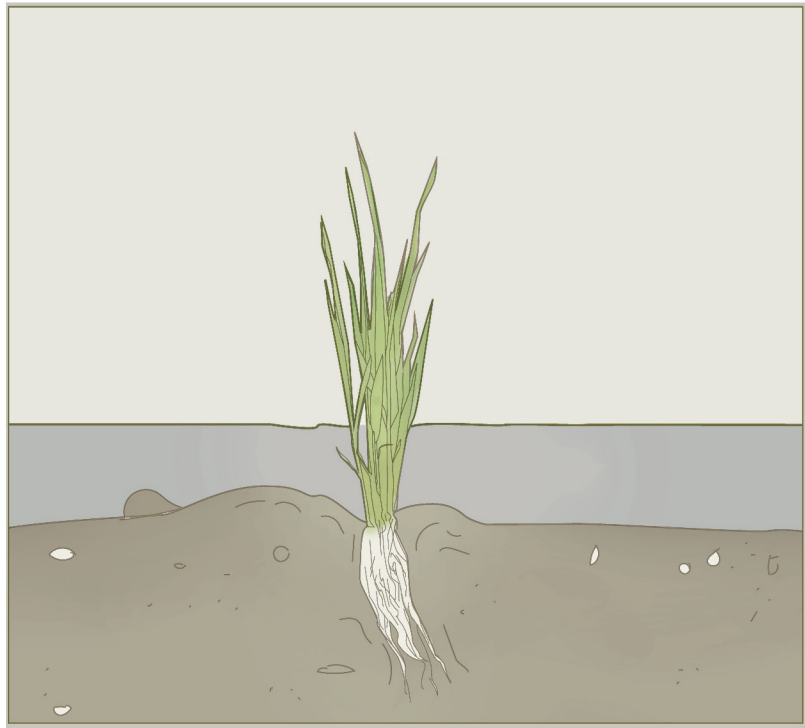


# 佐渡島物語



THE TALE OF SADO KATHERINE ANN CO

## 佐渡島物語

A SPECULATION OF FIVE EPOCHS

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KATHERINE ANN CO

# The Tale of Sado / 佐渡島物語

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**Master of Architecture**

in  
The Faculty of Graduate Studies,  
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The University of British Columbia  
May 2021  
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Fig.1 Map of Japan with Sado Island  
Highlighted, Author, 2020.

## Abstract

In the 3rd century BC, the first rice seedlings in Japan were gripped by human hands and tucked into a marshy pillow of soil. It was in these quiet moments where Japanese culture began, amongst the rice paddies of the countryside. Today, the rising sea levels induced by climate change threatens these rice paddies, and therefore, culture and community. This project imagines a possible future for outlying countryside landscapes and their inhabitants to create new relationships with each other and rediscover their local identity and culture amongst climate change. Ecological and demographic change are trajected and dissected factors in the future of the chosen location, the most notoriously isolated and abundantly beautiful island of Sado.





Fig.2 Aerial Photo of Sado Island, Stuart Rankin, 2015.



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# Acknowledgement

I could not have asked for a better group of minds and hearts to have brought through this journey.

Bill, thank you for giving me the space to explore and for cheering me on. Hanako, Chad and Danny, thank you for your time and for the memorable conversations.

Jed, thank you for the countless ways you supported me through this thesis. Thank you for reminding me to embrace my passions.

Thank you to my talented and sweet friends June and Kim for their time and help.

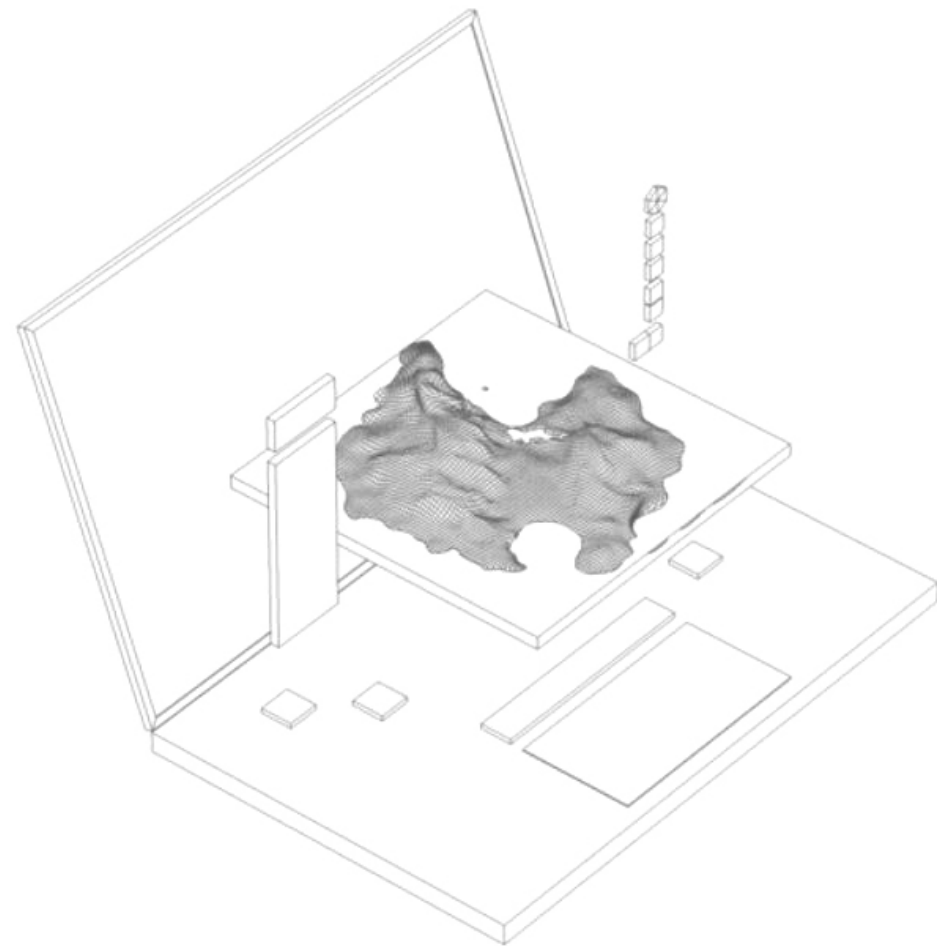
Thank you to Manuel, Shasha and Yekta for your encouragement and friendship.

Thank you all for inspiring me and believing in this project.

# Dedication

For my most loving, supportive, and *kulit* family  
Mom, dad, achi, and Cookie. For Jed. For Sonic.

# Introduction Pseudo-Sado/サド



1 Peter Matanle and Yuki Sato, "Coming Soon to a City Near You! Learning to Live 'Beyond Growth' in Japan's Shrinking Regions," *Social Science Japan Journal* 13, no. 2 (2010): 187.

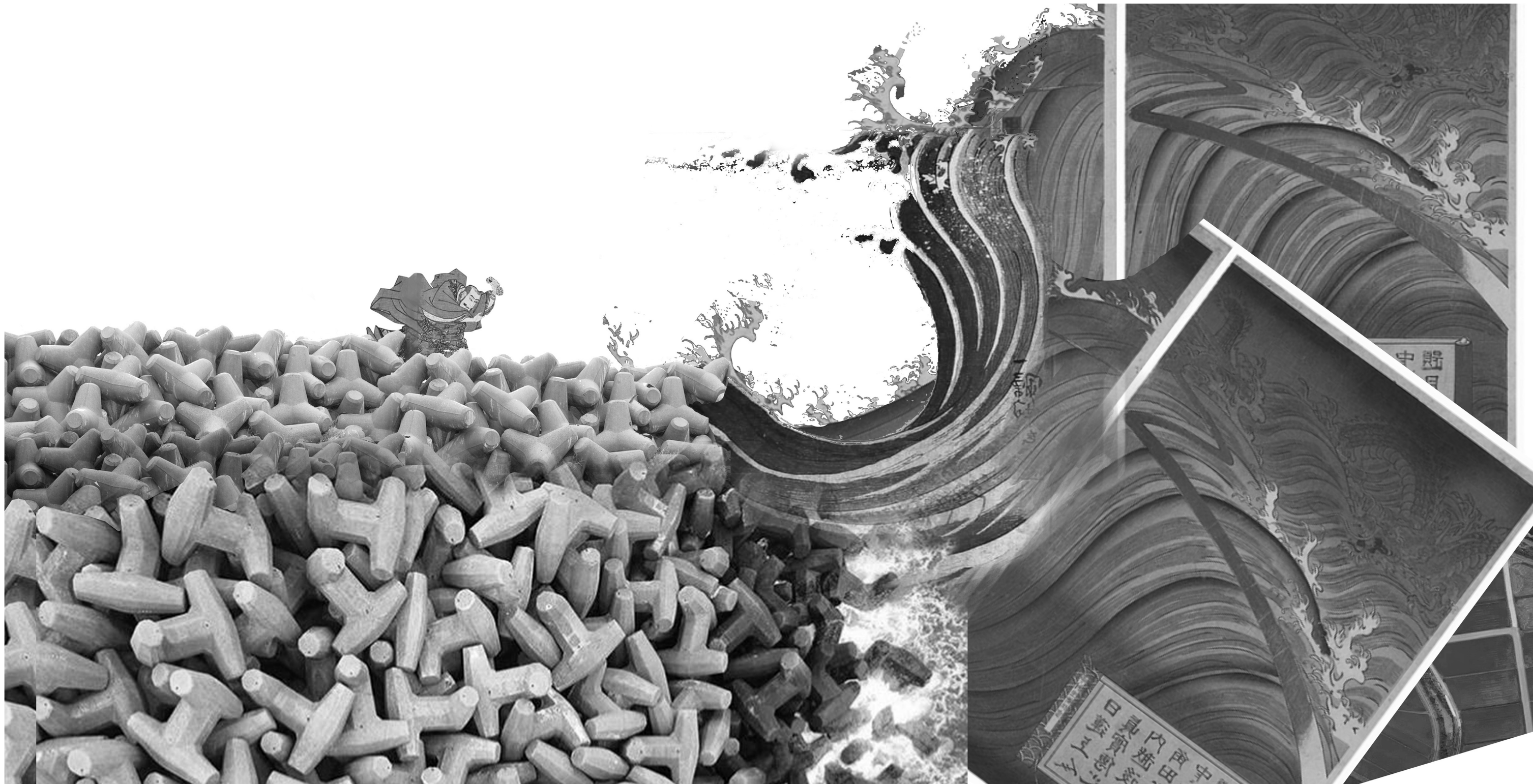
Left: Fig.3 Pseudo-Sado Illustration, Author, 2020.

This project is a combination of cultural and geographical research and architectural speculation. It is a pseudo-Sado, an amalgamation, a spatialized collage of google map views, Japanese and English sources, and a speculation of what may be. In its story, the island, the locals, the newcomers, and the nonhumans are the main characters that come together amongst rice paddies, become present in the moment and create a sense of ease through community and togetherness.

Sado island is a meeting point of drawing, story, and emotion. It has always been a place of growth through hardship. Throughout the island's existence, it has understood nature and its boundless power - a lesson we will all face in the coming years. The question is how will we live beyond growth' and beyond resistance? We can only build so many concrete tetrapods reinforcing seawalls against the ever-growing and enraged ocean waves.



荒海や  
佐渡によこたふ  
天河



Turbulent the sea Across to Sado stretches The Milky Way.

Above: Fig.4 Postcards From the Future, Author, 2020.







# On the Island サド島



Left: Fig.6 A Rice Farmer Sees a Japanese Crested-Ibis, Author, 2020.

*“It is not that rice was cultivated within the Japanese culture, rather it is Japan’s culture that was born from the rice paddies.”<sup>2</sup>*

## An Imaginary Memory

An elderly woman hunches forward looking down at the murky water. She is short and frail, but her work clothes are layered thickly under her wide-brimmed straw hat. Meeting her well-worn rubber boots is the warm rice paddy water. Her tired face softens slightly from its comfort as it contrasts the cold spring air. The water reflects her shadowed body next to the spontaneous and solitary ripples of wriggly tadpoles flicking from below. A slow elegant mass from above glides across the water’s surface. The woman, with her boots mounted in the flooded soil, stiffly turns her shoulders to look up at the sky. A Japanese crested ibis, with its wings extended, glides through the air weightless. Its outstretched wings are wide but so thin that they almost seem translucent. On the underside of its primary coverts of white is the most beautiful blend of an orange-pinkish hue that is so difficult to describe it earns its own name- toki-iro - the colour of the toki.

<sup>2</sup> “Tanada Terrace Office by Muji x Atelier Bow-Wow,” House Vision 2016 Tokyo Exhibition, <http://house-vision.jp/en/exhibition.html>.





Fig.7 Rice Paddies and the Satoyama in Sado, Shinya Ichinohe, 2011.

There is only one place in all of Japan to see this colour in its endemic setting, Sado island. The Japanese crested-ibis roosts in the tall cedars and ancient oaks on the hillsides and in the mountain forests so that it may survey its home range. It can only survive from the spatial variety of the satoyama, a tapestry of ponds, mountain forests, streams, floodplains, and paddies that flow, bend, and overlap each other on the landscape. Sado, a large island with its two parallel mountain ranges separated by a middle plain, warm tides, and mild winters, is the perfect host for many human and nonhuman ecologies to flourish. In particular, the rice paddies are a food source of bugs and amphibians for the ibis, but also for the small population of human residents. Because of conventional rice farming practises that used harmful chemicals, and that grew too competitive for some rice-growing families that abandoned their farms, the native crested-ibis became extinct on the island. Realizing the degradation of the satoyama, the people of Sado reviewed their environmental impacts and moved towards organic rice farming. After several new Japanese crested ibis from China were released onto the island, the native bird began to repopulate within the satoyama.



Fig.8 Sado's Rocky Coastline, Shinya Ichinohe, 2012.

This story reflects the creative and soft resilience found on the island of Sado. Once a place of imprisonment and exile, people from the mainland overheard the unique ways in which the islanders dealt with their adversities by turning them into something new. Amongst the hardened and banished political traitors, criminals, and religious outcasts, was a community interest in folk and traditional art, writing, song, and performance. Farmers sang the songs from famous Noh, the oldest form of Japanese theatre, while tending their fields. This collective love for theatre grew into community-driven projects to build Noh stages. On an island the size of Tokyo with the population of only fifty-six thousand people scattered across the edges and flatlands, Sado has always had a bold yet ancient attitude of adaptation and experimentation of new arts and practises. At times, this would emerge from the demands of the megacities on Honshu, carving a visible manmade crevice into the mountainside at Kinzan Gold Mine. And in other times, it would be purposely opening Kamo lake to the ocean in the Edo period, creating a brackish body of water to farm oysters and a love for seafood. In most its history, Sado has used its advantages of being an island far from the influence of the mainland to develop an unabashed effort in creating new spatial, environmental, and cultural configurations.





### The Pressures of the City

Across the sea, unseen yet foreboding, was the rest of Japan. Its densely beautiful and logistically challenging mountainous terrain would make anyone hesitant to believe it hosted one of the densest cities in the world. Japan's relationship to its landscape is a testament to its creative ability in developing an economically and technologically powerful nation while keeping one steadfast grip to its past and culture. Like many developed countries, industrialization and modernization are at the forefront of its success. The capital wealth attracted everyone from all parts of the country to move to places like Tokyo or Osaka, to get a chance at riches. This extreme migration to cities is a case that all industrialized cities are facing that poses a risk to the loss of local culture. With a lack of biodiversity and appreciation to the terroir, the changing climate can easily break down the fragile agricultural systems and cultures that are in place.

Without the diversification and evolution of the rural lifestyle, the world may become trapped into an ever-accelerating framework of profit in the city. Sado island becomes a testing ground freed from the most oppressing influences of the city to adapt to the ecologically and socially changing landscape as a part of taking control and assuring a place for tradition and values.

Above: Fig.9 Sado's City Center and  
Shibuya Station Density Comparison at  
Same Scale, Google, 2019.

Right: Fig.10 Sado Island Topography  
Map, Author, 2020.





# On the Farm 水田に

poro poro ぽろ ぽろ	The sound of rice spilling and falling all over
gutsu gutsu ぐつ ぐつ	The sound of a rolling boil
neto neto ねと ねと	A glutinous and gummy texture
paku paku ぱく ぱく	Gobble it up
hoka hoka ほか ほか	Warm and steamed
gohan o mori mori taberu ご飯を もりもり食べる	Eating rice hungrily

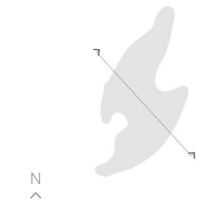
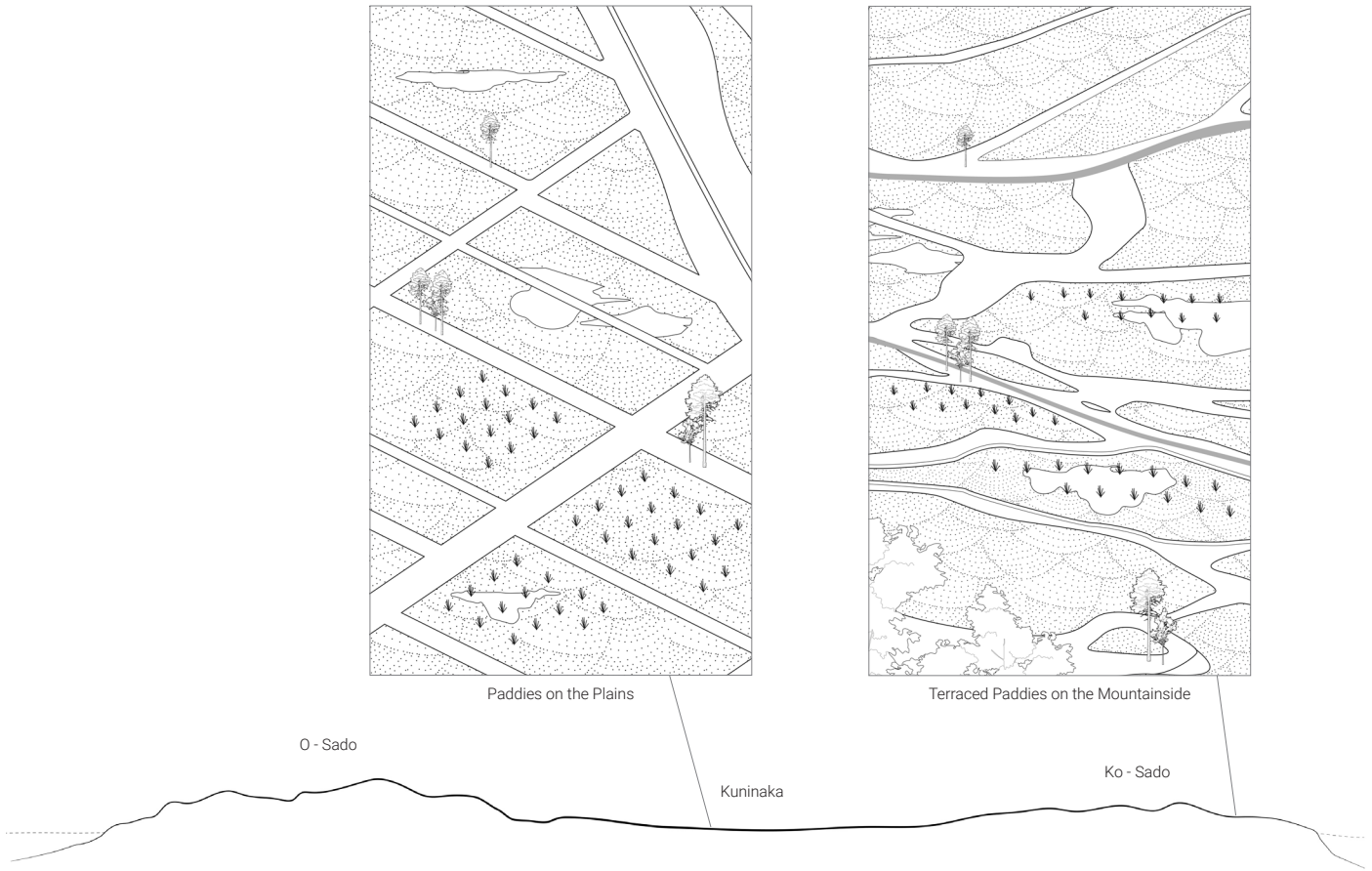


Fig.12 Sado Island Cross-Section and its Two Paddy Typologies, Author, 2020.

3 Evonne Yiu, *Sado's Satoyama in Harmony with Japanese Crested Ibis* (United Nations University Institute for the Advanced Study of Sustainability, 2011), 2.

Left: Fig.11 From Rice Grain to Cooked Rice, Author, 2020.

Rice farming is beyond the means of harvesting rice grains. It is the process that creates a sense of connection, responsibility, and respect to nature and other living things. It creates a year long ritualistic relationship with the land. The satoyama is a critical threshold in the Japanese countryside where agricultural land meets the perimeter of a forested mountain. It is the fuzzy meeting point of “secondary woodlands, plantations, grasslands, paddy and upland fields, wetlands, irrigation ponds, and canals”.<sup>3</sup> The growth and decay of biotic and abiotic systems constantly contribute to the soil, becoming a new layer of nutrients for future plant, bug, and animal life.

The satoyama's indistinguishable boundary promotes the migrations and ecological crossings of animals and insects that contribute to a diverse and enriched island environment. They all live their own lifecycles whilst influencing each other. The rice paddy is an important manmade landscape for these interactions to occur. Beetles feed on a nearby Japanese cedar with its voracious appetite. Ants and worms squirm through the soil in search of nutrition in the form of plant stems or leaves. In the same moment, a dark shadow flits by. A passing tadpole swallows a mouthful of murky paddy water and algae. The still water in the paddy allow algae and

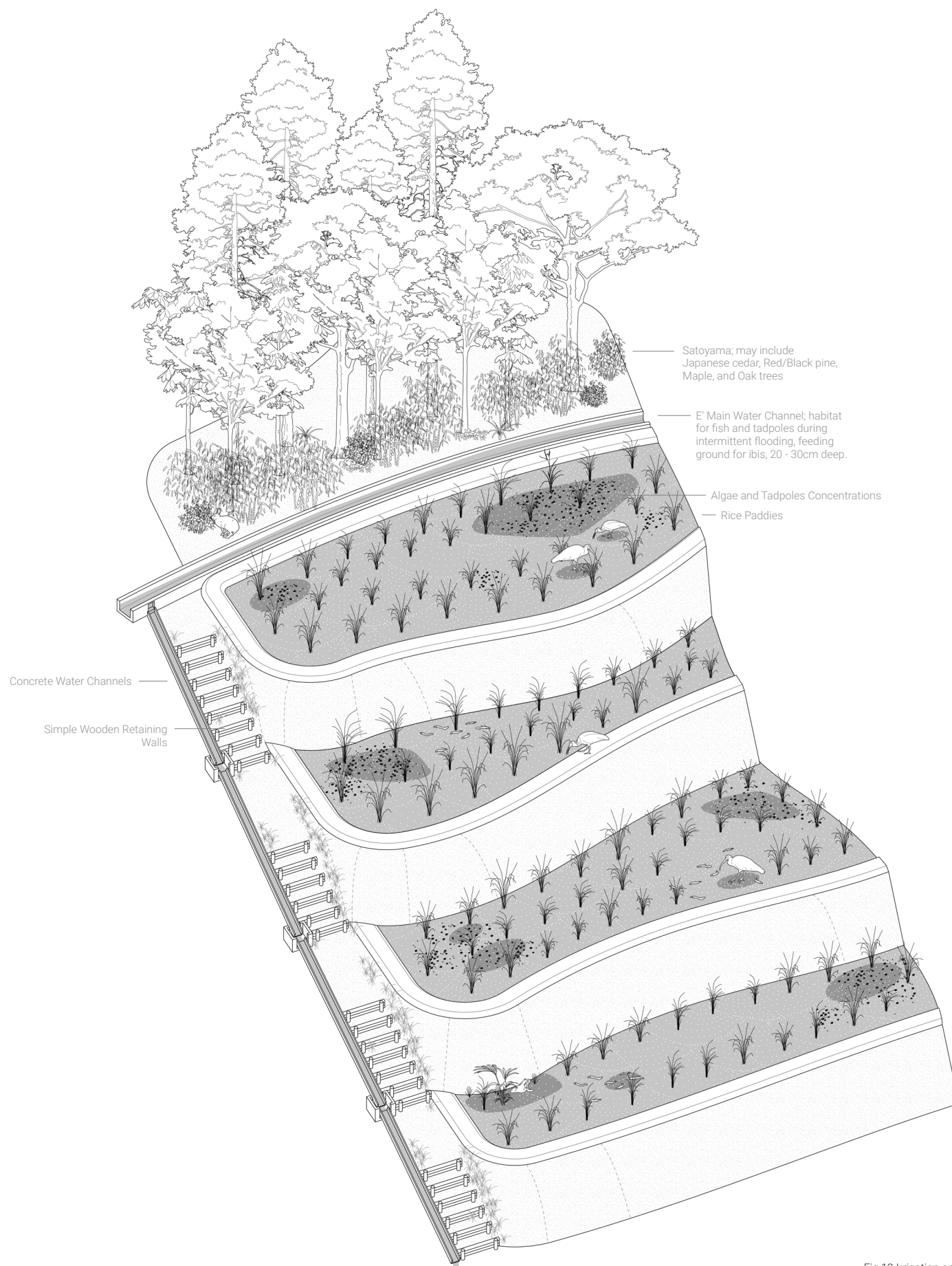


Fig.13 Irrigation on the Terraced Paddies, Author, 2020.

Japanese tree frog eggs to develop amongst the detritus of shredded bits of dead weeds and last year's harvest. In two months, that same tadpole will be preying on those insects as a frog if it manages to survive the crested ibis that frequents the paddy. All the while, the people on Sado maintain the paddies, tending the rice plants, and claiming their harvests in the fall.

People in Niigata prefecture have sculpted and cultivated rice using different methods through the centuries. It has only been in the recent century that the mechanization of the rice growing process has become more prevalent. Older methods of planting the paddies have not completely disappeared. This includes hand-planting in irregularly shaped paddies that cannot be planted by transplantation machines and using wooden tools to mark out the space for each seedling.

#### Climate Change

Climate change will come in several forms to Sado island such as sea level rise, more extreme weather, greenhouse gas emissions from irrigated rice fields, and river discharge. These studies project an estimation on how these systems will change through time and how important it is to consider them occurring simultaneously.

4 Yiu, 8

5 Estefânia Silva Camargo et al., "Intercontinental comparison of greenhouse gas emissions from irrigated rice fields under feasible water management practises," *Soil Science and Plant Nutrition* 64, no. 1 (2018): 59.

Sea level rise is a prominent topic in climate change discussions affecting coastal settlements. On Sado island, the most endangered area to sea level rise is the most populated and prosperous, the Kuninaka. Currently, the plains easily flood whenever there is intense rainfall. On the coast, there are drainage pump stations and concrete tetrapods that combat sea level rise and act as a buffer against violent sea waves.<sup>4</sup> For now, the present structures are preserving the island. But with the slow depopulation, weakening local economy, and increasing demands for larger and more robust anti-flooding projects, the future of Sado's infrastructural strength is questionable.

Greenhouse gas soil emissions is another issue that may evolve through time and affect the survival of the paddy ecosystem. Flooded paddies emit significant amounts of methane (CH<sub>4</sub>) and nitrous oxide (N<sub>2</sub>O), both



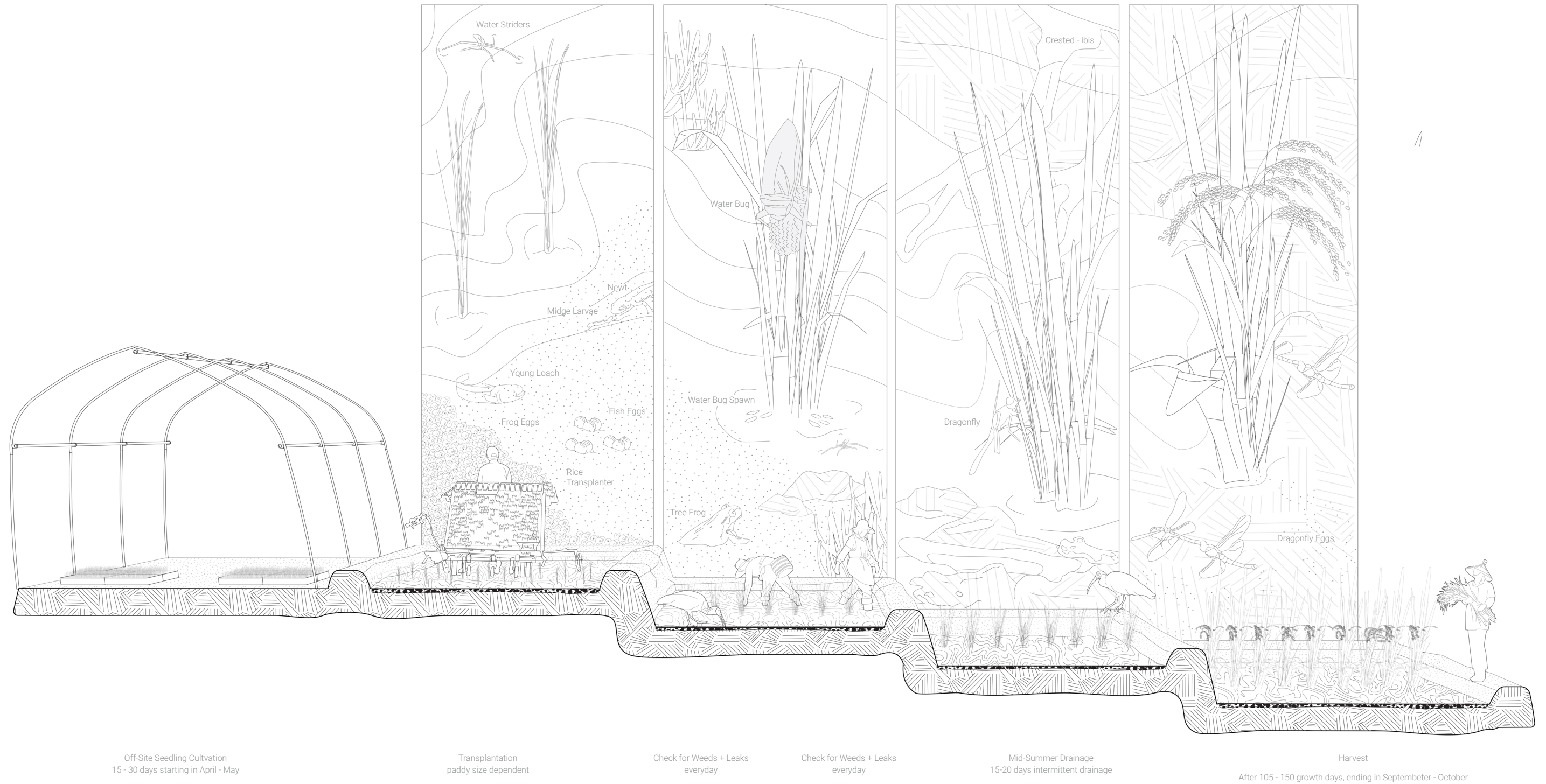


Fig.14 Cultivating Rice and the Satoyama Ecosystem Diagram, Author, 2020.

