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Water

Hydrotopia

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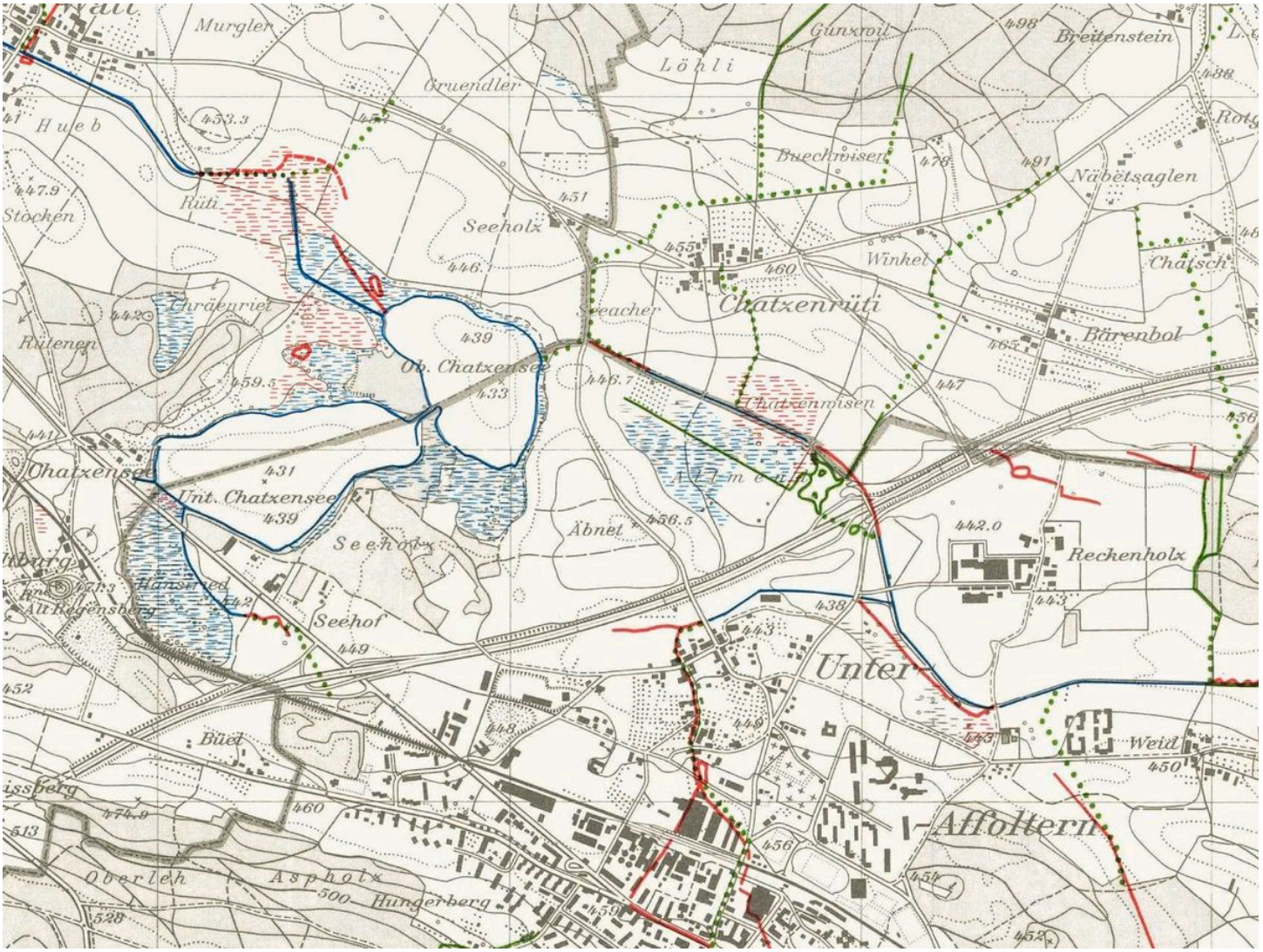
Over the course of the last two centuries, farmers drained almost 90 % of wetlands in Switzerland to gain land for agriculture production. Our site in Zürich Nord, located in the Furt Valley, is no exception. The area that once consisted of marshlands and small-scale fields divided by hedges has transformed into vast arable land where humans aim to control the flow of even the last drop of water.

The drainage of land has proven to be a problematic practice. On the one hand, water runs off too quickly on drained land, causing soil erosion and leading to excess water on other areas. On the other hand, the loss of wetlands accelerates climate change as its soil can store great amounts of CO_2. Biodiversity is threatened as well since many specialised species can only be found in this environment. Finally, the drained soils are not apt to deal with the increasing number of heavy rainfall events and draughts ahead.

Introducing spatial interventions to slow down the water runoff and to keep the water on the site would allow to restore valuable wetlands while increasing local water self-sufficiency and resilience.

Anthropogenic Waterscapes



Human interventions have left a lasting mark on the water cycle of Zurich Nord. Throughout the 18th and 19th century, wetland were drained on a large scale to gain agricultural land and intensify production. By the 1900s, around 90 % of marshland in Switzerland had been destroyed.

The Swiss landscape underwent a significant transformation around 20,000 years ago when glaciers extended from the Alps to the southern tip of Lake Zurich. Following a warmer period, meltwater gave rise to lakes and wetlands. Examining the recent history of wetlands and water bodies in Switzerland reveals their evolution was shaped by three influential societies.

