# APPENDECES

Master thesis
Frederik Ueberschär

Design for Interaction TU Delft February 2021

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Design Brief

#### **APPENDIX 2**

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Design Cycle 2
Additional Exploration
Final validation cluster & raw data
Testing Consent form

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Final prototype: Processing & Arduino Code



### Al for Experience:

Designing with Generative Adversarial Networks to evoke climate fascination

### Master thesis

Design for Interaction

#### Frederik Ueberschär

February 2021

## **Delft University of Technology**

Faculty of Industrial Design Engineering

### Committee

Derek Lomas

Alessandro Bozzon

#### **Contact details**

frederik-ueberschaer.de

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# **APPENDIX 1**





# **IDE Master Graduation**

# Project team, Procedural checks and personal Project brief

This document contains the agreements made between student and supervisory team about the student's IDE Master Graduation Project. This document can also include the involvement of an external organisation, however, it does not cover any legal employment relationship that the student and the client (might) agree upon. Next to that, this document facilitates the required procedural checks. In this document:

- The student defines the team, what he/she is going to do/deliver and how that will come about.
- SSC E&SA (Shared Service Center, Education & Student Affairs) reports on the student's registration and study progress.
- IDE's Board of Examiners confirms if the student is allowed to start the Graduation Project.

#### USE ADOBE ACROBAT READER TO OPEN, EDIT AND SAVE THIS DOCUMENT

Download again and reopen in case you tried other software, such as Preview (Mac) or a webbrowser.

#### STUDENT DATA & MASTER PROGRAMME

Save this form according the format "IDE Master Graduation Project Brief\_familyname\_firstname\_studentnumber\_dd-mm-yyyy'
Complete all blue parts of the form and include the approved Project Brief in your Graduation Report as Appendix 1!

family name initials	Your master program  IDE master(s):	nme (only select the options that apply to you):    IPD
student number	2 <sup>nd</sup> non-IDE master:	
street & no.	individual programme:	(give date of approval)
zipcode & city	honours programme:	Honours Programme Master
country	specialisation / annotation:	Medisign
phone		Tech. in Sustainable Design
emai		Entrepeneurship

#### SUPERVISORY TEAM \*\*

Fill in the required data for the supervisory team members. Please check the instructions on the right.

** chair ** mentor	Derek Lomas Alessandro Bozzon	dept. / section: dept. / section:	HCD, Design Aesthetics SDE, Internet of Things	0	Board of Examiners for approval of a non-IDE mentor, including a motivation letter and c.v
2 <sup>nd</sup> mentor	organisation:			0	Second mentor only applies in case the assignment is hosted by an external organisation.
comments (optional)				0	Ensure a heterogeneous team. In case you wish to include two team members from the same section, please explain why.

Chair should request the IDE

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APPROVAL PROJECT BRIEF
To be filled in by the chair of the supervisory team.

chair <u>Derek Lomas</u>	date _	28 08 2020	signature SQ	2
CHECK STUDY PROGRESS  To be filled in by the SSC E&SA (Shared Service Cer The study progress will be checked for a 2nd time ju			fter approval of the project brief l	by the Chair.
Master electives no. of EC accumulated in total:  Of which, taking the conditional requirements into account, can be part of the exam programme  List of electives obtained before the third semester without approval of the BoE	28	EC X	YES all 1 <sup>st</sup> year master country with the state of the s	
name C. van der Bunt  FORMAL APPROVAL GRADUATION PROJECT To be filled in by the Board of Examiners of IDE TUI		29 _ 09 _ 2020	signature	iaf markad **
<ul> <li>Next, please assess, (dis)approve and sign this Project.</li> <li>Does the project fit within the (MSc)-programm the student (taking into account, if described, the activities done next to the obligatory MSc specificourses)?</li> <li>Is the level of the project challenging enough for MSc IDE graduating student?</li> <li>Is the project expected to be doable within 100 working days/20 weeks?</li> <li>Does the composition of the supervisory team comply with the regulations and fit the assignment.</li> </ul>	ect Brief, been decided as a second as a s	Content:  Procedure:  remark: the the develo	APPROVED NOT A	APPROVED APPROVED
name Monique von Morgen  IDE TU Delft - E&SA Department /// Graduation pro Initials & Name  Title of Project Design for Exploration: Fosterin				Page 2 of 7

#### Design for Exploration: Fostering Climate Understanding through Play project title

Please state the title of your graduation project (above) and the start date and end date (below). Keep the title compact and simple. Do not use abbreviations. The remainder of this document allows you to define and clarify your graduation project.

17 - 09 - 2020 17 - 02 - 2021 start date end date

#### **INTRODUCTION \*\***

Our world climate is incredibly complex and ever changing. The reality of climate change and the consequential pressure to act fast to reduce our greenhouse gas emissions and general impact on the world has reached an unprecedented amount of attention from public, political, corporate and academic communities [1]. Recent years have also shown an increased public interest in climate developments, manifesting in climate protests like Friday for Future [2], but also vocal voices of climate change skeptics [3]. Vast resources are pooled into researching its past, present and future developments of our climate with modern data collection methods and intelligent algorithms helping scientists in their understanding and predictive efforts of our climate development [4]. Especially innovations in digital technology, like the continuous progress of artificial intelligence (AI) & machine learning (ML) enables more complex data analysis and even the generation of visuals to bring scientific data and connected predictions to life [5].

Private companies like Google, Microsoft, Amazon and Apple are on the forefront of Al development [6]. Their access to vast amounts of data about our world and consumer behaviour and ability to invest heavily in the development of Al systems allows them to improve their products and in some instances use the emerging knowledge to contribute to climate science, While Google DeepMind, based on climate science, looked into ways of utilizing deep learning to improve energy efficiency of server farms [7], Google Research worked on and published about improving weather forecasting using machine learning models [8]. Continuing their work on the topic gives them an opportunity to improve their public image as green companies and add another example to their list of experimental projects without direct commercial viability.

Academic climate scientists on the other hand are often publicly funded and constrained in their budget and therefore (technical) ability. They, too, need vast amounts of data and accurate models to make sense of the past and predict the future of our climate to suggest appropriate actions to reduce the cause and minimise effects of global warming. One crucial task of climate researchers is to inform others about their findings. They need and have the skill to communicate to their academic colleagues, but also legislators and other stakeholders in order to enable them to make an informed decision. This communication is characterized by numbers, graphs and elaborated reports in scientific language.

While this form of communication is perhaps fitting for their main target group, its complexity and scientific nature makes our climate and ongoing development a topic that is hard to grasp and imagine for a novice. The general public as an active shareholder in our climate discussion requires a different form of communication and preparation of climate findings in order to be able to participate in the discussion. It is challenging to get into the space and understand the complexity of climate modeling and appropriate climate actions - where to start looking? How to understand the data? What to make of different opinions and how to judge it appropriately?

As a designer, how can you support the communication of climate data and make it accessible to stakeholders beyond the scientific community?

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Initials & Name

introduction (continued): space for images

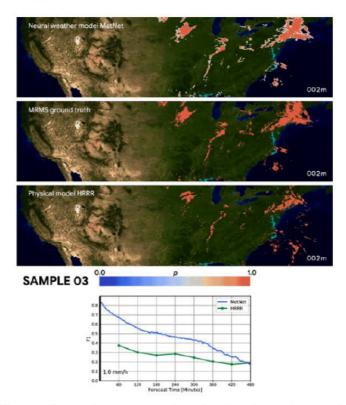


image / figure 1: Using ML to predict weather patterns and precipitation cheaper, faster and more accurate [7]



image / figure 2: Exhibitions as a way to engage people and let them explore complex topics in a playful manner



#### PROBLEM DEFINITION \*\*

Limit and define the scope and solution space of your project to one that is manageable within one Master Graduation Project of 30

The issue described in the introduction is mainly the inaccessibility of climate science for the general public. This graduation project will take a deep dive into exploring the opportunity of transforming abstract data and climate models through Al into a playable experience, fostering understanding and making it engaging and immersive for stakeholders beyond the scientific community, while still potentially providing benefits for climate researchers themselves.

Since both domains of AI and climate research are too vast, the project needs to be limited to one concrete kind of AI and one specific topic of climate research. The use of AI in this project will be to generate visual representations of future climate scenarios. The specific definition of the climate niche will be determined through initial research findings in the first stage of the project.

The goal is not to build a finished and financially viable product, but to explore the domain of climate research and prototype a different form of communication by translating it into a playable, visual experience. The prototypes will research the element of play to support the understanding of complex topics and how contemporary technologies like a generative AI could be utilized to support scientists in their communication of future climate scenarios.

