CRITICAL ZONES

IN SEARCH OF A COMMON GROUND

FIELDBOOK

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.

ORIENTATION

WHAT IS A CRITICAL ZONE?

1, STARTING TO OBSERVE: A CRITICAL ZONE OBSERVATORY

1.1 Heinrich Karl Wilhelm Berghaus: *Physical Atlas: or collection of maps on which the main phenomena of inorganic and organic nature are illustrated*
1.2 Alexandra Arènes and Soheil Hajmirbaba: *Critical Zone Observatory Space (selection)*
1.3 Daniel Fetzner and Martin Dornberg: *DE\GLOBALIZE: An Artistic Research About How To Deglobalize The Global*
1.4 Rasa Smite and Raitis Smits: *Atmospheric Forest*

INTERVENTION A

2, WE DON'T LIVE WHERE WE ARE – GHOST ACREAGES

2.1 Uriel Orlow: *Soil Affinities*
2.2 Armin Linke: *Prospecting Ocean*
2.3 Edith Morales: *Raíz Aérea* [Aerial root]

INTERVENTION B

3, WE LIVE INSIDE GAIA

3.1 James Lovelock: *Gaia: A New Look At Life On Earth*
3.2 James Lovelock: *Gaia: The Earth System, N.D.*
3.3 James Lovelock: *Letter from James Lovelock to Lynn Margulis*
3.4 Lynn Margulis: *Symbiotic Planet*
3.5 *Symbiogenesis Through Fertilization Across Kingdoms, N.D.*

INTERVENTION C

3.6 *The Tissue of Gaia*
3.7 Pauline Julier: *Naturalis Historia. The World's Oldest Landscape*
3.8 Sonia Mehra Chawla: *The Universe in Details* and *Bioshield*

The travelling exhibition was conceived and first exhibited at ZKM | Center for Art and Media Karlsruhe, Germany (2020–2022) based on a concept by Bruno Latour and Peter Weibel. The adaption *Critical Zones. In Search of a Common Ground* is co-produced by the ZKM | Karlsruhe and the Goethe-Institut / Max Mueller Bhavan Mumbai.

Bruno Latour sadly passed away during the preparations of this touring exhibition. The exhibition owes its foundational ideas to him and his work as a science theorist, philosopher, sociologist and curator. We, the organizers of the exhibition, hope that it can keep his thoughts and ideas alive and we want to express our gratitude for being part of his inspiring work.

The exhibition in Karlsruhe and its activation program have been adapted for the local audiences in a close dialogue between the curators, art mediators, and the Goethe-Instituts in India and Colombo. Each further station will include further dialogues and co-creative moments to investigate and analyse what are issues of importance for each particular location, its Critical Zone, and its inhabitants.

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. In Search of a Common Ground*. It proposes one of many possible tours through the five topics of the exhibition:

STARTING TO OBSERVE: A CRITICAL ZONE OBSERVATORY

WE DON'T LIVE WHERE WE ARE: GHOST ACREAGES

WE LIVE INSIDE GAIA

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 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 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 digital platform of the exhibition can be experienced 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.

1. Starting to observe: A Critical Zone Observatory

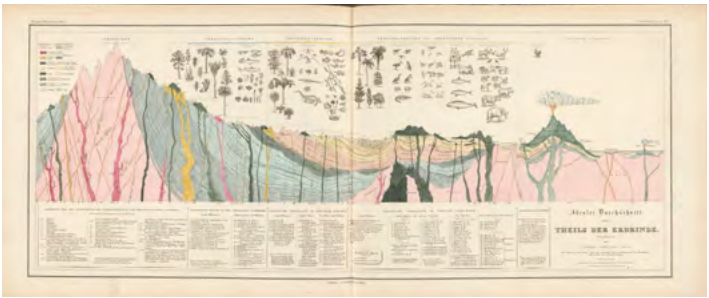
When a sick person enters an intensive care unit, the first thing caregivers do is to apply multiple instruments to get a good reading of the main variables that will help physicians to monitor the patient's condition. In the same way, it is necessary to devise Critical Zone Observatories (CZO) for the 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 the entrance area of the exhibition we gathered artworks that elaborate on the work of CZOs and further environmental laboratories: the Hydrogeochemical Environmental Observatory, a Strengbach water catchment area set up in the Vosges mountains in France; the Indian Institute of Science (IISc) in Bangalore, hosting a main CZO in Asia; and WSL – Swiss Federal Institute for Forest, Snow and Landscape. Equipped with many instruments these monitoring stations have become a sort of outdoor laboratories, main purpose of which is getting various data from the Critical Zone.

Instead of offering to you a tourist's view of the landscapes where these CZOs are located, 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. You, the visitors, will become the observers and will discover… 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.

1,1 PHYSICAL ATLAS; OR COLLECTION OF MAPS ON WHICH THE MAIN PHENOMENA OF INORGANIC AND ORGANIC NATURE ARE ILLUSTRATED ACCORDING TO THEIR GEOGRAPHICAL SPREAD AND DISTRIBUTION, VOL. 1,5, PERTHES, GOTHA, 1845

Heinrich Karl Wilhelm Berghaus

Heinrich Karl Wilhelm Berghaus was a German cartographer who brought thematic maps to public attention. Thematic maps are geographical maps that show a particular theme or set of data, for example, the distribution of certain plants and animals. This section is an idealized visualization of deposits of plants and fossils within the Earth's crust, and depicts the gradual transition from high mountains to the sea and volcanoes. This map enjoyed great influence and was the most reproduced geological image of its time. The geological history of the Earth is visualized here in a horizontal perspective. This horizontal geochronology, which splits Earth's history into four broad time periods was gradually replaced by the modern geological vertical timescale which was developed during the 19th century. It was popularized by the German geologist Abraham Werner who was also the teacher of Alexander von Humboldt at the Bergakademie in Freiberg. Von Humboldt's ideas were pioneering: he conceived nature as a dynamic system that is formed by both organic and inorganic matter, and in which processes operative in past eras of Earth history are shaping the present. Humboldt also perceived the human being as another influential force. He worked on new ways of representing these ideas in sketches and images that are situated between scientific representation and artistic visualization.

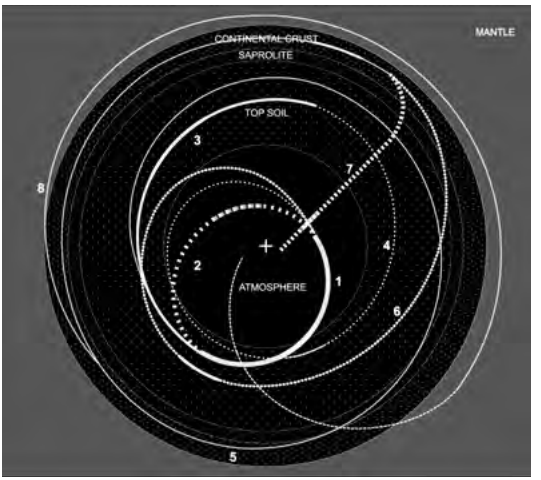


Print (reproduction), Staatsbibliothek zu Berlin – Map Department

This new look at the Earth's crust through presenting a cross section is very much in line with Humboldt's experimental representations. Though the scientific idea of a horizontal timescale became at some point outdated, the cross section of the Earth's Crust can be seen as an experimental way of changing the perspective from a Globe and a satellite-like view from above on the Earth to the view from inside the crust itself.

1,2 CRITICAL ZONE OBSERVATORY SPACE (SELECTION), 2018-20

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



Carbon Cycle, animation (detail), Collection ZKM | Karlsruhe

Produced in collaboration with the ZKM | Karlsruhe and SOC as well with the geoscientists of OZCAR network:
Paul Floury (Riverlab), Jérôme Gaillardet (geochemistry), Sylvain Pasquet (geophysics), Marie-Claire Pierret (Strengbach CZO) and the OHGE laboratory.
The Strengbach CZO is part of the OHGE (Hydrogeochemical Environmental Observatory: Strengbach water catchment area) national system of observation (CNRS founded), the French Network of Critical Zone Observatories (OZCAR), and the European infrastructure eLTER.
Film: Sonia Levy; Sound: Patrick Franke; maps: Alexandra Arènes and Axelle Grégoire; Film assistant maker: Frédérique Vivet; Animation cycles: Juliette Hamon Damourette and Sonia Levy

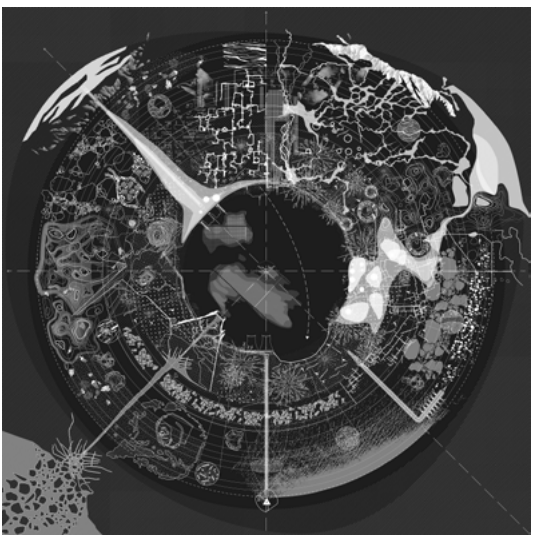
Thanks to the research teams LHyGeS, Strasbourg, and the IPGP, Paris

REVERSAL CYCLE, CARBON CYCLE, SOIL MAP

1,2

The presented animations and map refer to the Strengbach Critical Zone Observatory located in the Voges mountains in France. Its monitoring instruments distributed on site allow scientists to analyze chemical cycles, micro processes and depths of soil that exceed human sensorial abilities. The data collected by scientists provide us with a new understanding of nature: "There is no river, there are levels of wetness, clouds, molecules, and chemistry. There is no ground, there is water around grains of sand."[1] Instead of a landscape that we read with one gaze, we see complex relationships of many entities.