In the 1700s, the predominantly agrarian society coexisted with the surrounding wetlands, primarily using them for hay storage and meadows. By the 18th century, approximately 70–80 % of the population were farmers. The industrialisation from the 1850s marked an era of “economisation,” leading to the transformation of marshlands, rivers, and lakes. A drainage system featuring clay tubes was introduced to reclaim substantial portions of wetlands. The newly acquired agricultural fields were intensively cultivated, with heavy machinery, fertilisers, and petrol playing an important role in maximizing crops. Wetlands were further drained through the application of gravel, while river courses were straightened to enhance drainage efficiency. By the 1900s, around 90 % of marshland in Switzerland had been destroyed.



Historical water map showing changes since 1850. Source: GIS Kanton Zürich. [https://maps.zh.ch]

From the 1950s onwards, industrialization transitioned into the era of ecological awareness. Concerns about water pollution and the preservation of biodiversity gained prominence. Recognizing the significance of the Katzensee swamp, it was designated under protection with the “Rothenthurm-Initiative” in 1974. Efforts are directed toward restoring damaged wetlands and water bodies to create healthy habitats that support water supplies and biodiversity.



Unterer Katzensee. Source: Jan Aebi, 2023.



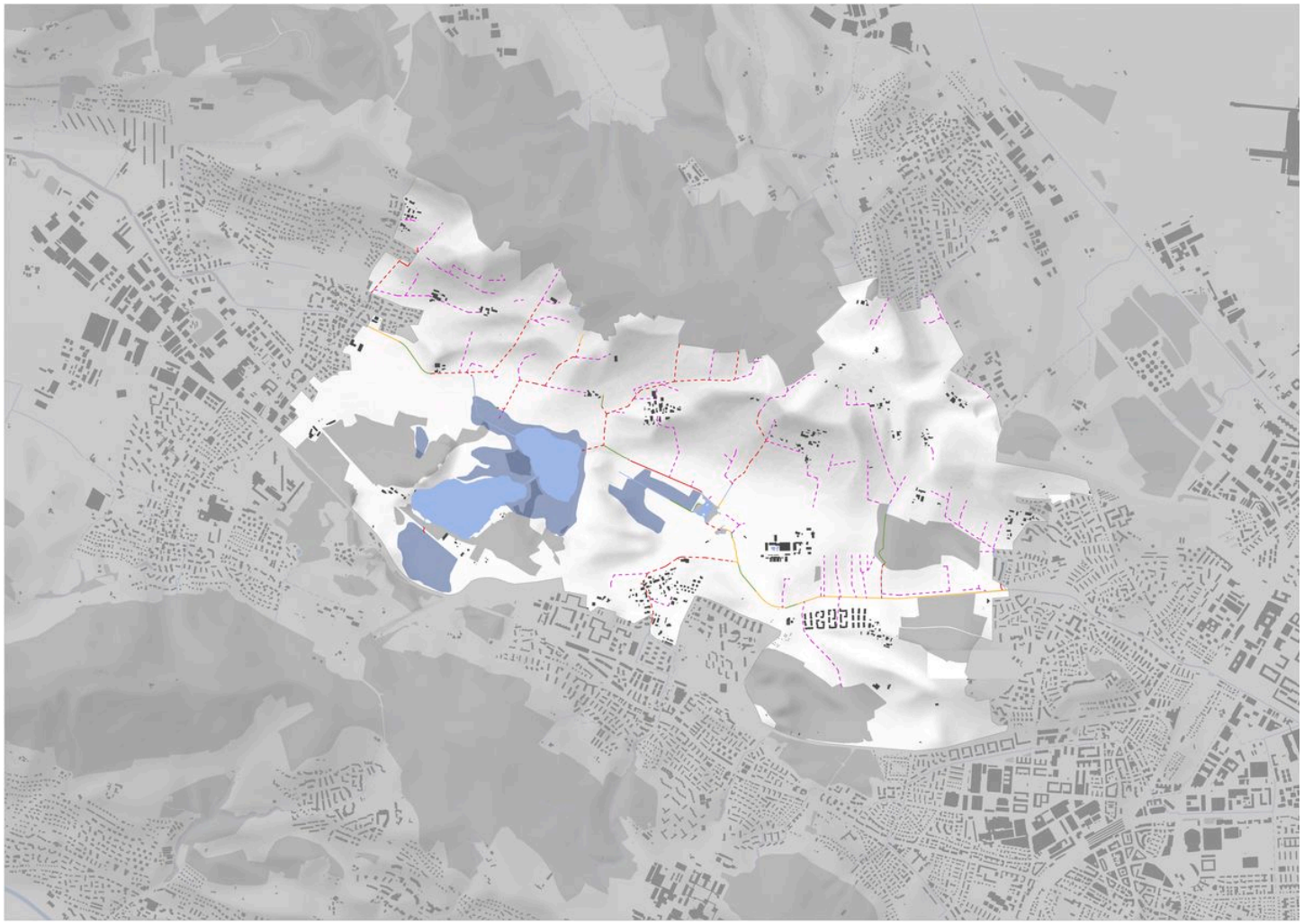
Oberer Katzensee. Source: Jan Aebi, 2023.



Wetland Allmende. Source: Jan Aebi, 2023.

