

Copyright is owned by the Author of the thesis. Permission is given for a copy to be downloaded by an individual for the purpose of research and private study only. The thesis may not be reproduced elsewhere without the permission of the Author.

Environmental Narratives Sustainable Futures

Exploring Spatial Storytelling
in Games Design
to Elicit Ecological Empathy and Action

An exegesis presented in partial fulfilment of the requirements for the degree of Masters of Design at Massey University, Wellington, New Zealand.

Yining Lai 2024

Acknowledgements

I am truly grateful for the outstanding support and guidance from my supervisors, Stuart Foster and Sven Mehzoud. Their encouragement, guidance, and wisdom have been invaluable to me.

To my parents, Junhua Ma and Shengyun Lai, thank you for believing in me and supporting me through my years of study.

To my friends, thank you for your love and support.

To Deb Cumming and Kendra Marston and the rest of the staff at the College of Creative Arts for your critical feedback and technical support.

Abstract

In the last decade, gaming has emerged as the fastest-growing media platform, with numerous studies highlighting its impact on individuals' perceptions and behaviour. This practice-based research investigates how spatial storytelling in video games can foster ecological empathy, particularly regarding declining mangrove ecosystems. Spatial storytelling enhances immersion in virtual environments, making it a central focus in contemporary game design.

This project examines the evolution of educational game design, delves into the definition and framework of spatial narrative in video games, and integrates cognitive empathy theory with the MDA (Mechanics, Dynamics, Aesthetics) framework. The goal is to offer a novel approach to designing environmental-themed games. The resulting design features a third-person perspective where players assume the role of a fishing cat travelling from an industrialised city to mangrove ecosystems. This journey allows players to experience firsthand the impacts of human civilisation on these crucial habitats, aiming to build cognitive empathy.

The eco-centred gaming experience incorporates transpersonal thinking exercises, encouraging players to view the world from perspectives beyond their own and fostering a deeper connection with nature. By providing positive feedback on players' environmental conservation efforts within the game, the design motivates players to adopt ecologically responsible behaviours in their daily lives. This project highlights the potential of spatial storytelling in video games to educate and inspire real-world environmental action.

Table of Contents

4	Acknowledgements	40	Section 3: Prototype
6	Abstract	43	Initial concept and design process
8	Table of Contents	50	Game Design
		62	Making
10	Section 1: Introduction	80	Design output: COME BACK HOME
10	Research Background		
15	Research Questions and Objective		
16	Research Aim	88	Section 4: Conclusion
		88	Findings
18	Section 2: Research		
18	Video Games and Environmental	89	References List
25	Spatial Storytelling	93	Figures
32	Ecology and Emotional		
36	MDA framework		

Section 1: Introduction

Research Background

Video games are a billion-dollar industry and have been for many years. Global gaming revenue is estimated to reach almost 347 billion U.S. dollars in 2022, with mobile gaming generating 248 billion U.S. dollars (Clement par. 1). Technological advancements in graphics and internet speeds have significantly contributed to the growth of the gaming sector since the early 2000s. China has the highest demographic share of global gamers as of 2019 (see Fig. 1.). Mobile gaming has seen substantial growth, with its revenues surpassing those of console gaming for the first time in 2015 and expected to reach \$91.2 billion by 2021, driven by markets in Brazil, India, and China (Patterson and Barratt 7).

Patterson and Barratt project that the gaming industry will experience double-digit annual percentage growth over the next five years, fuelled by the increasing accessibility of mobile phones and other gaming devices. This growth democratizes gaming, making it a global phenomenon that transcends age, gender, and income barriers. Nearly half of gamers are female, and significant numbers of gamers come from lower-middle-income countries such as India, Indonesia, the Philippines, Vietnam, and Nigeria (6).

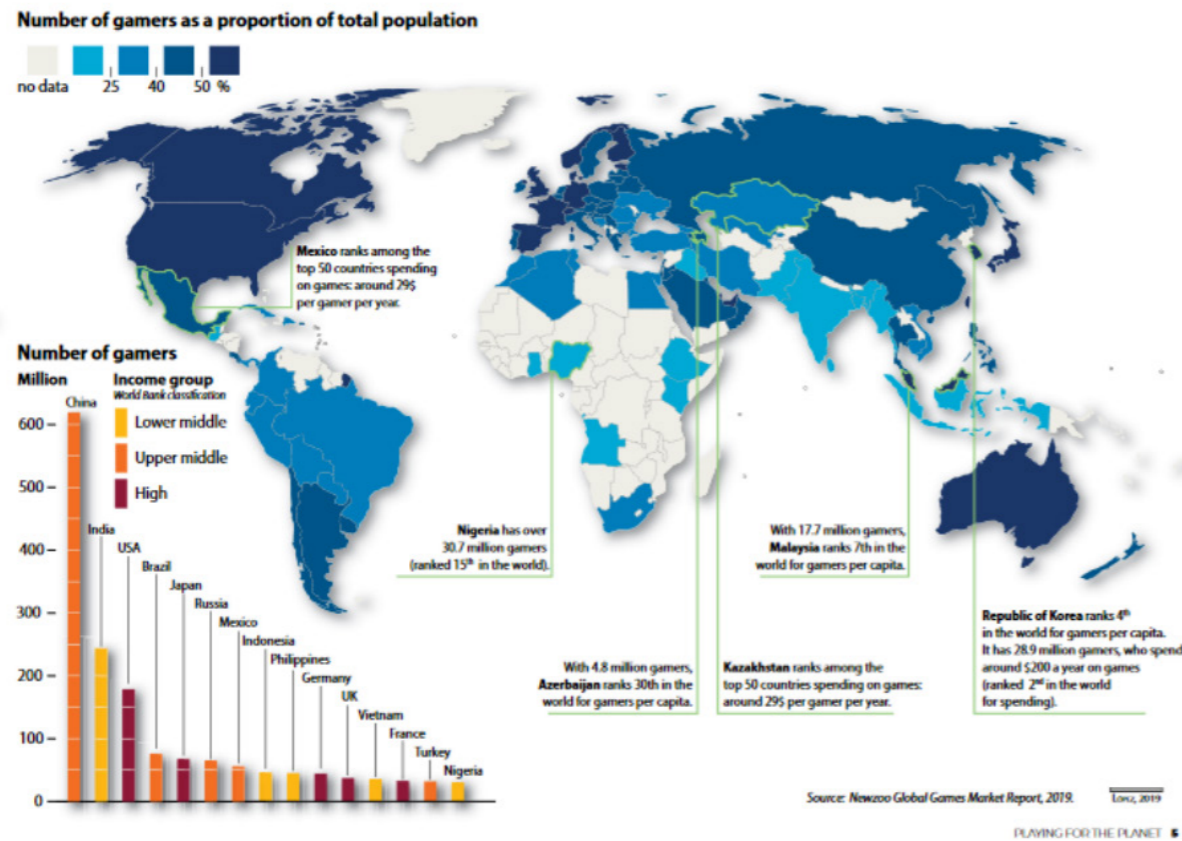


Fig. 1. Newzoo Global Games Market Report, 2019.

However, humanity faces numerous sustainability challenges arising from complex and nonlinear interactions between human activities and the environment. While often unintentional, human behaviour is widely recognised as a primary driver of environmental degradation (Kioupi and Voulvoulis 1). The Sustainable Development Goals (SDGs), which all United Nations members adopted in 2015, include several environment-related objectives, such as Clean Water and Sanitation (Goal 6), Climate Action (Goal 13), Life Below Water (Goal 14), and Life on Land (Goal 15) (Håk et al. 570). Achieving these goals necessitates changing public perceptions, values, and behaviours, with education playing a pivotal role in this transformation (Kioupi and Voulvoulis 2).

Given the expansive and diverse reach of the gaming community, video games possess immense potential as engaging educational tools. Despite concerns about excessive screen time distancing individuals from nature, video games can be harnessed to promote environmental awareness and action. Technology has not only transformed the gaming industry but has also broadened its demographic to include a wide array of participants on a global scale, making it an unmatched platform for educational initiatives (Patterson and Barratt 8).

In addition, games can be powerful tools for engaging children in climate change education, building empathy, and stimulating their emotions. Games can create intrinsic motivation by simulating complex systems and allowing players to test decisions, making them an effective approach to reaching a broad audience (Wu and Lee 413). According to Patterson and Barrett, well-written gaming narratives can significantly change players' perceptions, encouraging them to take on real-world challenges to reduce emissions and e-waste. Through these immersive experiences, players can develop a deeper understanding of environmental issues and feel more compelled to act (22). The dual approach not only educates and motivates players but also sets a positive example within the industry by emphasising the role of games in promoting environmental responsibility.

Today, the effective implementation of the global Sustainable Development Goals (SDGs) is paramount in advancing environmental preservation and ecological equilibrium. Notably, SDG 14 (Life Below Water) and SDG 15 (Life on Land) underscore the significance of safeguarding marine and terrestrial ecosystems. As pivotal constituents of these objectives, mangroves are indispensable in upholding the vitality and resilience of both marine and terrestrial environments (see Fig. 2). Mangroves serve not only as crucial habitats for myriad marine and terrestrial flora and fauna but also fulfil vital functions such as shoreline protection, mitigation of tsunami and hurricane impacts, and sequestration of carbon emissions (UNESCO Par. 1).

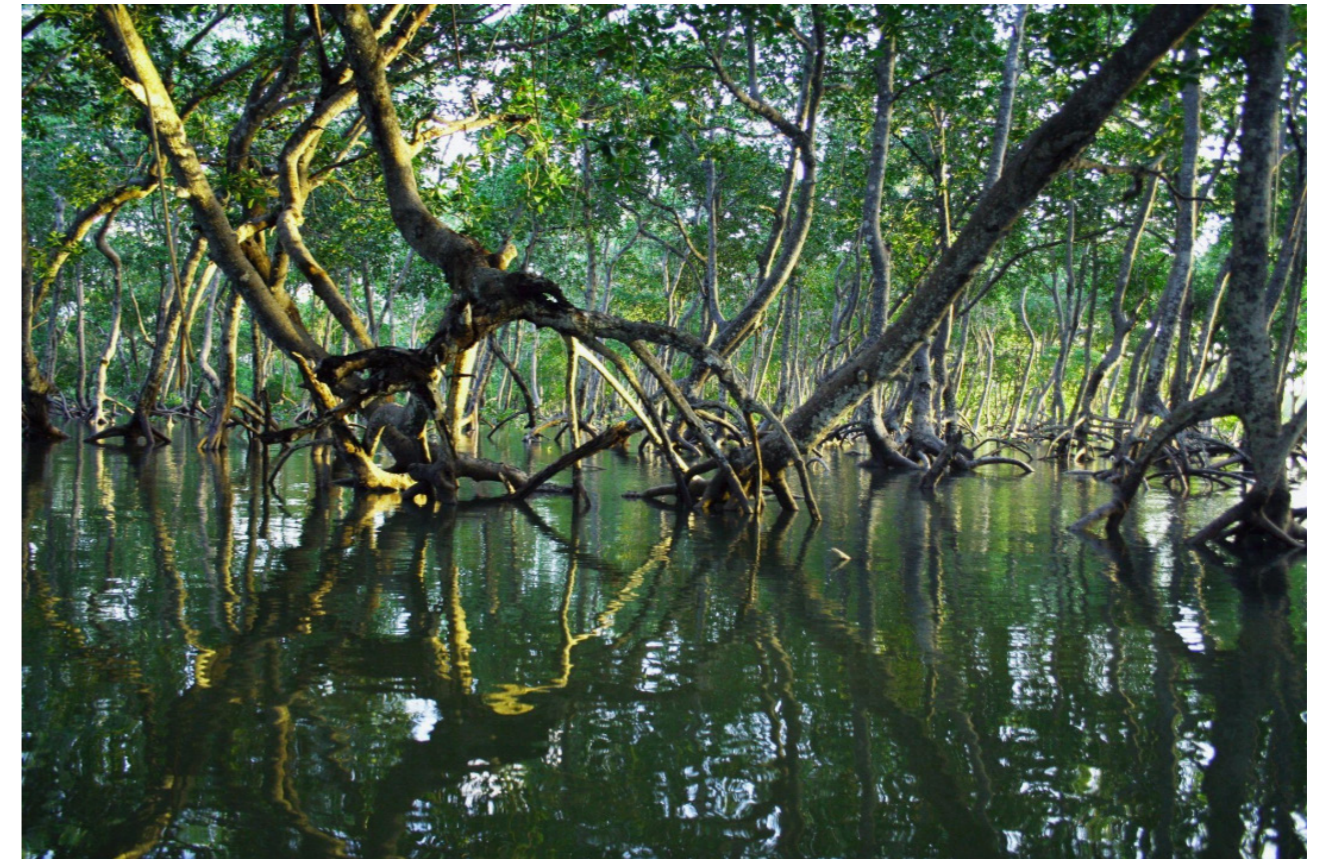


Fig. 2. Timothy K. Mangroves offer vast carbon capture potential.



Fig. 3. Les Sharp, Fishermen of The Mangroves, photograph, 2019.

Unfortunately, this unique ecosystem is being destructively harmed by the progress of civilisation. In recent decades, human actions such as excessive harvesting, development of aquaculture, and expansion of construction have changed the coastal ecosystems, resulting in the degradation and loss of mangrove forests (Lu et al. 39). In the past 50 years, more than 30 per cent of the world's mangrove forests have been lost (Li and Lee 242); between the 1950s and the beginning of the 21st century, the area of mangrove forests in China decreased by approximately 60 per cent. This is especially the case in Sanya, where the mangrove area has decreased from 94 hectares in 1998 to 78.99 hectares, a decrease of almost 16 per cent (Zhang and Sui 414). China has been identified as the nation with the most significant relative decline of mangrove forests worldwide (Zhang et al. 33).

According to Zhang and Sui, the primary restoration approach adopted in China is to incorporate mangroves into protected areas, limit anthropogenic activities, and focus on conservation. However, the establishment of protected areas affects the livelihoods of the surrounding population and leads to a growing conflict between humans and nature (414). Human activities in mangroves that are not included in protected areas intensify, destroying mangrove resources and creating an imbalance between conservation and use (Zhang and Sui 414). Within the current context, there is a need to conserve this fragile ecosystem. Though the mangrove ecosystem is an essential focus for conservation biologists and environmentalists, raising public awareness of this issue is necessary. Therefore, based on the concern for SDGs and awareness of the importance of mangrove ecosystems, this study chose mangrove ecosystems as the game's context. By exploring the use of spatial storytelling in video games, my aim is to gain a deeper understanding of the challenges faced by mangrove ecosystems and to find how gaming experiences can help educate and disseminate to elicit public awareness and action on mangrove conservation.

Research Questions and Objectives

Considering the severity of environmental problems, how to raise people's environmental awareness and prompt practical action through immersive and interactive media like games has become an important research direction. The purpose of this study is to explore how spatial storytelling methods can promote players' ecological empathy in order to encourage environmental action in real life.

This design research aims to address the following questions:

1. How can gaming experiences focusing on spatial storytelling and visualisations promote empathy towards mangrove conservation?
2. How can specific concepts of ecological empathy and conservation be effectively translated into game mechanics, dynamics, and aesthetics to design emotionally engaging and impactful moments within the game?

Research Aim

My project explores the potential of spatial storytelling in video games to communicate the impacts of relevant environmental issues to elicit ecological empathy and behaviour. The design aims to increase awareness about the effects of daily actions on the environment, helping people make informed decisions. The spatial storytelling experience takes the player on a journey through as a fishing cat from an industrialised city to the mangroves. Along the way, participants will witness how human civilisation's expansion has affected the ecology of the mangroves and the species that call it home. By participating in transpersonal thinking exercises, individuals will be instructed to adopt an animal's viewpoint and advocate for non-anthropocentricity, both of which are crucial for enhancing cognitive empathy. At the end of the game experience, players will be invited to interact with the game by making a commitment to being environmentally friendly and changing the game's sad ending.

Section 2: Research

Video Games and Environmental Education

Environmentally themed video games emerged in the late 1980s and early 1990s, influenced significantly by the political and cultural environment of the time. As global awareness of environmental issues increased and environmental movements gained momentum, public support for environmental protection grew. Simultaneously, advances in video game technology enabled developers to create more complex content and incorporate insights from ecological science. The success of early environmental games further inspired developers to explore this theme, leading to its widespread application in video games (Davis 97).

Sega was one of the first companies to incorporate environmental themes into games (Koebler par. 2). While the 1991 original did not feature large-scale environmental themes, the 1992 sequel *Sonic 2* included levels such as the “Chemical Plant Zone” and the “Oil Ocean Zone.” The Chemical Plant Zone is filled with purple chemical substances, while the Oil Ocean Zone features an ocean of oil with an oil refinery in the background. In the Chemical Plant Zone, Sonic and Tails battle Robotnik in a facility filled with purple chemicals. In the Oil Ocean Zone, they encounter a massive oil ocean and the silhouette of an oil refinery in the background. Falling into the oil causes them to slowly sink and perish unless they quickly escape. These designs reflect a critique of environmental pollution and oil extraction.



Fig. 4. Screenshot from Final Fantasy VII, 1997.

In the late 1990s, game developers began to explore and portray a form of radical environmentalism, often called “eco-terrorism.” In these games, developers depict characters or groups that adopt extreme, even violent, measures to protect the environment (Davis 101). An example of eco-terrorism is its presence in Square’s Final Fantasy VII (see Fig. 4. and Fig. 5.). The seventh instalment of the popular Final Fantasy series from Square (now Square Enix), depicts an environmental terrorist group, Avalanche, struggling with the Shin-Ra Corporation, a large corporate interest.

Released in 1997, such morally complex protagonists were a challenging prospect. In Final Fantasy VII, characters who could easily be classified as eco-terrorists invited the player to participate in their actions. Kelly expelled that these characters originated during a difficult period for Japan, specifically in the mid-90s when the country faced economic and environmental crises.

With the emergence of independent game developers and the expansion of video game experiences to various platforms (such as computers and mobile devices), the next generation of games can freely challenge previous taboos within the video game industry and are no longer constrained by large corporations. Controversial topics, such as climate change or other severe environmental issues, have the potential to become central themes in gaming experiences, enabling game developers to not only interact with these subjects but also to provide educational opportunities to the public, which could lead to the development of issue-led gaming.