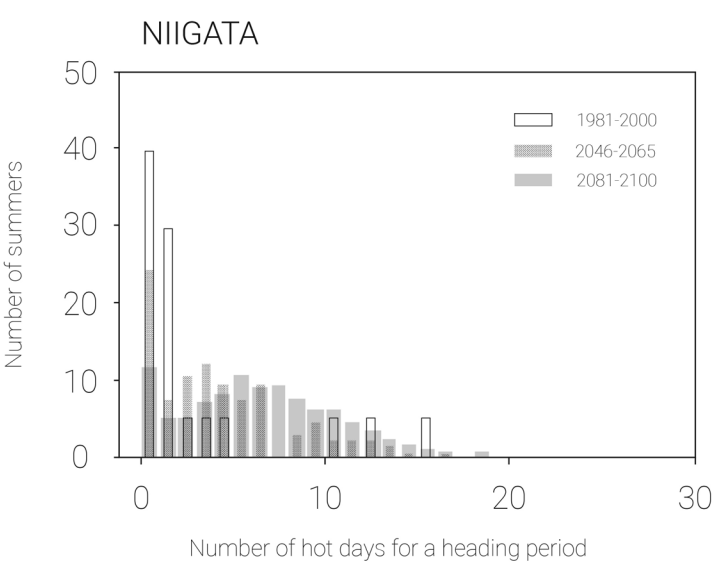
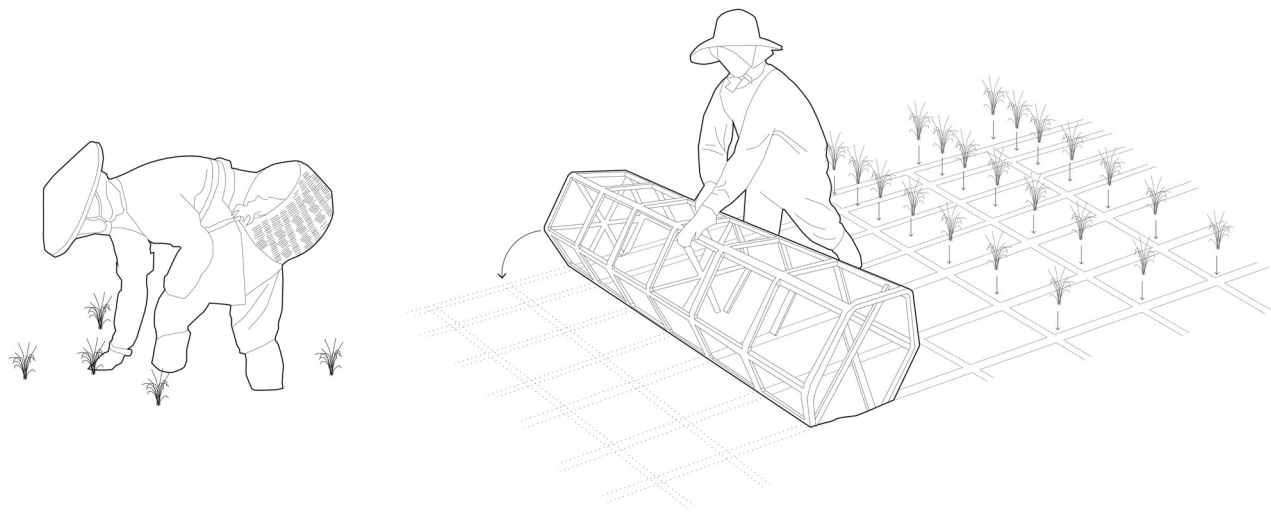
contributing anthropogenic global warming gases.<sup>5</sup> Camargo et al. show through their study on irrigated rice fields in Niigata, the prefecture that Sado resides in, and how intermittent irrigation systems reduce these emissions.<sup>6</sup> In this case study, intermittent irrigation was effective in lowering methane gas emissions when there was mid-summer drainage in the rice paddy. However, this data on intermittent irrigation becomes a more complicated issue when considering the biodiversity at risk of habitat loss. This study is imperative when considering the exponential decrease of methane gas emissions due to most rice paddies in the world adopting this farming practise. Soil emissions are part of a larger and more complex ecological system when overlaid with tadpole lifecycles within rice paddies and their foundational importance to the endangered crested ibis and biodiversity on Sado. If the intermittent flooding is done without reviewing the growth cycle of the tree frog, they would die and the weeds they used to eat would suffocate rice plants. Weeding is the most labour-intensive daily chore a rice farmer must do to avoid crops from dying, and this may result in the use of herbicides out of convenience.

Offsetting climate change effects cannot be done through one method, like the elimination of greenhouse gas emissions from the soil. Methane gas is harmful through the lens of global warming, as it is a predominant greenhouse gas. And, rice fields are the third largest methane emitter on Earth.<sup>7</sup> However, the waterlogged soil condition, and abundant organic matter of a paddy is necessary

6 Camargo et al., 66.

7 Edward Topp and Elizabeth Pattey, "Soils as Sources and Sinks for Atmospheric Methane," *Canadian Journal of Soil Science* 77, no. 2 (1997): 168.

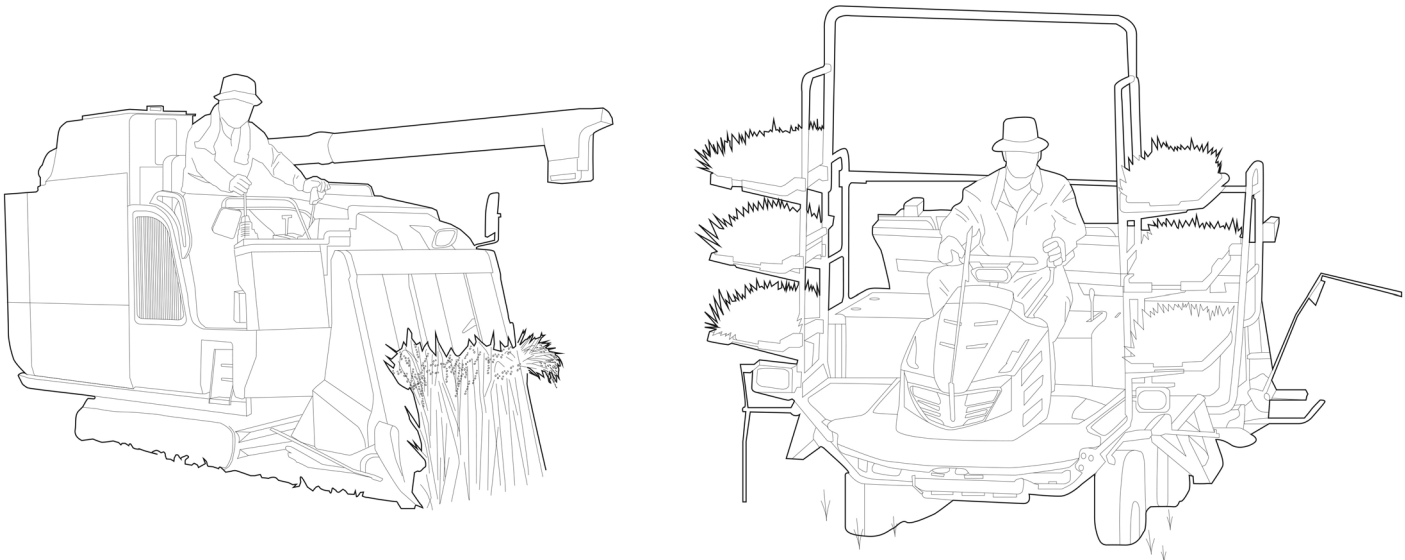
Below: Fig.15 Changing Rice Farming Technologies, Author, 2020.

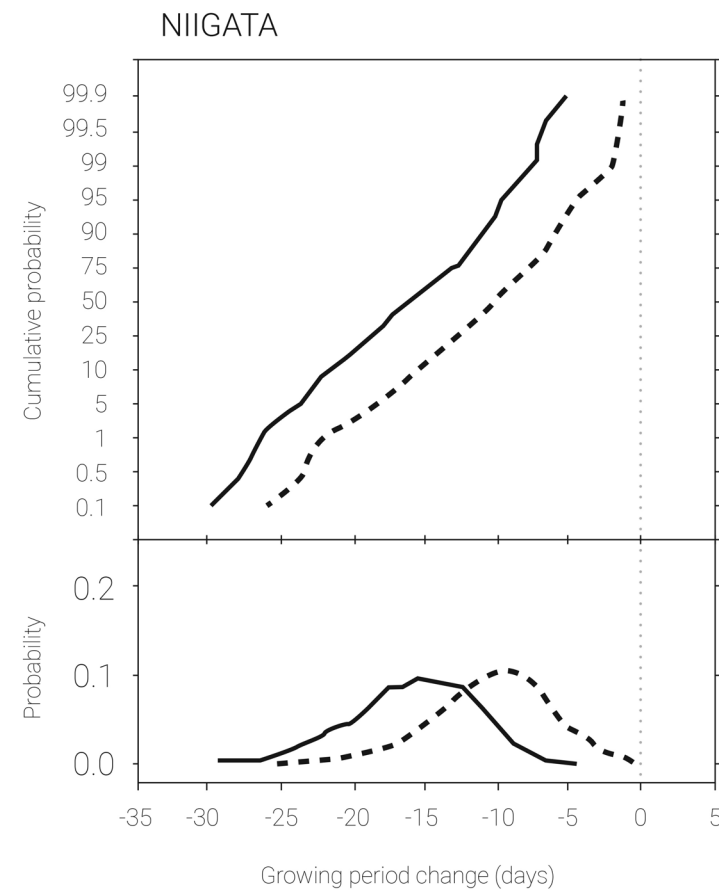


8 Topp and Pattey, 172.

Fig.16 "Histograms of Extremely Hot Days During a Flowering Period Projected for the 2050s and 2090s", Author, Data Acquired from Iizumi, Yokozawa, Nishimori's article in Climatic Change 107, no. 3, 2011.

for this ecosystem and is a natural part of the carbon cycle. Similarly, organic farming is critical to restoring agricultural soils that have been damaged by insecticides and herbicides. These chemicals, among their other side-effects, kill the soil's valuable microorganisms from developing, which can affect water retention and crop health. Yet, one could argue the methane emissions from organic farming, especially within the anaerobic soils of a rice paddy tended by tree frogs and other living species, produce too much global warming





emissions. Perhaps what is necessary is an equivalent methane sink<sup>8</sup> within the soil that occurs in the off-season on the rice paddies. The greatest challenge to these scientific projections is the uncertainty on how all these environmental systems that are constantly shifting, affect each other and become unbalanced.

Through the lens of national food security, Sado may become a larger contributor in Japan's economy and food production in the future because climate change will have a relatively milder impact on it. In projections for the 2050s to the 2090s, other rice-producing prefectures located in Kyushu or southern Honshu, such as Kumamoto and Aichi respectively, will experience significantly shorter seasons and an “anticipated spikelet sterility caused by heat stress.”<sup>9</sup> The lack of reliability on rice yields from rice farms south of Niigata may draw more attention, production strain, and demand for Sado rice. Additionally, Sado and other parts of its prefecture will experience an increase in rice yield due to a decrease in “cool-summer damage” frequency and intensity.”<sup>10</sup> Cool-summer damage occurs when the weather fluctuates during the summer

Above: Fig.17 “Cumulative Probability Density Functions of Growing Period Changes in the 2050s and 2090s”, Author, Data Acquired from Iizumi, Yokozawa, Nishimori's article in *Climatic Change* 107, no. 3, 2011.

9 Toshichika Iizumi, Masayuki Yokozawa, and Motoki Nishimori, “Probabilistic evaluation of climate change impacts on paddy rice productivity in Japan,” *Climatic Change* 107, no. 3 (2011): 403.

10 Iizumi, Yokozawa, and Nishimori, 408.

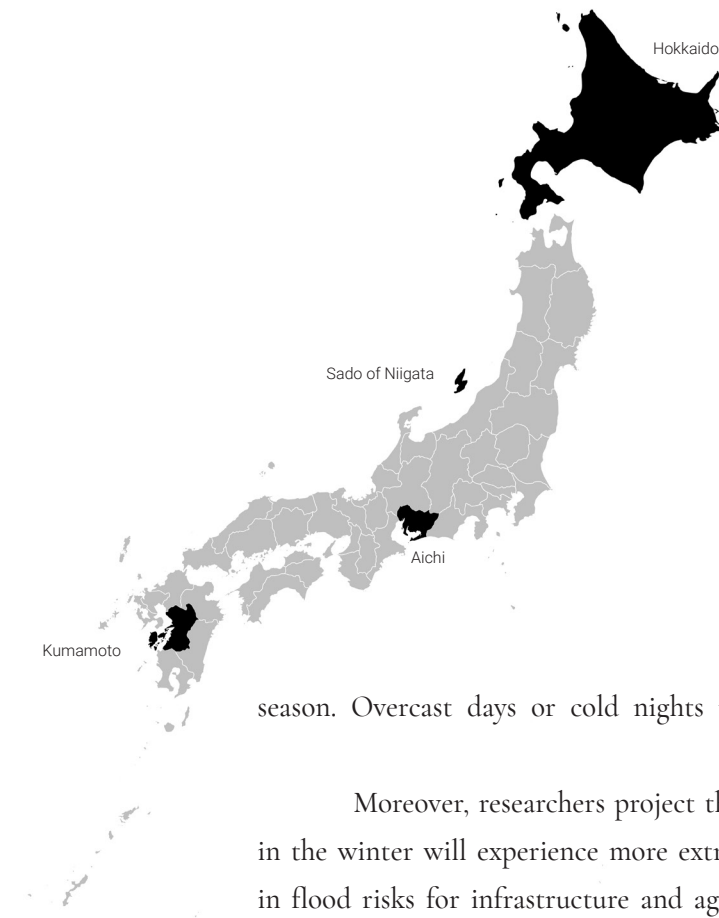


Fig.18 Four Prefectures of Japan Representative of Rice Production, Author, 2020.

11 Camargo et al., 62.

season. Overcast days or cold nights may stunt rice growth and harvest.

Moreover, researchers project that places with greater snow deposits in the winter will experience more extreme river discharge.” This can result in flood risks for infrastructure and agricultural land near rivers, rapid soil erosion and displacement of other anthropogenic and environmental debris. Sado receives two meters of, what is considered, low levels of snowfall. Its irrigation systems will be less likely be overwhelmed by a large amount of annual snowmelt and thus the rice paddies will have a more stable environment. When counting the quantitative data from these studies, it is easy to overlook the greater environmental biodiversity that it sustains. Climate change will impact Sado, like the rest of the world, in all forms of flood, drought, storm, and heat. The greatest challenge is imagining a community on Sado that accepts these conditions, weaves it into its culture, and changes alongside the climate and the landscape.

When counting the quantitative data from these studies, it is easy to overlook the greater environmental biodiversity that it sustains. Climate change will impact Sado, like the rest of the world, in all forms of flood, drought, storm, and heat. The greatest challenge is imagining a community on Sado that accepts these conditions, weaves it into its culture, and changes alongside the climate and the landscape.





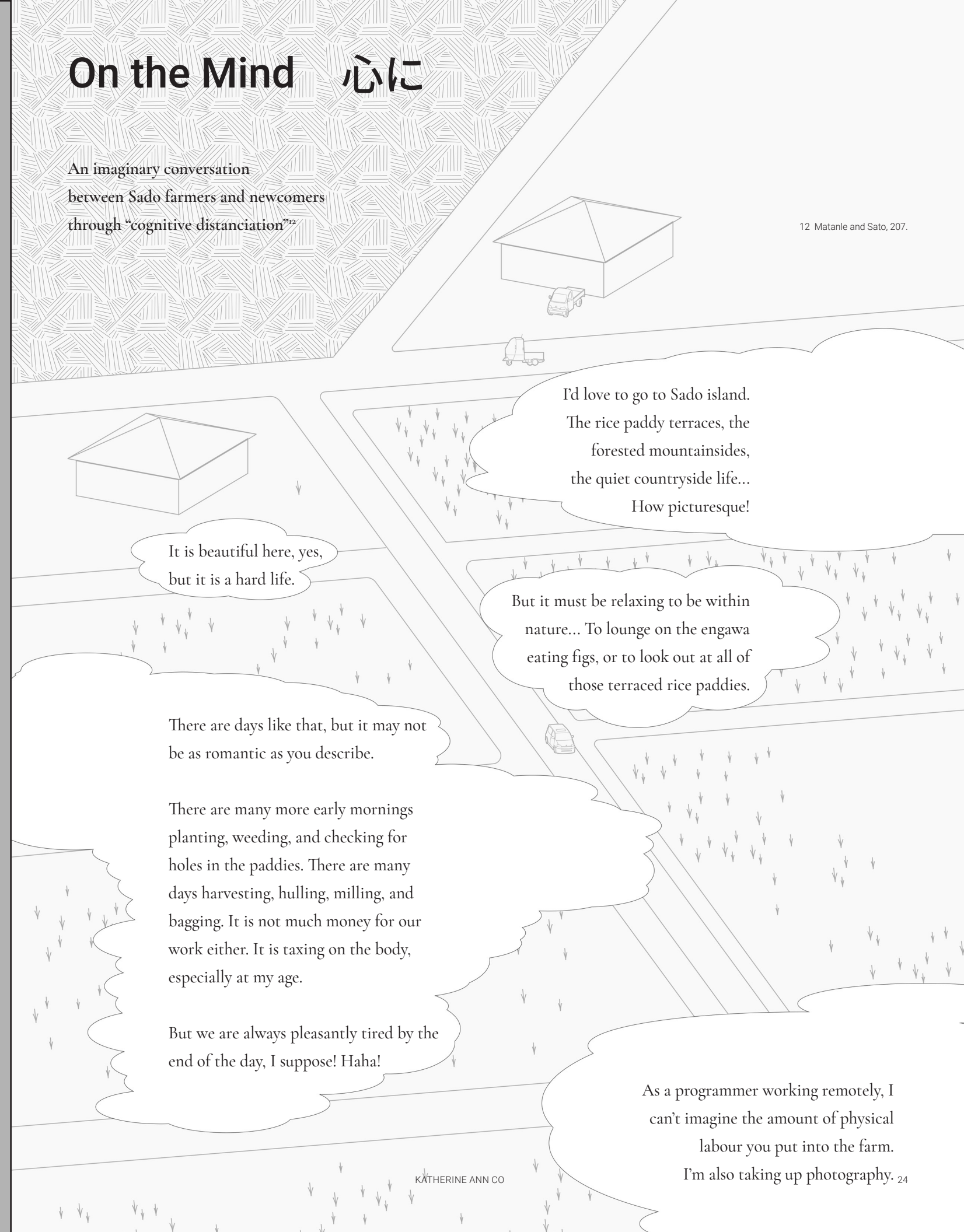
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Fig.19 A Speculative Future of Sado Island in 2100, Author, 2020.

# On the Mind 心に

An imaginary conversation  
between Sado farmers and newcomers  
through “cognitive distancing”<sup>12</sup>

12 Matanle and Sato, 207.



It is beautiful here, yes,  
but it is a hard life.

I'd love to go to Sado island.  
The rice paddy terraces, the  
forested mountainsides,  
the quiet countryside life...  
How picturesque!

But it must be relaxing to be within  
nature... To lounge on the engawa  
eating figs, or to look out at all of  
those terraced rice paddies.

There are days like that, but it may not  
be as romantic as you describe.

There are many more early mornings  
planting, weeding, and checking for  
holes in the paddies. There are many  
days harvesting, hulling, milling, and  
bagging. It is not much money for our  
work either. It is taxing on the body,  
especially at my age.

But we are always pleasantly tired by the  
end of the day, I suppose! Haha!

As a programmer working remotely, I  
can't imagine the amount of physical  
labour you put into the farm.  
I'm also taking up photography.<sup>24</sup>



I could move but for some of us here, we don't think of that possibility. There is a lot to do, and if I wasn't here, then no one would tend to it. I'm needed here by my neighbours, my ancestors, and my future generations to make sure I can pass this farmstead along to them.

Feeling needed and part of something greater than oneself is humbling and motivating.

When I was living in the city, I didn't feel needed. Unlike you and your family's farm, someone could easily take my place. I was a speck of dust floating. If my rent went up the next year and I couldn't afford it, I knew hundreds would be happy to take it. I never felt rooted to a place because the place did not want me. From all this moving around, "I am not particular about a place. I do not have this idea that I need to stay in one place for the rest of my life."<sup>13</sup>

The importance of feeling needed is beyond the minutia of urban life but a critical part to knowing and appreciating yourself in your community.

A few of our younger generations are returning to Sado. That doesn't always happen. That's why we have so few people left here.\* Most young people don't come back which means less children will take up our roles in the future. "For many people that leave, by the time they get a job and start to understand what they miss, it is impossible to come back."

These days, you need more than one job... Some people are unemployed while they travel, but that isn't sustainable for the life of a digital nomad. It crosses over the line and into being a long-term tourist. Why don't you move?

\* double-negative population disequilibrium phenomena

<sup>13</sup> Susanne Klien, "Young urban migrants in the Japanese countryside between self-realization and slow life? The quest for subjective well-being and post-materialism," in *Sustainability in Contemporary Rural Japan*, ed. Stephanie Assmann (London: Routledge, 2015) 95.

<sup>14</sup> Matanle and Sato, 188.

<sup>15</sup> Matanle and Sato, 204.

\*\* counterurbanization

<sup>16</sup> Klien, 96.

<sup>17</sup> Matanle and Sato, 207.

<sup>18</sup> Alyne Delaney, "Social sustainability in post-3.11 coastal Japan," in *Sustainability in Contemporary Rural Japan*, ed. Stephanie Assmann (London: Routledge, 2015) 11.

An encounter with a local during your travels is not the same as living 'like a local.' It is still a tourist experience. "One can't go hiking on the weekend as tourists do, there's work to be done!"<sup>17</sup>

The countryside does not work the same way that the city does. It is slow and the relationships you develop here take time and engagement to grow them. Relationships in Sado and rural Japan are critical to how hamlets and towns operate. They give a "role of civil society and collective action."<sup>18</sup> Not everything is easily available, marketed, or online.

I don't need to engage with social capital when I'm in Sado or another rural town. "One of the most important factors for any digital nomad in choosing destinations is access to the internet." It is difficult to enter a new community that has grown up with each other since childhood.

And even if I do give up my life travelling, I know I will not be accepted as someone who understands the struggle of countryside life.



Perhaps. People are stubborn. And it is hard to accept change. But we are learning to adapt slowly. And I think you would too. It can begin by understanding our role on Sado.

The "nature" that you spoke of before was to mean some rural landscape uncontrolled by humans, correct? But that's wrong. It has been cultivated for centuries by the people of here. The trees here, the flowers there, the stream over there. "Every bit has its history, not just the fields and the rice paddies. Someone's great-great-grandfather planted it, or cleared it, gathered firewood or picked mushrooms there."<sup>19</sup>

I have a love for nature and it's enlightening to see your relationship with it. It is a generational connection.

But when I see the paddies today, I see rectangle fields primed for transplanters, combine machines, and tractors. You don't commune with nature like people stereotypically believe. It simply isn't possible without machines or young people to work the fields for you.

People in the countryside have preferred the most convenient, logical, and strongest materials or methods of doing something. Perhaps it's the competitive city market that forces us to work too many fields. Regardless, work is work. Forces we can't control are our neighbours. We deal with landslides, floods, and heavy winds as they come in our own ways.

And yet, my urban life of "most convenient" and "most practical" has led me here. A modern life is to be in "cyclical scarcity and abundance."<sup>20</sup> In the city, I feel deprived of nature that has not been pruned or dropped into a tiny concrete box on the sidewalk. I crave for the sense of chaos and democracy between humans and non-humans that exists in Sado.

To make peace with nature and the beings that live in it, we have learned their way of life as clearly as we know our own. With traditions, though it may seem burdensome to people, comes the inheritance of specialized knowledge. Like kuruma-taue or how to weave sakiori.

My generation has grown up trying to be adaptable. Though we may not be experts at anything, we are flexible and, therefore, accepting of new ideas and traditions. We may also be great apprentices to arts and cultures that inspire us. I know that following your specialties does not mean an influx of commerce or new residents on the island... so that must be difficult to have to choose between your heritage and money.

We are trying to live on our own standard of "enough" for our population growth, our culture, and our rice.

We are trying to live "beyond growth."

21 Matanle and Sato, 187.

Fig.20 Multi-page Spatialization on Cognitive Distanciation, Author, 2020.

19 *Only Yesterday*, directed by Isao Takahata (1991; Tokyo).

20 Greg Richards, "The new global nomads," *Tourism Recreation Research* 40, no. 3 (2015): 343.



佐渡へと草木もなびくよ  
佐渡は居良いか  
住み良いか



Towards Sado, even the tree leaves and grasses are blown by the wind. Is Sado such a nice place to live?

Above: Fig.21 Postcards From the Possible Future, Author, 2020.

Coping with Climate Change

The planet is a constantly metamorphosizing composition of living and non-living things. This coincides with human’s relationship to the greatly changing climate and how its existence fluctuates. Beyond the discourse of technofixes, and engineering ecological efficacy, Donna Haraway and Thom van Dooren consider living with the inevitable mass extinction of countless species as a form of mourning “dwelling with a loss and so coming to appreciate what it means, how the world has changed, and how we must ourselves change and renew our relationships if we are to move forward from here.”<sup>22</sup> They bring to light what is lacking in today’s eco-conscious culture which is an emotional or ancestral connection to the planet. At the core of mourning is an empathetic understanding of grief and reflection. What the future hopes to emerge from this depressive sulking is a knowledgeable decisiveness with one’s actions. As apex predators, what sacrifices do we dictate and command upon the planet as acceptable for our benefit?

In contrast, mourning entails a devastating loss, with a definitive end of something’s existence. With climate change, that is not the case. It is a slow boil; we are frogs sitting in the pot, adding salt. Therefore, the idea of mourning as an outlook on our relationship with climate change is tangential to the larger concern on how humans will cope with climate change within the future.

Through the efforts of understanding and empathizing with the species that human’s risk for profit and power, comes the imperative destruction of the human ego. Ursula Le Guin shares the influence of literature and poetry as modes of tapping into the existential connection with the non-human. She writes an “awareness of belonging to the world, delight in being part of the world, always tends to involve knowing out kinship as animals with animals.”<sup>23</sup> By dissolving the delineation between animals and humans there is an intention to eliminate the current and past power structure. Originally existing as a way in normalizing and decriminalizing the mistreatment,

22 Donna Haraway, “Tentacular Thinking,” in *Staying with the Trouble Making Kin in the Chthulucene* (Durham: Duke University Press, 2016), 38-39.

23 Ursula Le Guin, “Deep in Admiration,” in *Arts of Living on a Damaged Planet: Ghosts of the Anthropocene*, ed. Anna Tsing et al., (Minneapolis: University of Minnesota Press, 2017) 15.

24 Munesuke Mita, “The History of Feelings of Transience,” in *Social Psychology of Modern Japan* (London: Routledge, 1992), 117.

25 Mita, 117.

26 Hirayama Toshijirō, “Seasonal Rituals Connected with Rice Culture,” in *Studies in Japanese Folklore*, ed. Richard Dorson (Bloomington: Indiana University Press, 1963), 64.

extraction, and exploitation of animal and environment destruction, there is a void that emerges from the melting glaciers asking humans to redefine our new relationship to the non-human and their struggle out of extinction.

Japanese Impermanence on Sado

In the act of humbling the ego, coping also revolves around the value, beauty, and acceptance of impermanence, a concept with a deep history to Japanese culture and ideals on Sado island. Impermanence (mujōkan) consists of perceiving change, and an “cathexis” into things that will die.<sup>24</sup> Therefore, mourning is only a portion of what a relationship with climate change means. When seeing the death, endangerment, and permanent end of a specie on an equal plane, humans may understand that no specie’s role is insignificant. No loss is inconsequential. Beyond inward-facing sadness, mujōkan embraces the “sensations of evanescence, of futility, of helplessness” as expressed “in a word as transience (utsuroi), either temporal transience (impermanence) or spatial transience (wandering or hyōhakukan).”<sup>25</sup> To explore even one instance of spatial transience means to discover its character, material quality, and temporality on land. Through the character of impermanence, it may or may not be physical. More importantly, it is a form of ritual that commands mindfulness and self-determined purpose that can be weaponized to fight the psychological burden of climate anxiety and green guilt. Spatial transience may depress lightly on the land, or be washed away in the storm, but it’s metaphysical power latches onto culture as a host to carry it, and us, through a future of living, coping, and dealing with climate change in a pleasant tussle for as long as we live.

For the people in Sado, the culture around nature is imbued with the beauty of impermanence. This permeates into rice planting culture in the form of the Spiral Rice Planting ritual called kuruma-taue. Along the sotokaifu, the coast facing away from the mainland, is Kitaushima village where this practise originates. Kuruma-taue is a ritual of three female rice farmers planting seedlings in a circular paddy. They start together from the center, working outwardly in unison. Transplantation, or taue, is a method that is traceable to the 5<sup>th</sup> century CE<sup>26</sup> that involves growing rice from seed elsewhere and planting

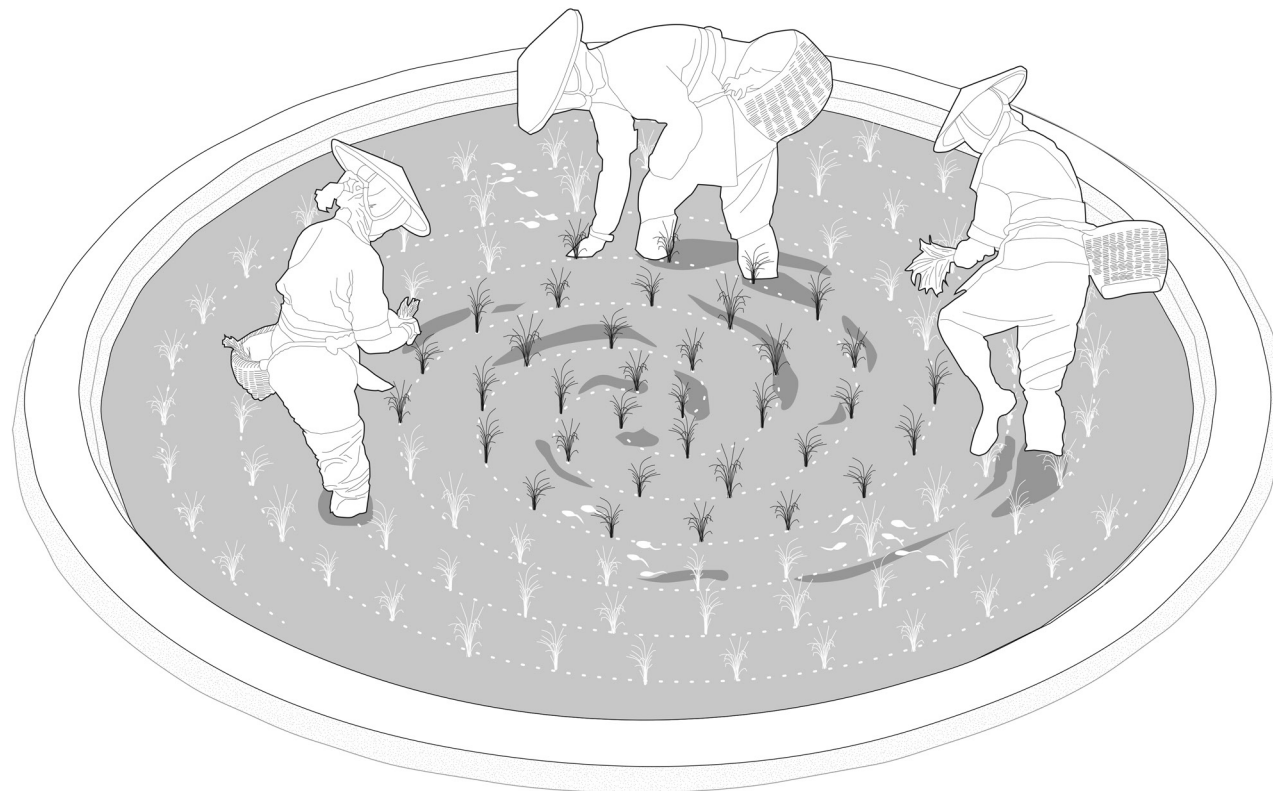


Fig.22 Kuruma-taue, Author, 2020.  
27 Fumika Taniguchi, "Kitaushima  
'Kuruma-taue' (Spiral Rice Planting)," *Kodō eNEWS* 8, July 2010.

it into a paddy. The tradition, both ritual and operative, is acknowledged as an "important intangible folk-cultural property" and has been passed down through generations for one thousand years.<sup>27</sup> Despite performing kuruma-taue each year, the people of Kitaushima may have an unfortunate season of rice yields and unsuccessful crops and they know this. Nothing is guaranteed despite all one does. Just as Kuruma-taue is a performance

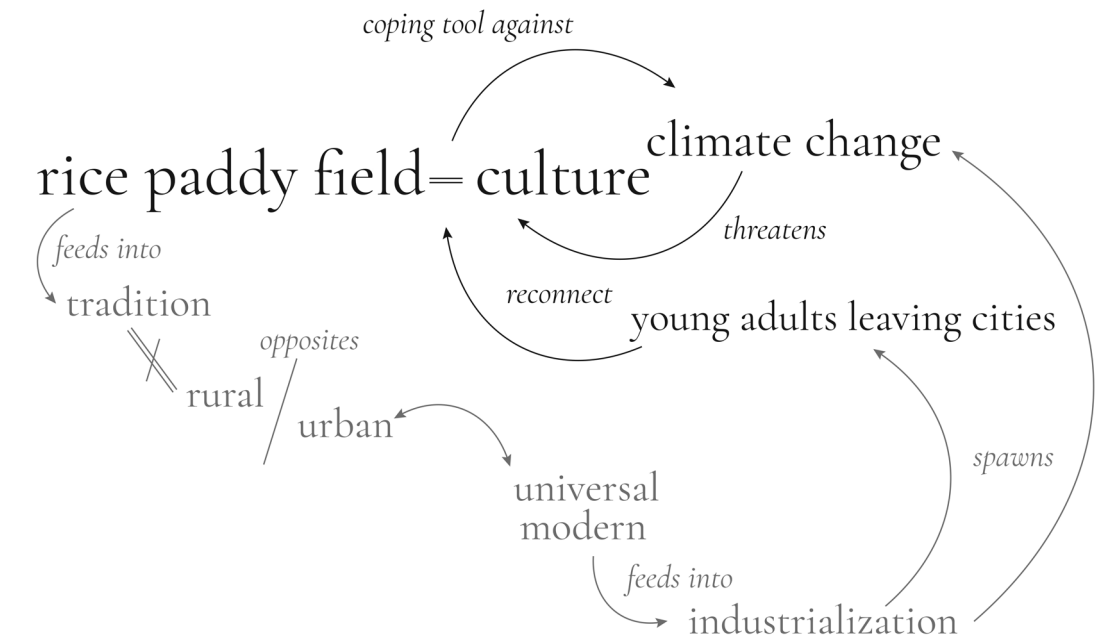


Fig.23 Rice Paddy and Culture Word  
Diagram, Author, 2020.

to wish for a good year of harvests, it exemplifies the quiet dominance of nature upon human fate. Yet the people in Kitaushima and in Sado do not live in fear of this uncertainty but take this time to celebrate and commune to create opportunities for a bountiful future in the form of rice planting. The tradition reinforces the community by reflecting how nature and agriculture is impossible in isolation but is possible through cooperation and influence of multiple people and species in a ripple-effect. An annual ritual such as kuruma-taue is a powerful way to strengthen a community through uncertain times.