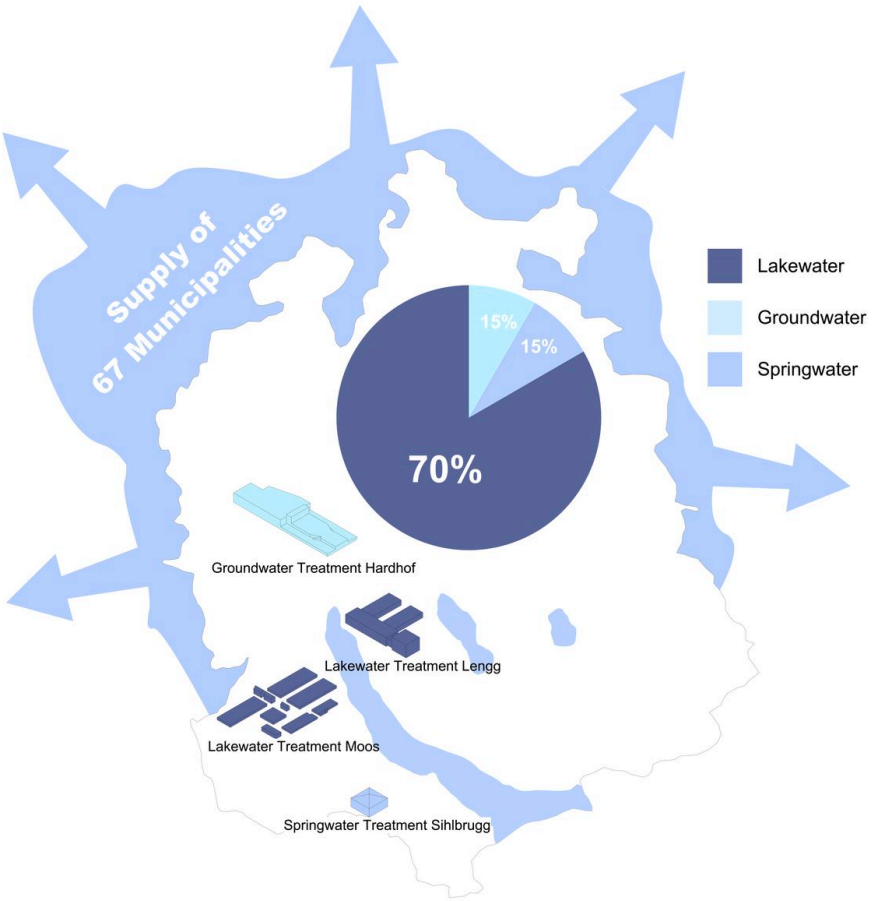
Site Analysis

The site is a tension field between the heavily cultivated agricultural landscape and the protected wildlife reserve around the Katzensee and the Chatzenbach. The tension becomes visible by exploring the landscape. The nature reserve aims to rewet the land and recreate destroyed marshland while the agricultural land aims to drain the site to maximize crops. The tension field between both parties leads to friction. Water bodies were straightened, canalized, and placed underground to efficiently manage and quickly remove water from the site. The red part shown on the map above is where drainage pipes were implemented to control the water flow and maximize flow rates. The blue area in the plan indicates where the objective is for the water to flow slowly and ensure soil saturation.



Map showing the waterbodies and manmade infrastructure.

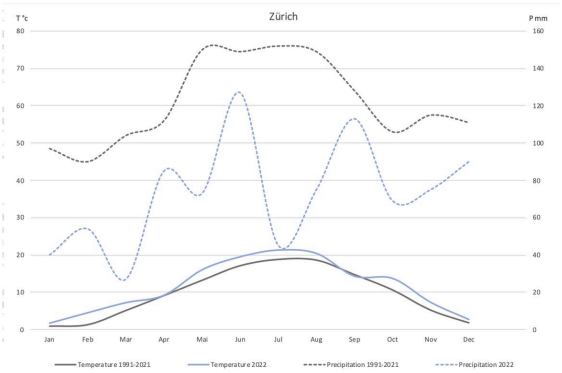
- Natural streams
- Slightly impaired streams
- Heavily impaired streams
- Artificial streams
- Culverted streams
- Drainage pipes



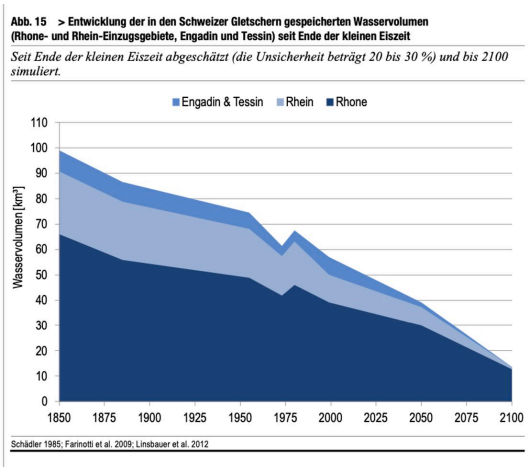
Water supply Zurich region.

Future Challenges

In the future rising temperatures will accelerate the melting of glaciers and reduce the country's natural water reserves, which can lead to water shortages. In the medium term, changing precipitation patterns and higher water demand in summer will lead to more frequent droughts or floods. In addition, the emerging problem of increased surface run-off will lead to more and more erosion of the soil, which can impede agriculture on a lot of surfaces. In the short term, groundwater sources and open water bodies are polluted by the intrusion of chemical substances, fertilizers and pesticides. Today, the constant drying of the swamp through drainage leads to high CO_2 emissions, which accelerates climate change.



Annual precipitation Zurich. Source: Sonia Simone, Viviane Viniarski, Dylan Torri , 2022.



Development of the volume of water stored in Swiss glaciers. Source: Schädler, 1985; Farinotti et al. 2009; Linsbauer et al. 2012.

