Free Diploma
Andronìki Prokopidou
D-ARCH, May 2020

WASSER-GENOSSENSCHAFTEN

Metropolitan
water of the Furt Valley

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Wasserversorgung Stadt Zurich

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Brunnenmeister (fountain master), Wasserversorgung Regensdorf

"The principle of all things is water : all comes from water, and to water all returns."
Thales of Miletus, (ca. 635-545 BC),

fig. 1 **A spectacular public event**
Pipe break at the Ottikerstrasse, 17 June 1974

Contents

PART B

PART A

I. RATIONALE: QUESTIONS OF WATER SUPPLY IN SWITZERLAND

Wasserschloss Schweiz?
The 21st century challenges of securing water resources

Rhine, Rhone, Inn, Ticino, Adige are only some of the biggest European rivers which originate in the high altitudes of the Swiss alpine mountain ranges. Switzerland is home to 5% of the European continent's fresh water reserves, even if geographically it constitutes only 0.04% of Europe's land masses. Because of it's glacial storage capacity it is praised as Europe's "water tower" (or Wasserschloss in german). However, with the forces of climate change unravelling, the water storage capacity of the Alps is sinking and this vital role is challenged: can Switzerland remain Europe's "watertower" ("Wasserschloss") in the era of rising global temperatures?

Current prognoses indicate that *"the overall water supply will change only slightly until 2100."* Rather, the precipitation will distribute differently over the year - more precipitation is expected during winter and more dry spells in summer, while at the same time the ice masses stored in the Alps are already decreasing significantly due to the rising temperatures. The annual loss of glaciers of 1km^2 is equivalent to the volume of 4386 Prime Towers! Consequently, the quantity of water flowing in surface- and ground-waterbodies will fluctuate inconsistently leading to extreme flood and low water events. Evapotranspiration will increase as well, due to higher temperatures, resulting in the decrease of surface- and ground waterbodies. Conflicts over freshwater resources will subsequently increase, especially locally, (for example in some, especially smaller regions, inhabitants are already confronted with seasonal water scarcity struggling to cope with irrigation and drinking water demands. The municipality of Enges in the Canton of Neuchâtel has even prohibited the building of new houses signifying the urgency of sustainable water resources management.

Switzerland's annual rainfall is so plentiful that if configured virtually the country would be one and a half metres under water. To put this in perspective, only two and a half centimetres of the annual precipitation are needed to supply enough drinking water." Hence, Switzerland's water stress is low in comparison to most of the other European countries. It is the distribution and the protection of water and not the quantity that is the issue. Even when today we need only 7% of the annually sustainably available groundwater quantity, this potential cannot be fully exploited due to the increasing pressure on this resource. Especially, in metropolitan areas most of the surface is occupied by the expanding urbanization and in regions used intensively for agriculture, the groundwater quality deficits are becoming all the more apparent. The emerging challenge is the design of adaptation strategies, protecting the water resource as a cyclic system, able to adapt to weather extremes. To meet these challenges, the current policy of the Canton of Zurich advises "two legs to stand on" in terms of water supply. In this regard, the need for collaboration between municipalities and Cantons, even between countries, linking and sharing of water sources is becoming more and more necessary.

The present work aims to adress the following question. What is a resilient terittorial scale of collaboration, protection and distribution of water resources? How can we design urban environments that integrate into the water cycle rather than obstructing it? How can we secure water as a vital public good and develop a culture of natural stewardship? How can we change land-use practices in order to protect local water resources?

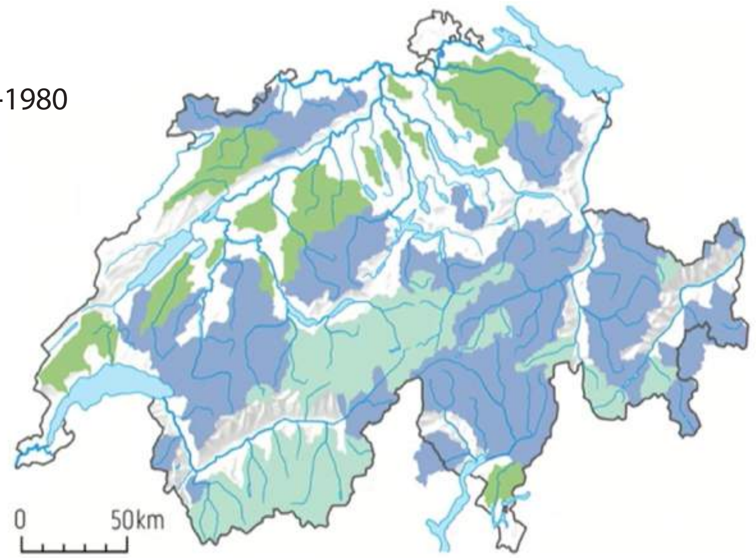
fig. 2 **Desperate measures in the melting age**
Ice-protecting blankets on the Rhone Glacier, Switzerland. Source: Keystone

fig. 3 **The seasons of the rivers**
River regimes of 189 medium-size watersheds of Switzerland for the years 1950-1980. Source: Hydrological Atlas of Switzerland (HADES)

fig. 4 **The future seasons of the rivers**
Change of river regimes of 189 medium-size watersheds of Switzerland for the year 2085, Source: BAFU, 2012. Glacial river regimes will almost vanish, while in the swiss Plateau new pluvial regimes will emerge, leading to higher runoff in winter and a minimum runoff in summer.

- pluvial river regimes
- nival river regimes
- glacial river regimes

1950-1980



2085

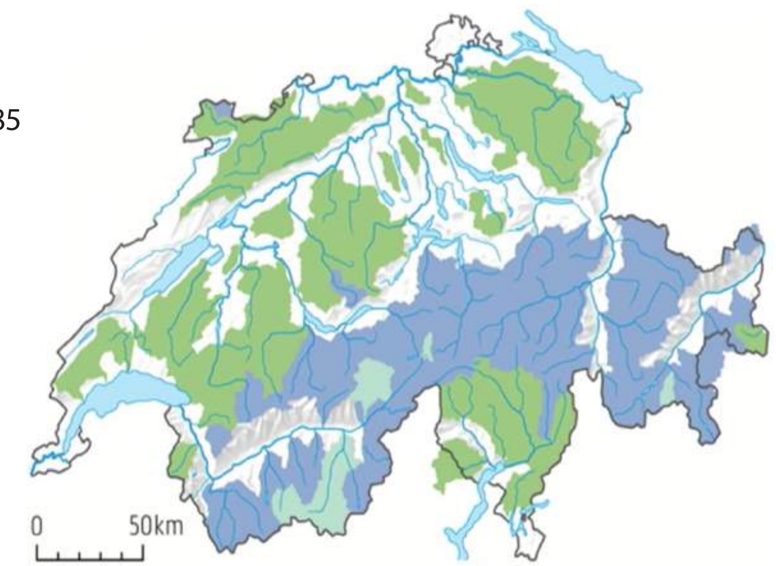


fig. 5 **Swiss water balance**
Only 1.5% of the annual precipitation is used as drinking water. One third of the annual precipitation evaporates, another third seeps in the surface - the rivers, and the remainder seeps into the groundwater.

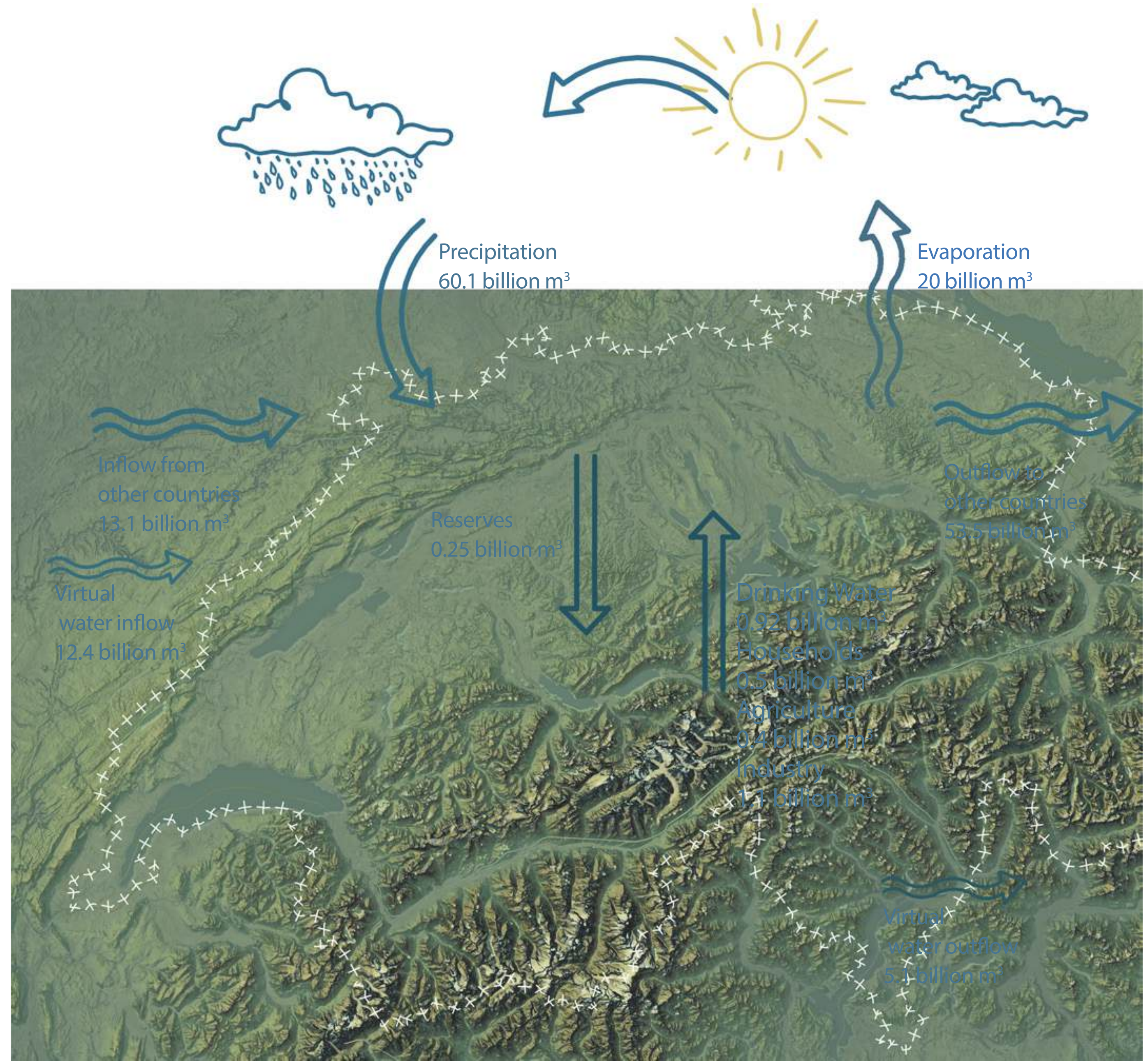


fig. 6 **Switzerland's changing climate**
Switzerland expects heavy rainfall winters and drier, hotter summers due to the changing climate.

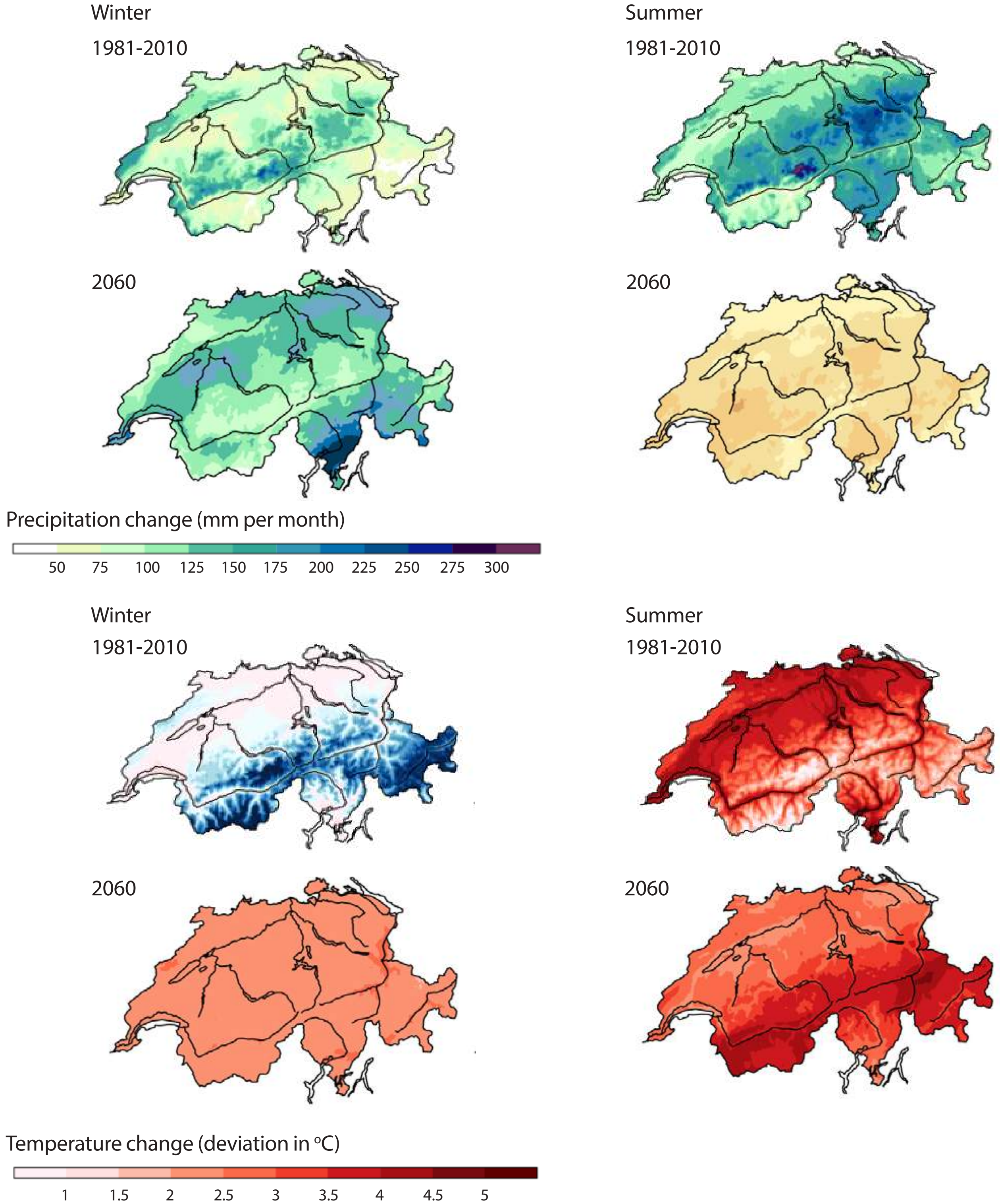


fig. 7 **Low swiss water stress**
The ratio of the water demand compared to the available regenerative water resources. Switzerland's low water stress indicates that there is still enough available water. Source: Aqueduct, Water risk atlas

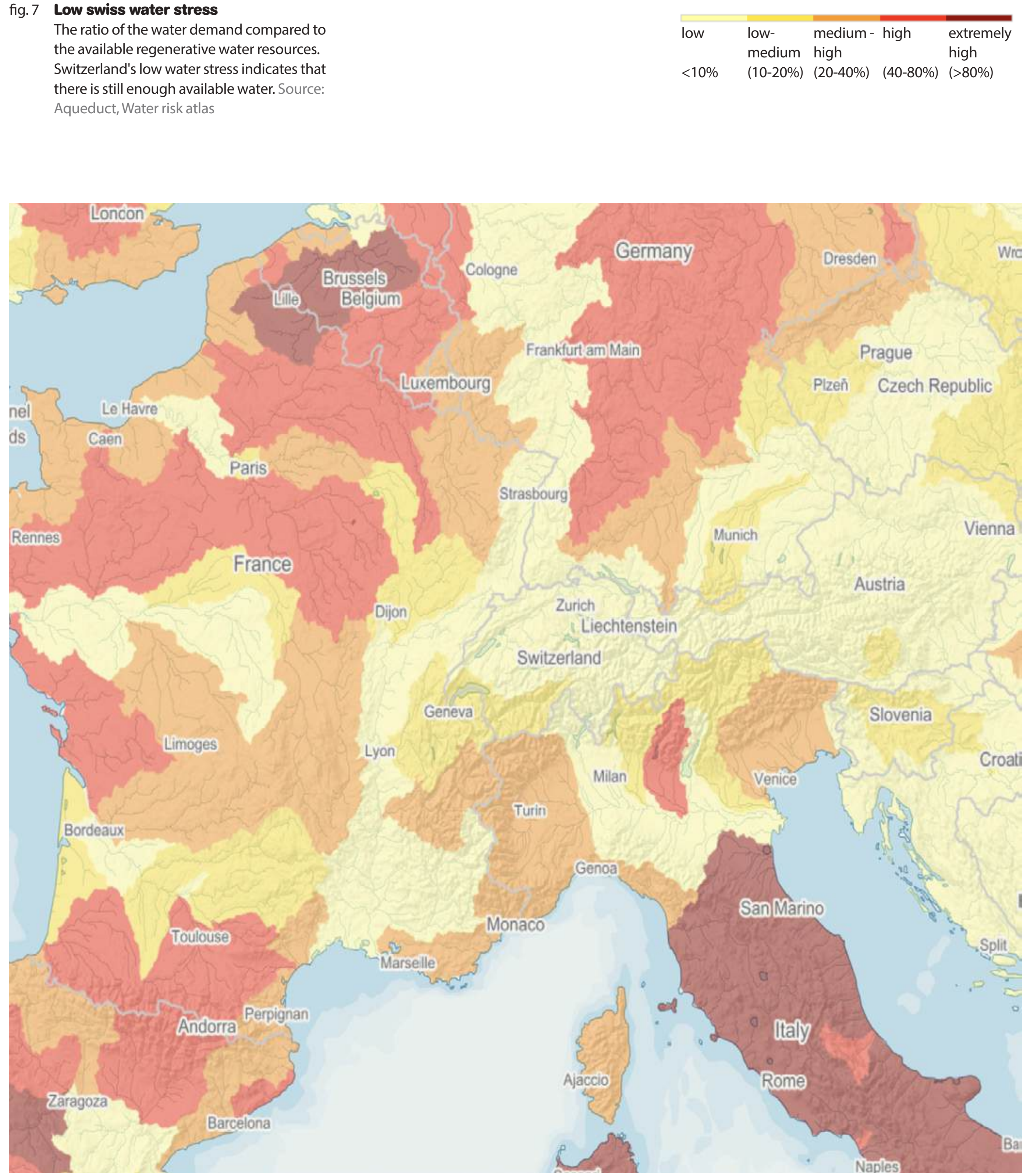


fig. 8 **Extreme weather effects in Zurich Lake**
Drone view of Hornpark, Zurich Lake, Küsnacht in August 2017 and in dry and hot August 2018. Photographer: Ann Ziegler

August 2017 August 2018

fig. 9 **Zurich Lake is a finite water reservoir**
Caricature from Felix Schaad

«Wir haben gewissermassen ein Klumpenrisiko und wollen die Abhängigkeit vom Zürichsee nicht weiter erhöhen.»
Kurt Nyffenegger, director of the department groundwater and water supply of the Canton of Zurich.

fig. 10 **Dried up Töss Riverbed**
Töss during the drought of August 2018.

fig. 11 **Regular water flow in the Töss River**
Full of water state of the River Töss in 2014.

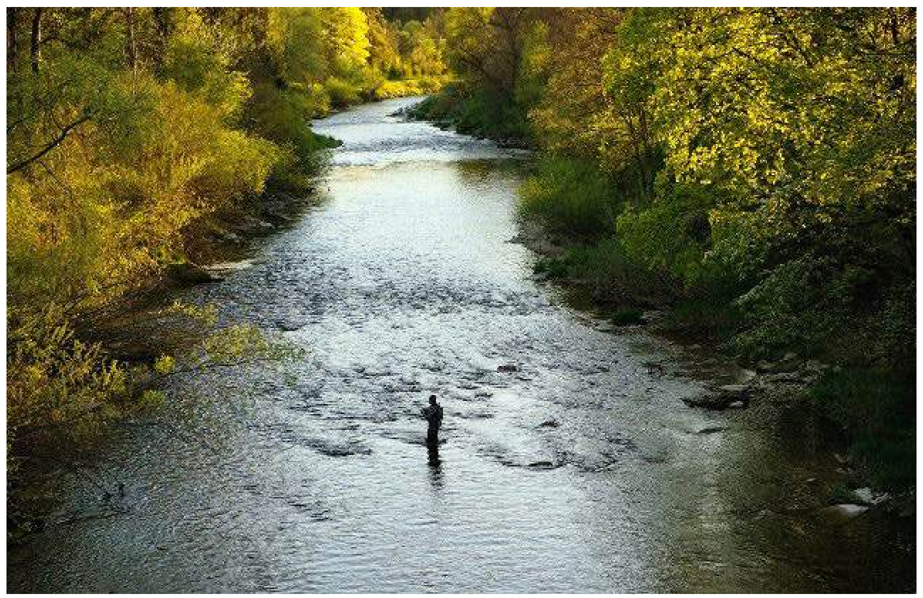


fig. 12 **Bigger rivers dry up as well**
The extreme low water level in the River Limmat revealed the lower steps, which are normally covered with water.
Wipkingerplatz, Zurich, July 2018

fig. 13 **Regular water level in the Limmat River**
Wipkingerplatz, 2017

fig. 14 **Five major drinking water hubs**
Canton Zurich's most important drinking water resources. Source: AWEL, Office of Waste, Water, Energy and Air

The map exemplifies the dependece on the larger, shared water resources. More specifically, in the Canton of Zurich, the focus, as of today, is set on Zurich Lake as the biggest water reservoir, the Limmat and Töss and the Rhine groundwater currents. The groundwater bodies located in between these 5 water resources are not likewise appreciated. However, these resources are not infinite.

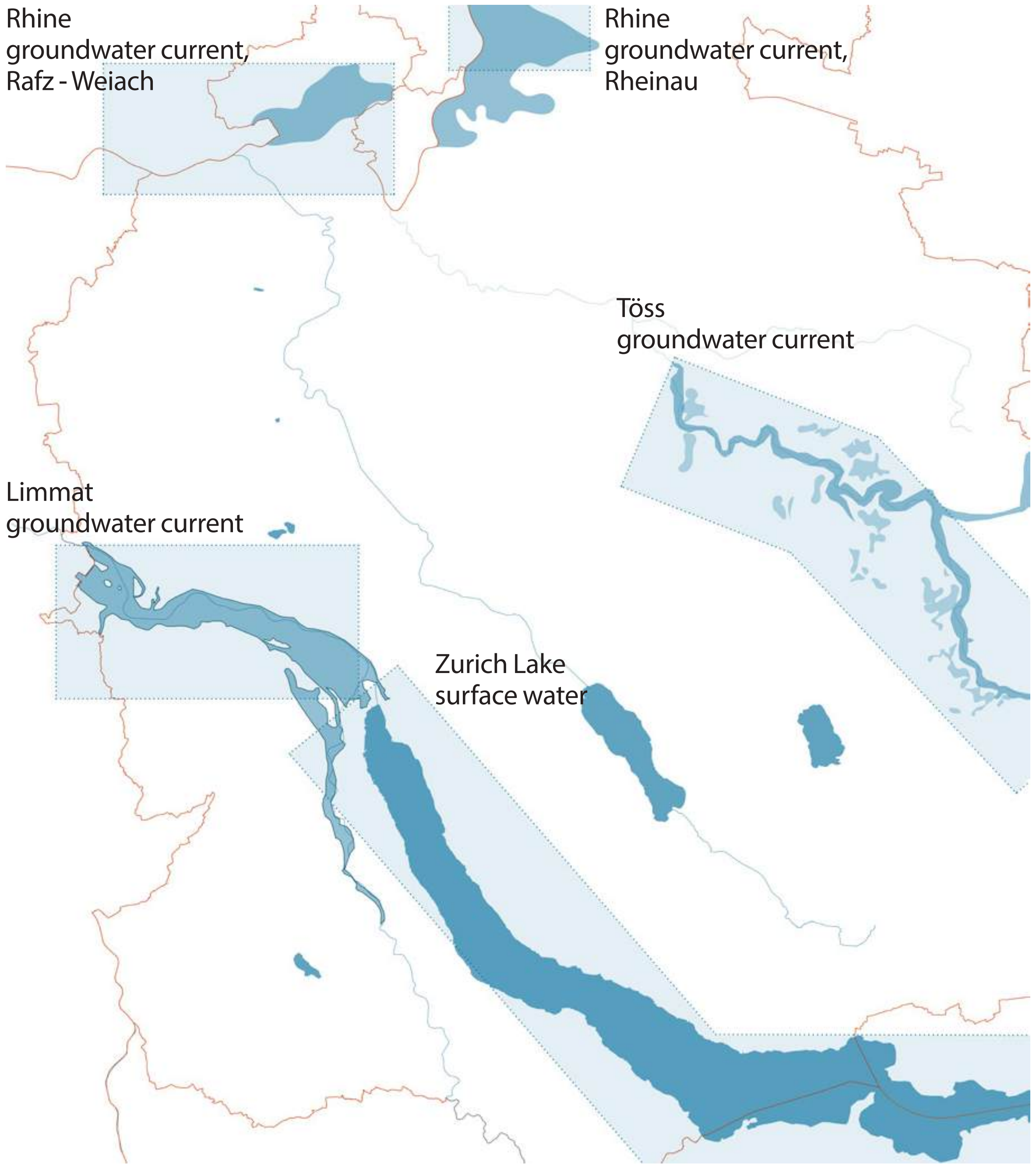
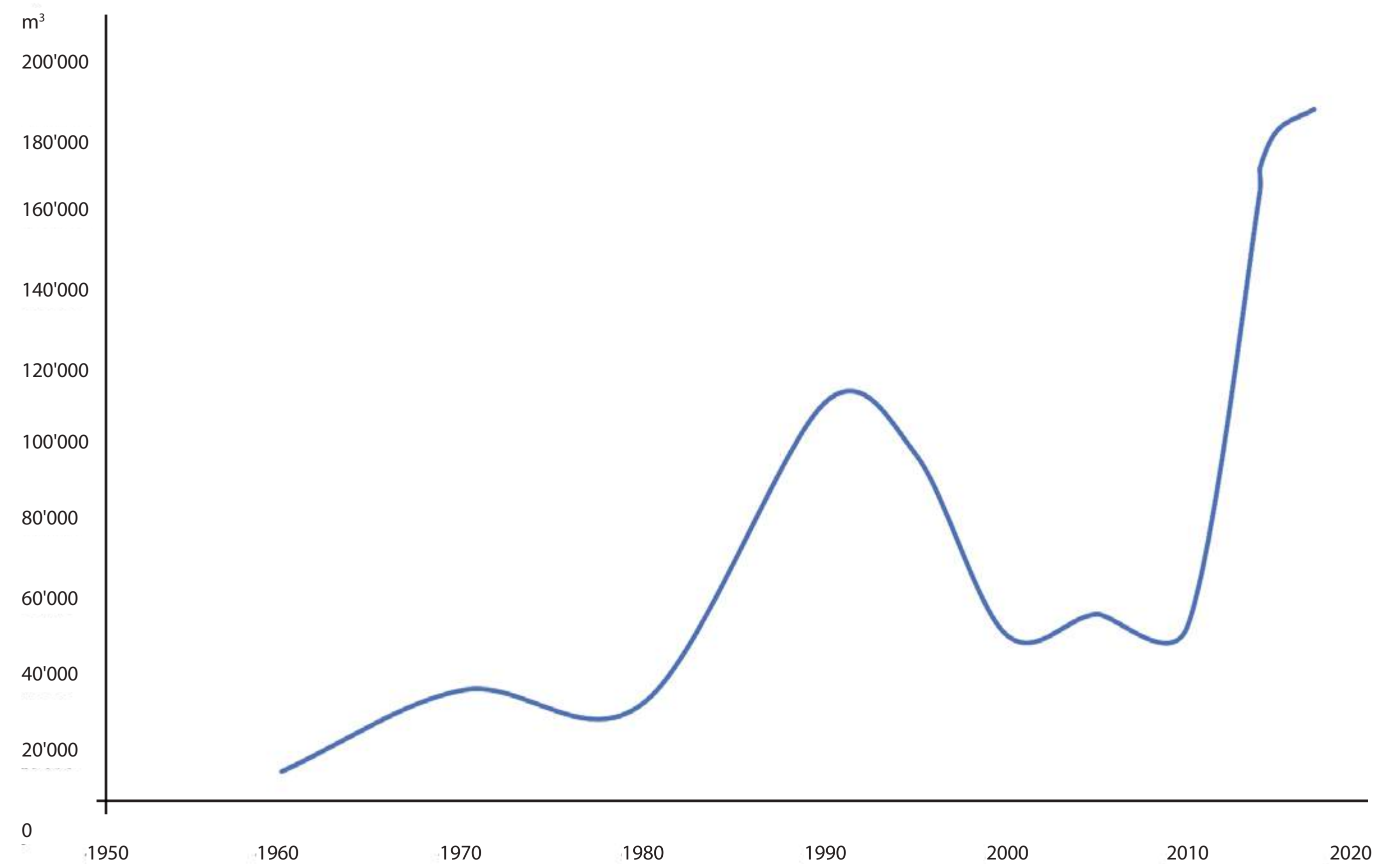


fig. 15 **Increasing sharing of water resources**
Amount of water distributed to other water supplies, outside of the own supply area across Switzerland, as a result of the current water supply policies. Source: Swiss Gas and Water Industry Association (SGWA)



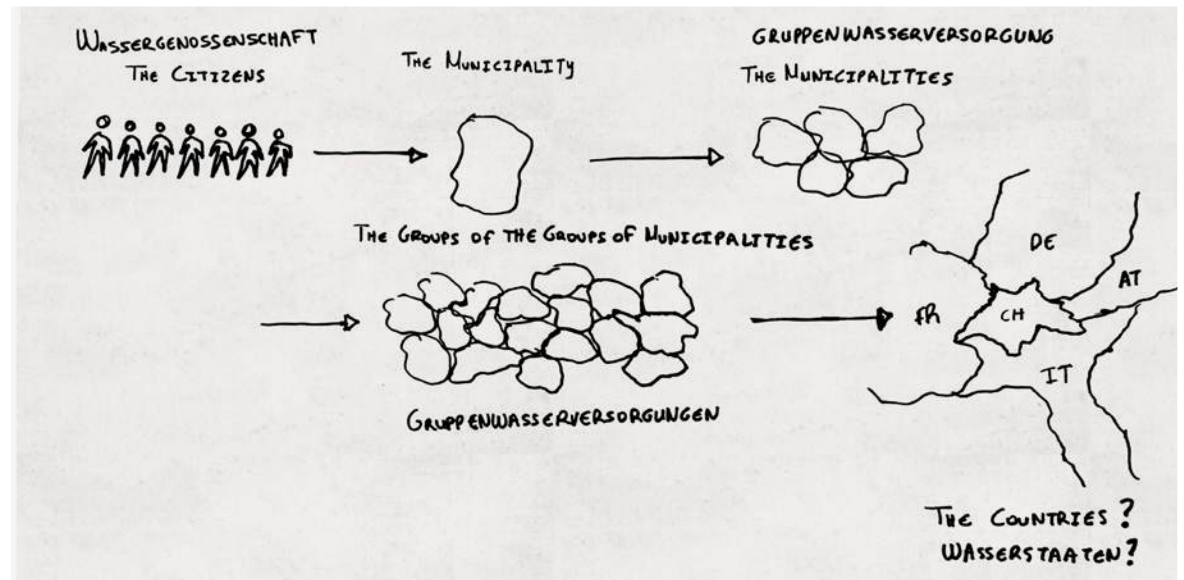
"The present water acquisition structure - approximately 50% regional/transregional and 50% communal Water acquisition - lead to a high water supply security and therefore sind crucial for the drinking water supply in distresses. These structures will consequently be maintained." Source: Cantonal Office of Waste, Water, Energy and Air (AWEL), Safeguarding of future drinking water supply, December 2013

Wassergenossenschaften New scales of territorial water management

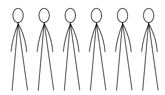
A successful water supply depends not only on the availability of water sources, but also on their proper organisation and distribution. In Switzerland, the sovereignty over the use of water sources lies at the cantonal level, but responsible for the water supply are the respective municipalities, whose water supply structures have emerged historically. Until the mid-19th century, the citizens had to transport the water themselves, through the means of tubs and buckets, which they filled in the public fountains. However, if this public supply would not suffice, some communities took action and organised themselves in "Wassergenossenschaften", with the aim to provide water for themselves. They were small groups of about 8 to 10 citizens, who searched for water sources, built reservoirs and capture wells and supplied their fellow citizens with water. As they were self-organised, they had to finance the necessary infrastructure out of their own pocket or with the help of loans. Even if they were becoming a popular model of private organisation, the Wassergenossenschaften could not sustain their power, neither in light of the rapid increase of population (especially in the 1970s) nor when faced with the increasing sovereignty of the municipalities over the water infrastructure. As a result, many of them had to dissolve by the end of the century.

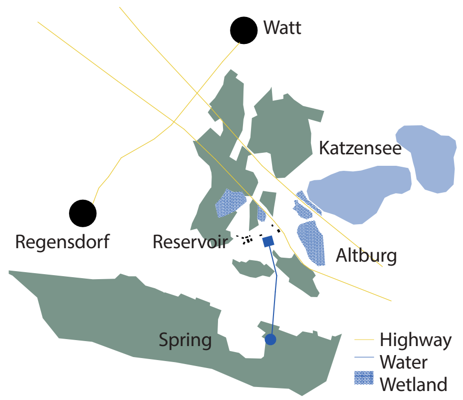
The continuously increasing population and correlative water demand, stimulated the collaboration of neighbouring municipalities for the purpose of a more secure water supply. In the Canton of Zurich, these so-called "Gruppenwasserversorgungen" (group water supplies) consist of several neighbouring municipalities that exchange water with other adjacent groups of water supply networks and have over time become bigger collaborating entities. These organise the exchange with the main regional water supplier of Zurich and are responsible for the transport of water from the city to the affiliated communes. The quantity and price of this water in this trade, the so called option, is regulated in corresponding contracts which are renegotiated in a 5-year cycle. Zurich supplies with water another 67 municipalities outside of the borders of the city, from which 12 are located even outside of the cantonal bordes. This general tendency towards the concentration of large water resources is followed by infrastructural and administrative efforts to create a large scale networks, which are regulated by market rules,resulting in a few large municipalities monopolising the supply and exhausting their resources. Coupled with more unstable resource availability, there is a higher risk of system failure. In order to avoid this risk concentration, caused by the current great dependency on Zurich lake water, the Canton of Zurich has decided to secure the future water supply by extracting groundwater from the Rhine current until 2050, expanding the supply network over more than 200 km and across national borders. The question remains if this new scale of water security is the only answer, or if a more resilient strategy can be found in the neglected smaller scales of cooperation.

fig. 16 **Towards Wasserstaaten**?
From Wassergenossenschaften to new scales of territorial water management, Concept sketch

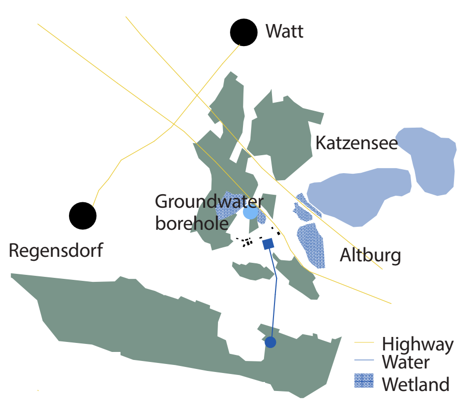


Emil Binder, Gebrüder Keller Hansen, Gebrüder Keller Mathisen, Simeon Frei, Fritz Kuhn , Rudolf Stüssi.





Wassergenossenschaft's Bond for the Zurich Cantonal Bank, 5 March 1916



1906 Formation of the Wassergenossenschaft

"Brunnengenossenschaft Alten-Burg" is denominated as "Wasserversorgungsgenossenschaft Altburg" (WVG Altburg)

1909

The governing council grants the operation of the reservoir.

1929

Request to integrate to the water supply of Regensdorf. Altburg belongs to the municipality of Watt but the rail line separated the territoty. The realisation fails due to high costs. The repair of the old pipelines is undertaken from the Genossenschaft, who also reimbursed the affected citizens.

1944

Request for groundwater capture. The Canton of Zurich refuses. Priority is given to the expansion of the water infrastructure of Regensdorf.

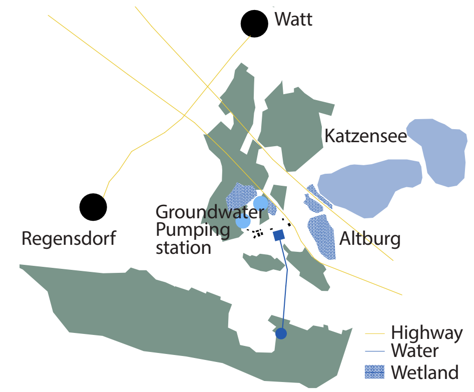
1947 Illegal groundwater exploitation

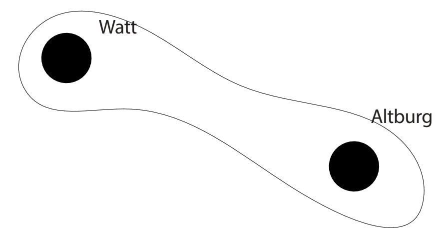
Extreme drought, farmers look for water at Katzensee and dig illegally for groundwater.

1948

The Genossenschaft requests the exploitation of Furttal's groundwater and indicates of the anticipated drought of 1974. The permission is being kept back, while Regensdorf already exploits groundwater.

Groundwater pumping station, 1950





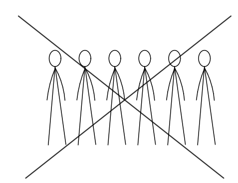


fig. 17 **Wassergenossenschaft Altburg**
The increasing population and power of the municipalities caused the municipality to disband.

1953 Official groundwater pumping station

Groundwater pumping station. Canton Zurich sets an annual fee of 240,- CHF.

1960s Formation of the group water supply

Industrialisation and increase of population lead to the formation of a special purpose association in Regensdorf's custody. Later, the group water supply Furttal. (Gruppenwasserversorgung) emerged from it. Wassergenossenschaft is not involved.

1964

Negotiations with the municipality of Watt for the takeover of the water supply facilities of Altburg fail. The political municipality of Regensdorf becomes a member of the Genossenschaft.

1970s

Groundwater gets polluted caused by sludge thrown by a farmer. Hydrants pipeline of Regensdorf is projected to pass through Altburg. Altburg is envisioned as a nice quarter of Regensdorf. The Genossenschaft is weakened. It has to give up to the municipality.

1972

Regensdorf leaves the WVG Altburg. Group water supply Furttal proclamates the saving of water due to drought. The groundwater stand of Furttal is lowered.

1976

Voting and resulting takeover of the water supply of Altburg by the Municipality of Regensdorf.

1984 The end of the Wassergenossenschaft

The Genossenschaft is dissolved.

fig. 18 **Mesh of Gruppenwasserversongungen**
List of the group water supplies of the Canton of Zurich

The water supply of the Canton of Zurich is regulated today by:

151 municipal facilities
48 private cooperations (Genossenschaften)
8 public regulated stock corporations (the majority of shares belongs to the community)

Group water supplies, Canton of Zurich:

I. City of Zurich
II. Amt, Limmat und Mutschellen, GALM
II.a. Limmat
II.b. Amt
III. Schlieren-Unterengstringen
IV. Steinmaur-Schöfflisdorf
V. Vororte und Glattal, GVG
V.a. Furttal, GWF
V.b. Kloten
V.c. Lattenbuck, GWL
V.d. Oberes Glattal, GOG
VI. Looren-Forch
VII. Küsnacht-Erlenbach, SWW
VIII. Meilen-Herrliberg-Egg, SWW
IX. Maur-Uster-Egg
X. Meilen - Egg
XI. Stäfa-Männedorf-Oetwil, SWW
XII. Zürcher Oberland, GWVZO, SWW
XIII. Küsnacht-Erlenbach, SWW
XIV. Horgen-Thalwil-Rüschlikon-Kilchberg, HTRK
XV. Thalwil-Rüschlikon-Kilchberg-Langnau, SWW
XVI. Fehraltorf-Illnau-Russikon
XVII. Tösstal
XVIII. Winterthur
XIX. Rafzerfeld + Stadtforen
XX. Steinmaur-Schöfflisdorf
XXI. Flaachtal
XXII. Thurtal-Andelfingen
XXIII. Kohlfirst
XXIV. Thurtal - Feldi
XXV. Forre

fig. 19 **Metropolitan water supply**
Group watersupplies and the water transportation infrastructure of the Canton of Zurich. Source: AWEL, Office of Waste, Water, Energy and Air

- water capture
- water transporting pipe
- water purchase with emergency connection
- superimposed water supplies
- water purchase via subsequent contract
- superimposed water supplies

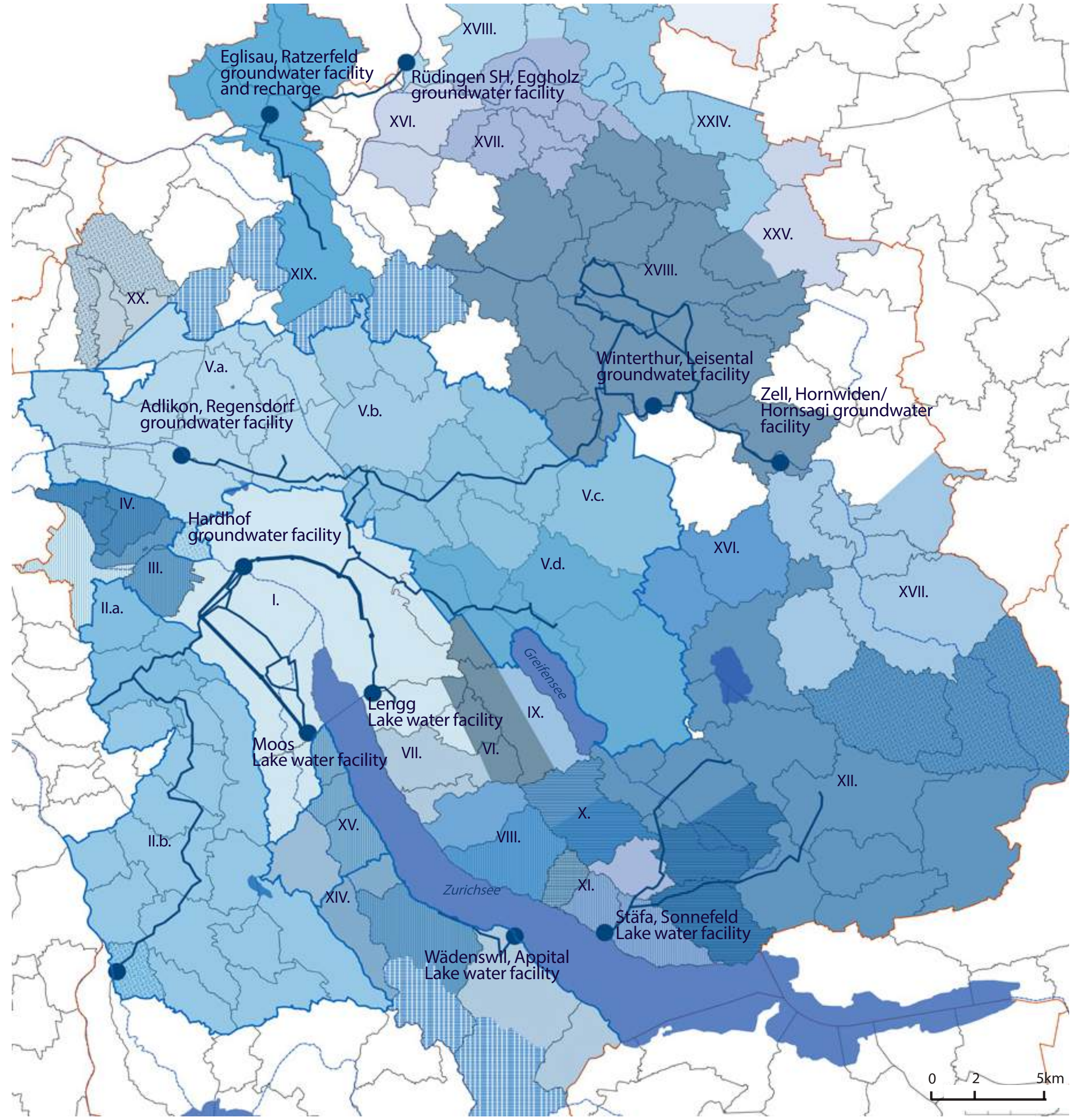
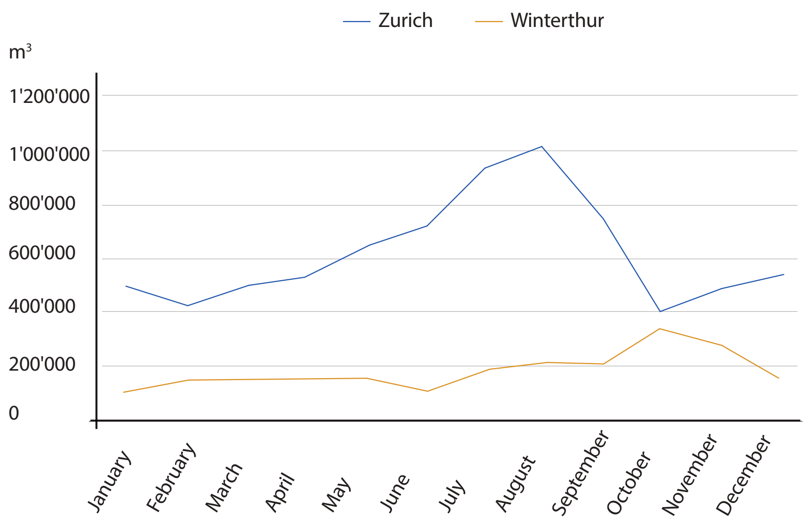
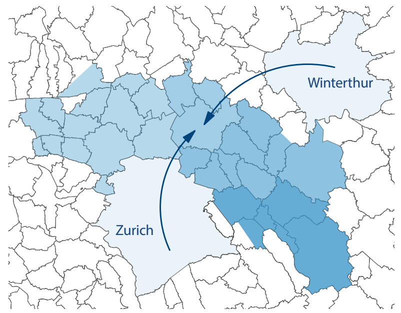
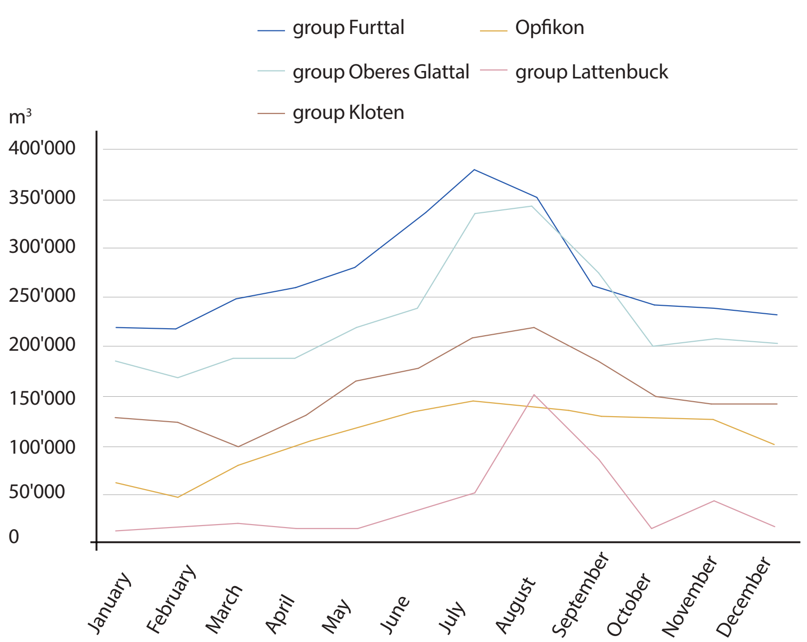


fig. 20 **Seasonal needs for additional water**
The quantity of water obtained from Zurich and Winterthur during the period October 2017 - September 2018 from the group water supply Vororte und Glattal, GVG.

fig. 21 **Seasonal distribution of water**
The quantity of water distributed to the affiliated sub-group supplies from the group water supply Vororte und Glattal, GVG during the period October 2017 - September 2018.







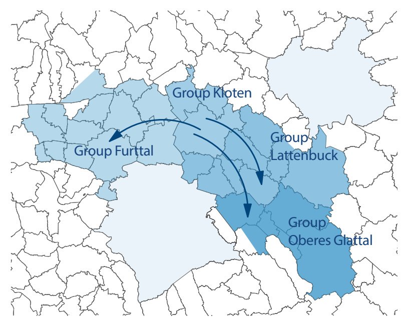


fig. 22 **Water distributing infrastructure**
The water network of the group water supply Vororte und Glattal, GVG.

group water supply pipeline network
water supply pipeline network of sub-groups
planned water supply pipeline network
pipeline network of the city of Zurich.
different colours indicate the different height zones

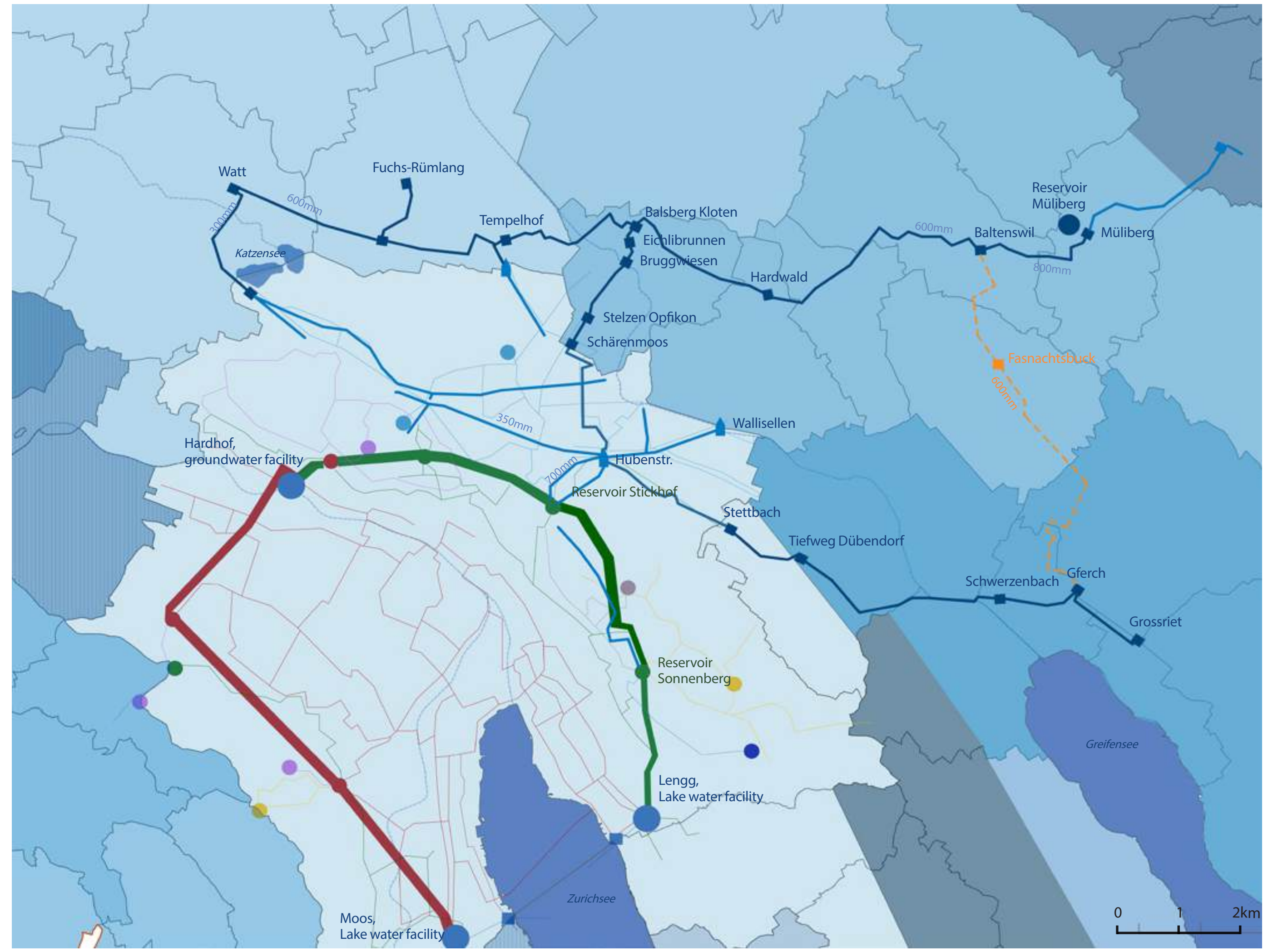


fig. 23 **Water supply contracts**
Left: Example of a contract between a group water supply and the city of Zurich.
Right: Example of a contract between a group water ssupply and the affiliated municipalities.

