fourth narrative in the attached document..."*

663 In the Discussion section below, we argue for the systematic use of these narratives as one way to address the challenge
664 of communicating complexity during PM processes. The five narratives elicited in our PM workshop are presented in
665 Tables 3-7.

666 **5. Discussion**

667 We divide our discussion into three sections. First, we reveal what our case study highlighted for those seeking
668 to increase adoption of RegenAg practices in Australia. Second, we explain what the experience of using FCM to
669 study this issue means for communication of complexity within PM practice, and outline some of the advantages
670 and limitations of remote facilitation methods and strategies that could be applied during and beyond the COVID-19
671 pandemic. Third, we discuss what can be learned and applied for future PM exercises seeking to improve management
672 of SES, before concluding this section with the limitations of our study and what that means for future research
673 opportunities.

674 **5.1. Solutions for Regenerative Agriculture**

675 This case study and the results of the workshop highlight that the actions needed to increase adoption of RegenAg
676 must break the current 'reinforcing' paradigm of conventional agriculture. Stakeholders, a mix of landholders, trainers,
677 researchers, and advocates, drew on their experience and knowledge to identify relationships within the Australian
678 agricultural paradigm. Currently, business, government, the market, and social pressures seem to spiral down together
679 in a race to the bottom, with few existing relationships in the system to incentivize a transformation. Understanding
680 these complex forces highlights the need for coordinated actions at the institutional, social, and individual levels,
681 across immediate and long timescales (decades). It is vital that RegenAg advocates find the messages and actions that
682 overcome any paralysis of action in individuals and in communities Polasky, Crépin, Biggs, Carpenter, Folke, Peterson,
683 Scheffer, Barrett, Daily, Ehrlich, Howarth, Hughes, Levin, Shogren, Troell, Walker and Xepapadeas (2020).

684 One notable point in the FCM is the lack of balancing arrows (red arrows) within the system without the presence
685 of the 'levers'—the blue icons noting actions we can take. Many of these were discussed or identified during the
686 Modelling stage of the workshop as possible 'solutions'. If the 'levers' or actions we can take to act in the system
687 are removed, the number of balancing connections in our model reduces by nearly half, going from 48 to 27 negative
688 relationships, meaning the ability of the system to deliver on the outcome of interest '*Improved Ecosystem Health*'
689 becomes diminished. If there is a push for conventional agriculture, the system, as it's currently drawn, intensifies
690 that push. This impetus can rapidly move in a 'race to the bottom', enshrining the dominant paradigm of conventional
691 agriculture in a downward spiral as degrading land leads to more artificial inputs, leading to further degrading land
692 and more money and incentives being put into the system to prop it up.

693 The supportive, even reinforcing nature of the agricultural paradigm and the relationships between entities
694 (government, business, and consumers) has the potential to 'lock-in' these conventional agricultural practices, as it
695 is difficult for RegenAg to break in to those relationships. Without significant policies or actions to provide a balancing
696 relationship, there is no obvious incentive to change. Climate change could be one incentive, as it presents a severe
697 challenge to human society. However, its impacts are often unclear, disputed, or occur over the long-term. Without
698 making the severe consequences of conventional agriculture (through impacts on climate change, biodiversity, human
699 health, or something else) immediately apparent, it is difficult for RegenAg to generate enough urgency to push through.

700 While it is important to note this may not necessarily reflect the reality of the system (those balancing feedbacks
701 may or may not exist regardless of what is shown here), the fact that stakeholders in favor of RegenAg believe this
702 to be true is striking. This insight leads to the question of how can those balancing relationships be introduced to
703 the system? This question is of interest to financial institutions and governments, many of whom have already begun
704 work in this area Bank (2014). To increase adoption of RegenAg, institutions can begin to investigate these balancing
705 feedbacks, including but limited to examining how 'support from industry groups' can depress fear of judgment or
706 how the 'vested interests of business' might be aligned with instead of against valuing natural capital. As an example
707 of a balancing relationship for example, determining where and how to value natural capital would be vital for those
708 seeking to increase adoption of RegenAg. Such efforts may also address the difficulties of "going green when you're
709 in the red." These and other opportunities present a possibility for more balancing relationships within the system.
710 The levers on the FCM also represent possible policy/intervention opportunities that workshop participants perceive
711 as fundamentally relevant to a wider adoption of RegenAg in Australia. These opportunities are further discussed and
712 explored in the five narratives. Notably, the solutions outlined under the five narratives coincide in the need for well
713 coordinated, multi-scale (state; catchment, community) and multi-actor (federal, state, local government; industry;
714 farmers and local communities) efforts to promote the desired shift from traditional to RegenAg practices. This need
715 for work at various scales is documented within the research and the RegenAg movement (Chapman, 2019; Gordon,
716 2020; Murphy, 2021). As noted by Gosnell et al. (2019), there are a number of 'spheres' or scales in which to push for
717 RegenAg, including the personal, the practical, and the political. Our work found a similar pattern. What is clear from
718 our exercise, is that among RegenAg practitioners, the role institutions play seems to matter to them a great deal, but
719 they also note the interactions with social groups and personal identities and habits.

720 In addition, a number of barriers identified during the workshop, including an up-front cost to convert to
721 regenerative, debt levels, lack of resources, and ingrained view that environmental and economic outcomes cannot both
722 be achieved, all suggest a transition to RegenAg is expensive. This expense may or may not reflect reality, particularly
723 when considering the return on investment and resilience offered by many RegenAg practices, but the 'perception' of
724 the expense seems to be important for those considering a transition.

725 The FCM process also noted behavioral traps and pain points of individual farmers, which are perhaps just as
726 difficult, if not more so, to change than government policy. This includes '*Fear of change*', '*Fear of Being Different...*,'
727 and '*Fear of judgment from peers*'. As an area perhaps less explored within agricultural policy, but with a growing
728 body of research on the importance of stakeholder outreach and 'tailored' communication Price and Leviston (2014);
729 Liu, Bruins and Heberling (2018), there is a potential to change 'faster' through education and outreach. We, like others
730 Gosnell et al. (2019) advocate that education and outreach should center on the personal sphere, aiming for critical
731 awareness Brookfield (1987), reflection Whitfield, Dougill, Dyer, Kalaba, Leventon and Stringer (2015); van Bruggen
732 et al. (2019) and transformative learning Mezirow (2000); Keen et al. (2005) that allows for the deeper questioning
733 and altering of underlying values and beliefs Meadows and Wright (2008).

