### An interactive capacity building experience – an approach with serious games

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### Abstract

Aqua Republica is an online serious game currently being developed by a consortium consisting of DHI, UNEP, and UNEP-DHI Centre, as well as other interested partners. Inspired by Integrated Water Resources Management, the game helps to raise awareness and educate stakeholders about the importance and challenges of managing limited water resources in the face of multiple and often competing demands in the drive towards sustainable development and climate change adaptation. This web-based game is designed to impart knowledge to players; knowledge such as an understanding of the strong links that water has with many sectors of society, the valuable services that ecosystems render to our society, the trade-offs that occur when water is allocated between competing water use sectors, and also the potential impact that climate change can have on the well-being of societies.

Aqua Republica combines a game layer with a water allocation model, MIKE BASIN, to create an interactive, realistic virtual environment where players play the role of a catchment manager of an undeveloped river catchment. The main objective is to develop the river catchment to be as prosperous as it can be. To achieve that, players need to develop the catchment's economy to provide the funds needed for development; have a steady food supply for a growing population and enough energy and water to maintain environmental services. Players are engaged and educated about the complex relationships between developmental actions in a river basin and the natural environment - as well as their consequences.

The game layer also consists of a reward system to encourage learning through competition and more positive actions. For example, a player who takes care of the ecosystem while developing the catchment gets a bonus score and gets a rewarding event. While a player who does not, will encounter pollution events, will need to spend more resources on cleaning up and will ultimately receive a lower score. Such game mechanics are designed to engage people and increases their interest in sustainable water resources management.

### Keywords

Serious games, IWRM, Trans-boundary, Governance, Capacity building, ICT

### Introduction

According to the 2012 UN Water Status Report on the Application of Integrated Approaches to Water Resources Management, 82% of countries are implementing changes to their water laws for a more integrated approach for the use of water resources. This shows that there is a lot of focus on how we could better use our water resources and definitely no shortage of opinions on the importance of water and how we should use it sustainably.

However, according to the same report, only 35% of countries have sufficient training programs for integrated water resources management (IWRM). That is a massive gap between the will and the capacity to solve water problems. If we do not know how best to use water resources in an integrated way, how could we make the right changes to our water laws? It is obvious that we need to narrow this gap but how do we that?

Capacity building programs and training programs have been going on for many years and education is a complex and continuous process, nevertheless there is a need to find a way to make it more efficient and scalable if we are to make serious progress, especially so in terms of information and communications technology (ICT). As a continuous process, the interaction and engagement between the various stakeholders is especially important. However human behaviour changes with time and with the advancement of technologies, digital communication and information are increasingly getting more prominent and becoming a norm.

The upside of digital communication and information is the accessibility; we can send emails on mobile devices and read about the latest trends and news while on the move. The downside is the overabundance of information; information is created at such a high rate that it creates "noises" and affects our attention span. Today, every single source of information, be it books and papers, webpages, television programs, podcasts, YouTube videos, smses, Facebook notifications and so on, competes for our attention and the most interactive and engaging one normally wins.

With this as a backdrop, we now face additional challenges in capacity building; besides having to make it more efficient and scalable, we also need to keep up with communication trends and technology to be able to attract the attention and interests of our target audience.

If we take a look at where capacity building starts, at a school and examine the teaching process in a school but there is a big difference between what students do for fun (e.g. interactive and entertainment games) and what is required to do in schools. The students are highly motivated by what they do for fun but are generally speaking unimpressed by school materials which are deemed as "important". (Valerie J. Shute et al) If we can combine the fun part with school materials, that would have tremendous potential to increase learning.

Such an approach is called serious gaming and it is has been used successfully in other non-water related sectors. In this paper we will take a look at an interactive approach to capacity development with the use of serious games in the field of water and especially so in IWRM.

## What is serious gaming?

When we encounter a problem, it is always wise to go back to the fundamentals. That leads us to a quote from Confucius, a Chinese philosopher who once said "I hear and I forget. I see and I remember. I do and I understand." The keywords are doing and understanding, but how could we do or practice integrated water resources management?

Imagine a virtual world that mimics the complexity of the real world, in terms of water environments. A virtual world which allows us to test out development plans, test out new regulations, visualizes the potential impacts, make mistakes and as a result learn through personal experience. This is the concept of serious gaming.

