A Multitude of Voices

Final Report of Participatory Game Design Study Project

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Foreword

Urban areas are increasingly confronting the impacts of climate change, like the rise of intense rainfall events and severe flash floods. The transdisciplinary CliWaC project (www.cliwac.de) explored strategies to address such challenges for the Berlin/Brandenburg area in Germany. One of the key obstacles for adapting to flash floods is the diversity of perspectives among stakeholders, each with varying costs and benefits related to flood protection measures, such as surface unsealing.

This report presents the findings from a nine-month study project conducted by six students in the International Master's Program in Integrated Natural Resource Management (INRM). The team (comprised of Jayshrita Bhagabati, Alieh Maddah, Alexandra Stockschläder, Mina Tayyebi, Hai Tran and Japhet Uchechukwu Agu) engaged in an inter- and transdisciplinary project to develop a game titled "A Multitude of Voices". This innovative format serves as a platform for stakeholders to engage in meaningful dialogue about the challenges posed by flash floods in urban areas, including actors from city planning, industry, research organizations, and citizens in general.

I am immensely proud of this dedicated group of students, whose professionalism and creativity have enabled them to meet the project objectives with captivating events and outcomes. Their ability to tailor insights about a general global challenge to Berlin's circumstances with a unique format exemplifies the essence of sustainability programs like INRM.

The project stands out for its innovative approach in two significant ways. First, it harnesses the power of games to communicate complex issues to a broad audience of stakeholders. While the use of games in similar contexts has been explored, it remains a relatively uncommon approach. Second, the project advances this concept of "participatory game design", which allows the game design process itself to facilitate democratic deliberation around the complexities of sustainability challenges. By involving a diverse range of stakeholders and experts already during game design, the study project created a dynamic environment for collaboration and problem-solving. With this approach, the journey is the reward.

I strongly thank the students for the effort they put into this report, but also the various people who collaborated with and supported the students. Several postdocs from the CliWaC project, the team of the Humboldt Labor at the Humboldt-Forum in Berlin (Daniel Tyradellis, Thomas Lilge, Bastian Herbst and Heide Barrenechea), Pauline Münch, Ines Jeworski and Bruce Lankford are just some of them.

This project not only exemplifies the forward-thinking initiatives within sustainability programs like INRM, but also sketches novel ways on how to contribute tackling pressing urban challenges through collective action.

Klaus Eisenack
Professor for Resource Economics
October 2024

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1. Introduction: Main Motivation and Objectives

Climate change has exacerbated the global water crisis, triggering widespread environmental, human health, and economic impacts (IPCC, 2022). The multifaceted nature of the problem means that no region is truly immune to climate-related water issues. For instance, rural areas, which tend to be more agriculturally dependent, are particularly vulnerable to droughts and rainfall shortages, while urban areas face heightened flash flood risks from extensive surface sealing. These uncertainties in how climate change affects water systems make their relationship a "wicked problem," with no one-size-fits-all solution that can address the needs of all stakeholders. Nevertheless, robust stakeholder engagement is a cornerstone of effective water governance (OECD, 2015), ensuring that diverse perspectives and interests are taken into consideration in the development of adaptive and inclusive strategies.

There has been an increase in the development and use of serious games to facilitate learning about water management issues, including the associated collective action problems (Mittal et al., 2022). Games, especially those based on participatory processes, can promote social learning and self-governance of such shared resources by incorporating relational values—connections between people and the environment—into their design (Janssen et al., 2023). Games that include diverse participants, thereby capturing a wide range of perspectives, and employ a co-design approach also enable socially driven sustainable water management (Aubert et al., 2019). Participatory games can, therefore, be an effective tool to deepen our understanding of some of the most complex and pressing issues with respect to wicked water governance issues.

In this context, as members of the Participatory Game Design (PGD) study project, we sought to use our interdisciplinary expertise and knowledge to develop a novel role-playing board game that would accurately represent the management challenges associated with climate-induced water crises. In particular, we decided to focus on the issue of flash flooding in Berlin due to its increasingly adverse impact on the city's infrastructure, transportation systems, and water resources (CliWaC, n.d.). The occurrence of flash floods is expected to increase significantly due to climate change (Zhang et al., 2021), and this could have serious implications for a city like Berlin, where approximately 34% of the land area is sealed by buildings, asphalt, and concrete roads (Berliner Regenwasseragentur, n.d.). While developing effective solutions is the need-of-the-hour, the presence of multiple stakeholders whose decisions and actions often interact in highly interdependent and unpredictable ways makes this an extremely complex, albeit interesting, problem.

The objectives of the project are twofold. First, to understand how different stakeholders make decisions when faced with trade-offs between their personal goals and common environmental goals (with respect to flash-flood risk reduction), as well as between their own goals and those of

other stakeholders. To enable the latter, the final game included both collaborative and competitive aspects, simulating real-world stakeholder interactions. Second, to facilitate learning among the players about the complexities of managing shared water resources when faced with the consequences of flash floods. To enable a proper understanding of the issues being analyzed, the game sought to represent the underlying biophysical and social contexts as accurately as possible (Section 2).

Over the course of two university semesters, spanning a year, we undertook a number of different steps to achieve the above objectives. These included, first and foremost, gaining a strong grounding in the background knowledge required to develop an effective board game relevant to the chosen context. This was achieved both by reviewing the existing literature (Section 3) and by conducting various forms of expert sessions (Section 5.1). Several iterations of the game were developed in the process (Section 5.2), and both formal and informal feedback and critique were actively encouraged at each stage (Sections 6.2 and 6.3). Extensive discussions were held regularly within the group to ensure that the best possible decisions were made in a democratic manner. This process also helped us gain soft skills in several areas, such as game facilitation and presentation, organizing workshops and game events, and communicating effectively with people from different academic and professional backgrounds.

The following sections provide a detailed explanation of the game design process, including methodological considerations (Section 4) and a description of the final game (Section 6.1). Key learnings, limitations of the current project, and scope for future research have also been explored (Section 7).

2 Relevant Context of the Project

Biophysical Condition

Social Aspects

Photo credit: Humboldt Forum

2. Relevant Context of the Project

2.1. Biophysical conditions

In recent years, the frequency of floods has escalated due to global warming and human activities (Gholami et al., 2024). An increase of greenhouse gasses through industrialization/urbanization have led to a significant climate change effect which alters the global hydrological cycle and influences climatological characteristics.

Owing to its flat terrain, lakes formed by the Spree, Havel, and Dahme rivers of Berlin, the pronounced low-lying Brandenburg featured by rolling hills alternate with extensive plains (Eurostat, n.d.) and the continuous urbanization, The Berlin/Brandenburg is not an exception to the effects of climatic changes with incessant flash floods as evidence.

Below are causal factors associated with some biophysical conditions of Berlin/Brandenburg.

2.1.1. Increased Atmospheric Temperature

For the near future, a further increase in the average daily maximum temperatures of about 1.2°C, for the distant future additional 3.2°C can be expected. This increase will be particularly striking during autumn and winter. Summers in Berlin will also become warmer (Berlin Senate, 2016). Influenced by a temperate seasonal climate, Berlin's temperature rise has already been observed in the recent past due to climate change.

A warmer atmosphere can hold more moisture. In fact, for every degree of warming the atmosphere can hold around 7% more moisture. More moisture can then mean that more rainfall comes in short, intense downpours. This can increase the risk of flash flooding (Council, 2022).

2.1.2. Changing Precipitation Patterns

Flash floods combine low predictability, erratic overflow behavior, high flow velocities, and often massive debris loads. They are mainly caused by heavy precipitation events (HPEs) with very high rainfall intensities and characterized by a rapid concentration of runoff (Voit, & Heistermann, 2024). Zhang et al., (2021) further noted that, when rainfall becomes more uneven and intense, such variations in rainfall have had serious impacts on urban flooding in recent years.

Alvarez et al. (2022) conducted a study using climate data from approximately 2000 to 2018, applying high-resolution COSMO-CLM models to assess precipitation patterns in Berlin. Their analysis indicates that, while the total volume of precipitation may not show significant increases, climate change is expected to enhance the intensity and severity of rainfall events (Fig.1). This suggests that, although overall precipitation amounts remain stable, the frequency and intensity of

extreme events—such as the heavy rainfall on June 29, 2017—are likely to increase due to anthropogenic climate influences (Alvarez et al., 2022).

In a very recent study, "a downward-counterfactual analysis of flash floods in Germany", Voit, P. et al (2024) mentioned that among 10 rainfall events studied, the Berlin/Brandenburg of Jun 26-Jul 2, 2017 (BB/Jun17), June 28 – Jul 3, 2021 (BB/Jun21) and June 11-16, 2020 (BB/Jun20) featured exceptional amounts of rainfall and a corresponding runoff response. BB/Jun17 caused massive urban flooding and a massive impact in Berlin. This HPE caused the largest amount of insured losses in the period 2002 to 2017 (EUR 60 million) in the greater Berlin area (Caldas-Alvarez et al., 2022).

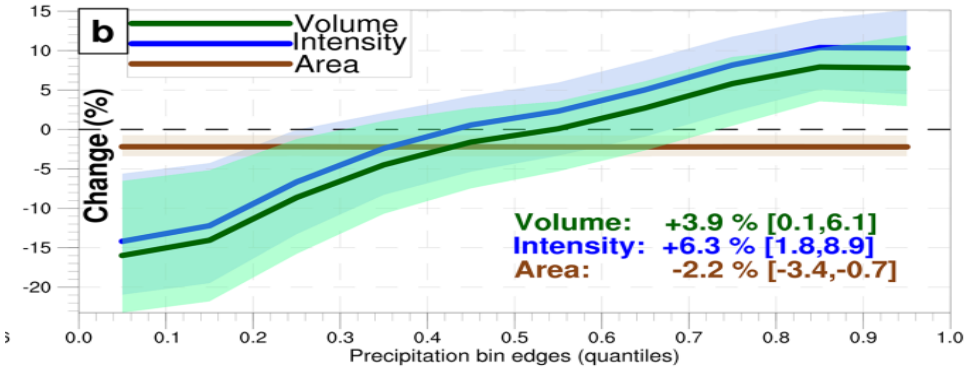

Fig.1: Changing patern of percipitation; the changes in area and volume represent the changes associated with precipitation in these bins. Based on the Wilcoxan–Mann–Whitney test, the total changes given are all statistically significant with at least p < 0:02. Shading denotes the 95 % confidence intervals based on 1000 bootstrap resamples (Caldas-Alvarez et al., 2022).

2.1.3. Urbanization and Land Use

The National Geographic headquarters New York defines Urbanization as the process through which cities grow, and higher and higher percentages of the population come to live in the city. Urbanization is powered by Industrialization which is majorly dependent on land use. This land use in most cases involves ground sealing (Paving) which causes impervious soil or infiltration. Impervious coverage is defined as the paving (or covering) of the soil with solid materials which can be divided into built-up impervious areas, i.e. buildings of all kinds; and non-built-up impervious areas, i.e. roads, parking lots, paved walkways, etc (Berlin.de, n.d.).

Ground sealing, be it partial or total changes the hydrological properties of an area through reduced water seepage, permeability and infiltration into the underlying soil in events of intense precipitation within a short period or prolonged downpour. Janicka & Kanclerz (2022) noted that during urbanization, rainwater movement and storage in the ground surface within a local watershed are significantly altered by the changes in landscape from natural to man-made. A

reduced area of biologically active land and an increase in artificial areas (urbanized areas) can lead to large flood peaks.

In Berlin, shown in Fig.2, 34.5 % land areas are covered by urban green spaces, including forest (18.1%), public green space (12.2%) and agricultural areas (4.2%), particularly towards the outer boundaries. Almost 60% of the city is covered by buildings and roads of which around 34% are sealed, especially in the centre (Kuhlemann et al, 2020).

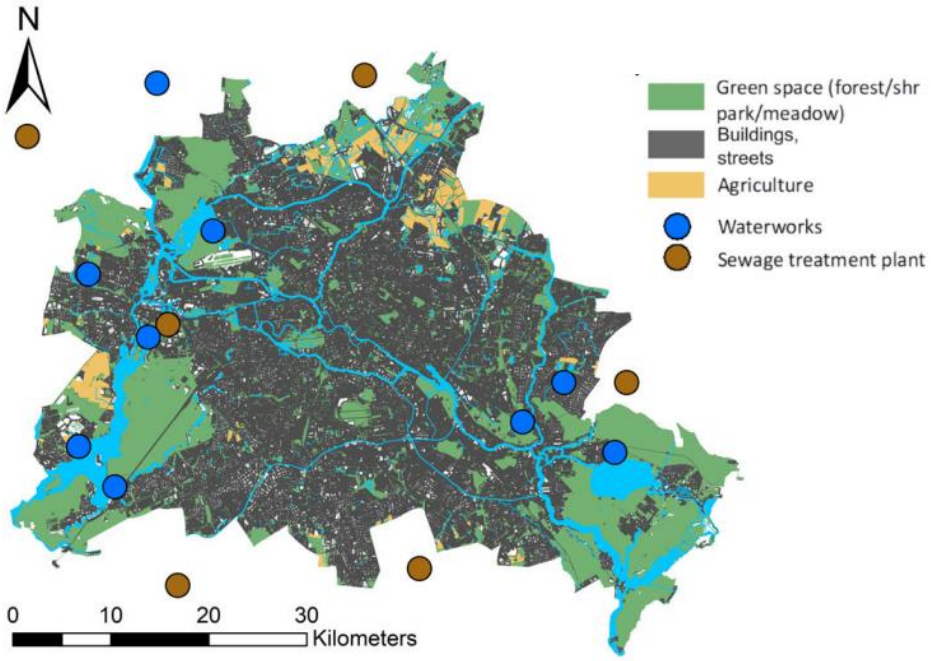

Fig.2: Berlin land use types and the waterworks and sewage treatment plants (Kuhlemann et al, 2020)

2.1.3. Topography and Geography

Mountains or steep hills can increase an area's flood risk through rain or snowmelt running down a mountain and rivers rise quickly. Flash flooding commonly happens more where rivers are narrow and steep, so they flow more quickly especially in built-up urban areas, where hard surfaces such as roads and concrete prevents water drainage into the ground. This leads to surface overflow and often overwhelms local drainage systems, leading to flash flooding (Met Office, Uk). Located in northeastern Germany in an area of low-lying marshy woodlands with a mainly flat topography (Wikipedia contributors, 2024). This relatively flat terrain can contribute to slow water drainage during heavy rains, increasing the risk of waterlogging and flash floods in the low-lying areas (Fig. 3).

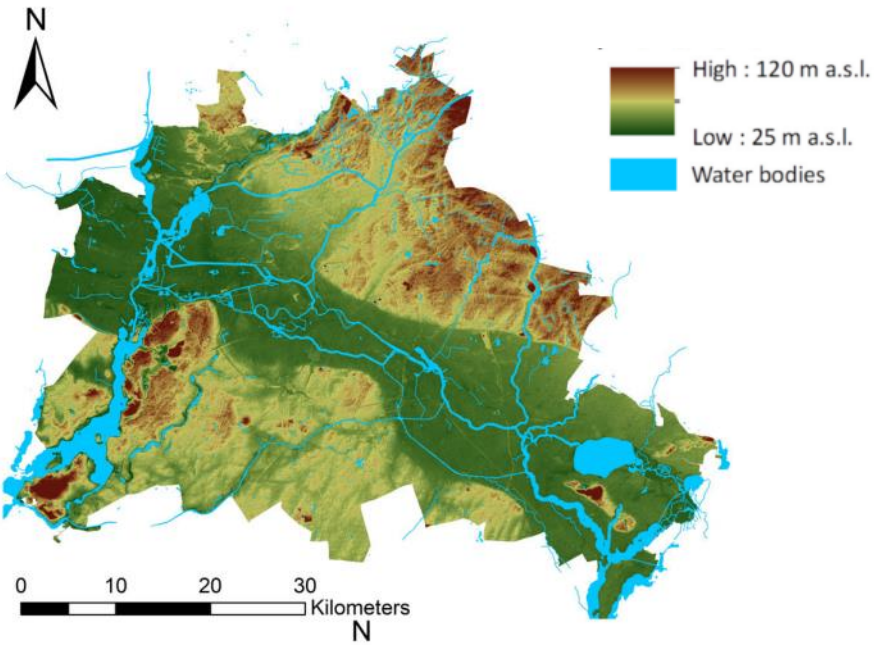

Fig.3: Berlin's topographic structure and surface water system (Kuhlemann et al, 2020)

2.2. Social aspects

2.2.1. Stakeholder

According to Eakin et al. (2014), stakeholders for climate adaptation in urban settings include public authorities, private sector entities, and community groups, each bringing unique capacities to the adaptation process. Public authorities, such as municipal governments, are responsible for implementing regulatory measures and managing infrastructure improvements to address climate risks like flash floods. Private sector actors, including industries and insurance companies, contribute resources and risk management expertise, essential for adapting to urban flooding. Community groups and citizens play a critical role in resilience building through localized knowledge and community-driven initiatives, which enhance adaptive capacity and ensure that solutions are locally relevant.

