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A Serious Gaming Approach For Serious Stakeholder Participation

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Serious games are a category of games which are designed for a specific purpose other than for pure entertainment. Serious games are not a new concept but advances in knowledge and technology open up a new paradigm for active stakeholder participation. DHI and UNEP-DHI Centre initiated a serious game project called Aqua Republica, where a virtual world allows participants to develop a river basin and visualize the consequences of their decisions. Aqua Republica combines a game layer with a water allocation model, MIKE HYDRO Basin, to create an interactive, virtual but realistic environment where players play the role of manager of an undeveloped river catchment. The aim of the game is to raise awareness of the interconnectivity of water and educate on integrated water resources management. This led to the development of MOSA Aqua Republica, a tailored version of the game to the Middle Olifants river basin in South Africa. During a series of workshops/ during a three day workshop the game was presented to a group of local stakeholders, to facilitate capacity building and to collect feedback. During the workshop/s, the benefits as well as the limitations of the game were discussed.

Introduction

There are critical connections between social and economic developments and environmental sustainability, with water being an essential building block. [1] Unfortunately these linkages are not widely recognized. As a result there is a lack of good decisions, or even a complete lack of decisions, on how water should be allocated between various domestic, agricultural, and industrial users. Often this is the result of silo-like thinking where, for example, upstream users underestimate or simply do not consider the need to consult and coordinate with downstream agricultural users, town planners and smaller communities. As countries develop, climate change impacts and demand for water grows, so does the need for holistic planning approaches and practices.

The first step in improving the development, management and use of water is to raise the awareness of people about how, what may initially appear to be unrelated, users and uses are in fact very closely interconnected. The second step is to begin to identify and implement the necessary solutions. While traditional education initiatives such as community programmes and

professional courses aimed at addressing this situation have been done for decades, compared to the scale of the challenge, the number of people they can reach is limited, which is reflected in the resulting impact. If we want to get more people to understand these issues and increase their interest in solving water problems, we need to take a look at other approaches. One of the approaches, which DHI and UNEP-DHI Centre have been looking at, is to raise awareness and educate in the field of water management, through serious games.

Aqua Republica is not just a game, it is a game platform. It is therefore possible to tailor the game to meet the needs of different stakeholders and to adapt it for different purposes. This paper will focus on a case where the game is tailored to a project site in the Middle Olifants catchment in South Africa.

Games and engagement

Before going into the example, we would like to explain about the design and concepts behind Aqua Republica. The game is inspired by meaningful play, a condition described by Katie Salen and Eric Zimmerman in, Rules of Play [3]. It is a condition that is very much like learning. For example we can take a look at how one learns to ride a bicycle. One first gets on to the bicycle, tries to balance and the bicycle reacts based on that action. When one fails at the first try, the body tries to balance a little differently and this cycle continues until one finally learns how to balance properly.

The learning experience is similar while playing a game. A well-designed game environment will provide a feedback mechanism that allows the player to reflect on his or her actions and adopt a different approach in the game. This internalization of actions and reactions is what referred to as meaningful play (see Figure 1).

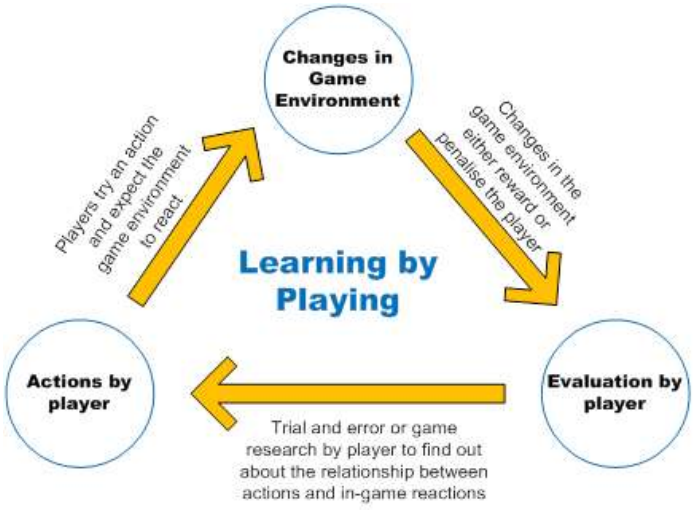

Figure 1. The cycle of learning by playing

What does the game teach? The game takes inspiration from the work of the United Nations Environment Programme and others who call for a more ecosystem-based management approach to development [2]. This includes the importance of recognizing and valuing the services that ecosystems can provide, and working with nature in order to achieve sustainable development. The game is also heavily based on Integrated Water Resources Management

(IWRM), an internationally acknowledged process which promotes the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems.

How does the game promote engagement? Any typical game design includes the following features – a well-defined space, a set of rules and struggles. If we take a look at the Monopoly game, you can easily identify the features. The space is the colorful and fun looking Monopoly board, the set of rules is how different players can develop in the game, for example by buying property, and the main struggle is to be the wealthiest player at the end of the game while going through random dice throws and negotiations with other players. These features (graphics, the interactivity, the challenges and the reward of winning) function together as great motivators for engagement [5].