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31. Ausfertigung

Dieser Vertrag wird in zwei Originalexemplaren ausgefertigt; jeder Partei wird ein Originalexemplar ausgehändigt.

Zürich, den ____________________

Namens der Stadt Zürich

Vorsteher des Departements der Industriellen Betriebe	Direktor der Wasserversorgung
Michael Baumer	Dr. Erich Mück

Namens Gruppenwasserversorgung Amt-Limmat-Mutschellen

Präsidentin	Sekretärin
Barbara Puricelli	Leandra Birrer

Beilagen als Bestandteil des Vertrags

Anhang 1 Technische Rahmenbedingungen
Anhang 2 Preisberechnung – Rechenbeispiel
Anhang 3 Überschreitung optierte Menge – Berechnung Zuschlag und Gutschriften
Anhang 4 Basis für die Überprüfung der Schlüssel von Leistungs- und Arbeitspreis
Anhang 5 Liste der akzeptierten Mailadressen
Anhang 6 Optierte Tagesbezugsmenge

VI. Schlussbestimmungen

Art. 19 Inkrafttreten

Der vorliegende Vertrag ersetzt den Gesellschaftsvertrag vom 9. Juni/23. Juni/2. Juli 1971 und tritt nach der Genehmigung durch die Gemeindeversammlungen der Gemeinden Uitikon, Urdorf und Birmensdorf per 1. Januar 2009 in Kraft.

Anhang 1:	Übersichtsplan 1:10'000	Plan Nr. 2005/180-01
Anhang 2:	Hydraulisches Schema	Plan Nr. 2005/180-02
Anhang 3.	Minimale Bezugsmengen von GALM bzw. GWL	

Vorstehender Vertrag wurde genehmigt:

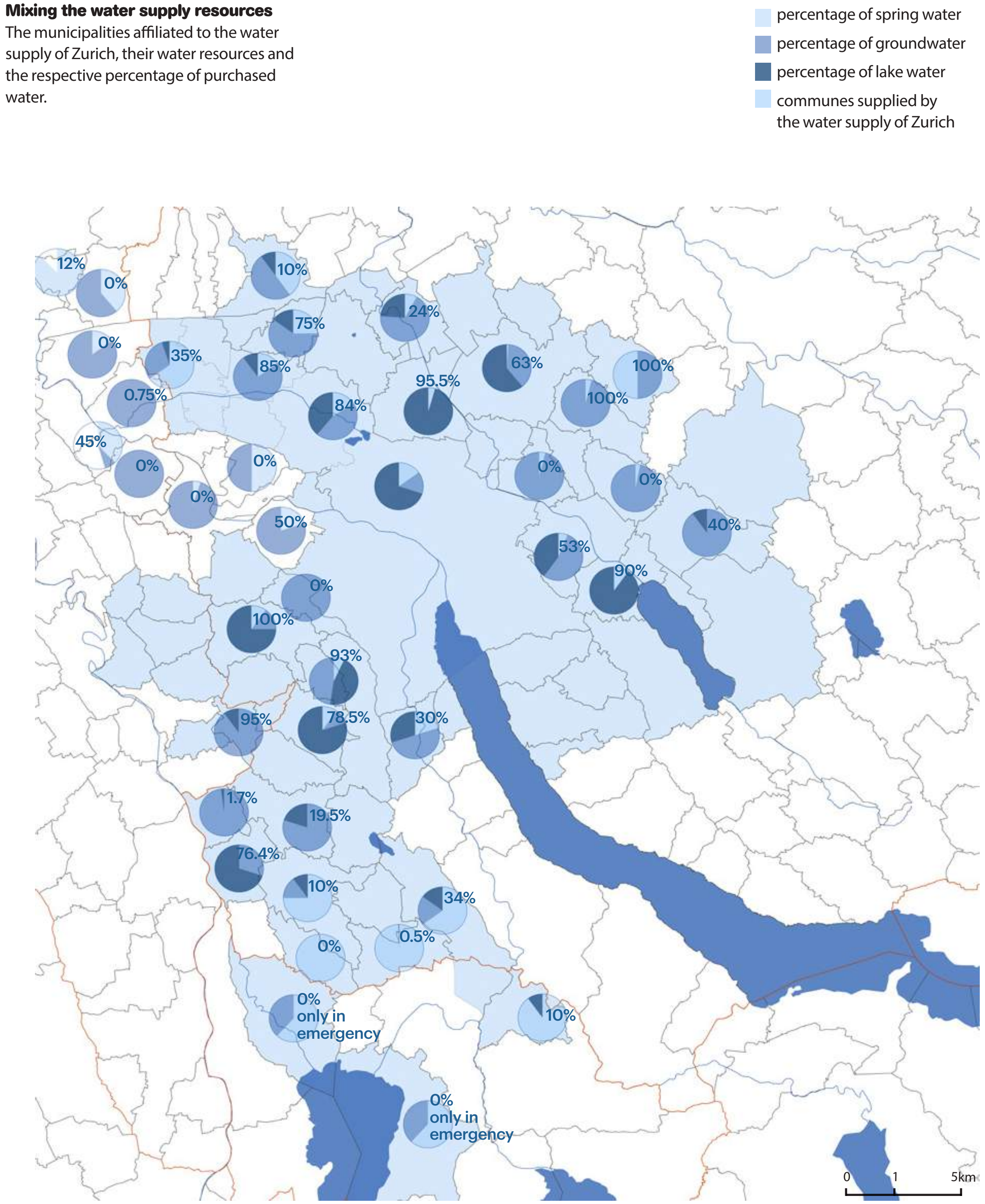
Gemeinde Uitikon
Genehmigt durch Beschluss der Gemeindeversammlung vom ....
Uitikon, ...
Für die Gemeindeversammlung: ....

Gemeinde Urdorf
Genehmigt durch Gemeinderatsbeschluss vom ....
Urdorf, ...

Der Gemeindepräsident Der Gemeindeschreiber

Gemeinde Birmensdorf
Genehmigt durch Beschluss der Gemeindeversammlung vom ....
Birmensdorf, ...
Für die Gemeindeversammlung: ....

fig. 24 **Mixing the water supply resources**
The municipalities affiliated to the water supply of Zurich, their water resources and the respective percentage of purchased water.



Drinking water supply of the Canton of Zurich
Key facts

"A spring source is nothing else than naturally coming to the surface groundwater" (Art. 704. ZGB)

In the scale of the whole Switzerland, groundwater constitutes 80% of the drinking water supply. While in Zurich, the privilege of Zurich Lake results in a high percentage of Lake water (70%) in the drinking water supply of the city, in the scale of the Canton of Zurich, groundwater gains importance. (40% of the drinking water originates from groundwater.) The resulting observation is that the greater the scale of the water supply, the water supply tends to rely on one main water resource, the groundwater.

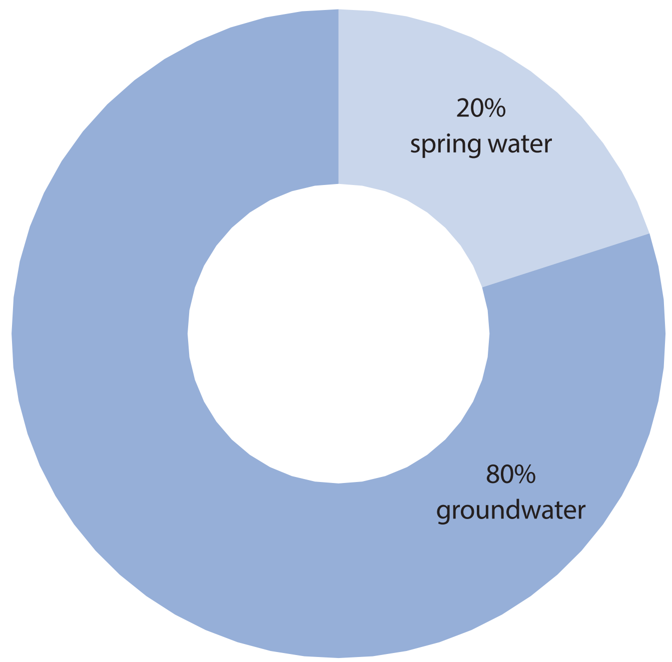
From the water economics point of view, the city of Zurich pays 55'000 Swiss francs per year in order to utilize and obtain water from the headwater region of Zug, which flows from Baar, Menzingen and Neuheim to Zurich.
Only, in an emergency case could Zug could abstract "Zurich water".

Drinking water is fundamentally available everywhere at an affordable price. However, there are occasionally extreme regional price differencies. For example, in Canton Aargau, a three-person household pays for an average annual water consumption of 200 cubicmeter, approximately 270 Swiss francs. In contrast, a three-person household in Bremgarten pays for the same amount of water much less., whereas the community of Widen or Zufikon pay more than 400 Swiss francs. A clear difference exists between the communities that have to buy their drinking water from the regional water organisation (Gruppenwasserversorgung).

fig. 25 **Switzerland's drinking water supply**
Origin of drinking water. Source: Amt für Abfall, Wasser, Energie und Luft (AWEL)

fig. 26 **Canton Zurich's drinking water supply**
Origin of drinking water. Source: Amt für Abfall, Wasser, Energie und Luft (AWEL)

Switzerland



Canton Zurich

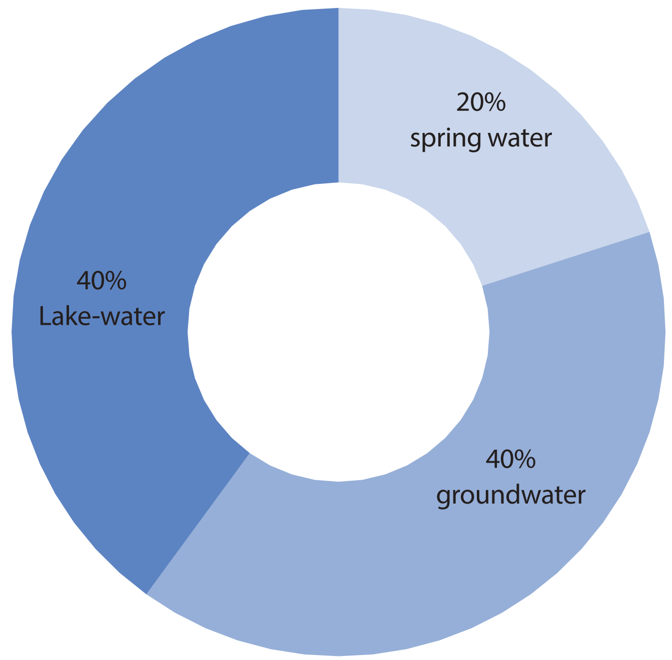


fig. 27 **Zurich city's drinking water supply**
Origin of drinking water. Source: Amt für Abfall, Wasser, Energie und Luft (AWEL)

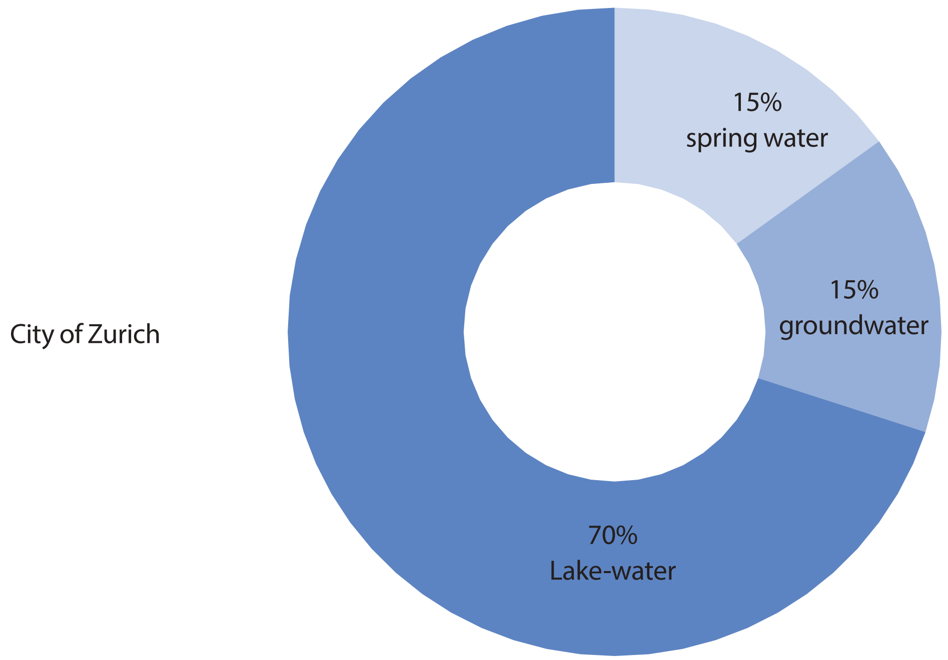


fig. 28 **Regional price of water**
Water tariff per m3 of water for a 3-people household in a four-room apartment for indicative municipalities of the Canton of Zurich. Source: Swiss Price Supervisor (Preisüberwacher)

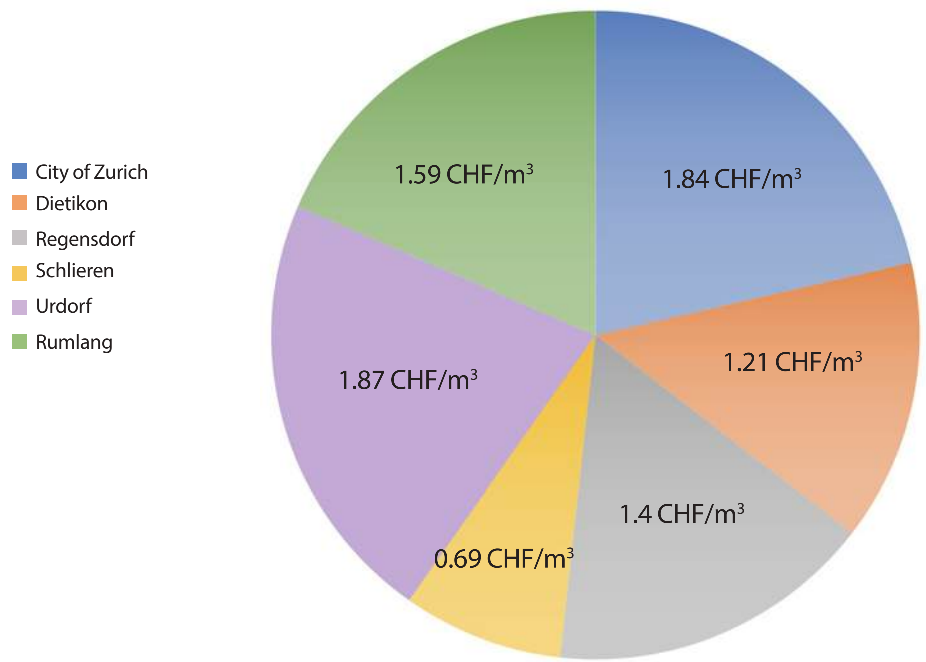


fig. 29 **Zurich headwaters**
Water from 120 spring sources in the Sihl- and Lorze Valley flows into the water supply network of the city of Zurich. 90% of this water is mixed with Lake water in the Lake water facility Moos and then distributed to the affiliated households.

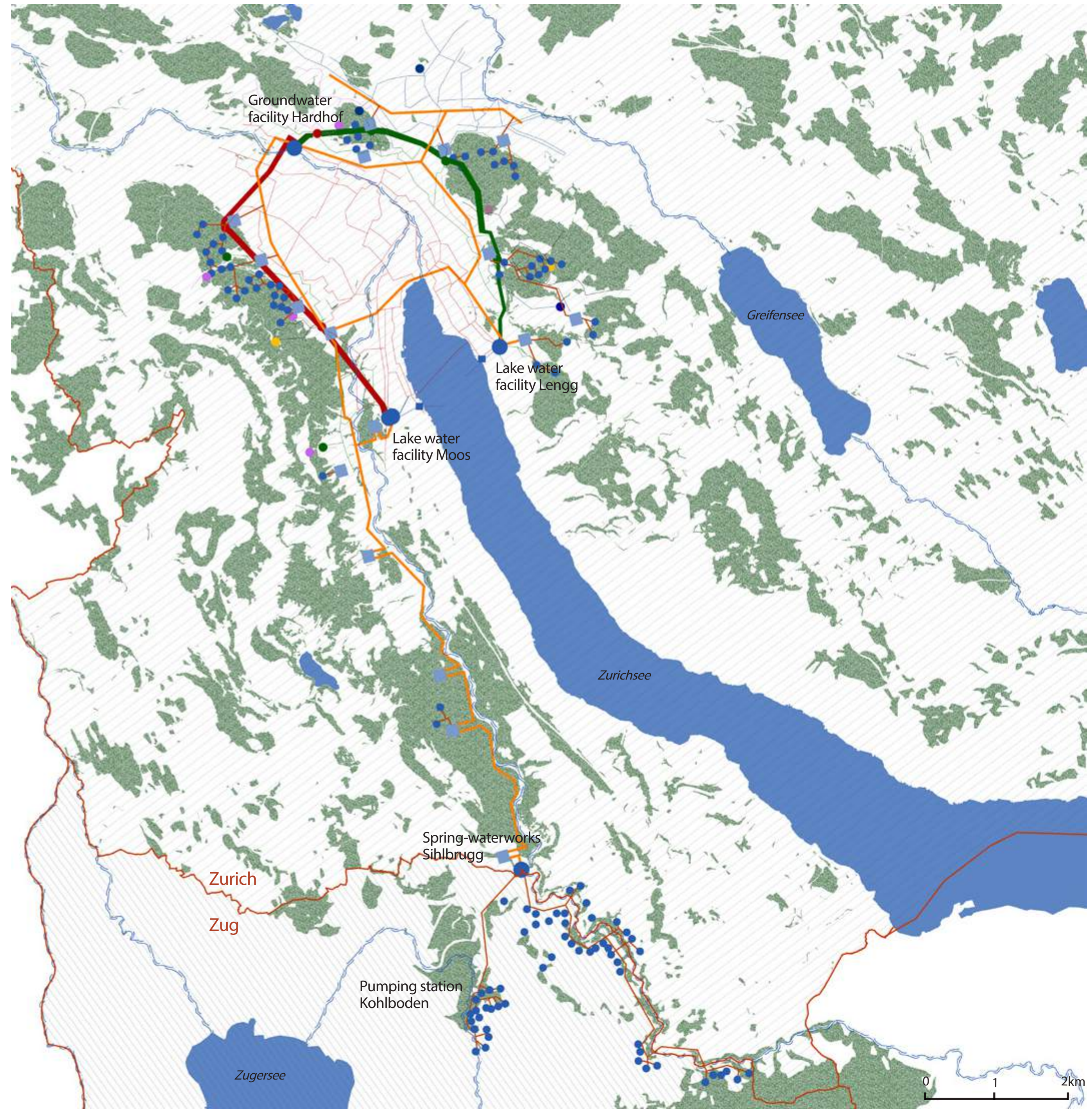


fig. 30 **From the source to the tap**
Section through the water infrastructure between the spring sources in Sihl- and Lorze valley and the supplied households.

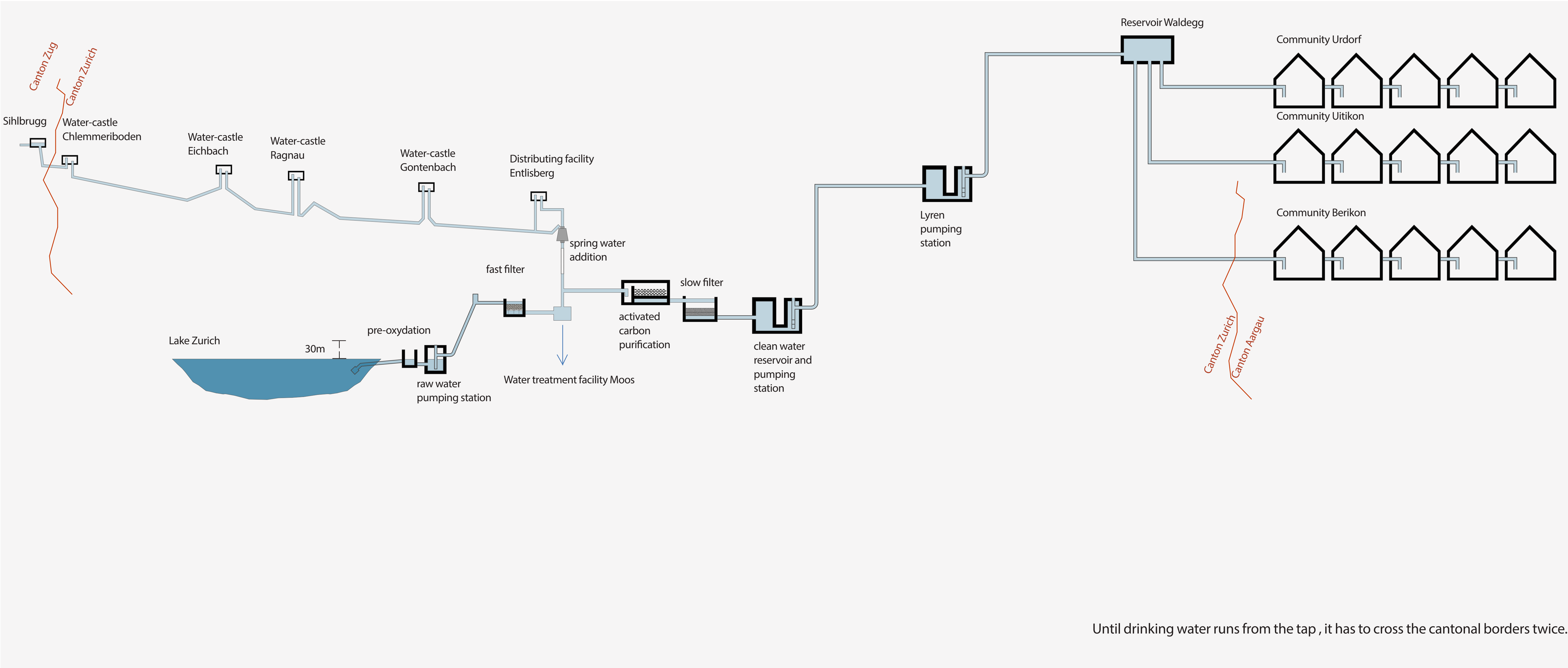


fig. 31 **Transporting the water**
Assemblers pose with a heavy-calibered water pipe by the Limmat Riverside, 1933.

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fig. 32 **Water infrastructure boom**
Poster of the water supply of Zurich, searching for personnel during the boom, 1970s.

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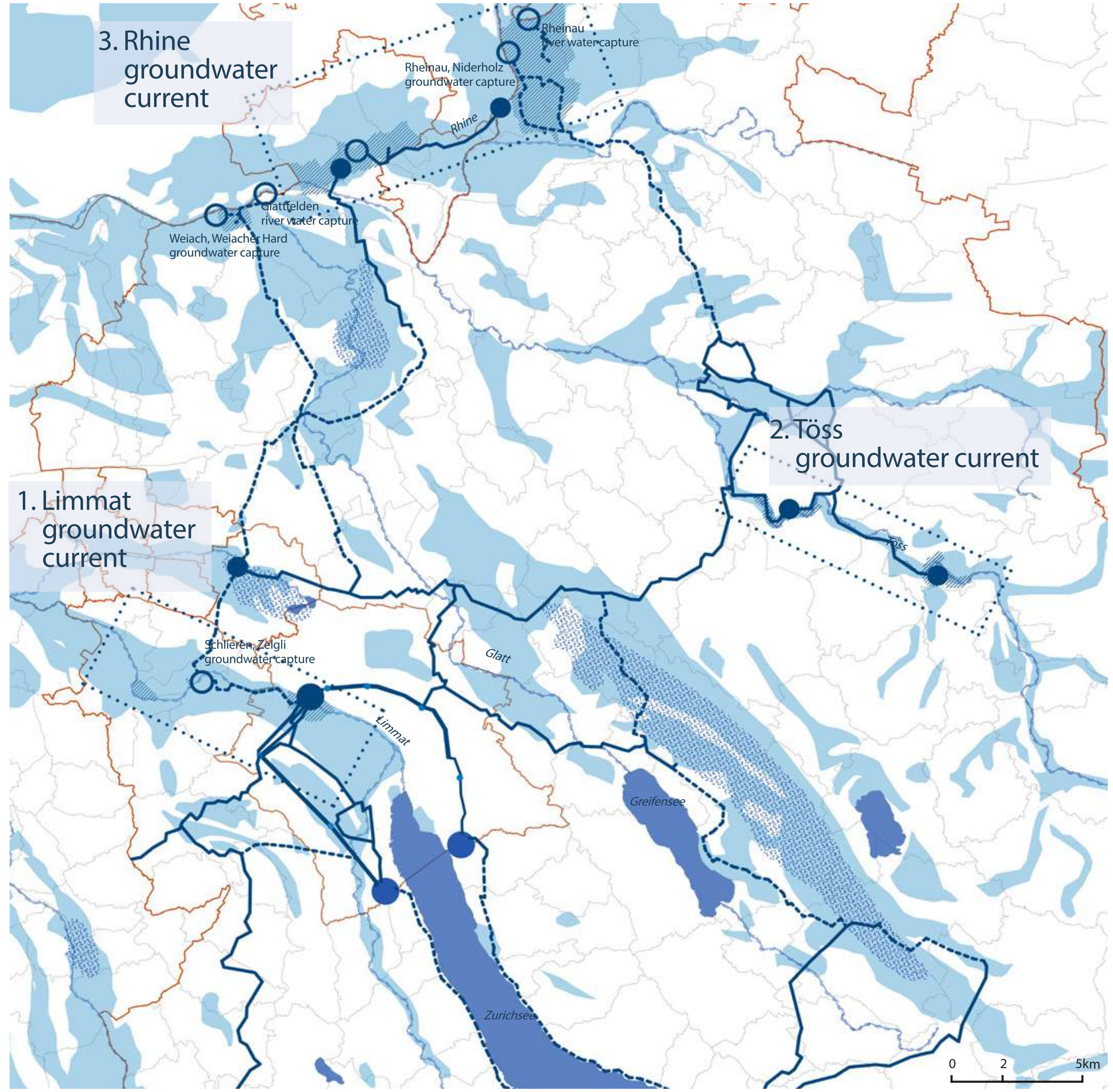
fig. 33 **Territorial water supply**
Securing the future water supply of the Canton Zurich by connecting to the Rhine groundwater current.
"In order to distribute the risk between ground- and Lake water no future capacity extentions for the drinking water supply should rely on Zurich Lake. Instead, future water extractions should exploit the groundwater current of Rhine." report of the Cantonal Office of Waste, Water, Energy and Air (AWEL) referring to the future water supply security of the Canton of Zurich.

- Planned water capture
- Existing water capture
- Planned water transport pipeline
- Existing water transport pipeline
- Groundwater protection zone
- Groundwater
- Deeper groundwater layer



Wasserböden
Holistic principles of water regeneration

The sub-surface is a water reservoir and a water filter at the same time. The Swiss Alps are a continental divide. Alongside the lakes, groundwater is the biggest water reservoir and is found in many different types of aquifers under Swiss soil. These emerge from sub-soil cavities and permeable soil strata filled with water, consequently being influenced by precipitation and infiltration of surface water. The occurrence and distribution of groundwater is not merely a product of chance, but the result of a combination of climatic, hydrologic, geologic, topographic and soil-forming factors that together form an integrated dynamic system.

Topography forms a watershed and determines where and how water flows. A watershed refers to the catchment basin where precipitation collects and drains off into a common outlet, such as into a river, bay, or other body of water. The Swiss Plateau covers about 30% of Switzerland and is the heartland of Swiss cities, farming and industry. It is a Molasse Basin that was filled with erosion debris during the Alpine folding and is drained by the bigger river networks of Rhine and Rhone. The most important zone of infiltration for groundwater lays in close to the surface unconsolidated rocks along the river valleys of the Swiss Plateau and along the bigger Alpine valleys. In the case of the Limmat groundwater current, one of the biggest in the Canton of Zurich, the corresponding catchment area shows the dependency on a significantly bigger scale. Originating in the Glarus Alps, water flows into the River Linth, mounting into the Walensee and channeled into Lake Zurich, at it's end feeding the River Limmat, which finally infiltrates and naturally recharges the groundwater current.

All the while, soil permeability determines the infiltration and runoff percentage of water. Albeit what we see, the water system has a "depth" and it's maintenance depends on the soil structure between the surface and the groundwater formation level. The highest permeability is a characteristic of clay free valley surfaces, and where the groundwater forming takes place. The retreat of the glaciers left back moraines, which form the hilly landscape of the Swiss Plateau and staunch the groundwater. Across the Swiss Plateau, there are unique situations, characterized by heterogeneous groundwater flow, where multiple groundwater levels lay on top of each other and most of the times are separated by geological layers of comparatively low permeability. Climate is one of the most important factors affecting the formation of soil. In the era of increasing temperatures and frequency of extreme events, soils tend to dry out and cannot recover their properties before the next extreme drought or precipitation event takes place.

How can we design our landscape, taking into account the hydrogeological conditions that could promote a sustainable water regeneration? How do we design adaptively for changing conditions of soil and how do we design locally taking into account the greater connected water network that will be influenced by the geological conditions as well?

fig. 34 **Water Cycle**
Concept sketch

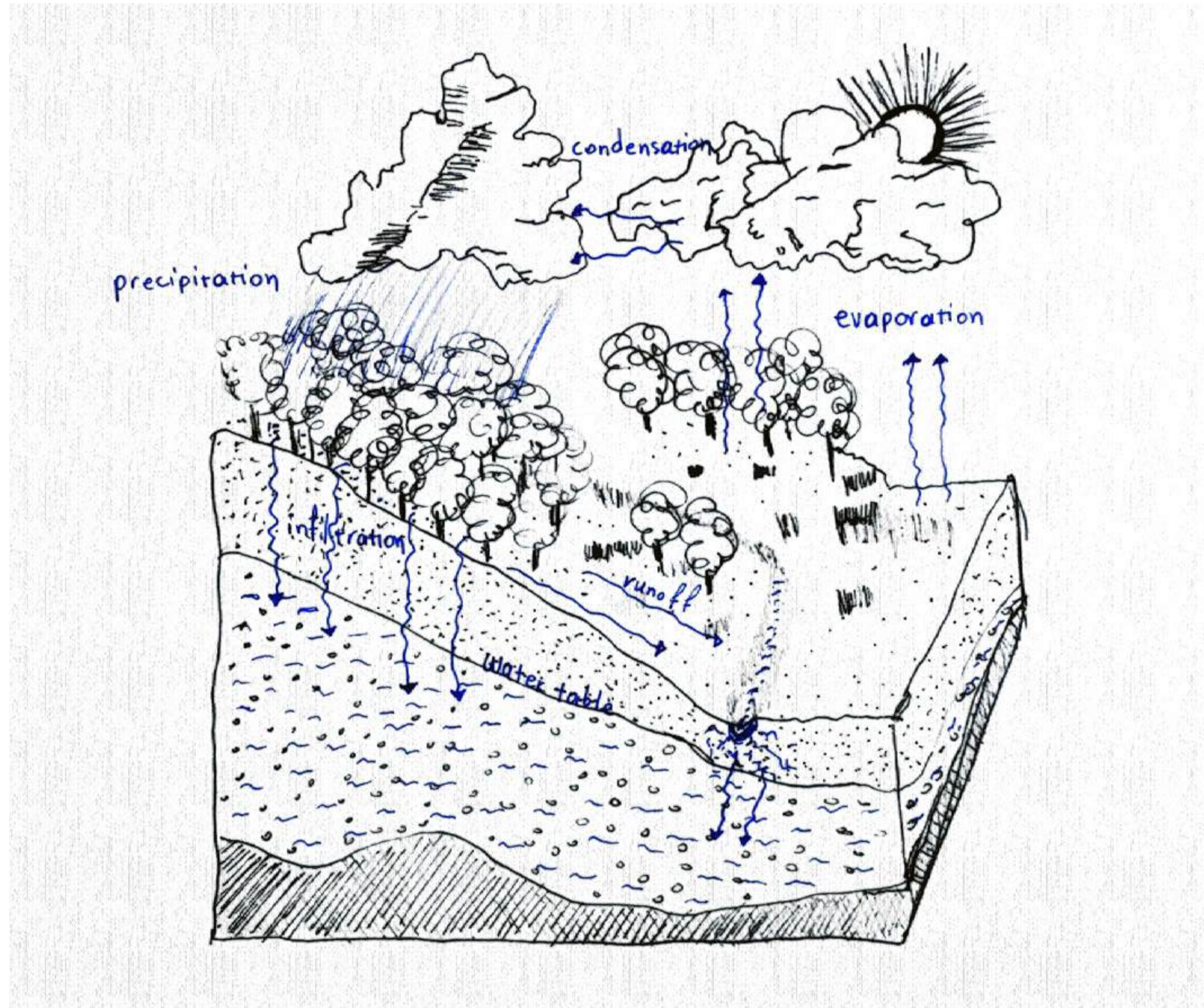


fig. 35 **The political and the hydrological Switzerland**
Watersheds of the biggest rivers running through the Swiss Plateau.

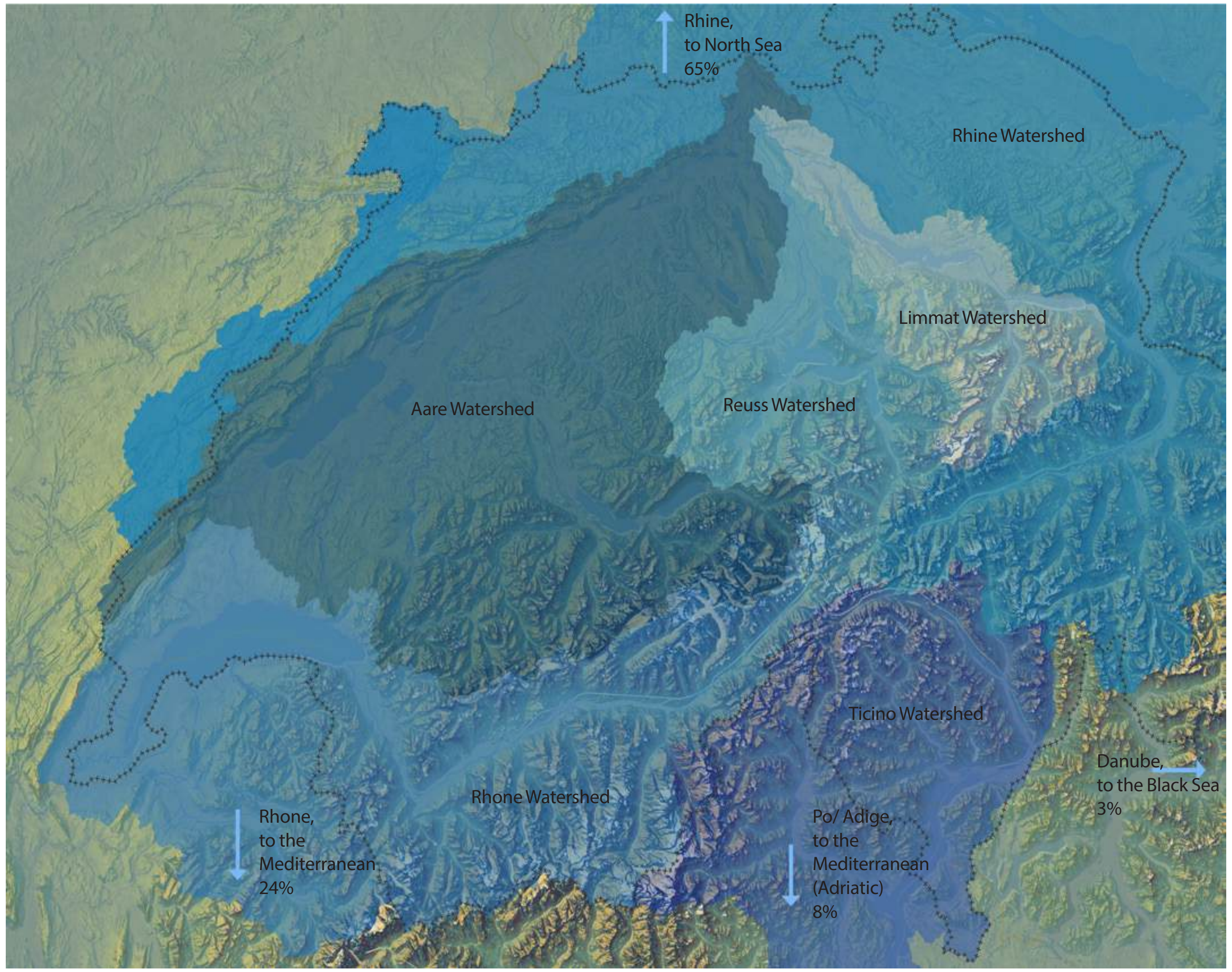


fig. 36 **Groundwater patchwork of the Swiss Plateau**
The most important for the water supply groundwater currents are found in unconsolidated rocks near the surface of the river valleys of the Swiss Plateau and along the biggest Alpine valleys.

fig. 37 **Regulating the Lake water level**
The Linth canal regulating the water flow of Zurich Lake. Source: ETH Archive, August 1977

fig. 38 **Taming the river flow**
Limmatwehr. The construction of the new weir in River Limmat in 1980. The Limmat backwater is important for the formation of groundwater.

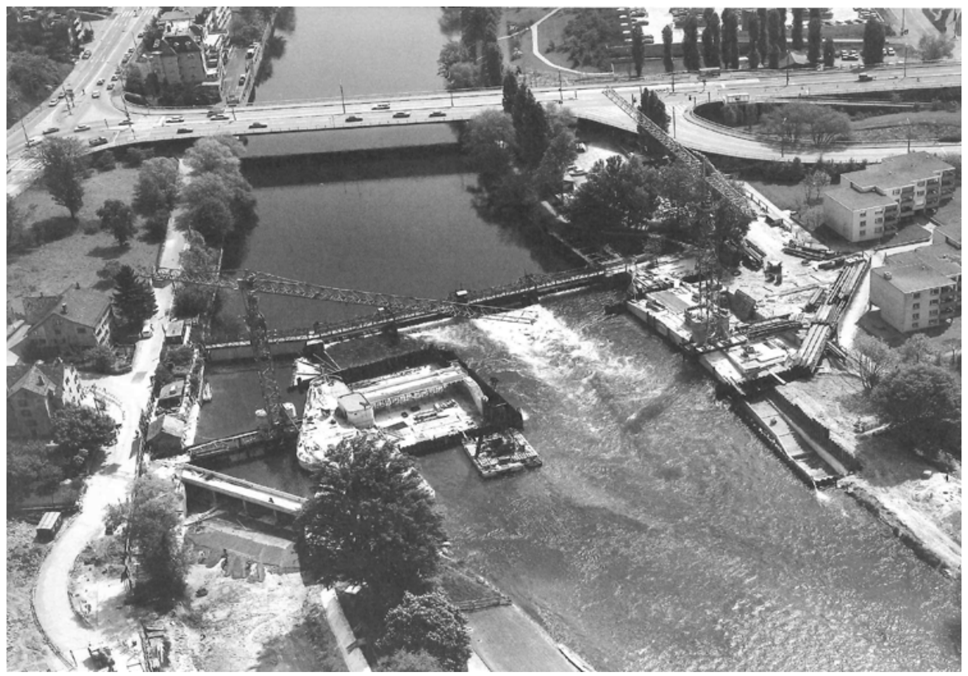


fig. 39 **Limmat groundwater regime**
The river network of the Limmat catchment basin.

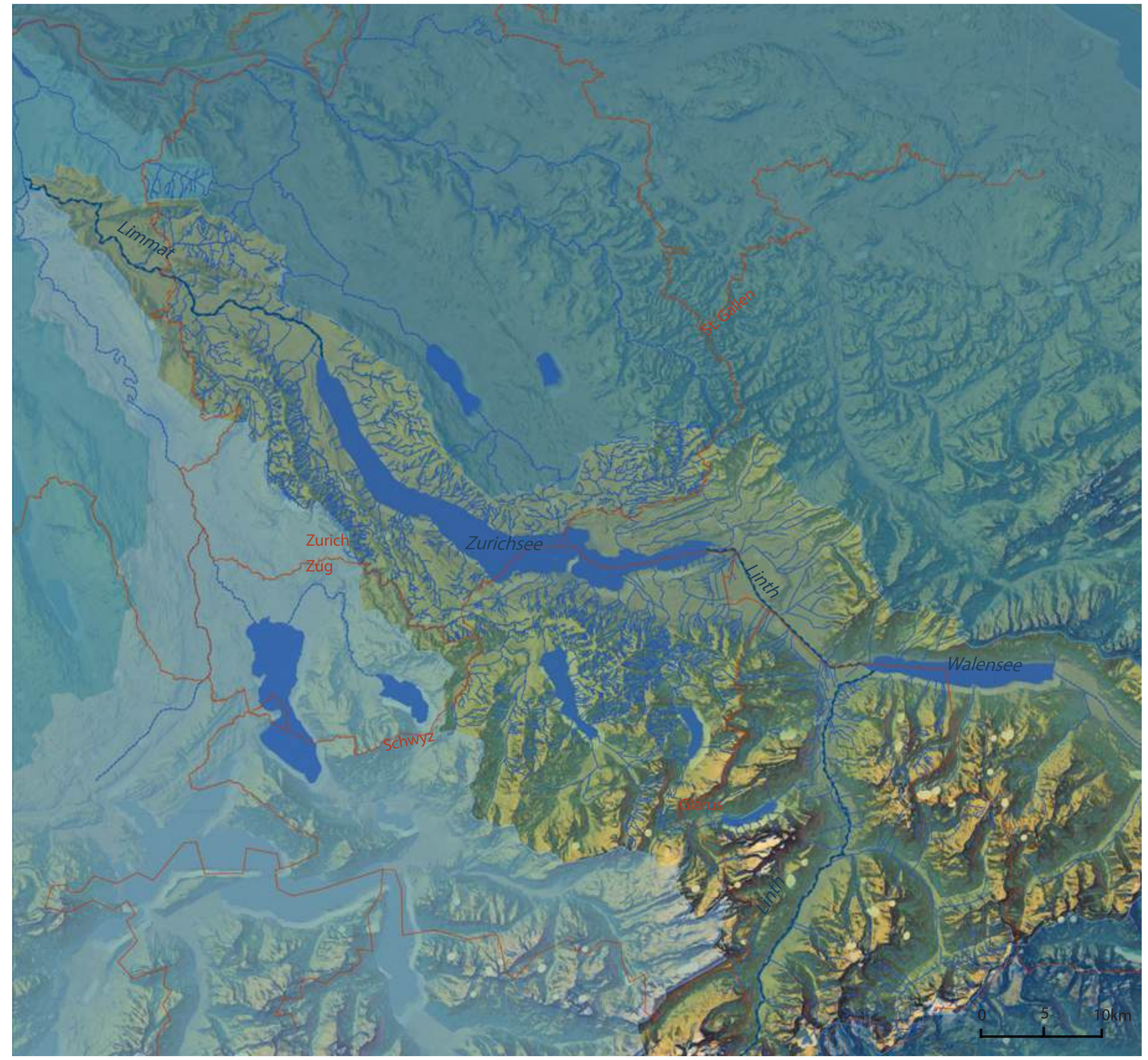


fig. 40 **The depth of water**
Hydrogeological section AA' across the Limmat Valley.

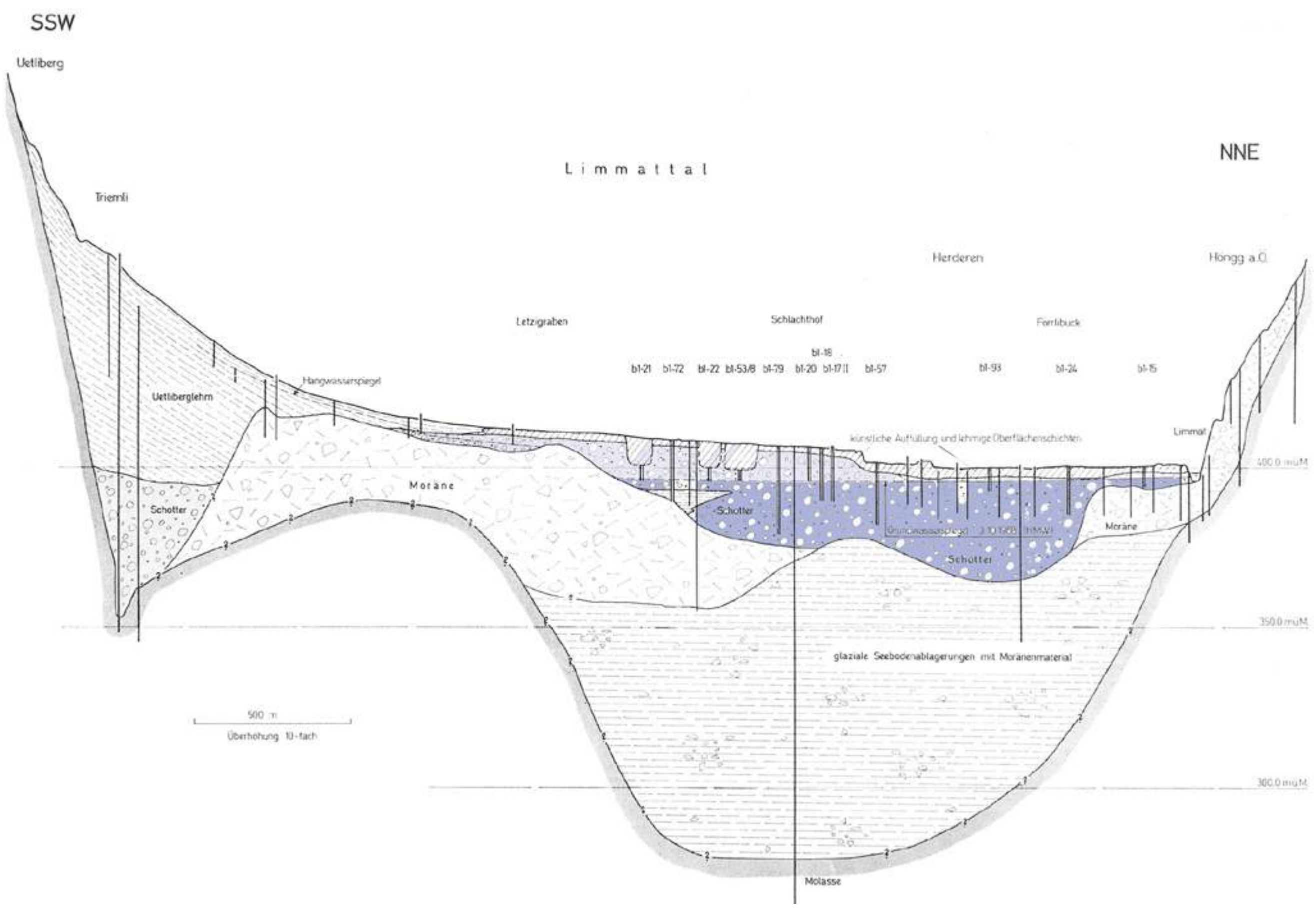
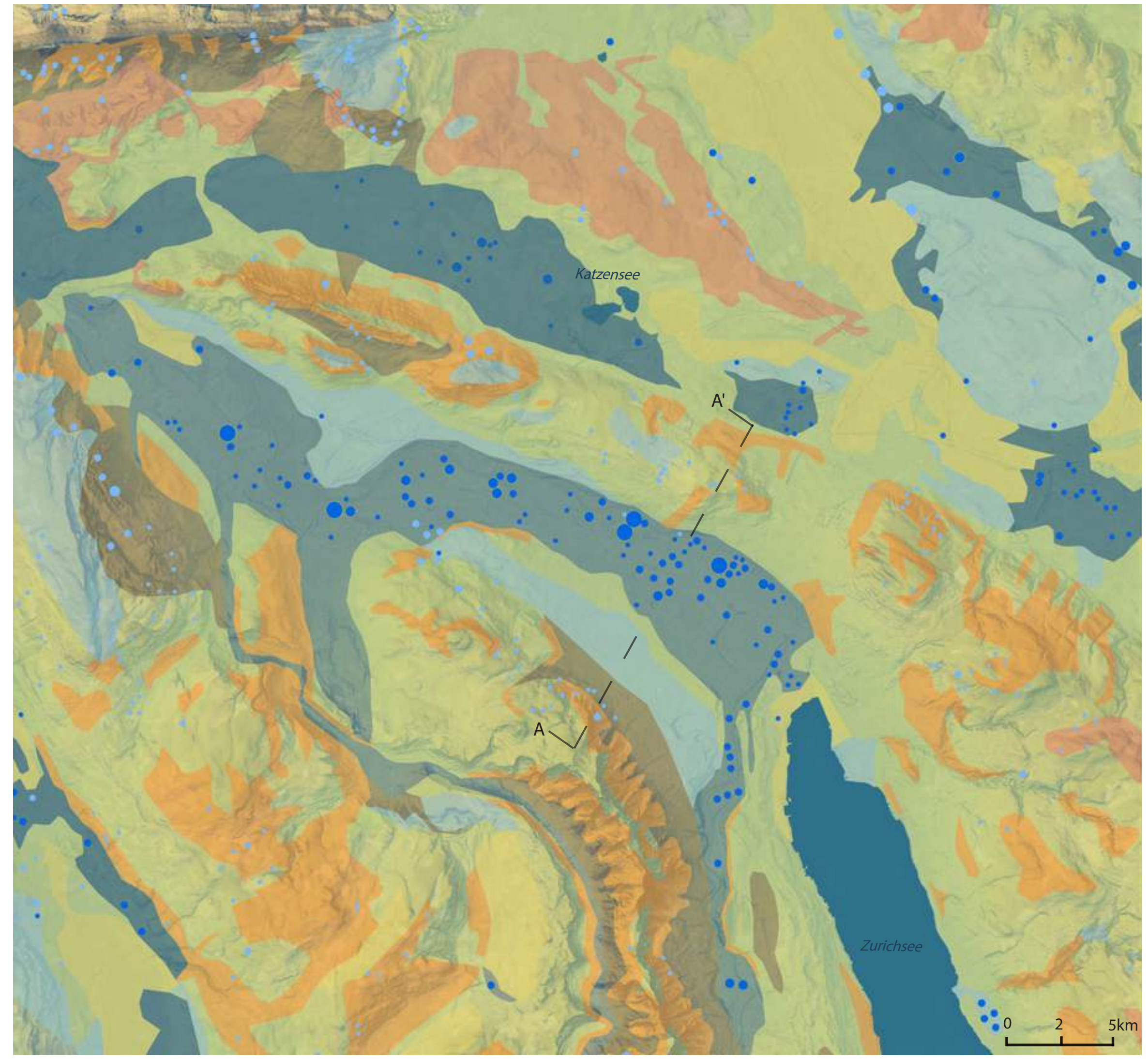


fig. 41 **Metropolitan soil water dynamics**
Hydrogeology and groundwater formation in the metropolitan region of Zurich.