In their study on governance approaches to climate risks, Mees et al. (2014) emphasize the importance of a collaborative, multi-stakeholder approach in addressing climate challenges. They identify health care providers, social organizations, and housing corporations as additional stakeholders that are vital in safeguarding vulnerable populations, such as the elderly, from climate impacts like extreme heat, which parallels flood adaptation efforts. The study underscores the need for flexible public-private governance models to distribute responsibility effectively, with public authorities often coordinating efforts while private entities, including community organizations and individual stakeholders, contribute through direct support and localized actions.

In designing the game, we selected key stakeholders—citizens, city planners, researchers, and industries—to reflect the diverse interests and roles highlighted in the literature, while keeping the game streamlined. Citizens embody community-driven initiatives, bringing localized knowledge and the perspective of resilience at the ground level. City planners represent public authorities responsible for essential infrastructure, such as water, wastewater, and transport utilities, addressing broad urban needs to mitigate climate impacts like flash floods. Researchers provide scientific insight and data, essential for understanding climate risks and informing adaptation strategies. Lastly, industries reflect private sector involvement, particularly in resource allocation. This selection captures the wider range of responsibilities and perspectives needed for urban climate adaptation, with each stakeholder group introducing distinct priorities that can sometimes create dilemmas, enhancing the game's realism and objectives.

2.2.2. Collaboration and Partnerships

Research in sustainability science increasingly emphasizes the importance of transdisciplinary collaboration for addressing complex environmental challenges, such as climate change. According to Ruppert-Winkel et al. (2015), successful transdisciplinary approaches integrate diverse scientific disciplines and engage stakeholders across public, private, and community sectors. These collaborations are vital for bridging the gap between scientific research and practical implementation, as they facilitate the co-creation of knowledge and solutions that are both scientifically robust and socially relevant.

As a transdisciplinary research initiative, CliWaC (Climate and Water under Change), part of the Berlin University Alliance, embodies a collaborative approach by uniting expertise from social and natural sciences, alongside stakeholder engagement, to address water-related risks under climate change. In partnership with CliWaC, our study project brought together students from the Integrated Natural Resource Management (INRM) Master's program at Humboldt University of Berlin, with additional support from the Humboldt Labor's team. These collaboration s allowed us to leverage CliWaC's interdisciplinary framework to inform and develop the Multitude of Voices game, which engages diverse stakeholders in understanding complex urban climate risks, such as flash floods.

2.2.3. Target Audience

Based on the objectives of our project and the social and biophysical context of Berlin, we identified a diverse target audience for the Multitude of Voices game. Firstly, our goal of understanding how stakeholders navigate trade-offs between personal and environmental goals, alongside facilitating learning about shared water management, required the inclusion of varied perspectives. Secondly, given Berlin's urban landscape, characterized by extensive impervious surfaces and heightened vulnerability to flash floods due to climate change, our audience needed to represent both professional and public sectors directly affected by these issues.

Therefore, our target audiences included researchers and students in environmental and resource management fields, who could bring insights from a scientific and academic perspective. We also identified stakeholders from industry and city planning as crucial participants, given their roles in managing infrastructure and resources. Finally, recognizing the importance of public engagement in addressing urban climate challenges, we considered Berlin citizens as an essential audience for the game.

3 Theoretical Consideration

Transdisciplinary Research Approach

Democracy and Stakeholder Engagement

Serious Games, Tool for Collaboration & Climate

Addressing Climate Challenges, The Interactions

4 Methodological Consideration

3. Theoretical Consideration

3.1. Introduction

The transition to renewable/conservation of energy, sustainable environmental practices through non-governmental organizations, international and national government agencies has championed the struggle against climate change and its impacts. Here, through games, we want to explore a possible solution by direct public and stakeholder engagement.

Complex, complicated, unpredictable and often considered a “wicked problem”, flash flood as one of the multiplier effects of climate change necessitates a multi-Sectoral intervention through concerned stakeholder engagement and public awareness. A holistic governance approach that tackles climate concurrently across all sectors is needed, particularly in water, health, agriculture, and urban development (Shada & Marwan, 2024). Exploring a possible solution for this menace through games, we will be relying on the Transdisciplinary research approach, Democracy/stakeholder engagement and Participatory game design principles as pillars for this multi-Sectoral intervention.

3.2. Transdisciplinary Research Approach

Flash Flood in Berlin like every other city is termed a complex and “wicked problem”. The complexity of these large societal issues is overwhelming, as the contexts and the various factors and actors at play are dynamically entangled. Therefore, the idea of a ‘systemic approach’ appeals to many; a way to understand the complexity of the problem better and more thoroughly. (Josephine M., et al 2023).

A systemic approach through “system thinking” demands that a complex issue is understood from various disciplinary fields and societal sectors simultaneously; the transdisciplinary approach (McPhee, C., et al., 2018). As an environmental issue, Eisenack, (2013) Opines that in consideration of the multilateral enforcement of environmental issues and the scientific community's involvement, practicing and developing transdisciplinary research is necessary. This analyzes and addresses problems to recognize its complexity, considering the diversity of perceptions in the real world and in the scientific field, linking abstract and case-specific knowledge, and developing knowledge and approaches that promote the common good (Pohl & Hirsch Hadorn, 2008). Through the crossing of disciplinary and sectoral boundaries, it integrates academic perspectives and the real- world context, stakeholders, and institutions as well as zeitgeist in its deliberations (Josephine M., et al 2023).

3.3. Democracy and Stakeholder Engagement

The nature of this problem and obvious divers' perspectives in the transdisciplinary research approach of concerned actors creates some level of doubts and uncertainty in the possible outcome of their cohesion and alliance. This makes it increasingly challenging to identify causal effects, which amounts to the realization that the potential effects of any intervention are unpredictable and unclear (Josephine M., et al 2023).

Funtowicz and Ravetz (1993) indicates that scientific results derived through post-normal processes (i.e. involving extended peer communities) may experience highly political repercussions. Lotz-Sisitka, W., et al (2019) & Temper et al., (2019), explicitly proposed introducing the idea of "political rigour" as a tool for promoting reflexivity and consciousness in every step of the research process. Political rigour can be reached through the design of tools and practices, like games, exercises, etc. (Temper et al., 2019).

For transdisciplinary approaches to effectively address complex societal issues like flash floods through methods like gamification, a more democratic setting is essential. This setup helps manage the uncertainties and challenges in integrating diverse knowledge areas, which are crucial for a well-functioning democratic society. The emphasis in such democratic systems is on broad involvement and the promotion of tolerance for difference (Funtowicz & Ravetz, 1993). To do this, strong public engagement is required, including the different opinions of all stakeholders and rights holders which ensure the active participation of all important parties in decision-making (Lindvall, 2021).

3.4. Serious Games, Tool for Collaboration and Climate Awareness

Games, particularly serious games, serve as powerful tools for addressing climate-related problems by fostering public awareness, education, and collaboration. By creating dynamic and engaging environments, these games connect diverse stakeholders with critical climate concerns and sustainability challenges. Through the simulation of real-world scenarios, serious games enhance decision-making skills and promote a deeper, more nuanced understanding of complex environmental issues (Reckien & Eisenack, 2013). They provide opportunities for experiential learning, allowing players to explore alternative climate futures without the risk of real-world consequences, thus supporting informed decision-making and policy development (Flood et al., 2018; Gugerell & Zuidema, 2017).

Furthermore, games play an essential role in promoting collaboration and dialogue among stakeholders. Games encourage joint problem-solving and teamwork, which are crucial for tackling the complex nature of climate issues. The participatory game design also extends the engagement process beyond gameplay, as stakeholders are actively involved in the creation and observation of the game, facilitating deeper connections between scientific knowledge and public awareness (Vervoort et al., 2022).

Moreover, games play a vital role in citizen science and participatory projects. Monitoring and reporting games actively involve participants in the collection of environmental data, fostering a sense of shared responsibility and contributing to collective climate action (Pallio et al., 2021). By immersing players in climate scenarios, serious games enhance public understanding and empower stakeholders to contribute meaningfully to climate solutions through individual and collective efforts.

3.5. Addressing Climate Challenges, The Interactions

Addressing climate-related challenges such as flash floods in urban settings requires a comprehensive strategy that encompasses interdisciplinary collaboration and democratic participation. Urban flash floods are multifaceted problems that necessitate insights from various sectors, including environmental science, engineering, social policy, and economics. To effectively tackle these challenges, it is imperative to consider the interconnections between climate-related issues, the role of public participation, and the utilization of an interdisciplinary approach. Consequently, developing a framework based on these interrelations would prove to be advantageous.

In recent years, games, particularly serious games and participatory game design, have emerged as potent tools for addressing climate-related challenges. These games engender dynamic and interactive environments that enable participants to engage with climate-related issues. Furthermore, the participatory nature of game design extends beyond gameplay. By actively involving diverse disciplines in the design and development process, games serve as effective platforms for enhancing democratic engagement. Traditional democratic systems often grapple with disengagement and dissatisfaction among citizens. Game design, however, offers a more interactive and participatory approach to public involvement. Games foster collaboration, negotiation, and shared decision-making, all of which are critical for addressing climate change through democratic processes (Stipelman, 2015).

Consequently, in addressing climate-related issues such as flash floods and sustainability challenges, as illustrated on Fig.4, we concentrate on the interactions between democracy, an interdisciplinary approach, and game design. We propose the utilization of game design as a suitable medium for synthesizing ideas from different scientific fields, stakeholders, and the public, thereby encouraging broader public participation.

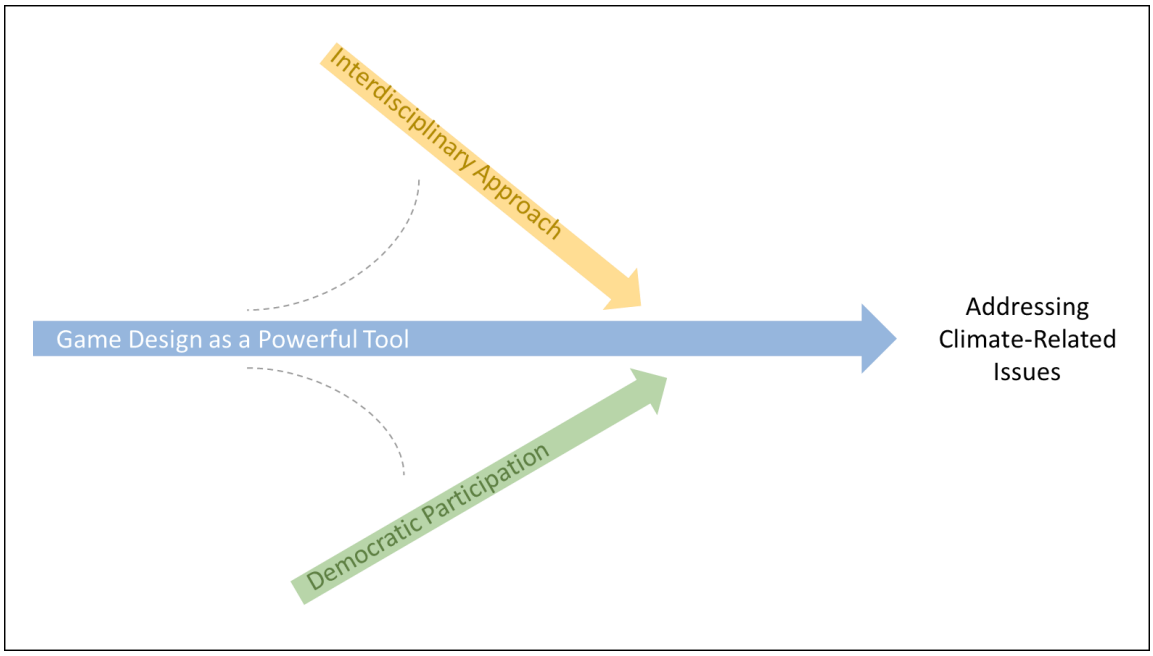

Fig.4: The conceptual diagram of theoretical consideration

4. Methodological Consideration

Participatory Game design is a collaborative method to engaging stakeholders in the design and developing process of a game. This method emphasized the active involvement of interest groups in a cycle of feedback and refinement to ensure that the game aligns with the concerns, experience and preferences of its audience (Ball, Jalbert, & Test, 2021).

For developing a participatory game design, a series of sequential steps is recommended to provide a higher level of engagement of the target audience. The primary goal of these steps is to achieve objectives in social, environmental and product design context by ensuring user involvement, collaborative and iterative design. Through the following steps, it is possible to facilitate learning in complex issues such as trading off between personal and common interests and understanding the complexity of managing shared water resources

Step 1: Defining the purpose and objectives

The first step is to clearly define the purpose and objectives of the game. It should be discussed whether the game is intended to educate, raise awareness, engage stakeholders, change behaviour, promote a cause or simply be an entertaining game. Clarifying the purpose of the game is important for the next steps. For this step, it is necessary to analyse the environment and collect data to identify which specific environmental issue the game will address. (Flanagan, 2009).

This study project is with partnership of the CliWaC, which focuses on water issues in the Berlin-Brandenburg region. After discussing and researching relevant theories and game design techniques, we decided to develop a game with a specific focus on flash floods. This game will deepen our understanding of the complexity of water management. And to understand how different stakeholders make decisions when faced with trade-offs between their personal goals and common environmental goals.

Step 2: Identifying the stakeholders

The core idea of participatory game design is to involve stakeholders in the game development process. Identifying relevant stakeholders enables the team to capture a wide range of perspectives and insights in the game (Simonsen & Robertson, 2013).

In the context of this study project, in relation to the Berlin flash flood, we categorised stakeholders into general stakeholders, who are generally affected by or influence the Berlin flash flood, and game-specific stakeholders, who will be represented as players in the game.

Step 3: Experts Interview

Once key stakeholders have been identified, interviews with them can directly help game designers gather knowledge and information on the subject. Experts can provide game designers with insights into complex issues and how to translate this complexity into game mechanics and narrative (Simonsen & Robertson, 2013).

For this reason, we conducted several interviews with researchers from the CliwaC project to gain scientific knowledge related to Berlin's water issues and flash flooding. We also interviewed game design experts to develop our knowledge of the technical aspects of game design and to understand how to incorporate complex issues into the game mechanism.

Step 4: Conduct participatory game design workshop

Workshops can provide an engagement space for stakeholders to brainstorm together, share their expertise and experience with game designers. In addition, by facilitating creative thinking and capacity building for non-game designers, workshops encourage stakeholders to contribute with game designers (Ball, Jalbert, & Test, 2021). In workshop participants are supplied with ample game material (abstract but colorful tokens, dice, paper, play dough, …) and get a game design crash-course (Lankford & Craven 2022).

To address this step, we organized a rapid game design workshop on urban water management. Experts from public administration and civil society, academics and students were facilitated by Professor Bruce Lankford to articulate their concerns and share their ideas on water issues with game designers through the process of game design.

Step 5: Developing prototypes

After gathering knowledge and information, designers use a form of collaborative decision-making to incorporate different aspects of real-world problems into the rules of a game. The views and concepts of the stakeholders gathered and developed in the previous steps are translated into the mechanisms and scenarios of a game. (Holz et al., 2016).

Taking into account the stakeholders' needs and expectations, as well as the results of the previous steps, we decided to adopt a role-playing board game format. We developed an initial model of player relationships, in which players make trade-offs between their personal and collective interests in protecting the city from flash floods.

Step 6: Play test sessions and feedback

Playtest sessions with stakeholders provide a platform to engage them more in the game design process. Playtesting sessions are crucial to identify issues, gather user feedback and observing different types of players experience during the game. The outcomes of these sessions improve the

game in an iterative way to ensure it reflect real world situation and align it with the objectives. (Khaled & Ingram, 2012).

For this reason, we conducted several test sessions with students, researchers and stakeholders to observe their feelings and discussions, and collect their feedback to improve our game and adjust it according to the objectives.

Step 7: Refine and finalise the game

After several playtest sessions and gathering feedback, multiple cycles of prototyping, playtesting and feedback are required to improve the effectiveness of the game (Flanagan, 2009). Therefore, after each playtest session, we made the necessary adjustments and reviewed the scenario cards to ensure that they met stakeholder expectations. We also modified the scenarios to ensure that all players and their outcomes had relatively equal weight. After refining and debugging, we improved the visual aspects of the game and changed the interactions to encourage players to think more about strategies to reduce the risk of flash flooding.

Step 8: Presenting the Game

Once the game is finalised, it will be disseminated through different strategies such as using online platforms, through exhibitions, schools and other channels. Also, stakeholders can help in the dissemination process and use their networks to promote the game (Simonsen & Robertson, 2013).

For this step, we decided to present our game at a water-related exhibition that was held at the Long Night of Science in Humboldt Forum of Berlin. Long night of Science is an event where scientific institutes present their state-of-the-art research to the general public. This event was a great opportunity for us to present our game to a wide range of society, including experts, scientists and students, as well as civil society.

Step 9: Evaluation and reflection

Once the game has been presented or launched, it is necessary to evaluate its effectiveness in achieving its objectives and its impact on the target audience. This involves qualitative and quantitative methods such as interviews, questionnaires or reflection sessions to measure changes in knowledge, attitudes or behaviour among players. Finally, documentation of all processes and feedback will help to identify areas for improvement in future projects (Khaled & Ingram, 2012; Simonsen & Robertson, 2013).

For the final step, we asked our audience to give us their feedback on our game, we reviewed all the feedback, we documented all the processes and practices in this report to show what worked well and what could be improved for other participatory game design processes.