A serious game is a category of games which are designed with the intention to teach rather than for pure entertainment, whereas a casual game is defined here as a game for pure entertainment. However it does not mean that serious games cannot be entertaining. Serious games that are well designed yield "meaningful play", a condition very much like learning. According to Salen and Zimmerman (2004), meaningful play is when the relationships between actions and outcomes in a game are both discernible and integrated in the larger context of the game. Serious games also shift the focus of control in learning from the teacher to the player and create an environment that stimulates learning, often resulting in an increase in self-learning and knowledge retention.



Figure 1, the cycle of learning by playing

While learning can occur within a casual game, it is a by-product rather than the intended outcome of the game play. Both types of games varies in different forms of genres, platforms and storylines but a good game, whether it is a serious game or a casual game has enough challenges and rewards, as well as entertainment value to keep players' attention.

When describing the distinct difference in the two types of a game it holds true that the devil is in the detail. A serious game is embedded in a realistic context whereas a casual game may use a realistic context as a way to create a more believable game.

This becomes clearer as we look at some of the key components of how games work on low level.

Games are interactive, which is what makes them different from traditional media. However interactivity itself is meaningless without a context. Opening or closing a door is interactivity, you interact with the door, but whether or not it makes sense requires that there is something we are striving towards – a goal. If we want to conserve heat by not letting cold air into the house, the interaction of closing the door is suddenly meaningful.

Games thus are interactive and have a goal. This is true for all types of games. The last part to making a game is to combine the purposeful interaction with opposition. Opposition forces the player to make choices, the type of choice that the player has to make is often part of deciding which genre label is put on a game. Shooting games requires quick twitch actions and many of the choices made are almost subconscious, duck, jump or sprint to the next piece of cover and such. Turn based strategy games involves choice based on analysis of the current state of game and the range of possible actions based on current resources and an understanding of how current actions changes the game state – for example chess.

Games also have a structure. In a typical board game the structure would be the rules which you play by. In a digital game the structure defines what you can do within the game and how the feedback loops works. The structure defines which actions you can take in order to overcome the opposition and reach your goal.

Every game also conveys information, which is passed on to the player. The information is needed for the player to make choices, without information the choices will be random and that will quickly grow boring, since then it is not you overcoming the opposition, then you might as well have flipped a coin in the beginning to determine the outcome.

The above is still part of games whether they are considered serious or casual, but we are getting closer to the part where they branch. The nature of games being a visual interactive environment with its own structure, feedback mechanisms also means that games "create its own meaning" also called "Endogenous meaning" in an article by Greg Costykian (2006).

For example a big white box with a red cross on it means that I get 100 hit points back in a shooting game. This makes sense within the game, making the same assumption, let alone that line of thinking wouldn't make sense in the real world.

This is where serious games tend to stand apart.

The meaning created in a serious game and the verbiage used to describe it should have a relationship to the subject matter it is trying learn the player about. So that if a player is asked to describe what happened in the game, this description will have roots in real life.

This is achieved by making the structure, goals and information received by the player through play related to the topic at hand.

What is my goal in Aqua Republica? It is to achieve the highest score possible to beat out your friends? How do I do that? You do that by balancing the water consumption between the different water users, one of them being the ecosystem. The structure of the game will make sure to pass on information to you if you start to skew the balance you will be informed. Since the game is built upon an engine that realistically simulates the flow of water in a catchment, and the game structure has been made to support this engine and uses this engine to produce feedback to the player Aqua Republica ensures that the endogenous meaning in the game is based in reality and will give the player an insight into the part of the world that is integrated water resources management.

# **Roots and development**

Using games in education is not something new, it started at least from the 1900s. However, with the advancement of computer technology, serious games began to take its present, more popular form i.e. as computer games. One of the most notable serious games is America's Army<sup>1</sup>. It started in 2002 as a video game with the intention to help with recruitment. You play the role of a virtual soldier and you go through a series of missions where you get a glimpse of what it is like to be part of the U.S. army. Since then, it has grown into a platform where it is used to train and educate U.S. Army soldiers.

Nowadays serious games are used not only in the military but in many areas. In health-care for example, the game Pulse is used by medical professionals to practise and improve their clinical skills. In other areas, for example Road Ready Streetwise is used to teach teenage users how to drive safely.