Blueprints for Resilience



To develop ideas for Hydrotopia, we looked at four existing projects and strategies in the field of nature conservation and agriculture: keylines, beaver dams, paludiculture, and a renaturation project of a river.



KeyLines implemented at NaturGut Katzhof. Source: WasserKultur [https://wasserkultur.ch/wasserkultur/]

The project of the Katzhof establishes a new water management system which is based on keyline design. On the whole site, small water ditches are used to capture slow down surface overflows.



Beaver Dam Analogs in Oberbalm BE. Source: Horbermatt [https://www.horbermatt.ch/unsere-dienstleistungen/vielfalt-geben-vielfalt-erleben.html]

A bottom-up approach is used on the Horbermatt farm. Similar to beaver dams the water is stopped by dams to moisten surrounding fields and retain it on the site



Paludiculture in the Greifswaldmoor. Source: Universität Greifswald [https://botanik.uni-greifswald.de/moorkunde-und-palaeooekologie/]

The university of Greifswald is one of the pioneers in researching alternative sustainable cultivation of wetlands. Introducing the techniques of the paludiculture e.g. for cultivating peat moss to strengthen the local ecosystem and simultaneously keep the site profitable.



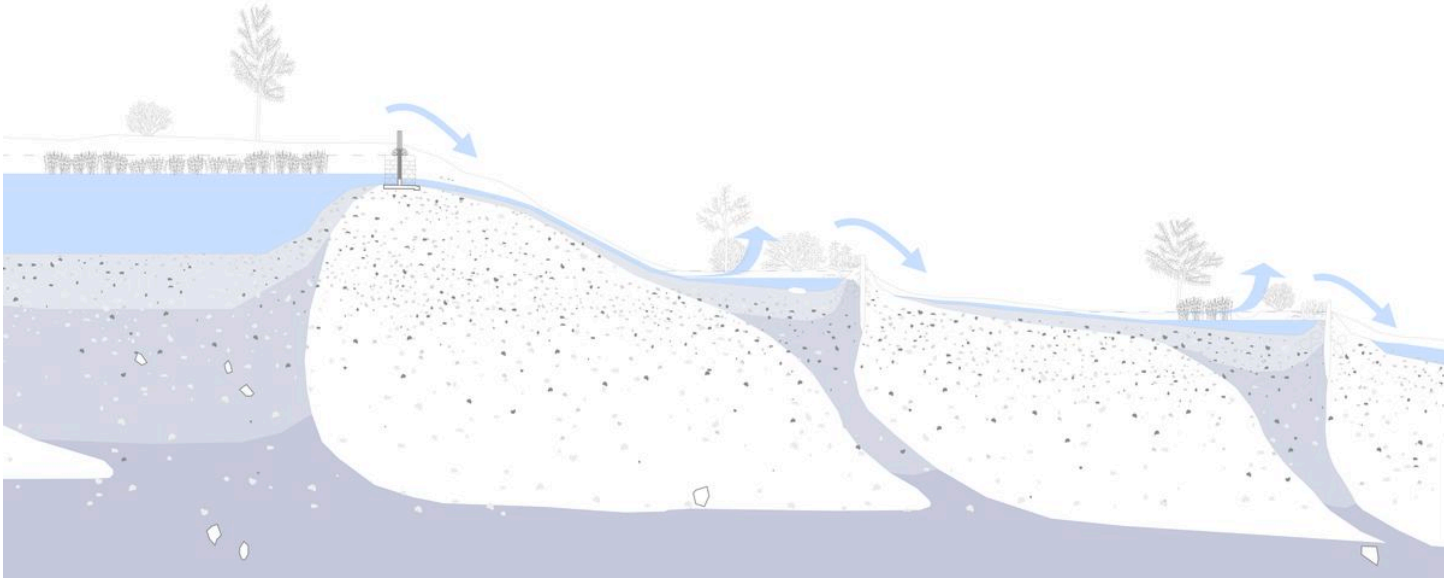
Renaturation of "Promenade de l'Aire" near Geneva. Source: XY



Renaturation of "Promenade de l'Aire" near Geneva. Source: Landezine Award [https://landezine-award.com/renaturation-of-the-river-aire-geneva/].

The project is a prime example of a successful project of renaturation and creates a recreation area. Modest interventions are implemented to allow water to shape the area naturally. The goal was to restore destroyed wetlands and biotopes.

Hydrating the Landscape



With our intervention, we aim at transforming the local water cycle towards more self-sufficiency and resilience. To achieve that, we have developed a strategy based on four key ideas: slow, spread, soak, and store.

Instead of continuing with the current water management of draining the soil and getting rid of valuable water sources, we want to set a new framework which is based on the following four key ideas: slow, spread, soak and store. To accomplish this, five different projects throughout the site are used to store and slow down the water flow: seasonal wetlands, beaver dam analogs, and keyline-design, the renaturation of the Katzenbach, and paludiculture

Seasonal Wetlands

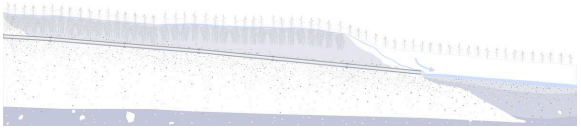
Through the establishment of seasonal wetlands serving as water storage on the site, changing precipitation patterns and heavy rainfall events can be taken into account to preserve the water on the site. The water then can be used during droughts to irrigate the fields and is not lost immediately due to the surface runoff. As the storages can also dry out when much water is used, seasonal wetlands emerge where the water level is constantly changing. When the ponds are full, the excess water is not spoiled as the overflow will run directly into the Beaver Dam Analogs system and thus is distributed evenly on its way down the topography ending in the wetlandland area around the upper Katzensee.