734 Based on the FCM that was elicited, the narratives derived from it, and follow-up discussions with workshop
735 participants, we identify several recommended areas of focus to improve adoption of RegenAg in Australia at various
736 scales:

737 **Narrative 1: Government First** — If ‘Big Government’ is the problem, then ‘Big Government’ must be a part
738 of the solution. This includes a coordinated effort from Federal and State governments. While noting the effect the
739 individual voters and media have on the government, if this narrative is true, a drastic reform of government policy
740 is needed. More incentives need to be provided for a switch to RegenAg, and could show up in a reform of drought
741 policy, or an integration of water and soil acts, perhaps more in line with watershed boundaries as opposed to arbitrary
742 geopolitical ones. Stakeholders noted that not only does this commitment need to be significant, it also needs to be
743 ‘long-term’ in order to align with the cycles of natural capital and to “give confidence to land managers, industry,
744 educational institutions, NGO’s, and the broader public.” Part of that effort could then include greater efforts to inform
745 the voting public of RegenAg interests and actively push Parliament to embrace policies benefiting RegenAg by direct
746 lobbying from RegenAg advocates and practitioners towards the relevant Departments and Ministers.

747 **Narrative 2: The Market Matters** — Find ways to increase consumer demand for products of RegenAg (affecting
748 ‘Consumer Demand for Cheap Food’ and ‘Market Demand for ‘Clean and Green’”), which could happen in a number
749 of ways:

- 750 • Provide government incentives to subsidize the cost of regenerative products, either in out of the gate packaging
751 and production, or in reducing the high up front costs needed to switch to regenerative.
- 752 • Create regional processing and distribution centers in high agricultural areas devoted to regenerative products
753 and lowering costs by producing at scale.
- 754 • Incentivize supermarkets to carry regenerative products either at lower prices or in high-value locations in stores
755 to encourage more sales.
- 756 • Increase funding to marketing and advertising to craft a more compelling narrative for regenerative products to
757 direct-sell to consumers

758 **Narrative 3: Pressured Communities** — ‘Normalize uptake’ of RegenAg practices to remove any social stigma
759 that comes from such a transition or practice. Being able to point to socially accepted indicators of success, or cultural
760 capital Bourdieu (1986); Burton (2004); Sutherland and Darnhofer (2012) for regenerative farmers, such as increased
761 income or production, can help shield such farmers from criticism. Therefore, building up evidence and case studies
762 to complement these transitions, ideally over the long-term can help. In addition, identifying and working with local
763 and community champions, which could include members of local Councils, NGO’s, or fellow farmers, could present
764 additional social visibility and support. Providing training and support and building “communities of practitioners and
765 networks of conversation” can also assist, and can span across regions due to the access and ease of the internet and
766 social media channels.

767 **Narrative 4: Start with People** — Appropriate solutions would need to address the fear that underlies much of the
768 social and institutional resistance. ‘Inducing epiphanies’ as sought by Gosnell et al. (2019) would be crucial. Central
769 to this effort, education and outreach to converse and and engage in dialogue with skeptics, with the ultimate aims
770 of transforming the hearts and minds of the agricultural industry, highlighting the “hope, dreams, and aspirations” of
771 “leaving the land in better shape for the next generation..” This would also include better marketing and targeting of
772 consumers to have them switch to products of RegenAg. However, the time-scale for this scale of change, as noted by
773 participants, is likely to take decades.

774 **Narrative 5: Community by Community** — In recognition of different geographical areas and bio-regions requir-
775 ing different land use and management approaches, this narrative recognizes that solutions should be implemented both
776 at the catchment and community scale. By having a community or catchment working together, an organization (non-
777 profit or even a government department) can identify solutions that mutually benefit the organization at multiple levels,
778 including but not limited to increased production, better profit margins, stronger social ties, or greater environmental
779 benefits. This could involve coordinating with local councils and farmers within the catchment and would necessitate
780 an organizing body (such as TMI) to ensure the appropriate training, education, and support were being delivered for
781 the community needs. By converting a whole community, one can benefit from the economies of scale that can be
782 delivered, as well as the combined expertise.

783 The bottom line is that it is critical to engage stakeholders in the adoption of RegenAg, as it is both a context-specific
784 area of practice within the limits of the land and, crucially, adoption of RegenAg is a personal and social issue Pannell
785 et al. (2006); Triste, Vandenabeele, van Winsen, Debruyne, Lauwers and Marchand (2018); Prokopy, Floress, Arbuckle,
786 Church, Eanes, Gao, Gramig, Ranjan and Singh (2019). We believe therefore that building on the current study, perhaps
787 by further investigating the validity of the narratives and their implications, could identify further actions to take to
788 improve adoption, as well as highlight additional barriers that the movement may face and that were not apparent to
789 the participants of our FCM workshop. Blindspots in the FCM could be illuminated from input from and conversations
790 with the voices and perceptions from conventional agriculture. By understanding the focus of different (and at times
791 opposing) stakeholder groups, PM practitioners could focus future workshop discussions on those actions and policies
792 upon which there is both broad consensus and a sufficient evidence base to operate. FCM was a suitable tool for us to
793 use to negotiate this effort in a small sample size, and may be worth exploring in subsequent PM exercises with other
794 stakeholders of Australian agriculture, including conventional farmers.

795 A note of caution is due here since this was one case study with a limited number of participants, and participants
796 largely in favour of RegenAg. It is important to bear in mind the possible bias in these responses. With a small sample
797 size, the findings might not be representative of the system at large and these results therefore need to be interpreted with
798 caution. However, the PM exercise that is reported here points to narratives of interest, and identifies several variables
799 and relationships worthy of further investigation. Each of these narratives could be improved and/or challenged by
800 asking questions such as “How do we know this to be true?”, “What would need to be seen for it to be proven
801 true/false?”, “What might some indications be to show that we are wrong?”. But these critical questions cannot be
802 asked if there is nothing to explore in the first place.

