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Serious games

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Key methods discussed in this chapter

Serious games

Connections to other chapters

Serious games are commonly used as part of the toolbox for participatory approaches, including for modelling or planning (Chapter 13). They are designed according to a conceptual model, coming from various types of modelling approaches, including system dynamics (Chapter 26) and agent-based modelling (Chapter 28). They need systems scoping to identify the roles and entities that need to be considered. To describe the dynamics, they may build on methods from state-and-transition modelling (Chapter 27). Serious games are behavioural experiments, but leave participants more freedom of action and exercise less control than controlled behaviour experiments, which are extreme cases of serious games (Chapter 12).

Introduction

Role-playing games as tools to support the understanding and governance of social-ecological systems (SES) emerged by the end of the 1990s, standing on the shoulders of experimental economics (Friedman and Sunder 1994) and policy exercises (Toth 1988; Duke and Geurts 2004). The experimental economics thread is closely related to controlled behavioural experiments (Chapter 21). The policy exercise thread was originally (as far back as ancient China) developed through war games (Mermet 1993), which are strategic simulations of war or crisis situations so that participants can experience virtually the joint outputs of their behavioural patterns. Policy exercises more recently grew as business games and developed as a type of group decision-support system. They have been included in the broader category of serious games.

Although ‘serious games’ first appeared in 1974 (Abt 1974), they really emerged in the 2000s and mainly after 2010. This category combines role-playing games, policy exercises and business games, among others. It focuses on the fact that these games are used for serious

 DOI: 10.4324/9781003021339-15

<table>
<tr><th colspan="2">SUMMARY TABLE: SERIOUS GAMES</th></tr>
<tr><th>DISCIPLINARY BACKGROUND</th><th>KNOWLEDGE TYPE</th></tr>
<tr><td>The methods in this chapter are derived from or have most commonly been used in:
Experimental and Behavioural Economics, Social and Cognitive Psychology, Environmental and Cultural Psychology</td><td>The methods in this chapter are primarily used to generate the following types of knowledge:
• Exploratory
• Explanatory</td></tr>
<tr><th>RESEARCH APPROACH</th><th>PURPOSE OF METHOD</th></tr>
<tr><td>The methods in this chapter originate from or most commonly adopt the following research approaches:
• Interpretive/subjective
• Collaborative/process</td><td>The most common purposes of using the methods in this chapter are:
• System understanding
• Stakeholder engagement and co-production
• Policy/decision support</td></tr>
<tr><th>TEMPORAL DIMENSION</th><th>SYSTEMIC FEATURES AND PROCESSES</th></tr>
<tr><td>The methods in this chapter are most commonly applied to the following temporal dimensions:
• Present (typically within the last 5–10 years)
• Recent past (post-1700s)
• Future</td><td rowspan="3">While most methods can do many things, the methods in this chapter are particularly good (i.e. go-to methods) for addressing the following:
• Transformation
• Social learning
• Collective action and collaborative governance
• Evaluating policy options</td></tr>
<tr><th>SPATIAL DIMENSION</th></tr>
<tr><td>The methods in this chapter are primarily either or both:
• Non-spatial
The methods in this chapter are most commonly applied at the following spatial scales:
• Local</td></tr>
</table>

matters, learning and/or decision-making. While serious games include individual games like online awareness-raising games and role-playing games, most policy exercises and business games are based on interactions among players. In this chapter, we refer to collective serious games unless specified otherwise. Although originally mainly based in the disciplines of economics and management sciences (operations research), serious games have now spread to the realm of conservation policies as a tool for land-use planning or ecology. The purpose is to design and/or implement tools to explore, in predefined scenarios, the consequences of interactions among players with diverse behavioural patterns. The main assumptions underpinning the scenarios are collective frames (e.g. existence of collective rules) and external drivers (e.g. weather sequence).

