AFTER THE FLOOD

LORAN ASAAD | CTU | STUDIO FLOW | 2018–2019 WINTER

AFTER THE FLOOD

LORAN ASAAD

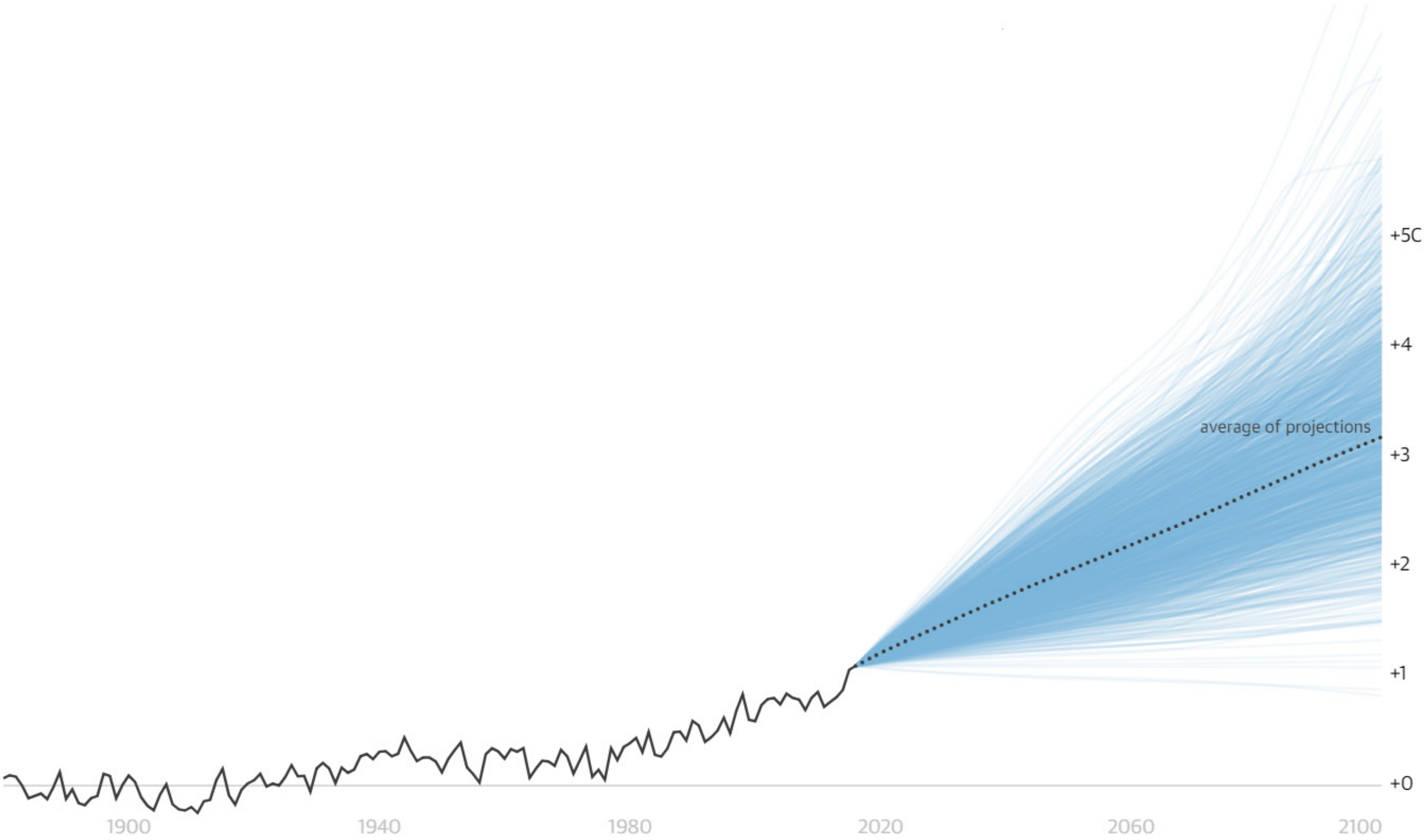
2018 - 2019- winter | DP

CTU

Studio Flow

MILOŠ FLORIÁN | LUKÁŠ KURILLA

INDEX



THE FLOOD

A vast amount of effort has been spent to keep the global warming 2C above the pre-industrial levels. Efforts such as Paris climate agreement .Nevertheless with the latest estimations the situation seems to be getting out of control. Average of the projections made indicates 3.2 C by 2100.

“[We] still find ourselves in a situation where we are not doing nearly enough to save hundreds of millions of people from a miserable future,” [1]

One of the biggest resulting threats to cities around the world is sea-level rise, caused by the expansion of water at higher temperatures and melting ice sheets on the north and south poles.

1-Erik Solheim, the UN environment chief, ahead of the upcoming Bonn conference.

Scientists at the non-profit organization Climate Central estimate that 275 million people worldwide live in areas that will eventually be flooded at 3C of global warming.
[2]

Again another study made by Dr. Robert Kopp of Rutgers University and co-authored by scientists at Climate Central suggests that Antarctic ice sheet models double the sea-level rise expected this century if global emissions of heat-trapping pollution remains high.The study provides a median projection for sea-level rise of 146 cm during the 21st century under a high-pollution scenario known as RCP8.5.

2- The Guardian - The three-degree world: the cities that will be drowned by global warming - Josh Holder, Niko Kommenda and Jonathan Watts

The Predictions get worse by the experts each and every day. The most extreme ones goes up until 250cm rise. But again in last decade even 146cm rise had been seen as extreme which is now an average estimation.

In the world of which 10% of the population lives under the sea level those numbers mean a catastrophe. In case of the predicted rise of the sea level we will end up with hundreds of millions of immigrants. For understanding the scale better we can compare it to the few million of immigrant who fled to Europe in recent years and the effects of it.

Figure 1 : Total population living on land that could be submerged by long-term sea level rise locked in after (a) 4 °C warming or (b) 2 °C warming. Panel (c) reflects the difference between these totals, in other words, the difference achieved by limiting warming to 2 °C instead of 4 °C. Panels (d)-(f) reflect the same quantities except measured as percentages of total national population. (source: Mapping choices, BENJAMIN H. STRAUSS)

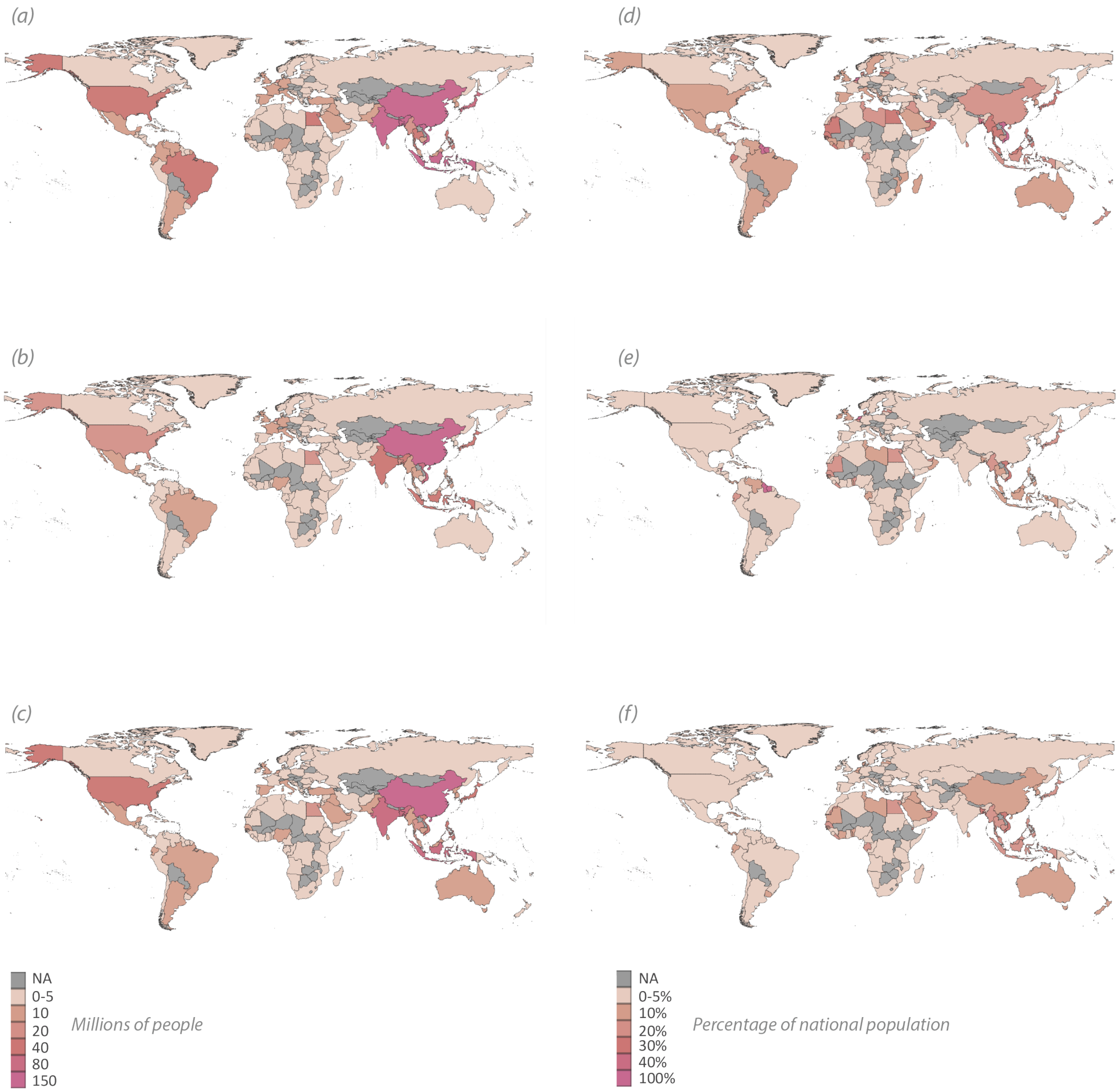


Figure 3: The areas with the highest risk to be Flooded (Source : Nicholls, R.J., P.P. Wong, V.R. Burkett, J.O. Codignotto, J.E. Hay, R.F. McLean, S. Ragoonaden and C.D. Woodroffe, 2007)

MAIN FACTORS

The rise in sea levels is caused by three factors

1-Thermal Expansion:

When water heats up, it expands. About half of the past century's rise in sea level is attributable to warmer oceans simply occupying more space.

2-Melting Glaciers and Polar Ice Caps:

Large ice formations, like glaciers and the polar ice caps, naturally melt back a bit each summer. In the winter, snows, primarily from evaporated seawater, are generally sufficient to balance out the melting. Recently, though, persistently higher temperatures caused by global warming have led to greater-than-average summer melting as well as diminished snowfall due to later winters and earlier springs. This imbalance results in a significant net gain in the ratio of runoff to ocean evaporation, causing sea levels to rise.

3-Ice Loss from Greenland and West Antarctica:

As with the glaciers and ice caps, increased heat is causing the massive ice sheets that cover Greenland and Antarctica to melt at an accelerated pace. Scientists also believe melt-water from above and seawater from below is seeping beneath Greenland's and West Antarctica's ice sheets, effectively lubricating ice streams and causing them to move more quickly into the sea. Higher sea temperatures are causing the massive ice shelves that extend out from Antarctica to melt from below, weaken, and break off.

URBAN VULNERABILITIES AND MIGRATION

The difference of the effect on our settlements between 2 °C and 4°C change is cannot be underestimated. Considering the percentage of population that will be affected by, these changes will completely change our understanding of the concept of cities and houses.

According to McGranahan, Anderson and Balk (2007), settlements in coastal lowlands are especially vulnerable to risks resulting from climate change, yet these lowlands are densely settled and growing rapidly.

To the extent that low elevation coastal populations are at risk from sea-level rise, stronger storms and other seaward hazards induced by climate change, it is important to assess the size of these populations and how they are distributed internationally. Similarly, it is important to gain a better understanding of how coastal settlements are changing, especially in light of the self-reinforcing and cumulative character of urban development and the difficulties inherent in shifting the direction of population movements and adapting to increasing risk.

Migration away from lowest elevation coastal zones will be important, but can be costly and difficult to implement without causing severe disruptions. Modification of the prevailing forms of coastal settlement, so as to protect local residents, will also be needed. [1]

1- The rising tide: assessing the risks of climate change and human settlements in low elevation coastal zones, GORDON MCGRANAHAN, DEBORAH BALK

The Climate Central Organization completed in 2014 an analysis of worldwide exposure to sea level rise and coastal flooding. They found that 147 to 216 million people live on land that will be below sea level or regular flood levels by the end of the century, assuming emissions of heat-trapping gases continue on their current trend. By far the largest group — 41 to 63 million — lives in China. The ranges depend on the ultimate sensitivity of sea level to warming. But even these figures may be two to three times too low, meaning as many as 650 million people may be threatened

One of the missions of this project is to provide the necessary environment to enable people to adapt instead of migrate

2010 population below median locked=in sea level rise from different warming amounts (millions)			
Country	4°C	2°C	Difference
China	145	64	81
India	55	20	35
Bangladesh	48	12	36
Vietnam	46	26	20
Indonesia	44	16	28
Japan	34	18	17
United States	25	12	13
Philippines	20	7	13
Egypt	19	9	10
Brazil	16	9	7
Thailand	15	6	10
Myanmar	12	5	7
Netherlands	11	10	1
Nigeria	8	4	4
Malaysia	7	2	5
Mexico	6	3	3
United Kingdom	6	4	2
Italy	5	31	2
South Korea	4	1	3
Taiwan	4	1	2

Table 1: Top 20 countries most affected by locked-in sea level rise from 4 °C warming, by total population, with comparisons to 2 °C warming (source: climatecentral.org)

CONCRETE

Over the past century, burning of fossil fuels and other human and natural activities has released enormous amounts of heat-trapping gases into the atmosphere. These emissions have caused the Earth's surface temperature to rise, and the oceans absorb about 80 percent of this additional heat.[1]

One of those human activities is usage of cement The concrete industry is one of the largest producers of carbon dioxide, emitting up to 5% of worldwide man-made emissions of CO2

The World Business Council for Sustainable Development (2002) states that the cement industry is one of the primary emitters of carbon dioxide (CO2); a potent greenhouse gas It is responsible for more than 5% of worldwide man-made emissions of this gas, being 40% from burning fuel and 50% from the chemical process. The high carbon emission is explained by the heating of the cement to very high temperatures in order for clinker to form during it's production process.[2]

Cement is made by heating limestone with small quantities of other materials (such as clay) to 1450°C in a kiln. The resulting hard substance, called 'clinker', is then ground with a small amount of gypsum into a powder to make 'Ordinary Portland Cement', the most commonly used type of cement (often referred to as OPC).[3]

Cement manufacture contributes greenhouse gases both directly through the production of carbon dioxide when calcium carbonate is thermally decomposed, producing lime and carbon dioxide and also through the use of energy, particularly from the combustion of fossil fuels[4].

Basically limestones are made by the organisms as their own construction material and holds a vast amount of carbon in the nature. So our approach to this matter is to take what nature created, modify it and give away the carbon dioxide to the nature. Not only that but also in production phase we use really high amounts of energy which also results as high carbon emissions.

1-https://www.nationalgeographic.com/environment/global-warming/sea-level-rise/

2- The Cement Sustainability Initiative: Our agenda for action, World Business Council for Sustainable Development, page 20, published 1 June 2002.

