HYDROUSA

H2020-CIRC-2-2017

Water in the context of circular economy

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HYDROUSA game for increased public awareness

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Brief Description	This deliverable constitutes the presentation of the ''HYDROUSA'' serious game for increased public awareness about water management. Its main target group players, apart from the project consortium itself, is potential stakeholders and entrepreneurs, even simple citizens, who are interested in water sources management, water infrastructures and sustainability, as well as students in the water and environmental fields.
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EXECUTIVE SUMMARY

The following deliverable aims to present the "HYDROUSA" game, designed to raise public awareness on water management. This deliverable, numbered D9.7, is part of WP9, which focuses on communication, community building, and dissemination.

The "HYDROUSA" game is an interactive media tool developed to address the social, cultural, and environmental challenges related to water loops at the project's sites. The game uses actual data and performance analytics of the project and calls for action and participation with a solution-oriented approach. The game is available for Android devices and Windows operating systems, targeting stakeholders, entrepreneurs, citizens interested in water source management, water infrastructure, sustainability, as well as students in water and environmental fields.

Moreover, the "HYDROUSA" game can serve as an educational tool, providing additional resources for teachers on science and environmental studies. By engaging players in the challenges presented by the game, it helps develop problem-solving skills and encourages high-order thinking.

This deliverable is structured in the following way:

- Chapter 1 outlines the structure of the project and displays information on the six HYDRO schemes
- Chapter 2 looks at the Methodology on Water Management Games and explains the stages on which the development of the specific game was based
- Chapter 3 focusses on the HYDROUSA game overview, the methodology upon the game was based, its objectives and displays the game's walkthrough both from an internal (how is the communication workflow between project partners organized) and external point of view (what is the project's main communication objective towards the public).

In conclusion, this deliverable serves as a valuable source of information for project partners seeking to familiarize themselves with one of the milestones within WP9. By presenting an overview of an internal project management procedure like the 'HYDROUSA' game, it provides important insights for all stakeholders involved.

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1. HYDROUSA PROJECT

HYDROUSA is an EU Horizon2020 Innovation Action project funded under the call topic CIRC-02-2016-2017 (Water in the context of the circular economy) (Grant Agreement No. 776643). This project aims to revolutionize the water supply chain in the Mediterranean Regions by demonstrating innovative solutions for water/wastewater treatment and management, which will close the water loops and will also boost their agricultural and energy profile (https://www.hydrousa.org/about-the-project/#1542971153971-15e86414-3619).

The HYDROUSA concept was materialized by implementing six demonstration sites at full scale in three Mediterranean Islands (Lesvos, Mykonos and Tinos). These demo scale solutions are named HYDRO1-6 and are briefly reported below.

1.1 HYDRO Schemes

1.1.1 HYDRO1

HYDRO1 (Figure 1), situated on the island of Lesvos, is a sewage treatment system specifically designed for decentralized areas with high seasonal loads. The HYDRO1 system utilizes a combination of anaerobic processes, constructed wetlands, and disinfection processes to effectively treat domestic wastewater. This integrated approach ensures a completely circular solution, where water, nutrients, and the resulting sludge are reused (https://www.hydrousa.org/hydro1/).

The anaerobic treatment takes place in two UASB reactors, leading to the production of biogas and a small amount of sludge. The process recovers energy in the form of biogas, has low operating expenses and low footprint requirements. The biogas produced is collected in a gasometer and is being upgraded in order to produce pure biomethane which is used as fuel, while the sludge is treated in a sequence of a sludge drying reed bed and a composting unit (mixed with biomass). The anaerobic treated effluent is fed in the constructed wetlands, which serve as a secondary treatment providing further reduction of the organic carbon content and suspended solids of wastewater. The treated effluent from the wetlands is further fed to a post-treatment unit which consists of a UV disinfection system (https://www.hydrousa.org/hydro1/).

Figure 1: Simplified scheme of HYDRO1 (www.hydrousa.org/)

1.1.2 HYDRO2

In **HYDRO2** (**Figure 2**), the nutrient-rich water recovered in HYDRO1 is used to cultivate 1ha of an agroforestry system. This ecosystem is divided into 3 main groups: (1) trees for fruit production, (2) orchards bushes and (3) herbs and annual crops. These resilient plant setups were selected after intense research of the HYDROUSA consortium, but also co-created with the locals, who shared their knowledge and experience on appropriate plants (https://www.hydrousa.org/hydro2/).

Figure 2: Simplified scheme of HYDRO2 (www.hydrousa.org/)

1.1.3 HYDRO3 & HYDRO4

In **HYDRO3** (**Figure 3**), an innovative rainwater harvesting system is implemented in a remote agricultural area, in Mykonos. It is an innovative, nature inspired rainwater harvesting system consisting of a shallow, sub-surface rainwater collector of 280 m^2 surface area. This is designed to collect rainwater by draining and then transporting it into two cylindrical, light-structure storage tanks having a total water storage capacity of 60 m^3. Harvested water is used to water 0.4 ha of oregano. The cultivation of oregano was selected as it can grow on the island and requires low amounts of water. Precision irrigation of oregano and online monitoring of the water quantity and quality are implemented. The oregano yield is processed to produce essential oil giving an added value to the whole chain that will be locally exploited (https://www.hydrousa.org/hydro3/).

In **HYDRO4** (**Figure 3**) an existing rainwater harvesting system for domestic residences was upgraded. It is located at the village of Ano Mera in Mykonos Island. The system consists of three subsystems:

1. **Subsystem:** Residential Rainwater Harvesting system
2. **Subsystem:** Slow Sand Filtration (SSF) system
3. **Subsystem:** Aquifer Storage & Recovery (ASR) system

In this site, rainwater, storm water and surface runoffs are collected and stored into buffering tanks, in order to recharge the aquifer during the wet season with the non-conventional water sources, to be recovered during the dry season. Storm water is collected through a 46.5 m long, hybrid bioswale system, rainwater from the 438 m^2 available rooftops and surface runoffs from 350 m^2 residential yards.