#### **ASSIGNMENT\*\***

State in 2 or 3 sentences what you are going to research, design, create and / or generate, that will solve (part of) the issue(s) pointed out in "problem definition". Then illustrate this assignment by indicating what kind of solution you expect and / or aim to deliver, for instance: a product, a product-service combination, a strategy illustrated through product or product-service combination ideas, .... In case of a Specialisation and/or Annotation, make sure the assignment reflects this/these.

For the graduation project I will design and build an Al powered experience that allows people to engage and play with climate models. The end result will be an interactive piece that allows people to get an understanding and insights into the complexity of our world climate through play, manipulate parameters to trigger different future scenarios and be immersed in the experience.

The main focus of the project will be the prototyping of an AI to generate visuals of future climate scenarios and the exploration of playful mechanisms and elements to make the topic of climate data and modeling accessible to non-scientists, in other words: the general public. This included the research of technical limitations, supporting interaction methods, exploration of visual, tactile and auditory communication methods and crucially the actual interest in such an experience.

The prototyping process and concept direction will be guided through a literature review and interviews with climate scientists. The literature review will provide insights on the topics of play as a learning facilitator, psychological factors that support people in developing an understanding of complex relationships and imagine future scenarios while the interviews will be used as a qualitative research method to find out about the scientist's way of workings, current use of AI or MI in their processes and present communication struggles with non-scientific stakeholders.

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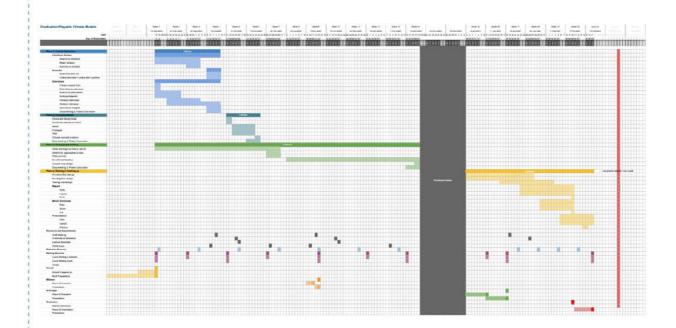
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#### **PLANNING AND APPROACH \*\***

Include a Gantt Chart (replace the example below - more examples can be found in Manual 2) that shows the different phases of your





The project planning is divided in four main components: Context exploration, ideation, prototyping and finalization. The start of the project is shaped by a literature review and interviews with stakeholders (climate scientists & Al engineers in the field) to provide a basis for the project.

Extensive prototyping, starting simultaneously with the exploration phase, will allow me to get experience with working with an Al and generating visuals using machine learning from the first week onwards. After the ideation phase, the usage and prototyping of AI and building playful exhibition elements will be focussed to achieve my actual project goal and proceed in quick, iterative cycles.

Each phase is wrapped up with a documentation of my progress and writing down key insights collected in the prior weeks. Reflective moments, although naturally present throughout the project, are planned every second Friday to allow for an agile scope and direction readjustment based on progress and insight gathered up to this point.



#### MOTIVATION AND PERSONAL AMBITIONS

Explain why you set up this project, what competences you want to prove and learn. For example: acquired competences from your

With this project I want to strongly improve my prototyping and building skills. I want to work with machine learning and artificial intelligence and use data as a design resource, like pushed for at IDE by Péter Kun [9]. I want to challenge myself by mapping out & communicating a complex space, understanding the data, climate workings, algorithms and public impressions to end up with a project I am proud of. On the way I hope to build professional relationships in a field I want to work in later, on the intersection of technology and research.

I personally believe in the importance of people's participation and the power of understanding to be the first step to an active involvement. Breaking out of an expert-driven domain and bringing people along in the discussion is an effort I want to be part of. I as a designer can support this through appropriate means of communication.

Lastly, I want to combine two passions of mine: Technology & climate, enabling me as a designer to have a meaningful impact on one of the most important and urgent topics of our time. I want to help enable us to have a future to actually design for.

#### References

[1] Schmidt, A., Ivanova, A., & Schäfer, M. S. (2013). Media attention for climate change around the world: A comparative analysis of newspaper coverage in 27 countries. Global Environmental Change, 23(5), 1233-1248.

[2] Fridays For Future is an international climate movement active in most countries and our website offers information on who we are and what you can do. (2020, September 1). Fridays For Future. https://fridaysforfuture.org/

[3] Dunlap, R. E. (2013). Climate change skepticism and denial: An introduction. American behavioral scientist, 57(6), 691-698.

[4] EU funds. Retrieved August 13, 2020, from https://ec.europa.eu/clima/policies/adaptation/financing/funds\_en [5] Rolnick, D., Donti, P. L., Kaack, L. H., Kochanski, K., Lacoste, A., Sankaran, K., ... & Luccioni, A. (2019). Tackling climate change with machine learning. arXiv preprint arXiv:1906.05433.

[6] Kukushkina, N. (2019, May 28). How Facebook, Apple, Microsoft, Google, and Amazon are investing in Al | Hacker

https://hackernoon.com/how-facebook-apple-microsoft-google-and-amazon-are-investing-in-ai-f58b5706e34a [7] Al vs Climate Change: Insights from the Cutting Edge (Google I/O'19). (2019, May 9). [Video]. YouTube. https://www.youtube.com/watch?v=AyHpt8uxwSo&t=6s

[8] Kalchbrenner, N., & Sønderby, C. (2020, March 25). A Neural Weather Model for Eight-Hour Precipitation Forecasting. Google Al Blog. https://ai.googleblog.com/2020/03/a-neural-weather-model-for-eight-hour.html

[9] Designers need to catch up on their user data. (2020, August 28). TU Delft.

https://www.tudelft.nl/en/ide/delft-design-stories/designers-need-to-catch-up-on-their-user-data/

#### FINAL COMMENTS

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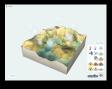
# APPENDIX 2

# Research & Design Activities //

# **Analysis of prior art**

## **Education Experiences**











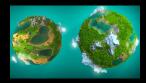
## Games with a building / climate aspect











## Simulators





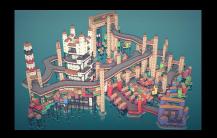
# **Analysis of prior art**

#### Positive characteristics & mechanics:

- 1. Actions have a clear impact: immediate, with delay or as a surprise
- 2. There is always something happening, be it sound, little movements, development of the landscape etc.
- 3. Time is present, but not linear nor realistic
- 4. Simplification is needed to make it manageable for the game to simulate, but also for the player to comprehend
- 5. World can be shaped through: Painting on the landscape, causing world events to happen, building infrastructure
- 6. Graphs and charts can be used to show hidden aspects
- 7. The player can move around, zoom in, zoom out and judge the situation from different angles

#### Research & Design Activities //

# **Analysis of prior art**









#### Main takeaways:

- 1. The most engaging games where the ones where the climate was a mechanic, not the focus of the game.
- 2. It is extremely hard to make a good, balanced game and it has to be complete in order to work.
- 3. I can take a lot of inspiration and mechanics from these games nonetheless
- Educational experiences, probably due to budget constraints, are often dull. I can't really imagine people playing those, if not forced to do so in a classroom.

# **APPENDIX 3**

# Design Cycle 1: Concepts

# Our New Planet

#### **Premise**

My climate research showed how complex a climate system is and how long changes need to usually take place. Geoengineering requires a good understanding of these interplays and might be a needed intervention to buy more time.

#### **Game Description**

Our New Planet is a simulation builder game where players are explorers of a new species that have to geoengineer a new planet to give the last survivors a new home after the old planet was used up.

Players start with a newly generated planet, that for some reason or the other is currently not inhabitable for organic life. They can scan the planet and get a first estimation of what it needs in order to become habitable. Through careful geoengineering the goal is to create a balanced system again. For instance might a planet covered in ice need some artificially introduced greenhouse gases in order to heat it up enough for plants to grow. Once they reach the goal, they get a score of how many years of geoengineering were required for the planet to become inhabitable, which will be many, many years. Their actions and progress can be shared with others on social media.

#### Desired effects on the player

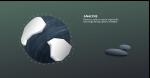
I would like the players to enjoy the experience of tinkering with a planet, and help them in understanding how the different elements of a climate system work together. The story of playing another species and starting with an inhabitable planet that gets shaped into a hapitable, arguably desirable, environment again was supposed to detach the player from our current reality and allow them to be immersed in the game without immediately being scared off by the dystopian narrative. The high number of years needed to finish the process was supposed to showcase the inertia of a global climate system, to not present geoengineering as an easy solution for our current climate crisis. This was a potential pitfall mentioned by two climate scientists from Hamburg and Delft when speaking about the idea of a climate game.

