‘Gamesourcing’ data for socio-ecological models

Jeroen Minderman

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# Summary

# Introduction

In recent years, the use and application of models has become widespread and indispensable in conservation science, ranging from demonstrating the likely effects of climate change **(ref IPCC report)** to supporting the understanding of fundamental processes in natural resource management (**ref Fryxell or similar**). Given the continued rapid loss of biodiversity, understanding the mechanisms and consequences of such loss is vital. Although a number of drivers of biodiversity loss have been identified, one of the most prevalent and widespread ones is human exploitation of habitats and natural resources, both directly (e.g. through hunting or habitat loss to agriculture) or indirectly (e.g. through international trade in natural resources) (e.g. Maxwell et al. 2016; Wilting et al. 2017).

Thus, the development of models that can effectively represent systems in which natural resource dynamics and human decision making interact is becoming increasingly urgent.

Cutting-edge modelling approaches have made significant inroads towards this goal.

It is clear that successful applications of such models rely not only on effective and accurate parameterisation, but also on effective communication of both the model itself as well as its inputs and outputs, particularly to non-specialist audiences.

Games have a long history of being used as educational tools, and in research settings as tools to communicate complex ideas and processes to non-specialists, including in socio-ecological studies. [EXAMPLES OF EDUCATIONAL/PROMOTIONAL GAMES] [NOTE ON CONCEPTUAL VALUE OF USING GAMES IN THESE SETTINGS].

Given this long history, it is striking that the parallels between games (particularly videogames) and models are not discussed more widely. All models are abstract representations of environments, actors and relationships, with inputs (parameters) and outputs (predictions or inferences). Similarly, all games present a player with an environment in a given state (parameters), including one or more actors, which can take actions (inputs) to affect the environment for a given effect (outputs). It is worth stressing that every game has an underlying model that defines the state of the environment, relationships between objects in this environment, and inputs and outputs available to the player. However, while games are by definition designed with player (user) interaction in mind, models rarely have user-facing or even user-friendly interfaces, and running or adapting them to specific circumstances often relies on technical expertise. Casting models as games therefore provides an opportunity to effectively improve the communication and understandability of even relatively complex models. Inputs and outputs may be presented in a visual way and tweaked depending on the type of audience, and both potential applications and limitations of the model can be demonstrated effectively.

In addition, presenting a model as a game provides an opportunity to empirically collect data on how stakeholders make decisions in the modelled environment

Thus, model-games can be considered “virtual laboratories” to not only test specific hypotheses or predictions, but potentially also as an effective method to source data to parameterise the underlying models, based on in-game decisions by real humans.

We here aim to illustrate the potential for this model-game approach, both in terms of aiding model communication as well data collection for improved parameterisation, by introducing Animal&Farm (A&F). We developed A&F as a simple interactive game front-end for a complex socio-ecological modelling framework (GMSE), in which the player acts as the manager of a virtual environment in which a population of wild grazing animals (the natural resource) may adversely affect farming yield, with farmers acting to maximise their yield and potentially hunting the animals. We argue that that by acting as an interface between users (i.e. players) and a complex underlying model with many components and assumptions, such a game can simultaneously (1) aid the communication and useability of the underlying model and (2) can be used to gather data to improve the parameterisation of such models. We first briefly summarise the underlying modelling framework, its potential and limitations. Second, we describe both the structure of A&F itself as well as its database back-end. Third, we outline how this approach may be used to collect data on player decision-making in simulated *in silico* experiments, and present some example results of doing so; noting that these findings are intended as illustrative only. Finally, we discuss both the limitations of this approach, using test player feedback as a basis for this, as well as its wider potential.

# Outline of approach

## Underlying model: GMSE

### Basic introduction of GMSE principles and structures

### Brief discussion of limitations of GMSE

## Animal&Farm

### Structure as relating to GMSE

### Database “back end”

### “Sandbox” for *in silico* experiments

Expandability of parameter variation

Setting up “scenarios” to test specific hypotheses/predictions

# Example application

## Methods/rationale for scenario set up

## Illustrative results

## Summary of player feedback

# Discussion

## Brief summary of aims, process and outcome of example scenarios

## Revisit player feedback

## Discussion of limitations of overall approach, with reference to player feedback

## (Potentially general discussion of issues with games approach?)

## Discussion of potential

### Communication/education: highlight player feedback as very point of approach: game may be abstract, restrictive and not representative of reality, but this is case for any model, yet latter point often “hidden.” By taking game approach, shortcomings more obvious to non-specialists.

### Yes, problematic when expecting direct application to real life, but again this is/should be clear for all models.

### Highlight expandability of approach, sandboxing ideas in flexible simulated environment

Maxwell, Sean L., Richard A. Fuller, Thomas M. Brooks, and James E. M. Watson. 2016. “Biodiversity: The Ravages of Guns, Nets and Bulldozers.” *Nature* 536 (7615): 143–45. <https://doi.org/10.1038/536143a>.

Wilting, Harry C., Aafke M. Schipper, Michel Bakkenes, Johan R. Meijer, and Mark A. J. Huijbregts. 2017. “Quantifying Biodiversity Losses Due to Human Consumption: A Global-Scale Footprint Analysis.” *Environmental Science & Technology* 51 (6): 3298–3306. <https://doi.org/10.1021/acs.est.6b05296>.