A small part of the water is upgraded to potentially potable water quality standards, using the slow sand filtration process. The majority of water is used for non-potable domestic uses and the irrigation of 0.2 ha

lavender, using precision irrigation and online monitoring of the water quality. Lavender was chosen as a cultivation to produce high added value essential oil (https://www.hydrousa.org/hydro4/).

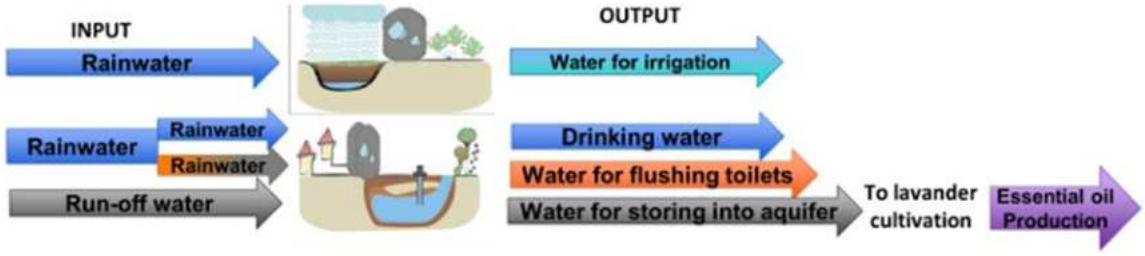

Figure 3: Simplified scheme of HYDRO3 (up) and HYDRO4 (down) (www.hydrousa.org/)

1.1.4 HYDRO5

HYDRO5 (**Figure 4**) is a biomimicry, low-cost solar driven desalination system based on the principles of evaporation and condensation, which is implemented in Tinos Island.

Seawater and brine from the existing desalination plant are treated in the Mangrove Still System, in order to produce 200 L/d freshwater and salt. The treated water is channelled to a 200 m^2 greenhouse, irrigating tropical plants (https://www.hydrousa.org/hydro5/).

Figure 4: Simplified scheme of HYDRO5 (www.hydrousa.org/)

1.1.5 HYDRO6

HYDRO6 (**Figure 5**) is an innovative combination of water management cycles, coupling agricultural and touristic activities. It is implemented within Tinos Ecolodge and aims to demonstrate how a small touristic unit can be self-sufficient and sustainable in using their resources efficiently.

Within HYDROUSA, new rainwater harvesting loops have been developed. Water is also harvested through innovative condensation vapour units. Finally, small constructed wetlands are coupled with disinfection to produce reclaimed water. The reclaimed and harvested water is used for the cultivation of 0.15 ha of fruits, vegetables, herbs using precision irrigation techniques.

The facility is remotely located off the grid and thus all activities are powered from renewable energy (PV panels) (https://www.hydrousa.org/hydro6/).

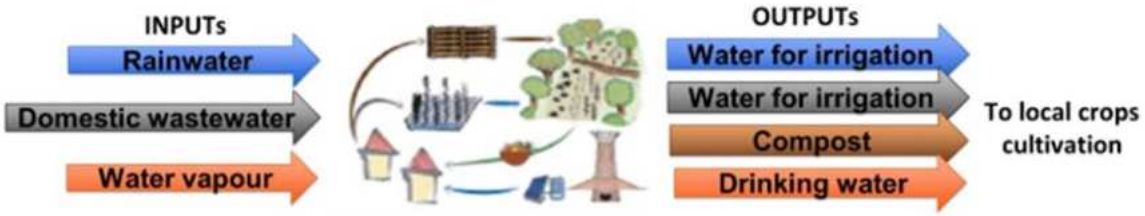

Figure 5: Simplified scheme of HYDRO6 (www.hydrousa.org/)

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2. METHODOLOGY ON WATER DEMAND GAMES

Introduction

In a global context of climate change, degradation of ecosystems and depletion of natural resources, the availability and access of water for nature, consumption and production, are of imminent concern. To prepare the way for the change that is urgently needed, persuasive communication, education and involvement of stakeholders in society is necessary (Medema et al., 2020).

2.1

Within this framework, games and other forms of media can be utilized to engage younger generations and foster dialogue among stakeholders. Consequently, numerous sustainability and water-focused organizations have proactively undertaken the development of games with persuasive or educational messages. These games serve as effective tools for raising awareness and promoting learning in these domains (Medema et al., 2020).

Serious Games

2.2

Serious games (SGs) are gaining popularity as a means to support decision-making processes in the water sector and illustrate how a visually rich informatics application with an intuitive user interface can address the problem of disintegrated policy-making. By combining computer simulations with an integrative decision support objective, serious games offer the water-energy-food (WEF) nexus a methodology/tool for discipline integration and stakeholder engagement (Pah Hang et al., 2017).

Initially designed for research and educational purposes, serious games have evolved to encompass a wider scope, including the creation of awareness and to inform multi-stakeholder decision-making in a broad range of policy domains such as water and environmental management (Pah Hang et al., 2017). In serious games, players learn through active participation and by experiencing their effects through feedback mechanisms. The assumption is that any learning that is acquired from playing serious games can be transferred to real-world contexts (Madani et al., 2016).

Game-based learning (GBL) has demonstrated its efficiency in enhancing soft skills, such as critical thinking, creative problem solving and teamwork, as well as to improve cognitive development, learning retention and social learning, which are important for future environmental researchers and professionals. Environmental management games can be applied in educational settings to promote awareness about sustainable resource planning and management among citizens who are increasingly exposed to products of the information age (Ghodsvali et al., 2022).