Serious games can complement other methods but are also appropriate alternatives when observation or experimentation is not suitable due to the time scale, harshness of potential outcomes of experiments or disagreement of some subjects with the experimental setting. They are also useful in exploring decisions and interactions in an 'action context', assuming that the interactional context drives the decisions of the actors. Having originated from 'policy exercises' and 'economic experiments', serious games have domains of application far beyond SES, with the military and security being the primary fields. However, application to issues related to environmental and land-use development came quite early. Within the two original threads, some works dealt with SES before the emergence of serious games as a tool to investigate the dynamics of these systems.

Seminal works by Ostrom, Gardner and Walker (1994) used economic experiments to analyse common-pool resources. The International Institute for Applied System Analysis (IIASA) applied policy exercises to foresights and the negotiation of global environmental issues (Mermet 1993). Companion modelling (Bousquet et al. 2002; Etienne 2011) initiated the convergence of both threads with a focus on SES and common-pool resources.

The emergence of games in the late 1990s and early 2000s was facilitated by two additional dynamics: the epistemology of models and the gamification of society. While the use of models as a tool to predict events used to be the norm, modellers in the 1970s started to discuss other potential uses. It was acknowledged that models could fit different uses, including potentially replacing (physical) experience when their implementation is not possible (Legay 1997). Models were then used to explore the consequences of a combination of assumptions to build new knowledge. The next step was to recognise games as models of social dynamic systems by themselves (Meadows 2001) and games became a possible tool to experiment on these systems. The development of computer capacity and the Internet made this easier and standardised the development of an artificial world for fun. Recent works on education theories point out the capacity of fun situations to generate learning, legitimising the use of serious games in these communities (Kapp 2012).

The main assumptions underlying the method of serious games are, first, related to the way in which participants play. In the game, they are supposed to act according to the environment provided, not according to the outcome they would like to see for the sake of achieving their own strategic agenda.

A second assumption is related to the capacity of games to represent an SES with meaningful reduction of the system's complexity. Constraints in game design include operational aspects such as the duration of the game, which has to fit the time available for participants to play the game, and the fun aspect. The game must be fun to incite participants to set their personal strategy aside, i.e. not to act according to their situation outside of the game or to pursue a personal agenda. These constraints mean the number of actions available to players must be reduced, including those related to their interactions with the fake environment simulated in the game.

A third category of assumptions is linked to the relationship of stakeholders to this type of tool: the willingness to play (is it 'serious' enough?) and the validity and suitability of the outcomes in the 'real world'. Hopefully the addition of 'serious' to the word 'game', reports of positive experiences and a deep trend to propose creative environments that enable participants to generate new knowledge and explore scenarios regarding 'serious' stakes will alleviate initial concerns about and prejudice against the futility of 'playing'. The addition of debriefings to game sessions further allows for meaningful outcomes and potentially paves the way for implementation of these outcomes (Ryan 2000; Meadows 2001).

A fourth and final assumption relies on the capacity of games to lead players to accept simulation as an activity echoing real problems without a direct connection to those problems. To be efficient, games should provide a delimited window for collective exploratory behaviour.

SES problems and questions

So far games have mainly been used to (a) disentangle the complexities of SES in order to help participants make sense of these systems, (b) inform participants about the diversity of viewpoints, interests and constraints present in an SES, (c) stimulate the emergence of desirable changes and actions in the real word that the game represents, and to experiment with them (Le Page et al. 2013), and (d) support adaptive governance of SES.

- **Disentangling complexities:** Disentangling the complexity of an SES means raising people's awareness of interdependence and the basic consequences of this interdependence, such as feedback loops and their cascading effects. It is well known that people find dynamic systems with feedback loops difficult to understand and foresee (Sterman 1992). In a game, the concentration of action within a limited time frame and space makes these consequences of complexity more apparent. Pioneering the use of games for dynamic systems, Meadows (2008) led players to acknowledge the existence of dependence among system components. He made them experience (unexpected) feedbacks of actions, which are consequently at best inefficient (Meadows 2008). The relationships emphasised within game settings are either social or social-ecological. In FishBanks Ltd (Meadows and Meadows 1993), players can observe the consequences of choices of some fishermen on the fish population and the cascading effects of these choices on other fishermen and fish populations. Games are powerful tools to demonstrate the existence and consequences of saturation effects (e.g. on land use), of competition for scarce natural resources and money, or the need for coordination to handle all these relationships.
- **Informing participants:** To inform participants about diversity within an SES, the game practice enacts the diversity of situations through role setting and incomplete information delivered to players during the game. Njoobaari Ilnoowo (Barreteau, Bousquet, and Attonaty 2001), for instance, is a game representing the issue of viability of irrigation systems in Northern Senegal as an outcome of multiple constraints on farmers with diverse cropping objectives. This game visualises the diversity of goals and hence behavioural patterns behind the mere activity of irrigation: practices differ significantly between a farmer cultivating to get the maximum out of his field and a farmer

