Design of three dimension models and visual elements

Deliverable 2.2

WP2: Systems Innovation Approach

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EXECUTIVE SUMMARY

This document complements D2.2 (Design of three-dimension models and visual elements) as part of ongoing work in relation to Task 2.5: Virtual Reality environment creation. D2.2 deliverable is a demonstration which showcases the first version of the 3D models for the Virtual Reality experience. This report describes the background research and implementation that went into the development of the first version of the 3D models for the choice experiment virtual environment and includes a link to the demonstration video (https://youtu.be/Cyowo5-lyzc).

1.0 INTRODUCTION

1.1 Objectives and scope

Task 2.5: "Virtual Reality (VR) environment creation" focuses on the creation of the virtual environment for the ARSINOE immersive VR engagement and decision support experiences. It will produce the necessary 3D models for prescribed case studies, as well as a series of short videos presenting, through animated navigations in these environments, the pathways identified in WP7, Task (T) 2.4 and illustrating the outcomes of the Systems Innovation Approach in various settings. The videos will be used for communication, engagement and education purposes, complementary to the experiences and the choice experiments developed within T2.6.

1.2 Focus of the VR experience

Tasks 2.5 and 2.6 will focus on the Athens and Mediterranean Ports case studies. The Athens case study features a strong citizen involvement, making it a suitable candidate for the re-use of the interactive and immersive content to be created in the context of these tasks. Furthermore, the heat wave concepts as well as the water level changes relevant to the two case studies are both suitable for representation in VR.

1.3 Content of this report

This document reports on the work completed so in the context of T2.5 and T2.6. This includes:

- Eliciting user needs in terms of the form and structure of a choice experiment questionnaire and designing its transfer to the VR experience.
- Conceptualizing an approach to integrate the questionnaire to the virtual representation of the physical space we wish to present.
- Designing and implementing a VR experience design that can be easily extended and adjusted to the needs of each case study.
- Collecting requirements in terms of the choice experiment questionnaire and corresponding VR environments needed for the Athens CS.
- Examining existing approaches to presenting environmental topics in educational and other contexts.

A walkthrough video of the VR experience can be found here: https://youtu.be/Cyowo5-lyzc

2.0 PRELIMINARY REQUIREMENTS AND LITERATURE REVIEW

2.1 Choice experiments

ARSINOE foresees the design and implementation of choice experiments in the context of specific case studies. The overall objective of a choice experiment is to estimate economic values for characteristics (or attributes) of an environmental good that is the subject of policy analysis, where the environmental good or service comprises several characteristics (Mariel et al., 2021). This aspect of the work is also linked to WP7, where the choice experiment as a tool will be designed. According to the authors, and which is also selected for ARSINOE project, the structure of the questionnaire is as follows (Mariel et al., 2021):

1. Information given in the introduction to the survey.
2. Behavioural questions.
3. Introduction in which the context of the choice task is described.

4. Detailed description of the environmental good at hand, the institutional setting and payment vehicle.
5. Choice experiment tasks
6. Follow-up questions to the choice tasks
7. Questions on relevant attitudes, norms, etc., which help to “explain” heterogeneity of stated preferences.
8. Questions on the socio-demographic background.
9. From a User Experience design perspective, we identify two main types of questionnaire content: (1) questions of different types, including multiple choice or text and (2) the choice cards.

Preliminary research (desk-based literature review, discussions with researchers working on T2.6, WP7 and relevant case studies – Athens and Mediterranean Ports) was carried out in order to explore different design approaches towards presenting questionnaires in VR, so as to identify the optimum solution for the representation of the choice experiment questionnaires. Based on this, the first version of the 3D models for the choice experiment virtual environment has been created.

2.2 Representation of environmental parameters

Different approaches to representing crucial environmental parameters in virtual reality were explored, including environmental temperature and heat in particular, since it is foreseen that this will be a focal area of the work to be conducted within the Athens case study. We focused on existing literature, concerning different means of depicting environmental changes, the climate’s characteristics and the effects of this visualization on the immersed user.

The aforementioned means of visualizing the climate’s characteristics include the use of multi-sensory virtual reality. In the work of Pochwatko et. al. (2021), they use visual, auditory, tactile and smell stimuli to depict the air’s pollution. This design consists of visualizing the air particles (inspired by the artistic installation “Pollution Pods” by Michael Pinsky) in an attempt to recreate the air quality of a chosen location. Ferrer et. al. (2017) have also chosen to visualize air particles for the purpose of depicting the temperature of a Virtual Environment (VE).

