CLOUDS ON THE HORIZON

Research Booklet
Morris Widmer
Master Thesis

Studio Tom Emerson
HS24

1. TRANSFORMATION

1. 1. Formation

Continental Drift

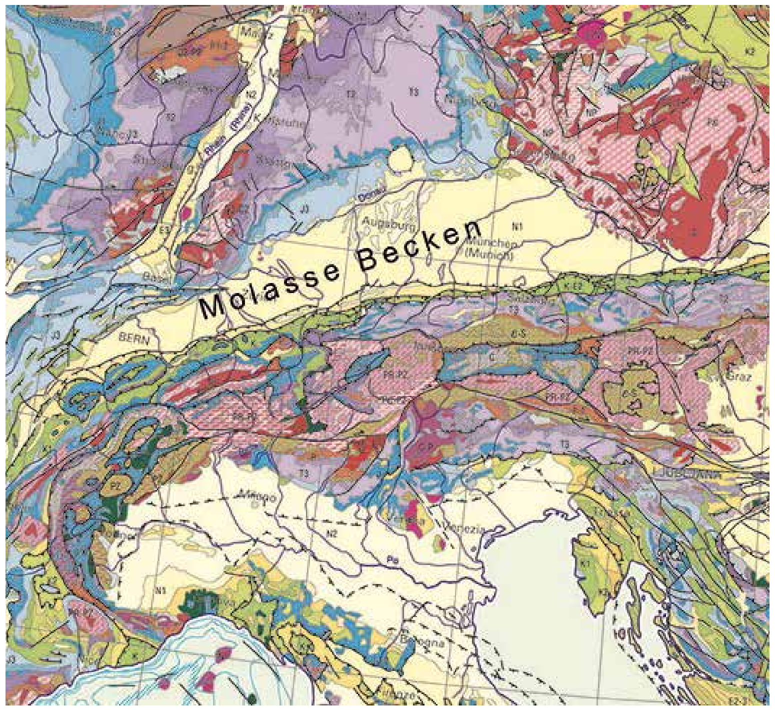
The formation of the Swiss Plateau began around 30 million years ago, during the Oligocene epoch. The collision between the African plate and the Eurasian continent caused the uplift of the Alps and the nearby Jura Mountains. This collision generated immense tectonic pressures, forcing layers of rock upward. The weight of the rising mountains created a large depression known as a foreland basin.

Sediment Deposits

Following this uplift, the newly exposed Alps and Jura were subjected to erosion, primarily driven by rainfall, rivers, and glaciers. Over time, these forces broke down the mountains into conglomerates, gravel, sandstone, and silt. Rivers and streams became the main agents of transporting these eroded materials into the Molasse Basin at the northern foot of the Alps.

Cycles

Sediment transport and deposition did not occur uniformly but in cycles, influenced by changes in climate, sea levels, and tectonic activity. These cycles created alternating layers of different types of sediment, leading to the complex stratigraphy found in the Swiss Plateau today.



Geological Map of the Molasse Basin

Fluvial Erosion

Following the tectonic uplift of the Alps, rivers like the Aare, Rhine, and Rhône became the primary forces shaping the landscape. This erosion is explained with three mechanisms.

Hydraulic action

The force of moving water dislodges rock particles from the riverbed and banks.

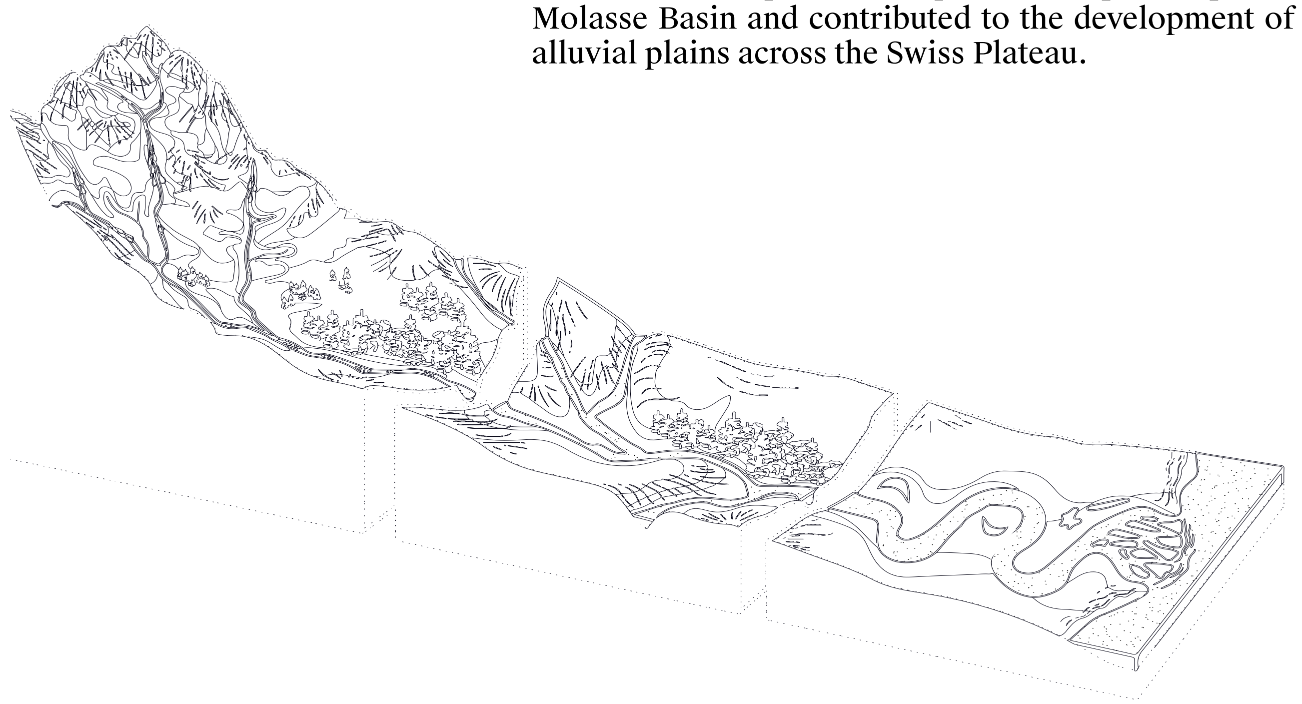
Abrasion

Sediment and rock fragments carried by the river act like sandpaper, wearing down the rock.

Vertical incision

The river cuts deeper into the landscape, carving V-shaped valleys.

In faster-flowing sections, rivers carried larger sediments like gravel and boulders, while in slower, flatter areas, they deposited finer materials like sand and silt, forming alluvial fans and river deltas. This combination of erosion, transport, and deposition helped shape the Molasse Basin and contributed to the development of alluvial plains across the Swiss Plateau.



Process o Fuvial Erosion

Headwater Zone: Headwater streams swiftly flow down steep mountain slopes and cut deep, v-shaped valleys. Waterfalls and rapids occur in this zone.

Transfer Zone: Lower-elevation streams merge to flow down gentle slopes. Valleys broaden as coalescing rivers start to meander.

Deposition Zone: At the lowest elevations, a river meanders across a broad, nearly flat valley and floodplain. At a river's mouth, it may divide into separate channels as it flows across a delta extending out to sea. The coastal plain and delta are made of river sediments.

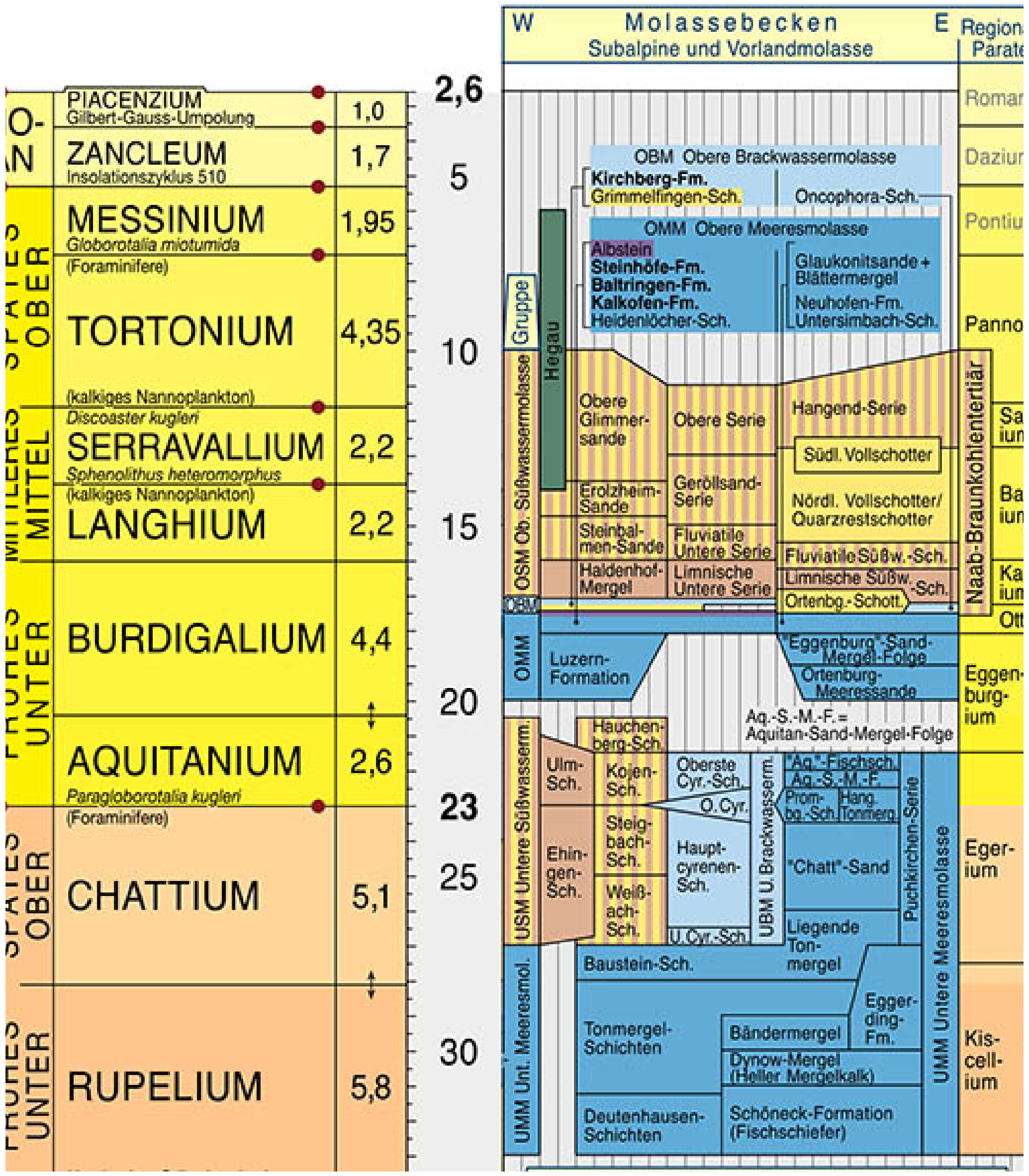
Extent of the Rhône Glacier, 1870

Glaciers

During the Würm Ice Age, glaciers became dominant agents of erosion, further altering the landscape. As glaciers advanced, they plucked large pieces of bedrock and abraded the underlying surface, grinding it down with debris trapped in the ice. This process created the U-shaped valleys characteristic of glacial landscapes, in contrast to the V-shaped valleys formed by rivers.

When the glaciers retreated, they left behind large deposits of moraine, consisting of unsorted material ranging from fine silt to large boulders. This glacial till was then reworked by rivers, which redistributed the moraine material downstream.

Glacial meltwater significantly increased river discharge, enhancing the capacity for sediment transport and further changing the landscape.