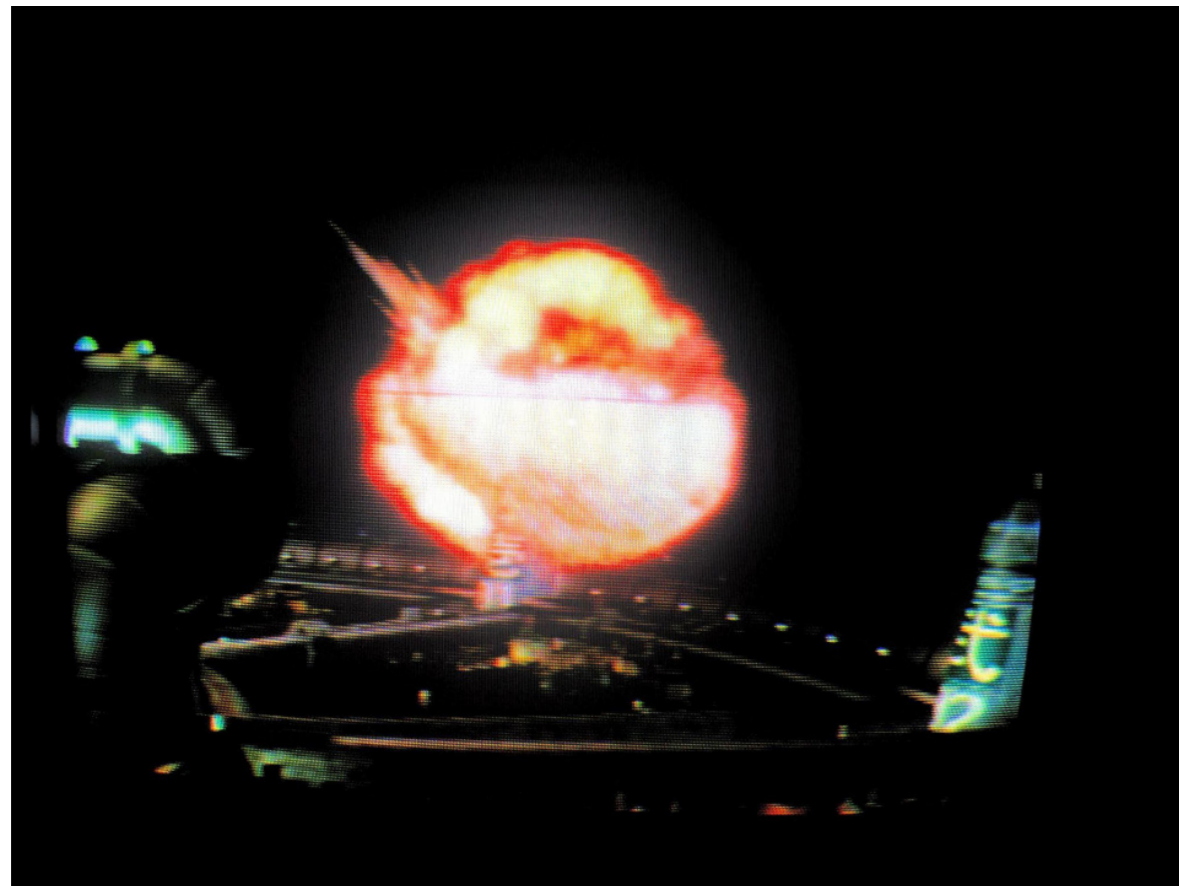


Fig. 5. Screenshot from Final Fantasy VII, 1997.



Fig. 6. Screenshot from Fate of the World, 2011.

Games created in the early 21st century augment user experience by adding relevant and accurate scientific and environmental science to educate the user (Davis 102). In the game Fate of The World by Red Redemption Games, the user is engaged in crafting environmental and climate policy to succeed in one of four designed scenarios. Fate of the World was developed in tandem with Oxford University climate scientist Myles Allen and uses current climate figures and statistics to provide a deep, complex, and thought-provoking simulation that allows the user to formulate strategies to curtail carbon emissions, negotiate political deals, and ensure geopolitical stability (Vaughan par. 2). In response to the game Fate of the World, gaming expert and author of Fun Inc: Why Games Are the 21st Century's Most Serious Business, Tom Chatfield, remarked, "This could be the beginning of a flowering of issue-led gaming. But it will be judged on whether it's a good game, not on whether it's worthy or not" (Vaughan par. 6).

Contemporary games have adopted adventure or roleplay aspects that allow the user to understand first-hand the environmental hardships ecosystems face (Davis 103). Flower, developed by Thatgamecompany in 2007, uses unique gameplay to convey an environmental protection theme. Flower blends interactivity with compelling storytelling to create an emotional experience about the relationship between people and nature (see Fig. 7. and Fig. 8). The story of Flower is simple but unique. The player's avatar in the game is a petal floating in the wind; the goal is to interact with the flower and other objects in order to affect changes in the surroundings and enter a vortex that brings the player back to reality (Plessis 8). During the final level, nature takes centre stage, and the player can experience a more peaceful and harmonious relationship in which human artefacts coexist within a natural environment (see Fig. 9.).



Fig. 7. Screenshot from Flower, 2011.

Yuen found the narrative of Flower to be centred on the key idea of empowerment. A petal, the most insignificant object imaginable, has the power to shape the world. At first, its power is subtle – small patches of grass, changing rock formations, making the wind blow – but by the end of the game, it becomes an irresistible agent of change, sweeping over the old decaying ruins of the city as an agent of renewal. For me, experiencing the last level conveyed the message that even the most powerless of us have the ability to transform the world we live in (Yuen).

Flower is able to go beyond mere anthropomorphism; the interactive soundtrack and beautiful visuals work in tandem to transport the player into an abstract, wordless, emotional, but completely non-human story. The player's character does not possess any human qualities. There are no people or even animals in any of the levels. The player must find an explanation for what is happening and why. By doing this, the player can become more accepting of considering, relating and connecting to the world from an eco-centric perspective. Flower as an experience helps the player think beyond their perspective, which is a key factor in developing a stronger ecological identity (Yuen par. 11).

My design incorporates real-life environmental threats, such as urban expansion, pollution, and habitat destruction, as the backdrop for the game's narrative. The fishing cat's journey from an industrialised city to the endangered mangroves revolves around these crucial issues. By presenting players with these tangible challenges, I aim to strengthen their connection to environmental problems, encouraging them to empathise with the natural world and reflect on the impact of human actions.

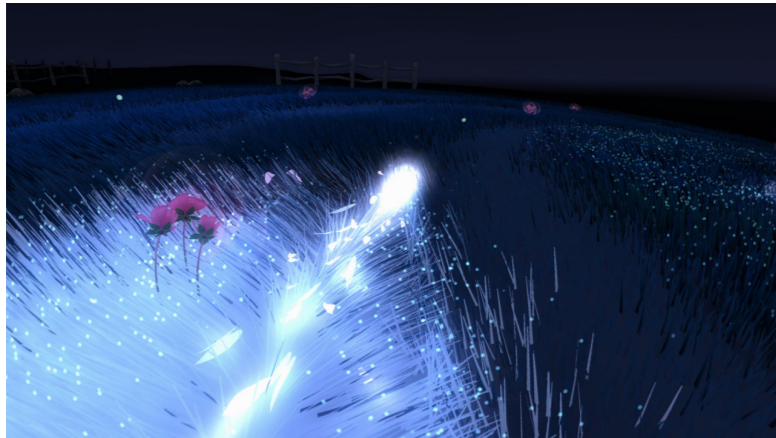


Fig. 8. Screenshot from Flower, 2011.



Fig. 9. Screenshot from Flower, 2011.



Fig. 10. Screenshot from Endling - Extinction is Forever, 2022.

Unlike Flower’s almost Zen-like gameplay style, Endling - Extinction is Forever, released in 2022 by Herobeat Studios, has a rich plot and slightly more complex action. Endling follows the last fox on Earth, struggling to keep her cubs alive in a world that grows more hostile daily. Endling is explicitly a story about the effects of climate change on vulnerable populations. Though the narrative never reveals this, the fox you control is the last living one of her species on the planet. In an interview with Unwinnable Magazine in 2020, lead programmer Javier Ramello said Endling’s narrative resulted from investigating “what the world will be like in the next 50 or 100 years if we do not change our consumption habits. Unfortunately, that investigation revealed a world in which even adaptable animals that today are far from danger, like foxes, will likely be on the verge of extinction.” (Price par.8)

Endling emphasises the environmental narrative. In an interview with 80 Level in 2023, Lead Programmer Javier Ramello said, “We want players to feel the effects of this fallen world and the struggles of our fox heroes. Instead of spelling it out in detail, we let the environment speak for itself.” (Tokarev) As the player plays this game, they will notice that the game is presented in two cool colours—deep blue and deep purple—and features fallen trees, crumbling buildings, and giant factories, all painted in icy tones that convey a world in turmoil due to climate change, deforestation, and pollution, among many other problems (see Fig. 10.).

Endling does a difficult thing: it balances conveying a coherent message about climate catastrophe with genuinely interesting and slightly challenging gameplay. It avoids feeling like a simple educational game while achieving an emotional climax that emphasises the impact of humans on animal populations (Price). At the end of this game, let's elicit empathy for the animals we live with. It should be evident that they are already suffering from the impacts of climate change, even before we are, and our destinies are deeply interconnected (Price). But while the events in Endling evoke sadness, those emotions have nothing to do with how humans are destroying the planet. The game's ending does not provide a satisfying resolution, and the world is still on the verge of extinction, so while events do occur, and we should feel something because they happen, the emotions are dimmed. The player is left with a sense of hopelessness and helplessness as no resolution or redemption is in sight. It also piqued my curiosity: how do you make ecological resonance in game design that players can put into action in real life?

With the diversity of environmentally themed games that tackle contemporary issues and offer potential solutions to remedy these crises, there appears to be a future role for these environmentally-centred games (Davis 104). I was deeply infected by the powerful environmental narratives in Flower and Endling: Extinction is Forever, which provided deep immersion for the player and were my inspiration for how to design a mangrove conservation game. I delved into empathy, spatial storytelling, and the MDA framework and explored their connections. In the following chapters, I will describe the study of spatial storytelling, examining how spatial narratives in video games can effectively communicate environmental messages and motivate players to engage in ecological empathy and take action in the real world. Finally, I will use my practice to demonstrate further the potential of spatial narratives in game design involving environmental themes, concepts, and their deeper connections.

Spatial Storytelling

The border dispute between narratology and ludology is already well documented. Ludologists wanted to shift the focus to game mechanics, while narratologists wanted to study games alongside other storytelling media. Narratology sometimes prescribes what constitutes a "good" game, leading to conflicts with ludology. Espen Aarseth refers to this as theoretical colonialism, where literary theorists and narratologists rely heavily on their traditional tools and expertise (Jenkins 1; Kokonis 174; Jones 20). Henry Jenkins writes, "The experience of playing games can never be simply reduced to the experience of a story" (1).

Patterson and Barratt project that the gaming industry will experience double-digit annual percentage growth over the next five years, fuelled by the increasing accessibility of mobile phones and other gaming devices. This growth democratises gaming, making it a global phenomenon that transcends age, gender, and income barriers. Nearly half of gamers are female, and significant numbers of gamers come from lower-middle-income countries such as India, Indonesia, the Philippines, Vietnam, and Nigeria (6).



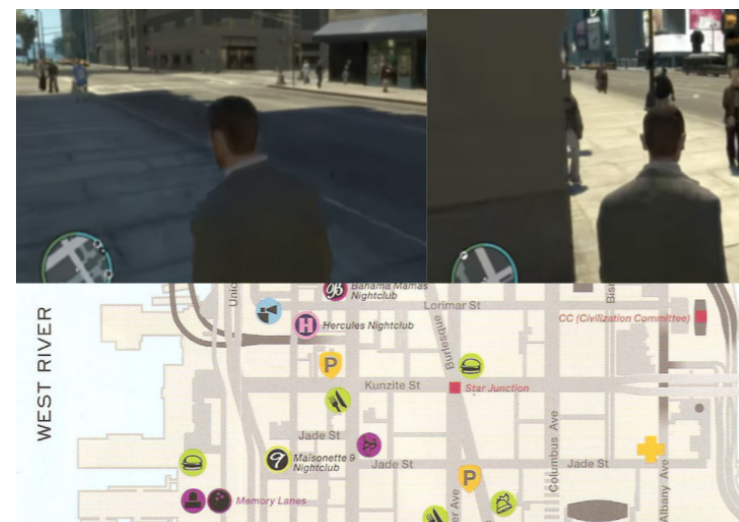
Fig. 11. Screenshot from Grand Theft Auto IV, 2008.

In early game design, the story played a secondary role in gameplay, existing to provide context for gameplay. The plot was the player's motivation, setting goals for them and making them want to progress. They are also all linear stories, which are an indirect result of the linearity of the gameplay (Stone par. 7). Jenkins introduces the term "spatiality," where the design and organisational choices of space in game design can significantly affect narrative outcomes across different forms. Game designers create immersive narrative worlds through environmental storytelling, using pre-existing narrative associations, staging grounds, embedded information, and resources for emergent narratives.

Hameed and Perkis suggested that spatial storytelling uses cognitive templates to tell a story, placing the user in a mediated environment and advancing a non-linear narrative by discovering that environment through exploration. It is inspired by immersive theatre and creates prerequisites for an immersive narrative experience in four possible ways (327):



Fig. 12. The Map of Grand Theft Auto IV, Rockstar Games, 2008.



Clockwise from top left:
 Fig.13. Screenshot of the urban scene from Grand Theft Auto IV. Rockstar Games, 2008. Fig. 14. Screenshot of character turning corner from Grand Theft Auto IV, 2008. Fig. 15. Screenshot of the game map from Grand Theft Auto IV game map, 2008.

1.The ability of spatial stories to evoke pre-existing narrative associations

Grand Theft Auto IV (GTA IV), a 2008 action-adventure game developed by Rockstar North and published by Rockstar Games, exemplifies this concept. In the game, players take on the role of a character who explores the open world of Liberty City to complete missions and advance the storyline. While Liberty City is inspired by New York City, the game's design avoids a replica of the real city. (see Fig. 11.). Instead, it highlights characteristics that best reflect the essence of New York City (Adam 338).

Art director Aaron Garbut aimed to capture a caricature of New York City, leveraging most people's familiarity with the city's highlights from film or literature without requiring precise knowledge of its areas (Goldstein). This approach allows players to draw on their pre-existing associations with New York City, enhancing their immersion in Liberty City while experiencing innovative narrative elements unique to the game.

GTA IV demonstrates how spatial stories can evoke pre-existing narrative associations by modifying familiar details to create a setting that resonates with players' existing knowledge and associations. Grand Theft Auto IV's use of New York City as inspiration is cultural and structural. The game's storyline empathises with the player's status as an immigrant in a foreign and renowned land of opportunity, raising enquiries about identity by exploring New York City's boroughs and neighbourhoods (Hernandez 23). According to Jenkins, games can be viewed as a large part of a broader narrative system encompassing books, film, television, comics, and other forms of media. Games give concrete shape to our memories and imaginations of the story world (6). Based on this inspiration, I intend to create an environment in my game that uses realistic environmental elements that will allow gamers to relate to environmental issues more readily.

2.Spatial storytelling provides a backdrop where narrative events unfold.

In this context, narrative enters games on two levels: broadly defined goals and conflicts and localised incidents. Spatial stories prioritise spatial exploration over plot development, while micronarratives create emotional impact. Game designers must balance performance and exposition to create a compelling framework without constraining player freedom (Hameed and Perkis 7).

Grand Theft Auto IV (GTA IV) is a prime example of spatial storytelling, firmly adhering to Jenkins' notion of creating an intelligible three-dimensional space to be explored and experienced rather than described verbally (Ruch 336). The game designers prioritised the development of the area before designing the quests, suggesting that the quests are influenced mainly by the environment (Bramwell).

For instance, in the "Objective A" mission, the player is introduced to a new and unfamiliar space, requiring them to figure out which exit from the station gets them closest to their destination. Initially, the player is restricted to Hove Beach (Brighton Beach) and cannot drive, walk, or take the train outside this area. They must rely on knowledge from the protagonist's cousin to advance missions (Hernandez 12).

This design choice exemplifies how GTA IV uses spatial storytelling to shape the narrative. The environmental layout and the player's movement directly influence the story's progression, making the exploration and understanding of the space an integral part of the narrative. When it comes to game design, I use the same approach, trying to develop the environment first before thinking about how I will design the quests in my game.

3. Embed narrative information within their mise-en-scene; game spaces are designed as memory palaces, requiring players to decode environmental cues to reconstruct narrative plots. This design emphasises player agency and engagement in the narrative reconstruction process.

For instance, *What Remains of Edith Finch*, a first-person game developed by Giant Sparrow and published by Annapurna Interactive, exemplifies this approach. The player controls Edith, the last living member of the Finch family, as she explores the family home on Orca Island, Washington State. Through this exploration, players uncover the Finch “curse”: the tragic deaths and disappearances that have plagued the family for generations.

The game is structured as a collection of short stories, each belonging to a different genre and employing distinct storytelling techniques. According to Bozdog and Galloway, the connection between the house and the Finch curse in these stories is both spatial and thematic, but they exist in different periods and are not arranged in chronological order. As players navigate the house, they find various written artefacts in the rooms. These artefacts transport them to the moment in which the room’s owner died, immersing players in different narrative experiences (Bozdog and Galloway 798).



Fig. 16. Screenshot from *What Remains of Edith Finch*, 2017.



Fig. 17. Screenshot from *Minecraft*, Mojang Studios, 2011.

4. Provide resources for emergent narratives; spatial storytelling provides resources for emergent narratives, creating a dynamic world where players’ interactions with the environment lead to unique and personalised stories. Emergent narrative refers to narratives not explicitly written by the developer but arising from the player’s interactions with the game’s subsystems (Ryan et al. 2). This concept is particularly significant in interactive media like video games, where player agency and decision-making shape the story (Game Developer).

The game *Minecraft* is a prime example of spatial storytelling, providing resources for emergent narratives (see Fig. 17). As a survival game, *Minecraft* lacks a predefined narrative, allowing players to set their own goals and create personal stories. According to Gerben Grave, the experiences in *Minecraft* are “unique, unplanned, and the building blocks for your personal story” (par. 3). The game’s design emphasises randomness, ensuring that every generated world is different, maintaining player immersion and interest.

According to “The Importance of Emergent Narratives in Games”, when playing with friends, you might start with a specific goal or roleplay a pre-planned narrative, such as surviving a plane crash and working together to find a way back to civilisation. In this scenario, each player’s actions, decisions, and interactions with the environment contribute to an emergent narrative unique to that playthrough. The stakes, such as permanent death leading to a player being banned from the server, add a layer of fear and connection to the characters, enriching the emergent narrative (par. 2).

These insights can effectively be applied to spatial storytelling in games to create experiences that elicit ecological empathy and action. By immersing players in the lives of animals through spatial narratives, games can evoke strong emotional connections. In my game, I have demonstrated the impact of human actions on wildlife through the journey of a fishing cat from an industrial city to threatened mangrove habitats. Ultimately, this immersive experience not only entertains the player but also conveys an important message about the consequences of human activities on the environment.

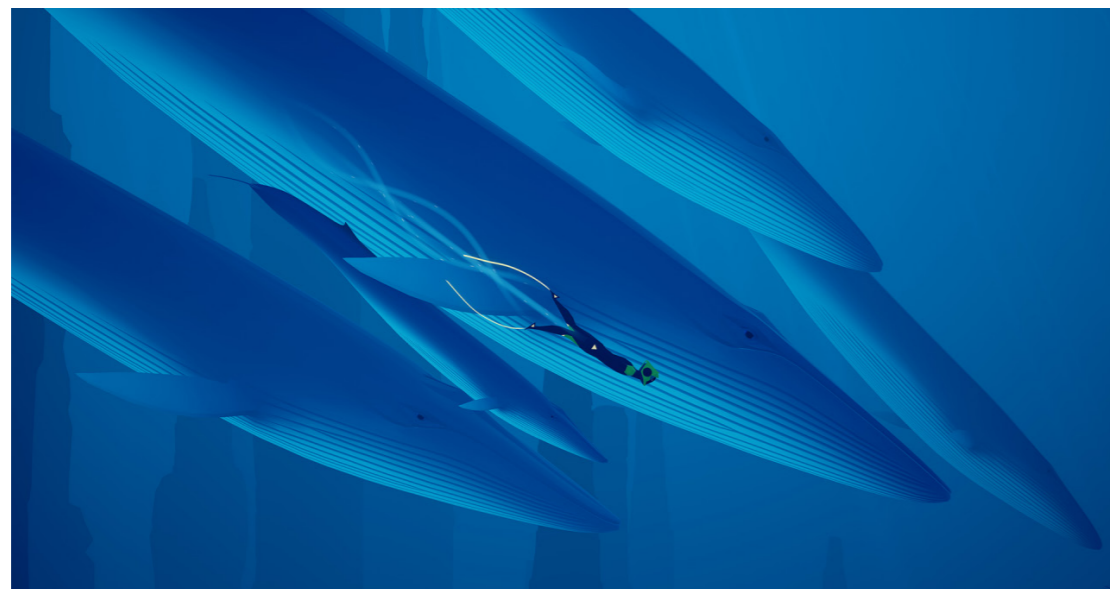


Fig. 18. Screenshot from ABZÛ, 2016.