3 -World Bussines Council for Sustainable Development

4- EIA – Emissions of Greenhouse Gases in the U.S. 2006-Carbon Dioxide Emissions

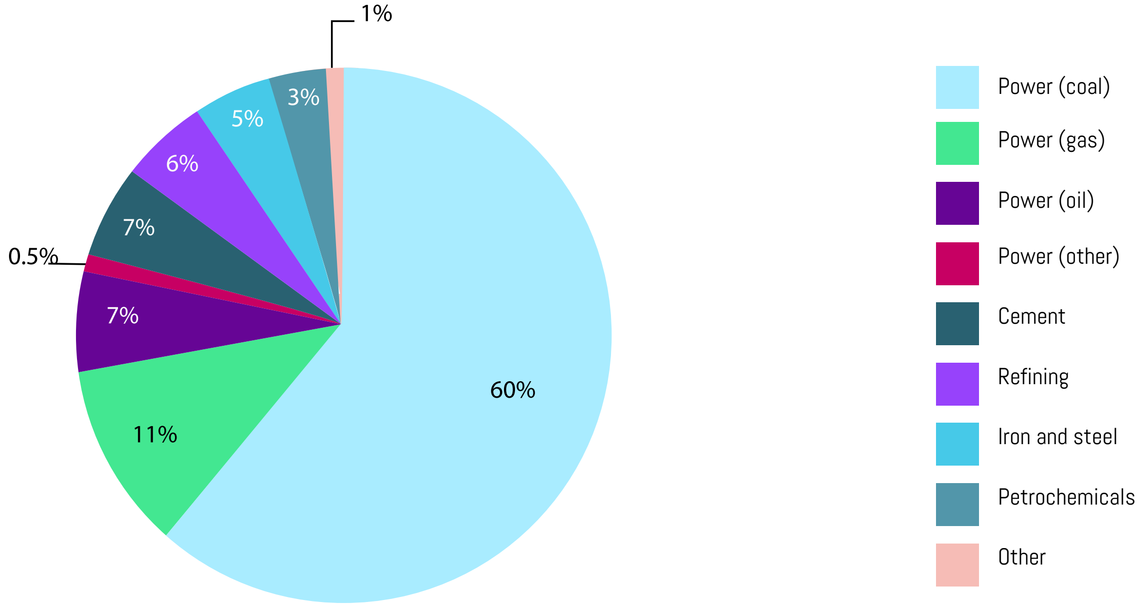


Figure 4: Stationary CO2 Emissions (Source: Intergovernmental Panel on Climate Change, "Sources of CO2," IPCC Special Report on Carbon Dioxide)

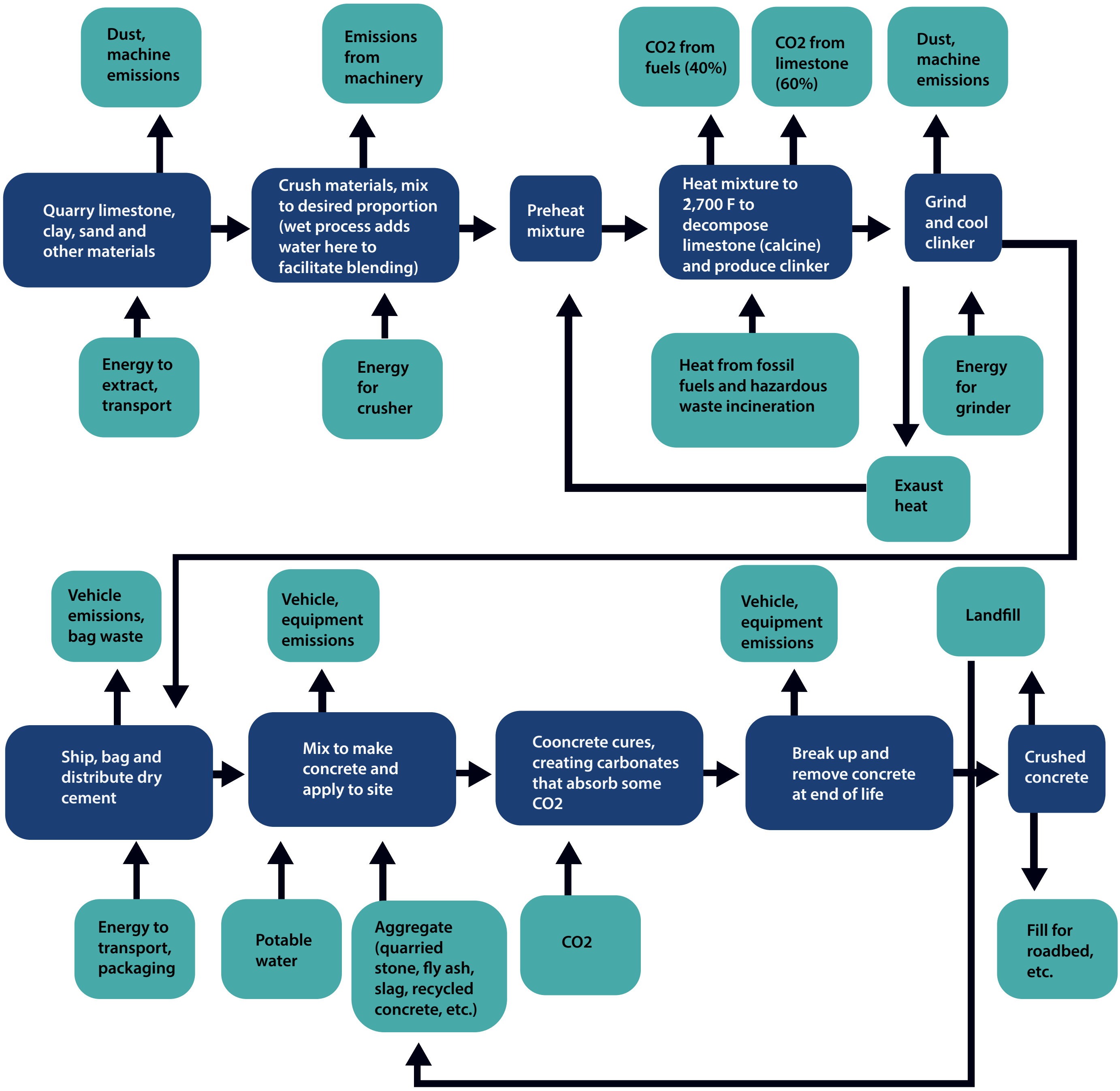


Figure 5: Life Cycle for Portland Cement Produced by Dry Process and Mixed into Concrete (source: calera.com)

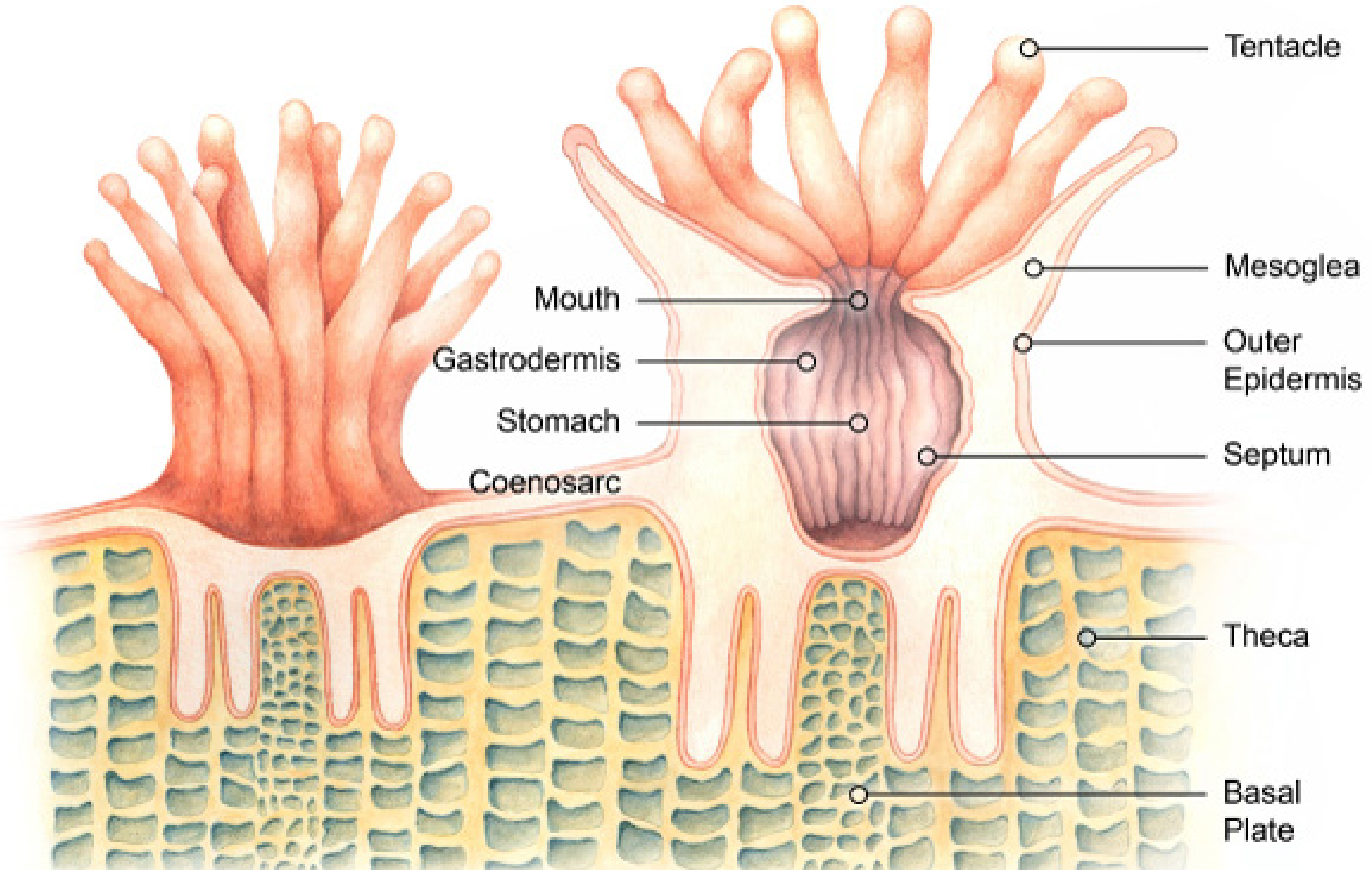


Figure 6: Coral's Anatomy (source: coral.org)

CORALS: LEARNING FROM THE NATURE

Limestone, the main material for the cement that we use today is actually an end product of a natural process that can be found among marine organisms such as forams, molluscs and corals.

A coral polypus is a cnidarian, an animal related to anemones and jellyfish. They can live individually or in large colonies called reefs. The polypus' form resembles a sac with an opening (also called mouth) that is surrounded by stinging tentacles, the nematocysts. The polyp uses calcium and carbonate ions from seawater to build a skeleton made of calcium carbonate (limestone) which protects the soft body of the polyp.

Corals usually stay inside their skeletons during the day and extend their tentacles at night to feed. Their skeletons are white as the human ones; its bright colors come from the pigments (such as chlorophyll and diadinoxanthin) produced by the millions of zooxanthellae that live inside the polypus' tissues.

The zoozanthellae are able to live in symbiosis with diverse marine invertebrates and are usually responsible for proving up to 90% of their host's energy in exchange for nutrients and carbon dioxide and also a position with access to sunshine

There are few companies today trying to mimicry this process in order to create the cement which is called Bio-Cement. They take the CO2 gas from industrial emitting sources and convert the CO2 into a novel calcium carbonate cement system that is used in various products.

According to the Calera biocement company, "CO2-sequestering cement could make a significant impact.
In 2008, 2.5 billion metric tons of Portland cement were produced with between 0.8 and 1 ton of CO2 emitted for every ton of cement."
"...process for the capture and conversion of CO2 takes its lead from nature. The earth's atmosphere has had higher concentrations of CO2 in the past and nature dealt with these high levels of CO2 by a mineralization process whereby marine organisms use CO2 to form calcium carbonate structures that deposit on the ocean floor over time. It is estimated that up to 100 million billion tonnes of CO2 is stored in the geological record in the form of calcium carbonate[1]"

1- source: calera.com

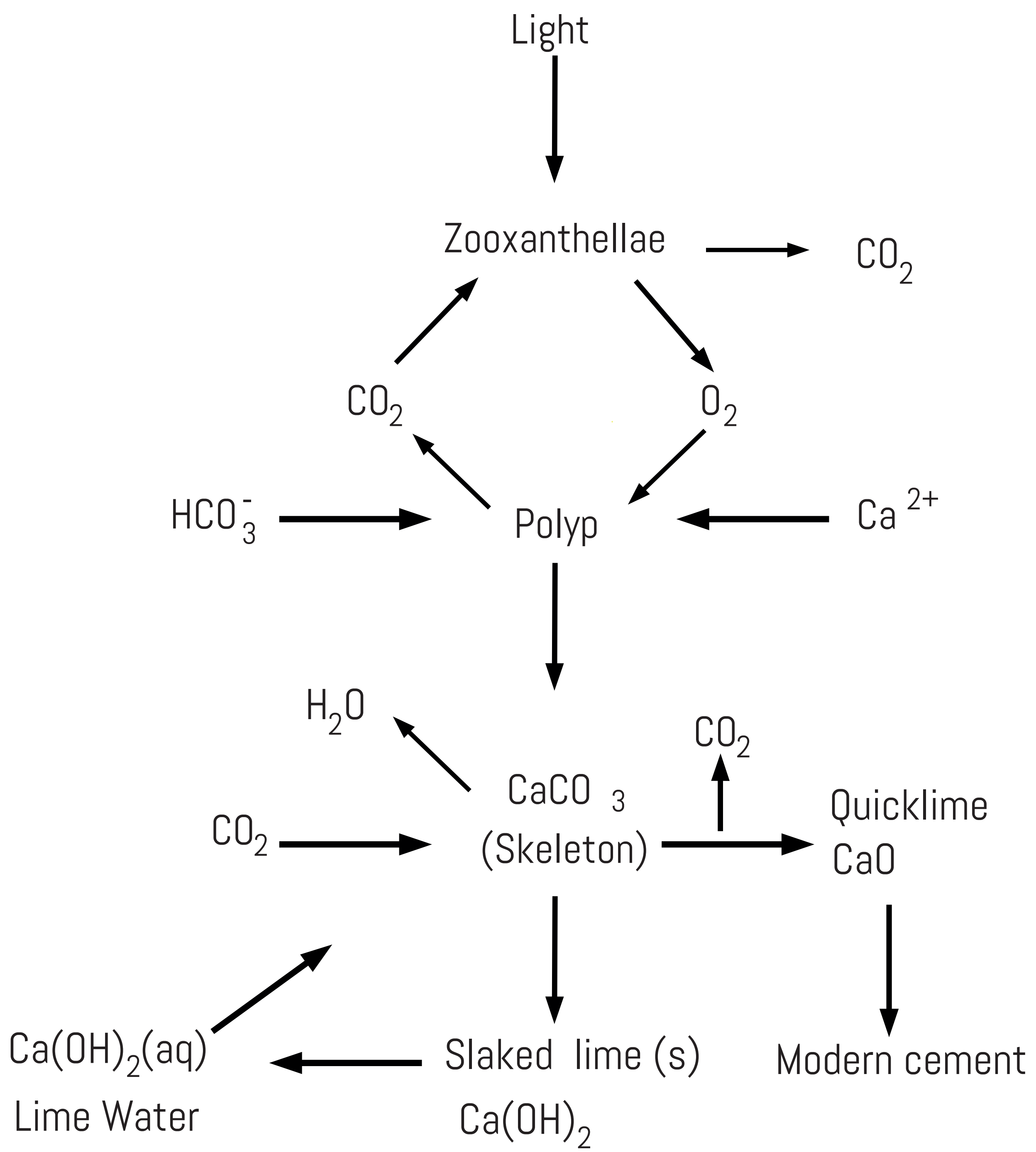


Figure 7: Life Cycle of limestone and the relation with the modern cement

Figure 8: Rendering of CE full-scale slab contactor design. This module would capture 100 kt-CO2/yr. (source: Outdoor prototype results for direct atmospheric capture of carbon dioxide , GeoffreyHolmes)

CARBON CAPTURING

There have been many attempts in order to achieve zero carbon emission to reduce our carbon footprints. Although significant improvements have been made in renewable energy and energy efficiency, these are not enough to keep the global temperature change less than 2 degrees. Direct carbon capturing removes CO2 from the air and purifies it. It enables negative carbon emission which seems to be the only way to keep the weather conditions in our favor.

According to the scientist Jennifer Wilcox, there are two main approaches to growing of building such a synthetic forest: one is using CO2-grabbing chemicals dissolved in water and another is using solid materials with CO2-grabbing chemicals; nevertheless. Since the CO2 is too scattered among oxygen and nitrogen in the atmosphere (400 molecules per million), a large amount of heat is required to unbind the molecules in order to filter the CO2 from the air - this system is called an air contactor. once the CO2 is captured, it enables to recycle that material that is used to capture it, over and over again. The scale of carbon capture is so enormous that once it is captured the CO2, you have to be able to recycle that material used in its capture to make it a sustainable process. .

The high-purity CO2 resulted of this process can be used as fuel coming out to 50 dollars a gallon. There are several companies trying to bring down those costs. One is called Carbon Engineering. They use a liquid-based approach for separation combined with burning super-abundant, cheap natural gas to supply the heat required. They have a clever approach that allows them to co-capture the CO2 from the air and the CO2 that they generate from burning the natural gas. And so by doing this, they offset excess pollution and they reduce costs. Other companies, such as Climeworks and Global Thermostat, focus on the heat required and the speed in which it moves through the material so that they're able to release and produce that CO2 at a really fast rate, which allows them to have a more compact design and overall cheaper costs. Climework's handles the heat problem with using low grade heat waste from the industrial zones which is one of the factors in choosing the project area.

According to Wilcox, the land area required for a synthetic forest or a manufactured direct air capture plant is 500 times smaller than the Amazon Rainforest. In addition, for a synthetic forest, there's no competition with farmland or food, and there's also no reason to have to cut down any real trees.

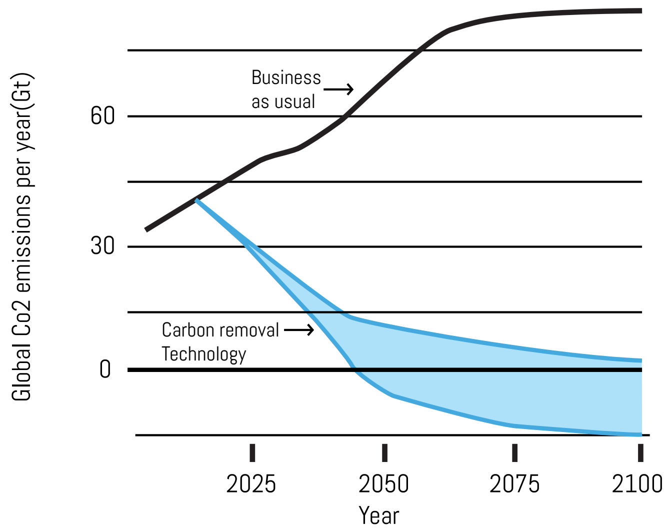


Figure 9: How to keep global warming under 1,5 C (data source: Mercator Research Institute)

CARBON PRODUCTS

The end product of this process, pure liquid CO2 can be used to produce gasoline, electricity and many other products. Another product that CO2 can be used is green cement which this project aims to do. The materials that is going to be used on this building will be made out of the air that have been purified.

