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# Beyond top-down policymaking: Policymaker–landowner interaction promotes reforestation in a strategy game

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ABSTRACT

Scotland aims to achieve net-zero emissions by 2045, with afforestation and native woodland restoration as key strategies, targeting 25% woodland cover by 2050, or roughly 10,000 ha of new woodland annually. Much of this expansion depends on private landowners often supported by public subsidies. Yet landowners are often resistant to native woodland expansion on account of their prioritization of traditional land uses and perceived economic risks. Understanding the factors that influence landowner uptake is therefore crucial for designing effective policies. This raises the question: how does interaction between policymakers and landowners affect policy adoption? To provide insights on this, we developed a custom strategy game as an interactive socio-ecological model in which local stakeholders develop land and resource use strategies as estate owners, farmers, or policymakers. In the game setting, 'landowners' made decisions on land-related economic activities, while 'policymakers' enacted policies with potential impact on the 'landowners' activities. In-game landscape indicators tracked land use changes. Discussions among players were recorded with a microphone for later analysis. We showed that interactions during policy drafting between land managers and policymakers within the frame of the game modeling process are associated with higher adoption rates of proposed policies. This suggests that, under simplified experimental conditions, integrating stakeholder perspectives early in real-life policy formulation could enhance the effectiveness of reforestation strategies in Scotland by addressing both ecological and social barriers to successful implementation. More broadly, in regions where policy adoption is limited by low stakeholder engagement or misaligned incentives, accessible and engaging participatory approaches as represented by strategy games may foster more effective and widely supported environmental governance.

## 1. Introduction

Scotland aims to achieve net zero emissions by 2045 under the Climate Change Act 2019 (Scottish Government, 2019). Afforestation and woodland restoration are key strategies to reach this target (Scottish Government et al., 2020), with a policy target to increase woodland cover to 25% of total land area by 2050, requiring the establishment of approximately 10,000 ha of new woodland each year (Thomas et al., 2019). Much of this expansion is expected to occur on privately owned land, supported by public subsidies through woodland grant schemes (Thomas et al., 2019). However, challenges to woodland expansion are often rooted in landowner resistance, influenced by traditional land use priorities and perceived economic risks (Burton et al., 2019). Such resistance continues to pose a significant barrier to meeting afforestation targets (Burton et al., 2019). The challenges Scotland faces in implementing its climate and forestry policies reflect a complex interplay of environmental, social, and cultural factors, including divergent stakeholder values regarding restoration and biodiversity (Gaia et al., 2017), misalignment between ecological and administrative boundaries (Fraser et al., 2006), and conflicting land use objectives between economic development and conservation (Reed, 2008).

Local community involvement has been shown to play a beneficial role in the success of environmental restoration initiatives, including afforestation and woodland restoration efforts (Ortega-Alvarez et al., 2021). This aligns with the UN Decade of Ecosystem Restoration 2021–2030's emphasis on community-based planning (Gann et al., 2019). However, most initiatives globally limit community participation to execution rather than decision-making (Derak et al., 2017; Silva et al., 2023). Such constraints often result in a misalignment between

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top-down restoration targets and bottom-up local needs. To address these complex challenges, researchers advocate for systemic approaches (Conklin, 2001; Davies et al., 2015) that incorporate multisector decision-making and cross-boundary collaboration (Defries and Nagendra, 2017). Still, participatory approaches are rarely implemented effectively, and shifting from top-down to bottom-up governance in landscape management remains a persistent challenge. This difficulty stems from deep-seated power asymmetries, institutional silos that resist cross-sector collaboration, and a lack of robust empirical evidence to prove these approaches outperform traditional top-down methods (J. Reed et al., 2020).

Participatory socio-ecological modeling can help to overcome these challenges. Companion Modeling (ComMod) is one such participatory approach that uses strategy games (also called serious games) which simplify real-world scenarios but represent their main elements and their underlying dynamics, while incorporating diverse stakeholder perspectives and deliberation. Functioning as a deliberative co-design interface, these games facilitate higher-intensity interactions than traditional consultations (Ampatzidou et al., 2018; Mayer, 2009; Savic et al., 2016). Strategy games have proven to be a valuable tool in natural resource management (Chen et al., 2025; Irabor et al., 2025) by supporting stakeholder and wider citizen involvement in environmental restoration and policy making (Edwards et al., 2019; Garcia et al., 2022). They have been applied across a range of contexts to investigate diverse aspects of environmental decision-making; Vesnic-Alujevic and Rosa (2022) use it to negotiate future-situated policy options, Sajjadi et al. (2022) found that a digital serious game about the Earth's critical zone improved support for environmental policies and Olejniczak et al. (2018) propose games as a tool to test and refine complex policies by simulating their impacts and actor responses in a safe, participatory environment.

Despite the various applications of strategy games, Edwards et al. (2019) highlight a key research gap: role-playing games are rarely designed to bridge community-level actors and higher-level policymakers, with most games targeting either local landowners or policy actors, but rarely within the same game. Through strategy game sessions simulating real-world land management decisions in the context of forest and landscape restoration objectives in Scotland, this paper addresses this gap by exploring how the degree of interaction between policymakers and landowners affects policy adoption by the landowners. Unlike surveys or interviews, where compliance and behavioral follow-through cannot be verified (Brenner and DeLamater, 2016; Romadiyanti et al., 2025), this study captures interactions as they unfold in real time and directly links these interactions to subsequent policy adoption. This approach not only provides stronger empirical evidence for the role of interaction but also highlights the methodological contribution of using a strategy game to observe actual decision-making dynamics rather than relying solely on self-reported attitudes. By simulating complex social-ecological dynamics, such games can bridge the gap between top-down policy design and the local realities of those affected by the policies.