2.3.

Game Development

The Game Development can be considered that it is emerging from three key perspectives:

1. Increasing awareness of water management issues: there is a growing recognition of the urgent need to address water resource challenges and the complex nature of integrated water management. This

awareness has spurred the development of games as a means to engage and educate individuals about these issues.

2. Embracing social learning for resource governance: a paradigm shift has occurred, advocating for the adoption of a social learning approach in the governance of natural resources, including water. This approach emphasizes the importance of collaborative learning processes involving diverse stakeholders. Games have been identified as a valuable tool for facilitating social learning in the context of resource management.
3. Growing interest in simulation games: there is a growing interest in the use of simulation games as a practical means of promoting social learning. These games offer a way to operationalize and apply the principles of social learning, providing participants with interactive experiences that foster understanding and decision-making skills related to water and resource management.

The game was developed, with the cooperation of all HYDOUSA partners, and having the active participation of students of NTUA (project coordinatioor).

Overall, these perspectives have contributed to the development of games as a powerful and effective tool for addressing water resource challenges and facilitating social learning processes.

3. HYDROUSA GAME

Overview

In the context of the project's WP9: "Communication, community building and dissemination", a serious game was developed according to the different social – cultural – environmental challenges that HYDROUSA addresses, which are connected to the water loop at the sites of the project.

3.1.

The HYDROUSA game which aims for increasing public awareness, was developed by AGENSO and can be accessed through the following links:

Android link (Google play store):

Hydrousa Game - Apps on Google Play

Web browser version link:

Hydrousa Game (agenso.gr)

Windows version link:

https://www.agenso.gr/HYDROUSA/hydrousa_windows.zip

3.2.

HYDROUSA Game Flow

In the game, players engage in resource collection to utilize them for production and increase their game scores. Their ultimate goal in order to win is to ensure the happiness of the citizens. By effectively managing and balancing the natural resources available to them, players aim to reach the maximum level of the happiness meter as quickly as possible. By doing so, they can advance in the game, earn higher scores, and ultimately succeed in completing the game successfully. Taking into consideration the happiness meter, the players/citizens have to use the HYDROUSA units, based on their specific needs, in order to max it out and win the game. Failing to raise the happiness meter for three consecutive months, means it will instead decrease, posing a challenge for the players to maintain and improve the overall happiness of the citizens in the game.

For each new month, there is a recommendation about which resources, the players could collect. At the same time, the players have to implement the HYDROUSA systems, by making all units comply with green standards, and protecting the sustainability of the city, in order to keep the virtual citizens happy, otherwise the scores will drop drastically. In addition, there are several monitors that indicate the levels of energy, human resources (workers), food and the type of water (potable and non-potable water, irrigation water and fertigation water) that also impacts the scores.

The citizens' happiness is visually represented by a smiley face that can turn sad, immediately indicating non-sustainable actions, while an informative message emerges that explains how a wrong decision can adversely affect the well-being of the entire city. Additionally, an orange icon displaying the passing months serves as a reminder of the game's progression. Players need to keep an eye on the scores and all these monitors to assess how well they progressed, while they are guided by text information that appears when any icon is right clicked. These icons are strategically placed in several locations providing cognitive knowledge. For example, clicking on the energy icon presents different options to generate power, with detailed information on where to install each option.

The real-life complex situations immerse players and helps them learn about how incorrect decisions can accelerate environmental and water management degradation, reduce citizens' happiness, and result in economic failures. The educational approach adopted in the HYDROUSA game, enables affective learning, raises the players' awareness and promotes attitudes of concern and responsibility for water management issues. To be successful in the game, players must strategically and economically build a sustainable city with happy citizens and buildings that are energy efficient by implementing a judicious mix of renewable and non-renewable sources of energy and water. A game score card, along with the duration of the project, is generated at the end of the game, which indicates how effectively a player balanced the economy, citizens' wellbeing, and the environment. The following text presents visual screenshots from the HYDROUSA game, offering a glimpse into the immersive gameplay experience.

Figure 6 shows the start page of the HYDROUSA game.

Figure 6: Start page of the HYDROUSA Game

Figure 7 presents the landing page of the game, showing an instance of game play with indicators and icons.

Figure 7: Landing page of the HYDROUSA game

The players can get more information for each icon and each HYRDOUSA unit, by holding the cursor upon them and then, by tapping them, they can start using them, as it is being shown in **Figure 8**.

The purpose of the emerging informative short messages is to facilitate the players in understanding the concept of the game and help them, eventually, to fulfil the HYDROUSA game's goals. More specifically, **Figure 8** shows the HYDROUSA game's main goals, which are, in chronological order, to first collect resources, secondly to use these resources effectively for production and then finally, to ensure the citizens 'happiness, in order to win. This sequence of goals highlights the importance of resource management, production efficiency, and citizen satisfaction as key factors for success in the game.

Figure 8: Explanatory note of the HYDROUSA game's goals

The 'HYDROUSA'' Game gives the opportunity to the players to regulate and customize the settings of the game, by muting either the sound effects or even the music (**Figure 9**). Moreover, there is an option of restarting the game (**Figure 9**). In case, the players want to quit the game, a short message emerges that informs them that they will lose any progress they have made (**Figure 10**).