The artists have been concerned with visualizing such a new approach to landscape, also intrigued by the scientists' dissatisfaction with their own tools. The two guiding questions for this experiment have been: How to visualize the shift from the Globe into the Critical Zone, putting the living in the center and how to highlight the dynamic nature of this new territory, defined by dynamic cycles of chemical elements?



Soil Map, print, Collection ZKM | Karlsruhe

The result is an unusual spatial configuration where the Globe that has informed our relationship to the Earth up to now, has been reversed like a glove. You see this process of transformation in *Reversal Cycle*. The *Carbon Cycle* animation shows the circulation of carbon molecules in the Critical Zones: "A carbon atom in the form of CO2 enters into photosynthesis, a reaction triggered by the sun energy, and passes into the biomass and soil reservoirs where it is either respired quickly and released to the atmosphere or transformed into refractory molecules."[2] Biochemical cycles are endlessly looping from the rocks to the atmosphere or from the atmosphere to the rocks. It is these dynamic processes driven by the interactions of life forms that scientists trace in the Critical Zone and that make the Earth unique.

On the *Soil Map*, you see the reversal mapping of the territory of the Strengbach Critical Zone Observatory with the atmosphere in the middle of the diagram, monitoring stations and vegetation, then the soils, and finally the rocks that surround them.

1 Bruno Latour and Peter Weibel, ed., *Critical Zones. The Science and Politics of Landing on Earth*, exhibition catalogue (MIT Press, co-published with ZKM | Karlsruhe, 2020), 130.
2 Alexandra Arènes, Bruno Latour and Jérôme Gaillardet, *Giving Depth to the Surface – an Exercise in the Gaiagraphy of Critical Zones* (Anthropocene Review, 2018), 20.

RIVER LAB STATION

1,2

Compilation of three videos, documenting scientific work at the Strengbach Critical Zone Observatory.

→ The Strengbach stream and the tubes allowing the water to flow into the Riverlab. Video documentation by Sonia Levy.

Video, color, 2:26 min.

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 "cardio-vascular 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.

1,2 SPRUCE TREES STATION

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

Video, color, 2:36 min.

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.

WEATHER STATION

1,2

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.

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

Video, color, 1:43 min.

1,3 DE\GLOBALIZE, AN ARTISTIC RESEARCH ABOUT HOW TO DEGLOBALIZE THE GLOBAL, 2018

Daniel Fetzner and 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 Asia and is a cutting-edge research spot in science, engineering, and space industry. In this area of the rainforest's conflict-ridden zone, a Critical Earth Lab was set up by the artists who invited a mixed bunch of experts in the field of the Critical Zone to act and reflect upon their research practice and discuss the site-specific themes during the monsoon. The artists documented these conversations that form part of the presented website www.deglobalize.com.

→ 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
www.mediaecology.de

ATMOSPHERIC FOREST, 2020

1.4

Rasa Smite and Raitis Smits

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 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. Through immersive experience of VR it makes sensible that with climate change we are heading toward a more fragrant and more "atmospheric forest" in the future.

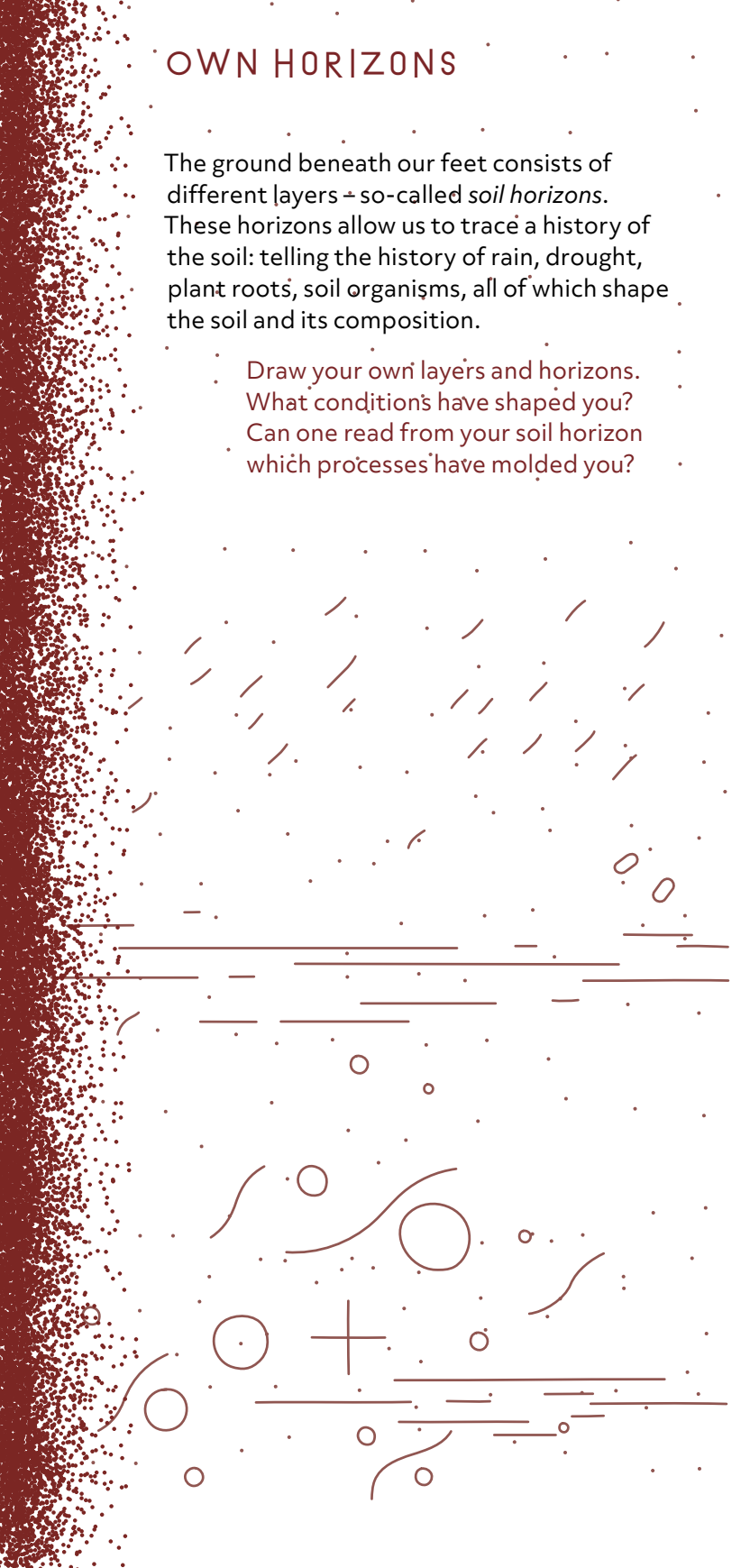
Produced in collaboration with the Ecodata Project Basel, the ZKM | Karlsruhe and RIXC Riga. Artists: Rasa Smite and Raitis Smits. Research: Rasa Smite, in the framework of Ecodata– Ecomedia–Ecoaesthetics (2017–20) research project, led by Yvonne Volkart, hosted by The Institute of Aesthetic Practice 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 / Switzerland, Kaisa Rissanen / Helsinki University, Finland / Visiting Researcher at WSL / Switzerland. Unity programming and data visualization: Kristaps Biters / RIXC

Mixed media installation, LiDAR scans, immersive environment, data visualization, videos. A showcase with performance artifacts consisting of resin, colophon, and turpentine is presented in Mumbai.

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

2, 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 youan 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 *home*. 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.

