FIELDBOOK EN

CRITICAL ZONES

OBSERVATORIES FOR EARTHLY POLITICS

23.5.2020
—9.1.2022

You want me to land on Earth? Why?

Because you're hanging in midair, headed for a crash.

How is it down there?

Pretty tense.

A war zone?

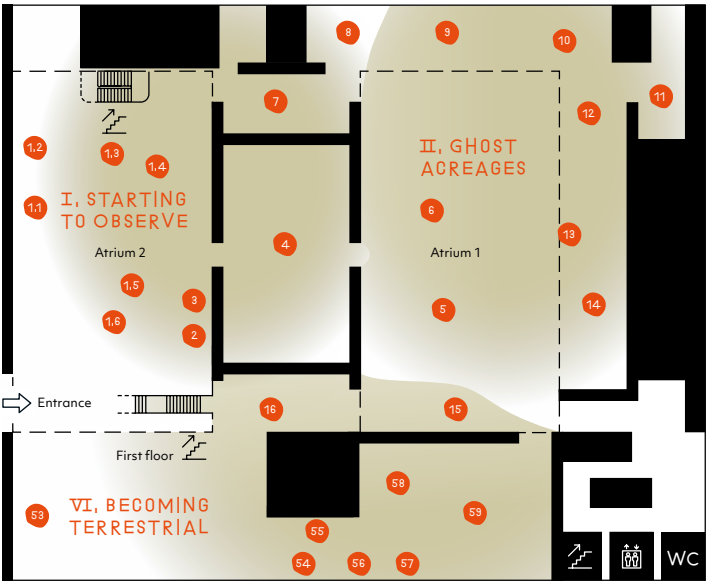
Close: a CRITICAL ZONE, a few kilometers thick, where everything happens.

Is it habitable?

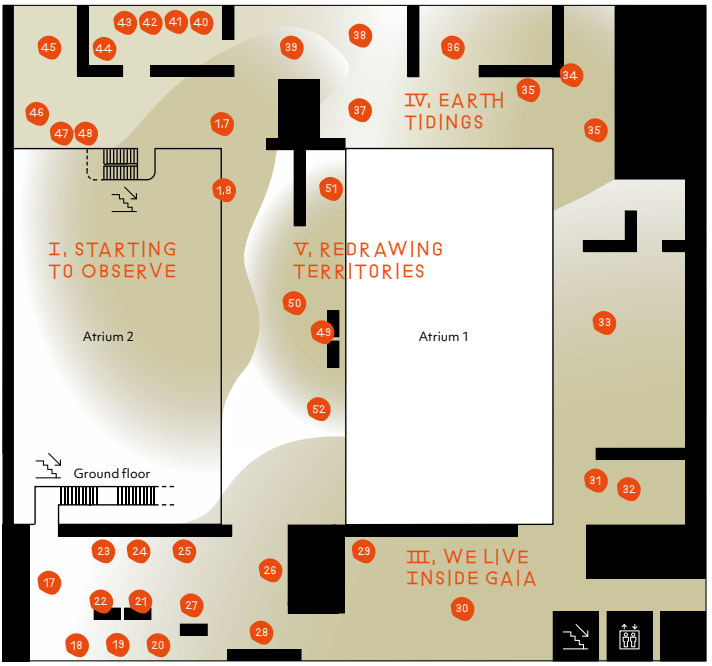
Depends on your chosen science.

Will I survive down there?

Depends on your politics.



Ground floor



First floor

60 ZKM Foyer

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62 EnBW headquarters
Durlacher Allee 93, 76131 Karlsruhe

19 Letter from Nigel Williams (*Nature*) to Lynn Margulis
20 James Lovelock: *Gaia: The Earth System*
21 Lynn Margulis / Michael J. Chapman: *Kingdoms & Domains*

INTERVENTION C

22 Stromatolites
23 *Symbiogenesis Through Fertilization Across Kingdoms*
24 *The Tissue of Gaia*
25 Gemma Anderson: *Garden of forking paths* (series); *Mitosis Score*
26 Len Lye: *Tusalava*
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INTERVENTION D

28 Cemelesai Dakivali (Arsai): *My Memory*
29 Gediminas & Nomeda Urbonas: *Swamp Observatory*
30 Sybille Neumeyer: *Souvenirs Entomologiques #1; Odonata / Weathering data*
31 Sonia Levy: *For the Love of Corals*
32 Anna Atkins: Cyanotypes Taken from *Photographs of British Algae: Cyanotype Impressions*
33 Pauline Julier: *Naturalis Historia*

IV, EARTH TIDINGS

34 Geocinema: *The Making of Earths*
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38 Rasa Smite / Raitis Smits: *Atmospheric Forest*
39 Measuring Instruments
40 Caspar Wolf: *Siebenbrunnen in Simmertal with the Plaine Morte Glacier*
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42 Otto Marseus van Schrieck: *Unkraut mit Schlange und Schmetterlingen*
43 Joos van Craesbeeck: *The Temptation of Saint Anthony*
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45 Karen Holmberg / Andrés Burbano: *Double-Sided Immersion*
46 Orra White Hitchcock: Selection of drawings
47 Athanasius Kircher: *Mundus subterraneus*
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1.7 CZO Space: Weather Station
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49 Meteorological Observation

V. REDRAWING TERRITORIES

50 Elise Hunchuck / Jingru (Cyan) Cheng / Marco Ferrari: *Sky River: Politics of the Atmosphere*
51 Dilip da Cunha / Anuradha Mathur: *Wetness is everywhere; why do we see water somewhere?*
52 Forensic Architecture: *Cloud Studies*

VI. BECOMING TERRESTRIAL

INTERVENTION E

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55 Jürgen Claus: *Medium Meer.* A selection of the works of Jürgen Claus
56 Petra Maitz: *Lady Musgrave Reef*
57 TBA21–Academy: *Sense to Act: The Aquatic Observatory*
58 Peter Fend: *Ocean Earth Projects*
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ZKM FOYER

60 Rachel Libeskind: *INBALANCE / IMBALANCE*

ZKM FORECOURT

61 Matthieu Duperrex: *We don't want to be called resilients anymore*

ENBW HEADQUARTERS

62 Fabien Léaustic: *Eau de Karlsruhe – Cyprès*

JUST IMAGINE THAT WE ARE ALL »PART OF A VAST, AGES-OLD WHOLE.«

(after Lynn Margulis)

This *Fieldbook* is an aid to orient visitors as they follow the multifarious stories told by the exhibition *Critical Zones. Observatories for Earthly Politics*. It proposes one of many possible tours through the six sections of the exhibition:

STARTING TO OBSERVE: A CRITICAL ZONE OBSERVATORY

WE DON'T LIVE WHERE WE ARE: GHOST ACREAGES

WE LIVE INSIDE GAIA

EARTH TIDINGS

REDRAWING TERRITORIES

BECOMING TERRESTRIAL

The numbers that connect these "Field Notes" to the exhibition space can be used as a guide.

Interposed between the artworks and texts of the exhibition sections are small "interventions." These are exercises in "Becoming Terrestrial" – invitations to perceive the ground beneath our feet in a different way, to comprehend our enmeshment with the organisms in and around us in a new way, and to understand ourselves as "Earthbounds."

We, the exhibition organizers, artists, and local Karlsruhe action groups, would like to embark on this journey of discovery with you. To this end, there is also a diverse activation program which takes place inside the physical exhibition as well as online. The exhibition can be experienced digitally at CRITICAL-ZONES.ZKM.DE.

We cordially invite you to find your own path. You might come across undiscovered kinships and unexpected dialog partners – and find for yourself a new position inside the structure as a whole.

WHAT IS A CRITICAL ZONE?

You are entering a Critical Zone! It is a notion invented by Earth scientists to bring together many different disciplines that have not collaborated sufficiently in the past. Whether you study water, soil, plants, rocks, weather, or animal life, all of those phenomena are confined to a very thin domain when compared to the whole of planet Earth, as viewed from outer space. The Critical Zone is just a few kilometers thick. It is the only region of the Earth that has been transformed by life over many eons. It is also the only part of the world that you have any chance to experience directly with your senses.

Although human activity is barely visible at the planetary scale – not to mention the scale of the universe – it is hugely disruptive at the scale of this thin, fragile, and highly complex Critical Zone. This is why we need to learn how it behaves just as much as we need to know how our body functions. And yet, although we have a vast number of tools and instruments to monitor our bodily health, we don't have many to monitor the health of the Critical Zone in which we humans live – as well as all of the life forms on which we depend. This domain is called "critical"

because this tiny part of the Earth on which we are totally dependent has entered into a sort of *intensive care*. All efforts should be made to sustain its well-being.

You are now about to enter into a scale model of what *intensive care* means for the Earth we inhabit.

I. STARTING TO OBSERVE: A CRITICAL ZONE OBSERVATORY

When a sick person enters an intensive care unit, the first thing caregivers do is to apply multiple instruments to get a good reading of the main variables that will help physicians to monitor the patient's condition. In the same way, it is necessary to devise Critical Zone Observatories (CZO) for the Earth, to monitor all of the different parts that compose the fragile and complex domain of the Critical Zone, and to come to understand how it has worked in the past and how it is going to cope in the future with human activity. In Atrium 2, you are going to enter into one of those CZOs. We have chosen the Strengbach Observatory, set up in the Vosges near the village of Aubure, 150 kilometers from Karlsruhe. Equipped with many instruments, it has become a sort of outdoor laboratory covering eighty hectares, getting data from the top of the tree canopy to 150 meters underground.

Warning: this view of Aubure is very different from a tourist's view of a Vosges landscape. Rather, we want you to experience, as close as possible, how scientists themselves follow the behavior of some

of the phenomena making up a landscape: the water cycle, forest evolution, chemical weathering, patterns of rain, etc. Most elements that sustain this landscape are invisible, except through long-term data accumulation and close monitoring. A CZO is composed of multiple sensors that give scientists another *feel* for the land. Those are the feelings we need to share with the scientists – just as the villagers of Aubure do. You, the visitors, will become the observers. In this zone of observation you can experience how scientists observe the Earth's crust with highly technical instruments. You will discover that you too are part of the natural cycle of atmosphere, biosphere, and hydrosphere. You do not only live *on* the Earth, but *from* the Earth, and by doing so you are changing the Earth. In this way, a *feedback* is established between what we are doing to the soil we live on, and how the soil reacts to our collective action.

1 CRITICAL ZONE OBSERVATORY SPACE, 2018–20

Alexandra Arènes / Soheil Hajmirbaba (SOC – Société d'Objets Cartographiques / atelier shaā)

1.1 GEOPHYSICS STATION
1.2 BOREHOLE STATION
1.3 BEECH TREES STATION
1.4 GRAVIMETER
1.5 SPRINGS STATION
1.6 RIVERLAB STATION
1.7 WEATHER STATION
1.8 SPRUCE TREES STATION

Mixed media installation, videos, models, objects, dimensions variable
Produced in collaboration with the ZKM | Karlsruhe and SOC
And in collaboration with: the geoscientists of OZCAR network: Paul Floury (Riverlab), Jérôme Gaillardet (geochemistry), Jacques Hinderer (gravimeter), Sylvain Pasquet (geophysics), Marie-Claire Pierret (Strengbach CZO); and the OHGE laboratory

The Strengbach CZO is part of the OHGE (Observatoire Hydro-Géochimique de l'Environnement) national system of observation (CNRS founded), the French Network of Critical Zone Observatories (OZCAR), and the European infrastructure eLTER.

Film maker: Sonia Levy; sounds: Patrick Franke; maps: Alexandra Arènes and Axelle Grégoire; assistant film maker: Frédérique Vivet; animation cycles: Juliette Hamon Damourette and Sonia Levy; composer: Grégoire Lorieux; handcraft modeler: Renaud Hauray
Thanks to the LHyGeS, Strasbourg, and the IPGP, Paris, research teams

CZO SPACE: GEOPHYSICS STATION

1.1

→ The geophysics campaign during the summer 2019.

The geoseismic technique uses geophones to record seismic wave propagation when a hammer hits the ground. The soil "hears" and vibrates back as the waves propagate underground. These data are then processed to produce images of the depths of the Critical Zone. They reveal a gradient in the porosity of the rocks and soils, and highlight the thickness of these layers.

1,2 CZO SPACE: BOREHOLE STATION

→ Core samples from the CZO archived in the basement of the lab in Strasbourg. Film still from the video documentation by Sonia Levy.

The deepest water, which has sometimes weathered the rocks to sand, is visible through vertical boreholes 50 to 120 meters deep that have been drilled along two transects on each slope of the watershed. The water may be ancient – "fossilized" – and rich in minerals at these depths. Three drill cores extracted at 55, 100, and 120 meters depth are kept in the laboratory archives to analyze the mineralogical, chemical, or isotopic composition of the granite and the fractures where the water circulates.

CZO SPACE: BEECH TREES STATION

→ The gutters standing under beech trees. Film still from the video documentation by Sonia Levy.

The beech station is located on a densely wooded slope, where rainwater falling through the leaves and then seeping into the soil is collected for analysis of its chemical composition. By cross-checking this analysis with the analysis of the chemical makeup of all compartments of the Critical Zone, the circulation of nutrients such as calcium and magnesium, which sustain the vegetation, can be traced to answer the question, How do trees, rocks, soils, bacteria, fungi, and lichens exchange their nutrients to maintain life?

1,4 CZO SPACE: GRAVIMETER

→ Taking microsounds of the gravimeter.

The gravimeter station is sheltered in a secure space at the top of the Critical Zone Observatory (CZO). It measures gravity fluctuations from varying mass distributions inside the Earth. Here the variations in the soil moisture and water table level in the depths of the soil are monitored and the data is sent directly to the laboratory. The gravimeter also records the solid Earth and ocean tides, as well as the ocean waves breaking on the Atlantic coast hundreds of kilometers from the Vosges forest.

CZO SPACE: SPRINGS STATION

1,5

→ Opening the spring. Field observations, July 2019.

Four sources flow from different depths in an underground concrete chamber nestled in the middle of the watershed. They merge to supply the village of Aubure, France, with drinking water. Each spring has a specific temperature, chemical composition, and rhythm. The water pathways from raindrop to spring cross the soil until they pass through the fractures of the granitic bedrock. Here the soil is porous: it is the groundwater's recharge area, which is threatened by increasingly frequent periods of drought.

