



**HAL**  
open science

## **Exp'Eau, a serious game for exploring pathways to improve water quality in agricultural catchments**

Isabelle Charpentier, Olivier Barreteau, H el ene Blanchoud, Mathieu Bonnefond, Christophe Piscart, Marie-No elle Pons, M elanie Raimonet, S ebastien Salvador-Blanes

### ► **To cite this version:**

Isabelle Charpentier, Olivier Barreteau, H el ene Blanchoud, Mathieu Bonnefond, Christophe Piscart, et al.. Exp'Eau, a serious game for exploring pathways to improve water quality in agricultural catchments. 54th edition of the International Simulation and Gaming Conference, Jul 2023, La Rochelle, France, France. hal-04056256v1

**HAL Id: hal-04056256**

**<https://hal.science/hal-04056256v1>**

Submitted on 3 Apr 2023 (v1), last revised 3 Jan 2024 (v2)

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destin ee au d ep ot et  a la diffusion de documents scientifiques de niveau recherche, publi es ou non,  emanant des  tablissements d'enseignement et de recherche fran ais ou  trangers, des laboratoires publics ou priv es.

# Exp'Eau, a serious game for exploring pathways to improve water quality in agricultural catchments

Isabelle Charpentier<sup>1,2</sup>, Olivier Barreteau<sup>3</sup>, H el ene Blanchoud<sup>4,5</sup>, Mathieu Bonnefond<sup>6,7</sup>, Christophe Piscart<sup>8,9</sup>, Marie-No elle Pons<sup>10,11</sup>, M elanie Raimonet<sup>12,13</sup>, S ebastien Salvador-Blanes<sup>6,14</sup>

<sup>1</sup>LTSER-FR Zone Atelier Environnementale Urbaine

<sup>2</sup>ICube - Laboratoire des sciences de l'ing enieur, de l'informatique et de l'imagerie

<sup>3</sup>UMR G-EAU - Gestion de l'Eau, Acteurs, Usages

<sup>4</sup>LTSER-FR Zone Atelier Seine

<sup>5</sup>METIS - Milieux Environnementaux, Transferts et Interactions dans les hydrosyst emes et les Sols

<sup>6</sup>LTSER-FR Zone Atelier Loire

<sup>7</sup>GeF - Laboratoire G eomatique et foncier

<sup>8</sup>LTSER-FR Zone Atelier Armorique

<sup>9</sup>ECOBIO - Ecosyst emes, biodiversit e,  evolution

<sup>10</sup>LTSER-FR Zone Atelier Moselle

<sup>11</sup>LRGP - Laboratoire R eactions et G enie des Proc ed es

<sup>12</sup>LTSER-FR Zone Atelier Brest Iroise

<sup>13</sup>LEMAR - Laboratoire des Sciences de l'Environnement Marin

<sup>14</sup>G eHCO - G eoHydrosyst emes COntinentaux

## 1 Introduction

Water quality depends on agricultural practices, but also on the nature, the state of the land cover and the distance between the pollutant emission sources and the hydrographic network. Consequently, water quality and agriculture are regularly in tension in rural catchments. Solving this issue requires actions by farmers. This may also involve other stakeholders, such as the local authorities and the catchment management, that can act through economic instruments and rules.

Over the last twenty years, serious games gain interest in environmental research and management. Such tools are used for simulating the dynamics of social and ecological systems for which a physical experimentation is not relevant due to questions of scale and potential consequences [1]. However, only a very few examples are targeting water quality in agricultural areas as the central issue, and these poorly include the diversity of interactions within the catchment.

To work on this issue, we develop the game simulator "Exp'Eau" in order to evaluate and to compare different pathways by facilitating the debate on possible collective actions at the scale of an agricultural catchment. We design the game through ARDI workshop [2] with scientists from seven French Long Term Social

Ecological Research (LTSER) platforms, completed by a few interviews of experts and the help of game designers.

## **2 Requisites**

The diversity of processes draining pollutants from the plots to the hydrosystem allowing for their slowing down and/or their degradation, the territorial aspect and the diversity of actors, and possible levers to limit these processes lead to a serious game-type tool to monitor and analyze the impact. This allows to experiment with different combinations of individual and collective actions on water quality.

The game should also enable to account for the multiple constraints on the transformation of agricultural catchments, allowing a better water quality while preserving the agricultural land use. Exp'Eau first targets a student audience to be able to repeat experiments and compare possible pathways. In a second phase, an audience of local stakeholders will be relevant to raise awareness about the collective dimension of the water quality issue, and secondly to explore possible courses of action at an actual catchment scale.

## **3 Implementation**

The virtual catchment we consider is designed on the basis of the Moderbach catchment (North East of France) simplified and discretized with hexagonal tiles [3]. The hydrographic network is reorganized into an explicit flow network oriented towards a single outlet. Each tile corresponds to a land use (Agriculture, Nature, Urban), assigned according to the dominant land cover.

The game is structured according to three levels of organization, spatially (cell, communal territory, catchment area) and socially (farmer, elected official, catchment area manager). The basin is divided into three independent boards located on different tables in order to create an effect of distance that enables to focus the interactions between the players around the same table, at the exception of the times dedicated to collective interactions. Each board corresponds to the territory of a municipality. Exp'Eau features three types of actions related to (1) agricultural practices, (2) the control of pollutants, and (3) a better valorization of agriculture.

Only cells with agricultural occupation are likely to generate an amount of pollution which depends on the type of crop and the agricultural practice, as well as on the presence of some agro-ecological infrastructures on the plot allowing to limit the spread of pollutants.

The farm practice action cards have the same structure. Each crop is described with two to three levels of practice that are more or less intensive in terms of use of chemicals and generation of pollutants. Practice parameters are a minimum level of technicality, levels of effort (measured in work time) and of investment (measured in units of goods), and levels of production (measured in units of goods) and of pollutant emission. All these parameters are valued on a scale ranging from 0 to 5. Cards include bonuses/maluses defined as deviations from a standard weather and as a pest

outbreak occurrence. Non-farming action modalities include investments in agroecological infrastructures or land use changes, and training to improve farming practices. They are also characterized by a cost in time and in unit of goods, as well as a possible effect on the production level of the plot and the emission of pollutants.

## 4 Experimentation

Firstly, we also developed a computerized version based on an Application Programming Interface (API server/smartphones) to facilitate the collection of the player's choices and the computation of their practice's outcomes. However, as mentioned in [4], this API was capturing the attention of the players, what was limiting the interactions between players.

The second attempt, a purely analog version, has proved to facilitate the interactions among players around the three game boards and during the collective setting. In this second version, the split of the game board/catchment into three tables was successful to embody the need to move so as to communicate with players coming from other geographical areas and to understand the interdependencies at the level of the catchment.

## References

1. Barreteau, O., Abrami, G., Bonté, B., Bousquet, F., Mathevet, R.: Serious games. In: Biggs, R., de Vos, A., Preiser, R., Clements, H., Maciejewski, K., Schlüter, M. (eds.) *The Routledge handbook of research methods for social-ecological systems*, pp. 176-188. Routledge (2021)
2. Etienne, M., du Toit, D., Pollard, S.: ARDI: A Co-construction Method for Participatory Modeling in Natural Resources Management *Ecology and Society* 16 (1), 44 (2011)
3. Charpentier, I.: XGeoTiles: Tiling watersheds with hexagons for serious games. 2021. hal-03154090
4. Becu, N.: 2021. Usability of computerized gaming simulation for experiential learning, in: Castro, L. M., et al. (Eds), *Software usability*, IntechOpen.