Earthly Forces

Rethinking the Potential Energies of the Episodic, Dispersed, and Unpredictable

by

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Bachelor of the Arts,
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ABSTRACT

The Earth is active. Mountains are violent, rivers relentless, and even the slightest movement of matter—drops of rain or grains of sand, when compounded can have exponential ramifications. Geology has a long history of being chained to the economies and ambitions of material and energy revolutions—and regimes of architecture and construction. This thesis project opposes modern desires of consistency, reliability and scalability that come at the expense of resource extraction and depletion. It imagines a world where humans might work with the rate at which the earth builds through erosion, transport, and accumulation. This research recognizes the force of water in its multitude of forms - turbulent, seeping, and crystalline. It explores ways in which the potential energies of gravity and earthly forces could create new forms of infrastructure that hold and store potential energy.

Among the many forces of nature, this thesis identifies and develops floods, rock fall, and avalanches - as forces with which design interventions can be paired. Each force can lift weight and hold mass at height as potential energy, as well as collect debris for architectural structures. By acknowledging the potential energy of earth's forces, this project reflects on how we can begin to imagine a world where these forces are seen as sublime and productive rather than terrifying and destructive. This research project proposes we modulate our energetic use and architectural output and calibrate these with the episodic, dispersed, and unpredictable eb and flow of the Earth's metabolism.

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Thanks!

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To all of MArch 2023 (and all MArchs) for lots of fun, friendship, and teaching me so much!

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Thank you for being patient, driving me around to collect rocks, and for carrying the heavy stuff.

All images and text by the author, unless otherwise stated. The work was produced for the Master of Architecture Thesis at the MIT School of Architecture and Planning.

Contents:

A Project, Situated in Time:

Architecture + Geology

Figure 01. Sandstone, Natalie Pearl

Geology is humanities understanding of the earth, how it has come to be, and the materials that compose it. It is understood as the resources used to build and is the foundation for all forms of building. Further, it has supplied all that is extracted, pumped, and burned, allowing for construction, and supplying the power that enables the built environment. This thesis argues that geology, energy, and architecture have always been intertwined, influencing one another.

A Project, Situated in Time:

Architecture + Geology

Figure 02. Mesa Verde, Natalie Pearl

Stone has always been a source of human comfort. Attracted to its overhangs, and its structural potentials, human engagement with stone has endured great time scales and climates while always resonating with the landscape. Eventually, stone was collected, quarried, cut, transported, and aggregated to provide architectural space.

Ritual
Enclosure
Dwelling
Institution

Water
Lime
Volcanic Ash
Form
Time

With the formation of earth,the collection of gases and cooling of a molten core caused movement and material transformations over the next 4.5 billion years. The rhythms of the earth began cycles and processes that undulate with temperature, time, and impact.

When gasses collected and this planet was formed, the newly created atmosphere shifted how all matter would live and die on earth.

Core

Humans were attracted to stone, moving towards it, its overhangs, and its comforting potentials. Stone remains, enduring great time scales and climates. Eventually, humans learned how to harvest, cut, quarry, move, and aggregate stone to provide space.

When humans transitioned from taking shelter in stone to moving stone, vast and significant spaces capable of enduring the elements were formed.

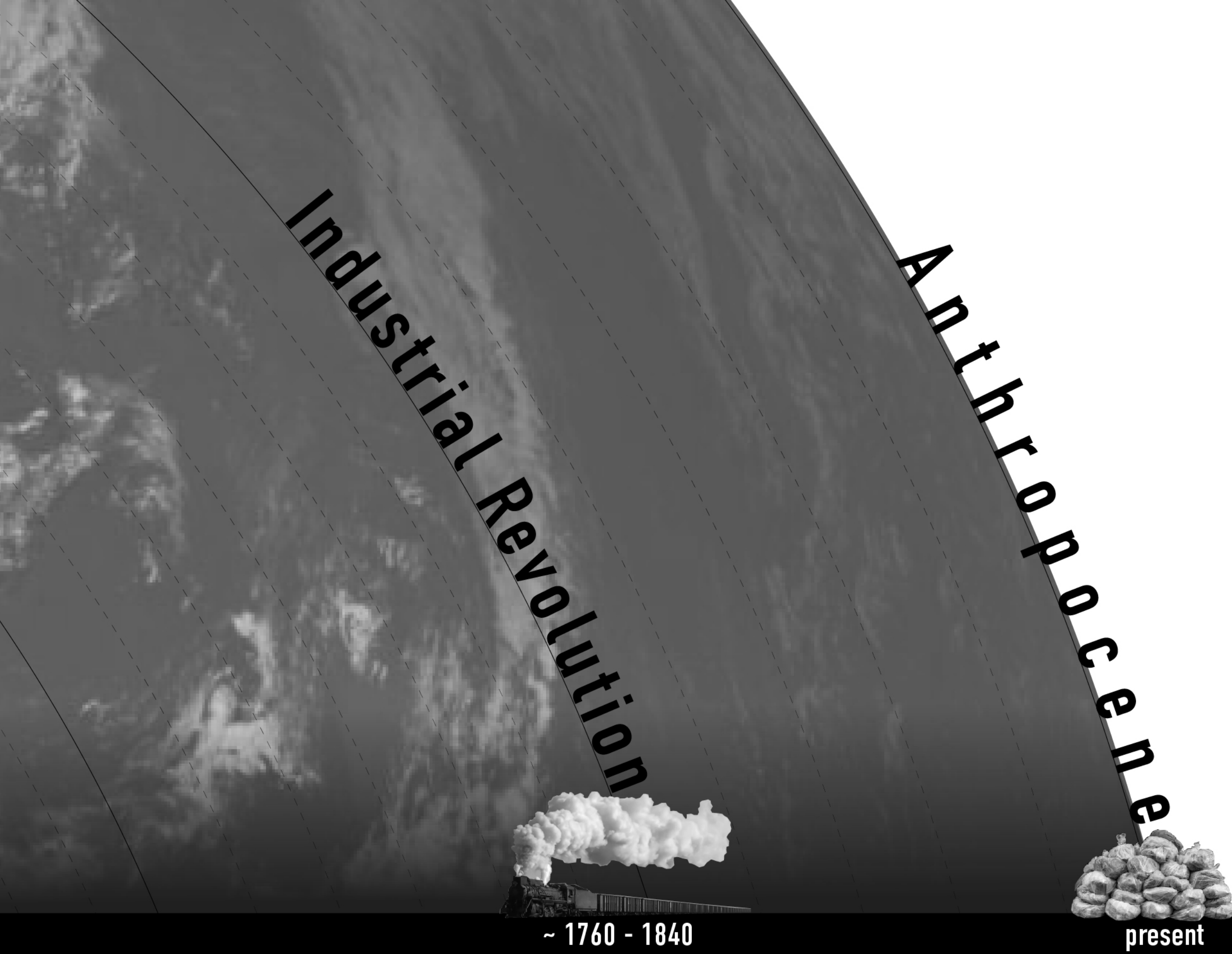
Mantle

Concrete ties earthly ingredients to human desires. Ash from volcanic activity, lime - the metamorphization of sediments containing shells of lost sea life - and sea water allowed humans to influence structural potentials and intervene in the endurance of the built environment.

Concrete marks a moment in time where humans begin to harness geologic matter and processes, forever altering how buildings will be erected.

Crust

Figure 04.



The Industrial Revolution transitioned making with hands to making with machine. This revolution transitioned our expectations of materials, spaces, and the time it takes to make. Mechanization was enabled by power and caused pollution that has influenced, amplified, and sped up the earth's cycles.

Mechanization emphasized production and a new era of consumption, rushing building, and causing environmental degradation which has shiftedhow the earthprocesses and digests matter.

Our present, where human impact is seen in the geologic record, is a time to reflect on the way we build. We can project on how geologic processes could influence the built environment and how said interventions will better allow architecture to relate to its surroundings and those within its spaces.

Recognizing our potential to influence earthly processes will shift the pace of production and inform a new age of building with the potential to influence and be influenced by geologic processes.

A Project, Situated in Time:

Geology + Energy

Over time, the building and inhabitation of architecture has knowingly intervened in terrestrial processes and their timescales, many of which precede and extend beyond those of humanity. Geological, environmental, and architectural processes are inevitably linked. Yet while geology and the environment are always in flux and dynamic, architecture and it's construction have calcified and become discordant with earthy forces.

When humans began to map the earth and its geology, it was with the intention to find and locate resources: matter for building and energy. Extraction, aided by geologic maps, led to 'exploration' and exploitation. Oil, iron, coal, gems, minerals, and metals were marked, and thus geology was chained to the economy, ambition, and fortune of material and energy revolutions. Coal powered movement and mass production, giving birth to steel and iron, and revolutionizing industry. Oil pipelines supported electric light and power, automobiles, and economic explosion that provided rubbers and plastics. Gas enabled the making of an onslaught of petrochemical products.

A Project, Situated in Time:

Geology + Energy

Figure 04. The Map that Changed the World.

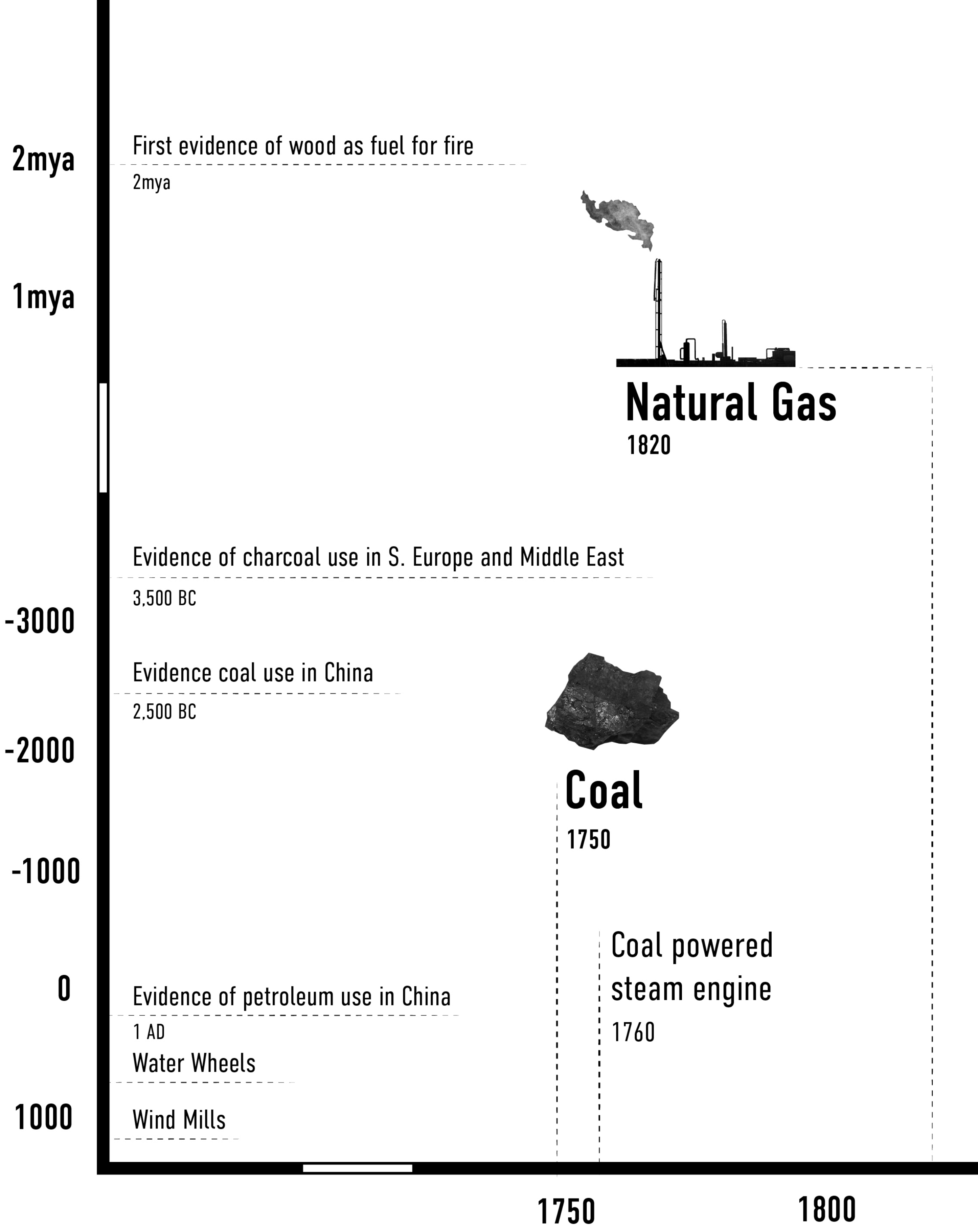
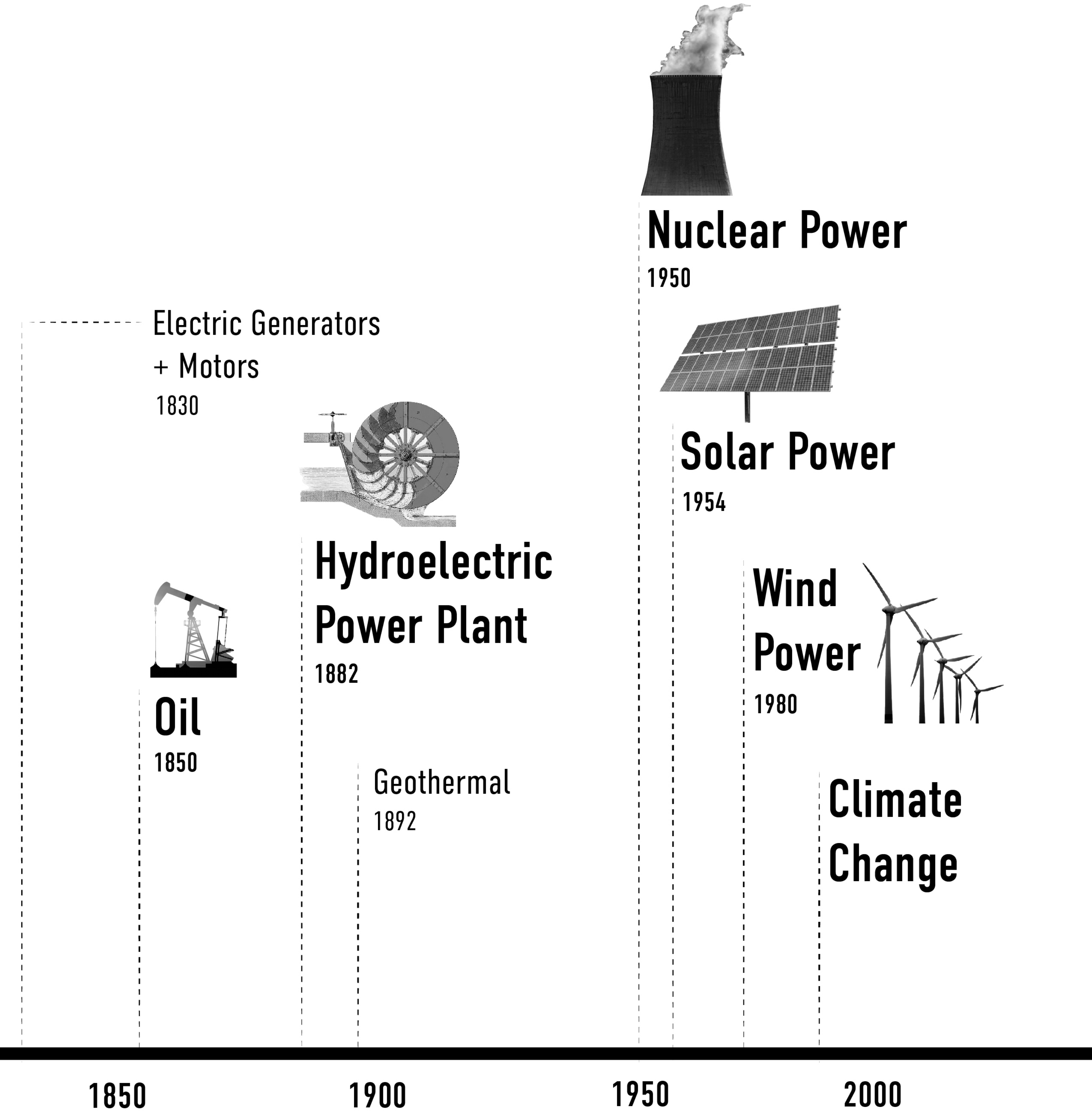

2mya
1mya
-3000
-2000
-1000
0
1000
First evidence of wood as fuel for fire
2mya
Natural Gas
1820
Evidence of charcoal use in S. Europe and Middle East
3,500 BC
Evidence coal use in China
2,500 BC
Coal
1750
Coal powered steam engine
1760
Evidence of petroleum use in China
1 AD
Water Wheels
Wind Mills
1750
1800

Figure 06.


Electric Generators
+ Motors
1830
Oil
1850
Hydroelectric
Power Plant
1882
Geothermal
1892
Nuclear Power
1950
Solar Power
1954
Wind
Power
1980
Climate
Change
1850
1900
1950
2000

A Project, Situated in Time:

Energy + Architecture

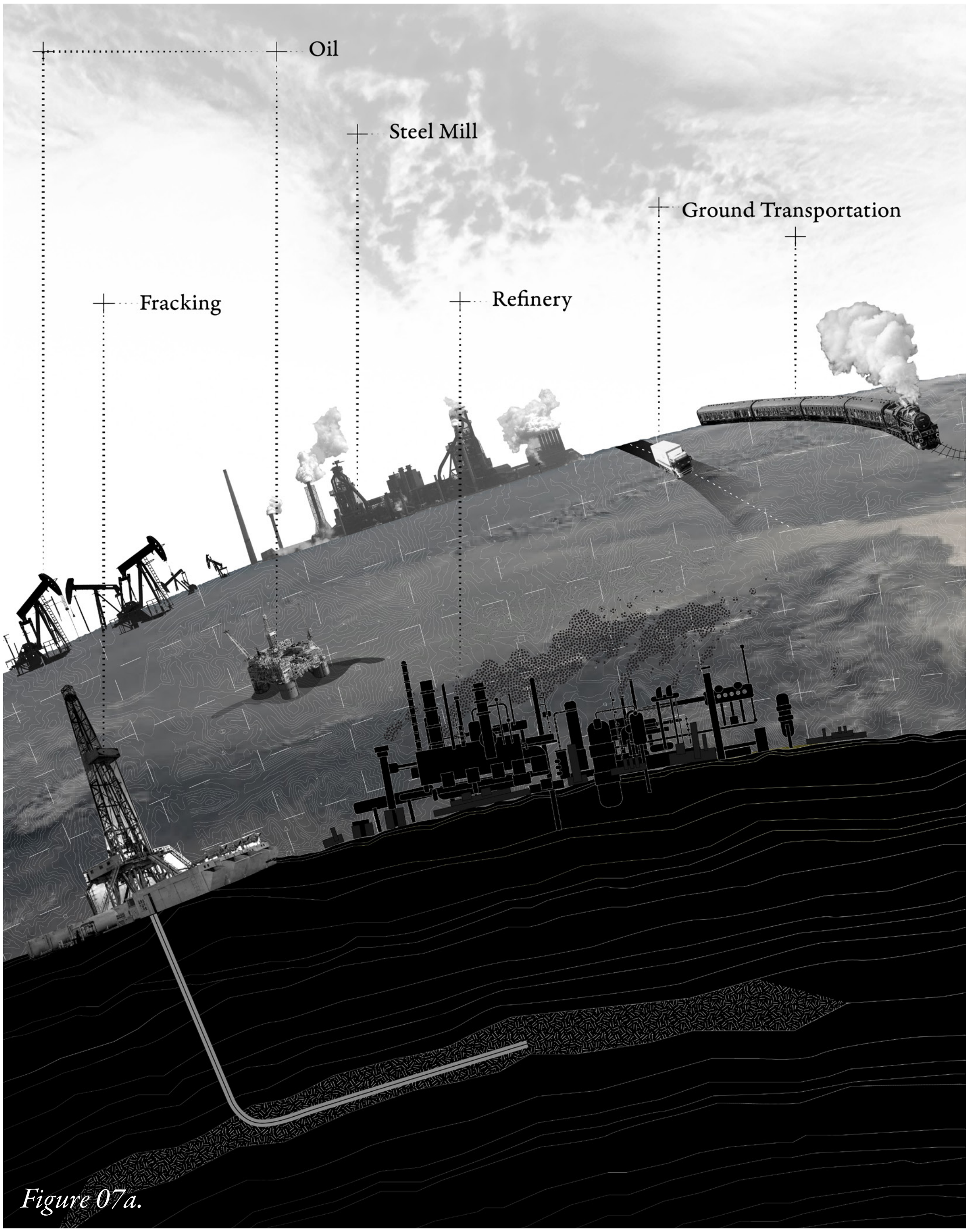


Figure 07a.

A Project, Situated in Time:

Energy + Architecture

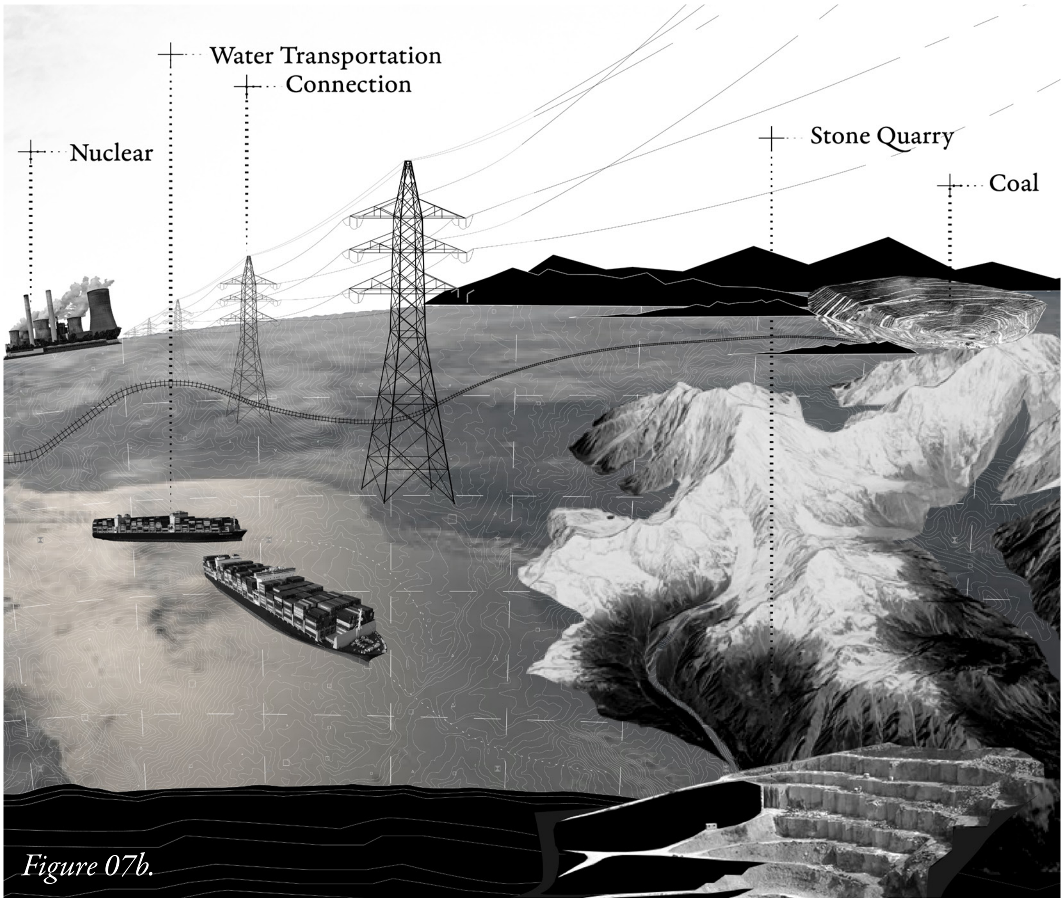


Figure 07b.

When human transportation was dominated by foot travel, the movement of geologic matter was limited due to the weight and mass of geologic conquests. Before railways and canals, the stone that was used to build architecture was either transported by nearby water or locally available. Once other methods of movement were made possible, geologic resources were sourced from much greater distances, enabling the perpetuation of energy intensive global sourcing we see today. Present building practices are responsible for over one third of global carbon emissions and are excessively wasteful. These emissions are linked to the embodied carbon of building materials via extraction, processing, and transportation. We extract to the point of depletion, process beyond the point of recognition, and transport redundantly around the globe, each phase accruing waste. The industry and its modernist desires is focused on cost, ease, and urgency.