Concerning the visualization flora, Huang et. al. (2021) have used LANDIS-II to run simulations of future forests. This tool has given them the data they used to visualize future forests under climate change. Using this data, they depicted how trees will look like in the future, by setting their height, crown diameter, species, and number. Each user in the VE can choose a species and see how they react to climate change individually.

A problem that has caught the community’s attention is that many people still do not have adequate knowledge on the subject, are not aware of the problem or, worse, deny its existence. Markowitz and Bailenson (2021), in their work, they present a review of papers that shows the relationship between VR and climate change from a psychological perspective. Some of the papers that they reviewed are:

(a) Markowitz et. al. (2018) on the visualization of ocean acidification, where they found out that the more that people explored the spatial learning environment, the more they demonstrated a change in knowledge about the matter.

(b) Ke et. al. (2019) on the visualization of extreme weather in Hong Kong, where they set up a system with a fan and a humidifier. When participants used more electrical appliances in the virtual world, the simulation depicted their impact on Hong Kong’s weather. Therefore, the participants connected their actions with the effect on the environment and became more invested in it by bringing climate change effects closer and in a more personalized manner.

(c) Chirico et. al. (2020) on the visualization of plastic consumption, where they found out that presenting plastic consumption numerically (e.g. the number of plastic water bottles consumed by 10 people per year) suppressed participant emotions toward the issue, reported levels of presence, and general attitudes toward the environment compared with a visually concrete (e.g. a pile of plastic water bottles) or mixed representation of visuals and numbers.

This matter of people not being invested in environmental problems, is also addressed by Ahn et. al. (2016). To increase the users' self-involvement, they allowed for them to inhabit the body of animals in VR to experience their point of view. Their findings suggest that embodied experiences in IVEs may be an effective tool to promote involvement with environmental issues.

Apart from visualizing the effects of climate change on the environment, there have been devices used to help the user understand the situation e.g. fans and humidifiers were used in Ke et. Al. (2019). In the same manner, Plijnaer et. al. (2022) have proposed a small device that produces heat (or cold) and that can be used together with the VR Controllers to provide the users with thermal feedback.

3.0 IMPLEMENTATION

For the implementation of the choice card and the questionnaire that is going to be presented within the Virtual Environment (VE), a JSON Importer was first created to enable the changing the questions, answers and choices easily. Figures 1 and 2 below show the template of the JSON files required to create (a) a Choice Card and (b) a Questionnaire and the outcome of these inputs.

Both Choice Cards and Questionnaires are scrollable and come with several functionalities that can be used by pressing the buttons on the top right corner of the cards. These consist of (a) moving, (b) scaling down, (c) scaling up and (d) following the user wherever he moves. These functionalities can be expanded in the future with whatever we see fit. In the case of the Questionnaire, the user can press the "Export" button, which is located at the end of the questionnaire, after filling it, to save a JSON file with the given answers. In the case of the Choice card, we opted to instantly change the surrounding environment of the user, when he/she chooses one of the given options. For these changes we chose to show some possible outcomes that include the water level, the terrain (the materials change to depict grass, mold, rocks, mud etc.), some trees, etc. The different environments can be seen in the images below (Figure 3).

For the purposes of ARSINOE project we chose to use Unity with URP (Universal Render Pipeline) and the Oculus Integration SDK to support builds in Oculus Quest 2.

```json
{
    "type" : "card",
    "name" : "Title of Card",
    "optionNum" : 4,
    "options" : [
        "option 1",
        "option 2",
        "option 3",
        "option 4"
    ],
    "contents" : [
        {
            "label" : "Label explaining the topic",
            "outcome" : [
                "option 1 outcome of the topic",
                "option 2 outcome of the topic",
                "option 3 outcome of the topic",
                "option 4 outcome of the topic"
            ]
        },
        {
            "label" : "Label explaining another topic",
            "outcome" : [
                "option 1 outcome of the topic",
                "option 2 outcome of the topic",
                "option 3 outcome of the topic",
                "option 4 outcome of the topic"
            ]
        }
    ]
}
```

```json
{
    "type" : "questionnaire",
    "name" : "Title of the Questionnaire",
    "contents" : [
        {
            "label" : "Question 1: ???",
            "outcome" : [
                "answer 1",
                "answer 2",
                "answer 3",
                "answer 4"
            ]
        },
        {
            "label" : "Question 2: ???",
            "outcome" : [
                "answer 1",
                "answer 2",
                "answer 3",
                "answer 4",
                "answer 5",
                "answer 6",
                "answer 7"
            ]
        }
    ]
}
```