1,6 CZO SPACE: RIVERLAB STATION

→ The Strengbach stream and the tubes allowing the water to flow into the Riverlab. Film still from the video documentation by Sonia Levy.

At the outlet of the system, downstream from the watershed and near the Strengbach River, there is a room equipped as a real indoor laboratory. The River Lab is an extremely sensitive instrument which measures in real time all chemical changes occurring in the water while it flows. The apparatus is like a "cardiovascular system," with the river's water constantly flowing through the machine at the exact same speed as it does in the river, allowing the water to be analyzed and the evolution of fifteen chemical elements to be followed live every twenty minutes. Each element behaves differently and varies according to its origin, day and night rhythms, seasons, and floods. These rhythms, perceptible thanks to automatic high-frequency sampling, allow us to listen at any moment to each element, each process, which, like musical notes, enable us to recompose the river's chemical symphony.

Kosmos: Entwurf einer physischen Welt-beschreibung, 1845–62

Alexander von Humboldt

2

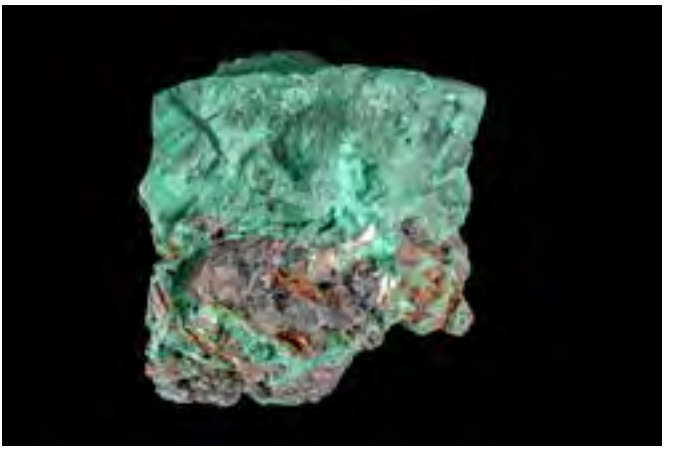
Cosmos is Alexander von Humboldt's most influential book. In it, he intended to describe the universe from the mosses to the galaxies, realizing a synthesis of the different branches of science during the nineteenth century, and to show that everything is connected by invisible mechanical and chemical forces. In this impressive but unfinished multivolume work, humans are part of a unique entity constituted by a large number of diverse agents that share reciprocal, harmonious relations. The energy that the Earth receives from the Sun controls the repartition of climates and life forms, but each place on the planet is unique, depending on local geological or topographical conditions and Earth's long-term history. Each place is a Critical Zone shaped by the geological legacy of a system in which life is the main driver.

Books, 5 vols., various formats
Deutscher Wetterdienst,
National Meteorological Library

3 Humboldt's Vision of Nature through Rocks and Minerals

Various stones and minerals from the collection of the Museum für Naturkunde – Leibniz Institute for Evolution and Biodiversity Science, Berlin

Rocks and minerals play an important role in Alexander von Humboldt's vision of nature. His background as a mining engineer never left him, but his curiosity extended to other branches of natural and human sciences. He considered rocks and their superimposition as means to better understand nature. His field observations in Europe, South America, and Russia and his network of scientific exchange led him to revise the idea of a universal succession of strata and to show the close association between volcanic rocks and mountains. Like plants, rocks are diverse, but unlike his detailed explication of plants and climate, Humboldt was far from being able to explain rocks' complexity within a global theoretical framework.



→ Malachite, provenance Russia, n. d.

FLASH POINT (TIMEKEEPER), 2018

Sarah Sze

4

Mixed media installation, wood, stainless steel, video projectors, acrylic, archival pigment prints, ceramic, and tape, dimensions variable
Private Collection

The globe makes the megalomaniac. How can we perceive the world without seeing it as, at best, a mere spectacle to enjoy or, at worst, a territory to seize by force?

Sarah Sze gives a successful answer: viewers must be *surrounded* by the artwork as they tiptoe toward it. Layer upon layer, veil upon veil, reflection upon reflection – this is how viewers can escape the dichotomy between seeing inside-out or outside-in, as if they were caught in a vortex, or pushed onto a carousel. They become "composers of space" in their own right, explicitly so when their own T-shirts are briefly visible on some of the many screens on which the projections appear, hosting this or that thing visitors will have to compose with. For, the Critical Zone cannot be escaped, cannot be judged from a distance – and this is one of the most exact characteristics of the verifiable image of the world.

OWN HORIZONS

The ground beneath our feet consists of different layers – so-called *soil horizons*. These horizons allow us to trace a history of the soil: telling the history of rain, drought, plant roots, soil organisms, all of which shape the soil and its composition.

Draw your own layers and horizons.
What conditions have shaped you?
Can one read from your soil horizon
which processes have molded you?

A

INTERVENTION

II. We don't live where we are – ghost acreages

Taking care of the land we live on would be fairly easy if we knew which land we live on! The problem is that we have no clear understanding of the soil that produces the resources out of which we gain our prosperity. There is no correspondence between the borders of our country and the real borders of the places that let us thrive – not only because we have no clear view of how the Critical Zone actually works, but also because there is a *disconnection* between the two definitions of the borders of our land. If you ask people where they live, they will give you an answer based on the map showing where their home is located. But if you ask them where are the places from which they draw their wealth, they will have to draw another map of the soil on which they rely.

This second map is called a "ghost map" or a map of "ghost acreages" (Kenneth Pomeranz). It extends much further in space and in time than a topographical map. For instance, you rely on international commerce, on a long history of colonization, but also on vast resources

of coal, oil, and gas accumulated millions of years ago, on millions of invisible life forms, and yet none of those sites, soils, beings, or populations are represented when you try to trace the borders to identify your *Heimat*. The whole idea of this exhibition is to make some effort to *superimpose* on top of one another the land *you live in* and the land *you live from*. Without such an overlap between the two, you will never know *what* to defend when you want to protect your land.

5 AN INVITATION TO DISAPPEAR, 2018

Julian Charrière

Single-channel video installation, color, sound, 76:44 min.

In this film by Julian Charrière, a linear shot travels through a seemingly endless alley. From sunrise till nightfall the camera moves in a straight line. On the side of what might appear to be an infinite highway, we can glimpse palm trees. The day finally ends and gives way to a rave without any humans. Only mosquitoes, palm tree leaves, and lights are dancing.

This no-man's rave occurs on the volcanic island of Sumbawa in Indonesia. In 1815, Mount Tambora erupted, creating a fog of dust, ash, and sulfur compounds across the globe and plunging Europe into a "Year Without a Summer." It was in fact during the aftermath of this eruption that Mary Shelley, cloistered in her home, wrote her famous novel *Frankenstein* (1818).

As pointed out by historian Dehlia Hannah – who collaborated with Charrière on this project – the present-day situation seems symmetrically reversed: we live in years without winter,[1] and on Sumbawa, the forest has been replaced by palm trees, as if they were haunting the island.

1 See Dehlia Hannah, ed., *A Year Without a Winter* (New York: Columbia Books on Architecture and the City, 2019).

FUTURE FOSSIL SPACES, 2017

6

Julian Charrière

Unlike ZKM | Karlsruhe's pillars, which are made of concrete, the columns of *Future Fossil Spaces* by Julian Charrière are made of salt and its resulting lithium brine. The origin of the materials is particularly important in this case: they have been extracted from the Salar de Uyuni, the world's largest salt flat, located in the Bolivian Andes. This white desert is said to contain about one-third of the world's reserves of lithium, a chemical element which is key in the manufacture of batteries for electric vehicles and digital devices.

The reserves of these pristine lands remain largely unexploited for the moment. Keeping in mind the economic potential of their exploitation for our technologies, one must ask how long this will be the case. The columns become monuments, standing above the ground to commemorate *now* the extraction holes that are likely to be produced in Salar de Uyuni in the time to come.

Installation, lithium deposit and salt lumps, dimensions variable
DITTRICH & SCHLECHTRIEM, Berlin
RICK COLLECTION
Studio Julian Charrière

7 THE NAMING OF A RIVER, 2014–18

Xinhao Cheng

The Naming of a River is a poetic investigation into time and space and their interactions through the artist's attempts to name the Panlong River. Because a river is a sophisticated time-space complex, Xinhao Cheng tries to define the present moment, observing and capturing the river in its different dimensions – as an evolving system, as a habitat to different species, as a part of the human infrastructure. But how to capture and represent something that is constantly evolving?

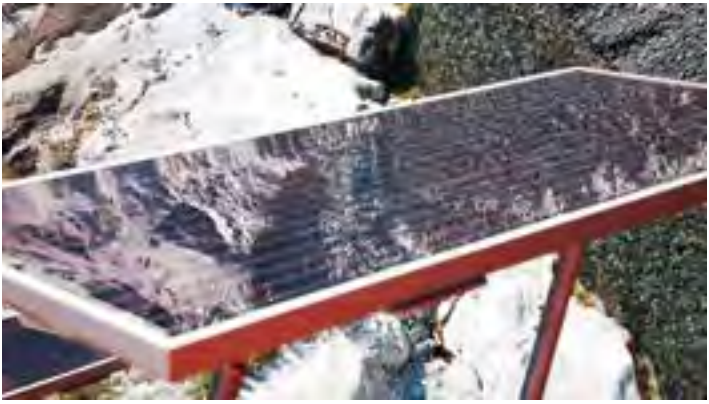
"The river presents itself so differently at various times and spaces, and thrives on every one of them. Therefore what I can feel about the river is only its projection within my lifetime and my living quarters, and apparently a metamorphic slice. I tried to be objective towards naming it, but all I obtained is still the most personal treasures. These pieces of my treasure are the specimens about the river in various time/space dimensions. They interweave and consolidate into another equally complex river – a river named by me."[1]

1 Xinhao Cheng, *The Naming of a River* (Jiazazhi Press, 2016).

Mixed media installation, dimensions variable

FRAME OF REFERENCE, 2020

Yu Hsin Su



Two-channel video installation, color, sound, 11:10 min.
Produced in collaboration with the ZKM | Karlsruhe

Yu Hsin Su undertook a residency at the Critical Zones Observatory (CZO) in the Taroko Gorge, Taiwan, which records some of the fastest rates of erosion in the world. Su looked at the infrastructure that is being built to monitor landslides and river erosion in the local catchment of the Liwu river. She paid special attention to the means of telecommunication that allow data to be transferred to the GFZ German Research Centre for Geosciences, where it can be studied. The video installation explores the nature of the CZO as a network between an indoor lab and the exterior field study.

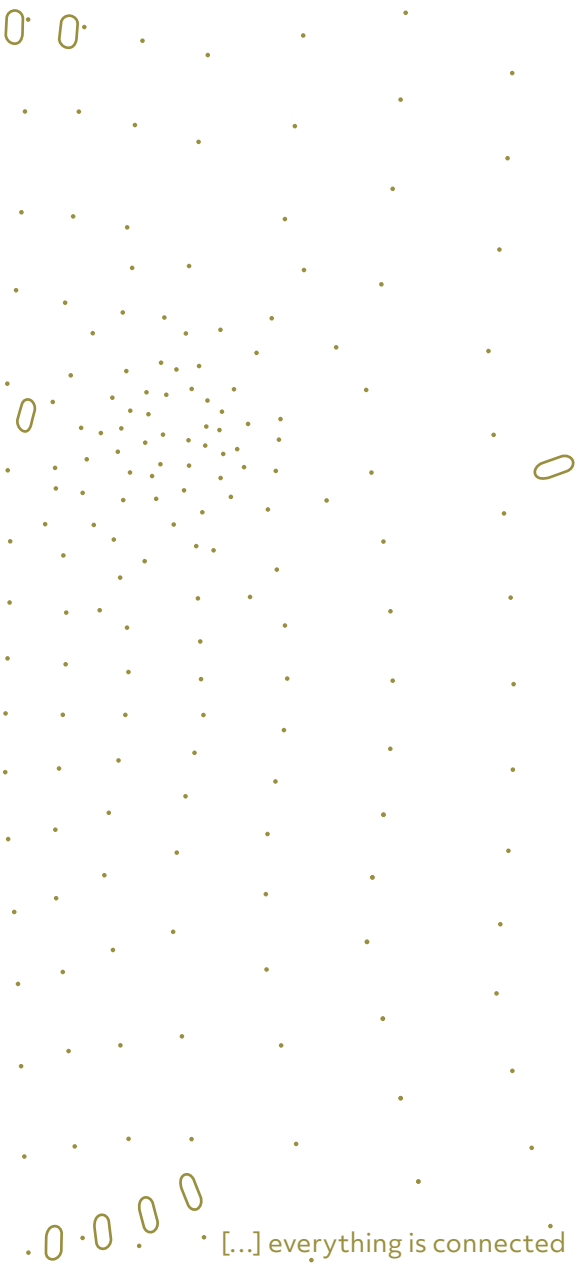
"With the disappearance of [the] metaphysical Globe, I am interested in the shift from [the] 'view from everywhere and nowhere' to [the] 'view from within,' and examine the infrastructure of [the] view from within. How do those sensory instruments form images within [the Critical Zone] and facilitate relationships between different materials and events at different scales?" (Yu Hsin Su)

MAP OF DEPENDENCIES

Reach for an object that is in your pocket or on your body. Write down a list or draw a map of its dependencies:

- From what and by whom was this object created?
- What path did it take, and who was involved in that path?
- How did it finally become yours, and what does it mean to you?

Maybe you will become aware of new connections: resources, landscapes, people, places, knowledge, power relations, institutions, paths, and yourself.



[…] everything is connected to *something*, which is connected to *something* else.

(after Thom van Dooren and Donna Haraway)

9 SOIL AFFINITIES, 2018–20

Uriel Orlow

Soil Affinities takes as its starting point the nineteenth-century agricultural past of the Paris suburb Aubervilliers, which ended when factories started to take over, workers' gardens replaced fields, and European countries began to develop colonial agriculture in Africa. From 1900, cocoa beans, coffee beans, and peanuts would be shipped from the Americas to the colonial experimental garden in Paris, and from there to the newly set up experimental gardens in Senegal and elsewhere in West Africa, using specially designed greenhouse transport boxes. The African experimental gardens started cultivating European staples such as tomatoes, peppers, onions, and cabbage. The cultivation of these vegetables took off after independence in 1960 and European companies created industrial farms in West Africa, which produce almost exclusively for the European wholesale markets.