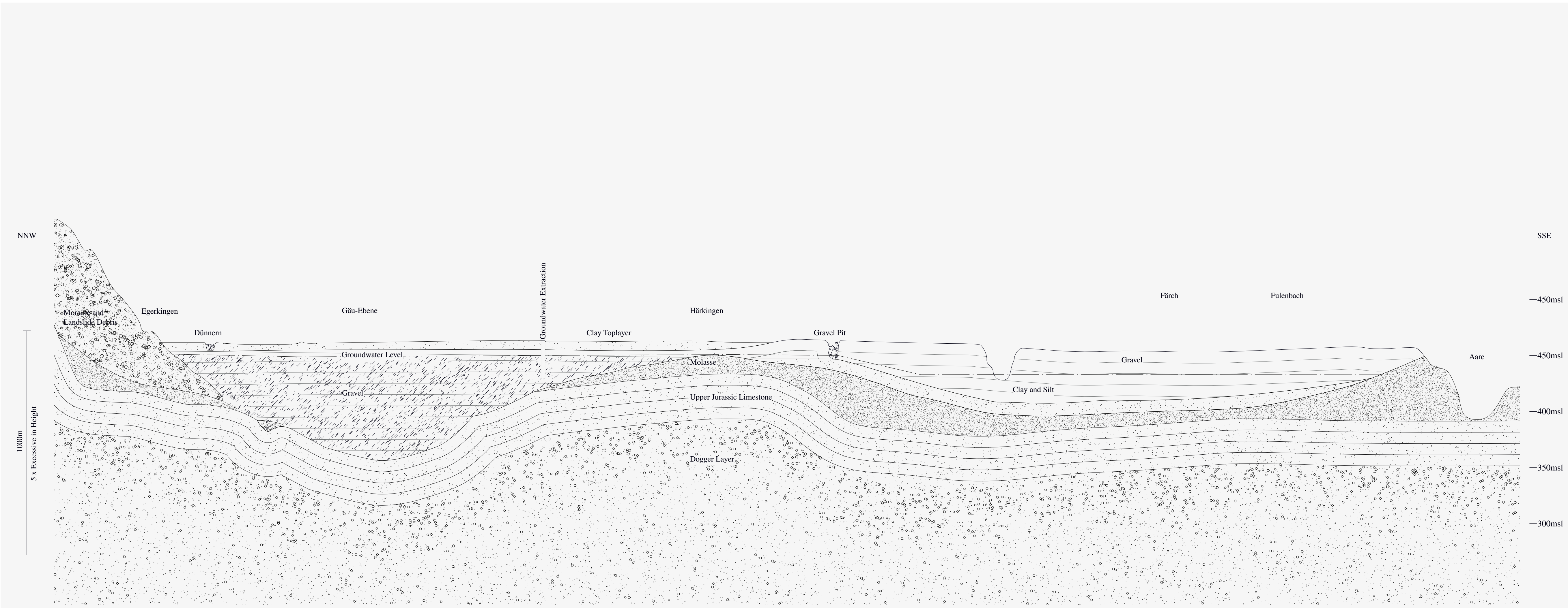
Stratigraphic Table of the Molasse Basin

Land Formation

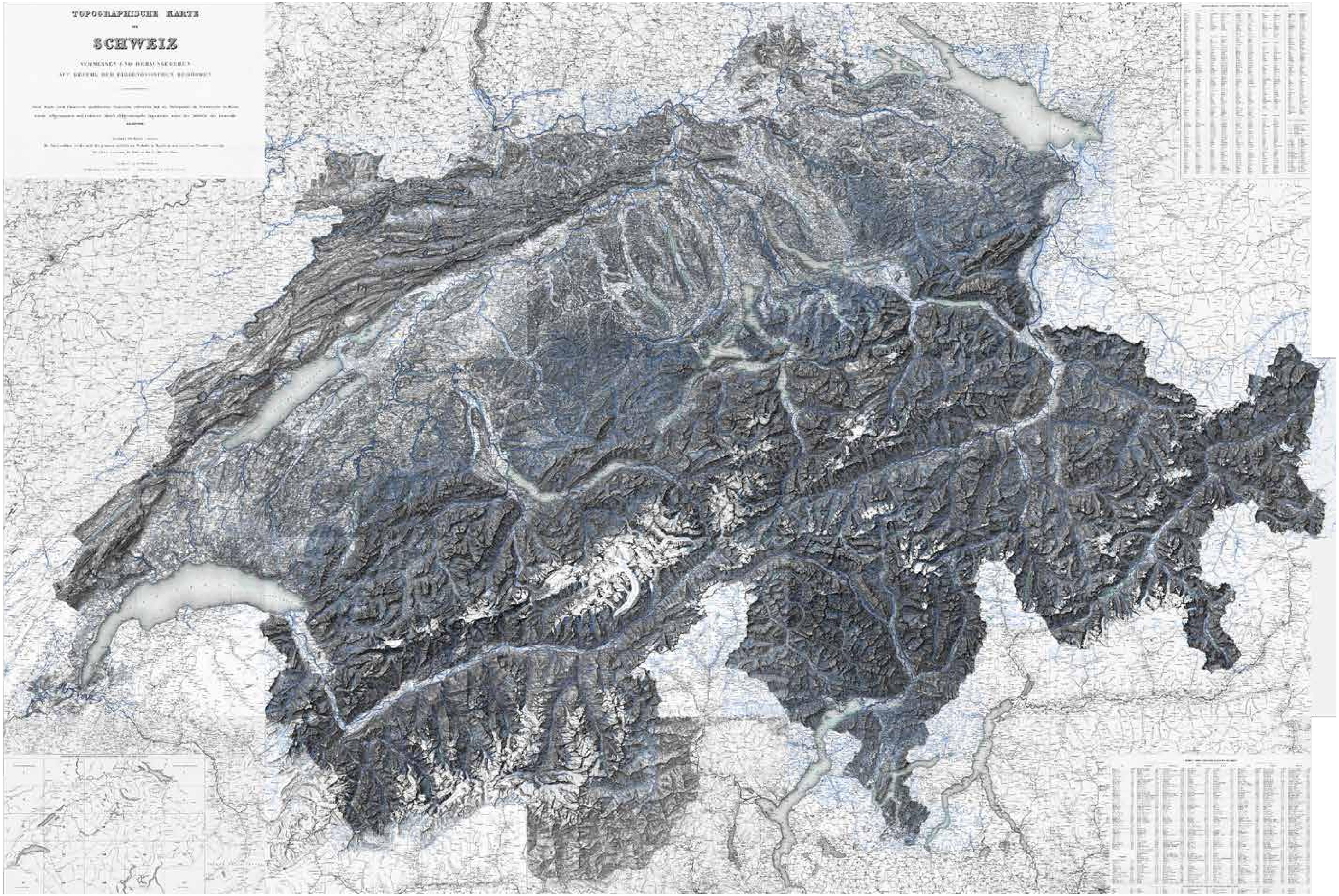
After the glaciers receded at the end of the Würm Ice Age, rivers like the Aare carved terraces, formed by the downcutting of rivers into previously glaciated valleys, and deepened the valleys left behind by glaciers. The meltwater from retreating glaciers added to the river's flow, transporting both morainic and fluvial sediments further downstream.

Rivers also played a key role in forming floodplains, broad, flat areas next to the river, through repeated cycles of flooding and sediment deposition.

During floods, rivers would overflow their banks, spreading water and sediment across adjacent land. As the water slowed, coarser materials like sand and gravel were deposited closer to the river, while finer sediments such as silt and clay settled further away. Over time, this process built up layers of alluvial deposits, creating fertile land ideal for agriculture. Rivers also contributed to the creation of lakes, where calmer waters allowed finer particles to accumulate, further shaping the Swiss Plateau's post-glacial landscape.



Section of the Geological Layers in Härkingen



Juxtaposition of Dufourkarte 1855 and Contemporary River Network

2. HAZARD

2. 1. Myth

Inequality

Poorer populations, confined to low-lying, flood-prone areas, suffered the most from floods, as wealthier citizens could afford land on higher ground. Floods destroyed homes and crops alike. The aftermath had negative effects on public health by creating favorable conditions for malaria and typhus outbreaks. Until 1898 it was believed that malaria originated from swamp-

and marshlands. ital. *mal aria*: bad air.

The idea of the flood being a divine punishment dates back to the very beginnings of recorded history. The great flood is an narrative element that can be found in various religions. The fear of floods was engrained in the population.

Bildlegende?

Überschwemmung 1732 mit Kapelle St. Jakob, David Redinger um 1732

Holztransport auf Flossen, Rodler 1546

The Middle Ages

Rivers were central to the growth of medieval Swiss settlements due to their importance in transportation, timber trade (Triften), and powering mills. The transport of timber, which floated downriver, was essential for construction and for heating. This practice lead to a deforestation in the mountains, which in turn amplified erosion. Additionally the transported logs can clog a channel, which triggers a flash flood.

Rivers also connected towns to broader trade networks, facilitating commerce and resource movement across the region. Fertile floodplains supported agriculture. But the proximity the rivers made communities vulnerable to seasonal flooding. Early settlements developed in river valleys where the fertility, water access, and economic progress outweighed the risk of floods.

Public Space

Early Water Supply (Roman Period–Middle Ages):

Roman Era (2nd–4th Century AD): Roman settlements like Augusta Raurica and Avenches had advanced water systems using wood, clay, and lead pipes to supply baths and homes.

Medieval Castles: Swiss castles were equipped with wells and cisterns to store water during sieges, ensuring a continuous supply for inhabitants.

Water Usage and Organization (Late Middle Ages – Early Modern Period):

Water Rights Disputes: Frequent disputes and agreements over water usage for irrigation and milling were documented, leading to formal contracts and legal settlements.

Development of Springs and Wells: Towns constructed spring catchments and local water supply systems to provide water for drinking, agriculture, and small industries.

Formation of Well Cooperatives: Communities organized cooperatives to manage and maintain shared wells and water systems collectively.

19th Century Technical Advances:

Introduction of Steel and Cast Iron Pipes: Mid-19th-century adoption of steel and cast iron pipes improved water pressure and distribution reach.

Centralized Water Supply Systems: Cities like Zurich (1864) and Basel established centralized water networks, offering more reliable and sanitary water supplies to growing urban populations.

Fischmarkt-Brunnen in Basel,1900

Modernization of Water Supply (Late 19th Century – Early 20th Century):

Increased Demand: Rapid urbanization and industrial growth necessitated modern water infrastructure, including iron pipes and hydrants for higher volumes and pressures.

Comprehensive Networks: Development of household connections and fire hydrants enhanced public health and safety. Municipal Control: Municipalities gradually took over water management from well cooperatives, ensuring consistent and professional oversight.

Formation of Water Associations (20th Century):

Regional Collaborations: Swiss regions formed water associations to coordinate supply and management, sharing resources across municipalities.

Consolidation: By the late 20th century, many regional associations merged to create more stable and efficient national water supply systems.

Legal Regulations:

1864 Water Use Law: Switzerland enacted its first law regulating water bodies, formalizing rights and responsibilities.

1957 Water Protection Act: Aimed at safeguarding lakes, rivers, and groundwater from pollution and overuse.

1976 Water Rights Act: Declared important water sources as public property to protect them for public use.

Adaptation to EU Standards: Alignment with European Union regulations, such as the Drinking Water Ordinance (2004), to ensure high water quality and safety.

Water Consumption Trends (Post-WWII to Present):

Post-1945 Increase: Sharp rise in water consumption due to expanded household plumbing, sanitation systems, and industrial needs.

1980s Stabilization: Water use leveled off between 7.8 and 9.3 million m^3 annually; industrial efficiency improvements reduced overall consumption.

Modern Water Supply Systems:

Priority on Spring Water: Emphasis on using high-quality spring water, supplemented by groundwater when necessary.