In fact the use of games in non-conventional ways is getting so popular that a new term called "gamification" is created. Gamification is the use of game mechanics and game thinking to engage the audience. One common example is airlines loyalty programme where frequent flyers earn miles and step up in the reward system as a basic member, silver member and gold member. Each different member class will have increasing priorities in the way they are being serviced by the airline. This game mechanic creates a positive reinforcement for the customer; by using the same airline more frequently, [s]he gains more miles which can be used for upgrades, and at the same time [s]he can increase the service level by attaining the higher member class.

Another interesting example is the speed camera lottery by Kevin Richardson<sup>2</sup>. A normal speed camera catches any vehicle which exceeds a certain speed limit and the driver is then fined. Kevin's idea is to also reward vehicles travelling within the speed limit. All the fines collected from the speed camera are being put together and drivers who have kept within the speed limit gets a chance to win the prize. The Swedish National Society for Road Safety and Volkswagen in

<sup>&</sup>lt;sup>1</sup> <u>http://www.americasarmy.com/</u>

<sup>&</sup>lt;sup>2</sup> <u>http://www.thefuntheory.com/speed-camera-lottery-0</u>

Stockholm conducted the test and it the average speed was reduced by 22% during the campaign, making it a big success.

Since serious gaming and gamification are used in different sectors, so why not in water?

# Methodology - Serious gaming and IWRM

Aqua Republica is a DHI and UNEP-DHI Centre project that focuses on the development and promotion of a not-for-profit serious game in collaboration with a number of partners. Our aim is to promote sustainable water resources management by sharing knowledge, raising awareness and building capacity in some of the most critical issues in water resources management through serious gaming. This is achieved through a computer-generated virtual environment called, "Aqua Republica" where participants can experience making decisions in managing a catchment in an interactive and engaging way, and in doing so learn about the connectivity and importance of water resources, as well as the need for careful management. While the world of Aqua Republica is fictitious, the challenges of sustainably managing a limited supply of water resources in a situation of growing demand between multiple users and uses are very much based on real life scenarios.



Figure 2, screenshot of a sample of Aqua Republica's user interface

The Aqua Republica game is designed to be a powerful teaching tool, which uses a reward system to encourage learning and desirable behaviour. It is designed to engage people and increase both their knowledge and their interest in water-related issues. The ambition is to continuously develop Aqua Republica in multiple versions which have both broad and very specific appeal to a wide range of people and contexts.

The following sections of the paper break down the game into a virtual environment and a learning environment and explain in more details how they support learning.

## Virtual environment

The core of Aqua Republica revolves around the computer generated virtual environment; this virtual environment tries to simulate a simplified version of the real world. The virtual environment consists of 2 layers – a water allocation and hydrology model and a game layer which uses the results of the model and links it to social-economic factors.

The water allocation and hydrology model is powered by MIKE BASIN by DHI, while the game layer is developed with inputs from various partners. MIKE BASIN is used widely to provide solutions to water allocation and water shortage problems, improving and optimizing reservoir and hydropower operations, exploring conjunctive use of groundwater and surface water, evaluating and improving irrigation performance, solving multi-criteria optimization problems, establishing cost-effective measures for water quality compliance. The concept of linking up the numerical model is simple; the game map is linked dynamically as an input to the numerical model and any actions on the game will affect the water use of each node in the numerical model.



Figure 3, a schematic view of how a map tile in Aqua Republica (left) links up to a node in the corresponding MIKE BASIN model (right)

Using MIKE BASIN as the backend model to calculation water allocation and hydrology provides a lot of benefits:

- It allows us to use hydrological data in a game, such as
  - Digital Elevation Model (DEM) of the area
  - Shape files of the river network
  - Delimitation of the sub catchments
  - $\circ \ \ \, Runoff\,data$
  - Evaporation losses, level-area-volume curve, bottom level, top of dead storage dam crest elevation, minimum and maximum release of reservoirs
- It allows us to use realistic water demands for various types of water users or buildings in the game (e.g. crops, irrigation, various industries, etc.)
- It gives us an accurate representation of how water is interacting in a catchment (e.g. upstream and downstream relationships etc.)

The game layer uses the results from MIKE BASIN and affects the social-economic factors in the game. The figure below summarises the interactions in the game that makes up the game layer.





Figure 4 Game interactions in Aqua Republica that constitutes the game layer. This game layer uses results from MIKE BASIN to process social-economic factors

#### Aqua Republica Game Features



Figure 5 Game features of Aqua Republica

The game layer consists of several indicators – population, funds, food, energy, ecosystem state and water. Every indicator is linked to one or many different structures.