Additionally, as much as kuruma-taue is an expression of growth and new beginnings, it anticipates the death of the planted crops as the source of birth for the next year. Steven Heine explores how the folk knowledge and religious contemplations of Buddhism and Taoism influence Japanese people and the rice paddy when documenting "The Meaning of Impermanence in Japanese Religion." He writes "the transformation from rice cultivation to mind contemplation is a multivalent process of shifting away from folk objectivism to contemplate subjectivism, and away from folk and Buddhist negation of death to folk affirmation of life by the way of Buddhist nonduality



of life and death.”<sup>28</sup> When given the same optimism and attention towards death as life, people in the rural landscape can draw the hope from a historical past where the securities of technology, data, and calculations were inexistent and see the uncertainty of future as “the precious thing.”<sup>29</sup>

When considering a rural landscape in 2100, one must consider how the concept of global warming is acclimated into modern Japanese culture and what, if anything, would be the source of anxiety. Anna Tsing in *Arts of Living on a Damaged Planet* presumes “as humans reshape the landscape, we forget what was there before. Ecologists call this forgetting the ‘shifting baseline syndrome.’ Our newly shaped and ruined landscapes become the new reality.”<sup>30</sup>

This is when rice rituals and other similar cultural traditions, both material and immaterial, become imperative pillars to a collective sense of identity. By neglecting the baseline, society and the industries that control it may forget, while amidst grand infrastructural projects, what people see as comforting, beautiful, or multivalent. Likewise, climate change, conceptually, will not be what causes a need to cope, but watching the small and slow moments of cherished characters of our environment becoming extinct. Literature and poetry revolving around impermanence commonly expressed grief and loss especially during times of war and change. There were poems in the 1930s that used key words symbolizing a modernizing Japan, and the sadness of the loss of Old Japan.<sup>31</sup> In the 21st century, Japan has an established modern identity as a developed country and all that it entails. The desire to mourn for a Japan before the 30s is stifled by the millions of people who have only known this modern kind of Japan.

In 2100, when we are in the midst of climate change and it is our childhood friend, the younger generations will not feel the same aching helplessness and desolation. What is yet to still cope with are the specific relationships the future generations will create with the land, the animals, bugs, trees, and rocks, and learning the importance, beauty, and nonduality of impermanence.

# The Tale of Sado 佐渡島物語

For decades we have seen the graphs, the charts, the formal letters, and petitions signed by scientists. The problem seems so far away yet we also know it is already here. Its presence is not felt because we cannot perceive the time scale in which climate change moves, and therefore cannot comprehend that what we hold dear may be lost. Climate change is not just the great pulses of ecological devastation. It is a pressuring and tightening grip felt as we slowly lose our familiar landscapes, beloved species, and therefore, our traditions and cultures that pivot on the ecological structures that have given humanity hope and stability for generations. A city may have its wealth, power, and resources to combat the effects of climate change, but it is the countryside that is most vulnerable and yet the most able to implement change.

How will we cope with climate change? How can we see our future that isn’t soaked in dream-drunk optimism or misanthropic ruination? How can we see how our actions can influence our future? This story is told in five epochs in the future, twenty years apart. It attempts to lay threads in its story and speculate on how they influence a possible future for the people living in Sado Island, Japan and how they might cope with the changing landscape.

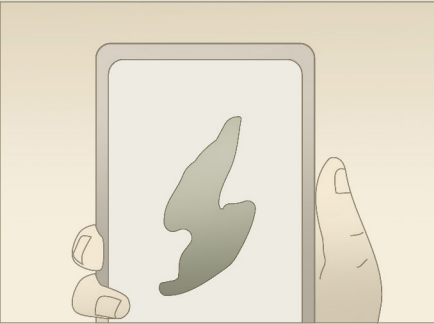
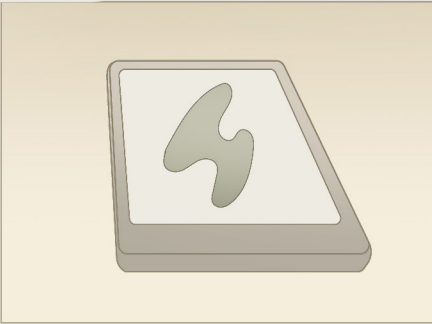
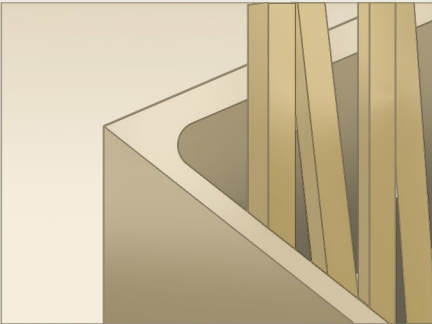
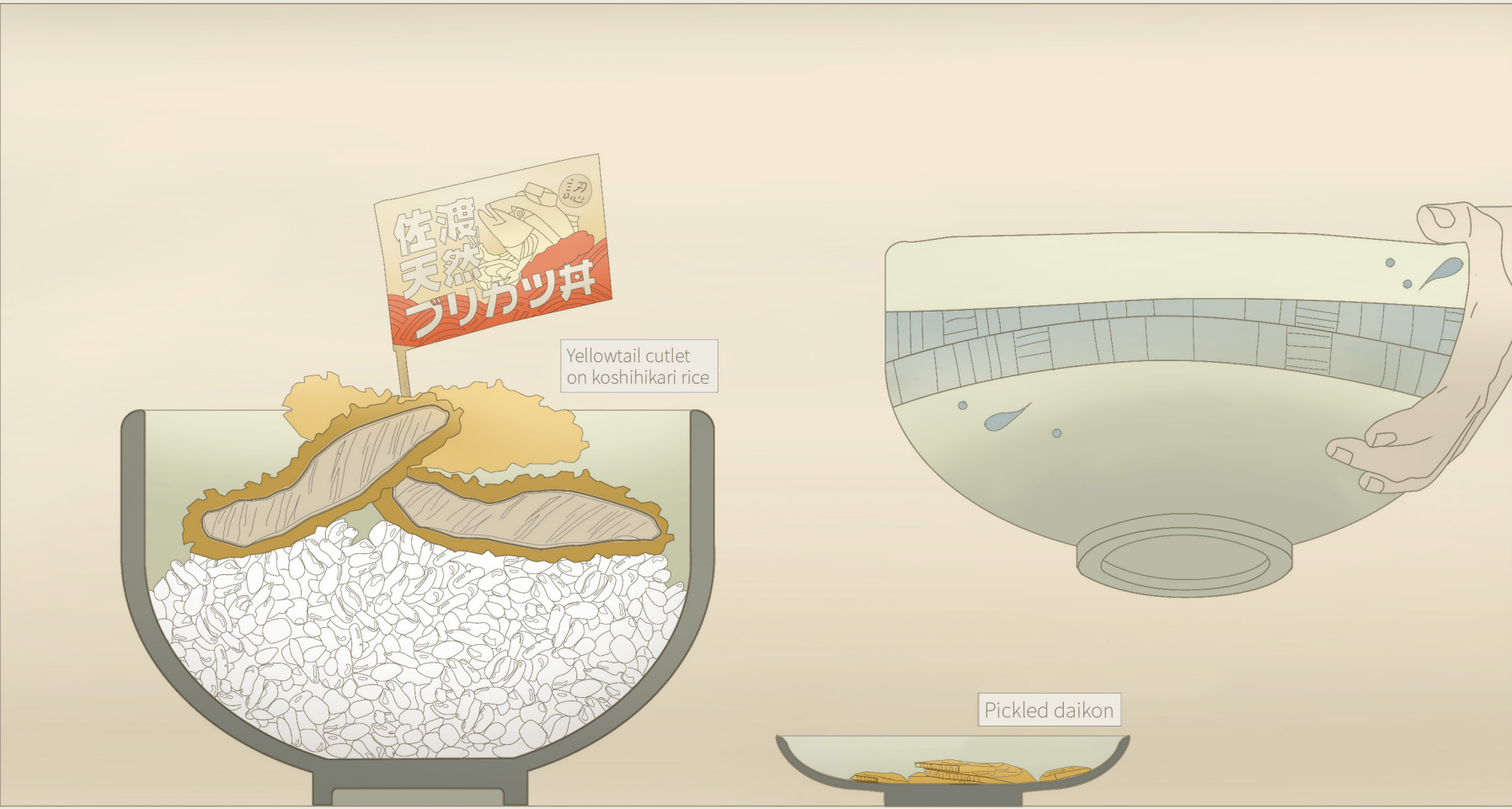
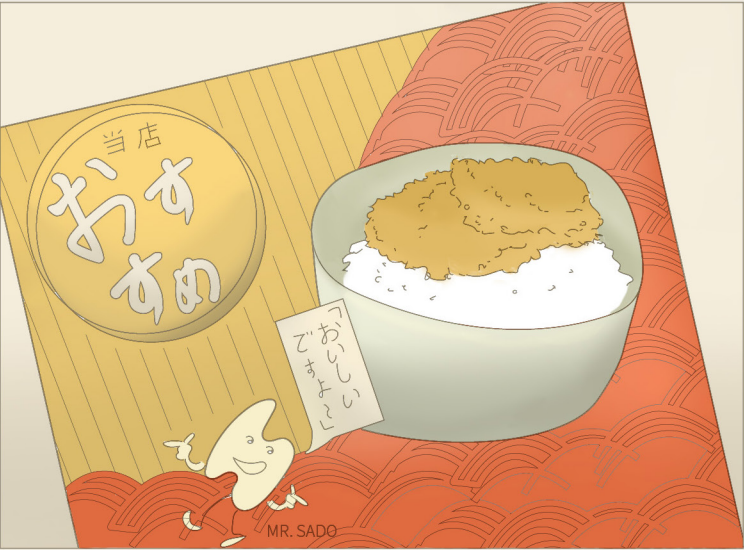
28 Steven Heine, “From Rice Cultivation to Mind: The Meaning of Impermanence in Japanese Religion,” *History of Religions* 30, no. 4 (1991): 401.

29 Yoshida Kenkō, *Essays in Idleness*, trans. Donald Keene (Tokyo, Tuttle, 1967), 18.

30 Anna Lowenhaupt Tsing et al., *Arts of Living on a Damaged Planet: Ghosts of the Anthropocene*. (Minneapolis: University of Minnesota Press, 2017), 6.

31 Mita, 124.

2020



A young girl named Ai and her mother Hana eat at a restaurant on the side of the highway. It's Ai's first time seeing her mother's birthplace, Sado Island. In her bowl, Ai has thick pieces of deep-fried amberjack, a hearty fish that is a specialty on the island. It's served on a bed of rice.

Her mother shares her memories eating this dish. She says, "I remember my grandmother lecturing me when eating this because I always had rice left over." The type of rice in their bowl was koshihikari, Sado's most popular kind of rice.

Fig.24, Author, 2021.

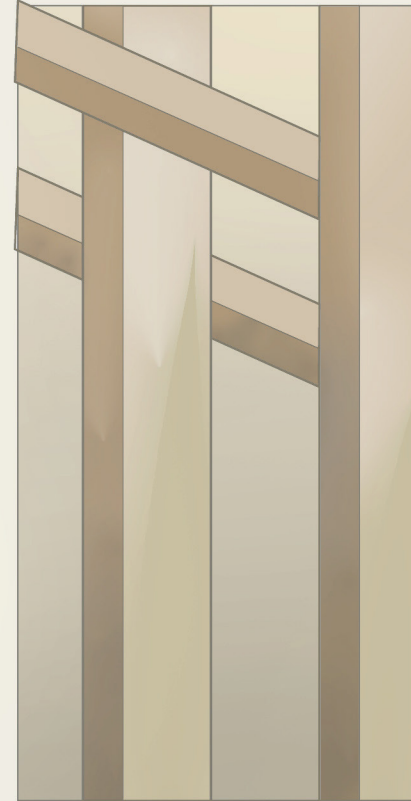
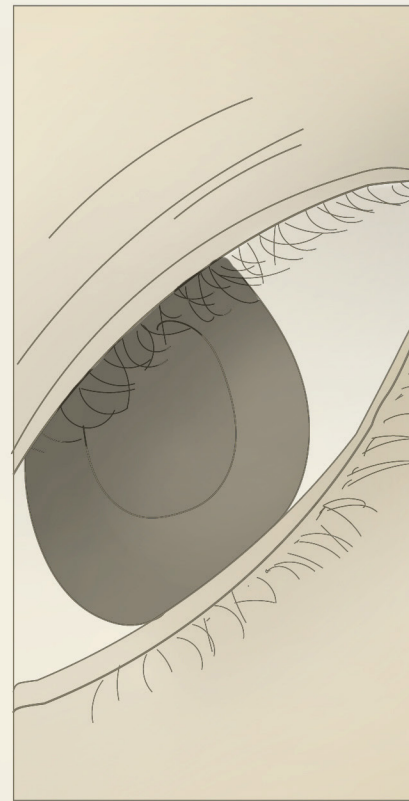
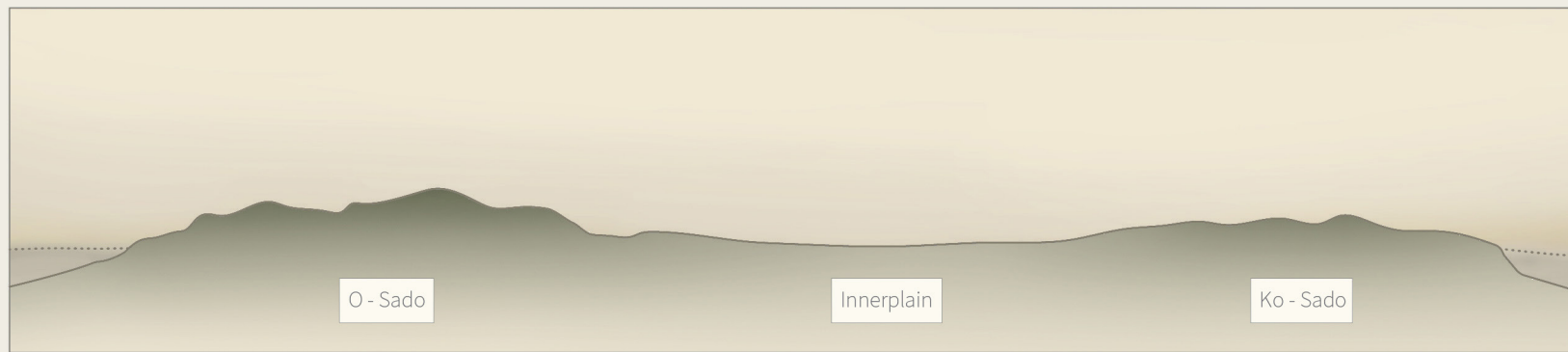
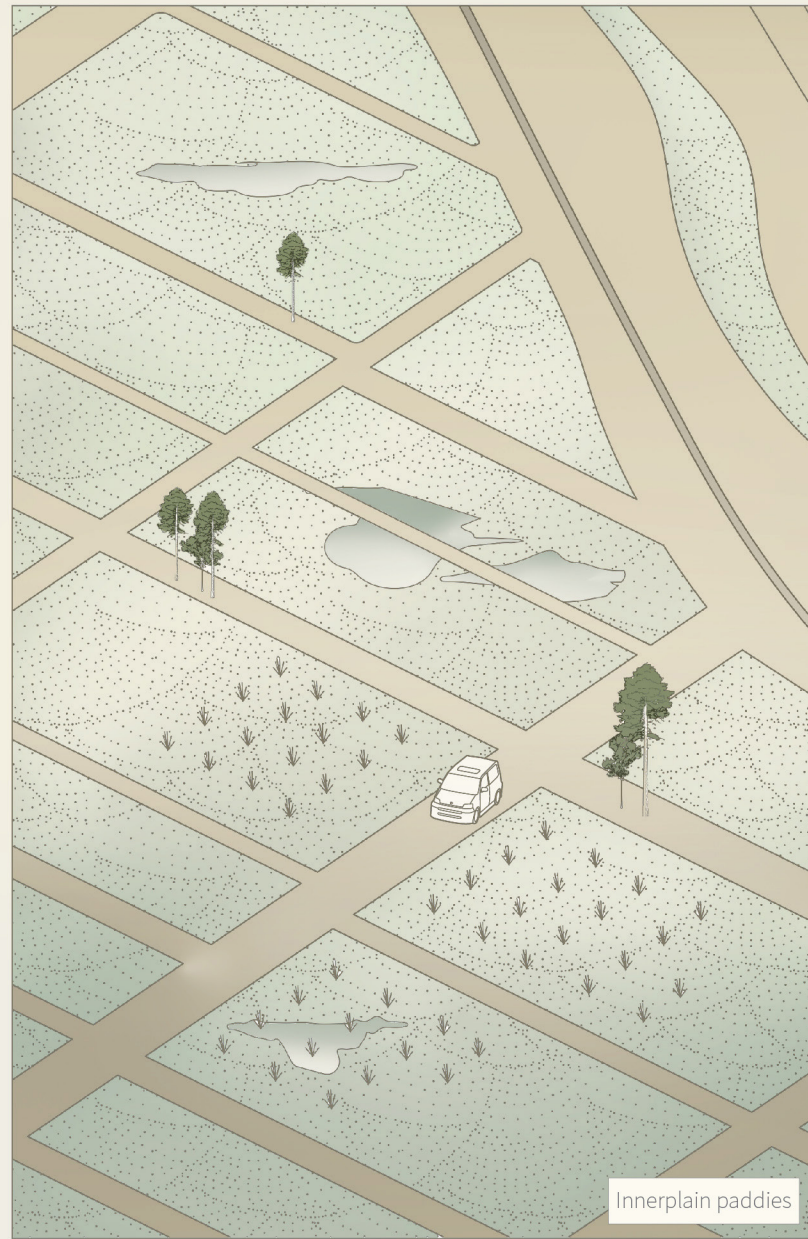


From the sky, Sado looks like a butterfly. It has two mountain ranges running parallel, with a flat inner plain in between. The trip from the city to Sado took two bullet trains, and a jetfoil ferry.

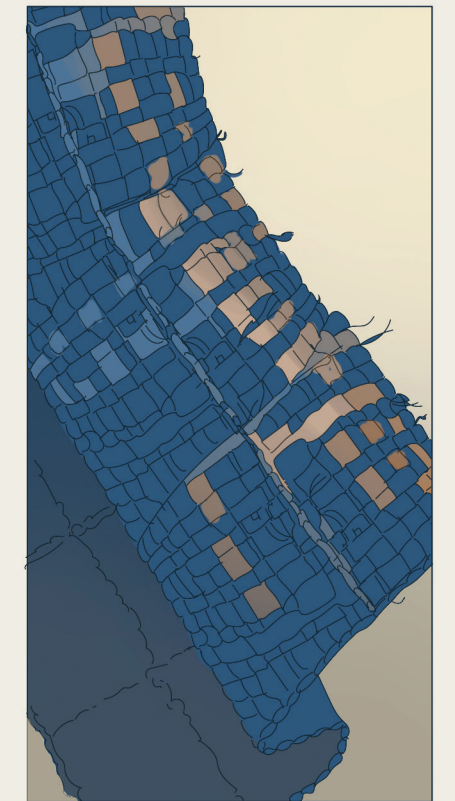
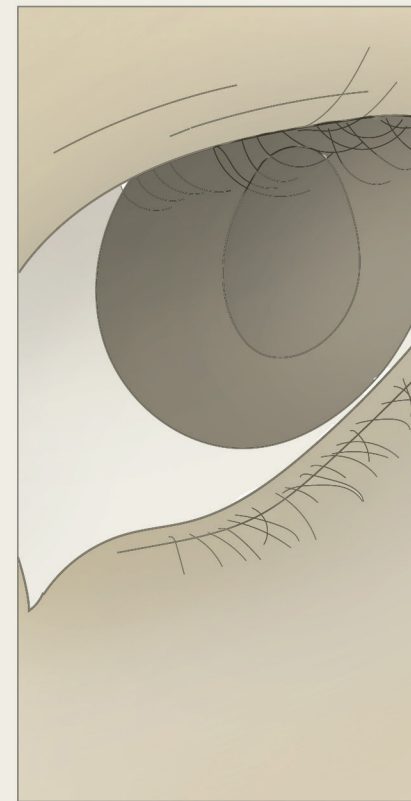
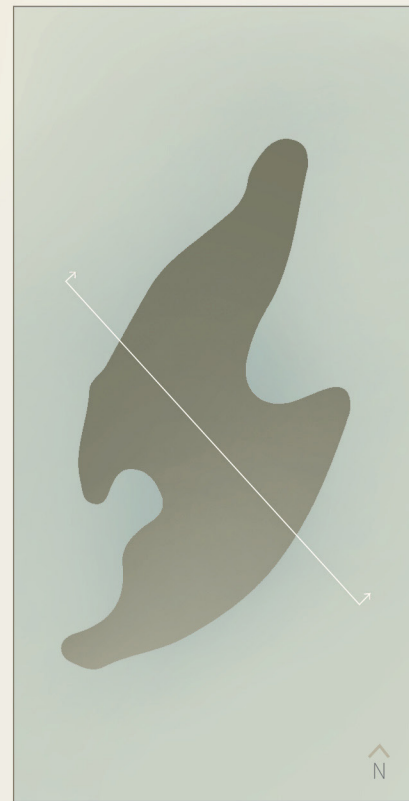
Fig.25, Author, 2021.



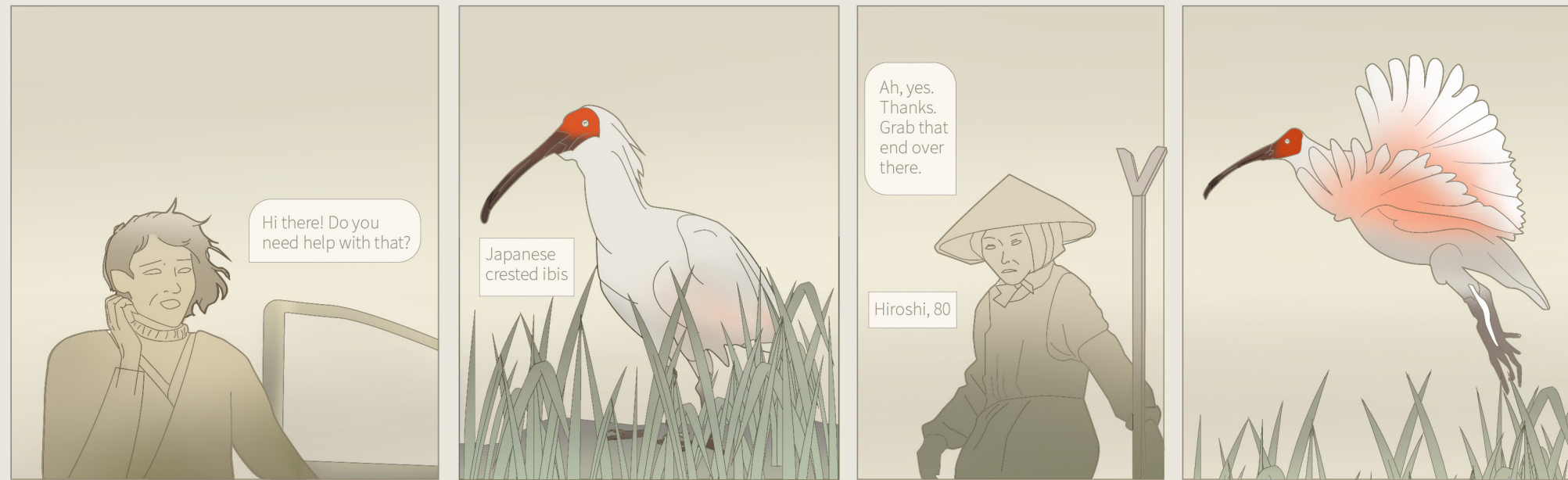




They see all kinds of rice paddies - some bending around hillsides, some flat and some square. On their way to their new home along the mountainside, Hana spots an unfamiliar form, a structure across the flat landscape.







Hana gets out of her car, nearly falling backwards from the wind. She offers the nearby farmer an extra hand in lifting what looks to be a blanket up upon a structure. “What is this?” “A few of my neighbours and I weave these sakiori mats. We’ve been having a lot of strong winds. In this way, we can easily see the winds blowing.”



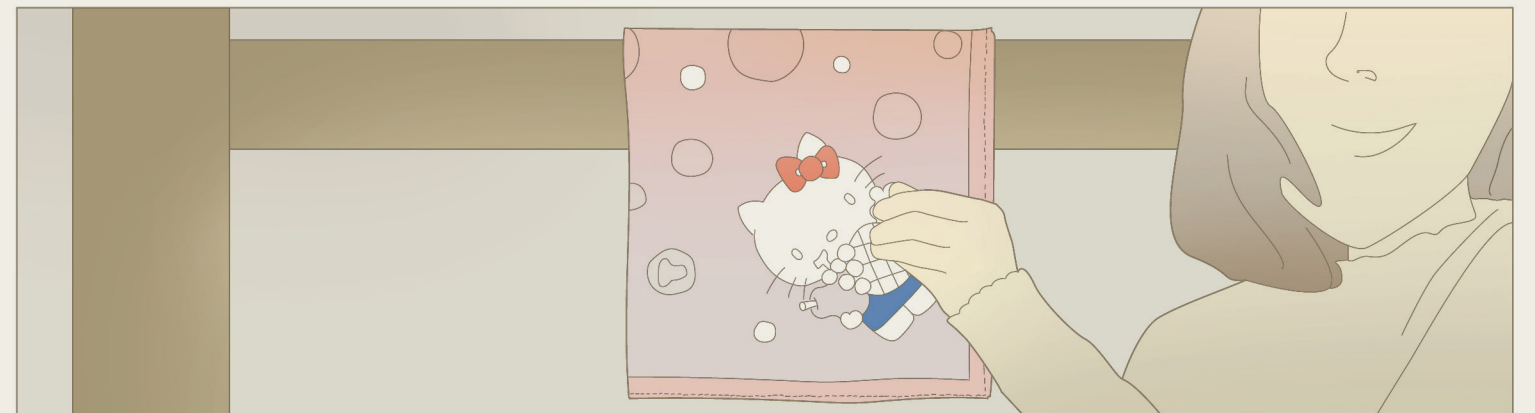
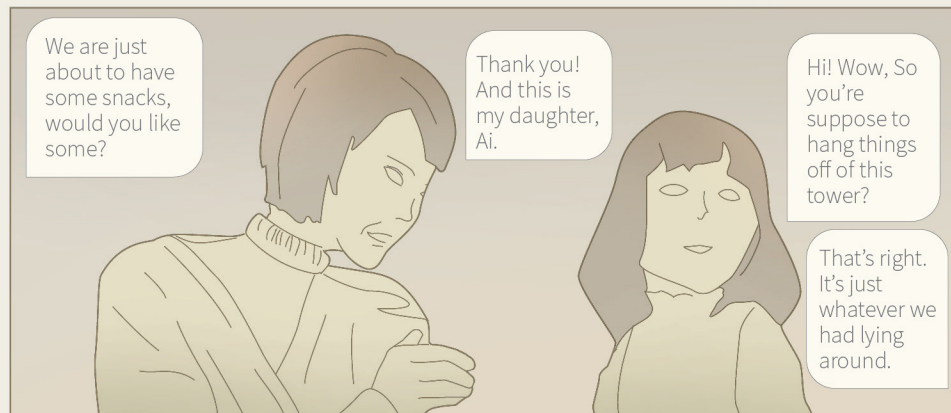