Strict Quality Controls: Rigorous testing and monitoring by waterworks and health authorities to meet stringent standards.

Protection of Water Sources: Establishment of protection zones around key springs and groundwater sources to prevent contamination and ensure long-term supply.

Achtungsvoll!

A. Gertsch, Installateur

Sonntag den 16 Februar, nachmittags 2½ Uhr

im Restaur. Waldegg, Gunzger-Allmend

Versammlung

der Interessenten für die Wasserversorgungs- und Hydrantenanlagen der Gemeinden Kappel, Gunzgen, Härkingen und Boningen.

Traktanden:

1. Eingehende Behandlung der Pläne und des Kostenpunktes für jede Gemeinde.
2. Freie Diskussion über die verschiedenen das Projekt betr. Fragen.
3. Verschiedenes.

Die Wichtigkeit der Traktanden läßt vollzähliges Erscheinen sämtlicher Interessenten erwarten.

224

Invitation to a Meeting of the ZVWU, 1933

Organization

Zweckverband Wasserversorgung Untergäu

The ZVWU focuses on sourcing, storing, and supplying water while also working with local farmers to reduce nitrate levels in the groundwater.

1907 Initial discussions with neighboring municipalities about a joint water supply system.

1913 Agreement and foundation of the Zweckverband Wasserversorgung Untergäu (ZVWVU) by the municipalities of Boningen, Gunzgen, Härkingen, and Kappel to ensure a reliable water supply.

1930 Expansion of Härkingen's pump station.

1949 A new pump station was built in Kappel (Dachsmatt).

1964 Establishment of the Untergäu Association and introduction of water usage measurement at municipal boundaries.

1973 Installation of a submersible pump at the Härkingen pump station.

1983 Construction of a new transport pipeline from Kappel to Gunzgen and Härkingen.

1985 Construction of the Zelgli pump station in Kappel, a key groundwater source for the area.

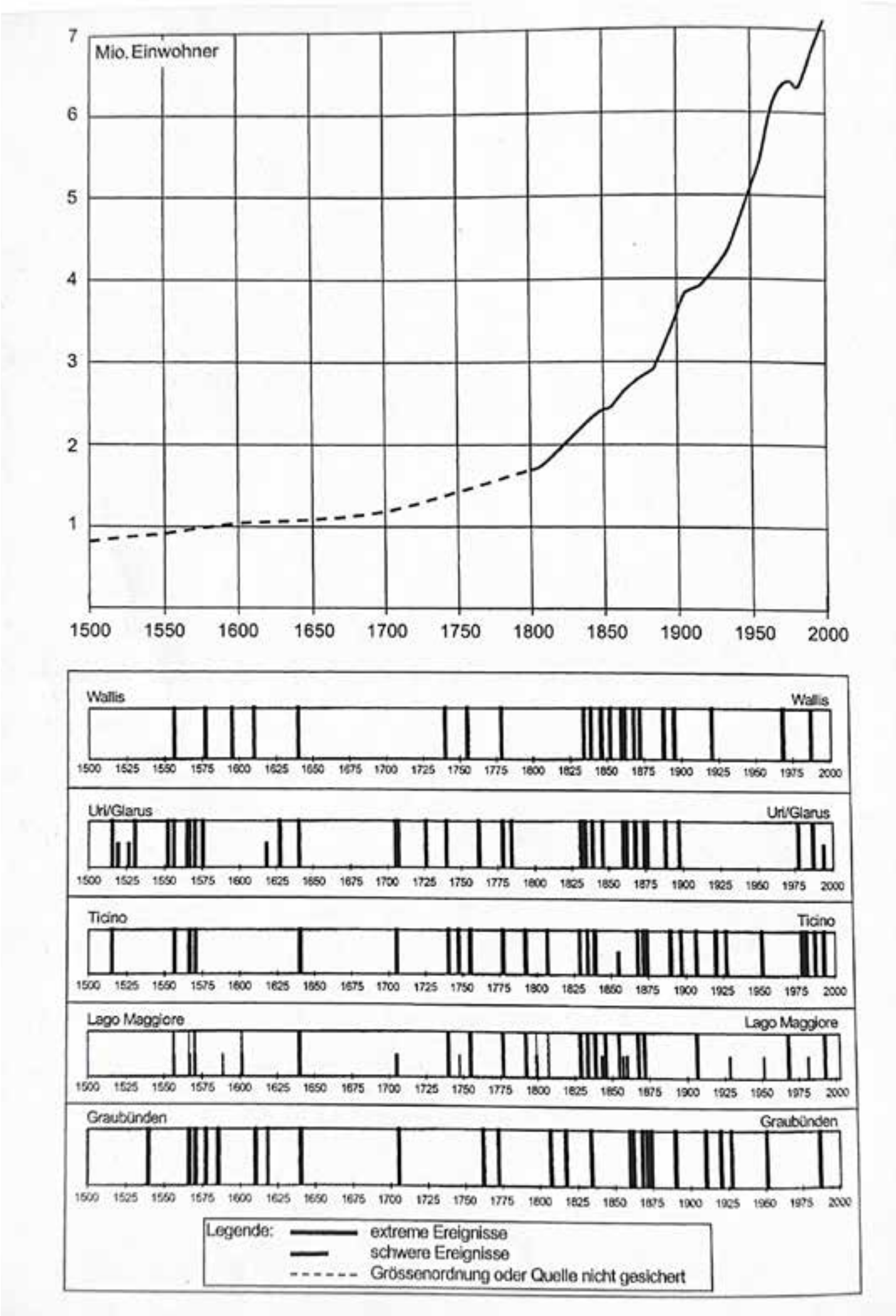
1988 Inauguration of the Zelgli groundwater pump station.

1998 A new reservoir was built at Born to enhance water storage capacity.

2010 Construction of a 2.8 km connection pipeline between the Untergäu and Gäu associations to improve water supply security.

Homes affected by the Flood, 1926

Flooding of the Balsthal by the Dünnern, 1926



Increase of Inhabitants in Switzerland and Statistics of Large Scale Floods from 1500–2000

3. CORRECTION

3. 1. Growth

Melioration

In the 19th century, frequent floods in combination with a population growth (1.7 - 3.5 Mil. Inhabitants) increased the demand for safety and space for buildings and agriculture. Additionally the Swiss railway network SBB relied on the topography of existing rivers. Because of the absence of excessive height differences, railroads were often built alongside rivers. These tracks had to be protected from flooding, which resulted in a fortification of the river banks.

Advances in hydrology, such as flow velocity measurement, and improved cartography facilitated the development of river management strategies. Because of an increase of severe flooding in the 19th century, a need for correction increased. By building dams and channels, wetland areas were artificially laid dry. This marked the beginning of large scale water-infrastructure projects.

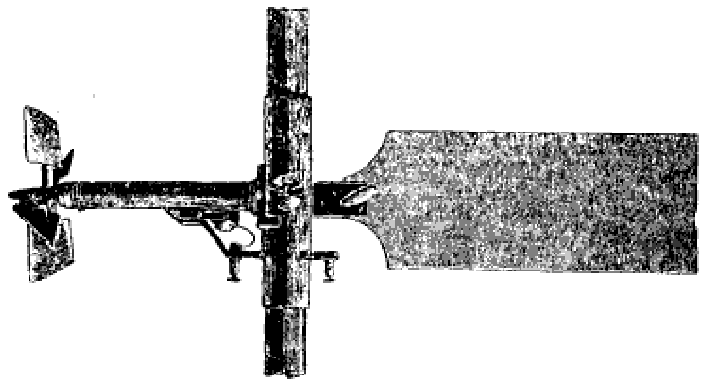
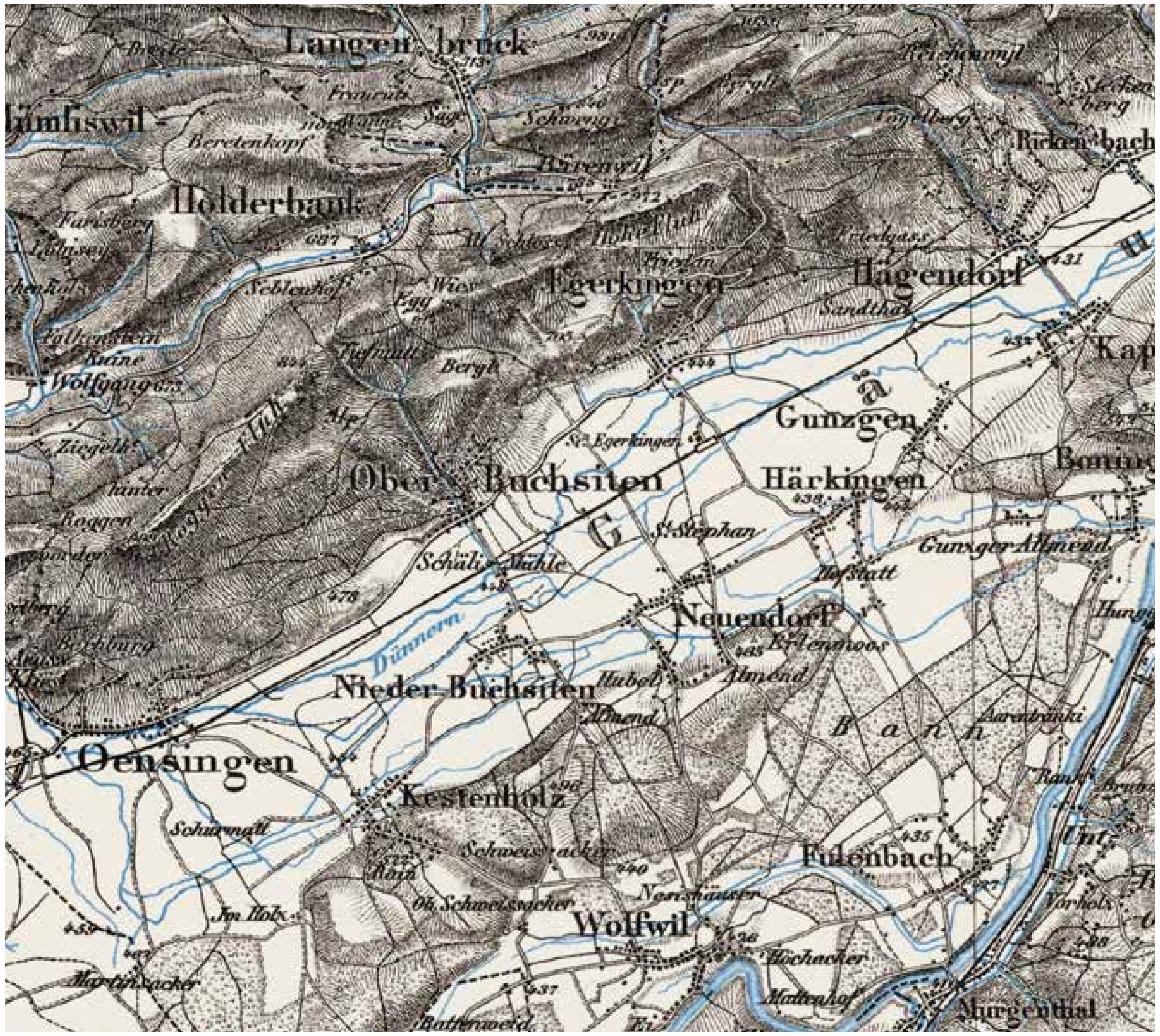
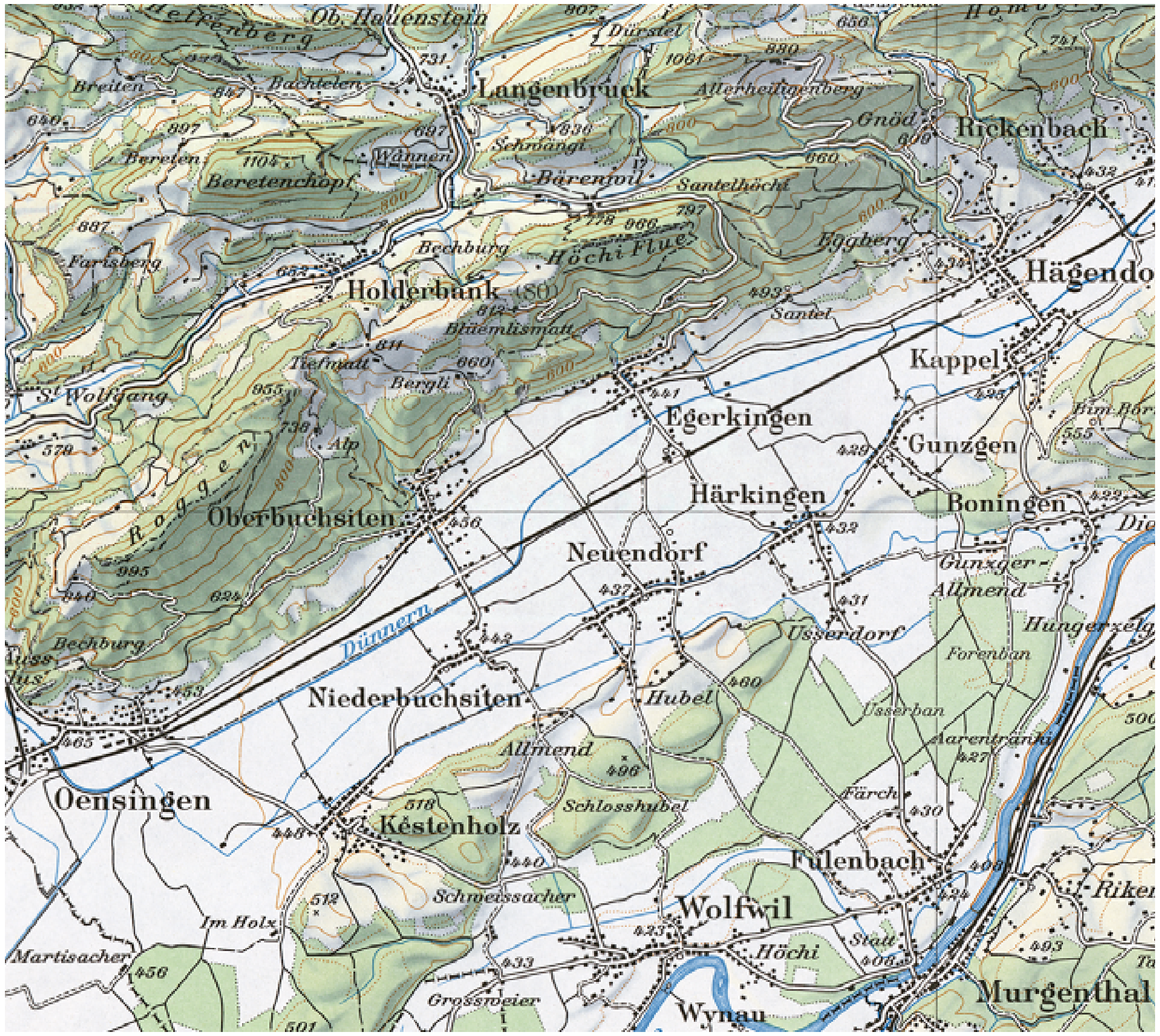