- Population
  - Each city in Aqua Republica houses a part of the population and the bigger the city, the higher the rate of population growth
  - o Every city also provides a small amount of jobs
  - Population in Aqua Republica consumes water, food and energy
  - Population requires jobs and also has an affinity to good ecosystem state
- Funds
  - Funds are needed to build new structures or enforce policies within structures
  - Funds come from employed population
    - Cities provide a small amount of jobs
    - Farms provide a small amount of jobs
    - Industries provide a bigger amount of jobs
  - Funds can also come from trading food or energy in the market place
- Food
  - Food is needed by the population to survive
  - Food is produced from farms. In Aqua Republica, the people have no real preference in the various crops
    - Different crops in the farms however provide different amount of food, uses different amount of water and impacts the environment differently
  - Food can also be purchased from the market place
- Energy

- Energy is needed to power all the buildings in Aqua Republica, except for ecosystems
- Energy is produced from power plants
  - Coal
  - Bio fuel
  - Nuclear
  - Hydro power
  - Different power plants provide different amount of energy, uses different amount of water for cooling and impacts the environment in different ways
- Energy can also be purchased in the market place
- Ecosystem state
  - Ecosystems require a minimum environmental flow of water
  - Ecosystems provide many different services to the catchment (ref to UNEP ecosystem picture)
- Water
  - Water is required for all structures including ecosystems to function
  - Water in Aqua Republica comes from an upstream source, local rainfall as well as local groundwater aquifers
  - Water also flows to a downstream neighbour
  - There are only two types of water quality in Aqua Republica clean and polluted water
    - Polluted water affects the productivity of all structures

The combination of the numerical model and the game layer creates a sandbox to practice making decisions. With all the underlying logic mapped out behind the scene, the player can apply theories on integrated water management, visualise consequences and learn both by taking the right actions and by making mistakes in the game.

# Learning environment

Aqua Republica is a learning tool. It is not meant to simulate actual river basin management in a real catchment. However, players will learn about the conflicts and trade-offs that exist in a real catchment by experiencing it through meaningful play. After playing the game, players will better understand the needs and perspectives of all the stakeholders involved in integrated water resources management as well as the role and value that ecosystems perform and provide.

The focus of control of learning in Aqua Republica shifts from the teacher to the student. This helps create a more personal learning environment. We have developed a learning system with events and advices. It also consists of a reward system that brings about positive reinforcements when the player does something right and negative reinforcements when the player does the opposite.

The key objectives of the game are inspired by UNEP's ecosystem approach to IWRM, highlighting the importance of ecosystems and services that they provide (e.g. food security, freshwater supply and disaster risk reduction, etc.) The game also shows that co-operation within a basin does not come automatically and needs to be both established and maintained.

The diagram below shows the key ecosystem services that will be included in the game.



Figure 6, ecosystem services represented in Aqua Republica, Source: UNEP Ecosystem Management Program

The first version of the game is a turn based strategy game and a player plays through 12 turns which is roughly translated to 20 years. The player can spend as much time as desired before making a move and committing to it by choosing to press next turn. As such there is no time pressure on the player to take a move, thus allowing discussions and deliberations before ending the turn and moving on to the next time step.

At the beginning of each new turn the player will be presented with a news screen which is made up of different events. These events inform the player of changes in the game environment, as a result of which actions the player took. The player can then evaluate the new state of the game and take informed actions.

The first 3 turns are part of a tutorial phase, where information about the entire gameplay is presented over 3 turns. During this phase the game informs the player on which actions are needed to fix immediate needs at the start of the game. This helps introduce the player to the interface of the game and guides the player on what possible actions to take. However the player can choose to take other actions which may result in other consequences. After the first 3 turns have passed the player has taken all basic actions and been able to reflect upon them.

Events in the game are classified into random and triggered events and are categorised into:

1. Tutorial events help guide the player to understand the mechanics of the game as well as the different components of the virtual world.