Gravitational Energy Storage:

Pumped Hydropower

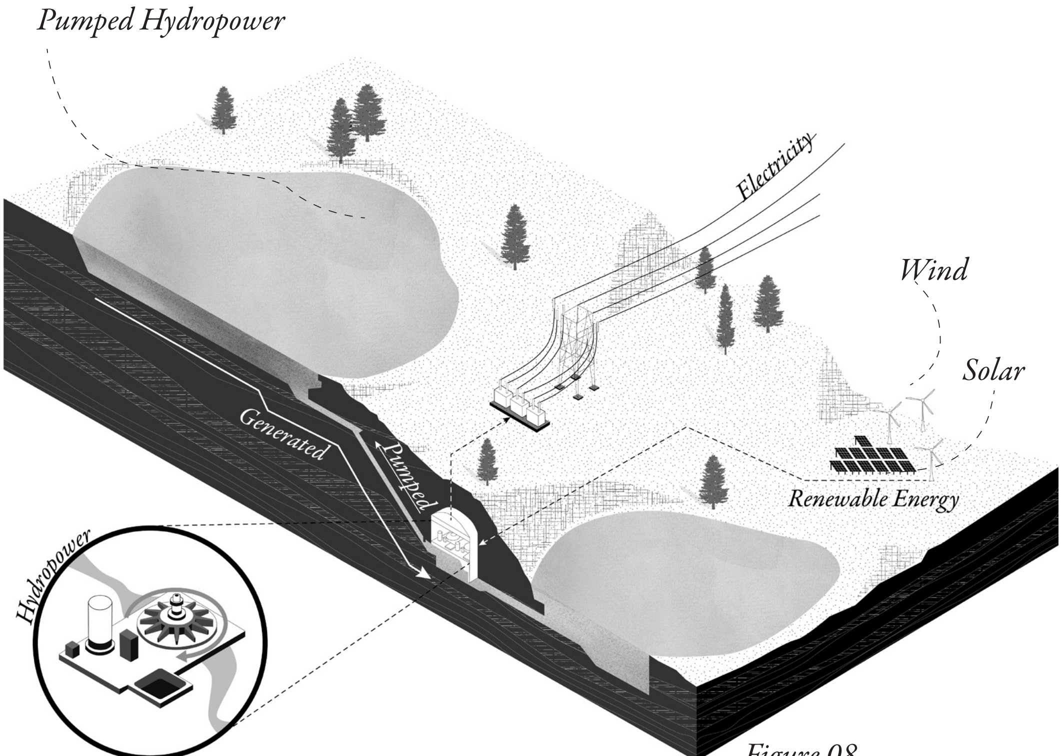


Figure 08.

Currently, renewable energies are coming into wider use. They are capable of supporting energy needs but they are limited by their intermittency due to the natural fluctuations of planetary patterns. The sun only shines during the day, winds shift, and water currents switch. The unpredictability of natural forces has required the development of energy storage strategies—large scale batteries that can be charged when energy is available.

Pumped Hydropower, which accounts for 95% of all energy storage in the United States, pumps water from lower elevation reservoirs up to higher elevation reservoirs when renewable energy is cheap and in excess[1]. It stores that water at height until there is energy demand and then releases the water.

1 "How Pumped Storage Hydropower Works." Energy.gov. Accessed January 4, 2023. https://www.energy.gov/eere/water/how-pumped-storage-hydropower-works.

Gravitational Energy Storage:

Switzerland's Energy Vault

Figure 09. Energy Vault®

The Swiss Energy Vault is a recent renewable energy storage system that lifts 30-ton blocks[2]. Lifting and storing these massive blocks at high elevations, enables the mass to hold potential energy. When released, spinning a turbine as it drops, that potential energy becomes kinetic energy, generating electricity.

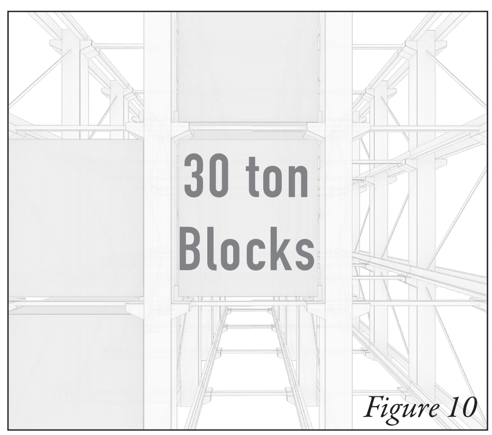
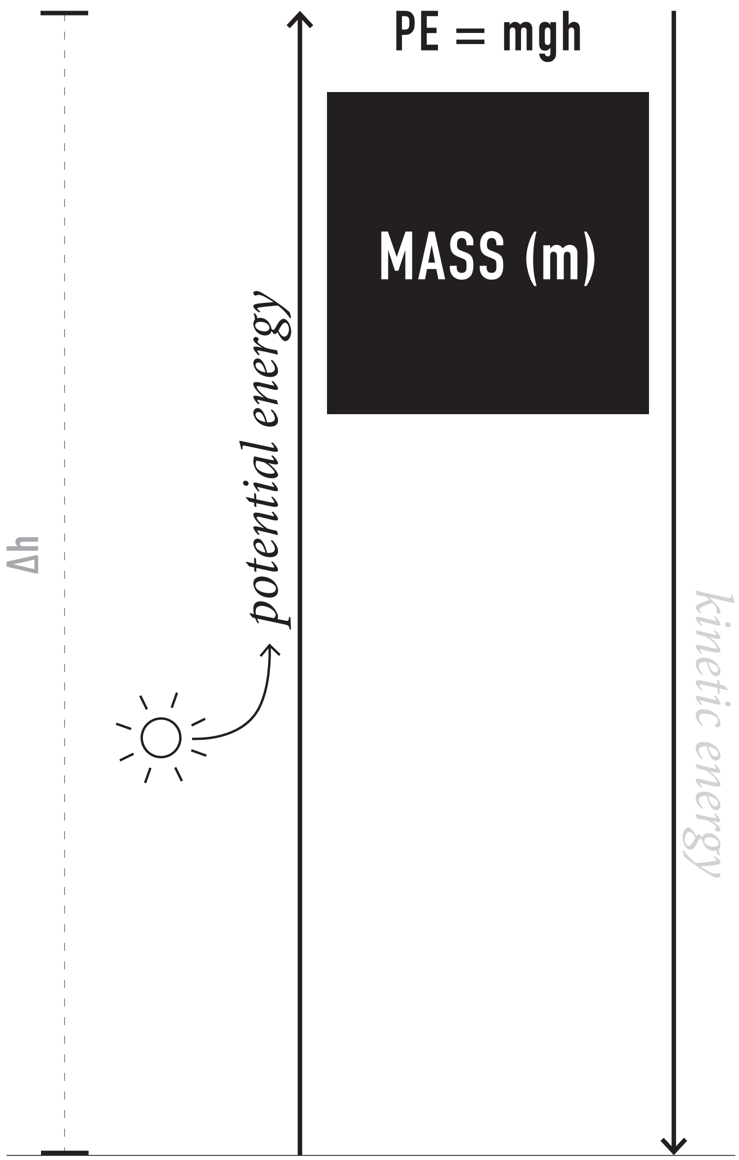


Figure 10

2 "Energy Vault ." Energy Vault - Enabling a Renewable World™. Accessed January 4, 2023. https://www.energyvault.com/.

Gravitational Energy Storage:

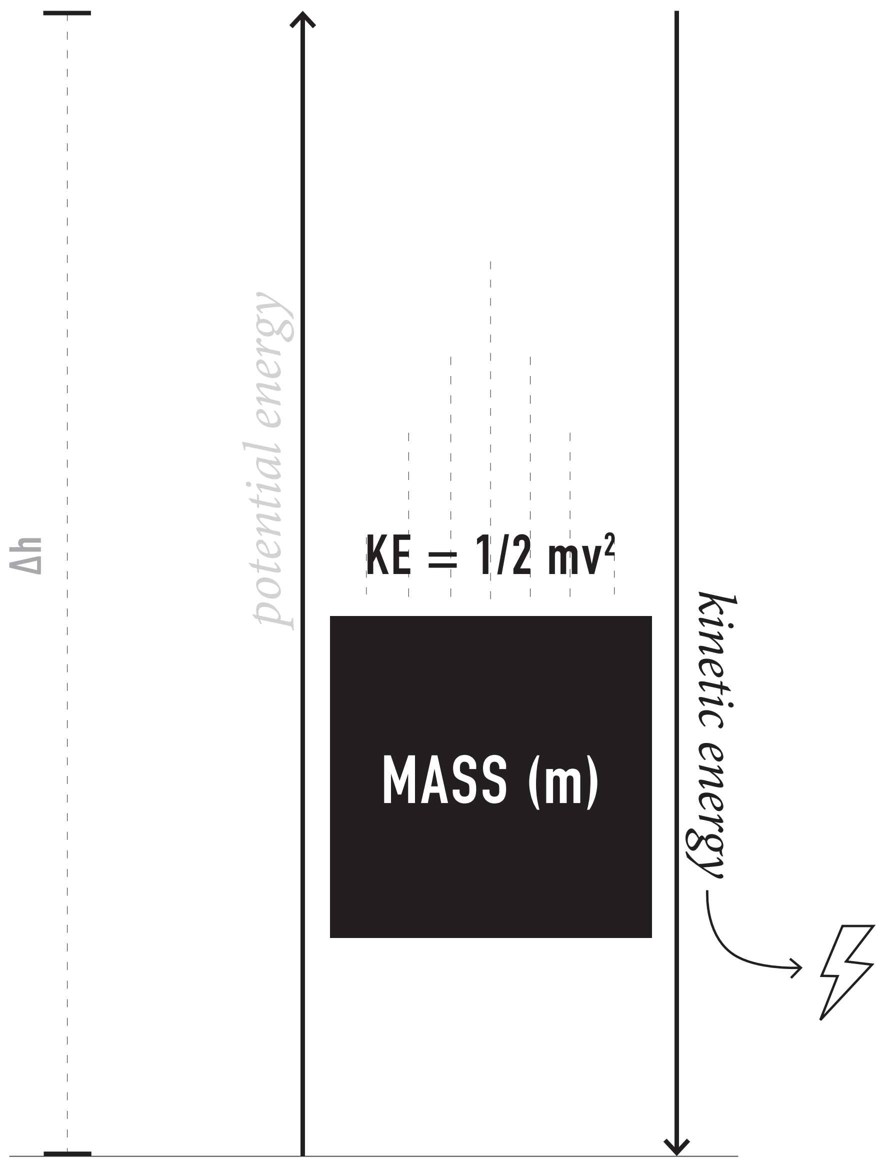
Potential Energy



(PE) = Mass (m) x Gravity 9.81 m/s² (g) x Height (h)

Gravitational Energy Storage:

Kinetic Energy



(KE) = 1/2 Mass (m) x Velocity² (v)

Gravitational Energy Storage:
Trade-offs + Efficiencies

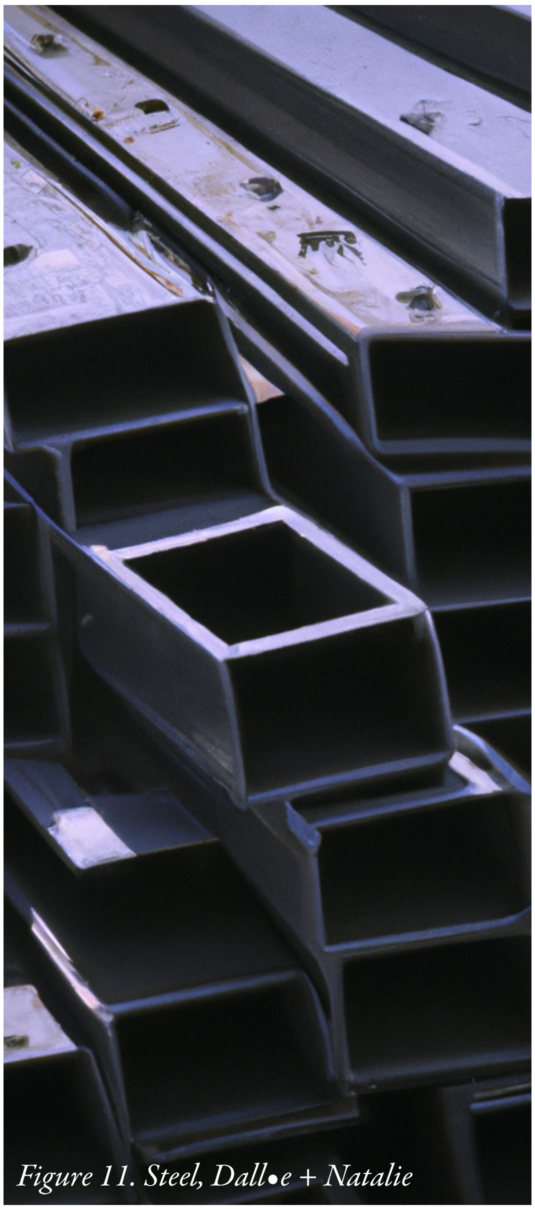
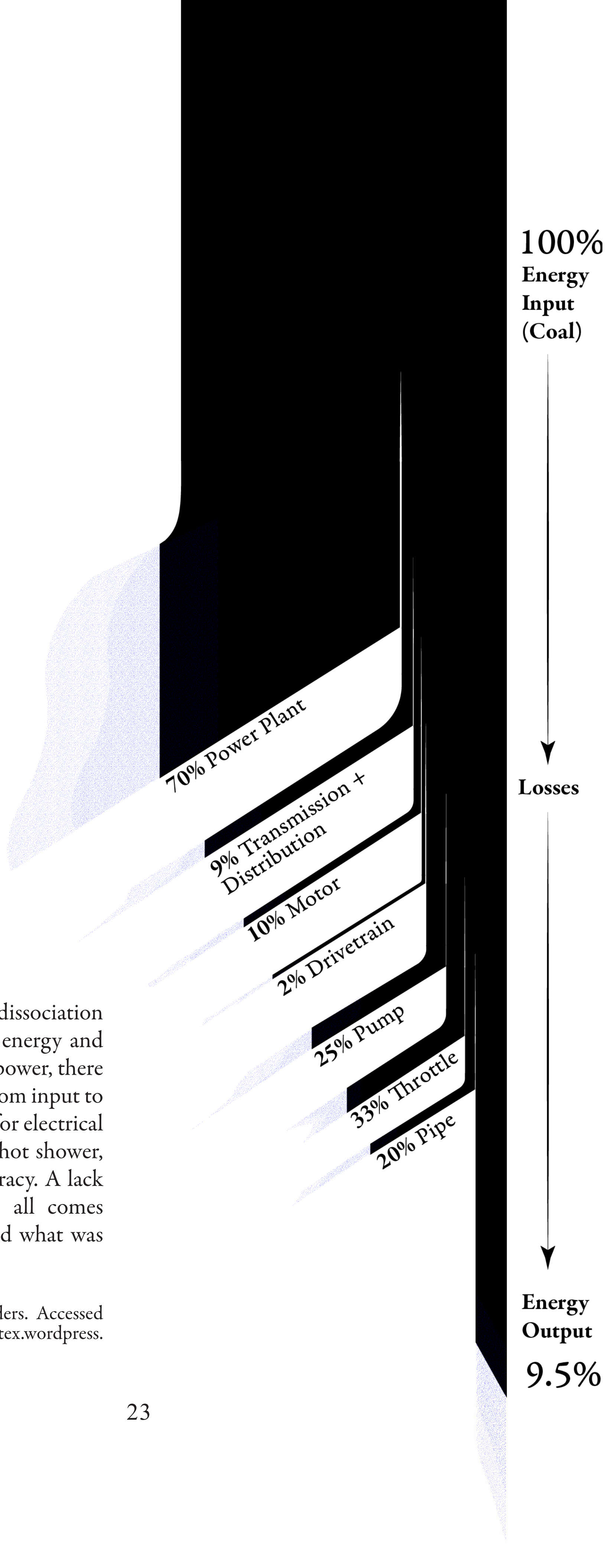


Figure 11. Steel, Dall•e + Natalie

While each of these demonstrate Gravitational Energy Storage, each comes at a cost. In the case of hydropower, vast expanses of land are flooded, excessive groundwater management is needed, ecosystems are displaced, and vegetation is drowned and decomposed, releasing carbon dioxide.

The Energy Vault, as a high-tech structure, demands a very high investment of embodied material and operational energy in an extractive cycle. While the use of height is a logical approach to gravitational energy storage, the energy vault lacks a fundamental relationship with the landscape as a dynamic field of geological process.



Currently, there is a large dissociation between the production of energy and its usage. In the case of coal power, there is nearly a 90% energy loss from input to output.[3] As we flip a switch for electrical light and turn a knob for a hot shower, there is a lack of energy literacy. A lack of understanding where it all comes from, how it got to you, and what was lost along the way.

3 "Energy Loss." GreenTex Builders. Accessed January 4, 2023. https://greentex.wordpress.com/tag/energy-loss/.

Figure 12

Forces of Nature:
Episodic, Dispersed, and Unpredictable

One begins to wonder if there is a way to bridge the gap between source and use, and in so doing, imagine or re-imagine new cultures of energy use and new forms of energy literacy. What would it mean to be able to tie architecture at the scale of landscape to quantities of energy? This would require a conceptual and cultural shift away from energy immediacy and consistency towards fluctuation and earthly timetables.

The forces of nature in a multitude of different global climates act on different timescales, gathering and releasing energy, and in doing so, influencing matter and mass on the surface of the earth. These forces are the actors in this thesis, and the change they impose on their surroundings influences the approach to material resources and the design of energy storage.

The modern economic perspective understands these events as disasters, but they are key aspects of planetary patterns. These events are inevitable, we must embrace them and live reciprocally with them.

"We must learn how to love our monsters."[4]

– Bruno Latour

4 Shellenberger, Michael, and Ted Nordhaus. Love Your Monsters: Postenvironmentalism and the Anthropocene. United States: Breakthrough Institute, 2011.

Forces of Nature:

Episodic, Dispersed, and Unpredictable


Figure 13. Avalanche, Dall•e + Natalie

Episodic

Diurnal

Some actors are episodic and diurnal, experienced each day.

Dispersed

Annual

Some actors are dispersed, emerging on a relatively predictable annual timetable. Their activation relying on climactic conditions.

Unpredictable

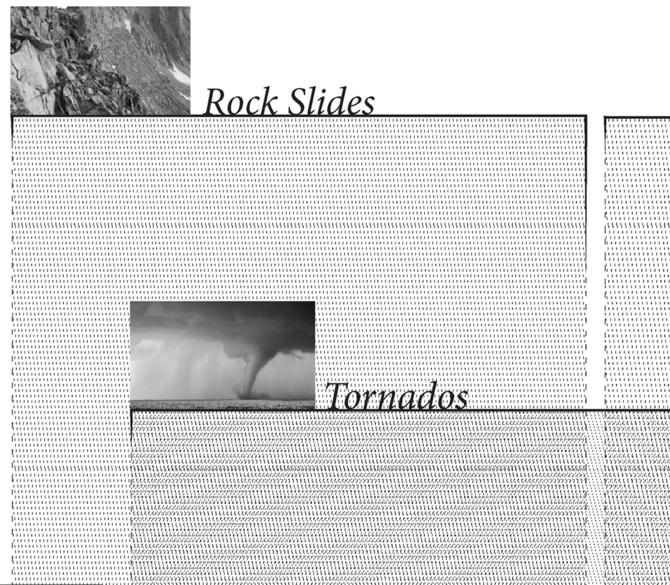
Geological

Some actors are sporadic and utterly unpredictable.

Forces of Nature:

Episodic, Dispersed, and Unpredictable

This thesis maps these earthly forces with time, to begin to see their energetic potentials. Some actors slip into dormancy as others awaken with fury. Engaging with each has the potential to provide energy frequently - yet periodically. While working across different geographies, varied episodic timelines could allow for the collaging of different energies sources for relative reliability.



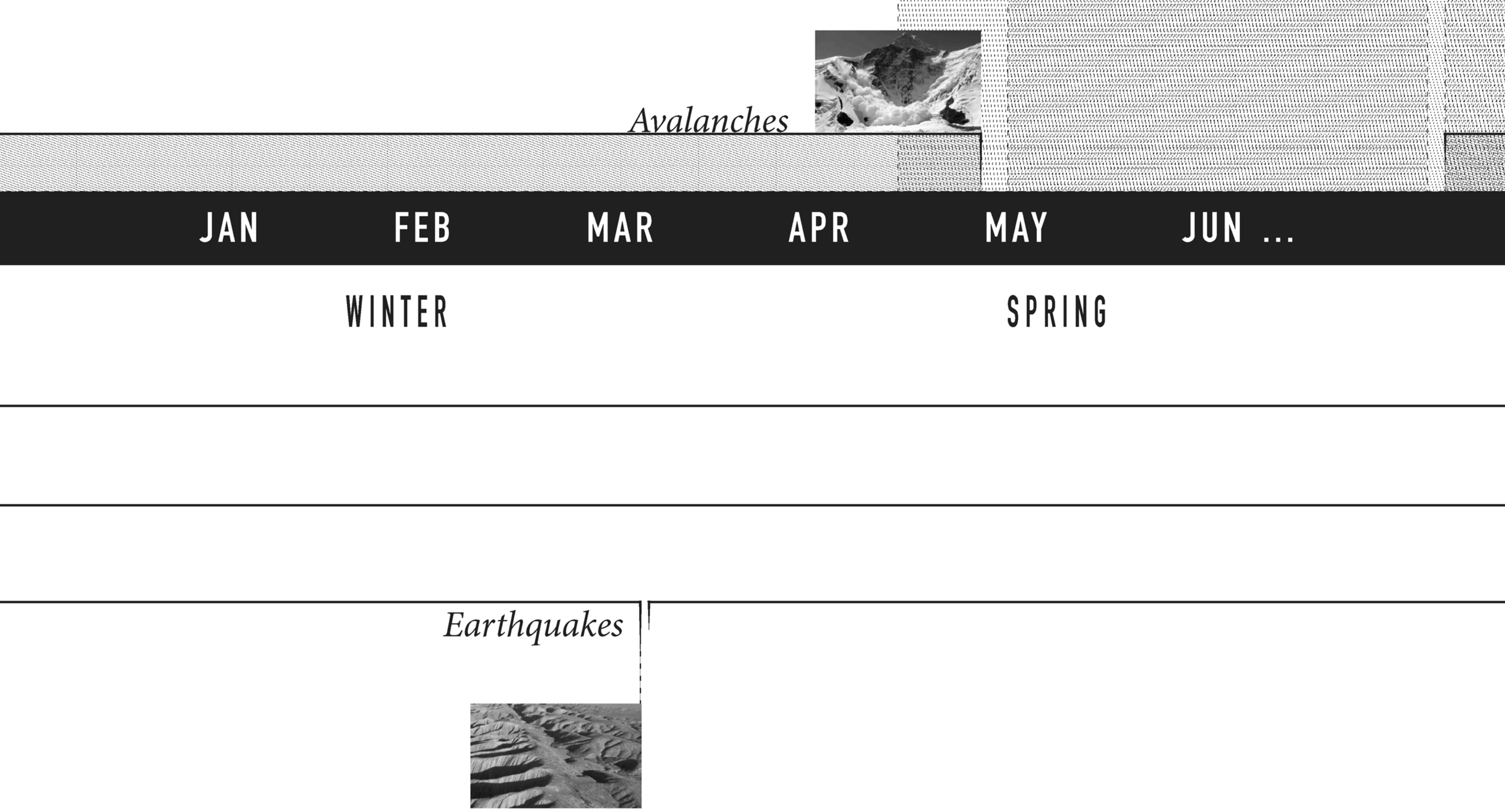
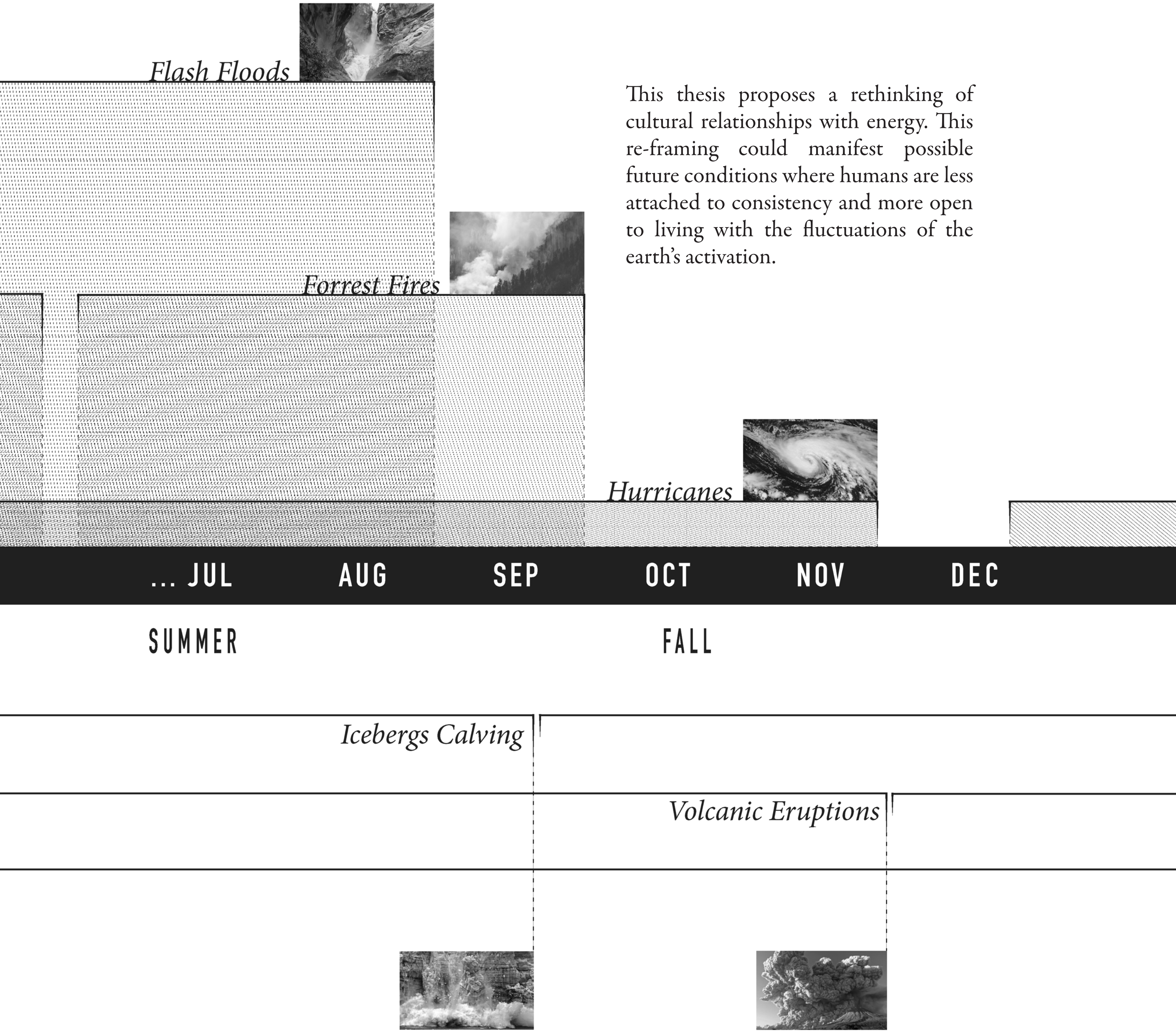


Figure 14.