Fig. 1. Woltmannska vingarna.

Woltmann Current Meter



Topographische Karte der Schweiz 1:50 000, Guillaume Henri Dufour, 1930



Landeskarte der Schweiz 1:50 000 (LK25), 1957

3. 2. Control

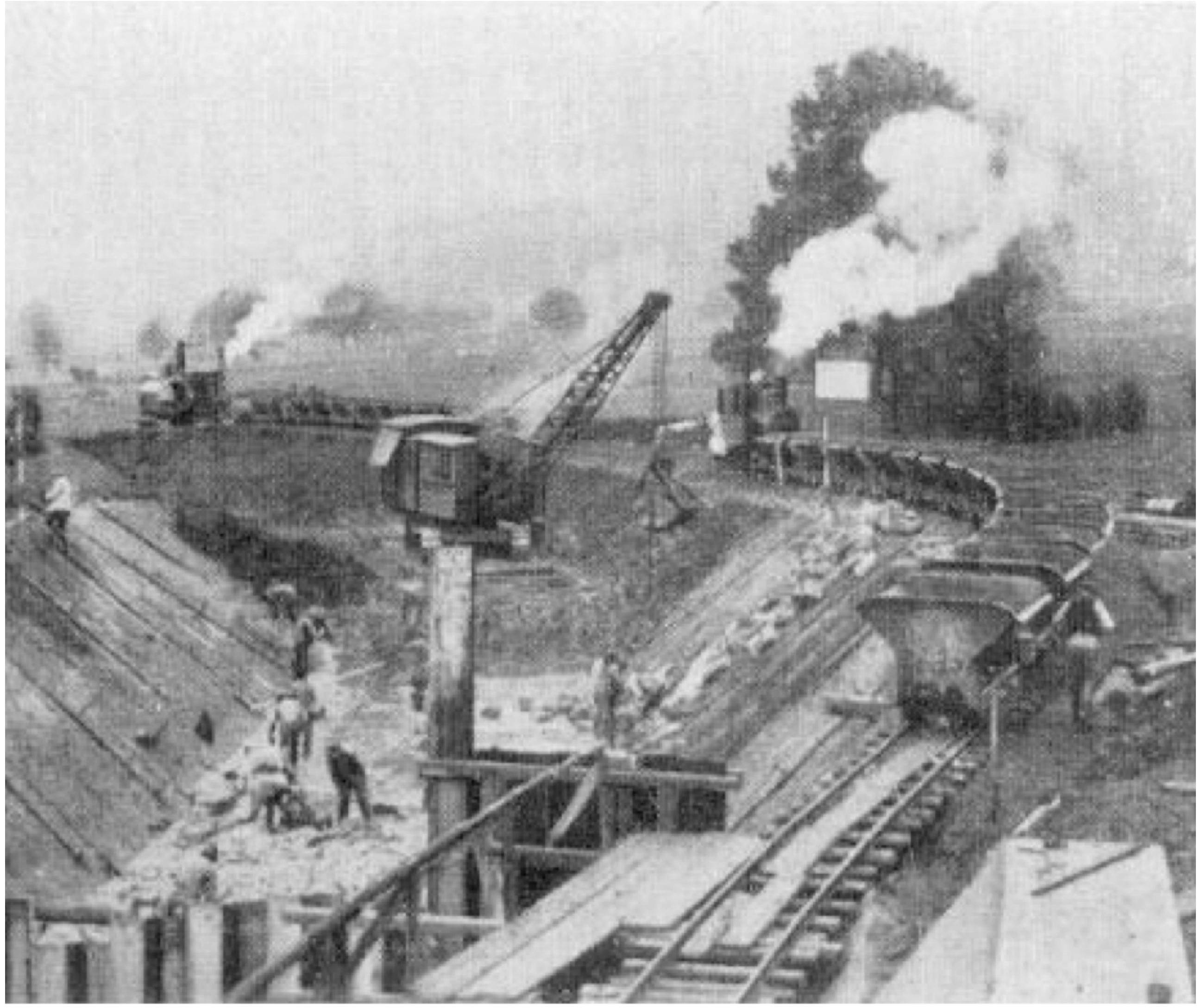
Socio-Economic Impact

Land reclamation improved soil quality, making more land available for housing and farming, which led to economic progress in rural areas. The extraction of river matierial fuelled urbanization.

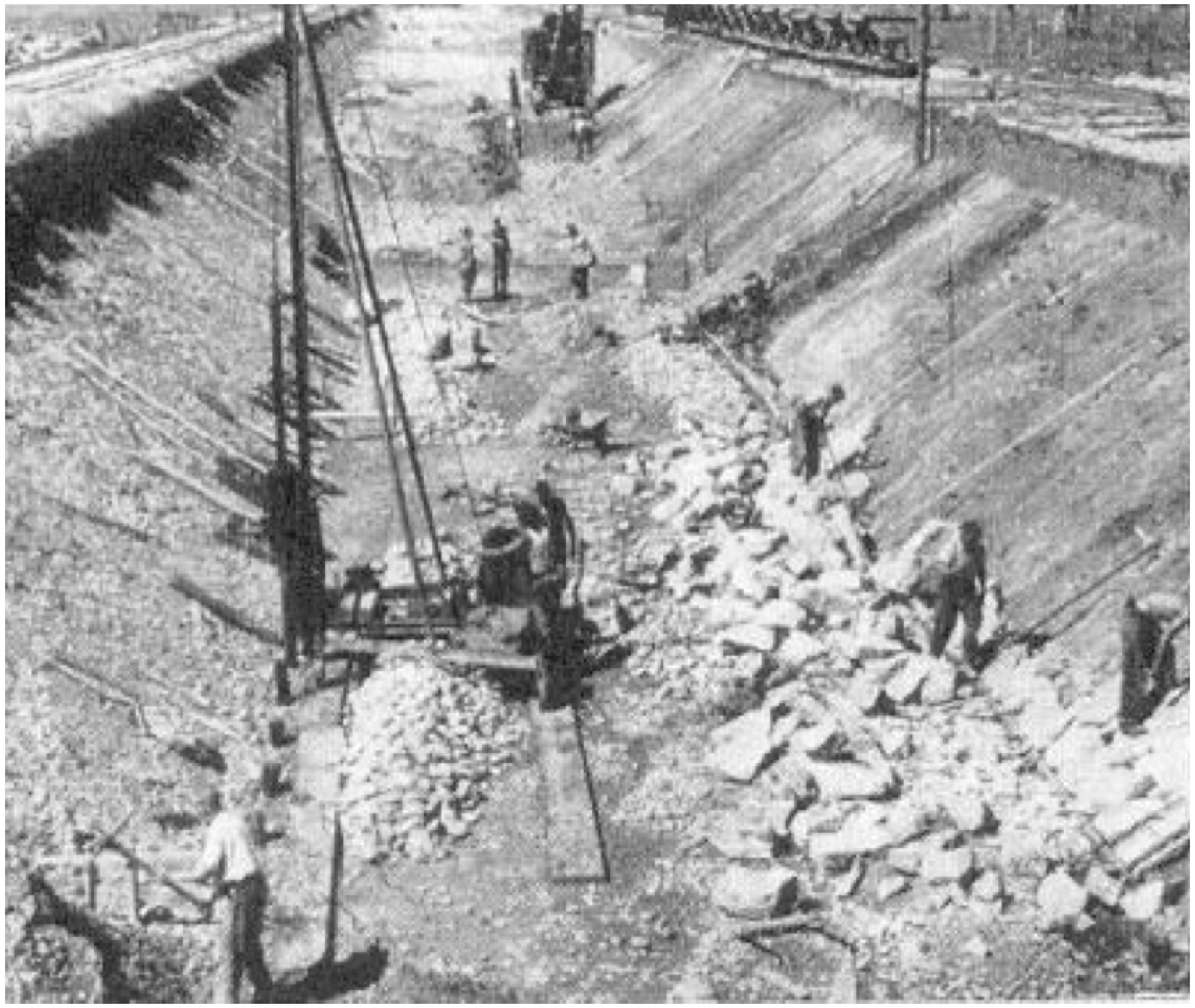
Ecology

While the process increased land availability, it also resulted in the loss of swamplands, crucial habitats for many species of flora and fauna *(BAfU: In floodplain landscapes, which make up less than 1% of the country's surface area, 80% of all native animal species can be found.)*

The alteration of natural watercourses and intensive land use have contributed to poor water quality in both surface waters and groundwater. This has also led to a rise in flooding events, showing the correlation between land modifications, precipitation patterns, and increased flood risks.