Table 1	Examples	of tutorial	events
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Name	Туре	Trigger Condition	Short Description
Welcome to Aqua Republica	triggered	tutorial set to true	Welcome and congratulations! You are now in charge of all the developments of Aqua Republica – an under-developed water catchment with great potential! Your people have high hopes for you and they welcome your efforts to turn this sleepy catchment into a thriving and prosperous one. Remember, it always pays off to work with nature rather than against it. Good luck!
Food, Energy, Money and Water	triggered	tutorial set to true	Your primary resources are food, energy, money and water. You need these resources to develop Aqua Republica. Industries produce money. Farms produce food and power plants produce energy. Water comes from the Great River and its tributaries. However everything is connected to each other. Farms need water and energy to function, industries need water and energy, and power plants need water. Your people need food, energy and water to survive, so keep everything in check!

2. Climate and hydrology related events, which emulate the weather system and transboundary related issues as well as disasters such as flooding and droughts.

Name	Туре	Trigger Condition	Short Description
Drought	triggered	runoff in river node < 30% of discharge in catchment node	Drought hits Aqua Republica!
Upstream greed	random		The Great River is running low! You found out your upstream neighbours have built a dam and are keeping more water for them than usual!

### Table 2 Examples of climate and hydrology related events

3. Farming related events highlight farming related issues, such as conflicts in land use and conflicts in water allocation, pollution and so on.

Name	Туре	Trigger Condition	Short Description
Farmers fight over	triggered	6 or more farms in	Your farmers are protesting over rights of farmland and water.

land		region	
Farmers take to the streets	triggered	2 or more farms with less than 80% of water needed	You farmlands are drying up and the farmers are protesting! There is insufficient water for them to grow crops and they demand your attention.

4. Industry related events highlight industries related issues, such as conflicts in land use and conflicts in water allocation and pollution.

Table 4	<b>Examples</b>	of industry	related	events
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Name	Туре	Trigger Condition	Short Description
Industry union orders workers strike	triggered	2 or more industries with less than 70% of water needed	Industry workers have started striking! There is insufficient water for industries to make money and workers are not getting paid!
Industry goes green	triggered	4 or more industries, all industries have green roofs and clean water act	The environmentalists are happy that industries are going green, and so is the wildlife in Aqua Republica.

5. Energy related events highlight the issues of energy, their use of water and their impacts on the environment.

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Table 5	Examples	UI	energy	relateu	evenus

Name	Туре	Trigger Condition	Short Description
Zero carbon emission energy	triggered	all energy is produced by hydro power	Aqua Republica is named the first catchment to be completely powered by hydro power. Congratulations!
Energy production goes green	triggered	3 or more power plants all have source water protection	All your power plants have agreed to protect your water source. A wise move to ensure sustainability for the environment.

6. Ecosystem related events are mainly events which highlight the benefits of ecosystem services.

#### Table 6 Examples of ecosystem related events

Name	Туре	Trigger Condition	Short Description	
Deforestation		>70% of	Forests hold more water than built up areas and forms. Experts are	
increases	triggered	land is built	Forests hold more water than built up areas and farms. Experts are	
flood risk		up	warning that excessive deforestation is increasing our risk of flood	
Outbreak of		water	Waterborne diseases are caused by organisms in polluted water. Most	
waterborne	triggered	pollution =	infected people have reported to have swum or drank some water from	
diseases		true	the Great River.	

7. Social or Population related events highlight the views of the population in the game and the issues that a city has in terms of water and the environment

**Table 7 Examples of population related events** 

Name	Туре	Trigger Condition	Short Description
Trash piling up in streets	triggered	Density high	The high population density in your cities is creating many problems with sanitation.
Green cities appreciated by all	triggered	Cities all have green parks/water meters and clean air/water	A recent survey has shown that your people are happy with your clean and green cities. Good job!

8. Economy related events affect the economy of the game, they also includes changes the economic rules of trading and how money is earned in the game, reflecting the flux of a global market

**Table 8 Examples of economy related events** 

Name	Туре	Trigger Condition	Short Description
Soft drink		income/funds low	A soft drink company opens business in Aqua Republica sparks some
company	triggered		debate. No doubt it is good for your economy but some argue that your
controversy			environment could be at risk.
Eco			
tourists	triggered	national park	Your national park has seen an increase in the number of tourists. Good
have		= true	news for the economy!
arrived!			

### **Reward and evaluation system**

Events in Aqua Republica are also an important part of evaluating a player's performance in the game. As events can be triggered by the actions of the players, actions which are in line with the principles of integrated water resources management will trigger positive events. This rewards the player visually, as the event will encourage the player with a virtual "pat on the back"; it may

also causes the game to display additional graphical rewards. The positive events moreover give extra score as well as extra funds or food in the game.