The installation traces networks of terrestrial connections between plants and people across different geographies and temporalities.

Mixed media installation, wooden boxes, archival pigment prints, 5 videos, dimensions variable
Courtesy Uriel Orlow, Mor Charpentier, Paris, and ZKM | Karlsruhe

RAÍZ AÉREA (AERIAL ROOT), 2020

10

Edith Morales

Mixed media installation, corn grains, video, color, sound, dimensions variable
Courtesy Edith Morales and Parallel Oaxaca
Produced in collaboration with the ZKM | Karlsruhe

The maize *olotón* has the ability to fertilize itself. It develops aerial roots that produce a gel in which bacteria live, pulling nitrogen from the air and making it usable for the plant. This ability evolved in a shared effort between indigenous communities of Oaxaca, Mexico, and the plant in a millenary process of selection and planting carried out by farmers over generations. In 2018, US scientists and the transnational biochemical industry took notice of this so-called miracle corn and plan to patent it as a biofertilizer by breeding it into a commercial corn to reduce the use of synthetic fertilizers – the leading cause of water pollution.

But how to ensure that indigenous communities equitably benefit when research scientists and multinational corporations commercialize their local crops and plants? Are their rights safeguarded? The case brings to mind the practice of biopiracy, the exploitation of indigenous knowledge and biological resources without legal agreements.

11 WILD RELATIVES, 2018

Jumana Manna

Single-channel video, color, sound, 66 min.

In 2012 seeds were removed for the first time from the Svalbard Global Seed Vault beneath Arctic permafrost, a backup facility for safekeeping crops from gene banks across the world. Because the Syrian revolution had escalated into a state of war, an agricultural research center in Aleppo was forced to relocate to Lebanon, leaving behind its gene bank. By taking out their back-up seeds from Svalbard, the researchers could start to cultivate their collection again and then return the seeds later.

The transaction of the seeds has a lot to tell: from the Syrian revolution in 2011, followed by a violent war, to the industrialization of farming and the monopolization of the crop market during the so-called Green Revolution in the mid-twentieth century, which caused a tremendous decline of biodiversity; to the change of climatic parameters due to human action in the Arctic and in the Levant; to the forced migration of seeds, as well as humans.

KUANERSUIT | KVANEFJELD, PHASE II, 2018–ONGOING

Lise Autogena / Joshua Portway

With the melting of its inland ice, Greenland has become a disputed territory in the global struggle for natural resources. By increasing the income from mineral extraction, it is hoping to fast-track national independence and rid itself of old colonial ties to Denmark; but in the process, it is entering a world of new interdependencies and power relationships, with unpredictable and possibly catastrophic consequences.

Mixed media installation, dimensions variable
Produced in collaboration with the ZKM | Karlsruhe

The artists are interested in the debate around the proposed mining of Kvanefjeld Mountain, one of the richest rare earth and uranium deposits in the world. Their ongoing project examines the tensions produced by the proposed mine, and explores the difficult trade-offs faced by a culture seeking to escape its colonial past and to define its own identity. In their work, they present an array of richly interconnected artifacts that constitute a web of relationships between local politics, global finance, science, history, culture, and sheep – a fractal narrative of a town that is simultaneously at the edge of the world and at the center of it.

13 OCEANS IN TRANSFORMATION, THE ARCHITECTURE OF THE CONTINENTAL SHELF, 2019–20

Territorial Agency

Seven-channel video installation, color, dimensions variable

"The ocean is a sensorium: it records the transformations of the Earth in its complex dynamics, and it inscribes back its cycles into the dynamics of life-forms. The global ocean is changing its circulations, energies, interactions, and ecologies. It is the most dynamic and sensitive component of our living planet, yet the most unknown. The ocean is in a new phase of its dynamic history, shaped by intensifications of the impact of human activities – the Anthropocene." [1]

The continental shelves of the oceans are being transformed into a complex architecture of extraction, where fossil resources are being extracted at greater and greater risk, where excessive fishing is depleting the livelihood of marine life, and where the plowing of the seabed through trawling is rearranging the sedimentary strata and eradicating life.

How can we imagine the continental shelves other than as an exclusive extraction zone? How can we engage with its architectures of invisibility? How can we be sensitive to an ocean in transformation?

1 https://www.territorialagency.com/oceans

PROSPECTING OCEAN, 2018

14

Armin Linke

Armin Linke's film is the result of a three-year investigation into the future of the oceans. It is mediated by legislation intended to reconcile the conflicting interests of scientific exploration, commercial extraction, and environmental protection. Interviews with scientists, glimpses into international conferences, and actions by local activist groups in Papua New Guinea are accompanied by a monitor displaying commentaries, thus making visible the complex network of interdependencies among the different actors involved in the decision making about and investigation into the future of the oceans.

The global oceans are one of the most unexplored parts of the Critical Zone. They fulfill an essential role in maintaining the homeostasis of the planet. How will the "new global gold rush" of deep-sea mining affect the health of the planet in the future? How can we prevent it from resembling past paradigms of conflict over resource exploration, including the marginalization of indigenous peoples and their rights and disregard for environmental and social implications?

Two-channel video installation, color, sound, ca. 56 min.

15 THE WEIGHT OF SCARS, 2015
Otobong Nkanga

Woven textile and photography, inkjet print on viscose, wool, mohair, bio cotton and laser cut forex plates, 2.53 × 6.12 m
Courtesy Otobong Nkanga & Galerie In Situ-fabienne leclerc, Grand Paris JM Decrop, Hong Kong

Consisting of four woven textile panels that hold ten circular photographs, *The Weight of Scars* refers to the use of land, the natural resources found there, and its cultural value. After traveling to one of Namibia's oldest mines, the Tsumeb Mine, Otobong Nkanga studied the scars on this landscape. Until 1996 a large number of rare minerals had been mined there. The photographs make visible the remaining traces of this extraction today and the landscape's transformation through human intervention.

"When you see [...] the kind of scars we have in our landscape, how come we are not able [...] to make very big decisions about reducing certain things that we do? There is a kind of psychological state in which we all are, and I am also part of it. We are drug addicts in a way, and the drug is the resources. [...] If we start thinking in such a way, that we're that connected and that we are also part of elements that are in the soil, we will maybe think of the way we work within our landscape differently." [1]

1 Otobong Nkanga, "Imagining the Scars of a Landscape," interview for Tate, October 17, 2019, https://www.youtube.com/watch?v=qZZruEToDCI.

CINÉ-CIPÓ – CINE-LIANA, ATTO AMAZON TALL TOWER OBSERVATORY, 2019–20

Barbara Marcel

The ATTO is an international scientific project studying the complex interactions between the forest, soils, and the atmosphere in order to understand the role of the Amazon basin within the Earth system. In her video work Barbara Marcel observes the daily life of the ATTO observatory's scientists and two local women activists as they produce a radio piece that communicates different forms of knowledge, visions, but also threats concerning the Amazon.

Within this joint venture, different perspectives and knowledge systems challenge the veracity of universal assumptions about science and society, and multiply the modes of engaging, understanding, and living within the Critical Zone.

Four-channel video installation, color, sound, ca. 90 min., dimensions variable
Barbara Marcel with Natalina do Carmo Oliveira, Milena Raquel Tupinambá
Produced in collaboration with the ZKM | Karlsruhe

Direction and production: Barbara Marcel; Image: Felipe Frozza, Barbara Marcel; Direct sound: Anne Santos; Set production: Kandyê Medina, Thais Helena Medeiros, Bruna Bichara; Editing: Célia Freitas, edt.; Editing assistance: Beatriz Krieger, Felipe Frozza; Sound mixing: Sarah Lelièvre; Colorist: Guilherme Begué; Finishing editor: Beatriz Krieger; Music: Suraras do Tapajós

Funded by: Instituto Serrapilheira, Max Planck Institute for Biogeochemistry Jena

Supported by: INPA-National Institute of Amazonian Research, Goethe-Institut São Paulo, Casa Bicho

The ATTO project is funded by: German Federal Ministry of Education and Research (BMBF), Brazilian Ministry of Science, Technology and Innovations, Max Planck Society, Finep, Fapeam, and Fundação Eliseu Alves.

III. WE LIVE INSIDE GAIA

Taking care of the Earth is very difficult: we have no feeling for what it is made of or how it reacts to our actions. If you have to build a wall of bricks, you anticipate a whole range of attitudes and gestures, because you know how the bricks will react and how much they will weigh. But it is obviously very different if you have to hold a party with a hundred guests: you will have to anticipate a whole different set of gestures and attitudes, and be prepared for the surprising reactions of people of different ages and personalities, who will have different moods and behave unexpectedly. In a way, the same contrast exists depending on whether you think you live in "the natural world" or you think you live "in Gaia."

Gaia is the surprising concept defined many years ago by James Lovelock with the help of Lynn Margulis: if you wish to study the material world in the Critical Zone, you should also *include the ways life-forms behave*; and, conversely, if you wish to understand bacteria, plants, and animals, then you should consider how they have engineered the material world in which they reside. For instance, the very oxygen you breathe is not a given feature of the material world;

it is the result of the activity of bacteria and plants. In other words, inside the Critical Zone, every single element – rocks, gas, minerals, water, atmosphere, soil – has been modified by the action of life forms. To assume a separation in this respect would be like separating a termite mound from the activity of termites, or a beaver dam from the action of beavers. This also implies to reconsider natural history museums, which play a decisive role in mediating and popularizing the perception of and our relation to what we are used to call the "natural world."

To shift from "nature" to "Gaia" allows us to land on a completely different territory and to look differently at how life-forms have created the habitability condition for other life-forms. And humans should learn how to prolong or improve these habitability conditions, not destroy them.

17 Letter from Abe Silverstein (NASA) to James Lovelock, 1961

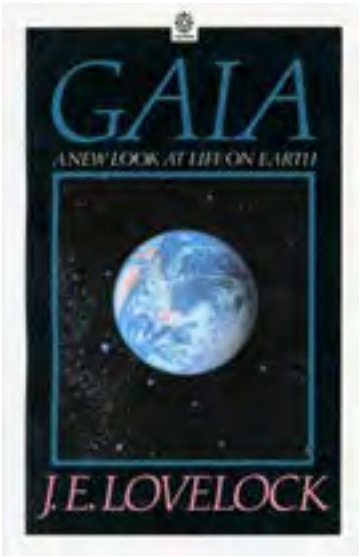
In his autobiography, James Lovelock recalls the moment when he received the invitation from NASA: "It was an invitation to join a party of scientists who were about to explore the moon. [...] Here was a serious person asking me to join with others in what a few years back would have been science fiction." [1] Lovelock has ceaselessly stressed the importance of his work for NASA. It enabled him to leave his job as a chemical engineer to establish himself as an "independent scientist," as he calls it. His work for NASA was also an important starting point for the Gaia hypothesis since, as he always says, it was in this context that he started thinking about ways to detect life on other planets: this paved the way for the landmark paper on the Gaia hypothesis, highlighting life's massive influence on the terrestrial environment.[2] But Lovelock was first and foremost invited by NASA not to think about experiments to detect life, but to invent chemical instruments that would equip space missions, and for which his expertise remained unmatched worldwide.

Letter (reproduction)
Courtesy James Lovelock, Science Museum, Science & Society Picture Library

1 James Lovelock, *Homage to Gaia: The Life of an Independent Scientist* (Oxford: Oxford University Press, 2000), 144.
2 James Lovelock, "Gaia as seen through the atmosphere," *Atmospheric Environment* 6, no. 8 (1972): 579f.

GAIA: A NEW LOOK AT LIFE ON EARTH, 1987

James Lovelock



Book
ZKM | Karlsruhe

James Lovelock is a practical chemist and engineer. His talent for inventing new instruments capable of measuring chemical substances in trace quantities led to his decisive contributions to various fields such as analytic chemistry, biochemistry, cryobiology, and atmospheric chemistry. In the 1960s and 1970s, while Lovelock was working at chemical industries and for scientific institutions, he made numerous chemical measures – of ozone, nitrous oxides, etc. – on the shore of Ireland's beaches, or onboard oceanic vessels or stratospheric aircrafts. This research put him at the center of reflections on emerging global pollution issues, from acid rain to the hole in the ozone layer. Alongside his collaboration with Lynn Margulis, these chemical works were decisive for the writing of his influential book, *Gaia: A New Look at Life on Earth* (first edition: 1979). *Gaia* has since had profound consequences on the Earth and life sciences at large, our philosophical conception of nature, and our political approaches to environmental issues..

19 Letter from Nigel Williams (Nature) to Lynn Margulis, 1984

Fourteen journals rejected the seminal paper "On the Origin of Mitosing Cells" by Lynn Margulis (then: Sagan) before its publication in 1967. The Gaia writings of James Lovelock and Margulis also encountered early rejection and sustained opposition throughout the 1970s and 1980s. Their collaborative work began to appear in sympathetic journals in 1974 and was featured by *CoEvolution Quarterly* in the summer of 1975. By the end of the 1970s, with the publication of Lovelock's first book, *Gaia: A New Look at Life on Earth*, Lovelock and Margulis had learned how to cultivate their own scientific and popular audiences. Nevertheless, this rejection letter from the journal *Nature* sent to Margulis in 1984 shows a continuing resistance to the Gaia concept in mainstream science periodicals. Margulis worked closely with Lovelock to develop his second book, *The Ages of Gaia: A Biography of Our Living Earth*. Its publication in 1988 marks the beginning of the end of Gaia's outright rejection as a scientific idea.


nature

Letter (Preproduction)
Science Museum /
Science & Society Picture
Library

GAIA: THE EARTH SYSTEM, N. D.