This thesis proposes a rethinking of cultural relationships with energy. This re-framing could manifest possible future conditions where humans are less attached to consistency and more open to living with the fluctuations of the earth's activation.



Orders of Magnitude:

Volcanoes

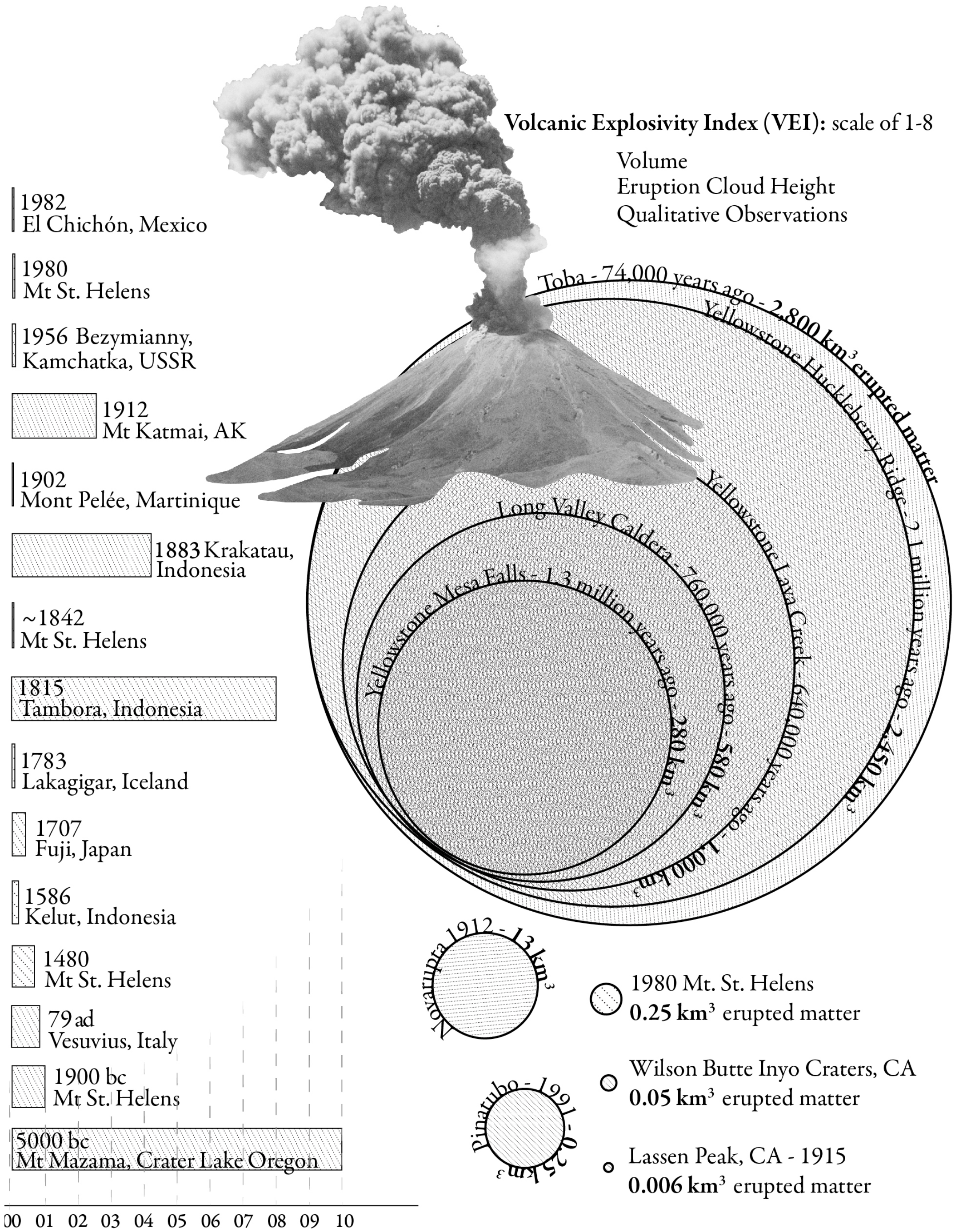


Figure 15. Volcanoes of History

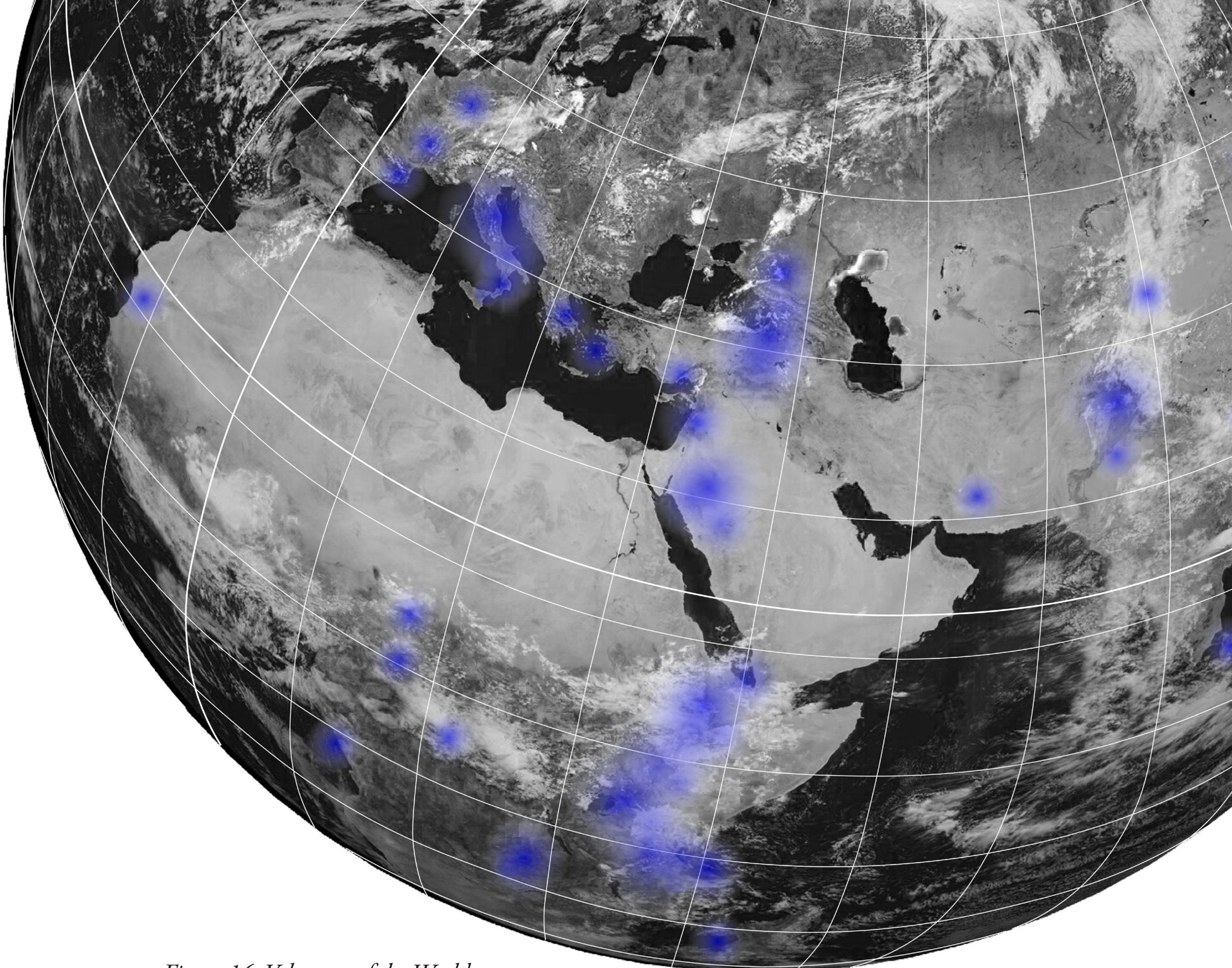


Figure 16. Volcanoes of the World

Energy sourcing and usage may by necessity become more localized. Moving toward decentralization, different geographies will work with regional forces, decreasing distance and energy loss between source and use. Looking across the globe, there are an immense array of processes and forces at play, each unique to its landscape.

By looking at the potential energy of unique, forces, such as volcanoes, avalanches, and floods and comparing that energy output with the global distribution of those force events, this thesis has begun to investigate the magnitude of energetic potential these forces have on a global scale.[5] For example, there are 1,350 active volcanoes[6] on land and one can imagine the magnitude of magma that can be expected in the future based on past eruptions.

5 "Volcanic Explosivity Index." National Parks Service. U.S. Department of the Interior. Accessed January 4, 2023. https://www.nps.gov/subjects/volcanoes

6 "How Many Active Volcanoes Are There on Earth?" U.S. Geological Survey. Accessed January 4, 2023. https://www.usgs.gov/faqs/

Orders of Magnitude:

Avalanches

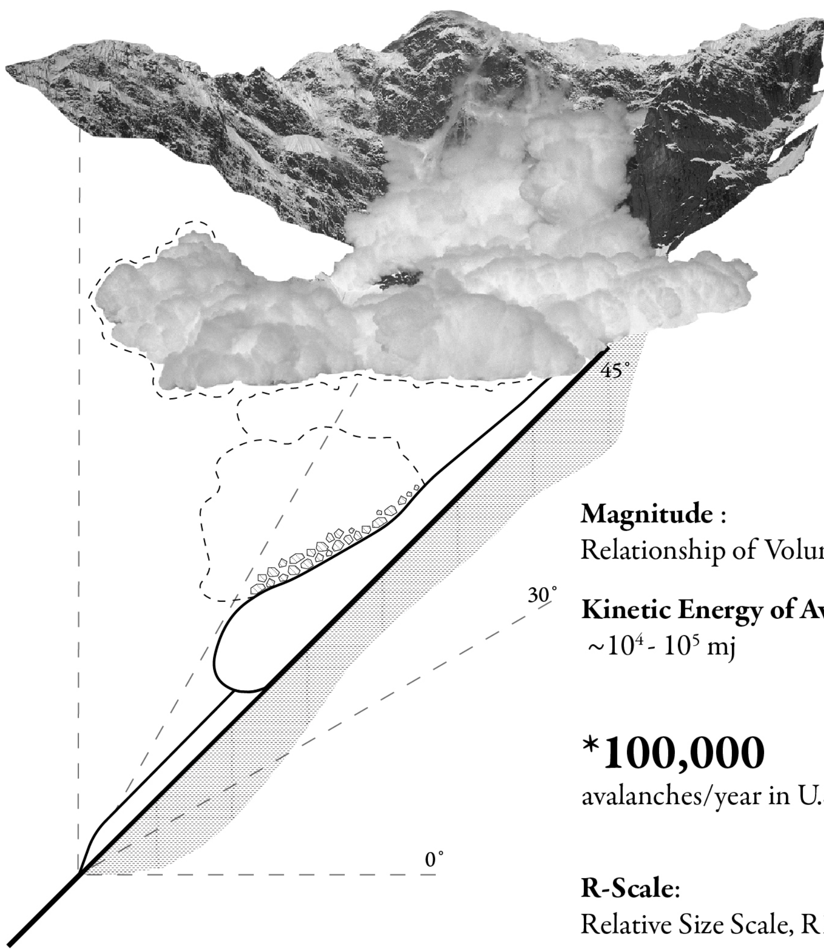


Figure 17. Avalanches

Magnitude :
Relationship of Volume to Path

Kinetic Energy of Avalanches:
~10^4 - 10^5 mj

***100,000**
avalanches/year in U.S.A.[7]

R-Scale:
Relative Size Scale, R1 - R5

An estimate of the size, based on volume, of an avalanche relative to its path.

D-Scale:
Destructive Size Scale, D1 - D5

An assessment of the destructive potential of an avalanche.

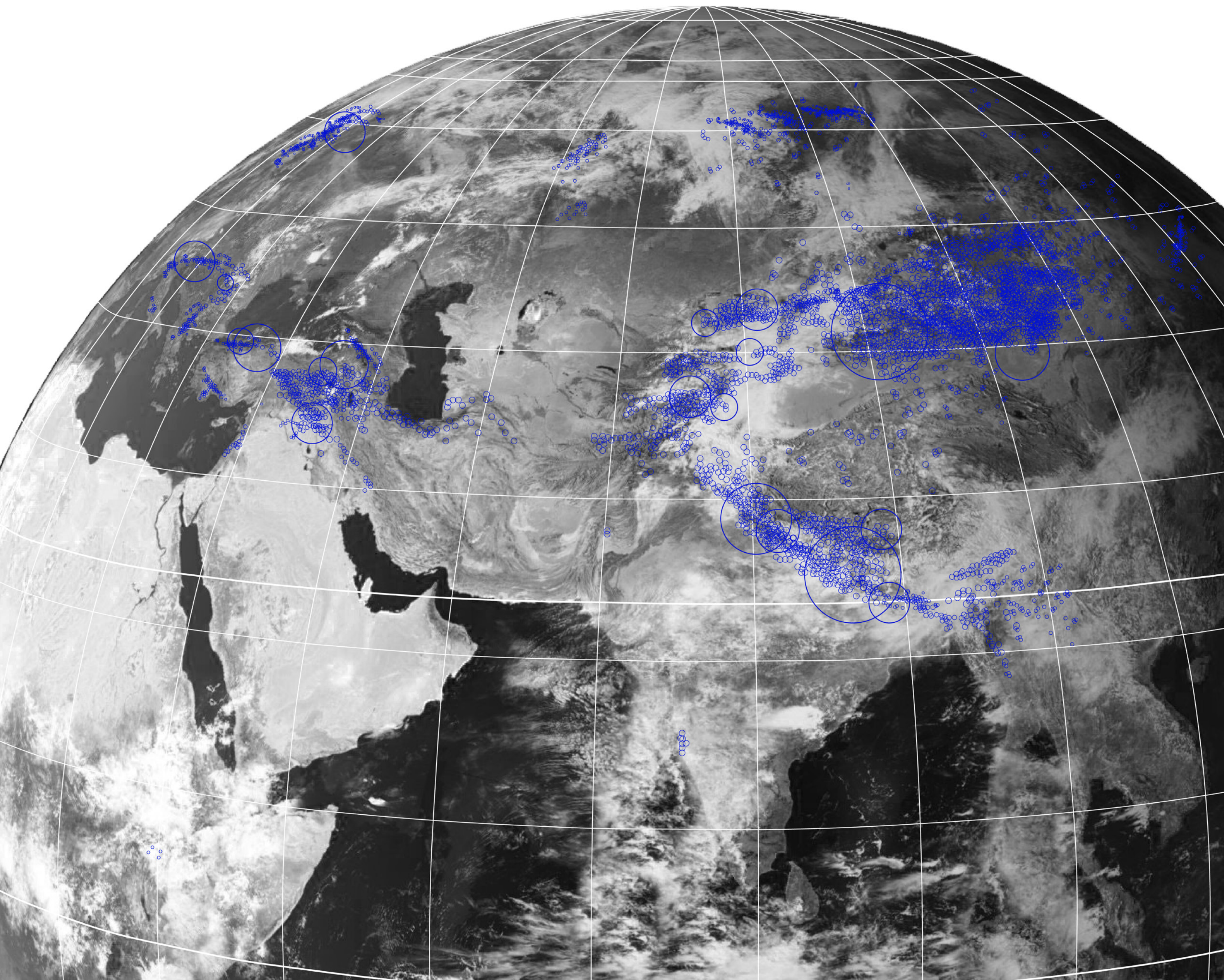
Orders of Magnitude:

Avalanches

In the case of avalanches, or crystallized water, there are global expanses of mountains with slopes greater than of 30° accumulating snow during winter months, indicating significant potentials on a planetary scale for avalanche energy collection.

7 Avitt, Andrew. "When Snow Becomes Deadly: How to Survive an Avalanche." USDA. USDA Forrest Service, June 16, 2021. https://www.usda.gov

Figure 18. Avalanches of the World

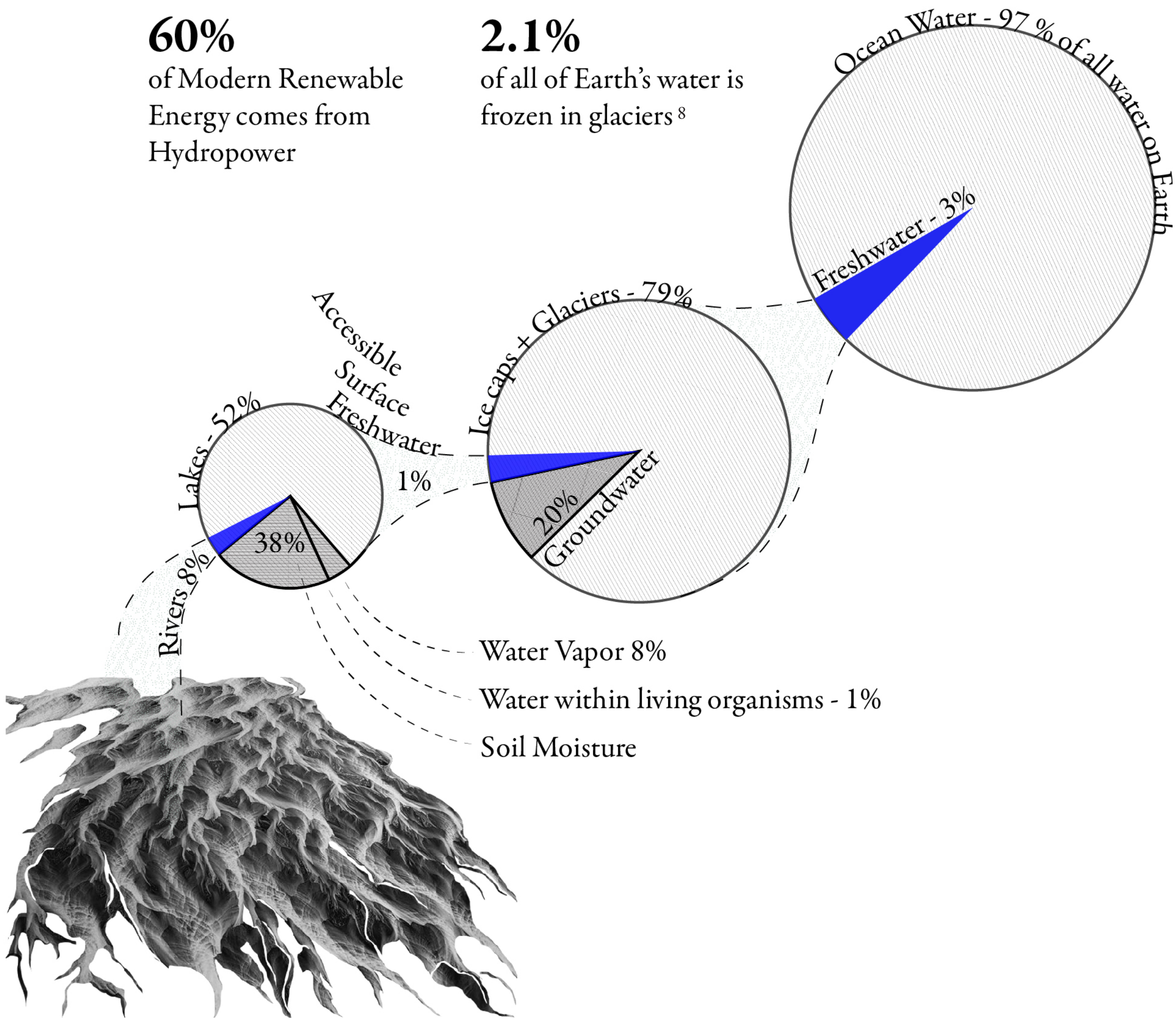


Orders of Magnitude:

Water

60%
of Modern Renewable Energy comes from Hydropower

2.1%
of all of Earth's water is frozen in glaciers [8]



Flow Rate = Velocity (m/s) * Width * Depth

Kinetic Energy of Water (J) = 1/2 * Volume (m^3) * Density (kg/m^3) * Velocity^2 (m/s)
Power Harnessed (W) = 1/2 * Density (kg/m^3) * Cross Section (m^2) * Velocity^3 (m/s)

Potential Energy of Water (J) = Volume (m^3) * Density (kg/m^3) * Gravity (m/s^2) * Height (m)
Power Harnessed (W) = Density (kg/m^3) * Flow Rate (m^3/s) Gravity (m/s^2) * Height (m)

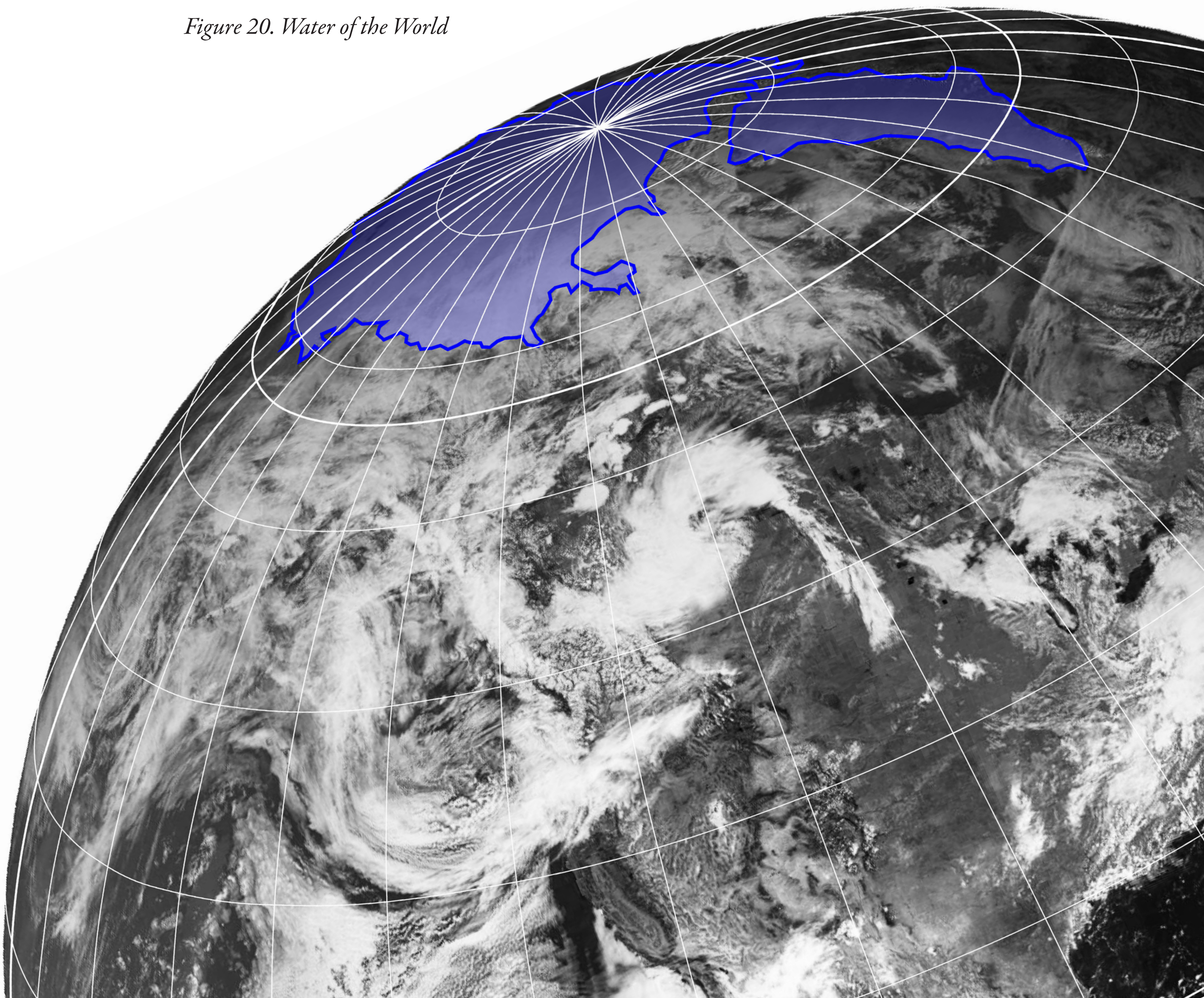
Figure 19. Water

Orders of Magnitude:

Water

Currently, roughly 60% of modern renewable energy is produced by water.[9] While only 8% of the world's accessible freshwater is available in our rivers, as glaciers begin to melt there, will be more fluid potential as about 2% of all Earth's water is frozen in glaciers.