2,1 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, 3 videos, dimensions variable
Courtesy Uriel Orlow, Mor Charpentier, Paris, and ZKM | Karlsruhe

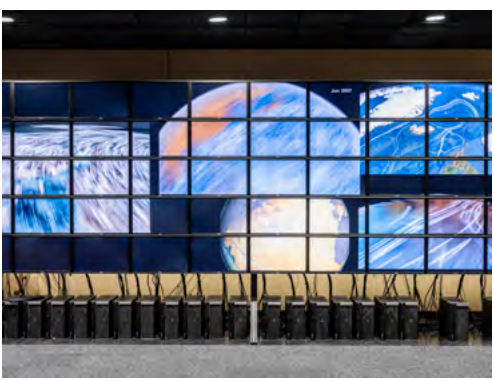
PROSPECTING OCEAN, 2018 / 2022

Armin Linke

2,2

Armin Linke's project *Prospecting Ocean* marks the culmination of three years of extensive research. Between 2016 and 2018, Linke spent time with leading marine scientists in their labs, interviewed experts on the law of the sea and met environmental activists. In his work Linke exposes sites and situations that are commonly invisible and accesses meetings of decision makers that are usually closed to the public. At a tipping point for oceanic ecologies, *Prospecting Ocean* weaves an intricate network of the technocratic entanglement of industry, science, politics, and economics at the new frontier of ocean excavations.

His book project (2022) is a visual essay of the project and comprises a selection of photographs and video stills from the multi-channel video installations that portray the complex of infrastructure, legal frameworks, policy, and resistance at play with regard to the extraction of ocean resources, including deep-sea minerals.



The University of Texas at Austin, Ocean currents modelling room, 2018; Courtesy Armin Linke

Book
Produced in collaboration with the Goethe-Institut / Max Mueller Bhavan Mumbai and ZKM | Karlsruhe
Layout: Elena Capra. Printing: Graphistudio, Arba, Italy

The film project *Prospecting Ocean* (2018) was commissioned and produced by TBA21–Academy, in collaboration with Giulia Bruno (camera, editing), Stefanie Hessler (curator, text), Giuseppe Ielasi (sound, editing), Renato Rinaldi (sound), and Kati Simon (project management).

2,3 RAÍZ AÉREA [AERIAL ROOT], 2022

Edith Morales

Mixed media installation, corn grains, videos, color, sound, 6:21 min. and 6:43 min.
Courtesy Edith Morales and Parallel Oaxaca

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.

〉〉
WHO ARE
WE?
WHAT ARE
WE?
WHO AND
WHAT
ARE 〉WE〈
THAT
IS NOT ONLY
HUMAN?
〈〈

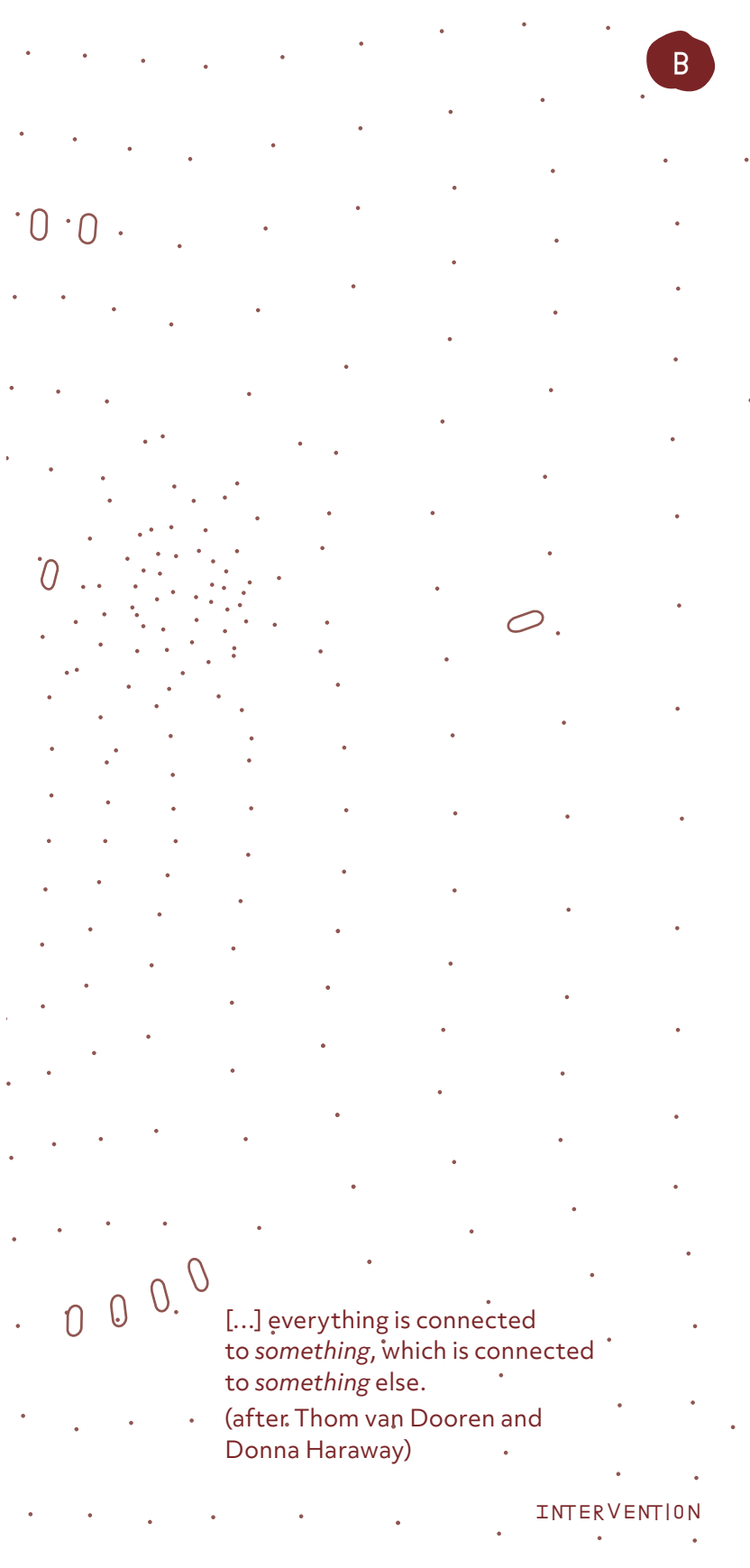
(Donna Haraway)

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)

3. 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;

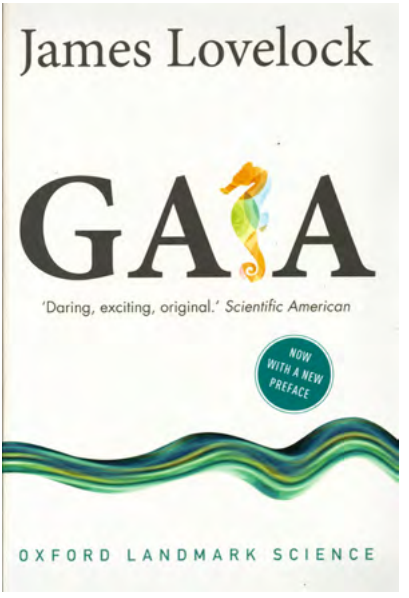
it is the result of the activity of bacteria and plants. In other words, inside the Critical Zone, every single element – rocks, gas, minerals, water, atmosphere, soil – has been modified by the action of life forms. To assume a separation in this respect would be like separating a termite mound from 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.

3,1 GAIA: A NEW LOOK AT LIFE ON EARTH, 2016

James Lovelock

James Lovelock was 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.



Book
Goethe-Institut / Max Mueller Bhavan Mumbai

GAIA: THE EARTH SYSTEM, N.D.

3,2

James Lovelock

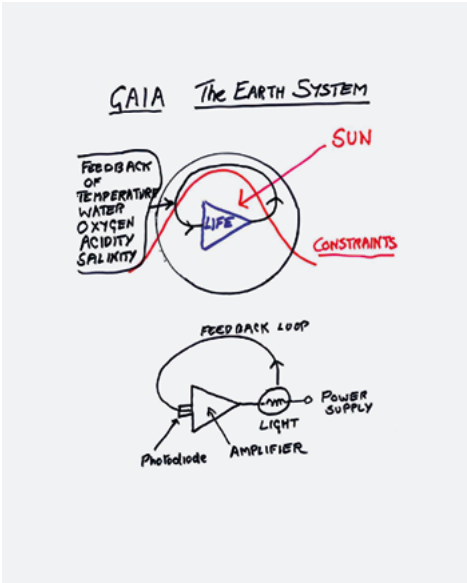


Illustration (reproduction) Courtesy James Lovelock Estate, Science Museum, and Science & Society Picture Library

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).

3,3 Letter from James Lovelock to Lynn Margulis, 1972

James Lovelock

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. 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.

J.E.LOVELOCK
Bowerchalke Salisbury Wiltshire
Telephone 1722 78 881

11th December, 1972.