James Lovelock

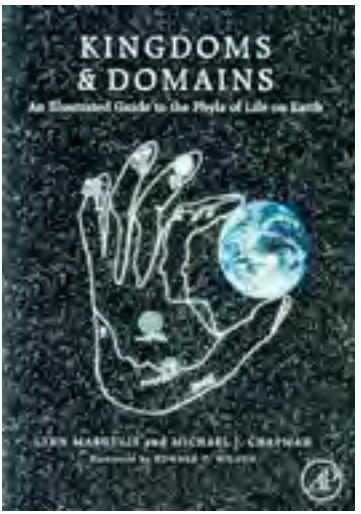
Illustration (reproduction) Courtesy James Lovelock, Science Museum, Science & Society Picture Library

James Lovelock and Lynn Margulis's major achievement is their discovery of Gaia, or the Earth system. This entity was defined as being constituted by "the biosphere and all of those parts of the Earth with which it actively interacts." [1] Lovelock and Margulis used "life" or "all living beings" interchangeably with the term "biosphere". "Life" was thus the largest biological entity on Earth, which had not yet been studied by biologists nor scientists at large until Lovelock compared Gaia with an organism. As depicted here, he also often compared it with thermostats and cybernetic systems: with organisms, they share the important property of being regulated. Toward the end of the eighteenth century, the recognition of a new entity – biological organisms – and the correlative replacement of natural history's tripartition – animal, vegetal, mineral – by the bipartition living/nonliving led to the constitution of biology as a discipline. Similarly, here, the recognition of a new object – Gaia, or the Earth system – paved the way for the Earth system sciences.

1 James Lovelock and Lynn Margulis, "Atmospheric homeostasis by and for the biosphere: the gaia hypothesis," *Tellus* 26, nos. 1–2 (1974): 2–10, here 3

21 KINGDOMS & DOMAINS: AN ILLUSTRATED GUIDE TO THE PHYLA OF LIFE ON EARTH, 1982

Lynn Margulis / Michael J. Chapman



Book
Estate of Lynn Margulis

Lynn Margulis's foremost scientific contribution is the serial endosymbiosis theory. This theory now has ample evidence to show that all animals, fungi, and plants descend from an ancient series of bacterial mergers to form the eukaryotic or nucleated cell. Moreover, sexual reproduction itself evolved only after the long evolution of the nucleated cell. Margulis's central contribution to the Gaia hypothesis, in collaboration with James Lovelock, was her addition of deep time, or "big history," in tracing the Gaian system to its emergence in the bacterial biosphere of early life. Writing with her son Dorion Sagan, Margulis has presented her ideas to general readers in a series of popular volumes. In *What Is Life?*, they write: "Chance mutations, blind and undirected, are touted as the leading source of evolutionary novelty. We [...] do not entirely agree. Great gaps in evolution have been leaped by symbiotic incorporation of previously refined components." [1]

1 Lynn Margulis and Dorion Sagan, *What Is Life?* (Berkeley and Los Angeles, CA: University of California Press, 2000), 8f.

THE ARTS OF NOTICING

We know more about the surface of Mars than about some places on Earth. Time to explore the Critical Zone confidently on your own! Here is one possible guide for experiencing the life that surrounds you – an exercise in the art of noticing. Take this *Fieldbook* on your journey through the Critical Zone!

1. Look for a spot off the beaten track: on a field, in a forest, underneath a tree.
2. Take a moment to simply be.
3. Take a close look at your surroundings. What do you see? What do you hear? What do you smell?
4. Imagine what is happening a kilometer below the soles of your feet, down in the earth.
5. Next time you see an insect, take a moment to observe it. Follow it wherever it goes and keep a record of your discoveries.
6. Imagine being connected to everything you are perceiving right now.

These beautiful books have offered us a lot of inspiration. You may find a selection at the ZKM shop:

Vinciane Despret. *What Would Animals Say If We Asked the Right Questions*. Minneapolis: University of Minnesota Press, 2016.

Alexander von Humboldt. *Views of Nature* [1808], ed. Stephen T. Jackson and Laura Dassow Walls, trans. Mark M. Person. Chicago: University of Chicago Press, 2014.

Carla McRae und Catherine Ard. *Let's Play Outdoors! Exploring Nature for Children*. Berlin: Gestalten, 2020.

The Mindfulness Project (Autumn Totton and Alexandra Frey). *Into Nature: A Creative Field Guide and Journal*. New York: The Experiment, 2018.

Anna Lowenhaupt Tsing. *The Mushroom at the End of the World: On the Possibility of Life in Capitalist Ruins*. Princeton: Princeton University Press, 2015.

22 Stromatolites, ca. 290 million years old

Stromatolites (Greek: *strōma* = layer, *lithos* = stone) are one of the oldest life-forms on our planet. They are referred to as biosedimentary formations because they have been formed by the periodic growth of microorganisms. They represent not a fossil organism, but merely the product of biological activity. Photosynthetic cyanobacteria produce a slimy biofilm that captures particles of sediment. Both are then turned into a thin layer of limestone through the metabolism of cyanobacteria.

→ Stromatolite, ca. 290 million years old. Longitudinal section, 22 × 11 cm. Rhineland-Palatinate.

Stromatolites are survivors from the very early days of life on Earth and existed over 3.5 billion years ago (during the Precambrian era). They are probably the earliest evidence of life that could have been visible to the naked eye. At that time cyanobacteria started to produce oxygen on a larger scale, forming the oxygen atmosphere and the ozone layer. That caused a crisis for life-forms adapted to an oxygen-free environment but simultaneously became a prerequisite for the development of eukaryotes and multicellular life-forms.

7 stratified limestones, dimensions variable
Senckenberg Research Institute and Natural History Museum in Frankfurt am Main

SYMBIOGENESIS THROUGH FERTILIZATION ACROSS KINGDOMS, N. D.

Single-channel video, digitized, color, sound, 01:39 min.,
Archival Source: Voices of Oxford
All video material kindly provided by Bruce Clarke
and John Feldman
Estate of Lynn Margulis

"Neo-Darwinism took the life out of biology." [1] What does Lynn Margulis mean by this? Darwin himself could not account for the source of variations, that is, for the heritable changes that occasionally survive elimination by natural selection. What he could affirm was that "novelty" happened, and thus gave "nature" something to "select." The theoretical argument here centers on a modern disagreement over the main source of variations.

Neo-Darwinists posit that variations result from genetic mutations, some few of which, over the eons, yield beneficial changes. Margulis presses the counter-argument that symbiogenesis – as seen in the mergers among pre-evolved symbionts that gave rise to the eukaryotic cell – is the more positive and pervasive process. This debate pits molecular biology's genetic view of life as rooted in the structure of DNA versus organismal biology's epigenetic focus on the living body, or phenotype, and its symbioses. Margulis means that neo-Darwinism has marginalized the living body.

1 Lynn Margulis in the film *Symbiotic Earth* (2017) by John Feldman.

24 THE TISSUE OF GAIA, 1993

The landscape of the Ebro Delta on the Spanish coast of the Mediterranean models the Archean eon three billion years ago, when bacteria were the only form of life. Lynn Margulis cuts a piece from the sandy mat: this is "the tissue of Gaia."[1] She explains that within this coastal ecosystem, the green layer is cyanobacteria. These are the "masters of the world," for all they need to flourish is sunlight, water, and CO_2. The photosynthetic cyanobacteria are the primary producers, the food supply for the entire biosphere. Their descendants are the chloroplasts that carry out photosynthesis inside all plant bodies. The bacterial residents of the mat use the wastes of neighboring but different bacteria for their own food. Such coevolutionary arrangements solve the recycling problem within the bacterial biosphere. The tissue of Gaia teaches us to integrate human activities more fully with the global environment by perfecting our own recycling arrangements. After all, "garbage never goes out, it just goes around."

1 Here and the following Lynn Margulis in the film *The Tissue of Gaia* (1993).

Single-channel video, digitized, color, sound, 07:41 Min.
Archive NHK TV
All video material kindly provided by Bruce Clarke and John Feldman
Estate of Lynn Margulis

GARDEN OF FORKING PATHS (SERIES); MITOSIS SCORE, 2019

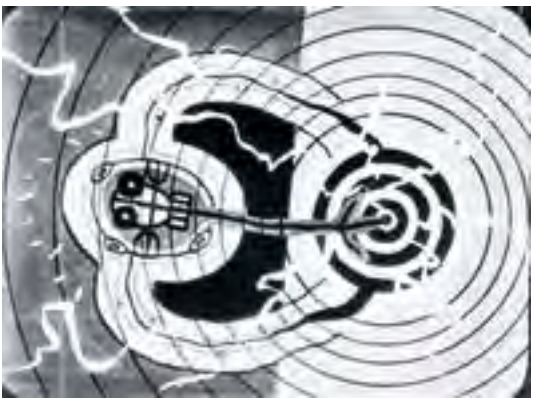
Gemma Anderson

Drawings, pencil, watercolor, and color pencil on paper, 29.7 × 42 cm

Gemma Anderson's work is based on collaborative drawings with scientists. Through "relational process drawings" she has developed a new approach to depict natural history. Rather than focusing on the morphology of the object, these drawings focus on the dynamic patterns of the processes of life and draw together relationships between energy, time, movement, and environment at the molecular, cellular, and organismal scale.

The processes drawn here are co-dependent and nested: protein folding is essential to cell division (mitosis), which is essential to the development of the embryo of the cell (embryogenesis). Each process is intrinsically and reciprocally related to many others. The artistic view of this delicate, beyond visible, dynamic procedure allows us not only to see scientific data collated into images on a screen but to explore the entire process of cell division in one connected image and to think of it in different terms – as a dance, a score, an energetic form.

26 TUSALAVA, 1929
Len Lye



35 mm film, digitized, b/w, silent, 10 min.
The Len Lye Foundation
Digital version from material preserved and made available by Ngā Taonga Sound & Vision

This experimental animated film was conceived by Len Lye as the first of a trilogy of films about "the beginnings of organic life." Lye drew inspiration for it partly from Aboriginal art from his own region (New Zealand, Samoa, Australia). The film's title originated from the Samoan phrase *tusa lava*, suggesting that "in the end, everything is just the same" — in other words, things go full circle. In the film, wriggling forms evolve into more complex shapes by interacting with each other. This leads to confrontation: one species consumes the other in the end, but paradoxically it annihilates itself in the process.

Lye described *Tusalava* as "life among the microbes" and compared his imagery with that seen through a microscope. Later, he came to regard it even as an intuitive vision of "antibodies and microphages." The artist poses several questions that lead to an understanding of life processes: Is the interaction between different organisms, whether mutualistic or parasitic, the driving force for evolution? What ways of cohabitation can allow us to survive in the Critical Zone?

OBJECTIVITY [TENTATIVE], 2010–ONGOING

27

Nurit Bar-Shai

Nurit Bar-Shai's work *Objectivity [tentative]* is a series of experiments and interventions with "smart" bacteria, drawing a link between microbial morphogenesis and designed ecosystems, between structure and behavior. Bar-Shai synthesizes traditional lab techniques and artistic inquiries to visualize the "chemical tweets" of microbial morphogenesis, as well as the complex network and communication systems reflected in microbes' advanced social behavior and decision-making, while developing colonies with elaborate architectural arrangements.

The body of work exhibited includes Petri plates with treated bacteria, including some from Bar-Shai's *Soundscapes* series, and uses pure sound waves and a range of frequencies to initiate sound-generated topographies for bacterial growth. The outcome is a visual representation of a fleeting moment of bacterial communication fixed in time, reflected in the development of masterful patterns.

Installation, petri-plates, nutrient media,
lifeless microorganism, dimensions variable

D

ENCOUNTERS

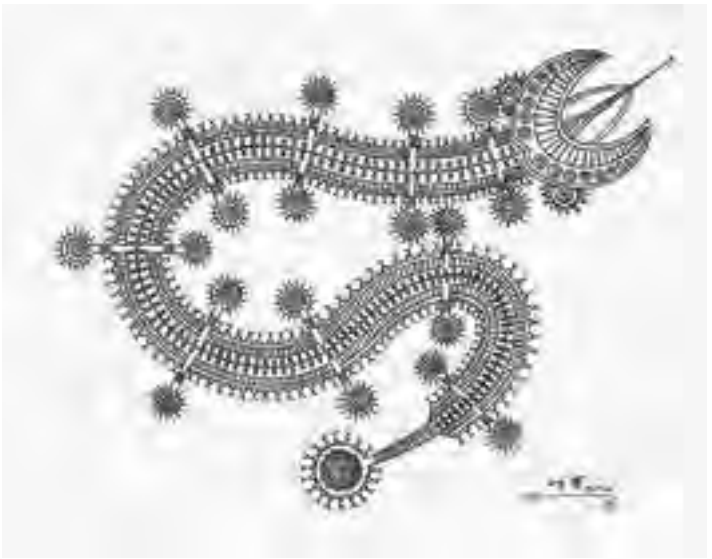
Make a list of every nonhuman living being you have encountered in the past seven days.

MY MEMORY, 2017

Cemelesai Dakivali (Arsai)

With their tentacles, their sinuous shapes and their mandibles, the strange creatures envisioned by the artist Cemelesai Dakivali float on the pages of the drawings with a disquieting air.

The artist has had a strange experience. Around three years ago, in the South of Taiwan, a group of young people from his tribe contracted a mysterious disease after a field research in their traditional territories. This incident reminded Dakivali of the legends told by elders that certain territories should be protected from any human intervention. He drew large-scale versions of the viruses and creatures released from wildlife as a reaction to human intrusion. In doing so, he reverses the logic of the invasive species, where humans venturing in the forest are the main factor of disruption and are attacked back in a retroactive loop.



Series of drawings, ca. 21 × 29.7 cm

29 SWAMP OBSERVATORY, 2020

Gediminas & Nomeda Urbonas

→ Installation model for the exhibition *Critical Zones*.

In a time marked by radical instability and threats of total war and environmental collapse, the *Swamp Observatory* illuminates the vital urgency of human cohabitation with other forms of life. The swamp offers an opportunity to test the idea of sympoiesis – coming together in order to find a new ethos of coexistence, a direction that stems from the act of recognizing the poetic power of the ecologies surrounding us.

Through four swampian figures – Swamp Brain, Biotope Model, Time Stack, and Olfactory Crevasse – the *Swamp Observatory* grows into a parasitic structure on the architectural envelope of the ZKM | Karlsruhe exhibition space. As an altered sensorial organism that acts beyond exclusive human control, it drags the audience into a holobiontic relationship between natural, cultural, material, and immaterial swampian nodes.