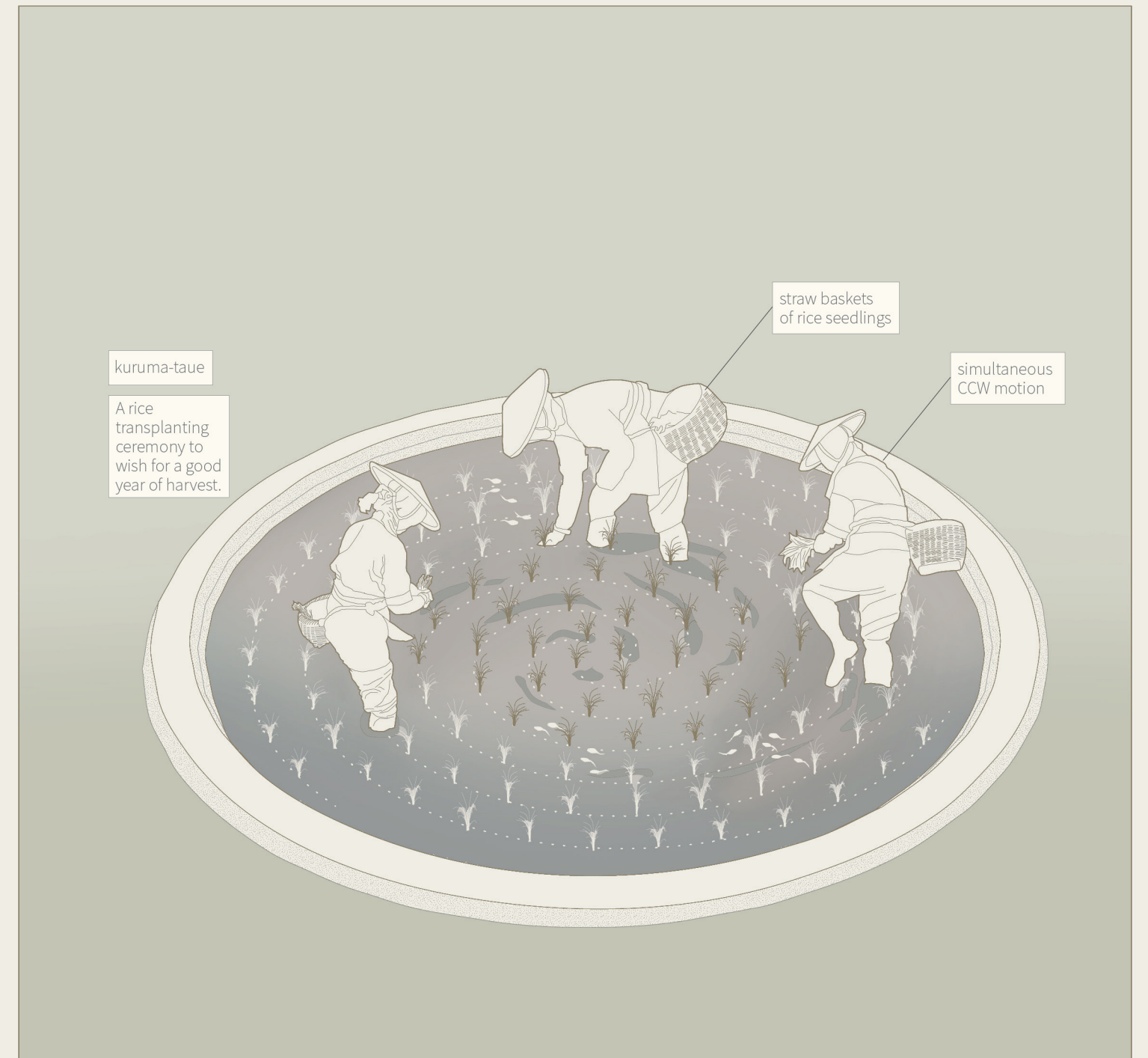
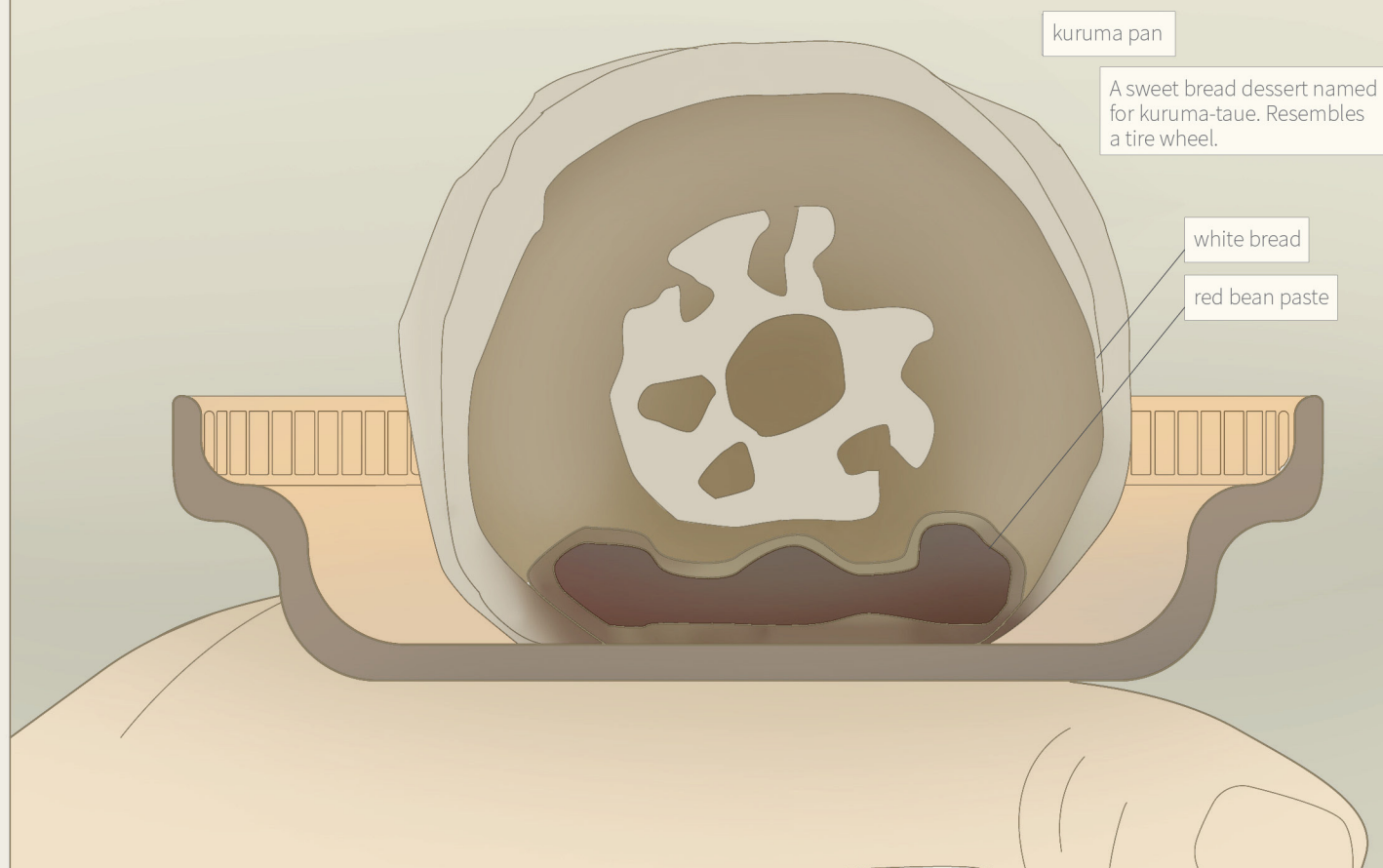
Just then, the wind blew. "Don't push against it, you might fall down," warned the farmer. When it was over, they all sat under the tower.

Fig.28, Author, 2021





Hana introduced Ai to the farmers who offered them some snacks. “This is “kuruma-pan”, a sweet bread with red bean paste. It was named after the spiral rice farming ceremony on Sado called kuruma-taue. Hana beamed, “Thank you for letting us try this specialty of Sado!” The farmer laughed, but there was no humour. “It’s simple flour and red beans - there’s hardly anything special about it. If anything, it’s odd to have something made of bread to symbolize rice. Is rice even important anymore?”



2040

The year is 2040, the environment data market lists the recent temperatures, sea-level and specie count in the Niigata prefecture. Attached to the broadcast is a personalized government letter. “They’re telling us to drain the paddy? They’re not allowed to do that!”





# STORM WARNING 警告

佐渡島 新潟県

SADO ISLAND

NIIGATA PREFECTURE

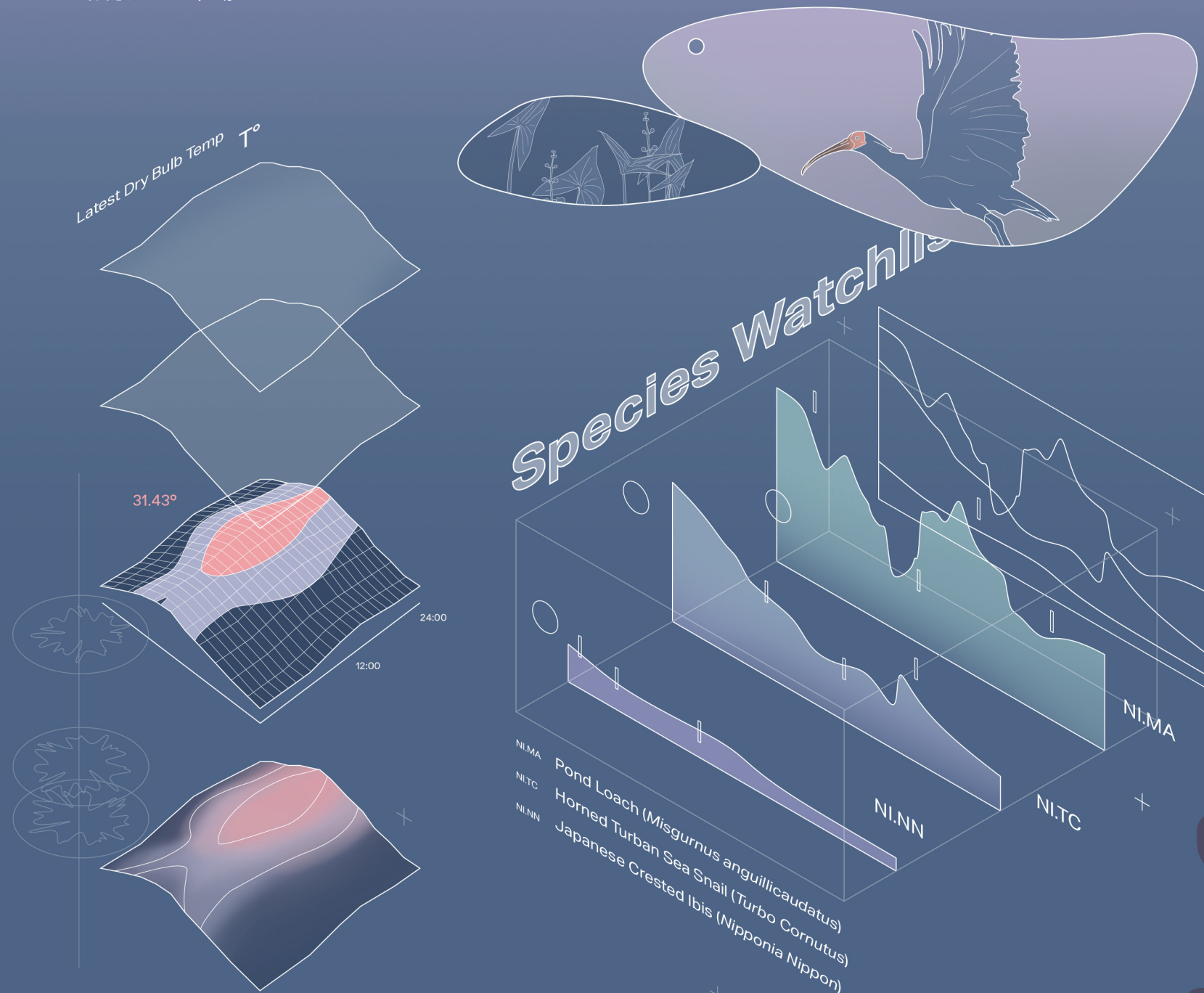
HAZARDOUS STORM SURGE IS EXPECTED. HEAVY RAIN ACCOMPANIES HIGH WIND SPEEDS ...



## 90-100KM/H

SADO, NIIGATA, JPN  
38.01° North, 138.37° East UTC+9

### NIIGATA PREFECTURE - ENVIRONMENT DATA MARKET 環境データ市場



NIIGATA NEWS

トキの森公園

### LAST SEEN TOKI?

The delayed migration of the Toki Forest Park Breeding Enclosures has led an unsuccessful breeding season for the remaining 10 Japanese Crested Ibises. After massive flooding and structural damages, the original Toki Forest Park located in Shinho had to be closed. Construction was fast-tracked but the constant handling and unpredictable weather while captive has led to stress and unknown causes of death. Ibis in the wild have trackers and show that their numbers have also substantially decreased due to the widespread government notice, 60% of mountain paddies to halt submerged rice farming.

### RECORD LOW AMBERJACK HARVEST

2040 09 01

To Hana Kawakumi,

We are informing you that the prohibition of agricultural use of your 3661m<sup>2</sup> hectares paddy in the form of submerged rice farming will be in effect starting 09-31-2040.

As part of the country's promise towards carbon neutrality by 2050, we are enacting widespread change in all sectors of production and transportation. Your understanding and contribution to this effort is appreciated as we combat the effects of climate change. There will be unscheduled review of your property to ensure compliance. Failure to do so will result in fines and/or imprisonment. Thank you for your cooperation.

Niigata Prefecture  
Ministry of Agriculture  
Forestry and Fisheries

新潟県  
農林水産省



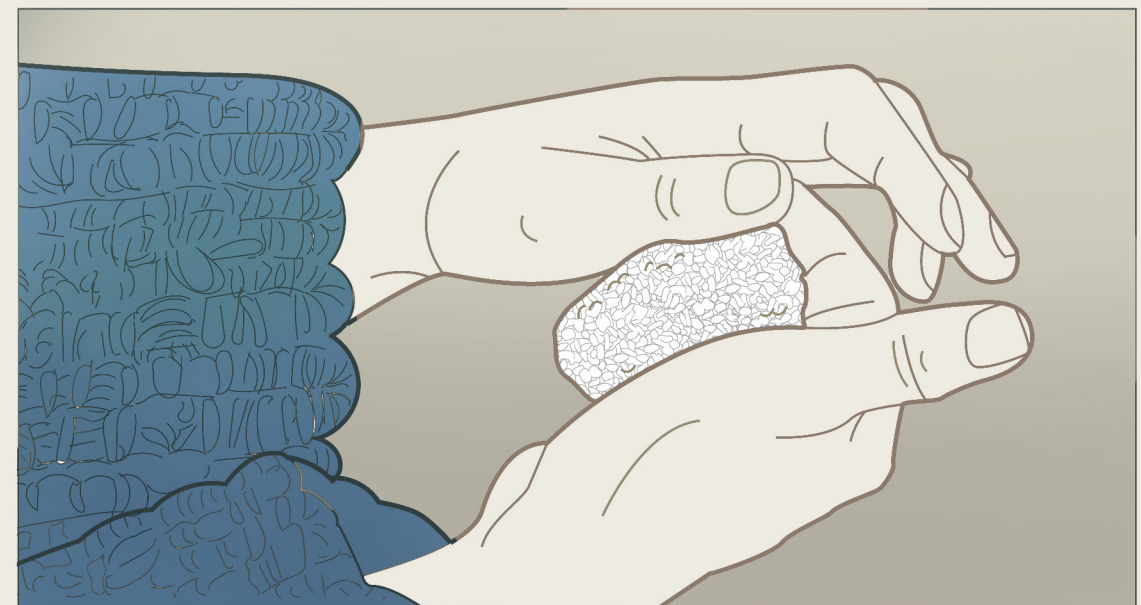




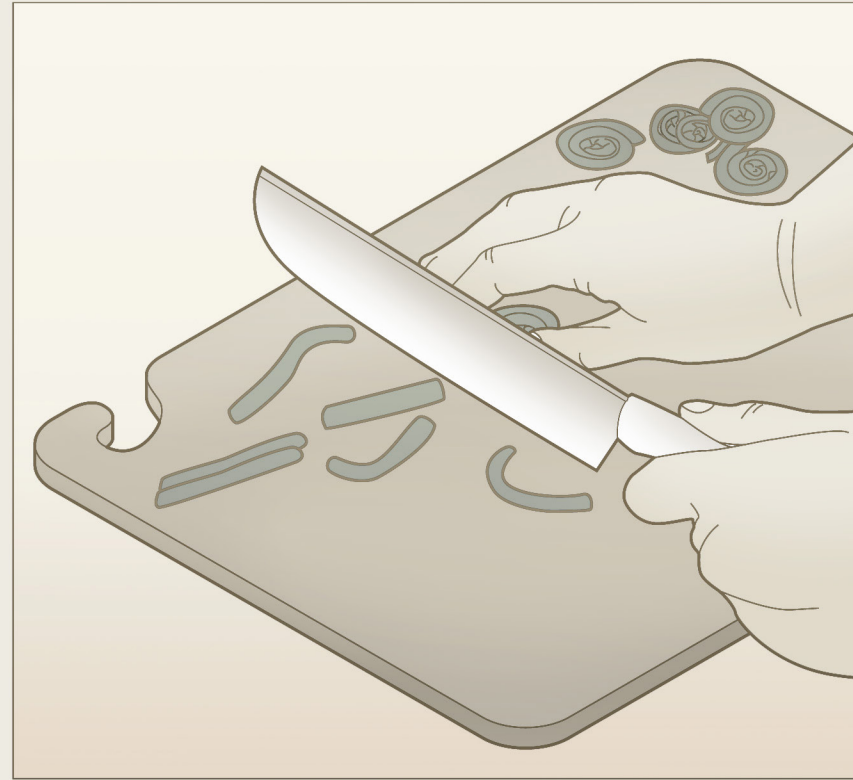
“Yes Mom, they can. Let me sign it.” Ai and Hana bought the old farmstead from the farmer they had met on the paddies when she passed away. She happened to be their landlord. None of the farmer's children wanted to inherit the place.

While Ai signs the agreement to drain their paddies, Hana takes a handful of warm rice and begins to prepare their tenant's meal. She always shaped them perfectly. After coming to Sado and putting in some hours in the paddy, she realized she didn't like farming rice as much as she liked eating it.

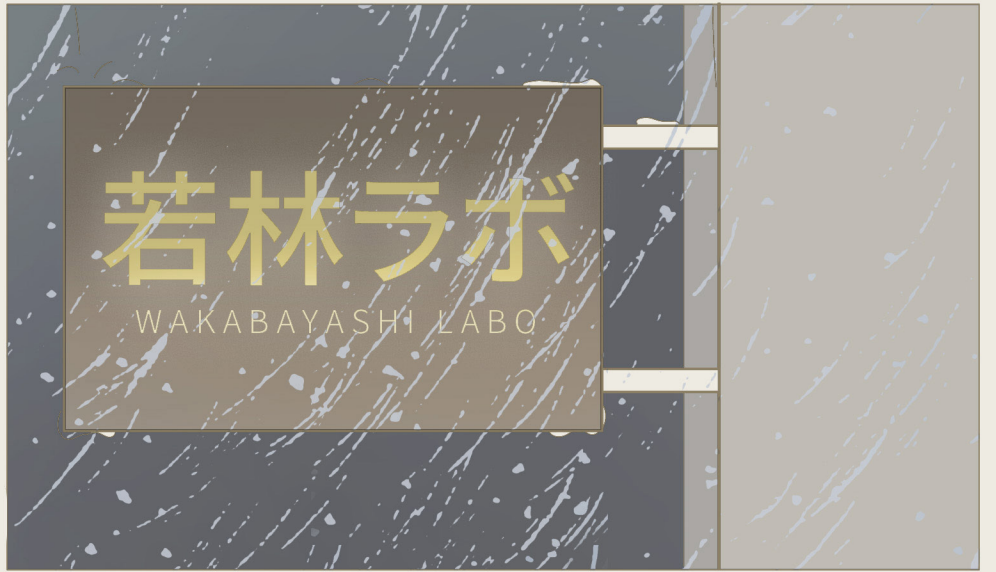
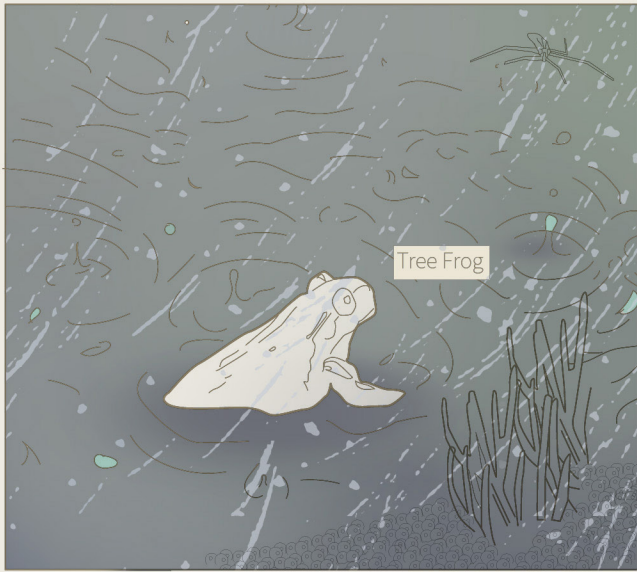
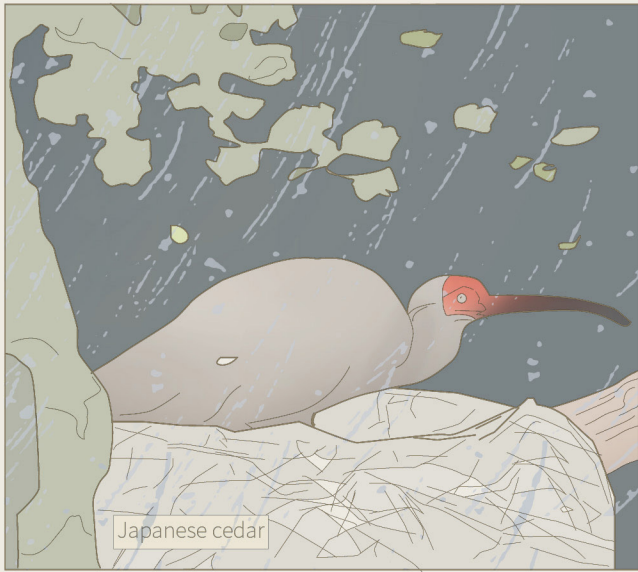
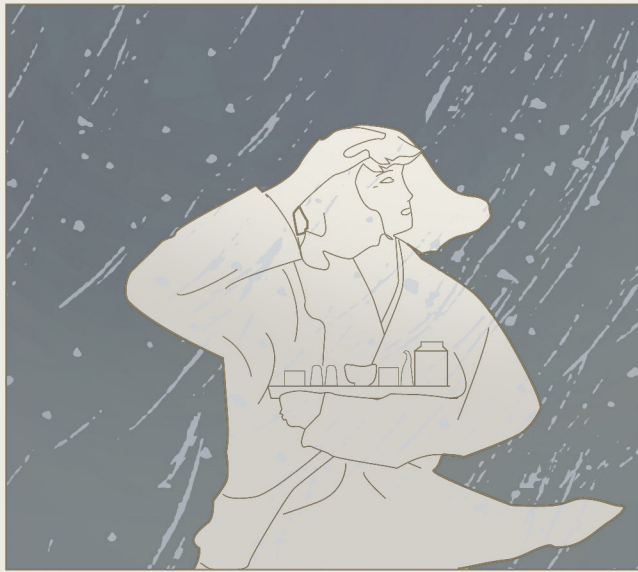
Fig.31, Author, 2021.











The rain sputters, bouncing off the leaves of the fiddleheads in the garden. The storm is just starting to begin. Ai makes her way to the property's work shed.



Fig.33, Author, 2021.



Inside, Ame modifies a brand-new robot companion with some forgotten items around the workshop. No one would miss an old plastic laundry basket and the other junk the young inventor sourced, but Ai is less enthusiastic seeing the farmer's transplanter gutted of its contents. "From one rice machine to another!" Ame demonstrates how her robot dog spins dried rice straw into rope. "That old machine was collecting dust anyways. In this way, it can still serve a purpose." Ai sets down the tray of food and leaves without another word.

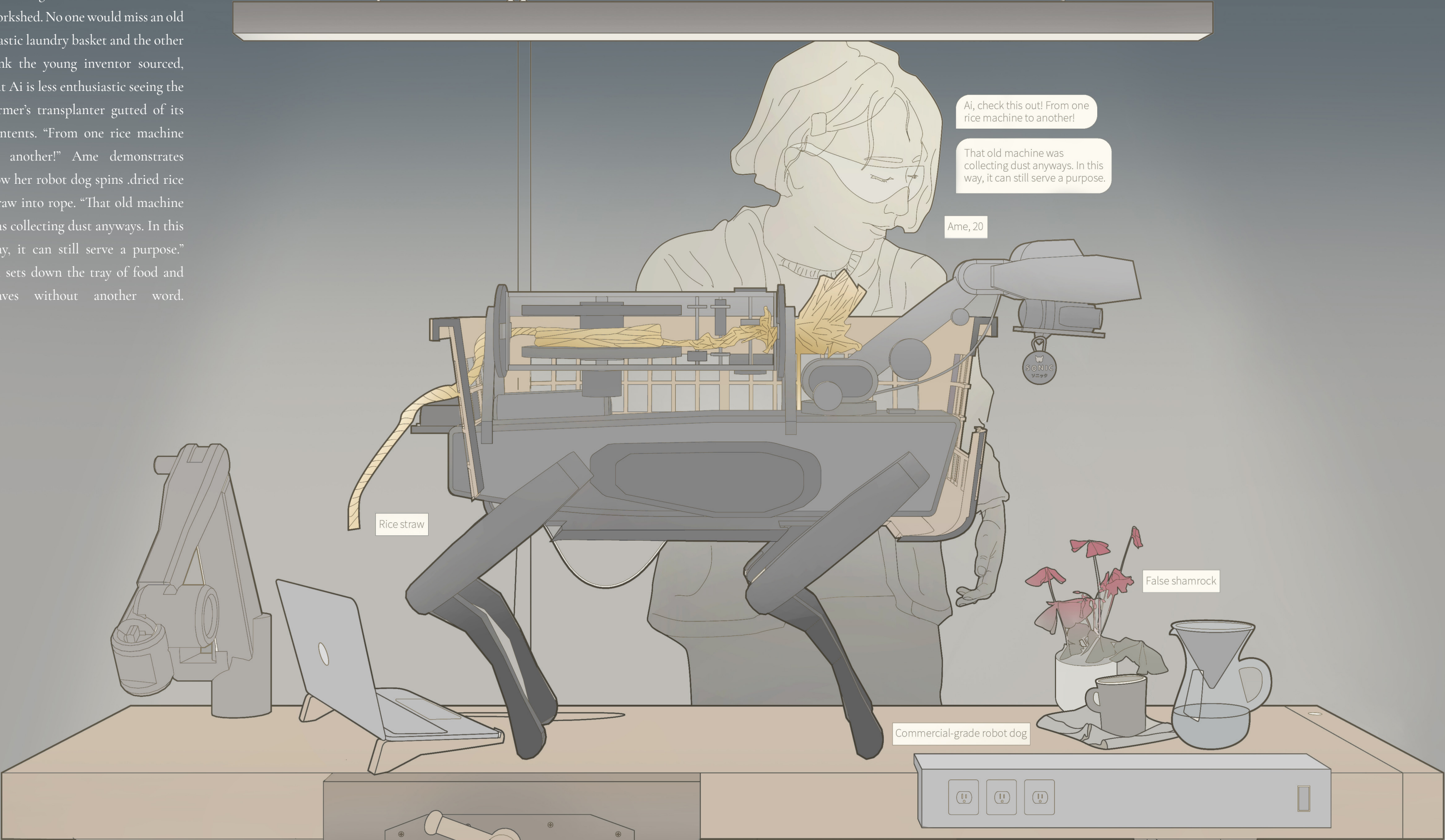


Fig.34, Author, 2021.

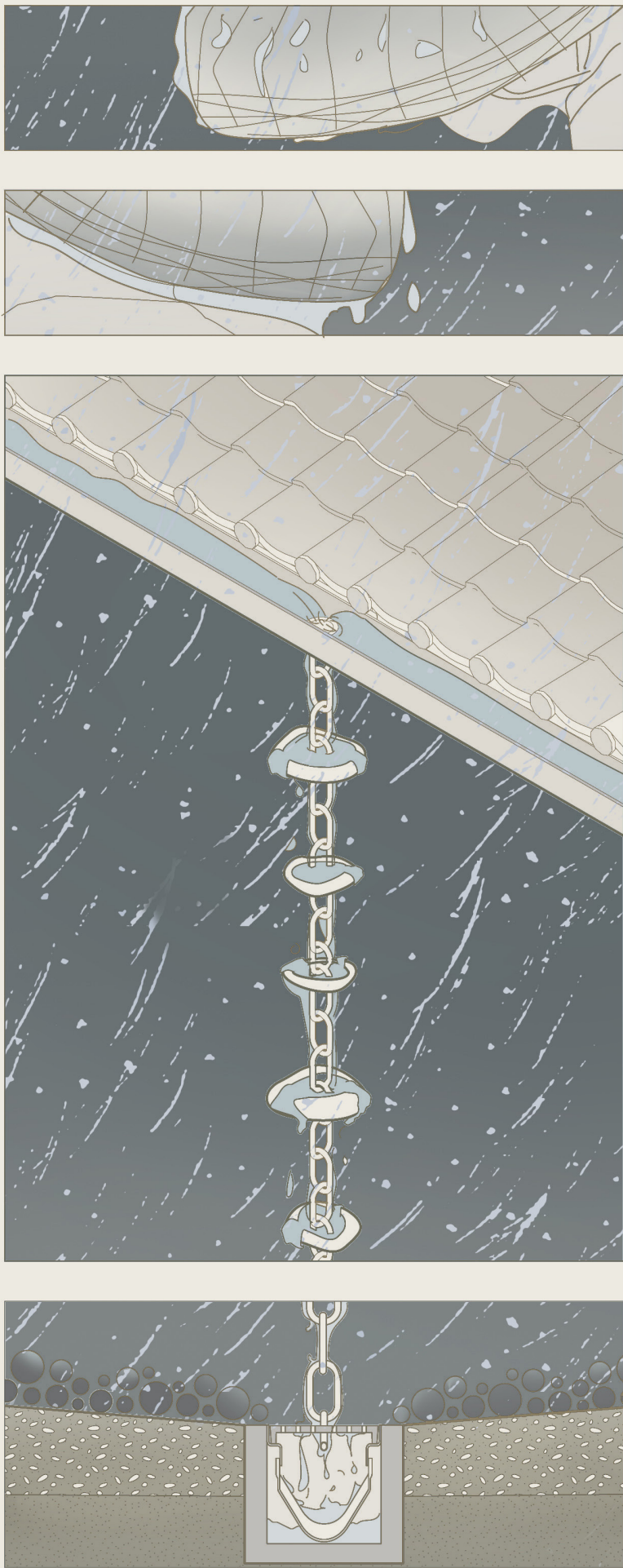


On her way back, she greets Porter Tanaka who is out on his deliveries. He has plenty left to do, but she hopes he would help her with a favour. “Could you run to the Milling House and get our portion of rice? I’m worried we’ll run out before the storm passes.” He agrees.



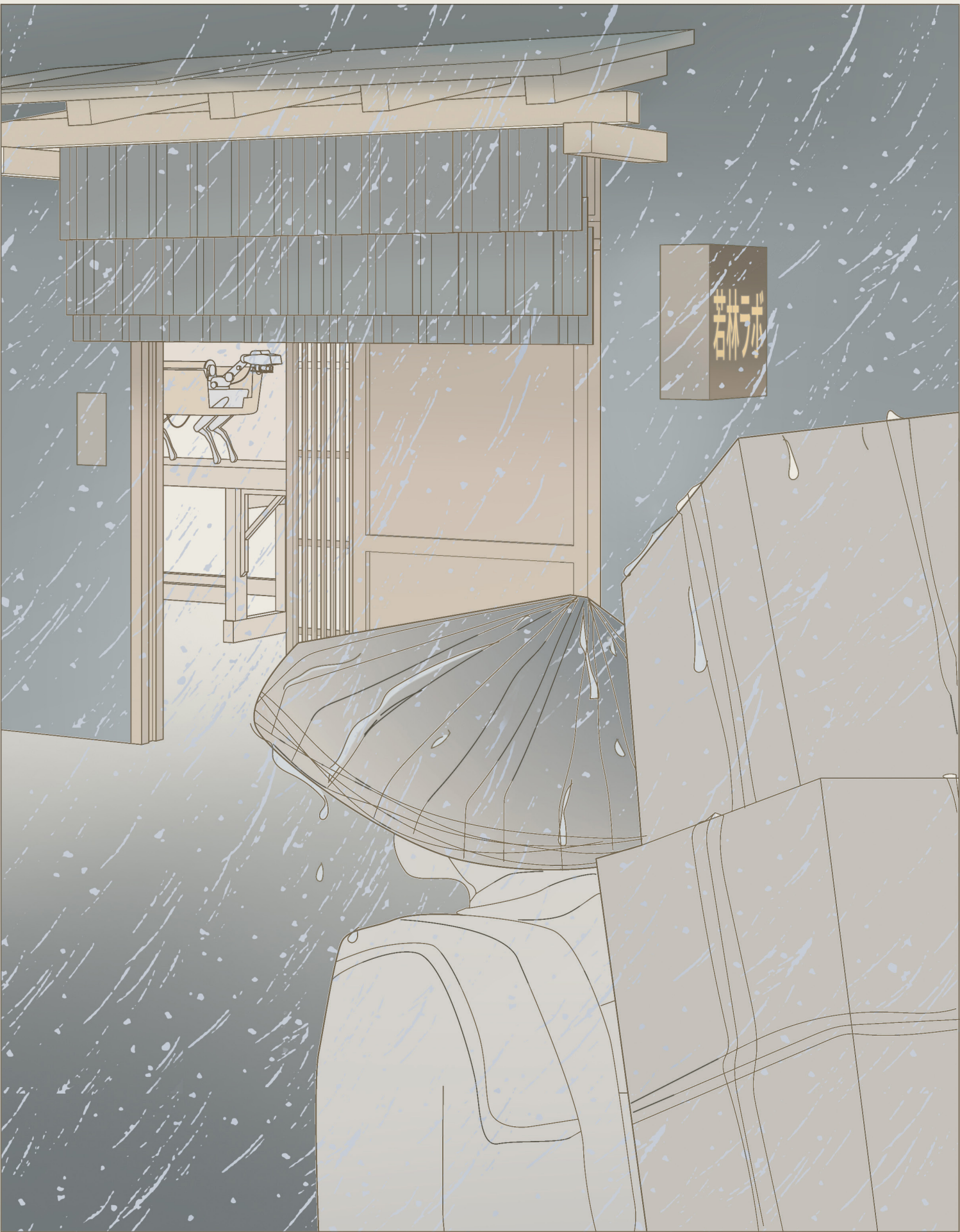
Fig.35, Author, 2021.





