Fuzzy Cognitive Mapping as tool for scenario development. Conceptual added values and practical pitfalls

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Abstract

Fuzzy Cognitive Mapping (FCM) is highly suitable to meet the demands of scenario development: it uses a mix of qualitative and quantitative approaches; it enables the inclusion of multiple and diverse sources to overcome the limitations of expert opinions; it aims to make implicit assumptions explicit; and it considers feedbacks that lead to non-linear dynamics. Moreover, the radically different equilibriums that the application of a FCM often yields can be linked to the concepts of resilience and adaptive capacity as coined by Holling in the 1970s, and further elaborated by a rapidly growing number of research groups, notably those involved in the Resilience Alliance. FCM holds the promise of connecting the concepts of resilience and the practice of scenario development. Despite these properties, the field of Future Studies is slow to adopt FCM and lacks solid theoretical foundations and rigorous practices for FCM applications. The main objective of this presentation is therefore twofold: First, to introduce and illustrate the potential Fuzzy Cognitive Mapping and elaborate on the large and untapped potential to model tipping points and regime shifts. Second, to analyse the recent surge of practical applications in environmental studies and illustrate practical pitfalls.

FCM is best described as a "quick and dirty" method. The "quick" aspect appeals to many and has led to a rapid expansion of the number of applications. In recent years, a number of research groups across the globe have started to develop FCMs in a participatory manner, during workshops or using interview techniques. The "dirty" aspect, however, did not receive nearly as much attention. The growing body of literature now enables us to go beyond praising the potential and speed with which it can be developed and applied, and start critically evaluating the lessons learnt and pitfalls encountered. Two main lessons stand out:

1. The practical application of FCMs has many different steps, each of which presents its own issues that are often poorly understood and insufficiently tested in practice. Important issues include: using overly simple methods for mathematical aggregation of individuals; insufficient care for post-processing; and faulty inclusion of quantitative information.

2. The lack of a proper validation technique might well be the largest hindrance in getting a broader acceptance and use of FCMs.

We conclude that FCM lives up to its expectations, and continues to hold a large promise to
become a key tool in quantifying behaviour of complex systems, particularly related to Future Studies. Yet, we also conclude that many practical pitfalls exist, and that mis-interpreting and therefore mis-using FCMs is a real and underestimated danger. We recommend to focus on augmenting our practical knowledge base, which needs to be accompanied with studies on the fundamental characteristics of the underlying mathematics.

**Keywords:** scenario development, participatory methods, Fuzzy Cognitive Map, resilience, quasi quantitative model, Future Studies