The project is an outgrowth of the Swamp School – a future learning environment that embraces the swamp as an evocative form of primordial technology.

4 swamp figures: Swamp Brain, Biotope Model, Time Stack, Olfactory Crevasse

Mixed media installation, data visualization, AI projection, computer rendering, peat from the Neman delta, ox bladder, cast resin

Produced in collaboration with the MIT Climate Visions, Cambridge, MA, and the ZKM | Karlsruhe

Concept: Nomeda & Gediminas Urbonas;
Research team: Nikola Bojić, Kristupas Sabolius;
Architecture: Indrė Umbrasaitė;
Fabrication: Rytis Urbanskas, Simona Kačinskaitė;
Drawings: Serge Rompza;
Scientific advisors and data: Vesta Aleknavičiūtė / Vytautas Magnus University / Kaunas, Lithuania, Jūratė Sendžikaitė / Nature Research Centre, Institute of Botany / Vilnius, Lithuania;
Processing programming: Thomas Sanchez Lengeling / MIT Media Lab;
AI module: Jonas Kubilius / Three Thirds / Vilnius, Lithuania;
Smell: Jurga Katakinaitė-Jakubauskienė and Reda Valentinavičienė;
Supported by: Arts at MIT and Philip Khoury, Associate Provost for the Arts, Gintaras Rapkauskas and Sigita Kantautienė / Durpeta UAB / Šepeta, Lithuania

30 SOUVENIRS ENTOMOLOGIQUES #1; ODONATA/WEATHERING DATA, 2020

Sybille Neumeyer

Souvenirs entomologiques [Entomological memories] is an inquiry into the lives and histories of insects and spiders. On their journeys from habitat to natural history museums and into datasets, organisms undergo many metamorphoses: they become specimens, taxons, metaphors, bioindicators, models, and data points. The series of video essays examines how politics of collection, concepts of nature, technologies and cartographies co-evolve along these transfers. In times of increasingly disturbed ecosystems insects emerge as central protagonists: caterpillars and bugs survey ecological niches while dragonflies indicate the health status of aquatic ecosystems, and the enormous decline in insect biomass forecasts further extinctions. Following the idea of weaving, *Souvenirs entomologiques* speaks to the interconnectedness of arthropod and human worlds and reappraises processes of mapping and monitoring natural histories and ecological futures. *#1; Odonata/Weathering data* traces the entanglements of humans, insects and clouds by following the journeys of dragonflies.

Mixed media installation, single-channel video, color, sound, 19:43 min., 3 emergence trap sculptures, 6 insect drawers with specimen from the SMNK
Produced in collaboration with the ZKM | Karlsruhe and the SMNK – State Museum of Natural History Karlsruhe
In dialog with Dr. Hubert Höfer, Lukas Kirschey, Dr. Andreas Martens, Dr. Tahani Nadim, Dr. Alexander Riedel, Dr. Manfred Verhaagh

FOR THE LOVE OF CORALS, 2018–ONGOING

Sonia Levy

Two-channel video installation, color, sound, 25:40 min.

Corals are highly endangered due to rising sea temperature and acidification. Within this context, the Horniman Museum and Gardens in London has become a pioneer in breeding certain coral species in vitro by stimulating their sexual reproduction. Sonia Levy takes us into the basement of the museum, into the labs where the scientists breed the corals. In her film she pays equal attention to the corals, the instruments used in the process, and the scientists meticulously taking care of them.

In a time of massive destruction of living things and habitats, natural history museums have become a place where the once familiar – animals and plants of our childhood – is haunting us. What is the responsibility of a natural history museum in an accelerated present and past? The term "conservation of a species" may change its meaning in this context. Should museums keep displaying extinct species, or should they attempt to help preserve species from extinction? And therefore redefine our perception and relation to what we used to call nature?

32 Cyanotypes taken from photographs of British algae; cyanotype impressions, vol. 1 (1843)

Anna Atkins

Anna Atkins was the first person to illustrate a book with photographic images. In *Photographs of British Algae: Cyanotype Impressions* (1843) she captured ferns and other plant species using the technique of cyanotype. The process, also known as blueprinting, uses light exposure and simple chemical processes that resulted, in Atkins's case, in detailed blueprints of various botanical species. Her work is characterized by her sense of color and composition and the connection between art and science. It is believed that there are only twenty copies of this publication in total, of which only fifteen are preserved in their entirety. The photographic reproductions of Atkins's handwriting, which wind like algae along the edge of the cyanotypes, endow the individual sheets with a personal signature.

→ Anna Atkins, *Chorda filum*, 1843. Cyanotype, 25.3 × 20 cm. From *Photographs of British Algae: Cyanotype Impressions*, vol. 1 (1843).

NATURALIS HISTORIA, 2017

Pauline Julier

→ Pauline Julier, *Le plus vieux paysage du monde #1*, 2017. Film, 11:20 min. Film still.

Mixed media installation, dimensions variable

This installation oscillates between a personal travel diary and a documentary study. Each story in the installation explores a situation where humans are confronted with a version of "nature," and reveals obsessions as well as uncertainties. It began when Julier learned of a 300-million-year-old fossilized forest, discovered in 2010 in a coal mine in northern China. The artist was fascinated by the long time period separating the two eras. At the same moment, she was also writing on the sinking of the Tuvalu Islands, located in the Pacific Ocean. Between the vanishing of an island and the appearance of a fossilized forest, she saw unexpected connections.

As Julier points out: "I want to stress how much the concepts that are used to organize the diversity of the world are our own; we produce them and with them the risk of emptying the world of its essence by freezing it in a catalogue of images, landscapes, definitions [...]. It is the same movement as that of the volcano that snuffs out life by freezing a forest or city in place. The same drive as that of the photographic image which slices up the 'real' and thus plays a part in holding in place a world to be seen and understood." [1]

1 Pauline Julier, "Works: *Naturalis Historia*," http://paulinejulier.com/works_detail/naturalis-historia.

IV. EARTH TIDINGS

Erdkunde (Earth tidings) was an extravagant dream of Romantic science and art. According to this dream, Earth gives tidings to those who listen. Most urgently, it conveys intelligence about where we are and when we are. It gives these locally, as *this* terrain at *this* specific point in time, as *this* landscape beheld as the epiphany of *this* experience. Each earthly place expresses itself in the strata of its development in time. Looking into the hidden recesses of the Earth – into mines, caves, and craters – is both a shortcut to deep time and an objective correlate of "knowing thyself."

Romantic painting and Romantic science work to hear Earth's tidings, which are often faint or cryptic. They require humans to cast their most attentive gaze not up at the skies, as the astronomers and cosmologists do, or at the wide world beyond us, as the geographers and mapmakers do, but downward at the Earth underfoot.

Romantic painting soon lost its urgency, becoming sentimental or decorative. Romantic science was dismissed at its birth as a dead end, but it has been resuscitated two centuries on because of its prescient view of nature as a fragile and dynamic system and process

that includes the human, culture, and the political.

Knowing *where* and *when* we are, we discover *who* we are. Our place on Earth is no longer an accident but an origin. As origin it shapes and explains us, giving us direction: "Whither are we going?" asks the arch-Romantic Novalis, and then answers: "Ever homewards."

In resonance with the Romantic idea of Earth tidings, the contemporary artworks of this section try to grasp the sense of a particular place – such as the depth and deep history of a Chilean volcano or the soundscape of a Swiss forest – through the collaboration of scientific sensors and an artistic sensorium.

34 THE MAKING OF EARTHS, 2019–20

Geocinema (Solveig Suess / Asia Bazdyrieva)

Single-channel video, color, sound, 39 min.
Produced in collaboration with the ZKM | Karlsruhe

The Making of Earths acts as an investigative documentary into large-scale systems and infrastructures amid growing ecological and political anxieties. The film starts inside the Chinese Science Academy, before traversing outward across Earth-sensing landscapes. Satellites, surveillance cameras, and seismic and geo-sensors constellate as new international collaborations take shape. They are driven by a shared urgent need to predict the future of the Earth's increasingly volatile climate. Plans are simultaneously being drawn by China's Belt and Road Initiative, which seeks to synchronize the continuous sampling, surveillance, and quantification performed by a polyphony of instruments situated in territories spanning Asia and Europe. Together, they measure the limits of the planet to gauge how it is changing and how it can be changed.

SUNSET YEARS (SERIES), 2019

Sophie Ristelhueber

The swollen soil of Paris is nothing other than the collapsed soil of the Dead Sea. Dents and protuberances are the two sides of a single skin: this skin of the world that has been gnawed away by a dark force. We can call this warming, we can also call it nothingness, because it is indeed the negative that is constantly damaging the skin of the world, like a wound coming from within.

Sophie Ristelhueber is thinking of calling this new body of work *Sunset Years* (2019), a term used by one of her old American friends to describe the period in which he is living: a luminous twilight. It is true that at sunset, the light skimming the horizon reveals every bump of this Earth which it comes to caress for just a moment; light that is all the more beautiful and precious when, contemplating the world at sunset, one sometimes wonders whether after that, despite everything, anything will still have the strength to rise.

→ Sophie Ristelhueber, *Sunset Years #2*, 2019.

6 photographs, 120 × 160 cm each
Courtesy Sophie Ristelhueber and Galerie Poggi, Paris

36 PERIMETER PFYNWALD, A SOUNDSCAPE OBSERVATORY, 2019

Marcus Maeder

The installation is an acoustic-artistic representation of the Pfynwald in Switzerland, a forest which is already affected by climate change. In 2018, Marcus Maeder captured sounds of the Pfynwald forest by placing four recorders in different biotopes several kilometers apart. The Pfynwald ecosystem can now be experienced in a way that would not be possible outdoors – through spatial and temporal compression (e.g., acoustic time-lapse and spatial arrangement). Thus, it is possible to experience how drought and heat affect the forest's soundscapes between spring and fall: the fauna changes or retreats, mountain streams dry up, while the main river becomes louder with increasing melt water of glaciers. The humidity decreases and the temperature rises – microclimatic measurements are used to generate a synthetic forest voice. As air humidity decreases, the sonification gets lower in pitch; and with increasing temperatures, the sonification gets higher – until both lie outside of the audible range and the forest's voice is silenced.

Mixed media installation, video, photographs, loudspeakers, dimensions variable

Programming: Thomas Peter; environmental data Pfynwald: Swiss Federal Research Station WSL; processing and analysis of acoustic data: Martin Rüegg

Perimeter Pfynwald is part of the research project Ecodata–Ecomedia–Ecoaesthetics, funded and supported by: Swiss National Science Foundation (SNSF), Institute Aesthetic Practice and Theory IAeP, FHNW Academy of Art and Design, Zurich University of the Arts (ZHdK), Institute for Computer Music and Sound Technology

Hidroscopia Loa, 2018

Claudia González Godoy

Mixed media installation, wood structure, water, cupper engraves, cupper fountains, cupper canals and mineral samples, water pumps, videos (color, sound, 11:05 min.), dimensions variable

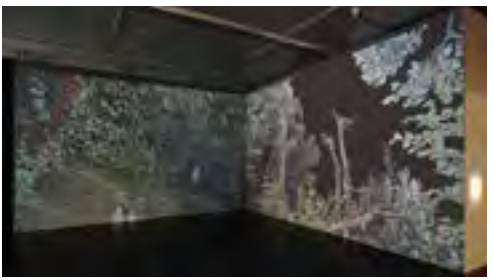
Through this artistic inquiry we analyze the river Loa, one of the most contaminated rivers in Chile, in its very complexity: from the micro level, in its chemical composition and microorganisms, to the people living along the river and facing increasing problems. Due to the enormous extraction of water, the river is receding, and the area is becoming more and more dry. Industrial overutilization and chemicals arriving through the air from places of excessive mining have led to severe contamination of the stream. In this installation, data collected about the volume of water in the river over the last seventeen years in combination with water samples from five points in the river translate its alteration into a language of image and sound.

The work challenges our sensitivity to changes and threats that are invisible to human perception: air and water pollution, and the slow but constant changing of the river's components and the river bed through human-induced actions that indirectly and directly interact with the river itself.

Supported by the Ministry of Culture, Arts and Heritage Chile, Museum of the Solidarity "Salvador Allende," CEGA of the Department of Geography of the University of Chile, Departamento de Artes Visuales (DAV) of the University of Chile

38 ATMOSPHERIC FOREST, 2019–ONGOING

Rasa Smite / Raitis Smits



Mixed media installation, dimensions variable

Atmospheric Forest visualizes the complex relations between a forest, climate change, and the atmosphere. It is the result of a three-year artistic research project on Pfynwald, an ancient Alpine coniferous forest suffering from drought, which Swiss scientists have turned into a living observatory.

Trees are not only oxygen generators, but they breathe as well, emitting large amounts of volatile organic compounds – a habitual scent of the forest. Scientists have long known about the link between a fragrant forest and the warming climate, but are uncertain about its impact and scale of these compounds. By visualizing the data of volatile emissions and resin pressure in pine trees during one growing season, *Atmospheric Forest* reveals patterns of this complexity, showing that with climate change we are heading toward a more fragrant and more "atmospheric forest" in the future.

Produced in collaboration with the Ecodata Project Basel, the ZKM | Karlsruhe and RIXC Riga

Research: Rasa Smite / in the framework of Ecodata–Ecomedia–Ecoaesthetics (2017–20) research project led by Yvonne Volkart, hosted by The Institute of Aesthetic Practice and Theory, HGK FHNW / Basel, Switzerland.
Research Support: Swiss National Science Foundation
Scientific Partners and Data: WSL – Swiss Federal Institute for Forest, Snow and Landscape
Research Scientific advisers and data: Andreas Rigling, Arthur Gessler, Christian Ginzler, Mauro Marty / WSL / Kaisa Rissanen / Helsinki University, Finland / Visiting Researcher at WSL. Michel Kalbermatter / VP Swiss Teleport / Signalhorn AG / Leuk-Stadt | Switzerland
Project Partner: RIXC / Riga, Latvia
Sound: Raitis Smits, Ivo Taurins / RIXC

MEASURING INSTRUMENTS

"Humboldt was a pioneer in the aesthetic presentation of scientific knowledge. Some of his motifs are what we would today call 'data visualization' or 'infographics.'" [1]

On his many research expeditions, Alexander von Humboldt carried numerous measuring instruments with him to determine, among other factors, the altitude of places, the intensity of the Earth's magnetism, or the specific components of precipitation and water. Telescope, microscope, thermometer, barometer, electrometer, and declinatorium were only a few of them. In addition to the mountain profile as a data carrier, the natural scientist described zones of the same average temperature in his 1817 essay "Des lignes isothermes et de la distribution de la chaleur sur le globe" [On isothermal lines and the distribution of heat over the globe]. His use of isotherms, which made the results of measurements at various sites visible, strongly expressed his globally networked thinking; they serve as a basis for today's weather maps.