Figure 20. Water of the World

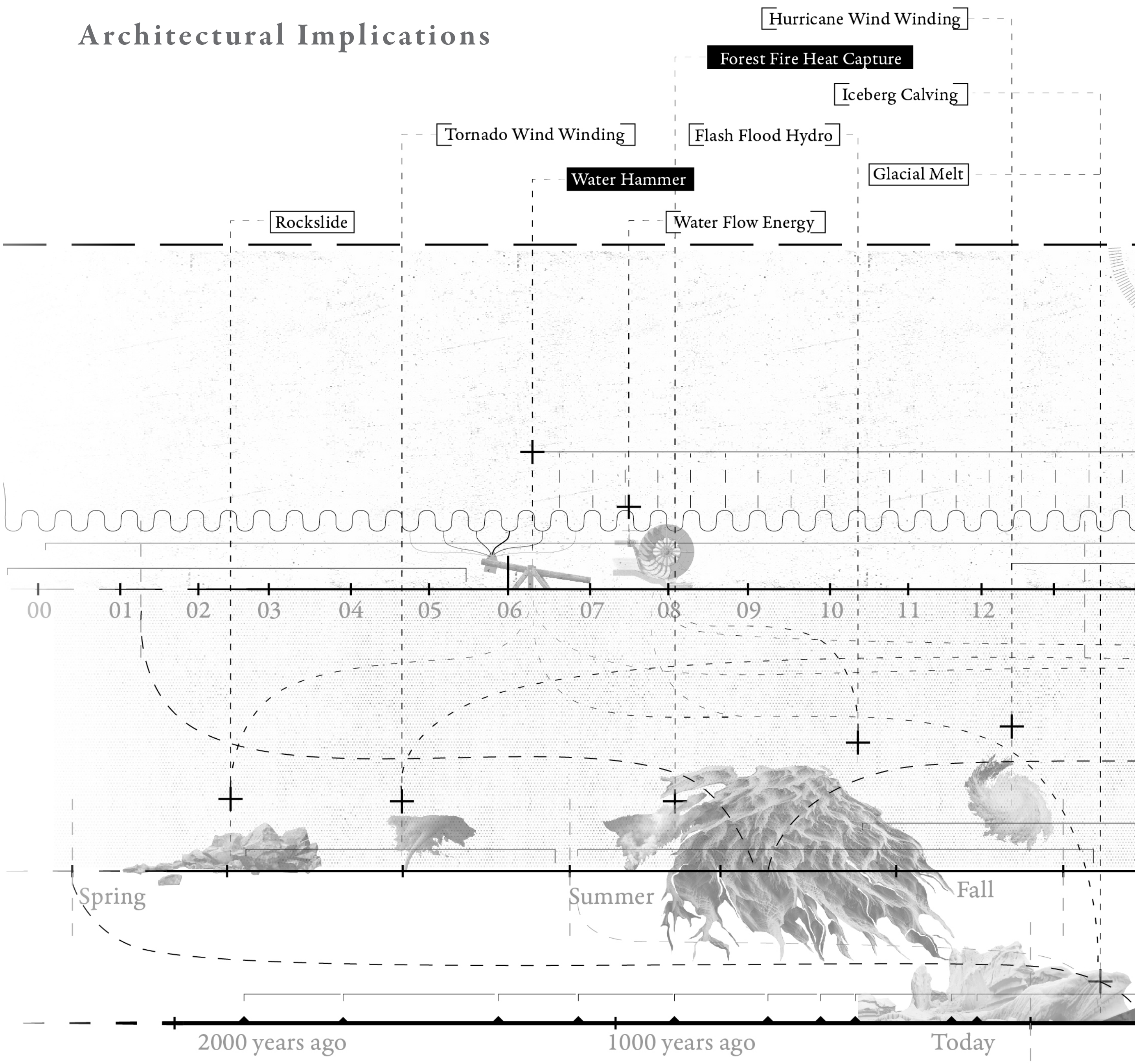


8 "Where Is Earth's Water?"U.S. Geological Survey. Water Science School. Accessed January 4, 2023. https://www.usgs.gov

9 Ritchie, Hannah, Max Roser, and Pablo Rosado. "Renewable Energy." Our World in Data. Global Change Data Lab, October 27, 2022. https://ourworldindata.org/renewable-energy.

Time:

Architectural Implications



Each force, and interaction can support architecture. Three possible strategies that this methodology support are becoming, producing, and charging.

Becoming - where geologic processes of erosion release material that can be used for architectural purposes in the proposed program of a gravitational energy storage structure.

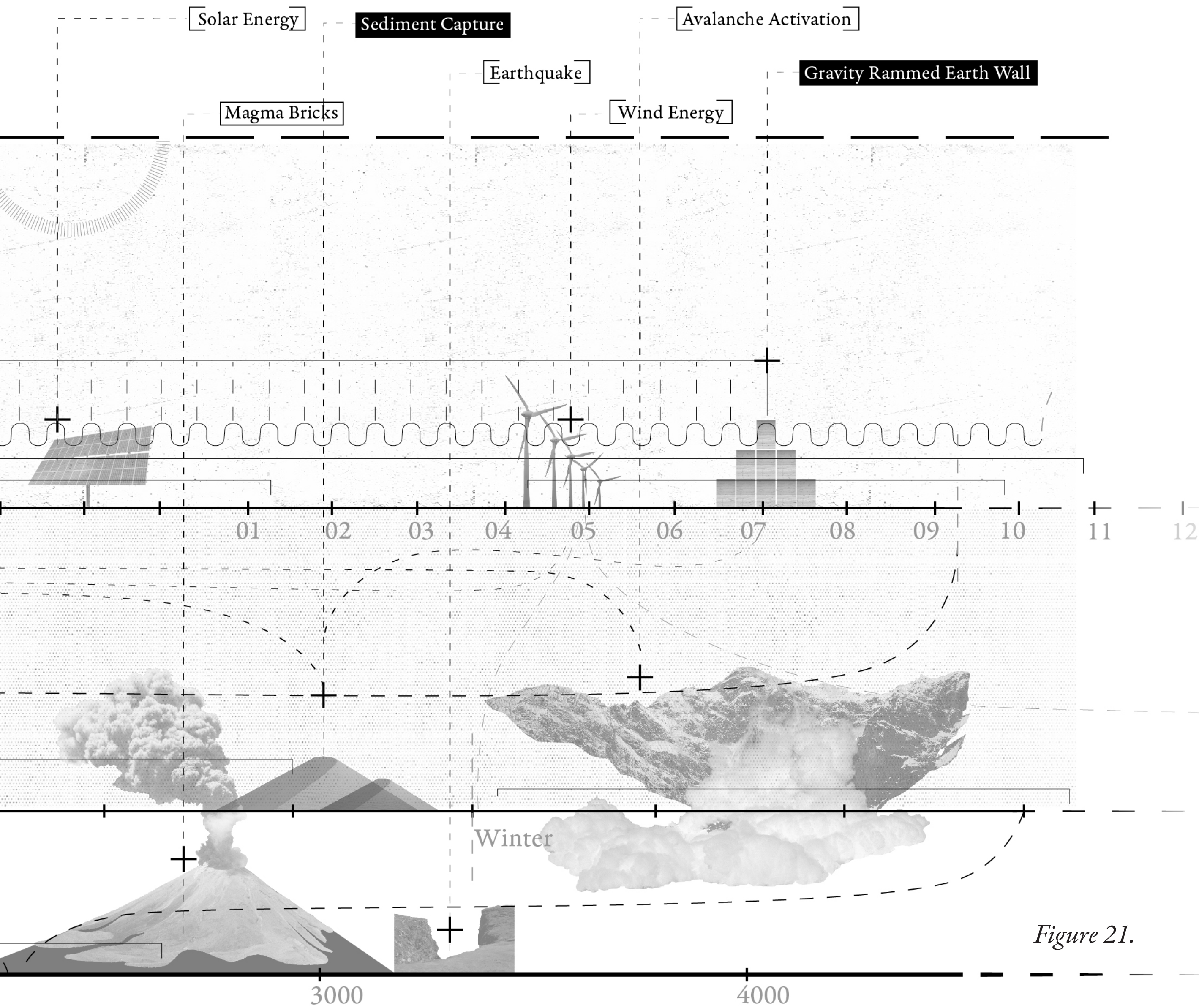


Figure 21.

Producing - where the repeated motions of lifting and lowering in energy use and generation either demonstrate geologic weathering or produce architectural elements, such as rammed earth building blocks.

Charging - where the natural or embodied energy of geologic processes provide the energetic force that enables charging of the architectural batteries.

Time:

Architectural Implications

This thesis imagines a world where architectural planning is modified with the timelines of forces. For example, river flow can trigger a water hammer every 60 seconds, producing one rammed earth block per day. We can expect elevation gain for gravitation energy storage enabled by an avalanche each winter. But we may have to be patient awaiting the volcanic eruption that will provide 20,000 cast blocks for building.

Figure 22.

A Landscape Approach:

Water

Figure 23: Shaun Hunter, outdoorproject.com

Figure 24: Ron Young, nps.gov

Figure 25: Feng Wei, outsideonline.com

My goal in designing speculative new infrastructures for energy storage is not to harness or manage renewable energy sources, but to tap into earthly forces, working with their unpredictability, varied conditions, and range of timescales.

This thesis presents three possible projects for water: engaging floods, rock fall, and avalanches. These forces represent earthly water in three forms, turbulent, seeping, and crystalline, and each has been designed with architectural interventions to lift mass as the energy input for gravitational energy storage infrastructures.

A Landscape Approach:

Site Analysis

In approaching the design process for architectural interventions, I investigated what is known about these active force events and which landscapes support them. I identify specific conditions and operations of production where interventions could have the most impact, and designs could be integrated with the landscape rather than imposing on it.

My approach considered and worked with conditions of topography, slope angle, humidity, and precipitation.

Thinking through these dynamic conditions is an attempt at cultivating environmental sensibilities tied not only to architecture but also to the earth's environment and the way we consume and interact with energy.

Figure 26: Green River, Google Earth

Figure 27: Capitol Peak, Google Earth

Figure 28: Independence Pass, Google Earth

A Landscape Approach:

Site Analysis

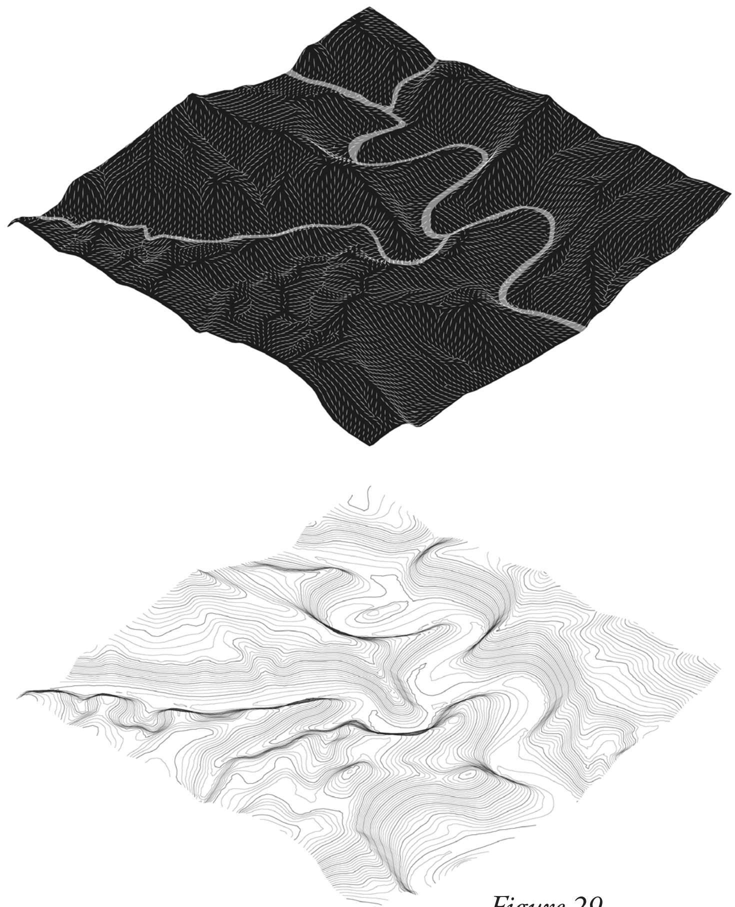


Figure 29.

Flash Floods usually occur in extremely dry climates that receive excessive rain during monsoon seasons. The dehydrated earth becomes impenetrable, only able to absorb a fraction of what is falling from the sky, and thus spilling that water across the topography where it is then channeled and flushed through crevices and cracks.

A Landscape Approach:

Site Analysis

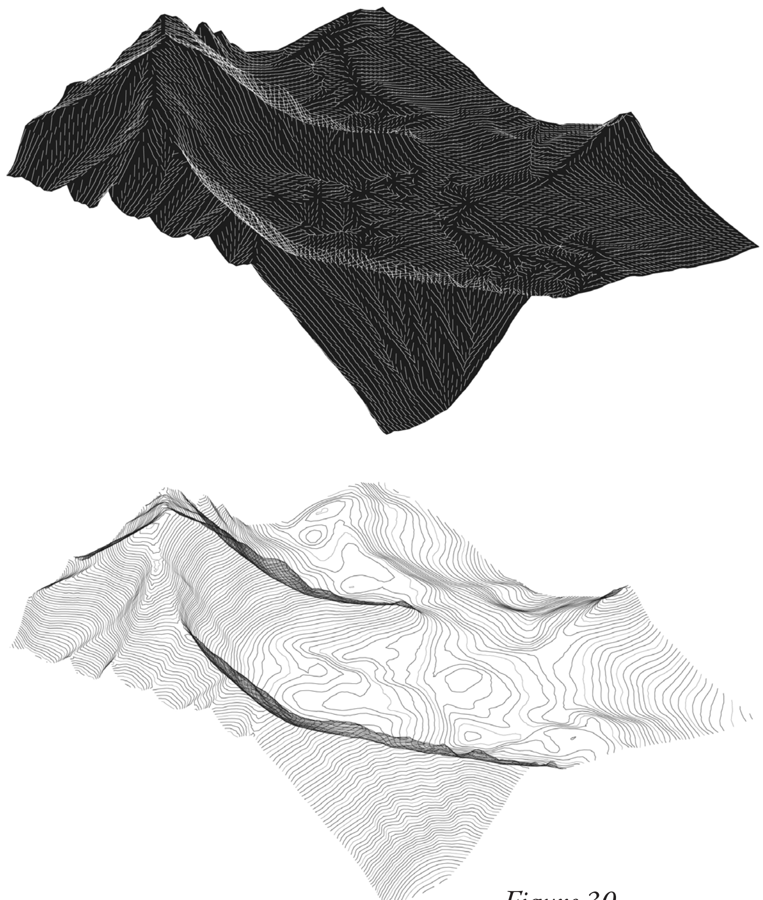


Figure 30.

Rock Fall can occur when rainwater seeps into steep terrain, loosening boulders. It can also occur over time, when very many drops of moisture seep into the cracks of stone, freezing, expanding, breaking, and loosening its mass.

A Landscape Approach:

Site Analysis

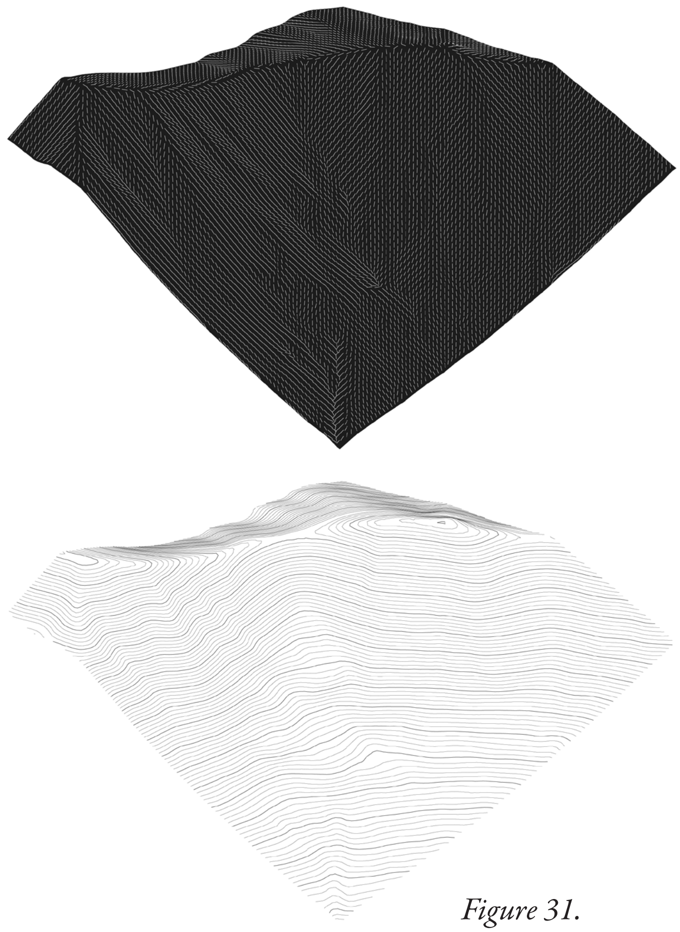


Figure 31.

Avalanches are triggered on slopes that exceed 30° and receive ample snow. Snow crystal transformations and additional snow fall over time can layer to increase or decrease the likely hood of a slide.

Physical Experimentation:

Flash Flood

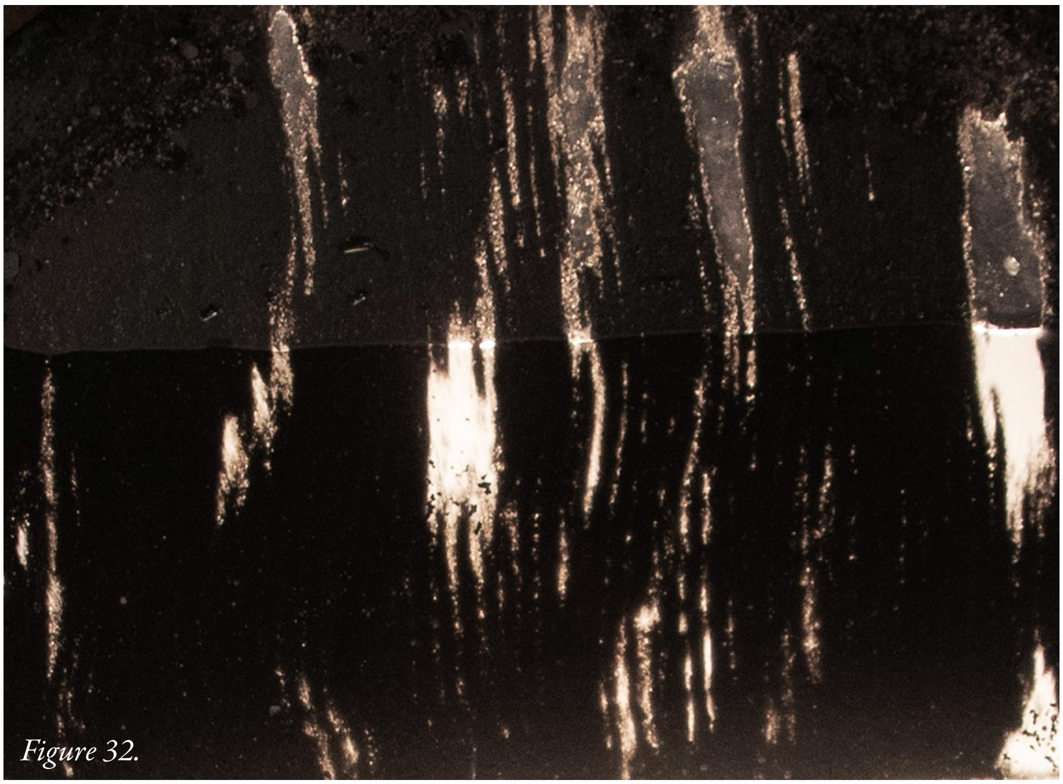


Figure 32.

Engaging such physical forces called for physical model testing that began to hint at the powerful potentials of such processes.