cultivating to keep his access to land, and the coexistence of these practices generates tensions among farmers and collective inefficiencies.
- **Stimulating and experimenting with desirable changes:** Beyond revealing diversity of behavioural patterns, using games is also a way to get players more acquainted with the viewpoints of others. In this case, players endorse a role other than their own and have to handle their constraints and work towards a common objective. SylvoPast is a game representing the capacity of an SES that includes forestry and cattle farming in the same area, with both facing fire risk. In this game, Etienne made forestry agents play herders, and vice versa (Etienne 2003). This process allowed foresters and herders to experience and feel the constraints they have on one another, realise their mutual dependence to achieve their respective objectives, and enter into dialogue for the co-management of forestry with a more open attitude.
- **Supporting adaptive governance:** Games are used in adaptive governance of SES. Even though governance or co-management can be internalised into the game, serious games are also used as exploratory tools to challenge or support governance. Indeed, while designing a game, governance scales are chosen for the processes represented in the game and for the targeted decision processes. Scales of represented and supported management processes can be identical to processes observed in the real world, or they can be simplified and aggregated or embedded to facilitate game play. This choice depends on whether the issue at stake with the game is to explore macroscale management choices or to experiment with framing microscale management choices.

Game sessions can test institutional settings through a game and discuss them on an overarching organisational scale which might facilitate or prevent their occurrence. Mathevet et al. (2007) proposed a role-playing game (ButorStar) based on a multi-agent model that simulates the effects of wetland multi-use on ecosystem and wildlife dynamics. This tool serves as a training support for students to talk about the pros and cons of various negotiation processes and integrated management approaches. Within a ButorStar session, players experiment with co-management meetings as they are usually promoted in local environmental governance. This active experience enables players to understand the critical issue of time management, especially for sharing key information on trends and cause-effect chain understanding. Solutions experienced in games can then be discussed further at different decision-making levels and related spatial scales (i.e. water or land management units, land estates, ecosystem units and local government scale). The ButorStar game was also used with protected area managers and local actors in several Mediterranean wetlands. The results showed that the approach contributes to an increase in the capacity of actors to implement modes of interactions that promote the adaptive management of wetlands (Mathevet et al. 2008).

Brief description of key methods

To deal with the SES issues listed in the previous section, serious games are used to explore the consequences of internal choices or external drivers, raise awareness of diversity, educate people on system complexity, observe behavioural patterns in specific situations and support the governance of SES. A serious game session typically consists of three steps: briefing, playing and debriefing. The first step, briefing, should ensure that all the participants understand the rules so that they can play. The brief should not be too long, otherwise participants get bored. This step should be prepared according to the complexity of the game design, taking into account how much participants know about the technical actions (roles) they may have to endorse. The second step, playing, lasts typically half of the whole session. In this step, the main issue is facilitation to keep the momentum and identifying participants that might get lost or drop off from playing. This may involve asking some participants to explain their behaviours when they seem to act inconsistently with the game. The last step, debriefing, is the most important one because it generates knowledge for facilitators, observers and participants. Table 12.1 provides a summary of key applications for serious games.