Guided by the central research question— ***How does policymaker – landowner interaction during policy drafting influence its adoption by land managers during strategy games?*** — this study investigates the rationale behind policy drafting (including interactions between policymaker and land manager players, use of available evidence, and reliance on intuition) to assess their influence on land use change. **We hypothesize that increased interaction during a deliberation process between policymakers and land managers during policy formulation are associated with higher levels of policy adoption within the game setting.**

## 2. Material and methods

### 2.1. Study area

The study was conducted in Scotland, with the strategy game addressing landscape management across a representative range of mainland contexts, across a generic landscape that encompasses both 'Highland' and 'Lowland' landscape elements. Rather than being anchored in a specific locality, the game was designed to reflect the diversity of Scottish landscapes and land use dynamics, creating a flexible space for players to engage with issues that resonate across the country.

The Scottish Highlands are typified by mountainous terrain, low population density, and extensive landholdings primarily used for grazing, forestry, or conservation. The Lowlands, by contrast, are characterized by gentler topography, fertile soils, and more intensive agricultural activity, alongside more fragmented landownership patterns. This contrast between regions provides a meaningful backdrop for exploring tensions and trade-offs between land use objectives.

### 2.2. Game design process

The strategy game *ScotScape* was developed by the Chair of Ecosystem Management, ETH Zurich, using the Companion Modeling (ComMod) approach, which emphasizes participatory modeling and iterative co-design to explore complex socio–ecological systems. This methodology fosters shared understanding among stakeholders by integrating empirical data, local knowledge, and system dynamics into a tangible, interactive format.

Working with Bioregioning Tayside, a local non-governmental and community-based organization concerned with landscape restoration, the Ericht Catchment in central Scotland was selected as the geographical template for the *ScotScape* game as it spans both Highland and Lowland characteristics within an area of more than 13,000 ha (UK Centre for Ecology and Hydrology, 2015). This allowed for a nuanced yet manageable representation of Scotland's diverse land use patterns and stakeholder dynamics.

The development of the game was informed by a combination of empirical and participatory sources. These included 14 in-depth interviews with key stakeholders such as community leaders, estate owners, farmers and representatives from development trusts. In addition, six group workshops were held with participants from farming groups, rural communities, academia, and local government. These consultations were complemented by an extensive literature review covering past and current land use policies, land tenure structures, landscape change, and dominant production systems.

Insights from these activities were translated into the game's physical components, including the board design reflecting land covers, land use tiles, role cards, and policy tools. The *ScotScape* game foregrounds contemporary landscape management challenges in Scotland, particularly those tied to climate change and land use policy. It explicitly engages with national climate targets, including Scotland's legally binding commitment to reach net-zero greenhouse gas emissions by 2045 and a 75% reduction by 2030 (Scottish Government, 2019).

Players take on the roles of farmers, estate owners, and ministers for agriculture or the environment, making decisions both individually and collaboratively. Gameplay unfolds over four rounds, during which players co-create and transform the landscape while negotiating trade-offs between personal objectives and collective goals related to food production, carbon sequestration, biodiversity, and water quality. The game creates an immersive setting for participants to explore alternative pathways for landscape governance under climate and policy pressures.

Following the development of the first full prototype, the *ScotScape* game underwent a series of crash tests to refine its mechanics and ensure its relevance to stakeholders. Crash testing refers to structured test sessions used to evaluate the game's functionality, flow, and clarity before final deployment. These tests were conducted in two phases. The first, internal testing, involved 10 sessions with students and academic colleagues and focused on improving game logic, pacing, and balance. The second phase of piloting the game in Scotland consisted of five sessions with Scottish stakeholders, aimed at validating the game's realism and resonance with the lived experience and expectations of the actors it seeks to represent. Feedback from these sessions led to iterative adjustments to both the game elements and facilitation protocol.

### 2.3. Game structure

The game involves eight participants. Four play the role of farmers, two act as estate owners, one as the governmental agricultural minister, and one as the environmental minister. Combined, farmers and estate owners form the landowner group, and the agricultural and environmental minister forms the policymaker group. The setup of the *ScotScape* game includes three main tables: one for all landowners, one for the market, and one for the government (Fig. 1).

The game is played over four rounds. Each round of the game proceeded through a structured sequence of phases (Fig. 2). For a detailed description of the game mechanics, see Appendix. During the *Decision Phase*, players allocated their financial resources by determining which crops to cultivate and which livestock to graze on their respective land parcels. This was followed by the *Announcement Phase*, in which the government introduced new policies. Subsequently, in the *Tax/Income Phase*, players received income and fulfilled their tax obligations (50% income tax for estate owners, 20% income tax for farmers). Finally, during the *Board Update Phase*, the game board was updated to reflect the outcomes of the preceding decisions and interactions. Market conditions were identical across all rounds and games. Flooding events were predetermined to occur at the end of Rounds 2 and 4 in every game. However, the effects of flooding on land use varied depending on land cover type. Players were able to mitigate flood impacts through landscape configuration strategies, such as placing native woodland adjacent to rivers.