August /

Dr. Lynn Margulis,
Boston University,
Department of Biology,
Biological Science Center,
2, Cummington Street,
Boston, Mass. 02215.

Dear Lynn,

The Gaia hypothesis is moving on to become a theory. The quiet and rest of the last weeks has enabled me to sort out evidence and discover that we were in possession of a much more solid argument than either of us realised. This is how it goes:

I first looked back at Hilton's data, which incidentally has been around since 1965, in order to generate the atmospheric evolution diagram. I noticed that from a chemical equilibrium viewpoint Ammonia vanishes from the Earth as soon as the pH rises above ~6 i.e. when the very first oxidised rocks appear and long before Oxygen appears in the air. Hence Carl's picture of an ammonia greenhouse will not do unless the biota did as they do now, inject ammonia continually to the air. Furthermore the half life of ammonia will always be short, after all even if we were with 8/10 of an atmosphere turns over in a few million years. Thus if Carl's picture is correct the maintenance of one in 10^{3} Sky in the air must have been a major biological activity. See figure enclosed which shows the evolution of the Atmosphere with and without life.

Just about as this was completed along comes Hitte and Pierre's nature paper on the Sun, which sets a much lower limit than Carl used for the Initialsolar output. Without Gaia there is no way by which the Earth could have kept warm. I am now convinced that the atmosphere ocean system is the key. Albedo and conductivity changes could help but certainly not alone. Consider what could happen if an extensive snowball and sea freezing took place. Albedo control alone would certainly fail.

The logic of the atmospheric life detection experiment (which proves beyond reasonable doubt that the Earth's atmosphere is a contrived mixture impossibly different from an abiological steady state) can only mean that Gaia exists. If the departure from steady state abiological equilibrium was not purposeful but just an accumulation of randomly generated waste gases, then it could not possibly be

Letter (reproduction)
Courtesy James Lovelock Estate,
Picture Gallery, and Lynn Margulis Estate

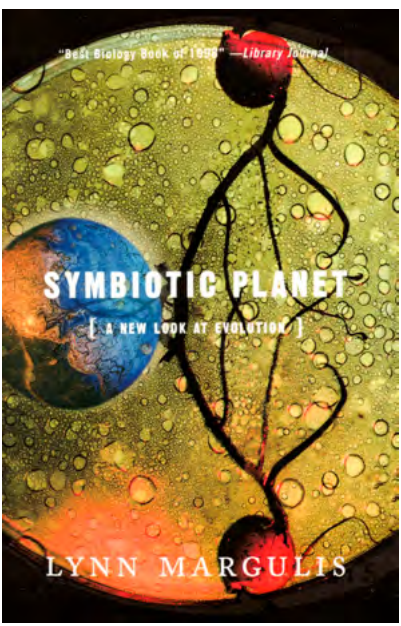
SYMBIOTIC PLANET, 1999

3,4

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.



Book
Goethe-Institut / Max Mueller Bhavan Mumbai

3,5 SYMBIOGENESIS THROUGH FERTILIZATION ACROSS KINGDOMS, N.D.

"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* (2018) by John Feldman.

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 Lynn Margulis Estate

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:

Bruno Latour. *After Lockdown. A Metamorphosis*. Polity Press, 2021.

Donna Haraway. *Staying with the Trouble. Making Kin in the Chthulucene*. Duke University Press, 2016.

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

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

3,6 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 CO2. 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 Lynn Margulis in the film *The Tissue of Gaia* (1993).

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

NATURALIS HISTORIA, THE WORLD'S OLDEST LANDSCAPE, 2017

3,7

Pauline Julier

This is the story of the oldest landscape in the world – that of the forest *Vegetal Pompeii* found fossilized under a coal mine. "Here, 300 million years ago, stood the northern part of the Huabei plate, on what is now China. Try and picture that this landscape looked like a large island surrounded by water. On this island, there was a huge volcano. One day, it erupted and spread over 250 kilometers, devastating everything on its path."[1] This video is part of the *Naturalis Historia* multiform project (an exhibition, an artist's book, and a medium-length film) that stages several natural stories. Each one explores a situation of humans at grips with nature, revealing their obsessions and shaking their certainties. Close to an essay, at the crossroads between a personal point of view and a documentary study, this body of works adopts a kaleidoscopic form. It arranges the narratives and traces forming the different strata of a personal, contemporary, and plastic encyclopedia extract.

1 Jun Wang, in *Naturalis Historia*, single-channel video, color, sound, 09:45 min.

Video, color, sound, 09:45 min., wallpaper

3,8 THE UNIVERSE IN DETAILS, 2019 & BIOSHIELD, 2022 [FROM THE SERIES CRITICAL MEMBRANE]

Sonia Mehra Chawla

Mixed media installation, 2 videos, color, sound,
13:30 min. and 22:00 min., vinyl print
Archival prints on Hahnemühle museum etching

Mangroves grow primarily in tropical and subtropical coastal areas, offering a diverse habitat for many organisms and a shielding ecosystem that serves as a barrier between water and land. This ecosystem has also become a site of destruction, scientific research, and indigenous knowledge, all of which are suggested in the title of Sonia Mehra Chawla's ongoing work *Critical Membrane*.

The mangrove ecosystem's diversity and productivity depends on its microbial communities. *The Universe in Details* shows the various microbes which contribute to the biogeochemical cycles maintaining plant health, resilience, and the transformation of nutrients. The artist collected samples of soil and water from mangrove ecosystems of which microbiological cultures were grown by scientists in the MSSRF (M S Swaminathan

Research Foundation, Chennai), laboratories which have been investigating the role and preservation of mangroves.

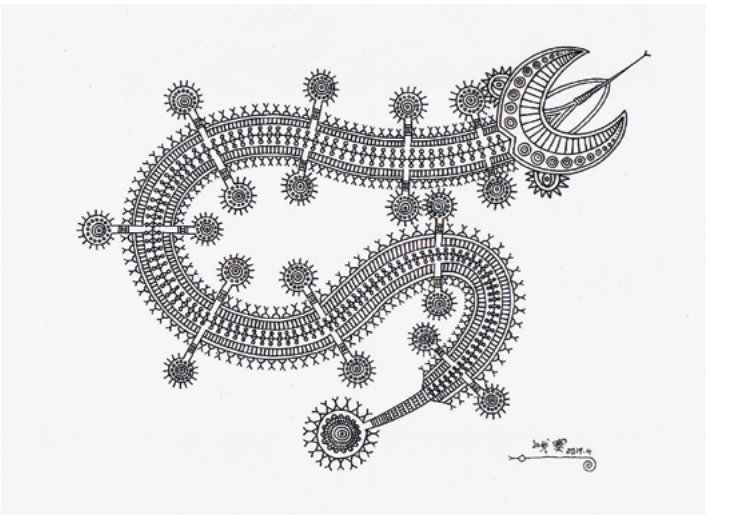
The MSSRF is also conducting research on local traditional fishing techniques, because they create a network of fishing canals that helps to keep the mangrove ecosystem healthy. *Signs of Skin II* documents the livelihood and challenges of fishing communities who are threatened by the destruction of coastal ecosystems that began with colonial extractivism, and whose knowledge is in danger of being lost to current unsustainable fishing, farming, and forestry methods. The Muthupet mangrove forests, for example, were partly restored by a 200-year-old traditional method of fishing in wetlands. Preserving wetlands and mangroves is dependent on the recognition of the importance of these methods.

The search for new and traditional ways of sustaining ecosystems, is determined by the direction of going inwards and towards the precious membranes making up life, like in the wetlands of Tamil Nadu in Southern India, which is portrayed in the video *Moving Inwards* by the artist. Being confronted with the discomfort of not arriving where we expected, how do we navigate and orientate in the labyrinth of challenges arising from the struggle for rewilding, biodiversity, and sustainability?

3,9 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. Several 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.



Drawing reproduced as vinyl cut

ATLAS PHAENOGAMIA OR THE ATLAS OF MIMETIC FLOWERING PLANTS, 2018*

3,10

Rohini Devasher

The pressed plant specimens exhibit a lateral mirroring due to their age. While the pages are mirroring each other, the specimens are also mimicking other species. Rohini Devasher's interest in hybrids and monstrous chimeras, as well as spontaneous mutations, becomes manifest in her subtle interventions into the images: turning flower heads into bee-like shapes and bringing leaves into proximity with butterflies, she merges plant and animal flesh in an act of uncanny mimicry. Living in Gaia means also recognizing relationships of interdependency and mutual entanglements between different species and organisms that question ordinary scientific classification and taxonomy.

The series is based on a selection from collection *Herbarium and Plant Description*, issued by the Biological Department of Southwest Kansas College in Winfield, Kansas, USA. It was compiled in 1893 by an unknown collector and is housed at the R.L. McGregor Herbarium which focuses on plants from the Central Grassland region of North America.