803 Another source of uncertainty is the inherent complexity of the socio-ecological system we are studying here.
804 A farm is subject to consumer demand, market prices, government policy, social pressures from peers and family,
805 environmental disasters, long-term climatic trends, access to education and research, and the struggle to get up early
806 in the morning. It is impossible to know with absolute certainty the status of some of these variables, or the nature
807 of their relationships. In this sense, the model here does not, and cannot, perfectly reflect reality (the map is not the
808 territory, Korzybski (1941)). Not only that, but some of these barriers, particularly institutional ones, are not only
809 complex, but slow moving, requiring huge efforts and investments to drive change over the long-term. Left untouched,
810 this seemingly insurmountable challenge could be discouraging. Complexity and uncertainty, however, cannot be an
811 excuse for inaction. The identification of key variables and relationships, as we’ve done here, provides one path forward
812 to asking better questions, and finding more targeted actions. The PM exercise and the FCM produced provides a
813 blueprint of the first steps we should be taking to untangle the complexity and uncertainty of the system in attunement
814 with people’s beliefs and perceptions of how the agricultural paradigm operates. With these new insights in hand, our

815 knowledge of the system becomes a little more complete, and we can work with stakeholders to look for new leverage
816 points for change.

817 **5.2. Reporting FCM**

818 Our FCM analysis was useful for understanding the various barriers that at present seem to limit increasing
819 adoption of RegenAg practices in Australia, as well as identifying the opportunities that exist for RegenAg going
820 forward. Unsurprisingly, our FCM highlights the complexity of this issue, the various scales at which change needs to
821 happen, and the multitude of relationships and actors that need to be involved. Our analysis showed that our stakeholder
822 group, as a pro-RegenAg group, are aware of these complexities and were able to work together to demonstrate this
823 understanding. While we did not include any ‘voices’ from conventional agriculture, this understanding is a useful
824 entry point for those promoting more sustainable practices in Australian agriculture, and offers a platform for outreach
825 to different, even ‘opposing’, voices.

826 From the analysis of the FCM, we are able to make suggestions about variables and relationships of interest. Our
827 centrality analysis highlighted several key variables, and these are ‘*Institutional Reticence to Adopt and Educate*’,
828 ‘*Valuing Natural Capital in Multiple Dimensions*’, ‘*Cost of Converting to Regenerative*’, ‘*Gov’t Policy Discourages*
829 *Regen Ag*’, and ‘*Lock In of Farmers with High Debt Levels*’. However, for us, the promise of FCM was in its ability
830 to serve as a ‘boundary object’ around which our discussion of RegenAg adoption could be mediated, negotiated, and
831 navigated. As we built our model, using MURAL and Zoom, the ‘visual’ nature of the process helped us to represent
832 the connections between abstract concepts, any of which could be changed by proposals from any stakeholder Luna-
833 Reyes et al. (2019). Used this way, our FCM, in keeping with the literature, helped stakeholders to: (1) create a shared
834 language, allowing for diverse knowledge and different disciplines to work together by creating a ‘model’ together
835 on MURAL and in iterations afterwards; (2) clearly identify points of difference or similarity of relationships within
836 and between stakeholder mental models; and (3) “transform their current collective knowledge toward an agreement of
837 facts through discussion, negotiation, and careful scrutiny of what they know” to move toward innovation, cooperation,
838 and consensus building Carlile (2002); Falconi and Palmer (2017); Star (2010). PM and the process we used provided
839 a model by which we could encourage individuals to share their perspectives on a collective issue of interest, forming
840 an explicit group mental model as the object around which the discussion could be mediated Schmitt Olabisi et al.
841 (2016); Voinov et al. (2018); Zellner, Lyons, Hoch, Weizeorick, Kunda and Milz (2012). Even if stakeholders did not
842 completely agree with the model, it is more difficult to ignore the model “because they built the model themselves”
843 Henly-Shepard et al. (2015); Norton, Mochon and Ariely (2012).

844 We complemented this use of the model as a boundary object with the development of ‘narratives’ to report the
845 findings of our FCM, in a way that facilitates the communication of complexity of this issue and the system(s) it
846 involves. While each ‘narrative’ is a simplification of reality, the presence of multiple stories actually allows us to
847 embrace complexity and to communicate it Eakin et al. (2019); Ryan (2019); Luhman and Boje (2001); Elliott (2005).
848 By showing a number of possible, plausible narratives, we demonstrate that there is more than one way to see and
849 interpret the system, helping participants to acknowledge that their interpretation is not the only one. And even if
850 valid, their chosen narrative is probably imperfect or incomplete. As such, we consider narratives as an instrument
851 to communicate complexity that is constantly evolving and under construction, aligning with the iteration so desired
852 and so necessary in an overall PM process. In short, FCM creates a visualisation, and together with the accompanying
853 reporting and communication of the results as narratives, this process of model building with stakeholders makes the
854 complexity of this system starkly apparent. Recognition of that complexity is the first step to finding the leverage points
855 needed to transform that system Meadows and Wright (2008).