Gasoline:
The Canadian company Carbon Engineering, can already produce a liquid fuel by sucking CO2 out of the atmosphere and combining it with hydrogen from water. This leads to a potentially cost-effective way to take CO2 out of the atmosphere helping fight the climate change, and also a potentially cost-competitive way to make gasoline, diesel, or jet fuel that avoids adding additional CO2 into the atmosphere.[1]

Electricity:
Scientists from Cornell University developed in 2016 an oxygen-assisted aluminum/carbon dioxide power cell that uses electrochemical reactions to sequester the carbon dioxide and to produce electricity. This new technology allows the capturing of CO2 while producing electrical energy. According to the research, the electrochemical cell generates 13 ampere hours per gram of porous carbon (as the cathode) at a discharge potential of around 1.4 volts. The energy produced by the cell can be comparable to that produced by the highest energy-density battery systems[2]

1- news.nationalgeographic.com

2- sciencedaily.com

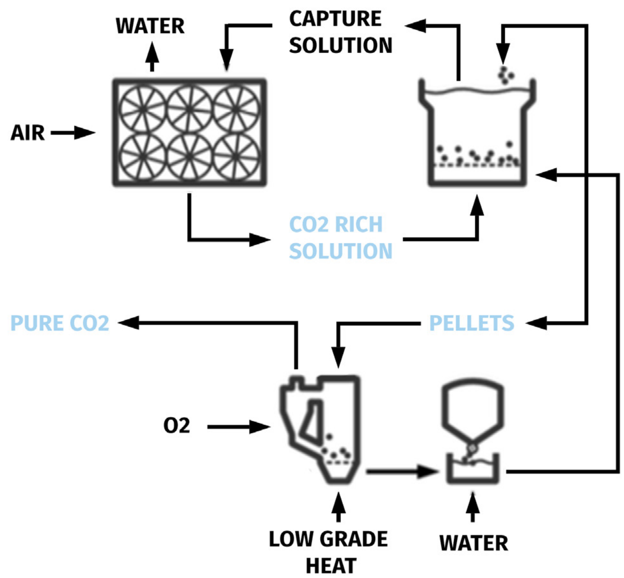


Figure 10: Carbon capturing process (data source: CarbonEngineering.com)

ALEXANDRIA

Alexandria is the second largest city of the Egypt and being on a coast of Mediterranean sea gives it a major role on the country's economy. This ancient city hosted many great civilizations like ancient Egypt, Macedonians, Romans and was the home to the Lighthouse of the Alexandria ,one of the seven wonders of the Ancient world .This historic city is also one of the most endangered cities around the globe. Its low elevation on Nile delta makes it highly vulnerable to rising sea levels.

According to the IPCC reports Alexandria's beaches would be submerged even with a 0.5-metre sea-level rise. While 8 million people would be displaced by flooding in Alexandria and the Nile Delta if no protective measures are taken. A world with 3C change threatens far greater damage than that.

The government claims that the necessary measures have been taken. "Egypt spends 700m EGP annually to protect the north coast," said Dr Magdy Allam, head of the Arab Environmental Experts Union, who was previously part of the Egyptian environment ministry.

Allam cited the Mohammed Ali sea wall built in 1830 as a key protection, as well as the concrete blocks lining the shoreline designed to "detour flood water away from residential neighbourhoods". However scientists believe this measures are far away from protecting the city from being sunk into the water.

The vast majority of the residents are unaware of the situation since there is a very little public information on the subject. One group, Save Alexandria Initiative, is working to raise awareness among the people living in the area about the dangers of the climate change.

"There are studies indicating that our city is one of many coastal human settlements around the world which will be partially submerged by 2070 if nothing is done," - Ahmed Hassan, of the Save Alexandria Initiative, [1]

1- The three-degree world: the cities that will be drowned by global warming - Josh Holder, Niko Kommenda and Jonathan Watts

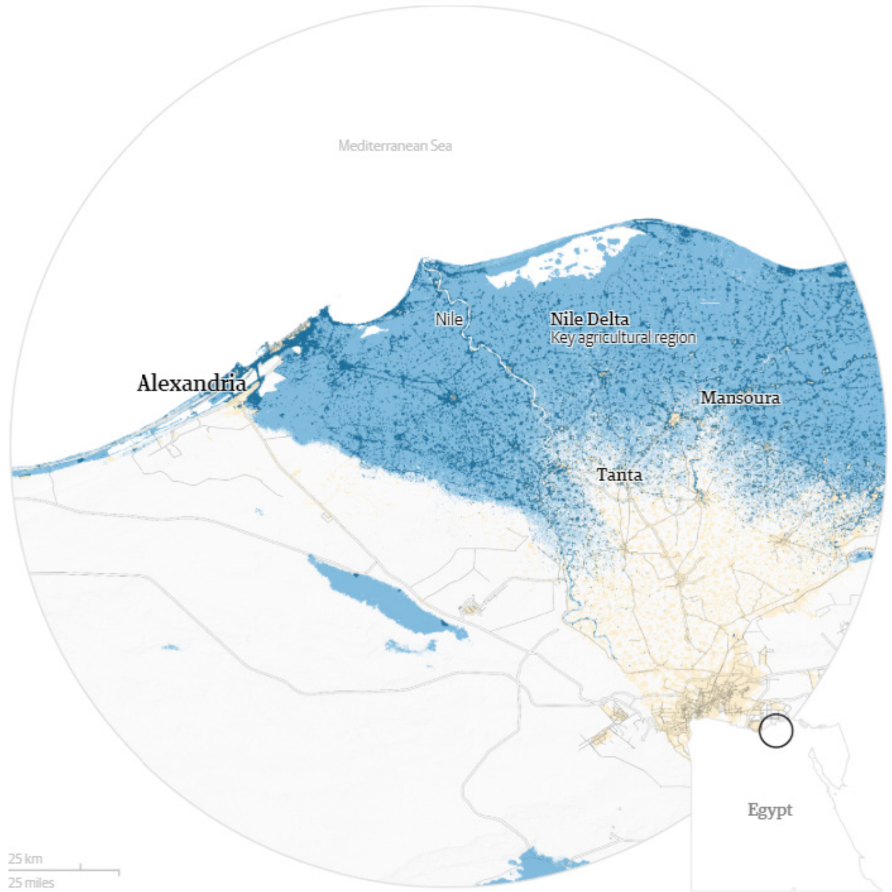


Figure 11: Alexandria and Nile. Blue areas indicates the areas that are most likely to be flooded . (source: Climate Central)

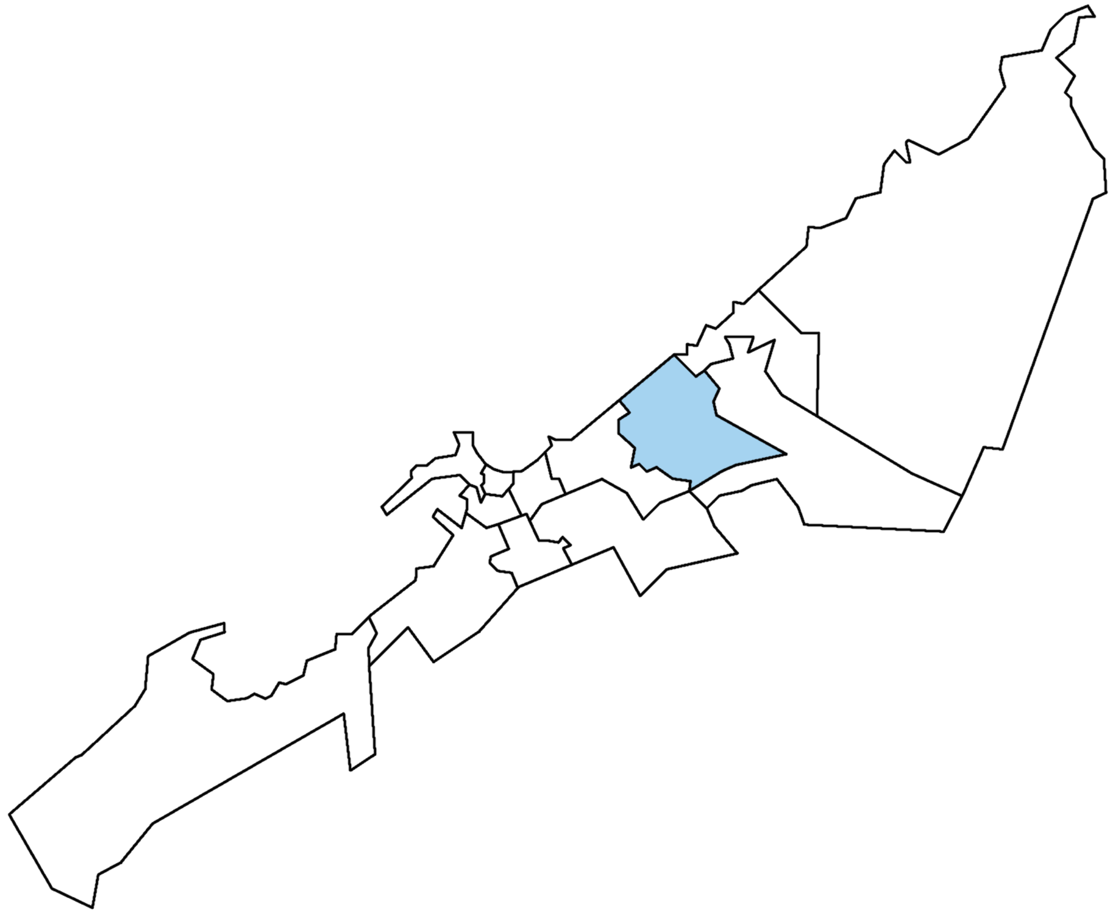


Figure 12: Alexandria districts map.

HAGAR EL NAWATEYAH

Hagar El Nawateyah is a peripheral semi-informal residential area of Alexandria. This settlement has been developed over the years through the conversion of agricultural land into an urban residential one. It covers an area of approximately 60 hectares and accommodates about 16.000 people. Hagar El Nawateyah is located on a poor soil flat salted plateau, with high water table and some remaining agricultural fields.

Like many other peripheral areas of third world countries, Hagar El Nawateyah faces the same housing problems. The accommodation of the growing number of the urban poor often overlooks important factors such as land acquisition, consolidation of the settlement and private developers in the settlement process.

Studies suggest that the population in Egypt that lives in squatter settlements reaches 20 percent. Moreover, 70 percent of the housing production is privately built by informal developers. The housing crisis in Egypt features the main problems of scarcity and rising cost of land, and the high costs of construction and materials.

These urban problems lead to several impacts on the population, caused by inadequate provision of infrastructure and services like water, sewerage systems and electricity, environmental pollution and erosion. The occupied areas are not usually illegal, but they lack the official planning permission and legal sub-division requirements. [1]

The situation and character of the area makes it a perfect choice as the location for the project considering the flooding danger and future possible housing problems . Being close to the existing railways makes it easier to adapt the future means of transportation. Another advantage is the existence of the industrial zone right next to the site. This will supply the necessary heat that is needed during the carbon capturing process.

1- Housing consolidation and the urban poor: The case of Hagar El Nawateyah, Alexandria - Ahmed M. Soliman

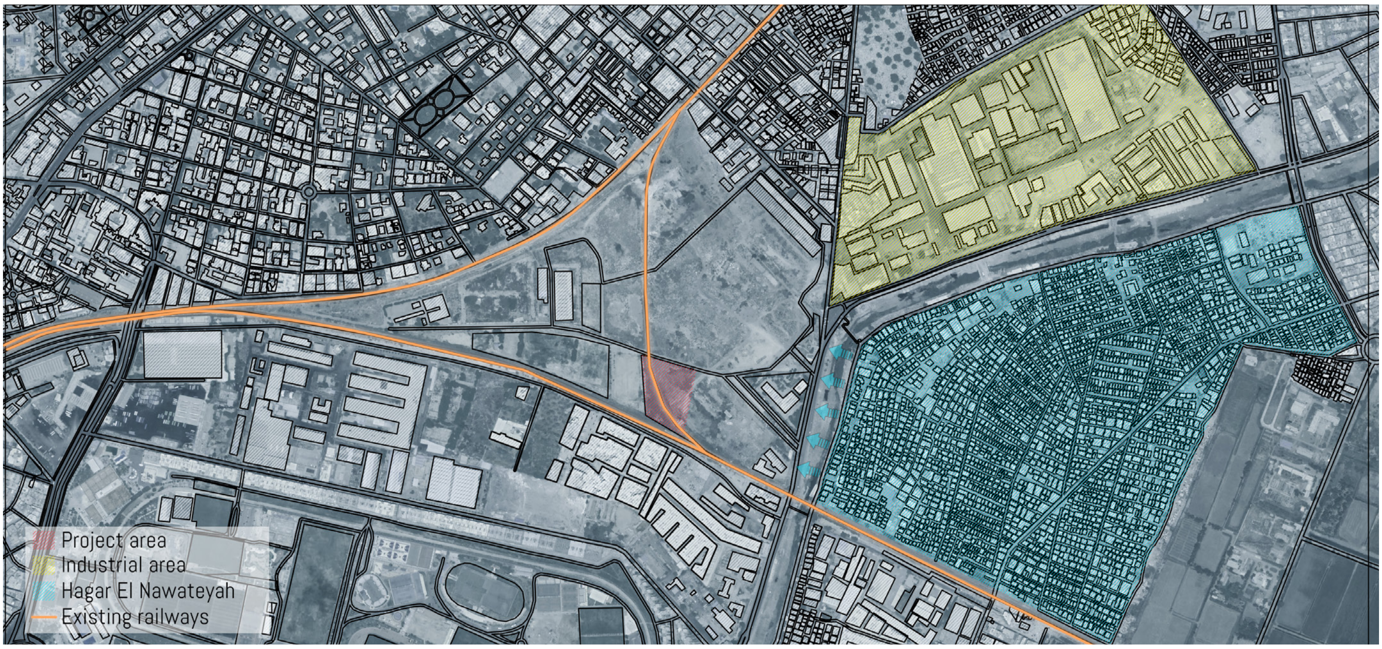


Figure 13: Project site plan

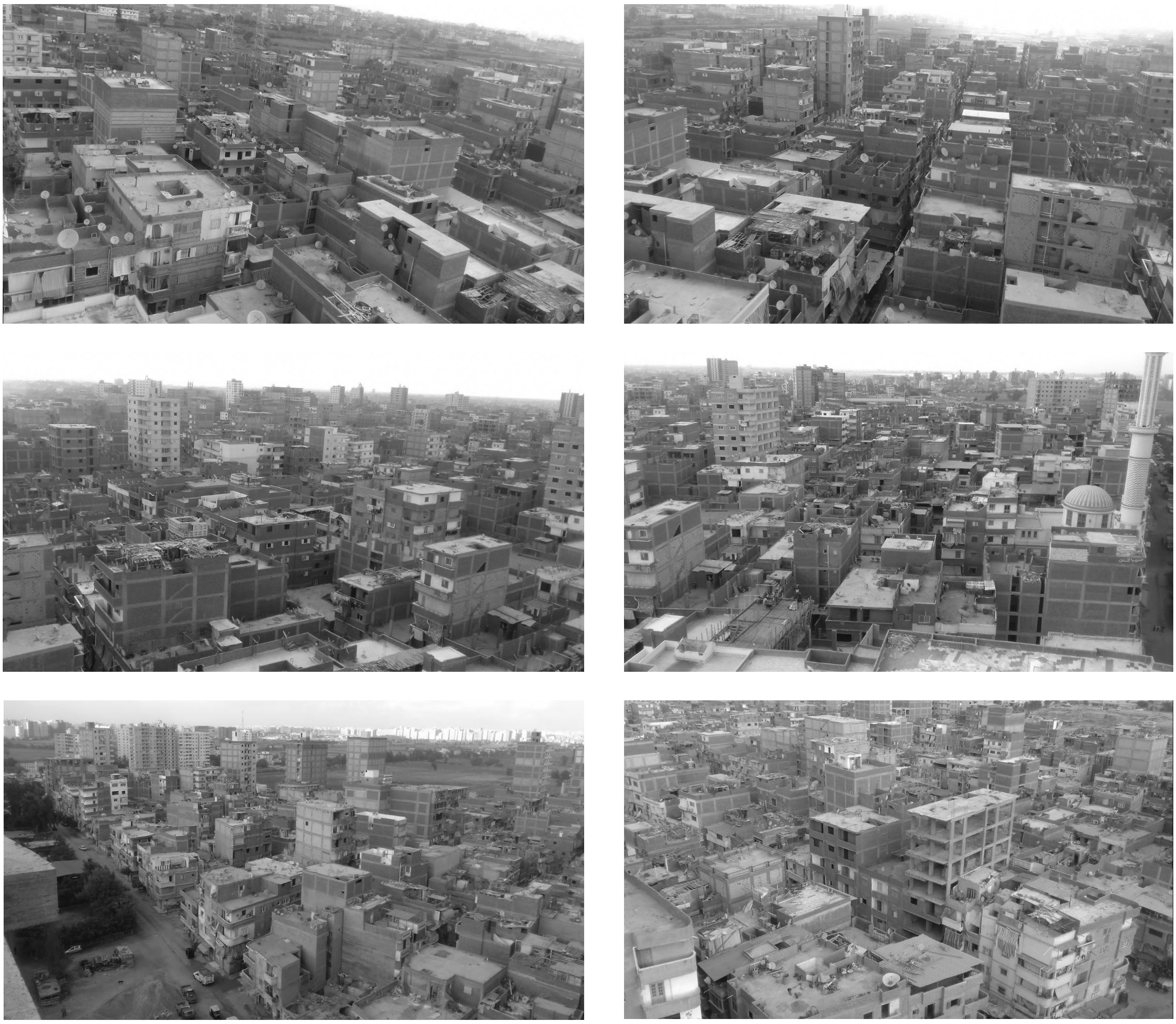


Figure 14: Photographs of the area

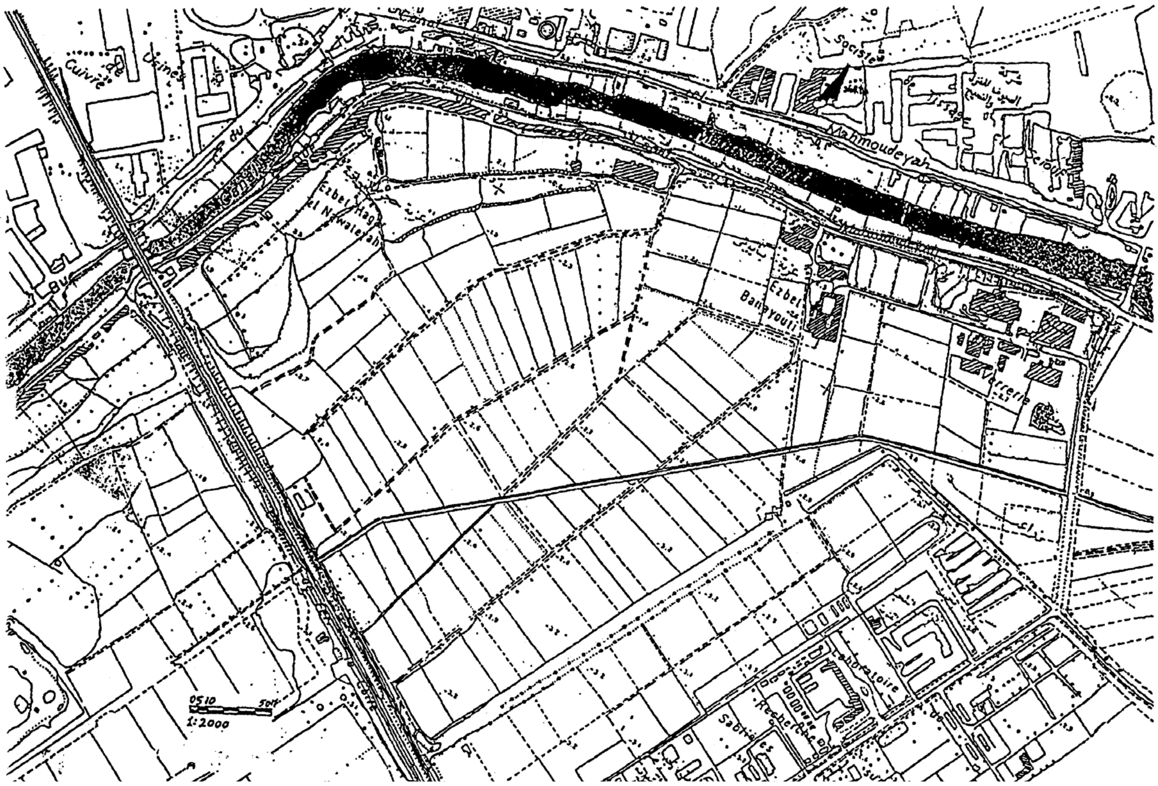


Figure 15: The original site of Hogar El Nawateyah before its development for housing. (source: Housing consolidation and the urban poor: The case of Hagar El Nawateyah, Alexandria - Ahmed M. Soliman)