The design of Aqua Republica is based on similar inspirations (see Figure 2). The space is a virtual sub basin within a larger river basin, this river basin can be fictitious or can be based on data from a specific project site. The rules of the game are the physical science or hydrology of a river basin and that is computed from the water allocation model called MIKE HYDRO basin. This model computes the water balance for the river basin and contains water data such as rainfall and runoff, water demand for various land cover, return flows and so on [6]. The model can be fictitious or it can use data from a specific project site.

Besides the hydrology, we also add in very simple mechanics that simulate the interactions and relationships between different water users. For example, the population in Aqua Republica requires food, water, housing and jobs; farms generate food, but require water and electricity, so in order to produce food, power plants are needed, and in order to build power plants, funding is needed, which comes from job providing industries, urban areas and so on. These mechanics are considered human interactions in the game and they form the struggles of the game. The player will have to navigate through these struggles along with the rules in a river basin to obtain their objective which is to get the highest score. The score is weighted such that actions that go along with the principles of IWRM will get result in higher scores. People can play and replay the game, get rewarded from performing the right principles and be penalized from failures in the game.

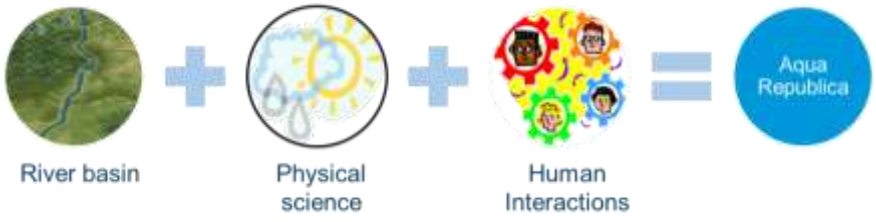

Figure 2. Components of Aqua Republica

Case example

During the first phase of the research project *Integrated Water Resources Management Pilot Project "Middle Olifants", South Africa*, the need of raising awareness and capacity building in

sustainable water resource management in South Africa was identified. The "Middle Olifants" river catchment lies northeast of Pretoria, the region is characterised by a large quantity of water users, with a high demand of water for households, large scale irrigation farming, mining and quickly growing settlements [7].

The potential of using a serious game to address this needs, led to the development of a tailored version of Aqua Republica for the pilot site in the Middle Olifants region in South Africa (MOSA). MOSA Aqua Republica reflects the conditions of the Middle Olifants catchment and has been customized to include typical features, including agriculture and specific irrigation methods, local industries, mines and different ecosystem types (see Figure 3). The MOSA version of the water game has been developed in the Unity game engine, is linked to the MIKE BASIN water allocation model (a model version prior to MIKE HYDRO Basin) and can be played online in a web-browser.

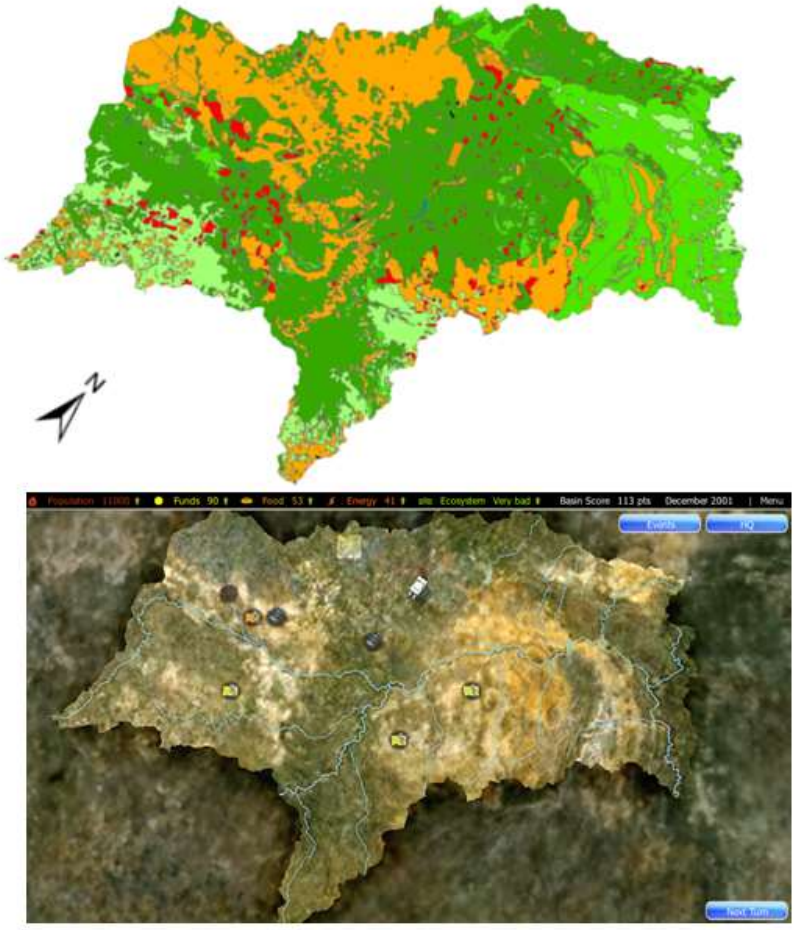

Figure 3. Snapshot of the MOSA version of Aqua Republica (bottom) compared to the digital elevation model (top)