Before leaving, Tanaka catches a glimpse of Ame's robot dog before setting off.

Fig.36, Author, 2021.





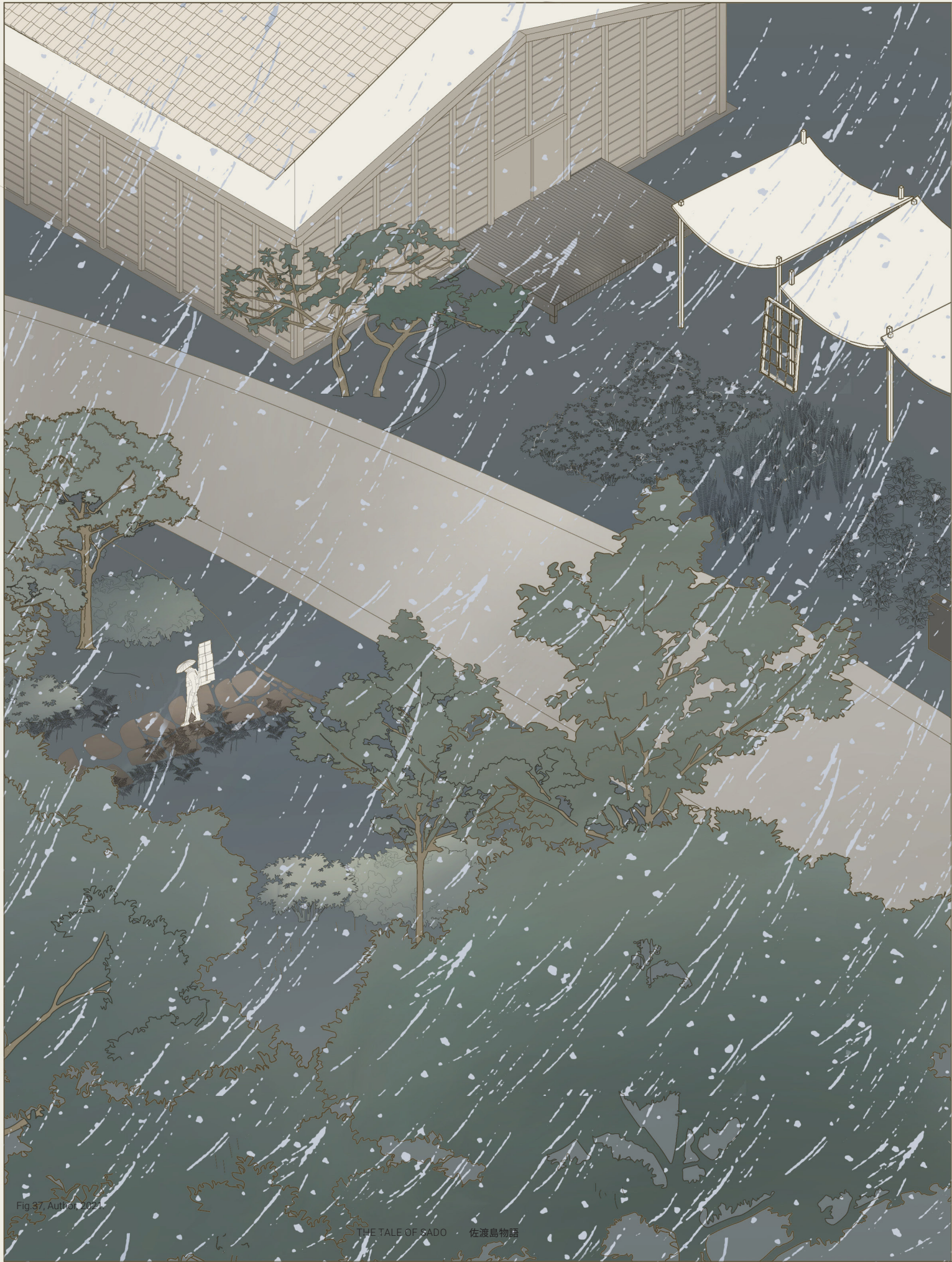


Fig.37, Author, 2021

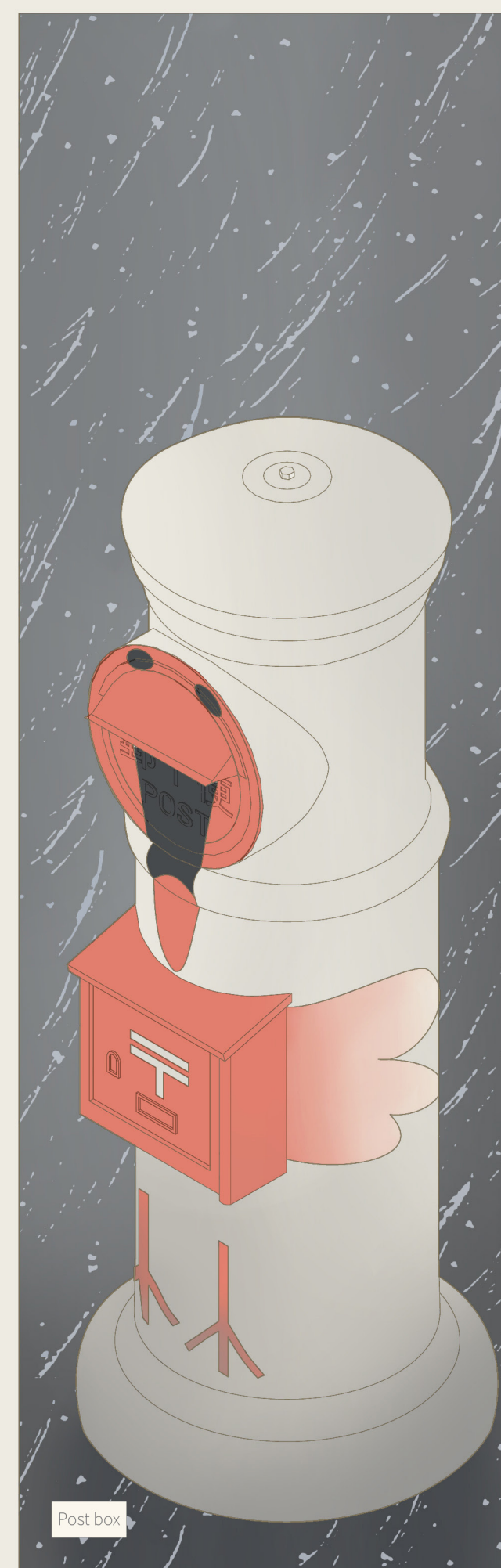


Down, down, down the hill he carefully hikes, following the well-trodden and muddy foraging path through the forest. He is working without his truck all day, as some land shifted onto the major roads.

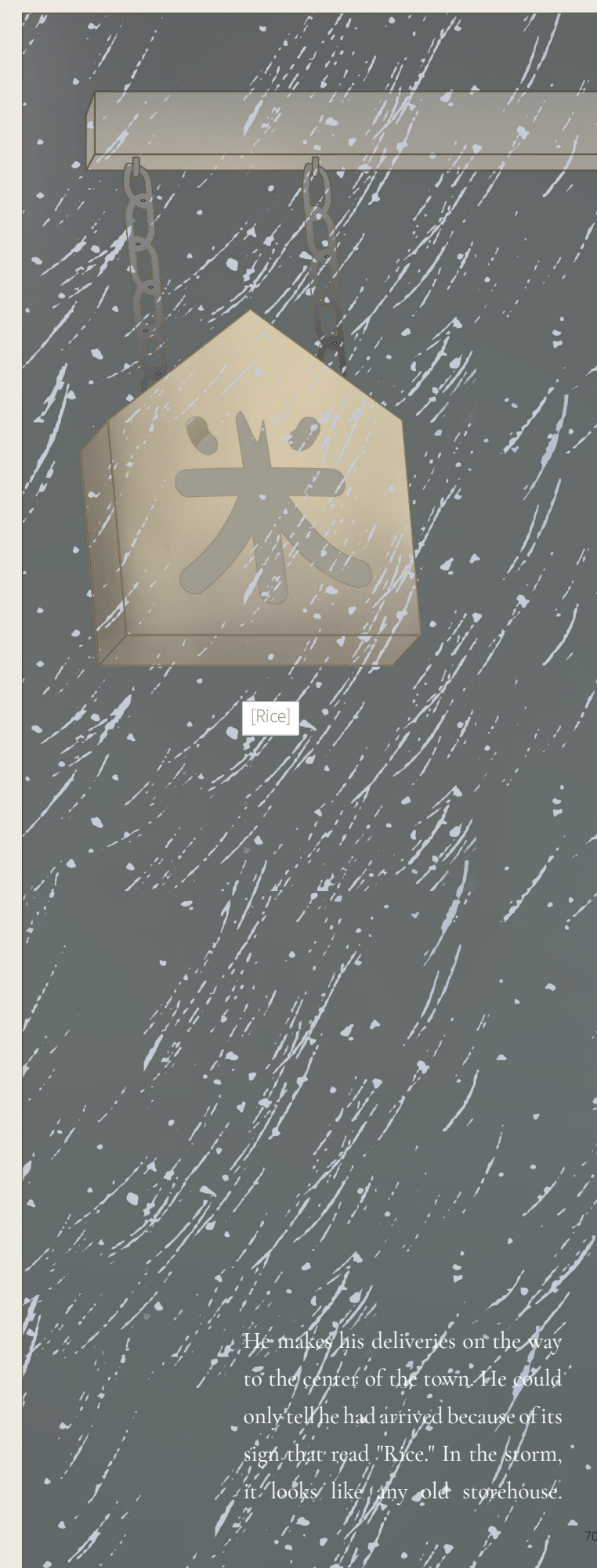




Fig.38, Author, 2021.



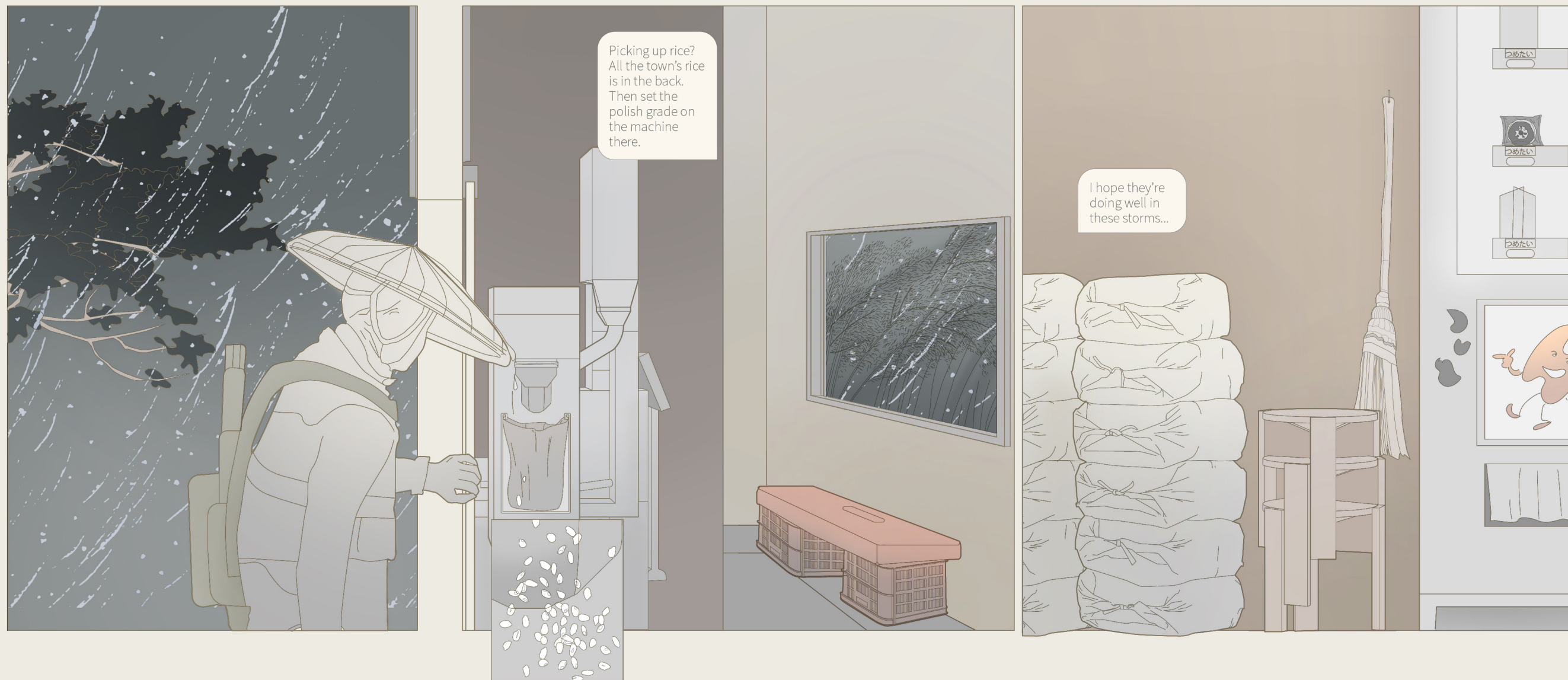
Post box



[Rice]

He makes his deliveries on the way to the center of the town. He could only tell he had arrived because of its sign that read "Rice." In the storm, it looks like any old storehouse.





It is empty inside besides one idling neighbour that notices Tanaka and his hesitation. “Picking up rice? All the town’s rice is in the back. Then set the polish grade on the machine there.” The neighbour, known as Komatsu, guides him, all the while filling the air with conversation. She spoke about how the native crested ibis on Sado had gone extinct and that the ibis in the wild were grown in a rehabilitation center. “I hope they’re doing well in these storms...” she said.

She spoke about rumours of big agricultural companies in the innerplain buying salt-tolerant rice varieties instead of koshihikari. Rice is sensitive to water salinity. This new kind of rice variety was developed in laboratories. Tanaka let her lead the conversation, watching the trees bend in the stormy winds outside.



# 2060

Tanaka steps out of the Community Milling House. It is now 2060 on the hottest day of the year. He’s doing his usual route with his companion. There’s one thing he hasn’t delivered yet- a bucket full of pond loaches. His neighbours pass by, on their way to hang their shimenawa, a good fortune loop, onto the Tower out in the inner plain. In earlier years, shimenawa would be hung on the front door of a farmer’s house using the rice they had grown the year before. But now that the townspeople shared the remaining paddies, whose front door did the shimenawa go on? The children are leading the parade singing a child’s tune.



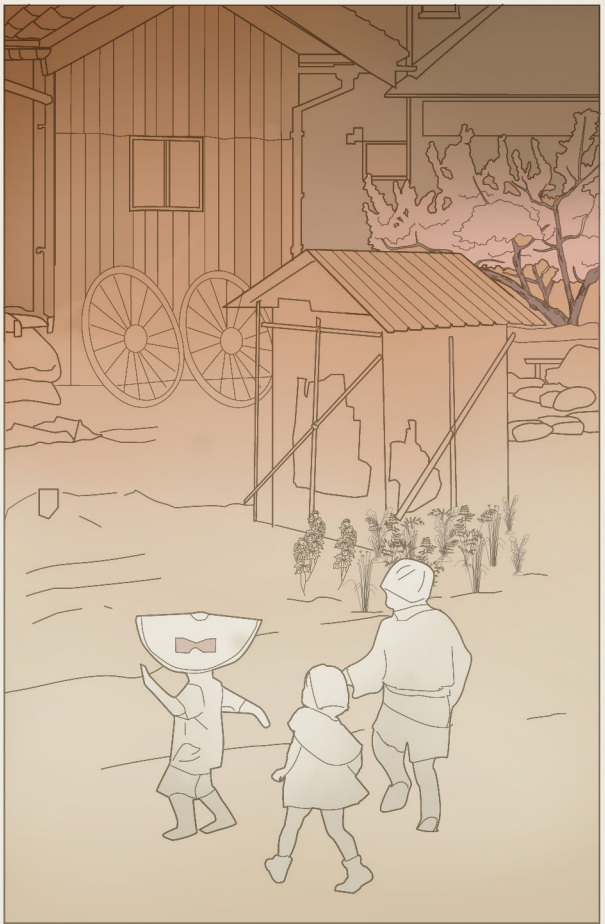
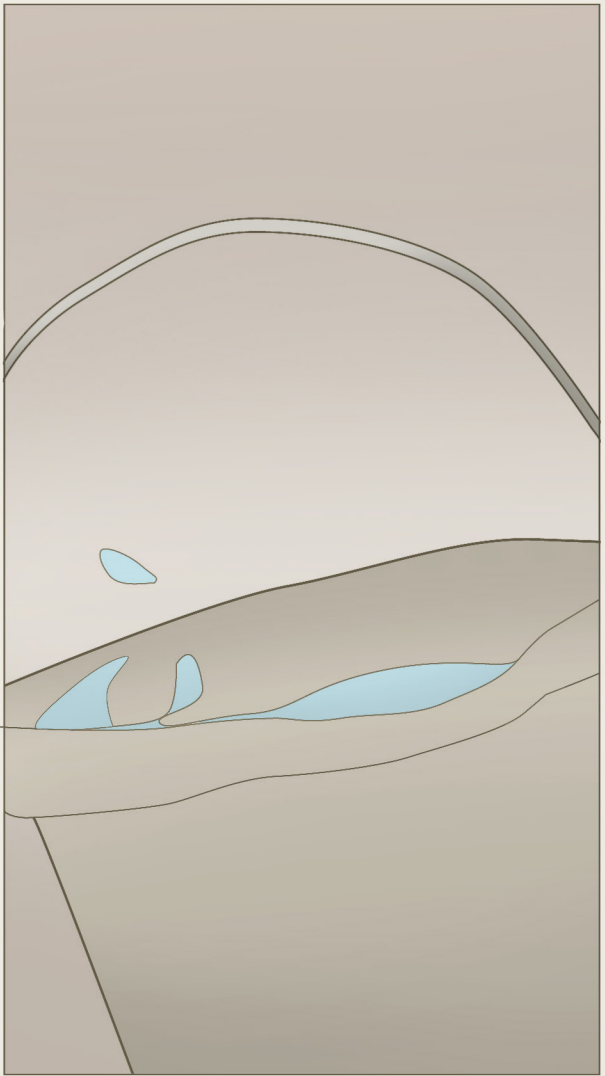
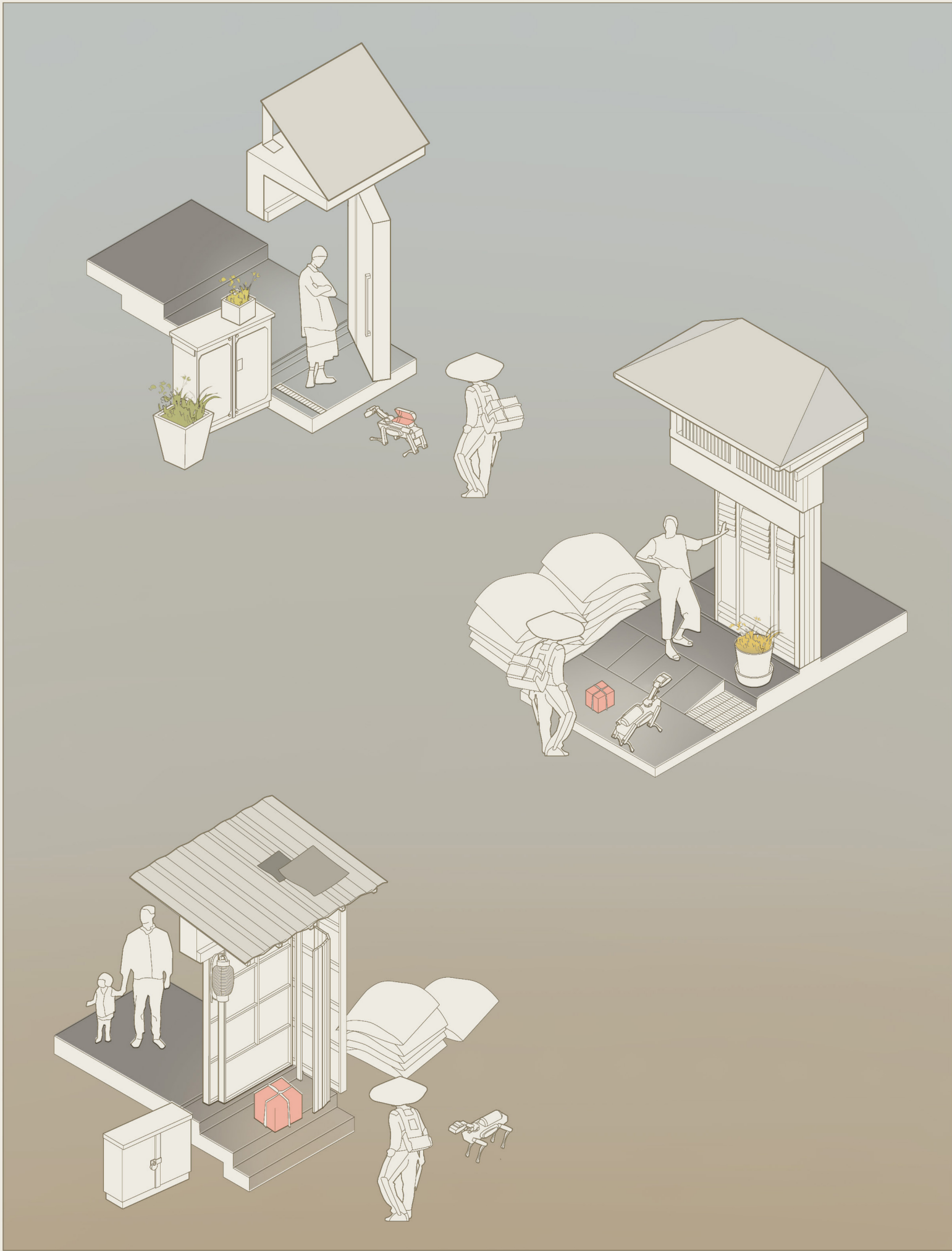
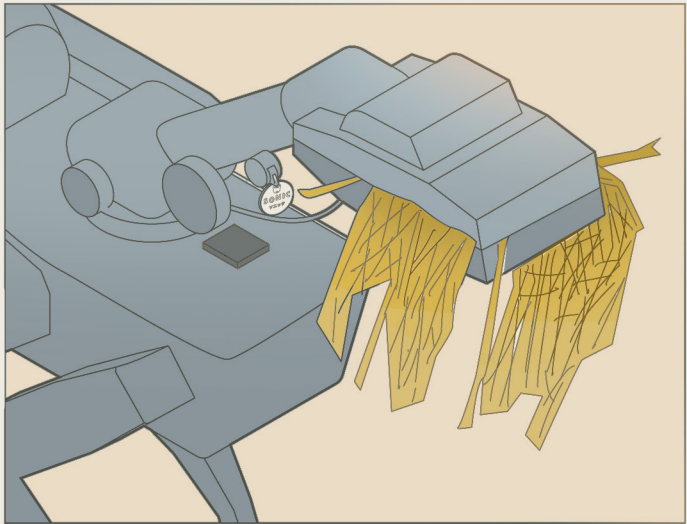
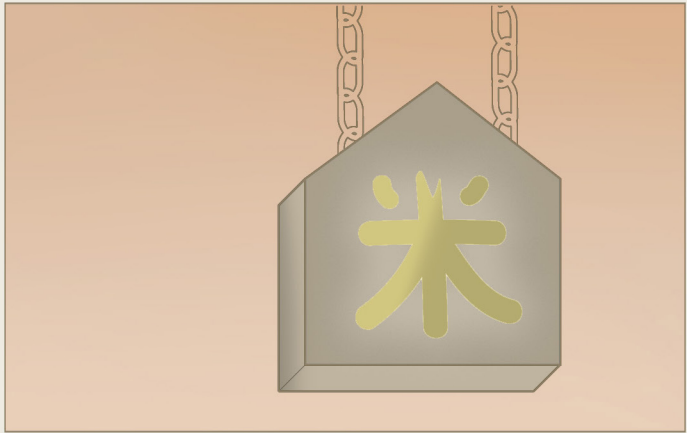
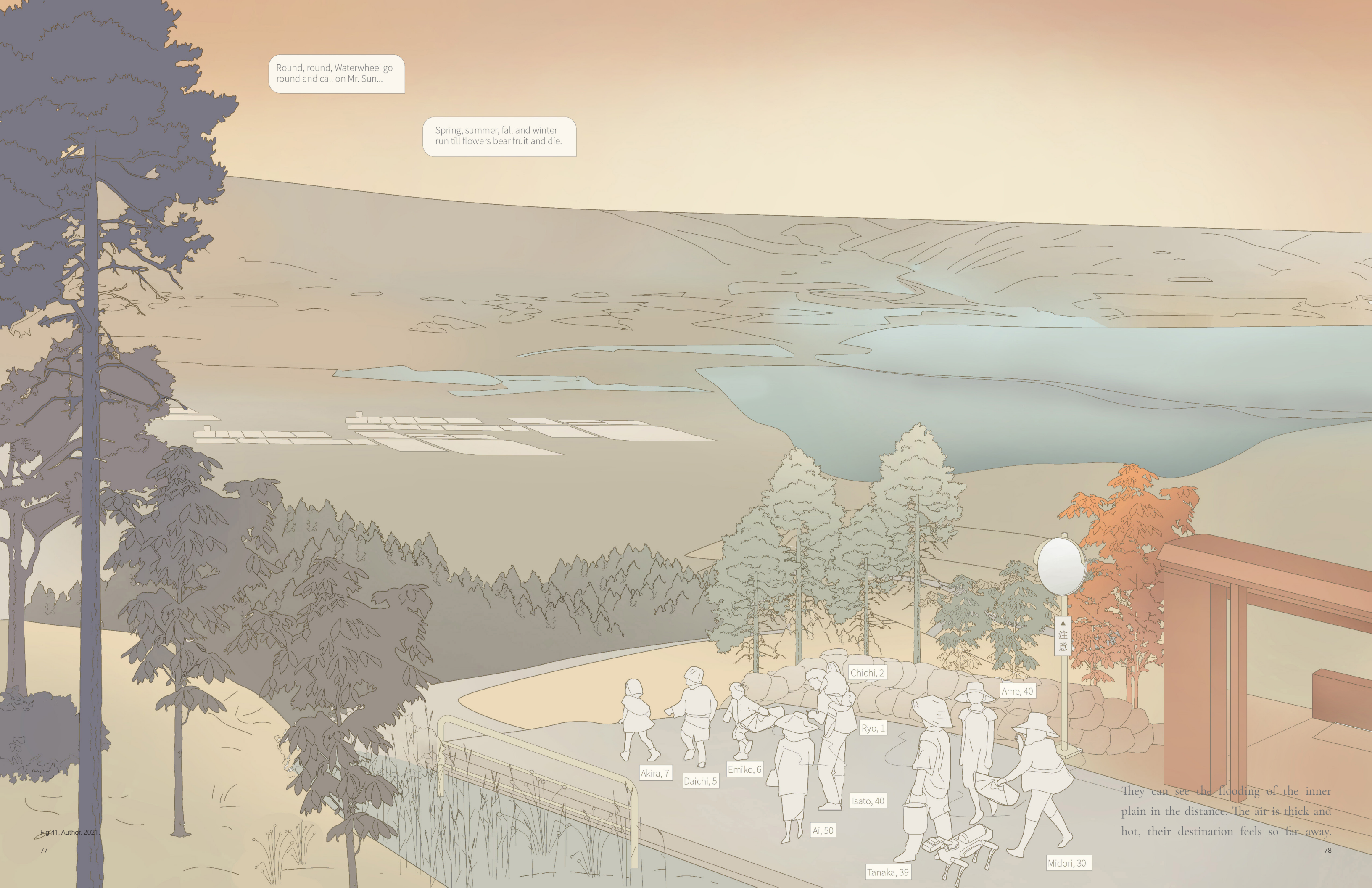


Fig.40, Author, 2021.



Round, round, Waterwheel go  
round and call on Mr. Sun...

Spring, summer, fall and winter  
run till flowers bear fruit and die.

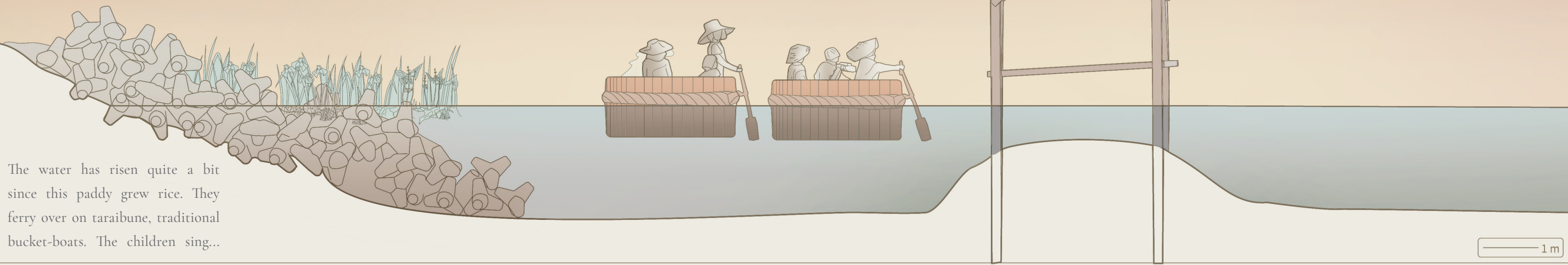


They can see the flooding of the inner  
plain in the distance. The air is thick and  
hot, their destination feels so far away.



Still rain falls, the wind will cry...

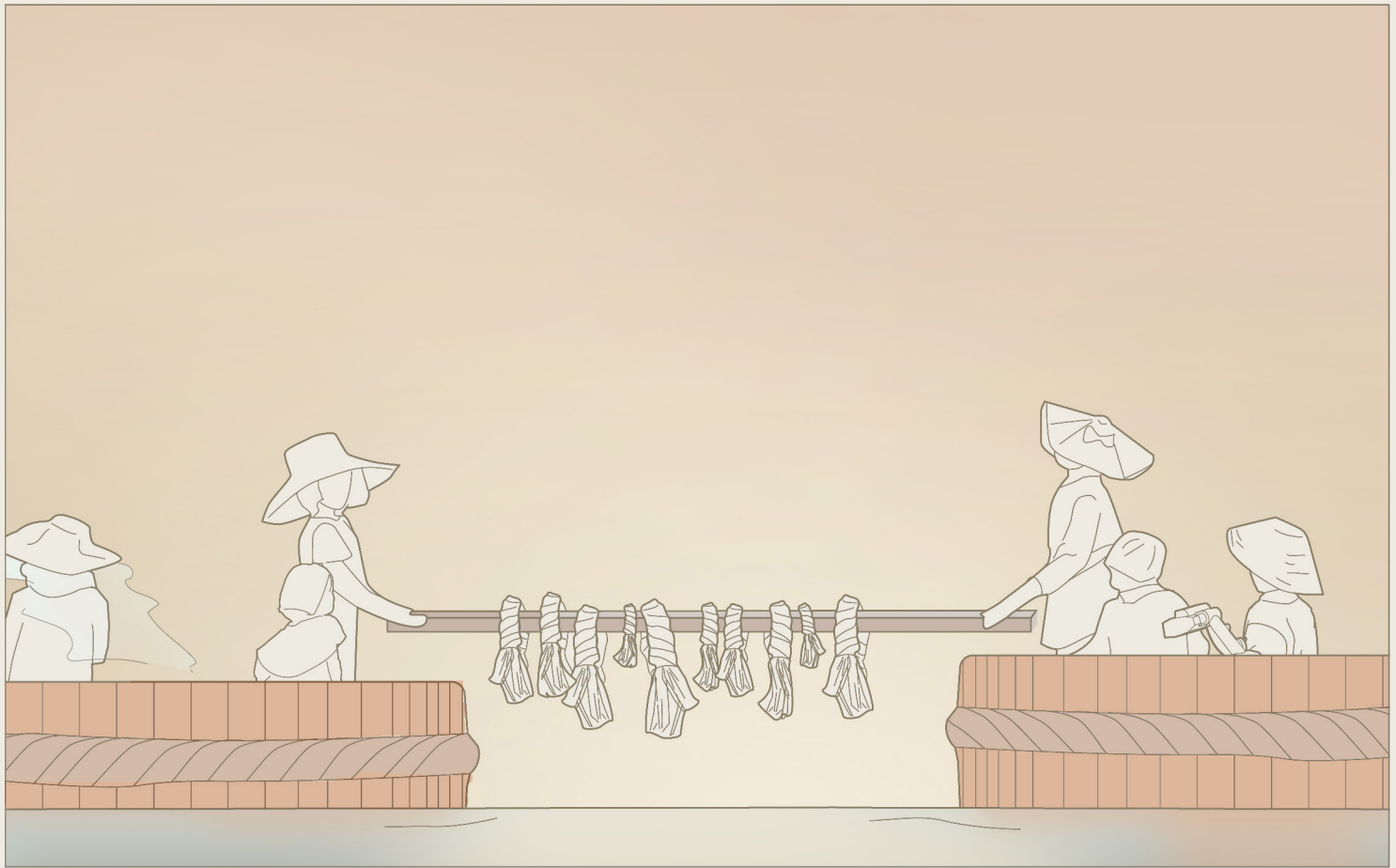
The waterwheel goes round and round.