856 **5.3. PM Practice in Value-Laden SES**

857 In seeking to better manage SES, there is increasing support for the vital role stakeholders can and should play
858 in identifying and implementing solutions Xiang (2013); Conklin and Weil (2007); Reed (2008). PM is one of the
859 ways to involve stakeholders in that process. However, a PM process does not guarantee success, as human behavior
860 can and often still does present barriers to deliver on the promises set out by PM. We encountered such challenges in
861 our case study, often a result of conflicting values, even among a largely pro-RegenAg audience. Fortunately, PM can
862 offer a way to foster the co-design of SES solutions and to address the barriers that human behavior introduces to any
863 participatory process in a number of ways:

- 864 • **Behavioral Attunement** — By framing PM as an ‘enabling environment’ that needs to be ‘behaviorally-attuned’,
865 we take PM for what it is: a process to build a collaborative model and a socio-emotional system involving the
866 dynamics of people, their beliefs, and their values. This means systematically and deliberately accounting for the
867 way people think and behave in the way we design, facilitate, and evaluate our PM processes. We can frame PM
868 as a way to solve problems or as a way to reduce conflict, we can design and manage the process in a way that
869 promotes critical thinking Brookfield (1987), a growth mindset Dweck (2008), and self-reflection Kusnandar,
870 Brazier and van Kooten (2019); Yukawa (2006); Mezirow (1990), and we can actively encourage social support
871 from the participants as a collective peer group Edmondson and Lei (2014); Duboz, Echaubard, Promburom,
872 Kilvington, Ross, Allen, Ward, Deffuant, de Garine-Wichatitsky and Binot (2018). PM can be a mix of these
873 efforts or focus solely on one of them, but at their heart, such considerations seek to account for the people at
874 the center of any PM process.
- 875 • **A Vehicle to Communicate Complexity** — PM can facilitate the representation and communication of
876 complexity in SES issues, as the often visual nature of the exercise, particularly methods like fuzzy cognitive
877 mapping, causal loop diagrams, and systems dynamics, can more easily illustrate the interconnected nature of
878 these systems Voinov et al. (2018). However, the limitations of people in their ability to process complexity,
879 means that complementing PM with additional measures to convey and, at times, simplify this complexity, is
880 an area that demands attention. Narratives, as used by Eakin et al. (2019) and as we have described them here,
881 provide one way to do that. While a simplification of reality, the presence of multiple (and at times conflicting)
882 narratives can convey the complexity of these issues without being overwhelming, particularly for non-technical
883 stakeholders. Together, narratives and FCM allowed for the scaling of the spectrum between specificity and
884 focus vs the interconnections of the ‘big picture’, as we did with moves between a category of variables (ex;
885 financial/economic) to drawing the connections between the variables to represent the whole system. While we
886 did not do this as a part of our workshop, we also could have solely focused on representing the environmental
887 factors, or chosen 3-4 variables on the FCM (ex; ‘*Fear of Change*’, ‘*Fear of Peer Pressure*’ and ‘*Farmer Lock-In*’)
888 and devoted the workshop to exploring the connections between these variables and finding all of the additional
889 variables that might positively or negatively influence them Such fluctuations between a narrow and broad
890 focus are necessary to allow for a discussion of the big systemic issues without losing sight of the local actions
891 that can be taken by empowered stakeholders. But it can become overly complex very quickly. Appropriately
892 communicating this complexity is key to addressing this challenge, and while there is no one size fits all, the
893 scalability of FCM and narratives can effectively accommodate the way people process information to steer them
894 towards action.
- 895 • **Virtual Engagement during COVID-19** — The virtual format of delivery we have described here allows
896 both for a way to scale up participation among various groups, and for easier and efficient iteration of any

897 model that's built. That capability can and should be used more often, and tools like Zoom and MURAL can
898 replace or complement that effort. Now is the time for transitioning to digital engagement in PM. The COVID-19
899 crisis unfolds at a time when web applications are widely used and accepted. We—and our stakeholders—have
900 more time to reflect and reconsider, the quality of our meetings has improved, and isolation has provided us
901 the opportunity to reconnect and show our social side. In our view, this dramatically changes the context and
902 scale of stakeholder interactions and participation in PM processes. Advances in videoconferencing and team
903 collaboration platforms (many of which can be used free of charge) make it easier to elicit information and
904 knowledge in visually interactive formats to enhance participatory experiences. Stakeholders are increasingly
905 demanding and are technically prepared to be engaged in planning and management decisions that affect them
906 and their communities, at scales from local to global. At the same time, how people interact with and access
907 scientific models and data is rapidly evolving. Stakeholders are increasingly aware of their own capabilities to
908 provide inputs to planning processes, including models of the systems being studied. Delivering PM exercises in
909 virtual formats therefore have the potential to provide a step change in how scientific models are conceptualised,
910 built, packaged, and disseminated. Remote facilitation methods and strategies could be applied within and
911 beyond the COVID-19 pandemic, to address the ubiquitous challenge of undertaking PM processes in situations
912 where stakeholders are spread across vast geographical areas, as is generally the case with common pool
913 resources.

914 **5.4. Limitations**

915 While the findings of our study build on work in RegenAg and contribute to PM in several ways, there were also
916 limitations. Being limited to one case study and one workshop meant that a cross-case analysis was not possible. No
917 PM, even with the same stakeholders, is the same and this makes the presence of a 'control' group impossible. However,
918 a workshop similar in intent with different stakeholders could have been interesting. In a similar fashion, a workshop
919 focused on a different topic (ex; groundwater usage) could have provided additional insights and comparisons between
920 how different workshops were both run and received, and what insights were produced as a result. For example, for
921 this workshop we introduced two possible metrics before the workshop. While neither was ultimately chosen as the
922 metric of the system, this may still have introduced bias by framing the conversation.

923 Additionally, this study was intentionally absent of conventional agriculture producers. While a purposeful choice
924 to minimise disruptive and destructive conflict, those 'voices' were not considered in our depiction of the 'barriers'
925 of RegenAg adoption. Indeed the workshop was based on the assumption that more RegenAg is desirable, to which
926 not all farmers might agree. However, the presence of a largely homogenous, pro-RegenAg group did allow for us to
927 notice some of the in-group distinctions and conflicting perceptions. We stand by the decision to proceed as we did, but
928 transparency dictates noting this absence, and future work can and should find ways to include more 'conventional'
929 participants, which could add more representativeness and complexity to our FCM. Another consideration for our
930 group was who was left out by the move to virtual. It was a necessary move under conditions of social distancing
931 imposed by the pandemic, but it did exclude those without internet access or the skill, and may have even limited full
932 participation from our participants who may have struggled to navigate the new technology. These limits should be
933 considered and accounted for in future studies of virtual PM.