Construction of the SBB-Bridge in Hägendorf, 1933



Placing of Slope Paving, 1933

Dünnern-Channel, photographed in1934

Landscape

The landscape was significantly altered, leading to the disappearance of commonly known landscapes, old river courses, and wetlands. Along with these changes, local knowledge about the maintenance and use of these areas was lost. This shift marked a transition from a romantic understanding of nature to viewing it as a resource, driven by technological progress of Industrialization around 1850.

The Lungernsee by Moonlight, J. M. William Turner, 1846

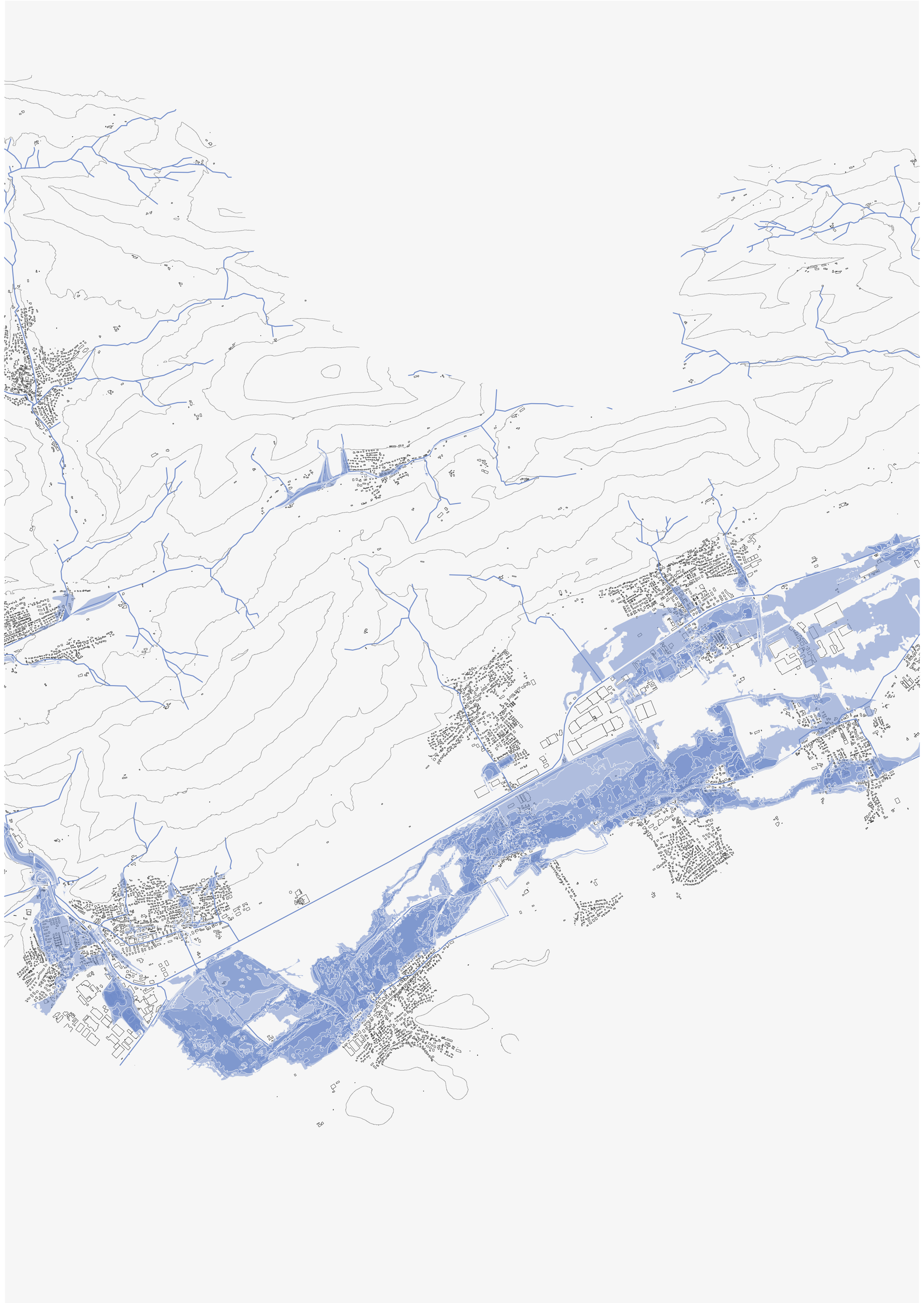
Bergsturz im Haslital, Alexandre Calame, 1839

Corrected River and Railway running parallel through an ideal pastoral landscape, Poster for the Chemins de Fer Jura-Simplon, Hugo d Alési, 1895

3. 3. Transition

During World War I (1914–1918), the shift to the ideas of enlightenment led to the objectification of nature, treating it as a resource. In Switzerland, this period saw the Heimatschutz movement gain momentum in protecting the Swiss landscape from exploitation.

However, patriotic sentiments justified interior colonization efforts like damming and land reclamation, all aimed at strengthening national autonomy.



Map of predicted flood risk HQ100 of the Gäu Region, SO

4. CONSEQUENCES / NOW

4. 1. Excess

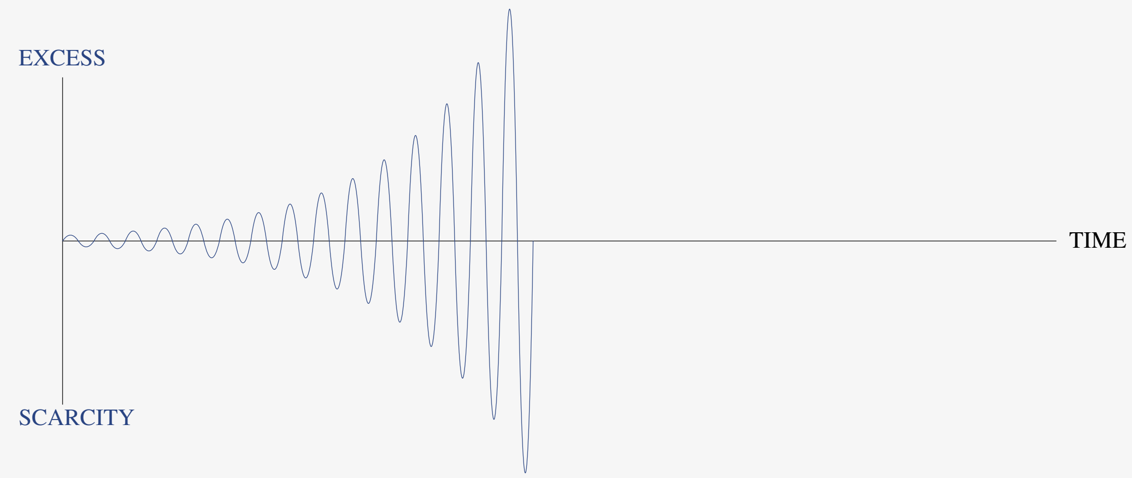
Abundance of Water

Härkingen and the entire Gäu region lies within the flood zone of an HQ100 flood- a hypothetical flood event which occurs once a century. The Dünnern, which runs through the region in an artificial channel, presents a significant risk.

Since the channel has a fixed volume, when the runoff rate from the watershed in the Thal exceeds the channel's output capacity, the water can back up and overflow the banks. As a result, Härkingen, including the research area, is directly affected by these potential flooding events.

AMPLITUDE

The increasing volatility of water availability is a direct consequence of climate change. The fluctuating modes of excess and scarcity of water will be amplified in the future. This will result in a higher frequency and intensity of surface flood and draughts.



Amplification Diagram

Atlas Drawing of the Watercycle

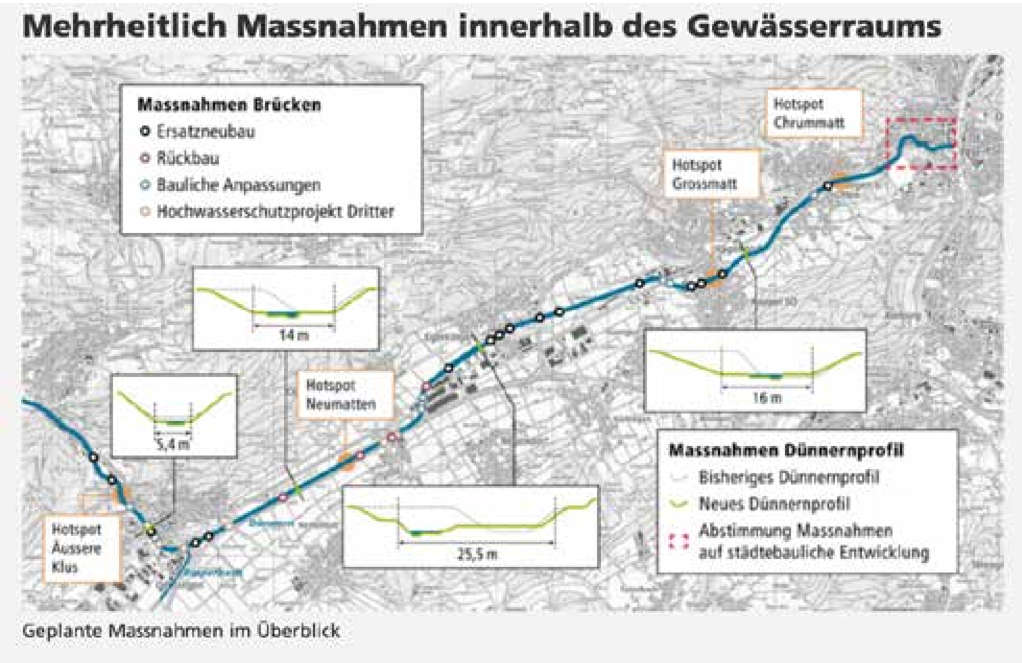
4. 2. Amplification

> "Heavy rainfall events have, on average,
> become 10 percent more intense,
> and their frequency has increased by
> 24 percent."
>
> **Sonia Seneviratne,**
> **Professor of Environmental and Climate Sciences,**
> **ETH Zurich.**

This trend is directly linked to climate change. Warmer atmospheric conditions can hold more moisture, leading to heavier downpours. Roughly 7% more humidity per 1 °C temperature increase. These intense rainfall events significantly increase the risk of flooding, particularly in areas already vulnerable to natural hazards.

These changes in weather patterns have been observed over the past few decades, and they are expected to worsen if greenhouse gas emissions continue to rise. This phenomenon is not unique to Switzerland but is part of a broader global trend, as regions around the world are experiencing increasingly erratic and extreme weather patterns.

Map of potential flooding zones at HQ100



Geplante Massnahmen im Überblick

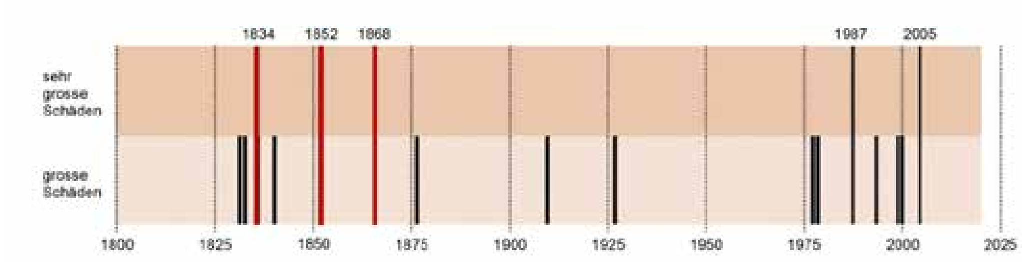
Flood Mitigation Measures by 2048

4. 3. Cost

Damage

For a once-in-a-century flood (HQ100), the damage in the districts of Gäu and Olten is estimated at around 680 million CHF. Additionally, the losses in revenue and operations can far exceed the damage to buildings. Consequently, the expected costs for damage remediation significantly surpass the costs for flood protection. Industrial and commercial buildings are particularly vulnerable to flooding events.