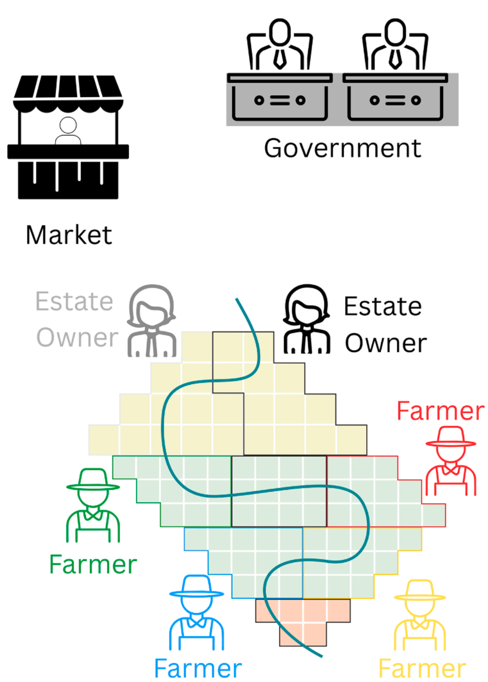


**Fig. 1.** The figure represents the layout of the room with the main game board in the middle. The market is placed to the left. The government is at the far end of the room. The physical distance of the government to the main game board represents their disconnection from the landscape. The distance to the government is less for the estate owners than the farmers.

Over the course of the four rounds each player pursues different objectives depending on their assigned role. For farmers and estate owners, these goals focus on improving the prosperity and productivity of their land. In contrast, policymakers, represented by roles such as the agricultural and environmental ministers, were tasked with achieving broader, sector-specific targets: the agricultural minister prioritized food production, while the environmental minister focused on biodiversity conservation and carbon sequestration.

Policymakers in the *ScotScape* game were equipped with multiple instruments to inform their decisions (Fig. 2, middle column). These included the ability to conduct research, engage with landowners through interviews or surveys, and formulate and implement new policies. Policy formulation required the specification of eligibility criteria (specifying affected land uses and target player groups) and duration (ranging from a single round to a multi-round lifecycle). Additionally, policymakers could implement conditional incentives, such as restricting subsidies to native woodland restoration within riparian zones. While policymakers could operate independently, the game also allowed for collaborative strategies, enabling participants to align or negotiate their objectives. The game also allowed for other forms of verbal interaction among participants. All landowners were seated around a single large table, which enabled open conversation. Nonetheless, participants were free to move around the room and initiate dialog with others. Landowners were also given the option to approach policymakers directly when facing challenges, fostering a more dynamic and participatory policy negotiation environment. Farmers, however, could only engage with policymakers after forming a cooperative and appointing a representative, while estate owners, due to their greater influence, had direct and unrestricted access. In both cases, interactions with policymakers occurred only if the policymakers themselves consented and made time for the exchange.

### 2.4. In-game indicator design and interpretation

The design of this strategy game aimed to represent key trade-offs in Scottish land use decisions through simplified indicators for food production, carbon sequestration, water quality, and biodiversity. While grounded in scientific literature and regional data, the indicator values used in the game are necessarily abstractions. Their purpose is not to model exact biophysical outputs, but to make visible the systemic tensions and value-laden choices that land managers and policymakers regularly face.

The indicator scores reflect typical or average effects observed in the literature, with modifications made to ensure game balance, strategic diversity, and meaningful negotiation. For instance, some food production options (e.g., sheep or cattle) are consistently associated with negative biodiversity and water quality impacts, while nature-based options (e.g., native woodland) offer ecological co-benefits at the cost of short-term profitability.

All indicators were normalized to a 0–10 range for ease of comparison, but internally they stem from semi-quantitative synthesis of Scottish datasets and studies. Carbon values were influenced by the sequestration potential of different land covers (Morison et al., 2012; UK CCC, 2023), biodiversity scores derived from habitat suitability studies (Øyen and Nygaard, 2020; Sánchez et al., 2022; Woodland Trust, 2025), while food production followed typical yield estimates for smallholder and estate systems (The Scottish Government, 2021). Water points were based on nutrient runoff from livestock agriculture, tree cover, and erosion impacts (Cooper et al., 2021; Jones et al., 2017). Finally, while the game uses real-world data, the primary goal is to facilitate reflective dialog and scenario exploration, not prediction. As such, we encourage players and readers to treat indicator values as heuristics for discussion, rather than as absolute truths.