Physical Experimentation:

Flash Flood

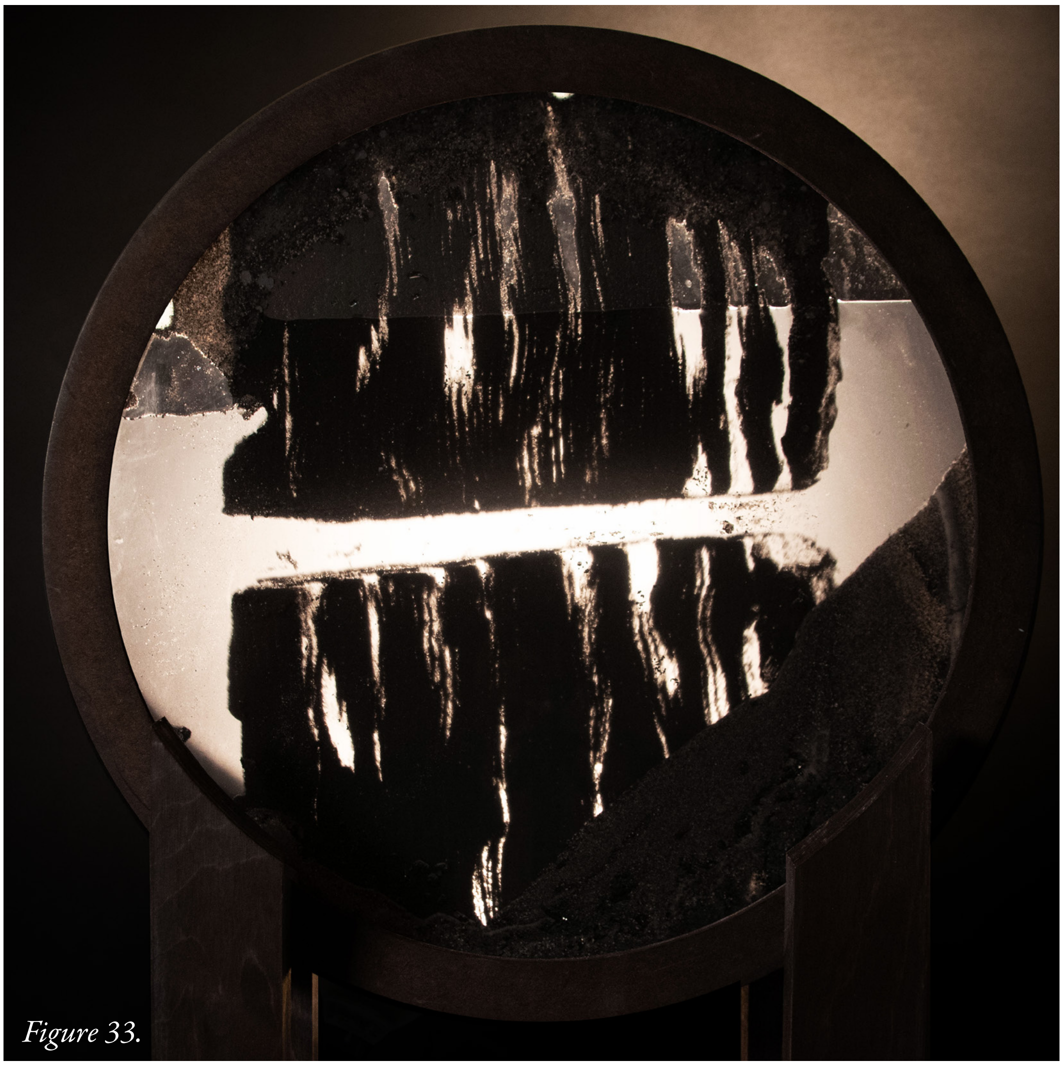


Figure 33.

Physical Experimentation:

Rockfall

Figure 34.

Taking advantage of the flow of material - whether water, stone, or snow - allowed for different mechanisms of dynamic movement to be explored, such as spin, pivot, and drag.

Physical Experimentation:
Rockfall

Figure 35.

Physical Experimentation:

Avalanche

Figure 36.

While physical experimentation is always beneficial, there is an exponential leap from human scale to landscape scale when looking at the entropic movement of mass and flows of energy.

Physical Experimentation:

Avalanche

Figure 37.

Architectural Intervention:

Designing Architectural Batteries

Figure 38.

Building on my understanding of landscape conditions and how matter is moved for each of these three natural forces, I have designed architectural interventions that will allow the forces of these events to be used as the energy input to lift mass and hold it at height as potential energy.

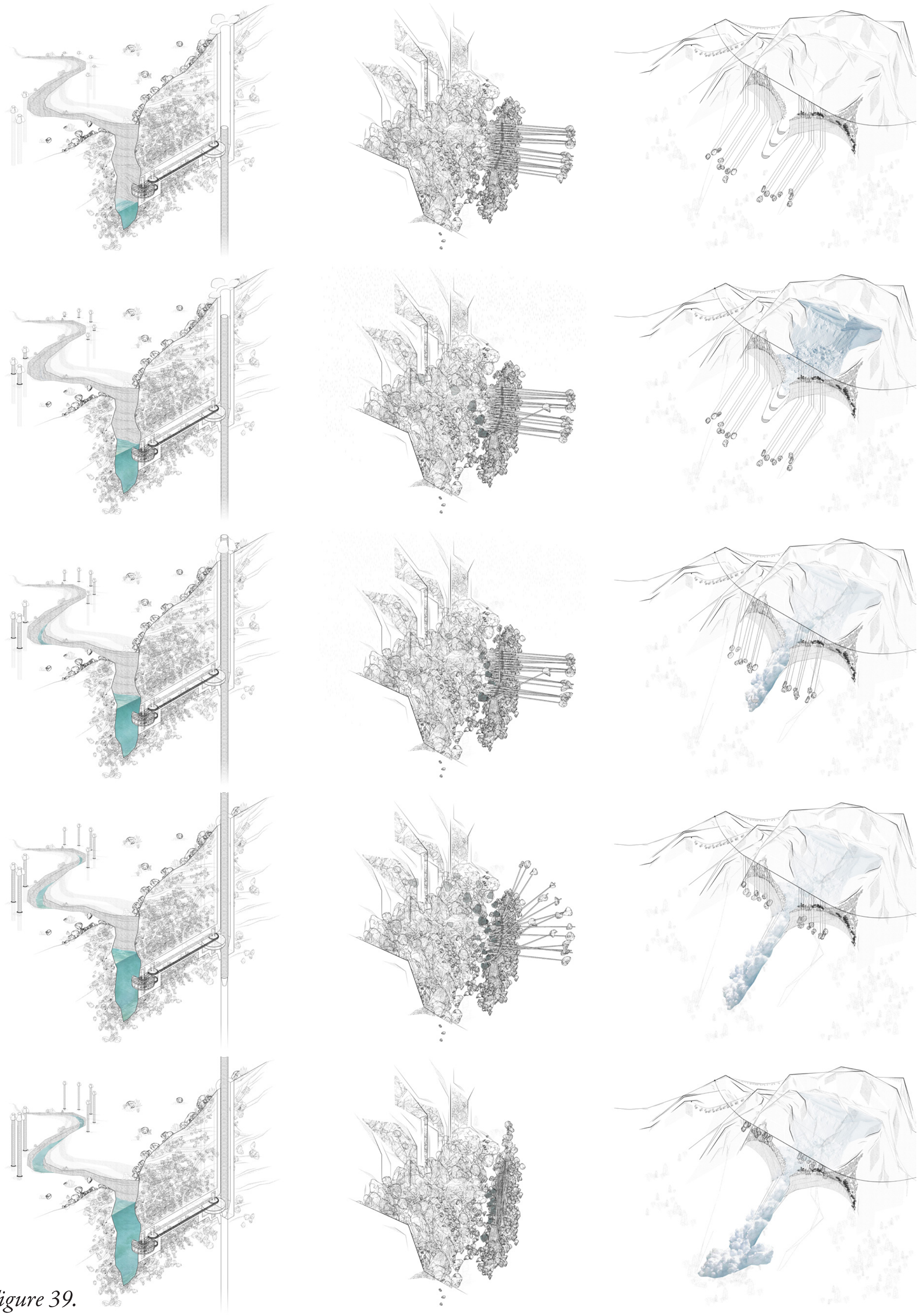


Figure 39.

Architectural Intervention:

Flash Flood

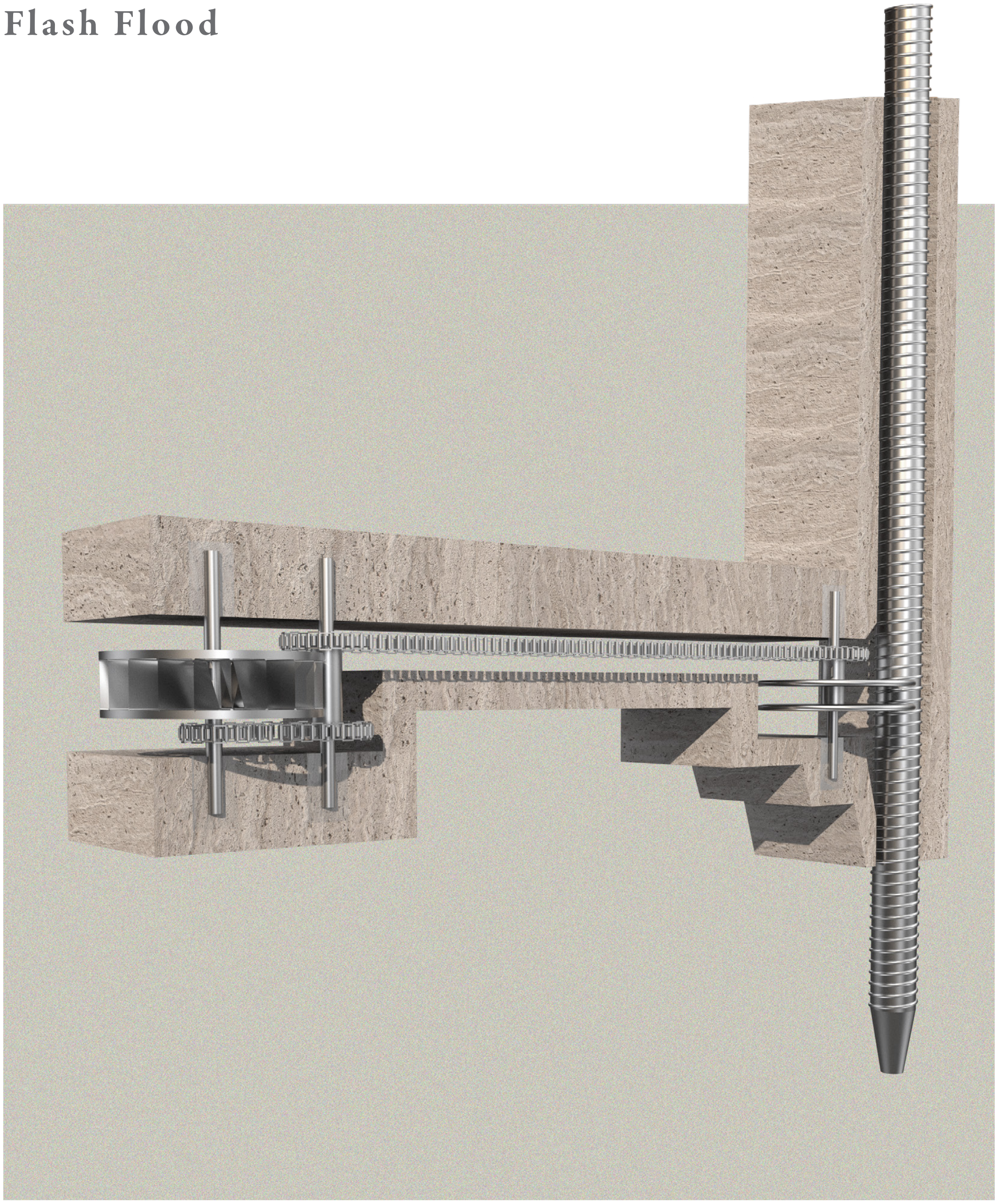


Figure 40.

Architectural Intervention:

Flash Flood

In the case of flash floods, naturally occurring river meanders and slot canyons channel water at great speeds. The velocity of water flow, which increases at the outer bends of a meander, can spin a horizontal water wheel tucked into the wall of a canyon. As this water turns, it slowly lifts a slender steel rod that has been embedded in the earth.

With each surge of water it lifts, its mass elevating until the river channel is lined with tall delicate weights waiting to descend when energy is needed.

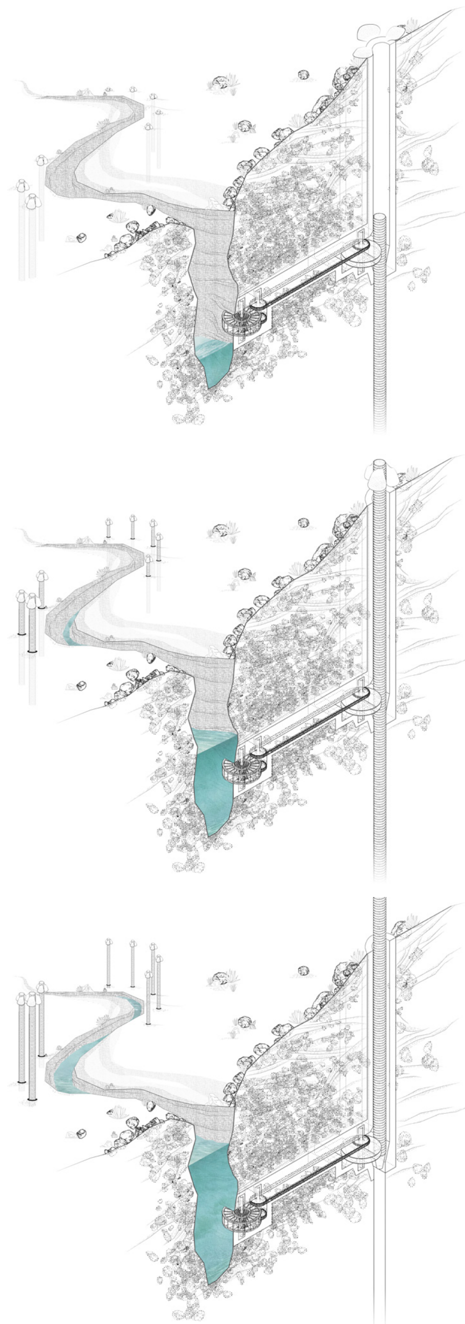


Figure 41.

Architectural Intervention:

Rockfall

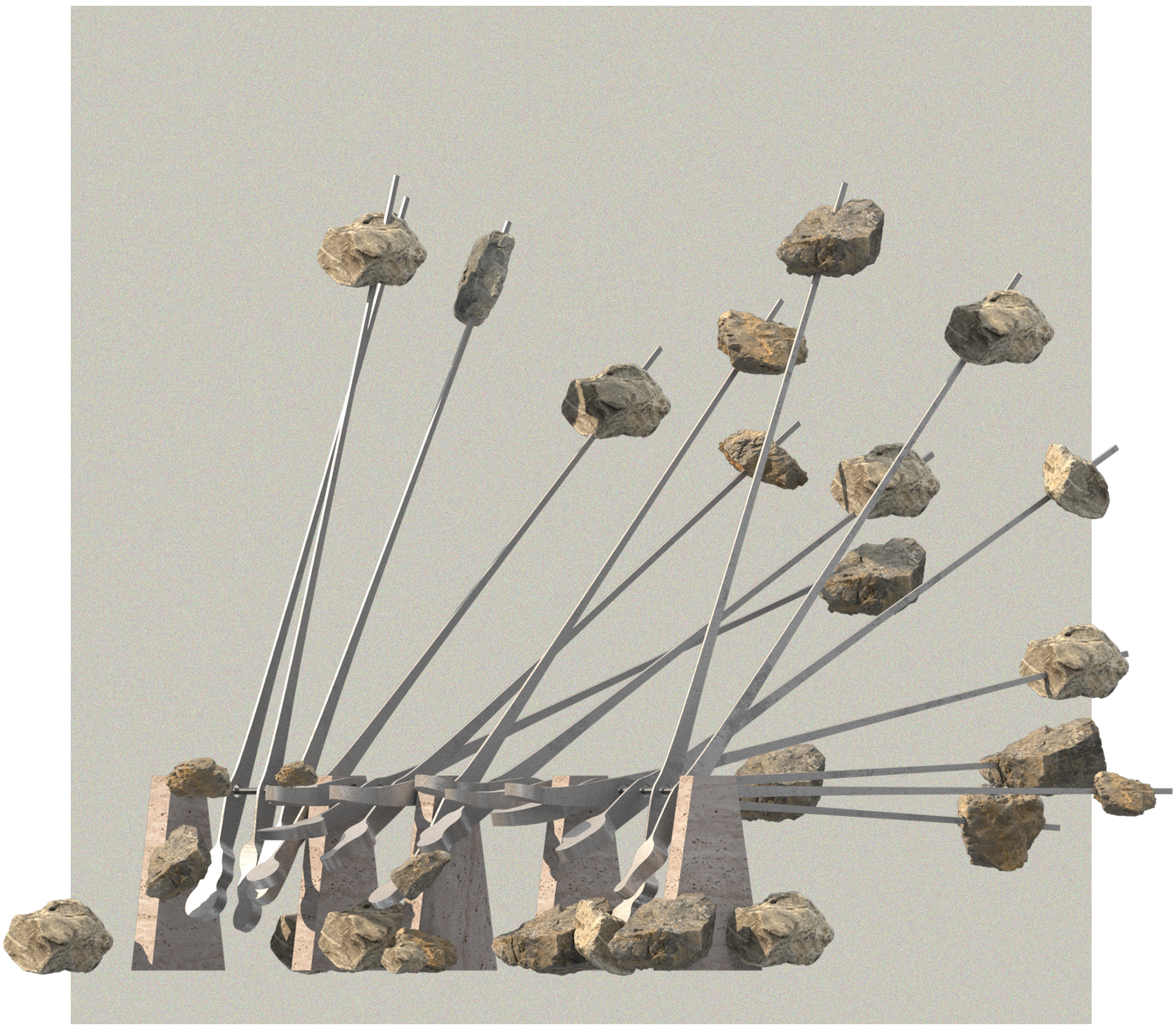


Figure 42.

Architectural Intervention:

Rockfall

In the case of rock fall, the stones in a rock field are slightly rearranged to support an axis that is threaded through a series of rods. On one end, there is a cupped surface awaiting rock fall, while on the other there is a great weight, a stone collected from the surrounding rock field.

As a rock falls from the steep rocky faces surrounding the infrastructure, the cupped surface is weighted - either by one large rock, or perhaps the aggregation of several small rock falls. Once the threshold of weight is reached, the rod spins on its axis, releasing the collected stone(s) to the foundation below and lifting its weighted side until it is locked in a vertical position.

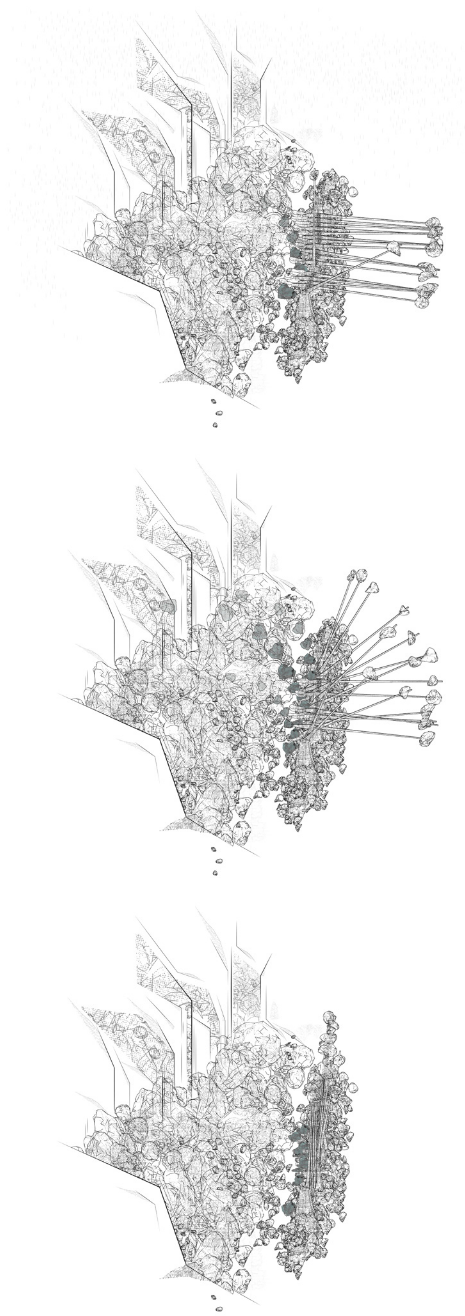


Figure 43.

Architectural Intervention:

Avalanche

Figure 44.

Architectural Intervention:

Avalanche

In the case of an avalanche, past avalanche debris is collected and piled towards the top of avalanche slide paths. These organized piles act as barriers that guide and channel the flow of snow when an avalanche is triggered.

They also act as a hinge point, connecting vessels that catch snow and are designed to be dragged down slope to the stone masses with a cable structure.

As the catchment vessels are dragged down, stones are lifted, as if on a pulley system, spanning between mountain peaks, awaiting their release as kinetic energy.

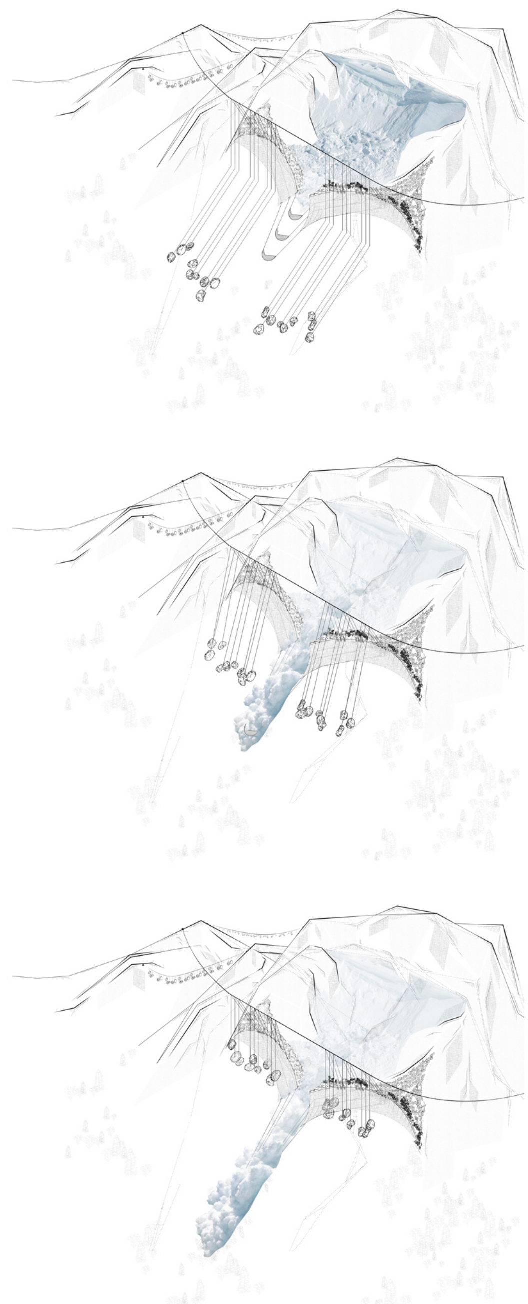


Figure 45.

Flash Flood

Section-Perspective

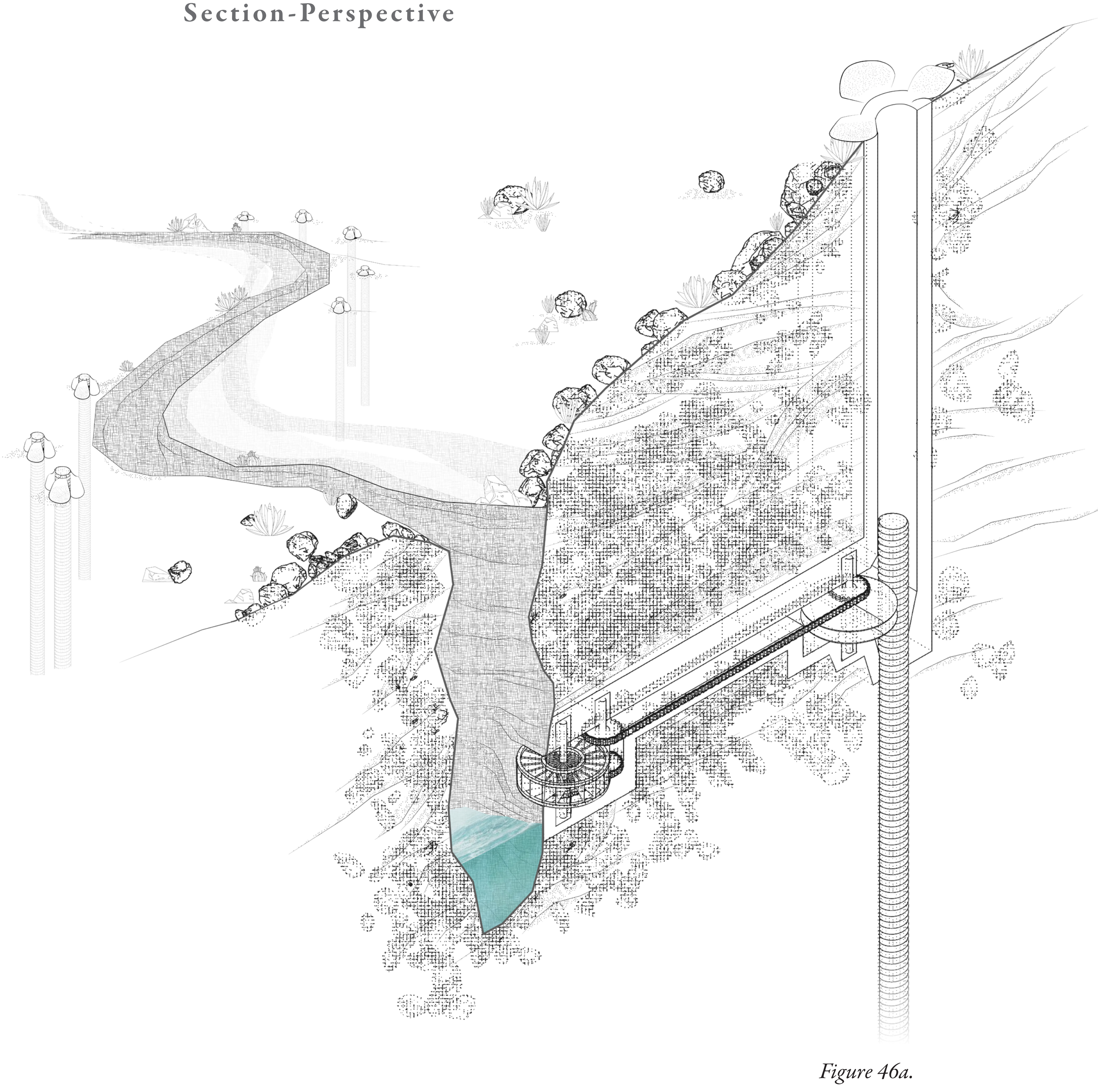


Figure 46a.