Color pencil,
acrylic on archival print,
museum etching paper

* The work is presented only at the Goethe-Institut / Max Mueller Bhavan Mumbai

3,10 GLASSHOUSE DEEP, 2021*

Rohini Devasher

Glasshouse Deep 2021, 2018
Video, color, sound, 14:21 min.
Commissioned by the Busan Biennale Organizing Committee, 2021 (diatom specimens collected and photographed by Minji Lee and Joonsang Park, Korea Institute of Ocean Science and Technology (KIOST)

This video work dives into the strange deep sea, where microscopic size assumes a planetary scale. It combines images and research of diatom specimens sampled by scientists from the KIOST. These images form the basis upon which layers of video-feedback build complex forms that explore the structural coloration of diatoms.

Diatoms are single-celled algae. Like plants they photosynthesize, but they also possess a urea cycle, a feature that they share with animals. This hybridity has been attributed to the incorporation of genes from their ancestors and by horizontal gene transfer from marine bacteria. Rohini Devasher combines the diatom's evolution of diverse bilateral and radial symmetrical glass exoskeletons with the processes of formation in the digital sphere by employing video feedback. In *Glasshouse Deep*, the organic shapes – here not only chimeras of plants and animals, but also of shapes derived from microbiological samples and digital experimentation – evolve, travel through the deep, and align in spatial structures. This process is accompanied in the soundtrack that builds on *Venus, The Bringer of Peace*, from *The Planets* (Op. 32) orchestral suite composed by Gustav Holst in 1914–1916, which feeds back on itself, mirroring the depth and thickness of water.

* The work is not presented at the Goethe-Institut / Max Mueller Bhavan Mumbai

FOR THE LOVE OF CORALS 2018–ONGOING

3,11

Sonia Levy

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?

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

3,12 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. Her name and contribution to art and science, – domains that stayed male dominated for most of the 20th century, – were forgotten for a long time, and rediscovered only in recent decades. 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 were made of this publication in total, of which only fifteen are preserved in their entirety. The photographic reproductions of Atkins's handwriting, which winds along the edge of the cyanotypes like algae, endow the individual sheets with a personal signature.

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

The film *For the Love of Corals* by Sonia Levy, exhibited next to Atkins' cyanotypes includes shots of artefacts from the Horniman Museum's collections, juxtaposing prints from the book with close-up shots of the corals at the beginning of the film. The artist was moved by the way writer Anna Riccardi spoke of Atkins' work: "As we face an accelerating environmental crisis in this century, Atkins' seaweed impressions surface with something like visionary timing, having slipped their privately-published moorings, to remind us about extinctions past and present, those erasures and absences yet to come." [1] It deeply resonated with a feminist methodology that Sonia Levy wanted to approach in her work, questioning the present moment we find ourselves in. "Climate change, ecological collapses: who are the most affected and vulnerable?"[2]

1, 2 *About the Art: Sonia Levy*, in: www.horniman.ac.uk/story/about-the-art-sonia-levy/

4. 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.

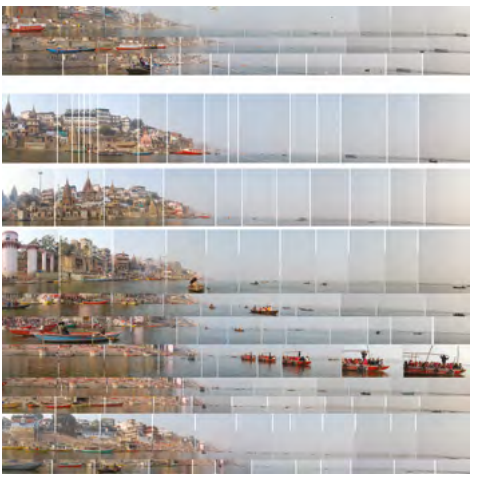
In this section, we give a number of artists the opportunity to examine controversies related to the issues at stake in this space invisible to the naked eye.

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

Dilip da Cunha and 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, 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!



Website
https://cz-artists.zkm.de/criticalzones/ocean-of-rain/

Produced in collaboration with the ZKM | Karlsruhe

Artistic online realization: Nupur Mathur, Sergiy Ptushkin, and Dan Wilcox
Video footage (contribution): Ishan Hendre

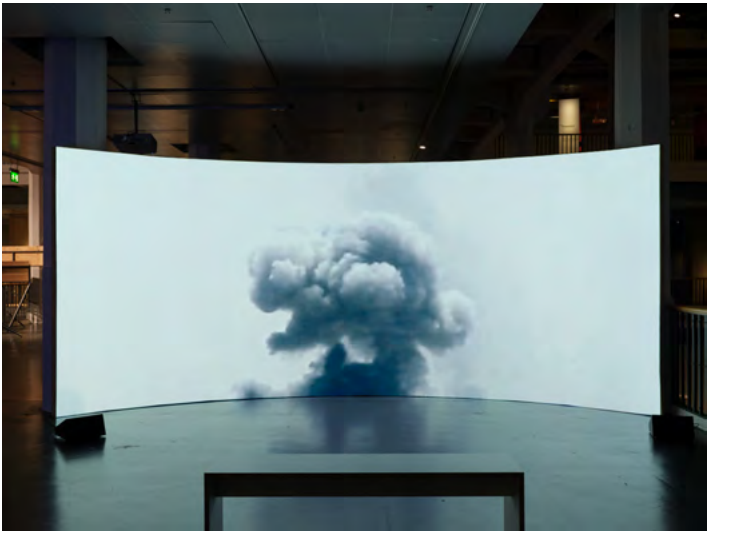
»
FOR THE
TERRESTRIAL
IS BOUND
TO THE EARTH
AND TO
LAND BUT IT
IS ALSO
A WAY OF
WORLDING,
IN THAT
IT ALIGNS WITH
NO BORDERS,
TRANSCENDS ALL
IDENTITIES.
«

(Bruno Latour, *Down to Earth)*

4,2 CLOUD STUDIES, 2020

Forensic Architecture

Mobilized by state and corporate powers, toxic clouds colonize the air we breathe across different scales and durations. Repressive regimes use tear gas to clear democratic protests from urban roundabouts. Carcinogenic plumes of petrochemical emissions smother racialised communities. Airborne chemicals such as chlorine, white phosphorous, and herbicides, are weaponised to displace and terrorise. Forest arson in the tropics creates continental-scale meteorological conditions, forcing millions to breathe toxic air.



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

It is a basic principle of forensics that, between solid objects, "every contact leaves a trace." By contrast, clouds are the epitome of transformation, their dynamics governed by nonlinear, multi-causal logics. This condition was apparent throughout the history of painting, when clouds, moving faster than the painter's brush could capture them, needed to be imagined rather than described.

Clouds are always double. Seen from the outside they are measurable objects, seen from within they are experiential conditions of optical blur and atmospheric obscurity. Today's clouds are both environmental and political. Their toxic fog is easily surrounded by lethal doubt. When denialism obscures acts of violence and compounds the harm, we, the inhabitants of toxic clouds, must find new means of resistance.

Forensic Architecture is a research agency employing pioneering techniques in spatial and architectural analysis, open source investigation and digital modeling to carry out investigations with and on behalf of communities and individuals affected by conflict, police brutality, border regimes, and environmental violence.

5, BECOMING TERRESTRIAL

The notion of "becoming terrestrial" challenges us both to leave behind us the modernist promise of endless progression or withdrawal into the sense of national belonging and identity and instead to establish a new common ground. The topics of this exhibition and fieldbook led the way – step by step we have now arrived at the realization that we cannot describe Earth and life any longer through a system of Cartesian coordinates. Instead, we have to recognize that each entity is producing its own time and space. Finding a new common ground is thus different from an all-encompassing metric space: it has to acknowledge the many specific situations and dependencies of each life form. It has to acknowledge that it is not the same thing to live on the globe or to live within the Critical Zone, enfolded into a space which is sensitive to all our actions.

We have yet to develop new tools in order to describe these interspecies and sensitive relationships and our own place within them. Becoming aware of these entanglements would also mean answering the question: What allows me to subsist? What are the entities that I depend on? This kind of inquiry would be at odds with merely simple quantitative measures. It would need a new set of practices that

try to emphasize our interrelations within and their impact on the Critical Zone. The project initiated by Stéphane Verlet-Bottéro at the ZKM | Karlsruhe and followed up in this exhibition brings awareness of the carbon impact of an exhibition like this one but without following a mere quantitative approach by trying to "offset" the carbon consumed. Indeed, such an approach would foster the illusion that there can be an equivalent fix for any damage done. Instead, the project attempts to engage in regenerative practices at different scales: from institutional change to cross-disciplinary actions and food politics to building up connections between cultural institutions worldwide.

This *agencement* seeks to be done collectively with a multiplicity of voices and agents – humans and nonhumans. Therefore, we have joined forces with institutions and people across continents as well as local initiatives (public and private actors, activists, scientists, artists, entrepreneurs). Together we have tried to find ways to build up assemblies and modes of becoming terrestrial, and we invite visitors to participate in this multifarious process.