Figure 9: Settings of the HYDROUSA game

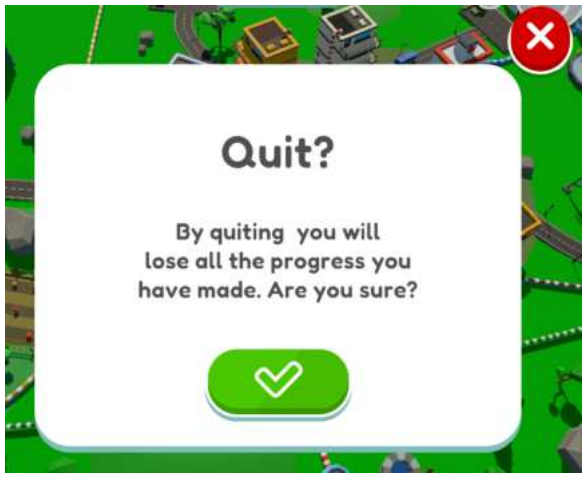

Figure 10: Quit message

Figure 11 to Figure 17**Figure 17** show certain additional informative messages that emerge, whenever the gamers hold their cursor on each icon. These short info's contribute to the game play, as an assistant manager to the gamers' strategy.

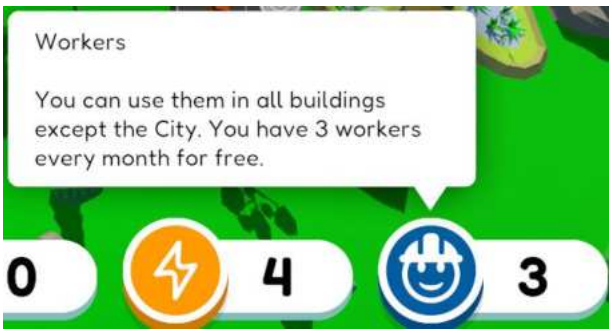

Figure 11: Info about Workers

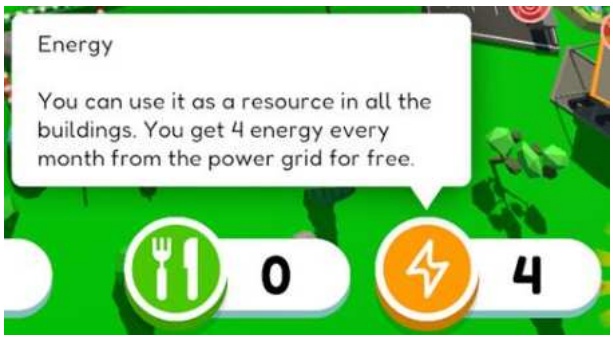

Figure 12: Info about Energy

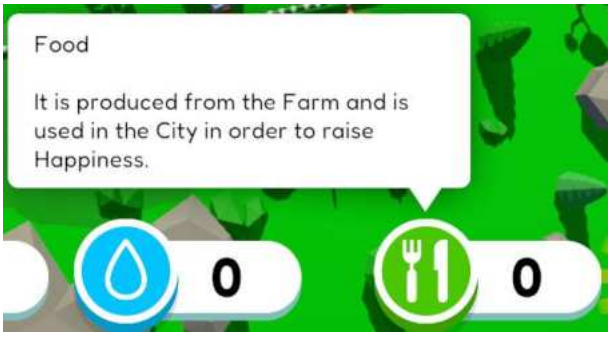

Figure 13: Info about Food

Figure 14: Info about Potable Water

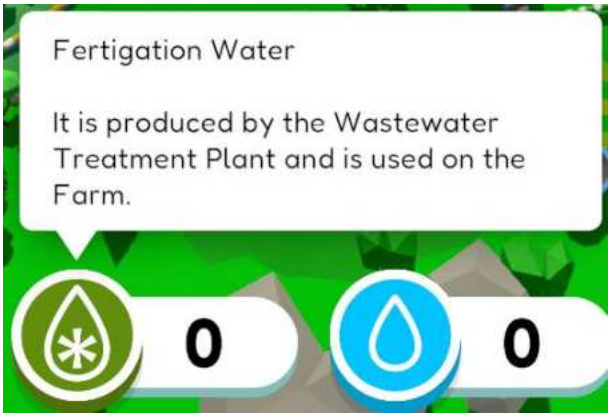

Figure 15: Info about Fertigation Water

Figure 16: Info about Non-Potable Water

Figure 17: Info about Irrigation Water

The following instances of the HYDROUSA game show the HYDROUSA game buildings and give a short description for educational purposes on each of the six HYDRO schemes. A hyperlink to the HYDROUSA project's site is also available, in case the players want to learn more about the HYDROUSA sustainable HYDRO systems.

As described in **Figure 18**, HYDRO1 presents the HYDROUSA wastewater treatment plant. In order to produce fertigation water (represented by the green colour) and energy (indicated by the orange icon), players must first consume energy resources to operate the plant and additionally human resources such as workers (represented by blue icon) are required to ensure the smooth operation of the plant.

Figure 18: Wastewater Treatment Plant

Non-conventional water resources (seawater, wastewater and rainwater) are valorised to be used in the farm for the cultivation of a variety of crops, essential for urban nutritional sufficiency. Additionally, the compost and the energy, produced in HYDRO1, are utilized in the farming activities (**Figure 19**).

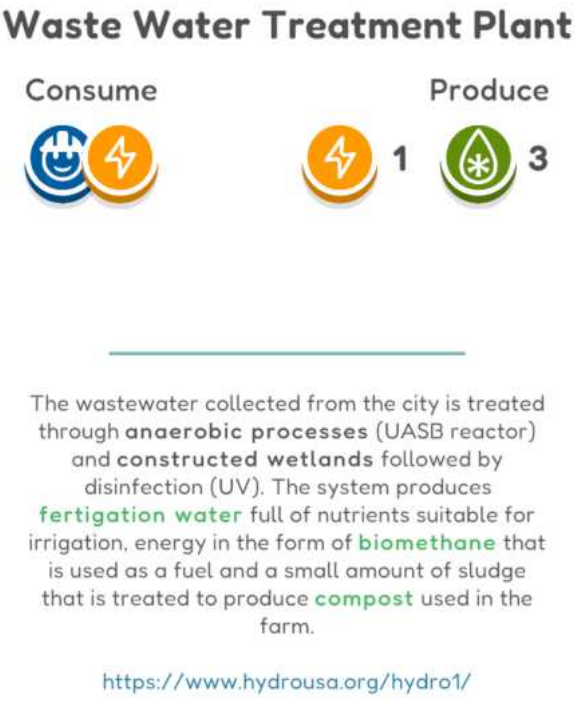

Figure 19: Pop-up explanatory message for HYDRO1's Wastewater Treatment Plant

Figure 20 shows the HYDROUSA Game Purification Centre. As described in **Figure 21**, in the purification system, the non-potable water, originating from the wells, is treated through a sand-filtration system, followed by disinfection, resulting to a potable water quality, ready to be distributed to the city citizens.