934 Our small sample size also did not allow for a 'full' representation of RegenAg, as it is not a homogenous group.
935 RegenAg is an umbrella, covering a variety of practices and outcomes Newton et al. (2020) and working with a different
936 group of participants may have led to a different model. The small sample size also limits the degree to which statistical
937 analysis can find 'significance' in the strength of relationships on our model. Future work could combat this by creating

938 individual maps with participants before aggregating into a larger ‘group’ map or a separate larger group discussion.
939 We could not take this approach with our limited time and resources, but hope to do so in the future. In addition,
940 sample size is a pervasive issue in PM, but one that has the potential to be overcome with virtual facilitation (even
941 beyond COVID-19) as shown here. Under normal circumstances, COVID-19 and social distancing restrictions would
942 have made this engagement impossible but we managed to pivot to a successful virtual delivery under lockdown and
943 that same method could be used to expand sample sizes as geographical distance or the physical size of the room are
944 no longer limiting factors.

945 **5.5. Future Research**

946 Notwithstanding the above limitations, our case study suggests important areas of future development and research.
947 The first is that for those seeking to increase RegenAg, we should further investigate the narratives presented along
948 with their accompanying solutions to ascertain if they are ‘true’ in the eyes of stakeholders and in reality, as ‘truth’ in
949 one does not guarantee ‘truth’ in the other. Our aim is for narratives to be the best representation of reality we can have
950 at a certain point in time given the information available. A good narrative should be accepted by many stakeholders
951 as possible, meaning that the narrative speaks to multiple perspectives, and possess multiple, legitimate sources of
952 corroborating evidence. This entails examining the relevant variables and their relationships to ascertain if available
953 evidence supports their existence. For example, for **Narrative 1: ‘Government First’**, to determine to what extent
954 “*Government policy discourages RegenAg*”, a policy ‘wish list’ of RegenAg stakeholders could be created during a
955 follow-up a PM workshop, online or offline iteration (Google Docs, email, etc), or by compiling and synthesizing
956 reports from various interest groups—this could be compared to current policy to identify where the gaps are and what
957 is needed to address them. Bespoke follow-up activities could be implemented for each of the narratives, involving
958 stakeholders at various stages to further advance and solidify the opportunities identified during the initial engagement.

959 Second, our study suggests that the use of FCM (or any PM technique) in a virtual format should be explored further,
960 particularly considering the current COVID-19 contingency. Stakeholder engagement during the COVID crisis offers a
961 unique opportunity to benchmark remote facilitation designs against face-to-face workshops, with the aim of providing
962 general recommendations on when either method would be preferable (e.g., depending on problem situation, level of
963 stakeholder conflict, types of SES resources involved, etc.). However, it is also worth noting here who may be excluded
964 by such a move to virtual, including those without the internet access or technological skills needed to successfully
965 participate in this online format. The use of ‘virtual PM’ is explored further in a forthcoming paper by the authors, and
966 we can anticipate that, based on the experience of the activities conducted as part of this case study, the methodology
967 has the potential to offer benefits in coordinating participatory processes of large stakeholder groups spread over vast
968 geographical areas, which may be useful in many other SES issues.

969 Previous studies using FCM often begin with individual maps before aggregating to a larger collective map, usually
970 over the course of several meetings Henly-Shepard et al. (2015); Nyaki et al. (2014). We did not draw individual
971 models with stakeholders one-on-one, instead waiting to develop a full group map in one sitting due to our time
972 constraints imposed by the pandemic, with individual follow-up as needed. While not inherently a negative approach,
973 it is interesting to note the difference, and the possibility of further depth and complexity of the FCM presented by
974 iterations between individual maps and collective maps, depending on where the starting point may be. The use
975 of our ‘narrative’ structure and template (story, actors, model, solutions) may be an alternative way to guide this
976 process, collecting stories beforehand (which can be accompanied by individual cognitive maps) and then iterating
977 these narratives side by side with the main FCM over the course of PM.

978 Finally, to develop a full picture of the dynamics people bring into any participatory or PM workshop, we should
979 further explore the idea of what would constitute an ideal ‘enabling’ environment of PM (i.e. specify the articulation of
980 tools, facilitation techniques, communication strategies, and follow-up activities that should be implement to deliver on
981 the promises of PM), and its ability to construct and manage PM as a socio-emotional system from which to elicit and
982 transform individual mental models. This aspect of PM is often missing from reporting on PM, which tends to focus
983 on the model. The dynamics of the emotions and social structures that stakeholders bring with them into a workshop
984 holds implications for the way we conduct PM, the way we report the findings, and the way we seek to address issues
985 of SES (like increasing adoption of RegenAg practices). ‘Narratives’ seem to be one of many possible tools that can
986 assist in the PM process, as it can effectively align the insights developed from a scientific modelling exercise with
987 the ways people best assimilate information. Like narratives, are likely to be other tools out there and we should look
988 to further explore how concepts, ideas, and practices from various behavioral sciences can improve any aspect of the
989 design, practice, or evaluation of PM—so that it is behaviorally attuned to the problems that it is trying to solve.

990 **6. Conclusions**

991 Taken together, the findings of this paper have a number of important implications both for RegenAg in Australia
992 and the future practice of PM. In our case study, the co-construction of the FCM revealed the myriad of connections
993 at play in the adoption of RegenAg in Australia, highlighting the complex forces at work and the need for coordinated
994 actions at the institutional, social, and individual levels, across long timescales (decades). Such actions are necessary
995 for RegenAg to play a greater role in Australia’s agricultural paradigm, to bring ‘balancing’ relationships to a system
996 currently reliant on conventional agriculture with few internal incentives to change. The crisis of climate change and
997 a degrading environment may be the ultimate reasons for change, but in addition to communicating the severe danger
998 of these crises, RegenAg advocates must also find the messages and actions that overcome any paralysis of action in
999 individuals and in communities Polasky et al. (2020).

1000 We also used ‘narratives’ to identify some of these solutions, communicate with our stakeholders, and to report
1001 some of our findings Eakin et al. (2019). The simplicity of narratives (as a product derived from an PM workshop)
1002 makes it a replicable and repeatable format that should be used in the future for the practice of PM. Additionally, PM
1003 practice may also be improved by the use of our ‘virtual’ facilitation approach, as we were able to successfully build
1004 an FCM, despite participants being hundreds of kilometers apart from each other and from the research team.