The canton of Solothurn agreed to a floodmitigation project of the Dünnern. It will take 25 years until the construction of the riverbed enlargement is completed. Local farmers are taking legal action to delay the project, which would reduce their agreable land. The project is estimated to cost 180 milllion Swiss Francs.



Histogram of Floods in Switzerland causing high to very high Damage

4. 4. Ownership

Ownership Structure of Water in Switzerland

In Switzerland, water is a public resource whose ownership and management are regulated by a multi-level system. The Federal Government (Bund) establishes national standards through laws such as the Federal Constitution (Bundesverfassung, BV), the Water Protection Act (Gewässerschutzgesetz, GSchG), and the Water Rights Act (Wasserrechtsgesetz, WRG), and oversees their compliance. The cantons, like the Canton of Solothurn, implement these federal laws through cantonal legislation such as the Gesetz über Wasser, Boden und Abfall (GWBA) and its ordinance (Verordnung zum GWBA, V GWBA). They hold sovereignty over water resources and are responsible for issuing permits and supervising municipalities.

The Municipality of Härkingen is responsible for the local water supply and regulates it through its Wasserreglement. Its duties include the operation and maintenance of the infrastructure, fee management, and collaboration with the Zweckverband Wasserversorgung Untergäu (ZVU). The ZVU manages the regional water supply by extracting, treating, and distributing water, ensuring quality, and managing the infrastructure.

Citizens, as water consumers, use the water provided by the municipality. They are obliged to pay fees, use water responsibly, and report any disruptions. Overall, water ownership in Switzerland is based on public ownership, managed by the cantons in the interest of the general public, while municipalities and regional associations ensure the operational supply.

1.2. Öffentliche Gewässer und ehehafte Rechte an öffentlichen Gewässern

§ 6 Öffentliche Gewässer

[1] Gewässer sind öffentlich, soweit an ihnen nicht Privateigentum nachgewiesen werden kann.

[2] Öffentliche Gewässer sind namentlich:

a) die Flüsse (Aare, Emme, Birs), die Bäche und die Seen;

b) die Grundwasservorkommen;

c) die grösseren Quellen, insbesondere wenn sie für die öffentliche Wasserversorgung oder für die kommerzielle Nutzung von Bedeutung sind.

[3] Vorbehalten bleiben private Rechte an öffentlichen Gewässern sowie die privaten Quellen, einschliesslich der damit gleichgesetzten privaten Grundwasservorkommen. Als solche gelten Grundwasservorkommen, welche auf ein einzelnes oder wenige Grundstücke beschränkt sind (Art. 704 ZGB[10]).

§ 7 Hoheit

[1] Die Hoheit über die öffentlichen Gewässer steht dem Kanton zu.

712.15 Gesetz über Wasser, Boden und Abfall (GWBA), 2024

Excerpt from *Floodscapes: Contemporary Landscape Strategies in Times of Climate Change* by Frederic Rossano

"The difficulty of grasping the planet's slow changes isn't new in itself: Aristotle noted already that 'the whole vital process of the earth takes place so gradually and in periods of time which are so immense compared to the length of our life, that these changes are not observed, and before their course can be recorded from beginning to end whole nations perish and are destroyed' (Aristotle, 1931, I, 14). In ancient Mesopotamian, Greek, Hebrew, or Christian traditions, the Flood myth remained a short and a singular episode, however, hiding the reality of long-term geological processes and hindering a continuous vision of the earth history—a history that was thought to be only a few millennia long until recently.

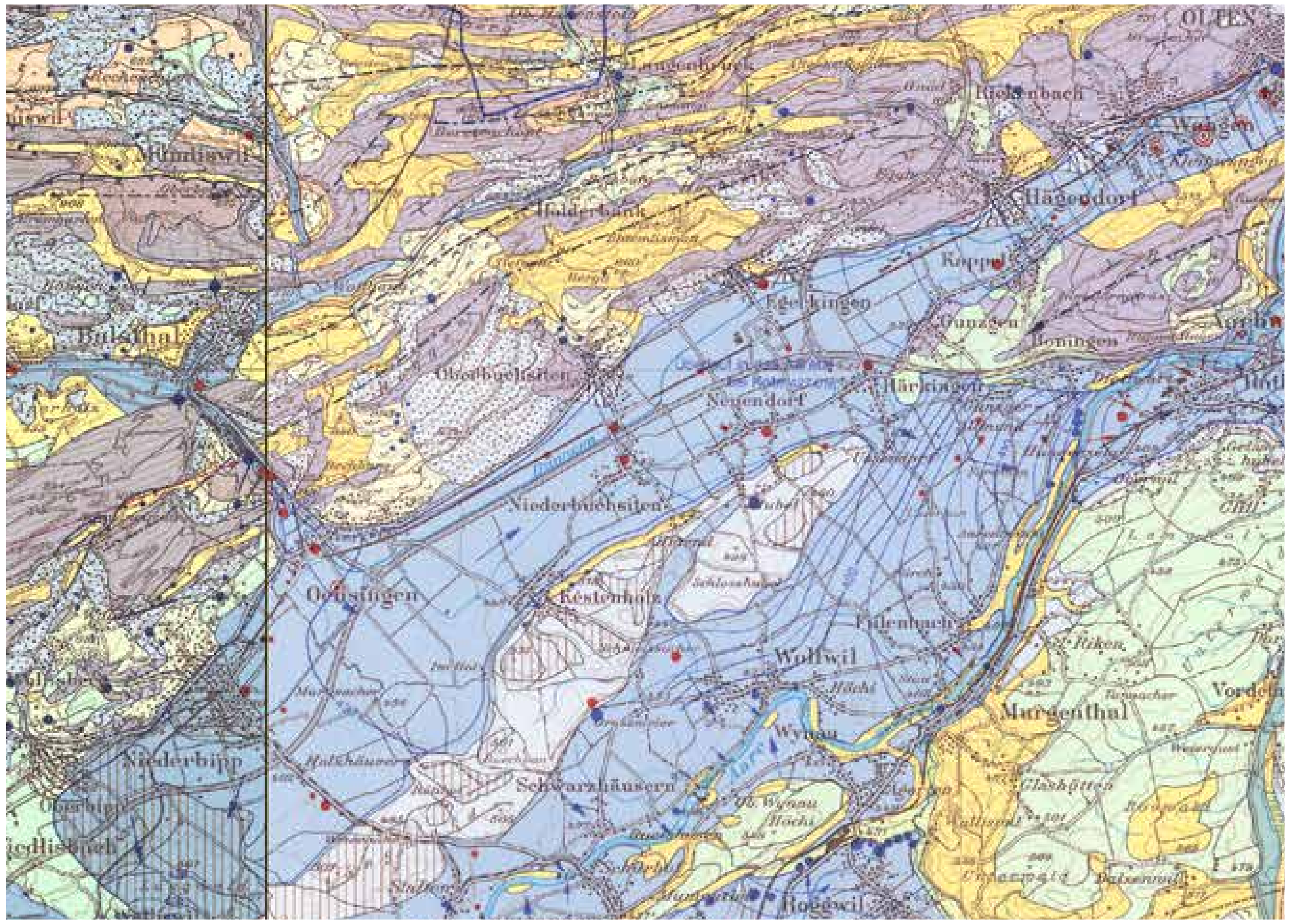
The main difficulty for river adaptation projects lies precisely in the gap that separates the different temporalities of reflection and action that condition these projects: the history of climate and its long episodes, measured in millennia for the Holocene epoch; the centuries of accelerated global warming (whether called as Buffon did the 'Seventh Epoch', When the Power of Man Has Assisted That of Nature, or currently the 'Anthropocene'); the time of a human life, which determines the perception of risk and the acceptability of planned measures; finally, political time, which determines the scale of these measures and the continuity of investments.

Humankind did indeed survive various episodes of glaciation and warming, which each time drastically transformed our living environment, starting with the layout of coastlines and rivers. The current transition, however, differs from the previous in key aspects: the size, the sprawl and the fixity of today's human settlement, which make adaptation measures much heavier, slower, and more complex. Compared to the hundreds or thousands of Scandinavians who escaped a cooling Greenland, today's global warming could affect billions of people living in regions threatened by sea level rise, river flood or desertification.

Contrary to Neolithic settlements, contemporary cities are nor transportable, nor compostable nor recyclable, and adaptation measures should be found on the spot, within existing infrastructures that were built for stable conditions. Conversely, human resources and knowledge are now much greater than in previous transitions, and adaptation measures, although necessarily local, can benefit from an unprecedented pool of experience and knowledge.

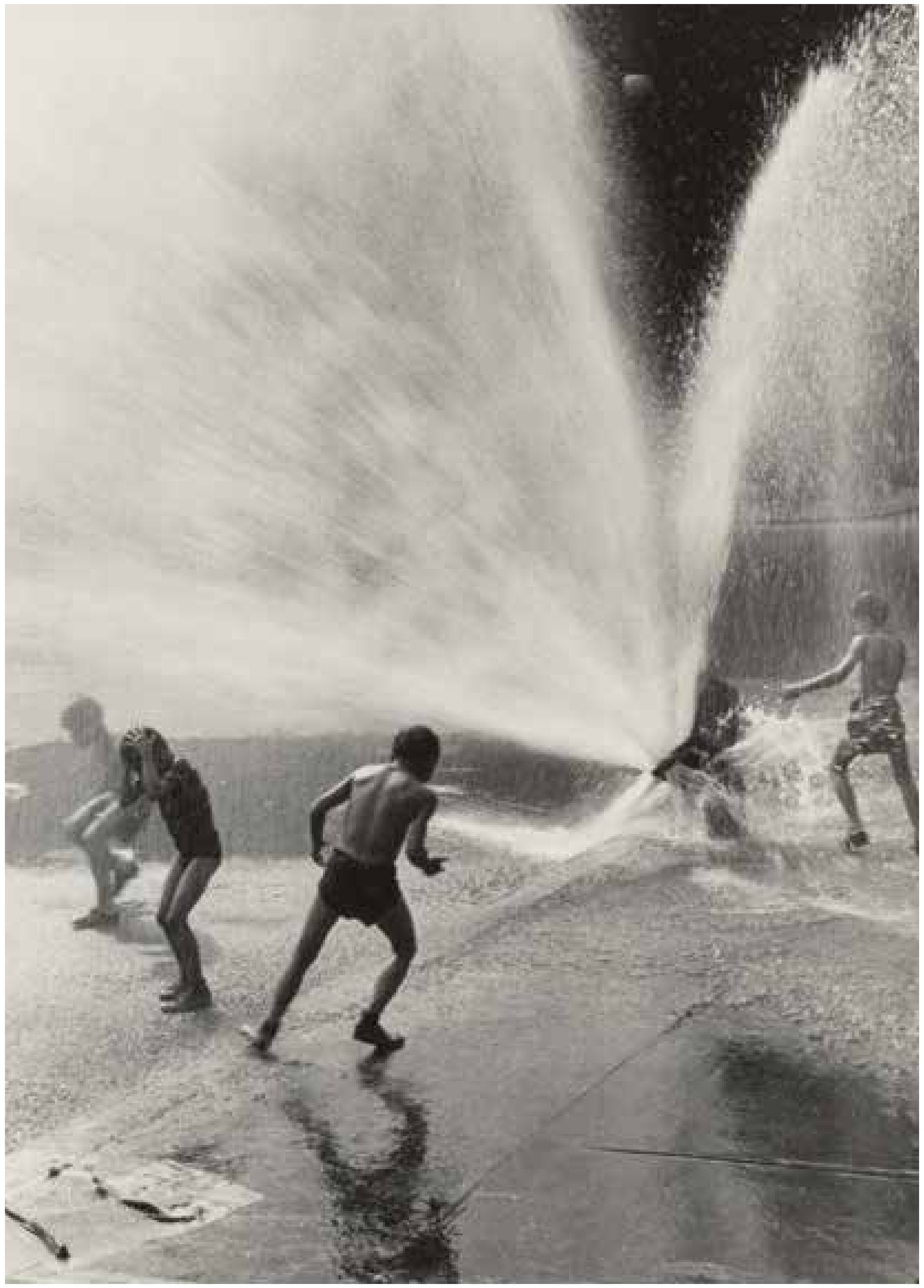
In terms of water management, the disparity of global warming scenarios beyond 2050, and the uncertainty concerning their local effects, neither ‚lasting' solutions nor ‚unsinkable' defence structures to combat yet unknown discharge levels are conceivable.