- clay - free gravel, high permeability
- low clay gravel, high permeability
- moraine, medium permeability
- bedrock, low or very low permeability
- unconsolidated rock, low/very low permeability
- unconsolidated rock, medium/low permeability
- granite, uneven permeability
- groundwater capture
- important spring soure



Wasserhülle
Stewardship towards water resources

The use of the surface is of key importance in securing water availability. Historically, stormwater was viewed as a hazard in urban areas and complex networks of drainage infrastructure were implemented in order to remove surface water and transport it away from the urban area. With population growth and expanding urbanisation people had already started in the mid-19th century to rectify and pipe water courses in order to builtd or cultivate the gained surface. However, this action, practised further until today, has tremendous effects on future water availability and quality as well as on the biodiversity.

Even if the drinking water demand of Switzerland measures only 7% of the theoretically available and regenerative groundwater, this potential cannot be effectively exploited, due to the intensive land use and the contrasting land-use interests. Even if the Cantonal Office of Waste, Water, Energy and Air (AWEL) defines several levels of water protection, 70% of the fountains in the Swiss midland Plataeu, supplied by groundwater, contain pesticides in quantity that exceeds the corresponding statutory requirements. All the while, the expanding urbanisation and sealing of previous porous surfaces decreases the infiltration and evapotranspiration capacity of the soil and increases surface runoff. As a result the natural regeneration capacity of groundwater is reduced.

However, there are potential land uses which can sustain and promote the soil porosity and the infiltration of clear water. The Hardhof groundwater facility in Zurich illustrates an exemplary approach. Green areas and sports fields on the Hardhof site protect and recharge the groundwater, while offering a public landscape for recreation.

The emerging challenge is the proper design of land use, while respecting and enhancing the availability and quality of water resources. *How do the contrasting interests over land use co-exist and promote the regeneration of water resources? Which are the hybrid landscapes that promote water protection and social interaction with water?*

fig. 42 **Water envelope**
The contribution of land use in the water cycle, concept sketch.

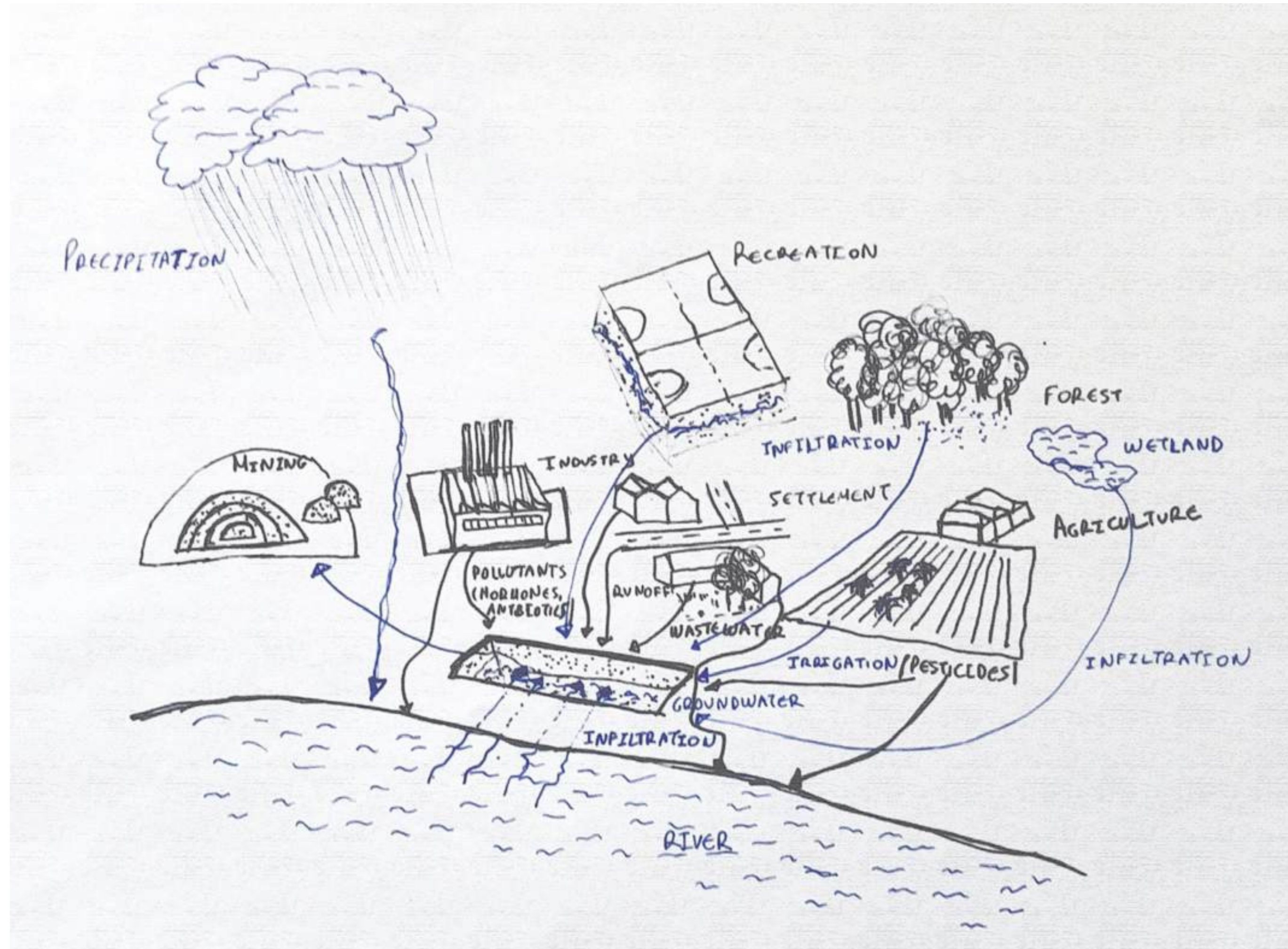


fig. 43 **River landscapes before their draining**
The Linth plain before the drainage. Aquarelle by J.J. Bidermann, 1787. Source: Bernisches Historisches Museum

fig. 44 **Artificially drained landscapes**
The meliorated landscape is used for cultivation and settlements. Aquatinta by Dickenmann, 1860. Source: Linth-Escher-Gesellschaft collection

fig. 45 **Missing water bodies**
Water courses change over the time period 1850 - 1980.

- wetlands vanished between 1890-1980
- unchanged wetlands 1850
- water courses vanished between 1890-1980
- water courses vanished between 1850-1890
- present-day water courses
- culverted water courses

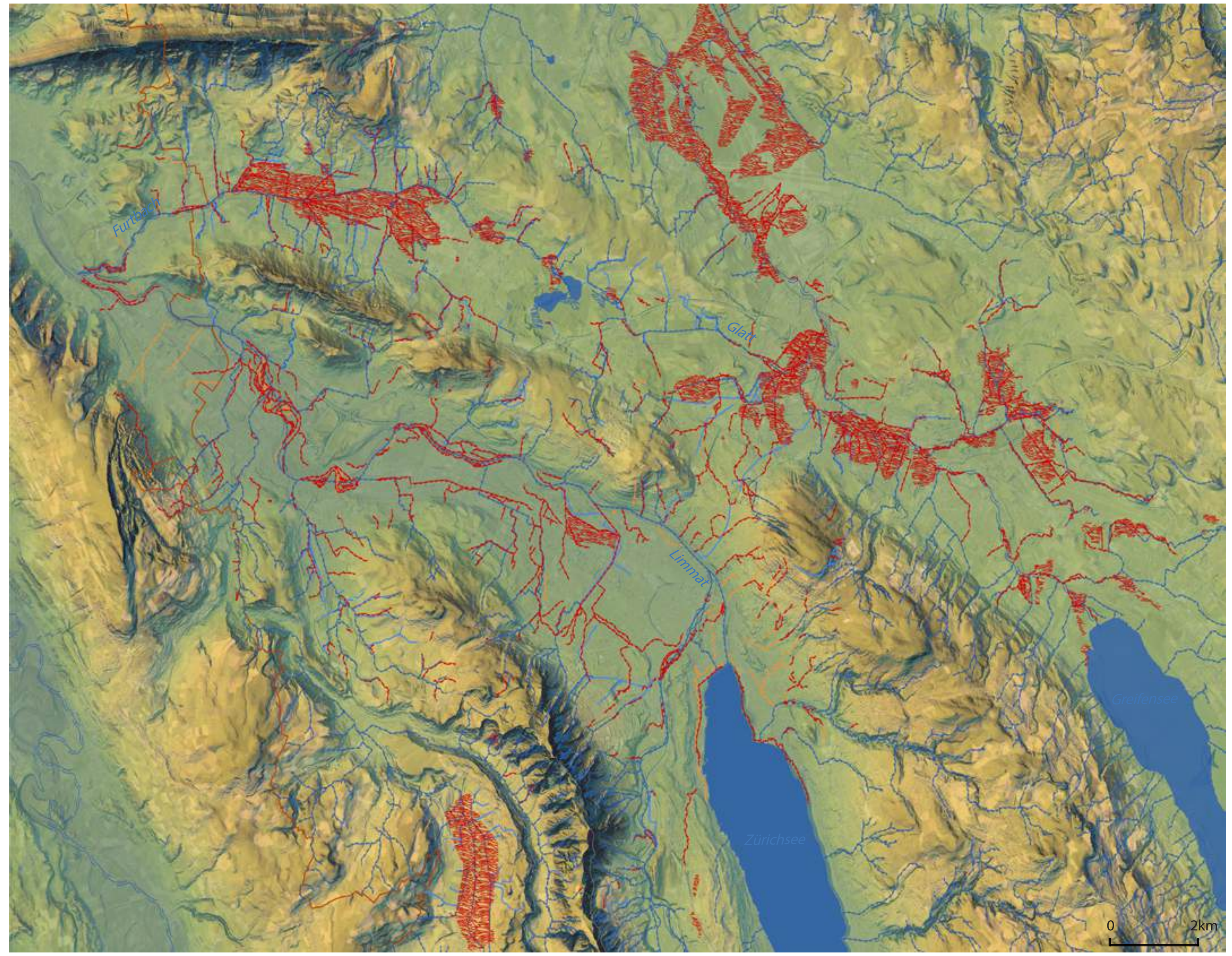


fig. 46 **Taming the water bodies as a public event**
Construction of the Rhone Dam, R. Ritz, 1888.
Source: Wallliser Kantonsmuseum

fig. 47 **Critique of the wetland drainage**
Moles, followed by rats explain the war to the frogs, who beg for mercy on their knees. Caricature from Léo-Paul Robert on occasion of the Jura water bodies in 1867. Source: Foundation Collection Robert (Biel)

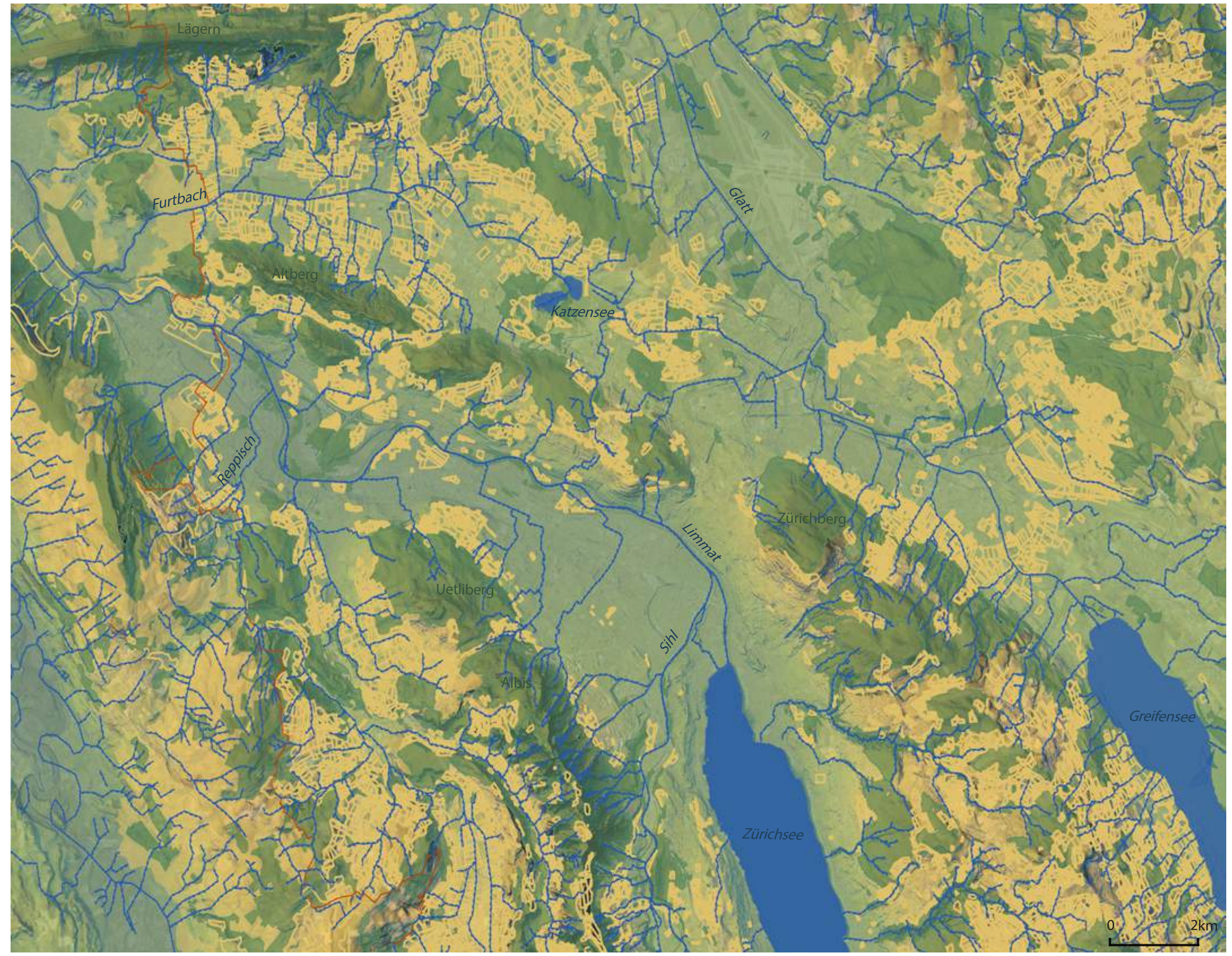
fig. 48 **Effects of wetland destruction**
The dead frog, the gravestone and the railway in the background symbolize the defeat of nature. Caricature from Léo-Paul Robert on occasion of the Jura water bodies in 1867. Source: Foundation Collection Robert (Biel)

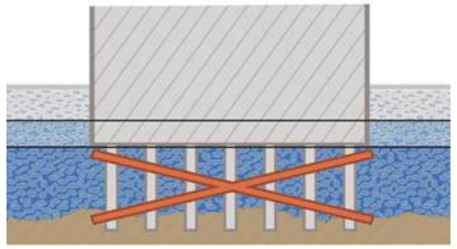
fig. 49 **Water as a leisure landscape**
Sport fields over the groundwater protection zones of Hardhofareal, Zurich.

fig. 50 **Recreational water landscapes**
The Sihlwald Nature Discovery Park is another example of water and nature protection combined with recreation opportunities.

fig. 51 **Porous water envelope**
Agriculture and forest surfaces of the metropolitan area of Zurich.

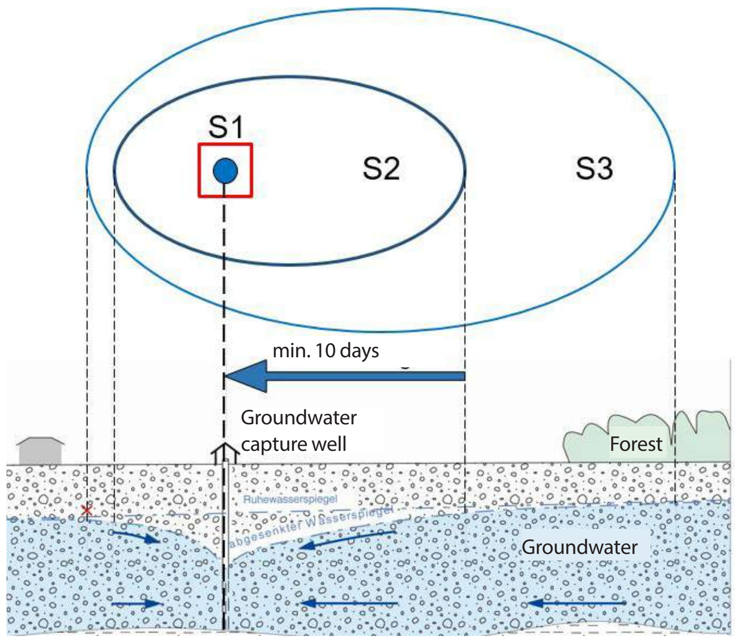
water courses
agriculture plots
woodland





The water protection area Au includes the available underground waterbodies and the necessary for their protection peripheral regions. For the Canton of Zurich these are the highly permeable unconsolidated rocks.According to the Schedule 4 of the Federal water protection regulation, no structures that sit under the long-term, natural , mean groundwater level are allowed. This means that in regions where the groundwater level is close to the surface, this regulation limits the allowed number of basements.

The groundwater protection zone S1 includes the immediate surrounding area of a groundwater capture or groundwater enrichment. It extends at least 10m around the mentioned point. In this area, only activities of the drinking water supply are allowed.



The groundwater protection zone S2 ensures that groundwater will not get polluted by excavations or underground works in proximity of the groundwater capture point as well as that underground structures will not hinder the groundwater inlet. It also ensures that no pathogens will reach the drinking water Slurry or infiltration of wastewater is abandoned in this area

The groundwater protection zone S3 ensures that in case of an accident there will be enough time and space to repel a threat for the captured drinking water. No infiltration of wastewater is allowed, as well as no undertakings that constitute possible

fig. 52 **Statutory water envelope**
Different levels of groundwater protection defined by the Canton of Zurich.

water courses
water protection zone Au
water protection zone Ao
provisory area Zu
groundwater protection zone S1
groundwater protection zone S2
groundwater protection zone S3

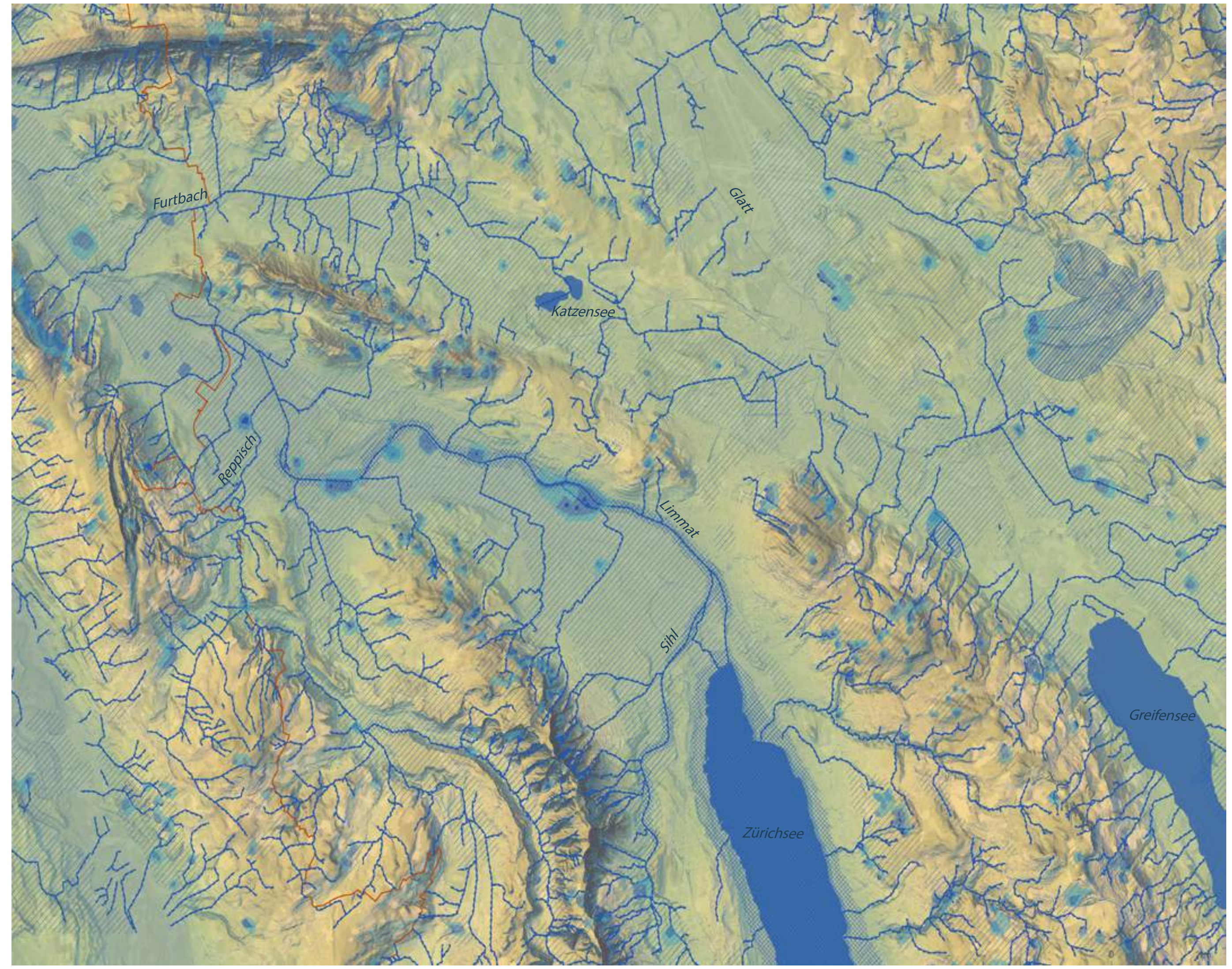


fig. 53 **Forest as water guard**
Capture well next to popular running routes on Käferberg, Zurich.

fig. 54 **Signage for groundwater protection**
The area next to the river is marked as a groundwater protection zone.

fig. 55 **Fenced off groundwater protection zone**
\ The groundwater protection zone S1 is fenced off approximately 10m around the groundwater capture well.

fig. 56 **Fertilizers in groundwater protection zones**
Use of chemical fertilizers is prohibited in the groundwater capture area because they can reach the aquifer and pollute the groundwater.

Wasserkultur
Celebration of water

More than 1200 fountains, numerous rivers and smaller creeks and the Zurich Lake, the water is omnipresent in the Canton of Zurich. Therefore, Zurich itself is and always has been a water city (Wasserstadt). In order to speak of the polyvalence of water, one can use the term water culture (Wasserkultur). Our social interaction with water affects the way we perceive, appreciate and consequently protect this vital resource. Throughout history, as well as today, cultural and social interaction with water has changed according to the greater social circumstances of the respective time. All the while, the design of the water presence in cities and in our everyday life has always been subject of discussions between artists, prize of architecture competitions and study subject of engineers and economists.

In spite of its' functional necessity, water infrastructure is subject of meticulous design and receives a public function. Water is celebrated in the smaller scale of the fountains, where drinking water runs continuously, as well as in the bigger scale of the Lake, with the quays constituting a popular bathing area. As an example, the visible facade of the water reservoir Strickhof on Zurichberg, one of the biggest water reservoirs in Zurich, has been designed by the artist Warja Lavater as a big mosaic and it's roof is used as a public terrace and playground.

Nonetheless, the increase of population and corresponding water demand, together with the changing climate result in the need of cultivation of a new water culture. The expected extreme weather events will threaten the cities with flooding and drought events. The increasing conflicts and negotiations regarding future land use often end at water resources' expense. Even if water is omnipresent we seem to neglect it's origin and take for granted that it runs from the tap and every public fountain. All the while, 12% of the Swiss population, this corresponds to approximately 1 Million people, is supplied with drinking water from sources where the protection zones are insufficient. Therefore, we have to recultivate our water culture, aiming to be able to adapt to a changing climate and protect our precious water resources. We have to reappreciate and develop a new stewardship towards our water resources.

fig. 57 **Water as a public event**
The jury studies the models for the emergency water fountains, 1973.

fig. 58 **Water as a leisure landscape**
A playground was designed over the reservoir Strickhof.

fig. 59 **Water architectures**
While the most water reservoirs are underground und remain invisible, the water reservoir Strickhof has been designed by the artist Warja Lavater with a visible facade reminding of a mosaic, 1972.

fig. 60 **Water celebration as a public event**
The water castle Gontenbach has been artistically valorized by the artist Warja Lavater with a publicly accessible installation, Wildnispark Langenberg, 1975.

fig. 61 **Water as an art event**
The artist Warja Lavater designs the "water caste" at Hardhofareal, Zurich.

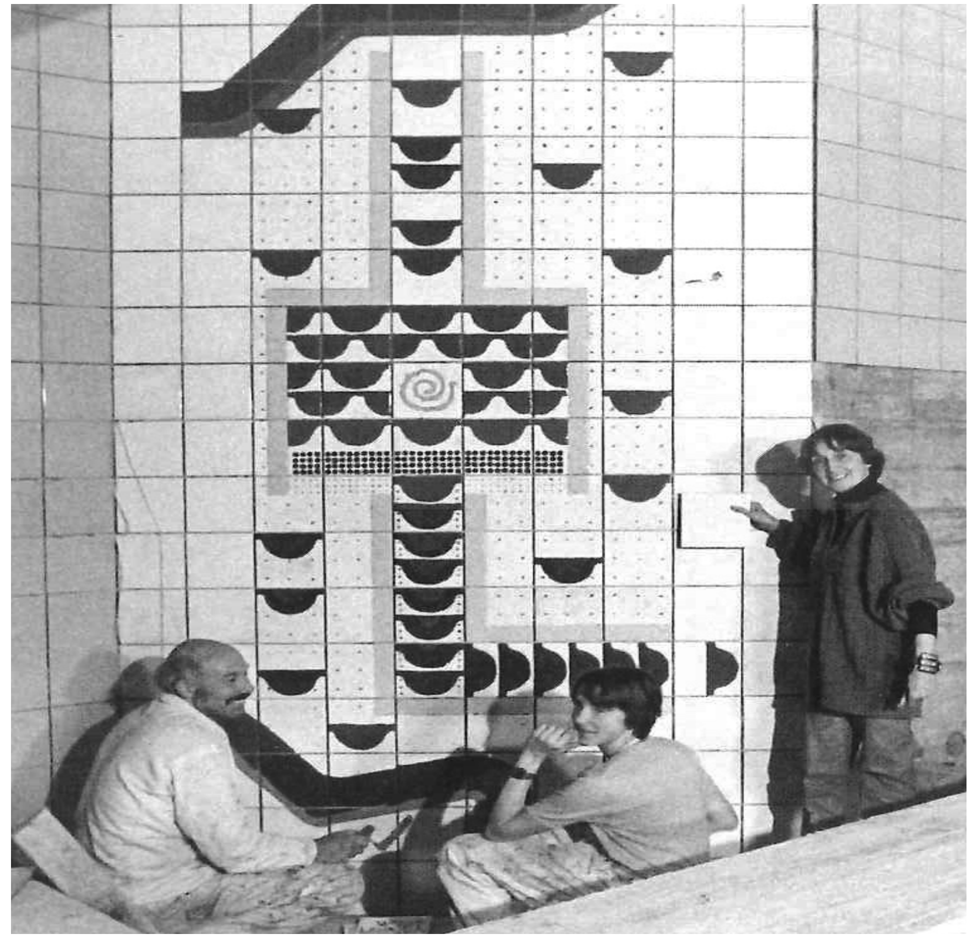


fig. 62 **Water micro-architectures**
Arnold Burkli built 12 copies of this cast-iron fountain. Raw water run with the press of the button. Only in one pipe spring water run continuously.

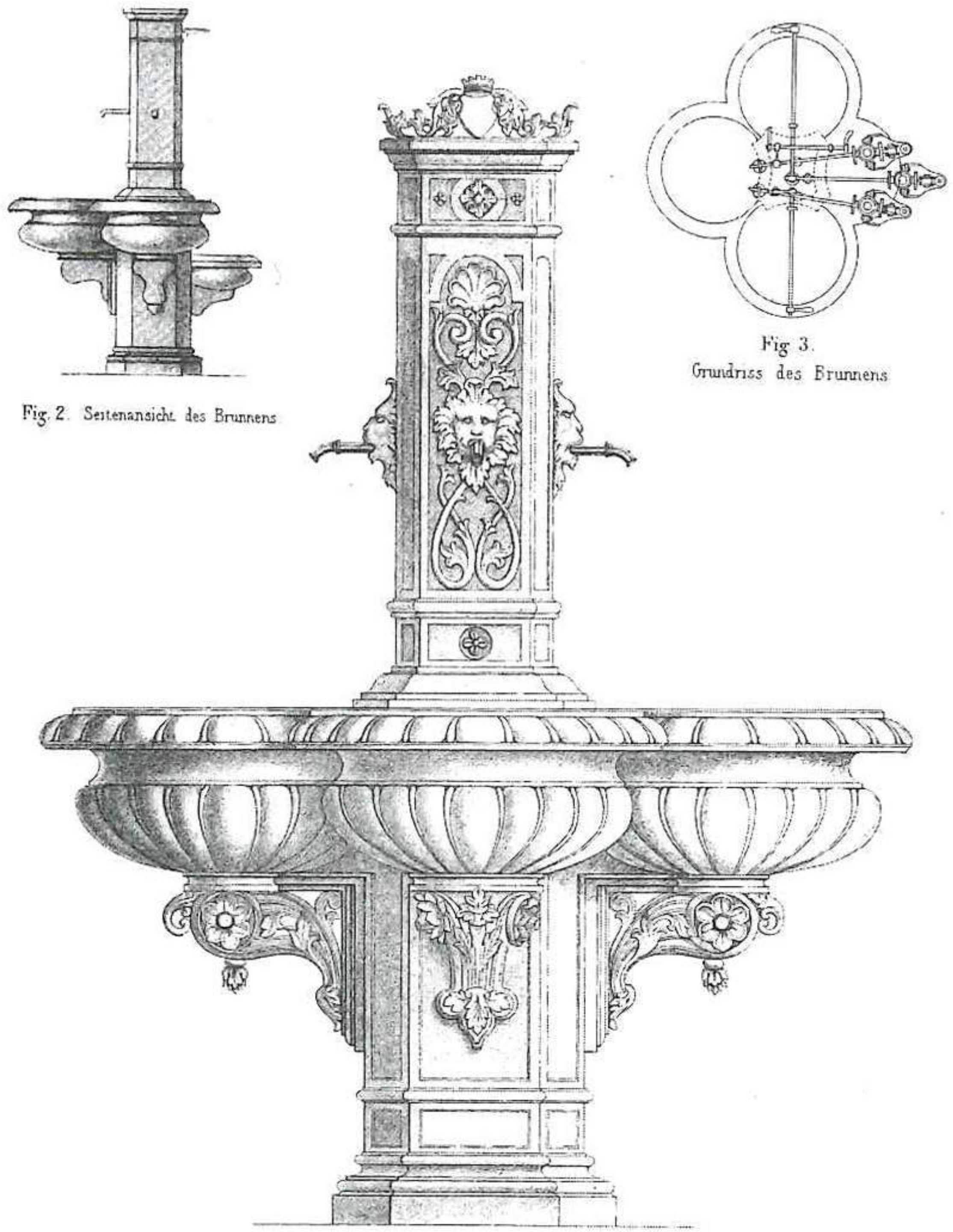


fig. 63 **Does a fountain need supervision?**
Fountain of 1742 at Fraumunster, Zurich in front of the old monastery.

II. CASE STUDY: THE FURTTAL

Furttal
Emerging from a marshland

Back in the days an intimidating wetland and today a prosperous region at the gates of the city of Zurich, Furttal lies only 30 minutes away from Zurich Main Station and Zurich Airport correspondingly. The other living and economic environment, where all the more people want to live, where attractive recreational areas and growing economic entities are situated and which is ideally connected in terms of transport infrastructure. Furttal connects the two centers of Zurich and Baden.

Defined by the surrounding mountain chains of Lägern and Altberg, the Furt Valley is characterised by the aqueous biotope of Katzensee Lakes on its eastern part, bordering with the city of Zurich and the eponymous stream Furtbach that flows through and meets the Limmat River on its western side, bordering with the Canton of Aargau.

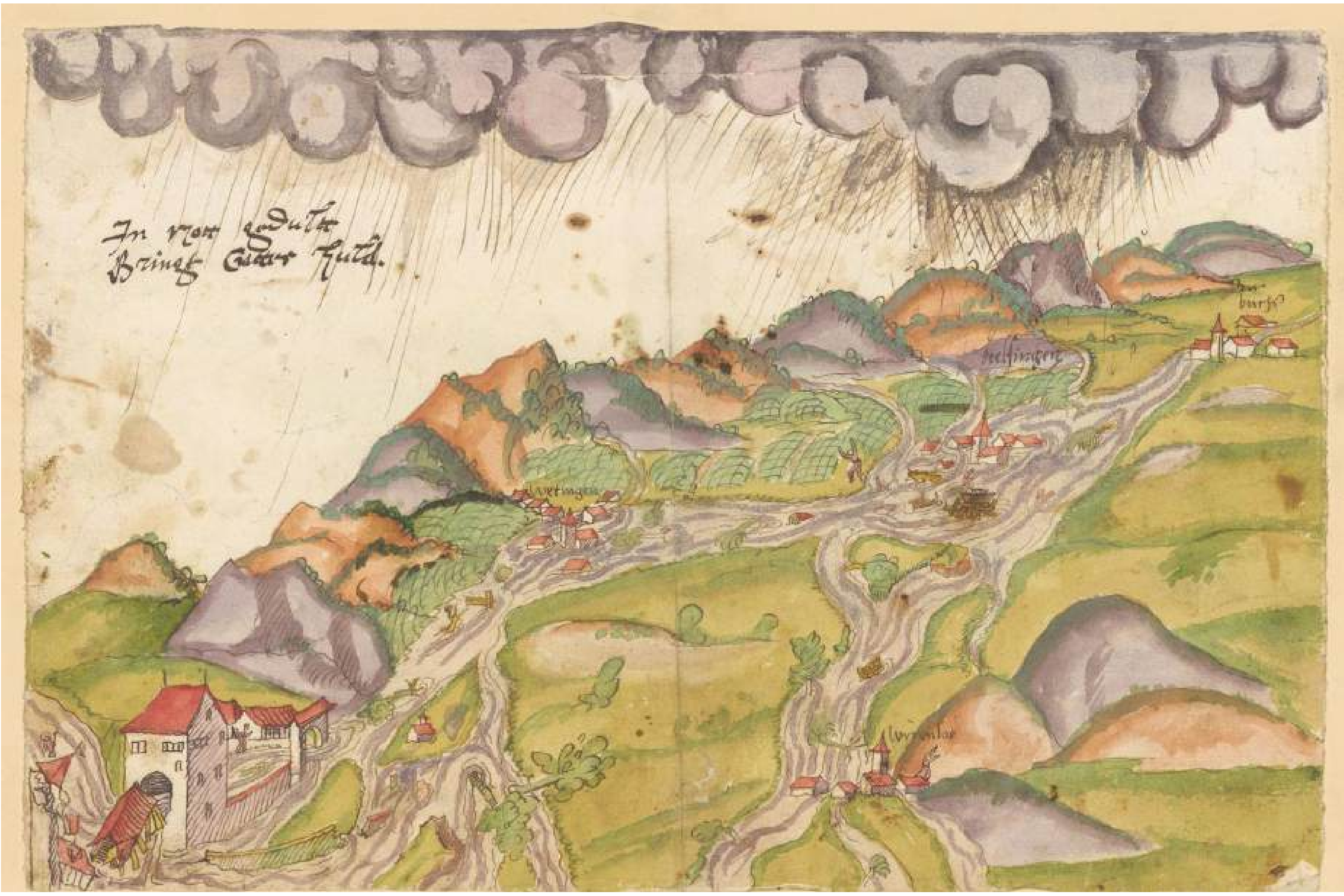
The valley has a long history connected to the water. For almost 120 years the flooding of its central area hindered the cultivation and colonisation of most of it's flat surface. The geology of this region has attracted the interest of geologists many times and is has mostly glacial effects. The moraine deposition in the area of Katzensee and at the western end of the valley, at Würenlos, during the last ice age, resulted in the formation of a closed hollow, which today constitutes a second deeper aquifer layer, recharging independently from the upper, and protected by an impermeable soil layer lying inbetween the two. Because of it's purity, this deeper layer of groundwater is still today used for the drinking water supply of the population. However, another significant part of the drinking water demand is supplied by the surrounding spring sources and by drinking water that has been purchased from the corresponding bigger group water supplies, being water from Lake Zurich or water purchased from the adjacent group water network of Winterthur.

The Furttal is also the biggest coherent crop area of the Canton of Zurich. Cauliflower, Broccoli, red and white cabbage are only some examples of the daily exported products that reach the markets of Zurich, Geneva, Chur and Bellinzona. This high productivity has taken a toll on the water quality: pesticide pollution levels in soil and water have exceeded the limits so far, that no surface water from the Furtbach or groundwater from the upper aquifer layer is allowed to be used neither for drinking water nor should it be further used as irrigation water, as the pollutants could be transferred into the food chain.

Even if the valley is not densely built, it constitutes a popular destination for many residents of the surrounding regions for the recreation possibilities that it offers (golf course, Lägern, Altberg, Katzensee, Furtbach as examples). The Furt Valley has always been in the vision of planners, being either the most appropriate location for a trans-swiss railway in the second half of the 19th century or the projection of the new city in the mid 20th century. Furttal may be the smallest - in terms of surface - region of the Canton, but it is nowadays among the most dynamic ones.

fig. 64 **The dynamic, still idyllic Furttal**
The Furt Valley is located arallel to the overcrowding Limmat Valley, at the gates of the city of Zurich.

fig. 65 **Recurrent flooding of the Furttal**
Flooding event south of the Lägern, 29 August. 1568. Source: print room, Central Library of Zurich



A marshland
Furttal until the mid-19th century

Silent and at most times secluded from the villages, Furtbach flows uncherished through the Furttal region. Only in Watt, its point of origin and in Würenlos, in the Canton of Aargau, this small water stream is celebrated. However, it was not always like this. Back in the times, the wild Furtbach used to meander through and flood the valley and therefore hindered the settlement development in its close proximity.

Furt is an ancient word meaning unbridged river crossing and gave at latest during the Middle Ages Furtbach it's name. Until the 13th century this water stream was named "Aabach" (=Water stream) in the Zurich part and "Würenlos stream" in the corresponding area.

Common Land is a noteworthy concept which consists of pasture, woodland and wasteland and could be freely used in the frame of a village community self-regulation. These surfaces would then be community ground, which would enable future meliorations.Due to the increasing population and corresponding food demand resultes in the dissolution of the almost 500 years practised three-field crop rotation, which hindered a rational and appropriate for the soil conditions agriculture and sets the foundations for modern practices.

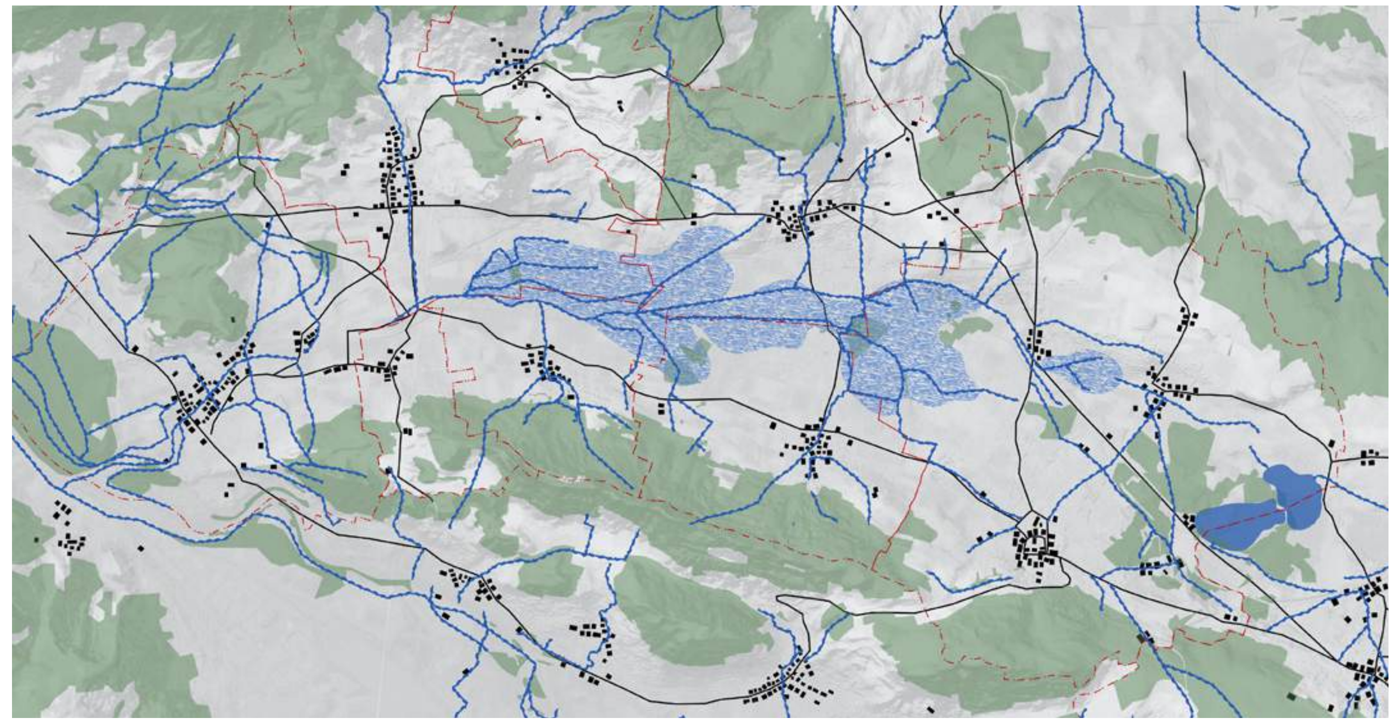
The property question.With the development of the land register, common property was often written as community property. The communities could then sell their property, which prompted the emergence of private land and private woodland. Together with tillable land to the increasing population, the landscape was scattered in small holdings, which then would have to be merged for the purpose of future meliorations.

fig. 66 **The meandering Furtbach**
Junction with the Limmat River, extract from the Gyger map, 1667.Source: public record office of the Canton of Zurich

fig. 67 **Pre-industrialised Furttal**
As seen from Buchs, ca. 1760. D= Regensdorf, E= Dallikon, F= Danikon, G= Huttikon, H= Wurenlos, M= Common Land (Allmend)

fig. 68 **Settlements avoid flooding waterbodies**
Furtbach in its still wild natural course, Furttal, 1860s.

1864

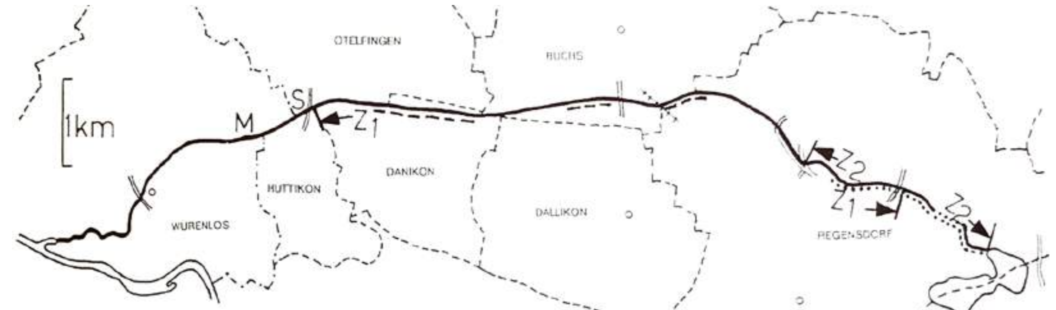


First attempts to drain the Furt valley - Furttal between 1850-1910

Furttal is a paradigm of how geology and landform define the soil fertility, but at the same time of how individual interests can destroy composite works. The free unhindered runoff of Furtbach led to flooding events in Wurenlos, the backwater to swamp formation in the Zurich part and the irregular Furtbach flow damaged the operation of the Oetlikon mill. Already in 1663, 8 floodgates were constructed in the Furtbach, by initiative of the Würenlos. At the beginning of the 19th century many attempts to drain the valley followed, aiming to a signuficant yield increase. In 1871, the drainage committee was founded and initiated a draining project which deepened the Furtbach by 1m. The plan extended from the Cantonal border to Watt, Regensdorf, which then requested its extension and tubing until the Katzensee. Nevertheless, the high cost (present day value 5-6 million swiss Francs) burdened the property owners without being amortisable.

The concept of a canal was driven to the extreme by various planners. In 1920 the Swiss water management association studied the potential of a 17km long water canal from the Limmat to mid-Glattal (Opfikon) through Furttal. With 14 watergates and the appropriate dock, this project wpuld have cost 14 million Swiss franc. In order to make its realisation profitable, Furttal would have to be heavily industrialised. Due to the high cost, this vision failed.

fig. 69 **Drainage plan, 1871-75**
fig. 70 **Furtbach before and after the correction**
Right: Floodgate at Furtsteg, on the still uncorrected Furtbach.
Left: Furtbach at Furtsteg after the correction, deepened and ingrown.



Drainage measures, 1871-75.

--- Extension
• • • New attachment
M Oetlikon Mill
S Weir at Furtsteg
Z1 Responsibility of the drainage committee until 1901
Z2 Responsibility of the drainage committee from 1901until 1923

fig. 71 **Through Furttal to the rest of the world**
Vision of a trans-Helvetian railway connection through Furttal, 1871-73.
Routing plan for the grand petition, 1872.

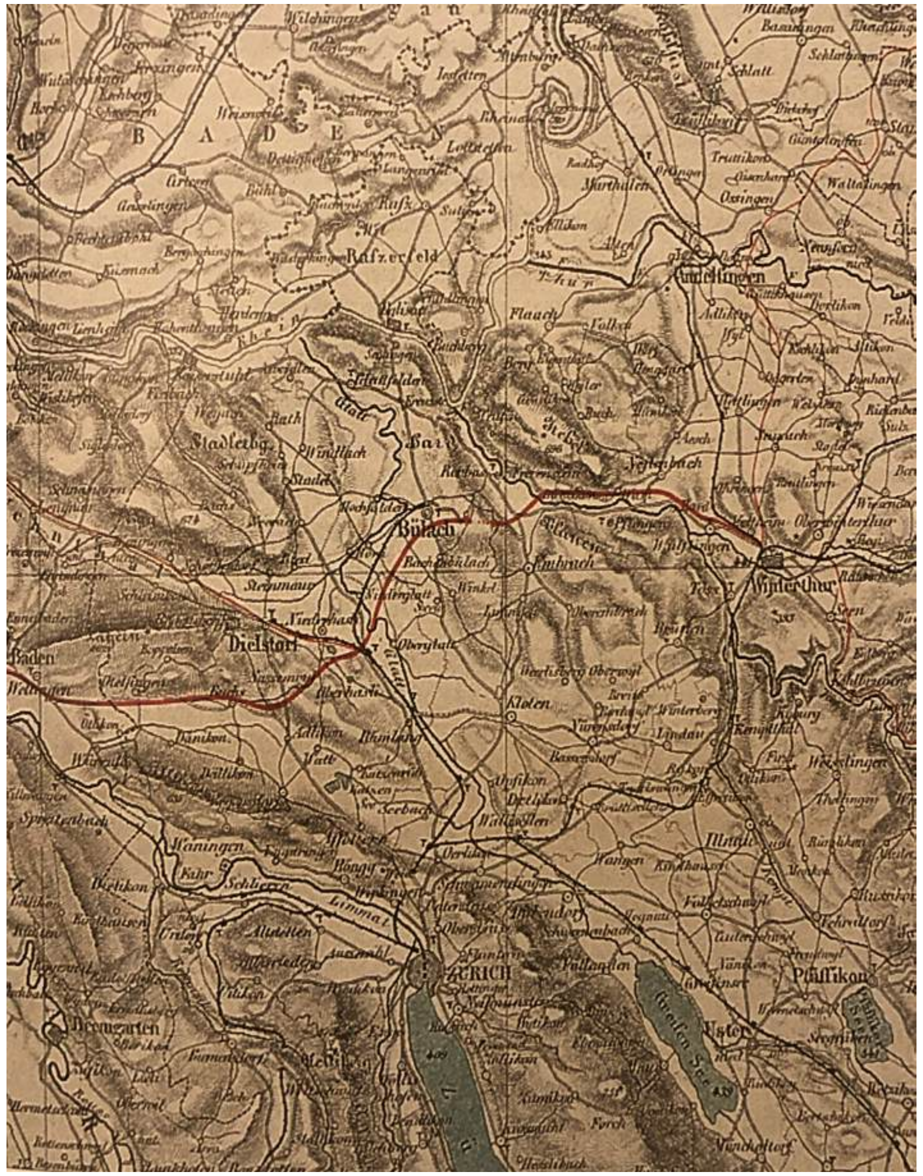


fig. 72 **Vision of a navigable Furtbach**
Plan and long section of the visioned canal from Limmat to Glattal (Opfikon) through Furttal, 1920.