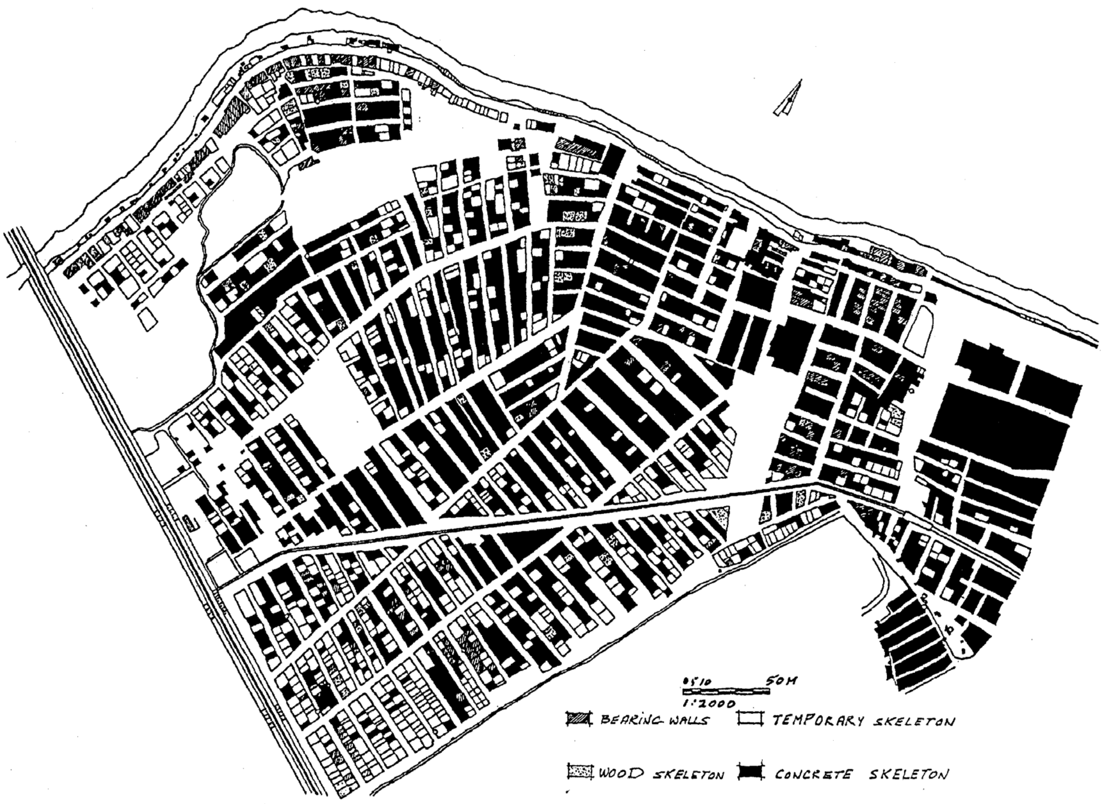


Figure 16: Hagar El Nawateyah showing the build up areas and the state of the buildings. (Source: Housing consolidation and the urban poor: The case of Hagar El Nawateyah, Alexandria - Ahmed M. Soliman)

AFTER THE FLOOD

The main proposal is to create housing which is well adapted to the future conditions .Embrace what is coming and not to be the part of the cause but instead to be a part of the solution. And to ask the question “What will our houses look like after the flood?”.

The future weather estimations are not in favor of us. Global warming is believed to affect hundreds of millions people by the year 2100. The living conditions are predicted to be very different than today. Those conditions which are created by us. So why should the housing be the same?

Today’s houses use the post industrial revolution technologies. They all have blueprints, industrial manufacturing and made by workers. This limits the adaptivity and the flexibility for future usage. Therefore the proposal is adapt to what is predicted and still be flexible for what is not predicted.

The project also learns from many attempts in the past such as metabolism movement and unit - cluster based architecture for the flexibility aspects.

The effects of global warming are already here and will be here to stay for a long time as long as we don’t take a step to change things. Instead of denying the inevitable, we should accept it and prepare ourselves for what is coming.

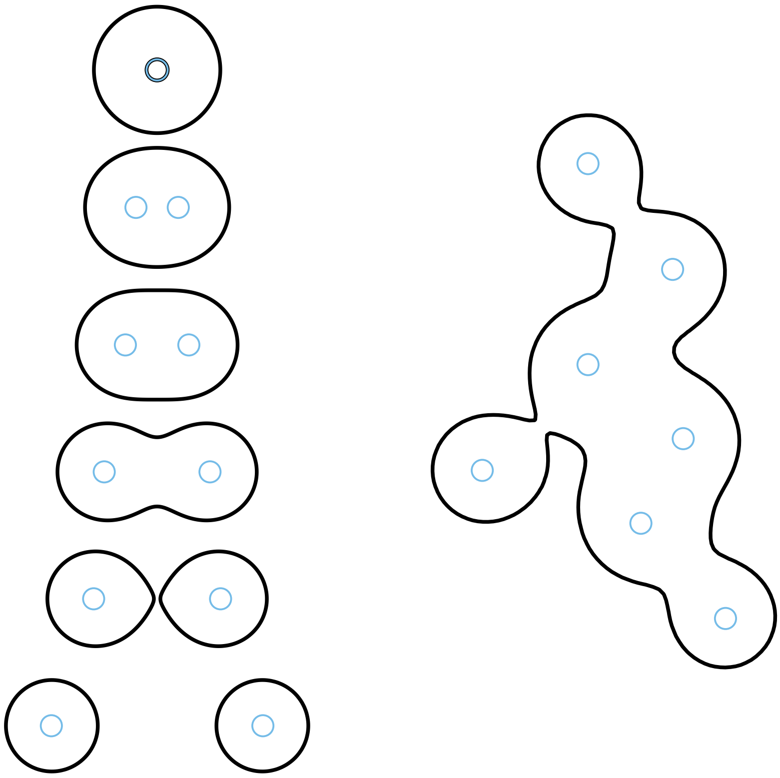
METABALLS

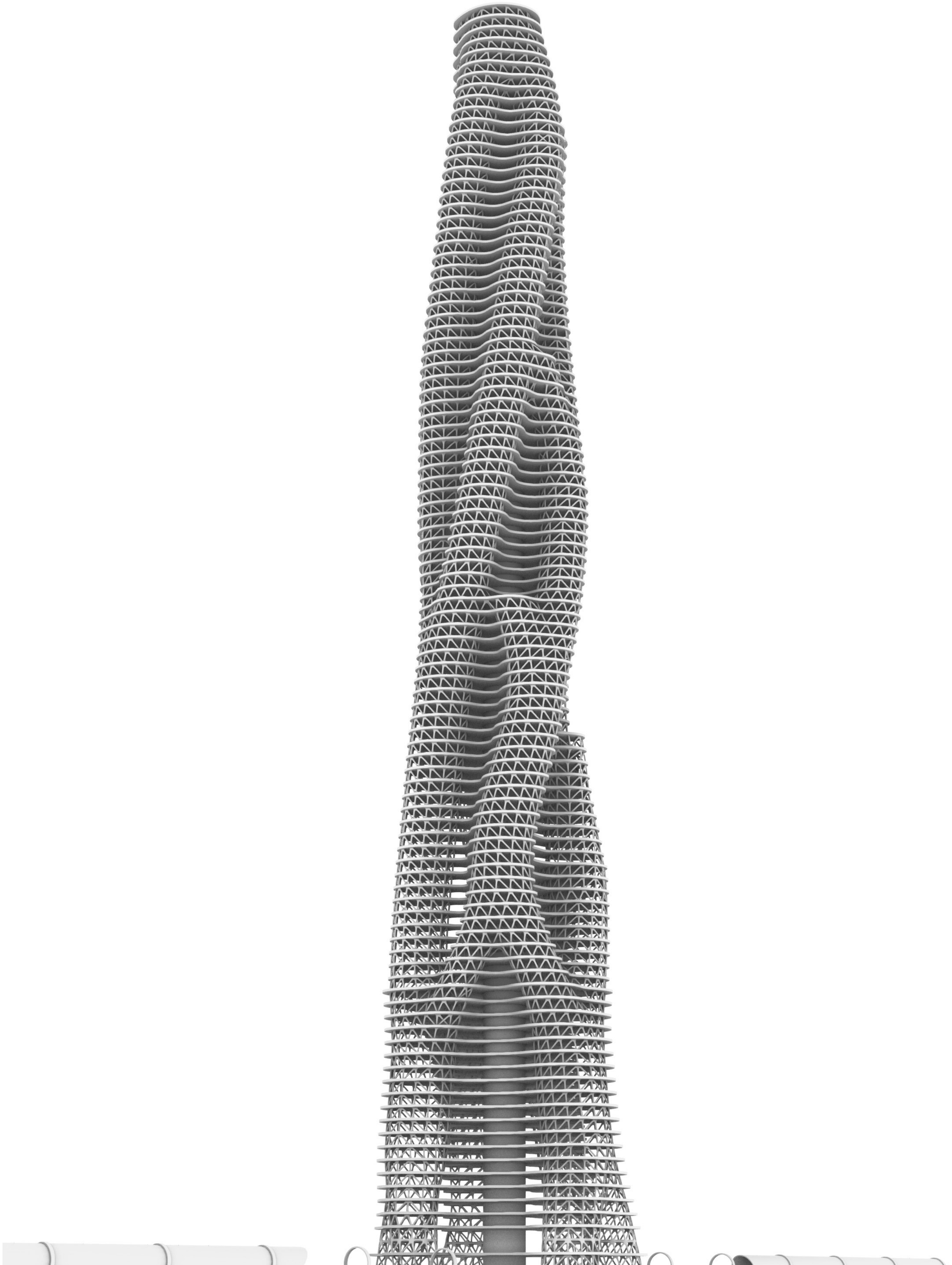
Metaball is an algorithm developed by Jim Blinn in the early 1980s. It is used in many areas such as defining elettvation contours on maps and computer graphics. In the computer graphics metaballs are organic looking n-dimensional objects.

Combining multiple metaballs creates amoeba like organic merged single cells. In this projects this algorithm is used in order to diverse the program combining the volume of the cells. Using different combinations of a single 50 m² unit ends up with various units to be used to fulfill the program of the building needs.

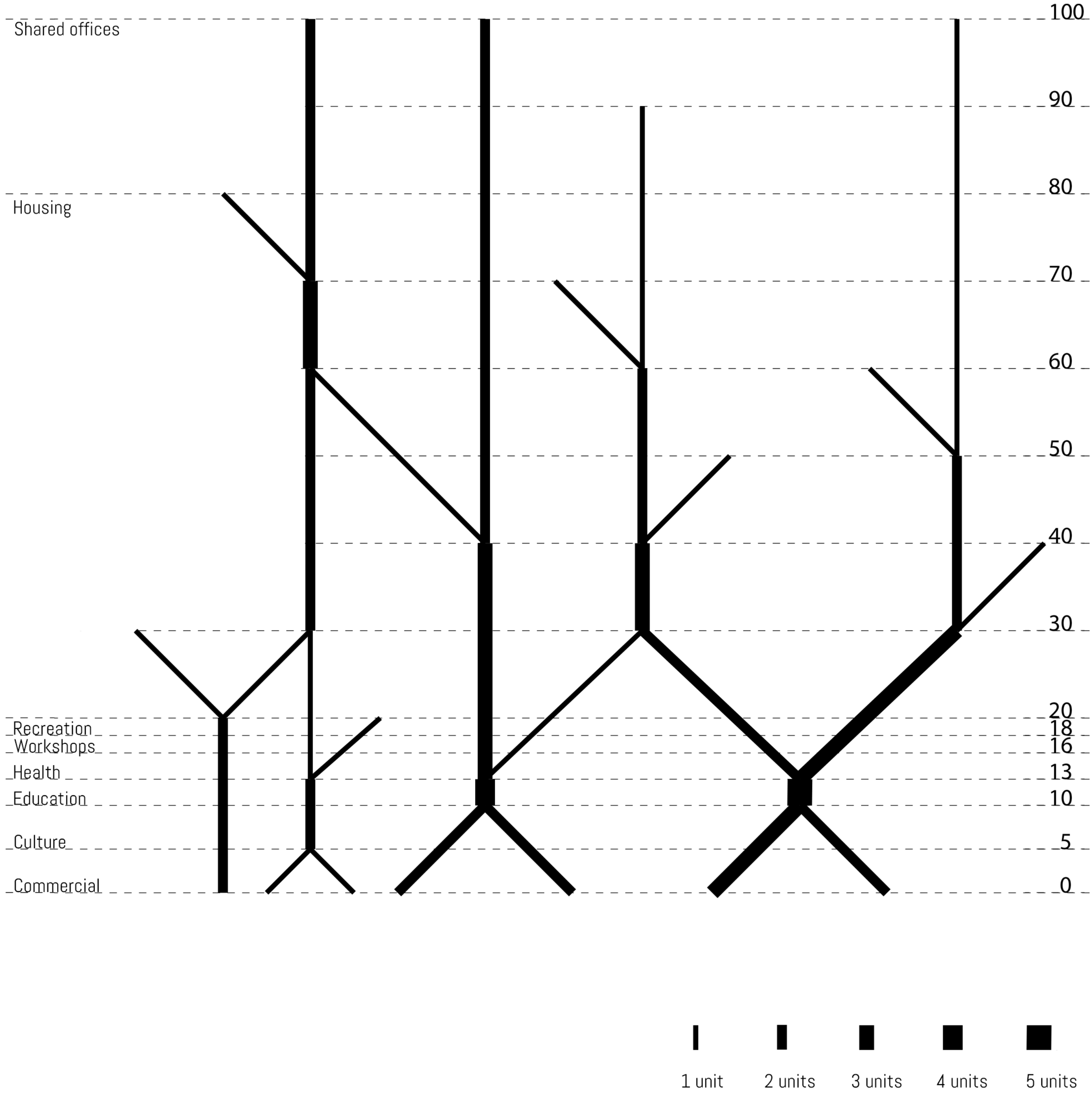
Function for a circle centered at (x0,y0) with radius r is:

$$f(x,y) = \sum_{i=0}^{n} \frac{r_i^2}{(x-x_i)^2 + (y-y_i)^2}$$

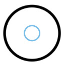


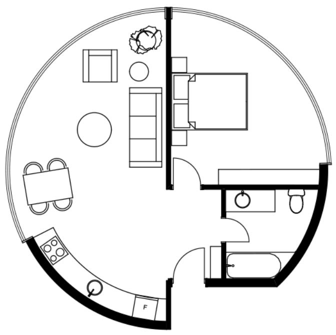


PROGRAM


Shared offices
Housing
Recreation
Workshops
Health
Education
Culture
Commercial
100
90
80
70
60
50
40
30
20
18
16
13
10
5
0
1 unit
2 units
3 units
4 units
5 units