LIFE?S TERRAINS

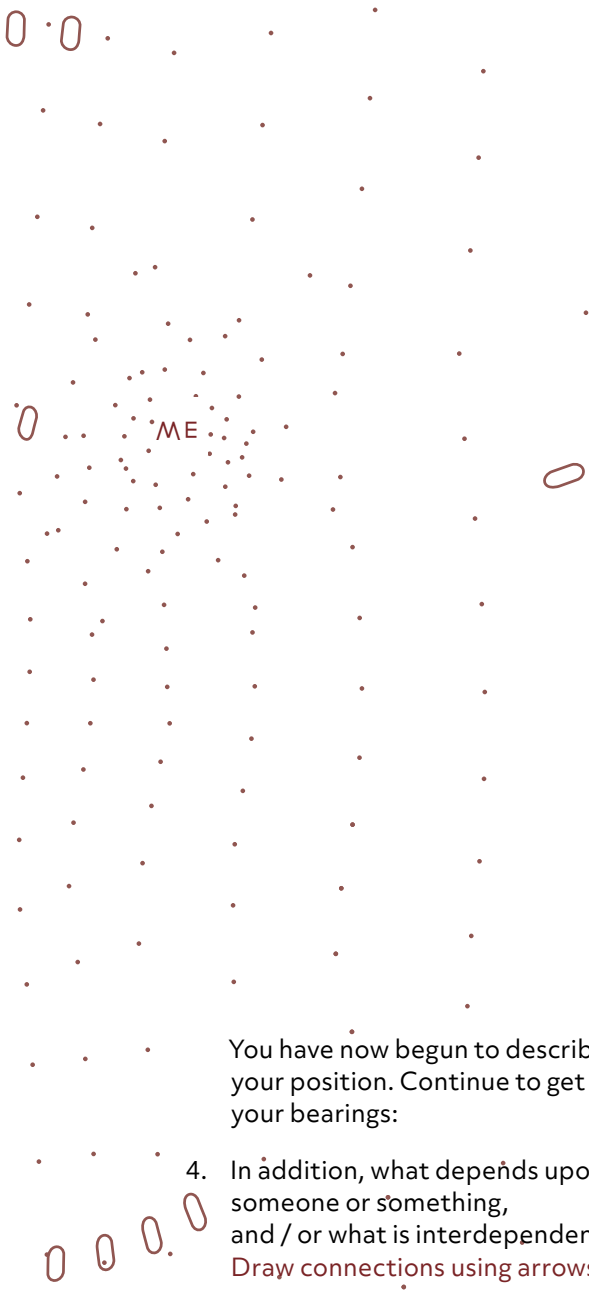
In order to know what we must support and stand up for, it is necessary to understand what the basis of our existence is. To this end, we have to describe the *terrains* on which we live out our lives: the network of connections that determines our co-existence. Here are five questions that can help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

5,1 CRITICAL ORCHARD, 2022

Stéphane Verlet-Bottéro

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

Studying Critical Zones takes us to the many corners of the Earth – but how about looking at what is located very close to us? As part of the artist's long-term research project *Notes Towards a Permacircular Museum*, this installation reflects on the museum as an integral factor within the local ecology of human, animal, and plant communities, revolving around the eco-regeneration of an abandoned orchard meadow in Karlsruhe. As part of this project, the ZKM has committed to revitalizing and maintaining this local fruit garden, as set down in a contract with the city of Karlsruhe.

Mixed media installation, video, color, sound, 9:03 min., website *Critical Sensors*
www.a-kugel.de.a-kugel.de, textile, jar
Produced in collaboration with the ZKM | Karlsruhe, Liegenschaftsamt Stadt Karlsruhe, Bürgerverein Bulach, Nele Kemper, Carmen Bouyer and Andreas Kugel

Orchard meadows are the most biodiverse landscapes in Central Europe. Developed over centuries of peasant farming, they are an example of human-nature cooperation. This traditional agro-forestry food cultivation requires extensive manual labor. It is endangered by urbanization and the mechanization of agriculture, and the last orchard meadows are rapidly vanishing. Since the start of the project, insects, animals, and flower species have flourished again in the garden. The work of caring for the land is accompanied by a sustainability working group, tree pruning courses, community workshops, performances, poetry, happenings, DIY technology for the remote monitoring of local ecological parameters, and a research and education program that explores themes of ecological repairing and sheltering, extending museum maintenance practices to other-than-humans, and reinventing art institutions.

5,2 ECOLOGIES OF LOSS I & II, 2022

Ravi Agarwal

The traditional fishing communities in Southern India are under stress from multiple sources. New ports are stopping the sand flows to beaches where they land their boats, deep sea trawlers cause severe competition, and boats with large diesel engines affect their fish catch. On the edge of a precarious existence, they are forced to sell their homes to new tourism and to take on other work, while their children seek other professions. Thus, a 2000-year-old culture with deep cultural roots in the sea landscape is fading away, and with it the ancient boats made of tied wood called 'kattumarans.' As everything changes around them, the fishing communities experience a loss of agency, being uprooted from both their lives and livelihood, which up to now have been inseparable.

The two banners are based on Ravi Agarwal's 4-year-long engagement with a fishing community of the Bay of Bengal as an artist-researcher. The long-term project (*Else All Will Be Still*) was an attempt to understand and learn from the ground up about the slow erasure of nature–culture inhabitations, and the embedded ethics of care and respect they embody. Bringing texts and images into a relationship, these works look into ancient Sangam poetry from 300 BCE, which reveals the fishermen's ways of coexisting with the sea landscapes, a relationship that cannot afford to romanticize nature. The artist often marries and compares traditional, academic, and scientific methodologies, an approach he also employs in his role as the founding director of the environmental NGO Toxics Link.

Print on canvas

ARTISTS BIOGRAPHIES

Ravi Agarwal (b. 1958) has an interdisciplinary practice as a photographer and artist, environmental campaigner, writer, and curator. His work has been shown widely including at the Biennials of Havana (2019), Yinchuan (2018), Kochi (2016), Sharjah (2013), Indian Highway (2009), and Documenta XI (2002). He has curated Indo-European public art projects (*Yamuna-Elbe* twin city project, 2011 and *Embrace our Rivers*, 2018), and was photography curator for the Serendipity Arts Festival (2018/19), *New Natures: A Terrible Beauty is Born* (Goethe-Institut Mumbai, 2022), and *Imagined Documents* (*Les Recontres d'Arles*, 2022). In addition, Agarwal has also published photography books and artist diaries. He is the founding director of the environmental NGO Toxics Link (ww.toxicslink.org) and recipient of the UN-IFCS Award for Chemical Safety, and the Ashoka Fellowship.

Alexandra Arènes (b. 1984) and **Soheil Hajmirbaba** (b. 1968) are cofounders and members of Studio SOC. Alexandra holds a PhD in Architecture from the University of Manchester. She studies the Critical Zones as a new paradigm to understand landscapes and their mapping at the scale of the Earth's cycles, which can be called a Gaia-graphy. Soheil is an architect and urban planner at Atelier Shaā. He advocates a vernacular production of architecture, from territory to building, inviting to consider architectural materialization as an outcome of field investigations and anthropological travels. Studio SOC focuses on long inquiries emerging from field practices and involving a network of actors from various disciplines. Currently, the three main inquiries *Terra Forma, Où atterrir?*, and *CZO, Critical Zone*s, lead to the production of various multimedia outputs (books, workshops, installations, cartographies, etc.). SOC's main objective is to contribute to fostering exchanges between arts, sciences, and architecture.

Heinrich Karl Wilhelm Berghaus (1797 –1884) was a German geographer who founded the Geographische Kunstschule in Potsdam and trained several German geographers and cartographers who were pivotal for their discipline in the late 19th century. He was also an associate of Alexander von Humboldt, publishing some of Humboldt's maps in his atlases. Berghaus' production of those atlases was influential, especially the *Physikalischer Atlas*, published in multiple editions in the 1830s–1840s. Its thematic maps were pioneering, which provided information on flora, fauna, climate, geology, and many more factors.

Sonia Mehra Chawla (b. 1977) is a multidisciplinary artist and researcher based in New Delhi. Working at the intersection of art and science, Chawla's artistic practice explores notions of ecology, sustainability, and conservation through a multispecies lens. Chawla's recent exhibitions include *The Beauty of Early Life* (ZKM | Karlsruhe, 2022), *New Natures: A Terrible Beauty is Born* (CSMVS Museum Mumbai in collaboration with the Goethe-Institut Mumbai, 2022), *Evolutionary Potential* (Akademie Schloss Solitude, Stuttgart, in collaboration with the Botanic Garden and Botanical Museum Berlin, 2022), *The Rooted Sea* (Summerhall, part of Edinburgh Science Festival 2022), *Entanglements of Time & Tide* (Castle Mills, Edinburgh Printmakers, in collaboration with Marine Scotland, Creative Scotland, and ASCUS, 2021), *Driving the Human*, (Radialsystem, Berlin, 2021), *Essl Collection* (Albertina Modern, Vienna, 2020), *Fragile Kinships* (Embassy of Switzerland, New Delhi, 2019), *The Undivided Mind* (Khoj International Artists' Association, Delhi, 2018), *The World In The City* (ifa-Galerie Stuttgart, 2017), and the Yinchuan Biennale 2016.