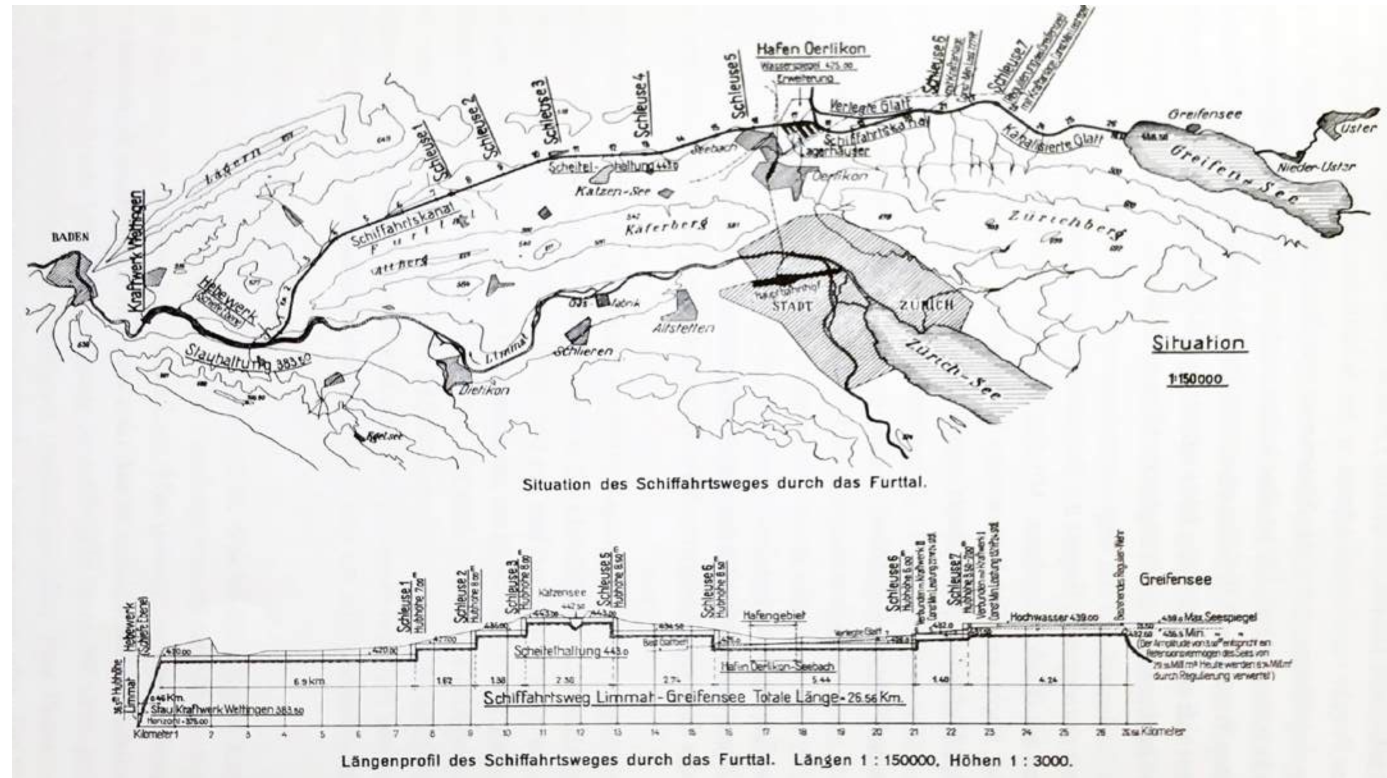
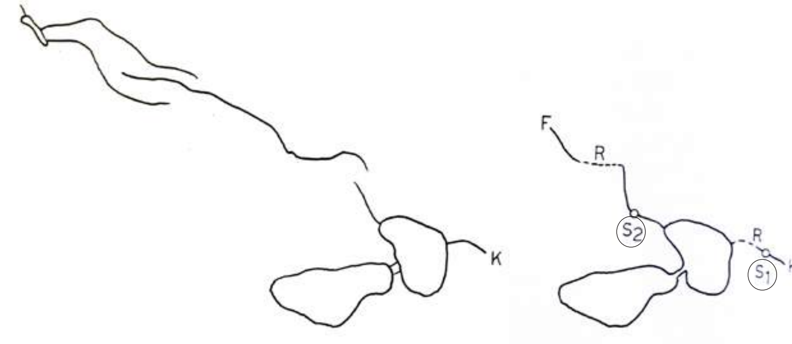


fig. 73 **Katzensee before the Furtbach correction**
Engraving of the Katzensee with still no outflow towards the Furt Valley.

fig. 74 **Furtbach springs from the Katzensee**
Drainage of the Katzensee. Situation before (left) and after (right) the draining.

fig. 75 **Unsuccessful draining of the Furttal**
The Furt Valley in 1904.



S1 Katzenbach valve in Seebach.
S2 Furtbach valve in Sebel.
R Pipelines.

1904

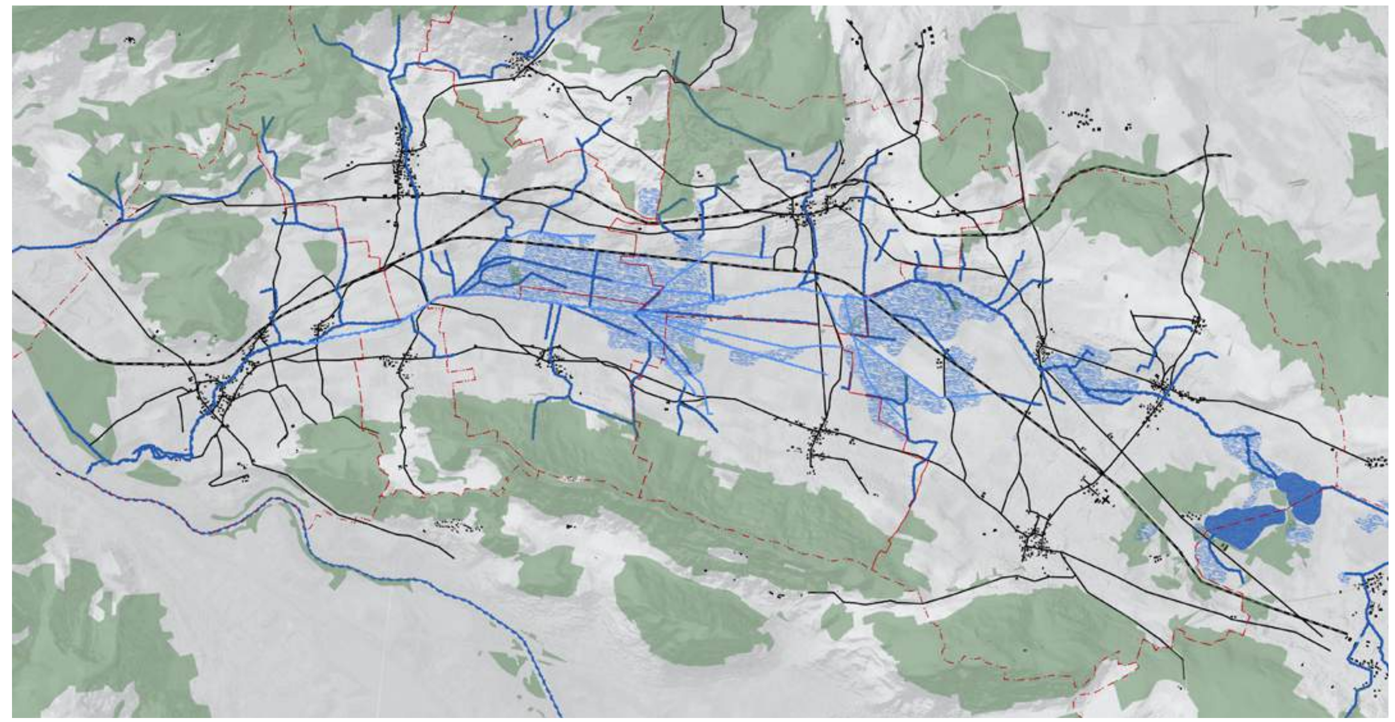
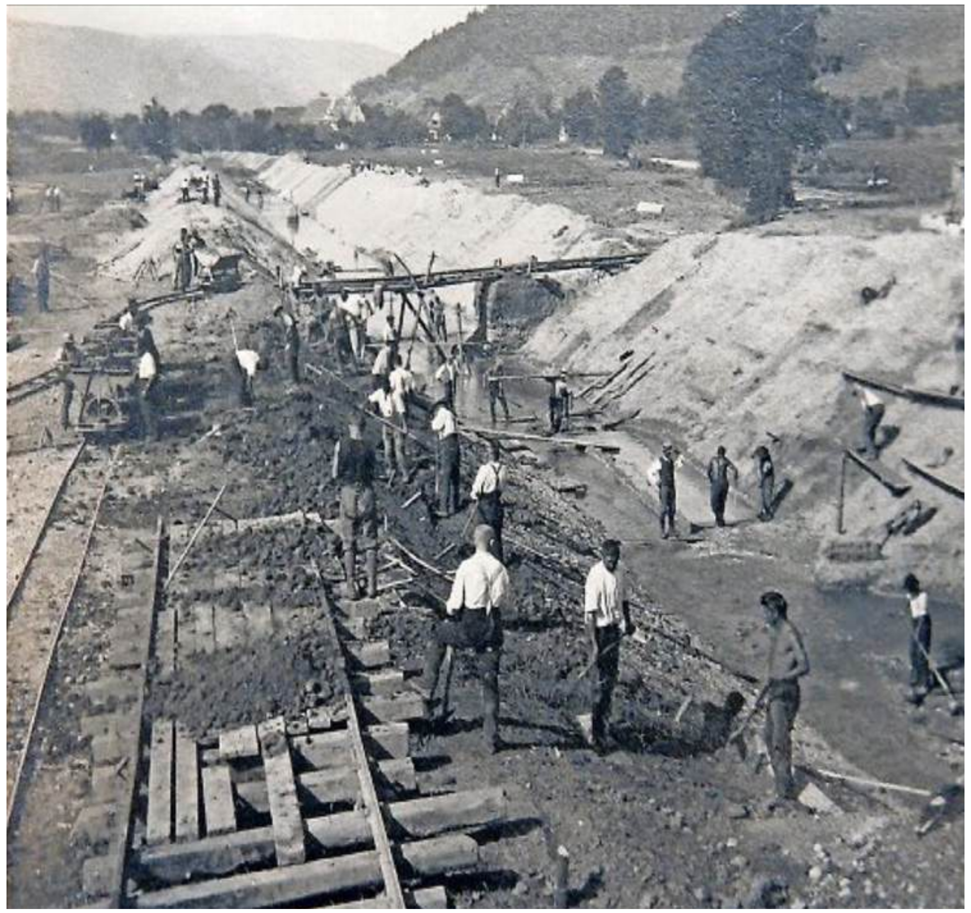


fig. 76 **Taming the waters with physical power**
Inhabitants drain the wetlands and lower the creek bed of the Furtbach, 100 years ago.



Second drainage attempt - Furttal between 1920-1955

The first World War evinced that Switzerland could supply itself. (Announcement of the Swiss Federal Council, 15.01.1918) Hereunder, the Swiss Alliance for Internal Colonization and Industrial Farming (today SVIL), strived to cultivate Furttal and construct settlements for agricultural purposes. The melioration of 1921 resulted in the ultimate canalised Furtbach under Canton Zurich maintenace obligation and supervision of the drainage committee. The Cantonal nutrition department decided for the penal institution in Regensdorf, the Swiss cooperative association for the production of vegetables (Kerzers) and the Association for the development of Furttal (industry investors who aimed to hand land over to private investors). The practical requirements for the urbanisation of the valley were laid.

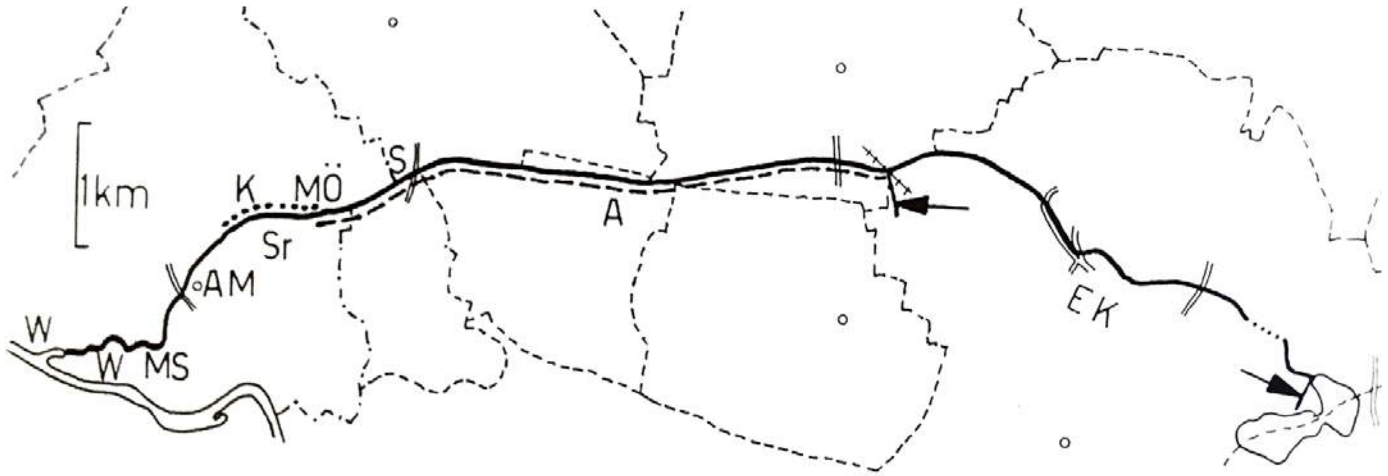
This time Furtbach was deepened by 2.6m. New open ditches were laid and old stream courses were leveled out. When before the War the crop yield was hardly reaching Fr. 80.-/ha per year, after the melioration a crop yield of at least Fr. 1'000,-/ha was achieved. To achieve this, as the soil improvement needed more time, great quantities of chemical pesticides had to be applied.

Apart from the practical measures, the Swiss Alliance for Internal Colonization and Industrial Farming (SVIL) undertook the colonisation of the meliorised surfaces.The original plan projected 18 yards, each of 5-10 ha and a common young cattle field. The project had the character of an ideal project, which should exemplify how Furttal should be built, but was not realised. The only settlement group that was built, consisted of 4 yards, Brüederhof and Erlenhof in Dällikon, Wiesenhof and Furthof in Buchs. The resulting image of the landscape reminded of the admirable typical isolated farmstead landscape found throughout the Canton of Bern or Lucerne. The design of several garden cities next to each other would have resulted into a more lively landscape image, but by respecting the traditional architecture, the idyllic character of Furttal would be sustained and enhanced. The settlements had their own water supply. A groundwater supply was examined but failed due to the high cost of groundwater capture, the necessary pipeline and the reservoir. However, the water supply design took into account the needs of future settlements as well.

Another measure of the melioration of 1918 was the placement of tree alleys as windscreens across the valley, as the example of Linth had already evinced their best result.

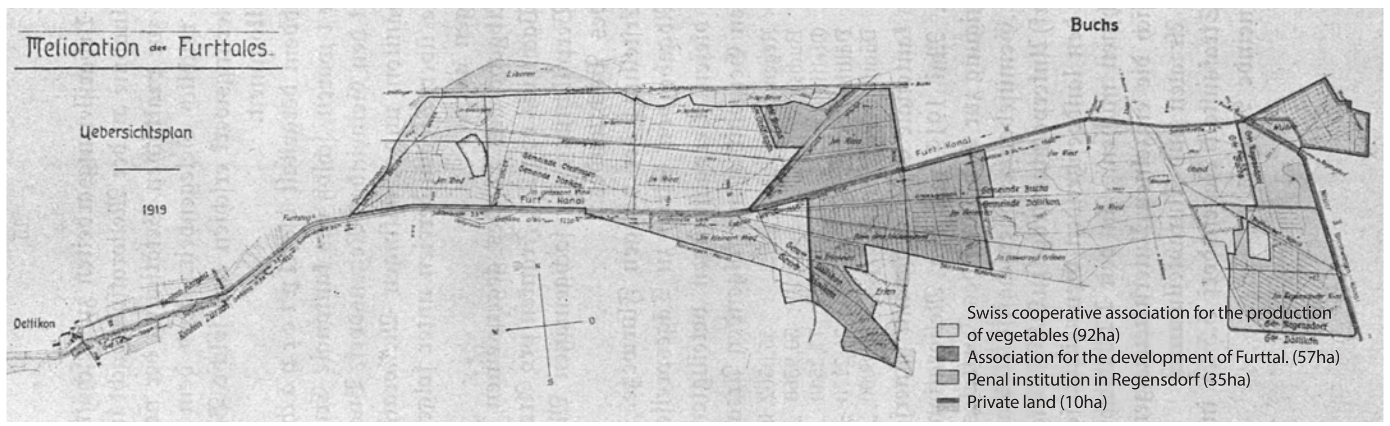
fig. 77 **Melioration plan 1918-23**
fig. 78 **Owners of the meliorated territory**
Overview map, 1919.

fig. 79 **An engraved landscape**
Field in Brüederhof, Dällikon after the completion of the drainage works.



Measures of the melioration 1918-23.

A. Subsidence by the Canton of Zurich.
S. Removal of the Floodgate.
MÖ. Shutdown of the Oetlikon Mill.
EK. Jurisdiction of the Drainage Committee 1923-1997.
K. Stream correction by the Canton of Aargau.



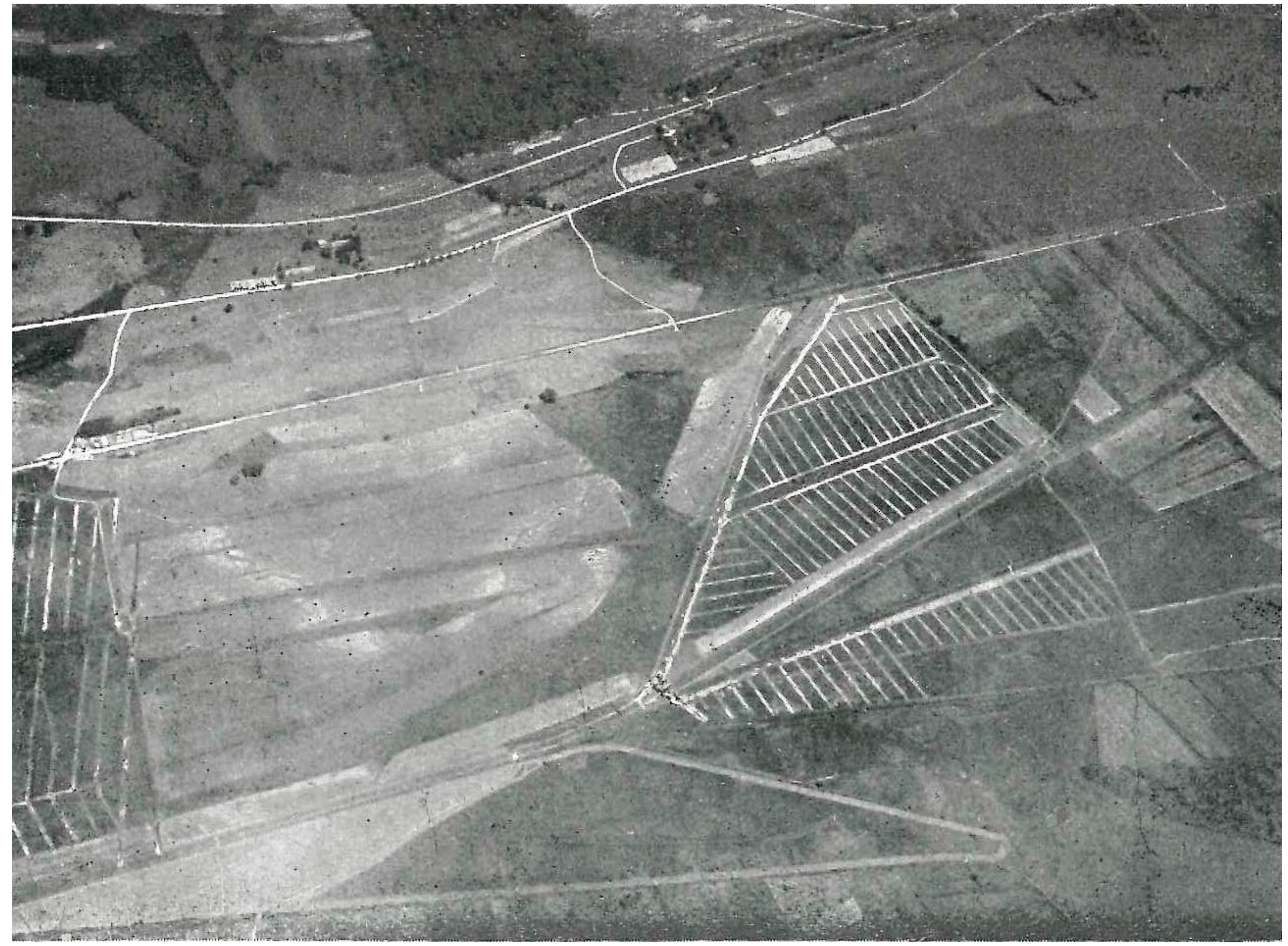


fig. 80 **Rural colonisation of the drained Furt Valley**
First project for 18 farmsteads on the gained meliorated landscape. 2 or 3 farmsteads are grouped together at the crossroads. In this way, the cost of the project would be lower and the solitude of each complex would be avoided.

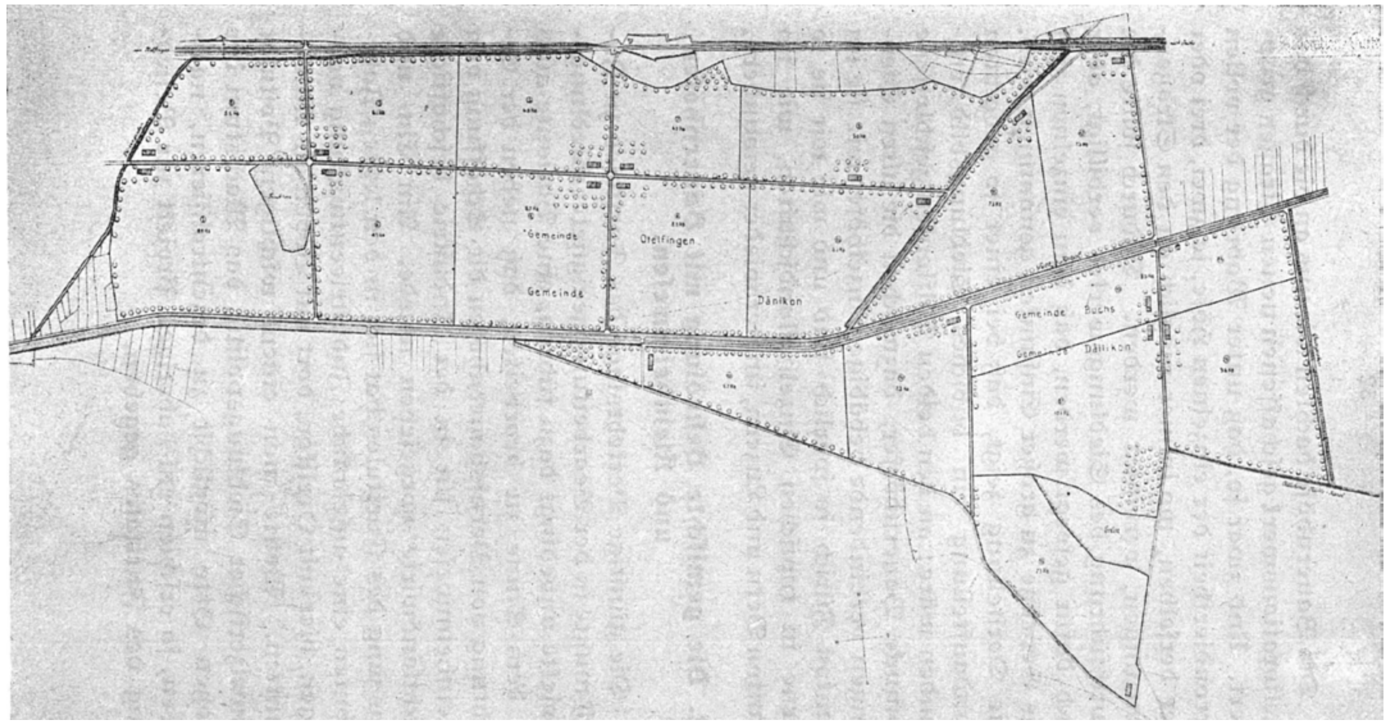
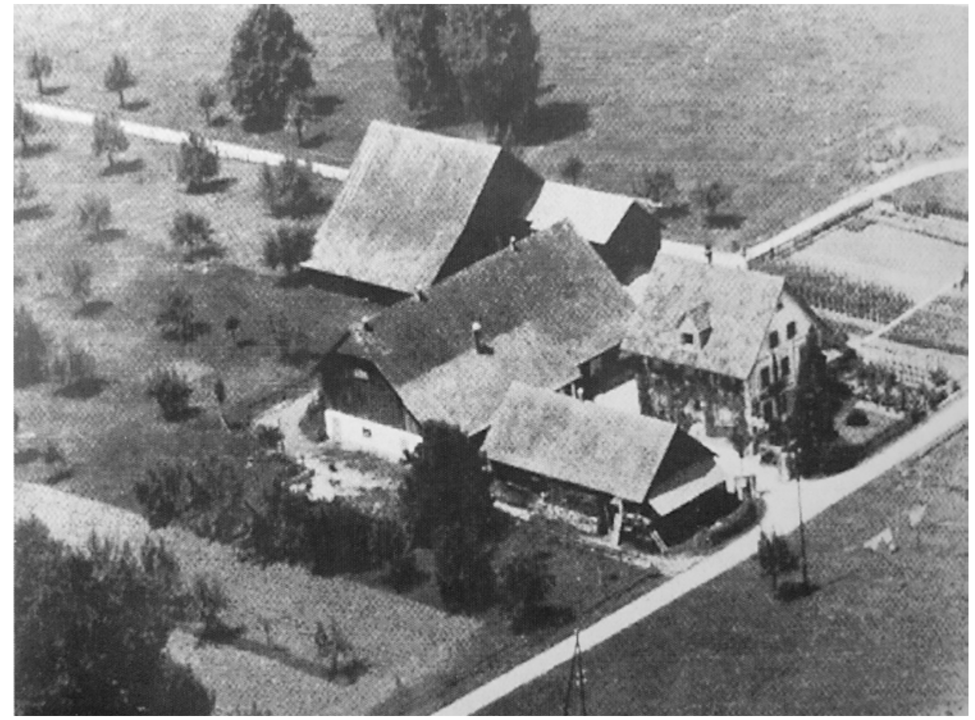


fig. 81 **New building types on the drained Furttal**
The Brüederhof in Dällikon is one of the four farmsteads built during the 1920s.

fig. 82 **Site plan of a typical new building**
Plan of the Brüederhof farmstead. The house had a complete underground level where except from the storage room for potatoes and vegetables, a fully modern equipped laundry room was also included.



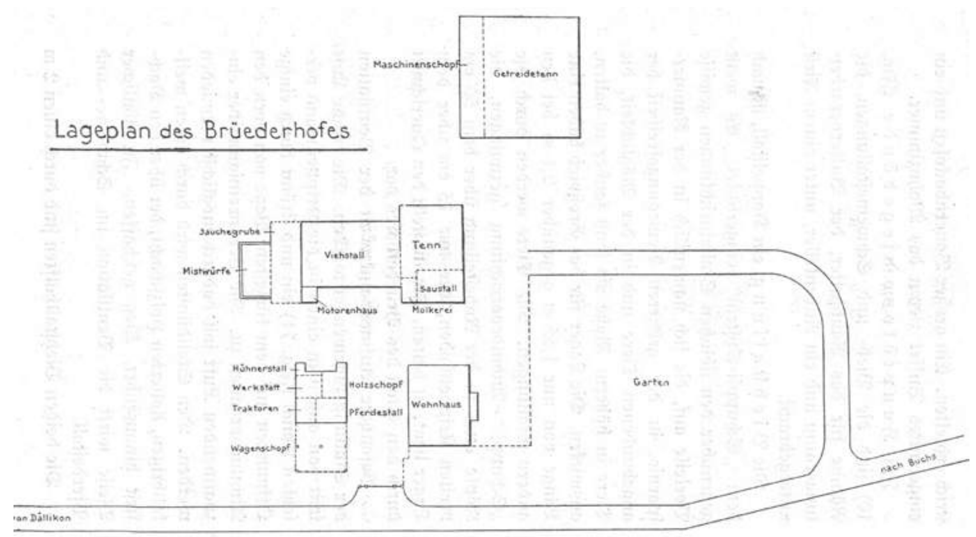


fig. 83 **A drained landscape**
Furttal, 1932

fig. 84 **An opportunity for industrial agriculture**
Corn harvest in the drained Furt Valley, 1950s.

fig. 85 **A machine for agricultural production**
Mechanical installation for the distribution of manure on a drained field of the Furtbach plain.

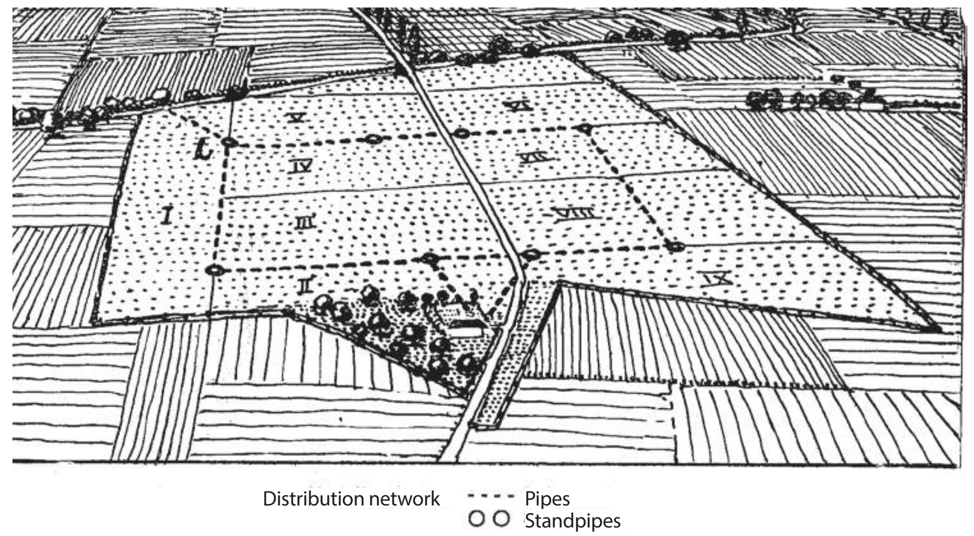
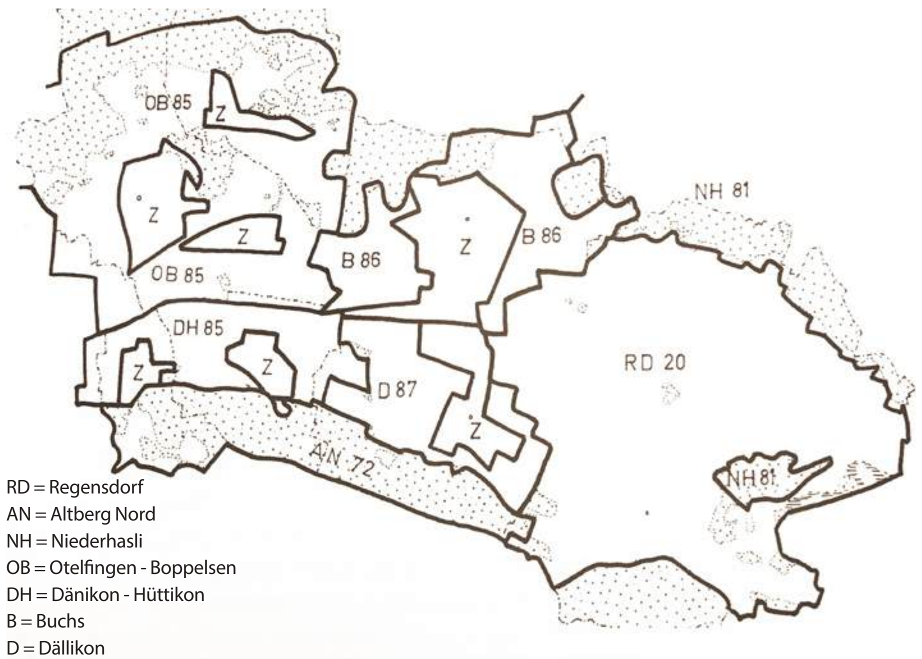


fig. 86 **Amalgamation of the fragmented Furttal**
After 1982, the amalgamation of the territory aimed at a better cultivation and exploitation of the gained landscape. The building zones indicated with Z on the map correspond to the present-day built fabric of the Furt Valley.

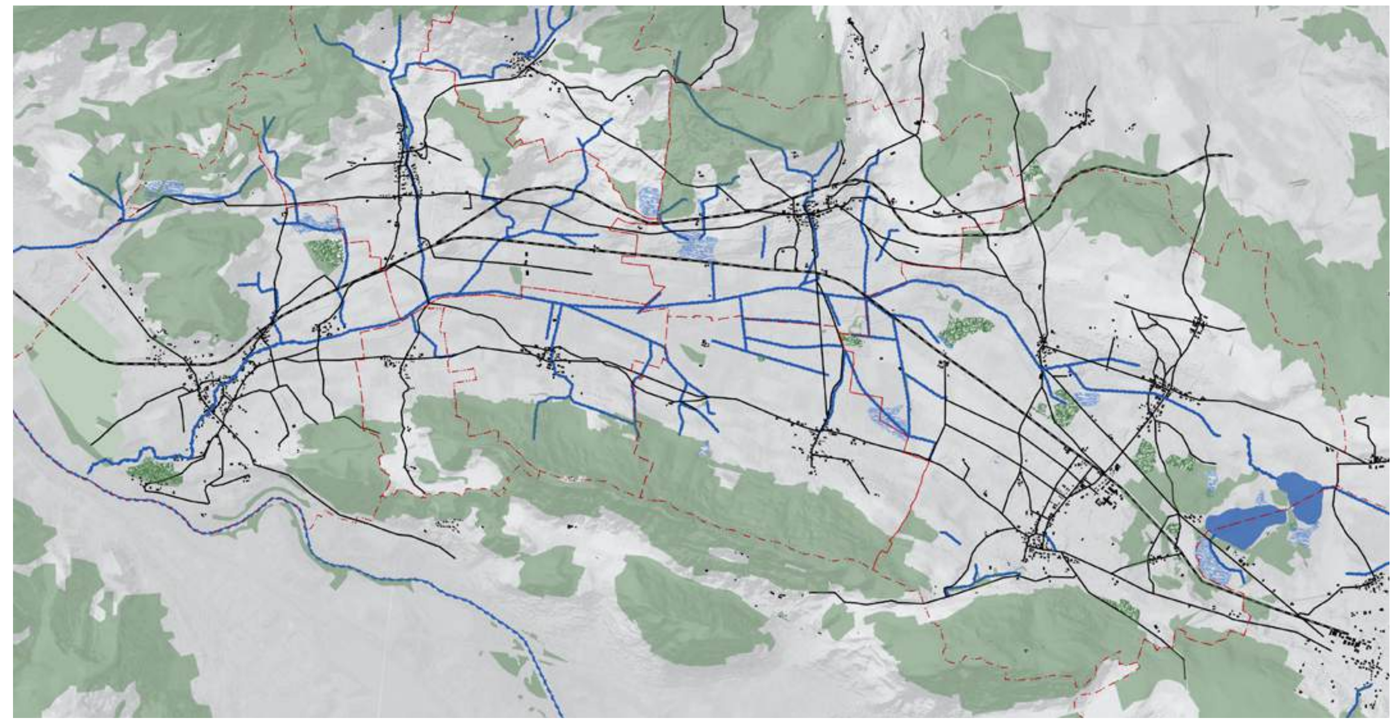
fig. 87 **Tree allees as a windscreen**
Trees were used as a way to protect the cultivated Furttal fields from the wind. Example of the Breitwiesenkanal which is still existing well-maintained. Aerial photo, 2019.



RD = Regensdorf
AN = Altberg Nord
NH = Niederhasli
OB = Otelfingen - Boppelsen
DH = Dänikon - Hüttikon
B = Buchs
D = Dällikon
Z = Building zone

fig. 88 **The tamed Furtbach**
Furt Valley, 1954

1954



Furttal in the modernist vision - New measures in the 1960s

Like every valley or village stream, so the Furtbach too was from the year one used for the intake of the domastic wastewater. The bigger the water flow, the more wastewater it can absorb. Thus, the difficulty with the low flow of water in the corrected Furtbach. With the expansion of the villages and the industrialisation respectively all the more wastewater was driven directly into the Furt Stream. Therefore, in 1949, it was decided that a settlement development would only be realized in parallel with a central wastewater treatment facility. In 1951/52 the municipality of Regensdorf constructed the respective facility Hardhölzli. In order to protect the water flow in the Furtbach, a biological purification was preferred from the beginning. However, the boom of the 80s brought the facility to it's operating limits. A new wastewater treatment facility, the WWTP Wüeri, started operating in 1995. In the meantime, two additional wastewater treatment facilities were constructed - in Otelfingen, in 1965, serving the municipalities of Boppelsen Dänikon, Hüttikon and Otelfingen, and in Furthof. in 1977, serving the municipalities of Buchs and Dällikon. The latter is today working to capacity and calls for renovation.

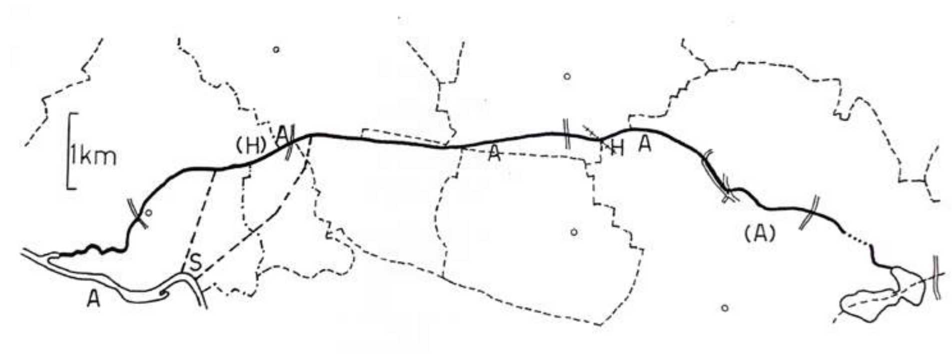
In parallel, in 1966, the Canton of Zurich put forward the construction of a connecting tunnel, which would divert the peak flows of the Furtbach to the River Limmat, until 1971. Due to high cost the project was never realised.

The consistent flooding problem was overcame with the construction of two detention basins, in Wüeri/Regensdorf and in the Müliwiesen - near the WWTP Otelfingen, in 1980. During the same time, the Canton of Zurich approved the deepening of the Furt stream for the third time, with the parallel mitigation of the canal-effect of the water stream. With the planting of vegetation, the optical re-integration of Furtbach in the landscape was strived.

The golf facility in Otelfingen with the respectively shaped water stream was seen as part of this "back to nature" in the broadest sense movement of the time.

fig. 89 **New measures for the untamed Furtbach**
Project of a connecting tunnel with the Limmat River for the discharge of excess water during the peak flows of Furtbach, 1966.

fig. 90 **A detention basin for the Furtbach waters**
The final solution for the control of the high waters of Furtbach in Wüeri, Regensdorf.

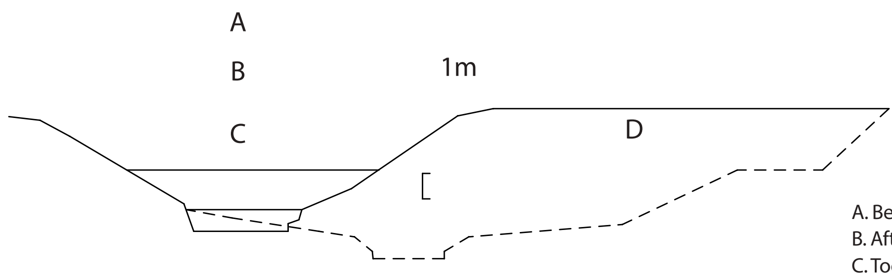


S projected tunnel to the Limmat Valley
A wastewater treatment facilities (A): old wastewater treatment plant Hardhölzli/Regensdorf
H flood retention basin (H): planned

fig. 91 **The Furtbach vision of 1962**
Cross-section of the bridge in Otelfingen.

Project "Neue Stadt Otelfingen", 1960

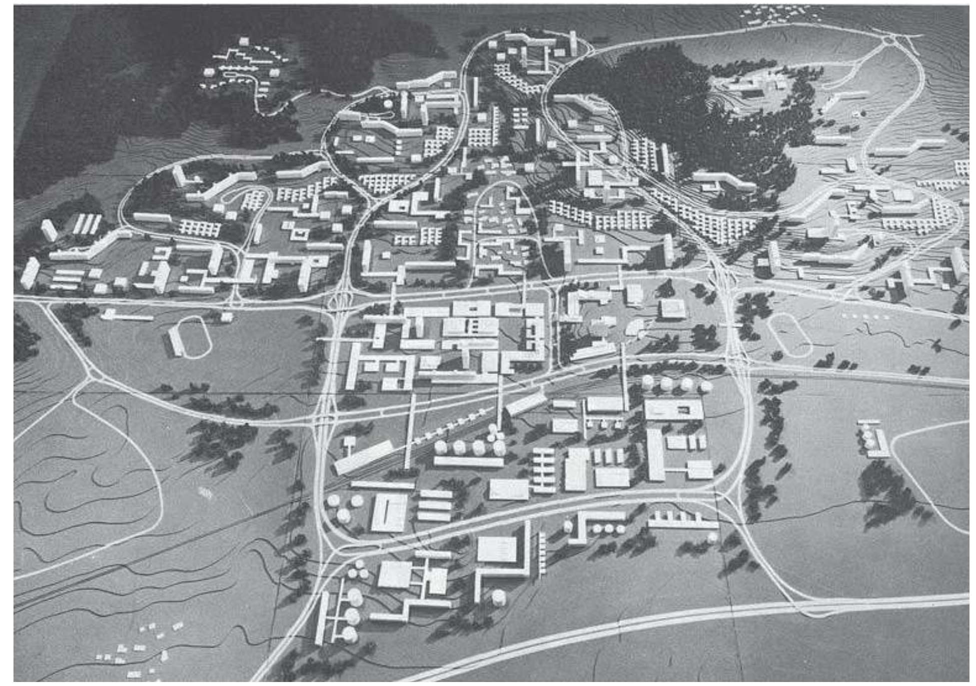
The increasing population and industrialisation of the valley led to the increasing sealing of the ground, prompting more extreme flooding events, with the most remarkable the flood of 21/22 September 1968. Therefore, two possible projects-solutions were studied. The first, in 1962, projected another deepening of 1-2m of Furtbach. However, this meant high land acquisition costs and radical change of the landscape. The inhabitants reacted against it. The second, in 1972, visioned the discharge of excess water with a pipeline through Altberg in the River Limmat. Although, this concept was approved as feasible, it failed due to its high cost.



A. Before the drainage
B. After the melioration of 1923
C. Today
D. Project of 1962

Furttal raisesd at that time again the vision of urban planners. Max Frisch, the sociologist Lucius Burckhardt and the historian Markus Kutter projected the construction of a new city in the Modern Era as a sign of the future oriented perspective of Switzerland and as an example of democratic planning. Inspired by this idea, Ernst Egli, professor of urban design at the ETH Zurich, together with Hans Aregger, decided for Furttal as the most suitable location. A city for 30'000 inhabitants, where social and economic processes of the time were expressed in surface needs and had gained the appropriate form. The old village core of Otelfingen was maintained and received a new function. It was envisaged for housing and ateliers for arists and craftsmen, cultural buildings, schools and asylums. However, the project was intensively discussed and criticised, even by its authors, as too constructed and not tailorable and was never realised. It was nevertheless an early manifestation of the upcoming development pressure on Furttal.

fig. 92 **A new scale arrives in Otelfingen**
Model of the never realised new city, 1963.
fig. 93 **Stand-alone high-rises in Otelfingen**
View of the projected district center, 1963.



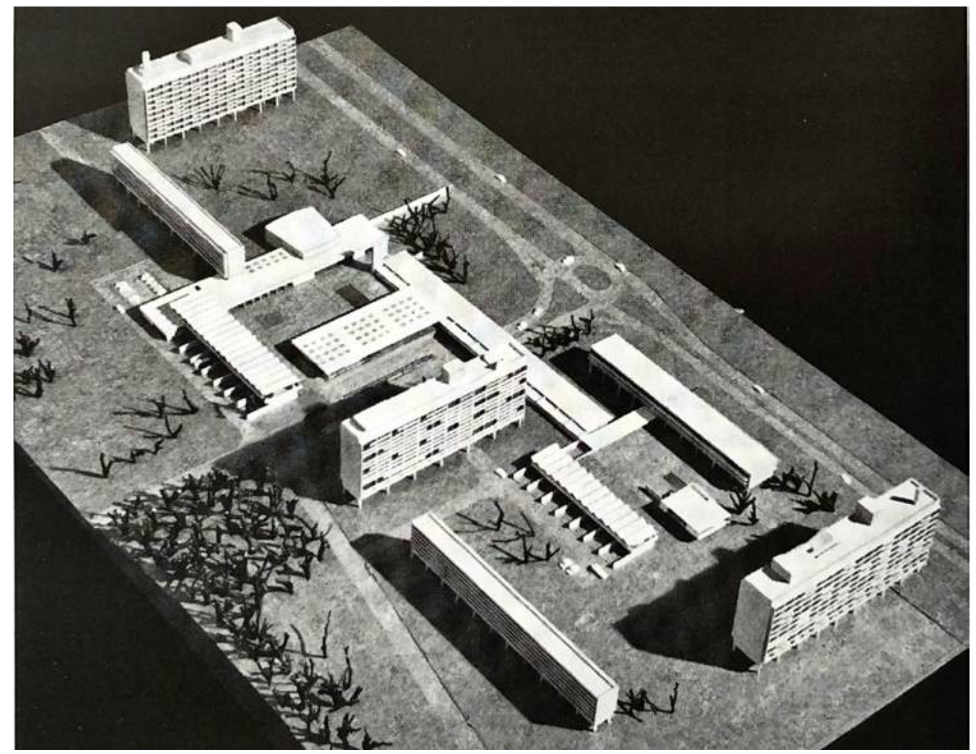


fig. 94 **Sealing the gained Furt Valley**
The extensive Jelmoli warehouse in Otelfingen was built in 1964. Sketch by Roland Rohn, 1963.

fig. 95 **New residential scale in Regensdorf**
The first of the more than 600 apartments of the housing estate Sonnhalde in Regensdorf were habitable in 1971.