Figure 20: HYDROUSA Game's Purification System

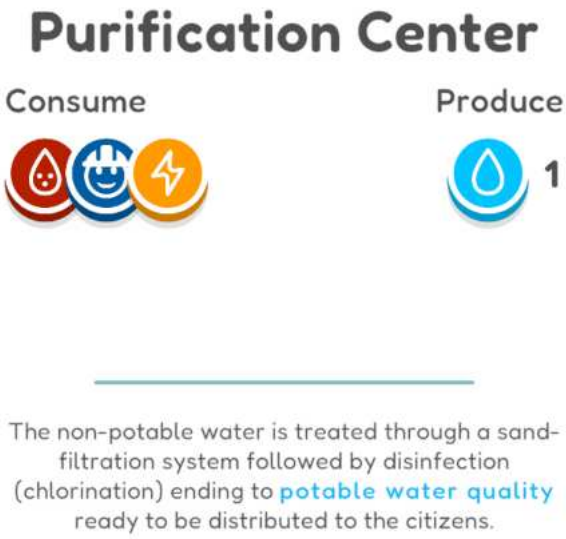

Figure 21: Pop-up explanatory message for the Purification System

In the game, players can collect rainwater from the rooftops of buildings in the city, as well as stormwater and surface runoff from other available surfaces. This collected water, along with food produced at the HYDROUSA Game Farm (**Figure 22)** can be offered to the citizens. Providing food and utilizing these water resources contributes to the happiness of the citizens in the game. As explained in the pop-up message (**Figure 23**), ensuring the citizens' happiness is crucial for succeeding in the game. This emphasizes the importance of

sustainable water management and agricultural practices in meeting the needs of the citizens and achieving success within the gameplay.

Figure 22: HYDROUSA Game Farm

Figure 23: Pop-up explanatory message for the farm

Figure 24 shows the HYDROUSA City. As described in **Figure 25,** the city has a rainwater collection system, where the rainwater is collected from the buildings' rooftops in the city. Stormwater and surface runoffs are also collected from other available surfaces.

Figure 24: HYDROUSA City

Figure 25: Pop-up explanatory message for the city

Last but not least, HYDRO5's Desalination Plant is presented in the **Figure 26**. The low-cost solar driven desalination system, based on the principles of evaporation and condensation, is composed of a series of interconnected desalination panels. By consuming energy and using workers' labour, the outputs of each unit are freshwater and brine, which can be further processed to produce edible salt (**Figure 27**).

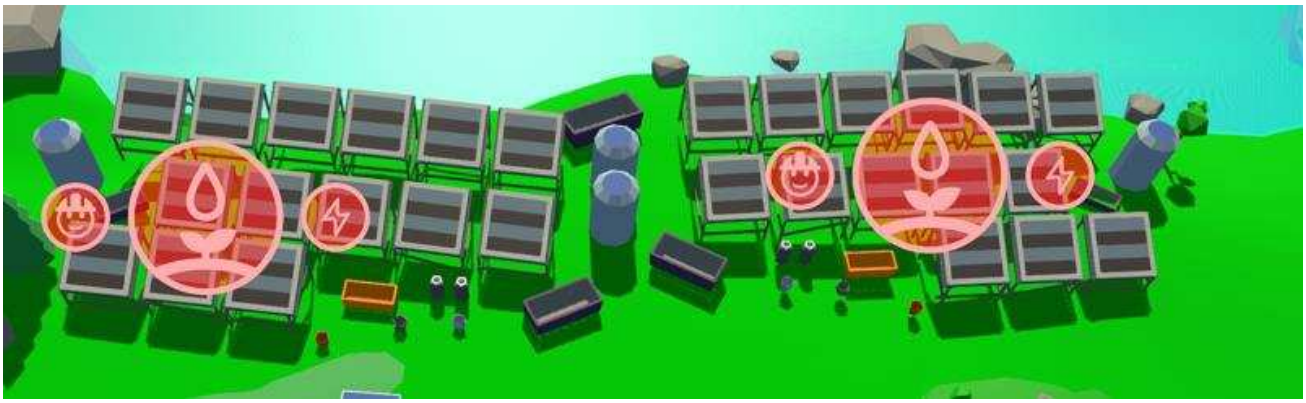

Figure 26: Desalination Plant

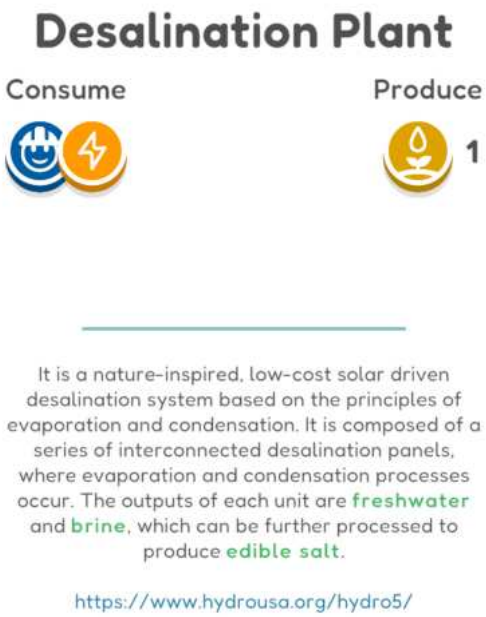

Figure 27: Pop-up explanatory message for the HYDROUSA Game's Desalination Plant

After the resources of the first month (September 2022) are collected, the players are able to set up their game strategy, in order to make the citizens happy, as soon as possible.