Table 12.1 Summary of key applications of serious games

Main applications	*Description*	*References*
Exploring consequences of collective decisions, as a tentative group decision-support system	This category of use is often related to 'management flight simulators', where each player holds a stick to pilot an SES. However, there are also other types of games, more based on an agent-based model structure.	*Applications to SES* Castella, Trung, and Boissau 2005 (land-use change); Martin et al. 2007 (interdependence of local industry and river-basin management); Krolikowska et al. 2009 (land reclamation); Flint 2013 (community development)
Exploring consequences of external drivers	This category of use is close to the previous one in terms of the objective. However, the focus is less on driving the system and more on elaborating consequences of external changes in complex situations.	*Applications to SES* Villamor and Badmos 2015 (adaptation to climate change, e.g. for grazing in Sahelian countries)
Making people learn about others' constraints and building an understanding of system dynamics	Different types of games lead participants either to swap roles or to explain their worldviews.	*Applications to SES* Etienne 2003 (forest/cattle-grazing competition); Mathevet et al. 2007 (land-use competition in wetlands); Richard and Barreteau 2007; Richard-Ferroudji and Barreteau 2012 (simulation of basin management with various worldviews)
Developing a joint representation of an SES and playing with it	This category builds on a set of predefined items that might be used to collectively build a complex representation, as with building bricks, following a 'design-by-playing' approach. The output is a model that might be implemented in a game or in any hybrid form with a computer-based model.	*Applications to SES* Ferrand et al. 2009 (Wat-A-Game); D'Aquino et al. 2017 (TerriStories: terristories.org)

(*Continued*)

Table 12.1 (Continued)

Main applications	*Description*	*References*
Collecting information on collective behaviour	Observation of game simulation with players performing their usual activities in a controlled situation brings knowledge on some tacit behavioural patterns. We refer here to an open frame of action. The objective is to understand how players (re)act in given situations. When players are framed and have a finite set of choices, they are not supposed to perform their usual activities (see Chapter 21). The whole spectrum between these two extremes is possible. Students appear as 'easy-to-grab' players. They need to have more framing, such as information on their roles, but they can still have more possibilities to play than in controlled behavioural experiments.	*Applications to SES* Souchère et al. 2010 (erosion and farming practices); Merrill et al. 2019 (collective investment in security)
Education on the complexity of SES	Games enable visualisation of the hidden complexities of SES. These complexities could stem from physical reasons (underground processes), social reasons (taboos) and social-ecological reasons (time or spatial scales beyond those usually grasped by participants).	*Applications to SES* L'eau en jeu: eauenjeu.org (simplified education games)
Crisis management training	A group of players is placed in a crisis situation that it has to manage collectively. This method is the closest to the original use of military games.	*Applications to SES* Stolk et al. 2001 (fire, flood, terrorist attacks)
Institutional arrangement	Institutional arrangement is a game that supports a group of stakeholders in piloting and adjusting their collective action processes. An initial game evolves with the emergence of new issues or new perspectives on an SES trajectory.	*Applications to SES* Gurung, Bousquet, and Trébuil 2006 (watershed management)

Limitations

Even though serious games are increasingly being promoted, they cannot be considered as panaceas. Several limitations exist, such as a limit on the number of players, limited duration, a lack of social acceptance, and too narrow or too large a representation of the processes. The critical issue of debriefing presents limitations of its own. It is essential to assess the various forms of knowledge that come not only from the game itself but also from debriefing on what happened during the game session. Game design and management must take these objectives into account to keep track of events during the game so that structured discussion can occur during the debriefing. Careful management of a game is essential to transform it into a meaningful learning experience, so paying attention to time and live data-collection management is essential (Daré et al. 2014).

Potential biases could arise due to the limited size of population samples (i.e. the number of players relative to the population they represent) and the difficulties inherent in power games. Social acceptance is also an issue, due to not only the status of the game but also the self-esteem of participants. Playing together means the playing field between participants is levelled and that people of different social status agree to interact directly. This is not always acceptable to those holding the economic, social or political power.

