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Conceptualising causal networks for environmental impact assessment

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Abstract: Hazard identification is one of the first steps in environmental impact assessment. The goal is to systematically and comprehensively list the various ways in which the proposed development or driver of change in the system may affect environmental assets, the aspects of the environmental system we value. There is a strong focus on establishing causality, describing the cause-and-effect relationships that link development activities with environmental assets. There is typically good knowledge of which activities are associated with a proposed development, as well as systematic ways to identify and prioritise environmental assets. It is much harder to map the logical connections between development activities and environmental assets.

Hazard identification approaches routinely used for environmental impact assessment include Failure/Impact Mode Effect Analysis (FMEA/IMEA) and Driver-Pressure-State-Impact-Response (DPSIR). FMEA/IMEA is a systematic hazard identification framework with a strong focus on prioritisation of hazards for risk assessment. The DPSIR framework is commonly used to assess and manage environmental problems and is focused on effects on or interaction of development with the existing environment.

This paper demonstrates how hazard identification can be integrated in a formal causal network that elevates the resulting register of individual hazards into a logically consistent network (Peeters et al. 2022). The formal logic structure of a causal network helps to identify implicit assumptions and refine causal pathways. Causal networks underpinned regional-scale impact assessments for future energy resource developments in Queensland, South Australia and Northern Territory.

Developing a causal network is necessarily iterative to refine network topology as information, knowledge and interpretation evolves throughout a project. The network is developed in two distinct phases: topology development and narrative development. The first phase, topology development, establishes a comprehensive, detailed causal network that attempts to accurately depict the natural system and how development activities may interact with this system. This is the phase in which many implicit assumptions surface and logical inconsistencies between causal pathways are discovered. The causal network forms a common ground for stakeholders and domain experts, facilitating interdisciplinary communication.

The causal network that results from the topology development phase is usually complex as it captures a great deal of detail. The second phase, narrative development, streamlines this network to create a simpler network, with fewer nodes and links, that nevertheless captures the essence of the detailed network. The narrative network aims primarily to be a communication and reporting device. It retains the transparent logic of cause-and-effect relationships, but in an easy to navigate format. The network becomes the structure of the evidence base required to justify the causality and materiality of hazards. It is the highest tier of information, allowing users to rapidly find the technical detail relevant to issues that matter to them.

The main challenges faced with causal networks is the suitability of software platforms and the consistency of materiality definitions. For topology development, a flexible network software platform is needed that allows iterative development in a workshop setting, while narrative development has a stronger focus on content creation and management. Causal networks are inevitably interdisciplinary, and a consistent method used to define materiality of cause-and-effect relationships is needed across disciplines.

Causal networks are an effective communication tool for regional scale environmental impact assessment. Future research is focused on assessing cumulative impact from multiple drivers, as well as opportunities for nature positive resource development and management.

REFERENCES

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