1005 By using ‘narratives’ to communicate the results of our FCM, we can tailor our findings to a format well-suited
1006 for communicating complexity. This format is compatible with the existence of various (and sometimes competing)
1007 narratives—more than one may be present, and the priority for any particular narrative may shift. This is where
1008 tools like FCM and narratives can work together. The narratives inform the FCM in looking at what variables and
1009 relationships to explore further, and the FCM informs the narratives by showing what is possible and what those
1010 relationships might mean for actions in the real world. Although our study suggests that this combination of storytelling
1011 and PM has enormous potential, more work can and should be done here, particularly in exploring how narratives
1012 might be developed into a consistent, repeatable framework to work alongside the PM process from start to finish.
1013 In this paper, we argue that understanding individual farmer perceptions should precede and accompany any effort to
1014 close the gap between barriers and opportunities for adoption of RegenAg practices, or indeed, any other practice that
1015 improves the state of a SES. This means that any effort to increase adoption of such practices should first consider
1016 how individuals make day-to-day decisions, by determining which narratives are dominant. Developing awareness and
1017 attunement to these narratives has helped identify those factors that undermine or shape potential solutions, and how
1018 limiting or deep-seated beliefs might be countered by articulating different problem definitions and framing different

1019 solution options. In short, instead of starting with models and policy, PM practice should start with people based on
1020 modern understandings and science of they think and behave.

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1026 **Conflicts of interest / Competing interests**

1027 The authors declare no conflicts of interest

1028 **Ethics approval**

1029 This study was conducted under a University of Technology Sydney Ethics Approval ETH19-4066

1030 **Consent to participate**

1031 Informed consent to participate was obtained from all subjects involved in the study

1032 **Consent for publication**

1033 Informed consent for publication was obtained from all subjects involved in the study

1034 **Availability of data and material**

1035 All articles analysed during this study are available online

1036 **Code availability**

1037 Not applicable

1038 **Author's contributions**

1039 Conceptualization / Methodology / Writing-review and editing / Visualization, D.K. and J.C.R.; Formal analysis /
1040 Writing-original draft preparation, D.K.; Supervision, J.C.R.

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Table 1
FCM results (network statistics)

Statistic	Total	Interpretation/Insight
Variables	31	Each iteration of 'modelling' added more variables as stakeholders further appreciated the complexity of the system, and the interconnection of various forces, including economic, social, environmental, and behavioral, that are present and interacting in this system.
Connections	140	With the addition of 'variables', the number of connections greatly increased from the first iteration of the model to the current version. This is reflected in the Connection Per Component, which roughly doubled from 2 to 4.5 from the initial workshop to the final iteration of the model. A greater number of connections could represent an increasing recognition of the interconnectedness of the system. Those increasing dependencies could make for a challenge, in the 'wicked complexity' Rittel and Webber (1973) of not being able to isolate variables within the system, but they also could present an opportunity, in that the right actions can have far-reaching effects in the system. It is also possible that the increase in connections is a result of more time given to participants in subsequent follow-ups, in contrast to our original modelling protocol which was designed to deliberately keep things simple.
Network Density	0.15	Our network density was quite low, although we did see an increase from the first iteration of the model to the final version. As the actual number of connections divided by the number of connections possible in the 'map', the more connected the map and the variables within became the higher the density. We expected the increase in the number of connections as participants grew more comfortable with the modelling process and had more time to think of them in the follow-up outside the constraints of the workshop. The increase in connections reflects the 'wicked complexity' Rittel and Webber (1973) of this system as an interconnected web of financial, social, environmental, and behavioral drivers.
Connections per Component	4.51	From the initial model to the final iteration, the Connection Per Component roughly doubled from 2 to 4.5. The majority of the connections in the map are 'positive' in their influence, so this increase in connections could, without the presence of balancing 'negative' connections, further spiral the system deeper into the conventional agricultural paradigm and, according to the model, decreased ecosystem health. However, as it is depicted in the system, were the trend in conventional agricultural dominance to reverse, those same 'positive' feedbacks present could spiral the system upwards towards better ecosystem health. This seems unlikely given the institutional and slow-moving nature of government as a key player in this system, but it is possible. Meanwhile, an increase in the number of negative feedbacks in the system, particularly around 'central variables' means that spiralling or rapid transitions of any kind (positive or negative) are less likely to occur as there are more 'balancing' relationships present to counteract the 'reinforcing' relationships.
Complexity Score	0.20	This is a low score, as we only had one receiver component, our metric for the system of ' <i>Improved Ecosystem Health</i> '. This 'score' is specific in the way it defines complexity as it perceives a model to be less complex "when many transmitters are represented with only a few outcomes (receiver variables) of those pressures represented" Henly-Shepard et al. (2015). More 'outcomes' could be added to the model, but the process we used was quite structured in using one metric to guide and narrow the focus.
Transmitter Components	5	The relatively low number of 'transmitter variables is likely a product of our approach to building the model. All of these components were 'levers', variables added to reflect actions that could be taken to influence the system. In that sense, it makes sense they have only outgoing arrows, designed as they are to 'impact' the system. In further iterations of the model, it would be interesting to see how other variables, especially other levers, might integrate with these identified variables, as it happened with other variables (ex; <i>Long Term Independent Research</i> has a positive effect on <i>Education and Ecological Literacy</i>).
Receiver Components	1	This was our goal and metric for the system, ' <i>Improved Ecosystem Health</i> ' that we established at the beginning of the exercise. As such changes in the system, in theory, should affect this metric, for good or ill. It is likely other metrics exist and could be used to monitor different parts of the system. Focusing on one metric was an intentional choice to narrow the discussion for our workshop.
Ordinary Components	25	The majority of our variables were ordinary components, meaning they were variables with incoming and outgoing connections. As noted by Henly-Shepard et al. (2015), this demonstrates the "significant interlinkages and influences between system components", potentially a sign of further complexity in the system. It is unsurprising how interwoven this system is, as agriculture, and RegenAg in particular, is a product of "multiple, simultaneous and inter-connected ecological, economic and social pressures" Feola et al. (2015).