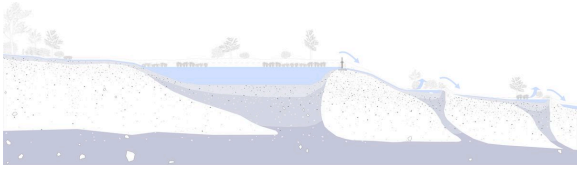
Map highlighting intended seasonal wetlands and beaver dam analogs on the site.

Beaver Dam Analogs

Beaver Dam Analogs (BDAs) are manmade structures, formed after the model of natural beaver dams. They are built out of wood, mud and plant matter, plaited between wooden poles, which are rammed into the ground. They can be built either mechanically or by hand, which makes them very cheap to build compared to the enormous advantages they can deliver. Entrenched streams are dammed up so mud and sediments are deposited in front of the dam and by doing so the flow level of the stream is heightened again. The emerging ponds serve as valuable biodiversity hubs and allow the dammed water to seep in on a wider area, providing irrigation for the nearby fields.



Drainage pipe and entrenched stream on contemporary field.



Seasonal wetlands and BDAs slowing down the water.



Current situation. Source: Aron Karrer, 2023.



After the implementation of beaver dam analogs.

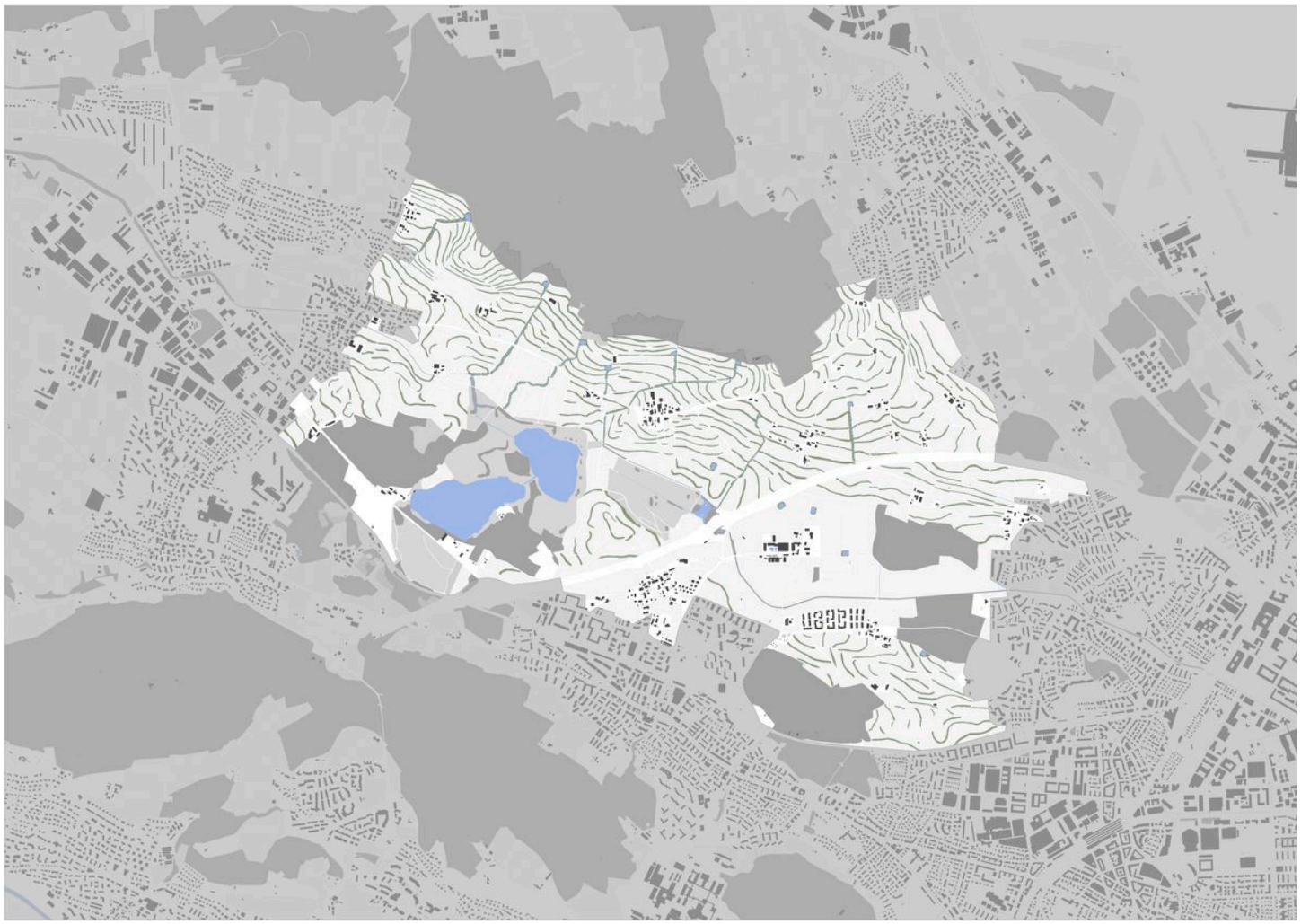
Keyline-Design

Examining the water surface runoff in this area reveals a significant issue associated with modern agricultural practices. During rainfall, water faces difficulty infiltrating the ground and tends to flow along the surface down the slope. This runoff accumulates in flat areas, giving rise to problematic zones depicted in dark red on the map. These problematic zones often resemble this photo, portraying an imbalance where excess water is concentrated. However, the water that is too much here is lacking elsewhere. It is missing at the top of the hills and is lost there for vegetation and agricultural production.