5 Project Plan

Learning Sessions

Gaming sessions

Photo credit Japhet Uchechukwu Agu

5. Project Plan

Based on the methodological concerns listed in Section 4, the entire study project plan was organized into four stages, as shown in Fig. 5

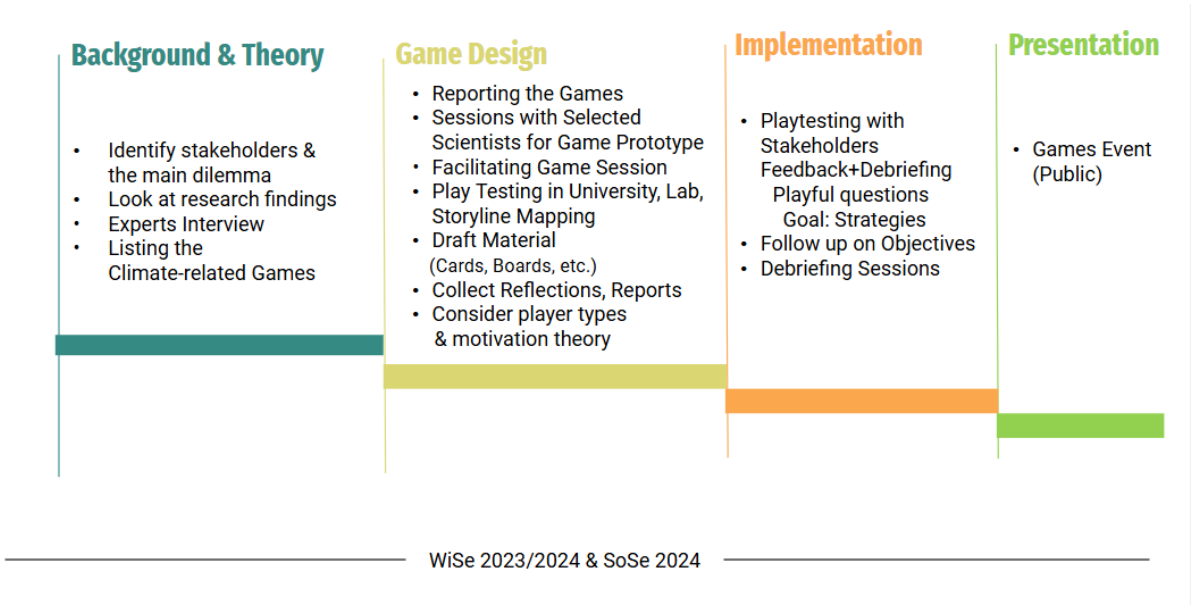

Fig.5 : PGD study project stages

5.1. Learning Sessions

5.1.1. Expert Interviews

During the learning session, we had the opportunity to conduct an expert interview with a seasoned professional in the field. The interview provided valuable insights into the topic at hand, shedding light on key concepts and best practices. The expert shared their wealth of knowledge and experience, offering practical examples and real-world applications that enriched our understanding of the subject matter. Their articulate responses and in-depth explanations not only deepened our comprehension but also sparked engaging discussions among the participants. Overall, the expert interview was a pivotal component of the learning session, enhancing the quality of our learning experience and equipping us with valuable takeaways to apply in our own work.

Pauline Münch (Coordinator of the Experimental Laboratory AnthropoScenes**)**
As part of our research, we conducted an interview with Pauline Münch to better understand the core dilemmas faced by Berlin and other cities when addressing climate-related challenges. One of the key questions we posed was about identifying the primary dilemma that cities encounter in managing such issues, as this is often critical for developing a meaningful game. Pauline

highlighted that a significant problem lies in the lack of engagement with local communities by policymakers and planners. She emphasized that climate-related plans and actions are frequently implemented without sufficient involvement of local people, limiting their effectiveness and inclusivity. To illustrate her point, Pauline referred to the Spreewald region, where pollution and other environmental challenges heavily impact local communities. She argued that addressing such issues requires actively engaging local stakeholders and integrating them into the planning and decision-making process. This insight underscored the importance of fostering participatory approaches to ensure climate solutions are both inclusive and effective.

Thomas Lilge (Co-founder of gamelab.berlin)

Thomas Lilge, a Playful Innovator with the mantra "The path is the game" is a researcher and the founder of Singleton-Change gamer (www.singleton.life), Mein Objekt, Der Multimedia Guide mit Objekt-Chat (www.meinobjekt.de). A co-founder of gamelab.berlin, his work focuses on the tension between theoretical research and practical development with a focus on motivation and decision-making in the digital world. The author of "the cultural technique of play with insanely smart people" and Co-Author of "Real change needs the game (2020)" is an inspiration for reinventing the world through gamification (playful transformation).

Dr. Thomas Lilge was invited to one of our seminar sessions as an expert to integrate the research and design prowess of gamelab Berlin into our project. On the 15th of January,2024, We had a successful and impactful session with Tomas Lilge where he gave us useful and invaluable insights on how we proceeded with our game design project.

Kamran Hatami (Founder of Mr.Gamification**)**

Kamran Hatami is an expert in gamification, with more than 12 years of experience in designing games and game-based solutions. He is the founder of Mr. Gamification website gathering a team of experts, focusing on various gamification and game design projects.

We had an online meeting on 07/11/2023 with him, to share his experience and knowledge in designing a game. During this meeting, we obtained valuable information about the technical aspects of game design. In his lectured he discussed the difference of ludic games and learning games, core dynamics, game mechanic, game types, evaluation of learning game, storytelling in game scenarios, and dramatic questions. He also gave us examples of games in each part. Overall, he provided us an initial road map on how to develop a game during this study project.

CliWaC Researchers

As a part of the CliWaC project, we had a meeting with three researchers and members of the Einstein Research Unit Climate and Water under Change (CliWaC). Dr. Thomas Vogelpohl is a postdoctoral researcher in energy, water and climate policy, Dr. Kei Namba is a postdoctoral fellow focusing on water governance, and Dr. Márk Somogyvári is a postdoctoral researcher developing a data-driven metamodel for Berlin and Brandenburg region.

The meeting took place on January 9, 2024, and we focused on the CliwaC project and scientific aspects of the game design and strategies related to water management in urban environment with a focus on flash flood. During this meeting we obtained valuable information such as a list of key stakeholders involved in water management and their contact information, details on CliWaC workshops, strategies related to flash flood such as the "sponge city" concept. During the discussion, we emphasised on the importance of integrating scientific data into the game and how a game can simulate real-world negotiations and conflicts of interest between stakeholders.

5.1.2. Rapid Game Design Workshop

As part of this project, a workshop on interactive rapid game design was held at the Humboldt Forum on March 5, 2024, facilitated by Prof. Bruce Lankford, Professor of Water and Irrigation Policy at the University of East Anglia, UK. The theme of the workshop was "Water Governance in Urban Areas in a Climate-Changing World", in line with the overall theme of the project. In order to ensure transdisciplinary participation, invitations were sent to a wide range of participants, including students, academics, utilities, urban planners, policymakers, and other important stakeholders representing different districts of Berlin. There was an enthusiastic response to the invitations and around 50 people were selected to attend the event. Documents were distributed to the selected participants in advance to help them prepare for the event, and catering was arranged for them.

Fig.6: Participants engaging in the Rapid Game Design Workshop (Photo credit: Hai Tran)

The main events of the workshop, which lasted about five hours, could be divided into three parts: Prof. Lankford's presentation on the workshop theme, group work involving rapid game designing, and participants' presentation of their games. In the first part, Prof. Lankford first introduced the participants to the relevance of games in understanding complex real-world issues, with particular reference to water-related challenges. He then trained the participants, through a series of rapid-fire exercises, on how to build a connection between the real world and the game world, for instance, by deciding on the game's objective, defining clear win/loss conditions, assigning player

roles, and using different types of game components or tools. In the second part, the participants were asked to sit around their tables, with an average of eight people around each table, and design a board game based on their understanding of the workshop theme. This part of the workshop witnessed active participation from the participants as they brainstormed different ideas on water and climate related issues. We, the organizers, kept a close eye on the needs of the participants and actively recorded our observations on the game design process. In the final part of the workshop, each of the five tables presented their game, answered questions from the other participants, and received feedback from Prof. Lankford.

Although all the games centered around the common theme of water management and distribution, they differed greatly in terms of their goals and mechanics. For instance, a few games used water as a form of currency or resource, requiring players to balance spending and investment. Extreme events such as droughts or floods affected players' ability to manage their resources effectively, which was represented by various game components such as tokens, dice, and chips. A variety of roles were assigned to the players (such as industry representatives, activists, or policymakers), and their specific interests and goals affected water usage and governance. The games included both cooperative and competitive elements, for instance, in some circumstances players had to compete for scarce water resources, while in others they had to work together to prevent water-related crises. The games also combined various educational and entertainment aspects, such as incorporating ideas about dam construction and sponge cities into their models. Overall, these games combined elements of strategy, negotiation, and education to represent the complexities of real-world water management in a simple and intuitive manner.

The workshop ended with a reflection on the outcomes of the presentation and a discussion on the objectives of the day. In addition, feedback was collected from the participants on various organizational and content-related aspects of the workshop (Section 6.2).

5.1.3 Collaborative session

In order to enhance the interdisciplinary nature of our study project, we organized a collaborative session with Professor Dr. Tyradellis and his students from cultural studies. The session was designed to integrate perspectives from cultural studies with our team's expertise in science, engineering, economics, and biological sciences. This section outlines how the collaborative session was organized and the key outcomes achieved

Session Schedule

The session had 6 parts, starting with introducing project objectives by Alexandra Stockschläder and continuing a shortexplanation about the Cliwac Project by Professor. Dr. Eisenack to help

cultural studies students get the context of water-related problems in Berlin, especially the flash floods. Afterward, all participants introduced themselves and their backgrounds.

The main part of the schedule was the brainstorming session. To give enough time for exchanging ideas and perspectives we divided our team into three key focus areas addressing various aspects of flash floods and their impact.

Group 1: Flash Floods - Background: Led by Mina Tayyebi and Alieh Maddah, this group explored the environmental and physical factors contributing to flash floods, focusing on hydrological aspects, urban planning issues, and historical data on floods in Berlin.
Group 2: Societal Impacts: Japhet Uchechukwu Agu and Hai Tran led discussions on the societal consequences of flash floods. The group focused on the social vulnerability of communities, emergency response mechanisms, and long-term adaptation strategies.
Group 3: Economic Aspects and Infrastructure: This group, led by Jayshrita Bhagabati and Alexandra Stockschläder, examined the economic impacts of flash floods and discussed infrastructure strategies for mitigating these events.

Afterward, the results were synthesized to identify overlapping themes, challenges, and potential solutions.

Outcomes of the Collaborative Session

The outcomes of the collaborative session varied based on the diverse perspectives of the participants. For our team, the session provided valuable insights regarding different approaches to game design. The cultural studies students, for example, suggested that a fully collaborative game might be less engaging and recommended incorporating competitive elements to enhance player interest. They also proposed the inclusion of antagonists and protagonists to create more dynamic interactions within the game. Additionally, they advised that card-based games could be easier to design and implement compared to board games. They encouraged us to explore Dungeons & Dragons (DnD)-style games, which led to finding an interesting comparable game, "Quiet Year," for our project mentioned in section 9.4 of the appendices.

Another key outcome from the cultural studies students was their realization of the complexity of water management problems, particularly the social and economic dimensions. They expressed surprise at how intertwined water issues are with broader urban challenges, such as the need to "unseal" cities to improve water absorption capacity. This feedback demonstrated the importance of interdisciplinary collaboration in addressing climate-related challenges, as it broadened their understanding of water-related issues.

One of the most significant long-term outcomes of the session was the potential for continued collaboration with Professor Dr. Tyradellis, who is the chairman of the Humboldt Forum. This collaboration is expected to extend into future activities, as referenced in Section 5.1.2 (RGD Workshop) and Section 6. 1 (Final Game)

5.2. Gaming sessions

5.2.1. Design sessions

From October 2023 to March 2024, we completed the first four steps of our methodology (section 4), focusing on building the foundational background and theoretical knowledge required for game development. These steps included defining the purpose and objectives of the game, identifying relevant stakeholders, conducting expert interviews, and organizing a participatory game design workshop. This phase laid the groundwork for the iterative design process that followed, ensuring our game design was informed by both theory and stakeholder insights.

Between April and June 2024, we progressed to steps five through nine of our methodology (section 4), involving game design, testing, and refinement. Over 20 design sessions (amounting to approximately 60 hours), we continuously brainstormed, developed, and tested multiple iterations of the game. These sessions were iterative by nature, typically structured around the following three steps:

- Brainstorming: Developing a new rule, concept, or idea through team discussions and collaborative problem-solving.
- Drafting and Playing: Creating or modifying physical game materials, such as cards, boards, or tokens, and playtesting the game to evaluate the new ideas.
- Debriefing and Documenting: Analyzing the outcomes of the playtest through team discussions, identifying strengths and weaknesses of the new rules, and documenting all changes for future iterations.

A critical aspect of our approach was calibrating the game to ensure fairness and balance among all players. We achieved this by combining mathematical analysis in Excel with practical testing. Using optimization models, we attempted to define a mathematical framework for player objectives and constraints. However, we found that the most effective method of calibration was repeated playtesting, allowing us to fine-tune the game dynamics and ensure an engaging experience for all players.Drafting and prototyping materials were integral to our game design process. Each session involved creating or modifying physical game components, such as cards, boards, and tokens, to reflect new ideas. Following each playtest, our team conducted a structured debriefing to evaluate the advantages and disadvantages of the changes. This process required reviewing the outcomes, refining the mechanics, and documenting every rule and adjustment made during the session. As part of this collaborative effort, we collectively evaluated the balance between the game's collaborative and competitive aspects, aligning them with the objectives of simulating real-world stakeholder interactions and decision-making.

The design process was further enriched by three major playtest sessions with external audiences. Each session highlighted new aspects for refinement and contributed to the overall development of the Multitude of Voices game.

5.2.2. Play test sessions

First test session: Student

After completing Step 3 of the PGD method and conducting eight design sessions (30 hours) to develop the first game prototype, we advanced to Step 4, which involved testing the game. The first testing session took place on May 15, 2024, with a group of four master's students from Humboldt University of Berlin. The students came from diverse academic backgrounds, who were studying at the Integrated Natural Resource Management and Agricultural Economics programs. This testing session lasted for two hours.

For this session, the game was designed for four players who must collaborate to save a city from flash floods while balancing their personal and common interests. The players, in decreasing order of their initial budgets, were: industry, city planner, researcher, and citizen. The game board represents the city with 100 cells, each equivalent to one point. Each player contributed in multiples of 50 euros, where each 50 euros saves one cell on the board. Players work with two types of cards: strategy cards (common to all players) and personal cards (unique to each player). The negotiation time for decision-making was in 3 minutes.

For the first prototype, the strategy cards were printed, while the game board was sketched manually. Instead of using tokens, the players used marker for colouring the board. The game rules and cards used in this initial prototype are documented in Section 9.1.

In conclusion, during this test session, we learned several important aspects that need improvement. Firstly, the game mechanics required adjustments to better balance the incentives for players, particularly concerning financial contributions versus personal goals. Secondly, the negotiation dynamics needed to be reworked to provide the responsible party with more authority during discussions. Lastly, introducing additional complexity, such as event cards, bluffing mechanisms, and clearer round structures, was recommended to increase engagement and introduce more strategic depth (More details on section 6.3).

Fig.7 : Student game test session (Photo credit: Hai Tran)

Second test session: Scientists

Following feedback from the first test session (as outlined in Section 6.3), the game rules were adjusted and refined over an additional six debugging sessions, totaling 28 hours. The initial budget for players became equal and also costs of individual personal cards were the same for all players to make sure everyone has the same opportunity to win. Random event cards were added to the game, and the board had high and low risk area with different cost for implementing strategies. The second testing session was conducted with researchers from the CliWaC project on Jun 3, 2024. Invitations were sent via email, and while 8 people initially accepted, the session was ultimately conducted with 4 researchers due to cancellations.

Overall, this session offered valuable insights into how the rules affected the game's dynamics. We introduced open strategy cards with designated responsible players to gather input from researchers on strategies that different stakeholders could implement to mitigate flash floods in urban areas. Based on observations of the game’s flow and feedback from the researchers (as outlined in Section 6.3), we refined and simplified the rules to ensure the final game could be completed within the 45-minute time limit.

