Ecological Modelling 322 (2016) 71–81

Contents lists available at ScienceDirect

Ecological Modelling

journal homepage: www.elsevier.com/locate/ecolmodel

Modelling and attitudes towards the future

Fabio Boschetti[a,b,*], Iain Walker[a,c], Jennifer Price[a]

[a] Commonwealth Scientific and Industrial Organisation, Canberra, Australia
[b] School of Earth and Geographical Sciences, The University of Western Australia, Crawley, Australia
[c] School of Psychology, The University of Western Australia, Crawley, Australia

ARTICLE INFO

Article history:
Received 9 June 2015
Received in revised form 9 October 2015
Accepted 19 November 2015
Available online 5 January 2016

Keywords:
Forecasting
Futures Studies
Ecological modelling, Natural resource management
Cognitive science

ABSTRACT

The outputs of ecological models often need to be projected several years, or decades, into the future. The psychological literature tells us that stakeholders rarely think of such a distant future and when they do, they employ cognitive styles different from the ones commonly used for planning and decision making, which the ecological models are designed to facilitate. This may affect the reception of modelling efforts in several ways. Stakeholders may question the very purpose of trying to say anything meaningful about such a distant future; may consider model outputs as irrelevant to planning; or may provide emotional, often unconscious, responses motivated by deeply held fears and aspirations. Modellers too may display some of these behaviours. Here, we review the relevant literature and describe a questionnaire a modeller could use to explore these issues within a stakeholder group. We also report an experiment which shows how the very act of answering the questionnaire can significantly change the perception of future time horizon and future concerns and discuss the possible implications for modelling projects.

1. Introduction

As a tool to support decision making, is it worthwhile to use computer modelling to explore the future 5, 10 or 20 years ahead of us? What about 50 or 100 years? There are at least two ways to address this question. One is technical and has to do with the process we want to study and the computer model we intend to use. It focuses on issues like the dynamical complexity of the process, its time scale, its sensitivity to initial conditions, the suitability of the model given the task, the type of questions we ask, our scientific knowledge, data availability and the level of inherent uncertainty. The second has to do with whether whoever has to make decisions based on the model's results believes the model can say anything useful about a future 20 or more years away from us. There are cases in which the scientific community believes some model results can reasonably be projected several decades in the future (once some crucial assumptions are understood and accepted) but some stakeholders may not be willing to believe the results, as in the case of the Club of Rome's Limits to Growth results (Meadows, 1972) and climate change and population growth projections, among other examples. There are cases in which the scientific community does not believe model results can be projected even a few years in the future but some stakeholders are willing to firmly believe the results (macro-economic forecast ahead of GFC).

The technical side of this question is briefly addressed in Section 2, where we discuss four broad scientific principles related to predictability. The core of this paper however is about the cognitive approach the above question. We first review some concepts from the social cognition and the psychology literatures which describe people's ways of thinking and attitudes towards the future. We place particular emphasis on how attitudes towards the future are related to other cognitive and psychological traits which are relevant to decision making and which may affect a stakeholder's willingness to include modelling results in the decision making process. We then describe a questionnaire we have used to survey the attitudes towards the future in a large sample of Australian citizens. The survey identifies five Myths of the Future, which represent beliefs, concerns and expectations about the future which most succinctly and clearly define individual differences in the way the future is conceived. The questionnaire, which we make available online, could be employed by a modeller to explore attitudes towards the future in the stakeholders of a specific modelling project.

One result from our survey is of particular significance for the modelling audience; answers to the purposely fuzzy question 'When you think of the future, what time frame is it?' change dramatically depending on whether the question is asked at the beginning or in the middle of the questionnaire. Answers to the question 'What are the first five words that come to mind when

* Corresponding author at: Commonwealth Scientific and Industrial Organisation, Canberra, Australia.
E-mail address: Fabio.Boschetti@csiro.au (F. Boschetti).

http://dx.doi.org/10.1016/j.ecolmodel.2015.11.009
0304-3800/

you think about the future?' behave similarly. This means that attitudes towards the future are ductile, at least for some individuals, and that the very act of addressing future issues can affect these attitudes. This also suggests that a modeller involved in a project requiring projections into the far future may see the stakeholder audience changing attitudes during the project itself, may need to be aware of this possibility and may need to tune stakeholder communication accordingly.