Surface runoff hinders water infiltration into fields and prevents adequate filling of soil stores. Consequently, plants are unable to draw water from the soil during dry periods, exacerbating the impact of heat on the landscape. The historical landscape is characterised by a harmonious mix of trees, hedges, and open spaces. This landscape has been transformed by modern agriculture, resulting in vast open areas. Unimpeded wind flow across these fields causes the rapid evaporation of water from plants. This, coupled with heat, induces evaporation stress, demanding excessive water consumption by the plants.

Addressing these dual challenges necessitates a transformative redesign of the landscape, introducing keylines as a pivotal element. These elongated ditches serve as reservoirs for water to collect and gradually infiltrate the ground, preventing surface water flow down slopes. Planting trees and hedges along keylines acts as wind barriers, disrupting wind flow and reducing evaporation stress on plants.

In conjunction with the previously mentioned tool, seasonal wetlands, this innovative approach results in a rejuvenated landscape marked by a harmonious blend of vegetation and open spaces. The keylines follow the topography of the slope. This small-scale intervention in the slope's topography yields significant benefits. Controlled water seepage promotes a balanced soil water profile and contributes to the long-term sustainability of groundwater resources. Importantly, such landscape structures play a vital role in decentralised flood protection.

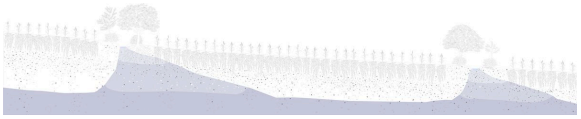


Map highlighting the intended keylines on the site.

Map showing the effect of keylines on surface runoff.



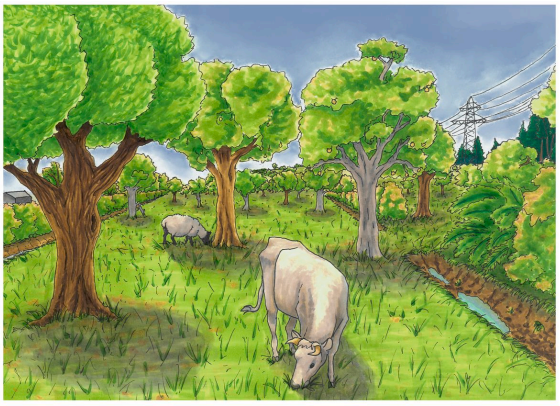
Field without keylines.



Water flow after the implementation of keylines.



Current situation. Source: Aron Karrer, 2023.



After the implementation of keyline design.

The Renaturation of the Katzenbach



Canalised Chatzenbach. Source: Jan Aebi, 2023.



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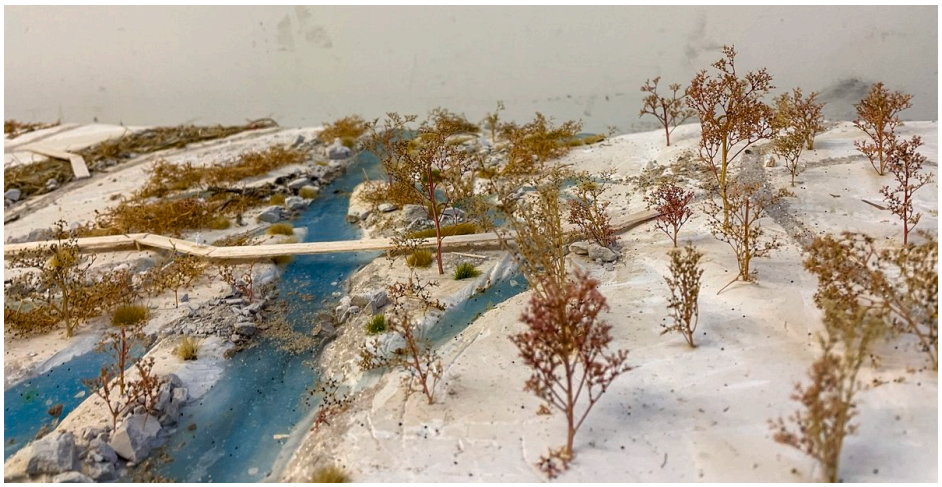


Renaturation of the Chatzenbach. Source: Aron Karrer, 2023.



Map highlighting paludiculture fields and the renaturation of the Chatzenbach.