Ecology and Emotional Engagement

Empathy has been defined and constructed in various ways throughout time and across different fields. Historically, empathy has been studied in relation to people; however, Young et al. suggest empathising with animals is similar to empathising with people and propose a definition of empathy that considers non-human animals (329). “Empathy is a stimulated emotional state that relies on the ability to perceive, understand and care about the experiences or perspectives of another person or animal.” (Young et al. 329). In this section, I will discuss empathy classifications and definitions and how spatial storytelling in games can relate to these theories with a case study to stimulate ecological empathy and action by players.

Empathy comprises three abilities: affective empathy, cognitive empathy, and empathic concern. These abilities occur in different brain areas, but all contribute to understanding another person’s perspective (Young et al. 328).

Affective empathy involves recognising other people’s emotions through facial expressions, body gestures, and voice prosody and responding with an emotional or verbal expression of empathy (Young et al. 329). Research has shown that humans can feel not only human emotions but also those of animals. The inherent effective connection between individuals, particularly children and animals, has consistently been a potent foundation for fostering a sense of concern for the environment (Kellert 7). ABZÛ is an adventure video game created by Giant Squid and published by 505 Games. Following the journey of a diver exploring the ocean and restoring life using sonar calls, the gameplay allows the player to freely navigate underwater environments ranging from open water and natural caverns to ancient ruins. The vibrant underwater environments create an emotional connection as the player interacts with various sea creatures. Players can experience affective empathy through the sea creatures’ detailed animations and responsive behaviour. (see Fig. 18. and Fig. 19.). Through such immersive experiences, ABZÛ effectively demonstrates how spatial storytelling can leverage affective empathy to deepen players’ emotional engagement with environmental themes and promote a greater awareness of the natural world.



Fig. 18. Screenshot from ABZÛ, 2016.

Cognitive empathy is the ability to understand the experiences of others by recognising and imagining their reality. It is a learned mental skill developed as a person cultivates their theory of mind (Young et al. 330). Visitors to an aquarium often express sadness for an octopus housed in a small exhibit alone. As social beings who require and enjoy space, we struggle to accurately empathise with the needs of an octopus who, when given a choice, prefers to live alone and in small, confined locations within the vast ocean. Research suggests that linguistic choices and cultural narratives can shape our perceptions of animals. Myers states that our tendency to project our understandings and experiences onto animals can challenge the development of accurate animal representations. Thus, cognitive empathy should build on our knowledge of the natural history of individual animals.

Young et al. suggest non-human animals are capable of complex emotional experiences, such as empathy, and evidence suggests they can display empathic responses. To increase empathy, frame the animal's story, provide care and role models, and activate the imagination (330). Endling - Extinction is Forever exemplifies how games can promote cognitive empathy by following the last mother fox on Earth as she navigates a devastated world to ensure her cubs' survival. As a fox, the player must use their sense of smell to navigate the game and feed, protect, and guide the cubs to foster an emotional connection between the player and the cubs. (see Fig. 20. and Fig. 21.). The immersive environments allow players to experience the broader ecosystem and human impact on wildlife, enhancing cognitive empathy. Through these elements, Endling - Extinction is Forever effectively fosters cognitive empathy, promoting a deeper understanding and concern for animal and environmental conservation. My game will be told from the perspective of an animal. I want players to be able to empathise with the animal and understand what it's going through. The game will be a powerful tool to raise awareness about the importance of protecting our planet and its animals.

Empathic concern is sometimes called compassion or motivational empathy, which asks that someone take action to relieve another's suffering (Young et al. 331). Empathic concern towards animals may mean helping an injured pet or untying a sea turtle trapped in fishing nets. It builds on the affective empathy we feel and the cognitive empathy we understand to prescribe action to relieve another's suffering. Positive empathy suggests that people are more likely to take action when they believe that their action will positively influence the recipient or that they will receive positive feedback or feelings (Lamm et al. 43). In addition, there is research supporting the relationship between empathy and conservation behaviour change. Empathy can be a powerful motivator for helping behaviour towards others, although it may not directly lead to the uptake of complex conservation behaviours (Young et al. 331).

These insights can effectively be applied to spatial storytelling in games to create experiences that elicit ecological empathy and action. By immersing players in the lives of animals through spatial narratives, games can evoke strong emotional connections. In my game, I have demonstrated the impact of human actions on wildlife through the journey of a fishing cat from an industrial city to threatened mangrove habitats. Ultimately, this immersive experience not only entertains the player but also conveys an important message about the consequences of human activities on the environment.

Moreover, games can incorporate elements such as prompts and feedback to translate this empathy into real-world conservation behaviours. I encourage players to commit by asking them to take in-game pledges to protect certain areas or species and then showing how these commitments are realised in the game world.

By combining spatial storytelling with these behavioural change strategies, games can create a powerful tool for promoting conservation awareness and action. This approach leverages spatial narratives' emotional engagement and empathy's motivational power, supported by practical elements that facilitate and sustain behaviour change. Through this holistic design, games can inspire players to empathise with the plight of wildlife and take meaningful steps towards conservation in their own lives.



Fig. 20. Screenshot from Endling - Extinction is Forever, 2022.



Fig. 21. Screenshot from Endling - Extinction is Forever, 2022.

MDA framework

After examining spatial storytelling and empathy, it is crucial to investigate the successful integration of these ideas into game design using the MDA (Mechanics, Dynamics, Aesthetics) framework.

In the context of spatial storytelling, Jenkins states that the experience of playing games is different from the experience of reading (1). Similarly, Hunicke et al. argue that games, unlike other forms of entertainment like books, music, movies, and plays, are distinguished by their unpredictable consumption patterns resulting from the variable events and outcomes that occur during gameplay (1). As a result, Hunicke et al. introduce a framework called MDA (Mechanics, Dynamics, Aesthetics), which formalises the deconstruction of games into their distinct components (2).

1. Mechanics:

The rules and systems that form the foundation of the game. These include the algorithms, data structures, and the basic actions available to the player.

2. Dynamics:

The interactions and behaviours that emerge from the mechanics during gameplay. In other words, how players use the mechanics to achieve goals and how the game world responds to player actions.

3. Aesthetics:

Aesthetics describes the desirable emotional responses evoked in the player when she interacts with the game system, which encompasses the overall look and feel of the game, the narrative elements, and the player's emotional journey.

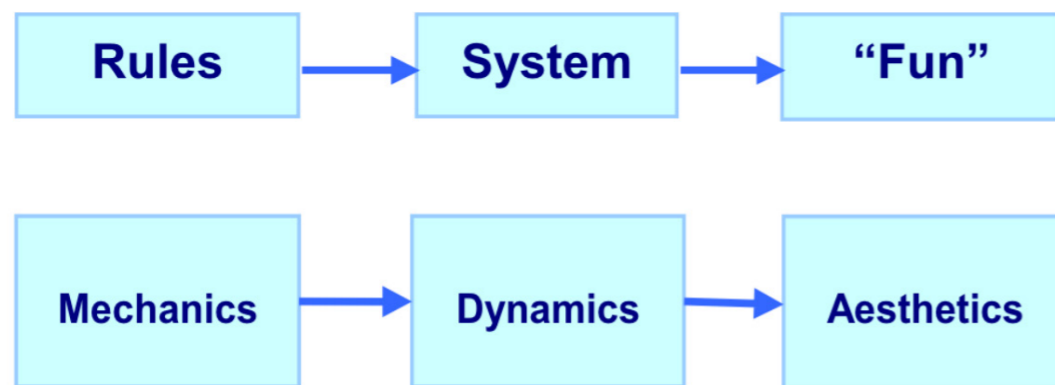


Fig. 22.

Robin Hunicke, Marc LeBlanc, Robert Zubek, The MDA framework formalises the consumption of games and establishes their design counterparts by breaking them into their distinct components, MDA: A Formal Approach to Game Design and Game Research, 2004.

Hunicke et al. state that, from the designer's perspective, the mechanics give rise to dynamic system behaviour, which in turn leads to particular aesthetic experiences. From the player's perspective, aesthetics sets the tone, which is born out of observable dynamics and eventually operable mechanics (2). When working with games, a designer should consider both the player's and the designer's perspectives. Furthermore, emphasising the player's perspective encourages experience-driven design rather than feature-driven design (Hunicke et al. 2). This approach aligns well with the principles of spatial storytelling, such as creating immersive environments, guiding player exploration, and evoking emotional responses through environmental cues. Therefore, when I design my game, I start with aesthetics, then move on to dynamics, and finally, the underlying mechanics.

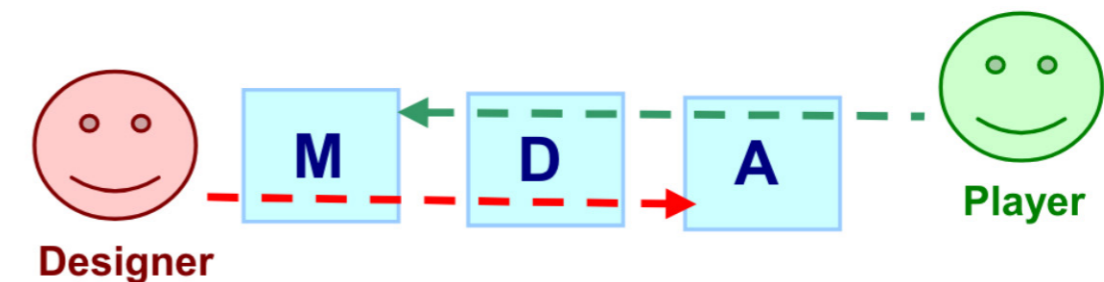


Fig. 23.

Robin Hunicke, Marc LeBlanc, Robert Zubek, The designer and player each have a different perspective, MDA: A Formal Approach to Game Design and Game Research, 2004.

Aesthetics

Hunicke et al. proposed that when discussing the aesthetics of a game, we want to move away from words like “fun” and “gameplay” towards a more directed vocabulary. This includes but is not limited to the taxonomy listed here (2):

1. Sensation: Game as sense-pleasure
2. Fantasy: Game as make-believe
3. Narrative: Game as drama
4. Challenge: Game as obstacle course
5. Fellowship: Game as social framework
6. Discovery: Game as uncharted territory
7. Expression: Game as self-discovery
8. Submission: Game as pastime

By using this directed vocabulary, we can better articulate the aesthetic experiences games offer and design more effectively to evoke specific emotional responses from players. For instance, in spatial storytelling games like *Endling: Extinction is Forever*, *ABZÛ* and *Flower*, the aesthetics of sensation, discovery, and narrative are particularly emphasised, creating deeply immersive and emotionally resonant experiences.

Using our aesthetic vocabulary like a compass, we can define models for gameplay. These models help us describe gameplay dynamics and mechanics (Hunicke et al. 2). For example, *Endling: Extinction is Forever* and *ABZÛ* are both discoveries. They succeed when players in these games are emotionally invested in exploring the environment. If the player loses interest in exploring the environment or feels like they know how to explore it, the game is suddenly a lot less interesting. Therefore, the initial step is to cultivate the setting, and spatial storytelling can help the designer in more effectively moulding the environment. In my game, I employ the spatial storytelling framework of Hameed and Perkis to design the impact of human activities on the mangroves.

Dynamics

Hunicke et al. state that dynamics work to create aesthetic experiences (3). For example, discovery can be encouraged by setting conditions that require interaction with the game world in order to reach a goal. We can also identify feedback systems within gameplay to determine how specific states or changes impact the overall game state. In my game, players will explore the city and find their way to the mangroves. This journey will be designed to emphasise the dynamics of exploration and discovery, encouraging players to interact with various elements of the urban environment to uncover clues and pathways leading to the natural habitats.

The player may additionally encounter issues such as pollution or deforestation while travelling through the city, where the animal they are playing as loses its habitat, which can cause sadness. However, at the end of the game, the player is demonstrated how to behave in an environmentally friendly manner in reality, and when the player makes a commitment in the game, the game environment changes as a result of these interactions, providing immediate visual and auditory feedback indicating the player’s contribution. Not only does this enhance the sense of immersion for the player, but it also emphasises the causal relationship between the player’s actions and the ecosystem’s health.

Mechanics

Mechanics are the various actions, behaviours, and control mechanisms afforded to the player within a game context. Together with the game’s content (levels, assets, and so on), the mechanics support overall gameplay dynamics (Hunicke et al. 4). For example, *Endling: Extinction is Forever*’s main mechanic is finding food to keep your cubs alive, and as a nocturnal animal, the other major goal is finding your way back to a shelter before morning arrives.

The primary gameplay mechanic of my game revolves around navigating the player character’s journey back to their home in the mangroves before daybreak. Additionally, players must scavenge for sustenance, evade perilous situations, and ensure their survival. Players will have to explore the city, seeking out food and safe routes. These mechanics not only create a sense of urgency and challenge but also serve to highlight the everyday struggles faced by wildlife in urban environments.

I will provide a comprehensive explanation in a subsequent section (refer to the game design), elucidating the rationale behind my setup and delving into how these mechanics harmonise with the game’s overarching themes and objectives. By carefully designing these gameplay elements, the game aims to foster a deeper understanding and empathy for the challenges faced by animals in their natural habitat, mangrove ecosystems, and the impact of human activities on their survival.

Section 3: Prototype

Mangrove forests are rapidly disappearing, and raising public awareness of mangrove ecology is vital. Video games are an effective tool for educating people about environmental issues and motivating them to take action (Patterson and Barratt 8). This study explores how spatial storytelling in video games can elicit ecological empathy and action.

Through a theory-based practical process, I will design a game prototype that demonstrates and expresses the potential of spatial storytelling in evoking ecological empathy. Aside from being a design tool, it will also serve as a showcase for exploring the research question: How can gaming experiences focused on spatial storytelling and visualisations promote empathy towards mangrove conservation? How can specific concepts of ecological empathy and conservation be effectively translated into game mechanics, dynamics, and aesthetics to design emotionally engaging and impactful moments within the game? This exploration was demonstrated using prototypes in the research. To better understand and demonstrate the effectiveness of spatial storytelling in communicating environmental issues, we can use actual game design and experience. This will be an invaluable reference for future design and research.

This game is intended for people who are unfamiliar with mangrove ecology or who wish to learn more about it, particularly those in the Chinese region. The experience will ideally be presented at the Hainan Museum or on online platforms related to mangroves, allowing users to interact with it in an environment that can effectively influence them.

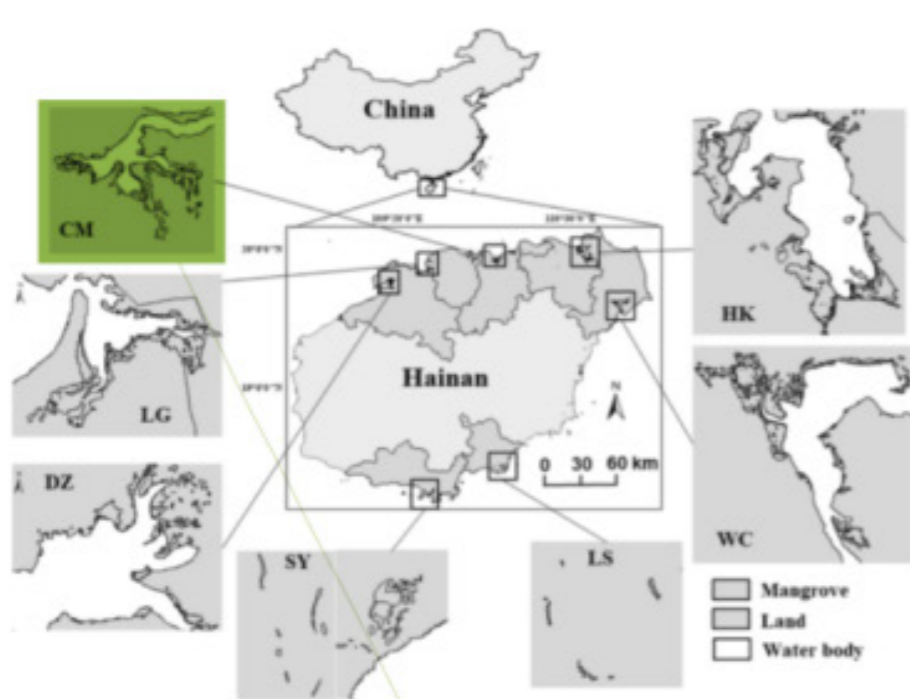


Fig. 24. Mapping of Hainan, Yining Lai, digital collage, 2023.

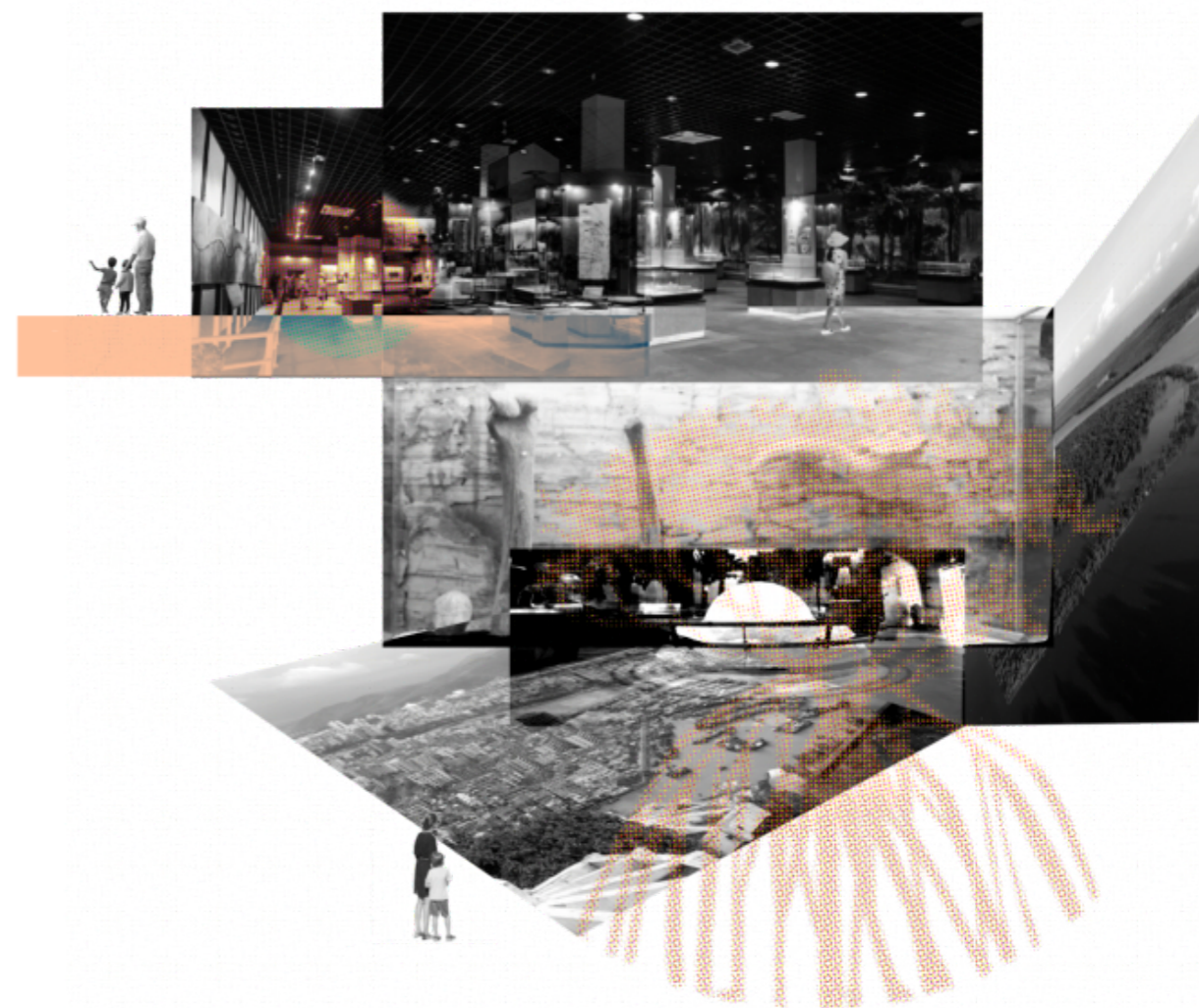


Fig. 25. The redesign of Sanya Nature Museum, Yining Lai, digital collage, 2023.

