Online multiplayer games as virtual laboratories for collecting data on social-ecological decision-making

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Introduction

In the Anthropocene, human actions affect the persistence and abundance of nearly all critical natural resources, including the biodiversity on which indispensable ecosystem services depend (Dirzo et al. 2014; Ellis 2019). Sustaining these resources is of global importance for humanity, as all humans rely on them to subsist and thrive. Yet natural resource management has become a difficult, seemingly intractable, challenge (Defries and Nagendra 2017). This is partly caused

by an inability to accurately predict social dynamics within social-ecological systems, especially in systems where conflict exists between the interests of human livelihoods and long-term conservation. In such systems, decisions are made by multiple interacting stakeholders with unique and potentially conflicting values, interests, and objectives (Redpath et al. 2013, 2018). To better predict social dynamics in these systems, new tools are needed that can manage the complexity underlying the causes and consequences of human decision making.

Games are valuable tools for studying human decision making (Chabris 2017; Vermillion et al. 2017; Reddie et al. 2018), and are increasingly being used in social-ecological research (Villamor and Badmos 2016; Garcia et al. 2016, 2020). Games have unique advantages and limitations (Redpath et al. 2018), but a thoughtful application of games can ultimately allow researchers to better understand how people make strategic decisions in complex situations involving trade-offs, conflict, and uncertainty. Developing, coordinating, and collecting data from research games often requires considerable time investment and technical skill (Redpath et al. 2018). This includes time spent recruiting players, and building physical game pieces (for table top games; e.g., Garcia et al. 2020) or developing software (for computer games; Janssen et al. 2014). For computer games, even researchers who are experienced programmers do not typically have the technical skill or expertise necessary to apply game graphics or game play mechanics on par with professional game developers. Harnessing such expertise could drastically increase the scale and complexity of questions that could be addressed, and data that could be collected, in social-ecological research games. The technology to do this already exists in commercially successful computer games, as does an audience for games involving social-ecological decision making (Del-Moral Pérez and Guzmán-Duque 2014; Burroughs 2014). The

time is ripe to take these games seriously as an opportunity for improving research game development, data collection, social-ecological models, and ultimately real-world solutions. We envision an open-source platform with a graphical user interface that researchers can use for game development, deployment, and data collection.

Game development for social-ecological researchers

Open-ended online social videogames (hereafter 'videogames') provide immersive simulated environments for millions of players world-wide (e.g., Del-Moral Pérez and Guzmán-Duque 2014; Burroughs 2014). This genre of games differs from what some might think of as a stereotypical 'videogame', so it is important to clarify what we mean. Open-ended games can continue indefinitely (players save progress and return to them as desired), and there are no set objectives or requirements beyond those which players create for themselves. There is no winning or losing. Instead, playing is primarily a creative process of building something new from an initially empty state. This process could be creating a fictional character that the player embodies, or building a city or farm from an empty simulated landscape that develops over the course of days, months, or even years (Del-Moral Pérez and Guzmán-Duque 2014; Burroughs 2014). Such development might be initially restricted by in-game barriers that must be gradually overcome (e.g., accruing sufficient in-game currency, production metrics, or tools through consequences of game play decisions). This can incentivise players to pursue specific in-game goals, as can social pressure from other players, but doing so is not a game requirement. Videogames such as SimCity, FarmVille, and CityVille have tens of millions of players (Del-Moral Pérez and Guzmán-Duque 2014; Burroughs 2014). Nevertheless, their potential in social-ecological research remains unexplored.

Building professional quality videogames from scratch is not feasible for most researchers, but it also should not have to be necessary. Commonly used elements of research games (e.g., graphics, game objects, player interface, game play options, etc.) could be developed and packaged as software for researchers to build their own custom game environments and rules from a common graphical interface. This type of world editor tool already exists in popular videogames (e.g., SimCity and Minecraft), and could be refined for a research gaming context. Researchers could generate their own maps with abiotic and biotic environments, and specify player communication rules and available player actions, or set schedules for in-game events (e.g., biological invasions, natural disasters). Once game conditions are specified, game play could occur remotely or in the laboratory, and detailed data on player decision making could be collected automatically. This software would greatly improve game quality and accessibility for researchers, as currently available research platforms do not offer the same quality of graphics or game mechanics for experimental games as exist in commercial games; customisation of experimental games with existing software also typically requires at least some coding (Janssen et al. 2014; Chan et al. 2019). Investing in a professionally developed, standardised point-and-click game development software would therefore have wide-ranging benefits for researchers, facilitating the collection of decision-making data and parameterisation of social-ecological models.

Data collection and application to social-ecological models

The videogame platform that we propose could be used to efficiently create complex game designs and automate data collection in game sessions, as they are currently conducted in social-ecological research. But this platform could also be used to deploy free and open online

games, allowing for game play on an unprecedented scale (e.g., Del-Moral Pérez and Guzmán-Duque 2014; Burroughs 2014). Realistic in-game ecological dynamics would allow for social-ecological feedbacks as thousands of players develop and maintain their own virtual lands, interact with virtual neighbours, and respond to in-game challenges (e.g., resource depletion, disease outbreaks, extreme events). For example, some virtual areas of the game environment might experience a local outbreak of agricultural pests, incentivising players to respond by changing their land use, creating parks, constructing deterrents (e.g., fences), or direct action (e.g., scaring or culling). Other virtual areas might contain valuable resources or high biodiversity, which could be exploited for profit or conserved. Player decisions might affect long-term ecological dynamics and resource sustainability, and positively or negatively affect in-game neighbours in ways that result in cooperation or conflict. The end result would be a rich source of decision-making data collected from *in silico* semi-natural field experiments (Chabris 2017), which could be used for both statistical inference and social-ecological model parameterisation.

