

Integration of games and models as an approach to support inclusive environmental conservation

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Abstract

Socio-ecological conflicts involving human beings, wildlife, livestock, and crops present significant challenges for communities and impact sustainable development efforts. This research explores the use of interactive simulation games that closely replicate and model real-world social-ecological systems and scenarios. These games are used to understand, learn and collect qualitative data about environmental lived experiences and player decision-making patterns. As part of this research, we developed EcoKnowGames Creator, a tool for integrating valid scientific models with video games. Focusing on Namibia as a scope country, we created a conflict game over lion conservation to engage participants in workshops, collect qualitative data on decision-making behaviours, investigate conflict mitigation strategies, and promote inclusive environmental conservation. This paper explains how the simulation game was used to explore decision-making patterns and trade-offs in a conservation conflict. It further addresses how games can facilitate dialogue and contribute evidence to inform research and support the uptake of inclusive sustainable conservation goals.

CCS Concepts

• **Computing methodologies** → **Modeling and simulation; Simulation tools.**

Keywords

Simulation games, decision-making, social-ecological, conservation conflicts

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1 Introduction

With global efforts to protect and conserve the environment in accordance with the United Nations Sustainable Goals (UN SDGs), it is increasingly important to understand how humans respond to environmental changes [14] and encourage inclusive and sustainable socio-ecological resource management. This research explores simulation games that closely replicate and model real-world social systems and scenarios.

In recent years, digital games have been developed to gain scientific and humanistic insights and tackle real world problems in fields including sciences, healthcare, humanities, education, training, visualisation, and productivity [16] [17] [23]. Senka et al. [19] argued that educational games can be used to gather data about game engagement and environmental decision-making, while also encouraging environmental awareness and sustainability. This research agrees with this premise and adds that simulation games can also serve as conduits for research and facilitating environmental discussions, collaborations and solution creation.

Numerous research has been conducted using simulation games for research and engagement in different contexts (see [3] [4]). In Tanzania, an experimental game was developed to explore preferences for coexistence strategies between humans and lions [15]. However, little research has been conducted on using simulation games in Namibia to understand decision-making behaviours and gather data about inclusive and sustainable environmental conservation practices. Recognising that human decisions universally impact the environment, including human beings and animals [14], this research builds on the findings of similar game research, such as PowerUp and RestoreID [9]. We conducted workshops in Windhoek, Namibia, to gain perspectives on participants' social-ecological decision-making patterns and examined the impact of games in facilitating dialogue around environmental sustainability challenges and solutions.

Consequently, this research used Ecological Knowledge Games (EcoKnowGames) Creator tool, developed with Glitchers (see <https://>



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(<http://www.glitchers.com/>), to create and integrate valid scientific models with video games used to investigate context specific socio-ecological challenges. For this project, we created a game that explores Namibian socio-ecological conflicts between farmers, community members, lions, and conservationists. The game is used as a tool to explore decision-making patterns and trade-offs in conservation conflict. It further addresses how games can facilitate dialogue between farmers, communities, conservationists, and policymakers, with the aim of contributing evidence to inform research, promote coexistence between wildlife, farmers and community members and support the uptake of inclusive sustainable conservation goals.

2 Related Work

Socio-ecological conflicts involving humans, wildlife, livestock, and crops present significant challenges for communities, and they impact sustainable development efforts [5] [24]. This research explores simulation games to understand ways communities and conservationists navigate environmental challenges and investigates how decision-making and trade-offs in conservation conflict impact ecosystem dynamics. Simulation games have been employed in various fields to engage people in gamified real-life scenarios, for training, education, analysis, information learning, conservation purposes [12] [1].

Games have also been developed in different contexts to conduct research and tackle environmental challenges focused on disaster risk management [21], restoring ecosystems [13], and the management of resources and pests [23]. These games can immerse players in real-world socio-ecological situations to collect data about player decisions and actions, and can also be used to promote conservation.

Similarly, in Namibia, various digital and board games have been created with an emphasis to promote entertainment, education, gamification, awareness, and storytelling. These include games such as Onlinicus: a game designed to prevent Online Abuse [7] and Cassette Roulette: a game that promotes music [6]. However, there remains limited evidence supporting the use of simulation games in supporting inclusive environmental management and conservation efforts.

Research conducted by Rakotonarivo et al. [11] in Gabon, developed a simulation game aimed at understanding approaches farmers use to mitigate conflict of elephants damaging crops, further learning about decisions made about land management. Their study found that simulation games can be used to engage communities and stakeholders, understand decision-making patterns, and manage socio-ecological conflicts. They further learned that people's decision to kill elephants was influenced by their evaluation of the positive effects that elephants have on well-being and the importance of elephants to the ecosystem [11].