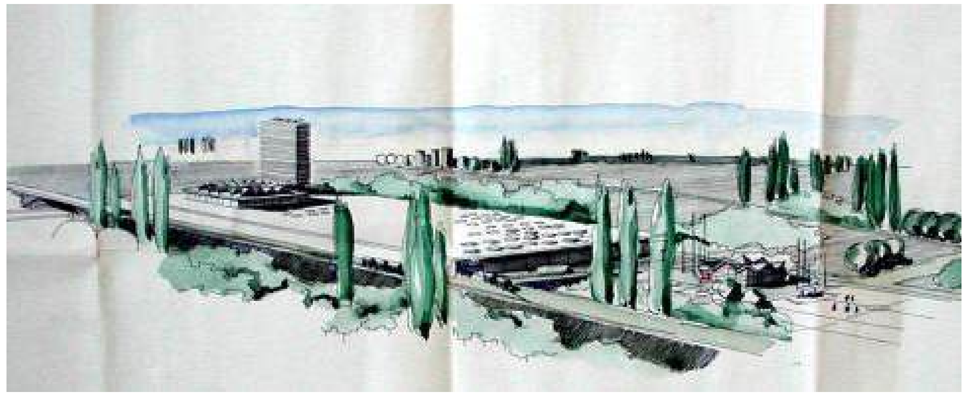
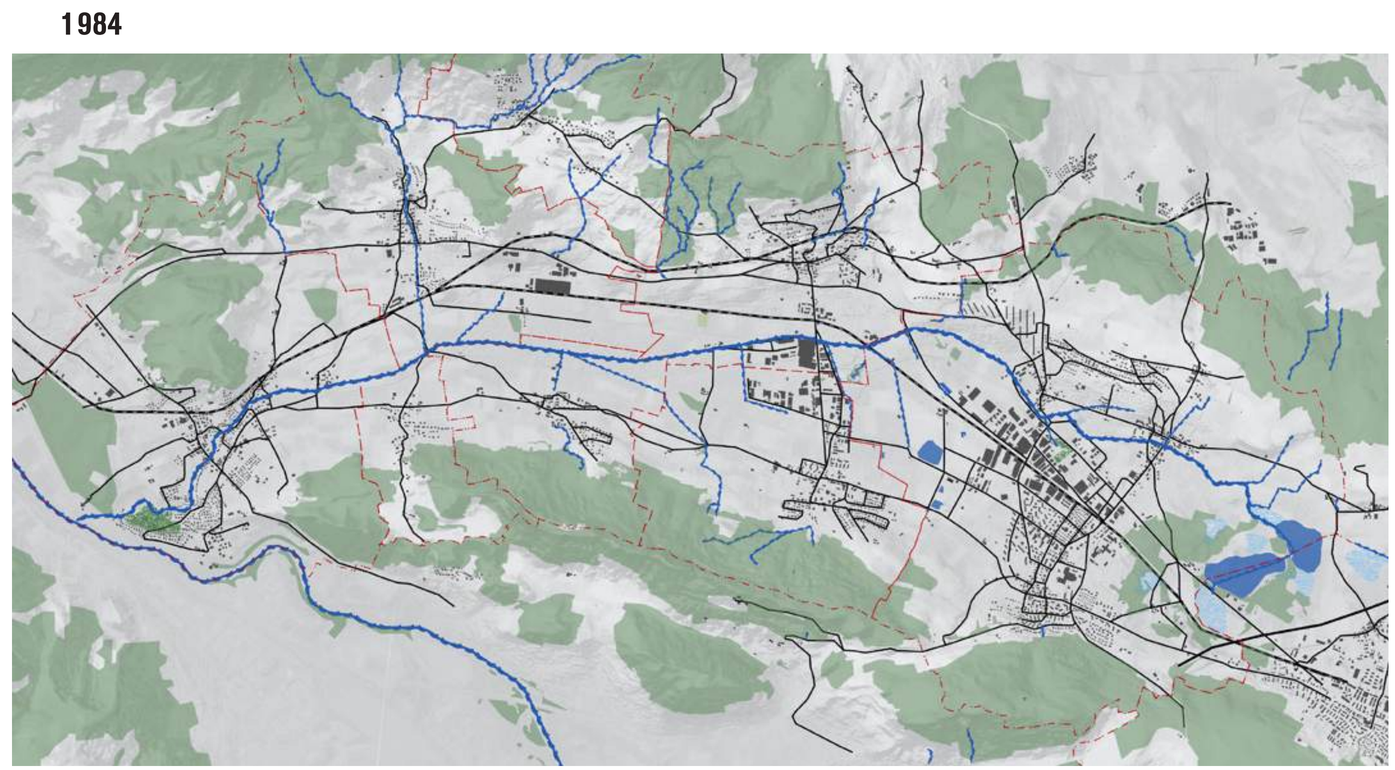


fig. 96 **A delayed building boom**
Furttal, 1984



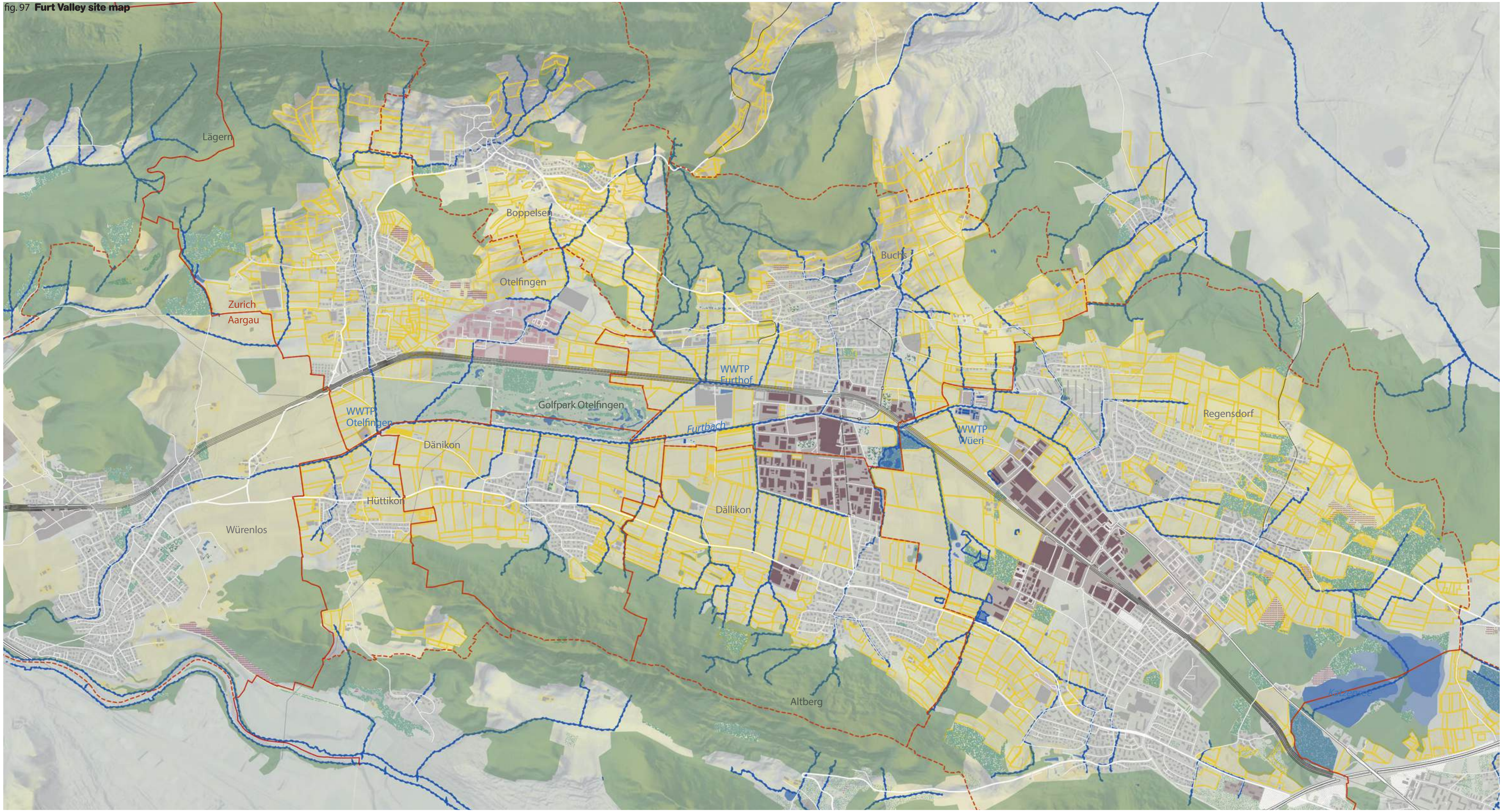
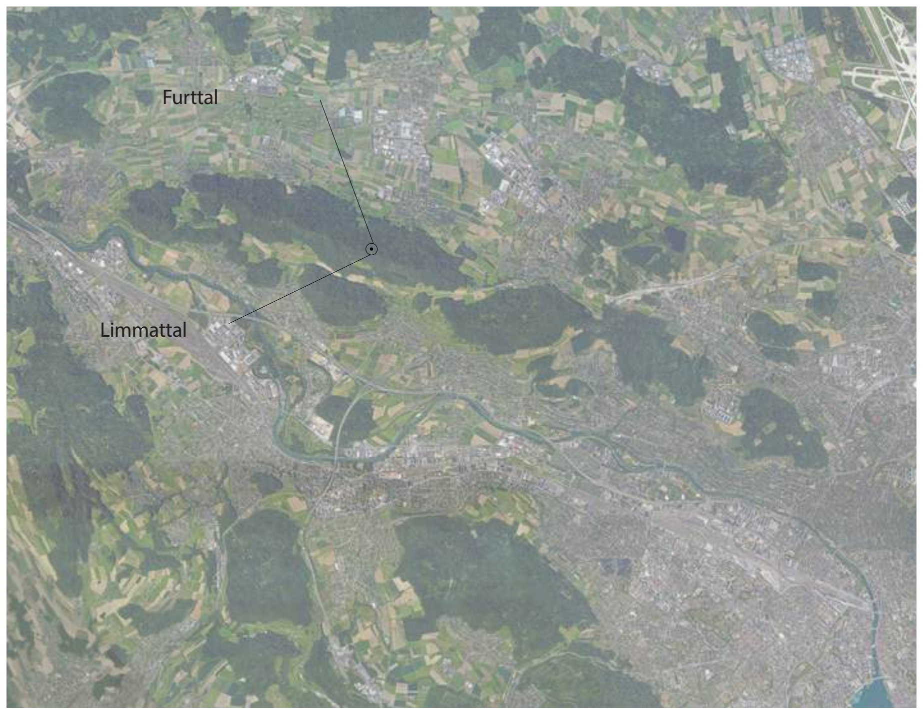


fig. 97 **Furt Valley site map**

fig. 98 **Overbuilt versus unbuilt landscapes**
The built-up Limmat- (left) and the more loosely built Furt Valley (right) as seen from the observation tower Altberg.

fig. 99 **Crossing the Furt Valley**
Panoramic view of the municipality of Buchs from the Altberg.

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Gruppenwasserversorgung Furttal - Transregional water supply networks

Once organized in Wassergenossenschaften - smaller groups of people organising the water supply of their municipalities - the current drinking water supply of the Furt Valley crosses the regional borders. High quality drinking water is extracted all year long from the deeper aquifer - almost 40m underground in two pumping stations in Regensdorf. However, the Furt Valley cannot at the moment fully satisfy the water demand of the valley with its own water resources - due to the heavy pollution of the upper aquifer and the limited capacity of the deeper groundwater level - and therefore it is connected to the more extensive network of the group water supply. The municipalities of the Furt Valley purchase water from the group water supply Furttal, which in its turn is one of the four group water supplies affiliated to the even greater network of the bigger group water supply "Vororte und Glattal". Drinking water treated in Zurich or in Winterthur, travels through the regional underground pipeline network to the Furt Valley, where it is distributed to the affiliated municipalities via the local water supply network. The needs of the Furt Valley for external purchased water differ according to the seasons. During dry periods, in order to avoid the risk of depletion of the deeper and slower recharging aquifer, the amount of water purchased from the group water supply increases. With the changing climate and all the more drier seasons, the dependency of the Furt Valley on the group water supply remains high over the last years.

fig. 100 **Emblems for the groundwater supply**
\Emblems of the municipalities participating in the groundwater supply of the Furttal. Facade of the groundwater pumping station in Regensdorf.

fig. 101 **Group water supply "Vororte und Glattal"**
The group water supply Furttal is one of the four sub-groups connected to the bigger group water supply "Vororte und Glattal" (GVG).

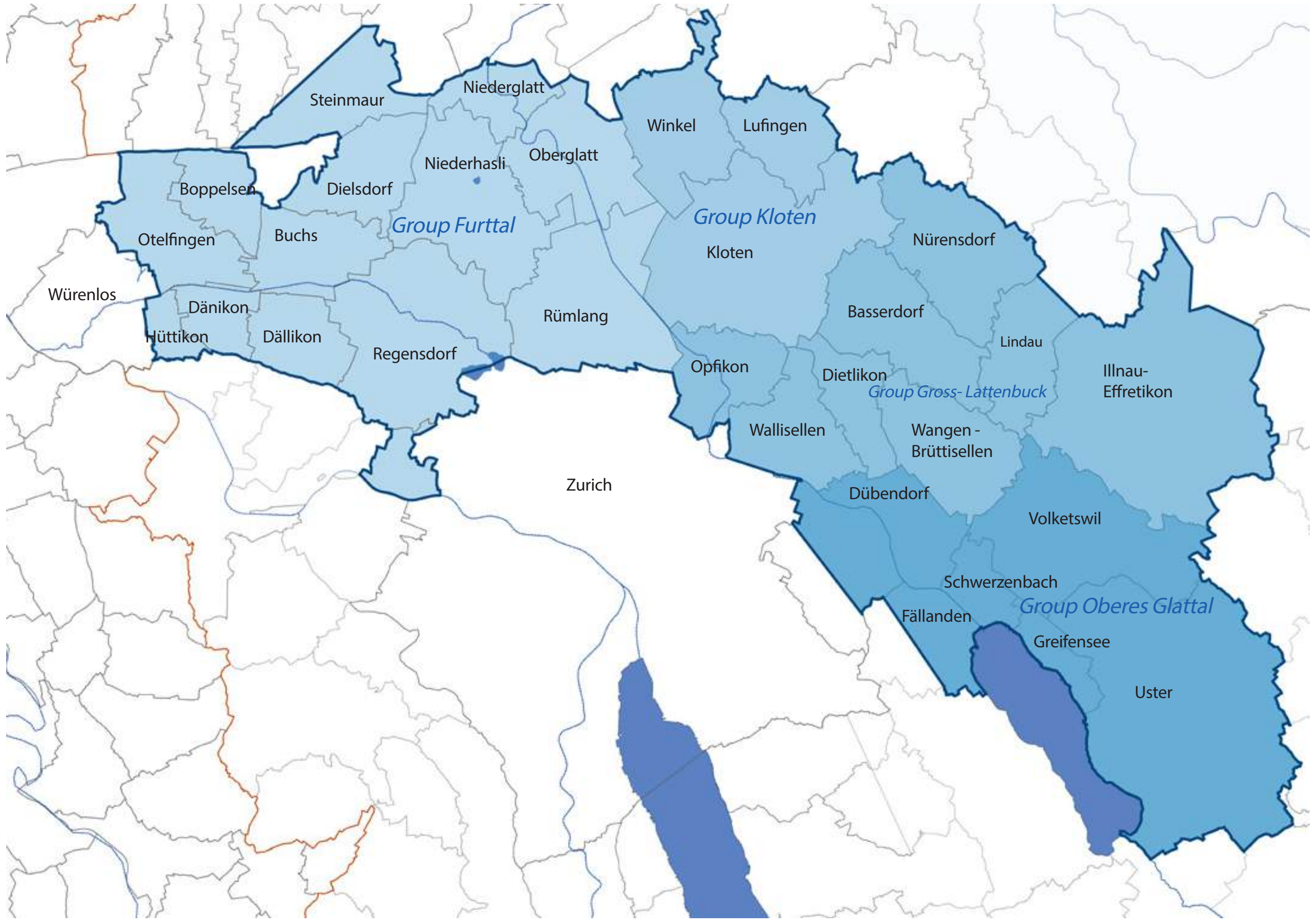


fig. 102 **Regional water freeways**
The water supply network of the Furttal.

pipelines of the group water supply
communal pipelines
communal main pipelines
water discharge shaft
groundwater pumping station
reservoir
pumping station
reservoir with pumping station
spring source pumping station

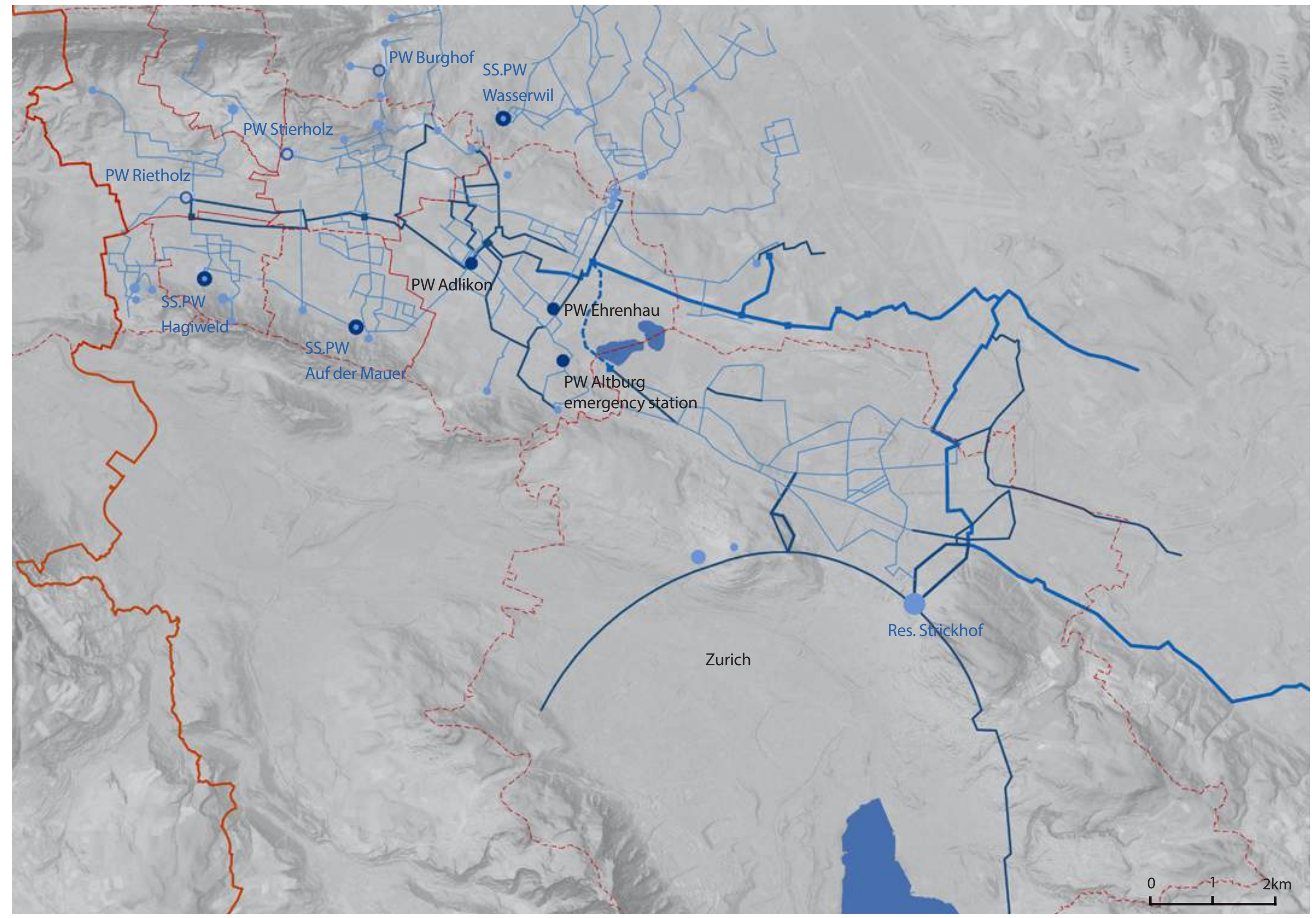


fig. 103 **"Wasserrichtplan" Regensdorf**
General water supply plan of the municipality of Regensdorf.

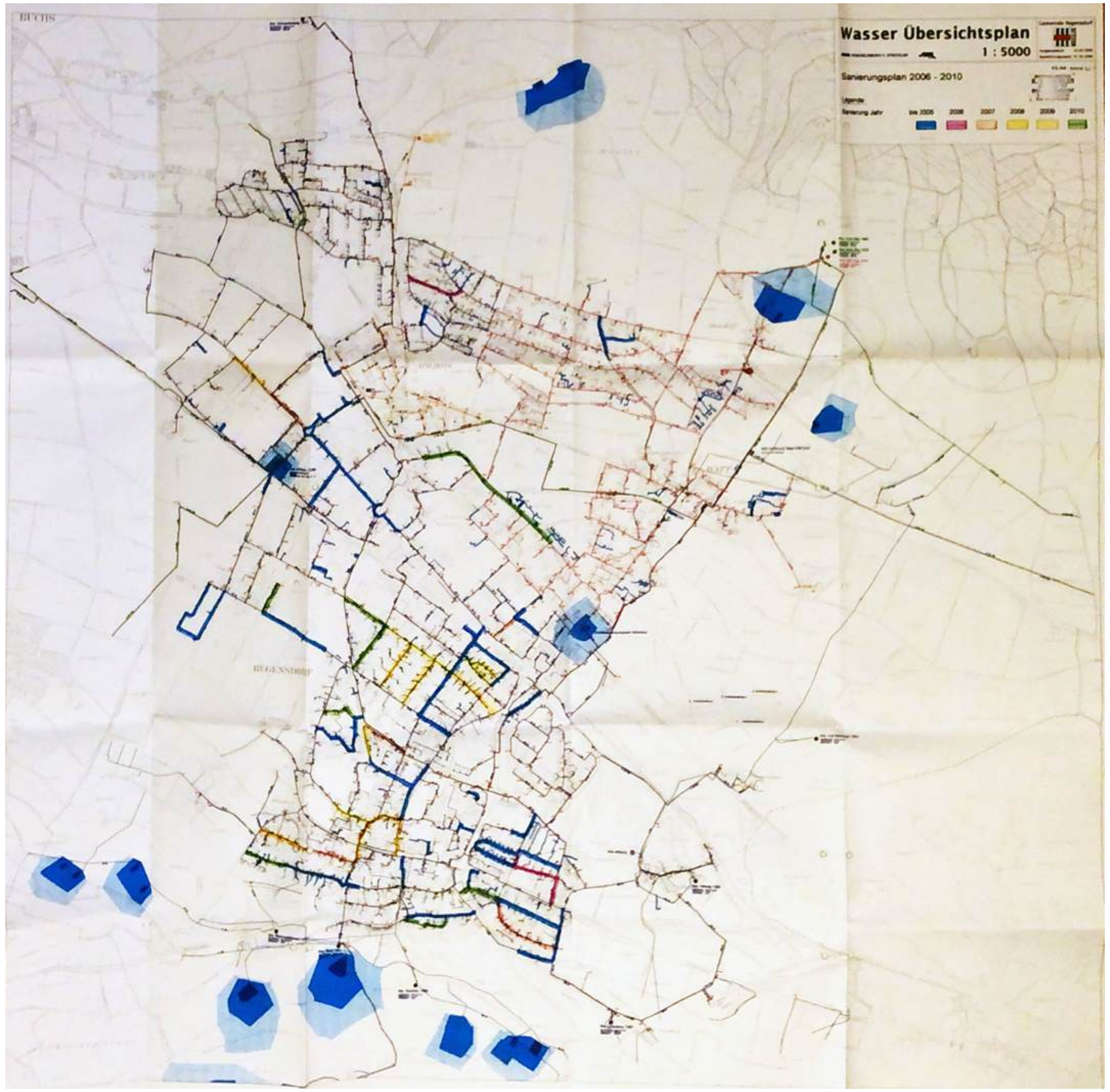


fig. 104 **Invisible water infrastructure**
The (deeper) groundwater pumping station Ehrenhau, Regensdorf.

fig. 105 **Drinking water from a depth of 35m**
Groundwater pumping well in the groundwater pumping station Ehrenhau, Regensdorf.

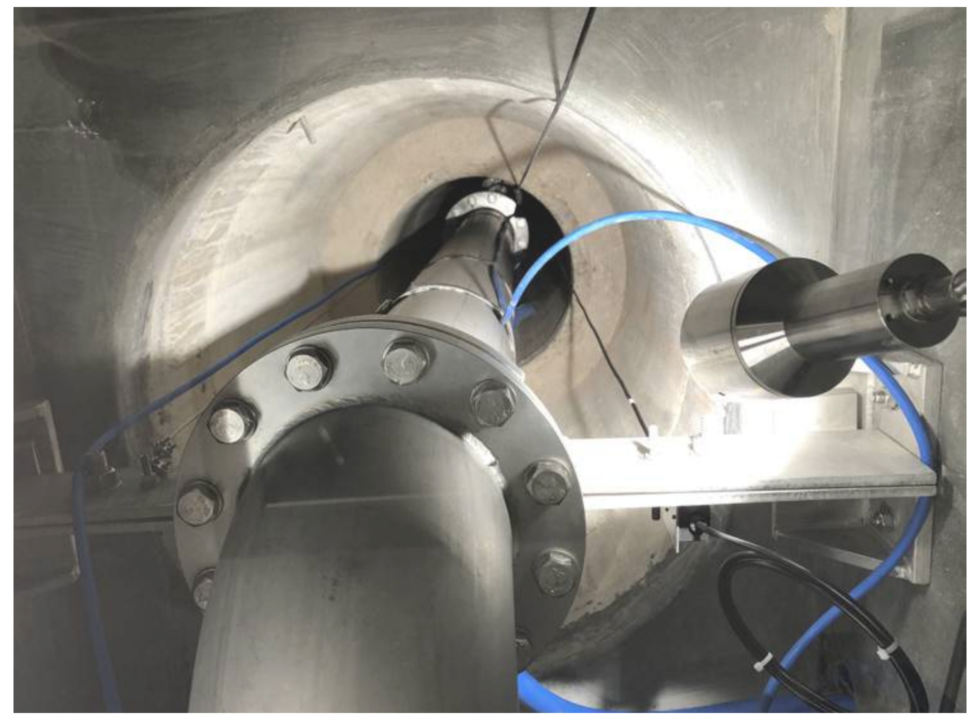


fig. 106 **Daily mixed drinking water resources**
Origin of a day's drinking water for the municipality of Regensdorf.

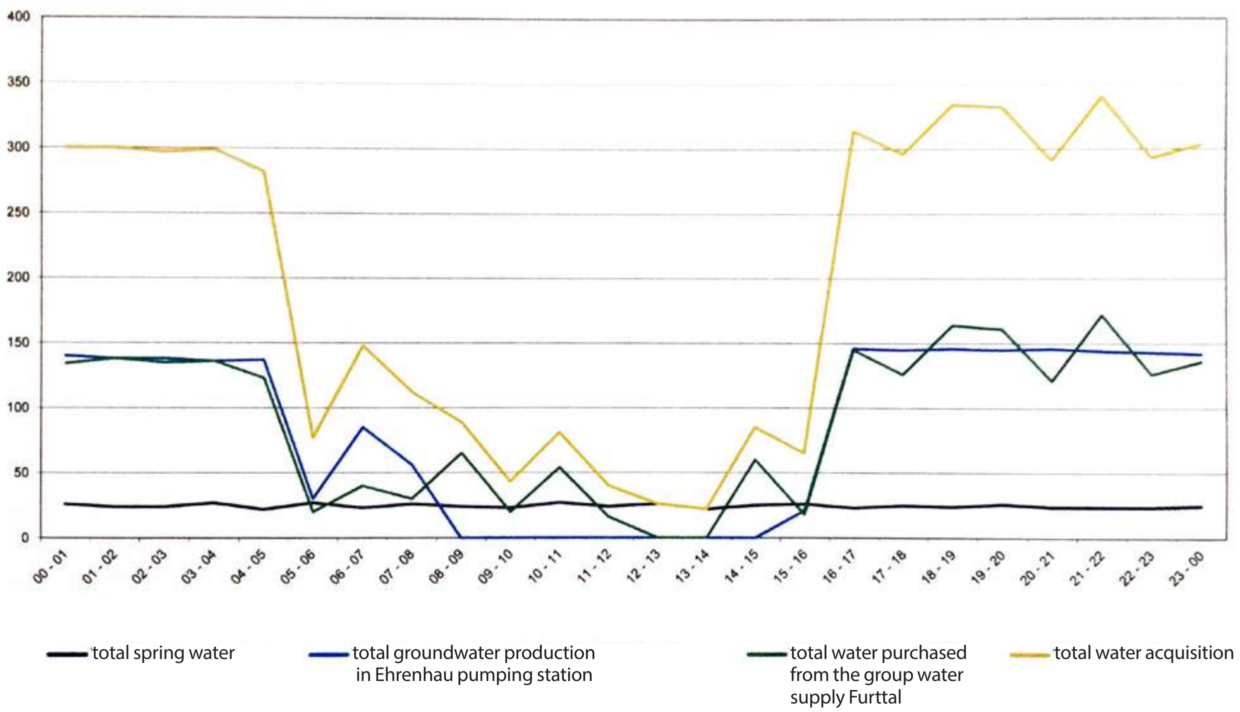


fig. 107 **Drinking water from 40m undergound**
The groundwater pumping well in the groundwater pumping station Ehrenhau, Regensdorf.

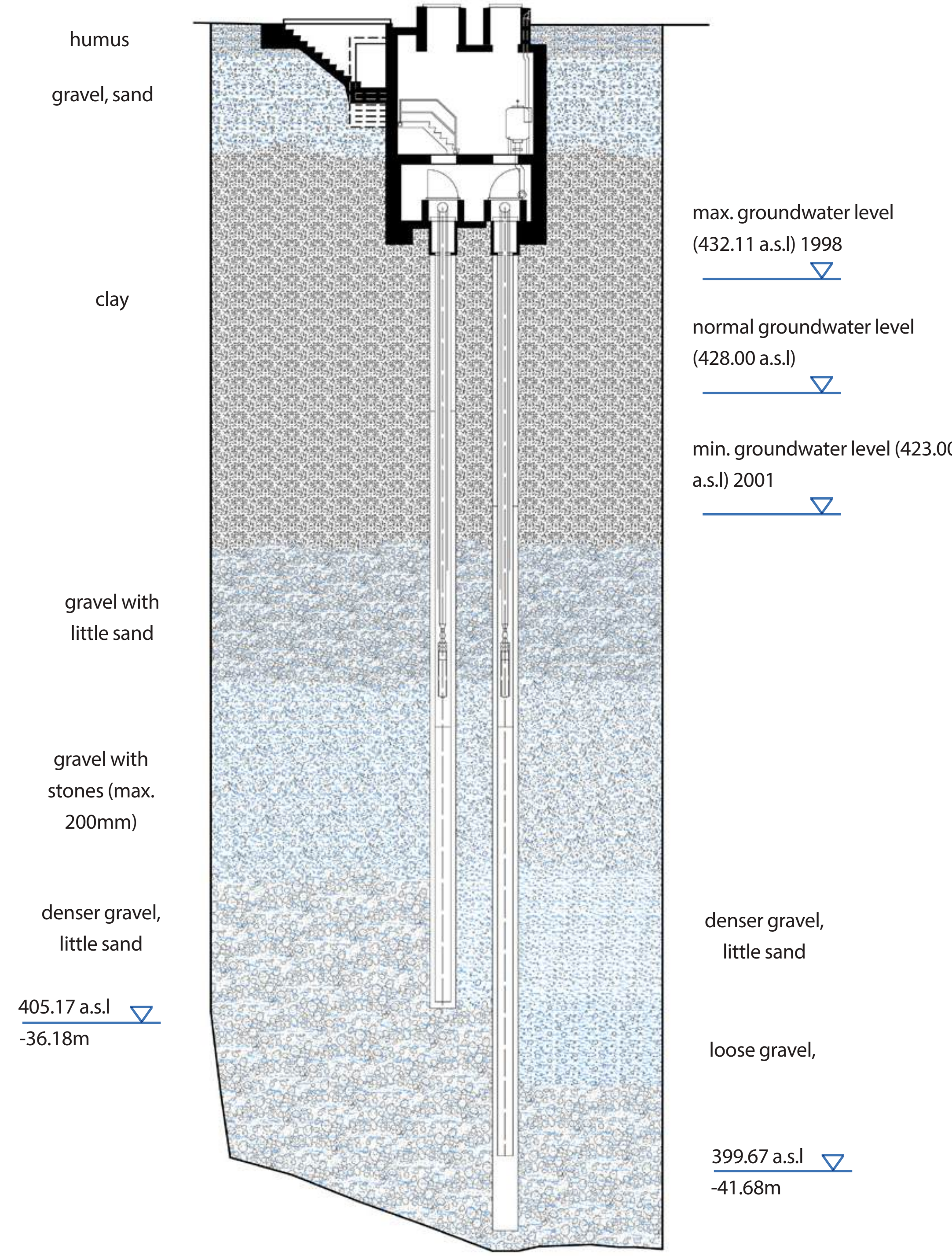
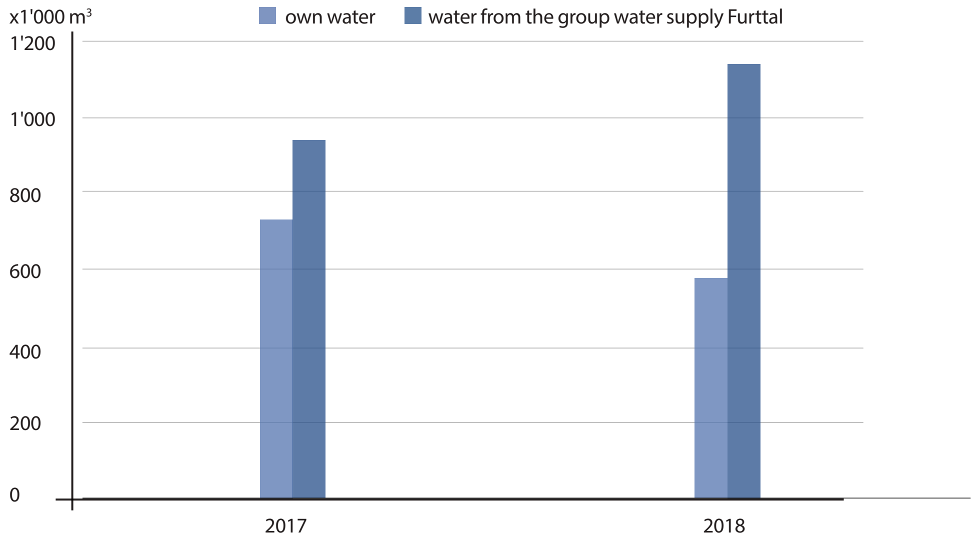
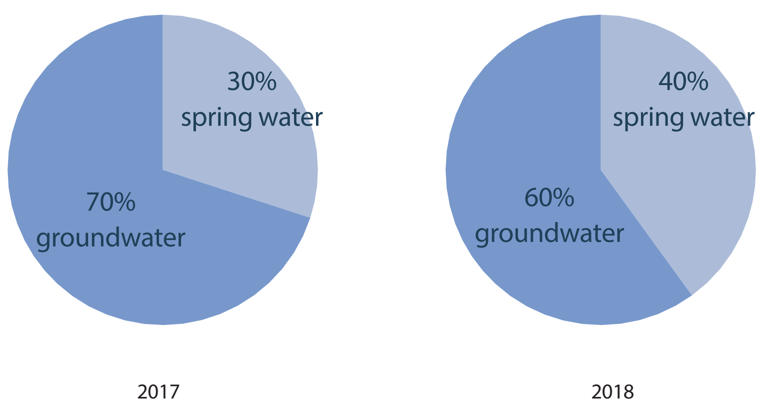


fig. 108 **Local need for more purchased water**
Increasing dependency on the group water supply Furttal during the dry summer of 2018. Comparison of the amount of water purchased by the municipality of Regensdorf in the years 2017 and 2018.

fig. 109 **Decreasing groundwater extractions**
Origin of drinking water for the municipality of Regensdorf during the dry summer of 2018. Comparison for the years 2017 and 2018.

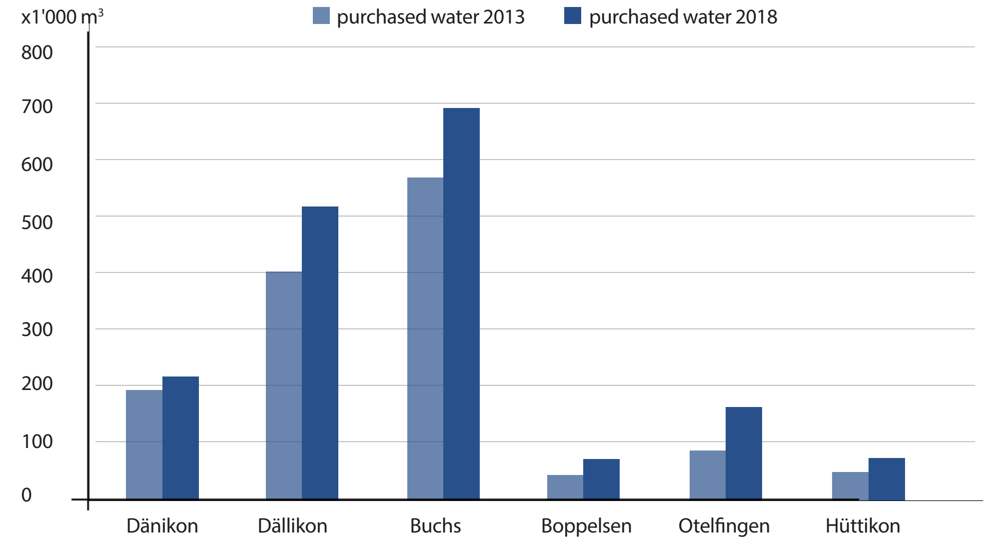


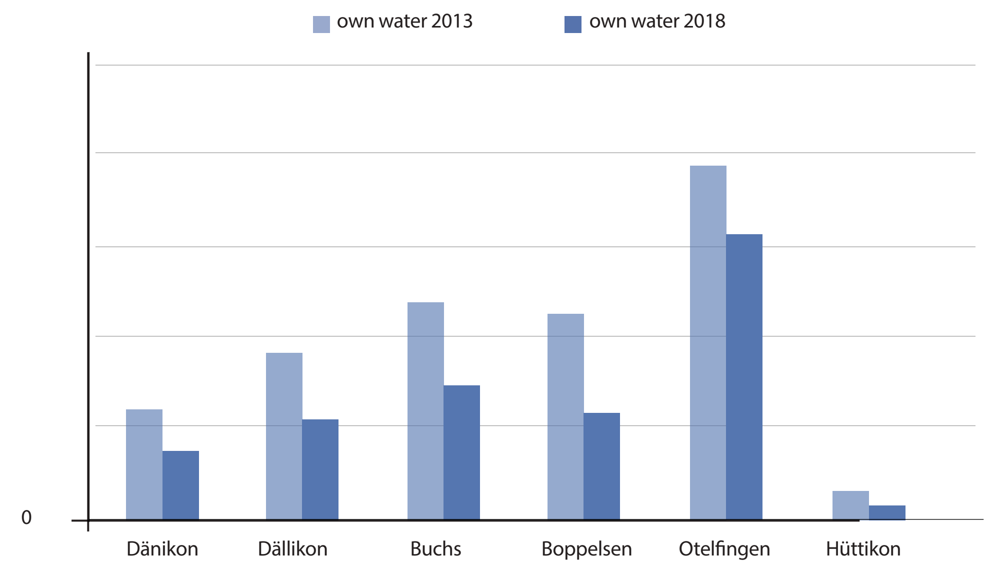


The municipalities of the Furt Valley become all the more dependent on the group water supply as a result of the more frequent dry periods.

fig. 110 **General dependency on purchased water**
Comparison of the quantity of water purchased from the group water supply Furttal by the affiliated municipalities in the years 2013 and 2018.

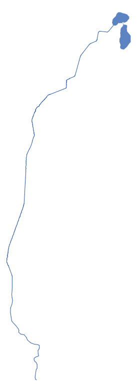
fig. 111 **Decreasing self-sufficiency**
Amount of own water in the water supply of the respective municipalities of the Furt Valley in the years 2013 and 2018.





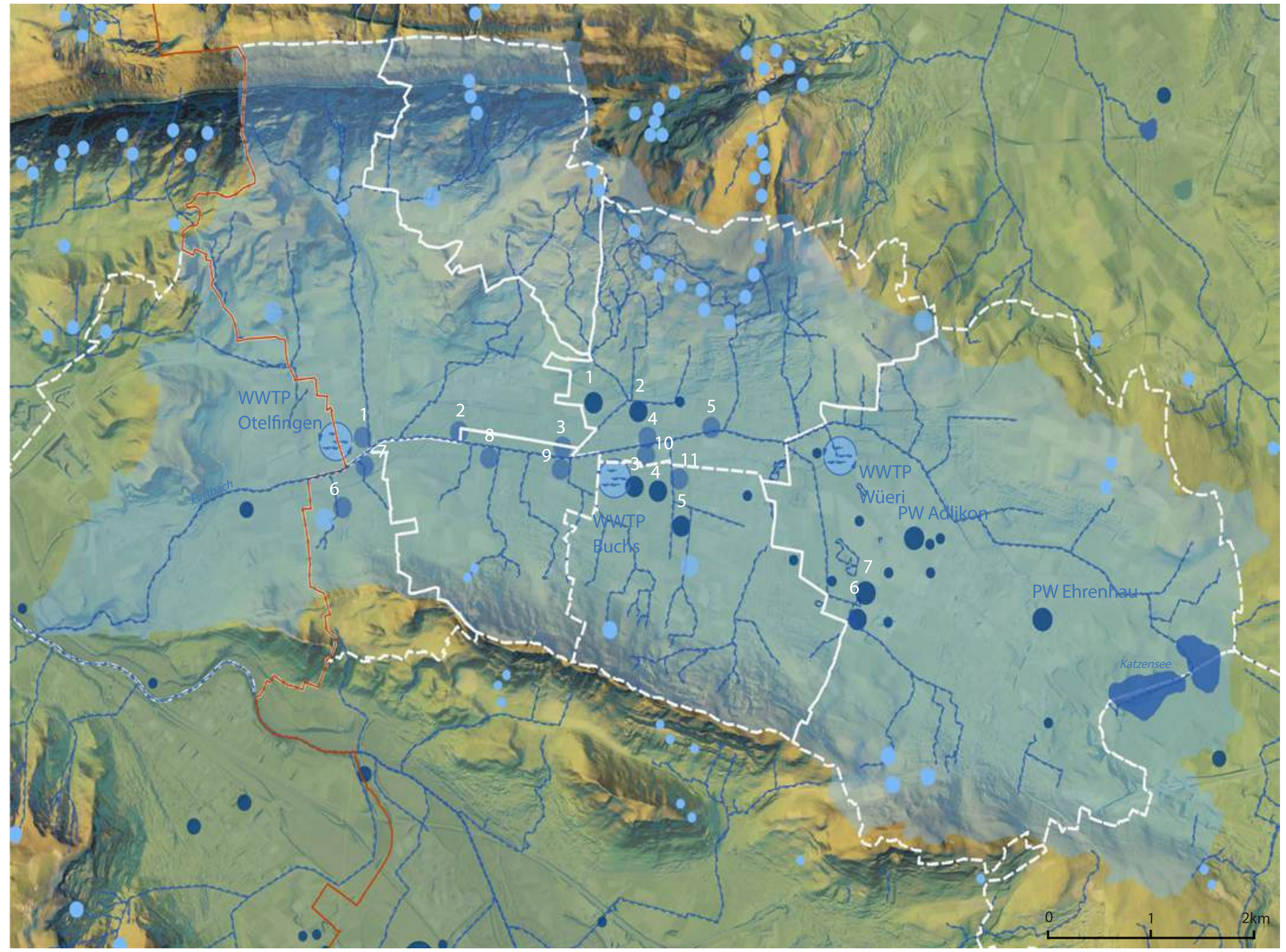
Groundwater extractions from the upper aquifer.	*Purpose of water extraction*	*Extracted water (l/min.)*
1. B. Huber, Buchs	Irrigation	520
2. Gebrüder Meier Wiesenhof, Buchs	Irrigation	300
3. K. Günthardt, Dällikon	Irrigation	150
4. Forster Gemüse AG, Dällikon	Irrigation	250
5. Forster Gemüse AG, Dällikon	Irrigation	50
6. Forster Gemüse AG, Dällikon	Irrigation	600
7. Municipality of Regensdorf	Emergency water supply, fountains	300
Municipality of Regensdorf	Emergency water supply	50
Municipality of Regensdorf	Emergency water supply	275
Paul Schiller Stiftung, Regensdor	Raw water	35
E. Keller AG, Regensdorf	Raw water and thermal use	2'600
Church community, Regensdorf	Thermal use	200
E. Sulzer, Dällikon	Raw water	50
Auto-Sigg, Buchs	Raw water	50
Kindt Fensterladen AG, Otelfingen	Cooling and civil protection	10

Groundwater extractions from the deeper aquifer.	*Purpose of water extraction*	*Extracted water (l/min.)*
1. PW Ehrenhau	Drinking water supply	6'000
2.PW Adlikon	Drinking water supply	8'500



Water extraction from Furtbach and its side-streams.	*Purpose of water extraction*	*Extracted water (l/min.)*
1.	Irrigation for agriculture	500
2.	Golf park	1'000
3.	Irrigation for agriculture	120
4.	Irrigation for agriculture	500
5.	Irrigation for agriculture	1'500
6.	Irrigation for agriculture	0
7.	Irrigation for agriculture	1'500
8.	Irrigation for agriculture	500
9.	Irrigation for agriculture	700
10.	Irrigation for agriculture	1'000
11.	Irrigation for agriculture	60

fig. 112 **Water beneficiaries in the Furt Valley**
Permissions for water extraction from the different water sources of the Furt Valley.



The deeper aquifer is exploited officially only for drinking water supply, however cultivators use drinking water for irrigation as well. The upper aquifer is exploited mainly for thermal use and irrigation.

Geology of the Furt Valley -
Two overlapping aquifers

About 22'000 years ago the glaciers reached their maximum level. An arm of the Linth Glacier reached the Furt Valley until the area of Regensdorf, where it left the end moraines that today form the hilly landscape of the surrounding area of the Katzensee Lakes. By that time, water streams run from the higher altitudes of the Lägern Mountain towards the Furt Valley, mainly through the ice masses. However, as the ice melt the bed of the valley was a big elongated lake. In the following stages, the wooded areas on the mountain sides started to develop and vegetation started to grow on the wetlands of the Furttal.

All the while, the impermeable clay that filled the valley in the following years covered the Lake and seperated it from the upper soil lazers. Thus, until today, clay protects the deeper level of groundwater from the polluted surface waters. The natural recharge of this lower groundwater level takes place only in the higher altitudes of the surrounding mountain sides by precipitation, making therefore the maintenance of the soil permeability in the corresponding area viable for the further regeneration capacity of this qualitative aquifer.

fig. 113 **"Chindlistein"**
Remnants of the last Ice Age -
Riss-moraines on the Altberg, 1932
Source: ETH library, Zurich

fig. 114 **Levels of groundwater in the Furt Valley**
Section through the different soil layers.

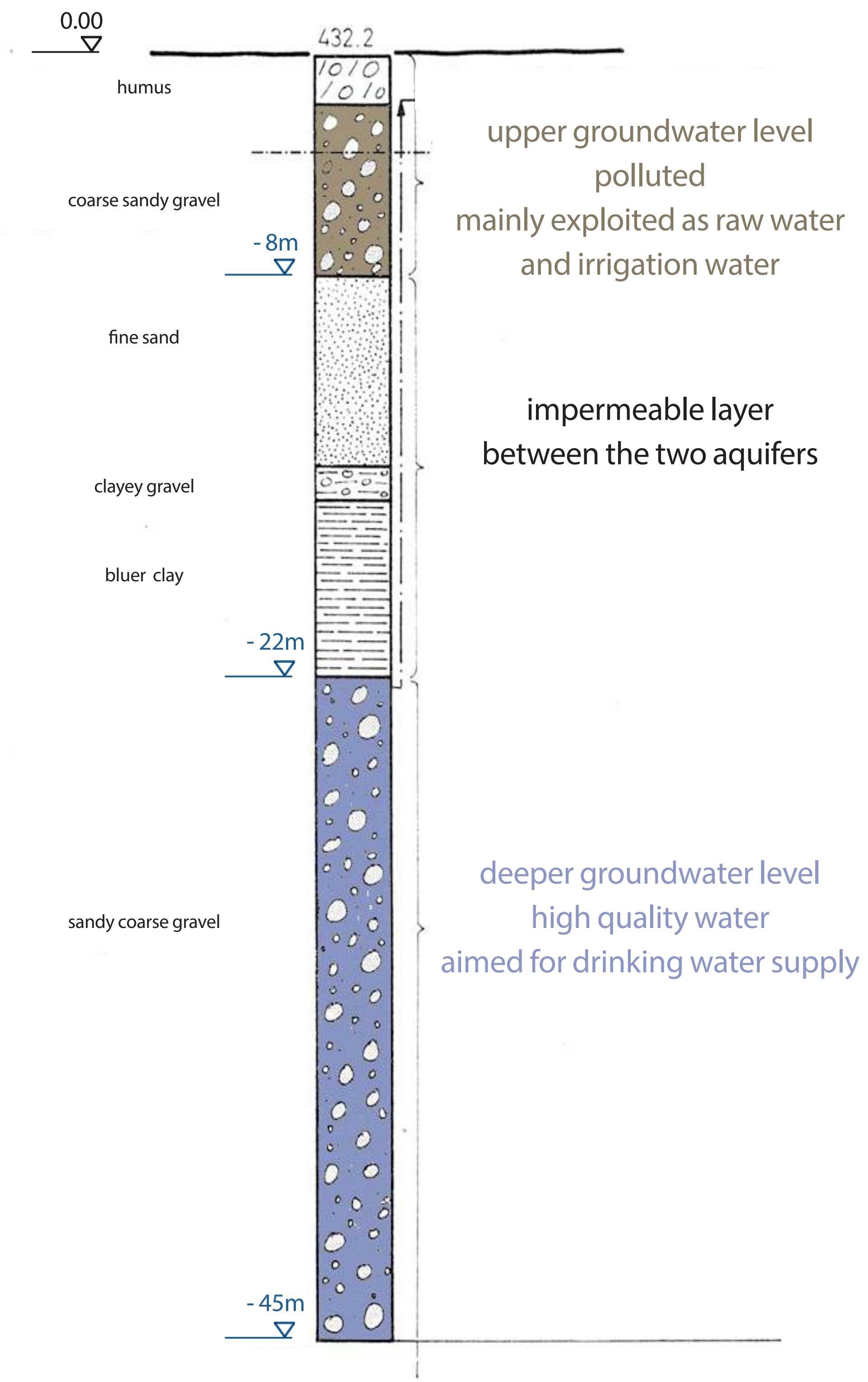


fig. 115 **Hydrogeology Furttal**
Soil structure and groundwater formation under the Furt Valley.

- groundwater thickness 2-10m
- alternating groundwater thickness in clayey gravel
- moraines, groundwater poor
- consolidated rock, groundwater poor
- consolidated rock without groundwater
- consolidated rock, alternating groundwater thickness
- deeper groundwater level
- moraine cover, moderate protection
- groundwater capture
- important spring source

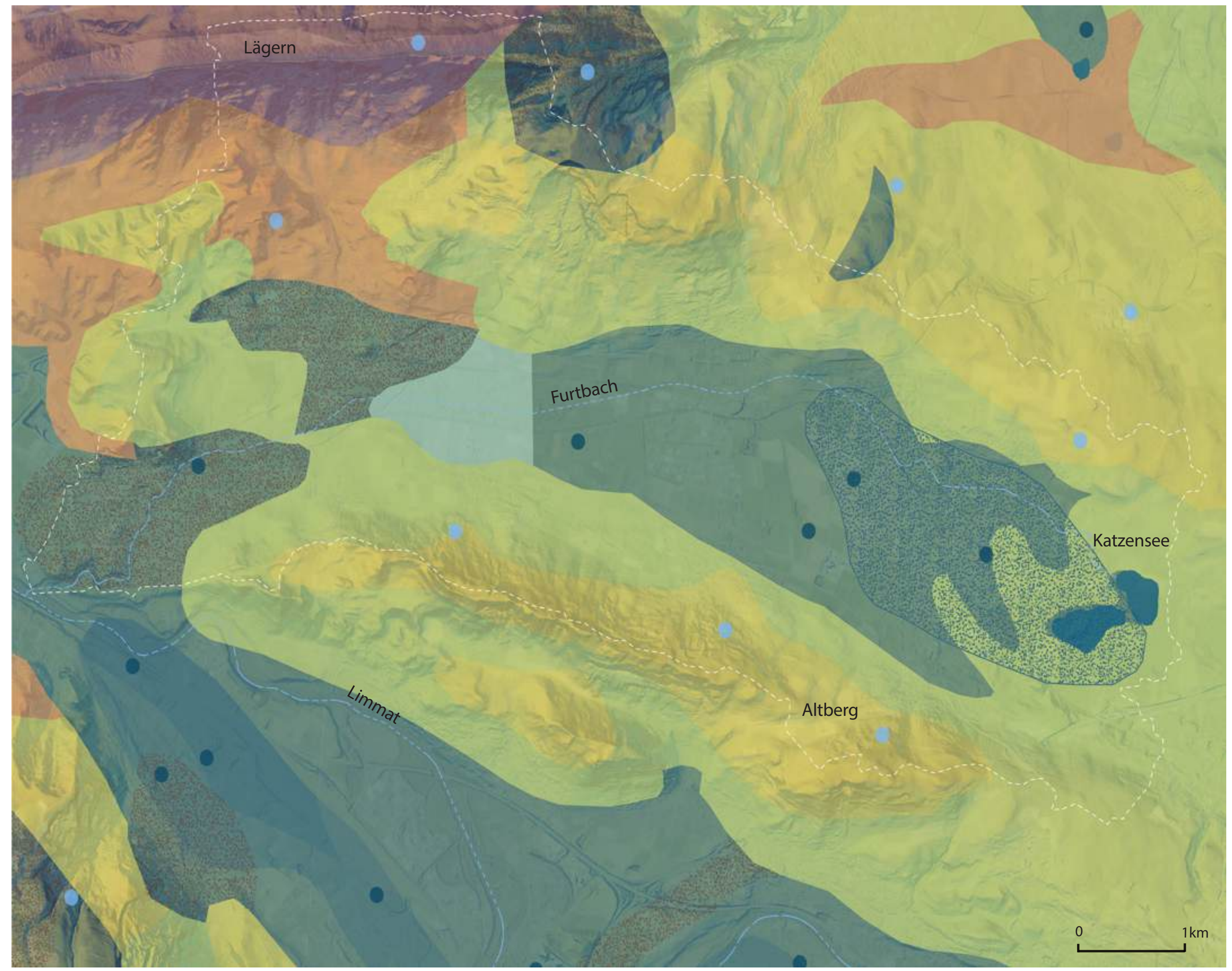


fig. 116 **Natural recharge cycles**
The upper and more extensive aquifer recharges naturally twice as fast as the deeper confined aquifer. Wet seasons/years correspond to higher groundwater levels and lower dependency on the group water supply network.