The water has risen quite a bit since this paddy grew rice. They ferry over on taraibune, traditional bucket-boats. The children sing...

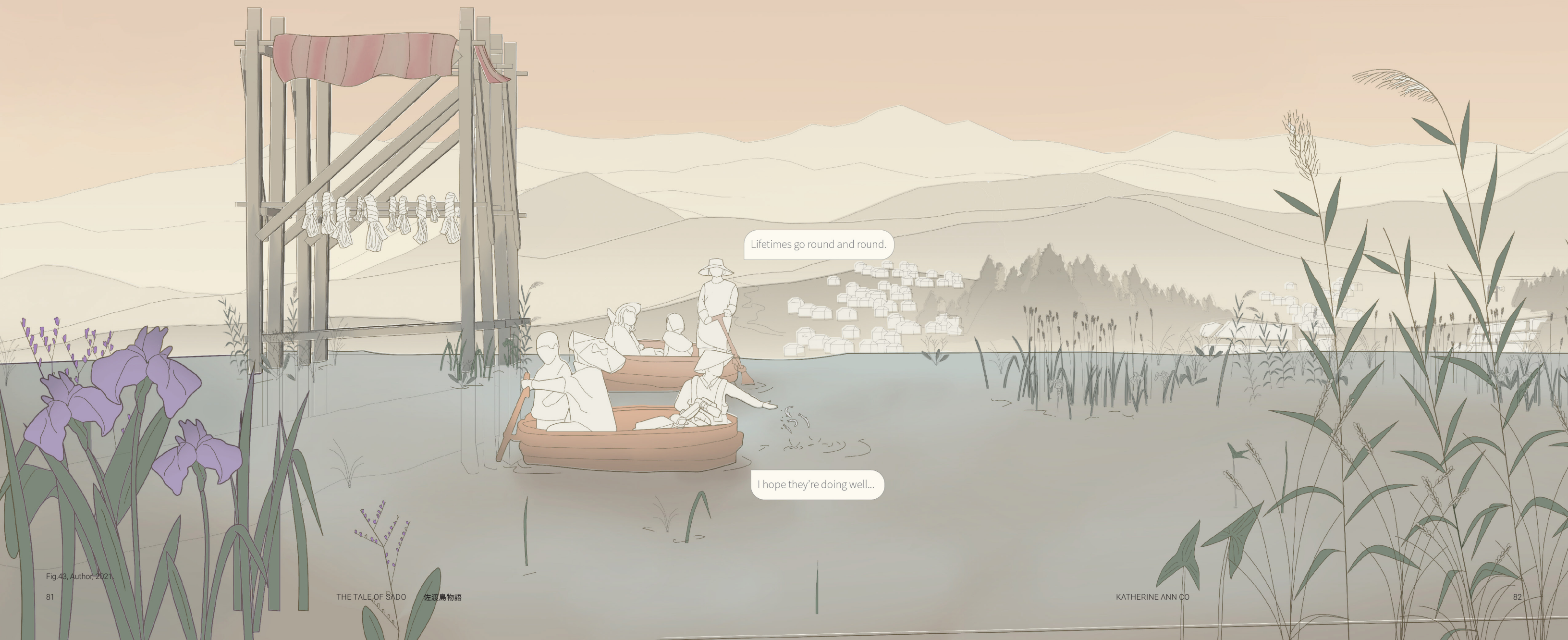


Fig.42, Author, 2021





Tanaka casts handfuls of pond loaches into the water for a crested ibis to find. The hot sun glints off its grey scales. "I hope they're doing well..." he thinks to himself.

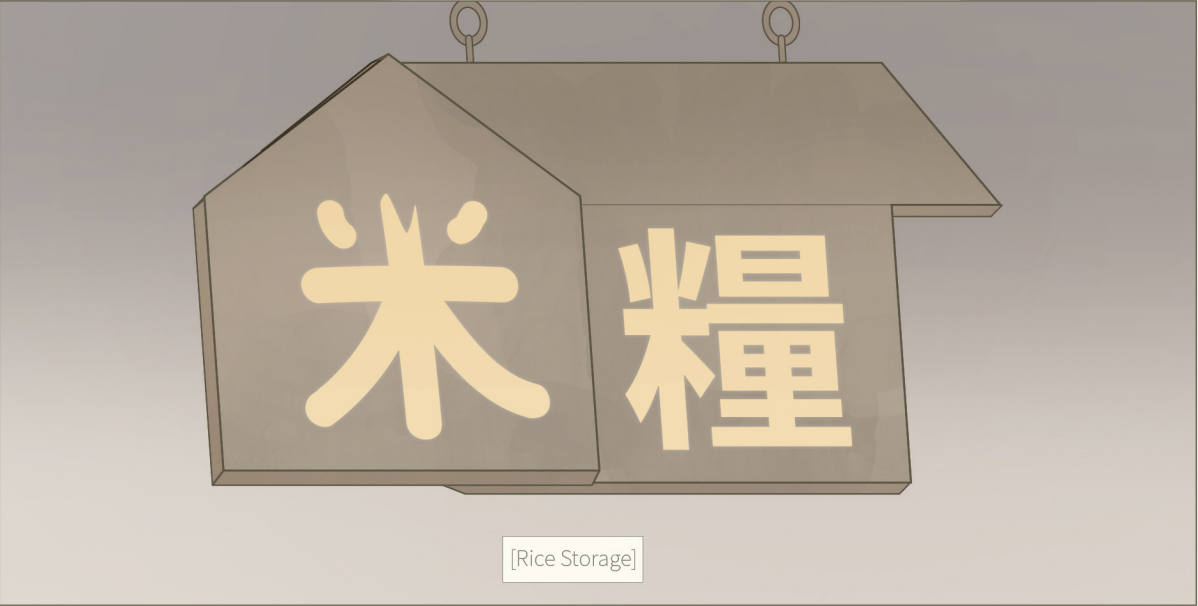




# 2080

In 2080, the townspeople find themselves slowly congregating in the Community Milling House. 70-year old Ai can be heard clearly over the murmurs, “I hate those corporate companies in the innerplain. Do they expect people will eat their rice? Koshihikari cannot be replaced, especially from some rice variety that is so tough and dry.”





[Rice Storage]

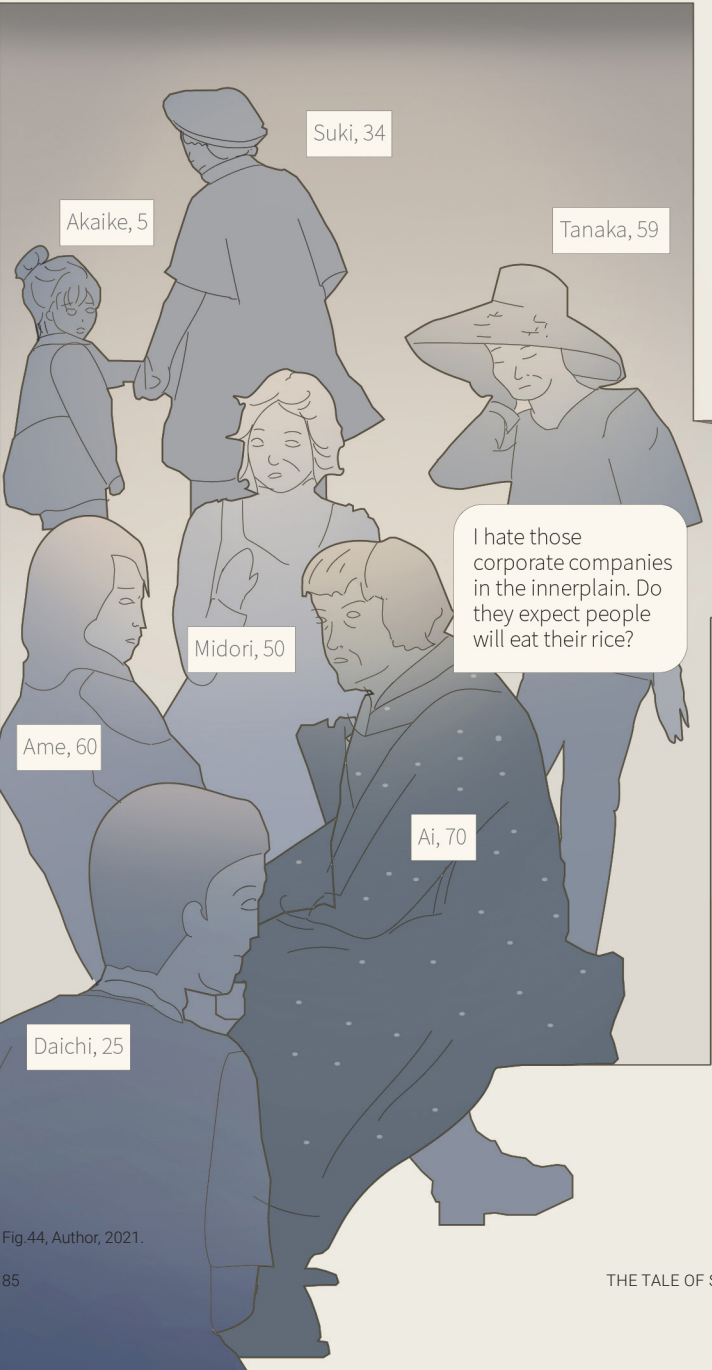
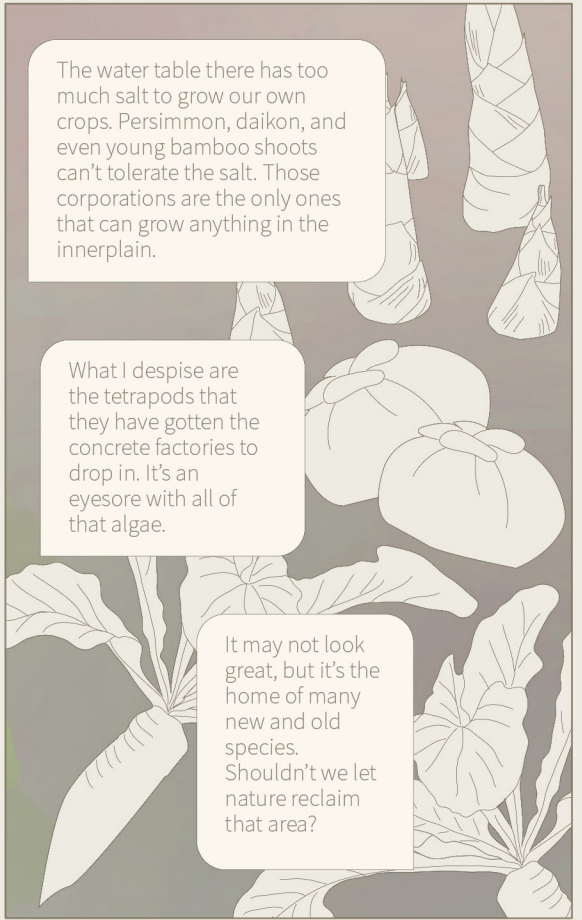
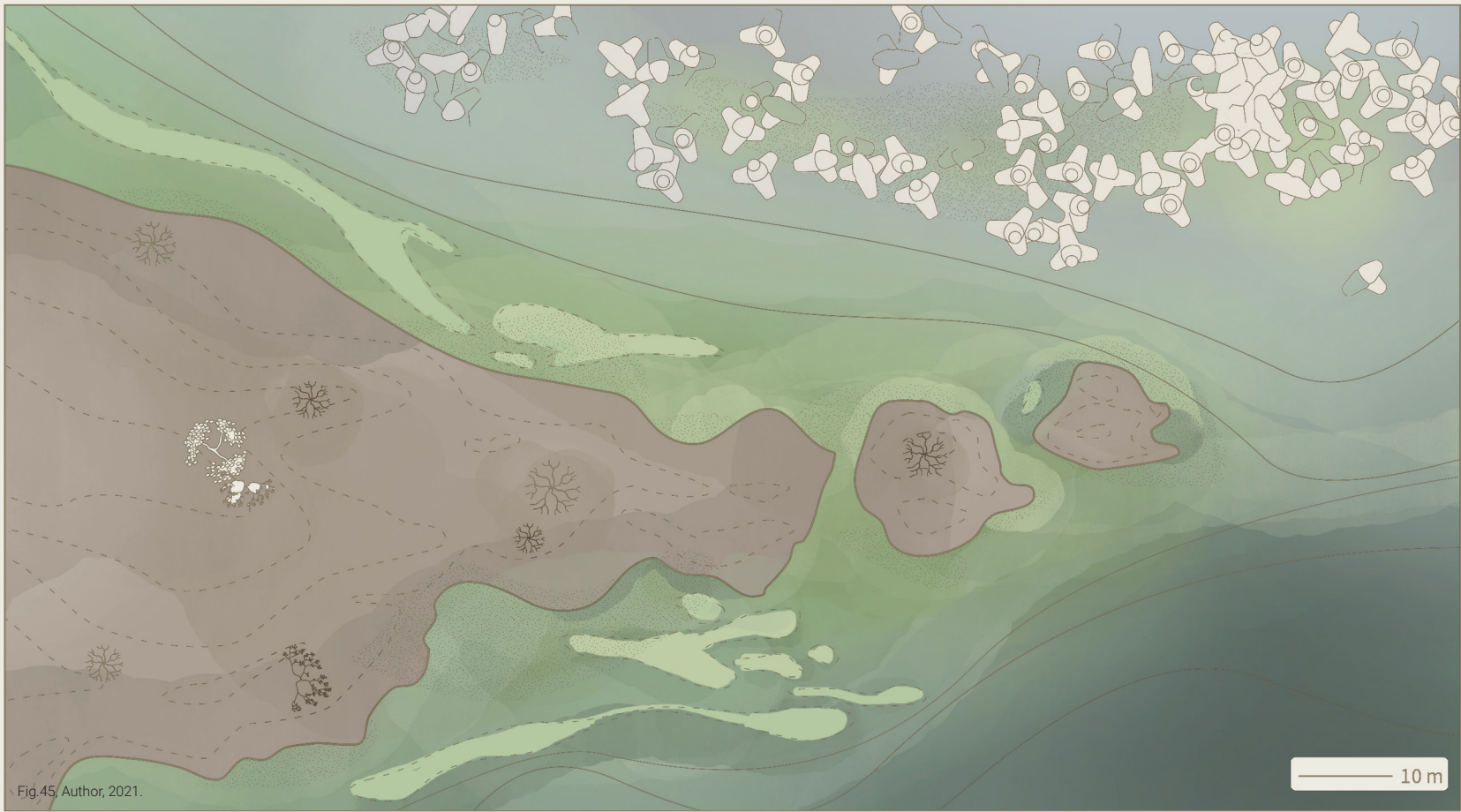
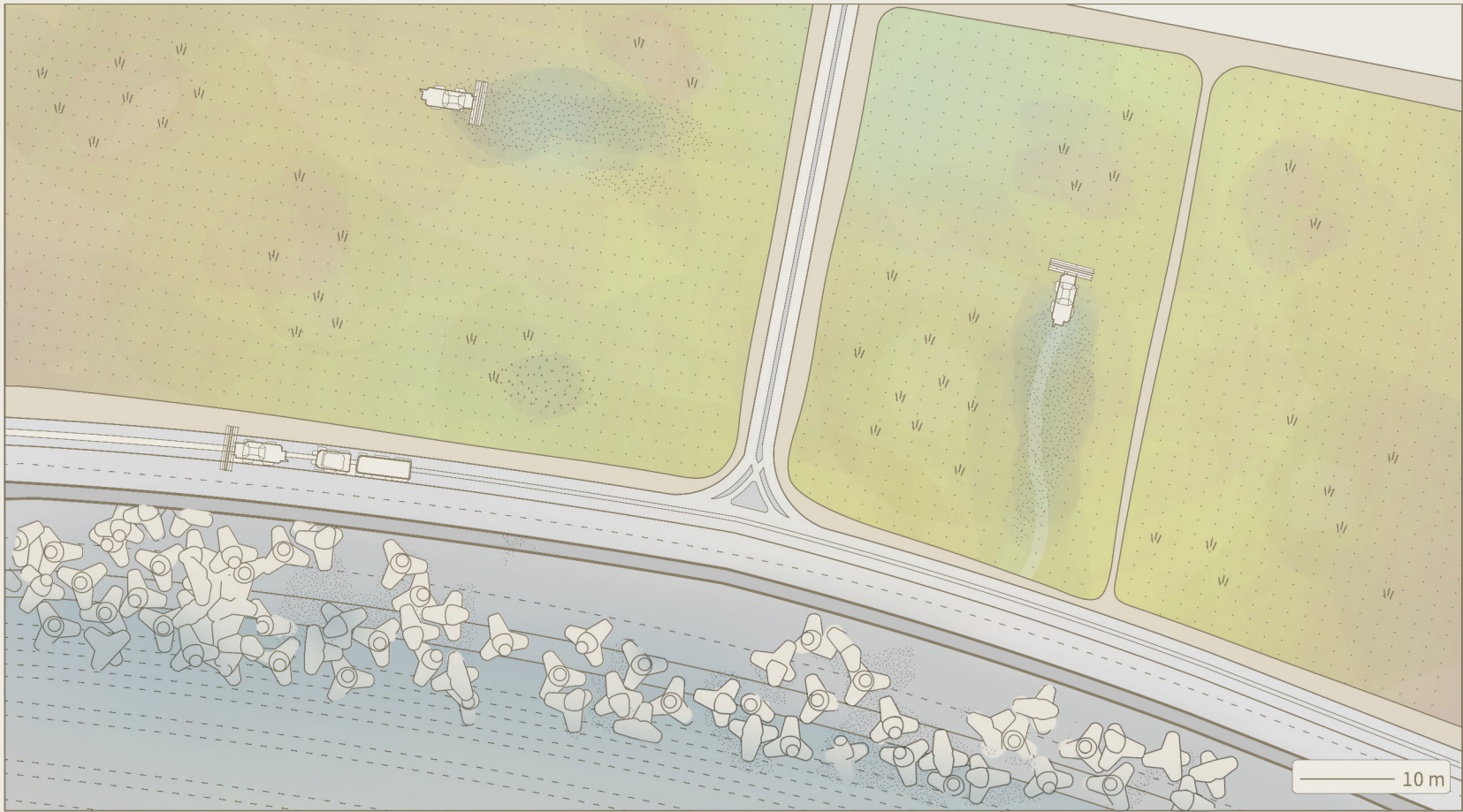


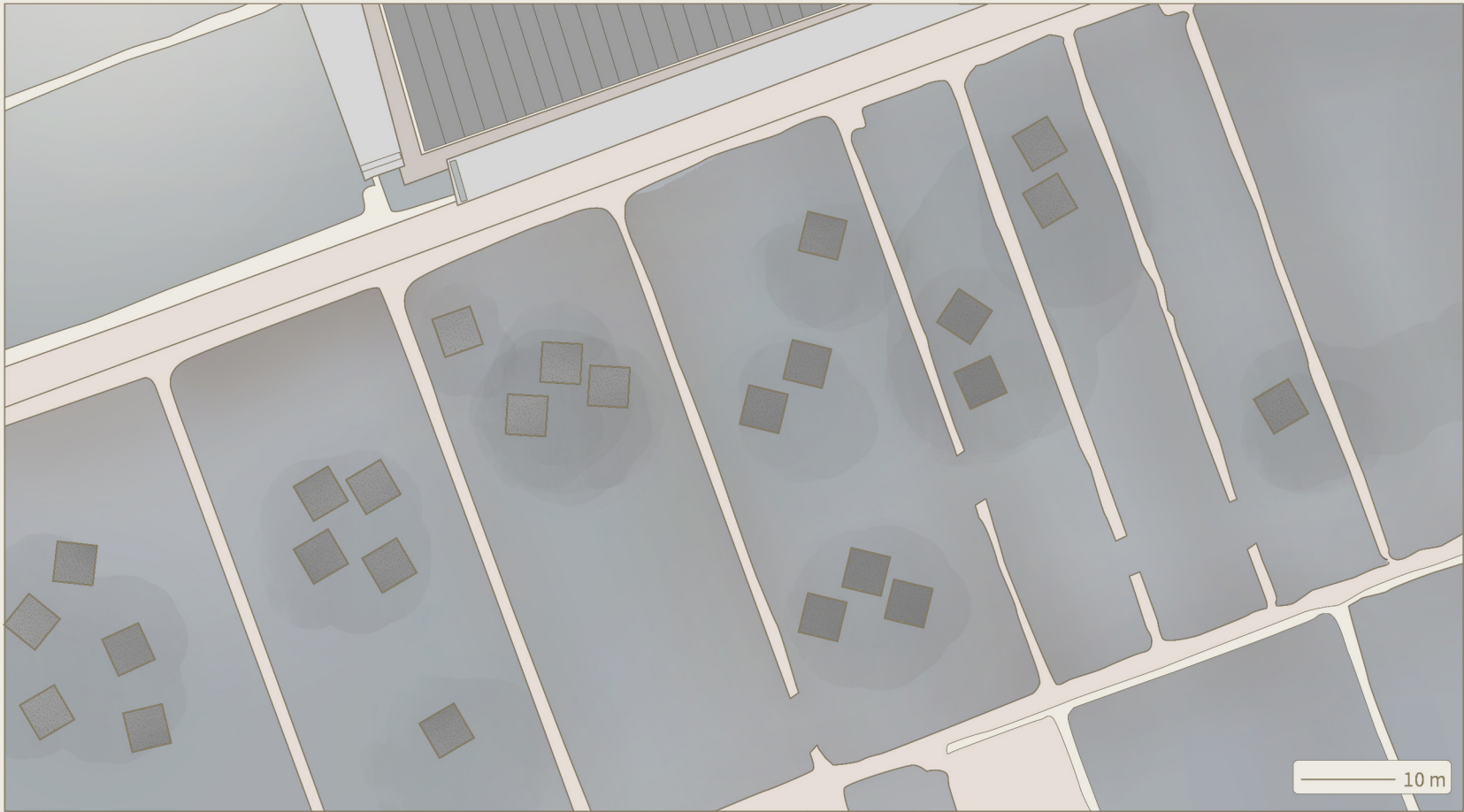
Fig.44, Author, 2021.











We can figure it out with the water samples I'm taking. If we leave that marsh to grow, it'll help buffer waves coming towards Sado.

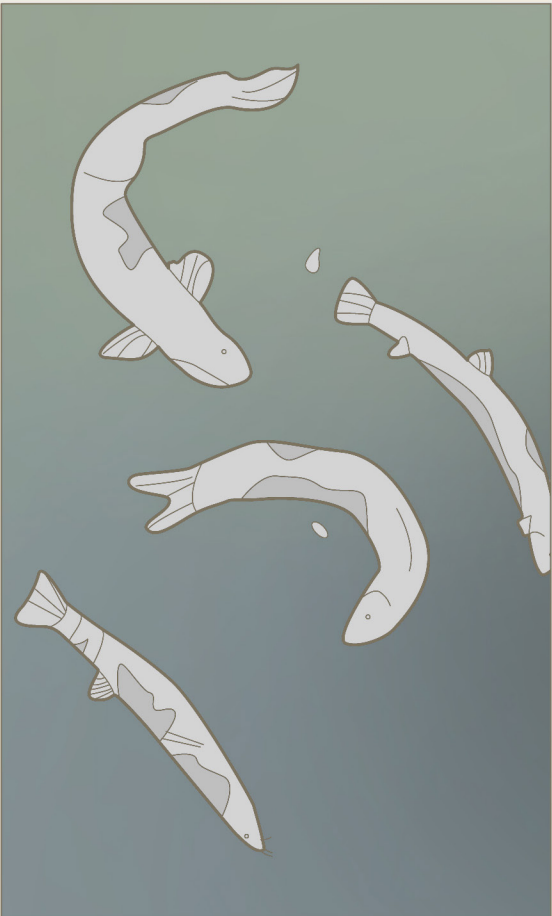
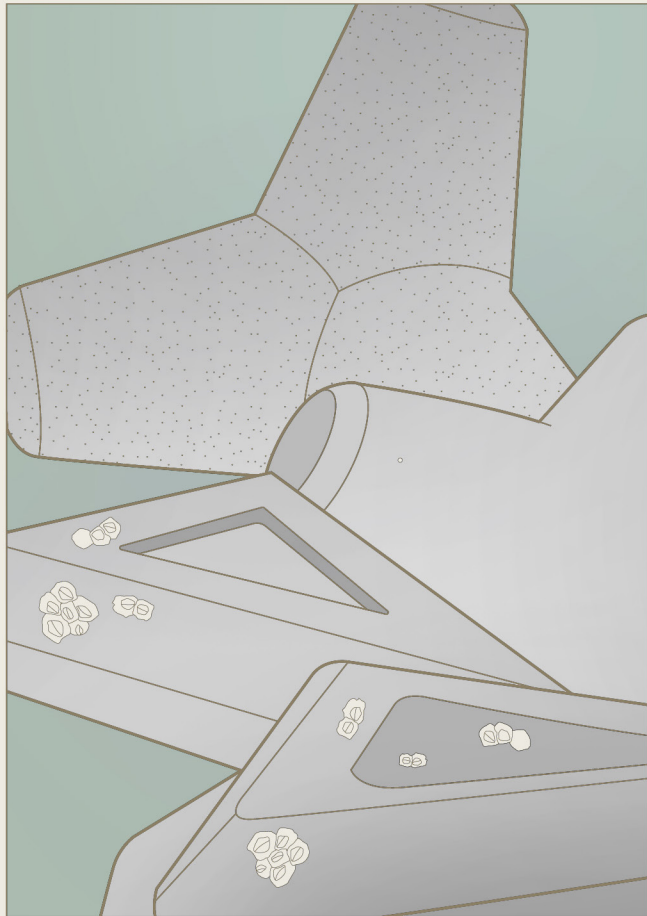
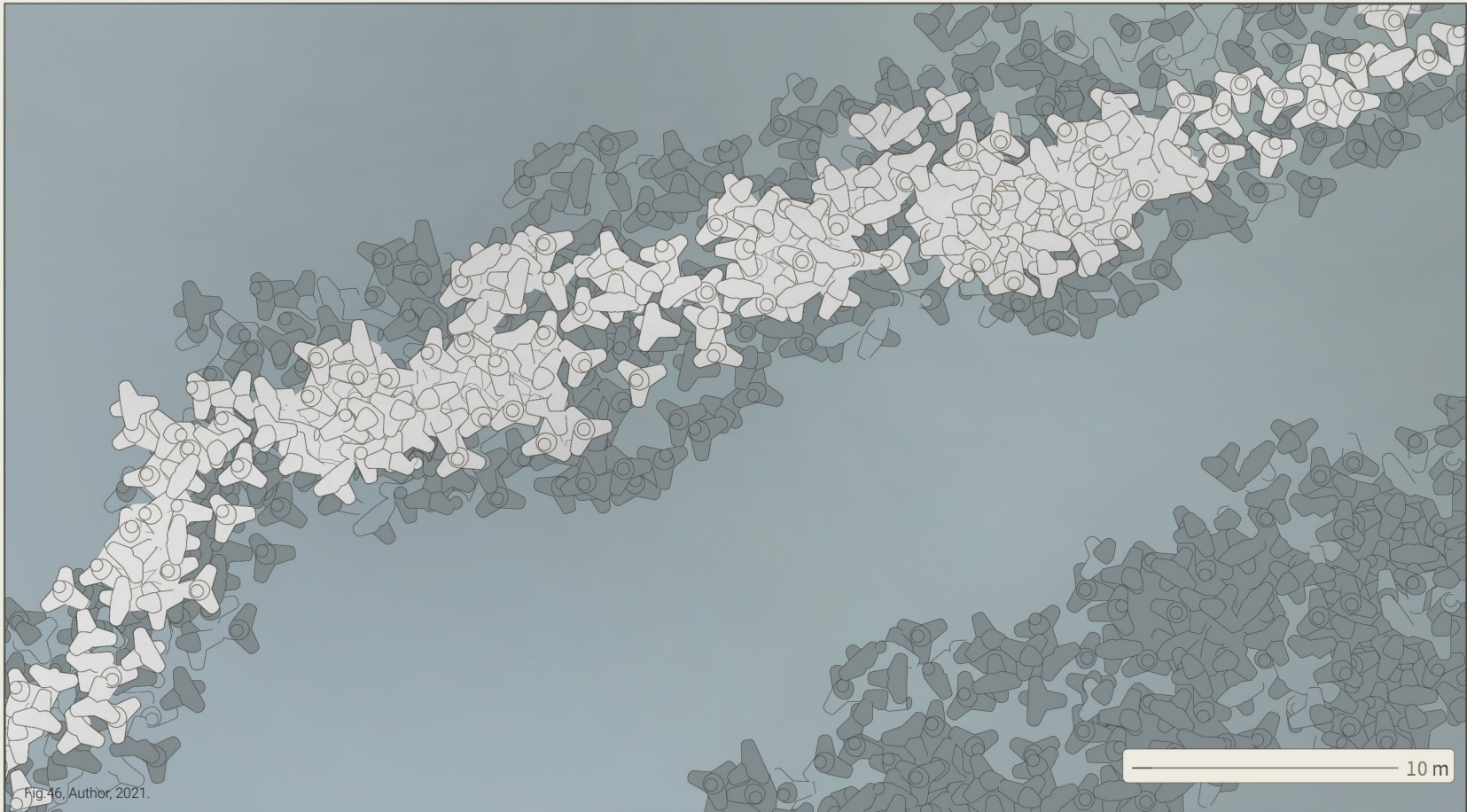
Aren't you working with that developer building aquafarms?

Yes, I was invited to be an advisor. But don't misunderstand. I've convinced them to preserve their footprints for the new aquafarms.

Besides, the division of spaces enable control over nutrients within the water column of each paddy which helps-

Yea, yea. But what if the algae is toxic and contaminates the aquafarms?

I'd rather eat a plate full of Tanaka's slimy loaches than eat the shellfish coming from that aquafarm! Straight from the bucket!





# 2100

Decades pass. It is 2100. Ame’s grandchild Mirai comes sprinting into the Community House. He proudly presents the pitcher of water he’s carrying to his father who is present through a virtual call from the city. Many of the townspeople are present to watch the rice planting. Weeks of growing the seedlings and monitoring the water and soil qualities led to this occasion. Too many factors had previously interrupted the outdoor rice planting- like irregular storms, extremely hot days, invasive bugs, and methane emission readers. So now it was done in secret.