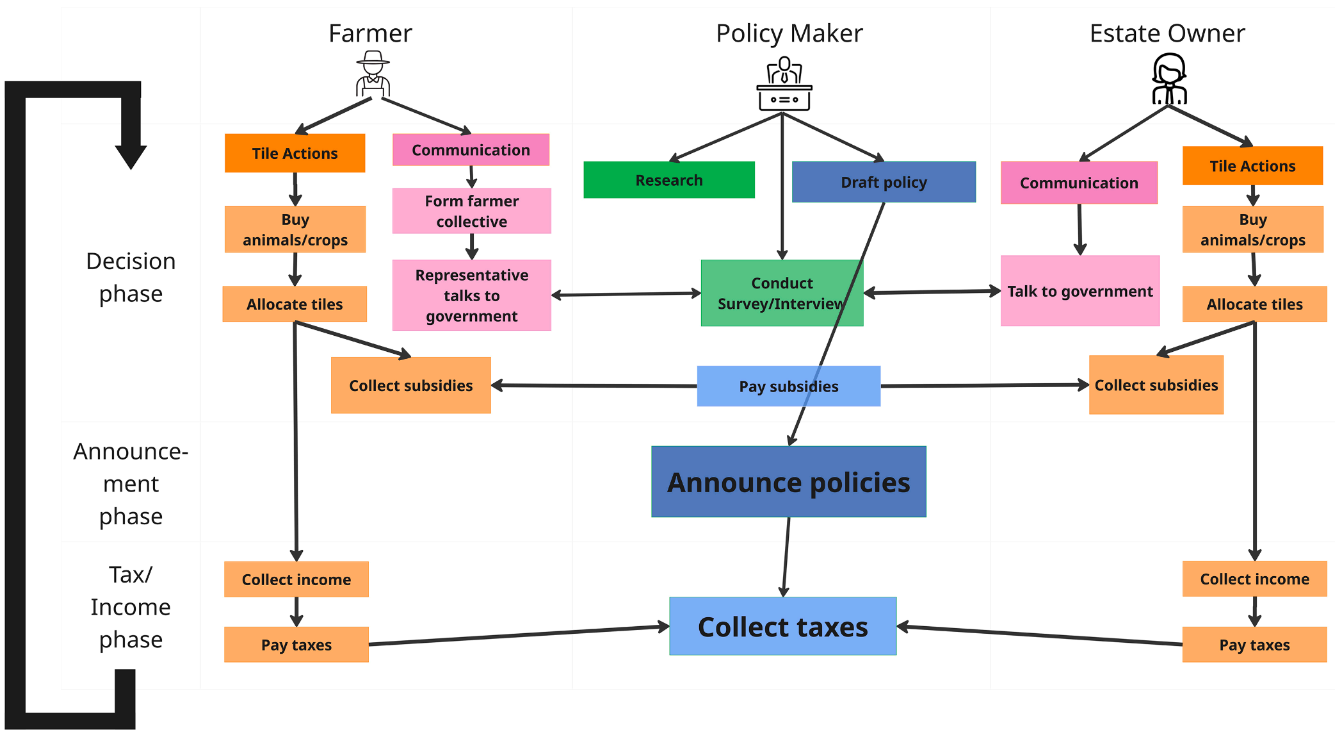


**Fig. 2.** Overview of the game's round structure. The three columns represent the different player types and their available actions during each phase of the round (listed on the left).

### 2.5. Data collection and processing

Seven sessions of the *ScotScape* game were conducted across various locations in Scotland. These took place primarily in two regions: Dumfries and Galloway, and Blairgowrie and Rattray, and in five different locations. These locations were selected based on logistical considerations, such as ease of access and suitability as meeting points, rather than for their representativeness of specific regions.

For each game session, participants from different backgrounds, such as farmers, forest/estate owners, NGO workers, and representatives of the local community, were recruited with the assistance of the Bioregioning Tayside group. Eight to twelve participants played each game session, depending on interest and people's availability. When the number of participants exceeded the eight roles available, roles were shared by pairs of individuals to ensure full inclusion. Participants were assigned roles that contrasted with their real-life positions; for instance, a real-life estate owner might take on the role of a farmer. This approach was intended to facilitate perspective-taking and encourage participants to internalize the trade-offs faced by other stakeholders. Each session, including the debriefing following gameplay, lasted approximately 120 min, which was the maximum time participants were able to allocate to this project.

The data was collected in two forms, voice recording and in-game decisions monitoring. The recordings were done by attaching, with their explicit consent, a Rode Wireless Go II to each participant. The voice recordings were first automatically transcribed using the software Notta (Notta.ai, 2019), and then manually reviewed and corrected. The in-game decisions involved monitoring land use activities from each farmer and estate owner player. For the policymaker players, their policies announced at the end of the round were recorded.

### 2.6. Analysis

#### 2.6.1. Policy rationale and decision basis

To better understand the motivations behind policy proposals, we developed a coding framework to classify each policy according to its underlying decision basis. These categories included: *evidence-informed* (based on player consultations of in-game research), *interaction-driven* (stemming from informal dialog with land managers), *both* (when interaction and in-game research happened), and *intuitive* (based on personal judgment or assumptions). Each policy was manually assigned a decision basis.

#### 2.6.2. Linking policy to land use change

To assess whether implemented policies were followed by changes in land use, we merged data on policy type, target group (farmer, estate owner, or both), the round the policy was in effect, and timing with land manager decisions in the rounds before and after the implementation of a policy. Land use was recorded as the number of plots assigned to each activity (e.g., livestock, native woodland, cereal).

We calculated the **mean number of tiles per land use** before and after a policy was implemented. This temporal alignment allowed us to evaluate not just the immediate reaction but also delayed responses over the following rounds. Policies that targeted multiple land uses were disaggregated into separate observations to avoid misclassification.