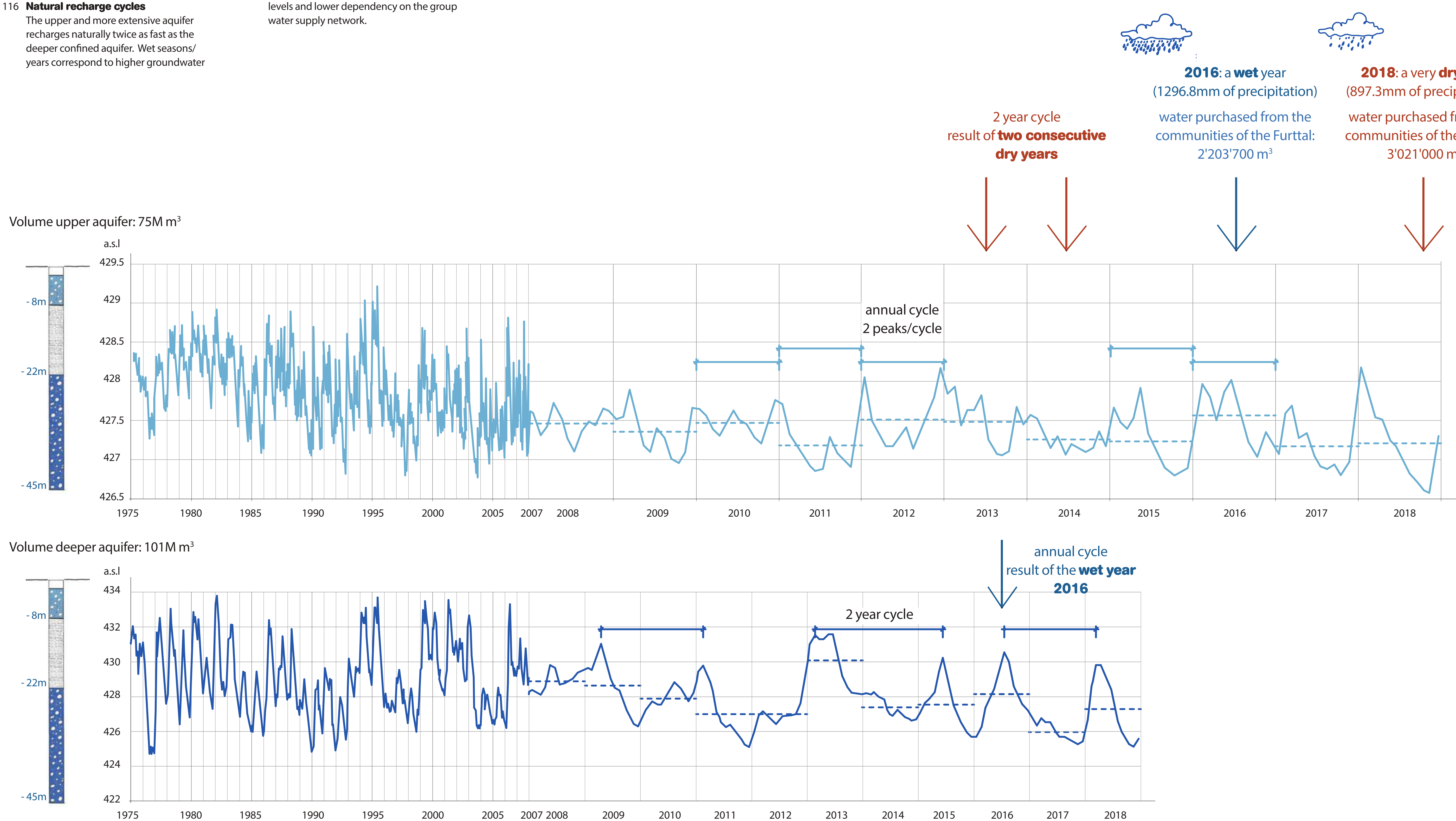


fig. 117 **Flooding water bodies in the Furttal**
The Furtbach flowing in a strictly straight line does not allow its waters to meander and pose a potential flooding risk. All the while, soil with low water storage capacity is often saturated and water remains partly on the surface (vegetation on saturated soil in the foreground).

fig. 118 **Flooding risk for the Furttal**
Soil water storage capacity of the Furt Valley.

- natural aquifer recharge areas (deep percolation)
- great water storage capacity
- medium water storage capacity
- low water storage capacity (direct surface runoff)
- delayed subsurface flow
- very slow subsurface flow

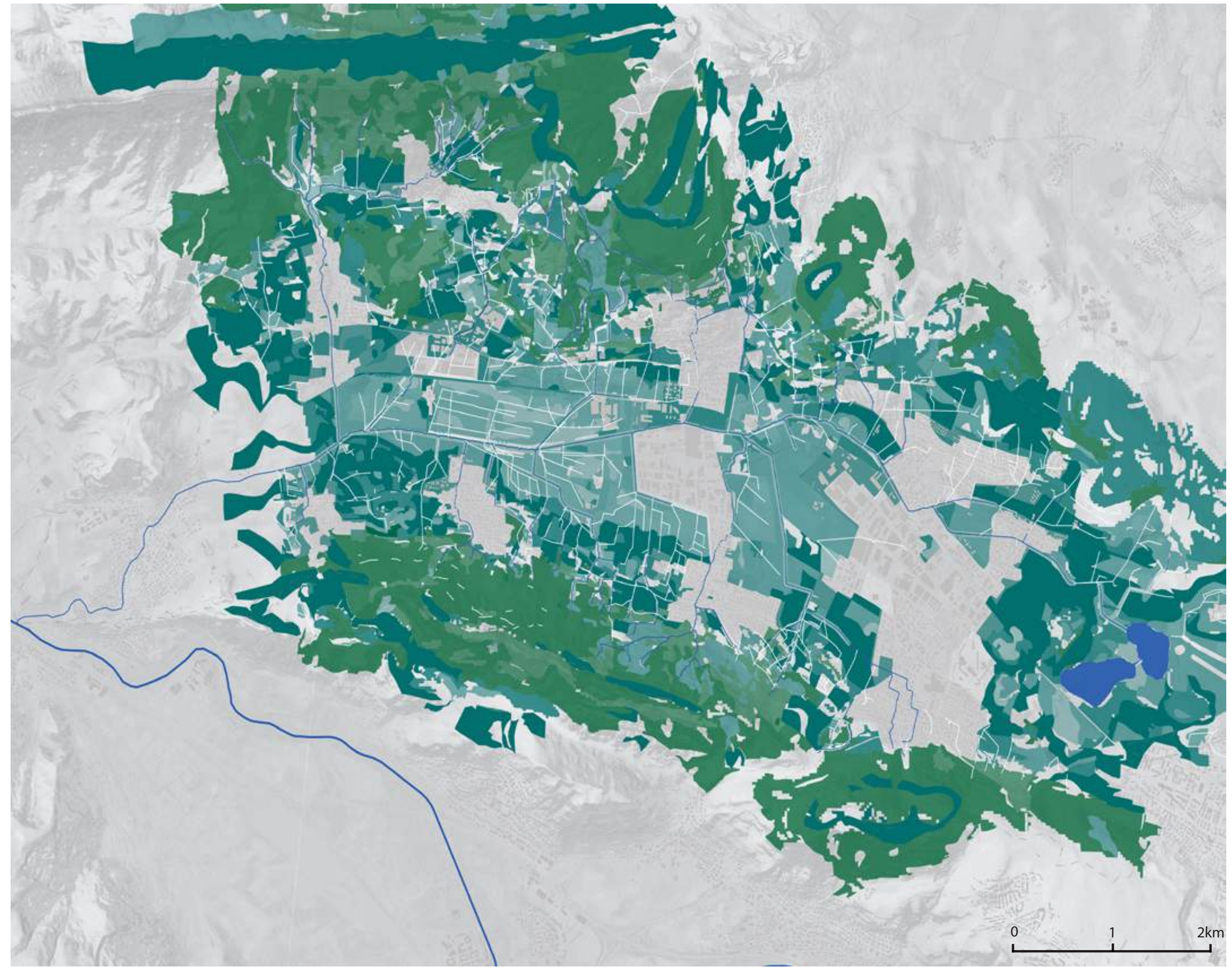


fig. 119 **The heavily polluted"Bennengraben"**
One of the smaller side streams of Furtbach carrying a "toxin coctail" into the main Furt flow.

fig. 120 **Main sources of the Furtbach waters**
The side streams of Furtbach, originating in the higher altitudes of the surrounding wooded slopes and bringing water into the Furtbach.

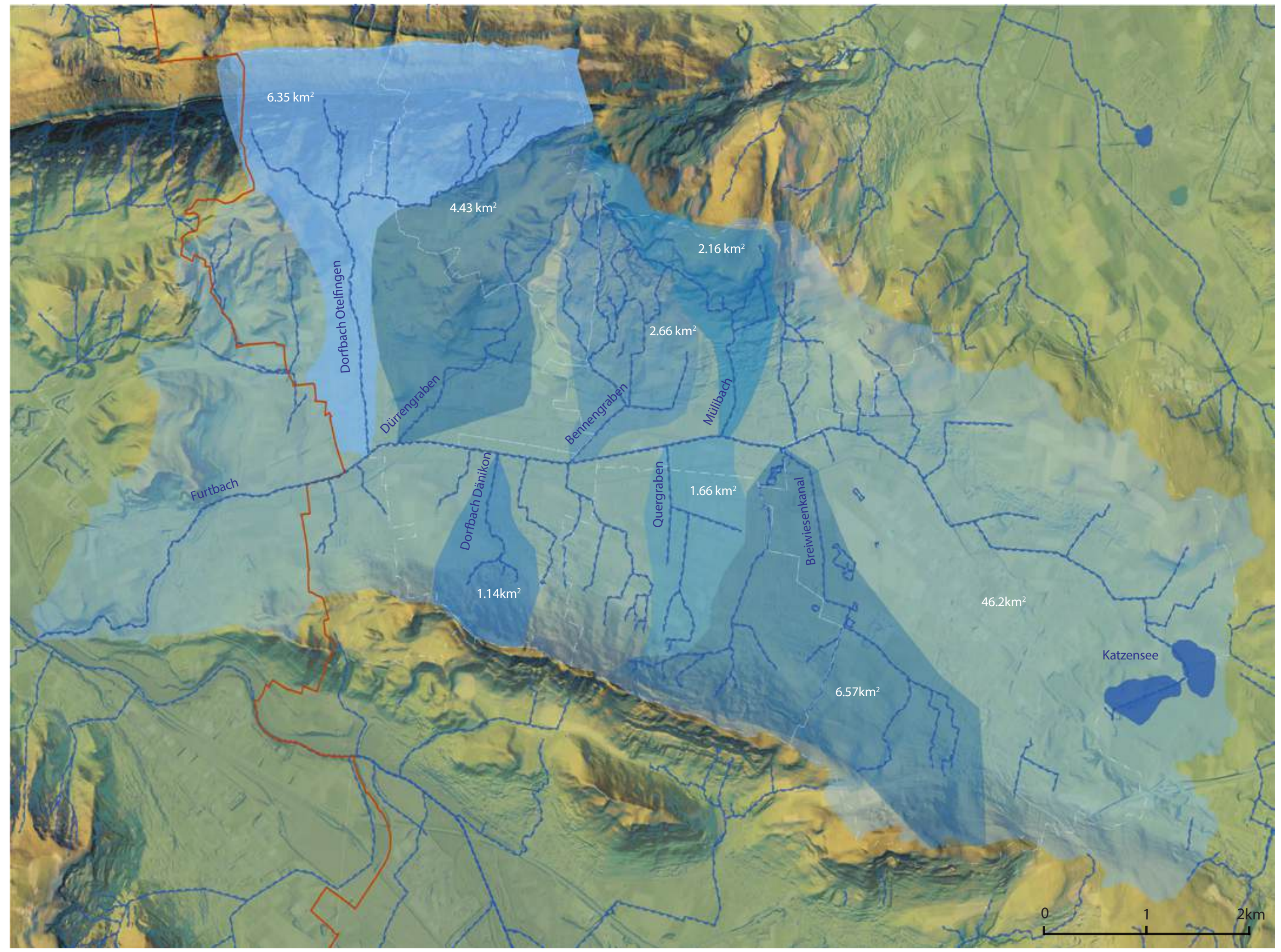


fig. 121 **Quergraben meets Furtbach**
The Quergraben is another side stream of Furtbach flowing in a highly artificial course, while half of its natural flow is channeled underground.

fig. 122 **Straight Furt flow**
Furtbach follows a staight narrow course for most of its path as a result of the many corrections and draining of the landscape. Here the Furtbach between Buchs and Otelfingen.

fig. 123 **A manipulated river network**
When meeting arable and buildable land, most of the Furtbach side streams have been artificially chanelled in straight courses or in underground drainage pipes.

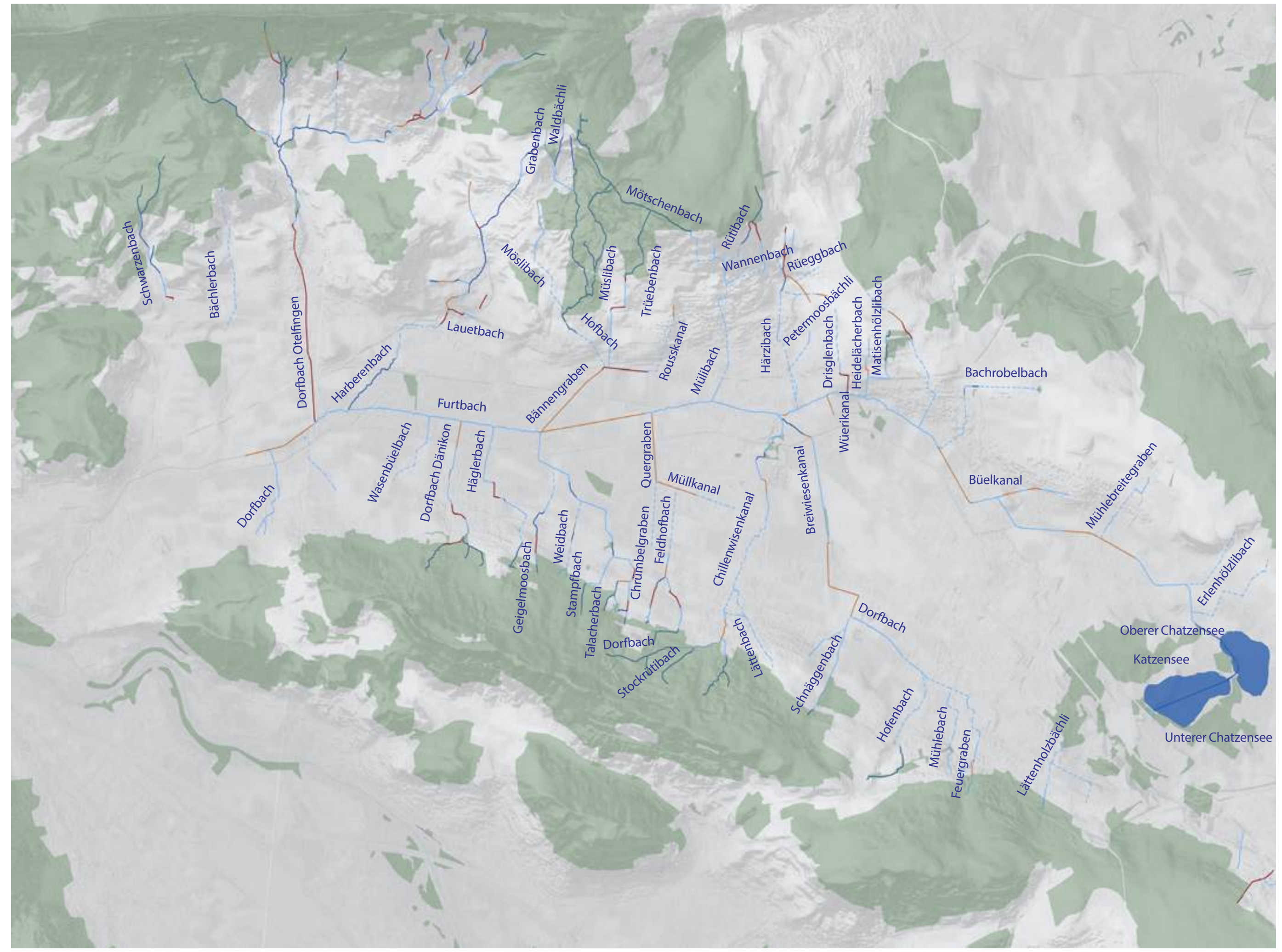


fig. 124 **Varying thickness of groundwater**
Consecutive cross sections through the Limmat- and Furt Valley.

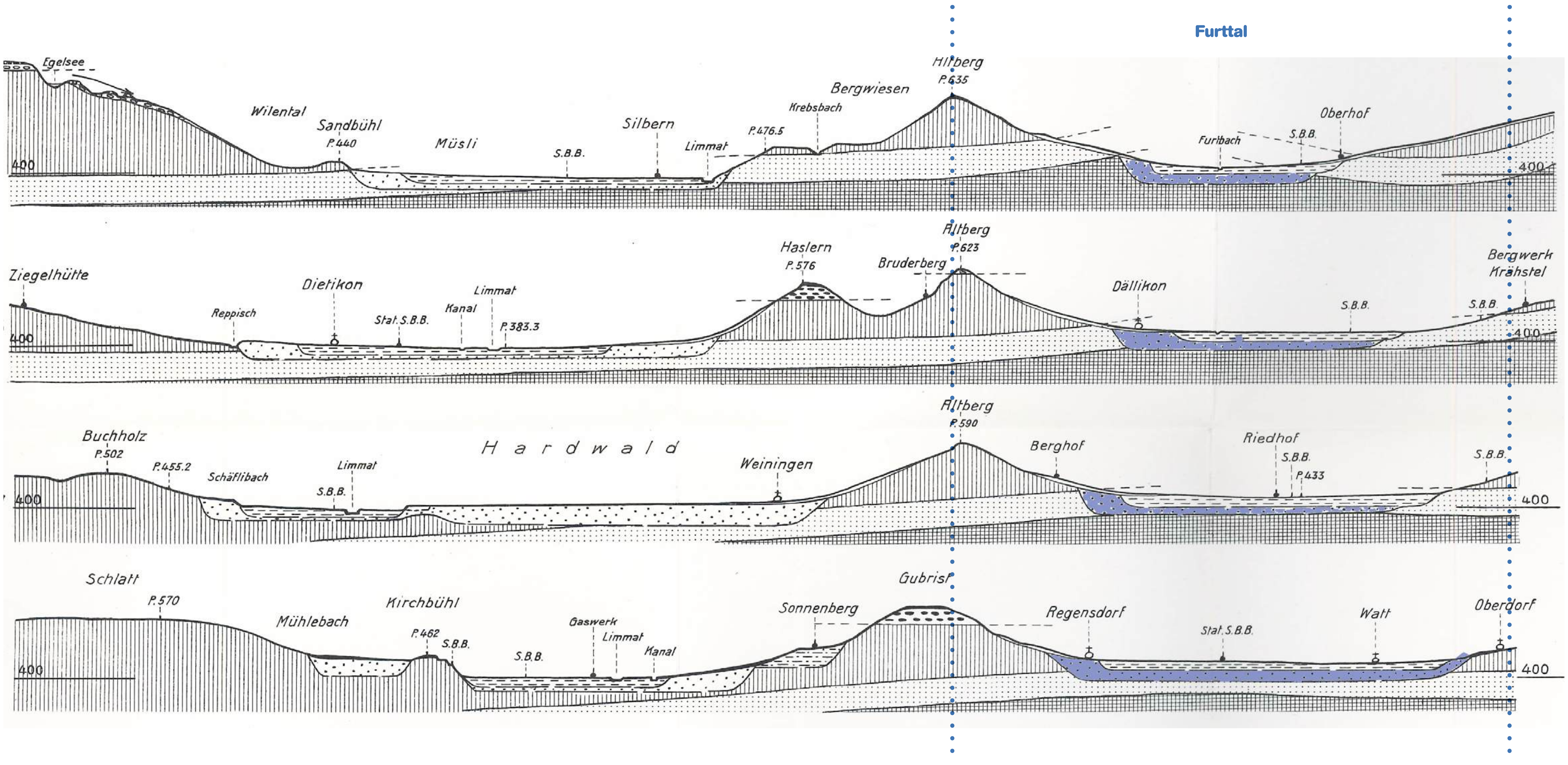
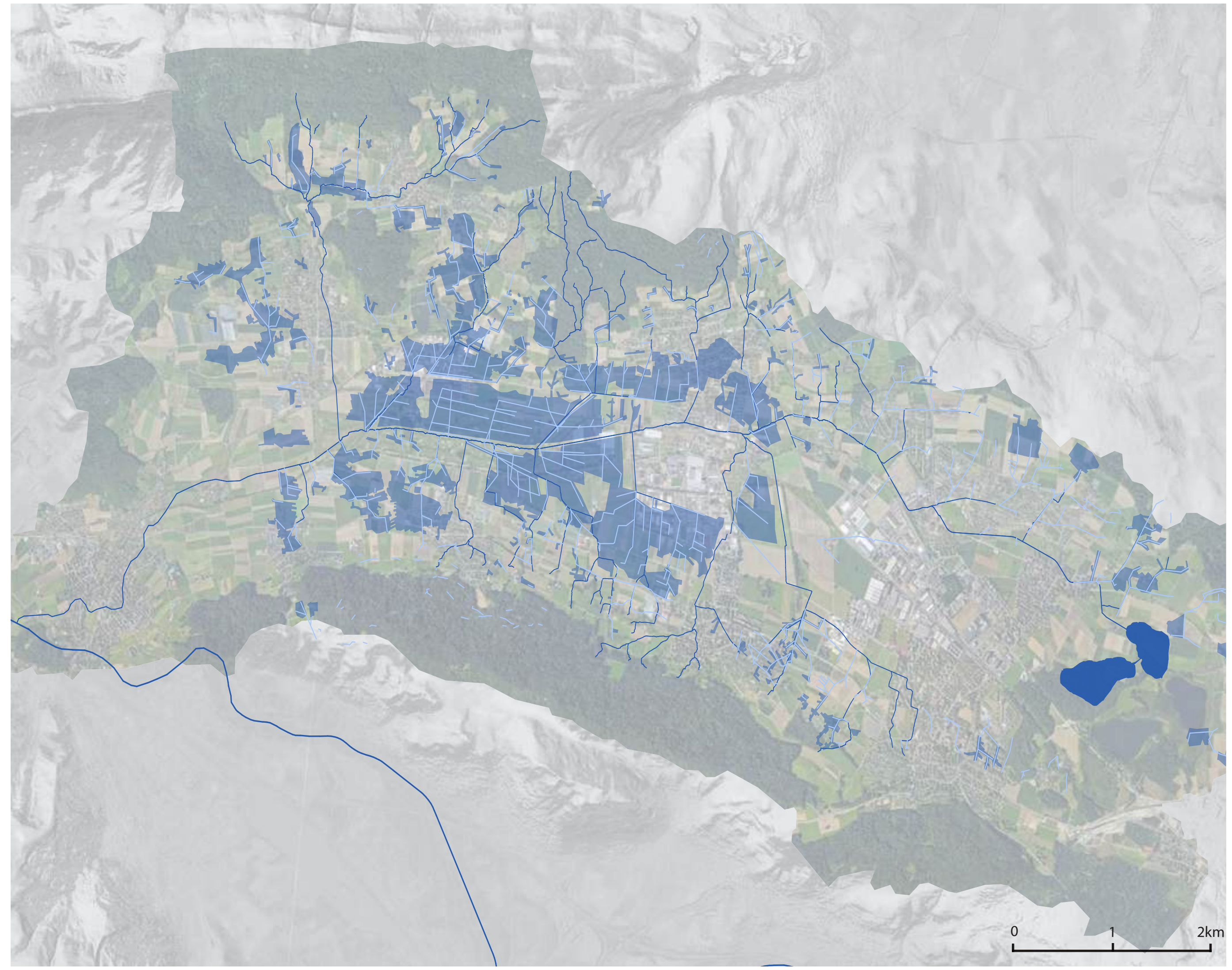


fig. 125 **Side streams as drainage channels**
Many of the Furtbach side streams are artificially chanelled in underground pipelines and are used for the drainage of the agricultural fields.

fig. 126 **The hidden Geigelmoosbach**
Geigelmoosbach is one of the Furtbach side streams which would normally flow through these agricultural fields but it is chanelled in an underground pipeline.

fig. 127 **A drained landscape**
Drainage plan of the Furt Valley.

- arable land
- artificial pasture
- (BFF) biodiversity promoting surfaces
- pasture
- meadow
- vines
- fruits
- rest permanent crops
- glasshouses
- (FFF) crop rotation areas



Zurich's vegetable basket - The main economic activity of the Furt valley

The Furt Valley is valued as the biggest coherent crop area of the metropolitan area of Zurich. As the soil of the previous marshland is the most suitable for productive vegetable cultivation, the inhabitants of the valley take use of the lowlands for industrial agriculture practices. On the other side, this requires an intensive use of pesticides which thus reach the upper aquifer and return back to the crops through the extraction of this groundwater for irrigation. A vicious cycle. In contrast to the practices on the lowlands, towards the slopes of the surrounding mountain ranges the agriculture practices include mainly corn cultivation and fields for pasture, which indeed require a lower use of pesticides. Further upwards, the foothills are defined by extensive meadows which act as a transition zone to the highly productive centre of the Furt Valley. All the while, greenhouses are scattered through the Valley and tend to increase in number during the last years.

Different crops require different amounts of additional water. Most of the vegetables, together with potatoes are the most water demanding crops, while corn, sugar beets, pasture and meadows can require significantly less irrigation provided that they are planed on appropriate soil and mown at the appropriate height. The cultivation of the appropriate for each soil crop means that the soil requires minimum artificial modifications, thus moderate use of pesticides.

fig. 128 **Agricultural Furt Valley**
Panoramic view from Heitersberg.

fig. 129 **Greenhouse industrial agriculture Furttal**
View of the alligned glasshouses in Buchs.
fig. 130 **Open field industrial agriculture Furttal**
Mixed open field cultivation in Otelfingen.

fig. 131 **Zurich's vegetable basket**
The Furt Valley is the biggest coherent crop area of the metropolitan region of Zurich. Different types of agriculture practised on the Furt Valley.

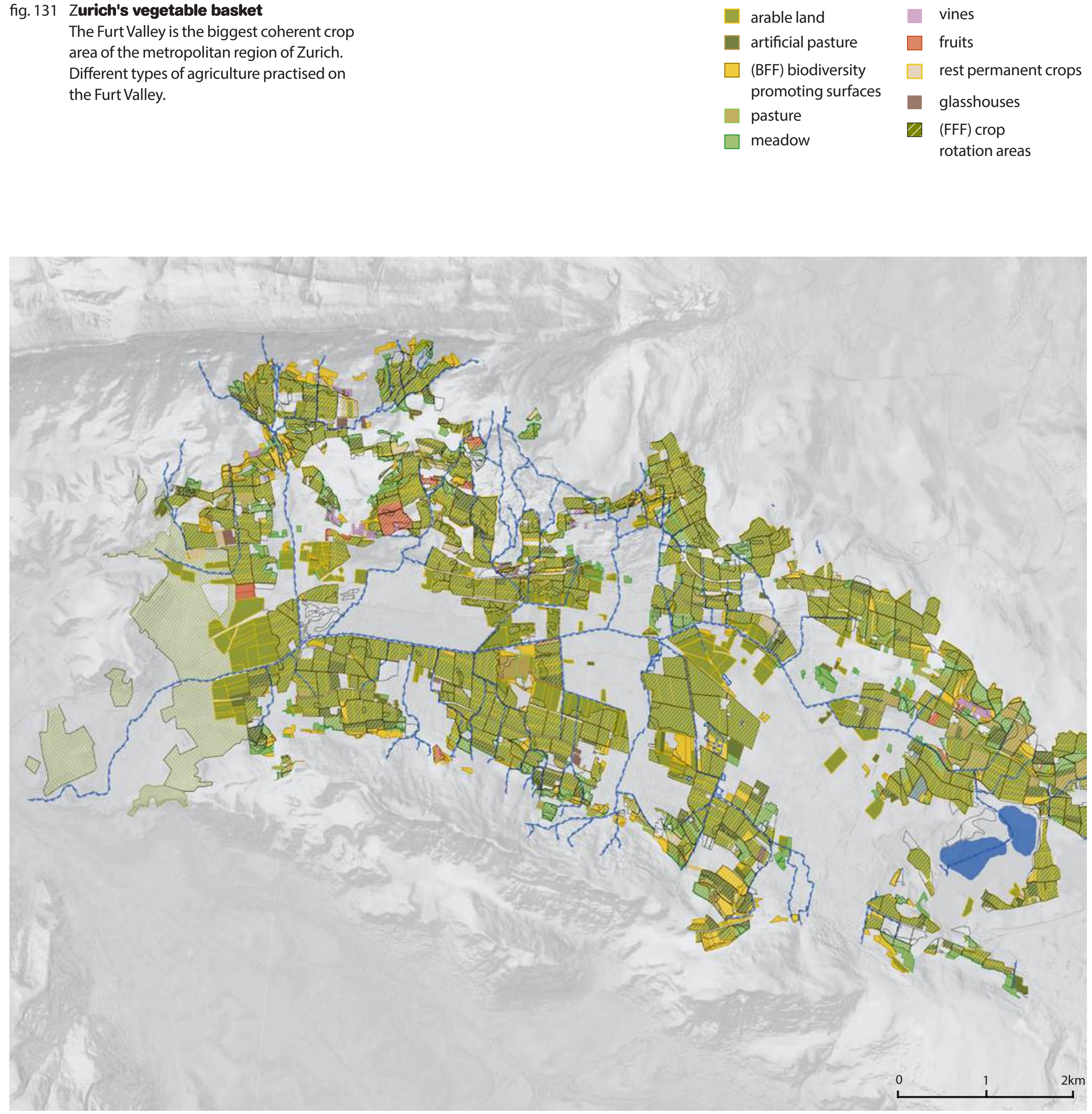


fig. 132 **A meadow valley**
Corn and field vegetables as secondary agricultural practices in the Furt Valley.

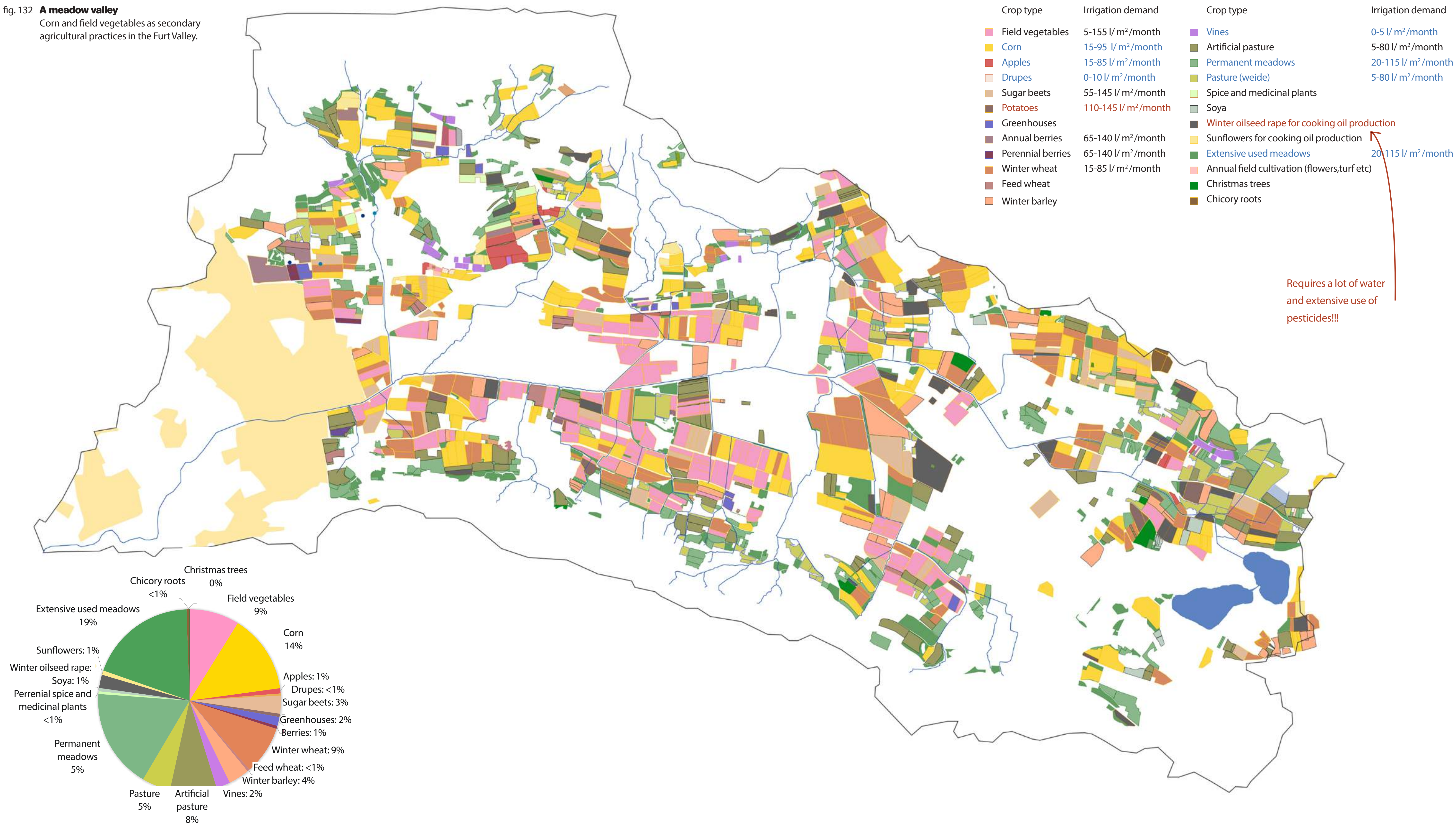


fig. 133 **Agricultural soil types of the Furt Valley**
Brown earth is considered to be one of the most fertile soil types.

- brown earth
- limestone brown earth
- luvisol
- acid brown earth
- alluvium
- regosol
- brown earth - pseudogley
- Buntgley
- Fahlgley
- marsh
- artificial backfilling

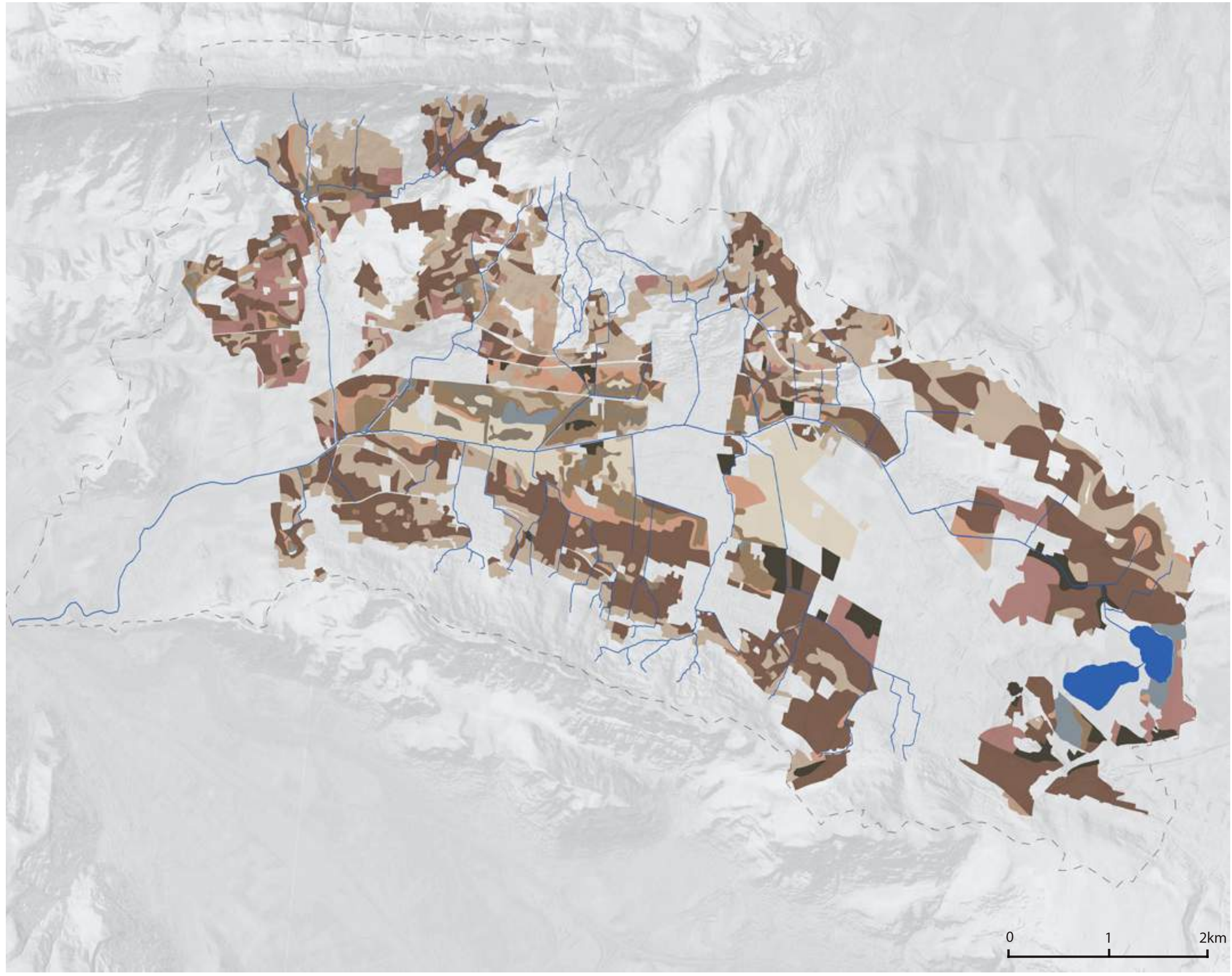


fig. 134 **Soil water dynamics of the Furt Valley**
Soil water regimes of the agricultural plain in the Furttal.

vertically grown
- permeable
- influenced by backwater
- influenced by slope- and groundwater

formed by backwater
- rarely saturated to the surface
- often saturated to the surface

formed by slope- or groundwater
- rarely saturated to the surface
- often saturated to the surface
- mostly saturated to the surface
- always saturated to the surface

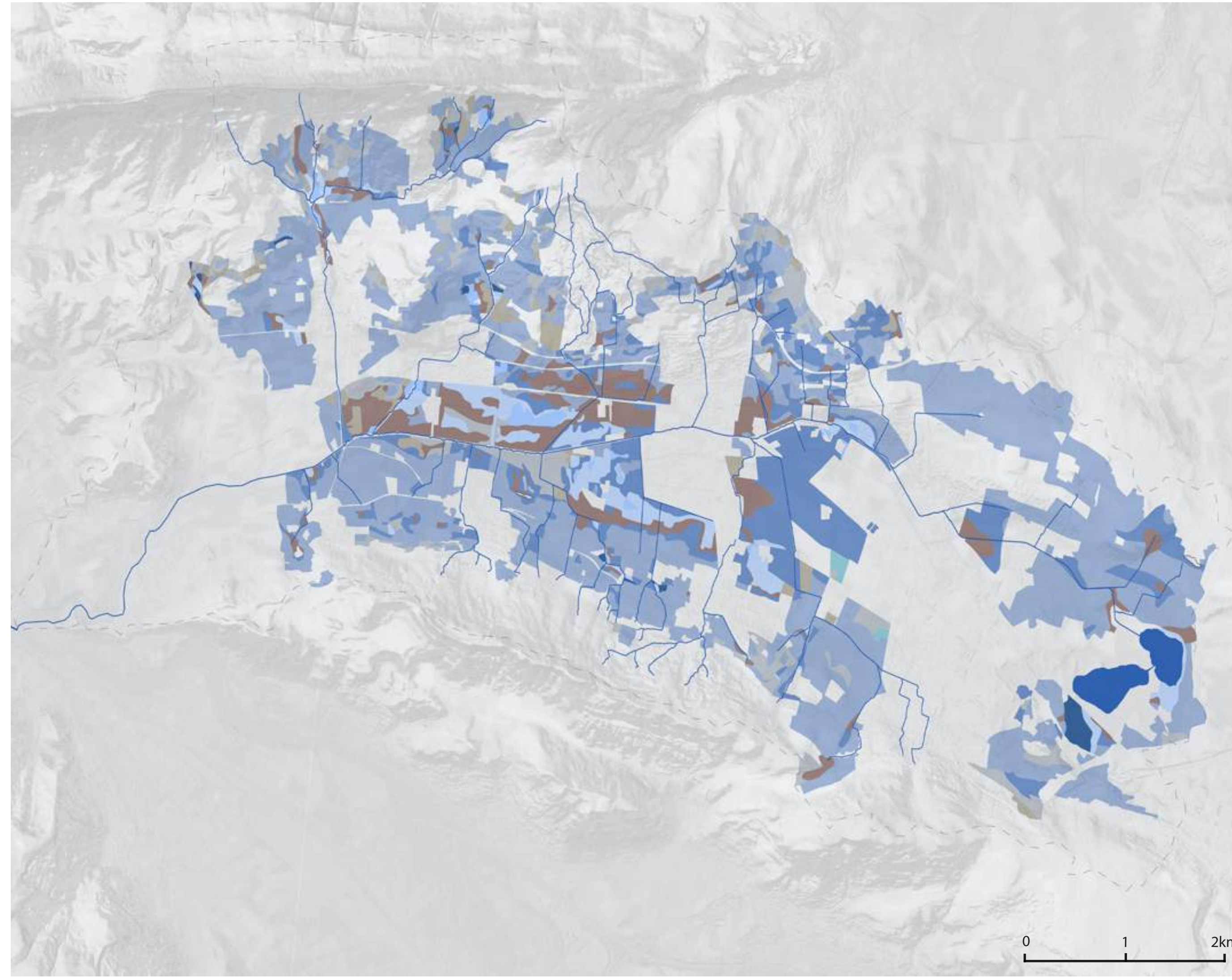


fig. 135 **Undefined meadows in the fringes**
Meadow fields in Dänikon.

fig. 136 **Fertile soil on the previous marshland**
Open vegetable field on the former marshland area on the Furtbach riverbanks.

fig. 137 **Meadows as a buffer zone**
Meadow fields mark the transition from the wooded slopes to the vegetable fields at the center of the Furt Valley.

fig. 138 **Industry conquers water bodies**
Furtbach is suppressed into a narrow straight course by industrial activities.

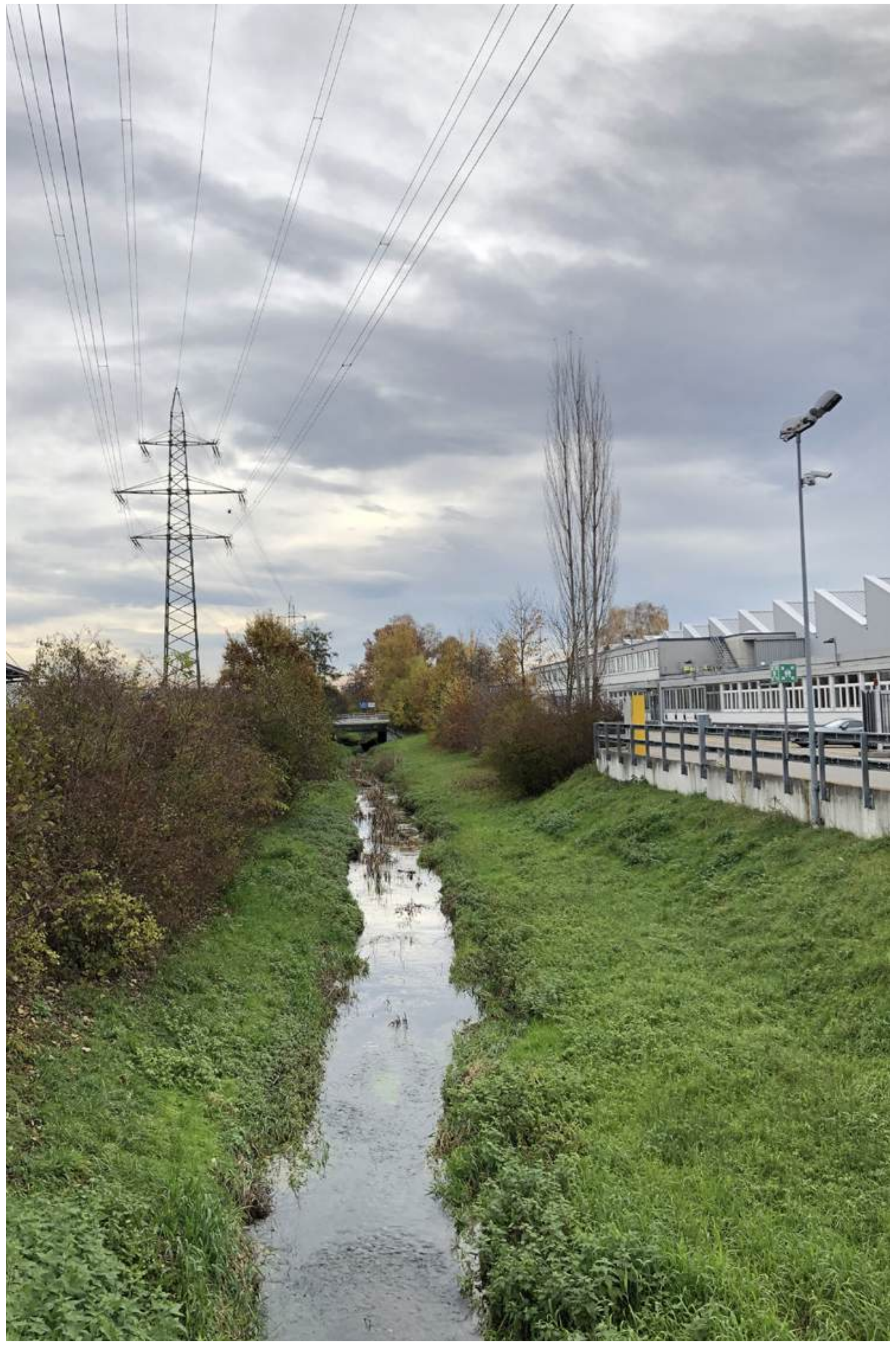


fig. 139 **Built-up Furtbach Riverbanks**
The Furtbach Riverbanks serve as an industry attractor.

fig. 140 **Residential Furtbach Riverbanks**
The Furtbach riverbanks as an attractor for bigger residential developments.

fig. 141 **Anonymous metal boxes**
Example of a pet supply store in Regensdorf.

fig. 142 **A developing valley**
Construction cranes in Regensdorf.

fig. 143 **Extensive logistics headquarters**
Examle of DPD logistics center in Buchs.

fig. 144 **Base for industrial production**
Example of the manufacture cluster in Otelfingen.

Administrative Furttal - The main sealer of the Furtbach Riverbanks

Industrial clusters and hubs of logistics are the economic activities that settled along the Furtbach. Following, the residential complexes tied on them and settled mainly on the foothills of the surrounding mountain ranges. In Regensdorf, industry and commercial activities surround the Furtbach and extend in the Valley sealing bigger surfaces of otherwise porous soil. Further west on the Furt Valley, these big-sized industrial buildings are mostly small equipment suppliers, wholesalers, logistic centers and soem scattered manufactures. This type of economic activities requires high traffic intensity, for the people working but not living in the near surroundings and for the materials that need to betransfered as well. Thus, bigger land areas have to be leveled and sealed in order to be used as parking areas.

This extensive sealing of bigger surfaces leads to a higher runoff which is directed directly into the Furt water stream. All the while the concentrated mostly aluminium facades lead to local heat islands with significant higher temperatures than the rest areas of the Valley.

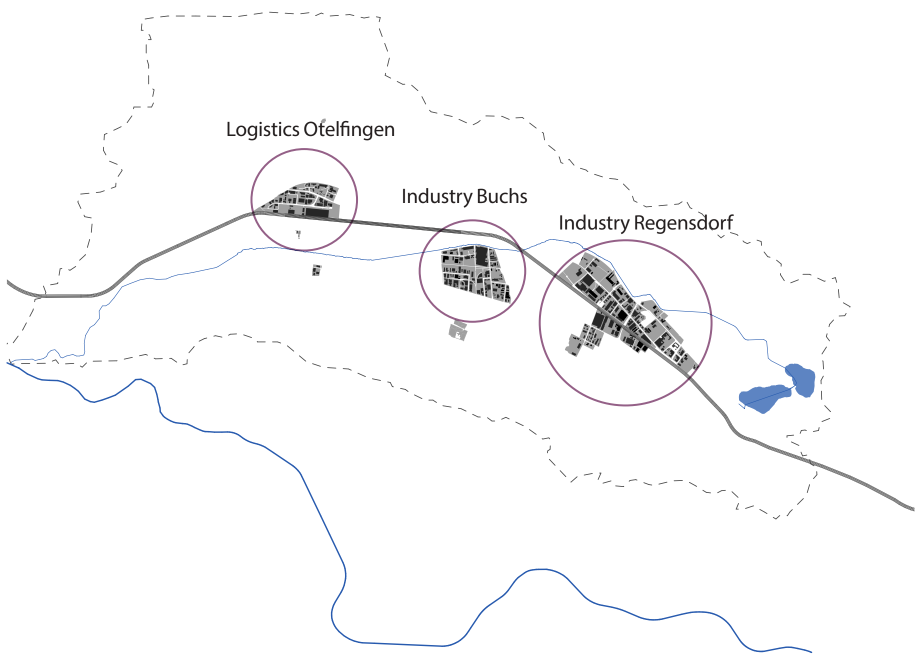


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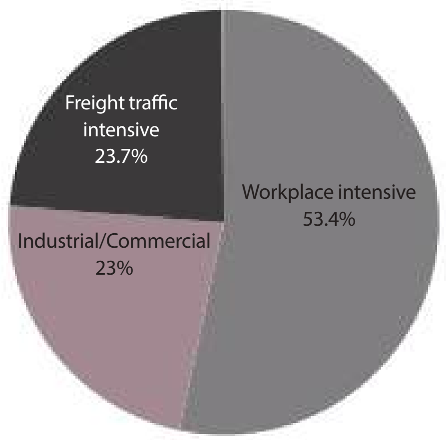
fig. 145 **Otelfingen logistics**
A workplace intensive wholesale and production cluster in Otelfingen.



A plant is characterised as freight traffic intensive when it generates more than 400 truck rides per day.

A complex is characterised as workpace intensive when it occupies a parking area of more than 100 parking places pro hectare.

Number of businesses: 126
Number of employees: 1'885

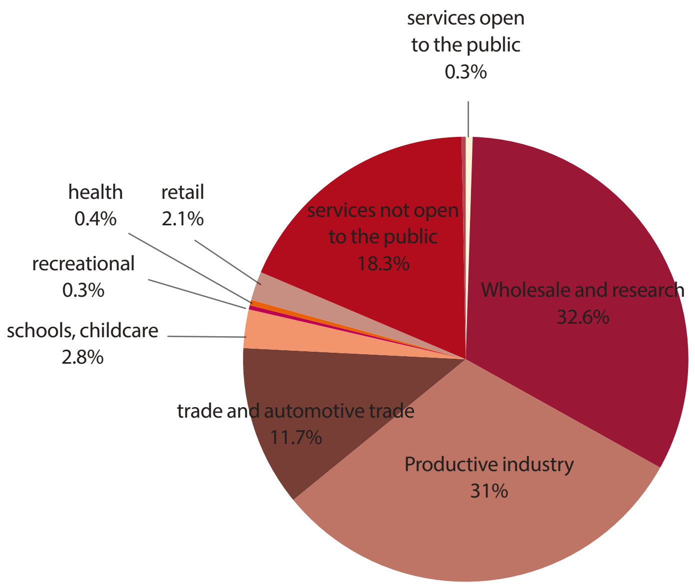


fig. 146 **Industrial sealers since the 1970s**
Building year and owners of the industrial hub in Otelfingen. The extensive Globus logistics center has settled in Otelfingen since 1965.