#### **Feedback**

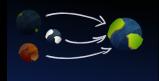
The feedback was gathered from multiple participants and condensed:

- + Looks appealing, and has a nice element of world building
- + The balancing act of different climate components, if simplified, is an interesting game mechanic
- + The importance of measuring and adjusting your actions is great
- Geoengineering shouldn't be seen as a solution









# Carbon Capture

#### **Premise**

Vegetation, on land or in the water, has a huge impact on our climate by storing carbon, but also naturally cooling the earth through the evaporation of water. However, not every tree is equal and not every tree planting is good.

#### **Game Description**

Carbon Capture is an AR, real-world multiplayer game where players are explorers that have to search and collect the biggest, most powerful trees in their area to create a personal collection of trees with the highest carbon captured.

Events pop up on a digital map that show a location close to a player where a special tree might be found and captured. The players have to find their way to the area, analyse the tree and find the biggest carbon capturer in this area. Once scanned and collected, it contributed to the score of the player and can be taken home to be placed with augmented reality (AR) in the neighborhood of the player. The AR placement is uploaded to a shared map, so other players can see your neighborhood be filled with trees again, too.







#### **Desired effects on the player**

I would like the players to explore their surroundings again, have fun doing so and learn something about tree properties and history and abilities of different species on the way. Having an ever growing score is supposed to contribute to long term motivation, and placing it in your immediate surrounding in an augmented reality environment should showcase that the shaping of our surroundings is a collaborative effort, and that you as an individual could do your part.

# Cloud Musician

#### **Premise**

Based on one of my conversations with a cloud modeling professor from TU Delft, I learned that clouds have an immense impact on our climate, and are influenced by it in return. The formation of a cloud is a fascinating process that starts on the micro level by tiny water droplets forming around a dust particle, which then contributes to the structure of a cloud. But not every cloud is equal. Different types of clouds have different effects on our climate, for instance high lying clouds causing a warming effect, while low hanging ones cause a cooling effect.

#### **Game Description**

Cloud musician is a music exploration game where players are a controller of forces that have to influence the formation of clouds and play with the different working of parameters in a simplified global world to create a harmonic music experience.

The players witness the life of a cloud, from its initial formation around a wave of dust to its journey around the world and finally its end by raining on a terrain. Each chapter explores a different theme, like the influence of dust, wind, height, temperature and terrain. The game is an aesthetically pleasing experience, with simple swipe interactions to influence different theme parameters. Changing visuals and a generative soundtrack give players feedback over their actions.



#### Desired effects on the player

I want the players of this game to feel a sense of peace, wonder and fascination, while learning something about the fundamentals of clouds. The experience should be enjoyable in itself, with the idea to shape their understanding of the relation between clouds, our actions and our climate without it feeling like an educational game.

- + Through the interaction, it feels like a sandbox game that you only play for a short time
- + Educational aspect / potential is clearly there
- + Visually interesting and abstract
- Perhaps not enough for a proper game
- Still quite vague in how it might feel and look like

# Coastal

#### **Premise**

Sea level rise is one of the dangers of a changing and warming climate, with coastal towns and tropical islands being the most affected. Water distribution around the world isn't as easy as you might initially think. It is influenced by different currents, which are equally influenced by temperature changes, and even the gravitation of massive ice sheets in the arctic and antarctic have an influence on the distribution of water around our globe.

#### **Game Description**

Coastal is a godlike tower defence where players are builders of a coastal town that have to create a flourishing town and build it in adjustment to the rising sea to a local coastline to keep their citizens safe.

The game explores the interplay between a small coastal city and the vast water system of our earth. By zooming in and out, the player can explore the sea on the local as well as on the global level and explore coastal cities other players build around the earth.



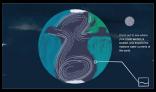












#### Desired effects on the player

I would like the player to enjoy the experience of building their own little coastal town, and aid this through quick and fun interactions with the game. Starting in different regions of the world, for instance a coast in north europe or an island in the tropics, is supposed to showcase that our global water system is complex and solutions to sea level rise are not a one-fits-them-all approach. I would like the player to understand more about how elements of our climate play together and that with the right treatment the sea could be seen as a partner instead of an opponent that needs repression.

- Looks like a fun game
- Hard to see the big picture perhaps, and the other towns
- "You can't just fix the climate yourself, so how do you see the impact you are having?"
- It might be a good idea of zooming out and not having the pettz human perspective, but focus on something bigger perhaps

# Hindsight

#### **Premise**

Today's world is shaped by past decisions and inventions, some of them being discovered by pure luck. Often, things are taken as given and it can be hard to think of alternative histories and futures our societies and planets might have taken. But what if you could go back in time and alter some of our decisions made in the past?

#### **Game Description**

Hindsight is an adventure game where players are time travelers that have to manipulate key events in history and alter the course of time to prevent the occurrence and effacing impact of climate change.

Starting in a dystopian future, with the knowledge of the impact of different discoveries or events on our climate, the player has to go back in time and manipulate these events in just the right way to open up the path to an alternative future.



#### Desired effects on the player

I would like the player to be immersed in the story and develop an understanding of how we got to the point we are today. Technological discoveries, like the discovery of the steam engine, had a massive impact on our history and the world we live in today. Through going back in time and understanding our technological impact on the climate, and opening up a window to alternative realities, I would like the player to again start questioning the status of our current society and feel like we have an agency over what happens in our future.

- Would be interesting to experience and change concrete events and then speculate what might have happened
- Difficult to avoid a set agenda from the game designers
- Easy to lose a target group by pushing an agenda

# Landshapes

#### **Premise**

Our actions have an impact on the surface of our earth, and the properties of the surface have an impact on our climate. It makes a difference if sunlight hits a reflective ice sheet, a vegetated area or an asphalted city. We often can't see the impact of our actions, either because they are too small to notice or the effect happens elsewhere. To act against climate change, we have to do it globally and do it together.

#### **Game Description**

Landshapes is a free exploration experience, where players can influence the surface of a generated map tile through swipe interactions and shape it to their desires. The landscape resulting from their individual actions is merged into a collaborative, physical art piece in a remote exhibition.

The interactive experience is surrounded by stories about fascinating interactions with and in our climate system that players can explore.

#### Desired effects on the player

I would like the players to enjoy the interaction with my experience, and have fun and be engaged for as long as they want. The engagement can last from only a few seconds to a few minutes or longer. I want them to feel a fascination for the shaping of landscapes and our climate system again and understand that our actions and how we choose to shape the world with our individual, as well as communal actions, does have an impact on the earth - even if you can't see it right away.

- Very abstract, so you would need to see your impact and a sense of progress
- On this abstract level it is very interesting
- Aesthetically pleasing and fascinating
- Very nice and engaging visuals
- Catching the attention
- How would people take notice of this experience?
- "What will people take out of this experience?"
- Interesting message, but it has to be clear and sharp
- Might be difficult to balance between desired outcome and freedom
- Going to an exhibition is a lot of commitment for people
- Testing data

# Cycle 2: Interaction Testing

The prototypes were tested remotely with three participants over Zoom and the feedback gathered in an informal fashion to encourage conversation and free expression. After each prototype test, the participant was asked to switch to a provided Miro board and give qualitative feedback. This process was supported by the PrEmo tool (Laurans & Desmet, 2017) to help participants express the emotions felt while using a prototype.

#### **Procedure**

- 1. **On Boarding**, explaining what the test will be about
- 2. **Testing** each prototype, sharing the screen at the same time and collecting comments on the way
- 3. **Evaluation**, collecting comments and feedback to each prototype on Miro
- 4. Creative session, collecting ideas and input

#### Questions asked during the interview:

- 1. How would you assess the aesthetic of the prototype?
- 2. How did this interaction feel to you?
- 3. What did you like? What didn't you like?

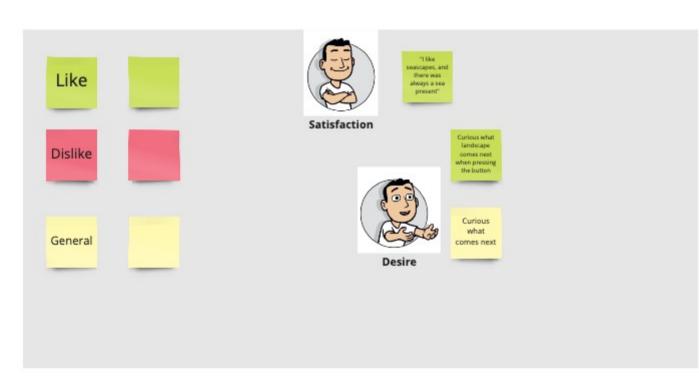
#### **Analysis**

The feedback of participants was combined and clustered into positive, neutral and negative feedback towards each prototype and color coded to aid quick viewability.