#### 2.6.3. Statistical analysis

To test whether interaction influenced land use decisions, we performed a difference-in-differences analysis (DiD). We classified each policy according to whether it involved interaction between players or not, and the specific land use it targeted (e.g., native woodland, potato, deer). We then calculated the number of tiles for the targeted land use before and after policy implementation. In the model, interaction served as the explanatory variable, and the number of tiles for the targeted land use served as the response variable. The model can be expressed as:

$$Y_{it} = \beta_0 + \beta_1 \text{Interaction}_i + \beta_2 \text{Post}_t + \beta_3 (\text{Interaction}_i \times \text{Post}_t) + \varepsilon_{it}$$

where $Y_{it}$ is number of tiles of the targeted land use for player $i$ at time $t$ (response variable); $\text{Interaction}_i = 1$ if the policy involved interaction between players, 0 otherwise; $\text{Post}_t = 1$ if the observation is after policy implementation, 0 otherwise. $\text{Interaction}_i \times \text{Post}_t$ is the interaction term capturing the DiD effect of communication after policy implementation. The fitted parameters have the following meaning: $\beta_0$ is the baseline intercept (mean number of tiles for non-interaction group before policy); $\beta_1$ is the difference between interaction and non-interaction groups before a policy is introduced; $\beta_2$ is the change in number of tiles after one round for the non-interaction group; $\beta_3$ is the difference-in-differences estimate (i.e., effect of interaction after policy implementation). Finally, $\varepsilon_{it}$ captures the error term.

To further explore players' adoption of policies, we disaggregated the data by (i) targeted land use, (ii) decision basis (interaction, evidence, both, or intuition), and (iii) player role (farmer or estate owner). For each subset, we performed a Mann–Whitney test to assess the significance of the change in the number of tiles before and after a policy. Then, we have also computed the rank-biserial correlation to quantify to what extent players responded to each policy. With this correlation, we do not focus on the change in land use in absolute terms, but rather on how coherent the response of players is to a given policy.

All the analyses were performed using Python 3.9.6 and the code is available on GitHub

## 3. Results

While given full creative autonomy, policymakers primarily focused on economic and regulatory instruments, specifically subsidies, financial incentives, and fines (regulatory backstops). Policymakers more frequently relied on in-game evidence when drafting policies (Fig. 3, left). Intuition was the second most common decision basis, while a combination of interaction and evidence was the least common. On average the agricultural minister enacted more policies than the environmental minister (Fig. 3, right). In terms of policy formulation, the agricultural minister most frequently relied on *evidence only*, followed by *intuition only*. In contrast, the environmental minister also most frequently based policies on *evidence only*, but this was followed by *interaction only* and then by a *combination of evidence and interaction (both)*.

To assess the impact of targeted policies on land use decisions, changes in land use before and after policy implementation were analysed. The DiD analysis indicates that policy developed with interaction are associated with an average increase of one tile compared to a policy without interaction ($p <= 0.05$, Fig. 4).

In Fig. 5, we disaggregated the results by the policy's underlying decision basis and by land manager type (estate owners vs. farmers). The rows are arranged by their rank-biserial correlation values, with the highest values at the top. The rank-biserial correlation values indicate the consistency of behavioral responses among land managers. A high

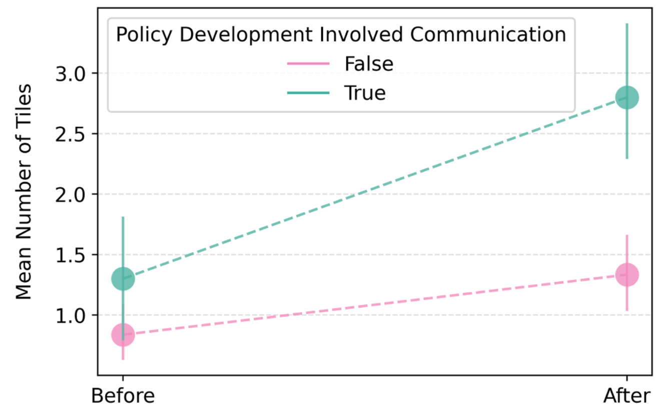


**Fig. 4.** Difference in Difference Analysis (DiD). Mean number of tiles assigned to specific land use before and after the introduction of a policy, comparing the cases where policy development involved communication (green) versus those where it did not (pink). Participants in the communication condition assigned more tiles on average at both time points, with a larger increase from before to after, while the no-communication condition showed only a modest rise. Error bars indicate sample standard deviations around the means.

correlation suggests that most participants responded in the same direction (e.g., consistently increasing native woodland). This is regardless of the size of the change, which is indicated by the length of the horizontal bars (Fig. 5). They indicate the average change in the number of land tiles used for a specific land use type following policy introduction. In contrast, a lower correlation reflects more varied responses, such as a mix of increases, decreases, or no change. Importantly, a large numerical change in land use does not necessarily imply a strong correlation, as the rank-biserial correlation measures the uniformity of the response, not its magnitude. It is important to note that the figures do not display the full reallocation across all land uses within a single scenario. Rather, each row represents a distinct policy treatment that targets a specific land-use category and a particular type of player.