Flash Flood

Section-Perspective

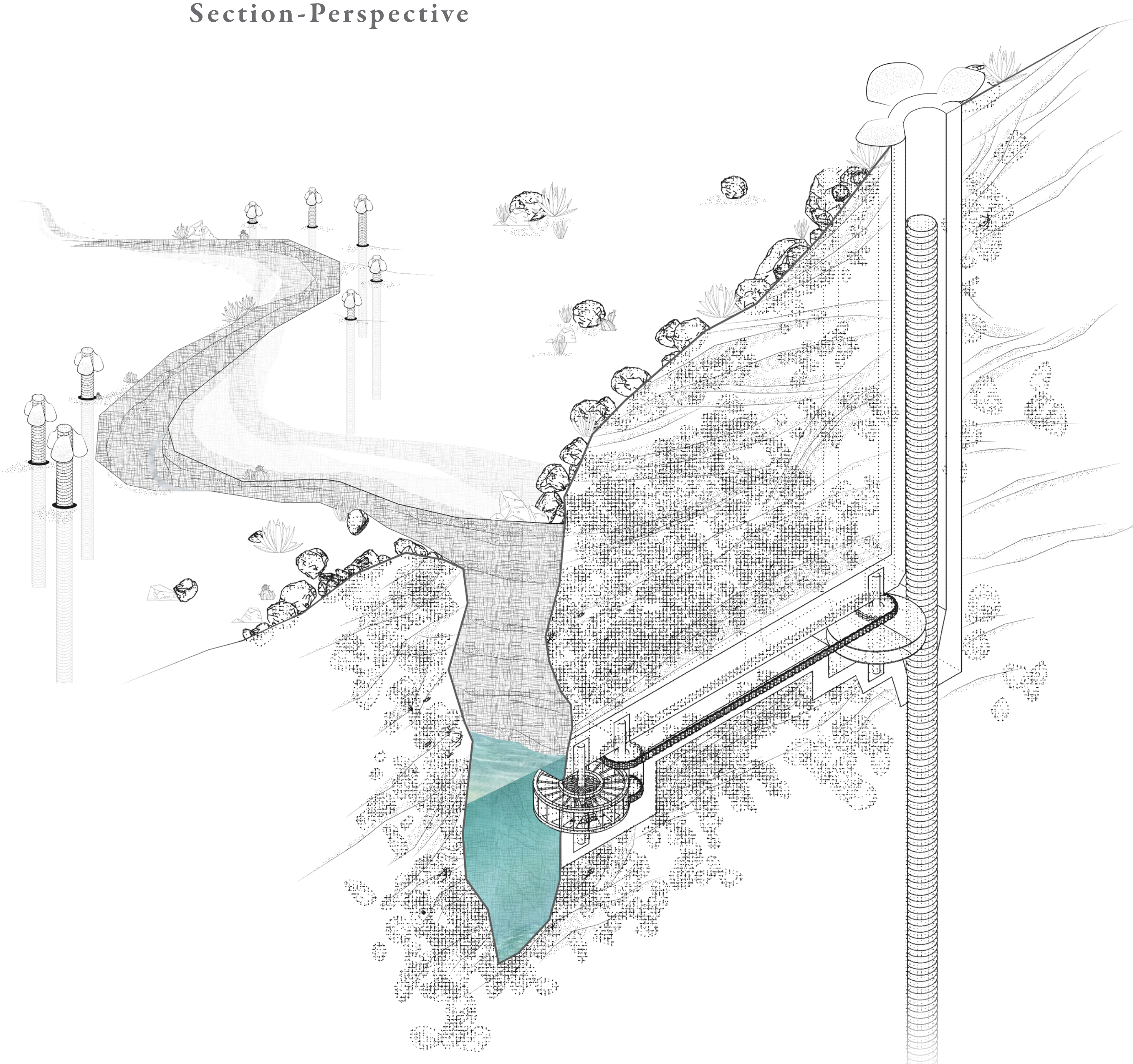


Figure 46b.

Flash Flood

Section-Perspective

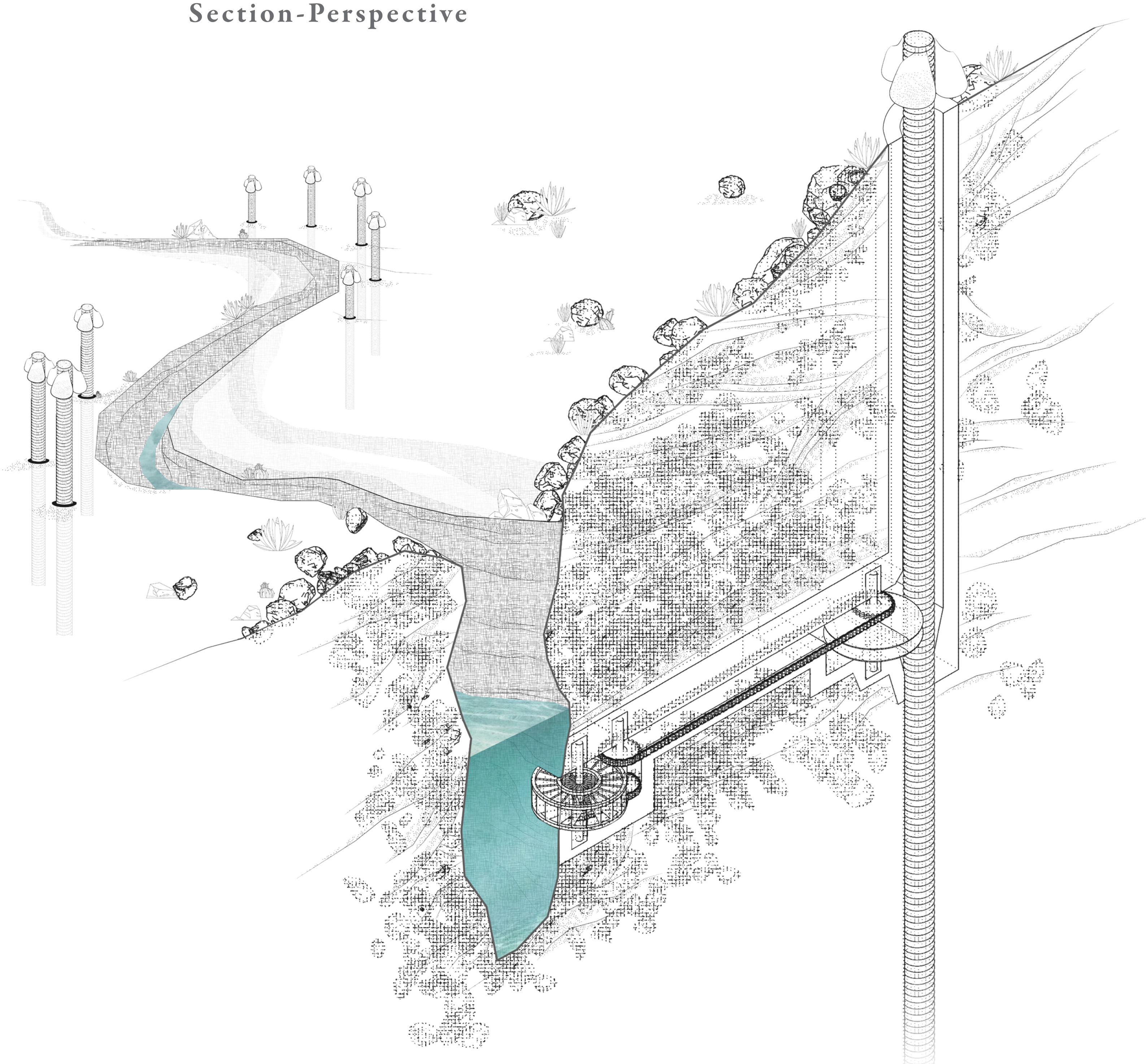


Figure 46c.

Flash Flood

Section-Perspective

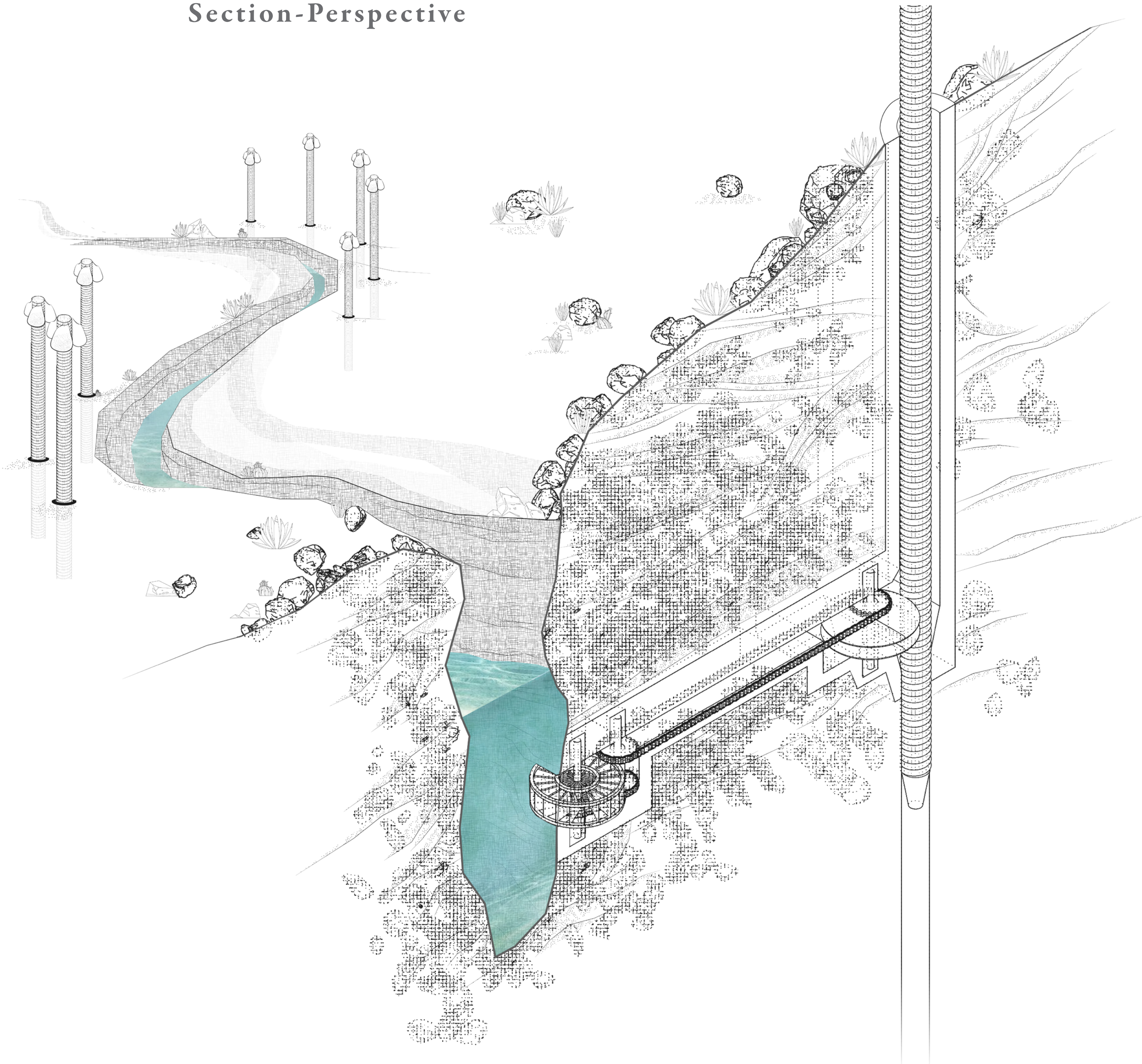


Figure 46d.

Flash Flood

Section-Perspective

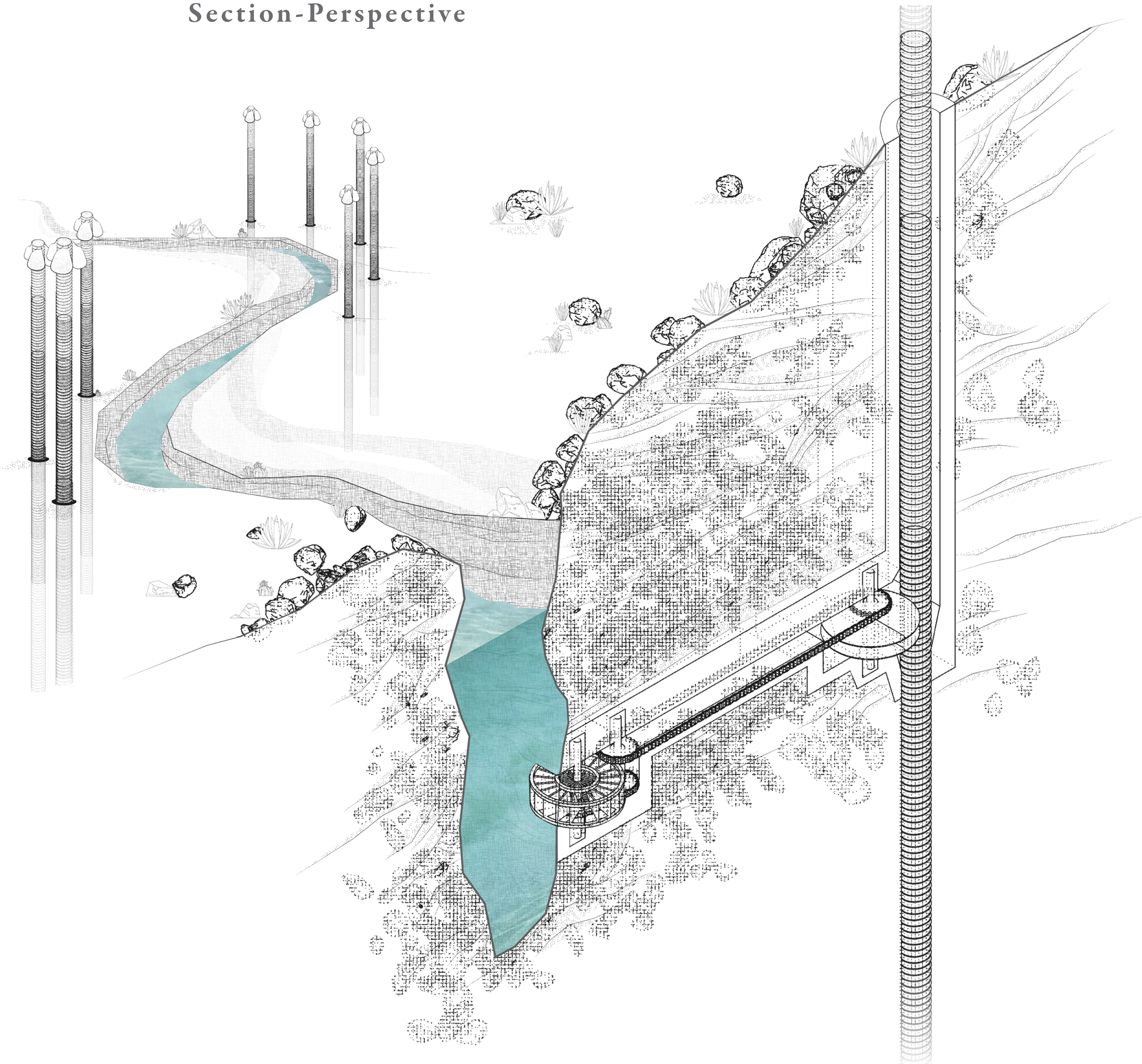


Figure 46e.

Flash Flood

Section

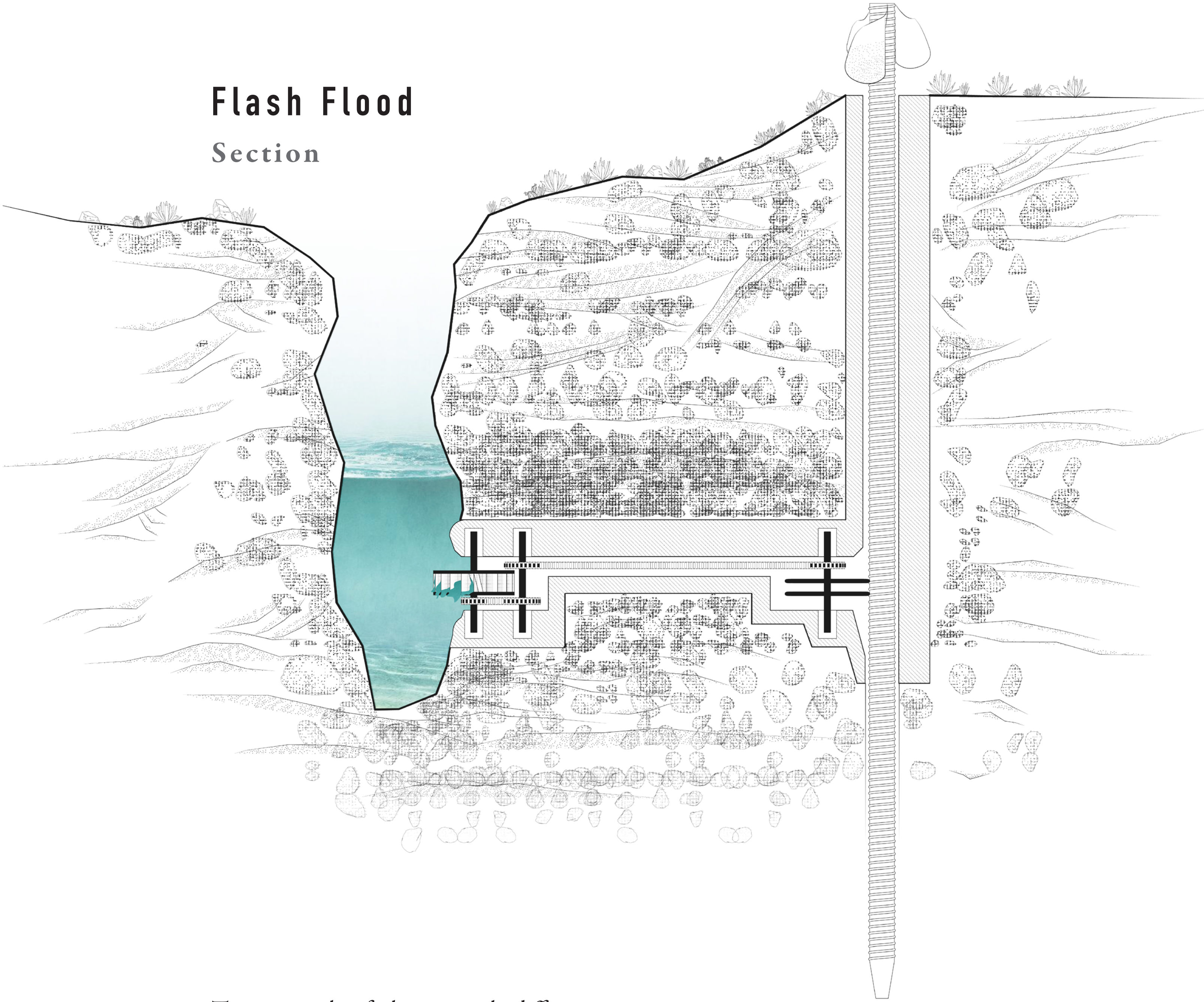


Figure 47.

The approach of this research differs from other energy systems, such as dams, mines, pipelines, and refineries in that it seeks sympathy with the landscape. It is not just making more machines; it is taking advantage of the episodic behavior of nature. The goal is not to regulate anything, but to embrace inconsistencies and a lack of control in our energy systems.

Humans must be thought of as a part of nature, not as its master. Opposing modern notions of immediacy and reliability, this proposal provokes a societal and conceptual shift in thinking— one that embraces the fluctuations of nature and having energy when that energy becomes available.

Flash Flood

Landscape view

Figure 48.

Flash Flood

Embedded in the Earth

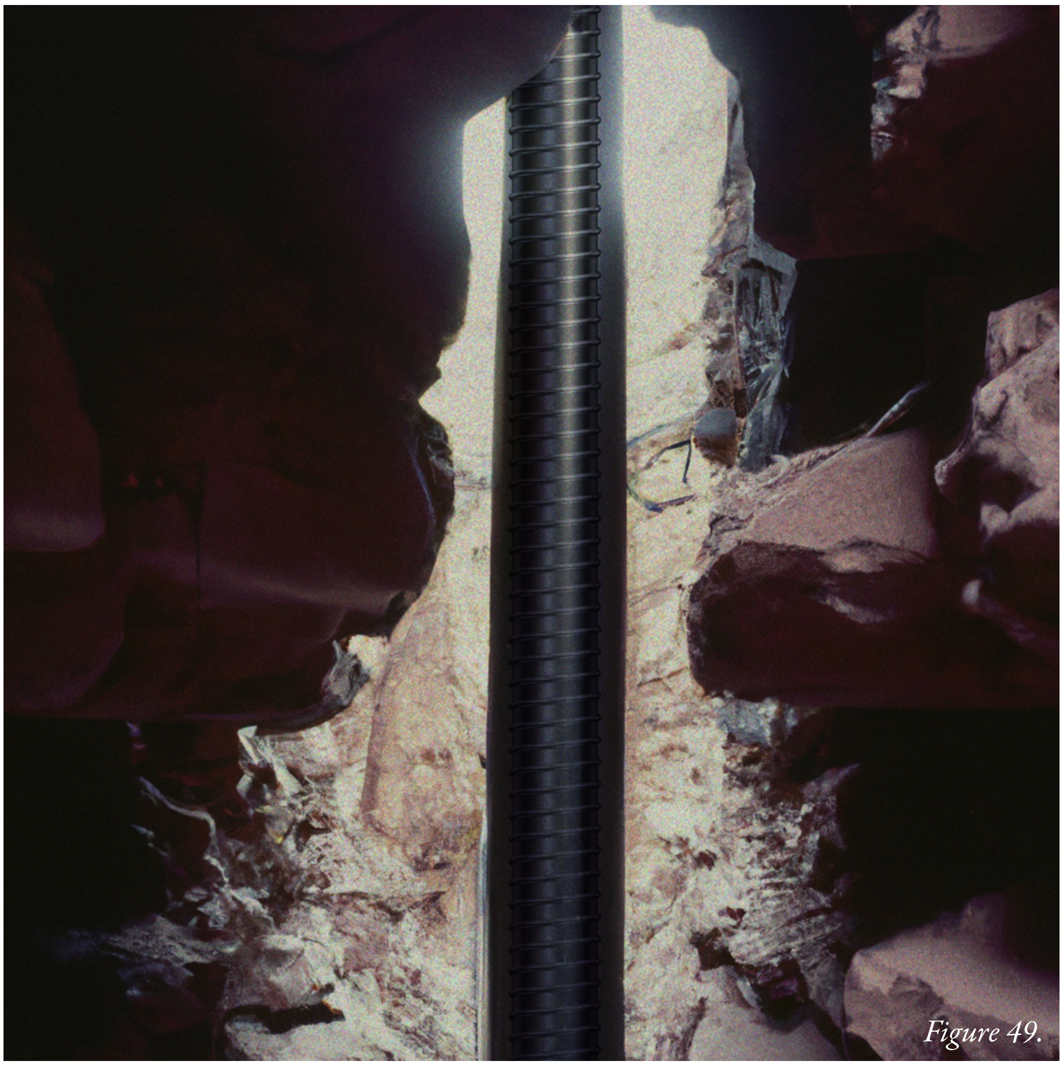


Figure 49.