1 Oliver Lubrich, *Alexander von Humboldt: Das graphische Gesamtwerk* (Darmstadt: Lambert Schneider, 2014), 7. Translated from the German.

→ Inclinatorium from Gambey, 1824.

Various historical measuring instruments from the collection of the Deutsches Museum and the Deutscher Wetterdienst

40 Siebenbrunnen in Simmertal with the Plaine Morte Glacier, 1774–78

Caspar Wolf

Painting, oil on canvas, 54 × 76 cm
Staatliche Kunsthalle Karlsruhe

Caspar Wolf's Alpine landscapes prefigure Alexander von Humboldt's *Naturgemälde* in their vertical elevations and legible arrangement of natural vistas. Here the passage of water from the melting glacier to the karstic waterfall Siebenbrunnen [Seven Springs] at ground level conjures underground wonders that engaged geological thinking of the day. Wolf worked from small oil sketches made on the spot, correcting the larger canvas created in the studio by revisiting the scene. His clients were a new class of travelers seeking adventure in the Alps, formerly shunned by tourists. Like the *vedute* of ancient ruins acquired on the Grand Tour, Wolf's Alpine paintings served as souvenirs, capturing the sublimity of natural monuments and infusing these with history – but on a scale vaster than anything conjured by Rome and Greece: geologic history, or "deep time," measured not by millennia but by eons.

CHEVREUILS À LA SOURCE [DEER AT THE SPRING], CA. 1860S

Gustave Courbet

In his treatment of rocks, Gustave Courbet trades the illusionistic effects of surface texture, contour relief, and perspectival recession for a rough, tactile, and direct approach that renders the artist's mark rock-like. The painting resists the claims and expectations of the human eye. This visibility of painterly substance and facture, as well as the emphasis on irregular nature and the evacuation of historical narrative, were hallmarks of Courbet's programmatic "Realism," yet the rocks' sedimented striations conjure time on a humanly unfathomable scale. The course of art's history, like that of human history in general, collapses in the face of deep time – an immensity that haunted the nineteenth-century imagination. Still, Courbet's rocks remain zoomorphic, harboring potential "images" (faces, etc.) and conjuring, via the stag and hind under the suggestive cleft, forces of libidinal desire.

Painting, oil on canvas, 50.4 × 60 cm
Staatliche Kunsthalle Karlsruhe

»
ONE WAY TO
STOP SEEING
TREES, OR
RIVERS, OR
HILLS, ONLY
AS ›NATURAL
RESOURCES‹
IS TO CLASS
THEM AS
FELLOW BEINGS.
«

(Ursula K. Le Guin)

Unkraut mit Schlange und Schmetterlingen [Weeds with a Snake and Butterflies], n. d., before the 1800s

Otto Marseus van Schrieck

Painting, oil on canvas, 41.8 × 44.2 cm
Staatliche Kunsthalle Karlsruhe

Otto Marseus van Schrieck was an expert in a branch of still life painting called *sottobosco*: up-close, snail's-eye glimpses of a forest floor. Virtuoso portraits – chiefly – of plants, insects, reptiles, and amphibians cast in a flickering chiaroscuro, Schrieck's canvases feature conflicts among the creatures – here between a snake and butterflies. At once spectacles of nature as a dynamic process and emblems of cosmic enmities between body and soul, nature and counter-nature, vice and virtue, etc., these small-scale agons engaged timely scientific debates. It was Schrieck who first observed that tiny flies escaping bizarrely from butterfly pupae were born from eggs laid by parasitic wasps. This discovery disputed Aristotelian theories of spontaneous generation by proving that these insects, like all of God's creations, reproduced "according to their various kinds" (Gen. 1:11).

43 THE TEMPTATION OF SAINT ANTHONY, CA. 1650

Joos van Craesbeeck

According to legend, Saint Anthony (born circa 250 CE) withdrew into the Egyptian desert to practice ascetic piety, in imitation of Christ, only to be tormented by demons. In the Middle Ages, Anthony's trials made him a powerful protector during outbreaks of disease, especially ergotism, a potentially fatal malady caused by eating moldy grain and manifested in psychotic visions and disfiguring gangrene. Anthony's diabolical temptations became, for artists like Hieronymus Bosch, Matthias Grünewald, and Pieter Bruegel, a fitting occasion for fantastical aesthetic invention. The giant monstrous face peering at the desert saint in Joos van Craesbeeck's *Temptation of Saint Anthony* is the artist's own, with a tiny homunculus-painter busy at work inside his brain – visible through his cutaway forehead. By mingling atmosphere, aqua sphere, and microbial biosphere, Craesbeeck sources global catastrophe to the self.

Painting, oil on canvas, 78 × 116 cm
Staatliche Kunsthalle Karlsruhe

ROCKY REEF OFF THE SEACOAST, CA. 1825

Caspar David Friedrich

Painting, oil on canvas, 22 × 31 cm
Staatliche Kunsthalle Karlsruhe
On show until October 5, 2020

Although painted on a tiny canvas, Caspar David Friedrich's vista looks unimaginably large. The trees in the foreground should serve to measure distances, yet Friedrich makes each leap into space feel incalculably long. A figure of the tragic, unbridgeable gap between self and world, the offshore reef is backlit by the moon, with its light brightest at the horizon hidden by the reef. For the Romantics, a "moonlit magical evening" was nature's deepest epiphany, revealing the world only through reflected light and therefore complementing the self-reflective nature of the mind. Friedrich gives a powerful emotional charge to this play between standing apart from, and being part of, nature through the specificity of every natural form, each of which seems to be charged with a special cryptic message for the beholder. The reef thus becomes a figure for our difficult but necessary landing on Earth.

45 DOUBLE-SIDED IMMERSION, 2018–20

Karen Holmberg / Andrés Burbano

Four-channel video installation, color, sound, 6:06 min., dimensions variable
Funded by National Geographic, produced in collaboration with the ZKM | Karlsruhe

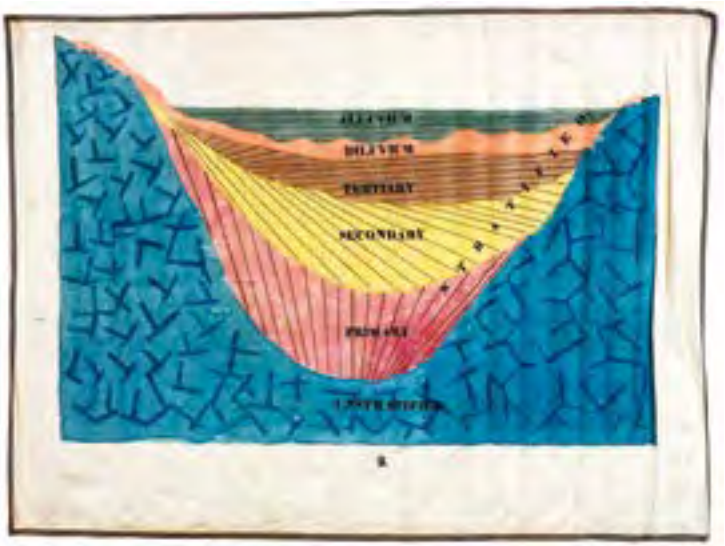
A cave with enigmatic prehistoric rock art under a volcano in Patagonia was the starting point for the research behind this immersive environment built with 360-degree photography and photogrammetry. All along, caves have enabled humans to explore the interior of the Earth. For tens of thousands of years, they have been marked with images. The volcano here represents not only how we perceive the interior of the Earth, but also how it has changed the surface of our planet and the environment over time. Caves and volcanoes can thus be seen as double-sided mirrors for our perception of the exterior and interior of the Earth.

SELECTION OF DRAWINGS, 1828–40

46

Orra White Hitchcock

Orra White Hitchcock was an American illustrator and artist in the mid-nineteenth-century who specialized in botany and geology. The works on display are her illustrations of the scientific research of her husband, the geologist Edward Hitchcock (1793–1864). Orra Hitchcock realized more than two hundred plates and one thousand wood-engraved illustrations. The subjects notably included geologic strata specimens at the moment of the formation of geology as a scientific field. At the same time that the German Romantics were trying to be sensitive to the "Earth tidings" (*Erdkunde*), in North America, Orra and Edward Hitchcock actively tried to depict what the Earth is made of, *strata per strata*.



→ Orra White Hitchcock, Drawing of slate, Devonshire, England, n. d.

Textile, pen and ink on linen, dimensions variable (Reproductions)
Archives & Special Collections, Amherst College, Amherst, Massachusetts

47 MUNDUS SUBTERRANEUS, 1678

Athanasius Kircher

→ Illustration of Aetna (200a).

Athanasius Kircher, *Mundus subterraneus in XII libros digestus; quo divinum subterrestris Mundi Opificium [...]*, 3rd ed., 1678
Württembergische Landesbibliothek Stuttgart

Inspired by observations of volcanic phenomena at Etna, Stromboli, and Vesuvius, the seventeenth-century polymath Athanasius Kircher composed twelve books entitled *Mundus subterraneus*, in which he elaborated a network of conduits that link the fiery furnaces below the surface of the planet to the mountains, winds, seas, and maelstroms above.

The second volume of Kircher's comprehensive work deals with the terrestrial world and details how minerals, gemstones, poisons, and antidotes intermingle with the fossils of animals, plants, and humans. Kircher regarded these natural phenomena as an entwined unit that can be elucidated only through speculation and literary tradition combined with experimental and empirical observation.

The exploration of the Earth's interior and the associated intensive examination of volcanism are also reflected in the exhibition by the art-science of Andrés Burbano and Karen Holmberg.

GEOGRAPHIE DER PFLANZEN IN DEN TROPEN-LÄNDERN, 1805

Alexander von Humboldt

In 1802 Humboldt climbed Chimborazo, a volcano in Ecuador believed to be Earth's highest elevation. Using precision instruments, he measured the altitude, temperature, and air pressure, and recorded plant distribution. Folded into his important 1807 book on plant geography, this huge engraving synthesized the information Humboldt had gathered into what he termed a "painting of nature" [*Naturgemälde*].

This engraving accorded with his belief that scientific knowledge about nature had to be expressed in humanly experienceable terms, in part as an aesthetic creation. The knowledge this "nature painting" expressed, moreover, was of the dynamic unity of nature, with human beings as a volatile part.

→ Lithography in publication.

Alexander von Humboldt, *Geographie der Pflanzen in den Tropen-Ländern; ein Naturgemälde der Anden, gegründet auf Beobachtungen und Messungen, welche vom 10.ten Grade nördlicher bis zum 10.ten Grade südlicher Breite angestellt worden sind, in den Jahren 1799 bis 1803 […]*, sketch from 1805, designed by A. von Humboldt, drawn in 1805 in Paris by Schönberger and Turpin, engraved by Bouquet, the writing by L. Aubert, printed by Cotta, 1807
Karlsruhe Institute for Technology, KIT Library

1,7 CZO SPACE: WEATHER STATION

→ Filming session during the Spring 2020 at the weather station.

At the top of the observatory, the weather station records the amount of rain, snowfall, wind strength and direction, solar radiation, pressure, and temperature to monitor climate fluctuations in the watershed. Rain and snow are also sampled and analyzed in the laboratory. These parameters allow the evaluation of everything that enters the system in order to quantify, in particular, the sulfate, acidity, or other pollutants. Originating from global industrial emissions, they are transported by the atmosphere into the Vosges forest – for example, their journey from Asia to France takes less than twenty days under favorable winds.

CZO SPACE: SPRUCE TREES STATION

1.8

→ Filming session during the Spring 2020 at the spruce station.

The spruce station is a large patch of forest that is equipped to monitor and collect rain passing through the canopy (throughfall) via rectangular gutters, or soil solutions with plates at different depths under the surface. These solutions are then analyzed in the laboratory, which has been accumulating data for more than thirty years, showing the resilience of the Critical Zone to past sulfur inputs (the sulfur chronicles). Forest decline has been observed for four decades due to soil acidification, leading to nutrients leaching from the soil. In addition, these already weakened trees are strongly impacted by storms, hydric stress or drought, and bark beetles, whose life cycle is increasing with climate change. This specific experimental station is constantly evolving to respond to these environmental changes.

49 METEOROLOGICAL OBSERVATION

→ Johannes de Sacrobosco, *Sphaera Ioannis De Sacro Bosco, Emendata: Eliae Vineti Santonis Scholia in eandem Sphaeram, ab ipso auctore restitute […]*, 1577.

A selection of books (15th–19th century) from the National Meteorological Library in Offenbach, Germany, traces the development and history of meteorology (Greek for "the study of things high in the air") as a science that studies physical and chemical phenomena and processes in the atmosphere and their interaction with the Earth's surface through observation.

Several volumes of *Ephemerides Societatis Meteorologicae Palatinae: Observationes* testify to the activities of the first society to conduct, organize, and publish weather observations worldwide: the Societas Meteorologica Palatina, established in Mannheim, Germany, in 1780. In addition to weather observations, the society also made phenological and nosological observations (including sprouting and flowering, as well as diseases in the population). The data, collected by observers in 39 stations, was later used by meteorologists and scientists – including Alexander von Humboldt – as an important basis for the calculation of climate zones and weather maps.

Various publications
Deutscher Wetterdienst, National Meteorological Library

»
WHO ARE
WE?
WHAT ARE
WE?
WHO AND
WHAT
ARE »WE«
THAT
IS NOT ONLY
HUMAN?
«

(Donna Haraway)

V. REDRAWING TERRITORIES

It is common to use the metaphor of "soil" to talk about sovereignty. But why is the atmosphere that surrounds us left out when one talks about territory? Remember, the Critical Zone is a few kilometers thick both above us and under our feet. So, how should we redraw borders within it?