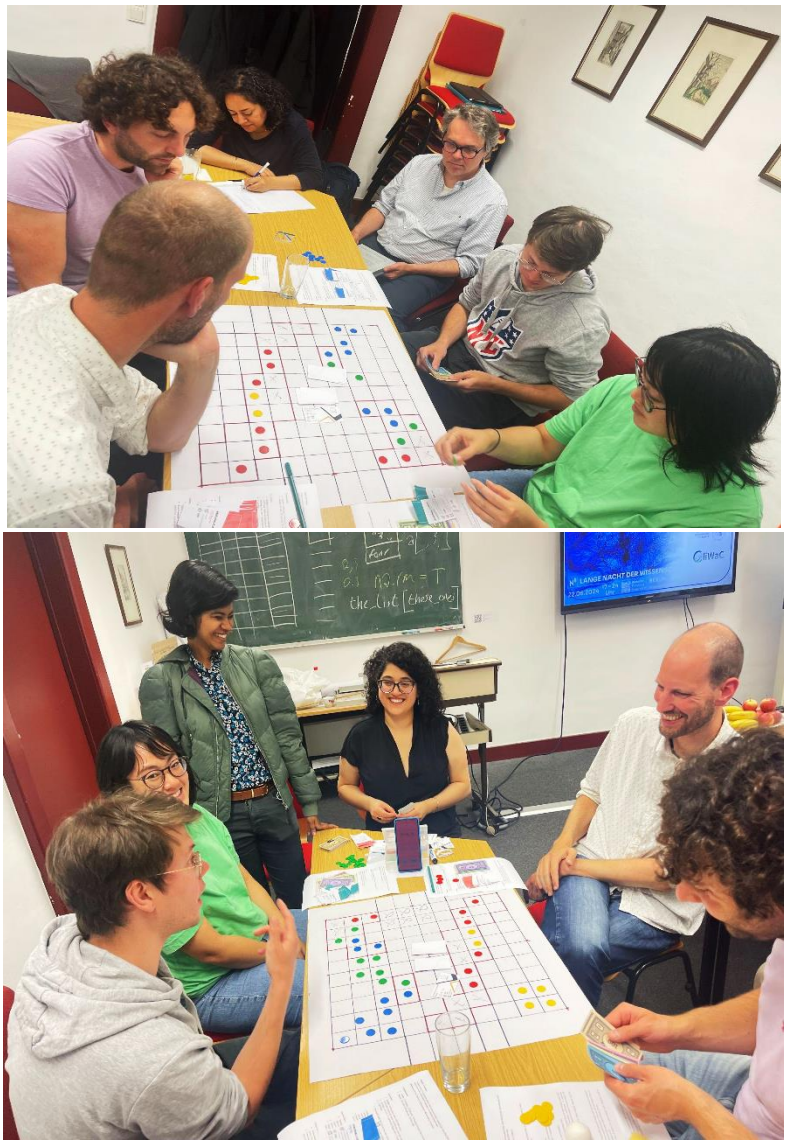

Fig.8 : CliWaC Researcher game test session (Photo credit: Hai Tran)

Final Game session: Public Audience

After multiple cycles of prototyping, playtesting, and gathering feedback, we finalized the game through five group design sessions in total 18 hours, along with approximately 20 hours of individual work. For the final version, we reduced the number of cards and enhanced the visual design of both the cards and the game board. We decided to write out the strategies on the open strategy cards, leaving the assignment of responsible players to be determined by the participants during gameplay.

The game was publicly showcased at the Humboldt Forum during Berlin's "Long Night of Science" event on June 22, 2024, from 8 to 11 P.M. The game tokens and hourglass were purchased from Amazon, and printed materials were produced by HU Printing Services. A promotional poster was designed, and a video clip was streamed continuously during the exhibition at the Humboldt Forum. Additionally, scientific text was prepared both online and in printed pamphlets. A detailed description of the tasks and responsible persons is recorded in the table in Section 9.3.

The final version of the game is described in Section 6.1, with observations and feedback provided in Section 6.3. Full documentation of the final game can be found in Appendices 9.3.

Fig.9: Presenting final game at "Long Night of Science" in Berlin (Photo credit: Humboldt Forum)

6 Main Results

Description of the Final Game

Observations and Feedback from the RGD Workshop

Observations and Feedback from the Playtest Sessions

Photo credit: Humboldt Forum

6. Main Results

6.1. Description of the Final Game

6.1.1. Game Elements

The final game, A Multitude of Voices, was presented at the Humboldt Forum on the occasion of the Long Night of the Science on June 22, 2024. Various aspects of the previous game version were adjusted to suit the event's three-hour duration. Since the goal was to play three games within this timeframe, each game was designed to last approximately 45 minutes. Below are the key elements of the game, including the players, game components, and the budget system.

Players: The game includes four players, each representing key stakeholders in flash flood management within Berlin: Citizen, City Planner, Industrialist, and Researcher. Each player has distinct personal goals and roles in mitigating flash flood risks.

Game Board: The game board is a 10x10 grid representing the city of Berlin, with 30 of the cells designated as high-risk (flood-prone) areas, while the remaining are low-risk areas. The high-risk areas correspond to real areas in Berlin that are prone to flash flooding due to factors like excessive surface sealing.

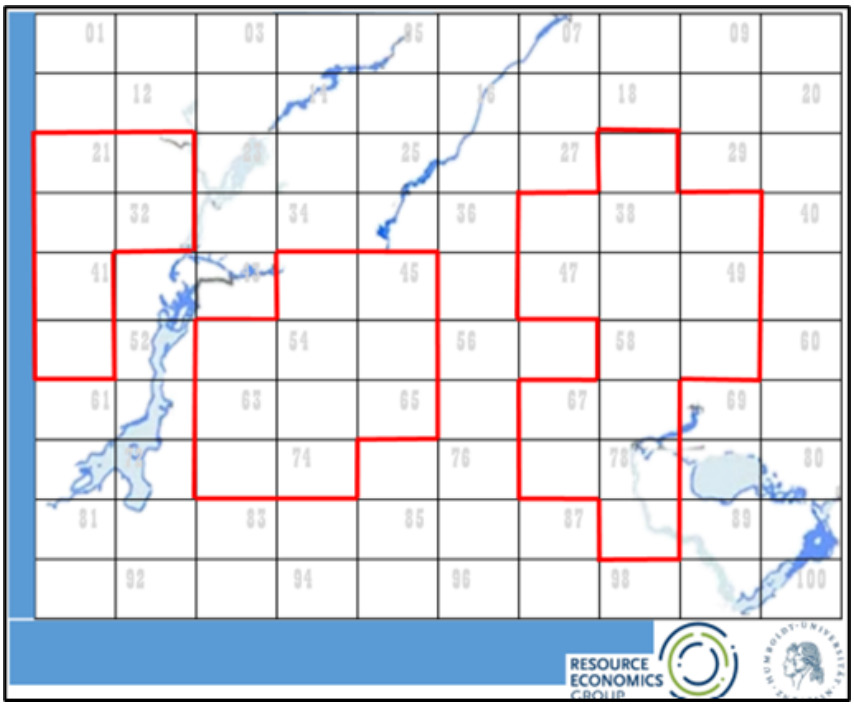

Fig.10: The Game Board
(The 30 cells marked in red indicate high-risk flood zones.)

Tokens: Four different coloured tokens represent the contributions of each player towards protecting Berlin from flash floods by implementing various collaborative projects.

Cards: The game utilizes three kinds of cards, each serving a distinct purpose:

- **Random Event Cards (8 cards):** These cards represent external events that impact the players' budgets, by either adding or subtracting funds from it.

Fig.11: Example of Random Event Card
(This card illustrates a Government Policy Change, crediting €350 to the City Planner and Industrialist, while debiting €150 from the Researcher and Citizen.)

- **Strategy Cards (8 cards):** These represent collaborative flood mitigation and adaptation strategies. They are of two types:
    - **Closed Strategy Cards (4 cards):** These cards specify project costs and assign one party as the Responsible Player.
    - **Open Strategy Cards (4 cards):** These cards outline project costs but require negotiation among players to assign two Responsible Players.

Fig.12: Examples of Open and Closed Strategy Cards
(The top card is an Open Strategy Card, marked by a handshake symbol, indicating no assigned player. The bottom card is a Closed Strategy Card, assigning the Citizen as the responsible player. Both cards list project details, such as the costs involved in saving cells by developing green roofs or organizing campaigns and workshops. Linked Strategy Cards also display a relation symbol, as seen on the bottom left, requiring players to deduce the linked party through context.)

- **Personal Cards (32 cards, 8 per player)**: These cards represent players' personal goals. Some are linked to specific Strategy Cards, while others are independent goals. The colors of these cards match the players' token colors to enable easy identification of players' actions.

Fig.13: Example of Industry Personal Card
(This card outlines a personal goal of the Industry player, with a cost of €150 and a linked strategy indicated at the bottom left.)

Budget System: Each player starts with a budget of €1000. Funds can be traded between players, and gained or lost through the Random Event Cards. Players can choose to keep their budget secret.

6.1.2. Game Rules

Objective: Players must collaborate to protect Berlin from flash floods while balancing their personal goals and flash flood mitigation strategies. Players aim to achieve the most points by the end of the game.

Turn Structure: At the start of each round, a Random Event Card is drawn and resolved. Players then jointly draw a Strategy Card, which can be either Open or Closed, and negotiate on it. Players simultaneously make decisions about resolving their Personal Cards, based on whether they are linked to the Strategy Card drawn in that turn or are independent goals.

Random Event Cards: These are drawn at the beginning of each round, affecting players' budgets with random money gains or losses.

Strategy Cards: When a Closed Strategy Card is drawn, the designated Responsible Player proposes the project location and cost allocation. Players negotiate on contributions and give their money to the Responsible Player, who then makes the final decision on how to use the money collected. The Responsible Player may, for instance, decide to keep the collected money with themselves or to contribute to the project on their own behalf, bypassing the previous discussions. However, the Responsible Player must contribute at least €50/€60 to the project, based on its location, otherwise the strategy is considered a failure, and the corresponding number of cells are flooded. A project cannot be solved in parts; if the Responsible Player manages to collect money only for a part of the project, all the designated cells are submerged and the collected money is returned to the respective players. Which cells are submerged depends on the initial proposal of the responsible player.

If an Open Strategy Card is drawn, the players negotiate and decide on two Responsible Players. As before, after the money has been collected from the other players, the Responsible Players have the final say in deciding the project location and cost allocation. If there is no agreement between the Responsible Players on these aspects by the end of the allotted time, the corresponding number of cells are submerged based on their original proposal, and money equal to the project cost is collected from the Responsible Players by the facilitator.

Personal Cards: Each player has a set of eight personal goals that can be viewed at once but only one can be solved per turn. Solving personal goals costing €150/€200 awards a player 4 points, while goals costing €250 are each worth 5 points. Linked Personal Cards, which generally cost €150, can only be solved if the Linked Strategy Card is also solved in that turn.

Negotiation Time Limits: In case a Closed Strategy Card is drawn, players are allowed to negotiate for up to 3 minutes. In the case of Open Strategy Cards, players are allowed up to 5 minutes of negotiation time, including 2 minutes for deciding the responsible players, which requires a ¾ majority. Failure to agree on the responsible players results in the submergence of low-risk cells. Players must inform the facilitator about their personal card decisions within these time limits.

Game Versions: There are three versions of the game. In one version, **r**esponsible players can move existing tokens around the board. In the second version, tokens cannot be moved. In the third version, tokens can only be shifted after all the risky cells have been protected.

Cell Costs and Points System:

- **High-risk cells:** Protection costs €60 and earns 1.5 points per cell saved.
- **Low-risk cells:** Protection costs €50 and earns 1 point per cell saved.

Winning Conditions: The game ends after 45 minutes (or 8 rounds), or if 30 cells are submerged. In the first case, the player with the most combined points (from strategy and personal cards) wins, while there is no winner in the second case. Players must solve at least 4 personal cards to qualify to win.

Responsible Player/Facilitator Responsibilities: The Responsible Player collects money for Strategy Cards and places tokens on the board. The facilitator ensures that players are contributing the correct amount of money, collects personal cards, and manages time limits.

6.1.3 Game Facilitation

The facilitator of the final game is primarily responsible for explaining the rules, distributing game components, and managing time. However, the facilitator's role can vary depending on the players' familiarity with the game and their level of trust. In some cases, the game can proceed without a designated facilitator, with one of the players taking on the facilitation duties. In this section, we outline the full range of responsibilities that can be assigned to a facilitator to ensure smooth gameplay. Additionally, we provide an overview of our team for game facilitation and how we managed the game in a public setting under intense conditions.

Role of the Facilitator

For the game to run smoothly, the facilitator needs to follow four steps: Pre-Game Preparation, Starting the Game, Facilitating Each Turn, and Ending the Game. The main tasks for each section are mentioned below.

Table 1 :Pre-Game Preparation facilitator’s task

Step	Details
Review Game Rules	Familiarize yourself with game rules and objectives. Ensure understanding of components.
Gather and Arrange Components	Ensure all components are available and in good condition. Arrange them neatly on the table.
Setup the Game Area	Place the game board in the center. Distribute initial budget. Setup cards in three piles.

Table 2: Starting the Game facilitator's task

Step	Details
Welcome Players and Introduce Game	Greet players and explain the objective: Save Berlin from flash floods.
Explain the Roles	Inform players of their roles based on colors and explain each role's influence.
Distribute Game Components	Distribute initial budget and personal cards. Setup strategy and event cards.
Describe the Turn Structure	Explain sequence: Draw event, strategy cards, use personal cards, negotiate.
Review Key Rules	Review scoring system and importance of negotiation and cooperation.

Table 3: Facilitating Each Turn facilitator's task

Step	Details
Draw a Random Event Card	Facilitator draws and reads event card. Allocate credits/debits to players.
Draw a Strategy Card	Draw strategy card and announce details. Start negotiations if necessary.
Manage Negotiations	Set timer (3 min for closed, 5 min for open strategies). Remind players of time.
Collect Decisions	Collect decisions on personal cards. Record and announce strategy.
Implement Actions	Oversee token placement, ensure correct budget is spent.
Submerge Cells if Necessary	Submerge cells if no agreement is reached.

Table 4: Ending the Game facilitator's task

Step	Details
Monitor Game End Conditions	The game ends when 30 cells are submerged.
Calculate Scores	Collect points from strategy and personal cards. Announce the winner.
Debrief Players	Discuss game outcomes, strategies, and negotiation dynamics.

Background knowledge of the Facilitators

The background knowledge of our team in game facilitation is built on several key experiences:

1. *Game Facilitation Lecture*: The main points of the session focused on the facilitator's role in recognizing different player archetypes and roles during the game. Based on Bartle's Player Types, players can be categorized as Achievers, Explorers, Socializers, and Killers, each with distinct motivations and behaviors. Additionally, players tend to adopt various roles such as leader, critic, observer, and follower throughout the game. The facilitator's responsibility is to pay attention to these dynamics and encourage participation from all players. The facilitator must maintain a balance between being approachable and firm, ensuring a smooth and inclusive game experience.
2. *Practical Experience – "The Quiet Year"*: Another experience was when Mina Tayyebi facilitated the game "The Quiet Year" mentioned in section 9. During this session, the facilitation process was observed and followed by a team discussion about the strengths and weaknesses of the facilitation style. This session provided valuable insights into the practical application of facilitation techniques.
3. *Additional Game Facilitation Experiences*: Our team gained further experience through various game-related events including the Rapid Game Design workshop facilitated by Prof. Dr. Bruce Lankford, as detailed in section 5.1.3, where we gained additional insights into the facilitation process. By attending both university-based and external events, we broadened our understanding of diverse facilitation approaches and how to manage group dynamics in different contexts.

Final Game Event Facilitation

As explained in Section 6.1.3, the facilitator of the game has multiple roles, which can be difficult to manage during a gameplay event. During the Lange Nacht der Wissenschaften (LNDW), where each round of the game was limited to 45 minutes, we decided to assign two people to each table (documented in Section 9). One person acted as the Facilitator, and the second person as the Observer, who monitored the gameplay session, identifying player roles and archetypes. To ease the facilitator's workload, we assigned some of their tasks to the observer.

During the event, the facilitator was responsible for the Pre-Game Preparation and Starting the Game tasks. However, for Facilitating Each Round, the observer took on the task of collecting decisions, which included receiving and redistributing budgets according to the cards. Additionally, after the game ended, the facilitator had a brief window to calculate scores, while the observer led the Debriefing with players and discussed the outcomes.

One important element that helped with facilitating the LNDW event, as outlined in Section 6.1.1, was that the facilitator allowed more time for negotiations at the start of the game than in subsequent rounds. This extra time was helpful for players to fully grasp the rules before playing under time pressure.

In conclusion, the collaborative approach to facilitation during the final game event resulted in a more straightforward gameplay experience, allowing both the facilitator and observer to efficiently handle their roles while increasing player involvement.

Fig.14: Game facilitation of the final event (Photo credit: Humboldt Forum)

6.2. Observations and Feedback from the RGD Workshop

6.2.1. Observations

As organizers, we actively took notes and recorded our observations of the game design process during the workshop. In general, two kinds of observations were made: the roles that participants took during the discussions at their respective tables (categorized as leader, follower, critic, and observer), as well as the general process of arriving at decisions during the design process.

All the tables consisted of a healthy mix of all four participant roles. Water and game design experts often took on the role of leaders at their respective tables, providing directions on the game theme and elements. Critics and followers played a key role in keeping the discussions balanced and on track. Few people were observers, but their presence could sometimes be attributed to the number of people at each table. However, even observers were generally witnessed to become an active part of the discussions at some point. In certain situations, there was a change in group dynamics, with participants changing roles from followers to leaders. Despite the possibility of conflict between leaders and critics, most discussions were very cooperative and decisions were usually made in a democratic manner.

Fig.15: A game developed during the Rapid Game Design Workshop (Photo credit: Hai Tran)

The five tables exhibited a range of different approaches to game design, with some prioritizing roleplay and others focusing more on game mechanics, concepts, and strategies. Some common challenges across the tables related to defining clear winning conditions early on, integrating ideas due to time constraints, deciding on the timeframe of the game and whether it should be competitive or collaborative, and confusion about game mechanics. The focus on water-related

issues and biophysical aspects sometimes led to the original game objectives being lost in the discussion. Overall, group dynamics were cooperative and participants showed a high level of motivation to participate in the ongoing discussions. Even the frequent last-minute changes and abstract game designs generally reflected the participants' enthusiasm to share interesting perspectives as they tried to strike a balance between the entertainment and educational aspects of their games.

