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Supplementary table 1: A non-exhaustive list of tools that research teams can use to create thick maps

Tool name	Description
Agent-based Modeling (ABM)	ABM is a valuable tool for constructing comprehensive and nuanced mappings, particularly when 'agents' are considered as both human and nonhuman entities with equal ontological significance. These agents influence and are influenced by their reciprocal interactions within socio-ecological systems (SES), in accordance with Latourian actor-network theory (ANT).[1]
Boids	Boids is an artificial life program created by Craig Reynolds[2], models bird flocking behaviour. The term 'boid' is short for 'bird-oid object', signifying a bird-like entity with emergent properties. Boids operate based on three simple rules: separation (avoiding crowding), alignment (matching the heading of nearby boids), and cohesion (moving towards the center of mass of nearby boids). These principles are valuable for mapping social-ecological network interactions.
Deep Mapping:	Deep maps explore multiple layers of both qualitative and quantitative data to uncover the diverse meanings, identities, and subjective experiences tied to a particular space. In deep mapping, quantitative data are transformed into qualitative narratives, a process essential for effective understanding and decision-making. This transformation answers the key question: What do the numbers and statistics signify for us, and how should we respond based on this embedded information? To achieve this, it is crucial to recognise that both human and nonhuman entities—such as trees, plants, soil, water, and air—should be seen as conveying stories that require interpretation. These nonhuman elements are considered to hold equal ontological and agency status as humans.[1]
Dynamic dashboards	Thick maps can be developed and visualised as dynamic dashboards. This plays an important role in real-time sense-making and decision-making purposes in transformative transdisciplinary research processes, which ensures a continuous flow of quantitative to qualitative data.
Dynamic narrative landscapes	Dynamic fitness narrative landscapes take the notion of fitness landscapes a step further with its dynamic visualisation of the connections both *within* and *between* the layers/facets.[3]
Fitness Landscapes	Fitness landscapes, introduced by Stuart Kauffman[3], visualise the link between genotypes and reproductive success. Each genotype's fitness, or 'height', determines its position on the landscape. Genotypes are 'close' if similar and 'far' if different. This concept explains evolutionary imperfections, including responses to supernormal stimuli and adjacent possibles.[3]
Internet of Nature (IoN)	Emerging IoN smart technologies[4], such as the itreetools, treetracker, internetoftrees tools, present new ways for research teams to work with natural nonhuman stories by generating mixed-methods data related to plants, soil,

Tool name	Description
	water, and air. Additionally, researchers are using recording devices to capture the sounds produced by living organisms, including trees and plants (biophony). These sounds are then analysed as qualitatively as 'signs' to investigate how these living beings are responding to the conditions of the environment or context in which they are embedded. This approach is key in JST-related research, and for thick mapping in particularly as the 'meaning' of nonhuman stories are not always immediately clear but can only be figured out collaboratively and in relation to related qualitative and quantitative data.
Narrative landscapes	Narrative landscapes can be used for capturing positive and negative lived experiences – signifying *attractors* as areas of attraction *towards* which social change actions can be nudged – AKA adjacent possibles – vs repellants as those negative areas to move *away from* (avoidance) – signifying said double movement.[5]
Net-Map	Netmap[6] specialises in mapping power relations within human networks, crucial for tracking and visualising the spatial and relational distribution of unequal knowledge and power dynamics.
OBS Studio	OBS Studio is a free and open-source software for video recording and live streaming. This can be a useful tool to apply when capturing narrative data to include in thick maps.
Praxis	This tool is available at no cost under a Creative Commons licence. Praxis is a free framework designed for managing projects, programmes, and portfolios. It encompasses a body of knowledge, methodology, competency framework, and capability maturity model. Additionally, the framework is backed by a knowledge base of resources and an encyclopaedia.
Sensemaker: Online narrative research tool	Online narrative tools, such as Sensemaker, provide valuable qualitative insights into the complex contexts of current issues by identifying and revealing narrative patterns. These tools facilitate human sense-making by highlighting how individual stories and experiences contribute to a broader understanding of the issues at hand.
Trellis and other social network research tools.	Trellis is an exciting collection of tools for developing, administering, and collecting survey and social network data. These tools help researchers to track and visualise emerging human and social networks. Used in conjunction with Internet of Nature (IoN) tools, Trellis can illustrate interactions between humans and nonhumans in socio-ecological systems (SES). Examples of IoN tools are: 1. Breadboard: Breadboard is a software platform for developing and conducting human interaction experiments in groups. 2. Felt: A cloud-native GIS platform for rapid maps, dashboards creation
Visual journalism	Visual journalism is a useful online storytelling application that can help researchers to make sense of complex data sets by simplifying concepts and stories, and turning them into accessible and engaging narratives. This approach not only helps us better understand the information but also encourages us to share it with others.

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