When nation states emerged in the nineteenth century, mountains and oceans were used to differentiate them from one another. While once they used geological separations to delineate their jurisdictions, these jurisdictions are now upset by the intrusion of Gaia. Hurricanes, trans-boundary hazards, clouds of chemicals: none of these phenomena respects borders as we know them, and all of this occurs with the lack of a clear juridical framework.

In this section, we give a number of architects the opportunity to examine controversies related to the issues at stake in this space invisible to the naked eye, whether manifested as what Peter Sloterdijk has described as "atmo-terrorism" or as new geopolitical issues like those traced by ADS7 to see "how the old geopolitical order of land sovereignty extends to the realm of the atmosphere." [1]

1 The Royal College of Art, "ADS7: Something in the Air – Politics of the Atmosphere", https://www.rca.ac.uk/schools/school-of-architecture/architecture/ads-themes-2019-20/ads7-something-air/.

50 SKY RIVER: POLITICS OF THE ATMOSPHERE, 2019–20

Elise Hunchuck / Jingru (Cyan) Cheng / Marco Ferrari
With Henry Valori, Lena Geerts Danau and Nico Alexandroff (ADS7)

ADS7 is an architecture studio at the Royal College of Art in London led by Marco Ferrari, Elise Hunchuck, and Jingru (Cyan) Cheng. The students include Nico Alexandroff, Lena Geerts Danau, Maciej Kanarkowski, Alice Marwood, Coline Mauroy, Michael McMahon, Alejandro Nieto, Yee Teng (Janice) Tai, Reediima Uppal, Henry Valori, Claudia Walton, and Rosa Whiteley.

The group analyzes the Chinese project Sky River, which will conduct what may be the largest artificial rain experiment ever attempted, potentially causing rainfall over an area of 1.6 million square kilometers. The project aims to divert clouds from southern China and India to fill the sources of China's main rivers, which spring from the Tibetan Plateau. Through this observatory, the group traces how the old geopolitical order of land sovereignty extends to the realm of the atmosphere. With maps and data visualizations, they develop "sensors" that detect the transformations on the ground as well as in the atmosphere, culture, politics, and law.

Single-channel video, color, silent, 16:13 min.
Produced in collaboration with the Royal College of Art, the RCA School of Architecture (ADS7), and the ZKM | Karlsruhe

ADS7 expresses it as follows:

"The idea that atmospheric water vapour can be thought [of] as a river … extends the control of a cartographic imaginary that is worth exploring. It occupies a void in a domain that lacks a clear legal framework – a space mostly unregulated and without definite borders – while it wipes off the map local communities, which have been living in these areas prior to the advent of the state organisations conducting these experiments. The atmosphere becomes a space that can be mapped through scientific research, appropriated through technology and administered through both land and geospatial infrastructure. Ultimately, the exploitation of the atmosphere fosters change at the ground level. New lines on the land are drawn by changing the geography of the sky, in the form of displaced rainfall, floods or chemical alteration of the water-bearing stratum." [1]

1 The Royal College of Art, "ADS7: Something in the Air – Politics of the Atmosphere", https://www.rca.ac.uk/schools/school-of-architecture/architecture/ads-themes-2019-20/ads7-something-air/.

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FOR THE
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TRANSCENDS ALL
IDENTITIES.
«

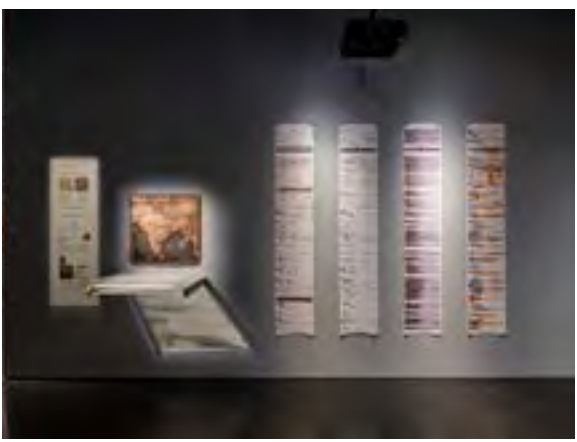
(Bruno Latour, *Down to Earth*)

WETNESS IS EVERYWHERE; WHY DO WE SEE WATER SOMEWHERE?, 2020

Dilip da Cunha / Anuradha Mathur

Sindhu is a Sanskrit word that is generally translated as "ocean." It does not, however, refer to the ocean beyond the land's edge, but rather to an all-consuming wetness, an "ocean of rain," *indu* being a raindrop. To inhabit *Sindhu* is to inhabit a wetness that is everywhere, replenished each year by the monsoon – a wind heavily laden with moisture that blows between June and September. Its wetness holds in everything – flora, fauna, air, earth, reservoirs, even building materials – before it soaks, seeps, osmotes, and transpires its way to ever-increasing holdings and eventually reconnects with the wind.

This wetness everywhere is at odds with India, where rain falls to a surface divided between land and water. This surface, fueled by a land-centric imagination that controls the place of water, dominates as the ground of habitation. But with this surface threatened by melting glaciers, rising seas, floods, droughts, species loss, garbage, and violence, it is time to explore *Sindhu* on its own terms!



Mixed media installation, video, acrylic model, photo-montage, prints on paper, text, dimensions variable
Produced in collaboration with the ZKM | Karlsruhe

52 CLOUD STUDIES, 2020

Forensic Architecture

Video installation, color, sound, 23:28 min.
Produced in collaboration with the ZKM | Karlsruhe,
in cooperation with Bruno Latour

Tear gas is used to disperse bodies gathering in democratic protest, chlorine gas bombs are used to spread terror in cities, herbicide is sprayed from airplanes to destroy fields and displace those whose livelihood depends on them, arson is used to eradicate forests for industrial plantations. Mobilized by state and corporate powers, toxic clouds colonize the air we breathe across different scales and durations, from urban squares to continents and from the incident to epochal latencies.

But cloud dynamics are elusive, governed by nonlinear and multi-causal logics. This is a problem that persisted throughout the history of painting, when clouds were moving faster than the painter's brush could capture them and needed to be imagined rather than described. The contemporary problem of cloud analysis shifts instead from the physical to the epistemological. Today toxic fog breeds lethal doubt, with naysayers operating across the spectrum seek to deny the facts of climate change just as they do of chemical strikes.

The research agency Forensic Architecture is working on cases of state violence linked to ecological change, "through the production and presentation of architectural evidence," whether buildings, urban environments, or other types of spaces.

» The new climatic regime has been sweeping across all our borders for a long time, exposing us to all the winds, and no walls we can build will keep these invaders out. «

(Bruno Latour, *Down to Earth*)

VI, BECOMING TERRESTRIAL

It is not the same thing to live on the globe and to live within the Critical Zone, to live on a solid geometrical body and to live folded into a space which is sensitive to our actions. This section gathers a set of practices that try to take the measure of this implication. Some projects try to rethink product design outside the vicious circle of extraction and programmed obsolescence. Another artistic activist project calculates the carbon impact of an exhibition like this one without following a mere quantitative approach by trying to "offset" the consumed carbon. Indeed, such an approach would give the illusion that there can be an equivalent fix to any damage done. Instead, the project tries to engage in regenerative practices of different scales: from institutional change to cross-disciplinary actions throughout the city of Karlsruhe to building up connections between cultural institutions worldwide. The question that remains is, of course, where do you put the sensor? How do you account for it?

Becoming terrestrial is a task of composing common ground. This *agencement* seeks to be done collectively with a multiplicity of voices and agents – humans and nonhumans. Therefore we have joined forces with local initiatives (public and private actors, activists, scientists, artists, entrepreneurs) as well as the participants of the *Critical Zones* Study Group at Karlsruhe University of Arts and Design (HfG), which ran for two years in order to co-prepare the exhibition. Together we have tried to find ways to build up assemblies and modes of becoming terrestrial, and we invite visitors to participate in this manifold process.

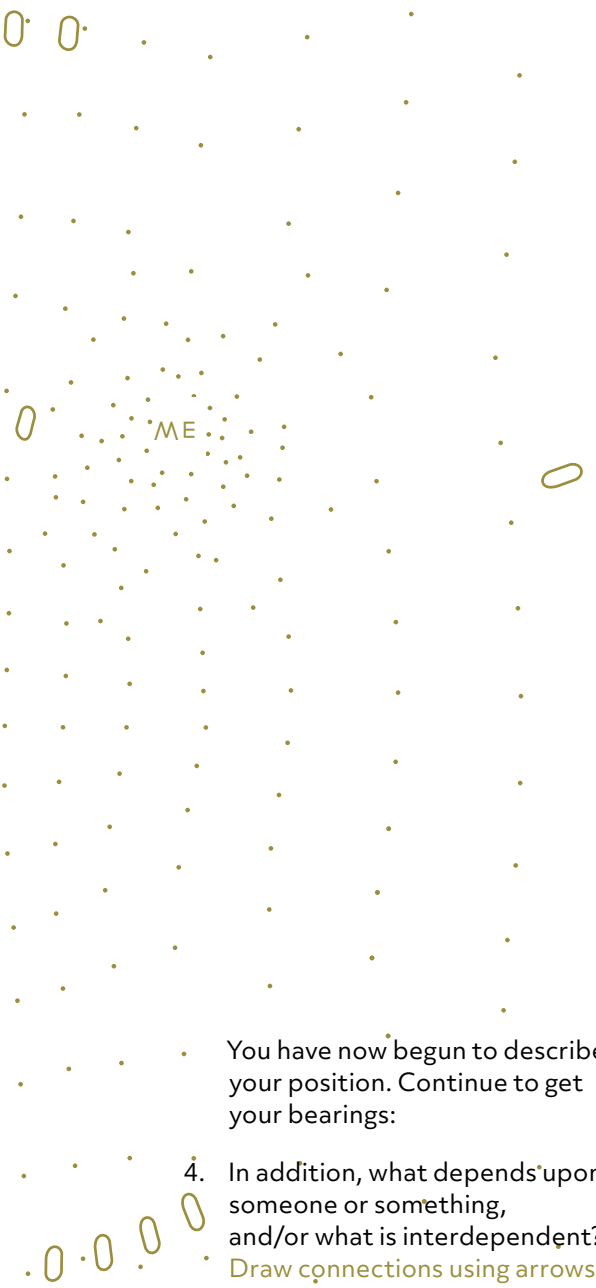
LIFE'S TERRAINS

In order to know what we must support and stand up for, it is necessary to understand what the basis of our existence is. To this end, we have to describe the *terrains* on which we live out our lives: the network of connections that determines our co-existence. Here are five questions that can help you to formulate a description of the terrain in and on which you live.

1. What surrounds you everyday?
   Make drawings of your conclusions.
2. Which of these are indispensable for you?
   Mark them.
3. Who or what depends on you? What do you depend on?
   Make additions and draw connections using arrows.

Pay attention to

- Organisms
- Landscapes
- Technical innovations
- Things
- Occupations
- Food
- Knowledge
- Production
- Institutions
- Ways
- Activities
- Resources



You have now begun to describe your position. Continue to get your bearings:

4. In addition, what depends upon someone or something, and/or what is interdependent?
   Draw connections using arrows.

5. Are any of the connections you have drawn at risk?
   If so, what is endangering them?
   Do you play any role in this?

53 NOTES TOWARDS A PERMACIRCULAR MUSEUM, 2019–20

Stéphane Verlet-Bottéro

→ Orchard regeneration workshop for the exhibition *Critical Zones*. Film still from the video documentation by Peter Müller and Moritz Büchner.

Can an exhibition reflect on its own trace?

The first step of the project is mapping the exhibition's greenhouse effect, ranging from artists' travels to hydrofluorocarbon leaks from ZKM | Karlsruhe's cooling system. The second step consists of generating a series of environmental restoration works, such as regenerating an abandoned fruit orchard in Karlsruhe – an example of a biodiversity hot spot and a disappearing form of traditional agroforestry.

A short film documents a ritual performance for the first day of winter pruning. This embodied elaboration of a theory of repair interrogates care studies and museum maintenance practices from a nonhuman perspective. In video interviews, the micropolitics that may lead cultural institutions to opt out of fossil causality are debated. Workshops on ZKM's sustainability commitments will culminate with a public gathering of museum curators, activists, and artists who are inspiring a revolution in making and circulating art in the New Climatic Regime.

Mixed media installation, wall diagram, video, photography, textile, dimensions variable
Produced in collaboration with the ZKM | Karlsruhe (Martin Guinard, Barbara Kiolbassa, Bettina Korintenberg, Jessica Menger, Daria Mille) and Carmen Bouyer

DE\GLOBALIZE, AN ARTISTIC RESEARCH ABOUT HOW TO DEGLOBALIZE THE GLOBAL, 2018–ONGOING

Daniel Fetzner / Martin Dornberg

DE\GLOBALIZE takes a media-ecological approach to the ethnographic study of climate change and artistic research on the de-globalization of the global.

The Indian Institute of Science (IISc) in Bangalore accommodates a major Critical Zone Observatory. In this area of the rainforest's conflict-ridden zone, an Earth laboratory was set up and experts were invited to practice and discuss the site-specific themes. In Cairo, on the other hand, the focus was on water as a critical resource and on the network of relationships between humans, waste, and the Nile. The Upper Rhine Valley will probably also be affected by climate change. Therefore, over the course of 2020, the Labor Medienökologie (LME) of the Offenburg University, in cooperation with local companies, will focus on the resilience of industrial production processes, employees, and their environment.

→ Seismic measurements being taken by Critical Zone scientists at the Earth lab of the IISc, Bangalore 2018.

Website
www.deglobalize.com

A production in collaboration with Ephraim Wegner and Adrian Schwartz, Offenburg University of Applied Sciences

55 MEDIUM MEER. A SELECTION OF THE WORKS OF JÜRGEN CLAUS

Jürgen Claus

→ Jürgen Claus, *Sternentaucher*, 1970. Slide collage.