The opposite approach, set waters free' and wait for a hypothetical natural balance, cannot ensure a credible flood protection for densely exploited and inhabited regions either. Lacking measurable objectives, adaptation policies can only focus on restoring margins for future fluctuations. This makes the shift from fixed flood-containment measures to flexible spatial strategies even more legitimate: more than sustainability (in the sense of a lasting state), elasticity should be ambitioned today for the development of river regions and estuaries."



Map of the ground infiltration rates





Fire Hydrant Street Play **in New York City, 1969**

5. CLOUDS ON THE HORIZON

5. 1. Thesis

"They leaped the fence and saw that
all nature was a garden." *

*** Quote on English Landscape Architects in Anectodes of Painting by Horace Walpole, 1849**

The project transformative nature of water on the land and its inhabitants. Throughout history and continuing today, water has shaped the way we live and how we build. Because of climate change, we need to recalibrate our relationship with the element.

The increasing volatility of weather extremes is a direct consequence of climate change. The fluctuation between excess and scarcity of water will be amplified in the future. Rising temperatures allow air to hold more moisture, which intensifies precipitation and increases the risk of flooding. Simultaneously, longer dry periods will lead to more severe droughts.

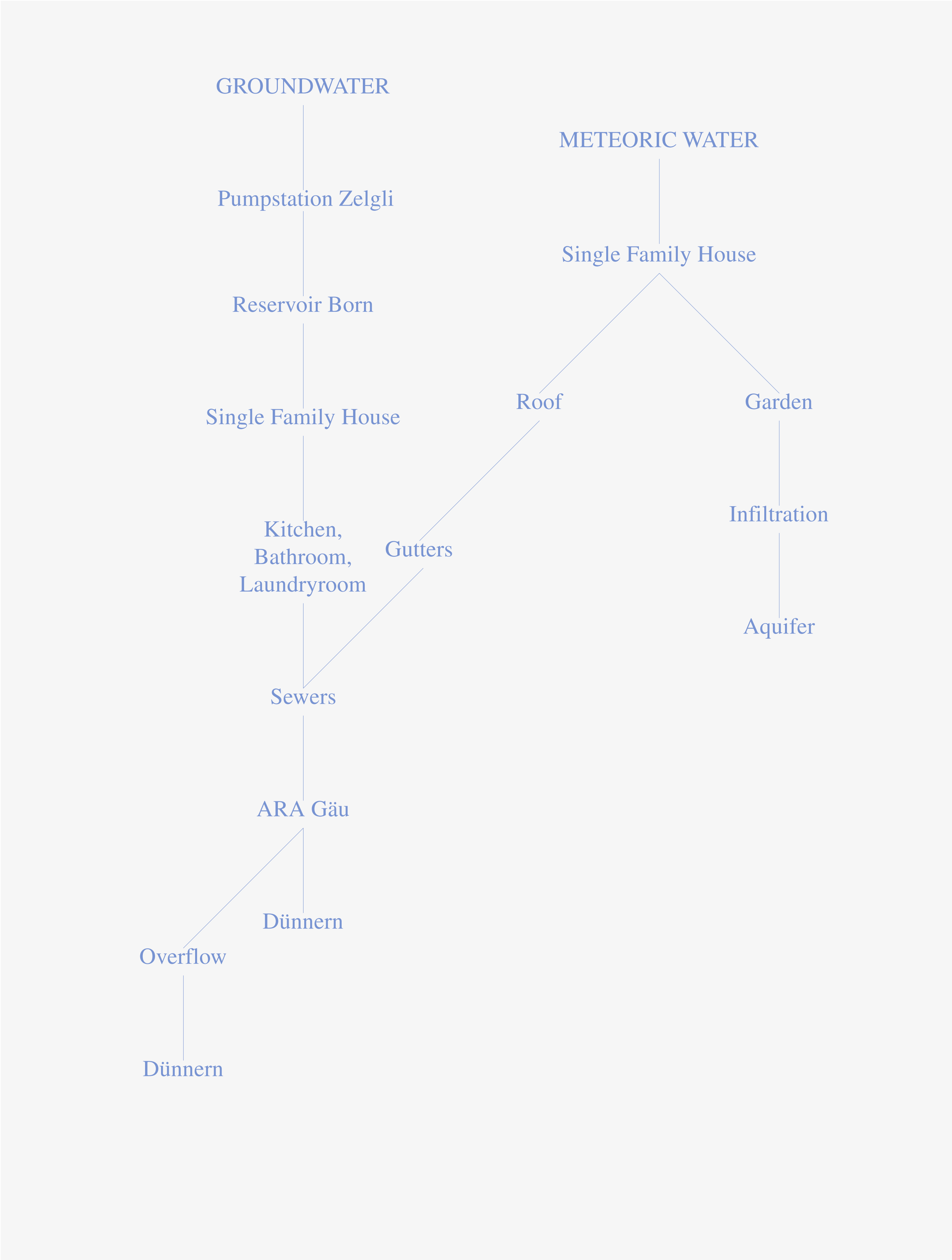
Today's water infrastructure is rooted in linear, centralized systems designed for maximum efficiency. However, its rigid, top-down nature fails to respond to the variable temporalities of water.

A raindrop's journey begins with light rain collecting in gutters and rain barrels, diverting water for irrigation and linking households to an ecological system. As the rain intensifies, barrels overflow, guiding water through channels that blend boundaries and follow the land's contours to a fountain, where sediments settle.

During the storm, overflow from streets and fields joins the fountain's runoff, filling retention basins that buffer excess water. Swales and basins guide the flow to streams that replenish wetlands and reconnect with the Dünnern, completing the cycle.

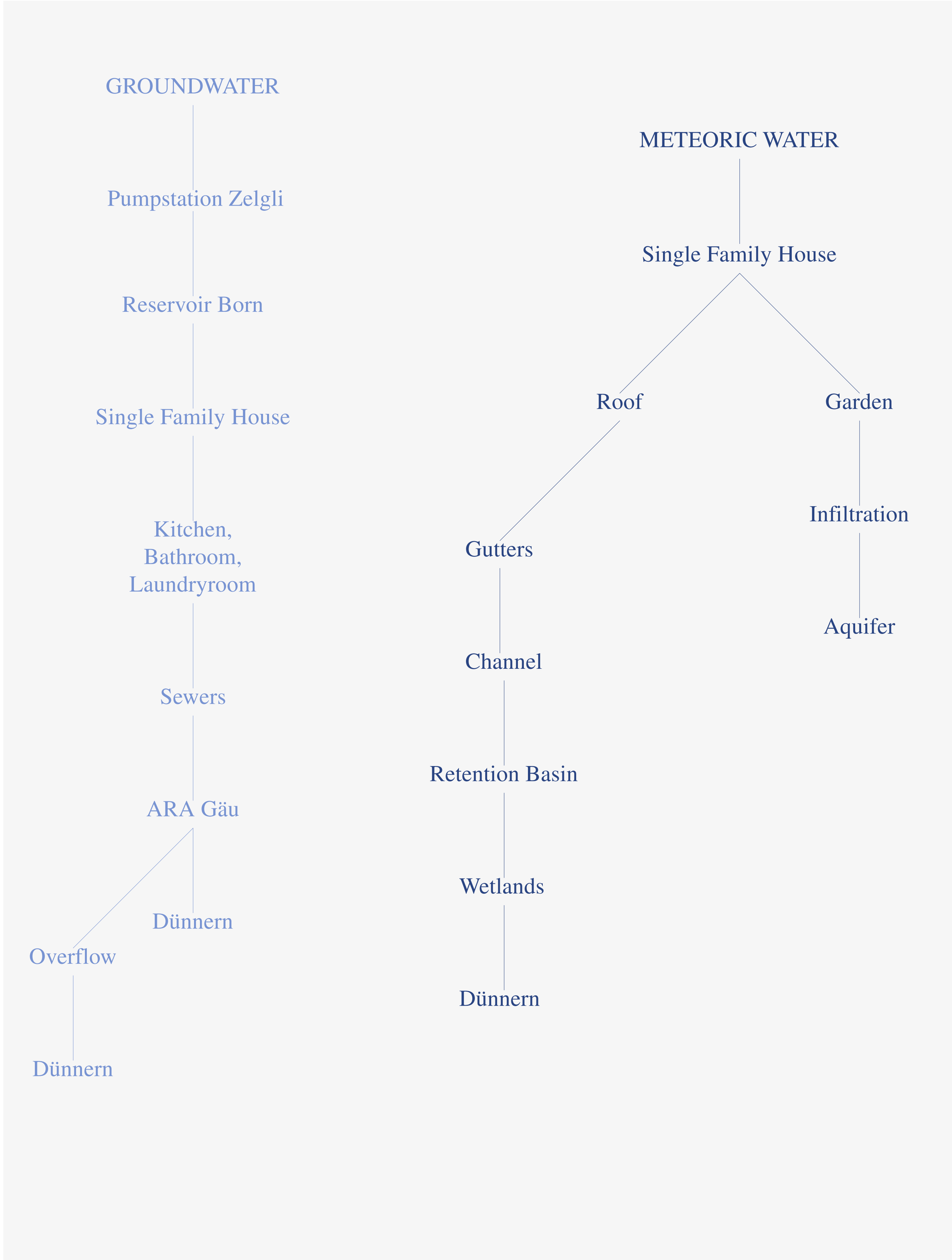
After the storm, the system thrives as a space for renewal, enriching plants, sustaining wildlife, and uniting people with water's rhythms.