6.2.2. Feedback Questionnaire

Participants were asked to complete a feedback questionnaire at the end of the workshop, consisting of five multiple-choice questions and two open-ended questions. The multiple-choice questions were as follows:

Please indicate your level of agreement or disagreement with the following statements/questions:
Q.1. Game may help people think together and achieve common goals.
Q.2. Using games is a recommendable method to gain insights on real-world concerns.
Q.3. It is crucial to include clear explanations of all aspects and rules in games, even if they restrict players' autonomy.
Q.4. How confident were you in the organization of the workshop?
Q.5. How strongly did you enjoy the workshop today?

Responses were recorded on a 5-point Likert scale, where 1 indicated strong disagreement or a very negative experience, and 5 indicated strong agreement or a very positive experience.

A total of 32 respondents, 18 of whom were researchers, provided feedback through the questionnaire. Their responses are summarized below:

Table 5: Descriptive statistics of participants' responses

Measure	Q.1.	Q.2.	Q.3.	Q.4.	Q.5.
Mean	4.47	4.31	3.77	4.28	4.56
Median	5.00	4.00	4.00	4.00	5.00
Standard Deviation	0.67	0.78	0.92	0.63	0.62
Minimum	3	2	2	3	3
Maximum	5	5	5	5	5

Fig.16: Participant responses summarized as cumulative scores across five multiple-choice questions (Q1 to Q5). Each bar represents the total score given by one participant, with a maximum possible score of 25 (indicating a rating of 5 for all questions).

Overall, participants responded very positively to the use of games as a method for addressing real-world concerns in a collaborative manner. In addition, the organization and enjoyment aspects of the workshop were highly rated, with no scores falling below 3. However, opinions were more varied regarding the importance of participatory elements of game design, although respondents generally favored clear explanations of game rules, even at the cost of some player autonomy.

In the two open-ended sections, participants were asked to note down interesting aspects of the games they had seen or presented, and to offer suggestions for future games on urban water governance under climate change (the workshop's theme). For the first question, players highlighted key aspects such as the distinction between cooperative and collaborative gameplay, managing competing stakeholder interest, addressing climate-change-related water issues, and representing complex real-world challenges through game-based scenarios. For the second question, common suggestions included extending the workshop's duration, improving the participatory elements of game design, reducing the number of players at each table to improve engagement, and providing more structured, clearer explanations of the workshop's themes.

6.2.3. Word Clouds

To assess whether the workshop influenced participants' views on the theme (urban water governance in a climate-changing world), an interactive word cloud exercise was conducted. At the beginning and end of the workshop, participants were asked to scan a code and enter three words that came to mind when reflecting on the workshop theme.

Fig.17: word cloud generated at the start of RGD workshop

Fig.18: word cloud generated in the end of RGD workshop

The results exhibited a notable shift in conceptual thinking. Initially, participants' responses focused mainly on events and material solutions, with commonly mentioned words including *rain*, *scarcity*, and *drought* (each mentioned three times), and *blue-green infrastructure*, *heat*, and *unsealing* (each mentioned twice). By the end of the workshop, however, the repeated exercise revealed a more frequent occurrence of institutional and transactional ideas, with commonly mentioned terms including *complexity*, *conflict*, *future*, and *power* (each mentioned twice).

This shift highlights the effectiveness of the workshop in deepening participants' understanding of the complex and interrelated challenges of water governance. It is likely that although most participants had some prior knowledge of these issues (as most of them came from academic backgrounds), they may have developed a greater appreciation of the intricacies and risks inherent in urban water management as a result of the workshop.

6.2.4. Participant Interview

Sebastian Uribe is an independent consultant and workshop facilitator who provided a follow-up interview on various organizational and design-related aspects of the RGD workshop. The interview was conducted via Zoom by Jayshrita Bhagabati and Mina Tayyebi on April 26, 2024.

Regarding organizational aspects, Sebastian Uribe was very appreciative of the overall structure of the workshop and the resources (in terms of manpower, catering, and location) allocated to it. He also praised the organizers for being present at the tables for observation in a non-invasive manner. Prof. Lankford's expertise in conducting gaming workshops and his willingness to stay after the workshop for further discussion were also cited as particular strengths of the workshop. The time constraint of five hours was not viewed as a major limitation, as participants were able to share a variety of perspectives and ideas even within this limited time.

However, Sebastian Uribe noted that more active moderation on the part of the organizers could have ensured more equal participation of participants at their respective tables. To improve the feedback process, he recommended that feedback be incorporated into the main part of the workshop in simple, use-friendly formats. He also suggested that the workshop would have benefited from more specific information about different aspects of urban water governance (such as, key actors, policy challenges, and governance modes) to promote deeper learning about these issues, especially since most participants were not experts in the field of water management. Moreover, this would have ensured that the games presented were more aligned with the overall theme of the workshop.

With regard to the game design process, Sebastian Uribe praised the diversity of ideas displayed by the participants in terms of game mechanics, player roles, and environmental scenarios. He was particularly impressed by the level of detail exhibited by the participants with no prior experience

in game design or water management. According to Mr. Uribe, disagreements at his table generally did not arise from the level of expertise of the participants, but from decisions related to game mechanics, which were the focus of the participants rather than the thematic focus of the game.

Sebastian Uribe also reflected on the growing popularity of serious games in multiple fields, including the environment. He attributed this mainly to the broad appeal of games, their ability to convey complex ideas in an intuitive manner, and their ability to enable systemic thinking among players.

6.3. Observations and Feedback from the Playtest sessions

6.3.1. First test session: Students

The first playtesting session provided valuable insights into how the game could be improved. Four players tested the game, and feedback focused on gameplay mechanics, player dynamics, and organizational aspects for future testing sessions. The session highlighted areas where adjustments were necessary to enhance both the engagement and balance of the game.

Areas for Improvement:

- Game Structure and Rules:
  - Providing an hourglass to clearly show the three-minute countdown for each round.
  - Use colourful tokens to mark the board instead of manual colouring to save time and avoid confusion.
  - Increase the number of personal cards to match the number of strategy cards.
  - Adjust the rules to ensure players resolve at least five personal cards, preventing them from focusing solely on common goals.
- Player Dynamics and Roles:
  - Enhance the authority of the responsible party to improve negotiation dynamics.
  - Create stronger incentives for players to solve their personal cards.
  - Rebalance the game to ensure players with smaller budgets (like citizens) have more power in certain decisions.
- Gameplay Complexity:
  - Introduce "event cards" (e.g., elections or inflation) to add unexpected elements and increase excitement.
  - Revise the game's win conditions to introduce more strategic depth and reduce predictability.
  - Allow players to bluff by keeping their remaining budget hidden, promoting more complex negotiations.
- Facilitation and Organization:

- Ensure facilitators are properly trained and avoid interruptions during gameplay.
- Provide a clear checklist of tools and responsibilities for each session to ensure smooth execution.
- Clarify the number of rounds and ensure players are consistently updated.

In Conclusion, this session revealed the need for more complexity, clearer rules, and better balancing between player roles. Incorporating these improvements will make the game more engaging, challenging, and enjoyable for future players.

6.3.2. Second test Session: Researchers

Researchers provided essential feedback, which led to adjustments in the final game rules. Below are the main changes required for the final version:

1. Reduction in Cards: The number of cards was reduced from 12 to 8 for each type. This adjustment was made due to the time limitation of the exhibition, ensuring the game could be completed within the 45-minute duration.
2. Decreased Initial Budget: The initial budget, originally set at 2000 euros per player, was reduced to accommodate the shorter gameplay time, simplifying decision-making. Additionally, fixed values were introduced for both personal and strategy cards to streamline the gameplay.
3. Open Strategy Cards and Negotiation Dynamics: In the testing session, strategy cards involved open cards where players negotiated to determine the responsible players. This concept engaged researchers in suggesting strategies. For the final game, the cards will be modified for a public audience by clearly writing the strategies on the cards, while allowing players to decide who will be responsible. This enhances negotiation dynamics and makes the game more accessible to non-expert players.
4. Endgame Conditions: In the earlier version, the game ended when 60% of the cells were saved. Due to the 45-minute time limit for the final game, the threshold for submerged cells was reduced to 30 cells, making the game more adaptable to different settings and time constraints.
5. Improved Facilitation and Time Management: Time management was enhanced by having the facilitator provide regular reminders and guide negotiations. Specific rules were introduced for when players must make decisions about random events and personal cards, ensuring smoother gameplay. However, to manage time more effectively in the final version, an hourglass will be required for clear timing.

In conclusion, these adjustments make the game more suitable for public audiences and ensure that it fits within time constraints while maintaining engaging and dynamic gameplay.

6.3.3. Final Game session: Public Audience

For preparation of the final session, an Excel sheet was used to delegate tasks, ensuring smooth execution of the event which is presented in Appendices 9.b. During the exhibition, three tables were set up: two for game play and one for general information on games. A video was streaming during the session to present the study project and game process to the audience. Pamphlets, and an extra set of game components were used to engage visitors. Feedback was collected verbally and participants showed their feedback on a board by pins (Fig.19). A QR code gave access to detailed information about flash floods in Berlin and mitigation strategies.

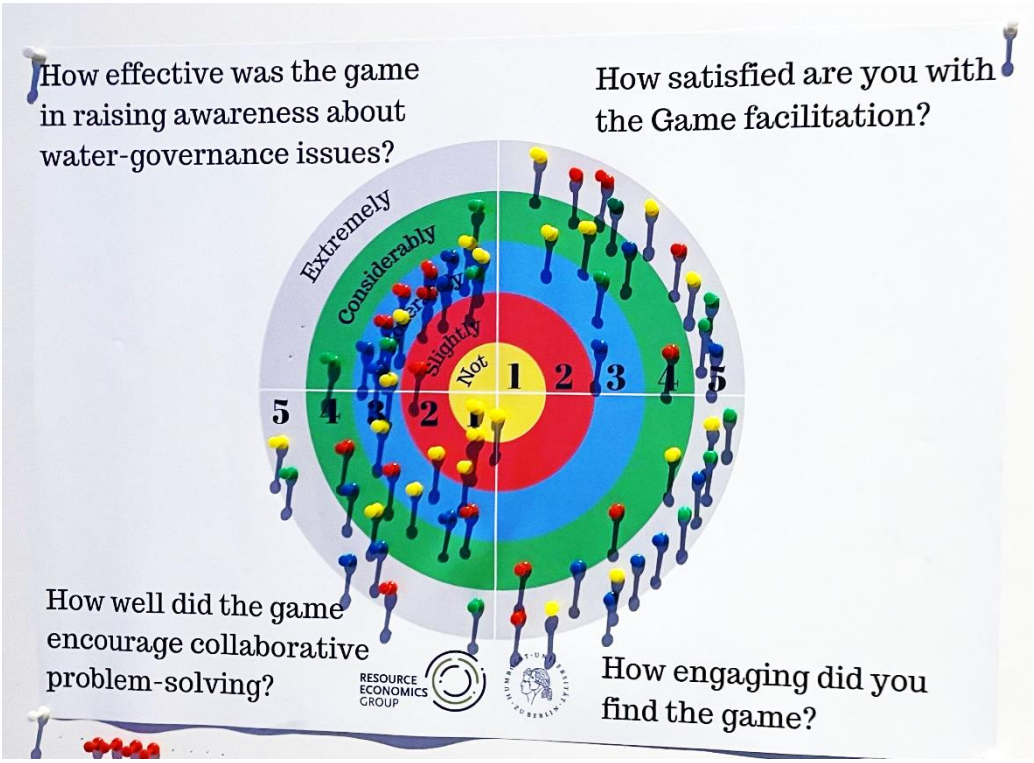

Fig. 19: Feedback board results from the final game event, (photo credit: Hai Tran)

Game Observations:

Initially, visitors were invited by the team to participate in the game. A total of five rounds were completed throughout the evening. Alieh Maddah was responsible for observing and taking note.r. Jayshrita Bhagabati and Mina Tayyebi facilitated two rounds each, Japhet Uchechukwu Agu facilitated one round, and Hai Tran managed the information desk for the entire event.

Player Dynamics:

Table 1:
In round 1 Jayshrita Bhagabati was the facilitator and Alieh Maddah had to step in as a player to meet the requirement of four players. Afterward, she resumed her role as an observer and note-taker. During the first round, players focused on their personal objectives, which hindered cooperation and led to the city's failure, as their budget was depleted. For this round, trust issues arose when one player pursued self-interested goals, reducing overall collaboration.

In round 2, the group showed better cooperation, with players working together to save the city. A key factor was the citizen player, who had prior experience with the game, contributing effectively to high-risk areas and helping guide decision-making. Despite stronger teamwork, the researcher won by strategically bluffing toward the game's end.

For Table Two, two games were facilitated by Mina Tayyebi while Japhet Uchechukwu Agu observed, and for one game, they switched roles.

Table 2:

In Round 1, four friends participated, displaying high levels of cooperation and without conflict. Decision-making was unanimous, with a focus on high-risk areas. A notable strategy was that the Researcher was often chosen as the responsible player due to an increased budget from random event cards. Players enjoyed the game but suggested adding more tension and reducing the initial budget to increase difficulty.

In Round 2, the game continued to focus on cooperation, but time pressure sometimes caused confusion in decision-making and token placement. Players enjoyed the added pressure but suggested a longer time frame to allow for deeper negotiation.

In Round 3, the removal of an event card increased scarcity, prompting more trade-offs. Players cooperated effectively, often lending money to save the city. There was deep engagement with the game, especially when the facilitator explained that the board was inspired by real Berlin locations. Players made decisions based on real-world city areas, showing a stronger connection to the game's theme.

Facilitation and Time Management:

Facilitation skills have been improved throughout the testing session. While some time pressure led to quick calculations rather than in-depth negotiations, the facilitators adjusted the game by reducing time pressure in later rounds, which improved player engagement.

Key Suggestions for Improvement:

- Increased Complexity: Players suggested adding more random events and strategies to create more diverse gameplay.
- Conflicts/Rivalries: More tension between players should be induced, potentially through penalties when solving personal cards.
- Clarifying Rules and Scoring: More emphasis should be placed on explaining the scoring system and the role of bluffing or risk-taking.
- Link to Reality: Players appreciated the idea of using a real map of Berlin for the game board, which could enhance learning opportunities.

Overall, the game was well-received, with strong engagement from participants, but more complexity and conflict could improve future iterations. The introduction of strategic depth, enhanced negotiation dynamics, and better clarity around scoring will help refine the game experience.

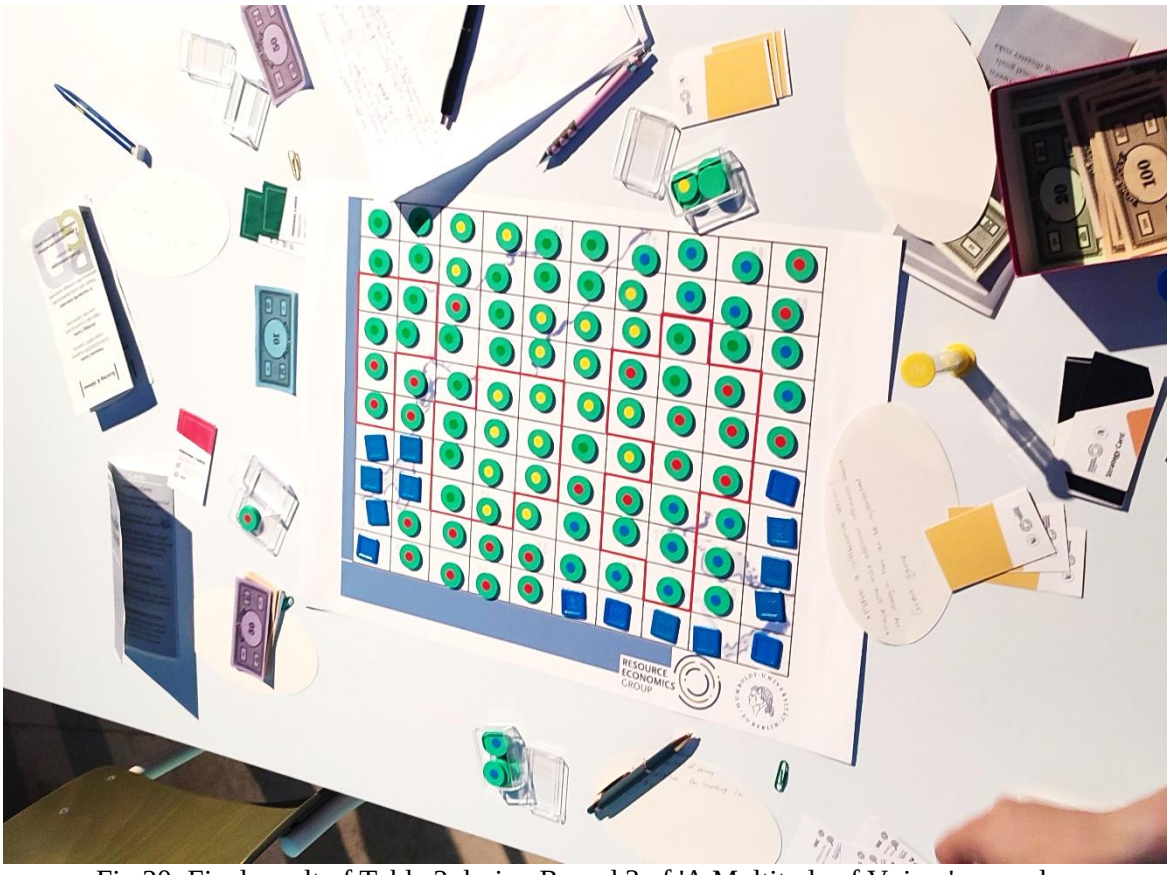

Fig.20: Final result of Table 2 during Round 3 of 'A Multitude of Voices' gameplay
(Photo credit: Mina Tayyebi)

7 Limitations & Possible Future work

8 Conclusion

Photo credit: Humboldt Forum

7. Limitations, and Possible Future Work

7.1. Limitations

Wicked Nature of Climate-Related Problems: Climate-related issues like flash floods in Berlin are wicked problems, characterized by their complexity and multifaceted nature. This makes it challenging to precisely target or simplify these issues for the purposes of game development.