The results of this analysis indicate that policies developed through interaction with land managers are associated with the highest levels of behavioral consistency. The top three rank-biserial correlation values were all associated with subsidies targeting native woodland, each of which involved interaction with land managers, either alone or combined with evidence. Notably, no policies related to other land use types were based on interaction or a combination of interaction and evidence. This suggests that, within this game context, only the native woodland policies were shaped through engagement with land managers, while all other policies were developed without such interaction. Fewer policies

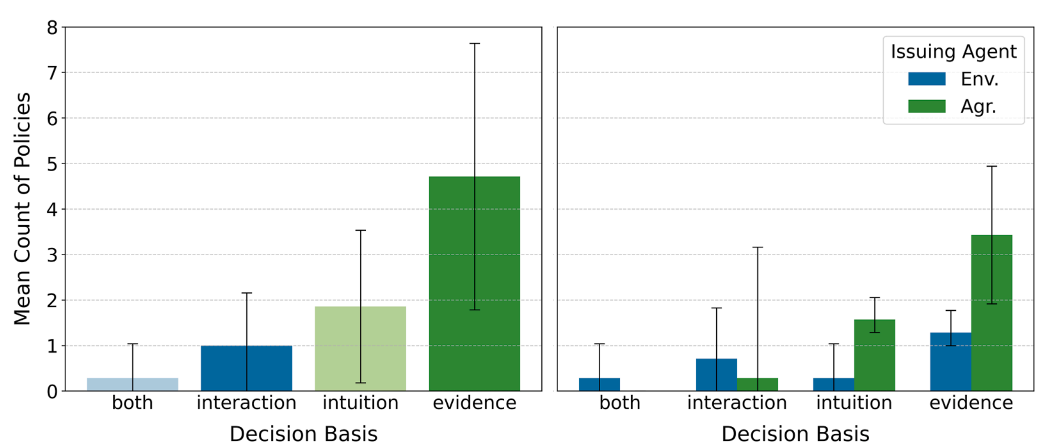


**Fig. 3.** Overview of policy design during ScotScape game sessions. (Left) Mean count of policies designed across the analysed games session divided by decision basis. (Right) Mean count of policies across the analysed games session divided by decision basis and issuing agent: environmental minister (blue) and agriculture minister (green). In both plots, the black error bars represent the sample standard deviations.

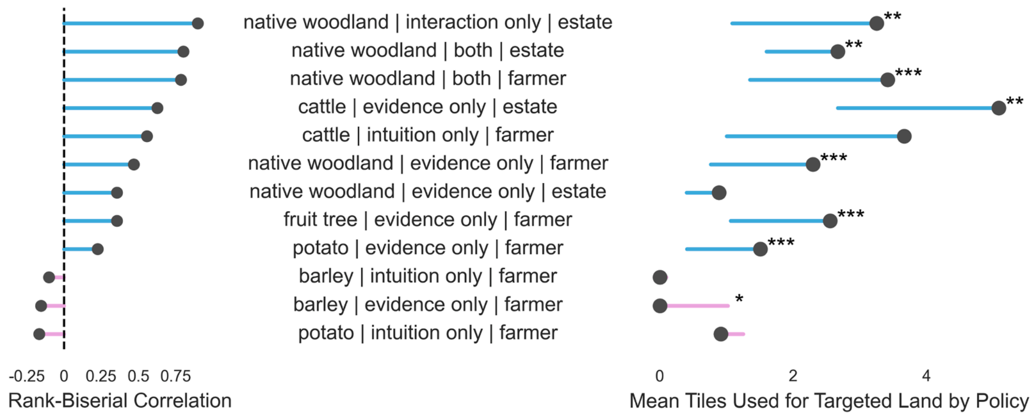


**Fig. 5.** Effects of policy implementation on land-use decisions across policy–land-use–player combinations (labels shared across panels). Left panel: Rank-biserial correlation of the change in land use before versus after policy implementation, indicating the direction and strength of shifts in tile allocation. Blue indicates positive correlation, while red negative. Right panel: Mean change in tiles following policy implementation. Gray points show post-policy values; horizontal lines represent the magnitude and direction of change (blue = increase, purple = decrease). Note: Each row corresponds to a specific policy–land-use–player combination aggregated across game sessions, reflecting average responses to individual policies rather than overall landscape composition.

were developed through interaction with land managers compared to those based solely on other decision-making approaches, such as evidence-only strategies. However, policies that did involve land manager engagement were associated with higher adoption rates among landowners. Policies based on intuition alone did not demonstrate significant effects, with the exception of those targeting cattle.

## 4. Discussion

The guiding research question of this study is: ***How does policymaker – landowner interaction during policy drafting influence its adoption by land managers during strategy games?*** Results showed that policies involving interaction with land managers were adopted more widely. This was reflected by an increased adoption of the targeted land use (Fig. 5). The higher adoption was particularly pronounced when land managers were included in discussions about policy design, suggesting that their participation enhanced both the relevance and acceptance of the proposed measures in the game.

This study is novel in that it analyses players' in-game behaviors directly, rather than relying solely on pre- or post-game data such as surveys or debriefings. By examining decision-making processes and interactions as they unfolded within the game, this approach provides a more dynamic and fine-grained understanding of how stakeholder engagement influences policy adoption in a game context.