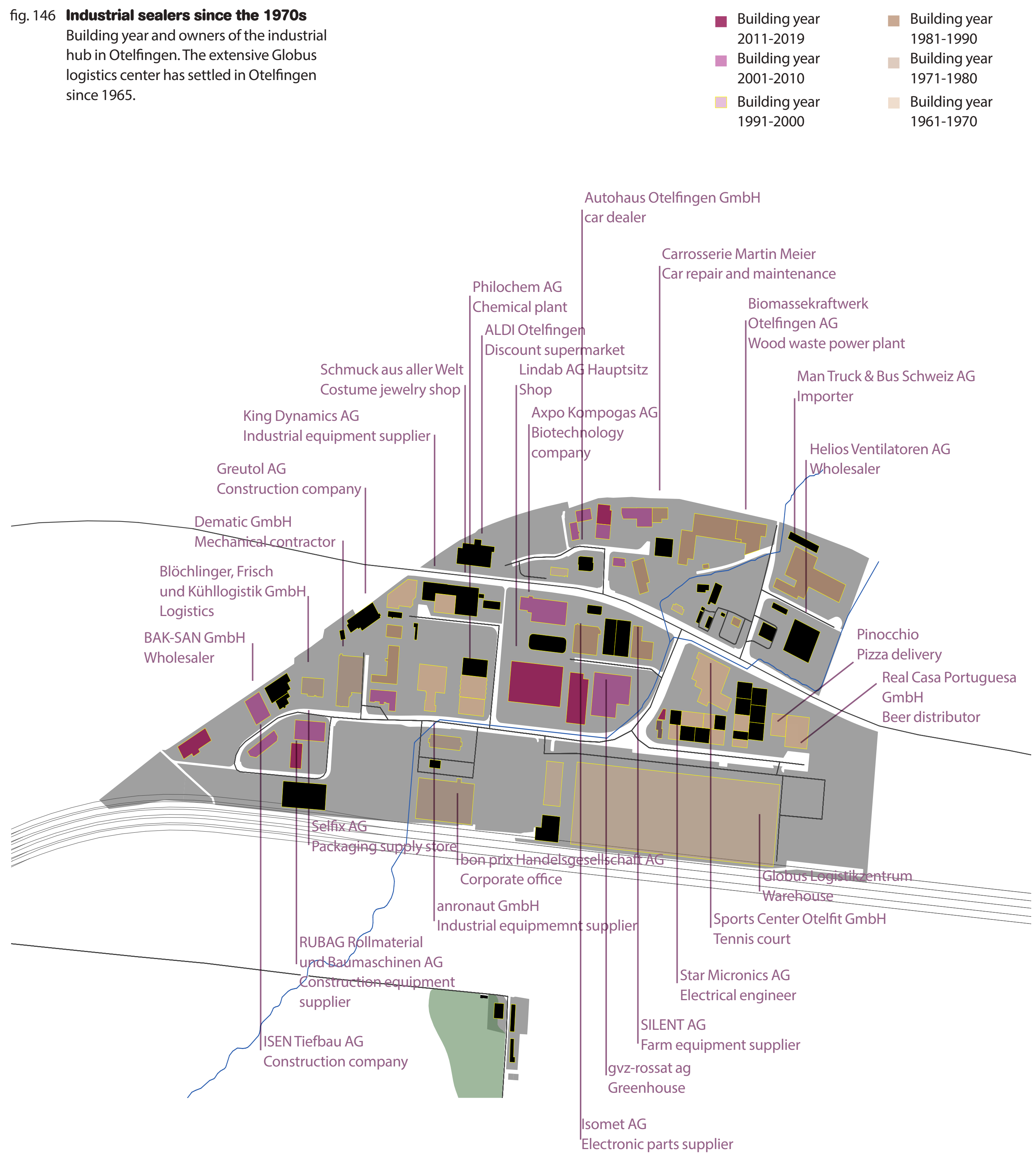
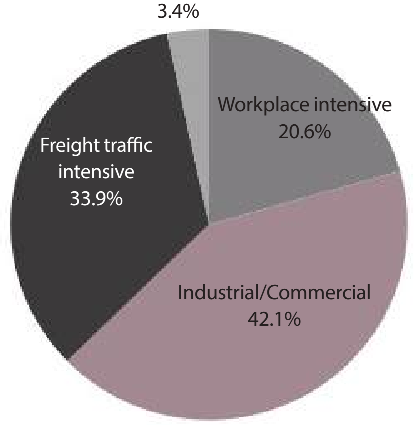


fig. 147 **Buchs logistics**
A wholesale and industrial production cluster in Buchs.



Number of businesses: 151
Number of employees: 2'673

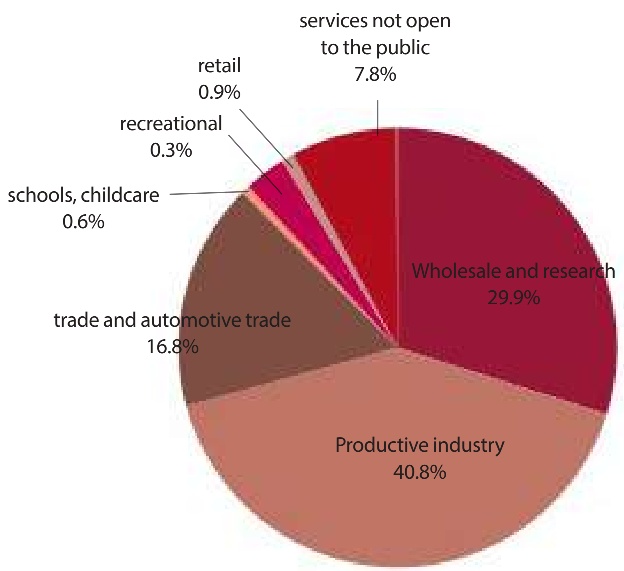


fig. 148 **Industrial sealers since the 1980s**
Building year and owners of the logistics hub in Buchs.

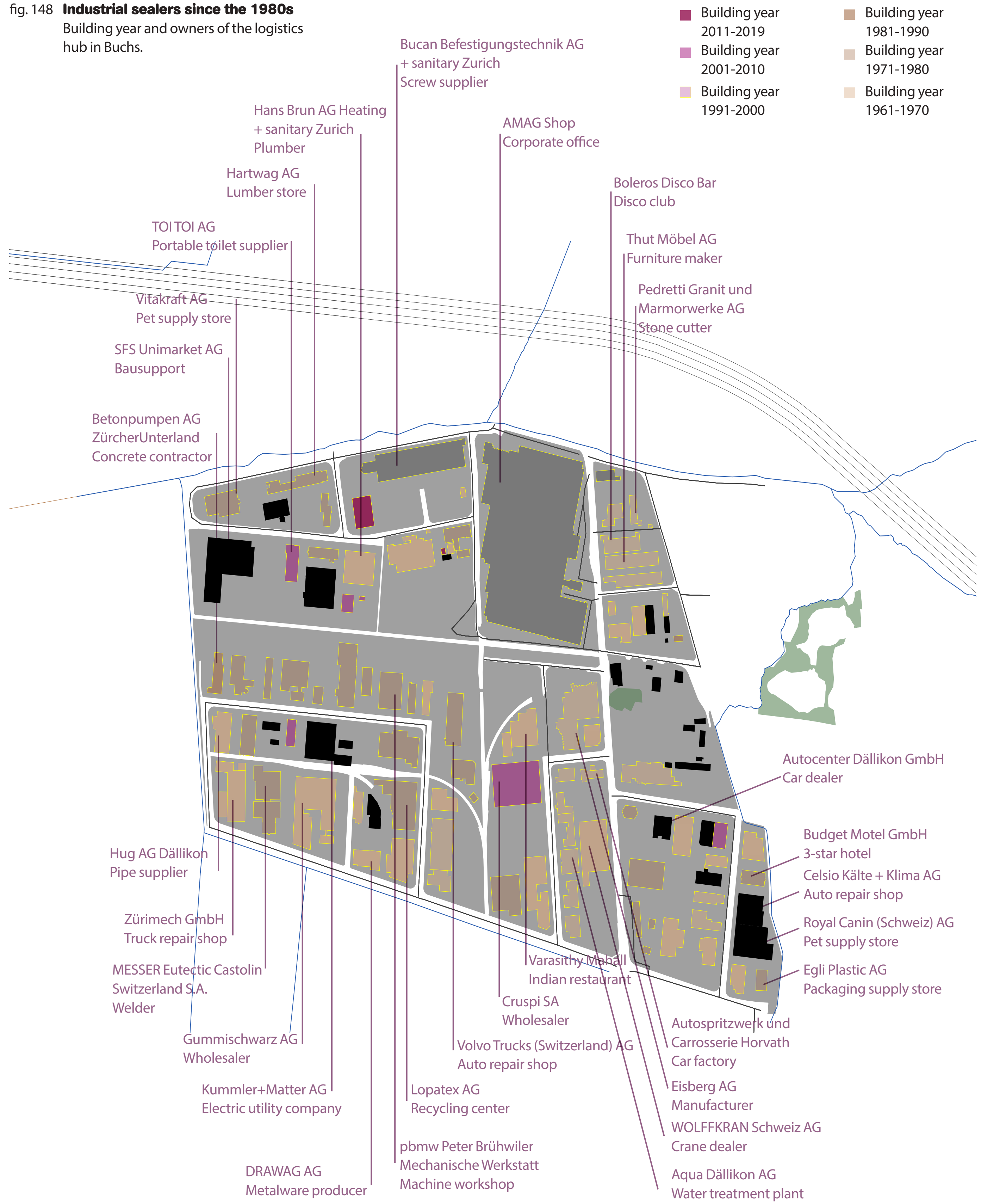
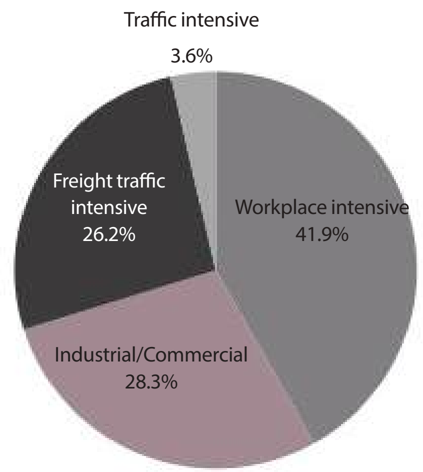


fig. 149 **Regensdorf logistics**
A well-mixed industrial and commercial cluster in Regensdorf.



Number of businesses: 454
Number of employees: 6'546

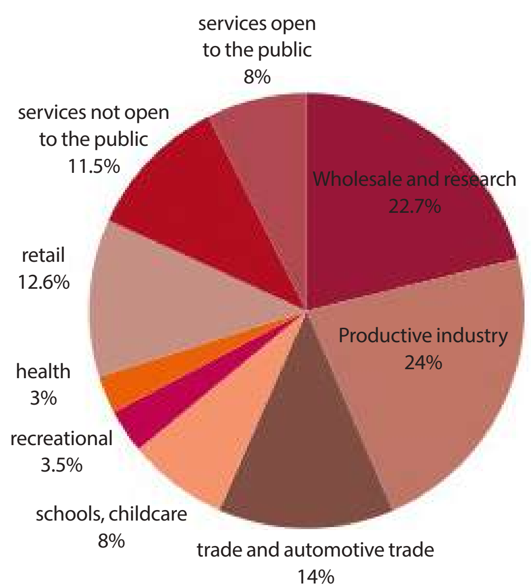


fig. 150 **The oldest industrial cluster of the Furttal**
Building year and examples of owners of the industrial and commercial hub in Regensdorf.

fig. 151 **Canton Zurich's most polluted waters**
Furtbach has the heaviest pollution index of the Canton of Zurich, according to the field Campaign of the Office of Waste, Water, Energy and Air (AWEL) for the time period 1999-2003.

Misuse of the Furt Valley - Heavy pollution of the water resources

The Furt Valley is confirmed by the Canton of Zurich as the most polluted water stream of the Canton. The main responsible for the heavy pollution not only of the open water stream Furt, but of the upper aquifer layer as well are the intensive industrial agriculure practices taking place across the valley. However, another significant contributor to the heavy pollution of the water courses of the Furt Valley is the industrial activity occupying most of the surface of the Furtbach Riverbanks. Industrial wastewater, together with residential wastewater is directed to the respective wastewater treatment facilities, which are located along the Furtbach Riverbanks as well. The treated wastewater returns then either back into the ground or to the Furt water stream, however carrying with it substances, which were applied for its treatment but are harmful for the water bodies. Zinc and copper found in the water probes of the Furtbach may be attributed to uncontrolled runoff from residential as well as industrial areas.

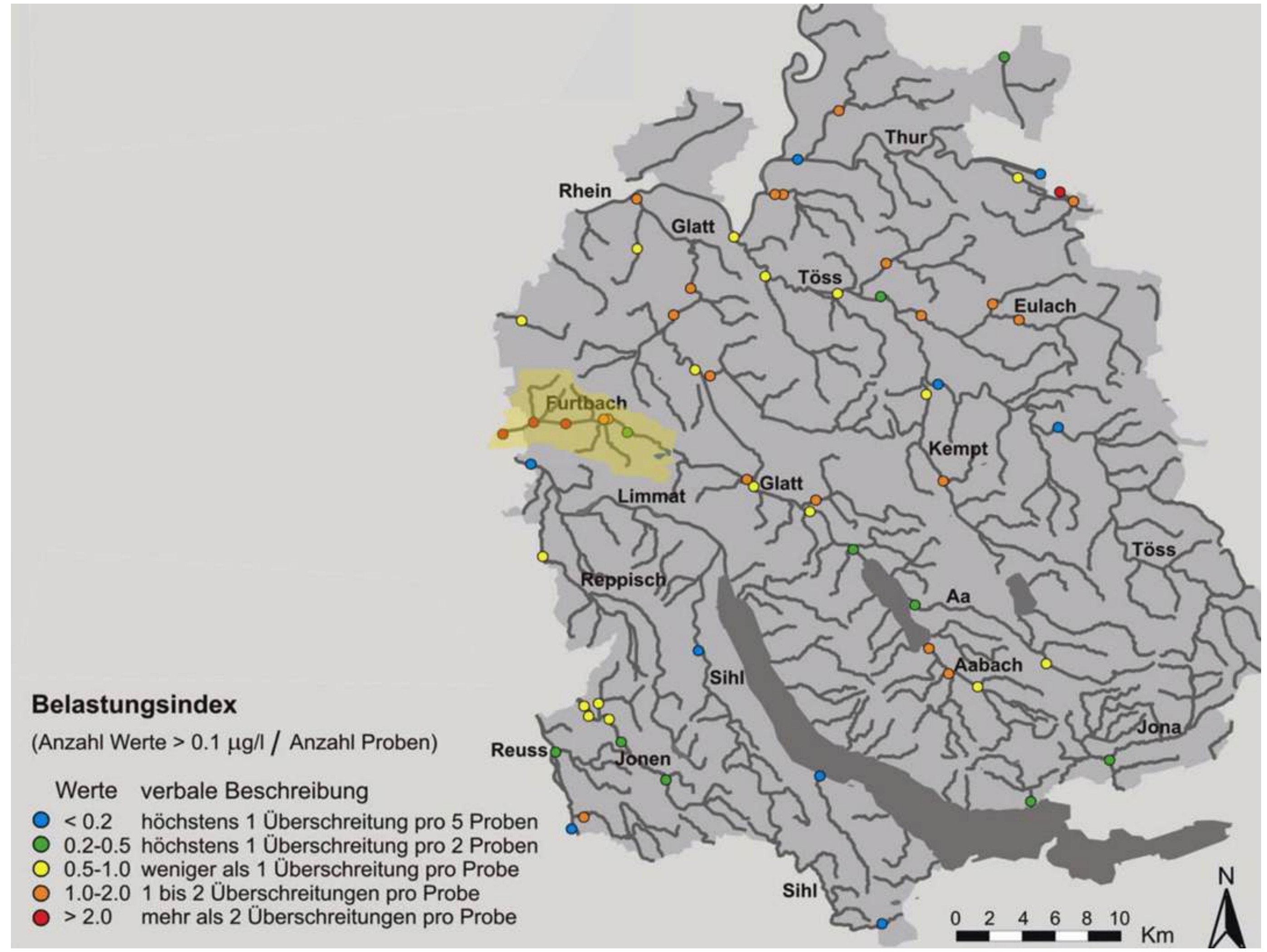


fig. 152 **Sources of pollution along the Furtbach** List of the substances observed exceeding the maximum allowed concentrations at each position along the Furtbach and its side streams. Substances marked with **red** indicate the at least double exceedence of the respective maximum allowed concentration.

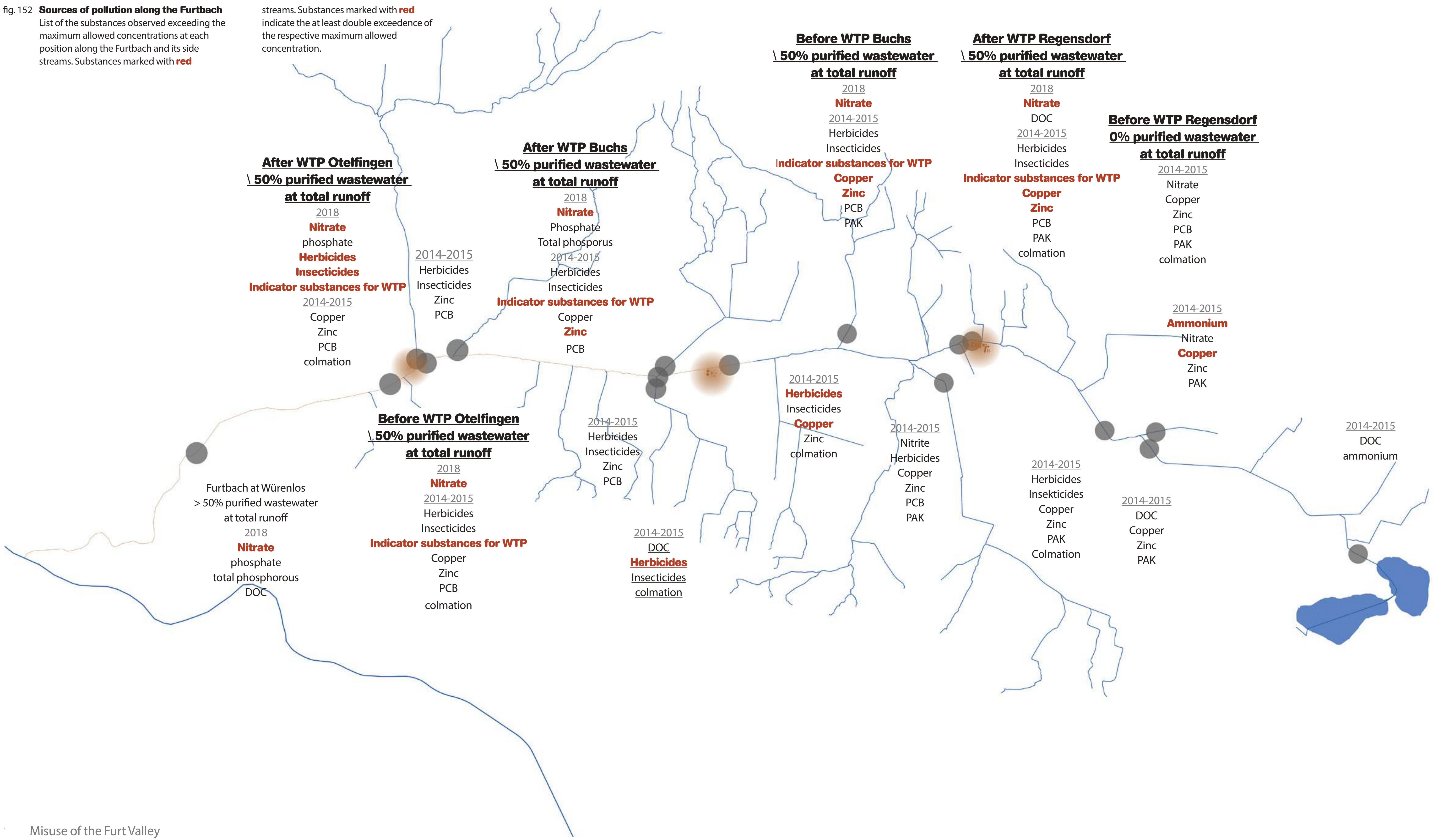


fig. 153 **Returning water back to the soil**
Wastewater from the municipalities of Buchs and Dällikon as well as the industries inbetween is being treated and returned to the soil in the wastewater treatment facility Furthof in Buchs.

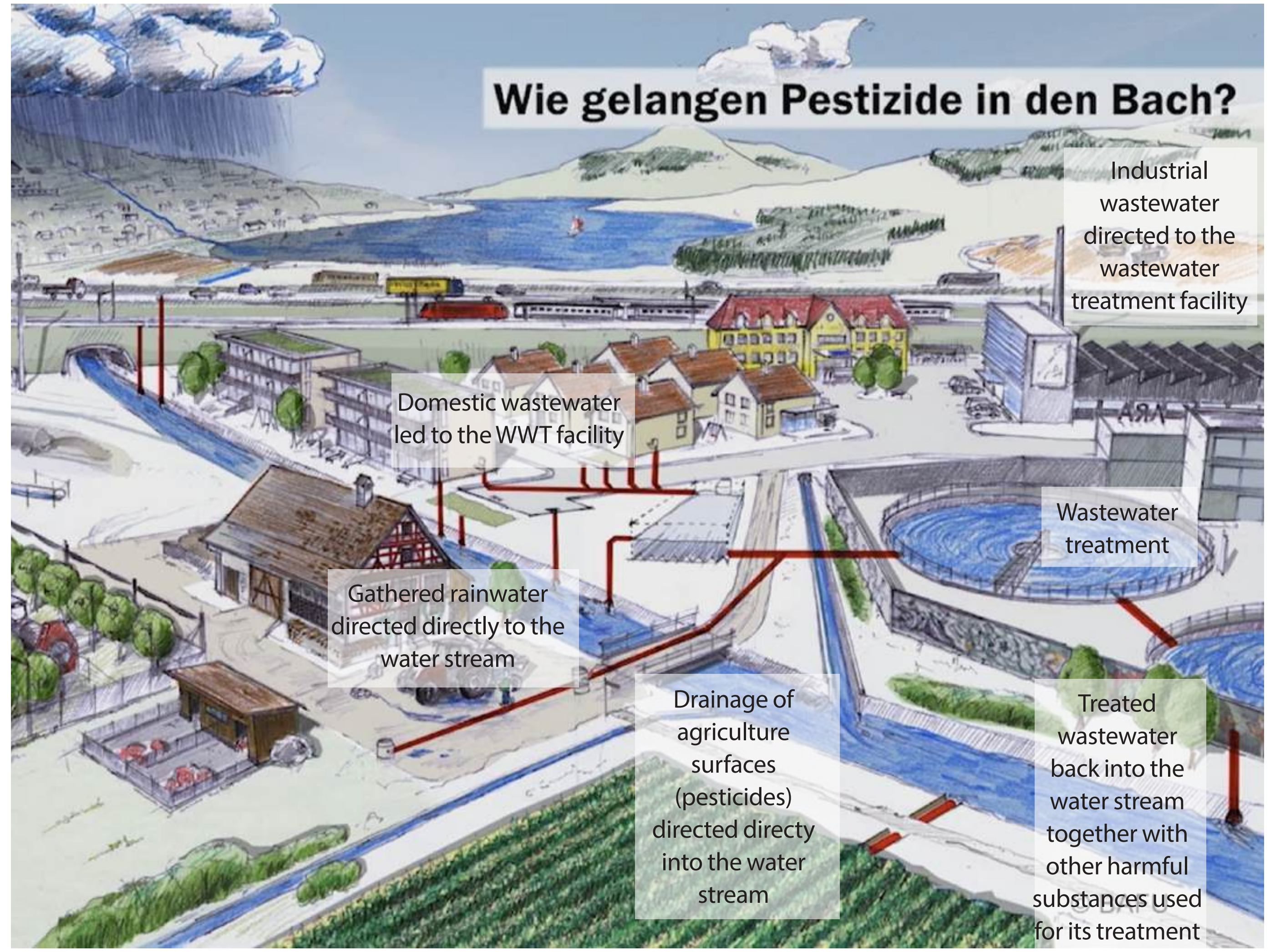
fig. 154 **Flowing Furtbach pollution**
Pollutants entering the Furtbach from a side water channel.

fig. 155 **Giving water back to the Furtbach**
Treated wastewater flows back into the Furtbach.

fig. 156 **Water pollution pipeline**
Agriculture or small residential complex drainage pipeline directing untreated wastewater directly into the water stream.

fig. 157 **Water protection attempt**
Signage on an open residential shaft warning that a river branch is flowing underneath. Aim is to prevent the passenger from throwing dirty water into the schaft.

fig. 158 **A typical urban water cycle**
Explanatory sketch of the main pollution sources for the local water bodies, applying also to the case of the Furt Valley. Source: Federal Office for the Environment (BAFU)



Current vision for the Furttal - Environmental challenges of a dynamic growth

In contrast to the Limmat and Glatt Valley, the Furt Valley has evolved less vigorously, but anticipates more growth in the future. At the end of 2017 approximately 36'000 people live in Furttal and current prognoses expect another 10'000 people by 2040. To facilitate this, a large development area is planned in Regensdorf (Zukunft Bahnhof Nord), combining an adjustment of the street network with a housing and busisness district, that should accomodate 6'500 inhabitants and workplaces.

With the increasing number of drought seasons, priority is given to the increasing drinking water demand of the population and many farmers are already faced with water scarcity. To mitigate the increasing pressure, an ongoing infrastructural project proposes a new pipeline bringing water from the Limmat River, through the Hüttikerberg, to the farmers of the Furt Valley, aims to be finished by 2020. Until then, the biggest part of irrigation water will have to be extracted from the Furtbach or the upper aquifer, which in turn is polluted from the use of pesticides and fertilizers on the surface. Due to the heavy pollution rates recorded in the Furt stream, the Cantonal Office of Waste, Water, Energy and Air (AWEL) extended the respective water concessions only until 2022, defining an exhaustion date for this water source. Nonetheless, current climate scenarios predict a higher frequency of heat waves and dry periods in the future and minimize the cooling effect of open green spaces, especially during the day, even in the Furt valley with its large unbuilt areas. Characteristic of the Furt Valley is its concentrated heat islands mostly in the aluminium glazed industrial clusters.

fig. 159 **Fast growing Furt Valley**
After the Limmattal, the Furttal is the strongest growing region of the Canton of Zurich until 2040. Regionalised population growth prognoses, 2019. Source: Statistical Office of the Canton of Zurich

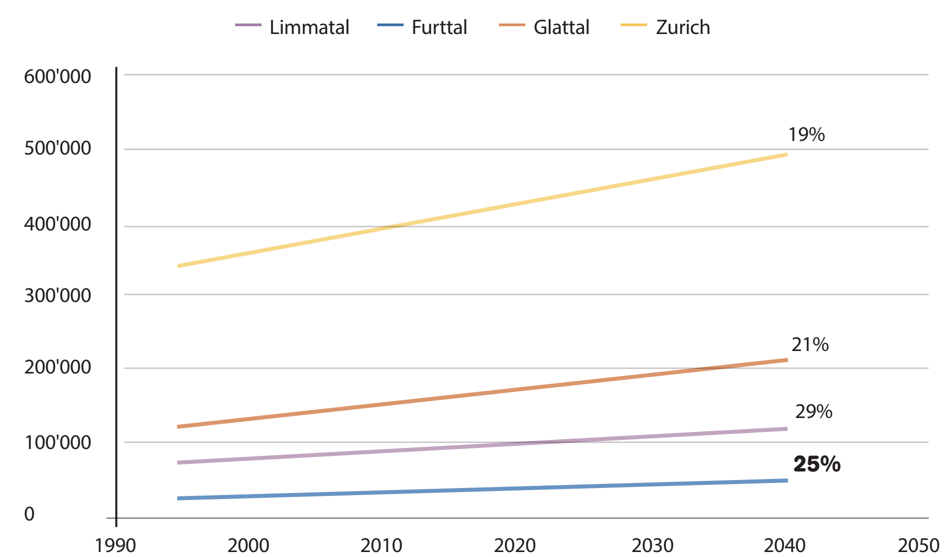


fig. 160 **Europaallee for Regensdorf**
At the approximately 215'000m² industrial area of Bahnhof Nord in Regensdorf, a masterplan with 16 building plots is being prepared. Regensdorf should develop in height and reach a density comparable to that of Europaallee in Zurich. The building permit is expected by the end of 2019.

fig. 161 **New building height for Regensdorf**
The new area around the new railway station Bahnhof Nord in Regensdorf should guide the expected population growth and create space for 6'500 inhabitants and workplaces. Over-dimensioned open public areas and high-rise buildings should give a new urban quality to the current industrial area. Visualisations from Gretag Areal.

fig. 162 **Bringing Limmat water to the Furttal** Water from the River Limmat is preferred for irrigation over water from the own aquifer of Furttal, as the latter is heavily polluted. A new pipeline should connect the Furt - with the Limmat Valley and transport water from the River Limmat over the Hüttikerberg fot the irrigation of the Furttal fields. The project is planned to start in 2020.

fig. 163 **A sizeable surf park in Regensdorf** The new 300 x 80m projected artificial lake in Regensdorf should not interfere with the upper groundwater level dutring it's construction, nor exploit the aquifer for filling the basin with water. The surf park is expecting more than 200'000 visitors per year - starting in 2020 - and it should rather be filled with water from the Limmat River.

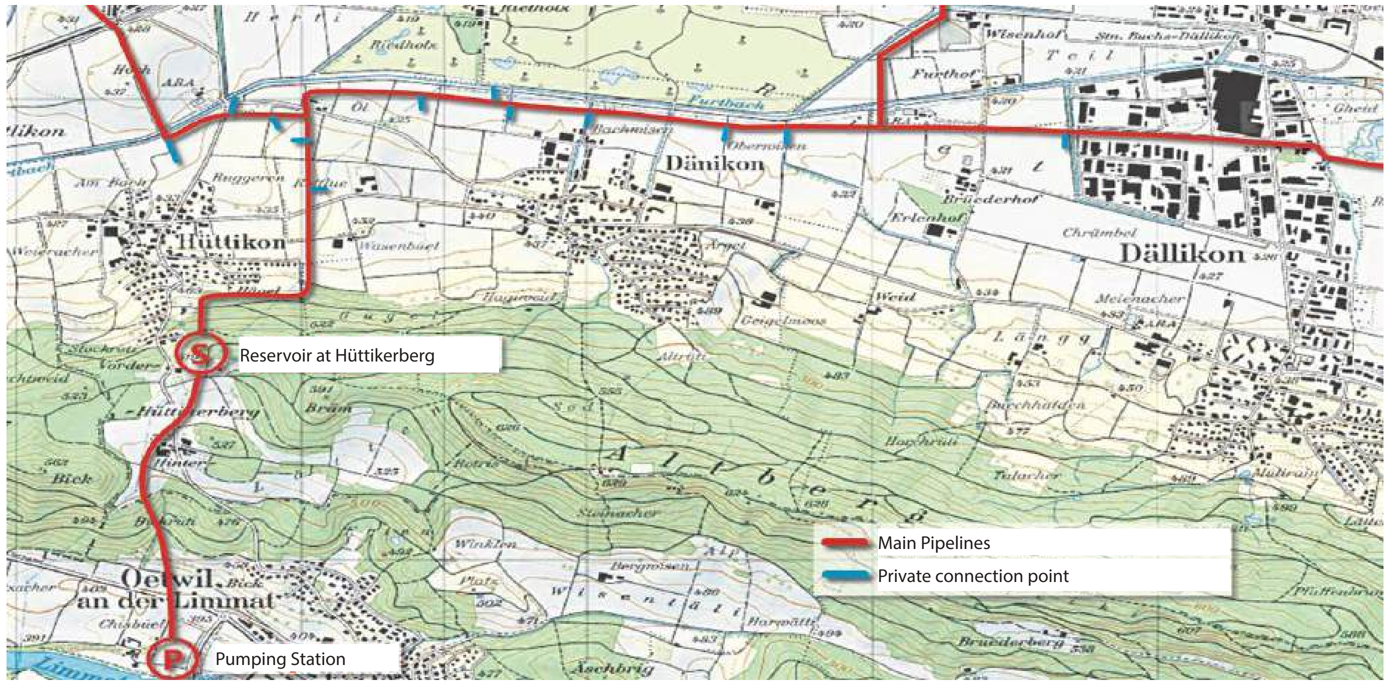


fig. 164 **Future Furttal as a heat island**
Up to 50 heat wave days per year (Tmax >= 30°C) are expected for the industrial hubs and the agricultural fields of Furttal by 2070 in the business as usual scenario. Source: AWEL

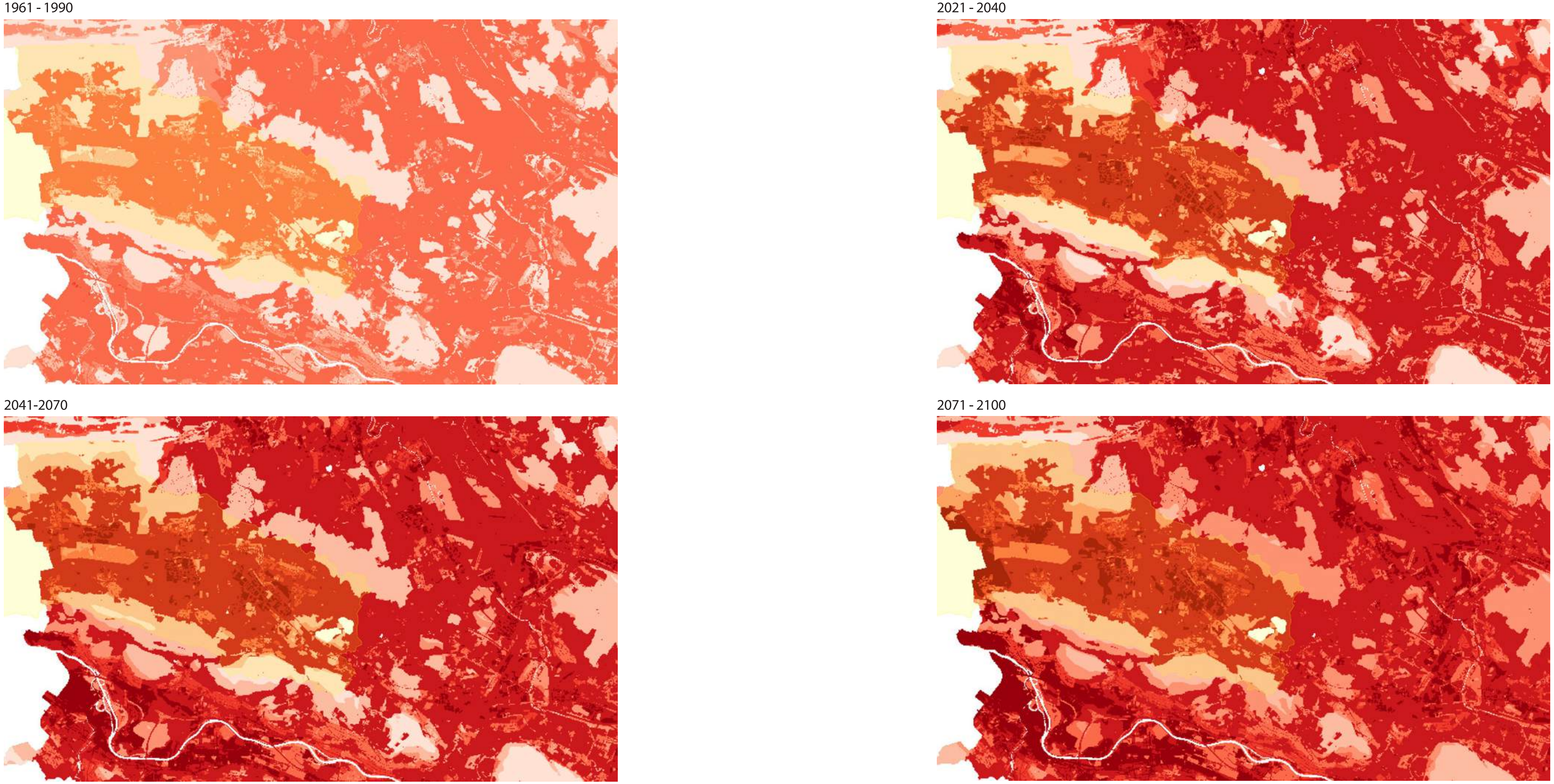
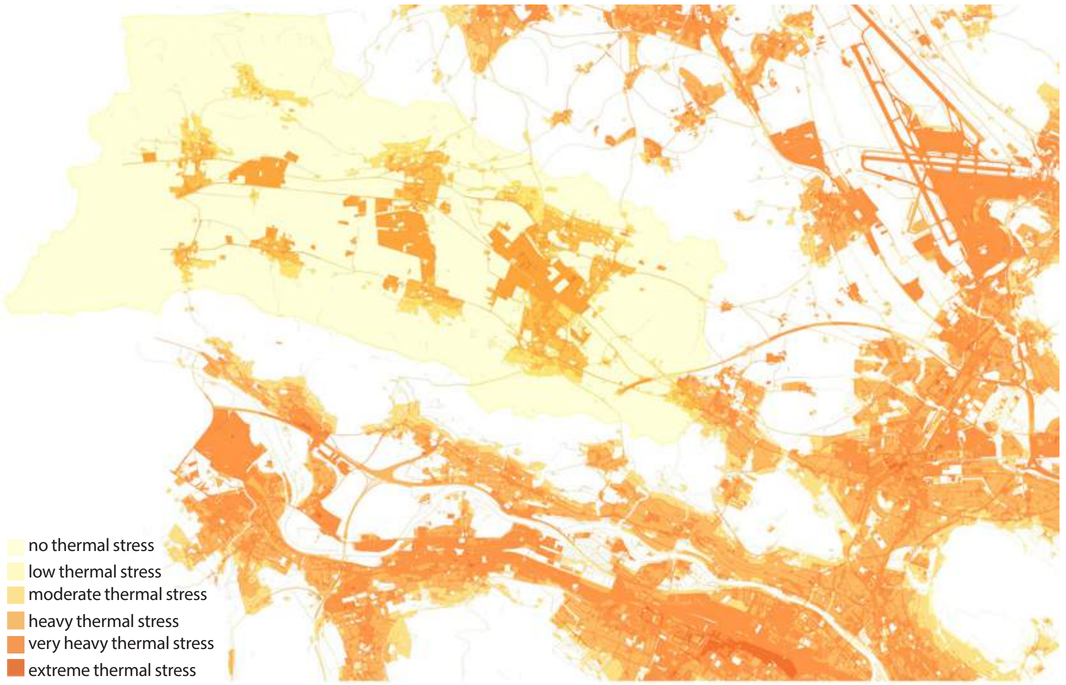


fig. 165 **Thermal stress in the built Furttal**
The denser built industrial areas have a heavier thermal stress compared to the lower density settlement areas. Measurements at 14:00 in the afternoon.

fig. 166 **Coooling islands**
Heat load relief capacity of the existing green spaces at 14:00 in the afternoon in the Furt Valley.



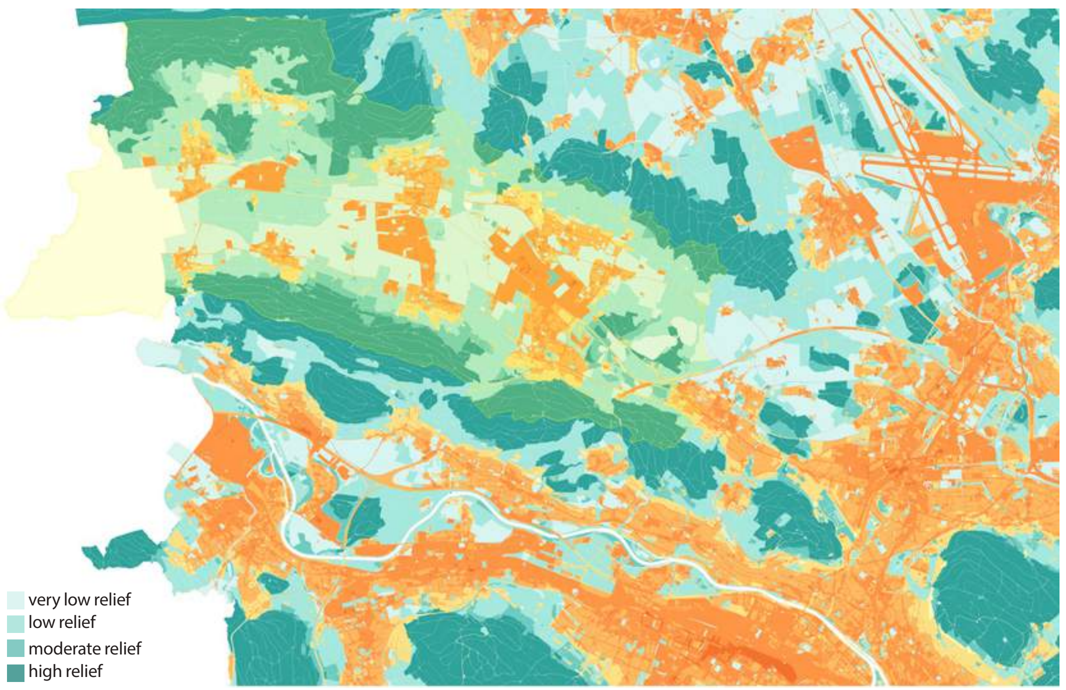
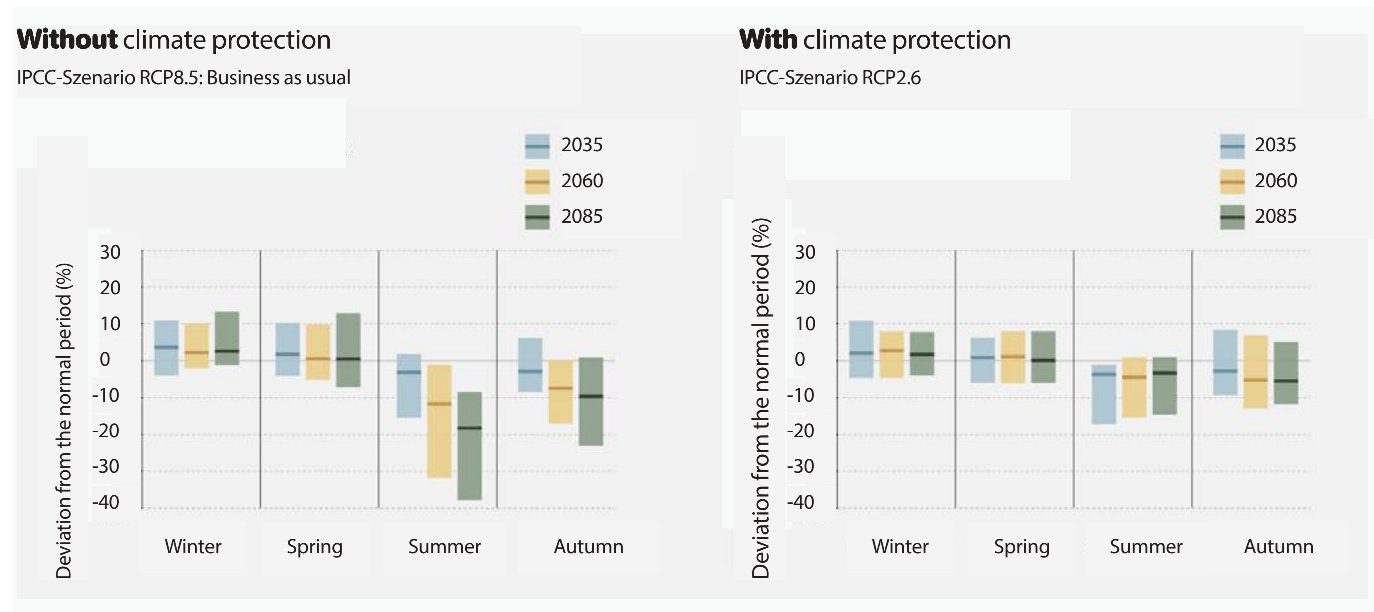


fig. 167 **Rainy days scenarios for the Furttal**
Extreme scenarios for the frequency of days with more than 1mm of precipitation - with and without measures against the changing climate.

RCP2.6: exploring the possibility to keep global mean temperature increase below 2°C. The RCP2.6 scenario assumes full participation of all countries. Cumulative emissions of greenhouse gases from 2010 to 2100 need to be reduced by 70% compared to a baseline scenario, requiring substantial changes in energy use and emissions of non-CO2 gases. These measures (specifically the use of bio-energy and reforestation measures) also have clear consequences for global land use.



Cartographic thesis on the Furttal The risks of the current development trajectories

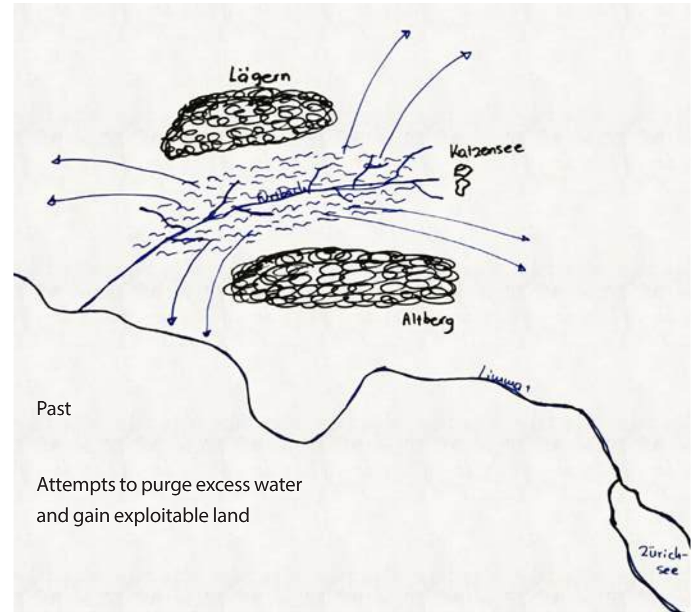
Current policies aim at bypassing the issue of of local water pollution and exhaustion by linking the communal water supply network stronger to the neighbouring, and more extensive, water network of the city of Zurich. This trajectory neglects the possibility of covering most of the regions' water demand from local sources, provided the mechanics of their natural recharge are protected. Interest of highly efficient agriculture, housing a growing population and lacking political cooperation among communes exhaust a local water cycle and thereby threaten a habitat for humans and nature alike.

Except for the visionary modernist planning "Die Neue Stadt" in the 60s, the Furt valley remained a blank spot on the map of planners in the past decades. Due to this and its peripheral location in the metropolitan region, it managed to maintain it's endemic idyllic landscape image. The unbuilt space is constituted mainly of agriculrural surfaces, protected as crop rotation areas, making the Furttal one of the largest producers of staple crops and vegetables in the region. Current visions for this region of the metropolitan area of Zurich aim to promote the quiet and less densely settled atmosphere of the valley. Nonetheless, the allure of the metropolitan area of Zurich and the industrialised practices of agriculture set an increasing pressure over land use and water resources.

The inhabitants of Furttal need clean drinking water. The crops need irrigation. The golf park needs irrigation. The waste water treatment facilities need fresh water in order to dilute the not yet completely cleared wastewater. The inhabitants of Würenlos wish for a more vivid, water - rich village stream, but also want to contain the flooding risk.The fishermen call for a regeneration of the habitat for fish, environmental protection agencies fight for a biotope for the river mussels in Watt. All the while, freshwater biologists strive to maintain the natural regenetion of groundwater, which constitutes an important source for all.

How all these contrasting interests can be satisfied and co-exist without depleting the water resources? What are the ramifications of holistic design approaches of water regenation on the landscape? Are water resources the determining factor of future urban development?

fig. 168 **A vicious cycle**
Concept sketches of the development of the Furt Valley through the times.