Time Constraints: The project was conducted within a limited timeframe, which restricted the ability to extensively develop, calibrate, and playtest the game. Iterative playtesting and debriefing sessions, essential for refining the game, were also constrained by time and scheduling difficulties.

Challenges in Designing a Fully Participatory Game: While the project aimed to develop a participatory game to foster engagement and negotiations among players, the inherent nature of participatory games requires flexibility and extended time to incorporate meaningful contributions from participants. Although the game included elements of participation—such as open strategy cards and player-influenced game elements—it was difficult to fully achieve the goals of a participatory game within the project's time and resource constraints.

Stakeholder Engagement Challenges: The diversity of stakeholders involved in climate-related problems posed challenges in ensuring comprehensive representation. It was difficult to bring together participants from different levels of governance and sectors to play the game and provide valuable insights.

Game Calibration for Complexity: Designing a game that effectively captures the complexity of climate dilemmas while remaining playable within a limited time frame was a significant challenge. Balancing these aspects required multiple iterations and compromises.

Language Barriers: Since the game was initially developed in English, language barriers arose during one of the playtest sessions, affecting participants' understanding and engagement with the game.

7.2. Future Research Directions

Exploring Stakeholder-Specific Game Versions: Investigate how different versions of the game can be tailored to specific stakeholder groups, such as policymakers, industries, or citizens, to maximize engagement. Research could focus on the impact of tailored game mechanics on stakeholder collaboration and decision-making.

Balancing Complexity and Playability: Further studies could explore methods to balance the complexity of game mechanics with the need for simplicity and time efficiency. This could involve

developing modular game elements that can be adjusted based on the time available or the expertise of the players.

Longitudinal Impact of Participatory Games: Assess the long-term impacts of participatory games on stakeholder behavior, decision-making, and collaboration. This could involve follow-up studies with participants to evaluate whether the game influences their actions and perspectives in real-world settings.

Incorporating Advanced Technologies: Examine the potential of integrating digital tools or simulations into participatory games to enhance complexity without compromising playability. For instance, digital interfaces could manage complex calculations or scenarios while maintaining an engaging player experience.

Evaluating Participatory Processes: Delve deeper into how participatory elements can be effectively incorporated into game design and how they influence player engagement and collaboration. Research could also explore strategies to involve participants more dynamically in the design process.

Assessing Cross-Cultural Applicability: Investigate how the game can be adapted and applied across different cultural or regional contexts. This research could focus on identifying universal game elements versus those that need to be context-specific.

Involvement of Artists in Game Design: Building on the interdisciplinary nature of this project, further research could explore the integration of artists and creative professionals in the game design process. Their expertise in visual storytelling, aesthetics, and innovative thinking could enhance the game's appeal, accessibility, and engagement.

8.Conclusion

Serious games are increasingly recognized as an effective tool for raising awareness about complex environmental challenges. Our personal experiences, along with the feedback received from the RGD workshop and the repeated playtest sessions, supports the view that games can promote a deeper and more nuanced understanding of pressing wicked problems, such the management of scarce water resources in the face of climate change. Such an effect was evident even among people with prior knowledge of these issues, which may be due to games' ability to generate empathy for the diverse needs of different water stakeholders, as role-playing enables players to adopt positions and perspectives outside of their everyday experience.

One of our most important observations during the final event of the Long Night of the Sciences was the fact that players generally exhibited a strong sense of environmental responsibility, prioritizing the protection of flood-prone (risky) areas and the achievement of common environmental goals, even at the expense of their personal ones (even though this would generally have allowed them to score more points). This tendency was particularly strong when participants could identify with the game board elements representing Berlin, suggesting that players can be incentivized to engage in environmental protection by drawing clear parallels between the real world and the game world. In addition, the introduction of random event cards showed that unforeseen external events that affect players' budgets can significantly influence their decision making, in the form of a stronger focus on fulfilling personal goals. Players also exhibited very high levels of cooperation, despite the inclusion of several competitive elements and opportunities for corrupt decision-making in the final game.

However, it is possible that the lack of familiarity between players affected their decision-making during the final game. Further refinements to the current game can explore how players' choices are affected by repeated gameplay among the same people, the introduction of additional players with more clearly defined roles, changes to players' budgets, and extended negotiation times. Addressing these aspects was beyond the scope of the current project, however, making these changes could enable this game to emerge as a powerful tool for understanding urban water governance, particularly due to its ability to strike a balance between educational and entertainment aspects. Another area for improvement is the possibility of increasing the participatory elements of the game, which could encourage more active learning, exploration of diverse perspectives, and greater stakeholder engagement.

Despite these limitations, the success of the project, as evidenced by the positive reception at the Long Night of the Sciences, is a testament to the potential of serious games to facilitate real-world understanding of complex environmental issues among diverse audiences. This is particularly important in the current context of escalating climate change impacts, as such challenges are likely to demand even greater attention and action in the future.

9. Appendices

To streamline the information presented in this section, some parts of the documentation are available online through the provided link.

9.1. Documentation of First Version of the Game

The following are the rules, developed and calibrated strategies, and designed components of the initial edition of the game, which was played during the first playtest session with Humboldt University students on May 15, 2024. The comprehensive documents can be found at the following link.

Core Concept, Mechanics and Elements

The primary objective of the game is for players to collaboratively save the city from flash floods while balancing their personal goals. Players are tasked with making trade-offs between addressing their own objectives and contributing to shared strategies aimed at mitigating flood risks. Success hinges on the players' ability to collaborate and make strategic decisions that impact the collective and individual outcomes.

Table a.1:First Version of the Game, Game Mechanics

Game Mechanics	Details
Budget Management	Each player begins with an initial budget based on their role (industry, city planner, researcher, or citizen). Players must allocate funds between strategy and personal cards.
Collaboration & Decision-Making	Players draw one strategy card collectively and personal cards individually. They have 3 minutes to reach a unanimous decision on how to cover the cost of the strategy card.
Cost Contribution	Players contribute in multiples of 50 euros, with 50 euros saving one cell on the board. Players can request funds from others, but are not obligated to spend them as agreed.
Game End Conditions	The game ends when one of the following occurs: - 80 cells turn green (successfully resolved strategies) - 50 cells turn blue (unresolved strategies, no winner) - After 12 rounds, the player with the highest overall score on strategy and personal cards wins.

Table a.2:First Version of the Game, Game Elements

Game Elements	Details
Players	Four roles—industry, city planner, researcher, and citizen—each with a unique starting budget, reflecting their responsibilities in mitigating flood risks.
Game Board	The board represents the city, with 100 cells (each cell is 1 point). Players prevent cells from turning blue by resolving strategy cards while pursuing personal goals.
Cards	
Strategy Cards (12)	Represent common strategies to mitigate flash floods. The cost of resolving each is proportional to the responsible player's budget.
Personal Cards (10/player)	Each player's individual goals. Each card is worth 3 points, but players must decide whether to allocate resources to personal or strategy cards.
Scoring	Players gain points by resolving both strategy and personal cards. Coloured cells instead of blue indicate strategy success. The winner has the highest combined score for both card types.

Strategies and Initial Budget Calibration

The total number of cells that can be saved by all strategies is 100, representing the entire city. To save the city, a total budget of €5000 is required. The budget needed to achieve the personal goals of each player varies based on their assigned role. Using an iterative method, the cost for each card (both strategy and personal) is calculated to ensure a fair distribution based on the responsible player for each card and their personal goals. The initial budget distribution is also calculated in parallel with this process. The calibration of strategy cards, personal cards, and the initial budget allocation are available on the following link.

Designed Components

The initial version of the game board was a simple 10*10 grided paper shown in Fig.a.1. Each player had a marker with an assigned color as a result only the cards were designed which samples can be seen in Fig.a.2.

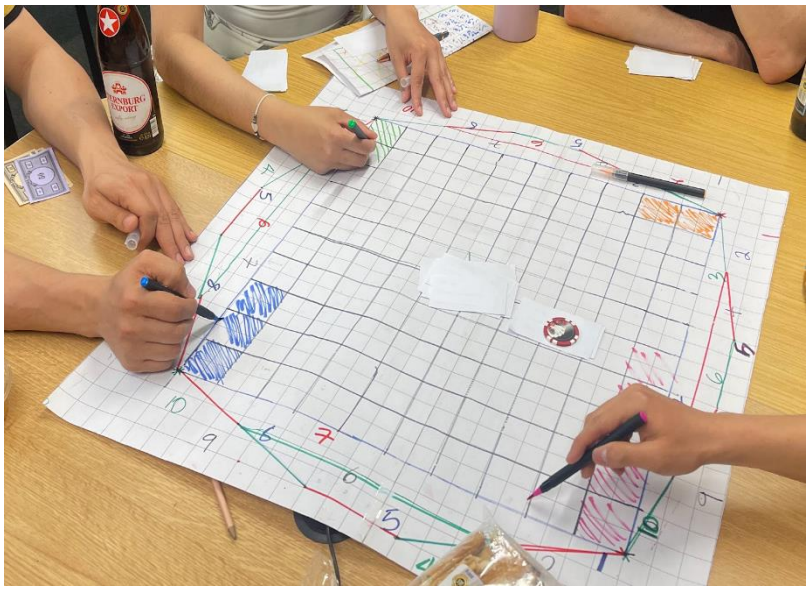

Fig.a.1 :Board game of first version of the game (Photo credit: Alieh Maddah)

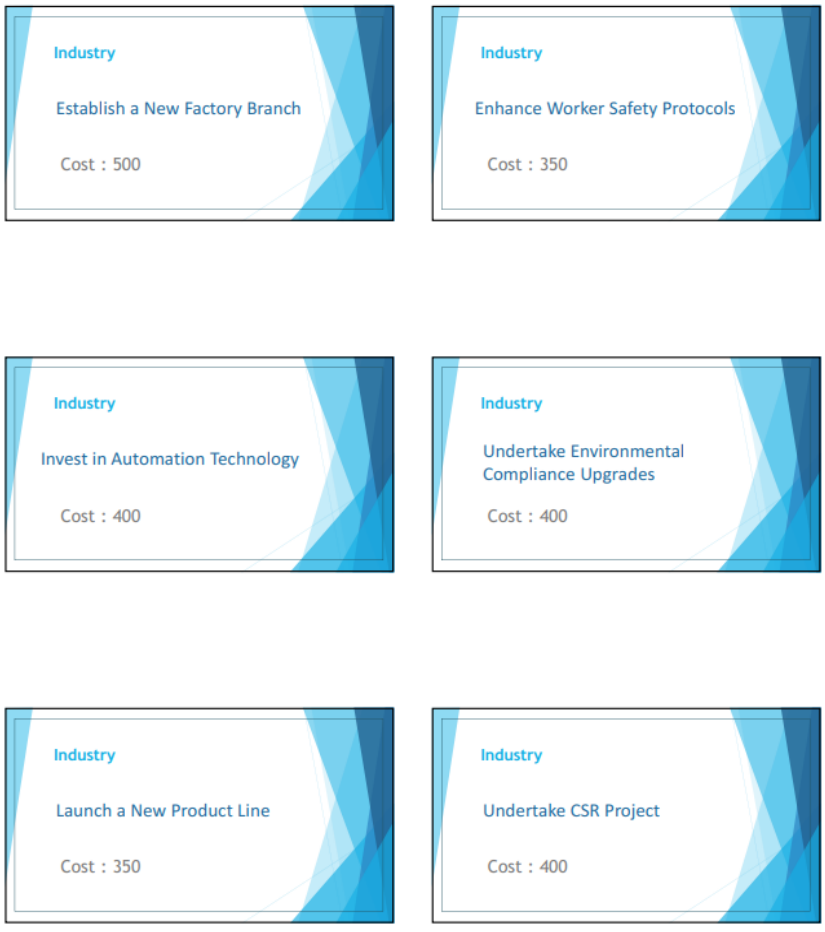

Fig.a.2: Samples of deigend cards of the first version of the game

9.2. Documentation of Main Events

9.2.1 Rapid Game Design Workshop

The Rapid Game Design Workshop (RGD), facilitated by Professor Dr. Bruce Lankford, was organized by our team on behalf of the Resource Economics Group, in collaboration with the CliWaC, on March 5, 2024, on Humboldt Lab (Humboldt Forum) as outlined in Section 5.3. The following section, along with the provided link, offers detailed documentation of the RGS workshop.

Pre-Workshop Planning

To ensure an organized workshop, invitations with registration forms were sent to participants, followed by reminder emails with the agenda and supporting documents. Venue arrangements, including site visits, were completed. Color-coded name tags for stakeholders, researchers, and students were designed and printed (Fig.a.3)

Fig.a.3: Sample name tags for the Rapid Game Design (RGD) workshop participants. Blue was assigned to researchers, beige to students, and green to stakeholders

Workshop Proceedings

At the start of the workshop, participants were asked to sign consent forms for photo documentation and a registration list. Professor Dr. Lankford opened the event with a slideshow presentation, which included a QR code linking to a word cloud activity as an icebreaker, organized by our team. The presentation also featured warm-up photos illustrating Berlin's urban water challenges and governance issues, which were collected by our team. Samples of the slideshow can be seen in Fig.a.4. Full presentation can be found through the link.

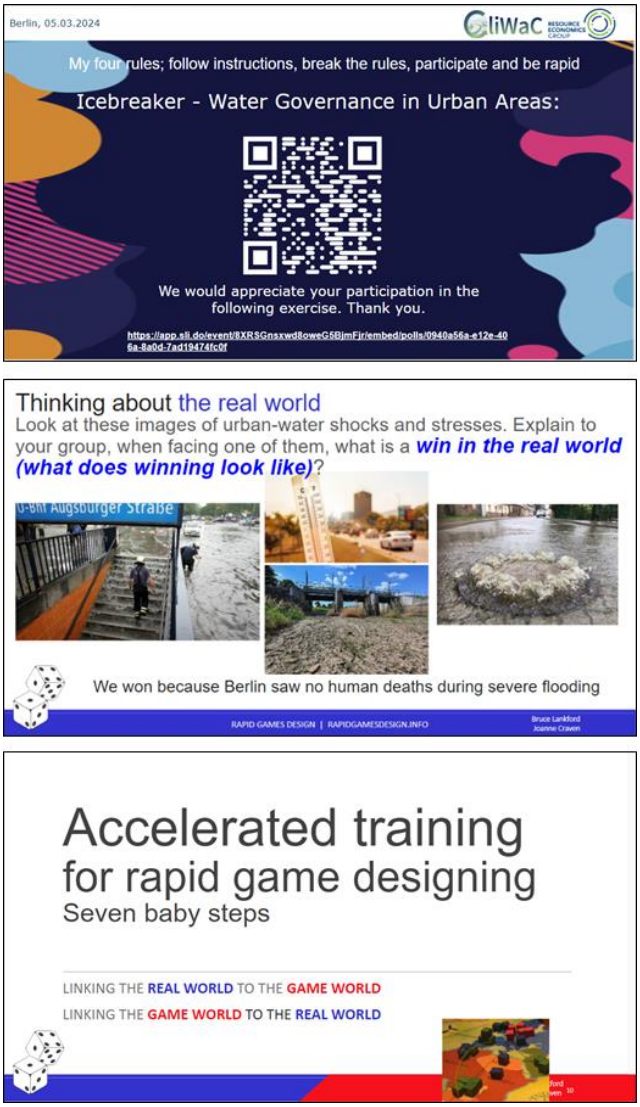

Fig.a.4: Samples of slide show presented on RGD workshop

Following the presentation, each team was tasked with designing their own game, leading to engaging discussions and presentations. Figures a.5 and a.6 capture some moments from the RGD workshop.

Post-Workshop Outcomes

Key outcomes from the workshop are explained in section 6.2.2 to 6.2.4.

9.2.2. Game Presentation at Long Night of Science

The "Lange Nacht der Wissenschaften" (Long Night of Science) is an annual event held in various cities in Germany, where scientific institutions, universities, and research organizations open their doors to the public. Visitors can explore a wide range of scientific presentations, experiments, and interactive exhibits, providing an engaging way to learn about the latest innovations and research. In collaboration with the Humboldt Forum, the final game was presented at this event. For preparation, a promotional poster, a short video introducing the PGD team, and an online document detailing the scientific background of the game and flash floods were created. These materials are accessible via the provided link.