This research learns from and builds on Rakotonarivo et al.'s [11] and [23] research studies and develops a simulation game that replicates socio-ecological challenges, particularly conservation conflicts in Namibia. It explores how communities and conservationists make decisions about socio-ecological conflicts and investigates the navigation of trade-offs within conflict complexities between human safety, livelihoods (livestock, farmland, gardens), and wildlife protection. The simulation game is further utilised as a platform to support dialogue around environmental sustainability

challenges and to generate insights that can promote the uptake of inclusive sustainable systems.

3 Methods

This project conducted focus group workshops in Windhoek, Namibia, employing qualitative methodologies. Convenience and snowball sampling methods were used to recruit participants. Twenty-seven participants from community groups and institutions participated in the workshops that focused on collecting data about human-lion conflicts taking place in Namibian conservations and surrounding villages. These conflicts involve lions attacking livestock, people killing lions to protect their livelihoods, and the protection of lions because they are a protected species.

3.1 Game design

As part of the EcoKnowGames research project, and in collaboration with the game company Glitchers, we developed EcoKnowGames Creator (see Figure 1), an open source tool (see <http://github.com/EcoKnowGames/creator>) used for integrating valid scientific models with video games that replicate context specific ecosystems. EcoKnowGames Creator was developed using Unity, a game engine used to develop 2D and 3D applications and experiences [22] and it builds upon two simulation games including PowerUp [18] and RestoreID [13], to address a similar goal. These games capture gameplay data and are used to investigate game trade-offs and player decision-making patterns across different ecological contexts. The games aimed to learn more about, mitigate, and create solutions for various environmental challenges, further promoting ecological sustainability.



Figure 1: Figure 1: EcoKnowCreator landing page. Design credit: Glitchers

The main aim of EcoKnowGames Creator, is to develop games that are used to gather gameplay data and explore decision-making and behavioural patterns as players engage with different environmental actions and resources on a spatially explicit game landscape. These games are underpinned by a generalised Lotka-Volterra model, which represents the complexities of ecological systems with interacting species [20].

We developed a conservation conflict game in the context of Namibia to understand how communities and conservationists navigate conflicts (see Figure 2). It is a single-multi player game and consists of 12 rounds, each with two play actions.

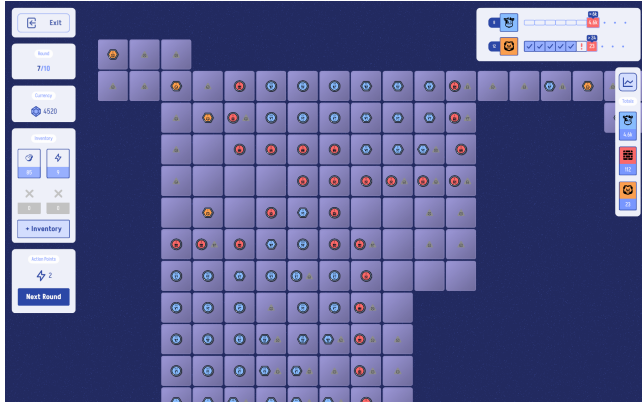


Figure 2: Figure 2: Round one map. Design credit: Glitchers

For this project, participants played the game as single players. The game landscape was designed to look like the Namibian map and includes options and resources such as animals (cows and lions) and fences that players engage with. During the game, players can make decisions about cows and lions, such as relocating lions from a specific area to protect cows or harvesting cows to sell. Both options allow players to gain currency, which they could use to purchase and introduce fencing to keep lions away from cows. The game actions taken by players incur different costs and can negatively or positively affect the environment. Game realism was influenced by spatial and temporal dynamics incorporated in the game that reflect realistic engagement with the environment, conflicts, and the impact on the ecosystem.

4 Data collection

During this study's workshops, the mechanics of the conflict simulation game did not incorporate a telemetry function to collect game-play data and analytics. Instead, the game was used as an approach to collect qualitative participant contributions about decision-making patterns, game engagement, and to learn about environmental lived experiences. Participants shared their views on current conservation conflicts, as well as their opinions of the game, its significance, and shortcomings. This paper thus analyses workshop discussions and survey data from two perspectives: understanding player decision-making and lived experiences, and the effectiveness of the game to support dialogue around environmental sustainability and conservation challenges.