From **Figure 28** to **Figure 47**, the time span of the 10 months (Sept. 2022 - June 2013) is presented. Every month, a message emerges that provides information about what resources are available to collect. Simultaneously, certain messages such as further fundings, precipitation or other events **appear randomly** to the main page **which affect the game play and the decisions that have to be taken**. For example, weather is of great importance because different meteorological phenomena such as rain or temperature affect the availability of water and thus, its use in certain units. It is essential to always keep track of the happy meter, as every three months, if the gamers do not manage to produce resources and use them in order to make the citizens happy, the meter drops down and this game strategy is not successful. **The gameplay, as the one presented below, depends on the random events that appear during the specific game session.**

Figure 28 shows the first month (September 2022) after the collection of the resources.

Figure 28: First month (September 2022) after the collection of the resources

By using the output from the wastewater treatment plant and the desalination unit, players have the ability to generate new resources. These include irrigation water (yellow) and potable water (blue) (**Figure 29**). In addition to these resources, players receive 4 energy icons from the power grid and are provided with three workers. Furthermore, players receive additional funding and one non-potable water resource from the wells.

Figure 29: Available resources to collect in the 2nd month (October 2022)

In order to gain a nutritional efficiency and make the citizens happy, within the three-month period, the players must produce food from the farm. Furthermore, the wastewater treatment plant is available for production of energy and compost, that will contribute to the cultivation of food crops (**Figure 30**).

Figure 30: Collection of resources in the 2nd month (October 2022)

During the 3rd month (November 2022), apart from the availability of certain resources, there is a weather forecast, which indicates that the farm will require no irrigation water for this month. Due to lack of energy, the desalination plant unit cannot be operated, (**Figure 31**).

Figure 31: Available resources to collect in the 3rd month (November 2022)

Furthermore, the happy meter may drop, if during these two months the citizens' needs were not satisfied. Thus, it is essential to produce both food from the farm and potable water from the purification centre in order to increase the resources for the citizens (**Figure 32**).

Figure 32: Collection of resources in the 3rd month (November 2022)

If the players fail to ensure the happiness of the citizens in the game, the happiness meter will turn red. This red indicator signifies that there has been a mismanagement of resources and improper utilization of the HYDROUSA units. It serves as a visual representation of the negative consequences resulting from ineffective decision-making and inadequate resource allocation. The red meter acts as a feedback mechanism to alert players that their actions are not meeting the needs and expectations of the citizens, prompting them to adjust their strategies and make improvements to achieve a sustainable and prosperous city in the game. Although, three months passed by and the citizens were not happy, there are still new available resources to collect. Fortunately, due to the winter and the low temperatures, the farms will require less water (**Figure 33**).

Figure 33: Available resources to collect in the 4th month (December 2022)

Figure 34 shows the collection of the resources during the 4th month of the game period (December 2022).

Figure 34: Collection of resources in the 4th month (December 2022)

In the **Figure 35**, the winter conditions continue, so as the low requirement in water for the farms. During the 5th month (January 2023), the gamers are capable of collecting resources, such as food and potable water. The extra power and workers are given for free, because of the arrival of the new month.

Figure 35: Available resources to collect in the 5th month (January 2023)

Figure 36 shows the collection of the of resources in the 5th month (January 2023).

Figure 36: Collection of resources in the 5th month (January 2023)

During the 6th month (February 2023), it starts raining. This weather condition results in no requirements for irrigation of the farms. Unfortunately, the power supplies are inadequate and thus, the desalination plant will not work for this month (**Figure 37**).

Figure 37: Available resources to collect in the 6th month (February 2023)

The collection of resources in the 6th month (February 2023) is shown in **Figure 38**.

Figure 38: Collection of resources in the 6th month (February 2023)

In **Figure 39**, the first month of the spring has come (March 2023) and the players can collect certain resources, such as food. Due to an unexpected blackout on the grid, there will be a power shortage for this month.

Figure 39: Available resources to collect in the 7th month (March 2023)

Figure 40 presents the collection of resources in the 7th month (March 2023) and the happy meter happens to be yellow, which means that the HYDROUSA units are well managed.

Figure 40: Collection of resources in the 7th month (March 2023)

A new month (April 2023) has arrived to the HYDROUSA city and different kind of resources are available to use, although there has been an accident in the Purification Centre and it will remain unavailable for the current month (**Figure 41**).

Figure 41: Available resources to collect in the 8th month (April 2023)

Figure 42 shows the collection of resources in the 8th month (April 2023) and according to the numbers of the icons, the happy meter will be increased.

Figure 42: Collection of resources in the 8th month (April 2023)

During the 9th month (May 2023), plenty of irrigation water (green water icon) seems to be available, although a blackout has occurred and there will a power shortage again, for this month (**Figure 43**).

Figure 43: Available resources to collect in the 9th month (May 2023)

Figure 44 presents the collection of resources in the 9th month, with the happy meter approaching the final goal of the game.

Figure 44: Collection of resources in the 9th month (May 2023)

During the 10th month (June 2023) of the HYDROUSA game time span, there are certain resources available to the gamers, so as a happy citizen face. Because of the incoming heatwave, the city and the farm will require more water. On the positive side of things, the wastewater treatment plant can produce more energy supplies (**Figure 45**).