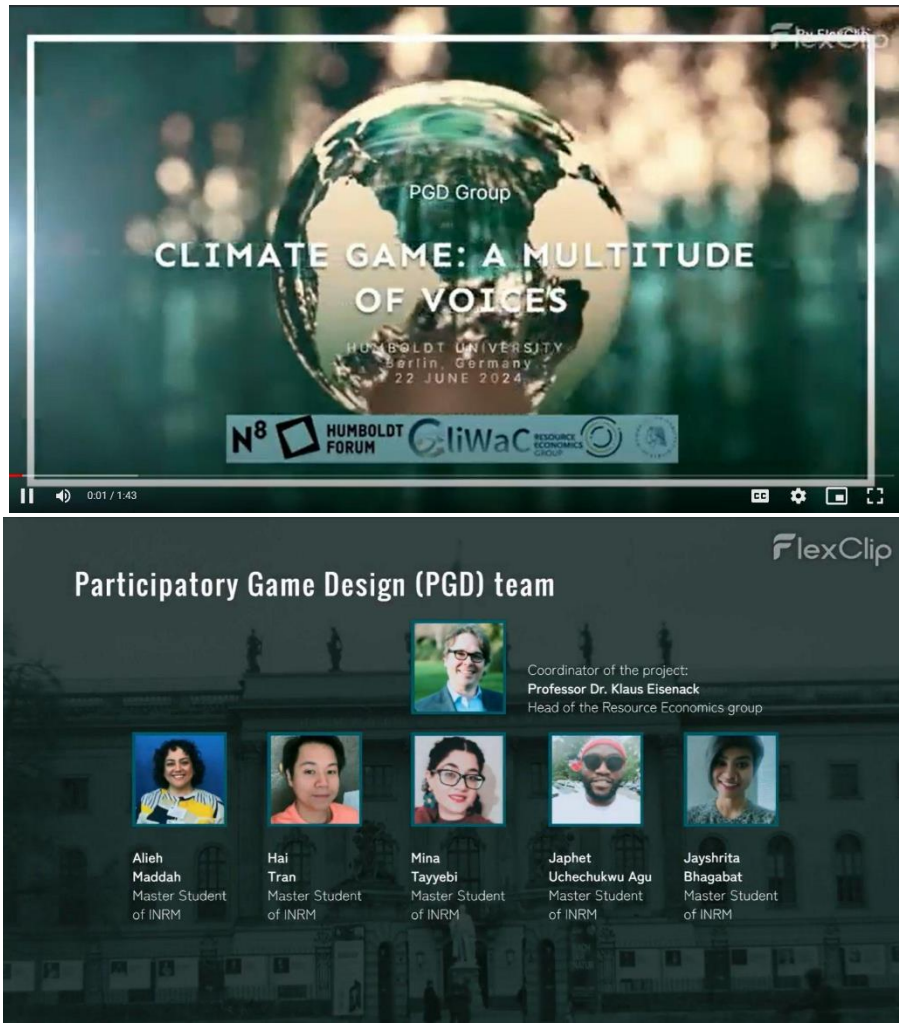

Fig.a.5: Sample slides of the Video

9.3. Documentation of the Final Game (a Multitude of Voices)

The final game with detailed rules is explained in Section 6.1. The following link provides access to the calibration tables for strategy cards, personal cards and their costs, and random event cards. The game board (Fig.a.6), game's short guide (Fig.a.7), strategy cards (Fig.a.8), random event cards (Fig.a.9), and personal cards (Fig.a.10-a.13) are displayed in this section.

To play the game:

- Simply print the cards and materials from Figs.a.8 to a.13
- If tokens are unavailable, substitute with small items of different colors, such as buttons or coins.
- If the game board cannot be printed, create a 100-cell grid and designate 30 cells as high-risk areas.