5. 2. Entangled

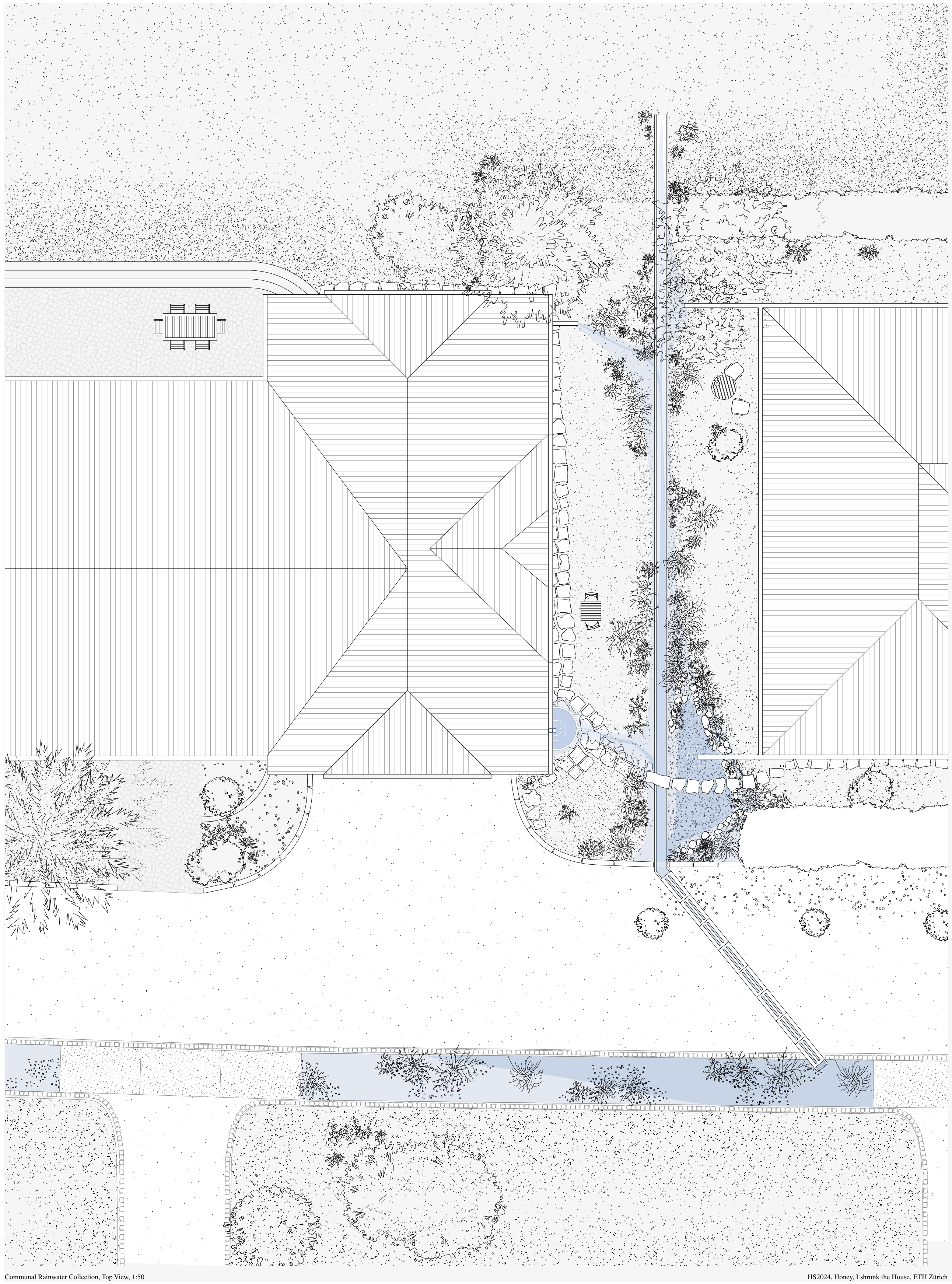


Existing Watercycle

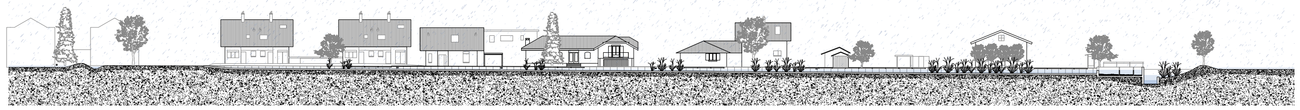
5. 3. Untangled

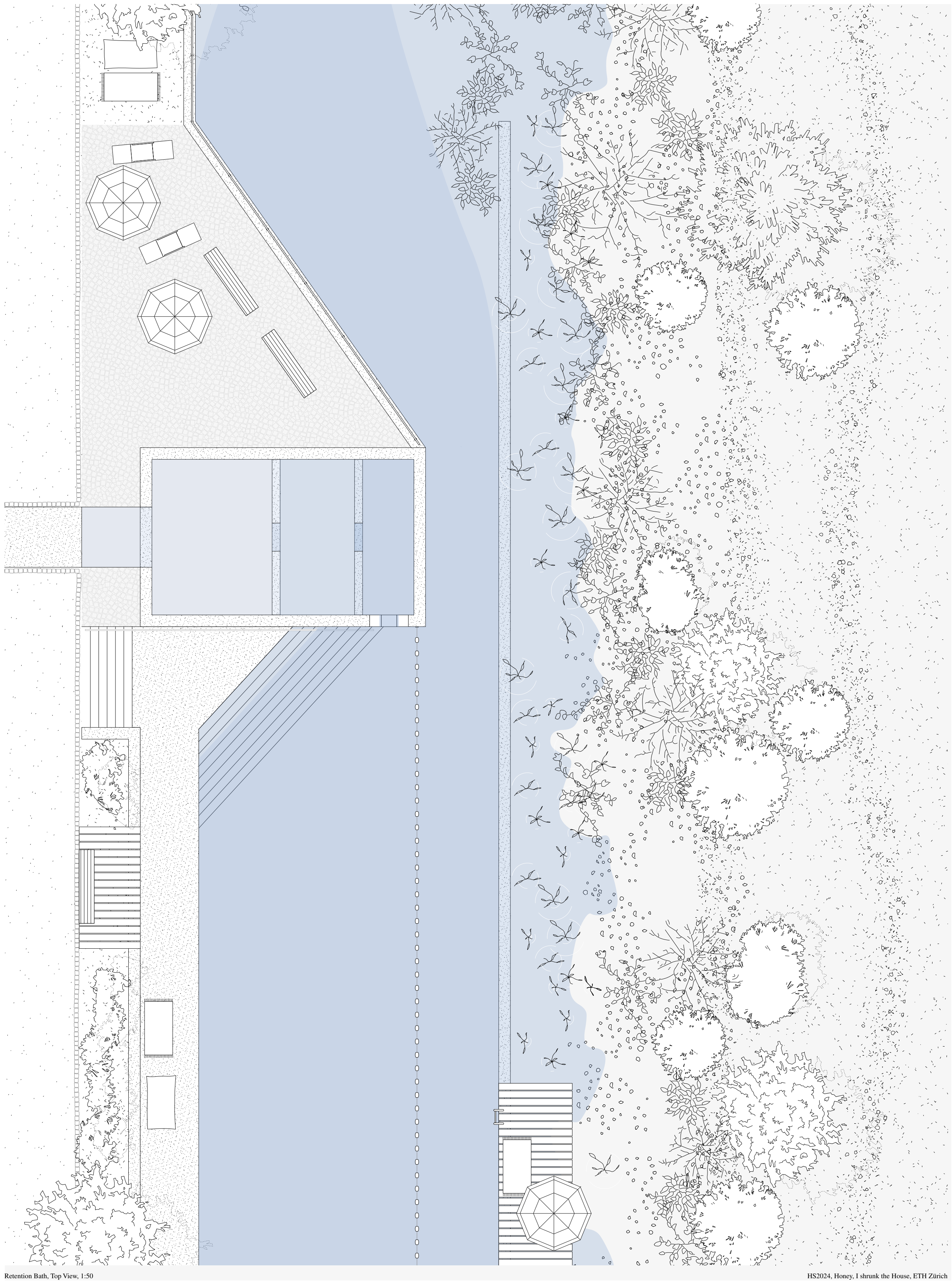


Adapted Watercycle

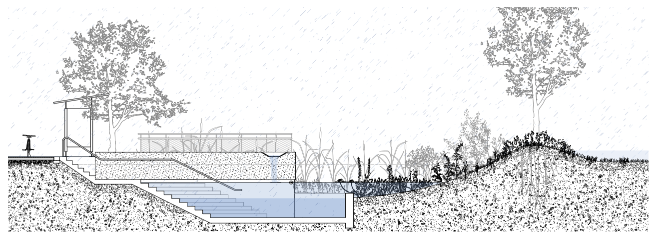

Communal Rainwater Collection, Top View, 1:50
HS2024, Honey, I shrunk the House, ETH Zürich

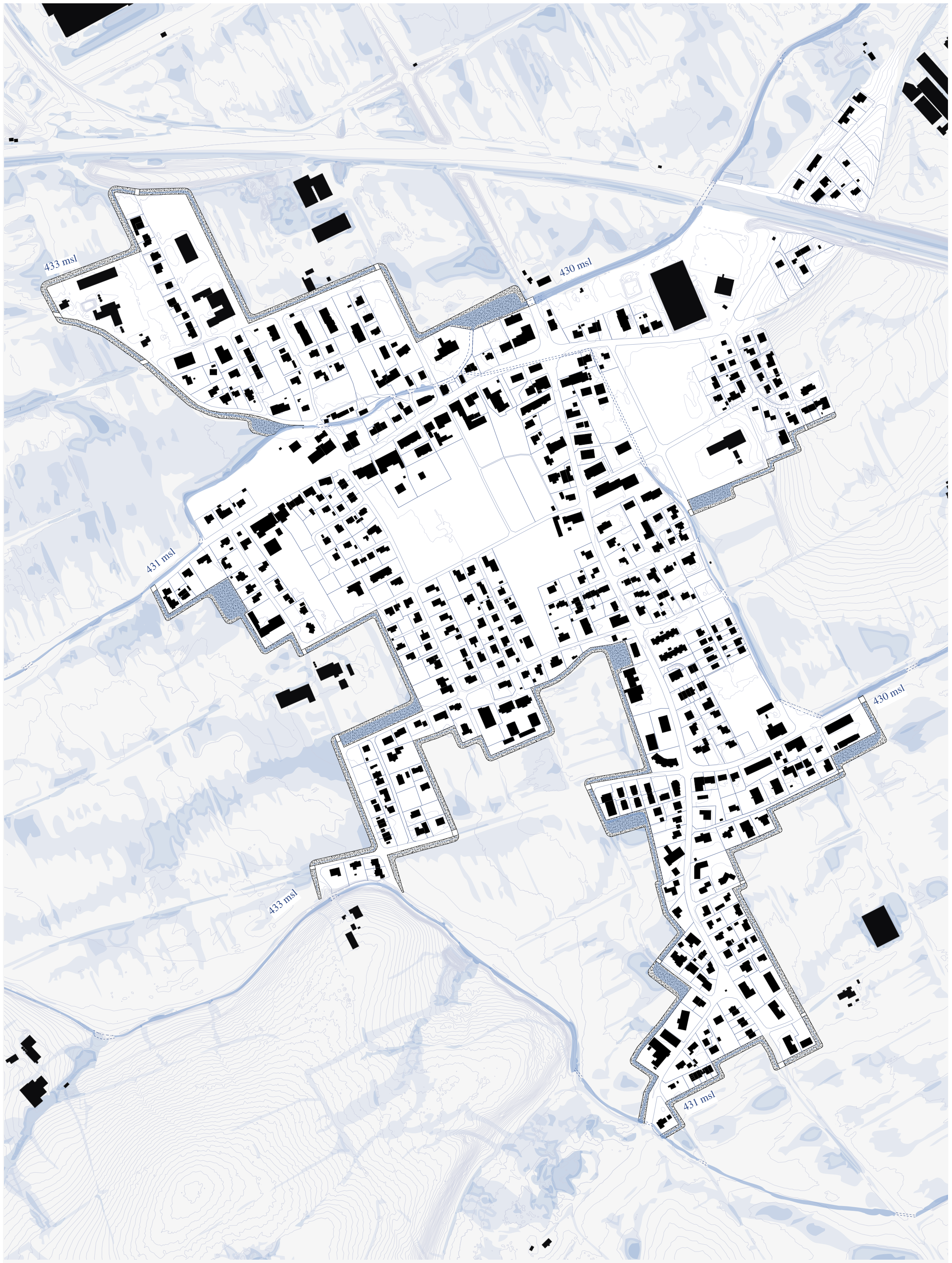
Neighbourhood Waterways, Top View, 1:200





Retention Bath, Top View, 1:50
HS2024, Honey, I shrunk the House, ETH Zürich





Swales, Retention Basins and Existing Streams, Map , 1:2500

HS2024, Honey, I shrunk the House, ETH Zürich