TYPOLOGY

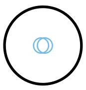


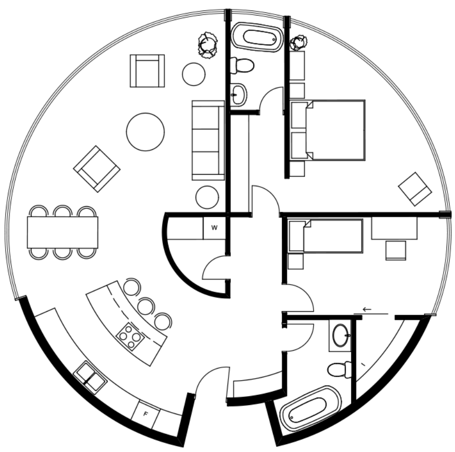


1/200

1 unit
50m²

1 bedroom,
1 bathroom

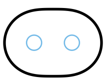


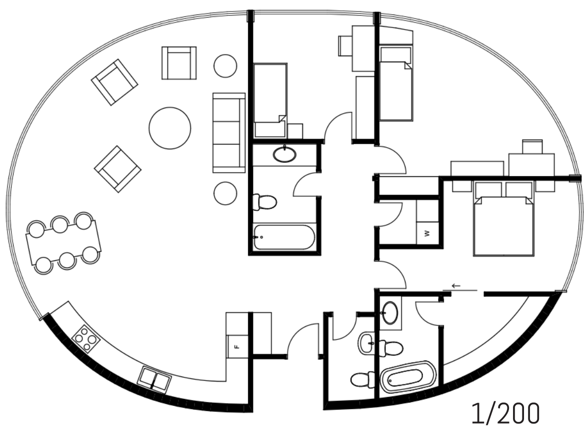


1/200

2 units
100 m²

2 bedrooms,
2 bathrooms

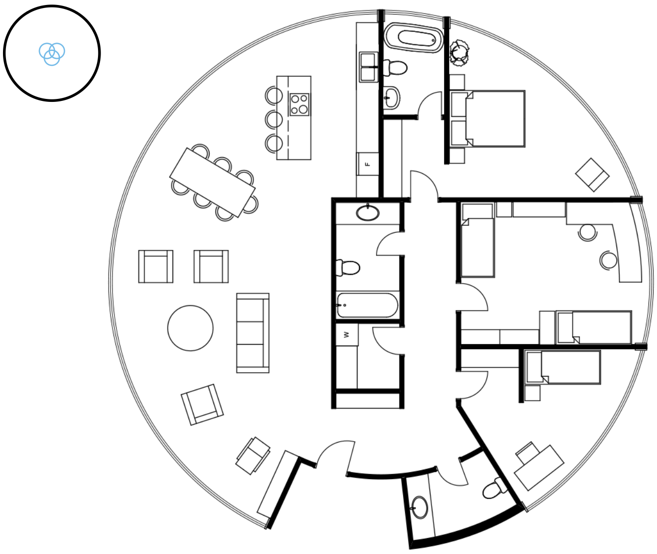




1/200

2 units
125 m²

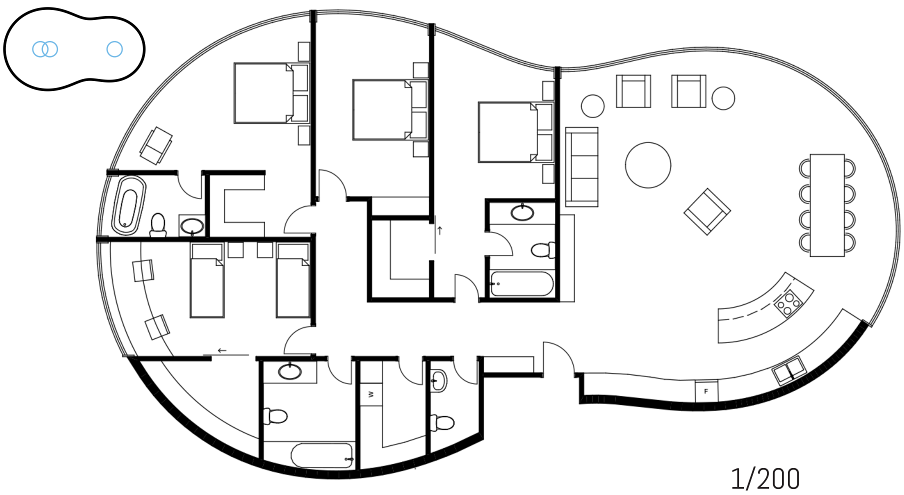
3 bedrooms,
3 bathrooms



1/200

3 units
150m²

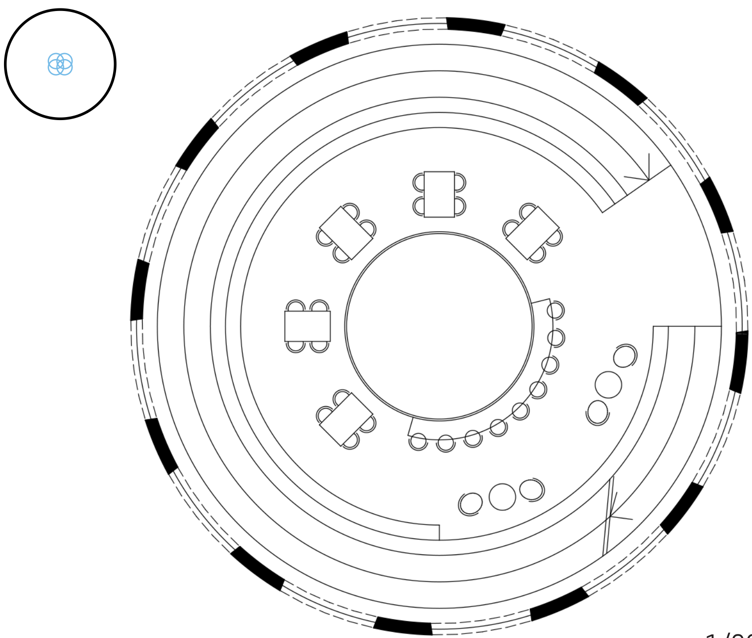
3 bedroom,
3 bathroom



1/200

4 units
190 m²

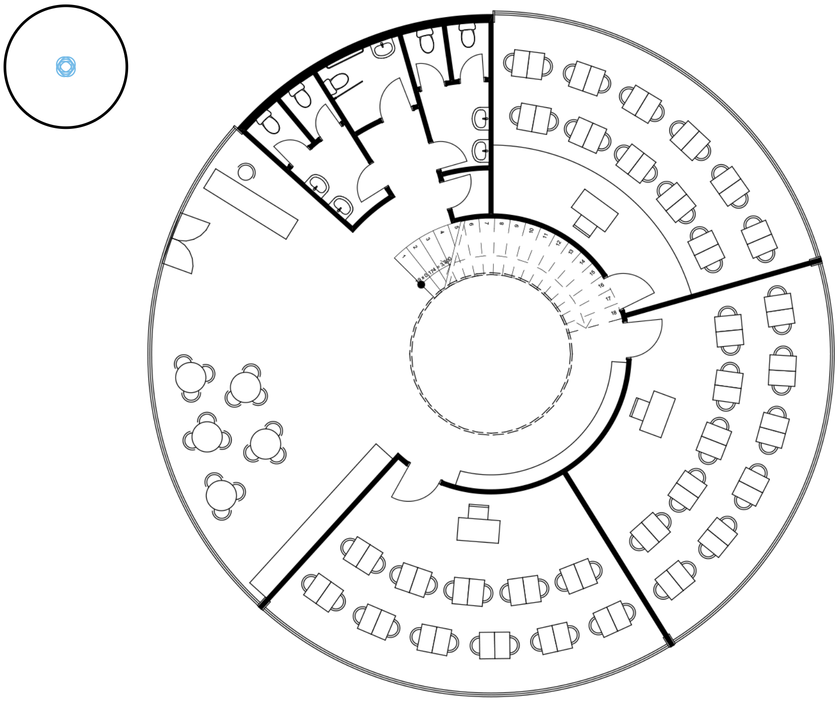
4 bedrooms,
4 bathrooms



1/200

4 units
200 m²

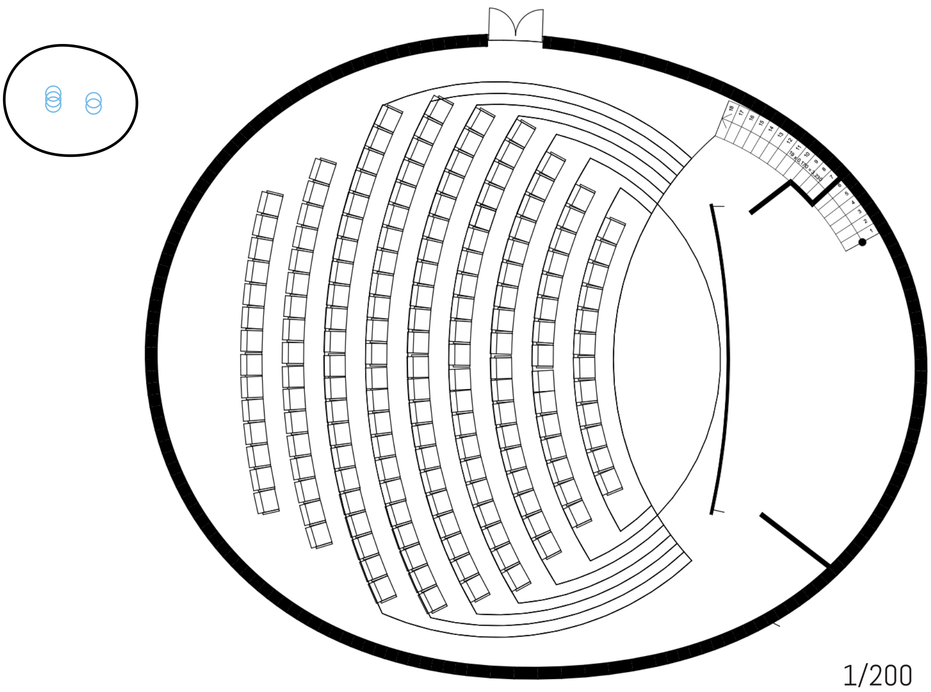
Library
normal floor



1/200

5 units
250 m²

School
normal floor



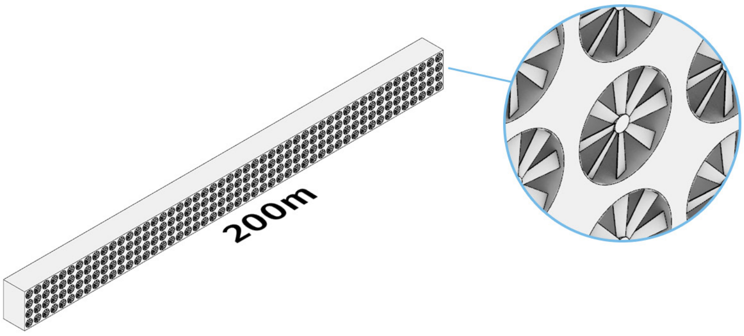
1/200

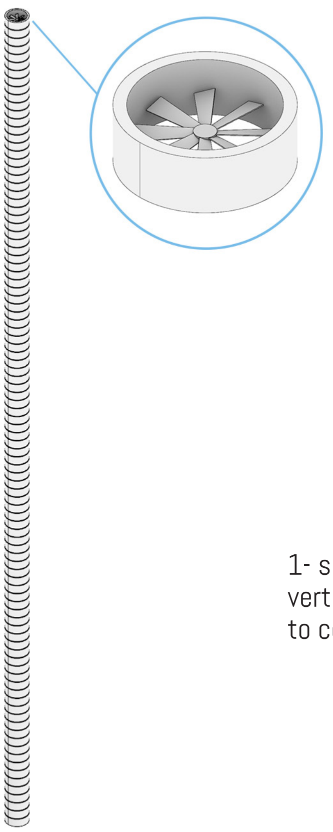
5 units
260 m²

Auditorium
normal floor

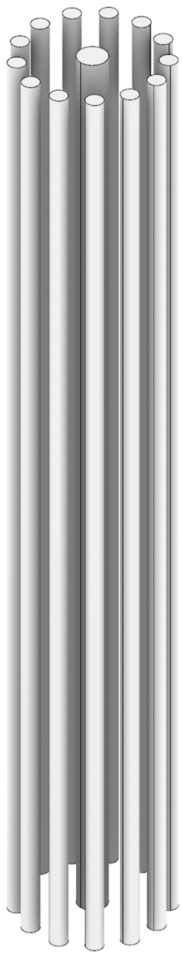
FORM FINDING

The plants that is being used to capture CO2 need a vast area so in this project those plants are adapted into the building's core to be surronded by the units that were planned according to the program needs. Having plants arrenged vertically also creates a high speed air stream combining plants power. This high speed air corridor enables a higher air suction around the skyscraper which is needed to filter out the CO2 from the air

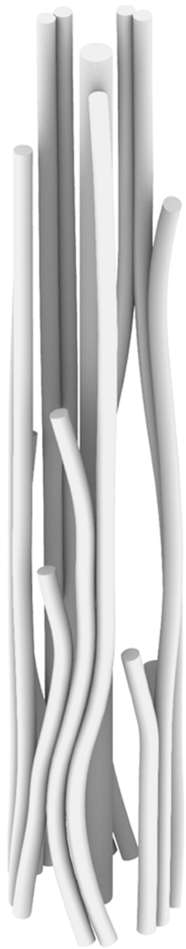




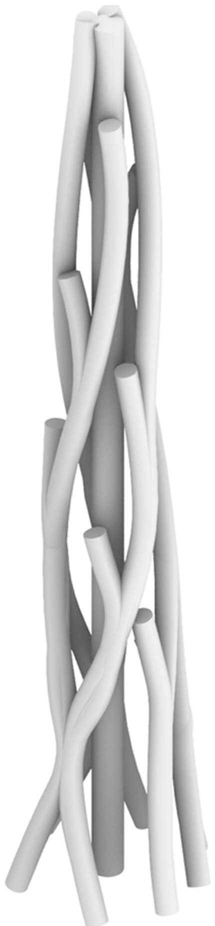
1- sorting the plants into vertical arrengement in order to combine it with the core



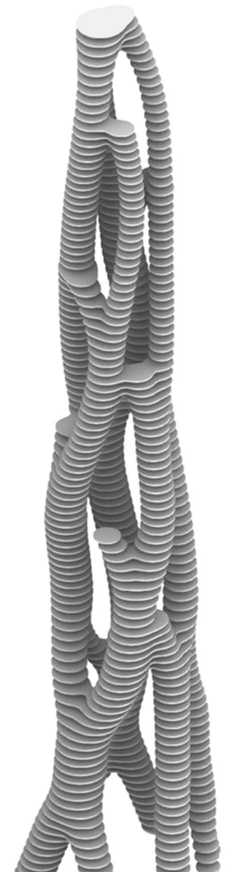
2- single units arround the core according to the spatial need



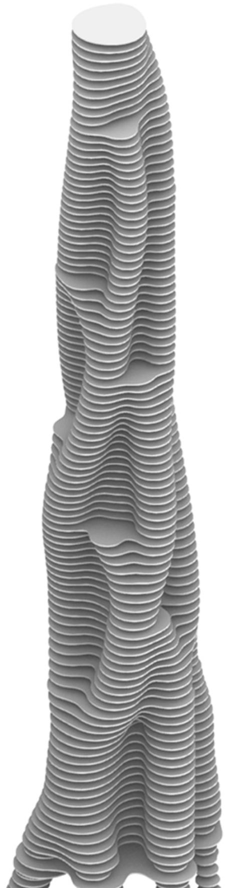
3- distribution of the units according to the program density