Initial concept and design process

Initially, I envisioned a game that would raise public awareness of mangrove ecology by evoking ecological empathy. To gain a deeper understanding of mangrove forests, I began by visualising the information I collected about them, mainly through drawing, collage, and storyboarding.



Fig. 26. How human activities affect mangrove ecology, Yining Lai, digital collage, 2023.

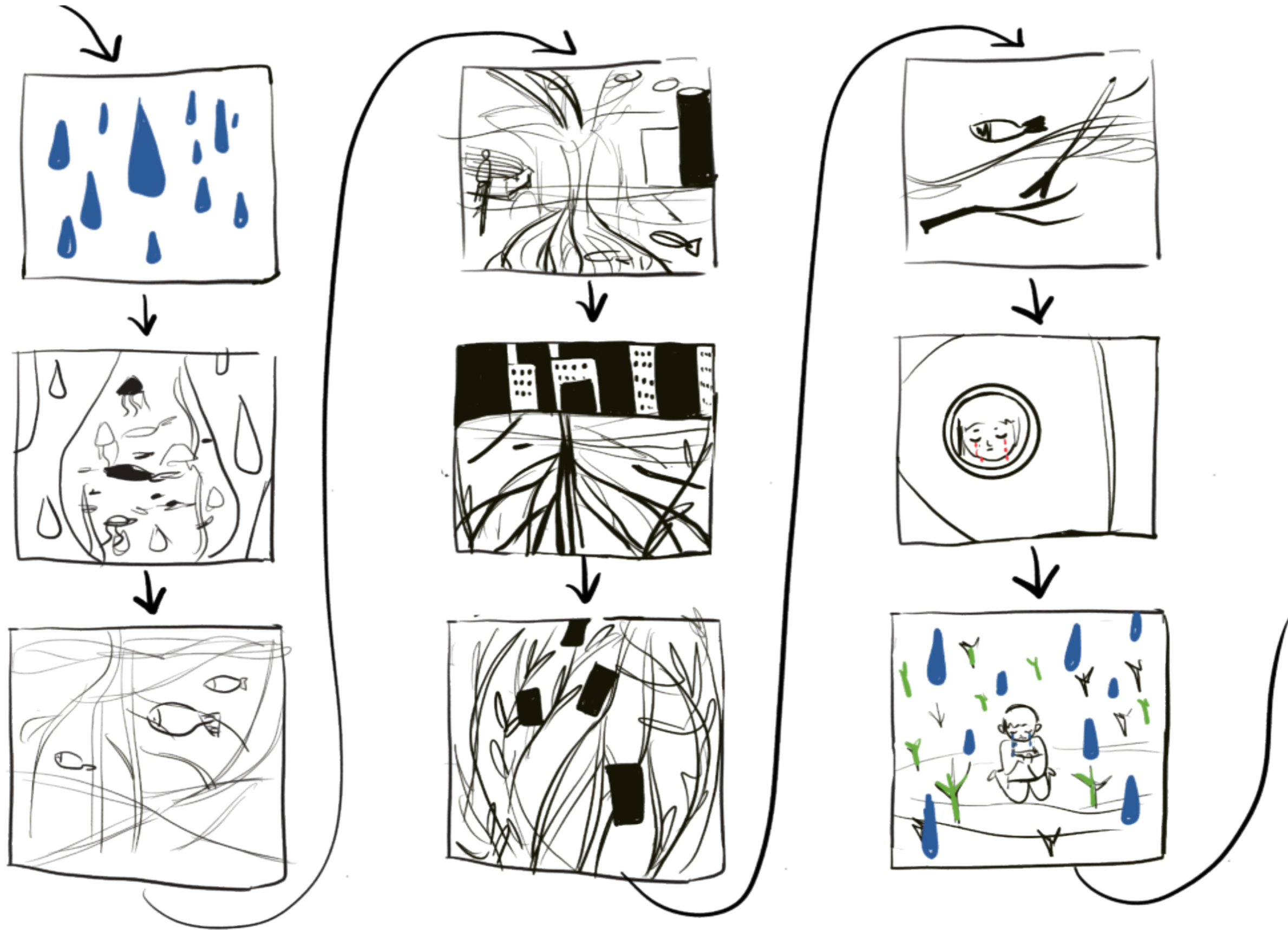


Fig. 27. Storyboard of Humans and mangroves, Yining Lai, digital drawing, 2023.



Fig. 28. Polluted mangroves, Yining Lai, digital drawing, 2023.

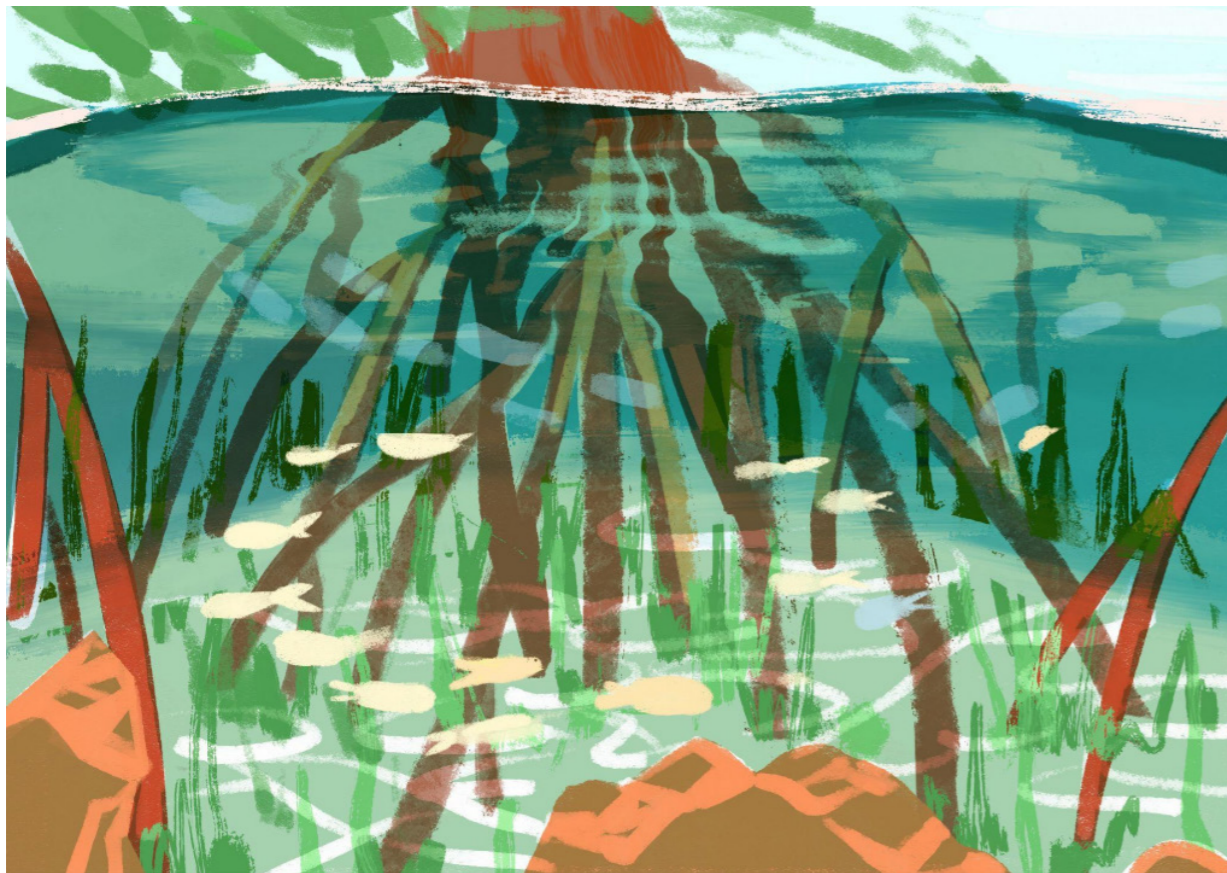


Fig. 29. Vibrant Mangroves mangroves, Yining Lai, digital drawing, 2023.

My research into environmentally-themed video games provided me with the opportunity to launch a study of spatial storytelling theory and empathy theory. This study was influenced by the non-anthropocentric concepts found in games like *Ending and Flower*, as well as spatial storytelling theory, which is a model of immersion that can be used in games to enhance player immersion and stimulate emotion (Hameed and Perkiş 327). Several studies have shown that stories in which animals are the protagonists can assist individuals with the development of cognitive empathy, an important factor in facilitating environmental behaviour (Young et al., 330). Therefore, the basic concept of the game is that the player travels between the city and the mangrove forest as an animal and experiences the impact of human activities on the mangrove ecosystem, thereby developing a sense of cognitive empathy.

The MDA (Mechanics, Dynamics, Aesthetics) framework assisted me in designing the game more effectively. Considering aesthetics, I identified how the aesthetic style, narrative elements and journey the player experiences might evoke ideal emotional responses. Based on these aesthetic goals, I designed the game's dynamics, including how players interact with the game and its pace (see game design). Then, I identified the specific mechanics required to realise these dynamics, such as character movement and interaction styles. After identifying the game's aesthetics, dynamics, and mechanics, I created a prototype using Unity and Photoshop.

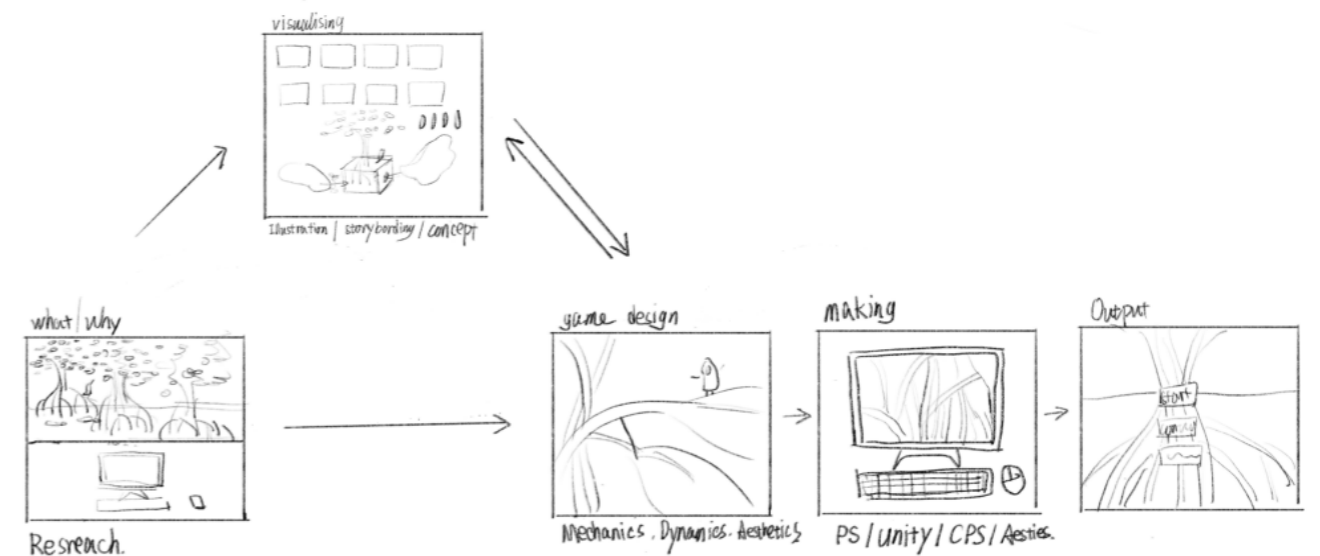


Fig. 30. Design process, Yining Lai, digital drawing, 2024.



Fig. 31.
This is the cover art for Super Mario Bros., Nintendo, 1985.

Game Design

Aesthetics

Aesthetics encompass the overall look and feel of the game, the narrative elements, and the player's emotional journey. The goal is to design an interactive game system that can inspire interest in mangrove ecology, promote empathy for impacted creatures and systems and promote environmentally friendly behaviour. For the player to experience a deeply immersive and emotionally resonant experience, aesthetic elements of sensation, discovery, and narrative are essential (see MDA framework).

Art Style

I chose pixel art because the game is set in Sanya in the 1990s. According to reported sources, mangrove forests disappeared in large numbers from the mid-1990s to the late 1990s due to the industrialisation of China's cities (Zhang and Sui 414). During the 1970s and 1990s, pixel art emerged as the prevailing style in video games owing to the technological constraints of that era. For example, Super Mario Bros. (1985) utilised the pixel art style (see Fig.31.). Using pixel art allows the aesthetics of that era to be accurately reproduced, aligning with the game's historical background. Additionally, pixel art evokes a unique sense of nostalgia, which can trigger players' memories of classic games and attract players of all ages (see Fig. 32.).

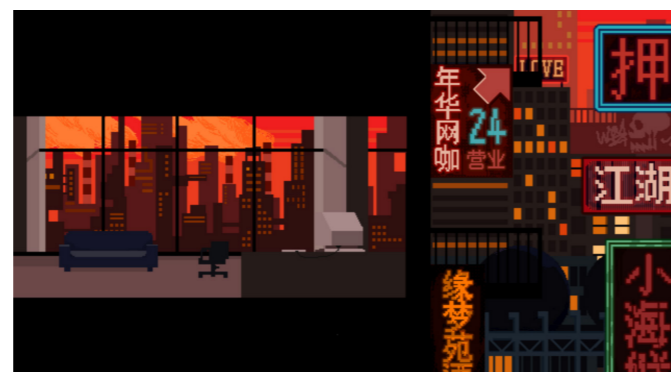


Fig. 32.
The city scenes for COME BACK HOME, Yining Lai, 2024.



Fig. 33. Partha Dey, The fishing cat's wetland habitat is threatened across much of its range.

Narrative

Young et al. argue that framing an animal's story can help people develop cognitive empathy for the animal from its perspective (330). Therefore, I developed a storyboard where a fishing cat is the main character. According to Malhotra, the fishing cat is distinguished by partially webbed feet, semi-retractable claws for hooking slippery prey, and two layers of fur for keeping it dry when hunting in the water, as shown in Fig. 33. There are populations of this species scattered throughout the wetlands of Asia, particularly in mangroves. With the disappearance of the mangrove forest, fishing cats face numerous threats. Besides habitat loss, many cats are hunted for stealing fish from fishermen and disrupting fishing nets (Malhotra).

Fig. 34. illustrates that a fishing cat captured by humans in order to reunite with its family sets out on a dangerous journey. However, it gets lost in an urban environment and encounters a city cat. Although the city cat invites the fishing cat to explore the city with it, the fishing cat refuses this generous invitation. Eventually, the fishing cat travels through industrial areas and residential neighbourhoods, eventually reaching the mangrove forest, which has changed dramatically. The story ends on a sad note, but the game ends on a note where the player will be invited to take part in ecologically conscious actions that will ultimately realise the essence of the story.

The narrative revolves around the concept of space. Spatial storytelling allows players to gradually discover and experience the story through the game's environment and space rather than relying solely on text or dialogue. This approach creates a rich, layered narrative experience, enabling players to participate in and experience the story directly. By assuming the role of a fishing cat, players can experience the animal's reality and better understand its experiences. According to cognitive empathy theory, this understanding helps players build empathy based on their knowledge of the animal's natural history, motivating them to take action in reality.

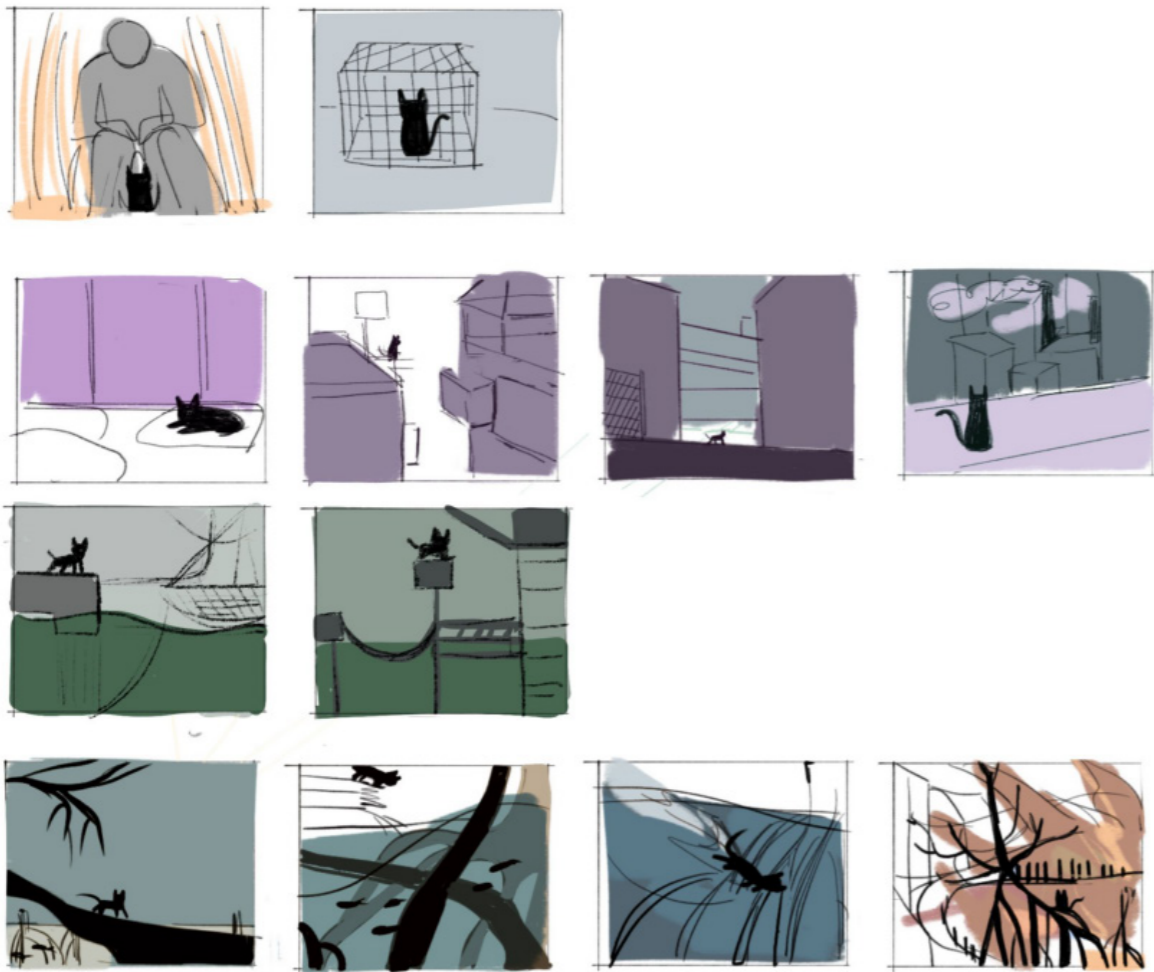


Fig. 34. Fishing Cat storyboard, Yining Lai, digital drawing, 2024.

city - factory - forest - home

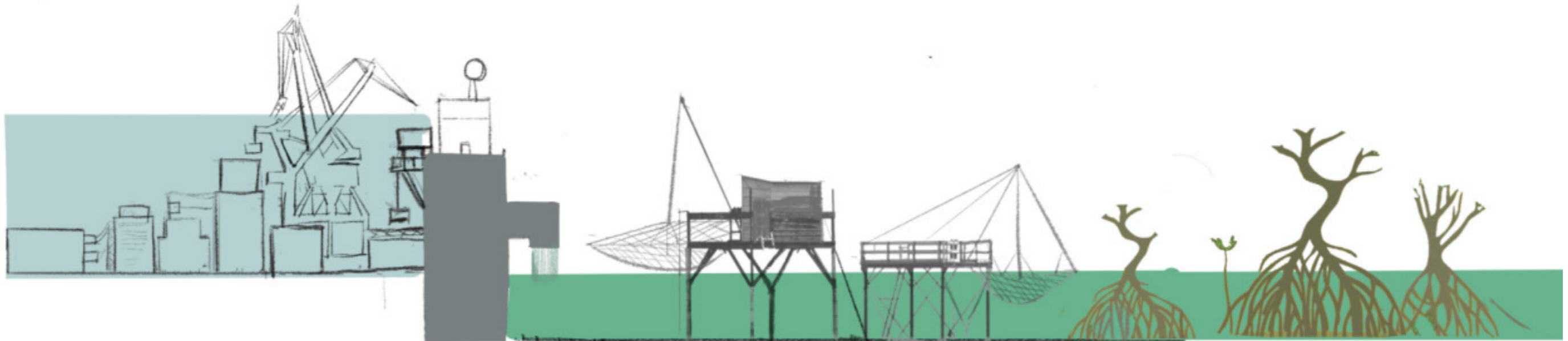


Fig. 35. Map design of Fishing Cat Storyboard, Yining Lai, digital drawing, 2024.