Rohini Devasher (b. 1978) trained as a painter and printmarker, works in a variety of media including video, prints, and site-specific drawings. Devasher's films, prints, sounds, and drawings map the antagonism of time and space, walking the fine line between wonder and the uncanny, foregrounding the "strangeness" of encountering, observing, and recording both environment and experience. Her work has been shown internationally at various institutions like the Open Data Institute London (2022), the Rubin Museum New York (2021/22), the Vienna Academy of Fine Arts (2021), the Kaserne Basel (2019), the MACBA Museum of Contemporary Art of Barcelona (2018), the Spencer Museum of Art USA (2016 and 2018), the MAAT Museum of Art and Technology Lisbon (2016), and the ZKM (2016). She was also represented at the 14th Sharjah Biennial *Leaving the Echo Chamber* (2019), the 7th Moscow Biennale (2017), the 5th Fukuoka Asian Art Triennial (2014), and the 1st Kochi Biennale (2012).

Martin Dornberg MD, PhD, (b. 1959) is a German philosopher and medical practitioner in the field of psychosomatics and psychotherapy. Dornberg is interested in intercultural exchange on issues of care, migration, de/development and kinship with Gaia. In doing so, he addresses the question of how stories, philosophies, and different kinds of artworks and performances can create meaningful meshworks that help foster comprehensibility and manageability in different worlds. Since 1989 Dornberg is a lecturer in the Philosophy Department and at the Centre of Anthropology and Gender Studies (ZAG) of the Albert-Ludwigs-University, Freiburg im Breisgau. Since 1998 he has been the director of the Centre of Psychosomatic Medicine and Psychotherapy at St. Josefs Hospital, Freiburg, and of the Consultation-Service for Psychosomatics and Psychotherapy of the St. Josefs and the Loretto Hospitals in Freiburg. In collaboration with Daniel Fetzner, Dornberg has created several artistic-philosophical works. He is also a founding member of the research group *mbody* for artistic research in media, somatics, dance, and philosophy.

Daniel Fetzner (b. 1966) is a media studies scholar and media artist from Baden-Baden, Germany. He understands his artistic explorations as speculative search movements for the terrestrial in the sense of the French philosopher Bruno Latour. In his ongoing research cycle DE\GLOBALIZE, he uses situationist interventions as both a method and a tool for reflections on media. He holds a W3-Professorship at Offenburg University with a focus on arts-based research. He has been invited as a guest artist to the ZKM | Karlsruhe (2007 and 2021) and also to the Indian Institute of Science (2014 and 2018). Fetzner has many years of teaching experience in Egypt, India, and the United States. He was a lecturer in media ethnography at Freiburg University and is head of the Media Ecology Lab. Fetzner is also a founding member of the research group *mbody* for artistic research in media, somatics, dance, and philosophy.

Forensic Architecture (FA) (founded 2010) is a research agency based at Goldsmiths, University of London, which investigates human rights violations including violence committed by states, police forces, militaries, and corporations. FA works in partnership with institutions across civil society –grassroots activists, legal teams, international NGOs, and media organizations – to carry out investigations with and on behalf of communities and individuals affected by conflict, police brutality, border regimes, and environmental violence.

Pauline Julier (b. 1981) is an artist and filmmaker. In her works Julier explores the links that humans create with their environment through stories, rituals, knowledge, and images. Her films and installations are composed of elements of diverse origins (documentary, theoretical, fictional) to restitute the complexity of our relationship to the world. Her installations and films have been screened at contemporary art centers, institutions and festivals around the world, including the Centre Pompidou (Paris), Loop (Barcelona), Visions du Réel (Nyon), Tokyo Wonder Site (Tokyo), Museum of Modern Art in Tanzania, Geneva Art Center, Palazzo Grassi (Venice), New York, Madrid, Berlin, Zagreb, Cinémathèque de Toronto, and the Pera Museum in Istanbul. Julier had a solo exhibition at the Centre Culturel Suisse in Paris (CCS) in 2017. She completed a year-long residency in Rome in 2020 at the Instituto Svizzero.

Sonia Levy's (b. 1982) practice focuses on site-based cinematic inquiries and interdisciplinary collaborations, fostering multiple perspectives to consider new worlds. Her work queries Western expansionist and extractivist logics while tending toward critical forms of engagement with more-than-human worlds. She has exhibited in the UK and internationally, including shows and screenings at Centre Pompidou, Paris; ZKM | Karlsruhe; Musée de la Chasse et de la Nature, Paris; Muséum d'Histoire Naturelle, Paris; ICA, London; BALTIC, Gateshead; Obsidian Coast, Bradford-on-Avon; Goldsmiths, University of London; The Showroom, London; Pump House Gallery, London; Art Laboratory Berlin; HDKV, Heidelberg; Harvard Graduate School of Design, Cambridge, MA; Verksmiðjan á Hjalteyri, Iceland; and The Húsavík Whale Museum, Iceland. Her work has been published by MIT Press, Thames & Hudson, Antennae Journal, The Learned Pig, Billebaude, Verdure Engraved, and has appeared in *NatureCulture* and *Parallax* journals.

Armin Linke (b. 1966) is a photographer and filmmaker who combines a range of contemporary image processing technologies to blur the border between fiction and reality. Linke indagates the formation – the *Gestaltung* – of the natural, technological, and urban environment in which we live. His oeuvre – photographs and films – function as tools to promote awarenes of the different design strategies. Through working with his own archive, as well as with other media archives, Linke challenges the conventions of photographic practice, whereby the questions of how photography is installed and displayed become increasingly important. Linke was a research affiliate at the Massachusetts Institute of Technology, Cambridge, USA, guest professor at the IUAV Venice, and a professor at the University of Arts and Design Karlsruhe (HfG). He is currently a guest professor at ISIA Urbino, guest artist at Arts CERN, and artist in residence at the Kunsthistorisches Institut in Firenze – Max-Planck-Institut. Linke's works have been exhibited internationally.

James E. Lovelock (1919–2022) trained in chemistry, medicine, and biophysics, and is the author of over 200 scientific papers, distributed almost equally among topics in medicine, biology, instrument and atmospheric science, and geophysiology. He applied for more than 40 patents, mostly for detectors for use in chemical analysis. Lovelock's first interest was the life sciences, originally as medical research but towards the end of his life more and more in geophysiology, the systems science of the Earth. His second interest – instrument design and development –often interacted with his first interest, to the mutual benefit of both. After a career in academia, at age 45 he became an independent scientist, collaborating with many colleagues on topics of

planetary research and environmental issues. His work for the NASA lead to the formulation of the Gaia hypothesis in the 1970s.

Lynn Margulis (1938–2011) was an American evolutionary biologist. She is best known for her serial endosymbiosis theory of the origin of eukaryotic cells, which posits that symbiosis is a driving force of the evolution of life. Although Margulis' theory challenged (and continues to challenge) Neo-Darwinistic views and was rejected by the scientific establishment for a long time, it is now included in common biology textbooks. Born on the south side of Chicago, she was accepted into the University of Chicago at age 14. Margulis taught as a professor at Boston University and University of Massachusetts at Amherst, among others. She was the author of many books, including *Origin of Eukaryotic Cells* (1970), *What Is Life?* (1995), and *Symbiotic Planet* (1998). Together with James Lovelock, Margulis also developed and refined the Gaia hypothesis.

Anuradha Mathur (1960–2022) and **Dilip da Cunha** (b. 1958) are founders of the design platform *Ocean of Wetness* which is directed towards imaging and imagining habitation *in* ubiquitous wetness rather than *on* a land-water surface. The shift from surface to wetness has profound implications for design in the face of climate change. Their objective is to resituate not just the future but also our understanding of the past and experience of the present. Art is central to the platform. Mathur and da Cunha have won several awards in their careers. They are the authors of *Mississippi Floods: Designing a Shifting Landscape* (2001); *Deccan Traverses: The Making of Bangalore's Terrain* (2006); *Soak: Mumbai in an Estuary* (2009), and coeditors of *Design in the Terrain of Water* (2014). These books accompanied major public exhibitions that form an intrinsic part of Mathur and da Cunha's design practice.