The game starts in a hypothetical scenario in 2000, with a certain amount of population, funds, food, energy and an unhealthy ecosystem. During each turn, the player has the possibility to

make changes in the basin area, while trying to achieve a high basin score, during a total of 13 rounds. While the original Aqua Republica has 20 rounds, the MOSA version has been reduced to 13 rounds with the aim to optimize the required game time for training and workshops. Every turn gives an indication of the achievements and the status of the water use can be checked. More development does not necessarily result in a higher basin score, which will educate the player in developing the basin in a more sustainable way. Further, during the game, events such as droughts and floods are triggered, depending on how the basin development is managed. To avoid such events, the player must keep an eye on the water use, the environmental status and if necessary, implement policies.

In November 2013, MOSA Aqua Republica was presented to a diverse group of local stakeholders in a two day workshop in Pretoria, South Africa. During two sessions, the participants had the opportunity to learn and play the game, while being accompanied by a team from DHI and in return provided valuable feedback about the game. The invited participants covered a broad background of specialization within the fields of water supply, ecology, mining and other industries, local, national and international politics and economy and a substantial share of the people was familiar with the project area. The participants were introduced to the concept of sustainable catchment development, but each player applied its own strategy to achieve a high basin score. The changes to the basin area, such as new buildings, infrastructures or policies were filled manually in a score sheet. After each session the accompanying team talked to each player about their impression on the game, collected the sheets and evaluated the scores.

In a closing ceremony an open discussion about the game and catchment development was held and the winners were rewarded with a prize. Overall, the feedback to the game was positive and its use as an education tool was widely recognized. It was emphasized that the game is not a decision making tool but an education and capacity development tool by synchronization of different components such as food, energy, economy, ecosystem and natural events.

After the workshop, the information collected in the sessions was evaluated. It was noted that the game is not completely intuitive and players need a few rounds to understand its concept. Mostly the players requested more educational information during the actions made in the game and more transparency in the calculation of the basin score. Local adaptations were suggested in regards to the type of crops, ecosystems, industries and policies available.

Discussion

With regards to the MOSA version of Aqua Republica, it is noted that the game physically represents the MOSA catchment, but it is to some extent unclear about the links to the specific MOSA catchment situation and real issues that stakeholders would struggle in. Currently, the game starts with a hypothetical situation with non-dense populated catchment and limited industry and farming. For stakeholders to understand complex problem solving that they encounter in their daily life, the game could start off with different scenarios. Implementing further local adaptations will certainly provide a more realistic representation of the local conditions, increasing the effectiveness of the capacity building within the project area.

In general, the introduction to the game requires more time and should be supported by an action-consequence explanation and provide information about what triggers an event and what proactive measures can be taken.

A supporting script with explanation about the real situation of the catchment and how it differs from the game as a model for catchment development would be helpful in the next IWRM capacity development session. Reviewers suggested the need of interactive training materials such as video clips, and a guide book to the game linking to the IWRM concepts, to explain possible game scenarios. A combined training module with IWRM concepts and the use of Aqua Republica as a practical lesson, supported with a handbook about the game could benefit the use of the game for capacity developers in waters sector.

Currently the game is set up as a single player-version. A multiple player version could be a beneficial extension of the platform for capacity development of decision making level stakeholders in a catchment. Multiple player versions that represent different interests of the role players in the game will help to understand on "how to come to a win-win situation". Also, the development of an offline version of the game was identified as an important aspect for increasing the spreading of the game, also in areas where internet access is limited.

Conclusion

Aqua Republica reflects the requirements of a serious game, by providing a learning platform for a sustainable river basin development. It requests the player to develop a prosperous river catchment, by generating a good economy to provide funds needed for development, having a steady food supply for the population and enough energy and water for the catchment. Through these actions by the player, a meaningful play is established to engage players and to educate them about the complex relationships between developmental actions in a river basin and the natural environment as well as their consequences. The game also includes a reward system to encourage learning, through the basin score.

The development of the tailored MOSA version displays the potential Aqua Republica has to be implemented for specific needs and environments. The workshop for stakeholders was a good opportunity to introduce the game and raise awareness, but also showed that it still has its limitations as a standalone tool for capacity development in IWRM. It will need separate training sessions on IWRM, using the serious game to understand the linkages among different components in a catchment and the comprehensiveness in a real world system. As noted by Egenfeldt-Nielsen S (2007) [4], "Serious games should not be seen as a standalone experience but optimally in interplay with other teaching tools. The serious games field has an even clearer rejection of the fallacy that an instructor can easily be replaced. The instructor is crucial for ensuring reflection and guidance during the learning experience. Obviously, you will still learn without an instructor, but you risk losing focus and effectiveness, as you can't replace the sensitiveness a good instructor can apply to progress learners."

The future development of MOSA Aqua Republica within the project will include improvements on how the information is displayed within the game, to make its use more intuitive and integrate further adaptations with respect to the local conditions in order to improve its effectiveness as an educational tool.

Acknowledgments
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