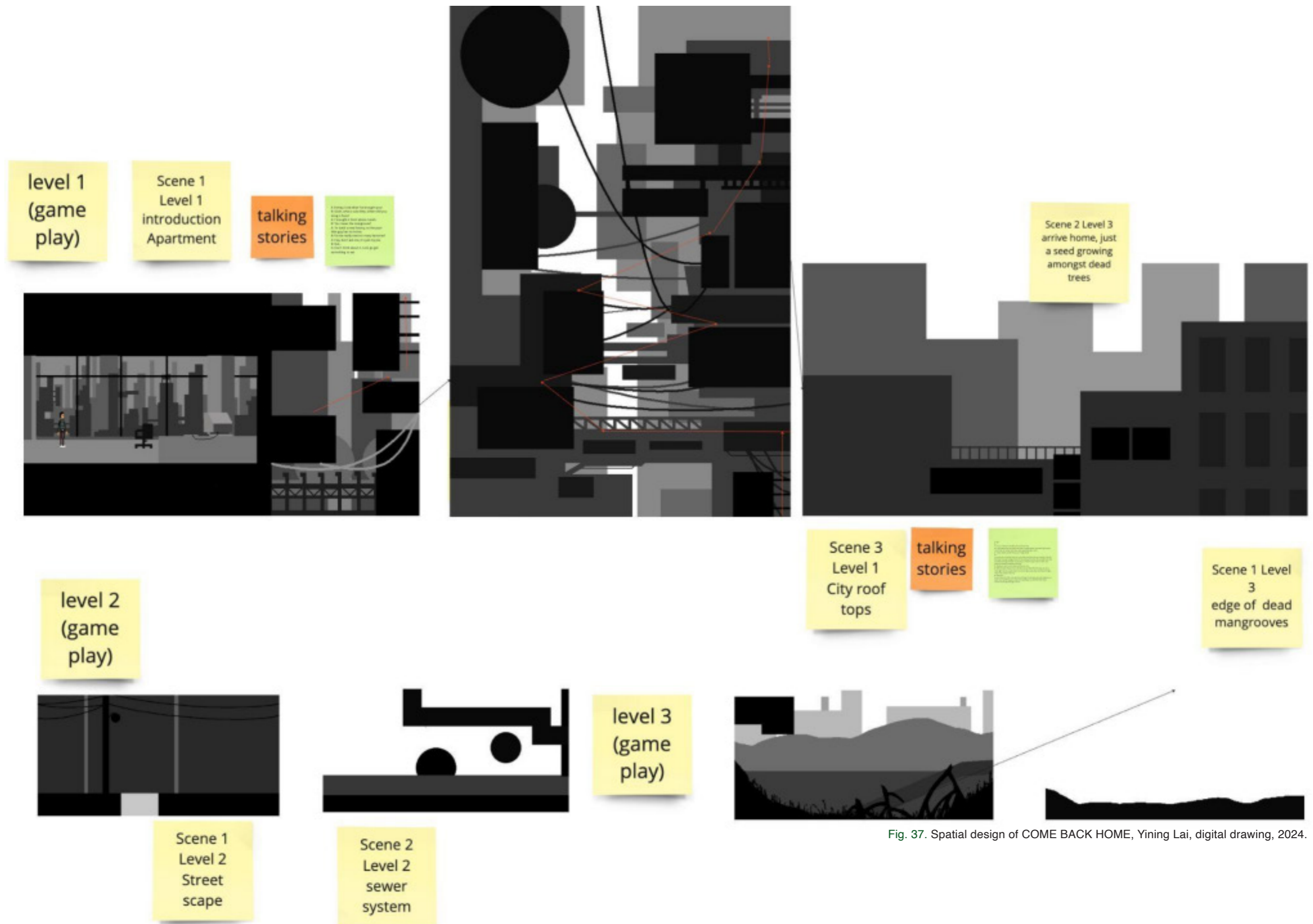


Fig. 37. Spatial design of COME BACK HOME, Yining Lai, digital drawing, 2024.

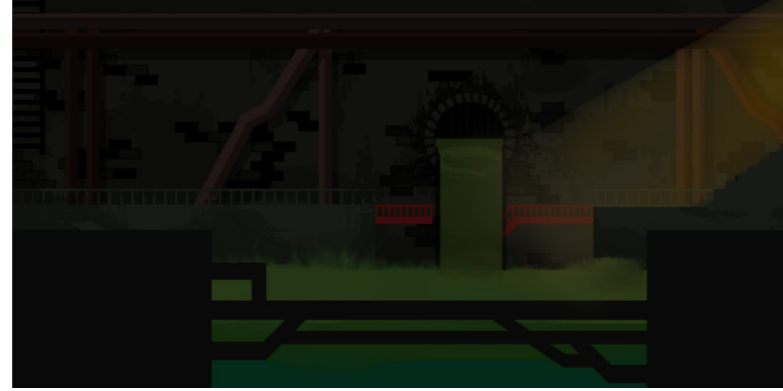


Fig. 39.
The sewer scene of COME BACK HOME, Yining Lai, digital drawing, 2024.



Fig. 38.
The city scene of COME BACK HOME, Yining Lai, digital drawing, 2024.

Spatial Storytelling in Games

This chapter focusses on the intricacies of game design and explores how I utilised the spatial storytelling framework to elevate the quality of my game. Spatial storytelling creates preconditions for immersive narrative experiences in four possible ways (Hameed and Perkis 327):

1. The ability of spatial storytelling to evoke pre-existing narrative associations is crucial. By designing scenes and props, each element in the game world serves a specific purpose in conveying the context and plot of the story. The environment itself becomes part of the narrative. For instance, the design of signboards in Hainan explains the story's setting (see Fig. 38.).

Spatial storytelling provides a backdrop where narrative events unfold. The spatial narrative framework uses meticulous environmental design and clever storytelling layouts to guide the player through a series of emotional changes, enhancing empathy and understanding of the story. To allow players to experience an emotional journey—from tension to relaxation and finally to deep reflection—I have designed emotional climaxes through plot development and visual effects changes. In the sewer level, as depicted in the figure, players experience nervousness and fear when they fall into the sewer. However, due to the fishing cat's ability to swim, it can escape the sewer by being carried by the flowing water, leading to an exciting, tense, and stimulating experience. This sequence allows players to appreciate the fishing cat's unique traits and develop a deeper emotional connection with the character.

Narrative information is embedded within the game's mise-en-scène. As players explore the game world, they gradually uncover hidden story clues and background information. This process enhances player engagement and immersion. As an illustration, within the game, the player has the ability to visually perceive the surroundings, which include vast industrial facilities, dense pollution, and peculiarly tinted water streams. These elements serve as indications of the detrimental impact on the environment caused by humanity's insatiable desire for more (see Fig. 40.).

The spatial storytelling framework emphasises the interaction between the player and the environment, where specific story events or environmental changes are triggered by the player's actions and choices. This interaction provides the player with a sense of agency and importance in the development of the narrative. For example, in the game, the player might encounter a city cat who invites them to explore the city together. The player can choose from several options, each leading to different events and outcomes, thereby influencing the narrative based on their decisions.

Dynamism and Mechanics

The dynamics of the game system are reflected in the player's interaction with the environment. As a fishing cat, the player faces the challenge of surviving in the city. The main mechanism of the game is that the player controls the movement of the fishing cat (e.g., jumping, climbing) to deal with obstacles and challenges in the environment and to find the way back home by interacting with the environment. Secondly, the player needs to search for food in the city in order to maintain the energy and health of the fishing cat and to manage the cat's resources in order to ensure its survival and progress in the game. At the end of the game, the player is shown how to make a change in real life and is invited to make a commitment in the game, and when the player sends a message to the game system, the game screen re-lights up and shows the beautiful mangrove.

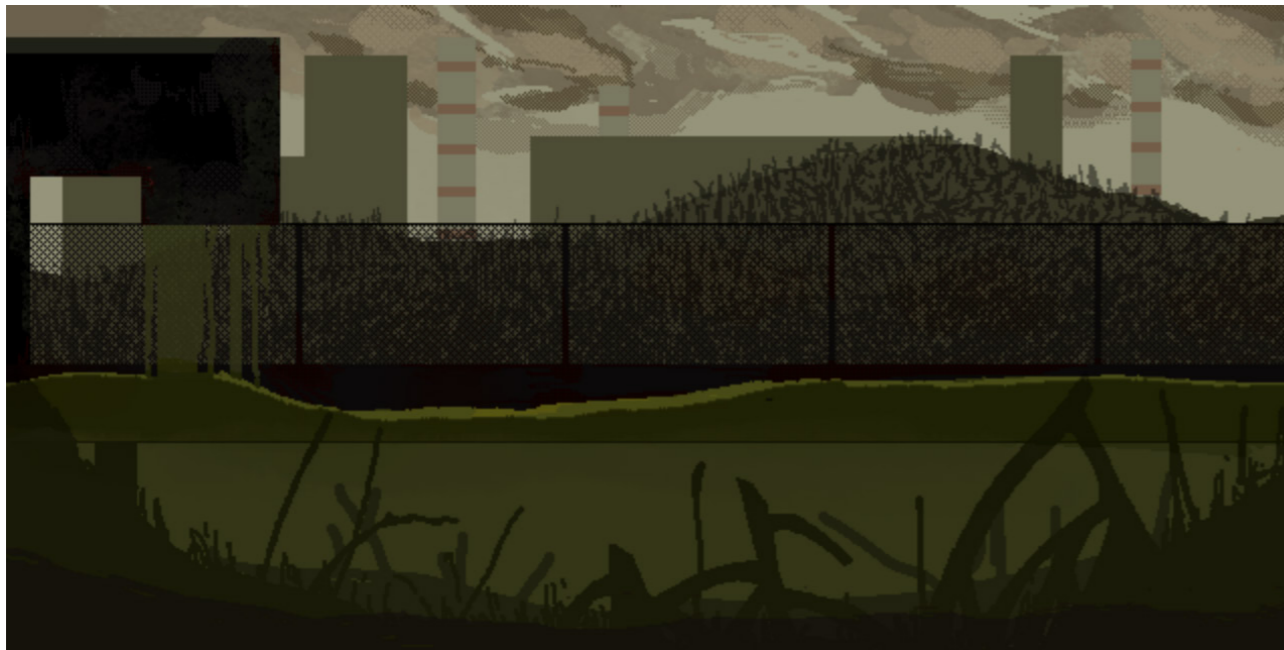


Fig. 40. The suburban scene of COME BACK HOME, Yining Lai, digital drawing, 2024.

Making

When I was creating the art assets, I drew inspiration from the game Rain World by Videocult. This platform survival game is inspired by the destruction of an ecological disaster and is represented as pixel art. After finishing the art assets, I moved to Unity to create the prototype.

In the drawing process, I placed a great deal of emphasis on colour. I used different shades of colour to convey the atmosphere required for each level. For example, In the city scenes of the game, I used the red colour palette scheme to express the atmosphere of danger and warning I also applied a grey and blue colour palette in the more peaceful areas to convey a sense of calm and tranquillity. I referenced images of real locations while drawing, and I went through several revisions (see Fig. 42.).

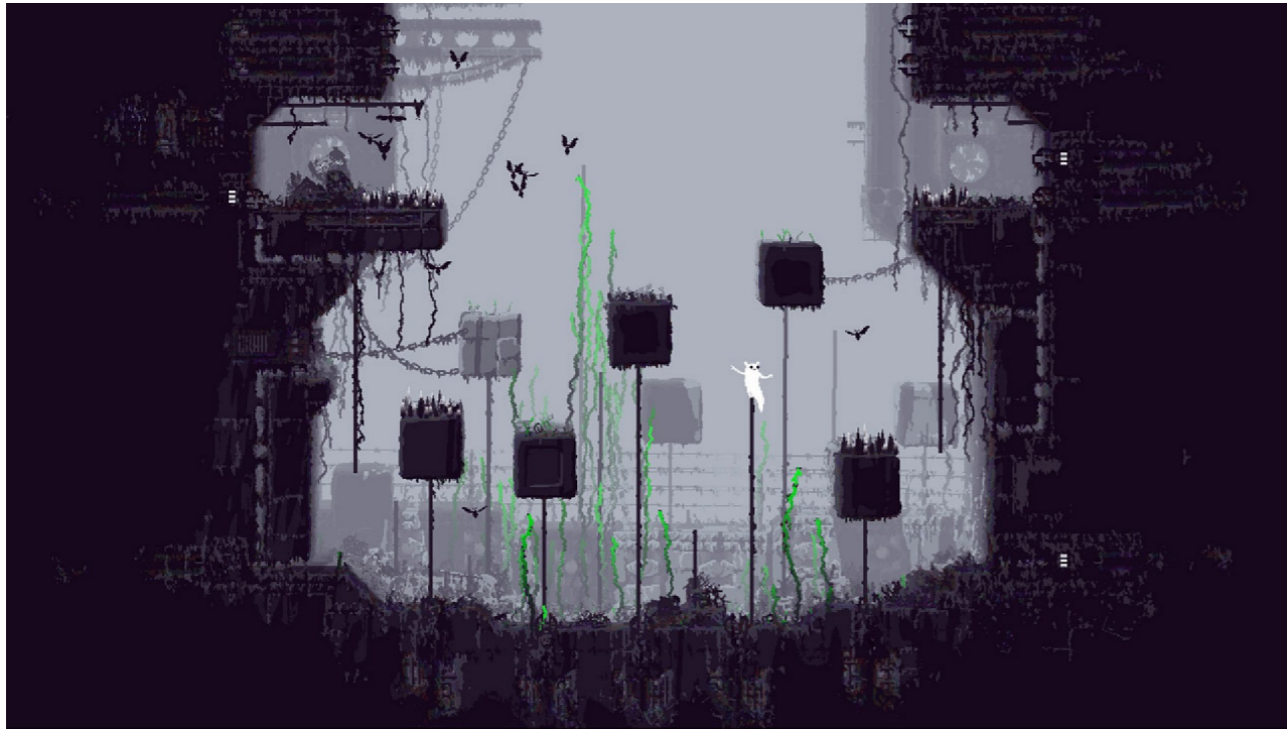


Fig. 41. Screenshot from Rain World, 2017.