The findings of this study are particularly relevant in the Scottish context, where there is an ambitious afforestation and woodland restoration program that is central to achieving the national net-zero target by 2045. UK stakeholders such as farmers, estate owners, and gamekeepers have expressed dissatisfaction with the predominantly top-down approach to land management adopted by policymakers (Lees et al., 2023). Existing instruments like the Forestry Grant Scheme (Thomas et al., 2019) employ financial incentives to promote sustainable woodland creation. However, even these well-targeted grants are not always adopted, as landowner uptake ultimately hinges on whether such schemes align with their values, land management goals, and perceived risks (Burton et al., 2019; Sander et al., 2024).

The present study indicates how these challenges can be addressed: Policies developed through stakeholder interaction achieved significantly higher adoption rates among land managers within the strategy game. This indicates that integrating stakeholder perspectives early in the real-world policy formulation process could enhance the effectiveness of restoration strategies in Scotland, addressing both ecological and social barriers to successful implementation.

While this study was conducted in the context of Scotland, its insights potentially extend beyond national boundaries: Fostering early interactions among stakeholders and policymakers during policy negotiation and development stages is likely to be broadly relevant across similar sustainable land use management contexts in other countries. In regions where policy adoption is hindered by limited stakeholder engagement or misaligned incentives, adopting more participatory approaches may thus contribute to more effective and widely supported environmental governance.

These findings align with previous research. For instance, a study examining the impacts of EU agricultural policies has shown that limited stakeholder engagement during the drafting phase can reduce the uptake of subsidy measures (Adams et al., 2025). Similarly, a review of policies promoting electric vehicle (EV) adoption in India found that transparent communication and collaboration among stakeholders facilitated better policy adoption (Devi and Sreekumar, 2023). Consistent with this broader evidence, the present study demonstrates in a simulated environment, that when policymakers engaged directly with landowners, landowners were more inclined to adopt the proposed subsidies in subsequent rounds of the strategy game.

These results underscore the importance of inclusive and participatory policy processes. They suggest that meaningful engagement not only enhances the perceived legitimacy of policies but also increases their practical effectiveness. Building on this, many studies advocate participatory approaches that promote active community engagement and collaboration among stakeholders (Defries and Nagendra, 2017; Gann et al., 2019; Ortega-Alvarez et al., 2021). Within this context, Empowered Deliberative Democracy (EDD) provides a more systematic framework for understanding how structured participation can enhance democratic decision-making: EDD (Fung and Wright, 2001) highlight the democratic value of structured stakeholder engagement in policy processes. They emphasize practical problem-solving, reasoned deliberation, and empowering citizens to meaningfully participate in decisions that affect their lives. Empirical studies have examined the application of EDD in various case studies, demonstrating its potential as an effective approach (Fung and Wright, 2001; Mustalahti and Rakotonarivo, 2014; Patsias et al., 2013). These studies primarily focus on case-specific applications of EDD, exploring how structured stakeholder engagement can be facilitated in particular contexts rather than providing direct guidance for broad policymaking. For example, Fung and Wright (2001) illustrate participatory governance in urban and community settings, Patsias et al. (2013) examine participatory budgeting in Montreal, and Mustalahti and Rakotonarivo (2014) analyse REDD+ projects in Tanzania, highlighting both opportunities and challenges in implementing EDD principles. Building on this foundation, strategy games offer a promising tool to bring EDD principles into practice by creating a safe and interactive environment where stakeholders, such as policymakers and landowners, can engage in dialog, explore consequences of decisions, and collaboratively test solutions in a way that mirrors the deliberative and inclusive ideals emphasized by EDD.

The strategy game used in this study helps to lower some of the key obstacles to effective collaboration, such as bureaucratic barriers (Barnsley et al., 2015; Md Rami, 2024; O'Toole et al., 2011). By doing so, it can encourage more active communication and engagement among participants. Institutional or structural barriers often limit direct engagement. Several factors may hinder real-life policymakers from engaging directly with landowners. First, policymakers frequently operate within institutional frameworks characterized by tight deadlines and limited resources, which can make extensive stakeholder engagement difficult to implement in practice (Innes and Booher, 2010). Real-life policymakers may anticipate resistance or conflict, which discourages proactive engagement (Fischer, 2004). Finally, a lack of training or confidence in facilitating effective participatory processes may lead policymakers to rely on more familiar approaches, such as evidence review or intuition, rather than direct engagement (Fung, 2006). During the game sessions of this study, policymaker players were confronted with constraints comparable to those in real-world settings, namely limited resources and very tight time constraints per round. These pressures were deliberately integrated to reflect how intensive stakeholder engagement can occasionally impede the drafting process by introducing procedural delays or diverting focus from core policy formulation (Gonçalves et al., 2025). Nevertheless, the study yields empirical evidence of a positive association between stakeholder engagement during the policymaking process and higher levels of policy adoption within the game setting: the most effective in-game policies, measured by consistent land use change, were those developed through direct interaction with landowners. These findings underscore the value of participatory interaction in shaping land use decisions, even under resource or time constraints.

The results suggest that, despite the costs and barriers associated with stakeholder engagement, investing in more inclusive policy design processes can lead to more widely accepted and effective outcomes. Prior research supports this view: deliberative engagement among stakeholders reduced conflicts and enhanced legitimacy in wildlife management (Lundmark et al., 2015), MacLeod et al. (2022) demonstrated that combining expert and stakeholder knowledge improves decision relevance and policy uptake, and Kizos et al. (2018) demonstrated that participatory landscape governance fosters shared understanding and local ownership. However, these studies largely focus on stakeholder participation during policy implementation rather than its formulation, leaving limited understanding of how interaction during the drafting phase influences subsequent policy adoption. This study addresses this gap by illustrating how structured policymaker–landowner interaction in the policy design phase of a strategy game enhances the legitimacy and effectiveness of land use policies.