Digitized slides, single-channel video, several publications, radiograph on sea chart, dimensions variable

In addition to his pictorial and literary work, the Berlin-born artist Jürgen Claus devoted himself from 1967 onward to environment-related art with a focus on the elements of sea, water, and sun. His work shown in this exhibition includes several sea charts, a video, a selection of digitized underwater diapositives, and publications.

The nautical chart *Architecture of the Ocean* (1973) illustrates Claus's vision of a marine architecture that relies on the use of wind and solar energy at sea, shown here in the Indian Ocean. In his publication *To the Oceans with Imagination* (DCV, 2020), he takes up these thoughts and deals with the following questions, among others: Are the responsibilities for such projects still in the hands of the countries of the coastal regions? How can such architectures be designed concretely? There is enormous potential for conflict not only over the use of renewable energies at sea, but also over the mineral resources located deep below sea level beyond national borders.

LADY MUSGRAVE REEF, 2007

Petra Maitz

The threat to corals is still acute in the wake of global warming due to rising sea levels, increased water temperatures, and the depletion of the ozone layer. With *Lady Musgrave Reef,* Petra Maitz, together with many helpers in years of work, created the first crocheted reef ever. In 2001, the artist began her crochet work after she had become increasingly fatigued with the growing disconnection in modern art from the natural environment. Maitz conceptually transferred the coral reef, as a complex ecosystem based on the interaction of many individuals with the physical environment, to the development process of her work: the focus here was on the collaborative creative process. The artist describes this as follows: "Reconnection to human nature and the social impact of co-operation and co-evolution went very well. We sent the yarns and cotton to people and they showed up with wonderful crocheted corals and were paid by the Foundation." [1]

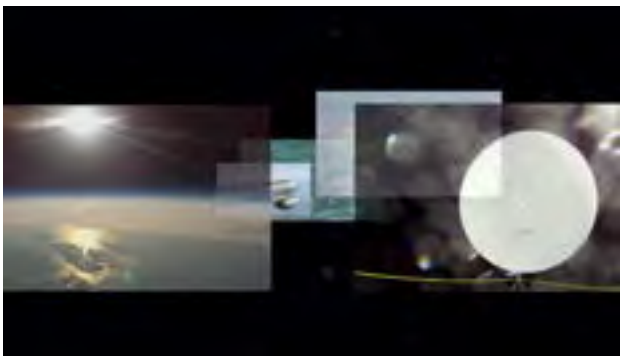
1 Petra Maitz, http://slowlife.ludwigmuseum.hu/en/artist/maitz-petra/.

Single-channel video, color, sound, 4 min.

57 SENSE TO ACT: THE AQUATIC OBSERVATORY

TBA21–Academy (2011–ongoing)

Sense to Act: The Aquatic Observatory is a film screening series co-curated by TBA21–Academy and ZKM | Karlsruhe for the *Critical Zones* exhibition showing a selection of works created as part of the long-standing commissions' program of the Academy dedicated to foster a deeper understanding of the ocean through the lens of art.



→ Inhabitants in collaboration with Margarida Mendes, *What Is Deep Sea Mining?*, 2018–20, four videos, color, sound, ca. 25:00 min., film still from: *Episode 1: Tools for Ocean Literacy*, 6:46 min.; commissioned by TBA21-Academy.

The fascination with the ocean and the fear for it necessitate demystifying the ocean in order to clearly see its fundamental role in the evolution and conservation of life on earth. The artworks on view employ different forms of storytelling — from educational and activist resources to loving propositions, and ancestral healing rituals — that motivate action and explore the continuous transformations of the ocean that surround and unsettle humankind. Identifying these rapid changes and caring about the ocean have become an essential commitment of the human-to-nonhuman relationship that is at stake, where observing and sensing are primary tools of understanding.

Ocean literacy resources are available at Ocean-Achive.org

With contributions by Inhabitants in collaboration with Margarida Mendes; Ingo Niermann; and Khadija von Zinnenburg Carroll. Commissioned by TBA21–Academy

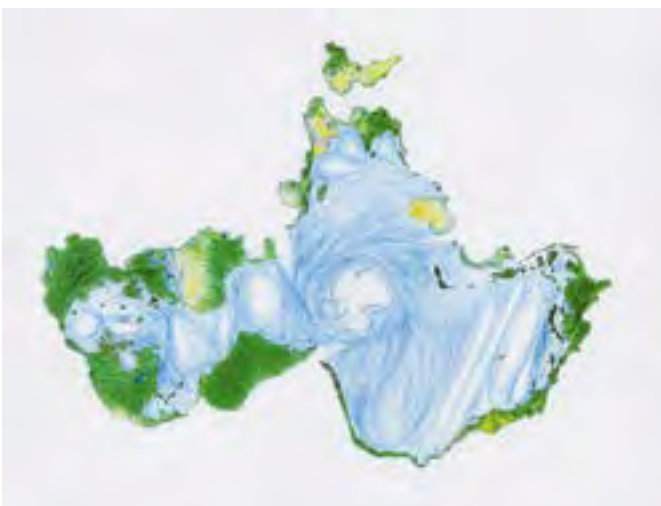
OCEAN EARTH PROJECTS

Peter Fend

The works by Peter Fend presented at ZKM | Karlsruhe include a large-format installation entitled *Algae Rig* (1992), as well as the map *Ocean Earth* (1998) and selected video works. With the founding of the Ocean Earth Construction and Development Corporation in the 1980s, Fend pursued the goal of researching the use of alternative forms of energy in order to provide all people with a socially just energy supply – without wars over distribution or monopolistic conflicts.

Ocean Earth works on concepts in which prosperity and the preservation of habitat are not seen as antagonists. Artistic, scientific, technological, and ecological factors are interwoven. Besides wind and water energy, *Ocean Earth* focuses on the use of seaweed, which is extraordinarily suitable due to its abundance and rapid growth. Furthermore, the combustion of methane and hydrogen in algae takes place without residues or environmental pollution.

Mixed media installation, dimensions variable
With contributions by Mark Boyle, Peter Hutchinson, Dennis Oppenheim, HA Schult, and Peter Weibel
Peter Fend, Peter Weibel, and ZKM | Karlsruhe



→ Peter Fend, *Antarctica centered world, with Macrocystis (Giant Algae) industry in the center*, n.d.

59 BIO DESIGN LAB, 2020

Karlsruhe University of Arts and Design

Conceived as a work in progress, the *Bio Design Lab* is a hybrid and evolving space in the atrium of Karlsruhe University of Arts and Design (HfG) that connects two exhibition spaces of ZKM | Karlsruhe. The *Bio Design Lab* is actively used to present and transmit knowledge. Visitors can interact with the objects on display while the laboratory members work within the space.

→ Atelier Luma, *Algae Lab*, 2018. Banquet at the Atelier Luma with local food from the Camargue and 3D-printed dishes.

Projects in the laboratory focus on the local area, its materials, and possibilities, actively aiming to reshuffle and rethink modes of production in southern Germany. The topics to be examined include algae, soil, plants, the body, and agriculture. Traces of these activities will remain in displays of existing and future objects, many of them developed over the course of the exhibition. While the lab at the HfG works with living materials, the exhibition section presents its results and insights into its work.

Mixed media installation, dimensions variable
Karlsruhe University of Arts and Design
(Project lead: Jan Boelen, Anne-Sophie Oberkrome, and Lisa Ertel)
Produced in collaboration with the ZKM | Karlsruhe

INBALANCE/ IMBALANCE, 2018–20

Rachel Libeskind

Banner, 160 × 250 cm
Produced in collaboration with the ZKM | Karlsruhe

A play on words. The same set of letters, the same spirit in the hand when writing either phrase – the single extra shoulder on the letter *M* transforms these words into counterparts. The balance of justice, hanging in the balance, to balance the books, checks and balances, balancing act, the balance of power, the imbalance of power, an imbalance in brain chemistry, to strike a balance. *Balance* conveys a notion of a providential, hidden entity that seeks an axis of harmony: it either is or isn't. For millennia, people spoke of the "balance with nature." We became obsessed with the archaic idea of the Earth being in balance. But there is no such force. James Lovelock's revelation that the imbalance of the planet's gases were the entropic result of living beings breathing and metabolizing what other living things excreted freed us from the obsolete image of a happy Earth as one in balance. The two words divided only by the absent shoulder of the *N* (for it could never be an *M*) and the difference of a single syllable. Imbalance in balance is what we need to live.

61 WE DON'T WANT TO BE CALLED RESILIENTS ANYMORE, 2019–20

Matthieu Duperrex

Installation, oak wood, iron, loudspeakers, photographs, 230 × 145 × 118 cm

August 29, 2015: New Orleans is commemorating the tenth anniversary of Hurricane Katrina. How is it possible to commemorate such a disaster? Communities in the Deep South are mobilizing and struggling for environmental justice. As Nick Slie, an actor and Katrina survivor, told the artist, "we need to move from resilience to resistance, we want to resist the things that keep making us have to be resilients." [1] Hopefully there will always be people dancing and singing to resist, to preserve and act upon their future in the ruins. We have nothing to lose but our chains! Here is the long parade of the discarded and forgotten people, hopeless to find a normal life in New Orleans, but nonetheless trying to make themselves visible to the politicians and the carbon industry. The dark prayer of the Second Line becomes a shout of revolt with touches of a bacchanal and the power of carnal life.

1 Sound recording of Nick Slie for *We don't want to be called resilients anymore*.

EAU DE KARLSRUHE – CYPRÈS, 2016/20

Fabien Léaustic

The EnBW group headquarters in Karlsruhe becomes a satellite of the ZKM exhibition *Critical Zones*. The installation *Eau de Karlsruhe – Cyprès* (2016/2020) by Fabien Léaustic will be presented here from July 24 through December 2020.

In his installation Fabien Léaustic engages with the cultural semantics of plants and what they have to say about our relationship to the world. The work focuses on three cypress trees. The cypress originally came from west Asia and is thus a symbol for the migrations of humankind. Since classical antiquity the cypress is also a symbol of eternity and eternal life.

What is special about *Eau de Karlsruhe* is that electricity constitutes the actual basis of existence of the work. In the ecosystem created by the artist the trees cannot be separated from electric light. Fabien Léaustic shows us plainly the various dependencies and the interconnection of our contemporary ecosystems.

→ Fabien Léaustic, *Eau de Paris – Cyprès*, 2016. Installation view EnBW, Karlsruhe, 2020.

Mixed media installation, cypresses, water generator, lights, tubular structure and mixed techniques, dimensions variable.

Co-production of: ZKM | Karlsruhe, EnBW, Arts Center of Enghien-les-Bains, DRAC Bourgogne-Franche-Comté.

Thanks to: the Aide individuelle à la création (AIC) – Arts visuels

Critical Zones. Observatories for Earthly Politics
23.5. 2020 – 9.1.2022

Curated by: Bruno Latour and Peter Weibel with Martin Guinard and Bettina Korintenberg
Curatorial committee: Alexandra Arènes, Bruce Clarke, Jérôme Gaillardet, Joseph Koerner, Daria Mille, and the Critical Zones Study Group of the Karlsruhe University of Arts and Design (HfG)

Exhibition

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Project assistance: Beria Altinoluk, Svenja Clauss, Mekhala Dave, Dorothea Deli, Alina Grehl, Annina Guntli, Elias Kautsky, Luzia Marek, René Sander, Leonard Sprüth
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Technical project management: Anne Däuper, Matthias Gommel, Christof Hierholzer
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Scenography: Matthias Gommel
Graphic design: operative.space (Stefanie Rau, Robert Preusse)
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Engaged citizens and initiatives from Karlsruhe: Marius Albiez (Energietransformation im Dialog), Christian Bauer (Open Knowledge Lab Karlsruhe), Frederic Bauer (NABU Gruppe Karlsruhe), Artur Bossert (NABU Gruppe Karlsruhe), Extinction Rebellion Karlsruhe, Hans-Martin Flinspach (Streuobstwieseninitiative im Stadt- und Landkreis Karlsruhe e.V.), Christine Geesing, Susanne Gerner (Umwelt- und Arbeitsschutz), Marlene Grabinger, Christian Hoffstadt (Karlsruher Coaching Community), Sebastian Köhli (Scientists for Future), Andreas Kugel (Open Knowledge Lab Karlsruhe), Alfred Lüthin (Gartenfreunde Karlsruhe e.V.), Jan Mast, Nils Mayer (Greenpeace Karlsruhe), Peter Müller (NABU Gruppe Karlsruhe), Eva Nöthen (Scientists for Future), Susanne Pimentel (Naturschutzzentrum Karlsruhe-Rappenwörth), Jürgen Reuter (Artists for Future), Gina Rezmann, Anne-Sophie Risse, Ulrike Rohde (Umwelt- und Arbeitsschutz), Dorothee Rosenbauer (Parents for Future), Renate Schweizer (Artists for Future), Armin Siepe (Büro SchwarzErde), Volker Stelzer (Energietransformation im Dialog), Gisela Toussaint, Susanne Volz (Umwelt- und Arbeitsschutz), Martin Weis (Open Knowledge Lab Karlsruhe), Eva Wendeberg (KonsumGlobal Karlsruhe), Simone Winter (Parents for Future), Anna Zinßer (Karlsruher Coaching Community), and many more.

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From July 24 to November 2020, *Critical Zones* is accompanied by a satellite exhibition at the EnBW headquarters in Karlsruhe (Durlacher Allee 93, 76131 Karlsruhe) with the presentation of Fabien Léaustic's installation *Eau de Karlsruhe – Cyprès*.

Digital Platform

https://critical-zones.zkm.de

The exhibition *Critical Zones* about the critical state of the Earth coincides with the coronavirus pandemic, evincing core questions of the ecological crisis we are witnessing. This situation requires a new earthly politics which also implies new policies for exhibitions. So, the physical *Critical Zones* exhibition at the ZKM is complemented by a digital exhibition platform and thus connects a non-local event field in real and virtual spaces.

Book

On the occasion of the exhibition, the publication *Critical Zones: The Science and Politics of Landing on Earth*, edited by Bruno Latour and Peter Weibel, distributed by The MIT Press, Cambridge, MA / London, England, was produced at ZKM | Karlsruhe.

Fieldbook

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OHGE

TBA Thyssen-Bornemisza Art Contemporary Academy

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