A bottleneck could arise related to the difficulties of upscaling experience from a role-playing game. Groups of people involved in game sessions constitute small societies, but participants and public engagement may not always be appropriate (Reed et al. 2018). Power relationships, social values and epistemologies of participants have to be identified in order to be able to generalise outcomes of game sessions. It should be borne in mind that engagement outcomes are highly scale dependent over time. Spatial scale, decision levels and the legitimate representation of involved stakeholders should all be taken into account (De Vente et al. 2016).

To overcome these biases, positive outputs have been identified and ways to circumvent the limitations proposed. Role-playing game literature shows three main types of social impacts of serious games: (a) the production of socially robust knowledge that fuels a more effective process of public policy construction, (b) social learning to solve practical problems, and (c) empowering actors by putting them in a position where they can participate in a change process and socio-political transformation. These social impacts are more easily reached in small groups with trust. Technology may facilitate a large population of players via remote control. However, it significantly simplifies the richness of environmental information and information gained from the diversity of actions. The Internet or any networking technology is a means to progress in the direction of remote interactions with large groups. However, technical solutions tend to limit face-to-face interactions, which are crucial for trust building among the group of players and for meaningful debriefing. The key characteristic of concentration of time and space is partially lost.

Debriefings often reveal the difficulties local players experience during game sessions. However, role-playing game arenas allow the exploration of various ways to elaborate on the strategic dimensions of upscaling explorations, solutions and rule-change and adapting them to the specific social-ecological problem. Enrolling stakeholders of various decision-making levels in the game could be essential to expand the exploration of the issue at stake and to engage in a real problem-based approach such as ecosystem management. Depending on the simplicity of communication among them, stakeholders acting at different scales may participate in a common arena, or not. Role-playing game design and organisation may thus help to circumvent issues related to upscaling. A few recent experiences have progressed in the direction of dealing with multiple scale issues within a single game. In Uganda, Hassenforder et al. (2016), for instance, have played at local scale but discussed and developed outcomes at regional scale. In Laos, Ornetsmüller, Castella and Verburg (2018) developed a 'metagame' for national experts that summarised findings from a series of local games. On the topic of coastal vulnerability, one game (see Case study 12.1) integrates multiple scales, with players having roles bridging the scales, thanks to a cautious management of space and a rather large number of facilitators (Bonté et al. 2019).

Resource implications

Serious games need skills for crafting the game at suitable levels of complexity to allow participants to play it easily and still be willing to discuss their issues. This means finding the right combination of related items but also providing an environment with suitable pace and willingness to continue. A second set of skills is the facilitation of games. Facilitators have a crucial role to generate a suitable gaming atmosphere for participants to accept the game as an exploration tool. They must keep control of the dynamics and adjust these according to the group. They also have a crucial role to play in the debriefing stage, to lead participants to elaborate on new knowledge derived from the game experience and to set an action plan accordingly.

Case study 12.1: Coastal regional planning under global changes at play in Languedoc, France

The Amenajeu game was developed for and used with a group of 40 stakeholders to support the review process of a regional planning document called the Scheme of Territorial Consistency (*Schéma de Cohérence Territoriale* or SCoT). Among other issues, the game aims to drive the urbanisation process of an area. The SCoT is a mandatory urban planning document reviewed every five years. The elaboration of this document is particularly difficult, due to the long-term and large-scale projection considered and the numerous stakes and sectors of activity involved. In this context, the Amenajeu serious game is designed as a participatory device dedicated to the co-analysis of multi-level and multi-scale adaptations to global change. Actions taken by some to decrease their vulnerability may increase the vulnerability of others. The participatory session is aimed at increasing awareness of potential vulnerability transfers in the group of decision-makers who are in charge of elaborating the SCoT together.

The structure of the Amenajeu game is based on the SES robustness analysis framework proposed by Anderies, Janssen and Ostrom (2004; Anderies, Barreteau, and Brady 2019) that categorises the entities of an SES into four main categories (resources, resource users, public and private infrastructure, and public infrastructure providers). The framework focuses on the interactions between these categories in order to study the impact of exogenous drivers that would affect any of the entities. In the Amenajeu game, we combine the SES robustness analysis framework with the paradigm of a multi-agent system commonly used to discuss natural resource management (Bousquet and Le Page 2004; Le Page et al. 2013) in order to make explicit spatial, multi-scale or multi-sectoral issues.