Combined P1: One Button  The Company of the Company	A ITTE  Sas area to   The area		P2: Swiipil	Tarabata	Manual  Manual	P3: Fly-through	Blood  Hopping  Harding  Hardi	Indiana Indian	P4: Choosing  No. Grps  Anders Syrut	The second of th	Control Contro	P5: Drawing	Lit's fun	Faccination  Faccination  Faccination  Faccination  Faccination  Value  Water of the control of
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# **Prototype Testing: Cycle 1 // Participant 1**

P1: One Button



## P2: Swiping

Most visually interesting (transitions)





Interesting to interact with the prototype

> First thought the website was broken, as nothing happened

Frustrating that I couldn't figure out how it works, or how to influence the landscape

Not clear how to interact, or that you can interact

I would feel proud if I would've figured it out

I'd like to

keep it as a

wallpaper

Mini introduction needed



Desire

Undear if I missed hidden interactions somewhere



#### Fascination



Joy

Transition was joyful to watch

Swiping was uncomplicated

## P3: Fly-through

Most engaging interaction in itself





Controlling with the keyboard had a better. more controlled experience

Surprise that there were so many different landscapes

> Mouse control was confusing acre was name writing





Hope



voxels

Suspension, excitement of what might still be to come

General



Cool that you can control something but you didn't know the limitations of the prototype

Need for tutorial or explanation



Joy

Exploring and using the keyboard

> Only small teasers for the worlds behind

When the 30 swipe-world to

## P4: Choosing



Most satisfying interaction (clear interaction)









Nice. simple website layout

"Not clickable anymore, so it is apparently done\*

I always have two options and



General













Selbstwirk samke itse rfahrung

Wondering what's coming mext?



Clear threat to follow

Satisfying that you come to an end

apparently create an image in the end

I get a different image in the end than I actually wanted

I'd espect that I narrow down my choices and that my chaices from the first steps are still visible

Either the last step has another change



I'd expect that during the last step that I can choose one of the above

> No Indication of "make your final choice"



Anger

The last step is confusing

why have doing at I the work of there is completely different

## P5: Drawing

Most engaging interaction (from a result)





# Dislike



General



Frustration that I wasn't done yet

Confusing in the beginning, thought it would be only a paint

The tools where not the nicest, with the paintbrush and so on A bit too open with no starting point.

> Open end can be good and bad

e Excitement and

Got nice once you saw it translate into the photo landscape



Fascination



Joy

Want to explore more of what you could do

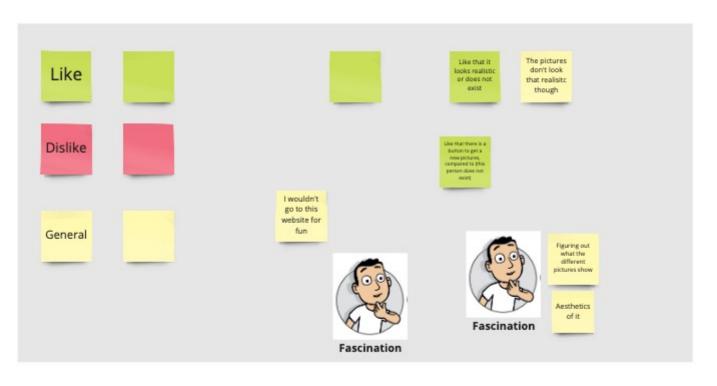
"I could spend way more time with this"



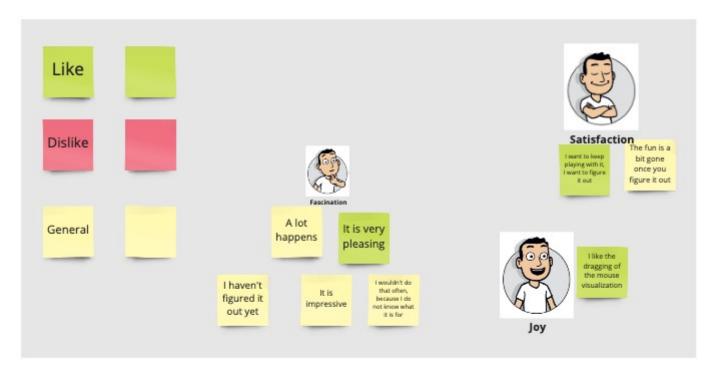
Ugly website

# **Prototype Testing: Cycle 1 // Participant 2**

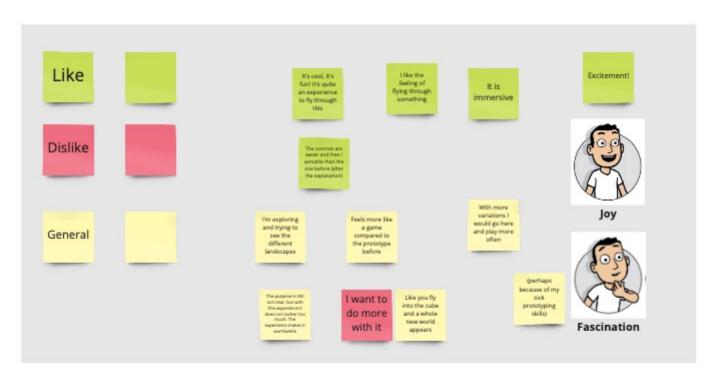
P1: One Button



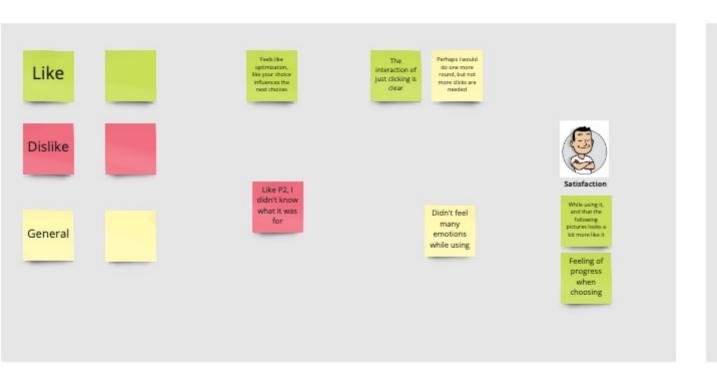
# P2: Swiping



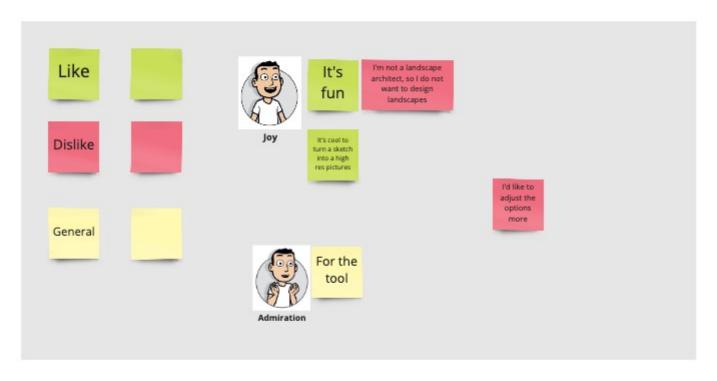
# P3: Fly-through



## P4: Choosing

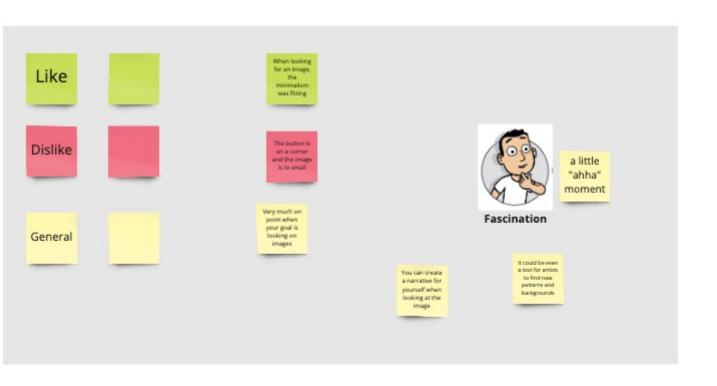


## P5: Drawing



## **Prototype Testing: Cycle 1 // Participant 3**

P1: One Button



#### P2: Swiping

the most engaging experience swiping the best emotional interaction





Good that you already have something to start with It is more interesting than the prototype before Feels like a nice foundation to build on top



I like that it is reacting to what I am doing (acting, reacting)

Dislike



Image size is too small again

I am missing a narrative around it Opportunity to add a narrative there .....

General



There needs to be a prior setup to make it personal Would be nice to have sliders to see what you are influencing How to make it more personal? How to allow them to attribute personal meaning?