Paludiculture

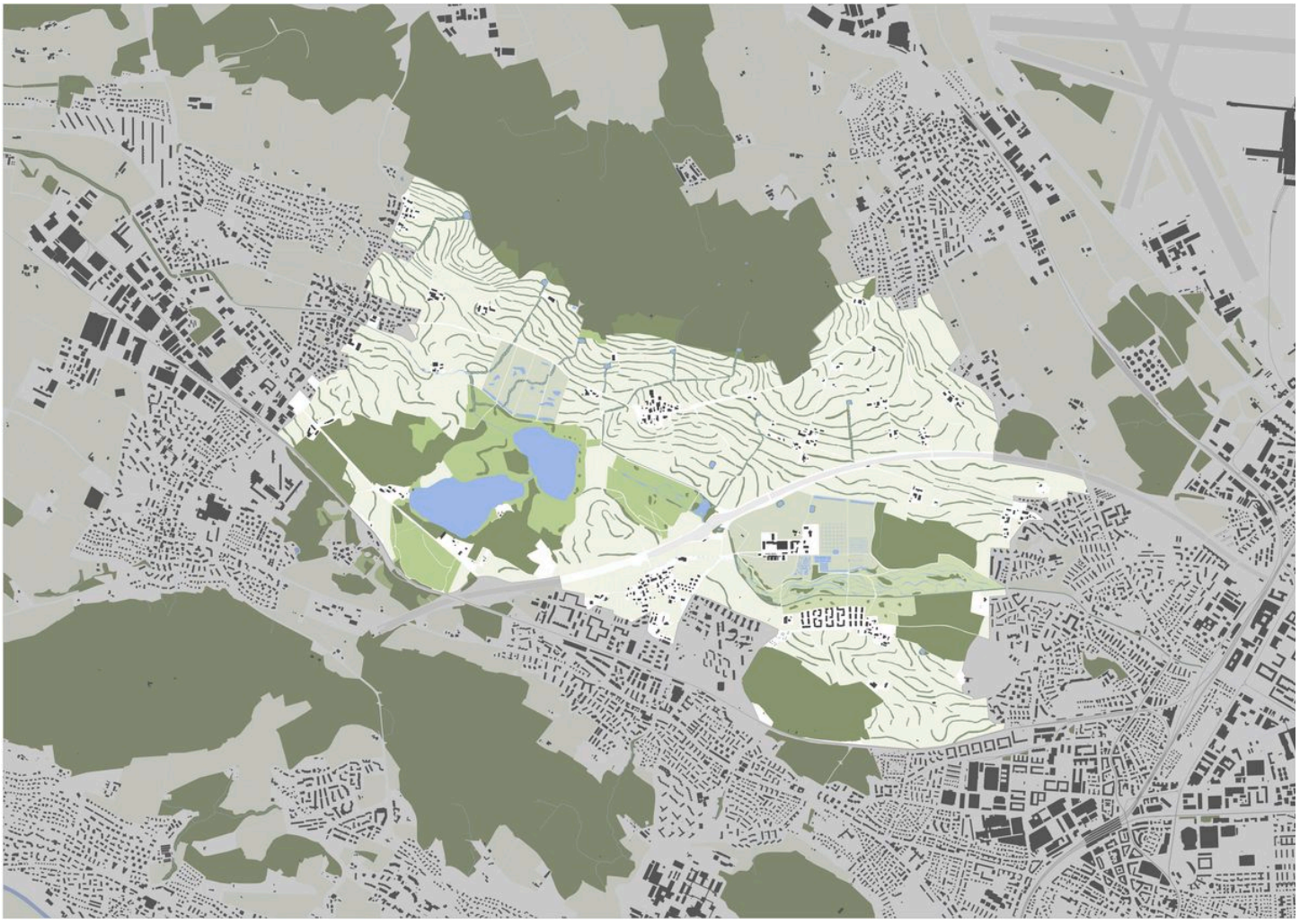
Through the rewetting of the peaty soils on the site, the agricultural land is not lost, as it can be cultivated using paludiculture. The high groundwater table of these areas makes it impossible to grow common cultures like corn and grain, but its exactly the conditions needed to grow mostly disregarded cultures like reed, cranberries, peat moss and reed tails. These plants can be used very diverse for example as a building material, food and in the case of peat moss as a peat substitute. The emerging problem with this type of agriculture is, that specialised machines are used for cultivation and more know-how is needed. Research on paludiculture has not gone as far as it went concerning the more common cultures. Because of this lack of innovation in this field, Agroscope serves as the new centre for research on the site.



Current situation at Agroscope.
Source: Jan Aebi, 2023.