To ensure high quality data, decision-making environments would need to be complex, and players would need to be invested in their decisions. Hence, in contrast to popular commercial video games that often tolerate or outright encourage antisocial behaviour for the purpose of entertainment (e.g., violence or recklessness), decisions in research videogames would need to have appropriate in-game consequences. If this were the case, then there is no inherent reason to believe that players would make careless decisions just because they are playing a game. In many videogames, players spend hours or days developing virtual objects, accruing in-game currency, and building within-game social capital (Balnaves et al. 2012). Virtual game objects

are often highly valued, and are sometimes even considered by players to be priceless (Yee 2006; Livingston et al. 2014). Hence, players are often highly invested in the digital worlds that they create (Lofgren and Feff 2007).

Conclusion

We have outlined a vision for videogames in research that we believe would benefit existing research programmes while simultaneously leading to entirely new avenues for big data collection. Social-ecological researchers could build off of the established popularity and technology of videogames to greatly expand the scale of game complexity, player engagement, and data collection. Big data generated from online games could be applied to suggest novel solutions to real-world problems (e.g., Khatib et al. 2011). Data could also be used to parameterise social-ecological models, which are currently limited in their ability to accurately model complex and goal-oriented human decision-making (Schlüter et al. 2012; Duthie et al. 2018). For example, videogame data might be used to build a robust Artificial Intelligence of stakeholder decision making in agent-based models to better predict biodiversity change across different local land conditions and management policies.

Lastly, it is critical to recognise that our proposal would present novel ethical challenges for data collection, which would need to be carefully considered before implementing videogames in research (Redpath et al. 2018). While a full discussion of videogame research ethics is beyond the scope of this paper, it is critical that informed consent be obtained from any players whose data are being collected. We also stress the importance of ensuring player privacy and safety,

and the need to be proactive to ensure that any new game platforms created do not enable hate

or harassment, or exacerbate existing inequalities.

Literature Cited

Balnaves M, Wilson M, Leaver T. 2012. Entering Farmville: finding value in social games. Pages 1–12 in In refereed proceedings of the Australian and New Zealand communication association conference: Communicating change and changing communication in the 21st century. Australian; New Zealand Communication Association.

Burroughs B. 2014. Facebook and FarmVille: A digital ritual analysis of social gaming. Games and Culture **9**:151–166.

Chabris CF. 2017. Six suggestions for research on games in cognitive science. Topics in Cognitive Science **9**:497–509.

Chan, SW, Schilizzi S, Iftekhar MS, and Da Silva Rosa R. 2019. Web-based experimental economics software: How do they compare to desirable features? Journal of Behavioral and Experimental Finance **23**:138–160.

Defries R, Nagendra H. 2017. Ecosystem management as a wicked problem. Science **356**:265–270.

Del-Moral Pérez M-E, Guzmán-Duque A-P. 2014. CityVille: collaborative game play, communication and skill development in social networks. Journal of New Approaches in Educational Research **3**:11–19.

Dirzo R, Young HS, Galetti M, Ceballos G, Isaac NJB, Collen B. 2014. Defaunation in the Anthropocene. Science **345**:401–406.

Duthie AB, Cusack JJ, Jones IL, Nilsen EB, Pozo RA, Rakotonarivo OS, Moorter BV, and Bunnefeld N. 2018. GMSE: an R package for generalised management strategy evaluation. Methods in Ecology and Evolution **9**:2396–2401.

Ellis E. 2019. Sharing the land between nature and people. Science **364**:1226–1228.

Garcia CA, et al. 2020. Coffee, farmers, and trees-shifting rights accelerates changing landscapes. Forests **11**:1–19.

Garcia C, Dray A, Waeber P. 2016. Learning begins when the game is over: using games to embrace complexity in natural resources management. Gaia **25**:289–291.

Janssen MA, Lee A, and Waring TM. 2014. Experimental platforms for behavioral experiments on social-ecological systems. Ecology and Society **19**:20.

Khatib F, Cooper S, Tyka MS, Xu K, Makedon I, Popović Z, Baker D, and Players F. 2011. Algorithm discovery by protein folding game players. Proceedings of the National Academy of Sciences **108**:18949–18953.

Livingston IJ, Gutwin C, Mandryk RL, Birk M. 2014. How players value their characters in world of warcraft. Pages. 1333–1343 in Proceedings of the acm conference on computer supported cooperative work, cscw.

Lofgren ET, Feff NH. 2007. The untapped potential of virtual game worlds to shed light on real world epidemics. The Lancet infectious diseases **7**:625–629.

Reddie AW, Goldblum BL, Lakkaraju K, Reinhardt J, Nacht M, Epifamouvskaya L. 2018. Next-generation wargames. Science **362**:1362–1364.

Redpath SM, et al. 2018. Games as tools to address conservation conflicts. Trends in Ecology and Evolution **33**:415–426.

Redpath SM, et al. 2013. Understanding and managing conservation conflicts. Trends in Ecology and Evolution **28**:100–109.

Schlüter, M, et al. 2012. New horizons for managing the environment: A review of coupled social-ecological systems modeling. Natural Resource Modeling **25**:219–272.

Vermillion SD, Malak RJ, Smallman R, Becker B, Sferra M, Fields S. 2017. An investigation on using serious gaming to study human decision-making in engineering contexts. Design Science **3**:1–27.

Villamor GB, Badmos BK. 2016. Grazing game: a learning tool for adaptive management in response to climate variability in semiarid areas of Ghana. Ecology and Society **21**:39.

Yee N. 2006. The psychology of massively multi-user online role-playing games: motivations, emotional investment, relationships and problematic usage. Pages 187–207 in Avatars at work and play. Springer, Dordrecht.