Table 2
FCM results (centrality)

Component	Centrality
Institutional Reticence to Adopt and Educate	10.1
Valuing Natural Capital in Multiple Dimensions	7.9
Cost of Converting to Regenerative	7.5
Government Policy Discourages Regen Ag	7.4
'Lock In' of Farmers with High Debt Levels	7.3
Market Demand for 'Clean and Green'	5.7
Consumer Demand for Cheap Food	5.2
Inertia of Existing Knowledge Structure	4.8
Vested Interests of Business Models	4.2
Politicization of the Environment	4.1
Need for Holistic Decision Making/Adaptive Management	4.0

Table 3
Narrative 1: Government First

Narrative	Component	Description
Government First	Story	The culture and current paradigm is so enshrined in society that only the government has the resources and the ability to break us out of it. It is their job to protect the environment and future generations and they must act and do so quickly. Their investment in and provision of incentives for transitioning to RegenAg is the first step in creating a spill-on effect to the rest of the system.
	Actors	The Australian Government / The Prime Minister and Cabinet (particularly Ministers of: Agriculture, Drought and Emergency Management, Environment, Education) / Voting Public
	Model	' <i>Government Policy Discourages Regen Ag</i> ' and ' <i>Institutional Reticence to Adopt and Educate</i> ' are two factors at the center of the model, and both currently in the top 5 'most central' and influential variables. This is a result of the number of strong, causal arrows emerging from and being received by these factors. Should this narrative be true, even more of these links will need to emerge from these 'variables' to create effects on the rest of the system as 'forcing' mechanisms. The pressure would then be to create relationships that positively influence these key variables to 'encourage' more of a transition or transformation to RegenAg.
	Solutions	If 'Big Government' is the problem, then 'Big Government' must be a part of the solution, although this includes the federal and state government. While noting the effect the individual voters and media have on the government, if this narrative is true, a drastic reform at the level of Federal Government policy is needed. More incentives need to be provided for a switch to RegenAg, and could show up in a reform of drought policy, or an integration of water and soil acts, perhaps more in line with watershed boundaries as opposed to arbitrary political lines. Workshop participants noted that not only does this commitment need to be significant, it also needs to be 'long-term' in order to align with the cycles of natural capital and to "give confidence to land managers, industry, educational institutions, NGO's, and the broader public." Part of that effort could then include greater efforts to inform the voting public of these issues and/or actively push Parliament to embrace policies benefiting regenerative agriculture by directly lobbying the relevant Departments and Ministers.

Table 4
Narrative 2: The Market Matters

Narrative	Component	Description
The Market Matters	Story	The combination of 'Consumer Demand for Cheap Food' and 'Vested Business Interests', along with the surrounding infrastructure can keep conventional agriculture in place by creating a system that seems to race to the bottom. As noted by one participant, the "consumer demand/expectations for 'brandless' cheap food commodities [is a] major hindrance" to the adoption of regenerative agricultural practices, as they tend to carry a higher up-front cost, and often necessitate premium pricing as a result. Shifting this demand to food more aligned with holistic and regenerative practices puts pressure on businesses and government to incentivize those practices further and provide the structures and policies needed to produce at scale.
	Actors	Australian consumers / Woolworths, Coles, and other supermarkets / Agribusiness / Department of Agriculture / Banks and Financial Institutions
	Model	Much of this story is reflected in the upper left corner, with 'Consumer Demand for Cheap Food', 'Vested Business Interests' and 'Lack of Support from Industry Groups' all playing a key role in keeping the current paradigm focused on conventional production to meet the needs of the market. If this narrative were true, the connections between these three variables would be strong, and would further tie into 'Institutional Reticence', 'Gov't Policy Discourages Regen Ag', ' <i>Lack of Resources/Finances</i> ', and ' <i>Cost of Converting to Regenerative</i> ' to lock in market control and limit regenerative to a niche category. To change it, this reinforcing system would need to be broken.
	Solutions	Find ways to increase consumer demand for products of RegenAg (affecting 'Consumer Demand for Cheap Food' and 'Market Demand for 'Clean and Green)'), which could happen in a number of ways: a) Provide government incentives to subsidize the cost of regenerative products, either in out of the gate packaging and production, or in reducing the high up front costs needed to switch to regenerative. b) Create regional processing and distribution centers in high agricultural areas devoted to regenerative products and lowering costs by producing at scale. c) Incentivize supermarkets to carry regenerative products either at lower prices or in high-value locations in stores to encourage more sales. d) Increase funding to marketing and advertising to craft a more compelling narrative for regenerative products to direct-sell to consumers.

Table 5
Narrative 3: Pressured Communities

Narrative	Component	Description
Pressured Communities	Story	Our communities have been conditioned to feel conventional agriculture is the only way, and this is present in our interactions with family members, neighbors, and peers in the agricultural world. As noted by one stakeholder, the supporting structures around agriculture (banks, agronomists, certain industry groups) also “have a lot invested in conventional farming” which strengthens this connection. Unless we can actively promote supportive mentors, community champions, community groups, and a solid evidence base, people will continue to avoid transitioning to practices viewed as ‘unconventional’, even ‘radical’.
	Actors	Landcare / Land Services (LLS) / Local councils / Banks (Bank managers and accountants)/ Agronomist groups / RegenAg practitioners and trainers / Individual landholders and farmers / Non-profit organizations
	Model	Currently, the fear-based trifecta, ‘Fear of Peer Group Judgment’, ‘Fear of Change’ and ‘Fear of Being Different to Others’, play a central role here (which is similar to ‘Start with People’, Narrative 4). However they combine, with the ‘Lack of Examples/Evidence’ and the ‘Cost of Converting’ and ‘Lock In’ of Farmers with High Debt Levels’ to create a risky proposition of upsetting social norms with the possibility of little to no pay-off. If this were the dominant narrative, these factors would need to be more connected to the ‘Vested Interests of Business’ as this provides further disincentives, possess a stronger connection to the ‘View that Regen Ag is a trade-off between environment and finances’ as this is a fundamental assumption of many who resist transition to RegenAg. These would have to be far more interconnected with the rest of the map, with ‘Support Mechanisms and Groups’ and ‘ <i>Long-Term Independent Research</i> on Regen Practices’ being pushed as a way to address these challenges.
	Solutions	The policy should center on ‘normalizing uptake’ of RegenAg practices to remove any social stigma that comes from such a transition or practice. Being able to point to indicators of success, or cultural capital Bourdieu (1986); Burton (2004); Sutherland and Darnhofer (2012) for regenerative farmers, such as increased income or production, can help shield such farmers from criticism. Therefore, building up evidence and case studies to complement these transitions, ideally over the long-term can help. In addition, identifying and working with local and community champions, which could include members of local Councils, NGO’s, or fellow farmers, could present additional social visibility and support. Providing training and support and building “communities of practitioners and networks of conversation” can also assist, and can span across regions due to the access and ease of the internet and social media channels.