Flash Flood

Meanders through time

Figure 50a.

Flash Flood

Meanders through time

Figure 50b.

Flash Flood

Meanders through time

Figure 50c.

Flash Flood

Meanders through time

Figure 50d.

Flash Flood

Meanders through time

Figure 50e.

Flash Flood

Meanders through time

Figure 50f.

Rockfall

Axo

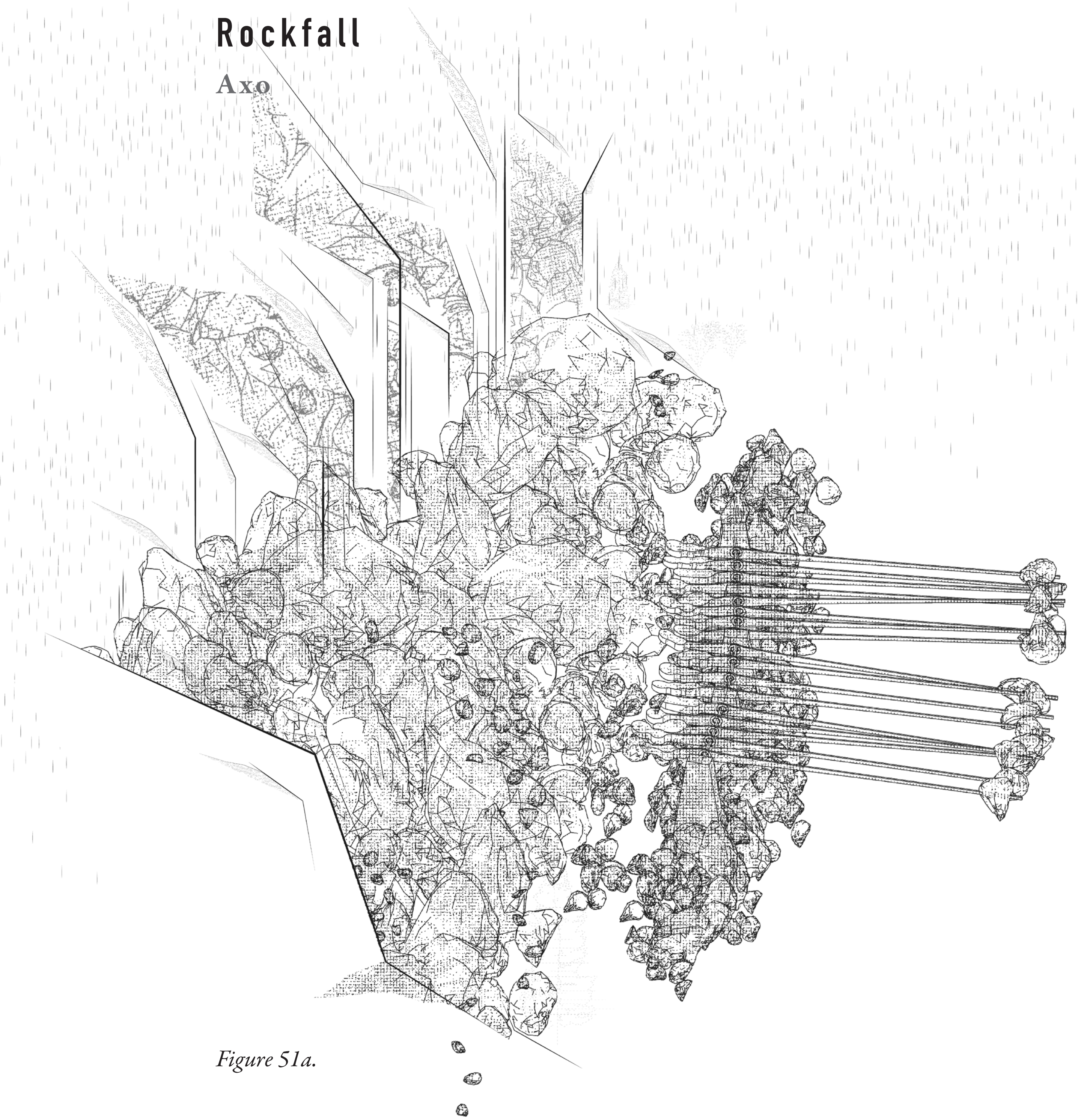


Figure 51a.

Rockfall

Axo

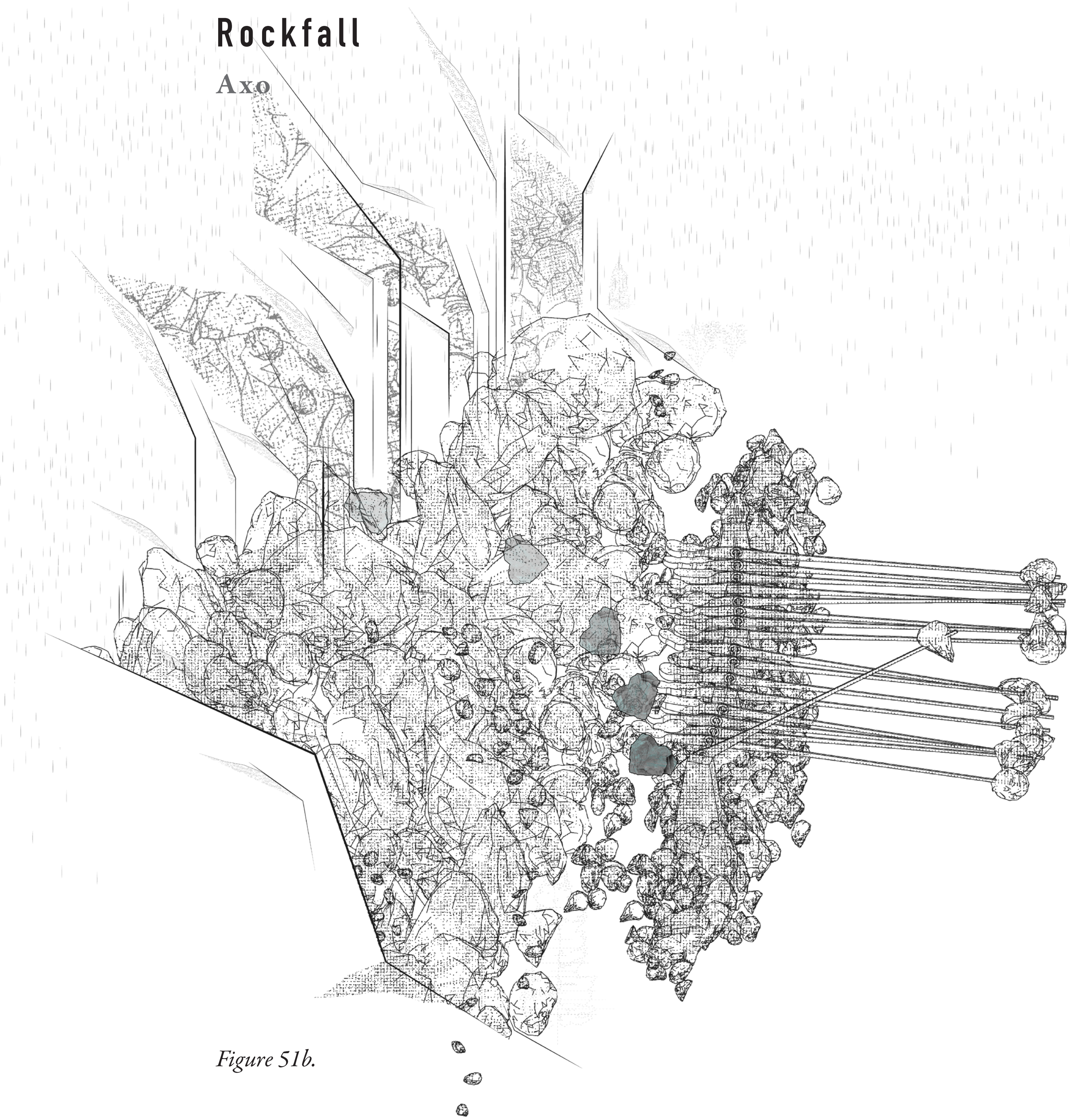


Figure 51b.

Rockfall

Axo

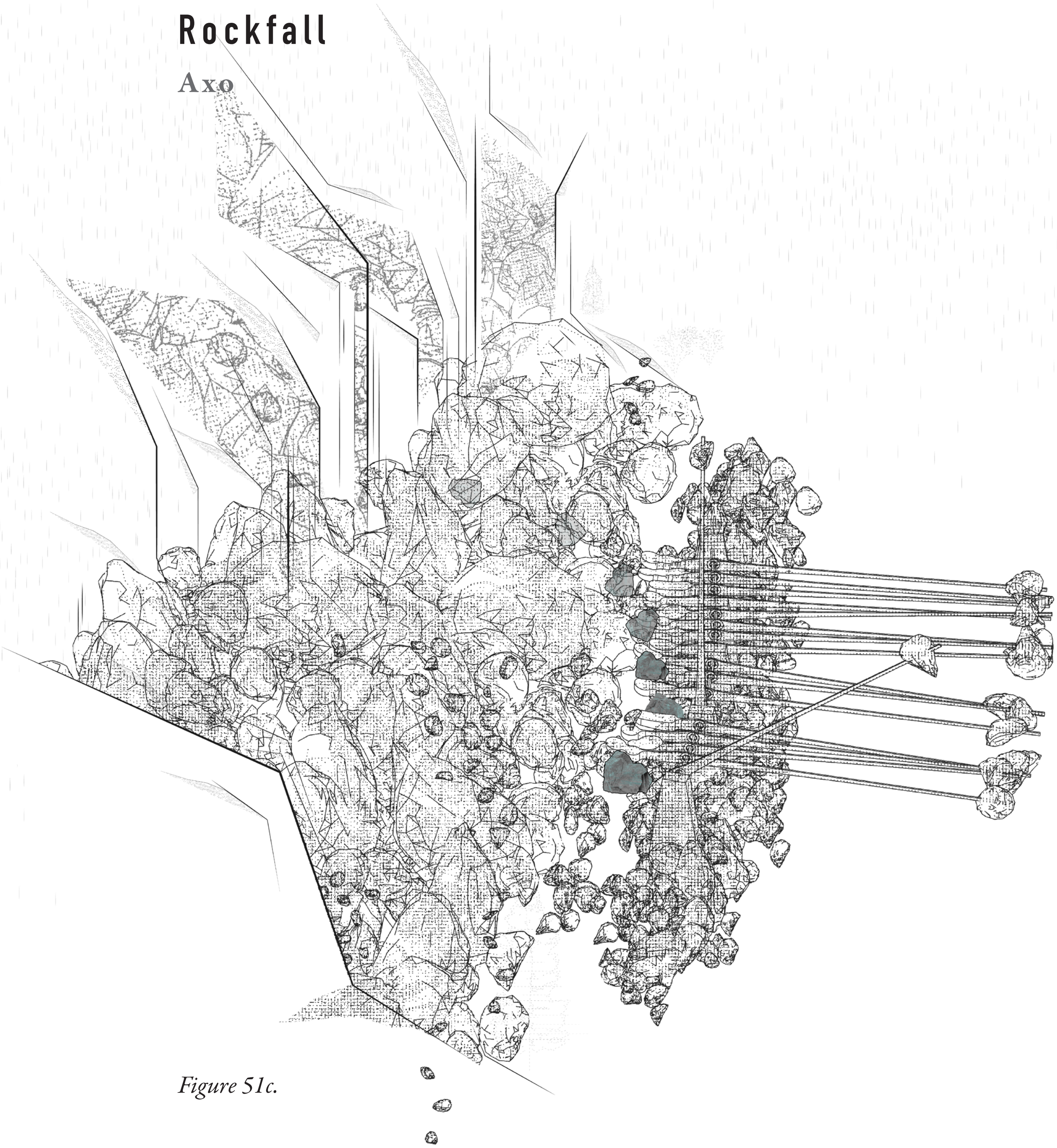


Figure 51c.

Rockfall

Axo

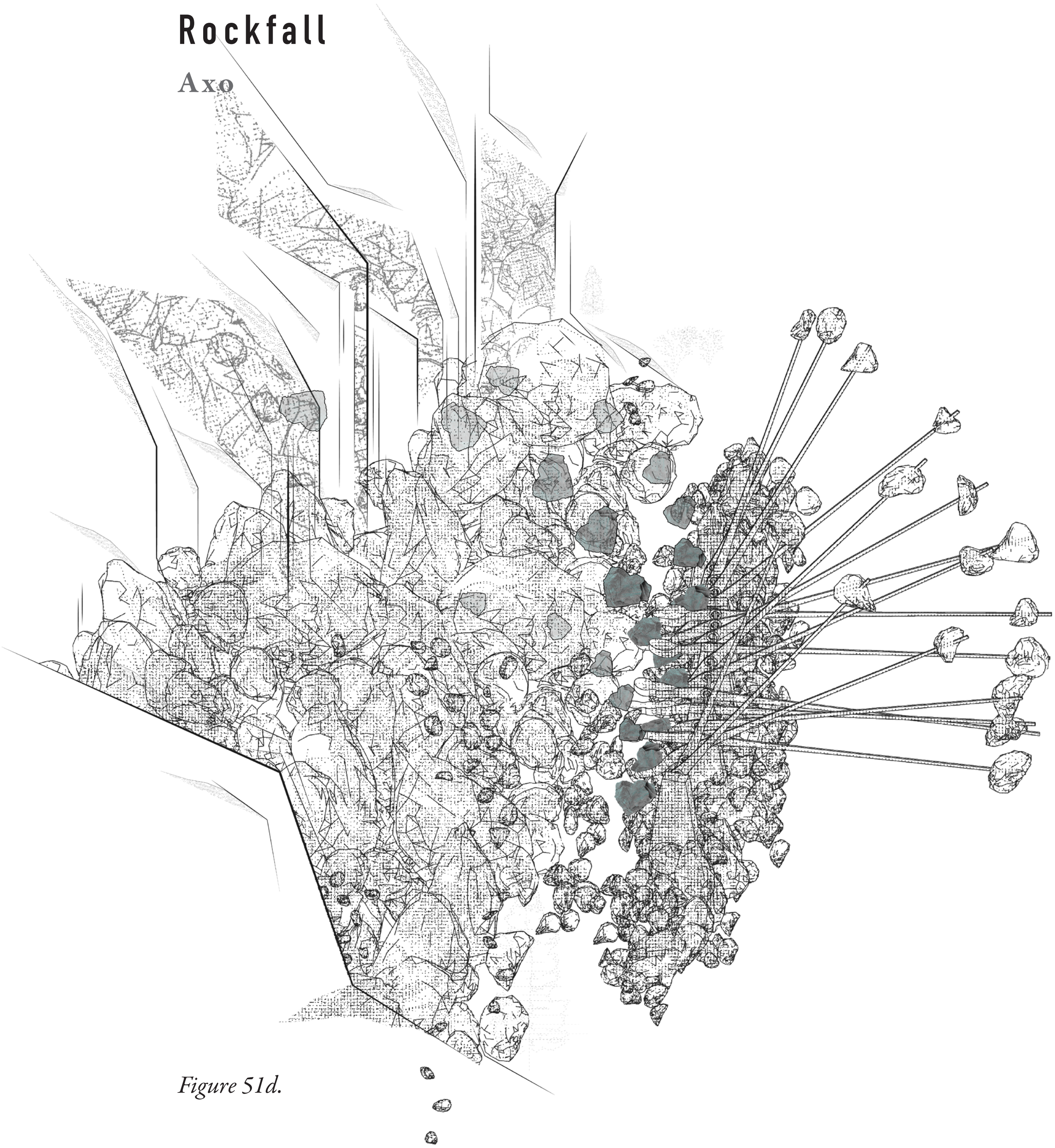


Figure 51d.

Rockfall

Axo

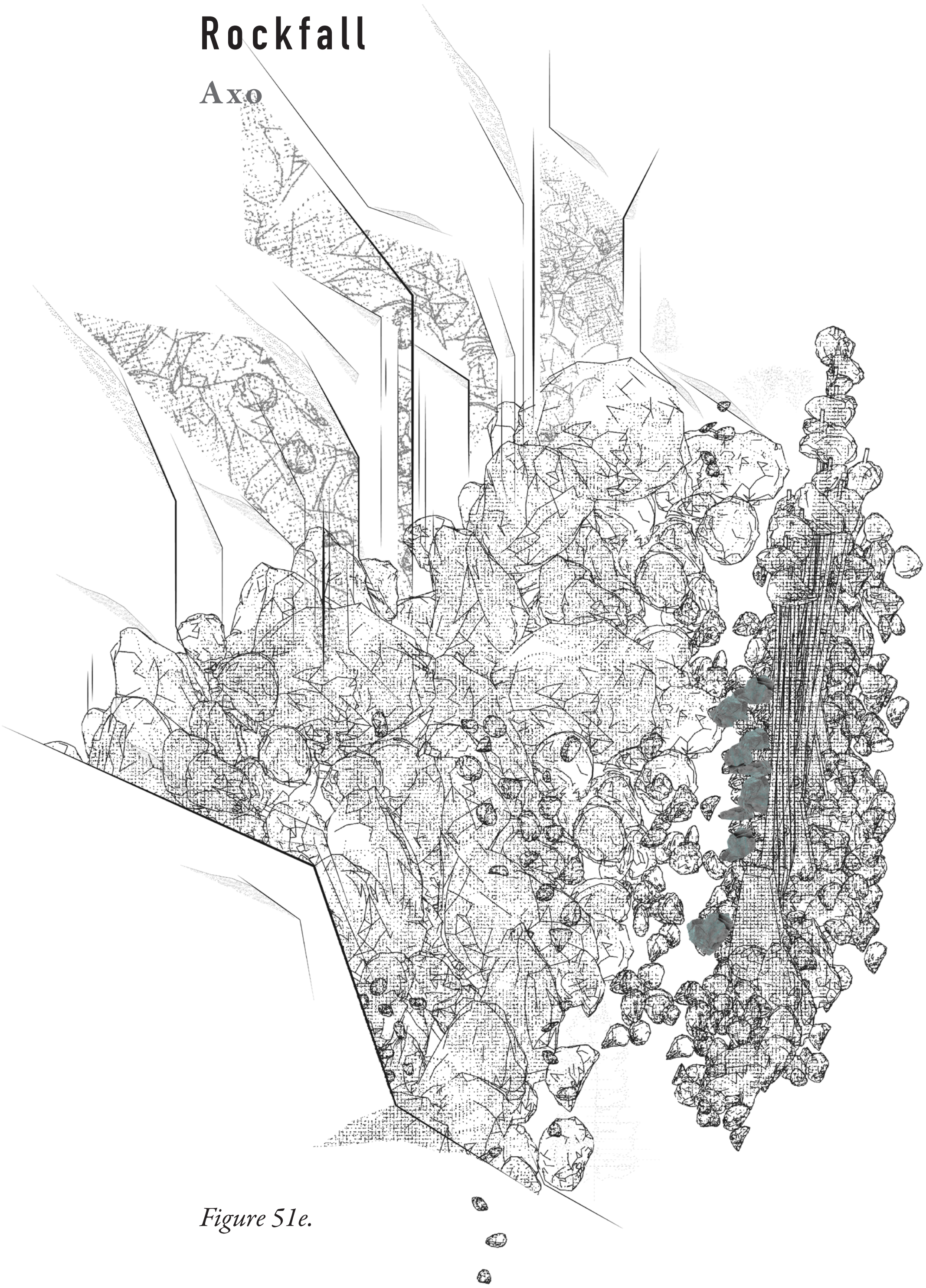


Figure 51e.

Rockfall

Section

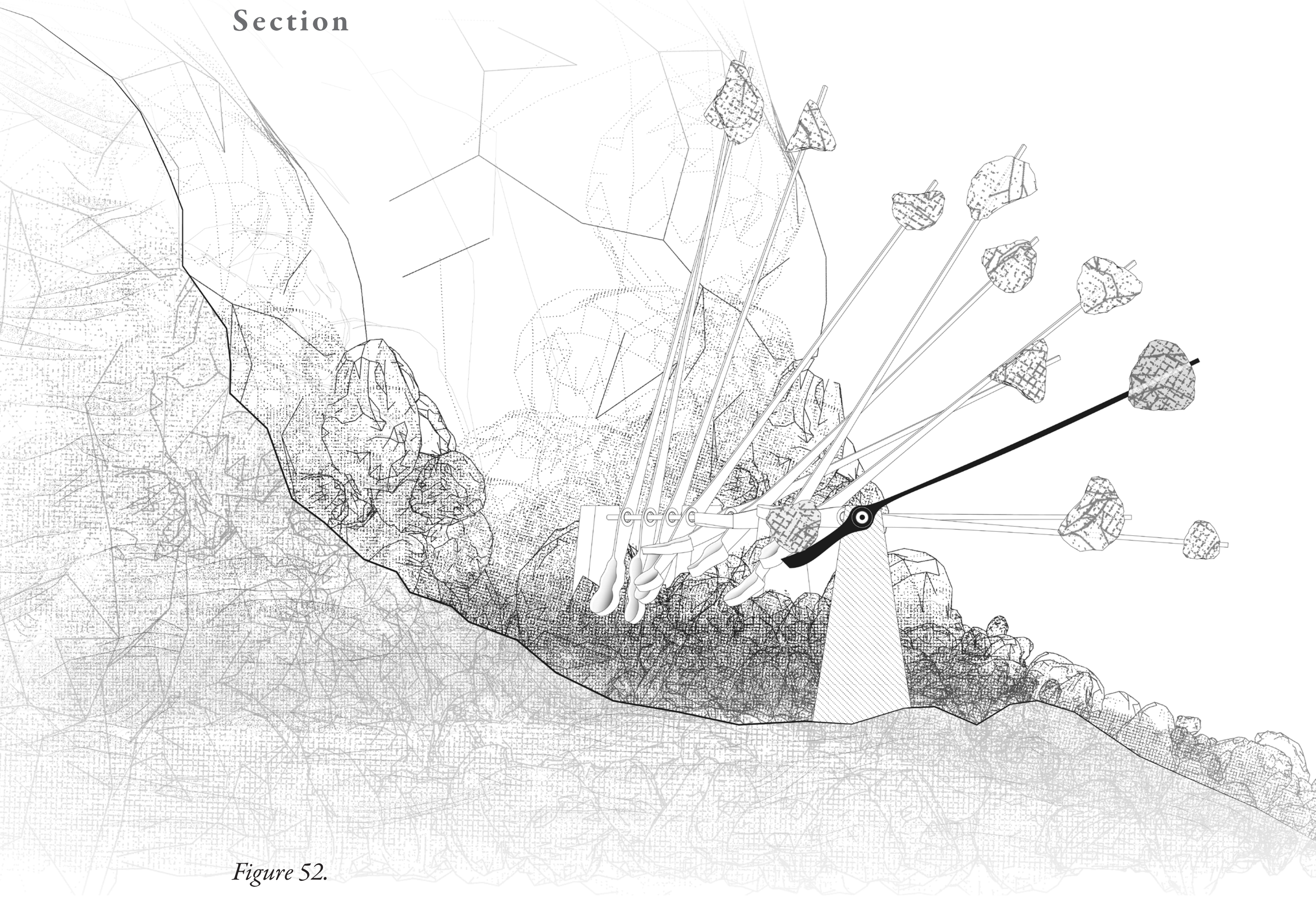


Figure 52.

This thesis is aiming to work with the stochastic and sporadic character of natural forces, so these infrastructural interventions are designed to be open ended in terms of their activation and energy production.

Perhaps the rainfall won't fall in some portions of the desert for a decade, but annually in other portions.

Perhaps, it is too difficult to know which stone will fall, so many pivoting rods are installed in a rock field in the hopes that when a rock does falls, as least one rod will be activated lifting its mass and out of the chaos, a little order is found.

Rockfall

Awaiting the rain

Figure 53.

Rockfall

Resting on debris

Figure 54.

Rockfall

Poised in the landscape

Figure 55.