Scene Iteration

Scene 1

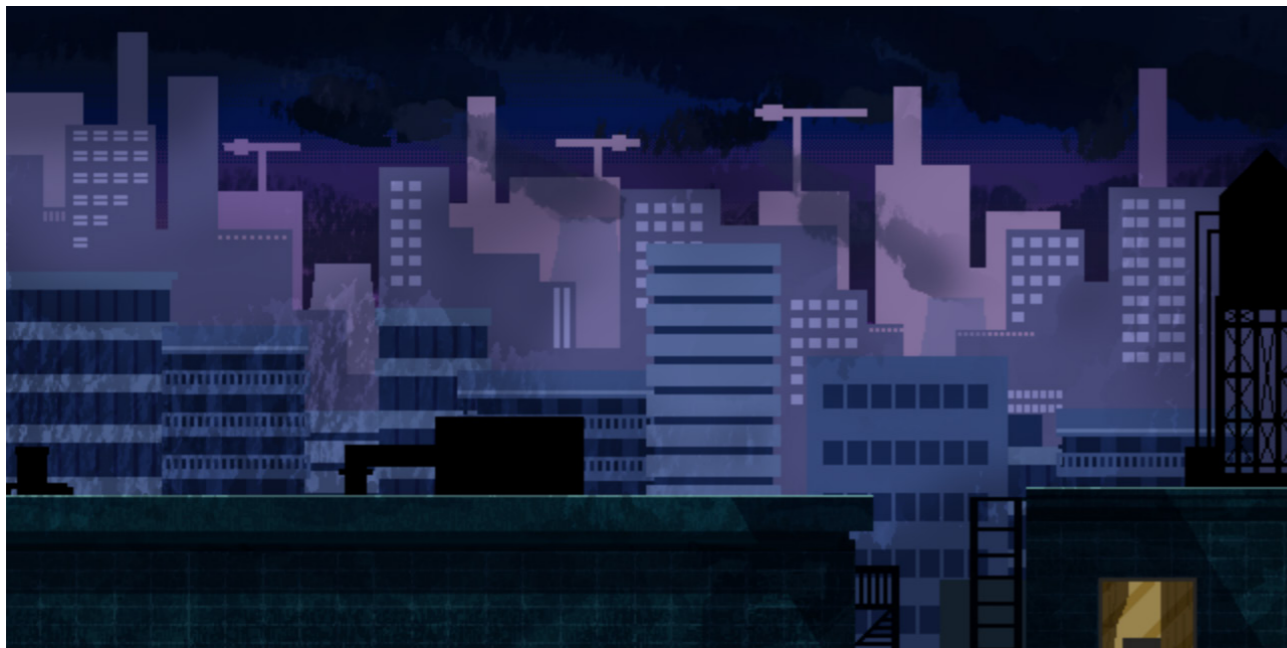
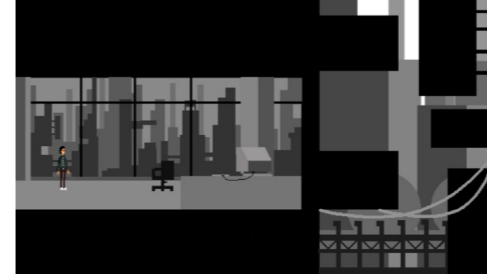
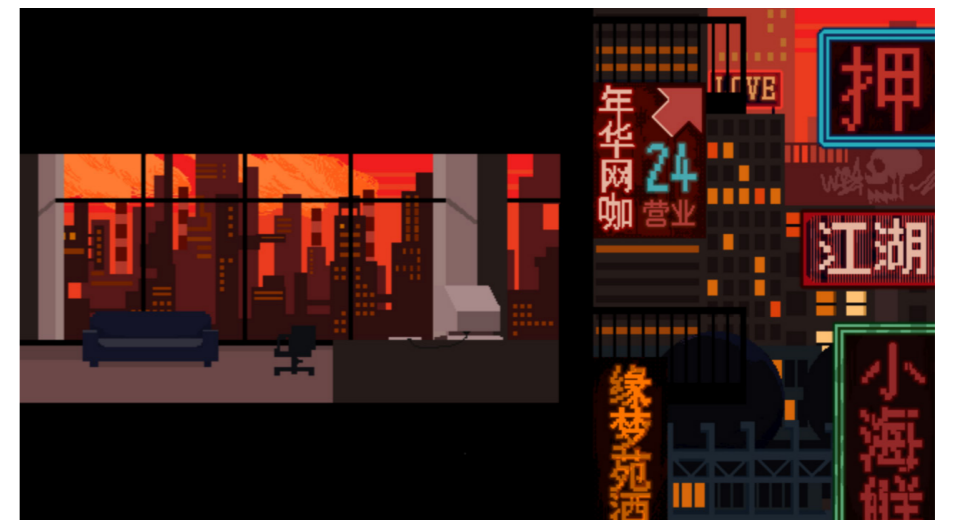
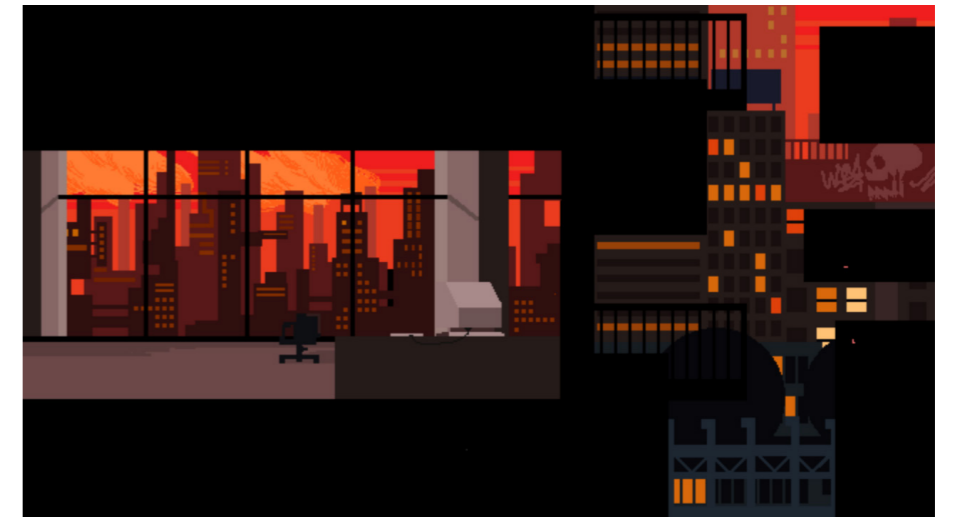
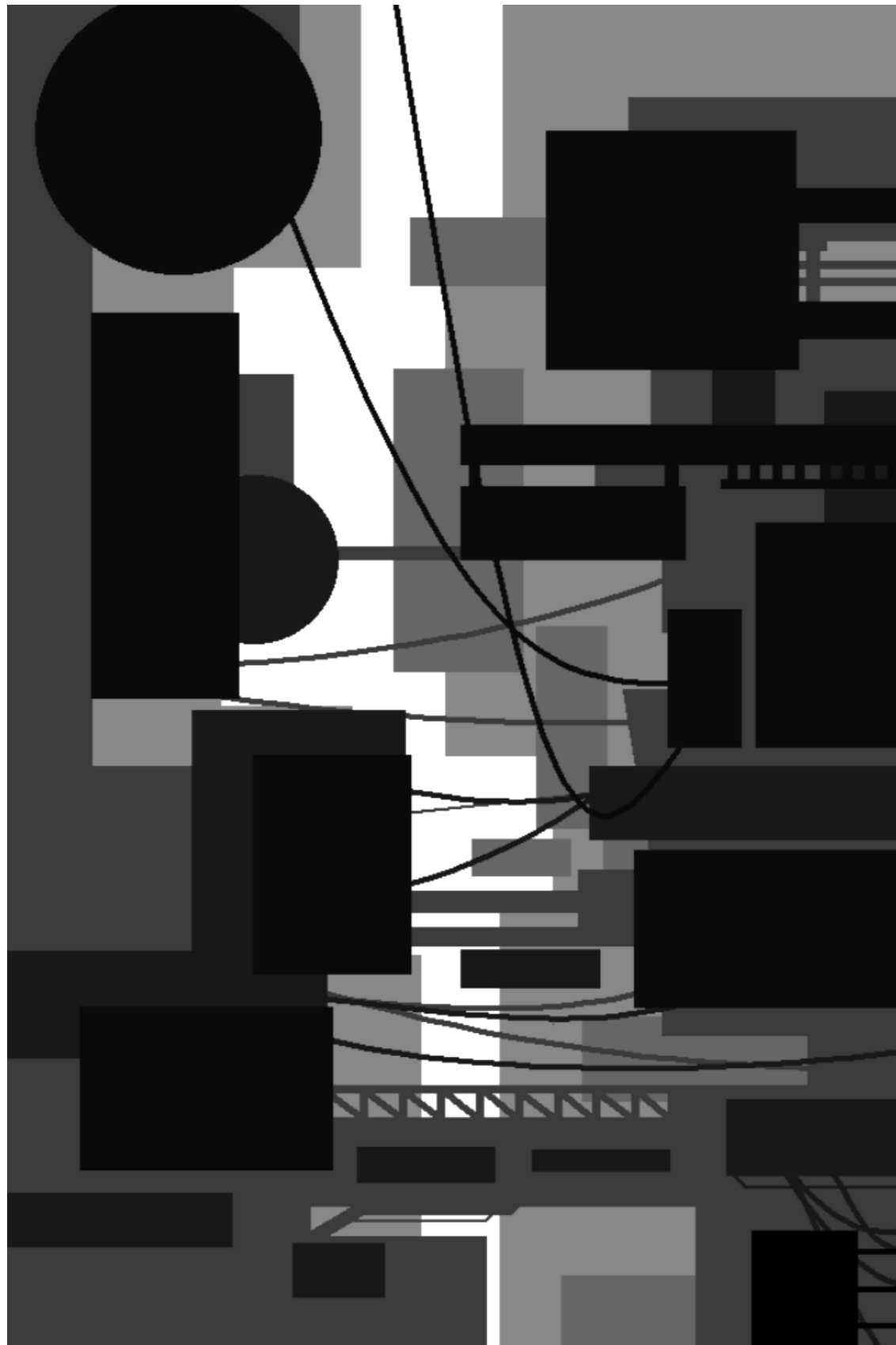


Fig. 42. The city scenes of COME BACK HOME, Yinying Lai, digital drawing, 2024.



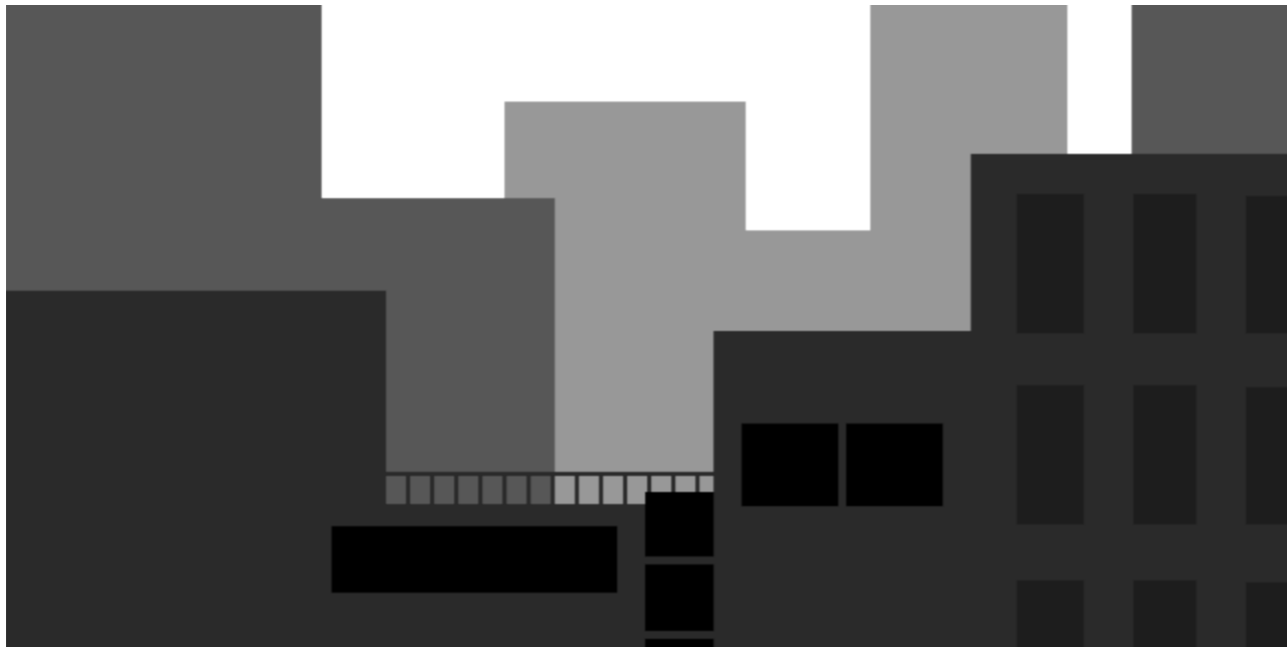
Scene Iteration

Scene 2



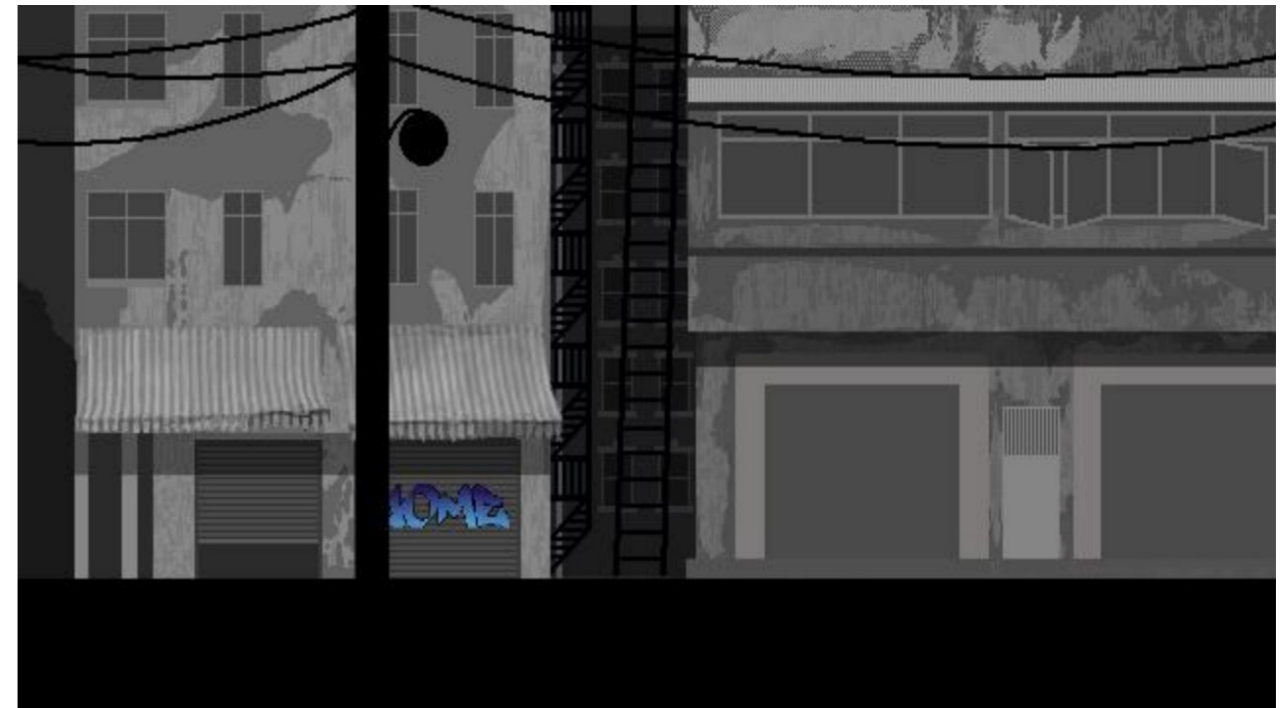
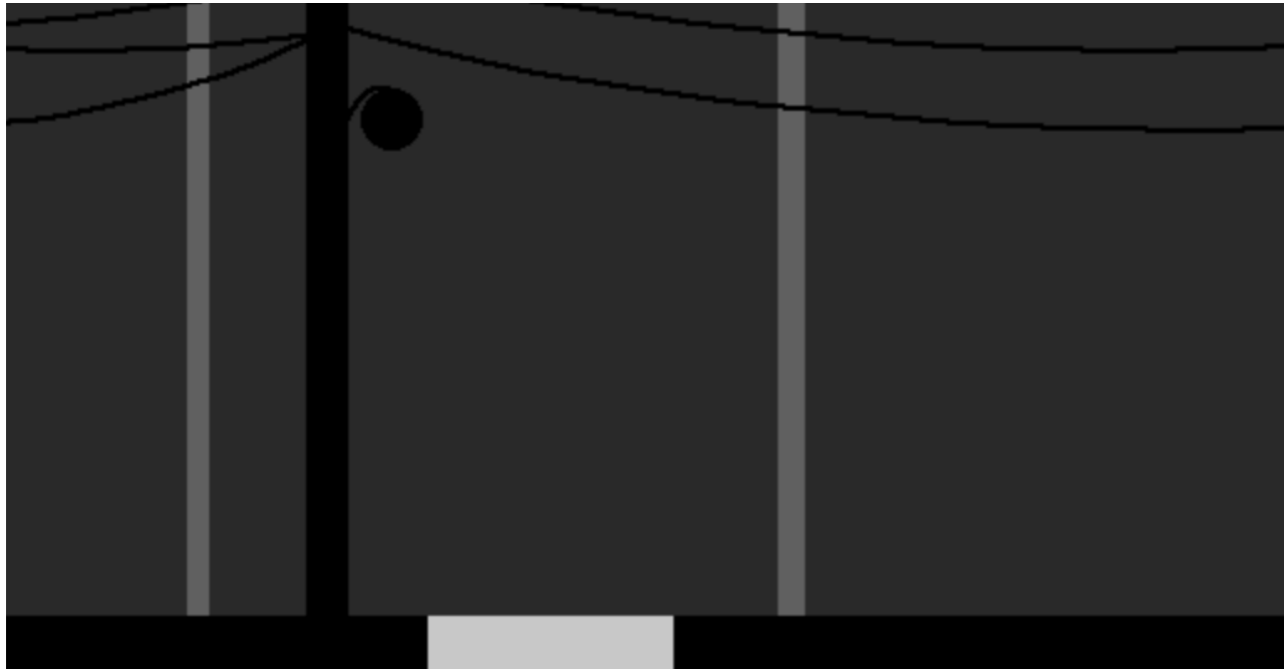
Scene Iteration