4- merging and organization of the units

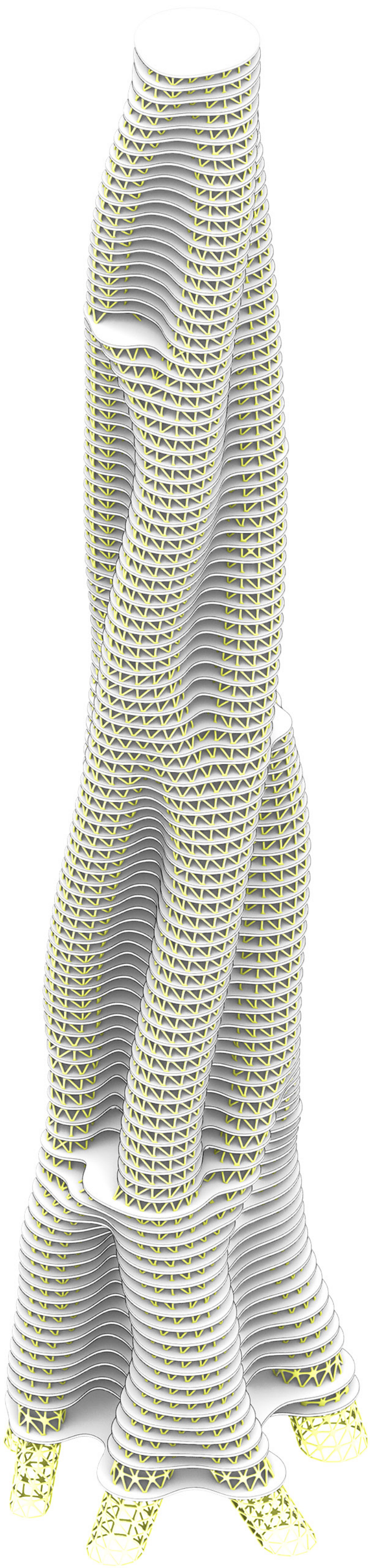


5- applying the metaball algorithm with varied program radius

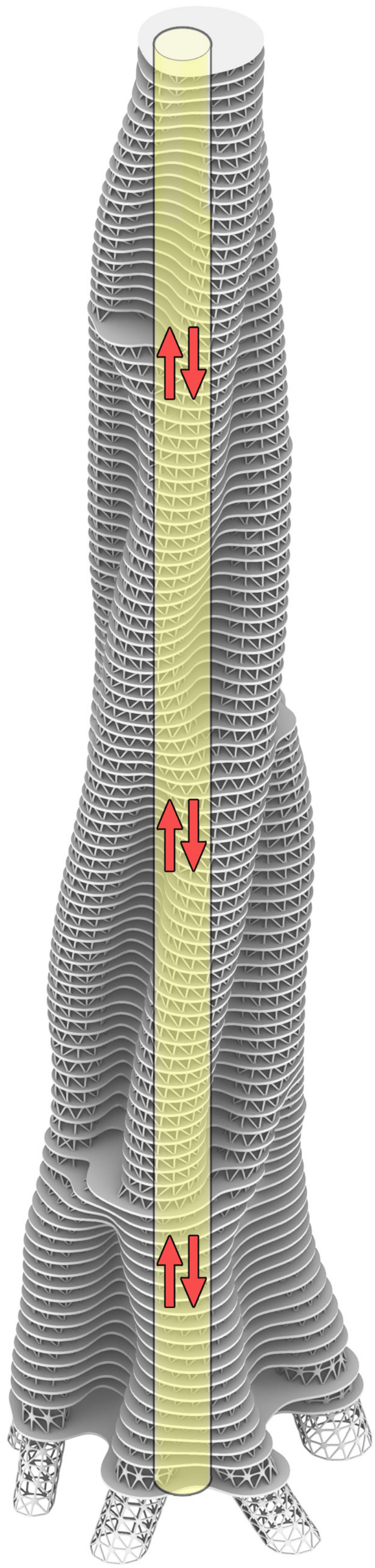


6- single units arround the core according to the spatial need

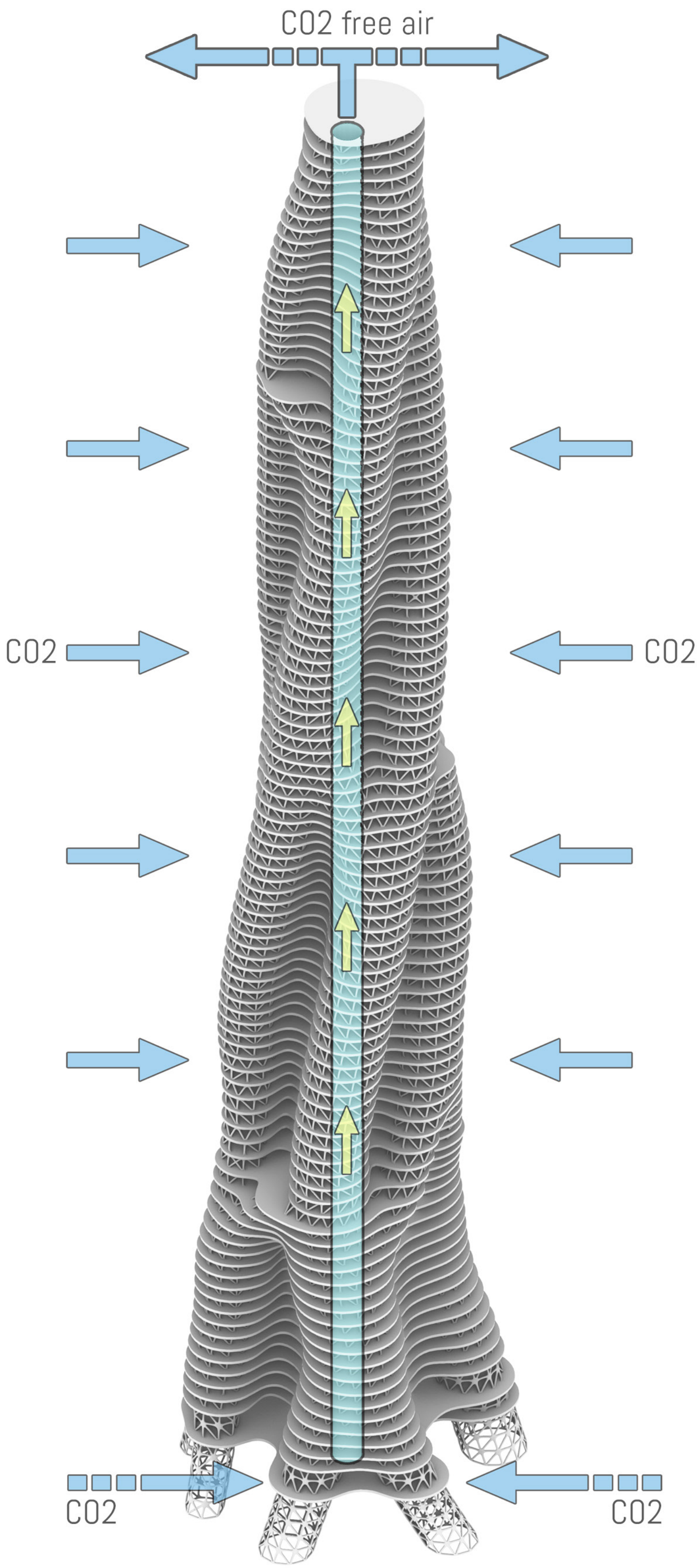
STRUCTURAL SYSTEM



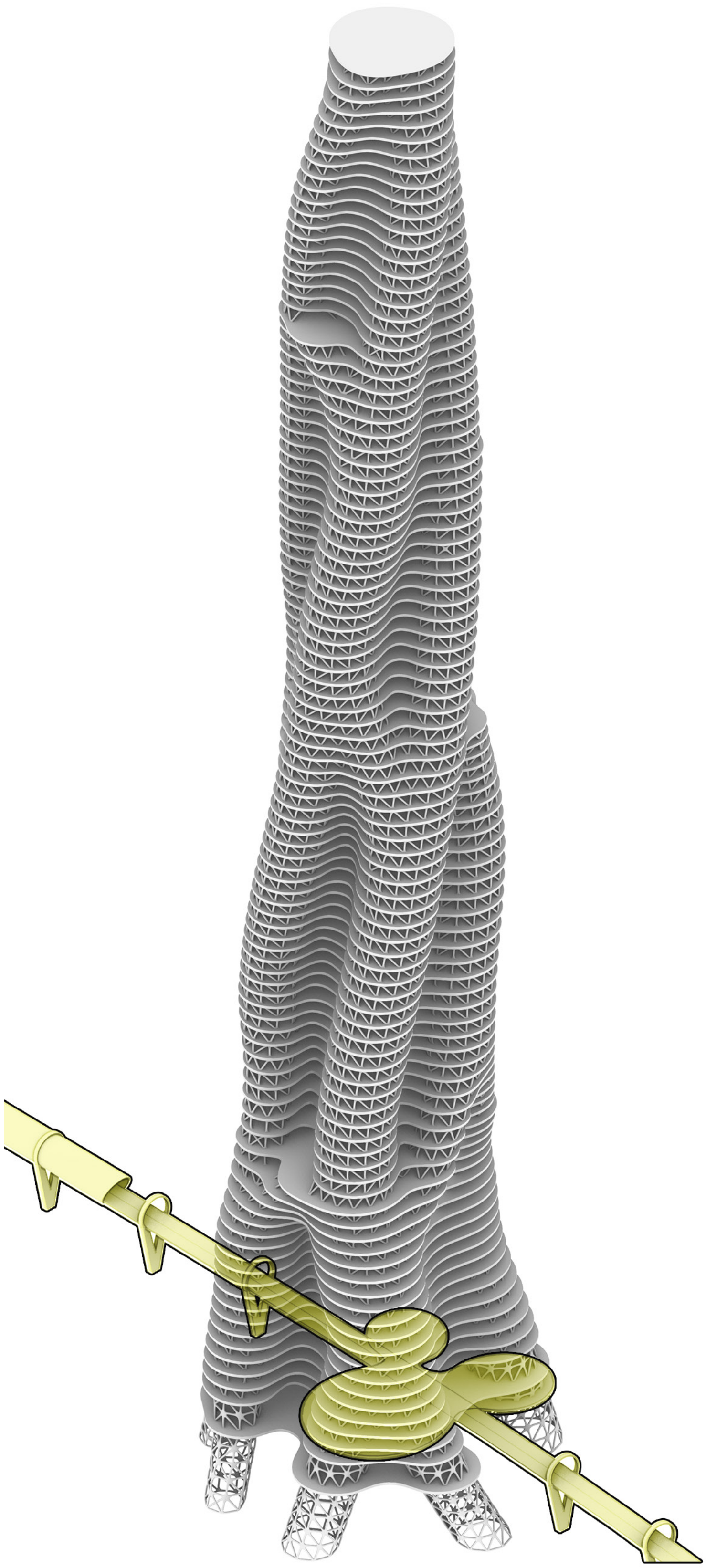
VERTICAL CIRCULATION

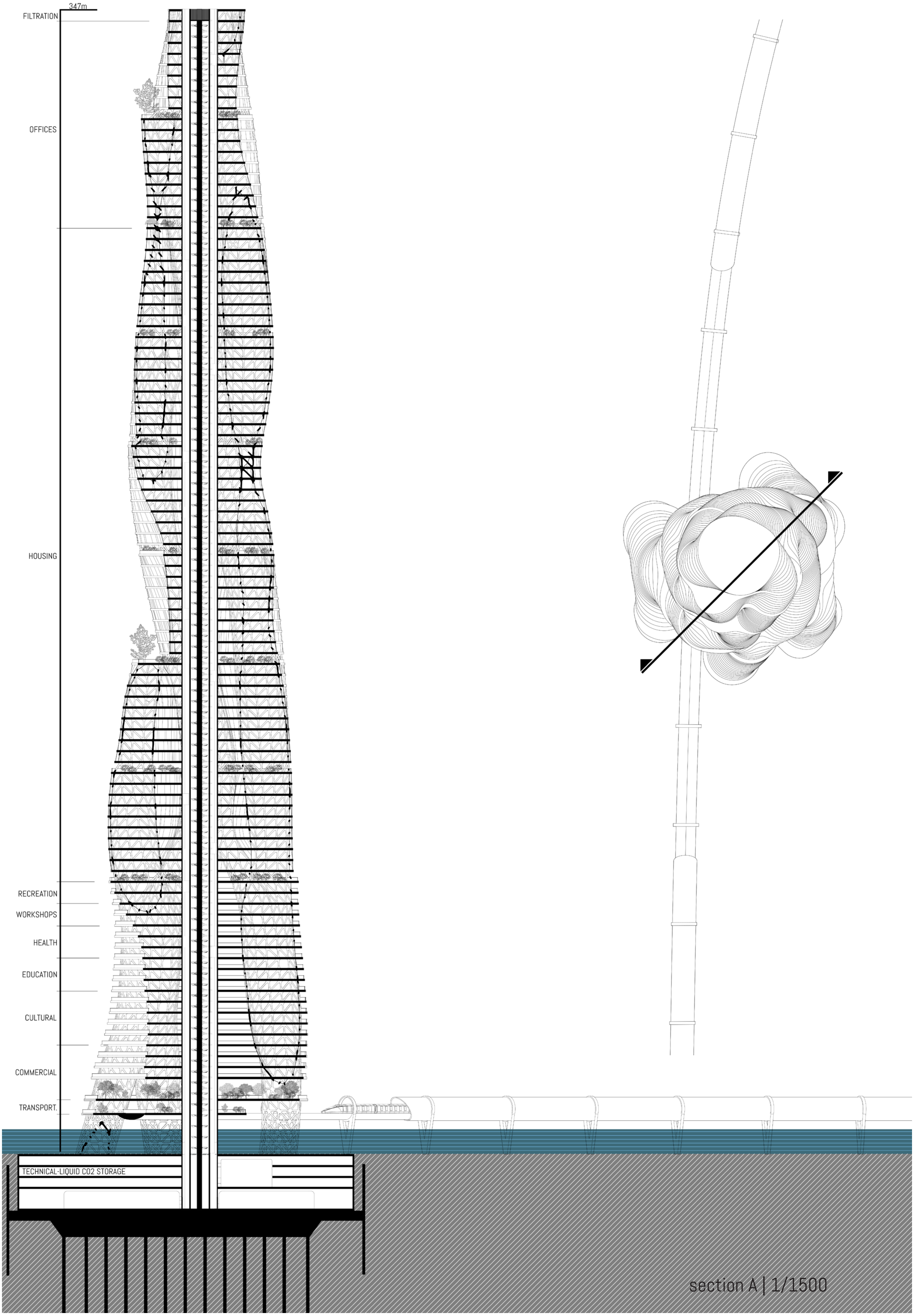


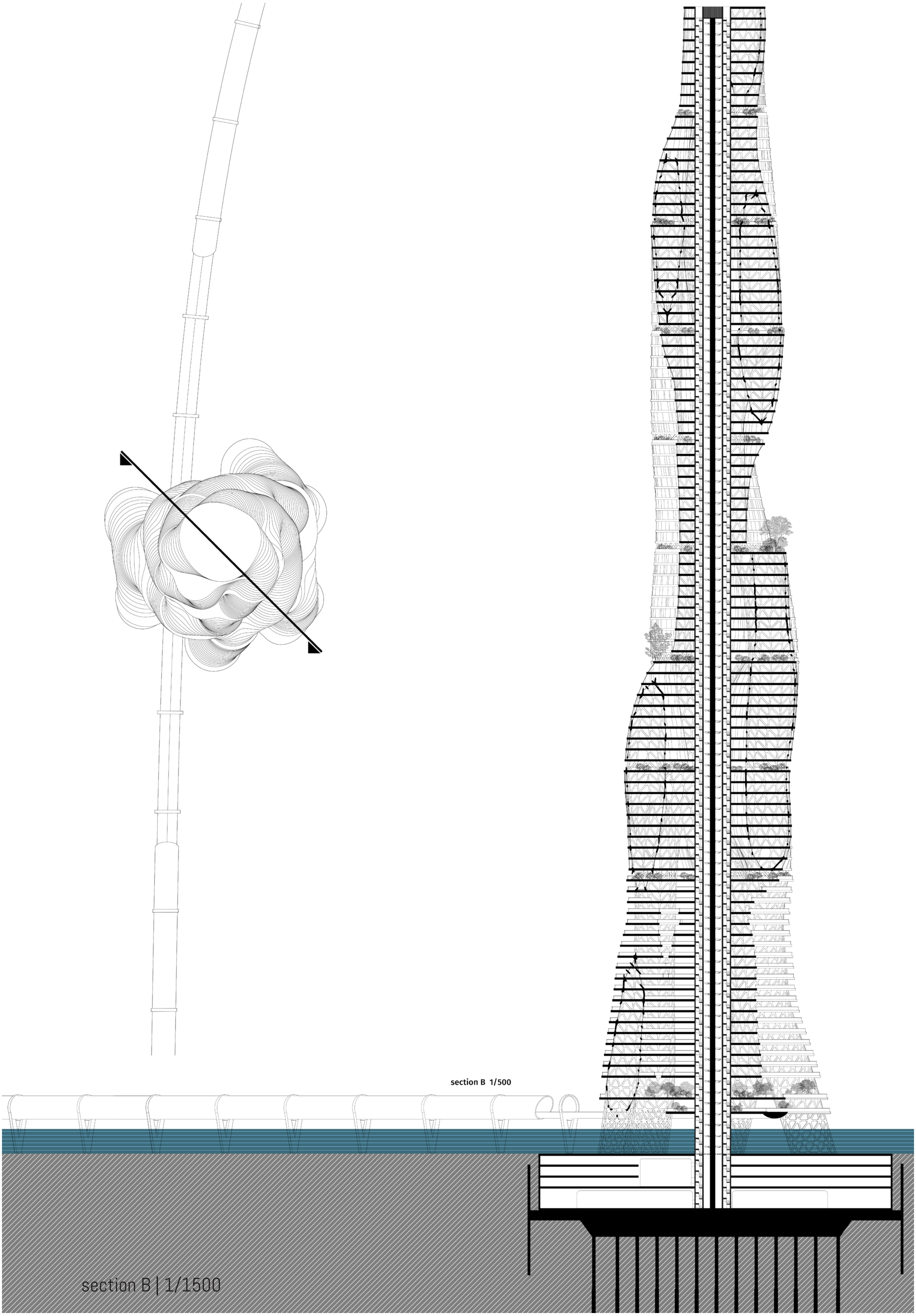
CARBON CAPTURING

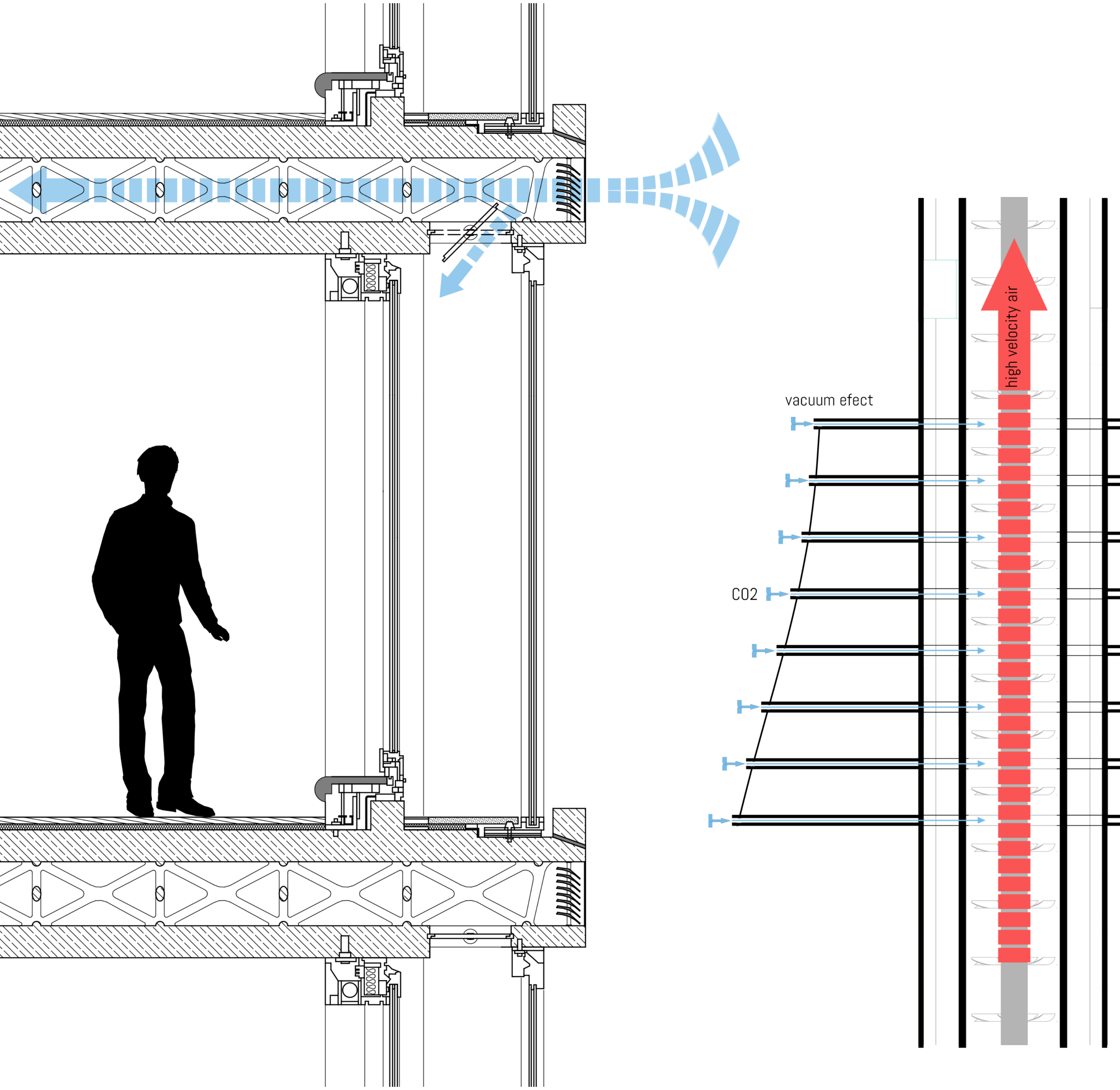


CONNECTION

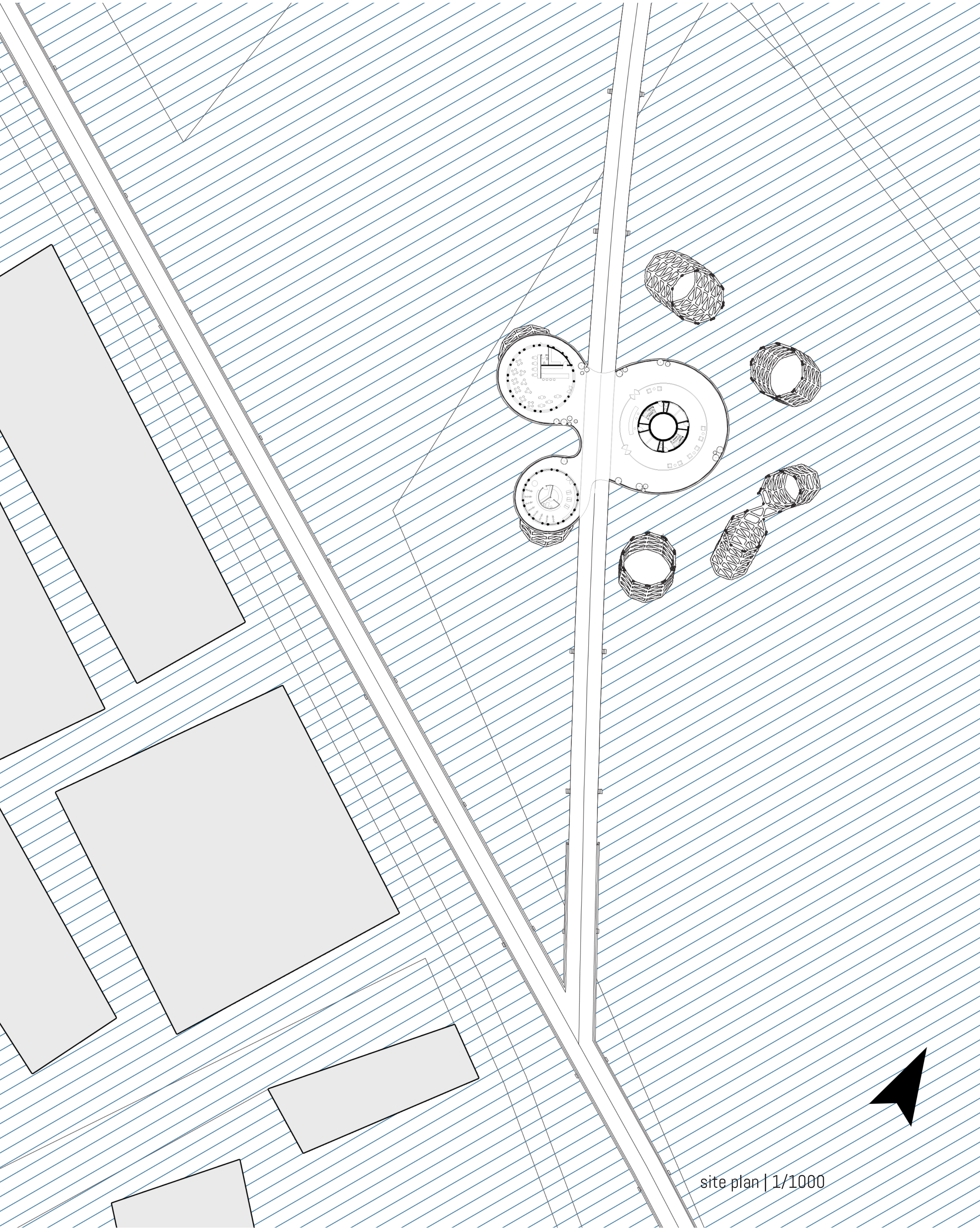



347m
FILTRATION
OFFICES
HOUSING
RECREATION
WORKSHOPS
HEALTH
EDUCATION
CULTURAL
COMMERCIAL
TRANSPORT.
TECHNICAL-LIQUID CO2 STORAGE
section A | 1/1500