Figure 45: Available resources to collect in the 10th month (June 2023)

In **Figure 46**, the collection of the available resources in the 10th month (June 2023) is shown and finally, in a 10 month time span, HYDROUSA City citizens are happy and the game successfully finished **(Figure 47**).

Figure 46: Collection of resources in the 10th month (June 2023)

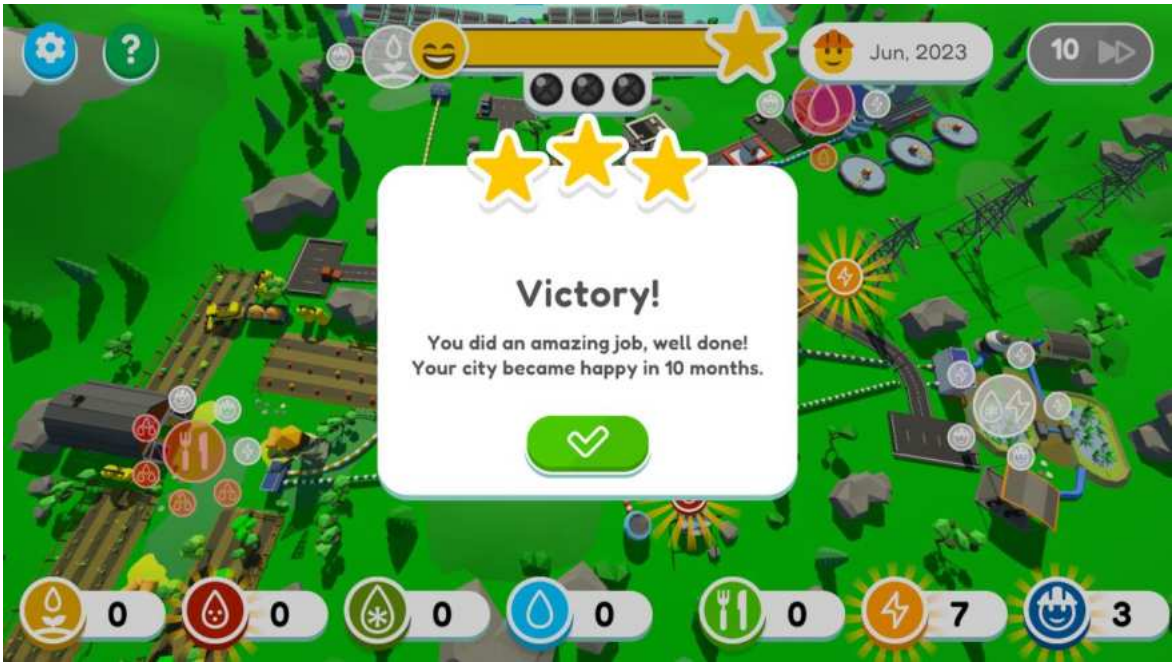

Figure 47: Victorious message during the 10th month (June 2023)

4. GAME VISIBILITY

In total, there were 3 different game versions. The Online one (web-based), the windows version and the Android version.

In the analysis below, only the results of the Online and the Android versions are analyzed as the windows version downloads cannot be tracked.

Android Version

In total the game has been installed in **187** devices since its first release. It has been rated from 10 different users, and it has a rating of 5 (**Figure 48**) which is the maximum possible rating that can be achieved.

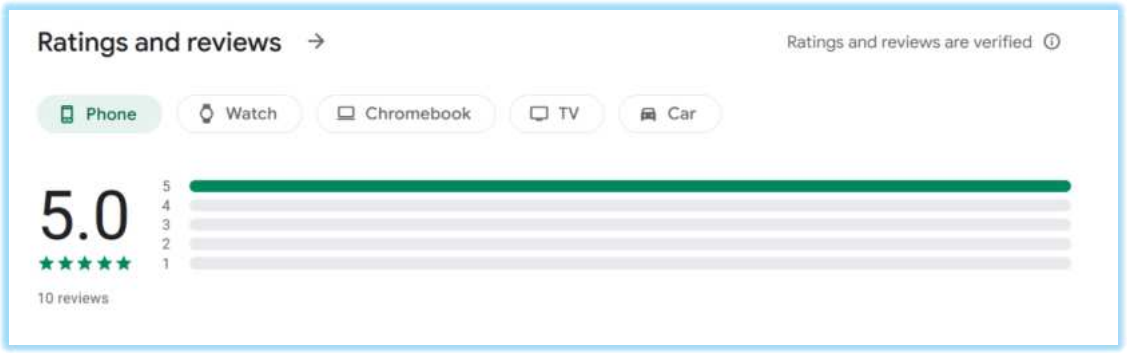

Figure 48: Android version rating

Online Version (web-based)

In total the online version of Hydrousa game has been played **981** times by **194** users from 27 different countries around the globe.

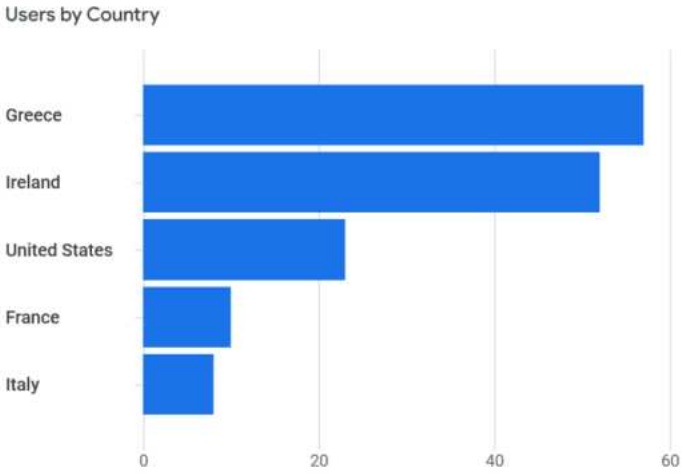

Figure 49: Online version – Countries with the most users

A very interesting fact is that the game has a constant visibility even after the project end, which means that its effectiveness is still continuing. It's worth mentioning that almost the 10% of its gameplays (92) has been achieved during the first 2 months of 2024, proving that the game has an impact that is being increased during time.