It is important to note, however, that the results from this study are derived from a controlled game setting and should not be directly generalized to real-world policymaking contexts. While the *ScotScape* game tries to simulate decision-making constraints and stakeholder interactions realistically, the behaviors observed are influenced by the game's design, rules, and incentives, highlighting the need to test and validate these design elements to ensure that they accurately reflect real-world dynamics. At the same time, research on environmental strategy games indicates that such simulated experiences can influence real-world behaviors by enhancing players' sense of ownership and self-efficacy, indicating that engagement within the game may foster tangible actions outside of it (Chen et al., 2025). Yet, although some evidence points to these transfer effects, only a limited number of studies have formally validated the efficacy of serious games (Bakhanova et al., 2020; Rodela et al., 2019; Stanitsas et al., 2019). Thus, it must be recognized that the game world remains a simplified representation of reality, offering valuable insights while not fully replicating its complexity. In the context of *ScotScape*, communication among players led to higher adoption rates of the proposed policy, suggesting that improved dialog between policymakers and landowners in real-world settings could similarly enhance policy acceptance. However, this remains a simplified depiction of decision-making. Real-world policy processes are inherently more complex, involving multiple actors, institutional procedures, and approval stages, such as parliamentary deliberations and administrative negotiations. Participants were deliberately assigned roles that contrasted with their real-life positions in order to facilitate perspective-taking and reduce reliance on pre-existing professional scripts. While matching participants to their actual roles might have resulted in more technically realistic tactical decisions, the role-reversal approach was prioritized to encourage transformative learning by requiring participants to internalize the trade-offs faced by other stakeholders.

Thus, while the game offers valuable insights into stakeholder interaction and communication dynamics, it does not fully replicate the intricacies of real-world policy formulation and implementation. Nonetheless, we believe that our results indicate that if there is active interaction between policymakers and landowners, and if landowners are meaningfully involved in the process, policy implementation in real-world contexts could lead to higher adoption rates. To further refine these simulations, future research should incorporate institutional frictions and asymmetric information into game design, thereby more accurately reflecting the nuances of real-world policy processes.

The game not only facilitates communication among players but also enables them to observe how dynamic socio-economic systems unfold and to recognize the consequences of their actions. In doing so, it creates a platform where real-life policymakers and landowners can experiment, explore, and debrief collaboratively. Beyond fostering dialog, such games may also act as catalysts in the early stages of policy development. By bridging the gap between land managers and policymakers, they can create a shared understanding of challenges and trade-offs, which may ultimately inform the drafting of real-world policies. Future studies could build on this potential by examining how insights and agreements generated within game settings can be translated into formal policy processes. Comparative research across different geographic and institutional contexts could further clarify the mechanisms and conditions under which serious games serve as effective tools for inclusive, evidence-based, and sustainable land use governance.

## 5. Conclusion

The empirical findings of this research demonstrate that, in a simulated context, landowner participation in the design phase is positively correlated with the successful adoption of land use policies. While these results are specific to the game setting, they serve as a functional proxy for real-world governance, indicating that the early integration of landowner perspectives could enhance the perceived legitimacy and practical uptake of land use policies. This study contributes methodologically and analytically: by implementing evidence-based, intuition-based, and interaction-based decision strategies within a controlled strategy game, it captures real-time decision-making dynamics and quantifies policy effectiveness through land use changes. These insights facilitate the design of more context-sensitive and stakeholder-aligned environmental policies. While the importance of stakeholder interaction in landscape management is widely acknowledged, it is difficult to observe directly due to the complexity of socio-ecological systems. Strategy games, by contrast, model and simplify these systems in a way that enables stakeholders to interact, test different policy options, and observe the resulting land use and environmental outcomes. Because complex socio-ecological systems exist across the globe, strategy games offer a valuable alternative for bridging the gap between policymakers and the landowners most affected by environmental policies.

## CRediT authorship contribution statement

**Simona Rödlach:** Writing – original draft, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Giacomo Vaccario:** Writing – review & editing, Formal analysis. **Jaboury Ghazoul:** Writing – review & editing, Conceptualization. **Ivan P. Novotny:** Writing – original draft, Supervision, Methodology, Investigation, Formal analysis, Conceptualization. **Clare Cooper:** Conceptualization, Project administration, Resources.

## Declaration of Generative AI and AI-assisted technologies in the writing process

During the preparation of this work the authors used ChatGPT in order to improve the readability and language of the manuscript. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the published article.

## Declaration of Competing Interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Ivan P. Novotny reports financial support was provided by ETH Zurich. Jaboury Ghazoul reports financial support was provided by ETH Zurich. Simona Roedlach reports travel was provided by ETH Zurich. Giacomo Vaccario reports financial support was provided by ETH Zurich. Clare Cooper reports administrative support was provided by ETH Zurich. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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## Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.landusepol.2026.108101.

## Data availability

I have shared the data at the Attach file step
Analysis Code (GitHub)

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