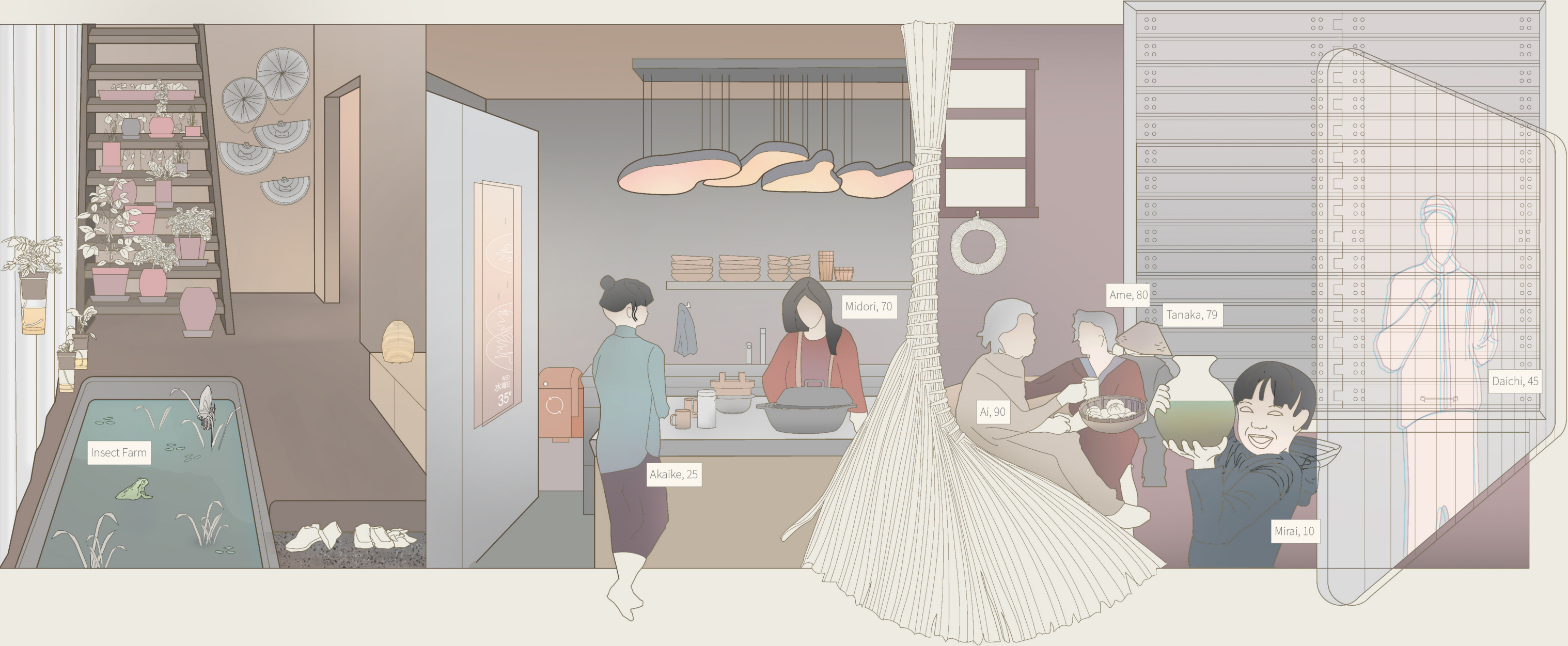


Fig.47, Author, 2021.



Mirai poured the water carefully into  
the paddy. Ai reminded the child...

Hold the seedling  
with your index,  
middle finger, and  
thumb. Gently  
push the soil to  
make room for the  
seedling with your  
finger. Exactly.

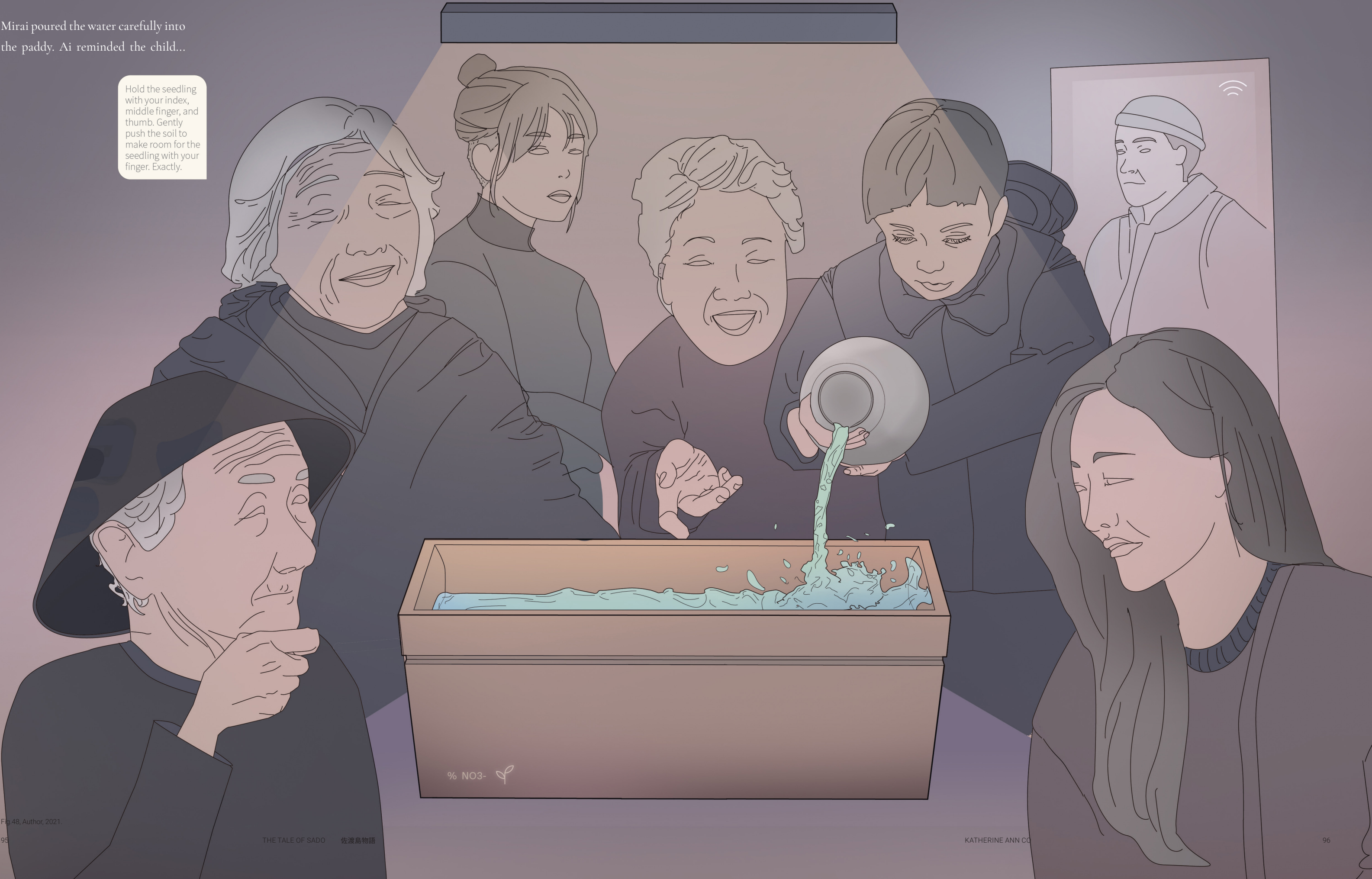
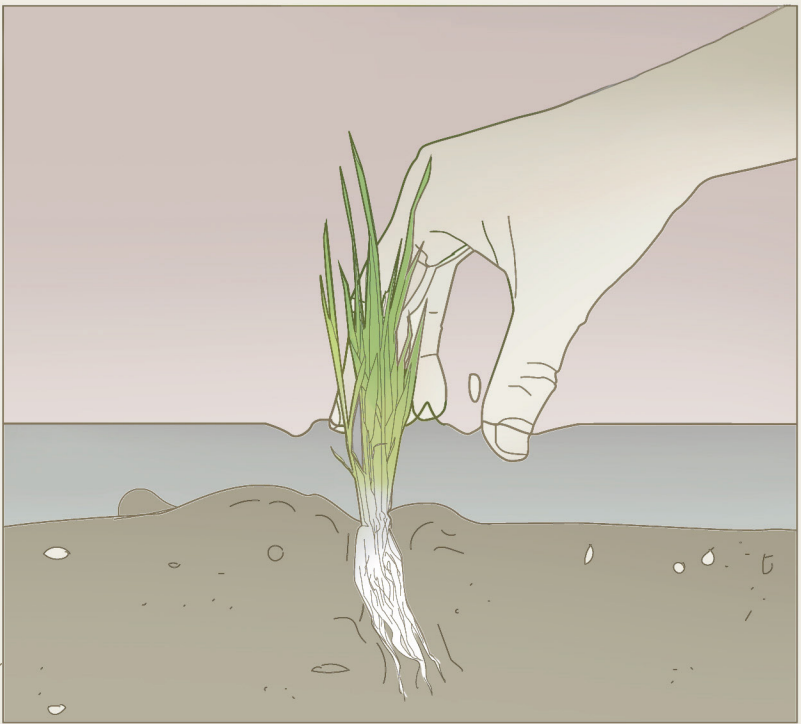
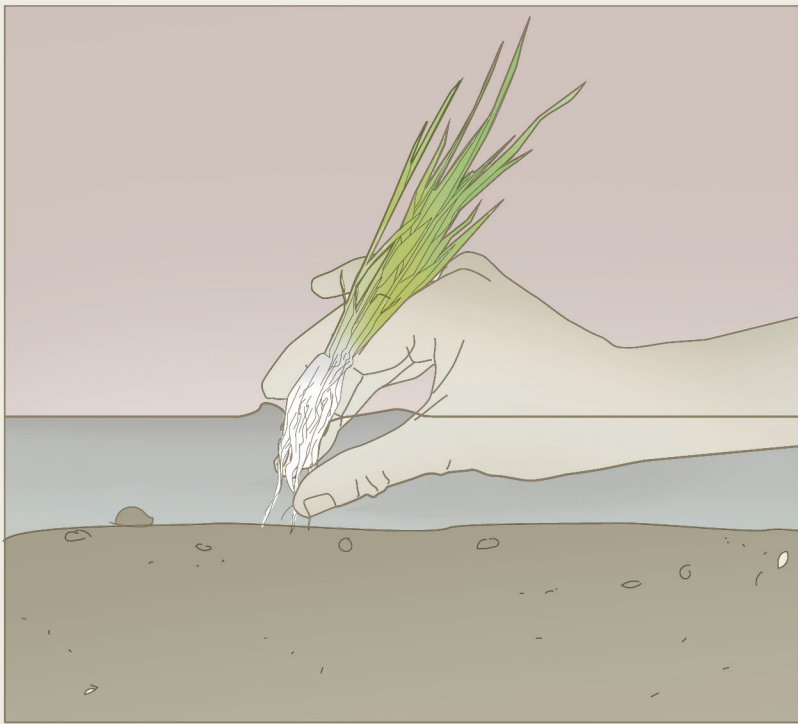


Fig.48, Author, 2021.



Mirai did just that. After the viewing, there was a reflective pause before they all set out a meal. Everyone brought their favourites.

Ai mastered growing her fiddlehead ferns. The Komatsu's had made rice balls. Ai noted they weren't as good as the ones her mother used to make. Ame still loved the Sado milk with the Crested Ibis mascot on the carton. And



Midori happily ate Tanaka's loaches, which he had deep fried. In between bites, Ame asked her grandchild why it took him so long to return with the water. He replied nonchalantly, "I had to go all the way down to the marsh to get it." People stopped eating and then slowly began to panic. "It won't grow!" "Child, that marshwater is no good for the seedling!"

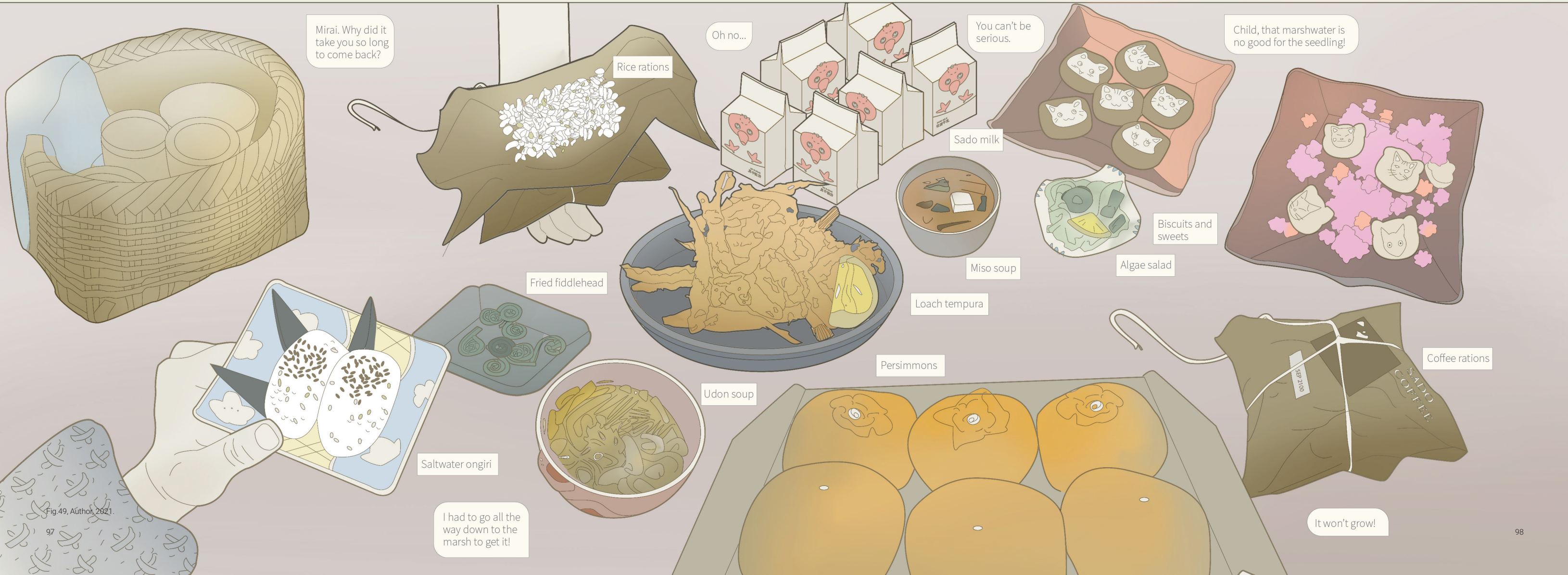
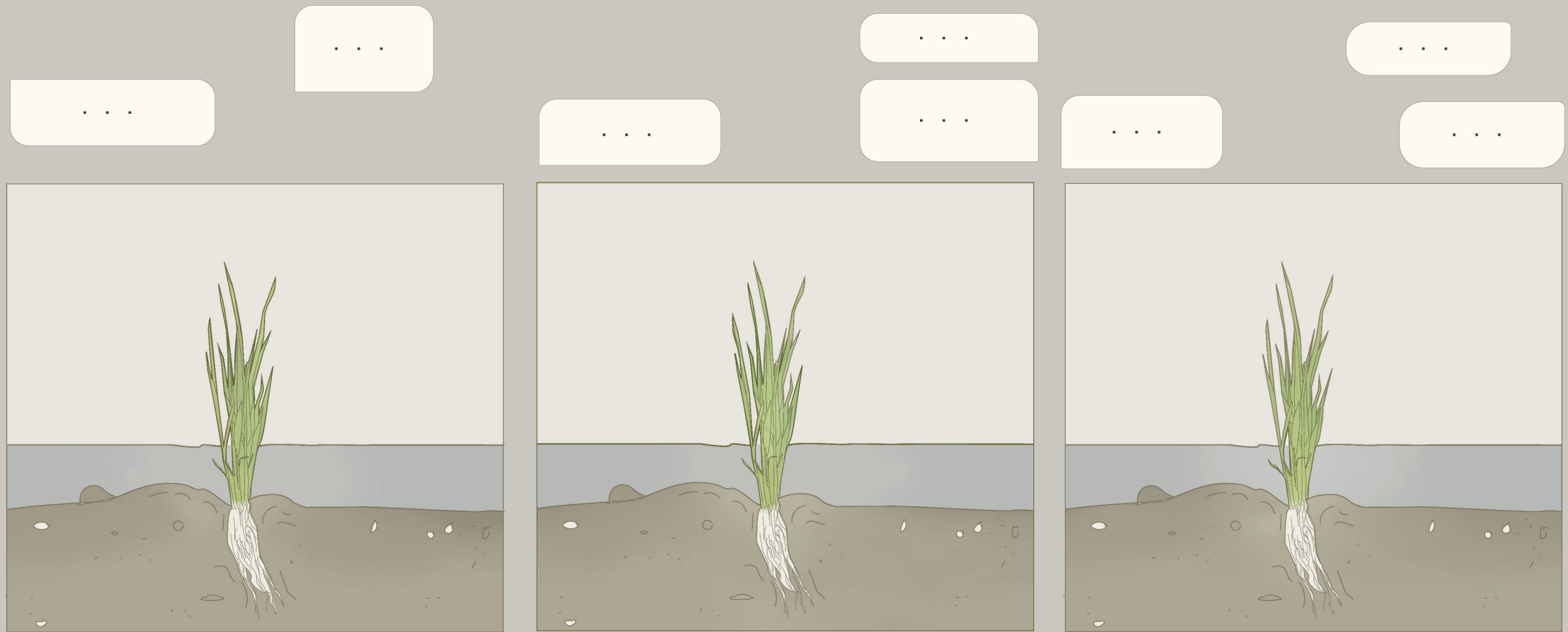


Fig.49, Author, 2021.





Everyone spoke over each other with accusations, with possible solutions, with apparent prophecy of this moment. Either way, the seedling sat in its synthetic paddy, watching the rambunctious group.

Fig.50, Author, 2021.



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# Appendix

## Refining the Argument

The rapid effects of climate change will continue to have a foreboding power over the planet. Destroying infrastructure and jostling society, it will strip away the stability of the routines and traditions that bring us comfort. The rural areas of the world, especially those in Japan where newly industrialized places border old hamlets, must find community resiliency and showcase a life with nature beyond trying to increase the rural population. Through the rising sea-levels induced by climate change, this thesis investigates, analyzes, and imagines a life beyond growth. It speculates an architectural narrative of psychological, physical, and cultural coping through the preservation of rice farming culture in the Japanese island town of Sado.

The beginning of rice cultivation for food was more than a technological advancement towards better food security. Rice paddies became the social space of the countryside where neighbors could rely on community engagement. It was an opportunity to talk, take breaks, and watch their children take over larger responsibilities around the farm. This was a massively shared memory of the Japanese before the 1950s when nearly half of the population of Japan, over 34 million people, were involved in farming.<sup>1</sup> Commitment to tending the paddies throughout the seasons embedded a culture of viewing and participating with the temporality of nature.

Farmers witnessed their efforts on the paddies as important participation to the success or decay of an ecosystem within their paddies. This ancient value needs to be unearthed in this age of climate change. Liam Young in *Machine Landscapes* warns that places that define our capitalist culture and existence are those that people do not visit or occupy.<sup>2</sup> This mental and physical disconnection to the agricultural landscape is dangerous towards the future of preserving a relationship to heritage, nature, and any figment of communal identity.

Sado island's main export is rice, making it an ideal representative location for a rice paddy culture that aids in coping with the frequent storms, floods, and droughts that threaten their future existence. Throughout history, Sado was a place of exile due to its distance from the mainland. Industry and infrastructure have slowly percolated onto its coastal towns but they have less reason to as the island experiences the double-negative depopulation phenomenon that pervades other rural parts of Japan. As an industrialized country that shows its capability in quickly evolving and metabolizing for one's economy, Japan foreshadows the future of many other developed countries.

Unlike the rural hamlets of Honshu, towns on Sado are unable to rely on neighboring industrialized cities and requires a more local and self-sustaining solution to solving the potential loss of rice paddys, culture, and quality of life on the island. This creates an opportunity for more localized designs that can be applied to other locations in Japan, when increasing natural disasters and extreme weather cause transportation failure. By addressing Sado's ecological adaptation to the extreme water-related issues that will arise in the future, its people can become more united and dependent to pressures of industrialization.



Fig.51, Author, 2020.



An opportunity arises for Sado's rice planting culture when the elderly residents can cohabitate the paddies and the island with the increasing number of newcomers that visit and explore rural areas. Beyond the lack of infrastructure and difficult underpaid work in Sado, it is the feeling of isolation that makes living there difficult. This feeling is pronounced within families, when young adults leave to receive an education in the city, only to never return. The disconnection of older relatives is not just a family issue, but it is a sign of cultural and social abandonment.

Simultaneously, Donna Haraway and Thom van Dooren reflect on the importance of mourning the decline of the Earth's ecosystems as a person is able to "appreciate what it means, how the world has changed, and how we must ourselves change and renew our relationships if we are to move forward."<sup>3</sup> The act of coping with climate change as a community is crucial to these small remote towns that already feel a sense of uncertainty for their future. Discussions amongst Sado townspeople reflect how they are less concerned with achieving expansion and, instead, "are positively and by necessity starting to embrace the prospect of living and working within a shrinking region".<sup>4</sup> They await some form of assembly of people and architecture to bring locals and visitors together. In the same way, this is a chance to introduce new ways of inhabiting places for neo-nomads, where they can be more than a tourist, and feel a sense of inclusion into a community.

3 Donna Haraway, *Staying with the Trouble* (Durham: Duke University Press, 2016), 38.

4 Peter Matanle and Yasuyuki Sato, "Coming Soon to a City Near You! Learning to Live 'Beyond Growth' in Japan's Shrinking Regions," *Social Science Japan Journal* 13, no.2 (2010): 208.

## Sketches

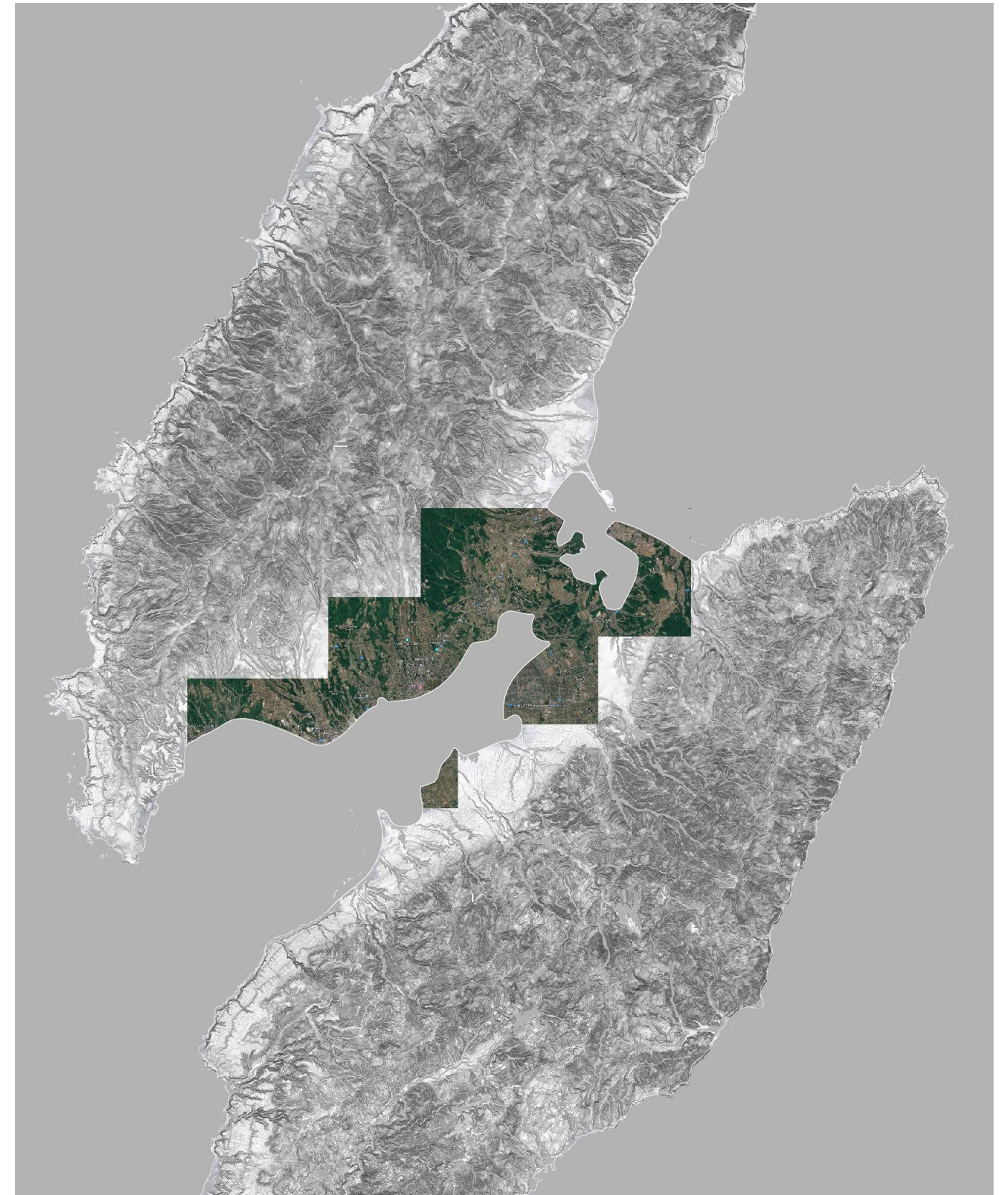


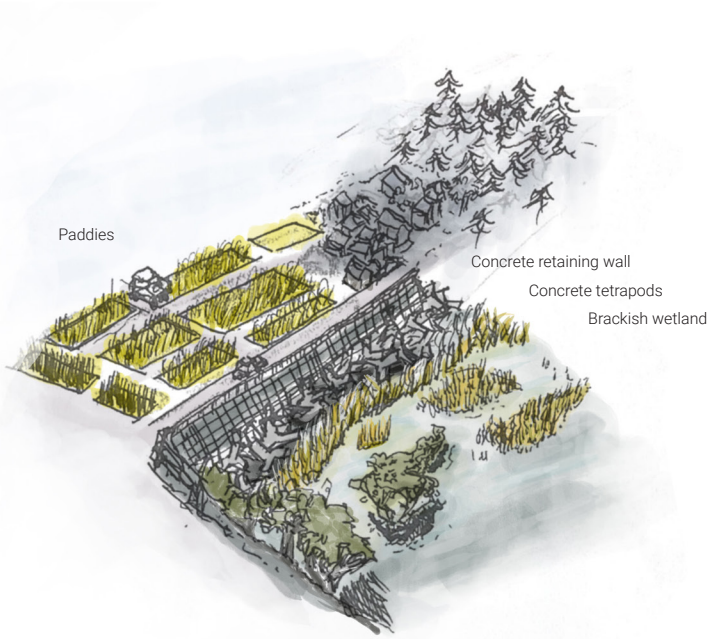
Fig. 52, Author, 2020.



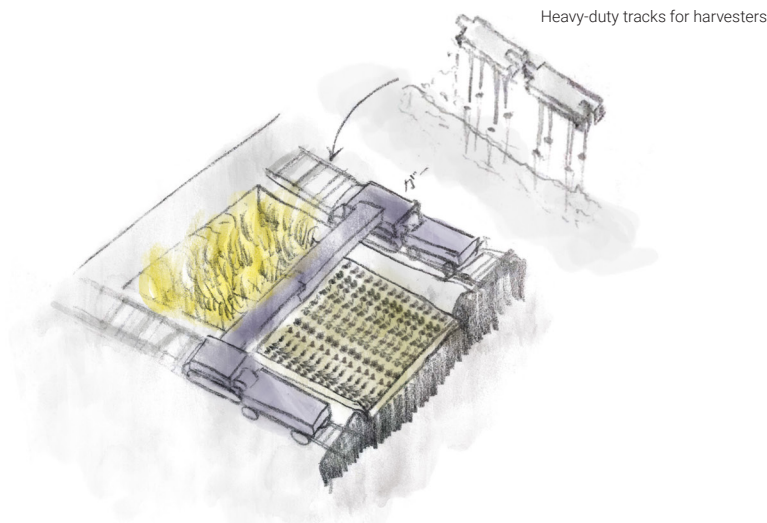
Sado's Rural Future - Sketches



New Kuninaka Program



Commercial Rice Farming



Commercial Rice Harvester

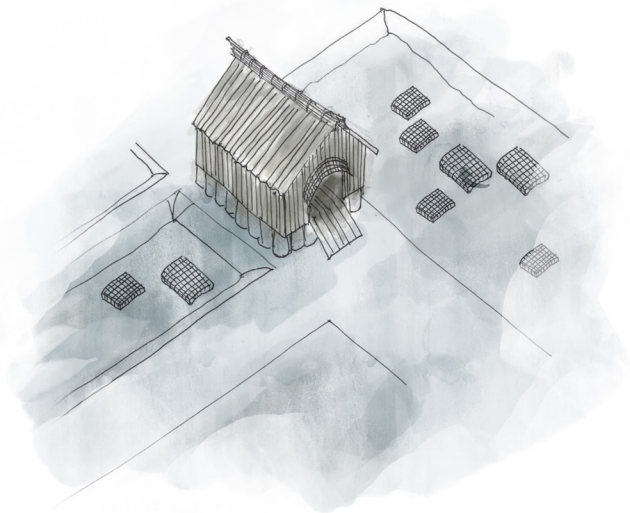


Taraibune (present day)