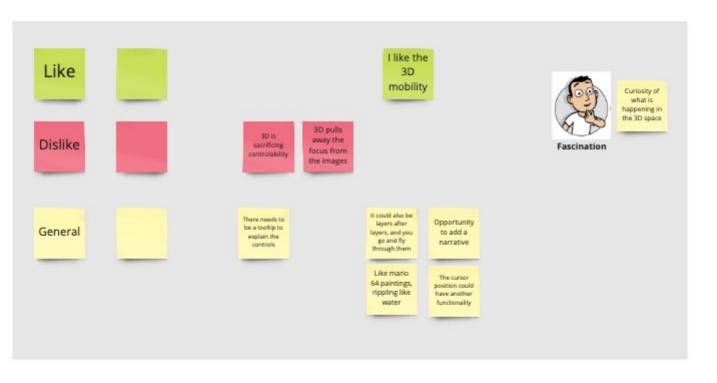


Fascination

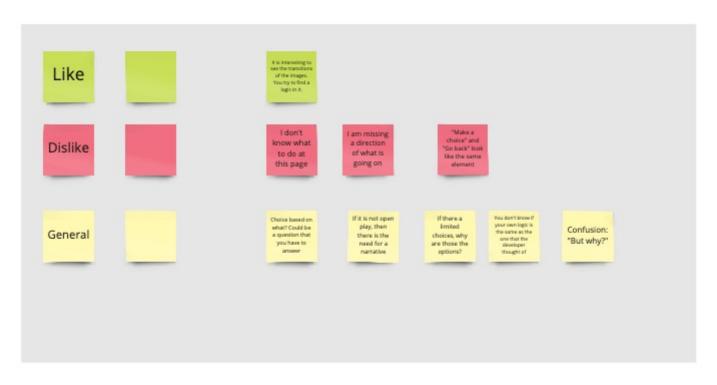


It feels organic, the transitions between images

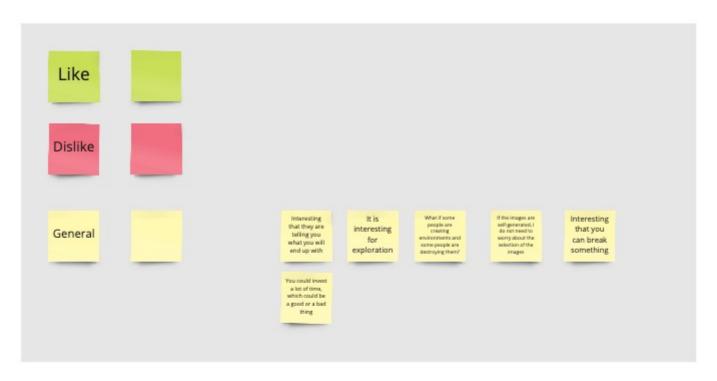
## P3: Fly-through

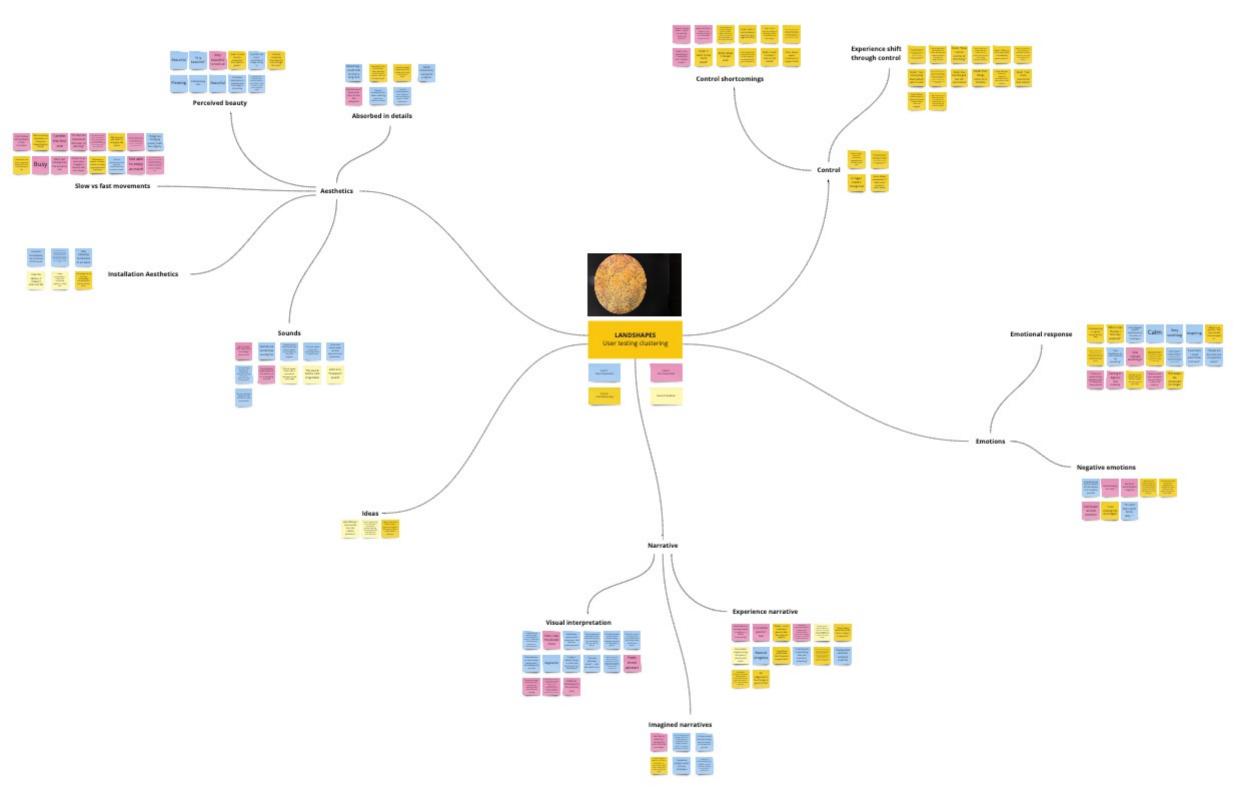


### P4: Choosing

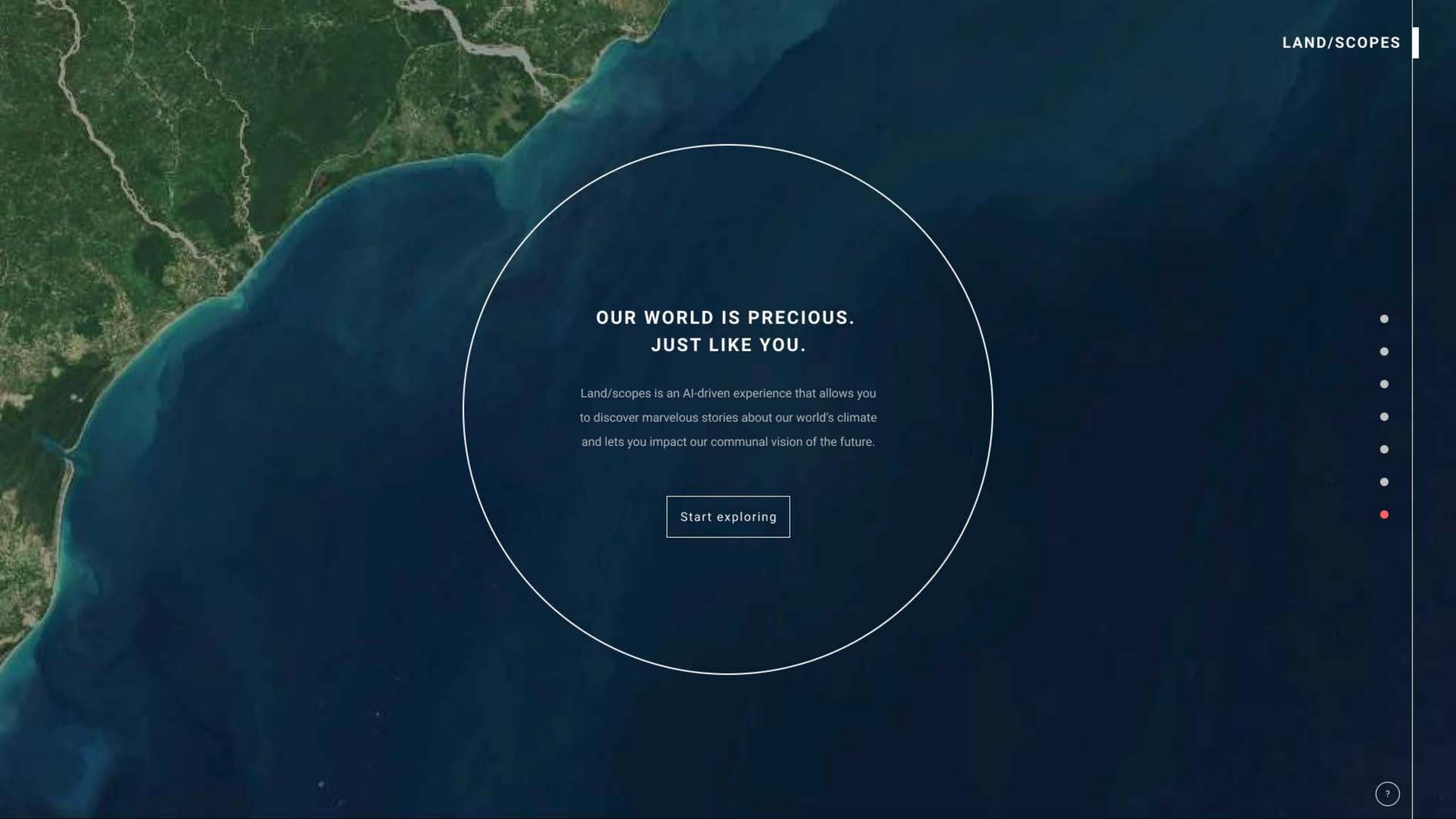


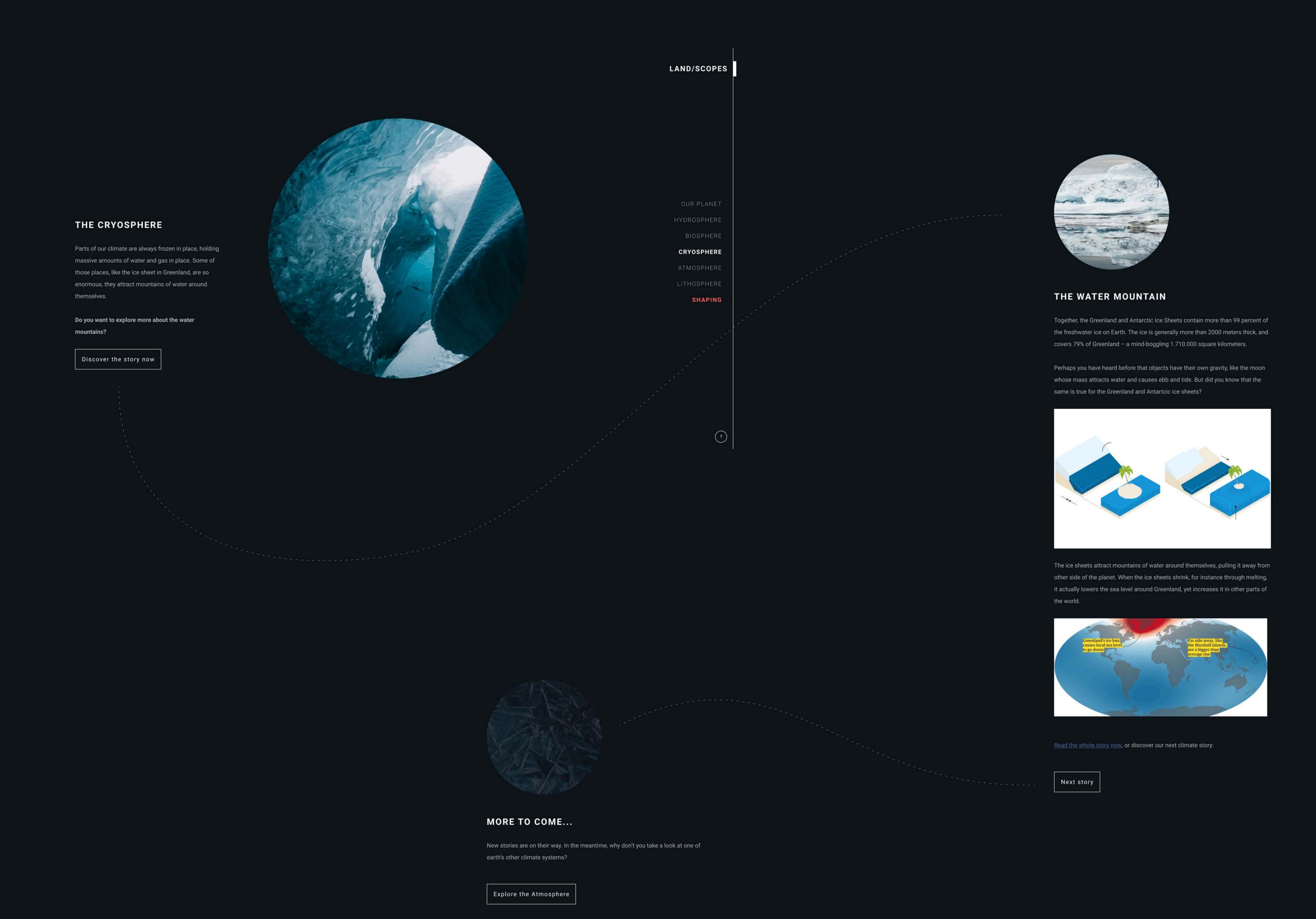