Figure 3.1 JSON description of the choice experiment questionnaire

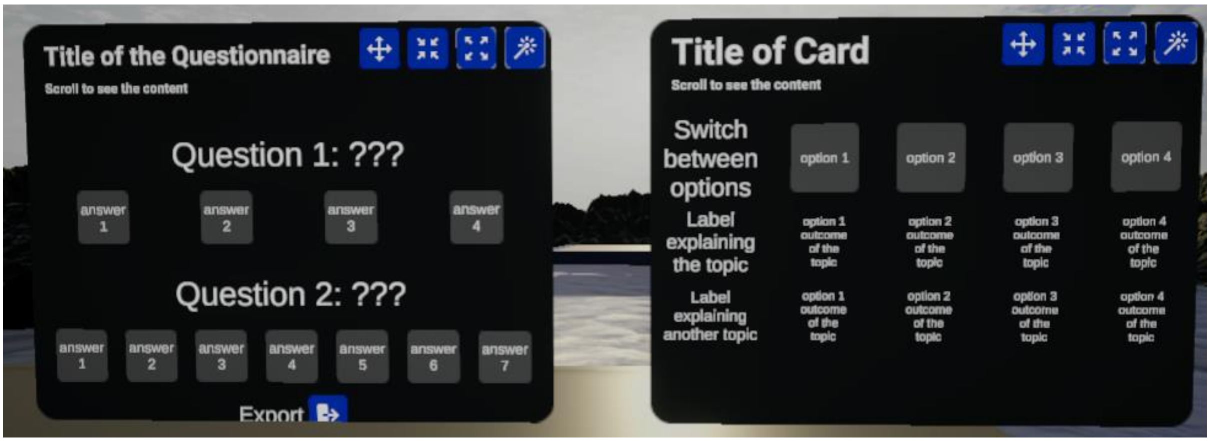

Figure 3.2 Representation of the choice experiment questionnaire in the VE

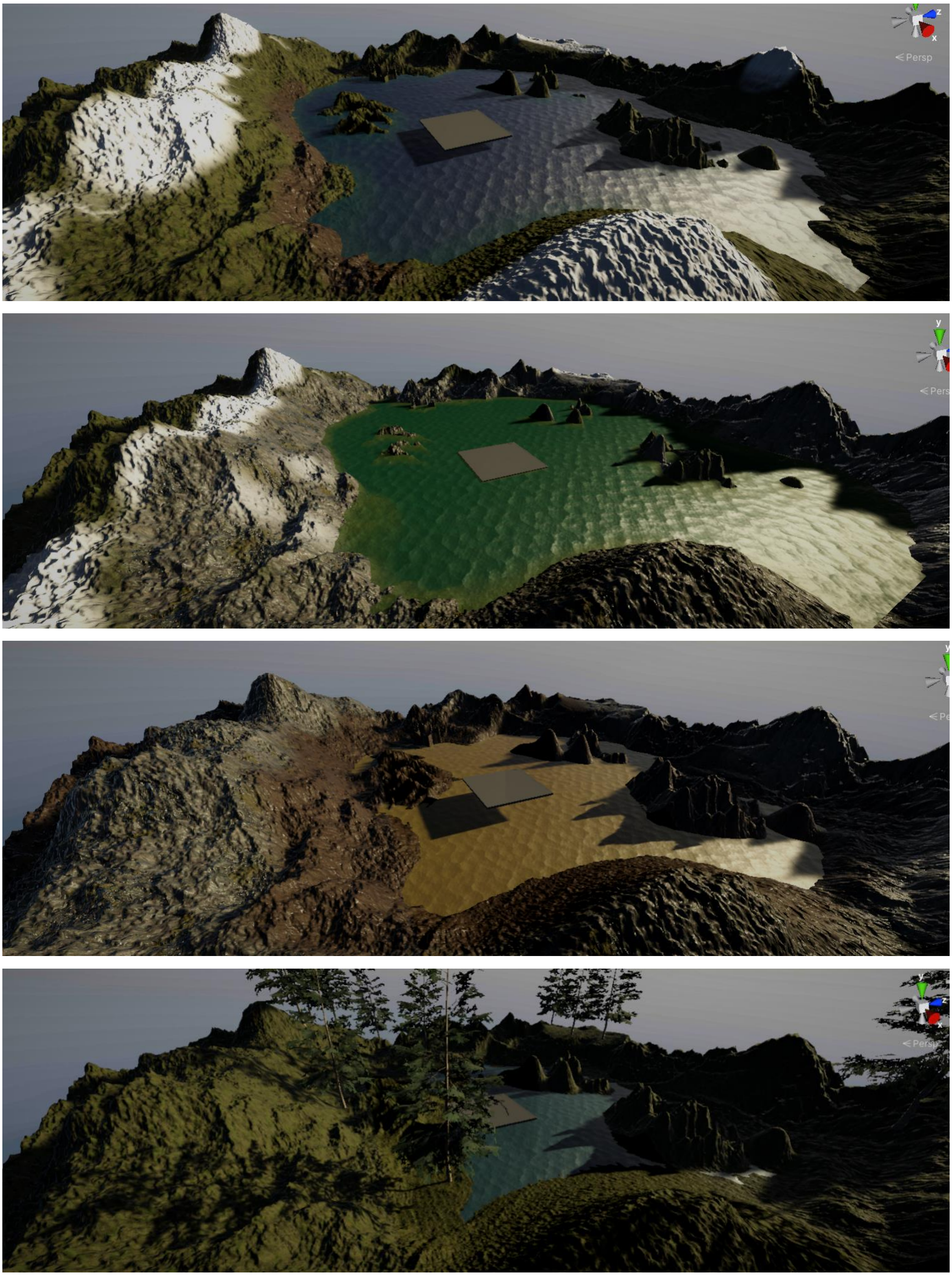

Figure 3.3 Indicative VEs to represent the different options in the choice card

4.0 CONCLUSIONS AND NEXT STEPS

Task 2.5 is directly dependent on the progress of WP6, and the case studies selected for the implementation of the VR environment for the choice experiment. After the second round of Living Labs and its analysis which is almost complete (in particular for Case studies 1 and 2); further outputs in the form of the "Future Narratives" will be obtained, and it is expected that the main areas of focus for the VR experience (both thematic and geographic) of the relevant case studies will become more explicit. This needs to correspond to the choice experiment objectives and the relevant questionnaires, especially the options to be represented in VR. Concrete locations need to be identified as the optimum to show case these options, by answering questions such as: "Which would be a suitable neighborhood in Athens to showcase the effects of extreme heat?" or "Which Athens park is a suitable candidate to show the effect on biodiversity?"

As such, the 3D models and corresponding VR environment development will be updated accordingl, following the requirements of the case studies.

Immediate next steps include the research and design of generic solutions for the representation of environmental conditions such as heat and air pollution, as well as visualizations for the user to explore these characteristics.