On the other hand, when the player's actions are not desirable, the game will trigger negative events. This will display events which will discourage the player to continue with the actions by penalising the player with reprimanding tones in the events as well as deduction in scores, and resources in the game such as food, energy, funds and state of the environment.

This means that the score at the end of the game gives an indication of how well the actions of the player are in accordance of the good water resources management. The scorecard at the end of the game will summarize the different score components of the game.



Score breakdown

### Figure 7 Scorecard and score breakdown in Aqua Republica

As shown in Figure 7, the score of the game is a basin score, and the basin score consists of the following:

- Population score shows the general well-being of the citizens of Aqua Republica. It is further broken down into 4 parts:
  - Density: The citizens will generally be contented if there is a good living space, so if population is increasing, there should be more cities in the game.
  - Job situation: The citizens will be contented if there are enough jobs in the game. Jobs are created by cities, farms and industries.

- Food Surplus: The citizens require food
- Steady power supply: The citizens also require energy
- Production score shows the economy and food production of Aqua Republica.
- Ecosystem score shows the state of the environment of Aqua Republica. There are 2 components to this score the rating of the ecosystem which reflects how pristine or damaged the ecosystems are and the water use in the game.
- Sustainability score shows how sustainable the developments are in the game. This is done by running the numerical model 3 time steps into the future and getting the score based on the future results.
- Achievement bonuses are extra score awarded to the player for outstanding feats of strength in the game. Some examples of achievements are Green Peace Award, which occurs when the player does not encounter any pollution event throughout the game; another example is Water Manager Award, which occurs when the player does not encounter any water shortage events in the game.

Now we have covered all of features of Aqua Republica and how they contribute to creating a virtual learning environment, let us take a look at how the game can be used and played for various applications.

# Game play and applications

Aqua Republica is designed to be used broadly and hence there is no one version of the game that can fit into all the scopes of integrated water resources management. To overcome this problem, Aqua Republica is spilt into core and unique versions.

The core version of Aqua Republica is a framework of game features and game modules which can be assembled into various unique versions. (Ref Figure 8) A unique version of the game can be a change of numerical model data, landscape of the game map, and having a different set of events and advice. A unique version is also more focused on a particular set of learning goals.

As mentioned by Simon Egenfeldt (2007), "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."

Therefore, there are many ways of using Aqua Republica, such as a stand-alone tool to promote integrated water resources management or using it as a supplement to existing training programs or workshops for more focused learning and effectiveness. Depending on the uses, there are also different ways to play the game.

The table below lists the possible applications of Aqua Republica. Each application can be used by itself or can be used in various combinations.

#### **Table 9 Different applications of Aqua Republica**

Applications of Aqua Republica	Purpose	Benefits of using a fictitious virtual environment in application	Benefits of using a more realistic virtual environment in
As a stand-alone web based game without any facilitators	Raise awareness of water issues Build capacity on an individual level	Appeals to a wider and more generic group of audience as game content does not reflect any local region	Allows more in-depth local issues to be taught through customised events Allows more in-depth local issues to be taught through the use of local hydrology
As part of hands-on exercises in a workshop of training course with a facilitator	Build capacity on an individual and organisation level Engage participants' interest		data
As a competition between participants in a workshop or training course	Monitor and track learning progress		
	Engage participants' interest and increase discussions		
As part of evaluation in a workshop or training course with a facilitator	Monitor and track learning progress		
As a tool to facilitate decision making discussions in workshops with a facilitator	Raise awareness of water issues Build capacity on individual, organisation and enabling environment level	The use of fictitious virtual environment is beneficial for breaking down barriers of communication. This is because of the neutrality of the environment so	The use of more realistic environment is especially important for more in- depth discussions relating to local issues.
	Engage participants' interest and increase discussions by visualizing consequences of various decisions	participants do not need to be concern about the possible political implications of their decisions in the game.	While being more realistic, the game is still a simplification of the real world. There are also certain mechanics such as political situation and
		This creates a relaxed environment which can further stimulate learning.	behaviour of various stakeholder groups which cannot be computed; hence the game can be used only as a discussion tool in decision making.