## P5: Drawing

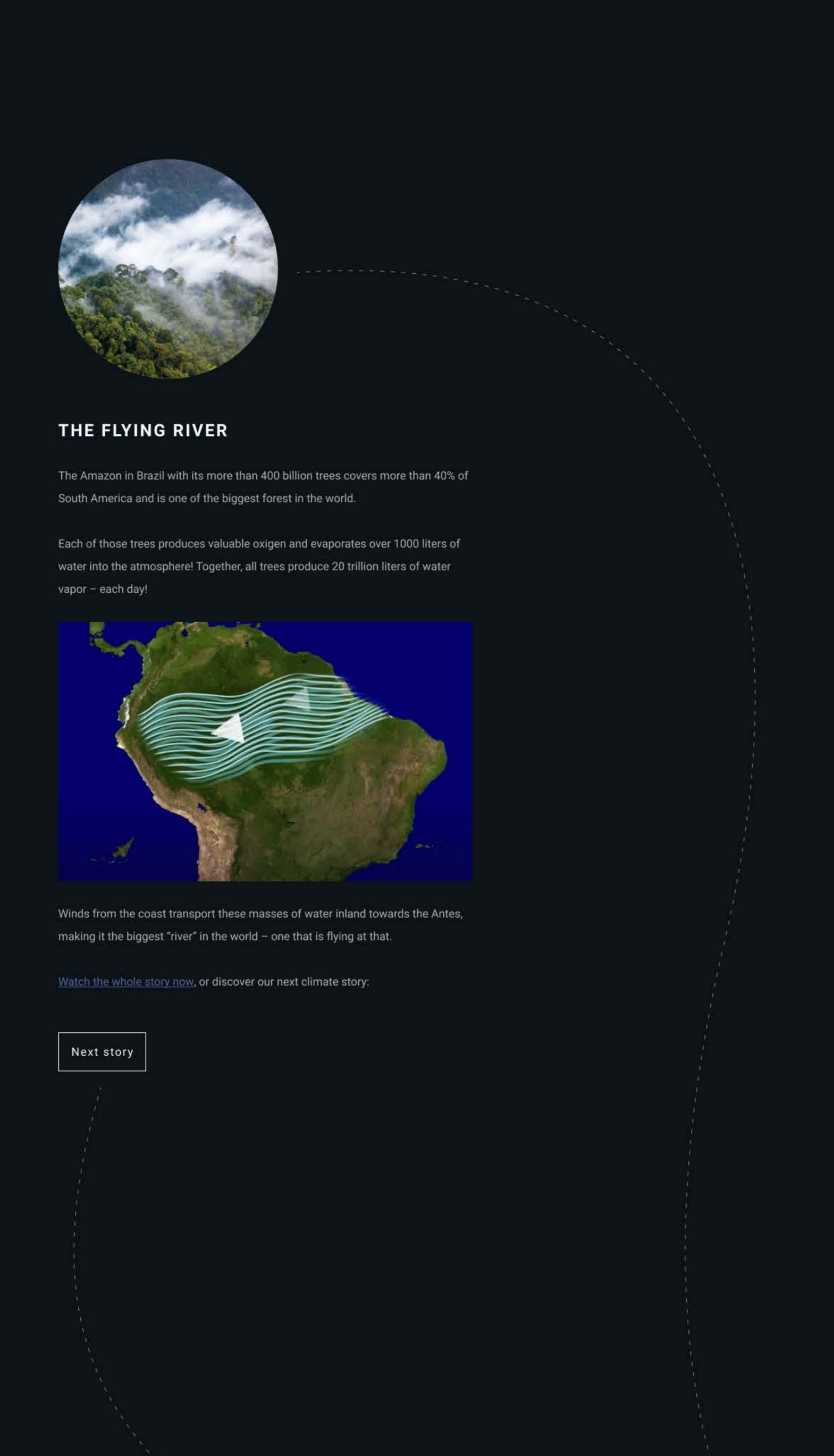




## Additional exploration









All living beings inhabitating our planet are part of the biosphere, living in constant change and interaction. Our rainforests, like the Amazon with its 400 billion trees, present one of the crucial habitats for thousands of species.

Did you ever hear about the flying river of the Amazon?