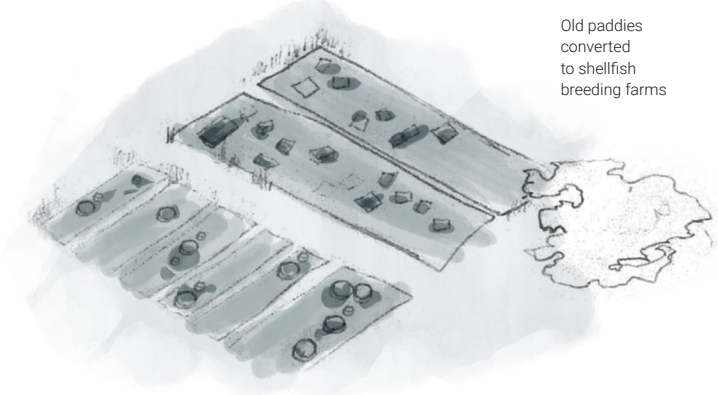
Automated taraibune



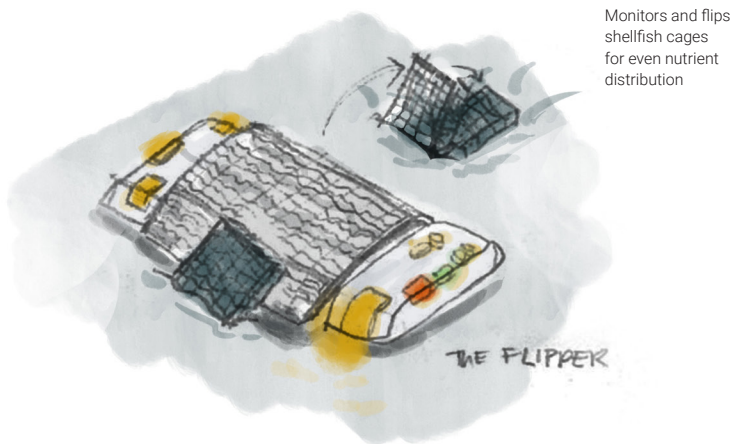
Automated rice transplanter



Shellfish farm

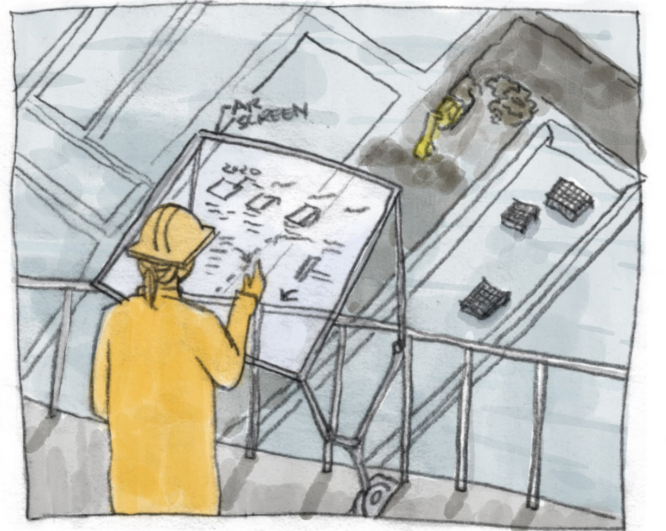
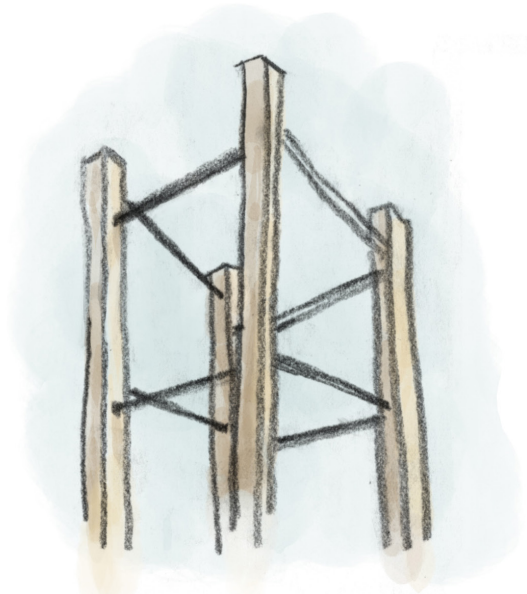
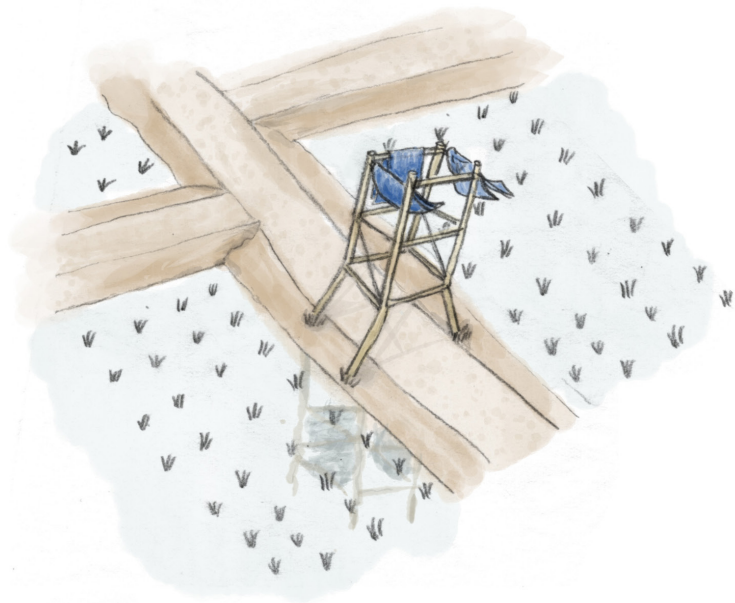
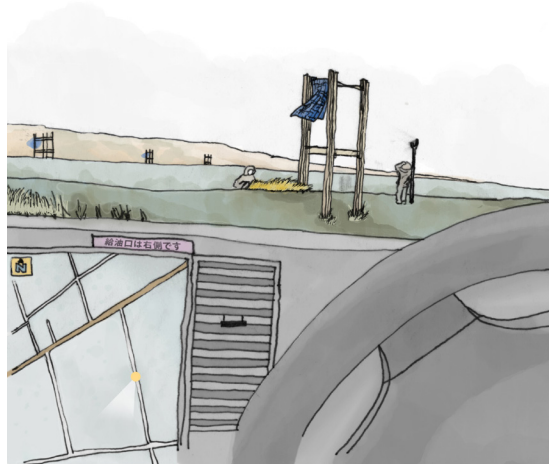


Repurposed paddies



Automated flipper

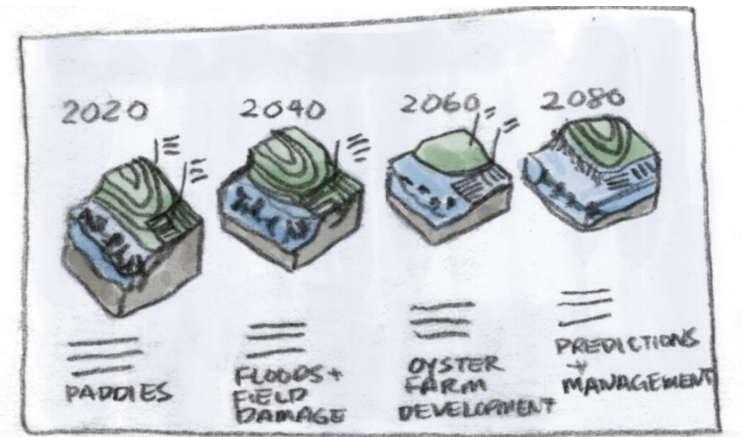
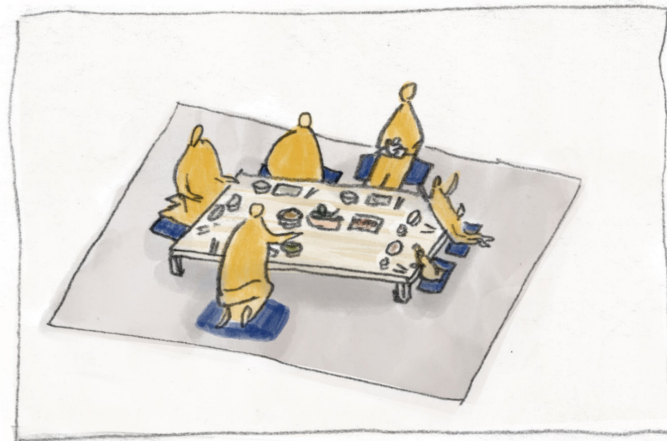
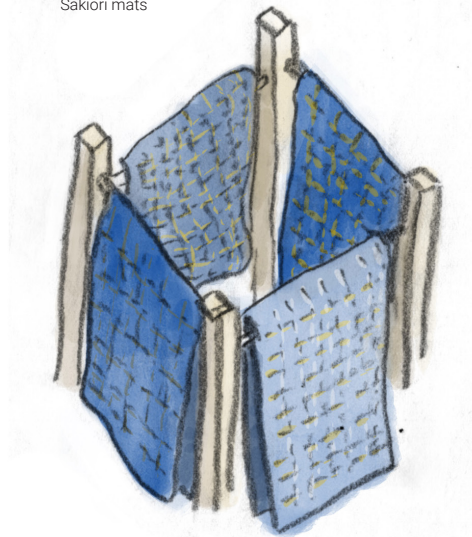
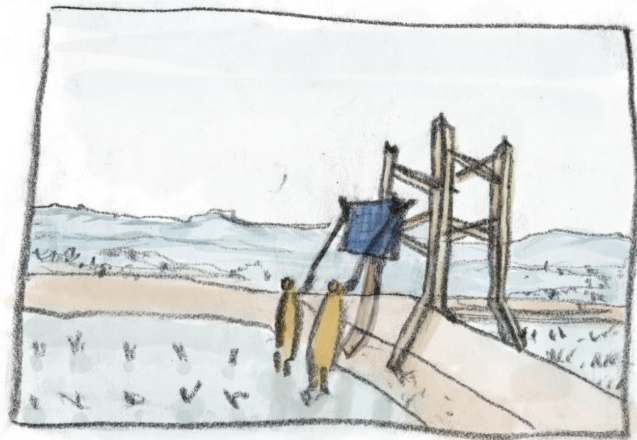




Storm tower sketches

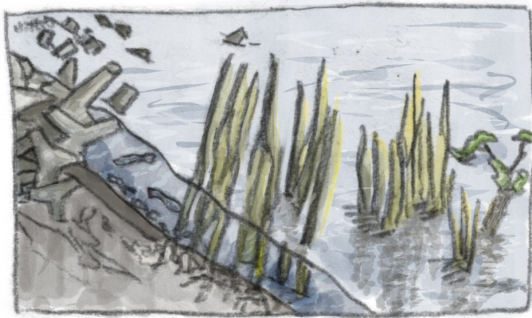
Sakiori mats

Porters with exoskeleton and robot

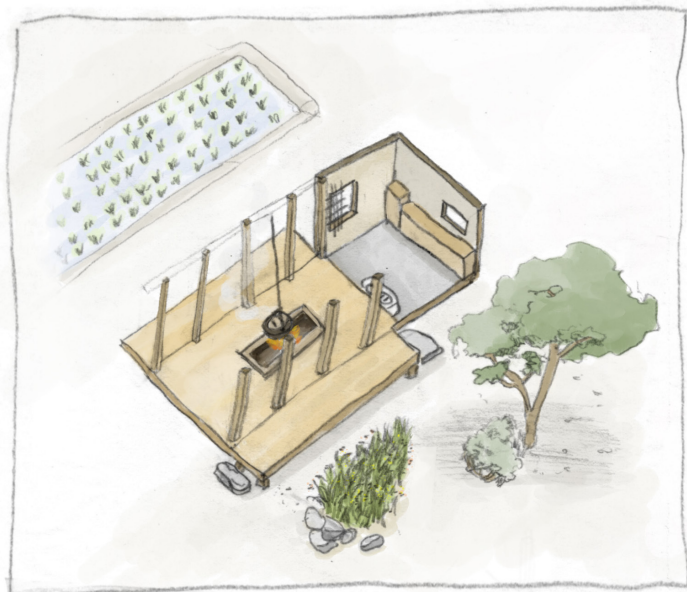
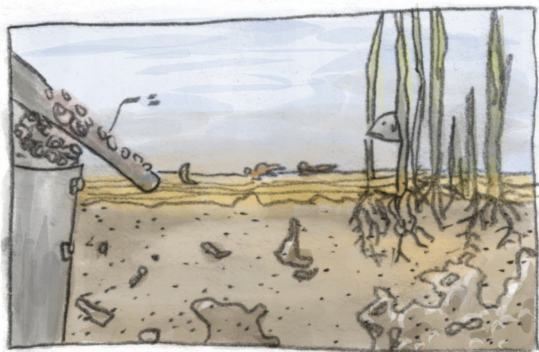


Porter and client having a meal

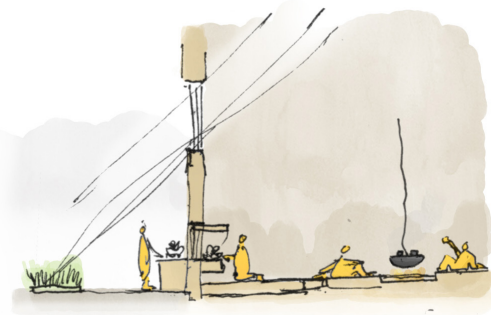
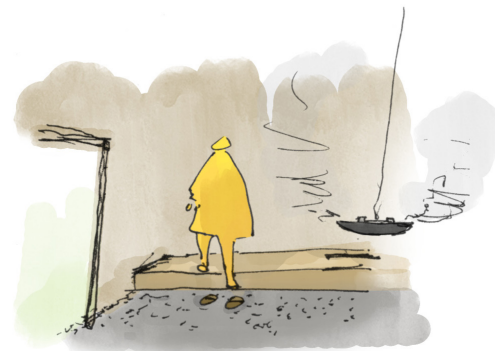




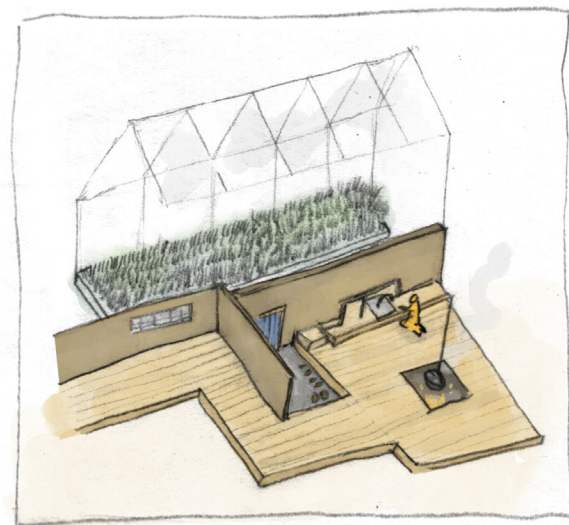
Brackish marsh



Homestead



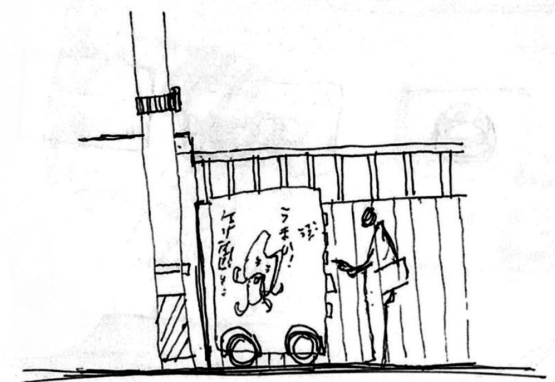
Irori



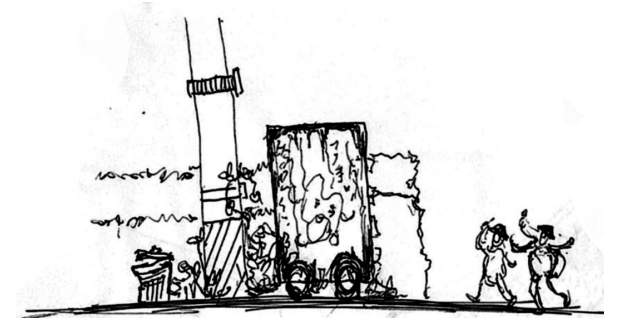
Service window from kitchen



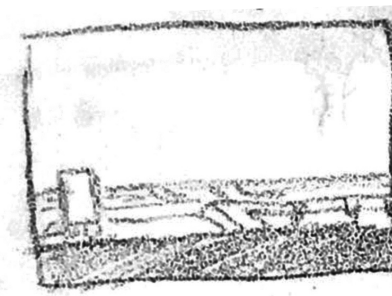
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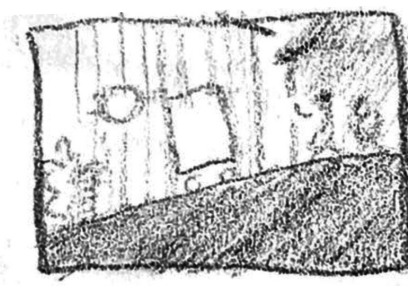
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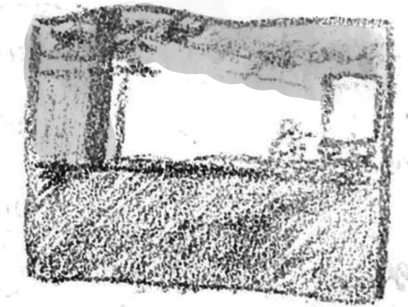
2080



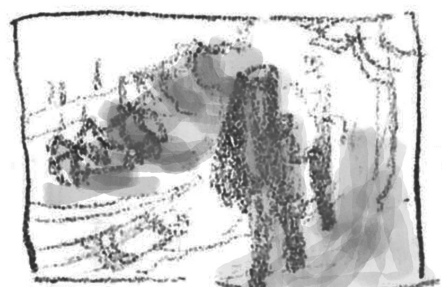
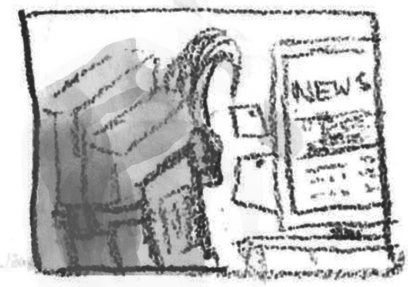
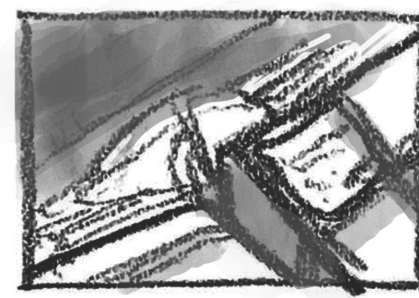
Deliveries/ Packages



Loading Backpack



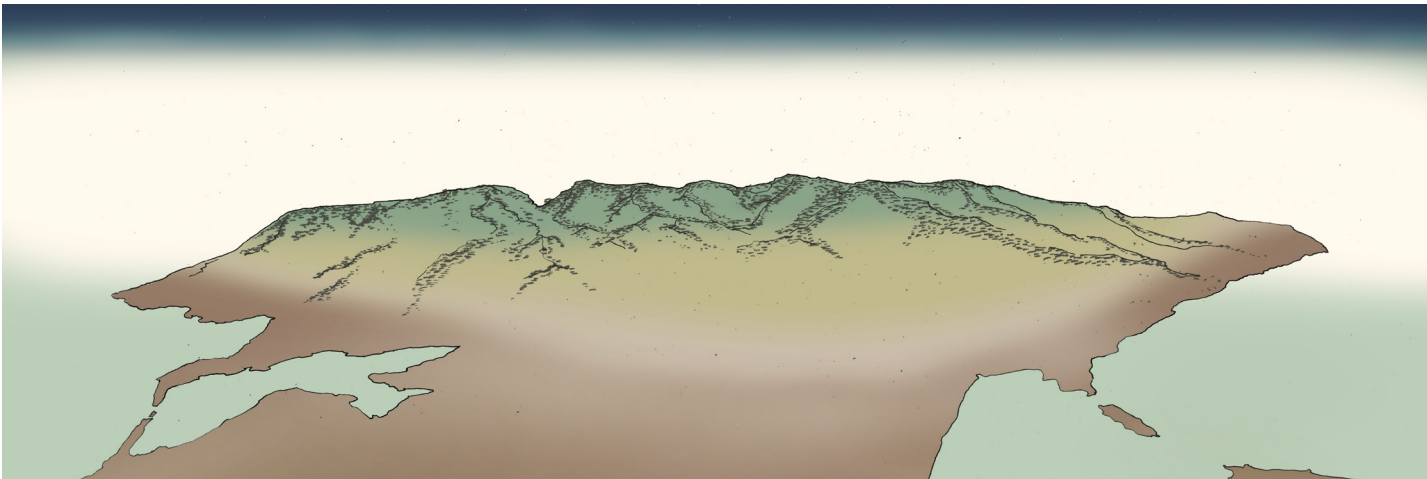
Old Hiking Trail



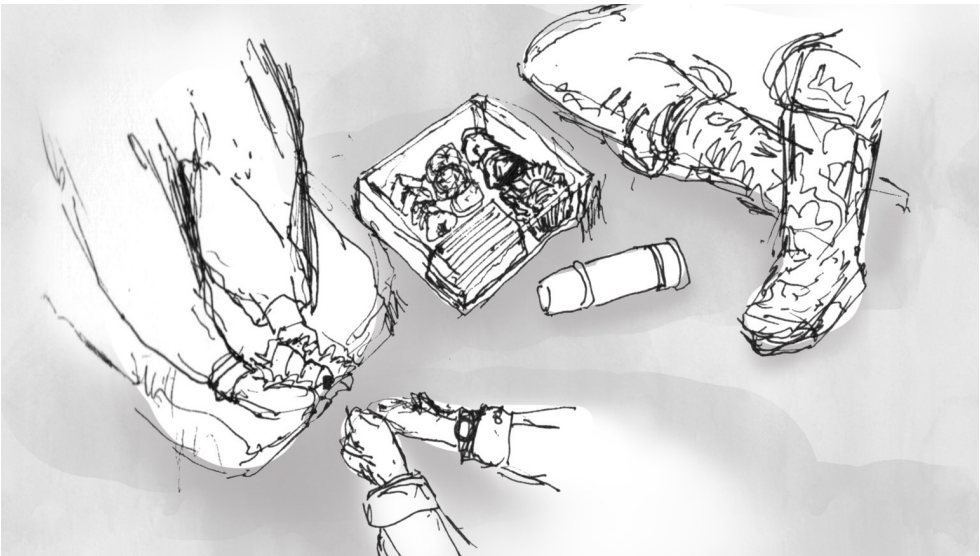
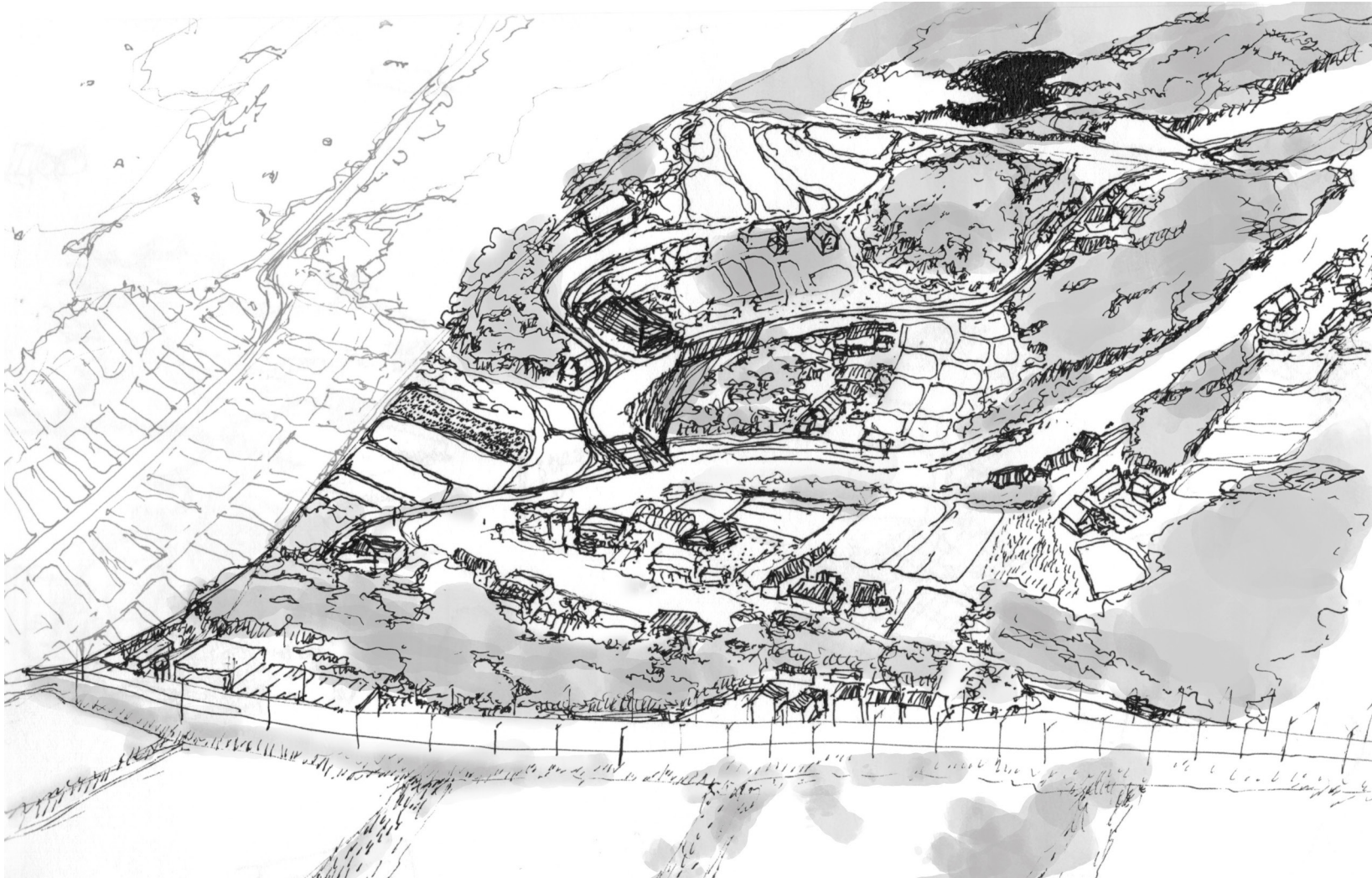




Inserting the Storm Tower in Hokusai's "Mt. Fuji seen from Senju Kagai"  
from Thirty-Six Views of Mount Fuji

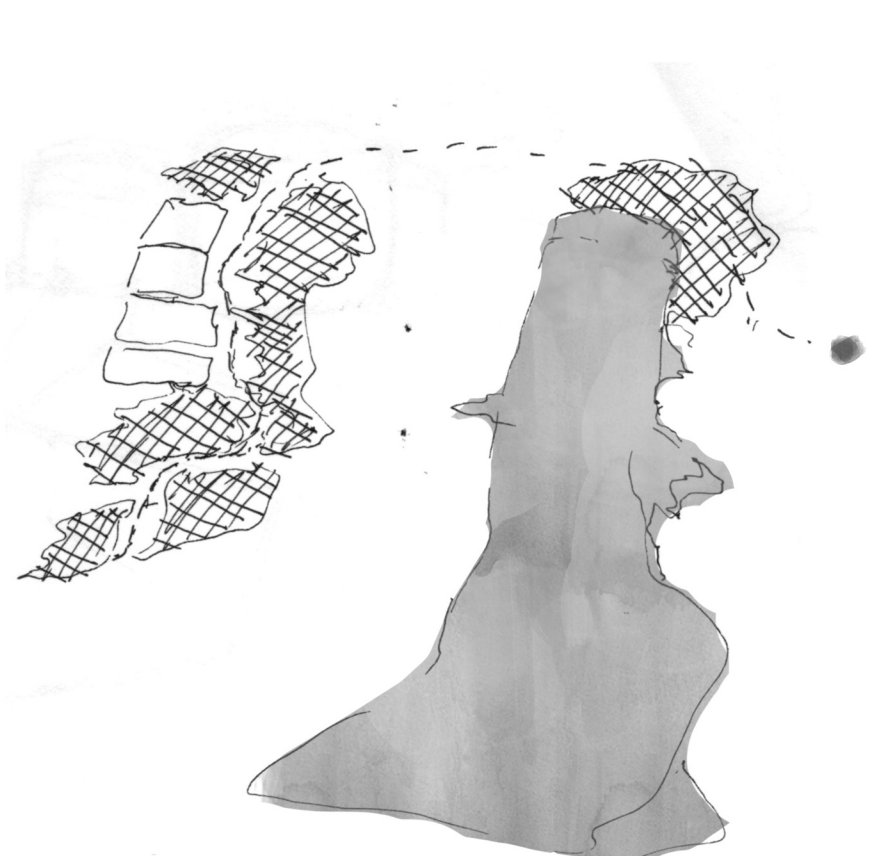
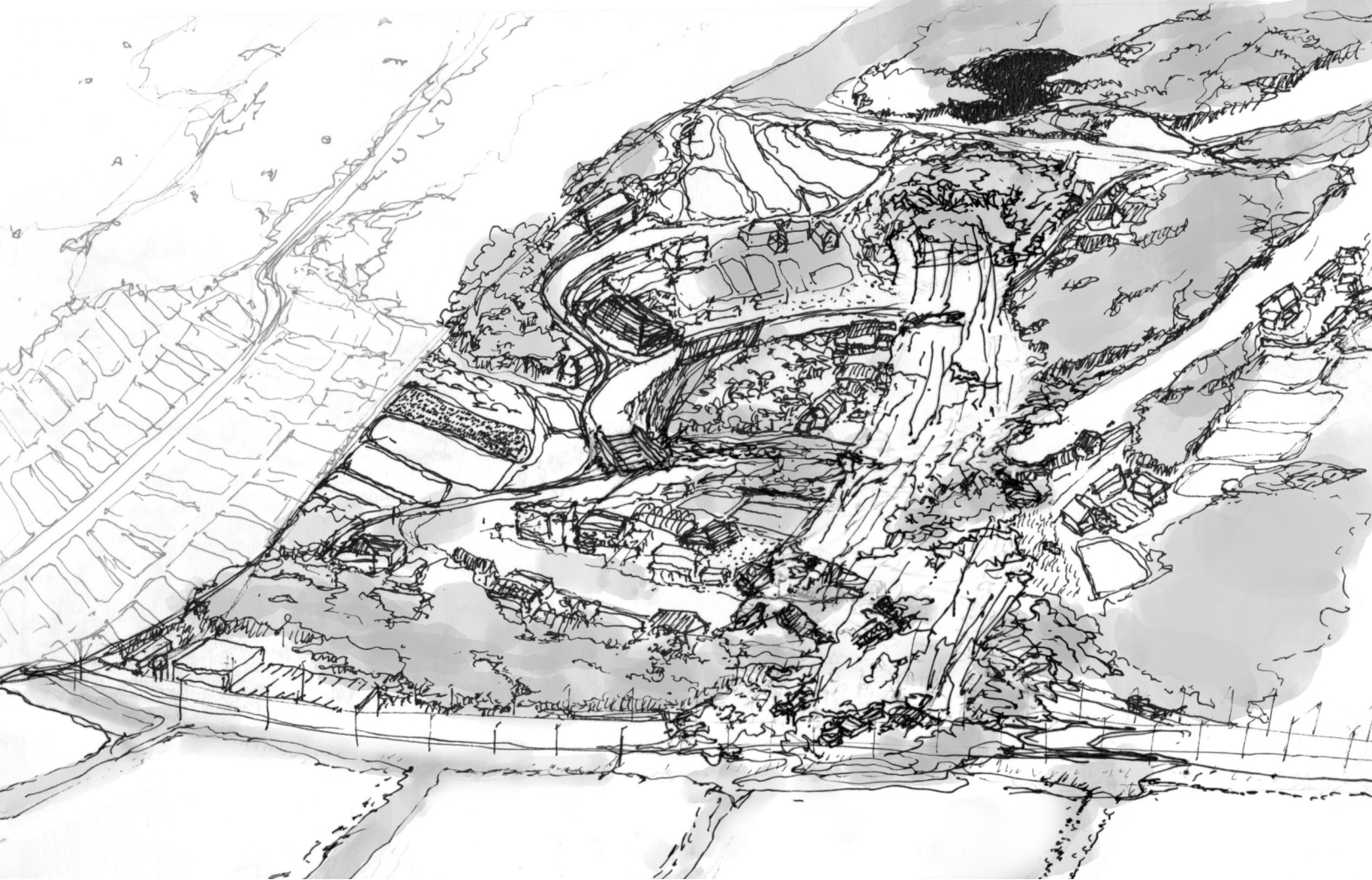


Gradient, Colour Experiments, and Analog Textures on Ko-Sado

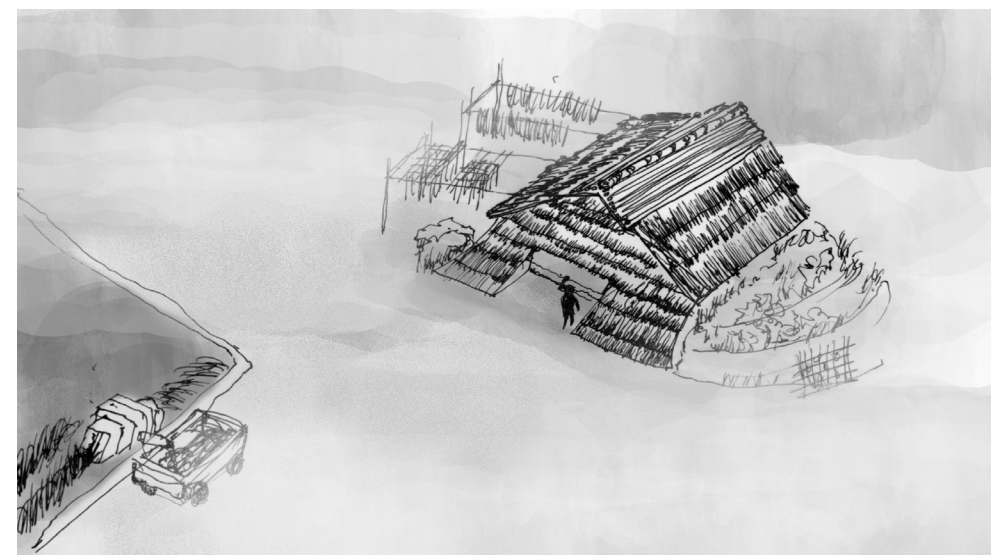


One version of this project was to create a website, showing a hamlet change over time. Viewers could scroll down to read through the story of that chapter.













Bracken ferns

Fiddlehead ferns

Honeydew

Daikon

Cabbage

Broccoli

Burdock

Cabbage

Sea lavender

Salt grass

Common reeds

Young bamboo

Soybean

Kale

KATHERINE ANN CO

Fig. 59, June Shiangchin and Kimberly Chan, 2021.