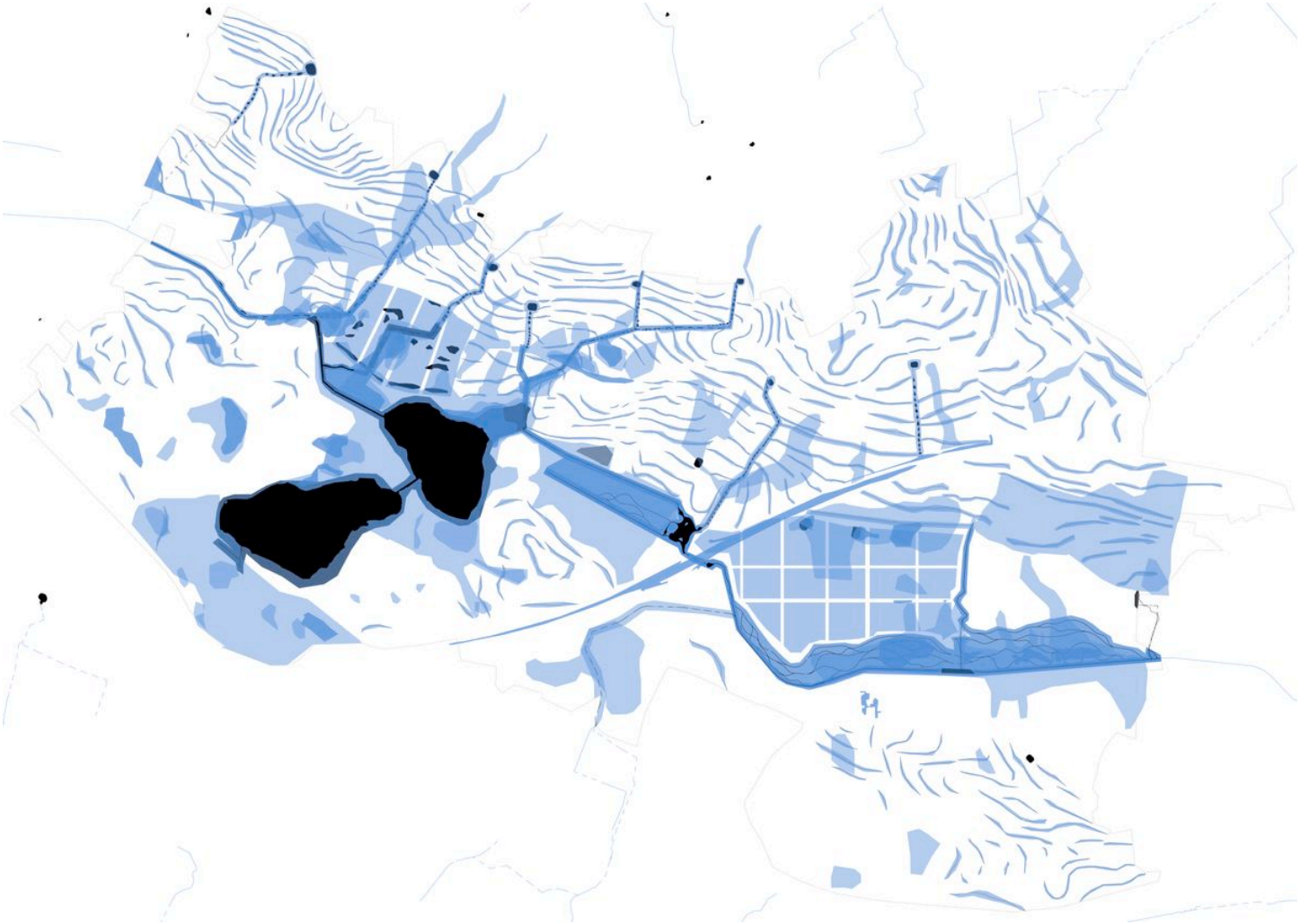


Agroscope after the transformation
into a centre for paludiculture.



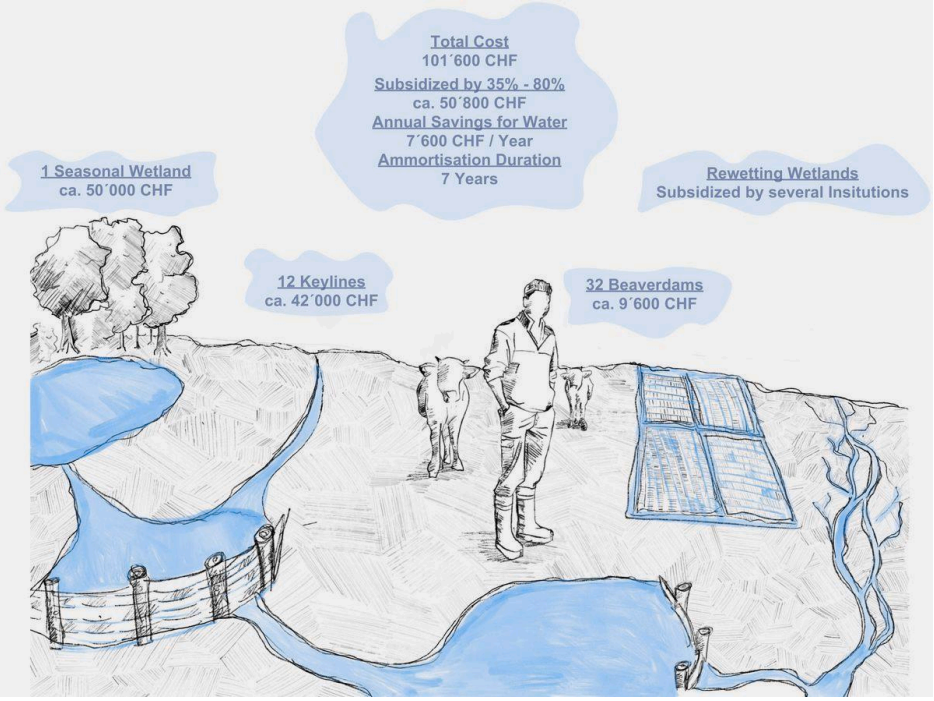
Map showing all the interventions on the site.

Hydrotopia



In Hydrotopia the water management is self-sufficient and capable of withstanding future changes. Through the diverse interventions, the water is guided by natural processes resulting in a slow-water system using site-specific advantages.

The system irrigates the fields while serving as a protective infrastructure against both droughts and floods. Through our tools water distribution changes, and valuable water is held back and lies longer on the site. The tools comprise a diverse range, spanning from top-down planning, such as wetlands, to small bottom-up initiatives like beaver dam analogs. The expenses and the effort occurring through the different tools will be returned over the years through the amortization of water cost savings.



Costs for one farm. Source: Alan James Thomas, 2023.

In the future, the region Katzensee will play a crucial role in lowering pressure on local water bodies during weather extremes. Existing and new wetlands contribute to soil protection, lowering CO_2 emissions tremendously and helping preserve endangered species. Streams are again allowed to flow freely and shape the landscape of Hydrotopia. The paludiculture will give insights into sustainable cultivation practices in wet areas and serve as a guiding beacon. On a smaller scale, keylines and beaver dam analogs managed by the local farmers and volunteers capture the water and protect the soil from erosion. The vision is to create synergies with environmental protection, recreational areas and natural preservation to eliminate existing tensions.

ACKNOWLEDGEMENTS

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