Edith Morales (b. 1968) is an artist and activist who reflects on food sovereignty, economic policies of capitalism, and the violence implicit in them. Her work has been included in the *Critical Zones* exhibition at ZKM | Karlsruhe, Germany; Museo de Arte Contemporáneo de Oaxaca MACO; Espacio Lalitho, Oaxaca; Washington & Lee University; Staniar Gallery; Lexington, VA, USA; San Diego Mesa College Art Gallery; San Diego California USA; Museo Internacional del Barroco, México; Manuel Álvarez Bravo Photographic Centre, Oaxaca; Lansing University Michigan, USA; Centro de Las Artes San Agustín, Oaxacan, among others. She is member of the Mexican Sistema Nacional de Creadores 2020.

Uriel Orlow's (b. 1973) practice is research-based, process-oriented, and often in dialogue with other disciplines. His projects engage with residues of colonialism, spatial manifestations of memory, social and ecological justice, blind spots of representation, and plants as political actors. His multimedia installations focus on specific locations, micro-histories, and forms of haunting. Working across installation, photography, film, drawing, and sound his work brings different image regimes and narrative modes into correspondence. Orlow's work has been presented at major survey exhibitions including the Berlin Biennale 2022, British Art Show 9, Kathmandu Triennale 2077, 14th Dakar Biennale, and previously at the 54th Venice Biennale, Manifesta 9 & 12 in Genk, and Palermo amongst others. Recent solo exhibitions include Casa da cerca (2022), Kunsthalle Nairs, Switzerland (2021), La Loge, Brussels (2020), State of Concept, Athens (2020), and Kunsthalle Mainz (2019–2020).

Rasa Smite (b. 1969) and **Raitis Smits** (b. 1966) are Riga and Karlsruhe-based artists and researchers, working at the intersection of art, science, and technologies. They are cofounders of RIXC Center for New Media Culture in Riga, cocurators of RIXC Art and Science festivals, chief editors of *Acoustic Space* journal & book series, as well as cochairs of recently founded NAIA – Naturally Artificial Intelligence Art association in Karlsruhe. In their artistic practice, Smite and Smits work together as an artist duo creating visionary and networked artworks – from pioneering Internet radio experiments in 1990s, to artistic investigations of the electromagnetic spectrum and collaborations with radio astronomers, and more recent "techno-ecological" explorations. Their artworks haven been shown widely including at the Venice Architecture Biennale, Latvian National Museum of Arts, House of Electronic Arts in Basel, Ars Electronica Festival in Linz, and various other venues, exhibitions, and festivals in Europe, USA, Canada, and Asia.

Cemelesai Dakivali (Arsai), born in Tavalan Community (Tashe Village), Sandimen Township, Pingtung County, Southern Taiwan. As he followed the local elders from a young age to hunt in the mountains, he has insightful observations on the color dynamic of the primeval forest. In his early career, he studied art with Sakuliu Pavavaljung, who broadened his horizon. In Cemelesai's drawings, the plants, fungi, and other forms of vegetation are depicted with a great deal of precision and detail with their geometric and repetitive patterns. The artist recalls his memories of what their shape was because some of the species of plants that he used to see and observe as a child seem to have disappeared today. He therefore creates an inventory, which oscillates between the precision of his observation and the fantasy of what his memories allow him to recall. He recently exhibited in *Distances Between Us and the Future, an exhibition of Taiwanese indigenous contemporary art* (Taiwan, 2021), *You and I Don't Live on the Same Plane*, Taipei Biennial (Taiwan, 2020), and *Changing Faces: Traditional Totem of Paiwan,* Exhibition Series of Activities (New Zealand, 2019).

Stéphane Verlet-Bottéro (b. 1987) is an artist, ecologist, and curator. His work deals with experiencing, excentering, and unlearning. His practice extends durationally and socially, weaving shared becomings with people and places. It takes the shape of gatherings, performances, films, and multimedia installations. In 2018, he coinitiated *The School of Mutants*, a collaborative art and research platform in Dakar. His work has been exhibited at ZKM | Karlsruhe; Centre Pompidou Metz; 12th Berlin Biennale; 14th Dakar Biennale; RAW Material Company, Dakar; Het Nieuwe Instituut, Rotterdam; 12th Taipei Biennial; 7th Oslo Triennale; Le Lieu Unique, Nantes; CIAP Vassiviere; Science Museum, London. He collaborates regularly with the ZKM | Karlsruhe and has also had institutional collaborations with Taipei Fine Arts Museum, NA Project, Institut Kunst at FHNW Basel, and Documenta 13.

Critical Zones. In Search of a Common Ground
2022 – 2023

A travelling exhibition that was conceived and first exhibited at ZKM | Center for Art and Media Karlsruhe (2020–2022) based on a concept by Bruno Latour and Peter Weibel. The adaptation *Critical Zones. In Search of a Common Ground* is co-produced by the ZKM | Karlsruhe, and the Goethe-Institut / Max Mueller Bhavan Mumbai.

Curators: Mira Hirtz and Daria Mille

Exhibition

Curatorial project management: Mira Hirtz, Jessica Menger, Daria Mille, Amruta Nemivant
Activation program: Mira Hirtz, Francesca Audretsch, Lena Reitschuster, Jandra Boettger, initiatives and practitioners from Mumbai, Pune, New Delhi, Kolkata, and Bangalore
Director of Goethe-Institut / Max Mueller Bhavan Mumbai: Björn Ketels
Head of curatorial department of ZKM: Philipp Ziegler
Graphic design: operative.space (Stefanie Rau, Robert Preusse)

Many thanks to: Janine Burger, Martin Guinard, Alexandra Hermann, Barbara Zoé Kiolbassa, Bettina Korintenberg, Christian Lölkes

Digital platform of the exhibition

critical-zones.zkm.de

Fieldbook

Editorial team: Mira Hirtz, Jens Lutz, Daria Mille, Miriam Stürner, Patrick Trappendreher, Caroline Meyer-Jürshof, Ulrike Havemann, Hannah-Maria Winters
Head of ZKM | Publications: Jens Lutz
Texts: Bruce Clarke, Sébastian Dutreuil, Martin Guinard, Mira Hirtz, Barbara Zoé Kiolbassa, Bettina Korintenberg, Bruno Latour, Jessica Menger, Daria Mille, and the artists
Copy editing: Gloria Custance, Amruta Nemivant, Paula Woolley, ZKM | Publications
Translations: Gloria Custance
Graphic design: operative.space (Stefanie Rau, Robert Preusse)
Printed and bound: Jak Printers, Mumbai
This publication was set in: ObjektivMk1, ObjektivMk3, Grow-B

Goethe-Institut / Max Mueller Bhavan
K Dubhash Marg, Kalaghoda
Mumbai 400 001, India
Phone: +91 22 69247500
info-mumbai@goethe.de
www.goethe.de/mumbai

ZKM | Center for Art and Media Karlsruhe
Lorenzstraße 19
76135 Karlsruhe
Germany
Phone: +49 (0)721/8100–1200
info@zkm.de
www.zkm.de

CEO and Chairman: Peter Weibel
COO: Helga Huskamp
Head of administration: Boris Kirchner

Founders of ZKM

Baden-Württemberg
MINISTERIUM FÜR WISSENSCHAFT, FORSCHUNG UND KUNST

Karlsruhe

Partner of ZKM

EnBW

Image Credit

1.1: image © Staatsbibliothek zu Berlin, Map department **1.2:** image © Frédérique Aït-Touati, Alexandra Arènes, Axelle Gérgoire, image © Sonia Levy, image © SOC – Société d'Objets Cartographiques, image © SOC – Société d'Objets Cartographiques **1.3:** image © deglobalize.com, image Daniel Fetzner **1.4:** Exhibition view *Earthbound – In Dialogue with Nature*, commissioned by Esch2022 – European Capital of Culture. Photo © Franz Wamhof **2.1:** image © Uriel Orlow; VG Bild-Kunst, Bonn 2022, image Ouidade Soussi Chiadmi **2.2:** image © Armin Linke **2.3:** image © Edith Morales **3.1:** image © ZKM | Karlsruhe **3.2:** illustration © James Lovelock Estate **3.3:** image © James Lovelock Estate **3.4 – 3.6:** Courtesy Lynn Margulis Estate **3.7:** image © Pauline Julier **3.8:** image © Sonia Mehra Chawla **3.9:** image © Cemelesai Dakivali (Arsai) **3.10:** image © Anil Rane **3.10:** image © Rohini Devasher **3.11:** image © Sonia Levy **3.12:** image © The Royal Society London **4.1:** image © Anuradha Mathur, Dilip da Cunha **4.2:** image © Forensic Architecture **5.1:** image © ZKM | Karlsruhe, image Peter Müller, Moritz Büchner **5.2:** image © Ravi Agarwal

zkm.de/critical-zones
critical-zones.zkm.de
goethe.de/india/criticalzones

GOETHE INSTITUT

zkm karlsruhe