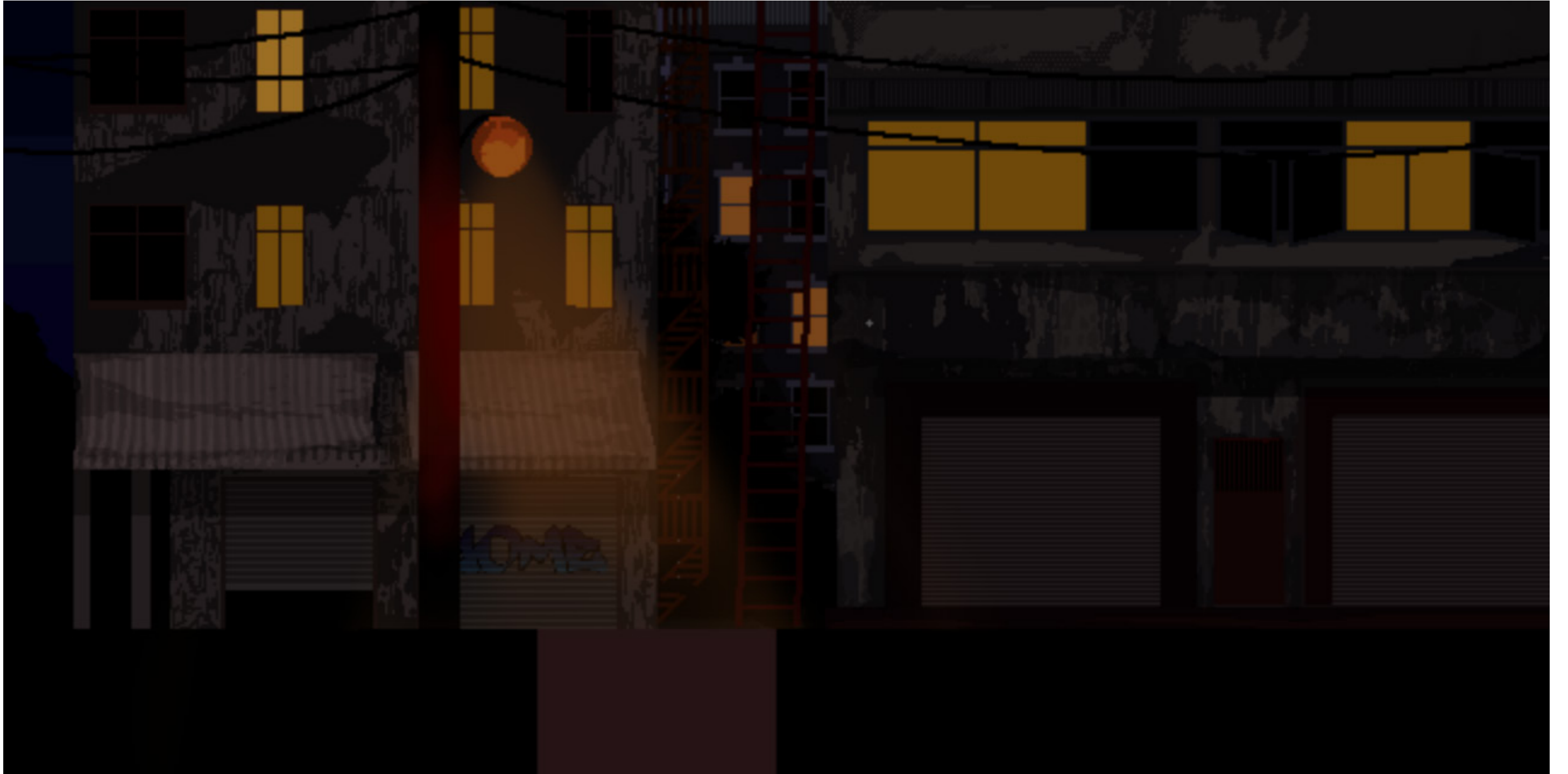
Scene 3



Scene Iteration

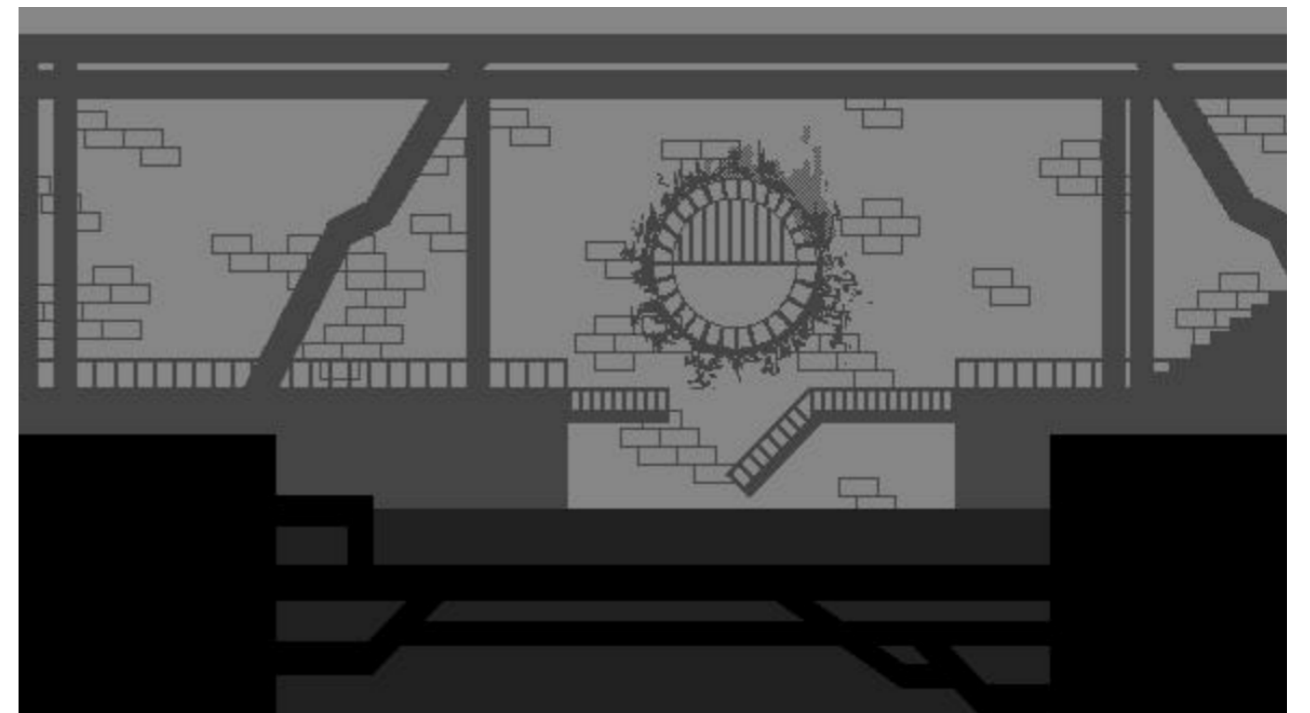
Scene 4

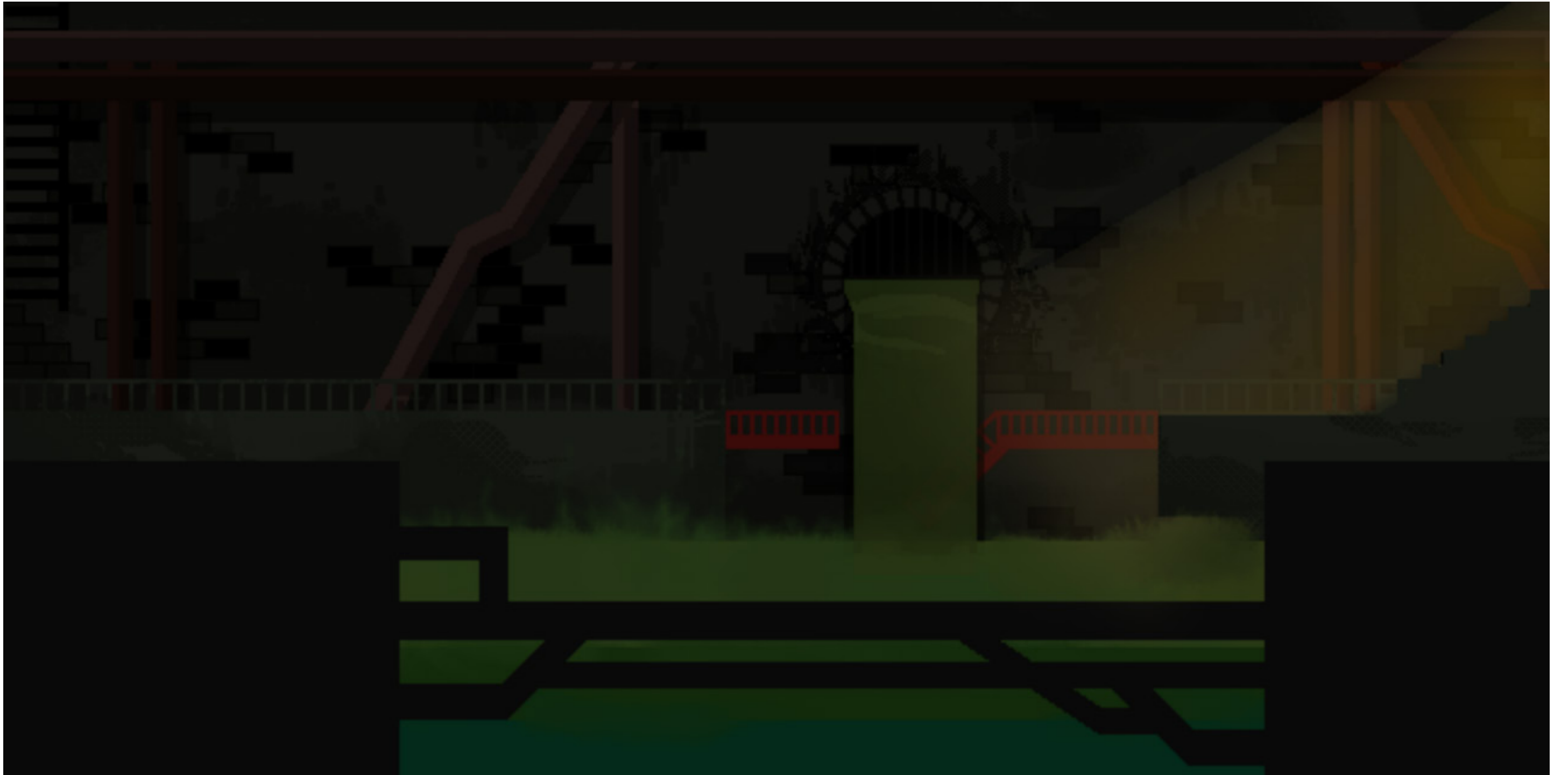




Scene Iteration

Scene 5





Scene Iteration

Scene 6



Scene Iteration

Scene 7

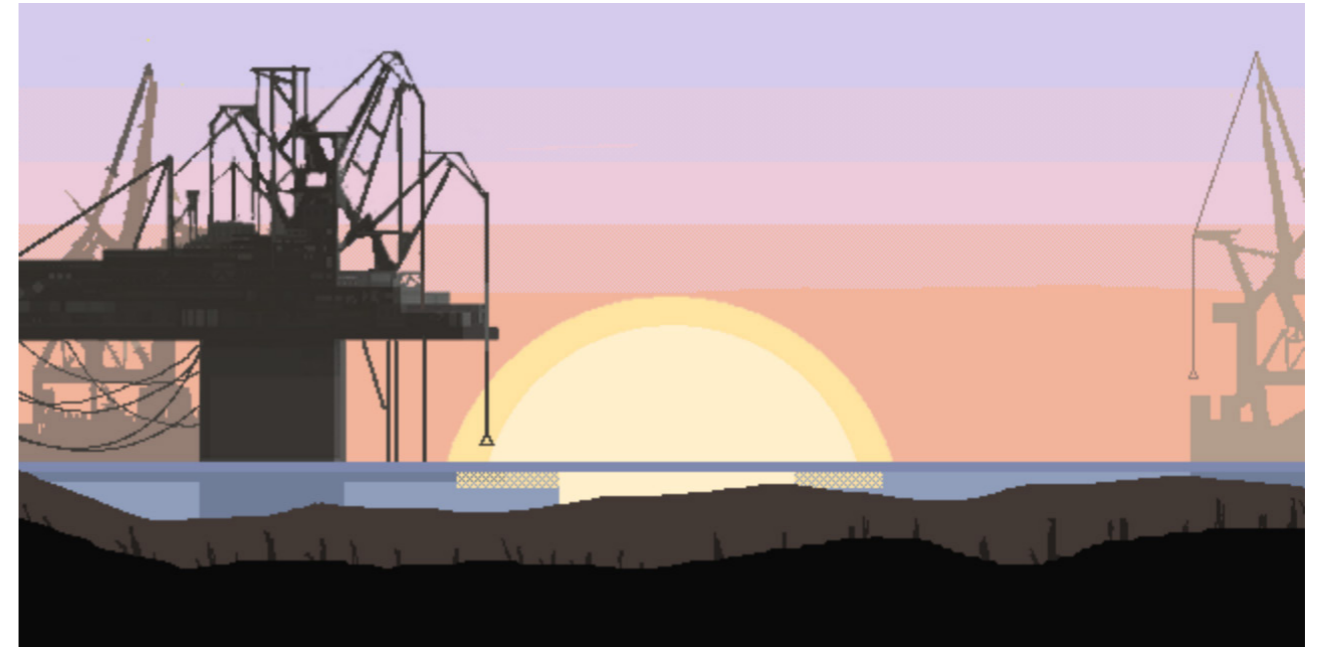
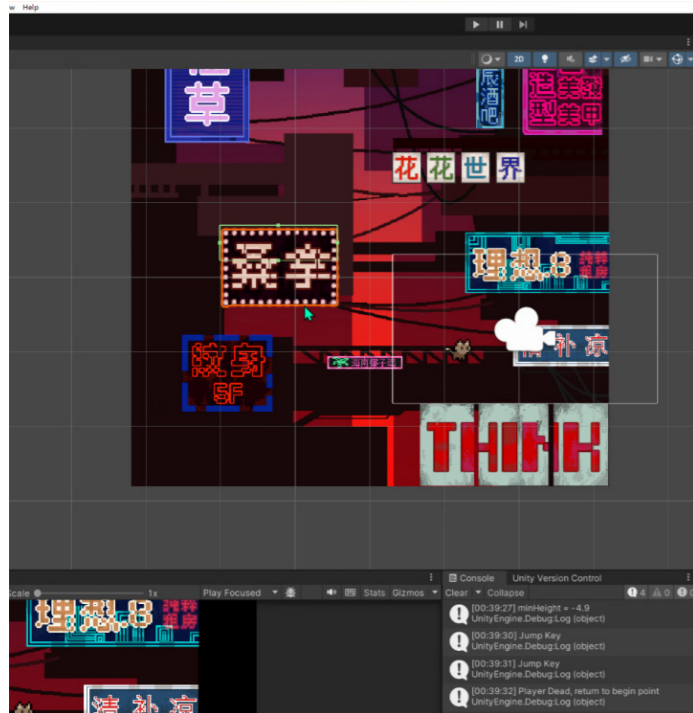


Fig. 43-61. Come Back Home's iteration of the game scene, Yining Lai, Digital Drawing, 2024.



Unity Process

During the Unity production process, I set up the project by configuring basic parameters like resolution and target platform. I then created the primary scene by using terrain tools and placing models to establish the foundational environment. Lighting and shadow effects were adjusted to enhance the visual experience. I wrote C# scripts to implement basic gameplay features such as character movement and interaction with the environment. Art assets, including background and animation, were imported into Unity and applied to the scene. I also designed a simple, intuitive user interface, added background music and sound effects, and performed basic testing to ensure all functions worked correctly before building the game for the target platform.

However, I encountered some challenges during the process. For instance, I faced collision conflicts that caused issues with the character's interaction with the environment. I resolved this by adjusting the size and positioning of the colliders. Additionally, there were animation display errors, where some character actions failed to play correctly. I addressed this by reviewing the animation clips and parameters and tweaking the animation controller, ensuring the animations played smoothly and consistently.

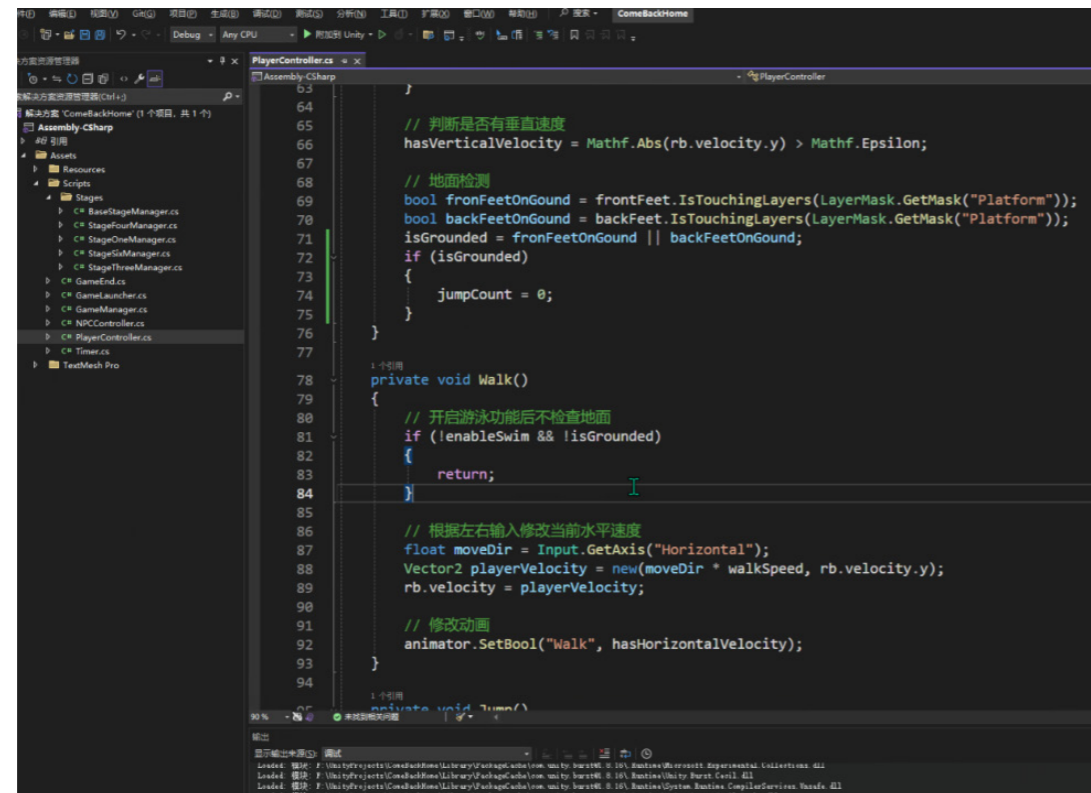
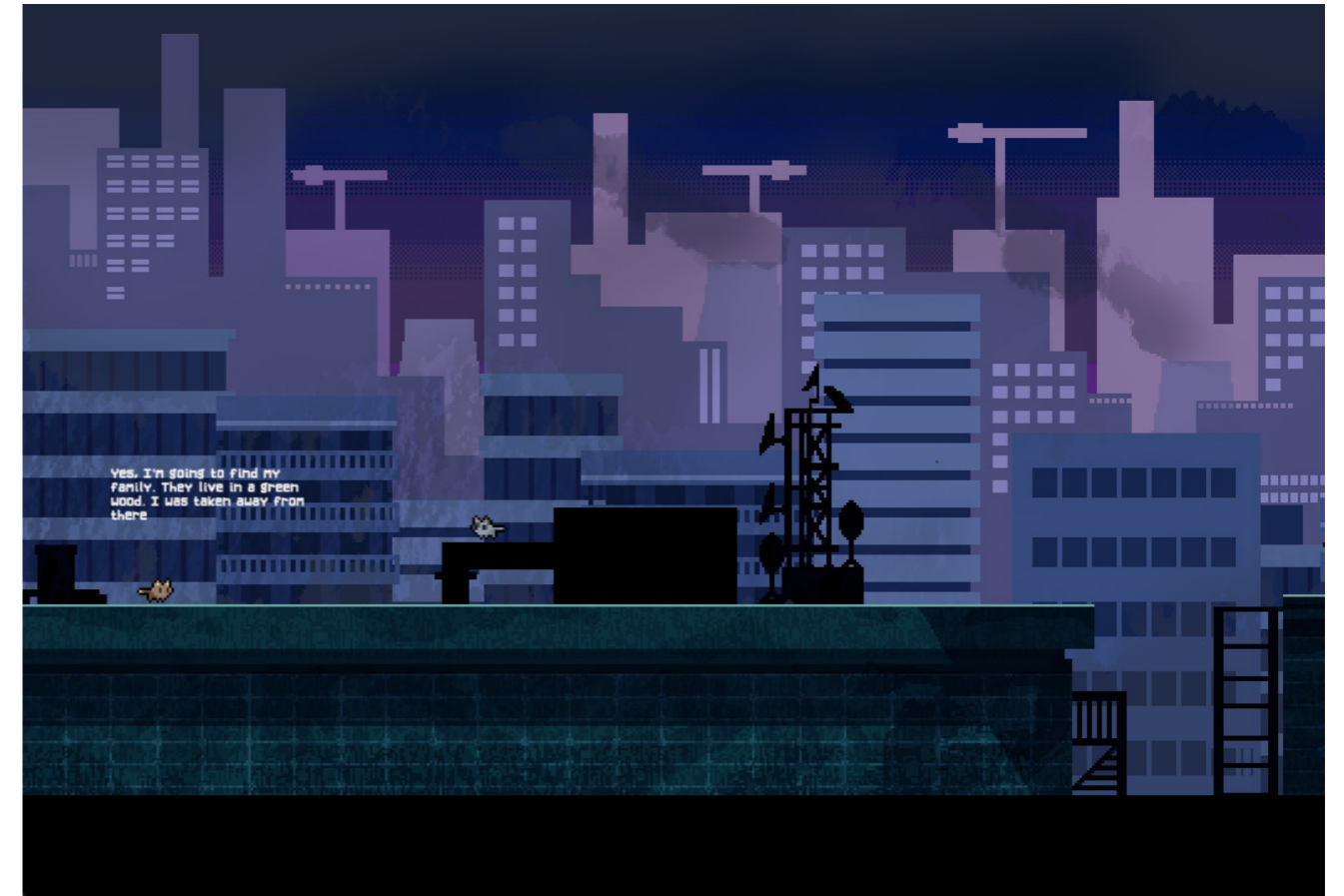
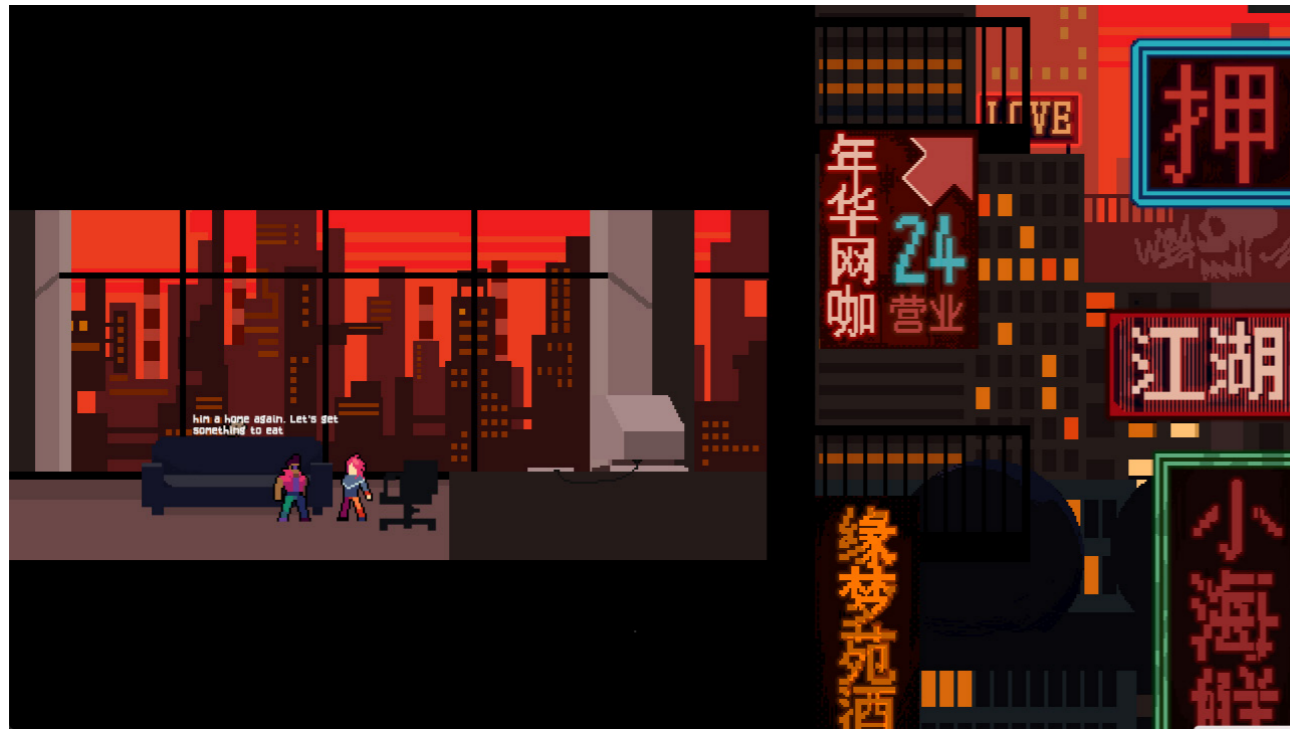


Fig. 62-63. Screen from Unity, Yining Lai, 2024.