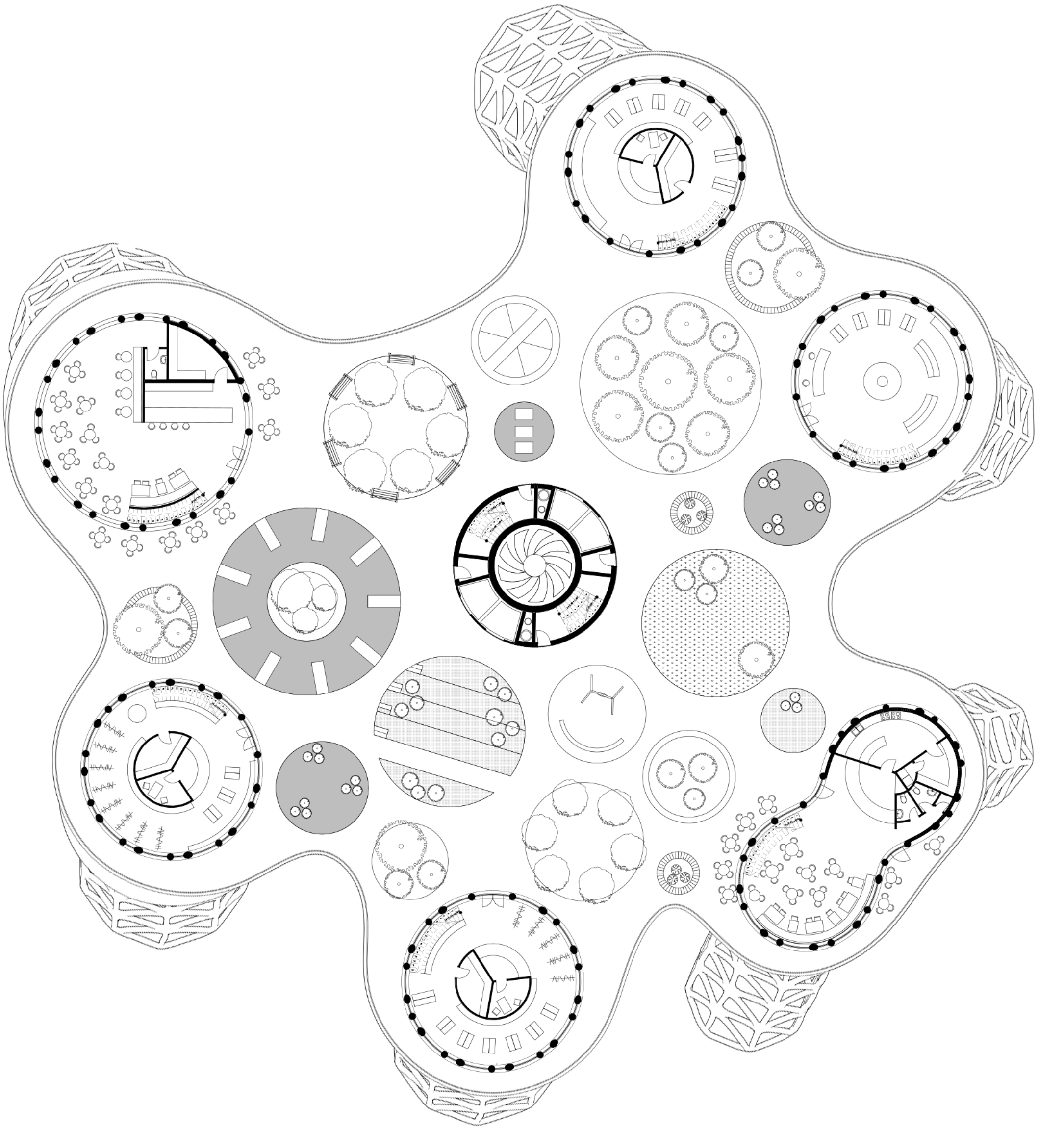

section B 1/500
section B | 1/1500



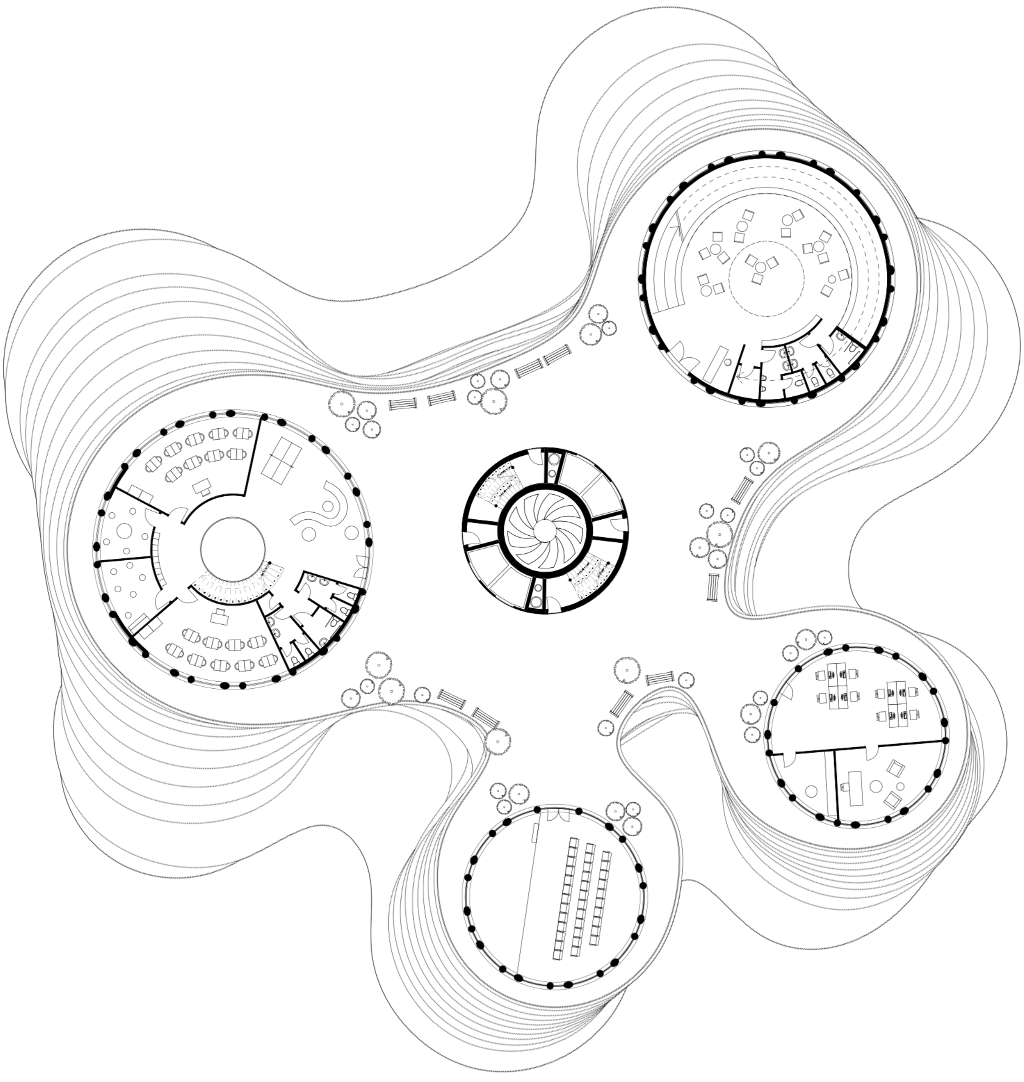
details | 1/25



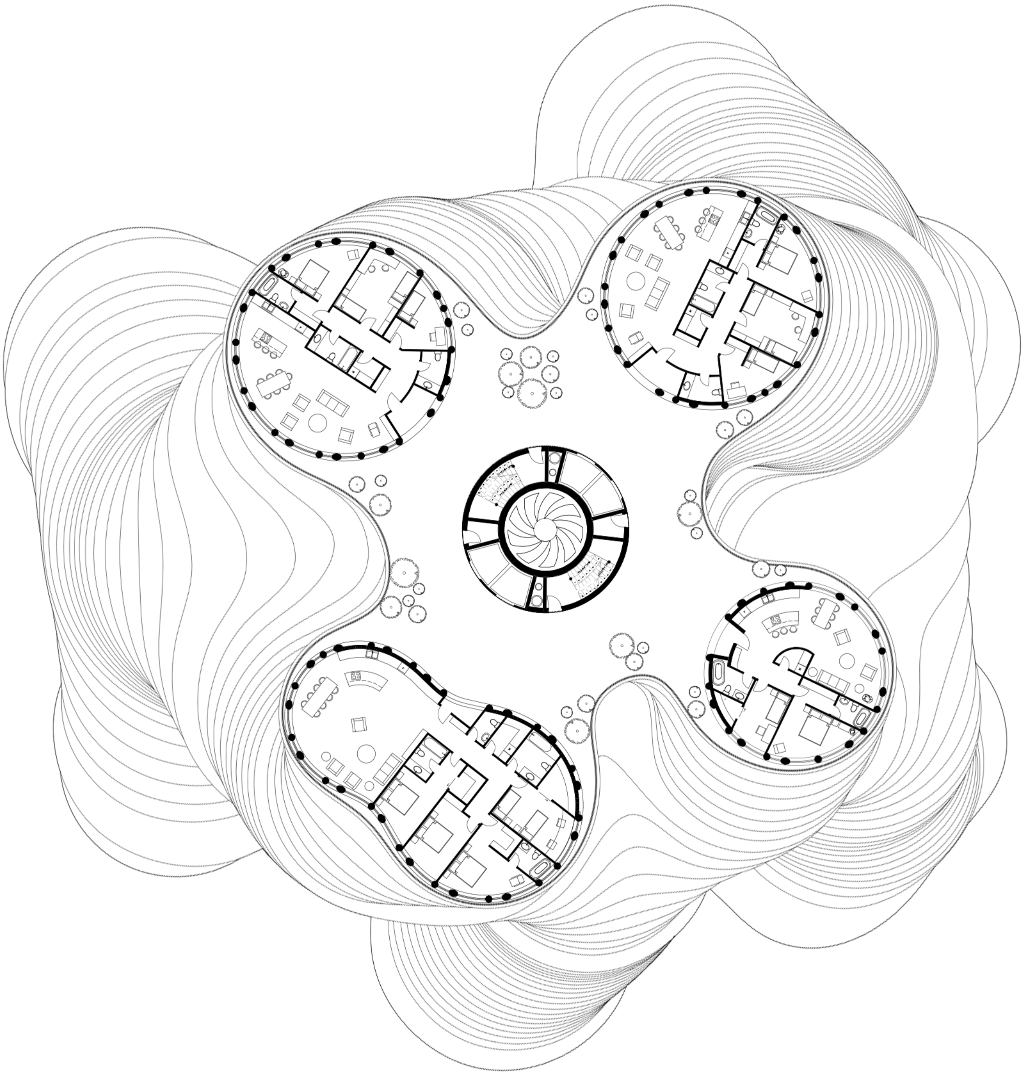
site plan | 1/1000



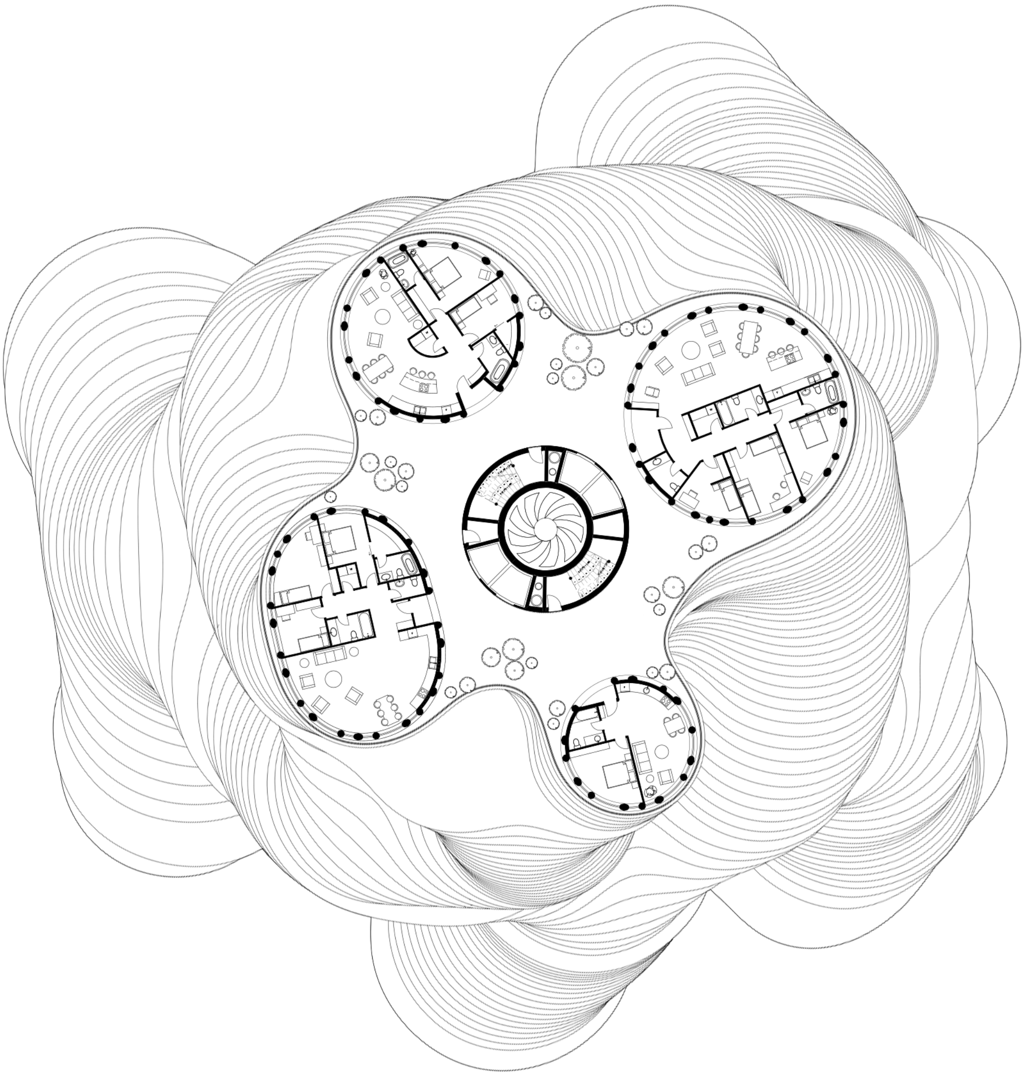
entrance floor plan | 1/500



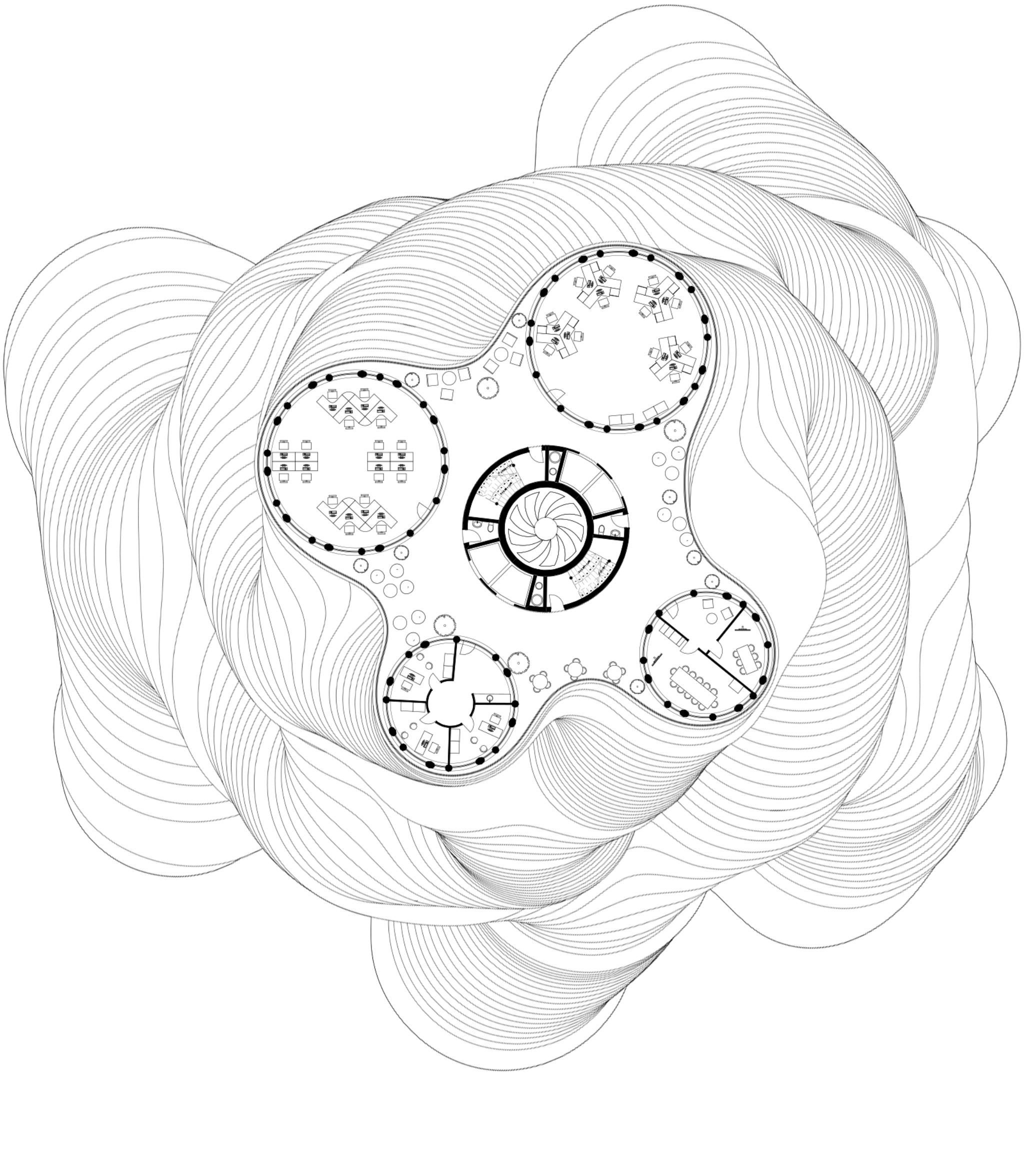
15th floor plan | 1/500



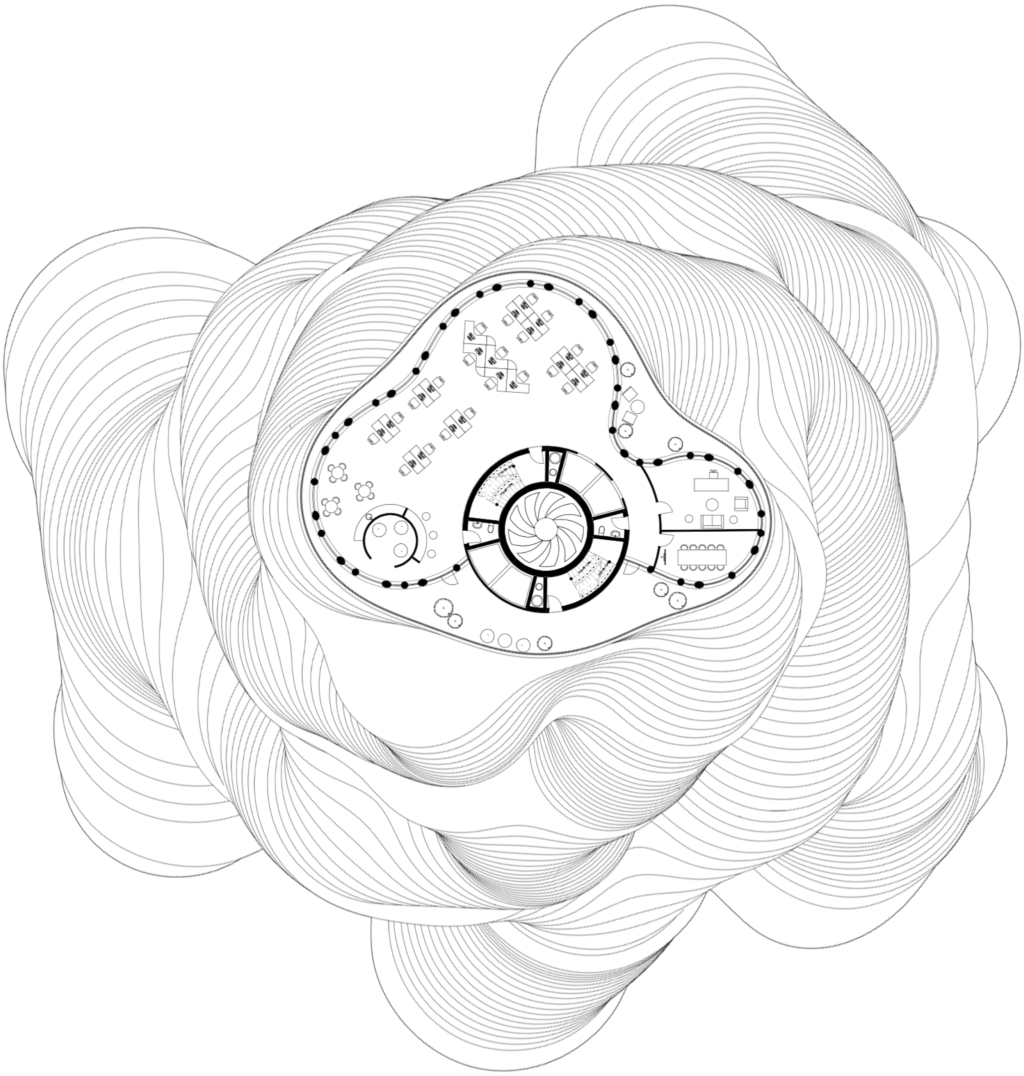
42nd floor plan | 1/500



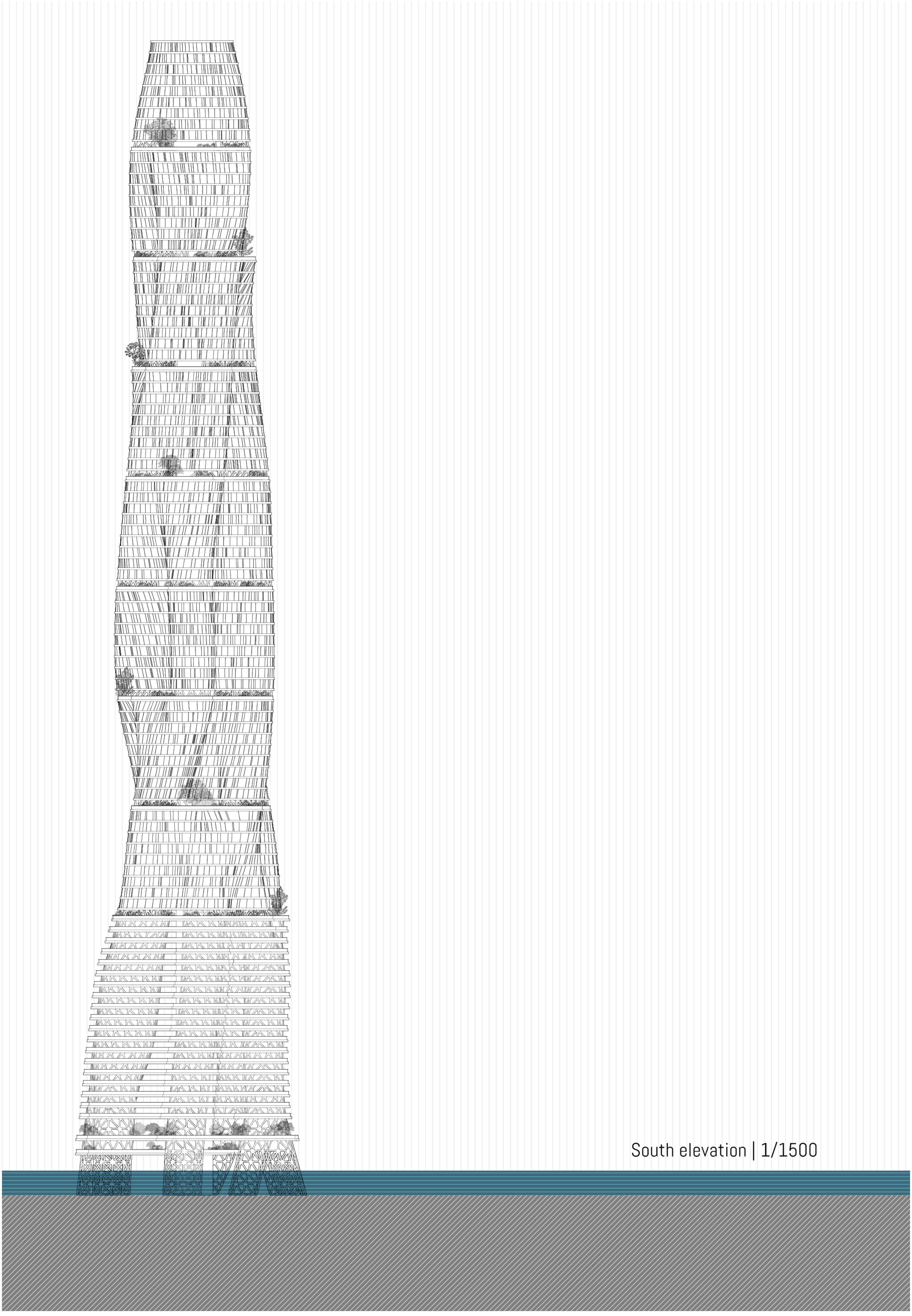
70th floor plan | 1/500



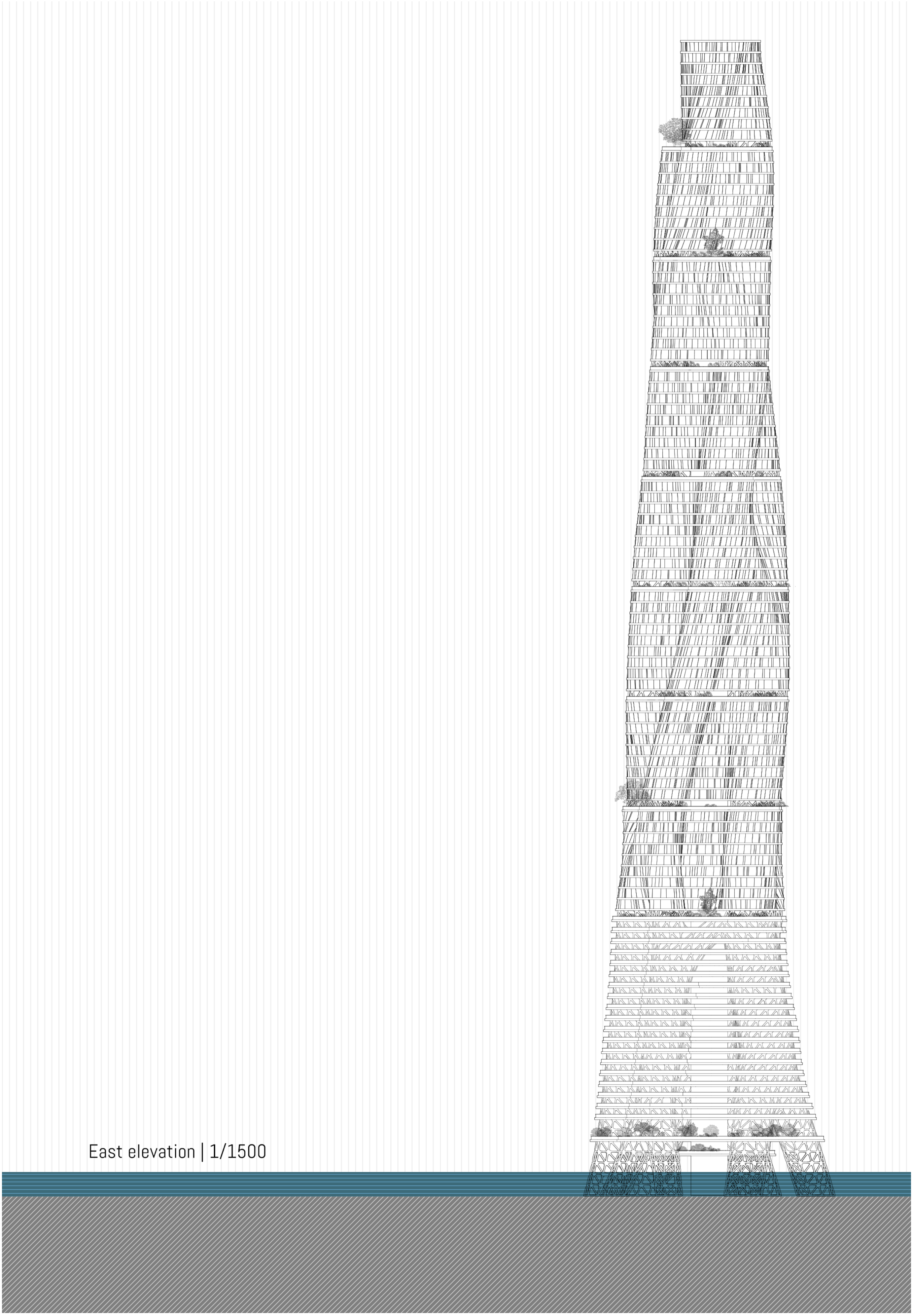
88th floor plan | 1/500



100th floor plan | 1/500



South elevation | 1/1500



East elevation | 1/1500

BIBLIOGRAPHY

1- The Guardian - The three-degree world: the cities that will be drowned by global warming - Josh Holder, Niko Kommenda and Jonathan Watts

2- Mapping choices - BENJAMIN H. STRAUSS,

3- Nicholls, R.J., P.P. Wong, V.R. Burkett, J.O. Codignotto, J.E. Hay, R.F. McLean, S. Ragoonaden and C.D. Woodroffe, 2007

4- The rising tide: assessing the risks of climate change and human settlements in low elevation coastal zones, GORDON MCGRANAHAN, DEBORAH BALK

5- climatecentral.org

6- https://www.nationalgeographic.com/environment/global-warming/sea-level-rise/
The Cement Sustainability Initiative: Our agenda for action, World Business Council for Sustainable Development.

7- EIA – Emissions of Greenhouse Gases in the U.S. 2006-Carbon Dioxide Emissions

8- Calera.com

9- Intergovernmental Panel on Climate Change, "Sources of CO2," IPCC Special Report on Carbon Dioxide

10- coral.org

11- Outdoor prototype results for direct atmospheric capture of carbon dioxide , GeoffreyHolmes

12- news.nationalgeographic.com

13-sciencedaily.com

14- CarbonEngineering.com

15- Housing consolidation and the urban poor: The case of Hagar El Nawateyah, Alexandria - Ahmed M. Soliman

16- Carboun.org