Before proceeding it is important to define some terminology. Considering modelling results pertinent to the future inevitably leads to the concept of prediction. As we discuss in Section 2, in some disciplines the proposal that (i) models generate predictions (Hempel, 1963) and (ii) predictions are necessary for decision making (Claveau, 2015; Pielke, 2003), is obvious and does not need justifying. In other disciplines a nuanced distinction is proposed between prediction, forecast, projection (extending model simulations into the future), foresight, prognosis and simulation (Bergman et al., 2010; Borjeson et al., 2006; Miles, 2010; Szpunar et al., 2014) or between potential, possible, plausible and probable futures (Hancock and Bezold, 1994). Given the scope of this work, we simplify the terminology by following Boschetti et al. (2011). First, we define projection as the output of a model which pertains to the future and prediction as an expectation on ranges of future behaviours, rather than the anticipation of an exact behaviour or event. In other words, a prediction is not a prophecy (Beven, 2002) and does not guarantee the certainty of an event. Second, we interpret a model output as a *conditional* prediction, which depends on the model's (explicit and implicit) assumptions as well as on the purpose of the model in the context of the problem at hand. Third, we assume that decision making implies choosing among potential alternatives and involves *predicting* the likely outcomes of these choices (Boschetti et al., 2013; Bradbury et al., 1985)[1]. With this understanding of the words prediction and projection, below we discuss what psychological and cultural factors affect their reception, how the time horizons of these projections affect their receptions and how these relate to attitudes towards the future in general.

2. Prediction and the future from the modellers' perspective

Beliefs about the extent to which a model projection to the far future can provide a useful input to decision making varies not only among stakeholders and decision makers, but also among modellers. It is possible that these different beliefs originate from the same attitudinal and cognitive biases which affect non-modellers and which we describe below. However, it is also likely that a modeller may feel a greater need to rationalise these beliefs, at least for communication purpose. Four broad scientific principles can provide an anchor for such rationalisation. The first invokes a time-symmetry between explanation and prediction: the principle which allows us to employ physical laws or statistical regularities to make a prediction is the same which allows us to explain an event from its past (Suchting, 1967; Symons and Boschetti, 2012). As a result, if we believe in our ability to explain we should also believe in our ability to predict. The second principle invokes a broad analogue of chaos theory, which emphasises predictions' (and model outputs in particular) sensitivity to initial conditions, data gaps and overall uncertainty (Aligica, 2003; Ascher, 1989, 1993; Beven, 2006, 2002; Brunner, 1999; Oreskes, 2000, 2001). Notice that, technically, accepting both the first and the second principles should lead us to dismiss not only our ability to predict, but also to explain and understand (Symons and Boschetti, 2012), while some modellers defend models' explanatory power, but not their predictive power (Brugnach, 2010; D'Aquino et al., 2003). The third principle highlights a prediction's scale dependence in both time and accuracy (Israeli and Goldenfeld, 2004), of which a well understood example is the difference between weather (fine scale) vs climate (coarse scale) predictions. The fourth principle refers to predictions' self-reference when they involve human behaviour: any prediction which is known to a decision maker can affect his/her decision and as a result the prediction itself.

These principles are well established in both theoretical and applied science as well as in the philosophy of science. In some cases they also come with rigorous mathematical formalisations. Some of these principles justify our reliance on (conditional) predictions, others not. As a result, modellers could invoke them to give firm theoretical justification for a wide range of beliefs regarding what, if anything, a model can say about the far future. This does not necessarily mean that a modeller would do so to deceive. However, scientists, and experts in general, are not immune from 'motivated reasoning' (Kunda, 1990). Motivated reasoning describes how, in order to justify a particular conclusion, people are more likely to employ beliefs and strategies which are compatible with such a conclusion. In the case of modellers, this may affect the adoption of or belief in certain types of models.

As we will see in the next section, the four principles described above (time-symmetry between explanation and prediction, sensitivity to initial conditions, prediction's scale dependence and self-reference) resemble very closely attitudes and beliefs towards the future which are also found among the general public. While motivated reasoning can affect anyone, individuals with higher cognitive skills or expertise will likely have a wider range of rational justifications at their disposal and a better ability to employ them (Kunda, 1990; Nisbet and Markowitz, 2015). It follows that in modellers motivated reasoning may interfere, or even be masked by expertise, something which both modellers and stakeholder need to be aware of.

3. Psychological and individual traits affecting attitudes towards the future

A number of approaches to study attitudes towards the future can be found in the psychological and social science literatures. Nevertheless, a unified framework is not yet available and the field is currently undergoing considerable development. In this section we review five main approaches which go under the labels of (1) Zimbardo's Time Perspective Inventory, (2) the 'mental time travel' literature, (3) Temporal Construal, (4) Consideration of Future Consequences and (5) Time-Discounting. Because our focus is specifically on the use of models to carry out (conditional) predictions, we place particular emphasis on two related concepts: (i) perception of time in terms of past, present, close future and far future components and (ii) attitudes towards these components.

3.1. Zimbardo's Time Perspective Inventory

Zimbardo's Time Perspective Inventory divides time into three components (Boyd and Zimbardo, 1997; Zimbardo and Boyd, 1999): past, present and future, without particular emphasis on scale, measurement or reference (little emphasis is placed on a distinction between close and far future). It suggests that people cluster around five different attitudes towards time. The first describes a negative attitude towards the past, which is

[1] This sentence may appear as normative, rather than descriptive. But consider the extreme case of a decision maker choosing according to his/her short-term interests, with no regard or knowledge of long term consequences. Even in this case, the decision is made following the prediction that the choice will likely fulfil the short-term interests.