Discover the story now



LAND/SCOPES

OUR PLANET
HYDROSPHERE
BIOSPHERE

CRYOSPHERE
ATMOSPHERE
LITHOSPHERE
SHAPING

?

# MORE TO COME...

New stories are on their way. In the meantime, why don't you take a look at one of earth's other climate systems?

Explore the Cryosphere

## THE LITHOSPHERE

Our earth crust is a constantly shifting layer of rock, like mountains, gravel and sand. Over billions of years, those movements formed our seven continents.



OUR PLANET

HYDROSPHERE

BIOSPHERE

CRYOSPHERE

ATMOSPHERE

LITHOSPHERE

## THE HYDROSPHERE

More than 71% of our planet are covered in oceans. With water being the foundation for all life on earth and crucial habitat for many organisms, it influences every other climate system.



OUR PLANET

HYDROSPHERE

BIOSPHERE

CRYOSPHERE

ATMOSPHERE

LITHOSPHERE

# OUR PLANET, OUR CLIMATE

Introduction



## OUR PLANET

HYDROSPHERE

BIOSPHERE

CRYOSPHERE

ATMOSPHERE

LITHOSPHERE

## LAND/SCOPES

## THE ATMOSPHERE

Our planet is encapsulated by a layer of gas, which we know as the atmosphere.



OUR PLANET

HYDROSPHERE

BIOSPHERE

CRYOSPHERE

ATMOSPHERE

LITHOSPHERE

# **APPENDIX 4**

#### **Processing Code for Video Control**

```
import processing.serial.*;
                                                   String portName = Serial.list()[4];
import java.io.File;
                                                   myPort = new Serial(this, portName, 115200);
import processing.video.Movie;
Movie myMovie;
                                                  void draw()
float fps = 25;
                                                   background(0);
                                                   if ( myPort.available() > 0) { // If data is available,
int startTime = 1;
boolean ended;
                                                     val = myPort.readStringUntil('\n');
                                                                                            //
                                                  read it and store it in val
int dWidth = 1920;
int dHeight = 1080;
                                                     if(val != null){
                                                     try {
boolean debug = false;
                                                       pos = Integer.parseInt(val.trim());
boolean goUp = false;
                                                       autoTimer = 100;
//Mask
                                                       automatic = false;
Plmage mask;
boolean masked = true;
                                                       myMovie.play();
                                                       if(pos > oldPos){
boolean rotate = false;
                                                       myMovie.jump(myMovie.time() + incre-
float rotationAngle = 0;
                                                  ment);
                                                       goUp = true;
float rotationIncrease = 0.1;
                                                       //rotationAngle += rotationIncrease;
boolean automatic = true;
int autoTimer = 100;
                                                       else{
                                                        myMovie.jump(myMovie.time() - incre-
                                                  ment);
                                                        goUp = false;
//rotationAngle -= rotationIncrease;
Serial myPort;
                                                       myMovie.read();
String val;
                                                       myMovie.pause();
int pos = 0;
int oldPos = 0;
float increment = 0.5;
                                                       if(myMovie.time() >= myMovie.duration()
                                                  && goUp){
myMovie.jump(0.0);
void setup(){
//size(1024,1024);
                                                       if(myMovie.time() <= 0 && !goUp){
                                                        myMovie.jump(myMovie.dura-
 myMovie = new Movie(this, "outputR1.
mov");
                                                  tion()-0.2);
frameRate(24);
 myMovie.jump(startTime);
 myMovie.loop();
                                                       oldPos = pos;
 fullScreen();
 println(width, height);
                                                     } catch (NumberFormatException npe){
 mask = loadImage("maskFS.png");
 printArray(Serial.list());
```

```
if(autoTimer < 0 && automatic == false){
  automatic = true;
  println("Switch on Automatic");
myMovie.loop();
 }
 if(automatic == true){
   myMovie.read();
   rotationAngle += rotationIncrease;
 if(rotate){
  pushMatrix();
  translate(width/2,height/2);
  rotate(radians(rotationAngle));
  image(myMovie, -512, -512, 1024, 1024);
popMatrix();
 else{
image(myMovie, width/2 - 512, height/2 - 512, 1024, 1024);
 if(masked){
  stroke(255);
  strokeWeight(5);
  image(mask,0,0,width,height);
 }
 if(debug){
text(pos, 20,80);
text(autoTimer,20,60);
  text(frameRate, 20,20);
 myPort.clear();
//println("Current Time = " + myMovie.
time()+ " || " + " Current Rotary Pos = " + pos/
fps);
 autoTimer--;
}
```

#### **Arduino Code for Video Control**

```
/* Encoder Library - Basic Example 
* http://www.pjrc.com/teensy/td_libs_En-
 coder.html
  * This example code is in the public domain.
 #include <Encoder.h>
 // Change these two numbers to the pins
 connected to your encoder.

// Best Performance: both pins have inter-
rupt capability
// Good Performance: only the first pin has
 interrupt capability
// Low Performance: neither pin has inter-
 rupt capability
 Encoder myEnc(2, 3);
// avoid using pins with LEDs attached
 void setup() {
  Serial.begin(115200);
  Serial.println("Basic Encoder Test:");
 long oldPosition = -999;
void loop() {
  long newPosition = myEnc.read();
  if (newPosition != oldPosition) {
   Serial.println(newPosition);
oldPosition = newPosition;
3
```