The stakeholders from the different sectors of activity are viewed as resource users of the SES. They are represented by tokens that are updated by the facilitators during every round. These tokens evolve according to the situation of the area, featuring changes in population, activities and the environment of the SES. Players play the role of infrastructure providers. These infrastructure providers can set up infrastructure on the game boards in order to influence the dynamics of sectors of activities in some locations within the area, or the main attitudes of governance agencies of subregions in the area. Then they can observe the effect of their decisions on the resource users.

The region represented in the game, the SCoT territory, was split into four subregions represented by four game boards placed on four tables (Figure 12.1). At the beginning of the game session, players were given a role of sectoral planner that was close to their functions in the real world (in agriculture, urbanism, nature conservation, tourism or general planning) and then were allocated to one of the four tables. Each player had to write down their objective at the beginning of the game and was asked

The second type of resource required is time. A game session is typically one to two hours long, with 10–15 participants and up to four or five facilitators and observers, depending on the game being played. The preparation stage in the game design might also be time consuming in that it will include test sessions. These test sessions involve colleagues or communities of practice with people involved in serious game facilitation and design (Dionnet et al. 2013).

Figure 12.1 Game session of Amenajeu with multiple tables representing various distant but connected places (© Raphaël Mathevet)

to base their strategies on this objective, their assets (infrastructure or money when we represented it) and existing infrastructure. Four rounds of five years each were played. In each round, facilitators came up with various climatic and demographic events to put stress on the players, which they had to adapt to.

Discussion about potential vulnerability transfers first occurred during the game, when players decided how they would set up various infrastructure. Then, during the debriefing part of the session, players discussed how they would reach their objectives. The exercise shows that local adaptations at the subregion level make it possible to temporarily cope with the pressures of global change, by transferring these pressures to other subregions. Players could observe that the good intentions of some are not always followed by positive impacts locally or regionally, sometimes simply owing to a lack of consultation. With the help of this serious game, participants were able to discuss future changes and to experiment with the interplay of social-ecological interdependencies, not only between subregions but also between sectors of activity. This first experience led to the design of a generic and computerised game and method implemented in several places in France and South Africa (Bonté et al. 2021).

Games are increasingly based on the use of computers to improve the representation of ecological dynamics. Even if these dynamics remain quite simple to prevent a black box effect (i.e. participants lose the meaning and relevance of the elements in the game and of game outcomes), there is a need to make laptops or networked terminals and possibly a router available.

According to the context of the game, money might be needed to pay participants (either according to results achieved in the game as in experimental economics, or a flat fee to compensate the players for their time). The game implementation also requires a venue that is acceptable to all participants and easy to reach.

As in any participatory approach (Reed 2008; Etienne 2011), ethics need to be taken into consideration when implementing the game. Contrary to standard workshops, participants are expected to leave aside their own strategies and agendas during the playing phase (step two) of the game session. They might reveal more of themselves than they would have wanted to in the presence of other participants, who could strategically use this in further interaction after the game situation. However, participants may deny the realism of what had taken place in the game during debriefing if they consider that it would harm their position in real life.

New directions

Online games with distributed and highly interactive simulation tools are increasingly being explored and developed to enrol more participants in role-playing game experiments (Becu et al. 2017). Computer simulations are also increasingly incorporating cross-scale and multi-level dimensions, at the risk of losing the easy use and playful or 'fun' characteristic of games. Serious games should remain games, i.e. players should react according to the situation in the game and not take strategic decisions based on their situation outside the game (Kizos et al. 2018). Computer simulations are an emerging area and mostly aim to explore complexity of SES dynamics and especially telecoupling issues. Another area in need of research relates to collecting evidence of the proven impacts (e.g. learning) of role-playing games in real-world settings. Recent progress in this direction should be reinforced by interdisciplinary works involving specialists in psychology and education and social and environmental scientists, with modellers and stakeholders.

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