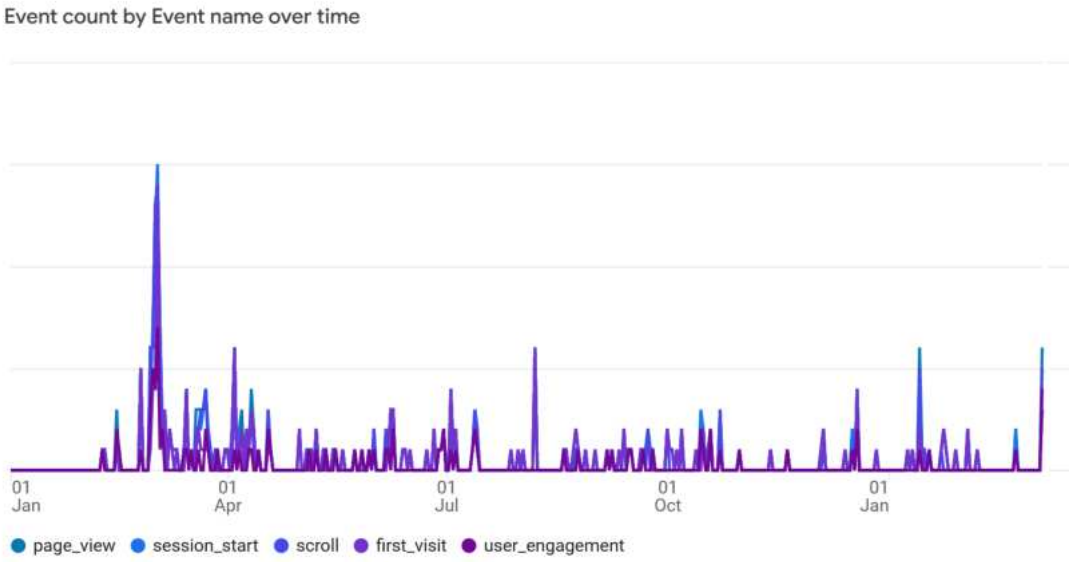

Figure 50: Online version – Event counts

Windows Version

As the number of downloads of the Android version of the game is similar with the number of users that accessed the web version of the game, it is assumed that a similar number has downloaded the windows version of the game. Even in case that we will assume that the Windows downloads are 50% compared to other versions (around 100 downloads), the game seems to have been played by around 500 different users, which is a satisfactory number.

5. CONCLUSIONS AND REMARKS

In all three islands, participants expressed their demand for access to sufficient supply water of high-quality. They were well aware of the need to save water and sustainable use of collected or treated water for various purposes. They also expressed their interest in the water treatment process including water management, harvesting, distribution, storage, as well as devices for measuring water quality and quantity, in order to establish a sustainable way of using water and adopt modern strategies for circular water management.

The development and launching of the HYDROUSA game for public awareness, aims to fulfil the demand of current stakeholders and potential future participants. As the HYDROUSA game is accessible to the public, it allows individuals from different sectors to engage with sustainable water management techniques and work collaboratively on various scenarios. Finally, the game successfully presents complex information in a way that will enable the players to interact with and learn from the realistic scenarios, while they gain knowledge about water management options and the ability to evaluate them in a critical way.

REFERENCES

Ghodsvali M., Dane G., de Vries B.,2022. An online serious game for decision-making on food-water-energy nexus policy, Sustainable Cities and Society,Volume 87, 104220,ISSN 2210-6707, https://doi.org/10.1016/j.scs.2022.104220.

Madani K., Pierce T. W., Mirchi A., 2017. Serious games on environmental management, Sustainable Cities and Society, Volume 29 Pages 1-11, ISSN 2210-6707, https://doi.org/10.1016/j.scs.2016.11.007.

Medema W., Mayer I., Adamowski J., Wals A. E.J. and Chew C.,2020. The Potential of Serious Games to Solve Water Problems: Editorial to the Special Issue on Game-Based Approaches to Sustainable Water Governance Reprinted from: Water, 11, 2562, doi:10.3390/w11122

Pah Hang M. Y. L, Martinez-Hernandez E., Leach M., Yang A.,2016. Designing integrated local production systems: A study on the food-energy-water nexus, Journal of Cleaner Production, Volume 135, 2016, Pages 1065-1084, ISSN 0959-6526, https://doi.org/10.1016/j.jclepro.2016.06.194.

Sites:

- https://www.hydrousa.org/about-the-project/#1542971153971-15e86414-3619
- https://www.hydrousa.org/hydro1/
- https://www.hydrousa.org/hydro2/
- https://www.hydrousa.org/hydro3/
- https://www.hydrousa.org/hydro4/
- https://www.hydrousa.org/hydro5/
- https://www.hydrousa.org/hydro6/
- Medema_Chew_Adamowski_Mayer_Wals_Understanding_Gamebased_Approaches_for_Improving_Sustainable_Water_Governance.pdf (buas.nl)
- An online serious game for decision-making on food-water-energy nexus policy - ScienceDirect
- Designing integrated local production systems: A study on the food-energy-water nexus - ScienceDirect
- Serious games on environmental management - ScienceDirect
- Grant Agreement-776643-HYDROUSA.pdf
- Impact - Hydrousa
- Aim & Objectives - Hydrousa