Table 6
Narrative 4: Start with People

Narrative	Component	Description
Start with People	Story	We have to start from the ground-up in creating a cultural change, by capturing the hearts and minds of farmers through conversations, education, and outreach. This is where conversations and dialogue need to proceed, both in understanding where individual circumstances work against a transition to RegenAg, and in tailoring messaging to highlight if, where, and how practices of RegenAg might better align with the values and beliefs of farmers considering a transition.
	Actors	CSIRO / Universities / RegenAg practitioners and trainers (including holistic management, landscape rehydration, and other areas)/ Non profit and research organizations (like The Mulloon Institute and Soils for Life)/ Individual landholders and farmers
	Model	This narrative puts the various 'fear' variables as the central focus, along with the 'Inertia of the Existing Knowledge Structure'. If this narrative were true, this would also require recognizing how deeply rooted the trifecta of Fear variables, namely 'fear of change', is in individual minds increasing the number of arrows emerging from this space, many of them weak, but with deep roots throughout the system. As a result, ' <i>Education and Ecological Literacy</i> ' and ' <i>Understanding Ecological Complexity</i> ' would need to play a much greater role in addressing these influences.
	Solutions	Appropriate solutions would need to address the fear that underlies much of the social and institutional resistance. Education and outreach would be the center-piece of this effort to have conversations and dialogue with the aims of transforming the hearts of minds of the agricultural industry, highlighting the "hope, dreams, and aspirations" of "leaving the land in better shape for the next generation.." This would also include better marketing and targeting of consumers to have them switch to products of RegenAg. However, it is likely this scale of change is likely to be long-term, as noted by participants, likely decades.

Table 7
Narrative 5: Community by Community

Narrative	Component	Description
Community by Community	Story	<p>As agriculture is often an area confined by ecological boundaries, we have to identify potential communities of farmers within watershed areas and provide incentives for individuals to change and for communities to collaborate. This is similar to Narrative 3, but instead focuses on an organization-led charge to benefit from the emergence of social, economic, and environmental outcomes that arrive from mutual support and collaboration on a conversion to RegenAg. Farmers need support from each other and from experts to complete this change successfully. The challenge is to find and/or create the good reasons that the members of a potential community will need to convert to RegenAg. That may include new marketing opportunities, or changes at the watershed scale allowing for improved production, or new social opportunities resulting from collaboration. Ideally, a permanent organization must be set up to undertake the work of identifying suitable communities, convincing the community to join, and to oversee the process of this change. The role of this organization is to marshal the expertise and resources required to totally transform existing farming operations into truly Regenerative Agricultural farms in such a way that the farmers involved achieve better outcomes and significantly improve their quality of life in ways that are congruent with their values.</p>
	Actors	<p>Community-led organizations or non-profits / RegenAg practitioners and trainers (including holistic management and landscape rehydration)/ Business consultants (including people experienced in community organization and decision making, marketing and sales, logistics, technology and finance)/Farmers of the targeted communities</p>
	Model	<p>In many ways, this narrative is the culmination of some of the other narratives, in that it acknowledges the fear-based role of Narratives 3 and 4, (and seeks to provide farmers with the means to deal with a 'Fear of Change', 'Fear of Peer Group Judgement', and 'Fear of Being Different to Others'), while highlighting the risk proposition of a perceived high 'Cost of Conversion' or the 'Lock-In of Farmers with High Debt Levels', and the difficulties of nudging people towards new ways of doing things. The 'Lack of Examples/Evidence' and 'Inertia of Existing Knowledge Structure' also play a role here, and in part this model of watershed community conversion seeks to address those variables to provide the incentives necessary for farmers to change. If this 'narrative' were true, then 'Catchment-Scale Community Building' becomes the primary lever, and the model would need to reflect the various relationships that either exist or that can (reasonably) be built in order to drive change in the system. More, stronger arrows would need to emerge from this variable to influence (directly or indirectly) the most central variables of the system, including 'Institutional Reticence to Adopt and Educate', 'Valuing Natural Capital in Multiple Dimensions', 'Cost of Converting to Regenerative', 'Gov't Policy Discourages Regen Ag', and 'Lock In' of Farmers with High Debt Levels'. It could also bring to the table with the farmers a wide range of external parties with experience, knowledge, skills, finance, and other resources to address 'Lack of independent agronomy advice'. Such an effort might also provide the case study needed to address the 'Lack of Examples/Evidence' and to realize the economies of scale needed to remove the financial limitations of 'Lack of Resources/Finance', 'Resources for new regen practices', and the 'Cost of Converting to Regenerative'.</p>
	Solutions	<p>In recognition of different areas and regions requiring different land use and management approaches, this narrative recognizes that solutions should be presented and tackled at the catchment and community scale. By having a community or catchment working together, an organization can identify solutions that mutually benefit the organization at multiple levels, including but not limited to increased production, better profit margins, stronger social ties, or greater environmental benefits. This could involve coordinating with local councils and farmers within the catchment and would necessitate an organizing body to ensure the appropriate training, education, and support were being delivered for the community needs. By converting a whole community, one can benefit from the economies of scale that can be delivered, as well as the combined expertise. Groups like The Mulloon Institute are one example of what this solution and narrative could look like.</p>