For a stand-alone tool, you play the role of a water manager and you are in charge of all the developments of a part of a river basin with multiple stakeholders. Your area initially contains a river, a small urban area that includes some businesses and light industry, a few farms and a small power station. Your aim is to create prosperous living conditions for the population in a healthy and sustainably managed environment. As time moves on, drivers such as population growth, climate change and trans-boundary developments, force you to adapt to survive and

thrive. For example, you may need to decide to clear a forest area to open up land to expand industry or an upstream neighbour uses too much water and you need to start to negotiate and react. However, developments are costly, take time to implement, use water and impact the environment. How would you balance all the developmental needs while taking care of the environment?

Other uses of the game are only limited by your imagination; you can play with a group of people, each person representing a different stakeholder role while one person represents the water manager that is in charge of Aqua Republica. Before deciding on which building to construct in the game, go through a series of discussions, do the actual construction in the game and visualise the impacts. A follow up discussion can be done after each turn to evaluate the previous decisions and discuss the next possible moves. This stimulates an actual process of integrated water resources management.

Another way to play the game in a group is to be more open-ended, for example if the group of participants are more homogeneous and come from a one specific group of stakeholders. Before any development in the game, a discussion can be held within the group of participants, the discussion can be driven by the events from the game. In this case, when the group of participants are more inclined to farming developments, the game will present more farming related issues and give the participants a bigger picture perspective of water and farming as well as the connectivity of other industries.

# Partnerships

Aqua Republica is a not-for-profit game and specific applications are often tied to partnerships. Depending on the partners involved in a unique version, that version can be used either freely by anyone or restricted to only a selected group of participants. In any case, the game should always remain as a not-for-profit game.

Partners typically have an interest in developing a specific version for a specific use, also called a unique version<sup>3</sup>. The unique version is based on the core version of Aqua Republica which forms the basic game platform (see Figure 8 below). This model is viewed as being cost effective for both the partner and for DHI/UNEP-DHI Centre: A partner's main financial outlay is the costs associated in developing the unique version, with DHI/UNEP-DHI Centre using comparatively smaller portion of the partner's funding to further develop and maintain the core version. This model also helps to define clear learning goals in a unique version so that the learning environment is optimised.

<sup>&</sup>lt;sup>3</sup> A version of Aqua Republica which is tailored made, where the contents of the game are changed to suit a specific use.



Figure 8 Partnership model and differences between core and unique versions

The current unique version that is developed is the Danida high school version. The target audience is from high school students and upwards. The aim of this unique version is to raise awareness of water issues and give an insight to how best to manage water from an ecosystem approach.

There are a few more unique versions which are in development. One of them is a South African Middle Olifants Catchment version that is developed in conjunction with the German Ministry of Education and Research. This unique version will use local data from the Middle Olifants catchment and teach about the impacts of different crop types as well as different irrigation schemes on the catchment.

The next upcoming unique version is a partnership with UNDP Cap-Net. This unique version will create accompanying training manuals and modify the events and content of the game to match specific scenarios (e.g. trans-boundary issues, climate change issues and so on) related to IWRM. The aim of this unique version is to teach high school students these scenarios, their impacts as well as possible mitigation measures.

# Discussions

Serious gaming in the water sector is looking to be an interesting and innovative way to enhance capacity building. Table top games and role playing games have been used previously in various capacity building exercises within the water sector (for example the IUCN's BRIDGE project) and they have been documented to increase the engagement of participants in workshops and training courses by breaking down the barriers of communication and therefore create a better learning environment.

Digital and web based serious games on the other hand are a new breed of serious games in the water sector, there are definitely benefits in using digital serious games in terms of scalability, using of real life data to create more awareness of local issues both in hydrology and in people's behaviour and the ease of running the game online. Digital games with scoring and achievement components are also able to track players' progress if the games are used often enough.

However digital games may fall short when it comes to building capacity in more rural areas where internet connectivity is low or areas where computer illiteracy is high. The approach is

then to use the appropriate tools to build capacity for the appropriate target groups. It is also worthwhile to consider having both table top and digital games with the same learning goals and be able to choose the most appropriate tool for different circumstances and different target groups.

Nevertheless looking ahead, technology is always improving and internet connectivity is increasingly getting more widespread. It is only a matter of time when computers and smart phones or other new devices becomes more popular than they already are today. For us to continue to promote IWRM and build capacity in water efficiently, we should embrace these new technologies.

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