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Choosing diverse sets of plausible scenarios in multidimensional exploratory futures techniques

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ABSTRACT

Morphological analysis allows any number of dimensions to be retained when framing future conditions, and techniques within morphological analysis determine which combinations of those dimensions represent plausible futures. However, even a relatively low number of dimensions in future conditions can lead to hundreds or even thousands of plausible future scenarios. Creating highly diverse but conceivable visions of the future in which to explore decision-making, exploratory futures techniques rely on the selection of a small number of plausible scenarios from the larger set. In this paper we describe a new method for finding maximally diverse sets containing a small number of plausible scenarios from a multi-dimensional morphological analysis. It is based on a mathematical optimization of diversity that is robust to the uncertainty in the framing of future factors and states and in what stakeholders might consider diverse combinations of those factors and states. We also describe implementation of the method as a software tool and its performance in recent exploratory scenario development by CGIAR and partners for regional environmental change, food security and livelihoods.

1. Introduction

Complexity and uncertainty are dominant features of many public and private decision-making issues (Vermeulen et al., 2013). The success of any decision in these situations is more often than not shaped by diverse actors, with differing perspectives and agendas, at multiple levels within changing interrelated social, economic, political and environmental systems (Vervoort et al., 2012; Gibbons, 1999). Exploratory scenarios are particularly effective tools for incorporating high degrees of complexity and uncertainty into planning and decision-making processes (Vervoort et al., 2014; Kok, van Vliet, Bärlund, Dubel, & Sendzimir, 2011; Schoemaker , 1993; Lempert, Groves, Popper, & Bankes , 2006; Bradfield, Wright, Burt, Cairns, & van der Heijden, 2005; Godet, 2000; Schwartz, 1996).

This paper introduces a new exploratory scenario method called OLDFAR used in participatory scenario development processes conducted by the CGIAR program on Climate Change, Agriculture and Food Security (CCAFS[1]). The CGIAR program has been developing socio-scenarios for East Africa, West Africa, South Asia, Southeast Asia, the Andes and Central America

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together with regional experts from 240 organizations in all sectors related to rural livelihoods, environments, climate adaptation and mitigation, agricultural development and food security. These scenarios have been used with decision-makers at regional (or sub-global) and national levels to help test the feasibility of policies and investments and guide priority setting, largely related to government policy but also with non-governmental organizations, development banks and private sector investors. The reference (Vervoort et al., 2014) describes the overall scenarios process and main lessons in terms of effective engagement with decision-makers. This paper provides the mathematical details of the OLDFAR method and discusses its application, benefits and drawbacks, both theoretical and as experienced in practice in the CGIAR program. A separate paper will discuss the broader considerations and theory around the design of scenarios in the process used in the CGIAR regional scenarios program.

Morphological Analysis (Zwicky, 1969; Godet, 2006; Ritchey, 2006; Rhyne, 1995; Rhyne, 1981; Coyle, Crawshay, & Sutton, 1994), in particular, Field Anomaly Relaxation (FAR) was chosen for the CGIAR program. FAR considers, in the case of the CGIAR program through participatory discussion, the important dimensions of future conditions (hereafter called factors) and mutually exclusive instantiations of each factor (hereafter called states of each factor). Incompatible combinations of states, also called implausible in the literature, are ruled out, leaving all remaining combinations of states as plausible future scenarios. Previous participatory regional environmental change, food security and livelihoods scenarios studies have mostly used the "two axis" or "quadrant" approach of two factors with two extreme states each, which provide four scenarios (van't Klooster & van Asselt, 2006; van der Heijden, 2005; Wilkinson & Eidinow, 2008). While this scenario development method has the benefits of being simple to conduct and understand, it runs the risk of strongly limiting and framing views of the future by these two factors and two states—leading to a limited exploration of the future possibility space and, in multi-stakeholder contexts, to perceptions of limited usability of the scenarios when potential users see key factors as under-represented. FAR is a multi-dimensional exploratory scenario technique which places no conceptual limit on the numbers of factors or states within factors.

The choice of factors and states in the FAR method are transparent. Alternative multi-dimensional techniques, such as the so-called "inductive" method which has been used by Royal Dutch Shell (Wilkinson & Kupers, 2014) and others, where scenarios are generated in an emergent, organic fashion, building on combining narrative elements by "trend crashing" and identifying relevant scenario narratives first, and only then providing an overall structure to the scenario set, has the drawback that the choices about which factors and states are explored, and which are ignored, are often intransparent.

In the context of interacting, multi-dimensional socio-economic and environmental changes, assigning specific probabilities to long-term scenarios that cover large geographic/political areas is problematic (Vermeulen et al., 2013; van Notten, Sleegers, & van Asselt, 2005). That FAR is based on plausibility, not probability, was another reason for its adoption by the CGIAR program. Plausibility emphasizes the need for scenarios to be believable from the subjective perspectives of scenario developers and users (Ramírez & Selin, 2014). Ensuring that scenarios are plausible to users is important to help them expand their perspectives on the future (Schoemaker, 1993)—if scenarios are considered to be too implausible, users will respond by narrowing, rather than broadening, the future possibility space they are willing to consider. Exploratory scenarios derived from the FAR method therefore may be different from, for instance, extreme scenarios that might consider extremely unlikely, though not impossible, future scenarios.

To create highly diverse but conceivable visions of the future in which to explore decision-making, exploratory futures techniques rely on the selection of a small number of plausible scenarios from the larger set with highly distinct narratives and back-casting. Having highly diverse and distinct scenarios is important because scenarios are often used to test the robustness of strategies, for priority-setting and to develop contingency plans. With these purposes in mind, and working from a notion that complexity and uncertainty make the assignment of exact probabilities difficult and often dangerous, distinct and diverse scenarios allow for a more comprehensive assessment of the viability of strategies (Wilkinson & Eidinow, 2008). When more factors and states are taken into consideration when structuring scenarios, the possibility space of the scenarios set increases. However, there are practical limitations to how many factors and states can be taken into account.

Applying the method described in this paper in South Asia we found that participants found six factors hard to remember when it came to quantification of the scenarios and we decided to use less factors in subsequent processes. Preliminary evidence suggests that participants in multi-factor, multi-state processes are more comfortable with a lower number of factors but a higher number of potential states. This way, participants have to consider less factor interactions, but a higher number of states per factor increases the scenario set's possibility space. In addition, with fewer factors and more states, not all states will end up in the final scenario set, reducing the complexity of the set.

Even a low-dimensional morphological analysis can contain hundreds and potentially thousands of plausible scenarios. Practice shows that between four and six scenarios is the best number for qualitative participatory exploration of highly uncertain futures, since this places the number of factors under the cognitive load rule of seven (Miller, 1956) beyond which individuals find it hard to keep distinct mental objects in mind together. Too few scenarios will not provide a sufficiently diverse set, and may additionally lead to participants viewing one scenario as the "good" scenario the other as the "bad" scenario, creating a one-dimensional scenario set. A set of 3 scenarios tends to support participants' consideration of one scenario as the "likely" scenario, the "baseline", etc. With too many scenarios that each represent multi-dimensional narratives on the future, scenario developers and users will lose sight of the whole and lose their sense of how the scenarios are distinct from one another, making the set a less accessible tool for decision guidance (Schwartz, 1996).

Generally, participants agreed with the above rationale for choosing four to six highly diverse scenarios from a larger set of thousands as the basis for developing further an exploratory scenario set. However, this does not imply that participants