Design output: COME BACK HOME

COME BACK HOME is a 2D platform adventure game that puts players in the role of a fishing cat who travel from the city back to the mangrove forest, exploring and interacting to understand the effects of environmental changes on the ecosystem. The game challenges the player to survive, exploring the environment by jumping and climbing to find food and a way home. At the end of the game, the player is invited to take a pledge to be kind to the environment. For example, reduce their carbon footprint, reduce plastic waste, and conserve energy. The game then encourages the players to share this pledge with their friends and family.





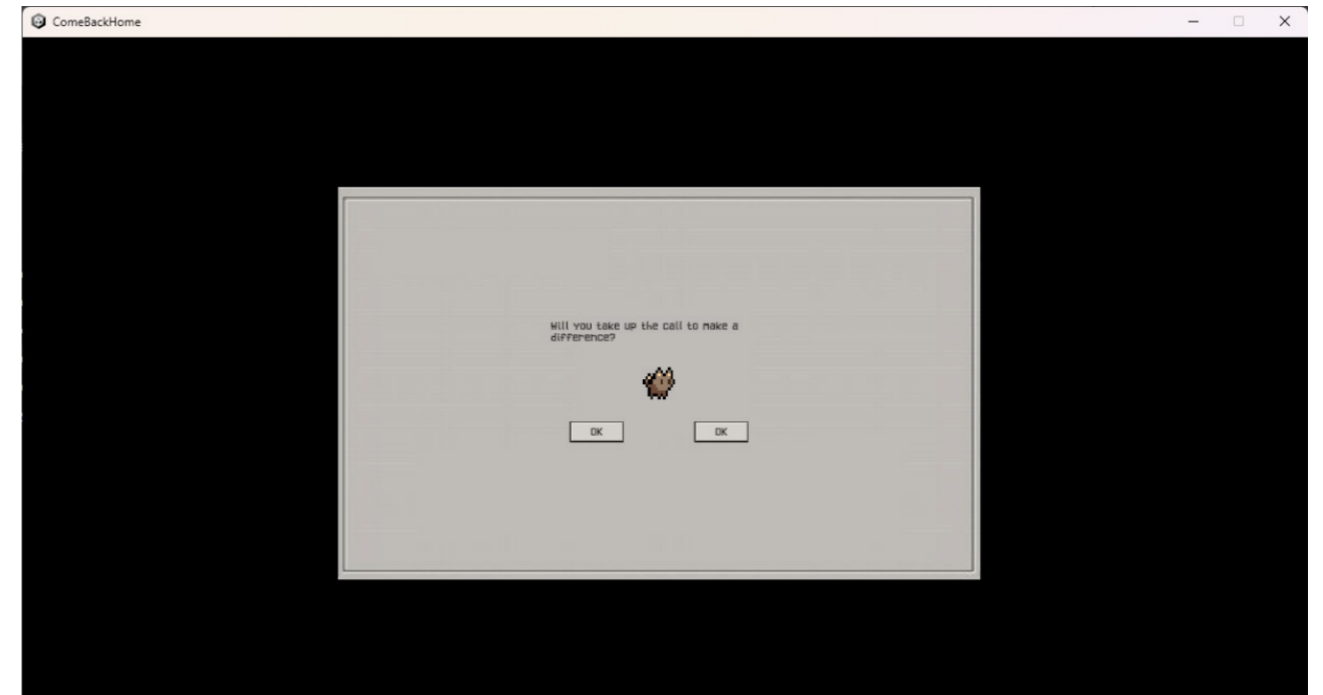
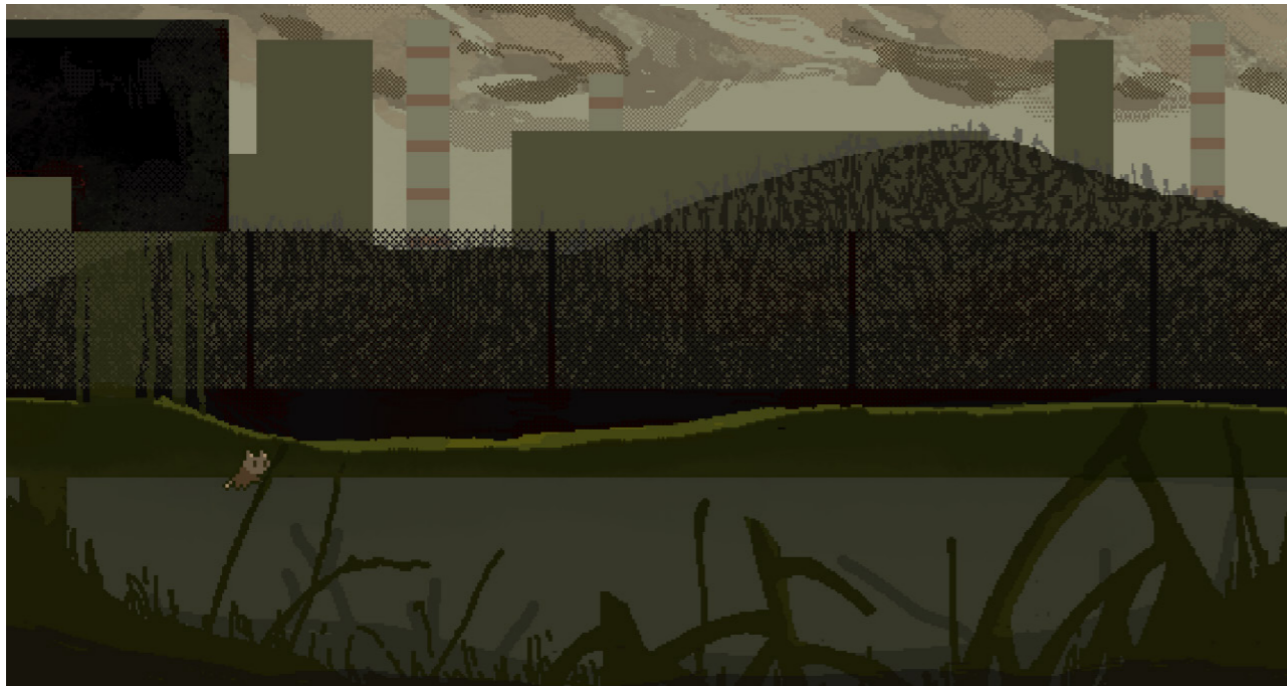
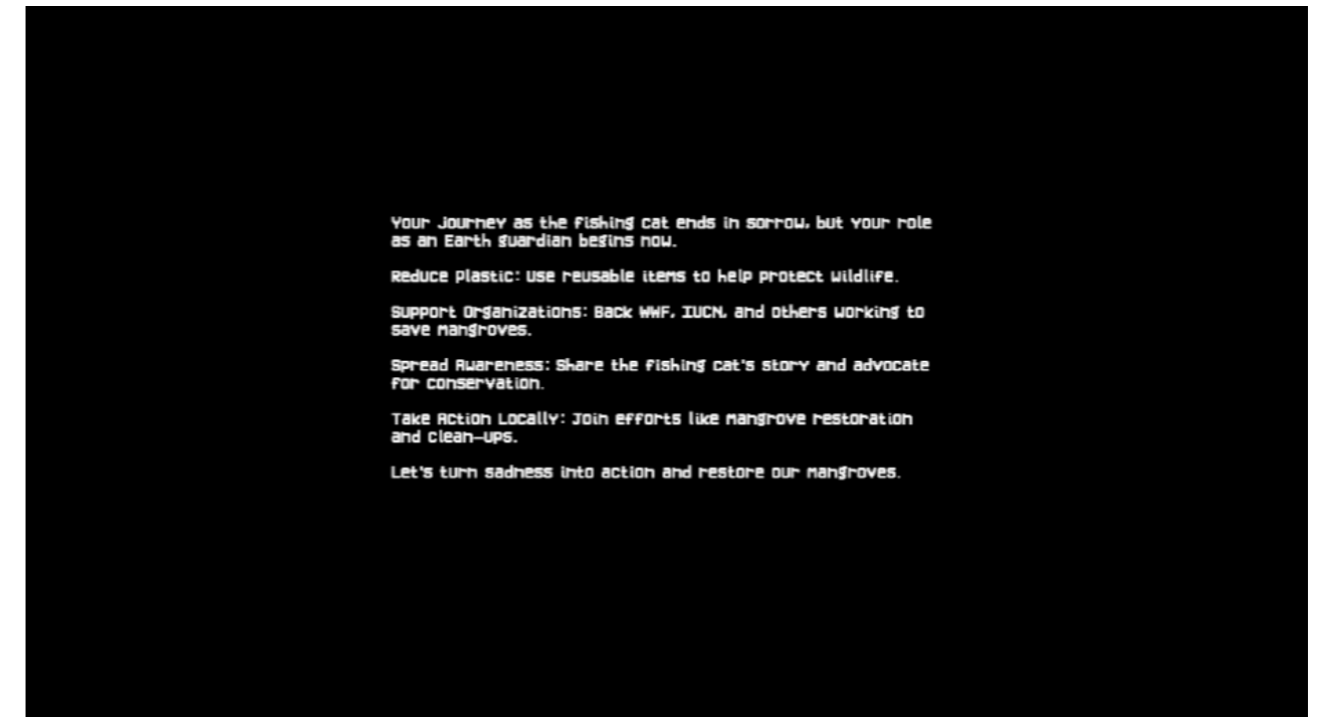


Fig. 64-67. Come Back Home Game Experience, Yining Lai, 2024.

Section 4: Conclusion

Findings

Through this research, I have demonstrated the potential of video games as powerful tools for communicating environmental issues, fostering empathy, and promoting pro-environmental attitudes and behaviours. By integrating spatial storytelling and empathy theory into the MDA (Mechanics, Dynamics, Aesthetics) framework, games can effectively generate emotional resonance and inspire actionable change.

The project of the fishing cat navigating an urban environment illustrates how spatial narratives can immerse players in realistic scenarios that highlight the impact of human industrial development on ecosystems. This approach not only educates players about environmental challenges but also cultivates cognitive empathy for affected species and their habitats. The emotional engagement facilitated by this game design extends beyond the virtual world, potentially bridging the gap between digital experiences and real-world environmental stewardship. By allowing players to make eco-friendly commitments within the game and visualising the positive outcomes, we establish a connection between virtual empathy and actual pro-environmental behaviour.

The principles explored can be applied to a wide range of ecological issues, from climate change and deforestation to ocean pollution. By harnessing the emotional power of spatial storytelling in games, we can create a ripple effect of awareness and action, potentially influencing global efforts towards environmental conservation. In an era of rapid climate change and environmental degradation, innovative approaches to raising awareness and inspiring action are crucial. This study contributes to that goal by offering a framework for designing games that not only entertain but also educate and motivate players to become proactive stewards of our planet.

Future research should explore the long-term impacts of such games on player behaviour and investigate ways to scale this approach to reach broader audiences. Ultimately, this work underscores the untapped potential of video games as catalysts for positive environmental change, opening new avenues for interdisciplinary collaboration between game designers, environmental scientists, and educators.

References List

Bozdog, Mona, and Dayna Galloway. "Worlds at our fingertips: reading (in) what remains of edith finch." *Games and Culture* 15.7 (2020): 789-808.

Chris, Stone. "GTA IV: Building a Brave New World." *IGN*, 13 May 2012, <https://www.ign.com/articles/2008/03/29/gta-iv-building-a-brave-new-world>. Accessed 3 April 2024.

Chris, Stone. "The evolution of video games as a storytelling medium, and the role of narrative in modern games." *Game Developer*, January 7, 2019, <https://www.gamedeveloper.com/design/the-evolution-of-video-games-as-a-storytelling-medium-and-the-role-of-narrative-in-modern-games>. Accessed 33 April 2024.

Davis, Michael A. "An Overview of Environmental Themes in the Video Game Industry." *Geographical Bulletin*, vol. 63, no. 2, May 2022, pp. 97–108.

Emily Price "Endling: Extinction is Forever Makes You Play Through the End of the World." *Paste*, July 20, 2022, <https://www.vice.com/en/article/the-radical-environmentalism-of-the-sega-genesis/>. Accessed 2 April 2024.

Escolano, Victor James C., et al. "Intelligence-based Serious Game for Environmental Awareness: System Model and Evaluation." 2023 8th International Conference on Business and Industrial Research (ICBIR). *IEEE*, 2023.

Game Developer, Staff "The Importance of Emergent Narratives in Games." *Game Developer*, August 29, 2019, <https://www.gamedeveloper.com/design/the-importance-of-emergent-narratives-in-games>. Accessed 3 April 2024.

Grave, Gerben. 'Emergent Narratives in Games'. *Gerben Grave | Multiverse Narratives*, 7 May 2015, <https://multiverse-narratives.com/2015/05/07/emergent-narratives-in-games/>
Hák, Tomáš, et al. "Sustainable Development Goals: A Need for Relevant Indicators." *Ecological Indicators*, vol. 60, Jan. 2016, pp. 565–73. *ScienceDirect*, <https://doi.org/10.1016/j.ecolind.2015.08.003>.

Hameed, Asim, and Andrew Perks. "Spatial storytelling: Finding interdisciplinary immersion." *Interactive Storytelling: 11th International Conference on Interactive Digital Storytelling, ICIDS 2018*, Dublin, Ireland, December 5–8, 2018, Proceedings 11. Springer International Publishing, 2018.

Hunicke, Robin, Marc LeBlanc, and Robert Zubek. "MDA: A formal approach to game design and game research." *Proceedings of the AAAI Workshop on Challenges in Game AI*. Vol. 4. No. 1. 2004.

International Day for the Conservation of the Mangrove Ecosystem | UNESCO. <https://www.unesco.org/en/days/mangrove-ecosystem-conservation>. Accessed 16 Mar. 2023.

Isaac, Yuen. *Interactive Storytelling: Thatgamecompany's Flower*. Ekostories, March 30, 2012, <https://ekostories.com/2012/03/30/flower-thatgamecompany-nature/>. Accessed 2 April 2024. Blog post.

J. Clement. "Video game industry - Statistics & Facts." *Statista*, May 16, 2024, <https://www.statista.com/topics/868/video-games/#editorsPicks>. Accessed 14 March 2024.

Jason Koebler "The Radical Environmentalism of the Sega Genesis." *vice*, 27, January. 2017, <https://www.vice.com/en/article/the-radical-environmentalism-of-the-sega-genesis/>. Accessed 2 April 2024.

Jenkins, H. 'Game Design as Narrative Architecture'. *Computer*, vol. 44, Jan. 2002.

Jones, Dave. 'Narrative Reformulated: Storytelling in Videogames'. *CEA Critic*, vol. 70, no. 3, 2008, pp. 20–34.

Kioupi, Vasiliki, and Nikolaos Voulvoulis. "Education for sustainable development: A systemic framework for connecting the SDGs to educational outcomes." *Sustainability* 11.21 (2019): 6104.

Kirill Tokarev "The Development Process Behind Endling - Extinction is Forever." *Paste*, 21 July 2023, <https://80.lv/articles/the-development-process-behind-ending-extinction-is-forever/>. Accessed 2 April 2024.

Kokonis, Michalis. 'Intermediality between Games and Fiction: The "Ludology vs. Narratology" Debate in Computer Game Studies: A Response to Gonzalo Frasca'. *Acta Universitatis Sapientiae, Film and Media Studies*, vol. 9, Dec. 2014. *ResearchGate*, <https://doi.org/10.1515/ausfm-2015-0009>.

Lamm, Claus, et al. 'The Neural Substrate of Human Empathy: Effects of Perspective-Taking and Cognitive Appraisal'. *Journal of Cognitive Neuroscience*, vol. 19, Feb. 2007, pp. 42–58. *ResearchGate*, <https://doi.org/10.1162/jocn.2007.19.1.42>.

McElveen, Kathryn C. "Children and Nature: Psychological, Sociocultural and Evolutionary Investigations." Edited by Peter H. Kahn, Jr. and Stephen R. Kellert. Cambridge, Massachusetts: The MIT Press. 2002. Reviewed by Kathryn C. McElveen." *Journal of Political Ecology* 11.1 (2004): 6-7.

Patterson, Trista, and Sam Barratt. "Playing for the planet: How video games can deliver for people and the environment." (2019).

Plessis, Corné. 'The Becoming-Flower of Video Games: A Deleuzoguattarian Analysis of Thatgamecompany's Flower (2009)'. *Image & Text*, Jan. 2018. *ResearchGate*, <https://doi.org/10.17159/2617-3255/2018/n32a16>.

Ruch, Adam W. "Grand Theft Auto IV: Liberty city and modernist literature." *Games and Culture* 7.5 (2012): 331-348.

Ryan, James, et al. *Open Design Challenges for Interactive Emergent Narrative*. 2015. ResearchGate, https://doi.org/10.1007/978-3-319-27036-4_2.

Vaughan, Adam. 'Climate Change Challenge for Computer Gamers'. *The Guardian*, 31 Oct. 2010. *The Guardian*, <https://www.theguardian.com/environment/2010/oct/31/climate-change-computer-game>.

Wu, Jason S., and Joey J. Lee. "Climate Change Games as Tools for Education and Engagement." *Nature Climate Change*, vol. 5, no. 5, 5, May 2015, pp. 413–18. www.nature.com, <https://doi.org/10.1038/nclimate2566>.

Young, Ashley, Kathayoon A. Khalil, and Jim Wharton. "Empathy for animals: A review of the existing literature." *Curator: The Museum Journal* 61.2 (2018): 327-343.

Zhang, Qiaomin, and S. Z. Sui. "The Mangrove Wetland Resources and Their Conservation in China." *Journal of Natural Resources*, vol. 16, Jan. 2001, pp. 28–36.

Figures

Unattributed figures belong to the author.

Fig. 1. Number of gamers as a proportion of total population, Newzoo Global Games Market Report, 2019, Newzoo <https://newzoo.com/resources/trend-reports/newzoo-global-games-market-report-2019-light-version>

Fig. 2. Timothy K. Mangrove forest located in the Mida Creek - Malindi. Photograph, 2020, Unplash. https://unsplash.com/@t_kiman

Fig. 3. Les Sharp. Fishermen of The Mangroves. Photograph, 2019, Art Photo Travel. <https://www.tokyofotoawards.jp/winners/social/2020/Fishermen-of-The-Mangroves-1/>

Fig. 4-5. Final Fantasy VII. Square, PlayStation, 1997.

Fig. 6. Fate of the World. Red Redemption, Soothsayer Games, Lace Mamba Global, 2011.

Fig. 7-9. Flower. Director by Jenova Chen. Thatgamecompany, Sony Computer Entertainment, 2009.

Fig. 10., Fig. 20-Fig. 21. Endling - Extinction is Forever, Herobeat Studios. HandyGames. 2022.

Fig. 11.-14. , Fig. 15. Grand Theft Auto IV, Rockstars North, Rockstars Game, 2008.

Fig. 16. What Remains of Edith Finch, Giant Sparrow, Annapurna Interactive, 2017.

Fig. 17. Minecraft, Mojang Studios, Mojang Studios, Xbox Game Studios, 2011.

Fig. 18., Fig. 19. ABZÛ, Giant Squid, 505 Games, 2016.

Fig. 31. Super Mario Bros., Nintendo R&D4, Nintendo, 1985.

Fig. 33. Partha Dey, The fishing cat's wetland habitat is threatened across much of its range. Photograph, <https://dialogue.earth/en/nature/fishing-cat-in-troubled-waters/>

Fig. 41. Rain World, Videocult, Akupara Games, 2017.