#### **Colab Code for Dataset creation**

```
# -*- coding: utf-8 -*-
                                                                          zoom = 8
"""210107-EE Sentinel Export.ipynb
                                                                           min = 0.0
Automatically generated by Colaboratory.
                                                                           #change the image output based on snow
Original file is located at
                                                                         probabiliy of latitude
                                                                          if latitude < -61 or latitude > 65:
   https://colab.research.google.com/
drive/1EZ6FtuU7Y5pY9wtgeDTnmUGP8s-
                                                                            print("adjusted max")
                                                                            max = 8000
0GOvl3
                                                                           else:
This notebook demonstrates how to save an
                                                                            max = 3000
Earth Engine [image collection animation]
(https://developers.google.com/earth-en-
                                                                           # Create custom color palette
                                                                          # Cleate custom color palette
palette = [
"000000", # Unknown
"33FF99", # Shrubs
"33FF99", # Herbaceous vegetation
"33FF99", # Cultivated and managed vege-
gine/ic_visualization) to Google Drive.
# Setup Earth Engine
                                                                         tation / agriculture

"FF0000", # Urban / built up

"FFFF00", # Cultivated land

"CC33CC", # Bare / sparse

"CC33CC", # Bare / sparse

"GFFFF", # Snow and Ice

"00FFFF", # Permanent water bodies

"00FF00", # Forest

"00FF00", # Forest
                                                                         tation / agriculture
import ee
import ee.mapclient
import urllib.request
ee.Authenticate()
ee.Initialize()
"""## Mount Google Drive to Colab VM"""
from google.colab import drive
drive.mount('/content/drive', force_re-
mount=False)
"""# Sentinel 2 Export
import pandas as pd
locations = pd.read_csv('/content/drive/
MyDrive/Studies/Design for Interaction/5. Se-
mester/Graduation/10 Data Collection/5000
random_land(excluding extremes).csv')
                                                                           center = ee.Geometry.Point(longitude,lati-
print(locations)
startLocation = 2087
                                                                           # Import Sentinel dataset
                                                                          s2 = (ee.ImageCollection("COPERNICUS/
for index, row in locations.iloc[startLocation:].
                                                                         S2_SR")
.filterBounds(center)
iterrows():
 print(index, row['id'], row['X'], row['Y'])
                                                                            .sort('CLOUDY_PIXEL_PERCENTAGE')
                                                                             .filterDate('2019-01-01', '2019-12-30')
 longitude = row['X']
 latitude = row['Y']
                                                                            .first()
 #longitute = -93.98257930473329
 #latitute = 77.5110301473185
                                                                           # Import landcover usage set
                                                                           landcover = (ee.Image("COPERNICUS/
```

```
Landcover/100m/Proba-V-C3/Global/2019").
                                                          'min': 0,
select('discrete classification'));
                                                          'max': 200,
                                                          'palette': palette,
'format': 'jpg',
'bands': ['discrete_classification']
 # Working, but with getInfo()
                                                        s2_url = (s2.getThumbURL(s2Vis))
  footprint = (ee.Geometry.Polygon((s2.
getInfo().get('properties').get('system:foot-
                                                       landcover url = (landcover.getThum-
print').get('coordinates'))))
                                                      bURL(landcoverVis))
 except:
  print("No Footprint found")
  continue
                                                       s2_name = "/content/drive/MyDrive/
                                                      Sentinel Landmass/RGB/S2_{}_{{}}*{}.jpg".
 # Create a rectangular export area
 exportAreaLarge = (footprint.centroid().
                                                      format(row['id'], longitude, latitude)
buffer(40000).bounds());
                                                      landcover_name = "/content/drive/MyDrive/
Sentinel Landmass/SEG/S2_{}_{}*{}.jpg".
 exportAreaMedium = (footprint.centroid().
buffer(25000).bounds());
                                                      format(row['id'], longitude, latitude)
 exportAreaSmall = (footprint.centroid().
buffer(10000).bounds());
                                                        urllib.request.urlretrieve(s2_url, s2_name)
                                                       urllib.request.urlretrieve(landcover_url,
 #print(footprint.contains(exportArea,1).
                                                      landcover name)
getInfo())
                                                        print(s2_url)
                                                        print(landcover_url)
 if footprint.contains(exportAreaLarge,1).
getInfo() == True:
  print("Large fits")
                                                      """# Single export"""
  exportArea = exportAreaLarge
 elif footprint.contains(exportAreaMedium,1).
                                                      longitute = -93.98257930473329
getInfo() == True:
print("Medium fits")
exportArea = exportAreaMedium
                                                      latitute = 77.5110301473185
                                                      zoom = 8
 elif footprint.contains(exportAreaSmall,1).
getInfo() == True:
                                                      min = 0.0
  print("Small fits")
exportArea = exportAreaSmall
                                                      max = 3000
                                                      center = ee.Geometry.Point(longitute,latitute)
 else:
  print("No fit")
  continue
                                                      # Import Sentinel dataset
                                                      s2 = (ee.ImageCollection("COPERNICUS/S2")
                                                       .filterBounds(center)
.sort('CLOUDY PIXEL PERCENTAGE')
 s2Vis = {
    'region': exportArea,
                                                        .filterDate('2020-01-15', '2020-12-15')
    'crs': (s2.select('B4').projection()),
    'dimensions': '1024x1024',
                                                       .first()
    'format': 'jpg',
    'min': min,
    'max': max,
                                                      # Import landcover usage set
    'bands': ['B4', 'B3', 'B2']
                                                      landcover = (ee.Image("COPERNICUS/
Landcover/100m/Proba-V-C3/Global/2019").
 }
                                                      select('discrete_classification'));
 landcoverVis = {
    'region': exportArea,
                                                      # Working, but with getInfo()
    'crs': (s2.select('B4').projection()),
                                                      footprint = (ee.Geometry.Polygon((s2.getIn-
    'dimensions': '1024x1024',
                                                      fo().get('properties').get('system:footprint').
```

```
get('coordinates'))))
                                                  mat(row['id'], longitute,latitute)
                                                  landcover name = "/content/drive/MyDrive/
                                                  Sentinel Coastline/SEG/S2_{}_{}*{}.jpg".
# Create a rectangular export area
exportAreaLarge = (footprint.centroid().
                                                  format(row['id'], longitute, latitute)
buffer(30000).bounds());
exportAreaMedium = (footprint.centroid().
                                                  urllib.request.urlretrieve(s2_url, s2_name)
buffer(20000).bounds());
                                                  urllib.request.urlretrieve(landcover_url, land-
exportAreaSmall = (footprint.centroid().
                                                  cover name)
buffer(10000).bounds());
                                                  print(s2_url)
print(footprint.contains(exportArea,1).getIn-
                                                  print(landcover_url)
                                                  """## Download the animation to Google
if footprint.contains(exportAreaLarge,1).
getInfo() == True:
 print("Large fits")
                                                  s2 name = "/content/drive/MyDrive/Sentinel
                                                  Coastline/RGB/S2_{}*{}.jpg".format(longi-
 exportArea = exportAreaLarge
elif footprint.contains(exportAreaMedium,1).
                                                  tute, latitute)
getInfo() == True:
                                                  landcover_name = "/content/drive/MyDrive/
                                                  Sentinel Coastline/SEG/S2_{}*{}.jpg".for-
 print("Medium fits")
 exportArea = exportAreaMedium
                                                  mat(longitute,latitute)
elif footprint.contains(exportAreaSmall,1).
getInfo() == True:
                                                  urllib.request.urlretrieve(s2 url, s2 name)
 print("Small fits")
                                                  urllib.request.urlretrieve(landcover_url, land-
 exportArea = exportAreaSmall
                                                  cover_name)
else:
 print("No fit")
                                                  while True:pass
 #continue
                                                  """# Landsat Mosaic Export
s2Vis = {
                                                  Retrieved from https://developers.google.
                                                  com/earth-engine/datasets/catalog/USGS
  'region': exportArea,
                                                  LIMA_MOSAIC#description
  'crs': (s2.select('B4').projection()),
  'dimensions': '1024x1024',
  'format': 'jpg',
                                                  saveFolder = '/content/drive/MyDrive/Antarc-
  'min': min,
  'max': max,
                                                 tica Coastline/coastline_large
  'bands': ['B4', 'B3', 'B2']
}
                                                  """## Single Export"""
landcoverVis = {
                                                  longitute = 164.619
  'region': exportArea,
                                                  latitute = -77.99
  'crs': (s2.select('B4').projection()),
  'dimensions': '1024x1024',
                                                 min = 0.0
  'format': 'jpg',
                                                  max = 10000
  'bands': ['discrete_classification']
}
                                                  center = ee.Geometry.Point(longitute,latitute)
s2_url = (s2.getThumbURL(s2Vis))
                                                  # Import Sentinel dataset
landcover url = (landcover.getThum-
                                                  antarctica = (ee.lmage("USGS/LIMA/MOSA-
bURL(landcoverVis))
                                                  IC")
                                                  .select(['B3', 'B2', 'B1'])
s2 name = "/content/drive/MyDrive/Senti-
                                                  # Create a rectangular export area
nel Coastline/RGB/S2_{}_{}*{}.jpg".for-
                                                  exportAreaLarge = (center.buffer(50000).
```

```
bounds());
                                                    tica Coastline/coastline_largest'
#exportAreaMedium = (center.buffer(20000).
bounds());
                                                    startLocation = 0
#exportAreaSmall = (center.buffer(10000).
                                                    # Import Sentinel dataset
bounds());
                                                    antarctica = (ee.lmage("USGS/LIMA/MOSA-
print(footprint.contains(exportArea,1).getIn-
                                                    IC")
                                                     .select(['B3', 'B2', 'B1'])
fo())
if footprint.contains(exportAreaLarge,1).
getInfo() == True:
                                                    for index, row in locations.iloc[startLoca-
 print("Large fits")
exportArea = exportAreaLarge
                                                    tion::15].iterrows():
                                                     #print(index, row['id'], row['X'], row['Y'])
elif footprint.contains(exportAreaMedium,1).
getInfo() == True:
                                                     longitude = row['X']
 print("Medium fits")
                                                     latitude = row['Y']
 exportArea = exportAreaMedium
                                                     id = index
elif footprint.contains(exportAreaSmall,1).
getInfo() == True:
print("Small fits")
                                                     min = 0.0
                                                     max = 10000
 exportArea = exportAreaSmall
else:
                                                     center = ee.Geometry.Point(longitude,lati-
 print("No fit")
                                                    tude)
 #continue
                                                     # Create a rectangular export area
                                                     exportAreaLarge = (center.buffer(200000).
vis = {
  'region': exportAreaLarge,
                                                    bounds());
  'dimensions': '1024x1024',
                                                     #exportAreaMedium = (center.buf-
  'format': 'jpg',
                                                    fer(20000).bounds());
  'min': min,
                                                     #exportAreaSmall = (center.buffer(10000).
  'max': max,
                                                    bounds());
                                                     vis = {
                                                       'region': exportAreaLarge,
image_url = (antarctica.getThumbURL(vis))
                                                       'dimensions': '1024x1024',
#With row row['id']
image_name = "{}/A_{}_{}*{}.jpg".for-
mat(saveFolder,0,latitute, longitute)
                                                       'format': 'jpg',
                                                       'min': min,
                                                        'max': max,
urllib.request.urlretrieve(image url, im-
age name)
                                                      image_url = (antarctica.getThumbURL(vis))
print("Saved", image_url, "to ", image_
                                                     except:
                                                      print("Export not possible")
name)
                                                      continue
"""## Multi Export"""
                                                     image_name = "{}/A_Largest_{}_{{}}*{}.jpg".
                                                    format(saveFolder,id,latitude, longitude)
import pandas as pd
locations = pd.read_csv('/content/drive/
MyDrive/Studies/Design for Interaction/5.
                                                     urllib.request.urlretrieve(image_url, image_
Semester/Graduation/10 Data Collection/Ant-
                                                    name)
arctica coastline copy.csv')
print(locations)
                                                     print("Saved", image_url, "to ", image_
saveFolder = '/content/drive/MyDrive/Antarc-
                                                    name)
```