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Systems Innovation Approach (SIA) addresses the growing complexity, interdependencies and interconnectedness of modern societies and economies, focusing on the functions of the cross-sectoral system as a whole and on the variety of actors. The Climate Innovation Window (CIW) is the EU reference innovations marketplace for climate adaptation technologies. ARSINOE shapes the pathways to resilience by bringing together SIA and CIW, to build an ecosystem for climate change adaptation solutions. Within the ARSINOE ecosystem, pathways to solutions are co-created and co-designed by stakeholders, who can then select either existing CIW technologies, or technologies by new providers (or a combination) to form an innovation package. This package may be designed for implementation to a specific region, but its building blocks are transferable and re-usable; they can be re-adapted and updated. In this way, the user (region) gets an innovation package consisting of validated technologies (expanding the market for CIW); new technologies implemented in the specific local innovation package get the opportunity to be validated and become CIW members, while the society (citizens, stakeholders) benefits as a whole. ARSINOE applies a three-tier, approach: (a) using SIA it integrates multi-faceted technological, digital, business, governance and environmental aspects with social innovation for the development of adaptation pathways to climate change for specific regions; (b) it links with CIW to form innovation packages by matching innovators with end-users/regions; (c) it fosters the ecosystem sustainability and growth with cross-fertilization and replication across regions and scales, at European level and beyond, using specific business models, exploitation and outreach actions. The ARSINOE approach is show-cased in nine widely varied demonstrators, as a proof-of-concept with regards to its applicability, replicability, potential and efficacy.

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CLIMATE-RESILIENT REGIONS THROUGH SYSTEMIC SOLUTIONS AND INNOVATIONS

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