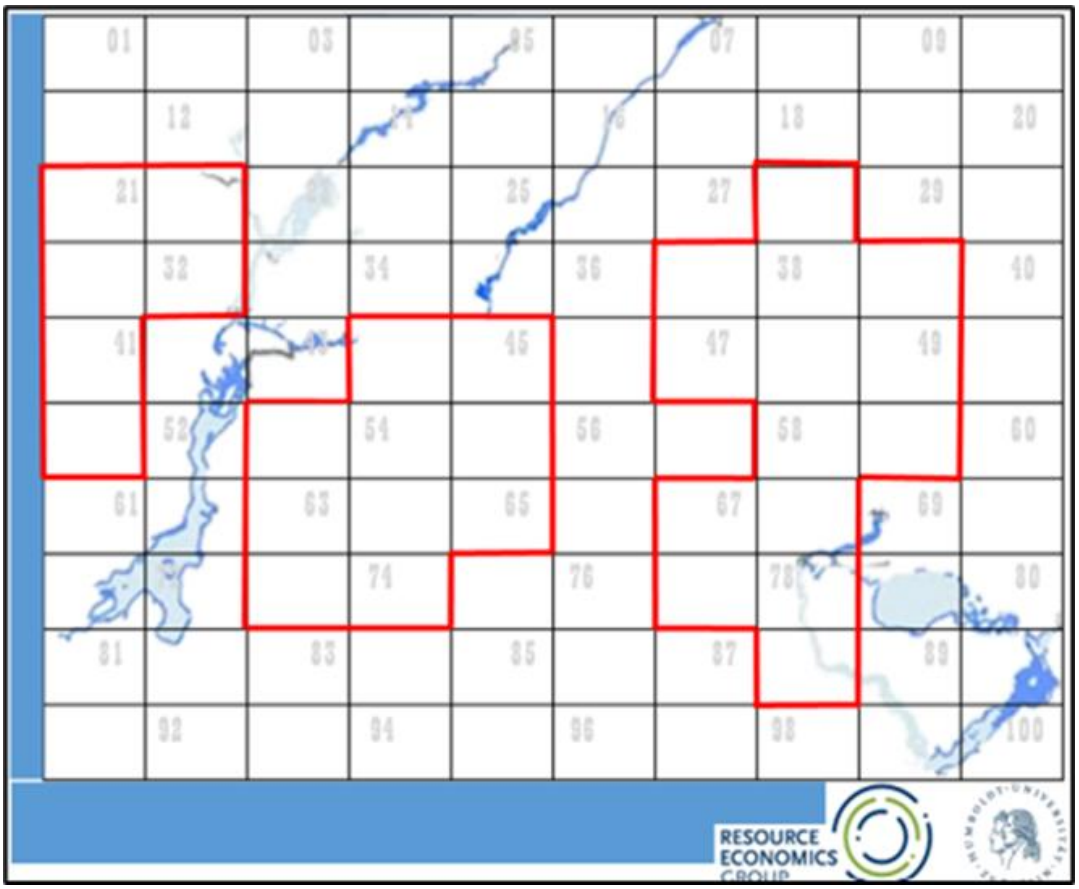

Fig.a.6: The game board

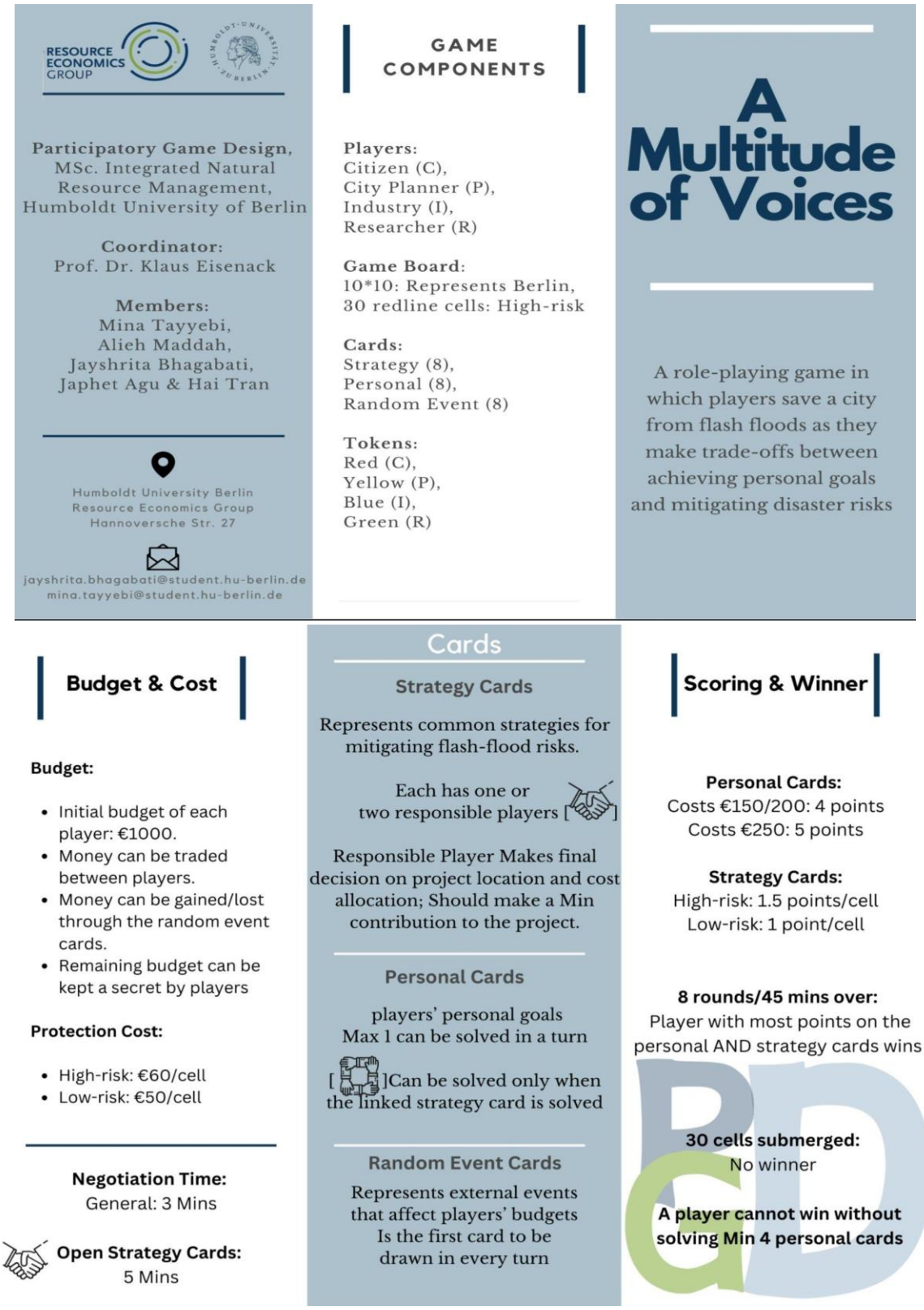

Fig.a.7: The game's short guide

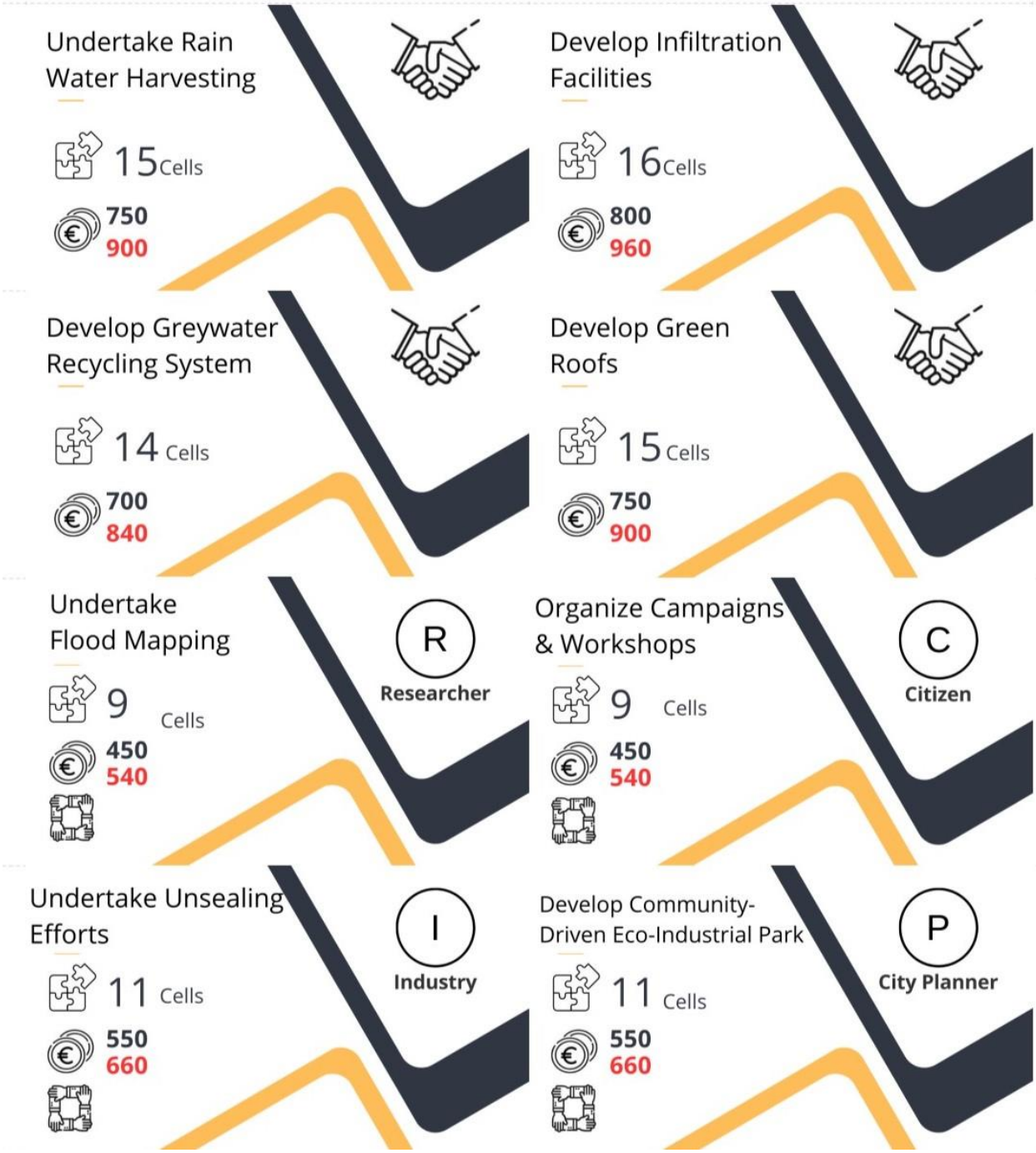

Fig.a.8: Strategy Cards

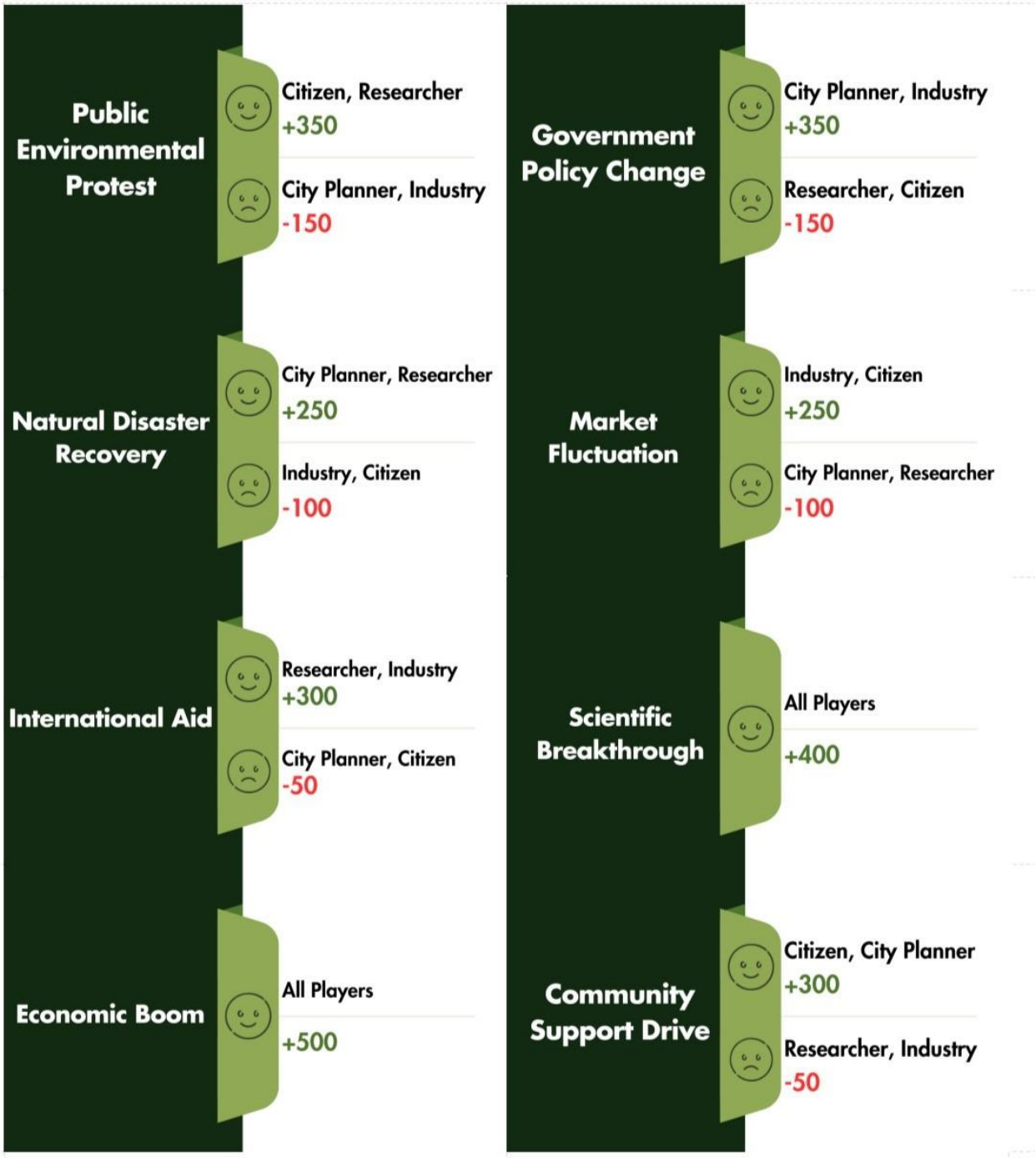

Fig.a.9: Random events cards

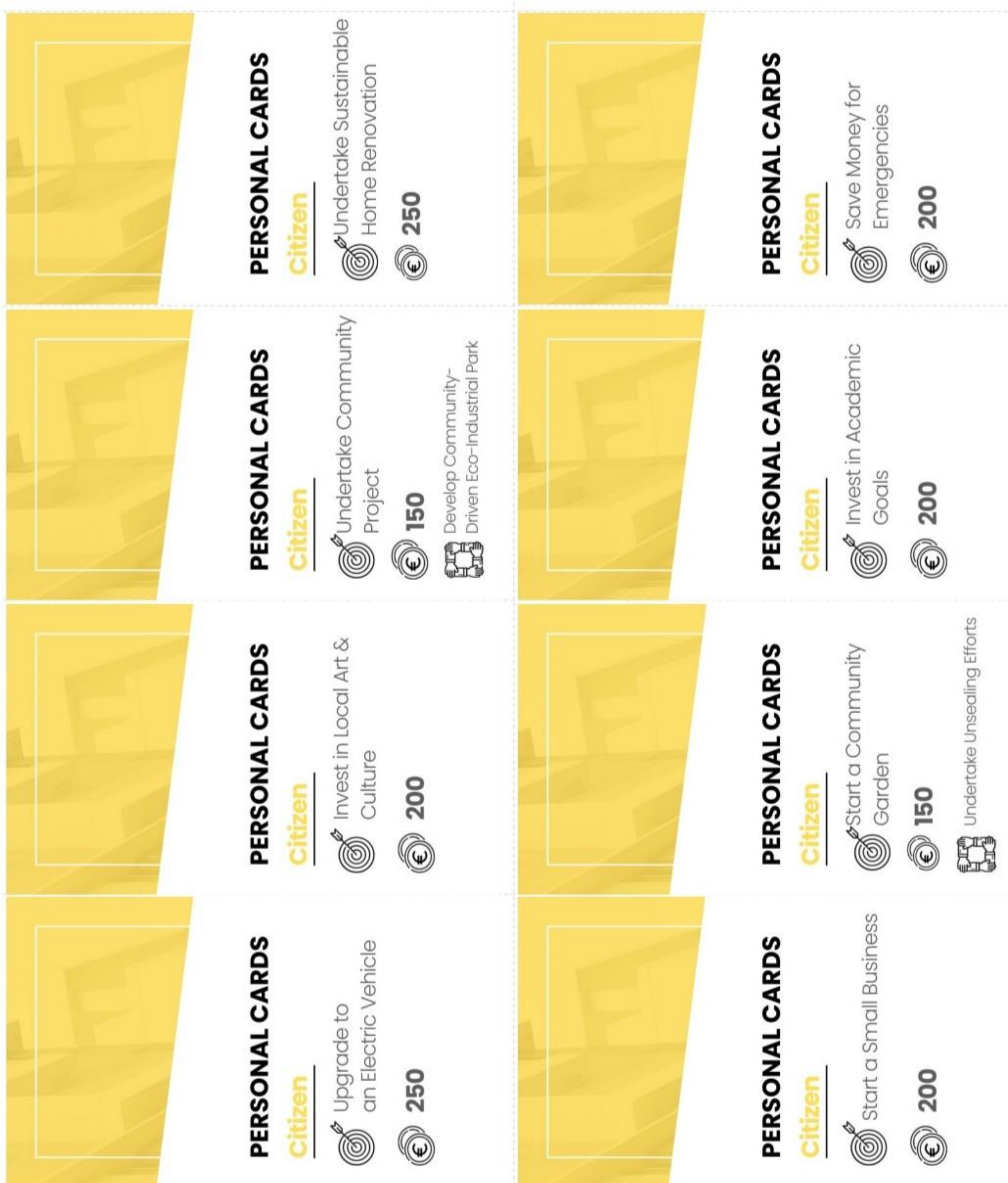

Fig.a.10: Personal cards (Citizens)

Fig.a.11: Personal cards (Researcher)

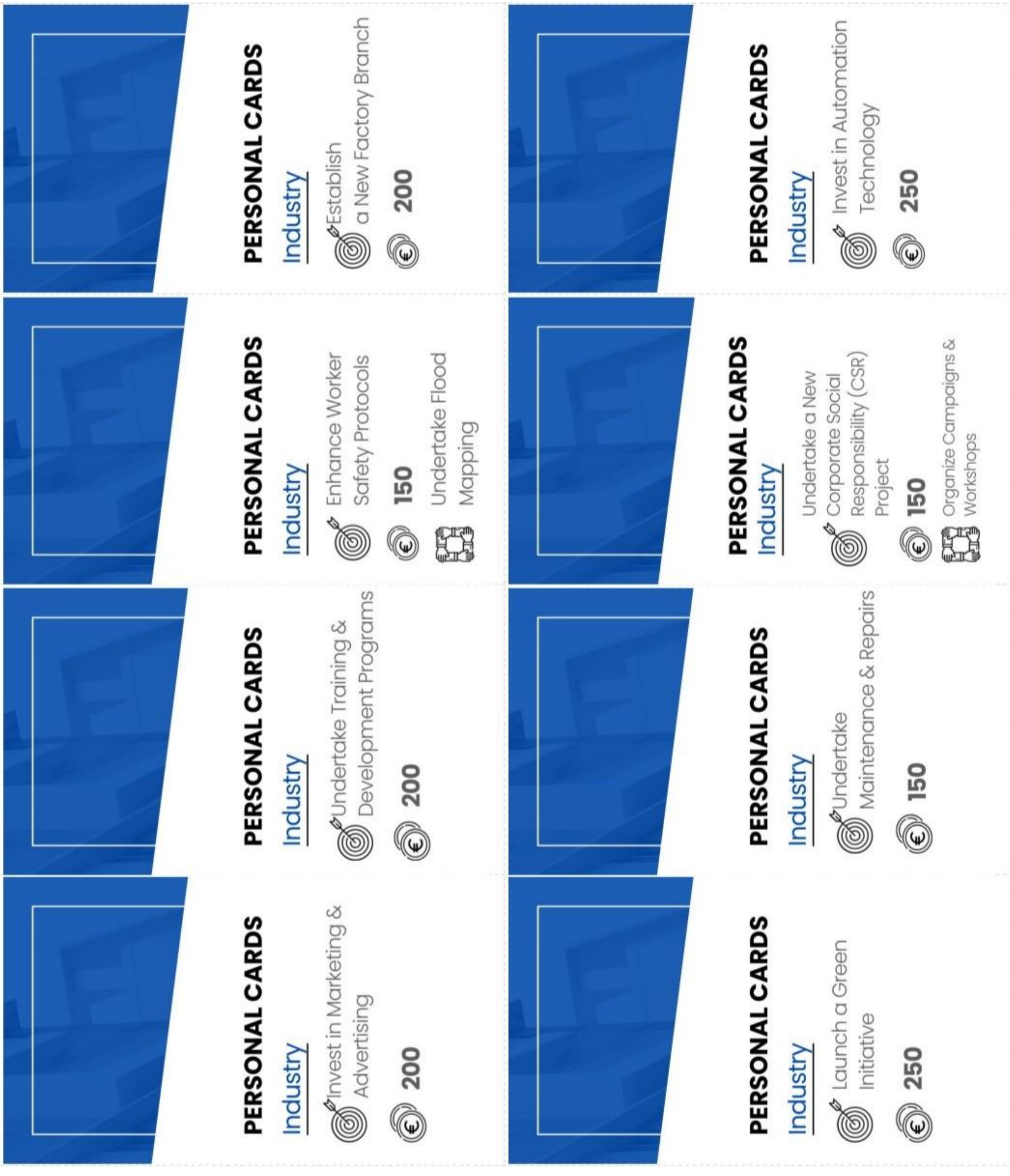

Fig.a.12: Personal cards (Industry)

Fig.a.13: Personal cards (City Planner)

9.4. Comparable games

Keep Cool

“Keep Cool”, like our game, addresses environmental issues and balances competitive and cooperative dynamics. In both games, both game is base on negotiation and players aim for individual success but must also collaborate to prevent larger environmental disasters—flash floods in our game and global climate change in “Keep Cool”. Both games emphasize the trade-off between personal interests and the need for collective action. This balance of individual and global priorities mirrors the diverse perspectives in decision-making that our game captures through multiple stakeholders.

Table.a.3: Keep Cool Aspects

Aspect	Summary
Description: (The story)	In Keep Cool, players take on the role of different countries or groups representing global powers like the USA, Europe, or OPEC. Players negotiate, strategize, and balance between economic growth and environmental sustainability while dealing with the impacts of climate change such as droughts and floods.
Goal: (Dramatic Question)	Players aim to balance their economic interests and the world's climate. They must achieve their economic target while navigating the risks of global warming and avoid global catastrophes.
Aim of the game:	The game helps players understand the complexity of international climate negotiations and encourages learning about climate change and sustainable development.
Game Type	Board game, serious game, global warming simulation
Core Dynamic	Negotiation and strategy: Players negotiate deals that help them achieve both their economic and environmental goals.
Game Mechanics	Players draw greenhouse cards representing random climate events, manage factories (green or black), and work towards fulfilling their economic and secret environmental goals. Players must mitigate disasters to avoid large-scale climate consequences.
Source for more info:	https://www.climate-game.net/en/

The Quiet Year

The Quiet Year is a rewarded mapping and storytelling game that was reviewed and played by our team. The game's goals and concepts are outlined in Table.a.4, and a picture of the game is shown in Fig.a.14. What makes The Quiet Year particularly relevant for our project is its flexibility—players can engage with it using only the event documents, without requiring additional materials.

In The Quiet Year, players collaboratively build a society with limited resources, and each player can express their social satisfaction through choices made by others. However, after a brief period of negotiation, the player whose turn it is makes the final decision. While the game does not have a traditional winner—much like our final game—it effectively illustrates social participation and negotiation among players. Similarly, in our game, although the responsible player may not have as much power as the decision-making player in The Quiet Year, there is a common thread: at the end of the dialogue, someone must announce the community's decisions.

Table.a.4: the Quiet Year game aspects

Aspect	Summary
Description	A map-drawing game where players shape a post-apocalyptic community's survival over a quiet year before conflict returns.
The Story	The community has one year of peace before an unknown threat arrives. Players manage resources and make decisions that impact the community's survival.
Goal	To collaboratively build a community's story through decisions on resource management and conflicts, with success defined by how the story unfolds.
Dramatic Question	How will the community manage its resources, navigate conflicts, and prepare for the inevitable threat?
Aim of the Game	To foster critical thinking and collaboration on community dynamics and survival challenges in a post-apocalyptic world.
Game Type	Collaborative storytelling and map-drawing game.
Core Dynamic	Collaborative world-building through map drawing, where players evolve the community's landscape week by week.
Game Mechanics	Turn-taking, map drawing, resource management, and decision-making through collaborative discussions.
Source for More Info	https://buriedwithoutceremony.com/the-quiet-year

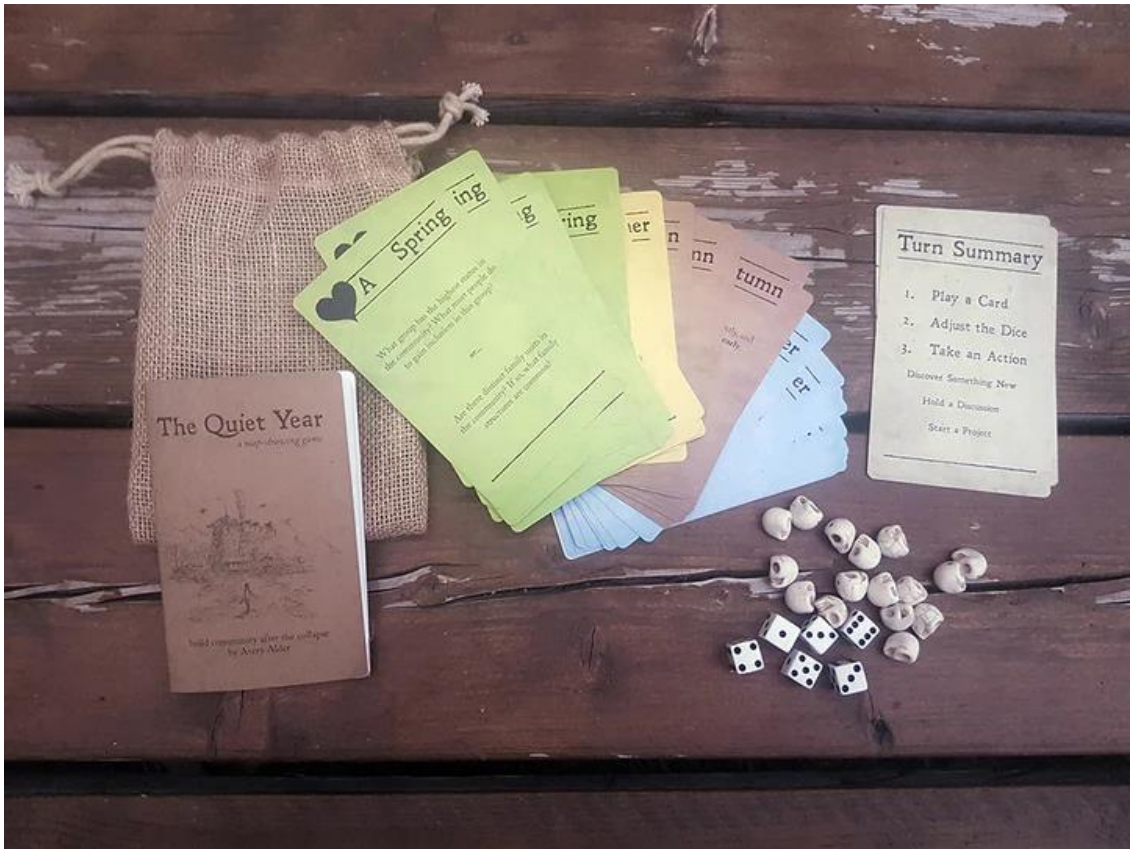

Fig.a.14: the Quiet Year game components (Photo credit: The Quiet Year)

Evolution Climate

Evolution Climate is a strategic board game that simulates the challenges of adaptation and survival in a dynamic ecosystem. Players must navigate the changing climate, food availability, and the presence of predators to ensure the survival and prosperity of their species. Traits such as Hard Shell, Horns, Long Neck, Heavy Fur, Migratory, Nocturnal, and Burrowing provide strategic advantages in different environmental conditions, allowing players to protect their species and secure food sources. The game presents a complex interplay of traits and environmental factors, challenging players to make tactical decisions to ensure the success of their species. In contrast, the climate game about Berlin flash floods involves a collaborative decision-making process among four stakeholders. Both games offer unique challenges and strategic decision-making processes tailored to their respective themes. Evolution: Climate focuses on biological adaptation and survival in a changing ecosystem, while the climate game about Berlin flash floods emphasizes collaborative decision-making and resource management in the face of natural disasters. Despite their differences, both games provide engaging experiences that require critical thinking, strategic planning, and adaptability to succeed.

9.5. Ethical Considerations

This study was conducted with regards to the ethical guidelines outlined by Art. 12, 13 GDPR as part of the registration for the workshop "Rapid Games Design: Water Governance in Urban Areas in a Climate-Changing World and approved by the President, Data Protection Office of Humboldt-Universität zu Berlin, Prof. Dr.-Ing. Dr. Sabine Kunst. With clear understanding of this study's purpose, procedures and right of withdrawal without consequence, the participants gave their consent.

For the purpose of confidentiality, all personal processed data were anonymized, and access to data was restricted to members of the study group. Until 31.12.2024, all processed data will be encrypted and destroyed.

Participant's risks were reduced through careful study design and monitoring for adverse events, which never happened. The study ensured fair participant selection via clear inclusion and exclusion criteria, avoiding discrimination.

No conflicts of interest were identified, and all data handling procedures complied with relevant institutional policies and guidelines.

Data Protection Document

This document contains the data protection information in accordance with Art. 12, 13 GDPR as part of the registration for the workshop "Rapid Games Design: Water Governance in Urban Areas in a Climate-Changing World. For details, you can access the Data Protection Document.via the provided link.

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