5 Findings: Player Decision Making Actions

Participants actively engaged with the game and shared insightful contributions about their decision-making patterns, lived experiences and existing conservation conflicts. Following the game engagement, participants and researchers discussed the value of

simulation games in supporting social-ecological dialogue and collaboration between farmers, communities, conservation stakeholders, and policymakers. We also discussed how learning outcomes from games engagement can encourage environmental conservation and inform policies that promote the uptake of new sustainable goals.

Participants shared that the game experience was enlightening and enabled them to think more about the decisions they make about the environment, understanding that decisions made and how conflicts are handled can impact both communities, farmers, livestock, wildlife, and conservationists.

Decisions participants made were influenced by the knowledge they possessed about the environment, and their personal and professional lived experiences. Participants indicated that they too have experienced lion impacts personally or by family and friends, in their communities, or during work. One participant shared that because of the context she comes from and with the lion being the totem animal for their village, she was inclined to protect the lions. She further added that wildlife usually wanders into villages and community settlements, but there are awareness projects and mitigation strategies in place that inform people how to respond to these encounters. These strategies include calling conservation officials to report wildlife sightings, using natural deterrents to keep wildlife away, and building secure fencing to protect livestock and crops (see [2] [10]). Another participant shared that her family owns and depends on farming for income, which led her to focus on harvesting cows to sell and invest in fencing to protect the cows. These findings suggest that personal and collective social-environmental lived experiences played a role and influenced some decisions made during the game.

We also discussed the possibility of making similar decisions in real-life as in the game. Most participants shared that in a real-life situation, they would protect both animals to conserve the environment. However, it's important to note that real-life conflict situations are different from simulation game experiences. In real-life, communities face real threats, and the killing of their livestock affects their livelihoods. Consequently, we recognise that the game's absence of 'real-world risk' has a potential to influence the players' decision-making toward more idealised outcomes.

With conservation related conflicts increasing, Naha et al., [8] emphasised the need for conflict mitigation strategies that consider both cultural and ecological factors to maximize conflict reduction impact. Therefore, promoting inclusive environmental conservation and having knowledge on how to mitigate and respond to conservation conflicts is critical. There is an imperative to understand conflict complexities, the different roles played by stakeholders and animals, and to create inclusive conflict mitigation solutions that promote sustainability. In that regard, one participant shared that environmental management, conservation, and conflict solutions should be inclusive, and consider learning from and incorporating community indigenous knowledge to learn about previous approaches used to navigate and respond to conflicts.

In terms of dialogue support and stakeholder collaborations, research findings indicate that simulation games can be used to support significant environmental dialogue and collaborations between farmers, communities, conservationists, and policymakers and can promote environmental sustainability and conservation.

6 Limitations

This research acknowledges several limitations that may constrain its scope. The results presented are primarily based on qualitative data and do not include quantitative gameplay data because the telemetry function was not operational at the time of this study. Moreover, the current game design includes a multiplayer feature that enables different players to play interchangeably, with each player making decisions on a specific round and their actions affecting the spatiality of resources in the next rounds. However, participants played as single players, and their decision-making patterns on the landscape were limited to individual participants rather than the group. The game also presents a limitation of system simplicity, in that factors that are important in the real world were not included in the game.

7 Conclusion and way forward

The research promotes simulation games as an approach to collect data and promote inclusive environmental conservation. It used EcoKnowGames Creator to create and integrate valid scientific models with a conservation conflict game that replicates real socio-environment and conflict situations in Namibia. The game was used to explore social-ecological decision-making and promote dialogue around ecological challenges. This paper emphasises the importance of using realistic and relatable approaches to include community members in conservation management conversations and the creation of responses and mitigation solutions to challenges faced on ground. Both game engagement and workshop discussion enabled researchers to learn from participants about conflict encounters and challenges, environmental lived experiences, decision-making, and the use of simulation games to promote dialogue and create sustainable socio-ecological solutions. This research recognises that human decisions have a high impact on people, animals, and the ecosystem, further reinforcing Heydinger et al.'s (2024) argument that the livelihoods of humans and survival of lions depend on each other. Consequently, there is an imperative to promote inclusive environmental conservation, while learning from community knowledge on how to mitigate and respond to conservation conflicts.

Future work will focus on improving the design and gameplay mechanics of EcoKnowGames Creator. It will incorporate a telemetry function to collect gameplay data that will be used to analyse and visualise player actions and behaviours. The gameplay data will be captured on the digital device and saved in a JSON file. More workshops will be conducted to collect quantitative and qualitative data and visualisations. Future research will also collaborate with policy makers to investigate how simulation games might inform and support the uptake of inclusive environmental policies

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