Rockfall

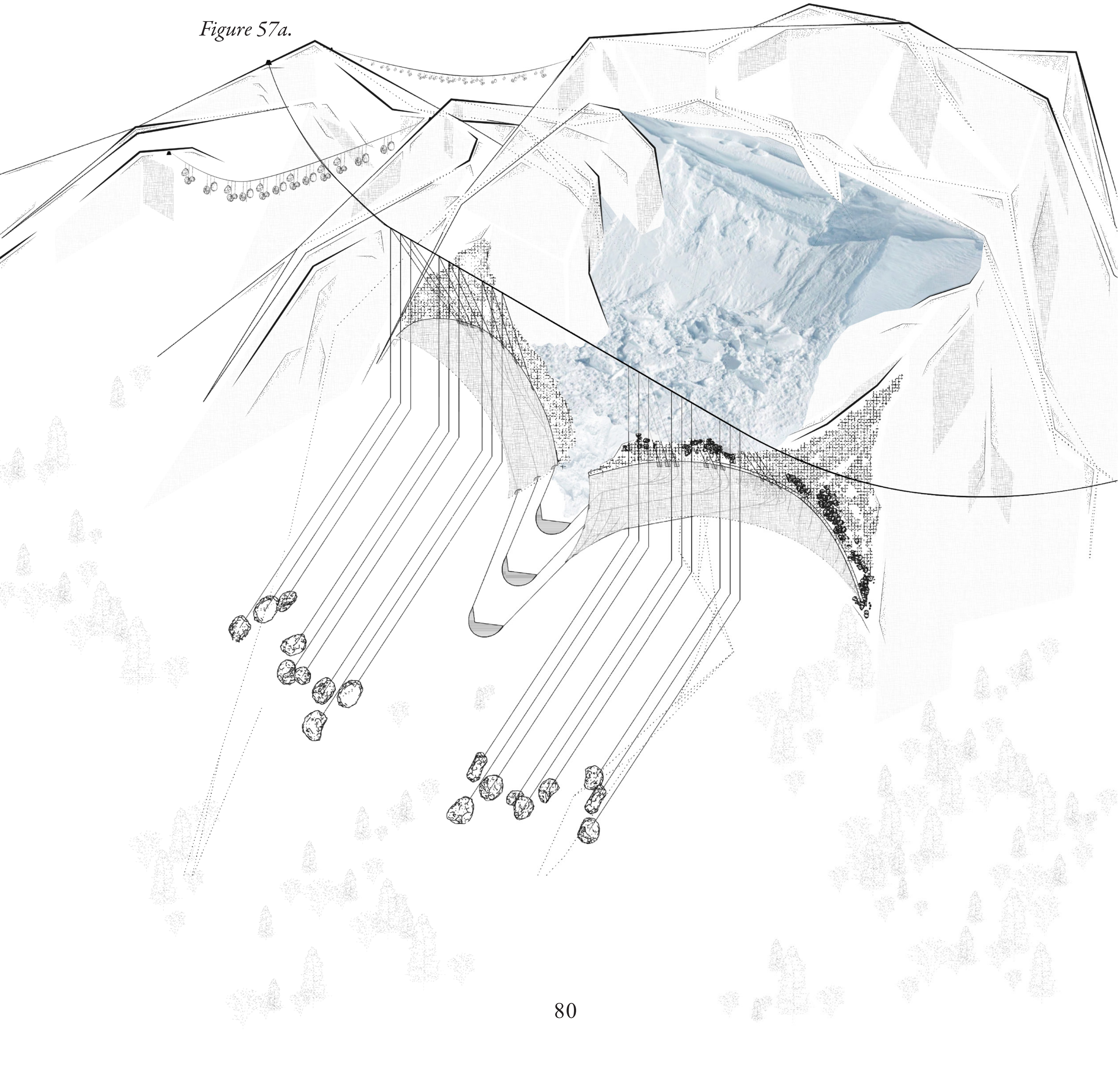
Waiting to charge

Figure 56.

Avalanche

Axo

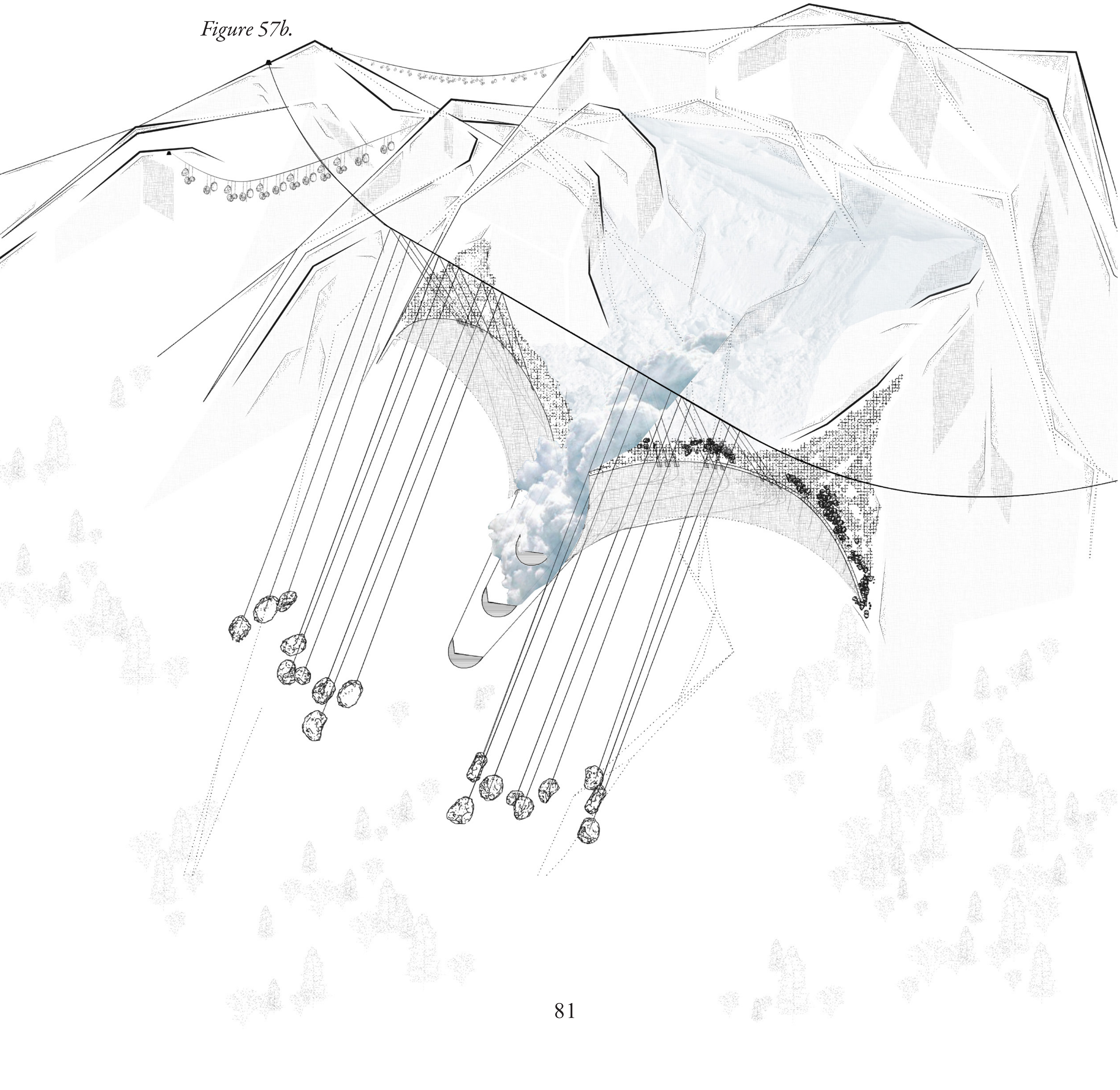
Figure 57a.



Avalanche

Axo

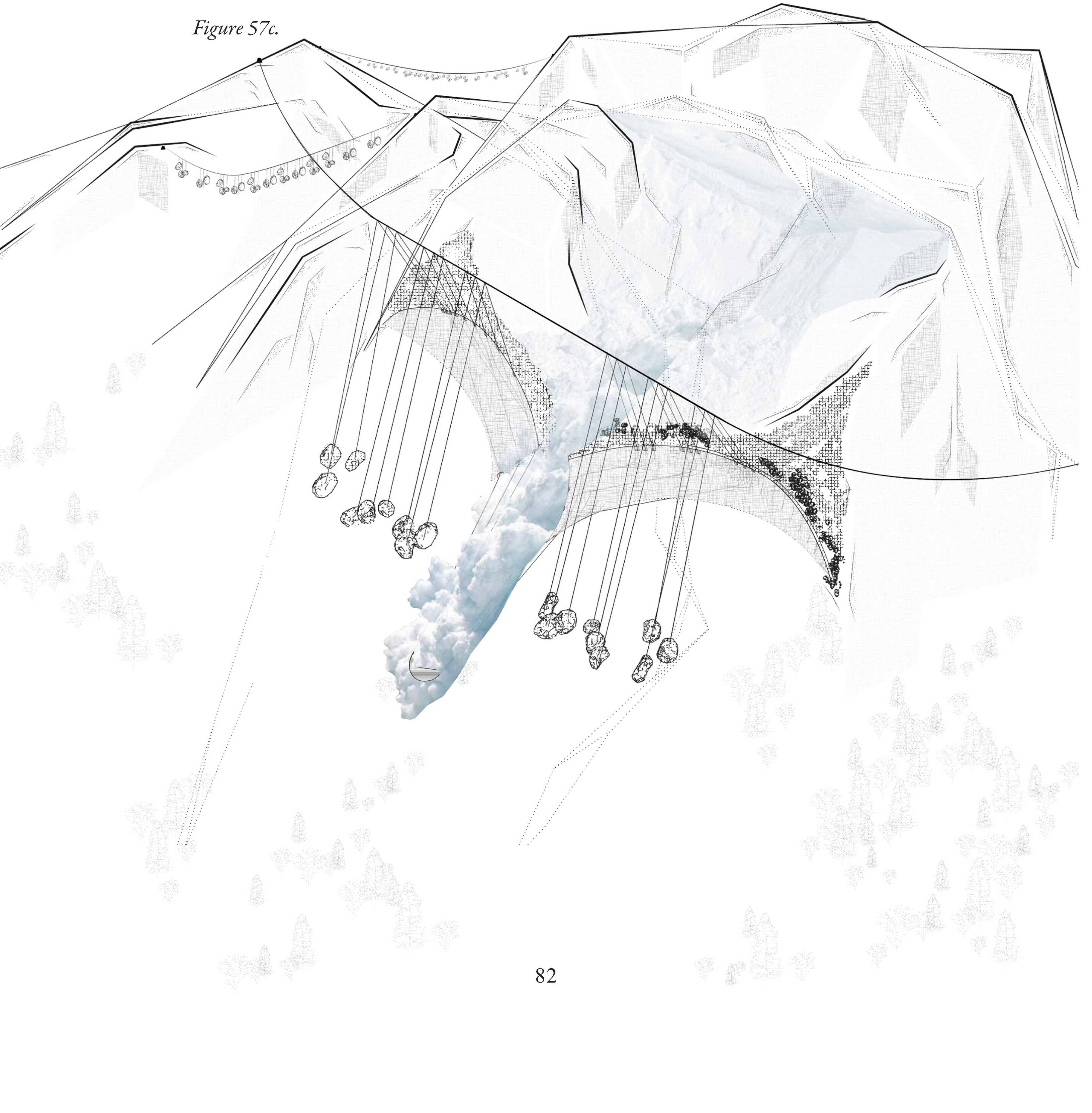
Figure 57b.



Avalanche

Axo

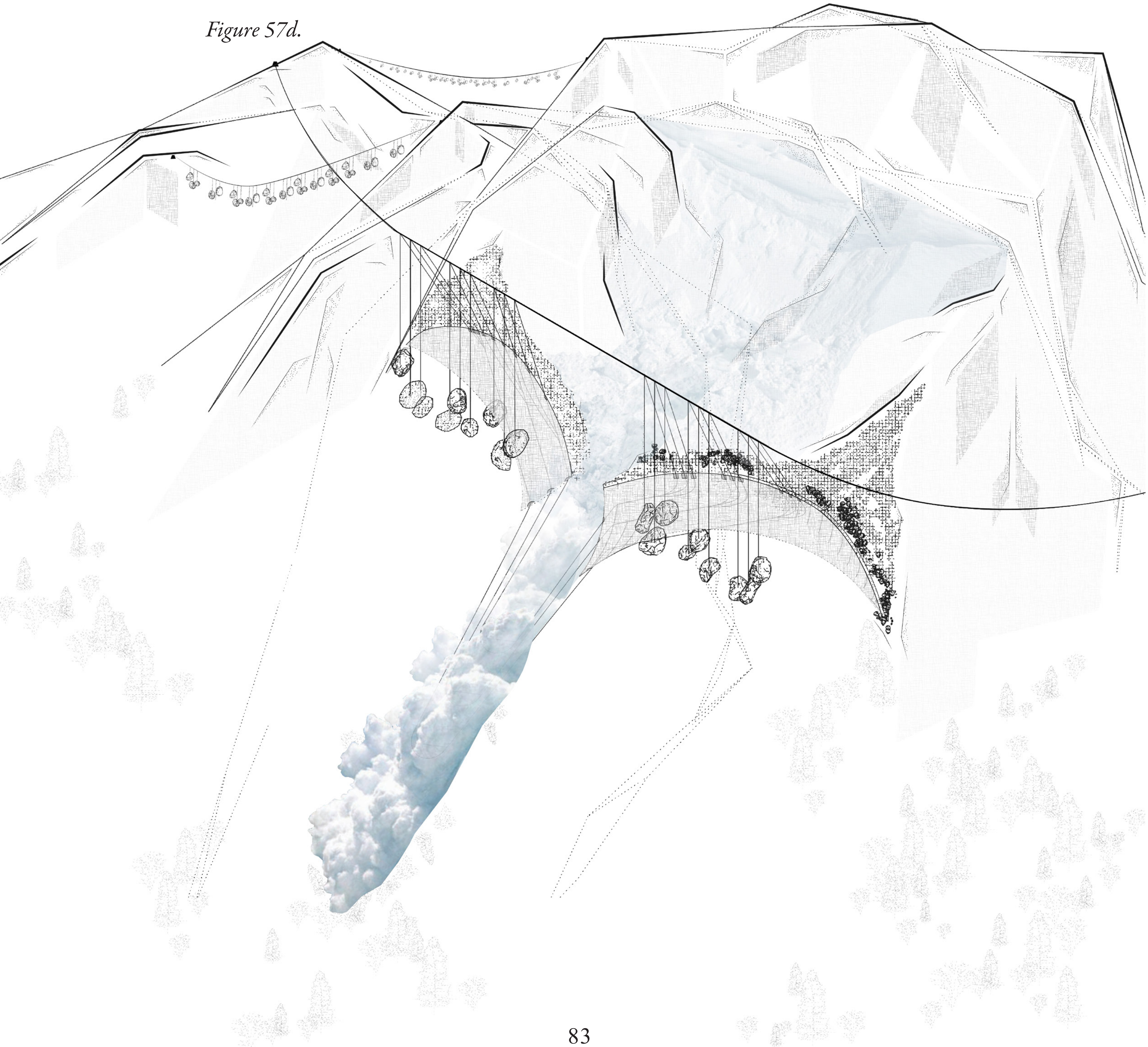
Figure 57c.



Avalanche

Axo

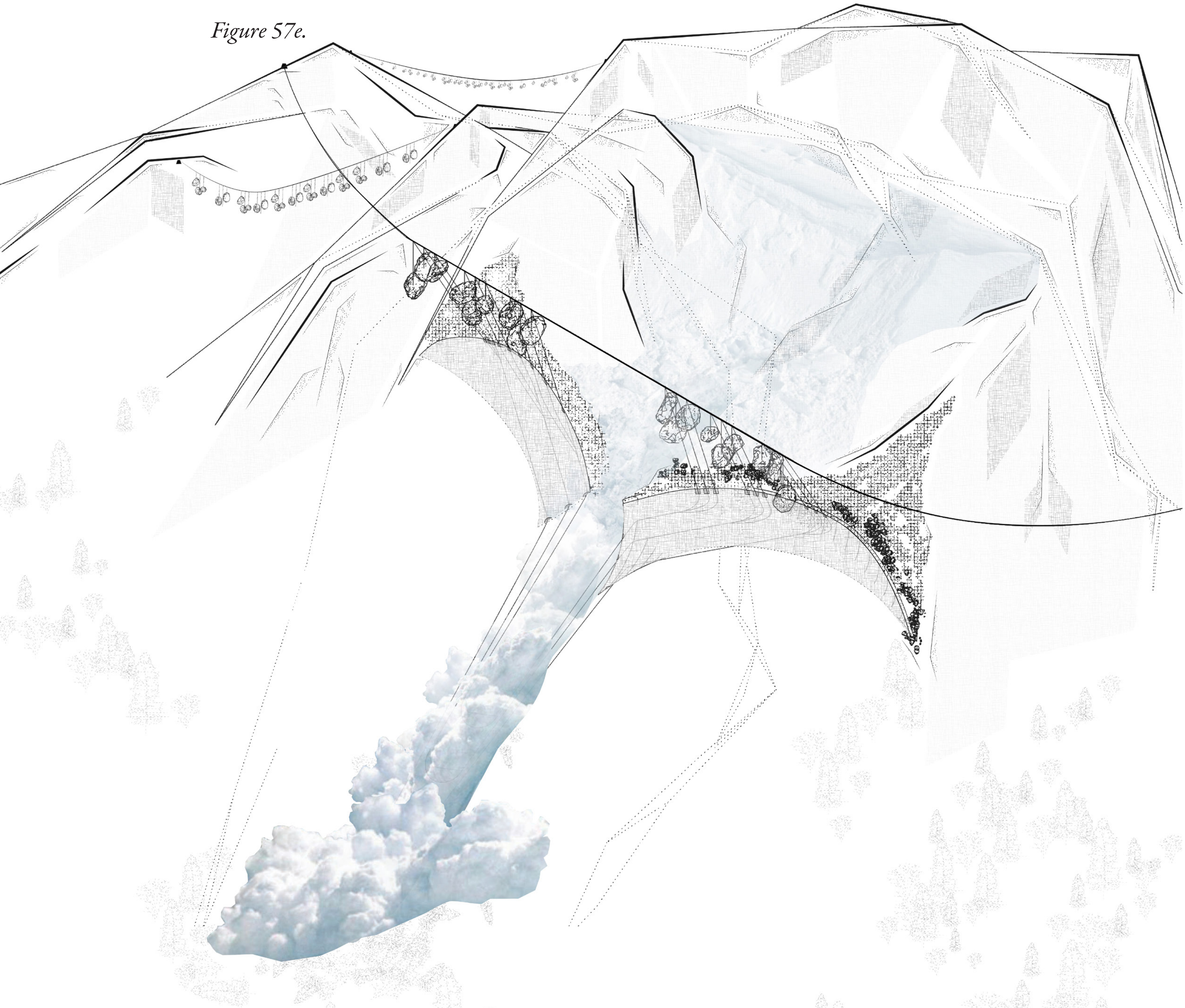
Figure 57d.



Avalanche

Axo

Figure 57e.



Avalanche

Section

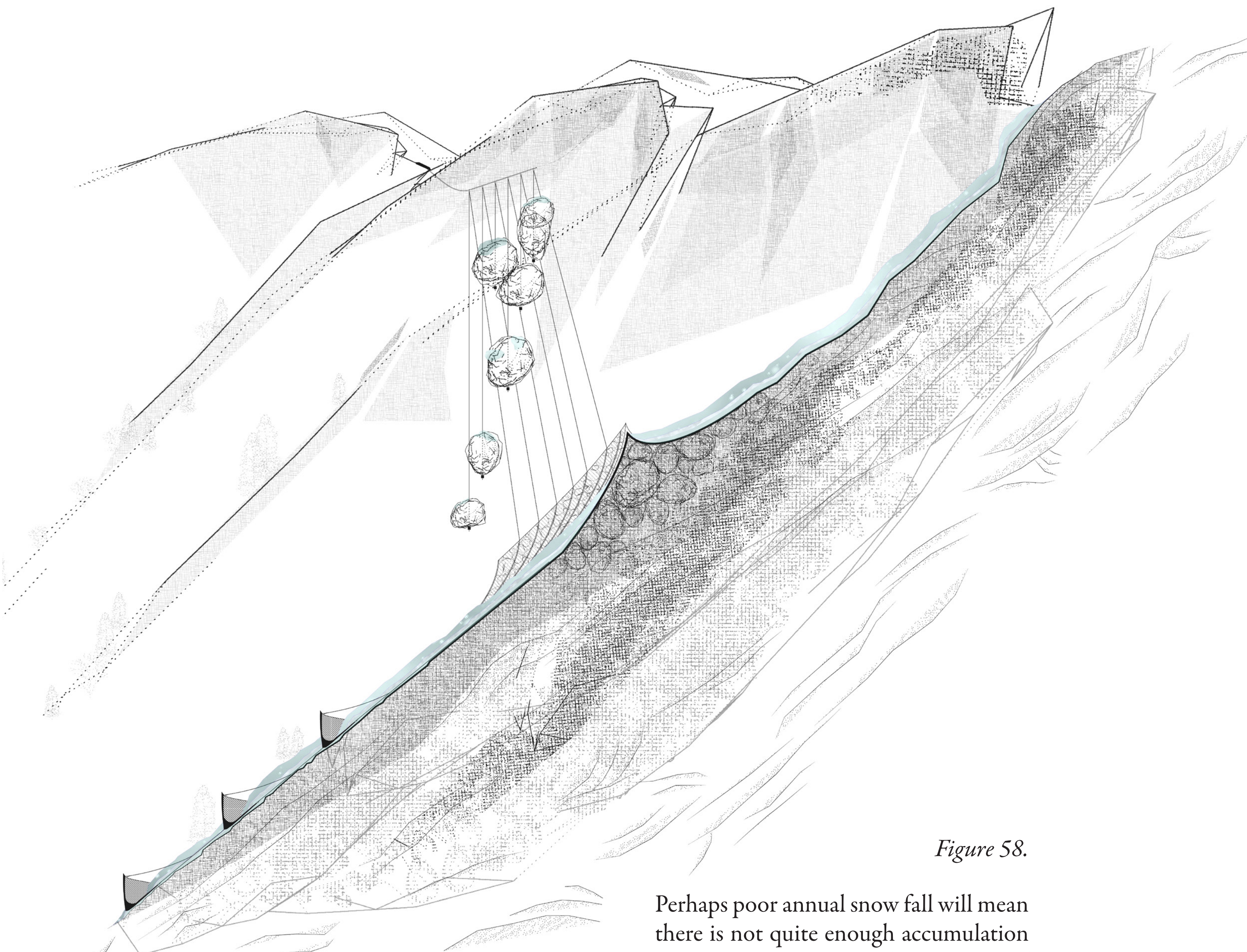


Figure 58.

Perhaps poor annual snow fall will mean there is not quite enough accumulation to trigger an avalanche for a couple of years. Or perhaps so much snow will mean there are several slides throughout one winter. As an active geological landscape is embraced, so must a dormant one.

Avalanche

Riding with the force

Figure 59.

Avalanche

Being overcome by the force

Figure 60. Avalanche, Dall•e + Natalie

Avalanche

Extreme potential

Figure 61. Extreme Potential, Dall•e + Natalie

Avalanche

Impact on the landscape

Figure 62. Impact on the landscape, Dall•e + Natalie

Avalanche

Debris

Figure 63. Debris, Dall•e + Natalie

Avalanche

Debris with architectural potential

Figure 64. Debris with architectural potential, Dall•e + Natalie

Avalanche

Charged landscape

Figure 65.

Avalanche

Awaiting release and generation

Figure 66.

Consequences

Concluding thoughts

What has been proposed are speculative designs and stories that do not offer an answer, and though they may not be probable, they are possible. There is power in new ways of thinking.

As current building and energy practices 'dig' the world deeper and deeper into the climate crisis, a new value system must be developed.

In many ways, working with natural forces invites a return to the basics, to a pre-modern time. Yet it also looks to a possible future world, one with unconventional environmental design.

Architecture has agency to work collaboratively with the earth's metabolic consumption and production of matter, and in doing so can design for longevity while playing a significant role in energy storage.

Let the mountain be, and what will follow are terrifying and beautiful opportunities to live with natural forces.

What would it mean for society to live this way?

What sort of society would this produce?

Figure 67. Avalanche Model, Photographed by Andy Ryan

Citations

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