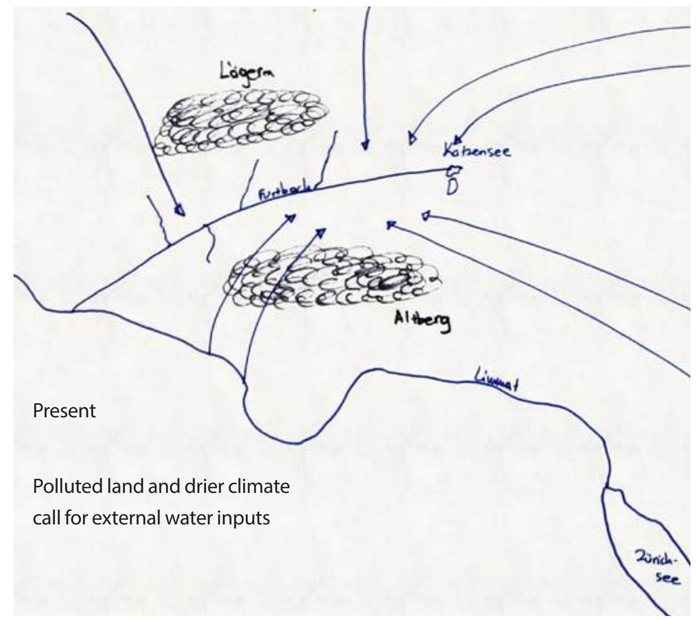
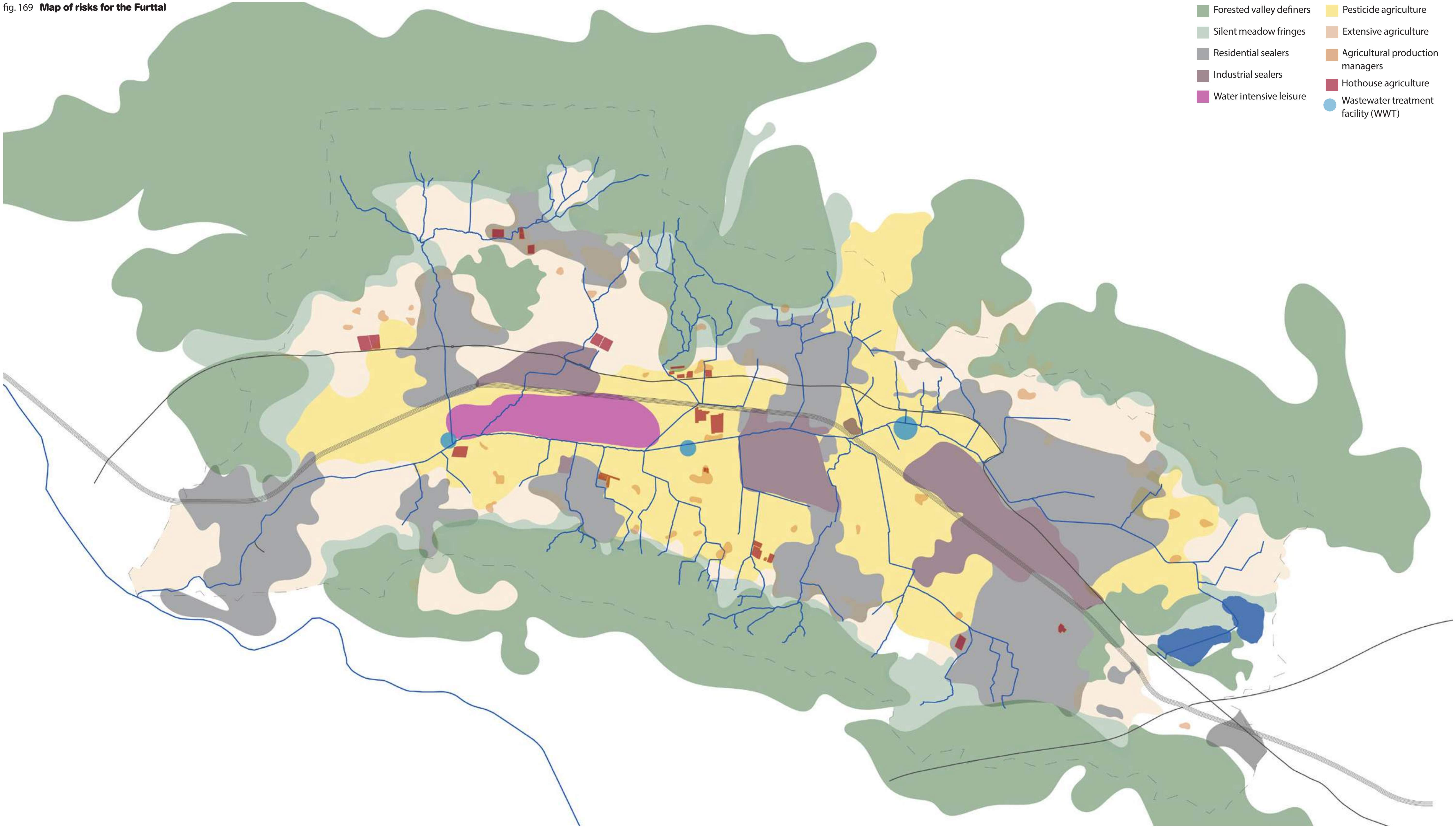


fig. 169 **Map of risks for the Furttal**



III. PROJECT HYPOTHESIS FOR THE FURTTAL

Scenario 01
Business as usual

Principal aim:	Maximize agricultural productivity, maximize urban development, promote space for new industrial activity based on the existing infrastructure
Spatial development and planning strategy:	Industrial crop region with larger areas of greenhouse cultivation, open field intensive cultivation of crops with intensive use of pesticides, new residential complexes at the foothills of Lägern and Altberg, new mixed-use complexes across the lowlands of the Furt Valley, new industrial clusters along the Furtbach Riverbanks, surfpark in Regensdorf, adventure park in Buchs, reduction of forest areas in order to use them for potential urban development
Landscape risks:	Risk of depletion of water resources due to overpumping of water, risk of heavier pollution of water resources due to high percentage of industrial activities, risk of desertification due to overpumping of the water bodies, risk of flooding due to high percentage of sealed surfaces, risk of urban sprawl due to the opening of land surfaces for urban development, risk of decrease of biodiversity due to depletion and pollution of natural resources, risk of food insecurity due to the use of the polluted water from the Furtbach watershed for irrigation

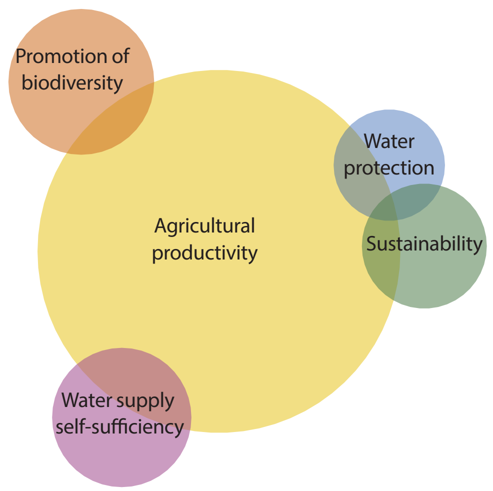


fig. 170 **Reference**
Greenhouses, Netherlands

fig. 171 **Reference**
Plain of Veyrier - Troinex - perimeter of the ZAS (special agricultural zones) in the cantonal master plan of Geneva where the installation of greenhouses should be encouraged and facilitated.

fig. 172 **Reference**
Dutch model used as reference for the planning study for the market gardening sectors of the Plaine de l'Aire and Veyrier - Troinex in Geneva.

Scenario 02
Green-tech

Principal aim: Maximize agricultural productivity by making use of renewable energy and technological innovation

Spatial development and planning strategy: High-tech valley with condensed vertical farms, surrounded by industrial and residential developments, use of the Altberg and Lägern slopes and peaks for photovoltaics, artificial channeling of water for hydroelectricity, ground source heat pumps across the lowlands of the Furt Valley for the exploitation of the big heat loads stored into the ground, potential nuclear plants on the Furt Valley, wind generators at the higher altitudes of Altberg and Lägern

Landscape risks: Risk of flooding due to the high artificiality of the landscape, risk of desertification due to overexploitation of the water bodies, risk of urban sprawl due to the opening of land surfaces for urban development, risk of decrease of biodiversity due to highly constructed landscape, risk of conflicts between farmers due to the takeover of their skilled manual work from automated processes, risk of unproductiveness of the natural soil due to the high interference on it, risk of loss of traditional leisure activities as for example hiking on Altberg and Lägern due to their occupancy for renewable energy production

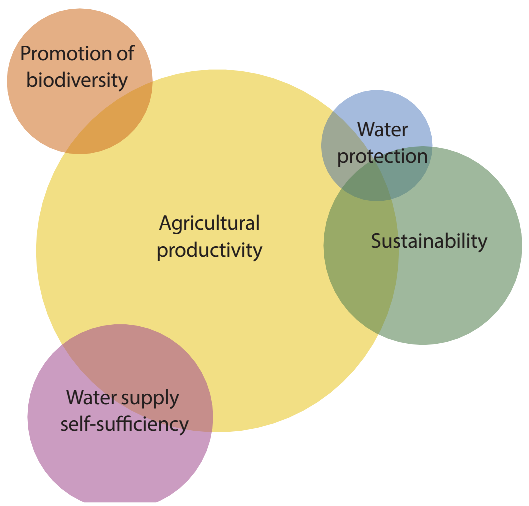


fig. 173 **Reference**
"Pig City", MVRDV, urban design proposal, Netherlands, 2001.

fig. 174 **Reference**
" 100ha high-tech farm for Shanghai", design by American architect Sasaki.

Scenario 03
Radical renaturalization

Principal aim:	Maximize the natural areas of the Furt Valley, Rewilderness of the Furt Valley
Spatial development and planning strategy:	Relocation of current industrial and agricultural practices of the Furttal to another valley in close proximity and renaturalisation of these land surfaces, mostly green surfaces will surround the Furtbach Riverbanks and the compact smaller-scale settlements of the 8 communities that will remain on the Valley, eRforestation of Altberg and Lägern, more animals and plant species in order to increase the biodiversity of the Valley, revitalisation of Furtbach and its underground chanelled water streams
Landscape risks:	Risk of food insecurity due to the relocation of all the agricultural practices currently taking place on the Furttal, risk of conflicts between the farmers due to the need to relocate and the loss of their skilled manual work, risk of conflicts between the people currently working in the industrial and logistics clusters of the Furt Valley due to the loss of their jobs, risk of flooding of the previous marshland area due to the extreme renaturalization strategy

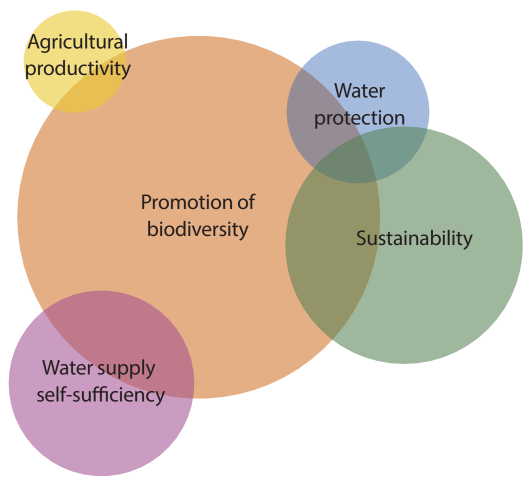


fig. 175 **Reference**
DOGMA, A Simple Heart, Architecture on the Ruins of the Post-Fordist City, Atlas of a City, 25, 2004 © Collection Frac Centre-Val de Loire, Orléans, Philippe Magnon.

fig. 176 **Reference**
Renaturation of the river Aire, Geneva, 2002 – today.

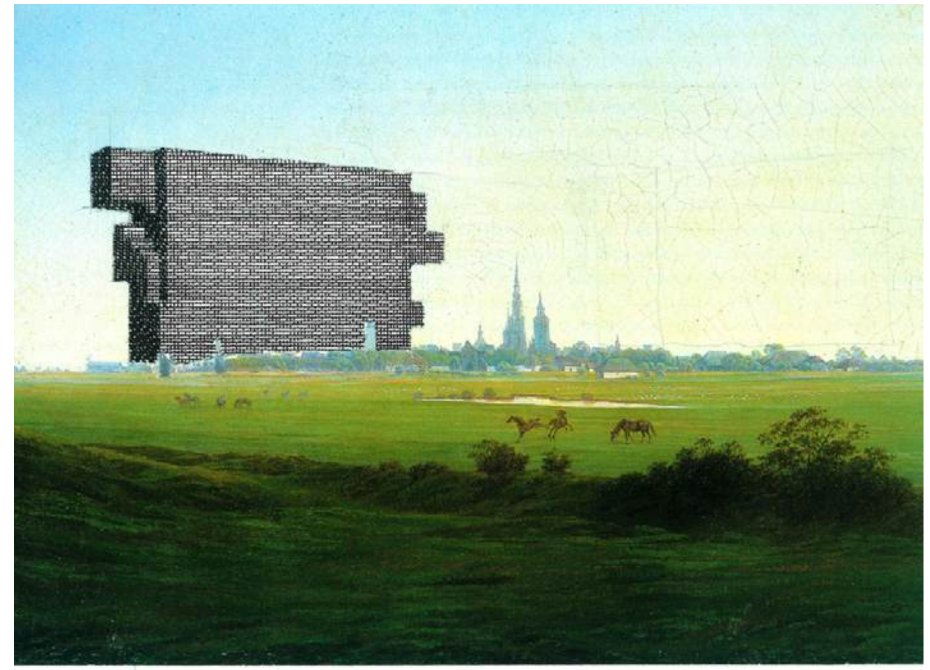
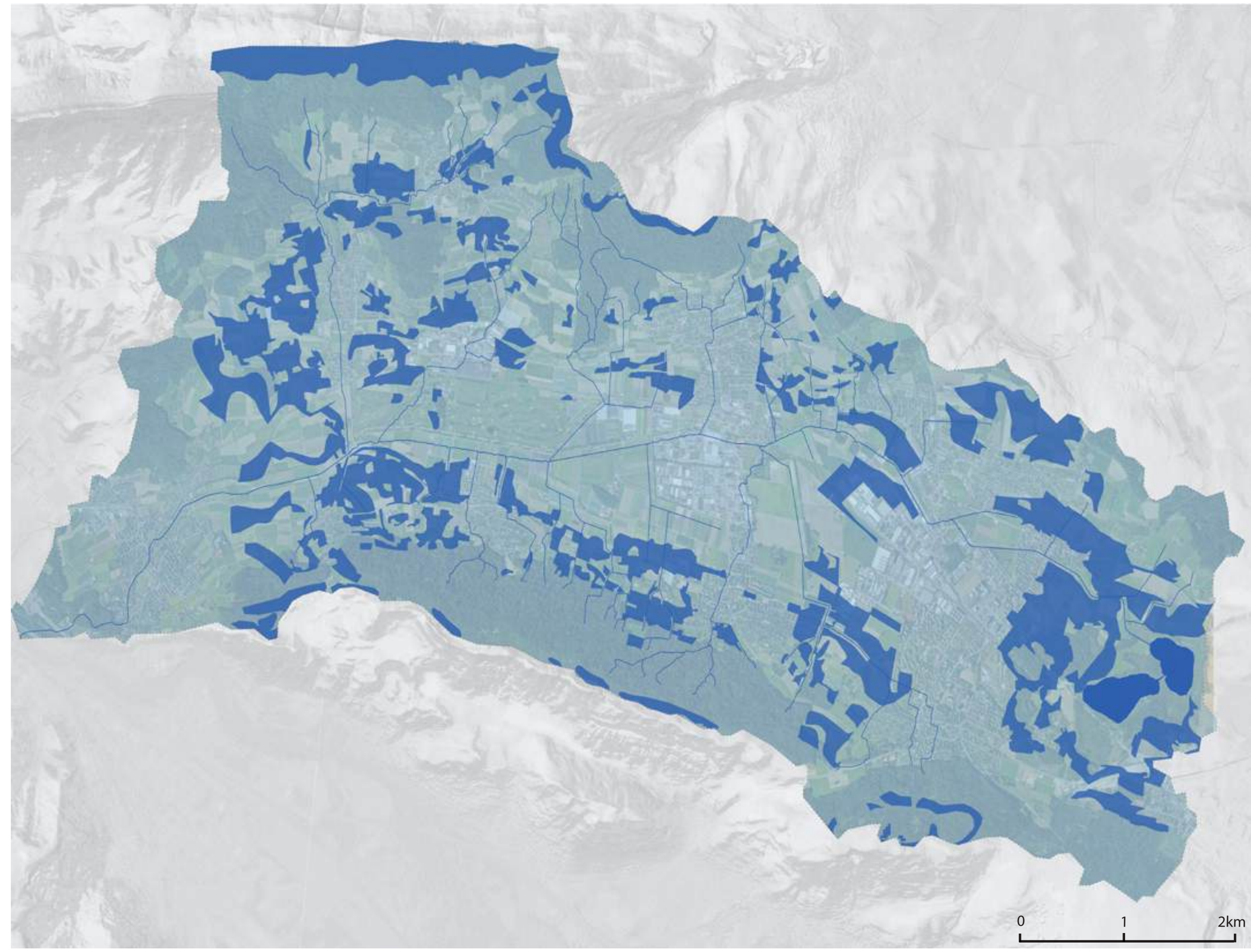


fig. 177 **Natural groundwater recharge potential**
Deep percolation areas of the Furt Valley.

Areas with great water capacity, natural groundwater recharge

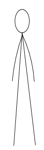


Hydropotentials for the Furt Valley - Potentials for a more resilient water supply

Proposing a hydroscopic ecology for the Furt Valley entails the exploration of the water potentials of the Valley and the corresponding land use practices which sustain and protect them. This process entails the mapping of the deep percolation areas, where soils have the greatest water storage capacity and the water slowly infiltrates and naturally recharges the aquifer. All the while, the hydroscopic approach to the territory investigates the water storage capacity and the natural water recharge cycles of both the upper and the deeper aquifer. At a second step, these numbers are compared to the present-day drinking water, irrigation and industrial water demand in order to explore different scenarios of self-sufficency in terms of local water supply. Taking into account the expected growth for the Furt Valley the calculations explore the possibility of a resilient future water supply, relying on the local water resources.

According to the soil water dynamics explored in the previous chapters, new or transformed land use practices are proposed for the Furt Valley. These promote the natural water recharge of both aquifers, all the while cleaning with time the upper - currently heavily polluted - aquifer and make resilient use of the local water resources.

fig. 178 **Water self-sufficiency potential**
Potential for a resilient, self-sufficient water supply of the Furt Valley according to the natural groundwater recharge of the two overlapping aquifers. In parallel to the mean natural recharge of the two independent aquifers, the case of an extreme wet or dry season define the maximum and minimum natural groundwater recharge respectively.



An average Swiss consumes 162 l/day for domestic purposes (cooking, drinking, washing etc)
The upper aquifer could be sustainably exploited only for drinking purposes for 143'412 people.
Today, **36'000 people** live in the Furt Valley, 2.13 hm^3, this means that current drinking water needs could be fulfilled with **25.1% of the upper aquifer's natural water recharge.**
However, this is not possible due to the heavy pollution of this upper aquifer and the conflicts with agriculture practices over the respective water exploitation.

The irrigation demand of the **250ha of crop fields** in the Furt Valley is approximately 350'000 m^3 water per year . This corresponds to 3.5 hm^3 - **41% of the upper aquifer's natural water recharge.** During **dry spells**, the irrigation demand increases up to 500'000 m^3 - **60% of the upper aquifer's natural water recharge.**

Therefore, provided that the upper aquifer is cleaned over the following years and all potential sources of pollution are minimized, it could supply both the inhabitants of the Furt Valley and the crop fields with water. As the water demand does not excced the natural water recharge of the upper aquifer, the water supply would be resilient, this means the aquifer will not be depleted.

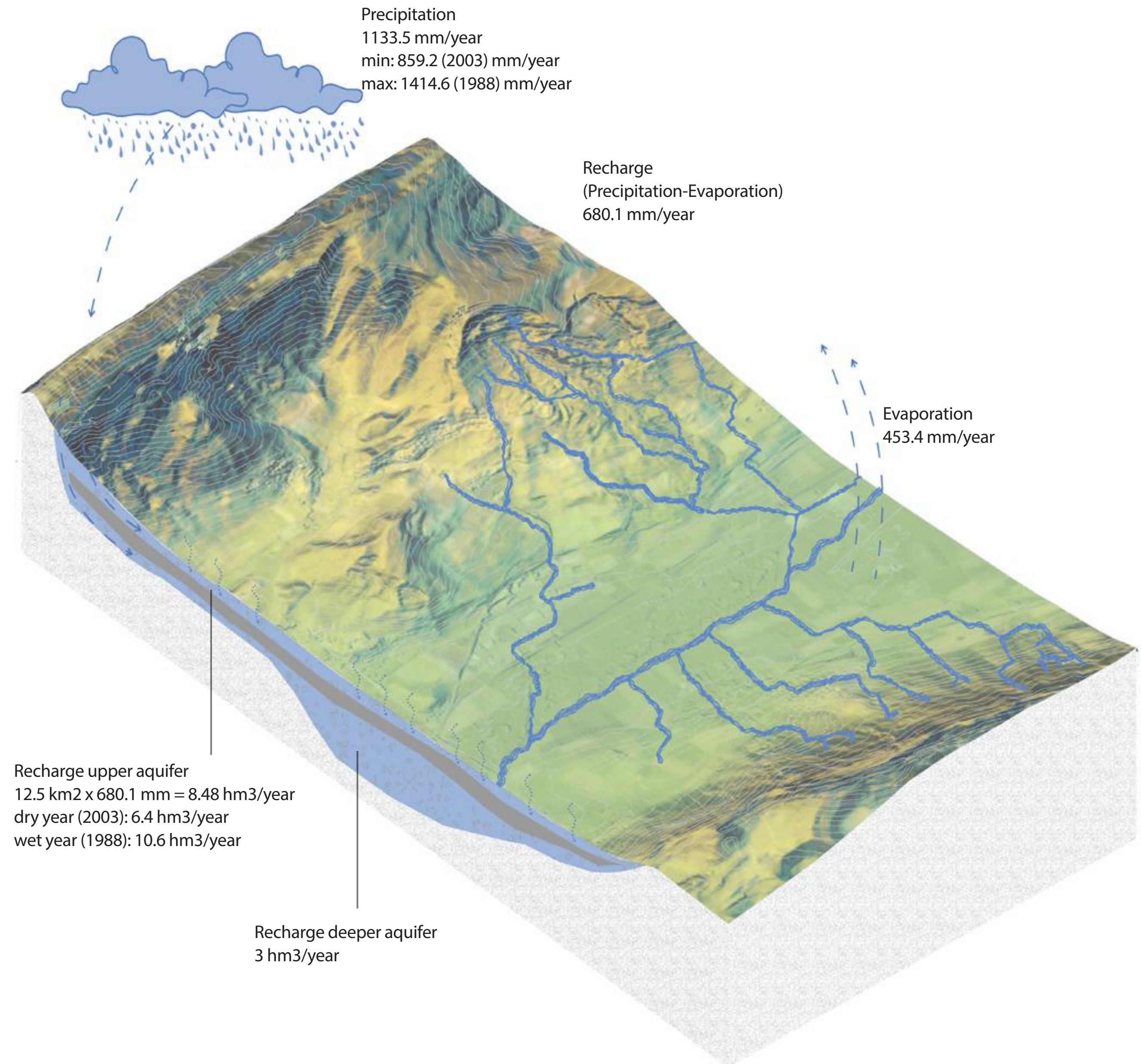


fig. 179 **Hydro- land use practices**
Potential land use according to soil water conditions in the Furt Valley.

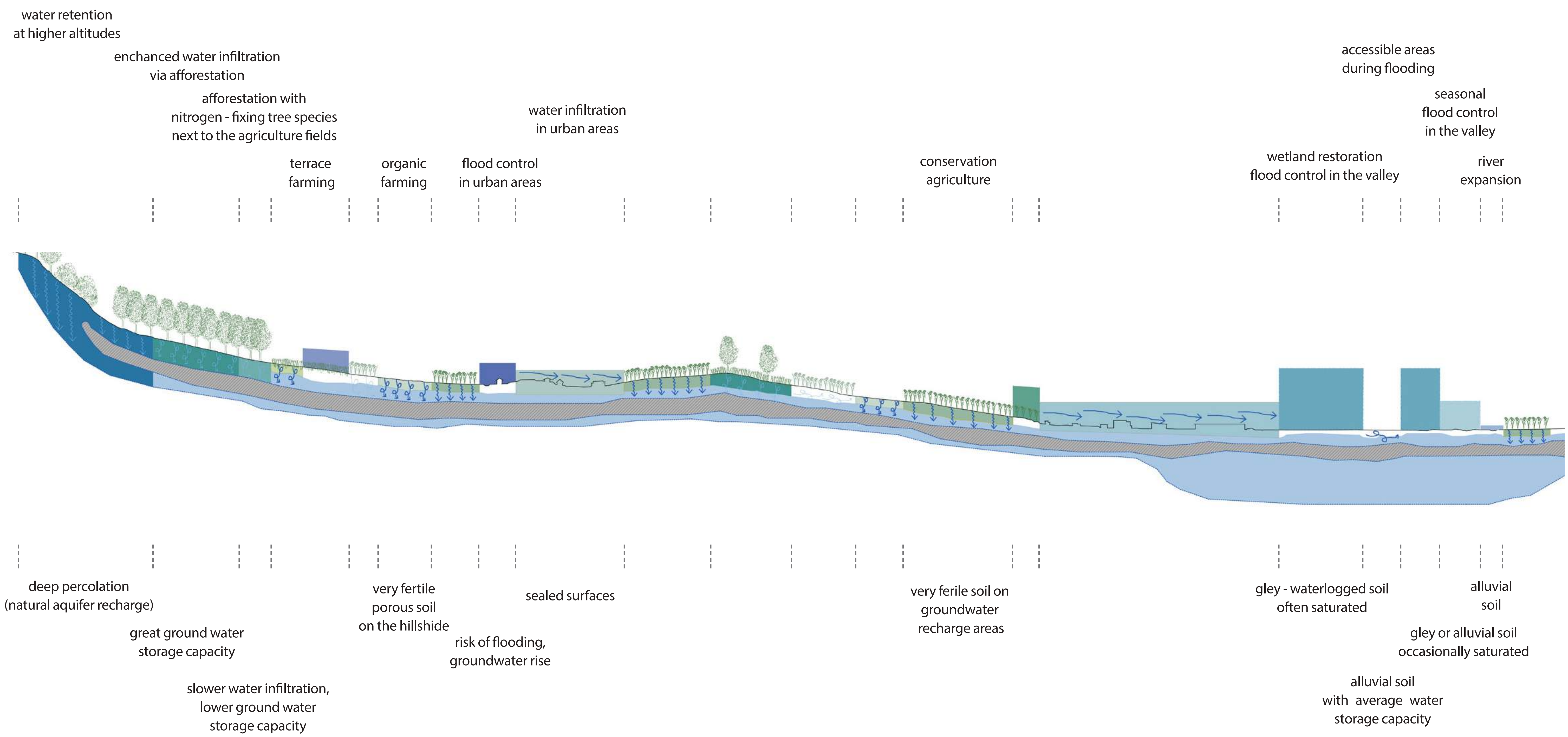
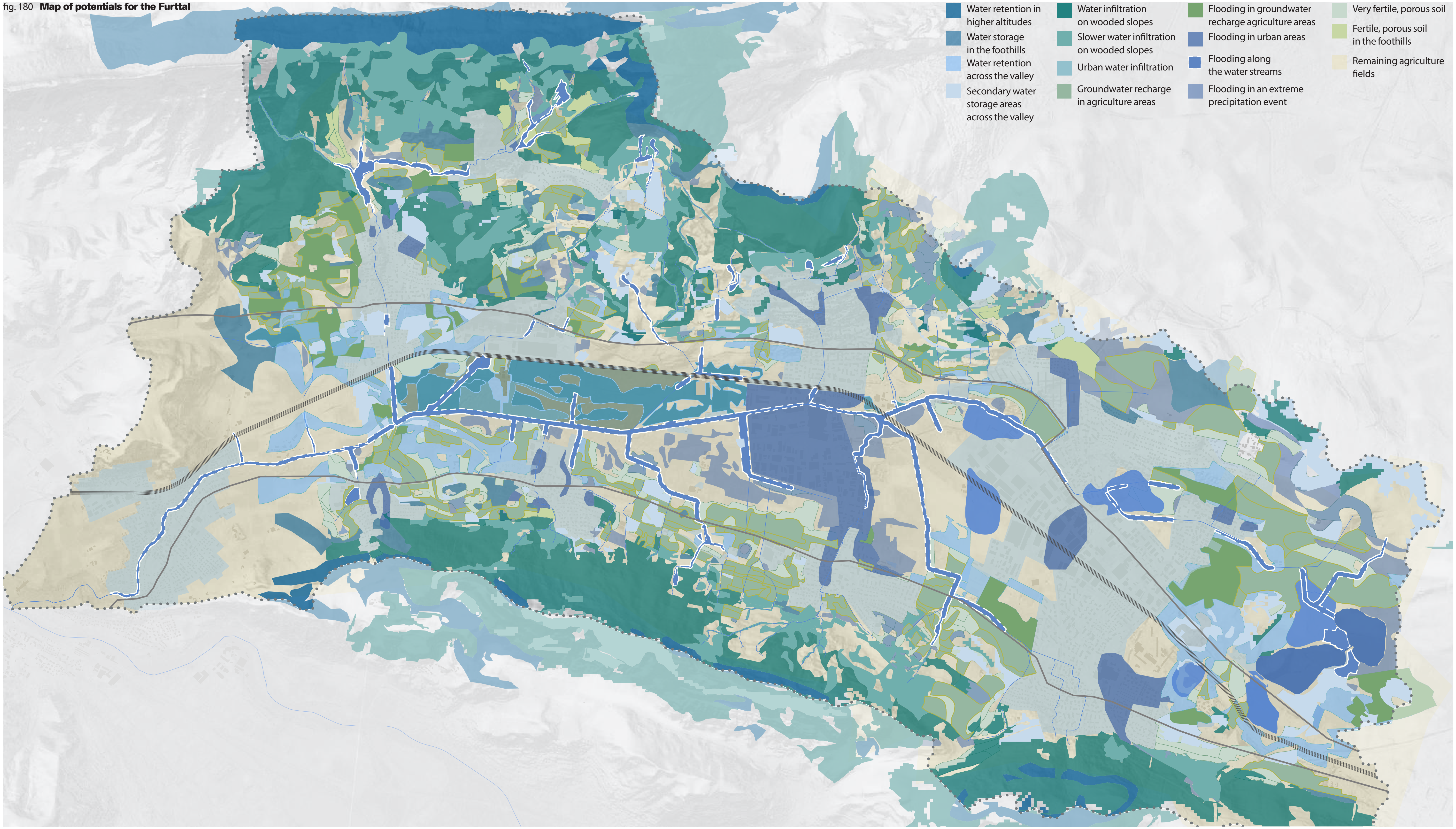


fig. 180 **Map of potentials for the Furttal**



PART B

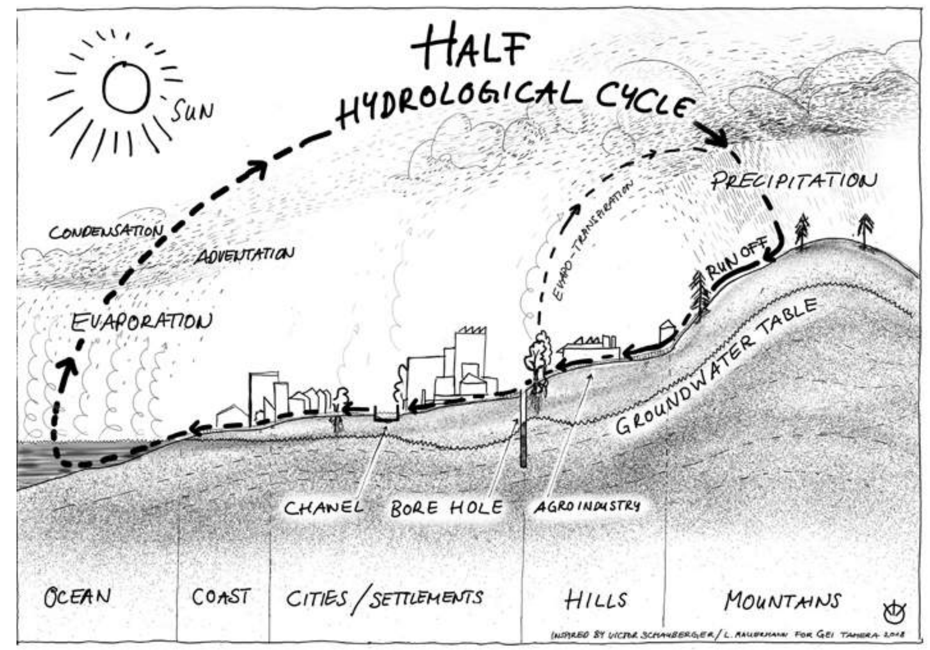
IV. HYDROSCOPIC ECOLOGY

Hydroscopic Ecology
A new approach to metropolitan water in the Furt Valley

Hydroscopic ecology as an approach to design resilient territories implies the reform of land use practices in order to protect and regenerate local water resources and restore local ecosystems. At the heart of this approach lies the retention and local infiltration of (rain) water and the shift to less polluting strategies of cultivation and urbanization. Hydroscopic ecology advances the topography, the soil and water conditions as equal design agents alongside the built environment. While currently most surface water systems are designed for most efficient drainage relying on an endless supply of fresh water, this approach proposes a cyclical understanding of the water resource: no rain and waste water should be discharged from the area. Rather it will be collected, cleaned and stored in local aquifers where it can be distributed again according to the seasonal needs, all the while retaining enough water for potential extreme weather events. Hydroscopic ecology promotes the sustainable use of local water resources by completing the hydrological cycle and ensuring the water supply of current and future demands of peripheral urban areas, taking into account their significance for food production as well as their potential for population growth.

The hydroscopic approach in the Furt Valley aims at cleaning and recharging the currently heavily polluted upper aquifer by changing the land use practices and establishing a new stewardship towards local water resources. During this process - which could last up to five to ten years - a series of secondary closed-loop water cycles will increase the self-sufficiency of the Furt Valley in terms of water supply. When the cleaning of the aquifer is completed, the hydroscopic Furttal is envisioned to be able to meet current and future water demands by having "two local legs to stand on" - two independent and thereby resilient water resources - the upper and lower aquifer. The existing connection to the group water supply of the greater metropolitan region should then only serve as an emergency solution, able to support the water supply of the Furttal in case of an extreme, at the moment unlikely scenario.

With the present land use practices, the natural water cycle has a growing deficit. Our current hydrological state is characterized by Viktor Schauberger as the "half hydrological cycle". Due to uniform vegetation patterns, deforestation and soil erosion caused by extreme weather events, the misuse of grasslands via overgrazing and the sealing of huge areas through urban development, water cannot infiltrate naturally into the soil and recharge the underlying aquifers. Instead, it flows fast towards the center of the valley, causing the water streams and areas lacking water storage capacity to flood. Additionally, through rising temperatures and more irregular precipitation, the ground warms up and even permeable areas, for example open agriculture fields or wooded areas, cannot absorb as much rainwater and cause additional run off and erosion. In this incomplete water cycle water, streams do not flow with clean spring water anymore, rather they collect and distribute muddy, polluted water. Less water infiltration corresponds to less natural aquifer recharge and falling water table, thus the system is not sustainable and the water resources will soon be depleted.



The hydroscopic approach proposed in this master thesis is a series of concepts presented through five characteristic case studies across the Furt Valley. The design concepts are based on the available geological information and typical water movement patterns. One of the basic design principles of a hydroscopic landscape - aiming to complete and restore the water balance - is the decentralized and holistic natural water management.

Excess water from the surrounding steep slopes of Altberg and Lägern which would normally flow quickly towards the valley will be held in protected areas at the higher altitudes. There, it can slowly infiltrate and recharge both aquifers underlying the Furt Valley. During drier periods, the captured water will be released and flow in the water streams towards the agriculture fields where it will be stored or directly used for the irrigation of the crops. All the while, the water reaching the underground water current - the upper aquifer of the Furttal- will find its way back to the surface in the restored wetlands at the center of the valley - the surface of the present golf park. A new leisure water landscape will remind of the historic marshlands, providing a valuable natural habitat and at the same time act as a flooding buffer for surrounding settlements and agricultural fields. Instead of draining the marshland and leading the water in the Furtbach, a landscape of deeper and shallower areas will be allowed to flood, keeping the water in the valley. Depending on the different seasons and corresponding availability of water - and taking into account the unpredictable changing climate - areas which during dry seasons will host public events or recreational activities, can flood during high precipitation and let water slowly and naturally infiltrate to recharge the aquifer. During this time, higher topographies created by the material -mostly clay - excavated during the restoration of the wetland will take over some of these activities and offer alternative access to the site.

Secondary water cycles are introduced and adapted according to the potentials of each proposed hydroscopic landscape. For example, hydrohabitats complete a resilient domestic water cycle via water reservoirs, raingardens and bioretention swales, while hydrologistics take advantage of the currently unutilised extensive roofs and mostly blind facades and transform them to green recreation landscapes mitigating the changing climate. Finally, hydrocultures are areas of cultivation that preserve the high quality of water by means of conversation agriculture enhanced with permaculture principles and controlled irrigation. Instead of exploiting the aquifer for the irrigation of the crops, rainwater stored on the different altitudes of the Furt Valley will release the stress from this water resource by flowing through the fileds, regulated accordingly by the farmers.

Together these measures can achieve a clean water supply for the valleys' residents and producers without depending on the metropolitan water infrastructure, that negates the problem of local pollution and exhaustion by shifting towards larger and less relatable scales of water supply networks. Hydroscopic ecology proposes the rethinking of the concept of the "Wassergenossenschaft" and proposes a more resilient scale of local water supply through the design of hydro-synergies among the different actors of the valley based on the availability and potential capacity of the local water resources.

fig. 181 **Hydroscopic ecology**
Concept sketch

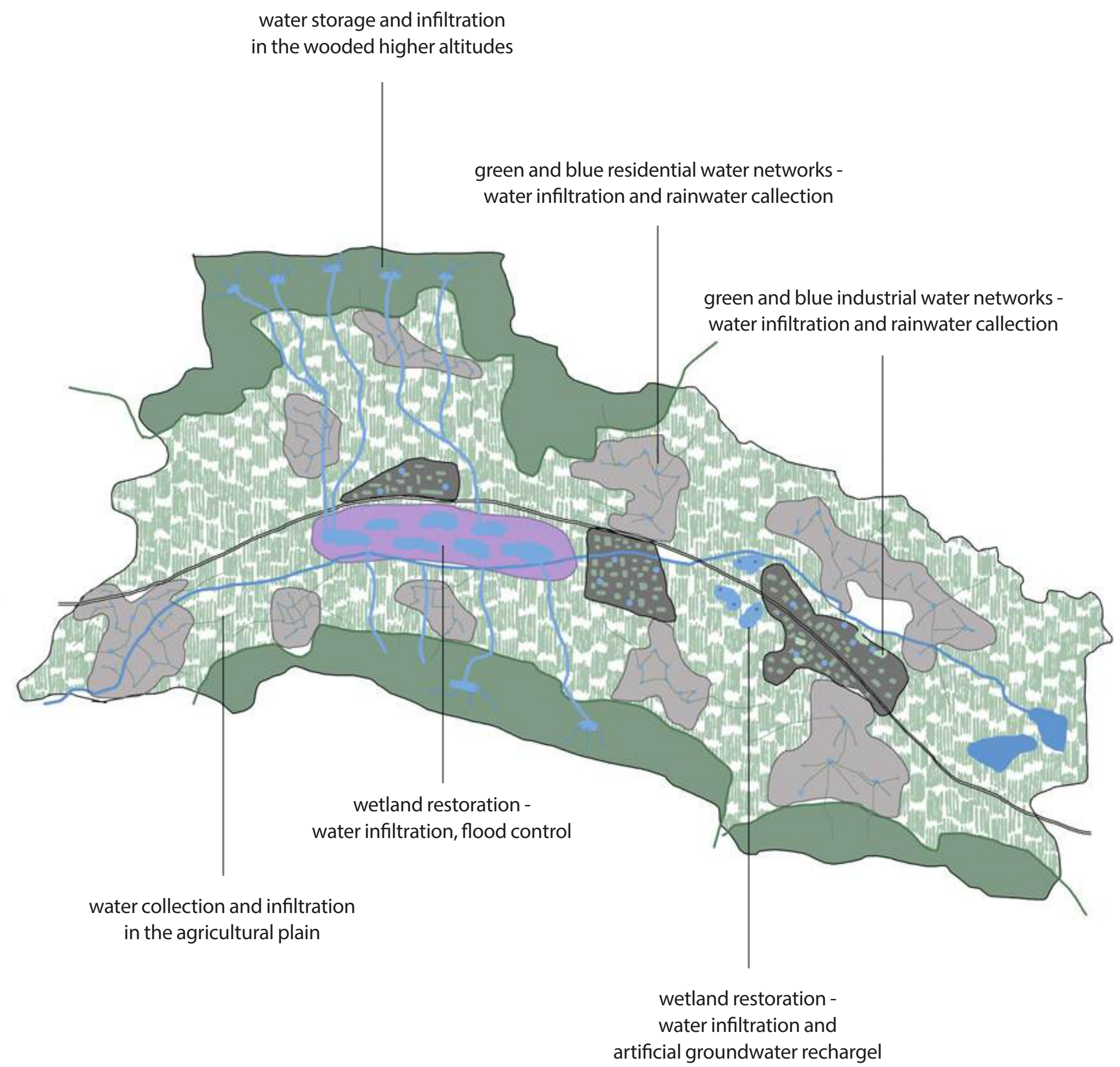
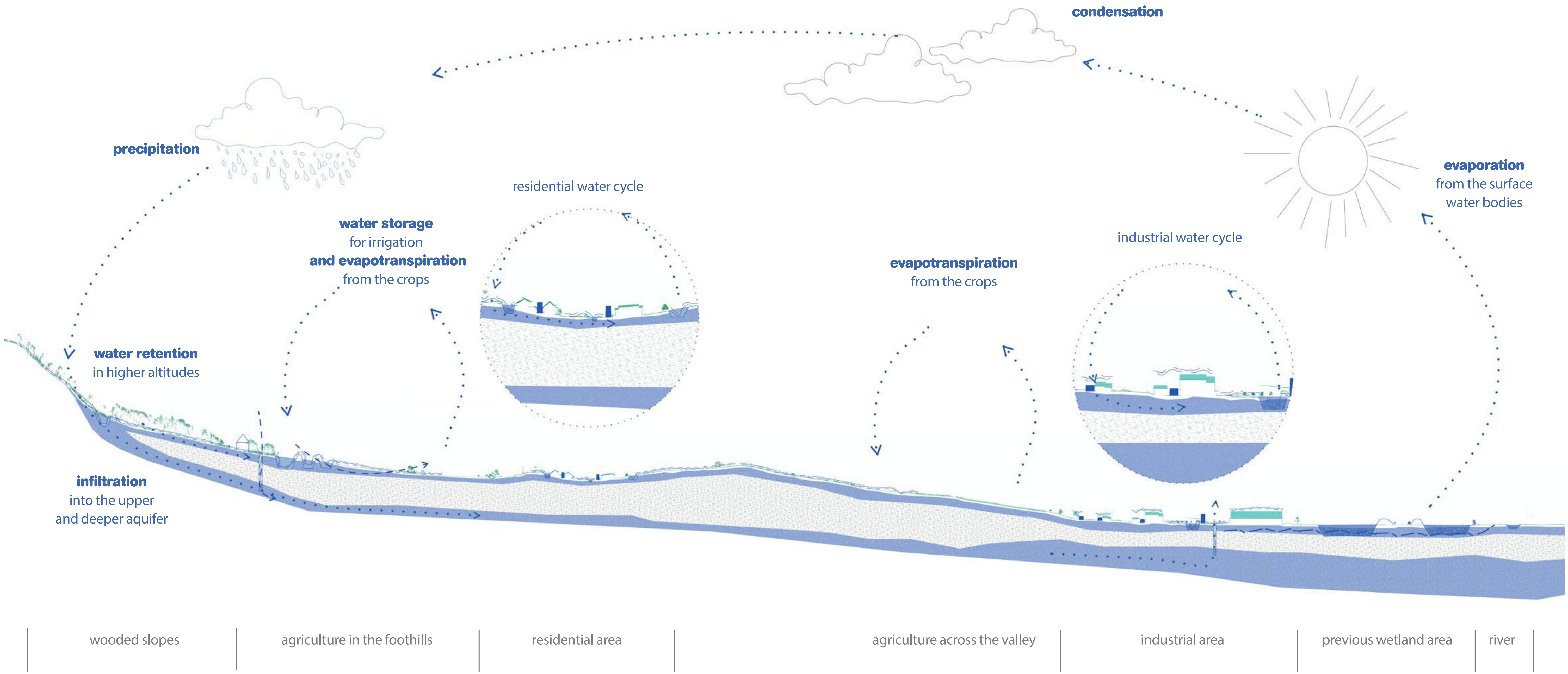


fig. 182 **Towards a complete hydrological cycle**
The case of the Furt Valley as a hydroscopic landscape.



precipitation + irrigation +water retention + rainwater capture +artificial recharge = water infiltration + water extractions + evapotranspiration

fig. 183 **Hydroscopic Furttal**
Plan of an exemplary segment of the hydroscopic Furt Valley.

The hydroscopic approach in the Furt Valley aims at completing the hydrological cycle through five design strategies - case studies.

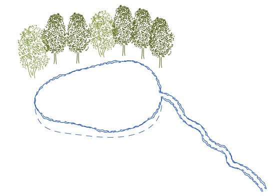
1. By storing excess water in the **hydrostewards** - water retention lakes on the higher altitudes, in deep percolation areas, this means in areas where the water slowly infiltrates in the soil and naturally recharges the aquifer. In the hydrostewards the stored water recharges both aquifers (the upper and the deeper). The level of water is controlled by small dams built with the excavated natural material.

2. By preserving water in the **hydrocultures** across the valley. The water stored in the hydrostewards flows in water courses towards the valley through the cultivated fields. The water flow is slowed down in terraces in the valley fringes, from where it can be used used directly for the irrigation of the crops or stored temporarily. At this point, the water flowing from the higher altitudes could also be used for the production of hydropower. In order to clean the upper aquifer over the following years, conservation agriculture practices are proposed at first in the deep percolation fields - fields where the water penetrates into the aquifer. Permaculture principles enhance the water infiltration in these fields and at the same time reduce evapotranspiration from the crops.

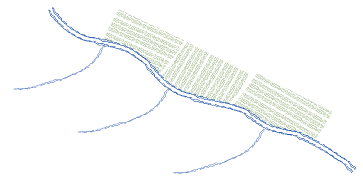
3. By harvesting and reusing rainwater in the **hydrohabitats**. With public and more private raingardens, with private water reservoirs and with bioretention swales parallel to the main streets of the communities, rainwater is collected and surface runoff from the sealed surfaces is minimized. The collected rainwater can be used by the hydrohabitats for the irrigation of the gardens or other activities, such as car washing or infiltrates into the upper aquifer - already filtered by the appropriate vegetation in the raingardens and swales.

4. By reducing the water runoff from the sealed surfaces and creating more permeable industrial landscapes in the **hydrologistics**. Evapotranspiration from the green roofs cools down the buildings and creates a more pleasant working atmosphere. All teh while, constructed wetlands filter out the pollutants and let water infiltrate into the upper aquifer.

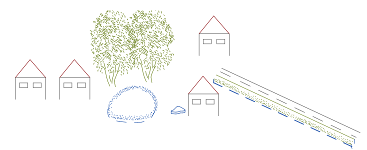
5. By restoring parts of the previous wetland in the **hydrocommons**. Water is kept into the valley and is allowed to flood according to the different seasons and levels of water parts of the new recreational water landscape. Among its recreational value, the collected water naturally recharges the upper aquifer. All the while, it can be used by the farmers for the irrigation of their crops. By implementing water fuel cells, the accumulated water could also be used for renewable energy production.



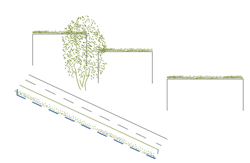
1. Hydrostewards



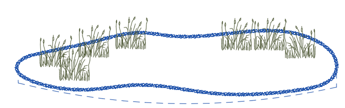
2. Hydrocultures



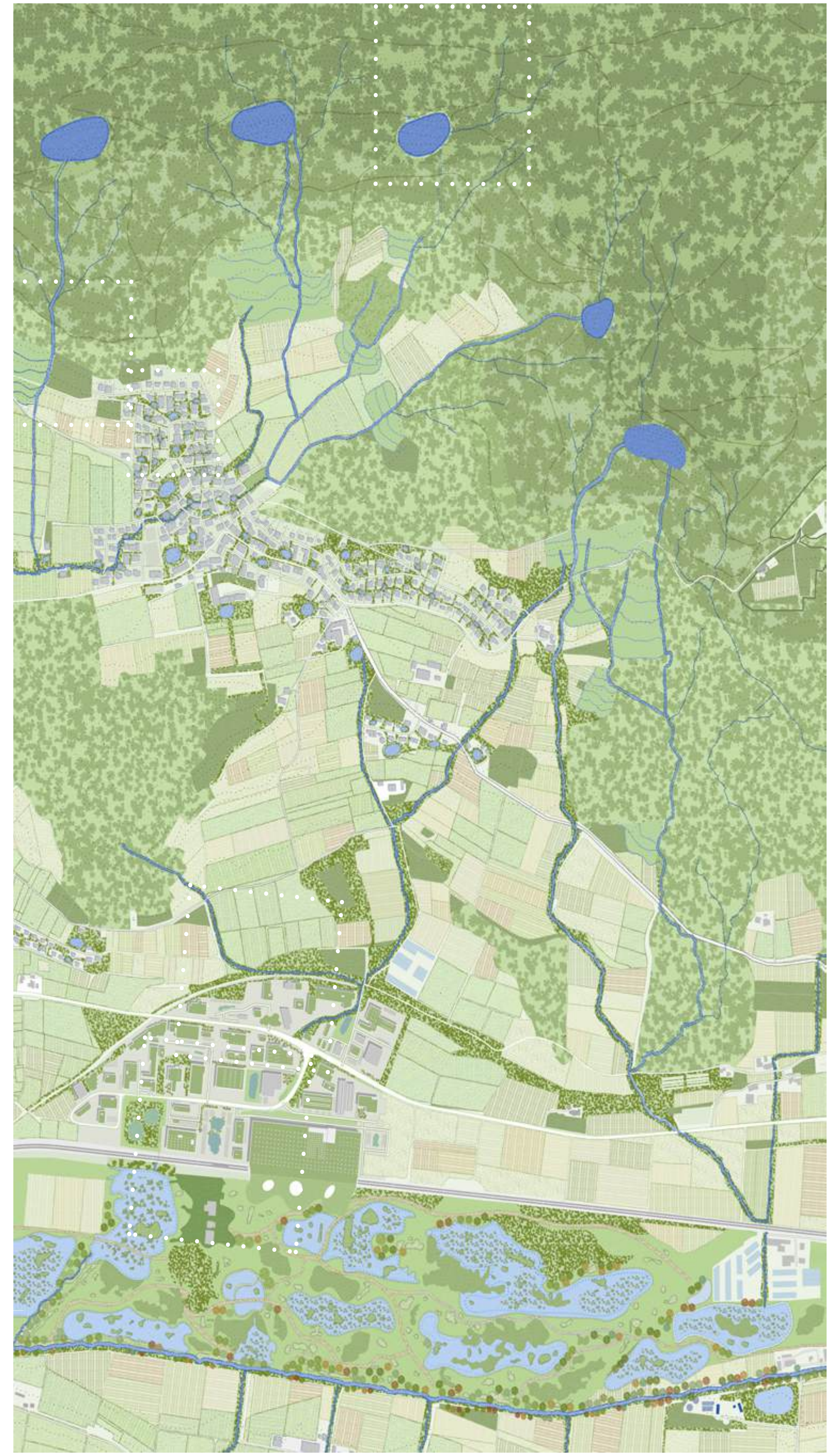
3. Hydrohabitats



4. Hydrologistics



5. Hydrocommons



1. Hydrostewards
Water retention landscapes at higher altitudes

The natural recharge of both the upper and the deeper aquifer begins at the higher altitudes of the mountain ranges Altberg and Lägern. Areas where the water infiltrates into the soil and reaches the ground water table are defined as deep percolation areas. The aim of the design of lake-sized retention landscapes in these areas is to store every form of precipitation - rain and snow - at the higher altitudes. In this way, water which otherwise would flow fast towards the valley and intensify soil erosion on the steep slopes will be held back and recharge both the upper and the deeper aquifer of the Furt Valley. The risk of flooding during the expected frequent and intense precipitation events will be thus also minimised. Water stored during wet seasons will then be used as a reservoir for the following dry and warmer seasons. Either by artificial regulation of the water flow in underground pipelines or by opening the small dam gates on the water retention lakes, water will flow in the streams towards the valley. The water dams holding the water back into the retention lakes will be constructed with the natural materials excavated during the construction of the lakes. At the foothills, agriculture fields will use the flowing water for the irrigation of the crops.

These water retention landscapes have to maintain a pristine water quality and will therefore be declared nature reserves so any potential pollution of the surface water can be avoided. The quiet water landscapes will shape biotope networks where local fauna and flora species can blossom. Although they will not be public attractors, wanderers will still pass by and have at specific points through the existing hiking trails.

Another principle of the hydrostewards is that of afforestation with more mixed composition of indigenous tree species maintaining a more porous top layer of the soil, that can store more humidity and thus create a forest that is able to tolerate longer dry periods. The aim is to support the water retention and natural recharge of the aquifer all year long. All the while, mixed forest, with species that grow deep root systems, will will restore the currently eroded soil and contribute to the mitigation of the changing climate, preventing further erosion.

fig. 184 **Potential areas for the hydrostewards**
The chosen case study and further areas for the implementation of the water retention concept of the hydrostewards.

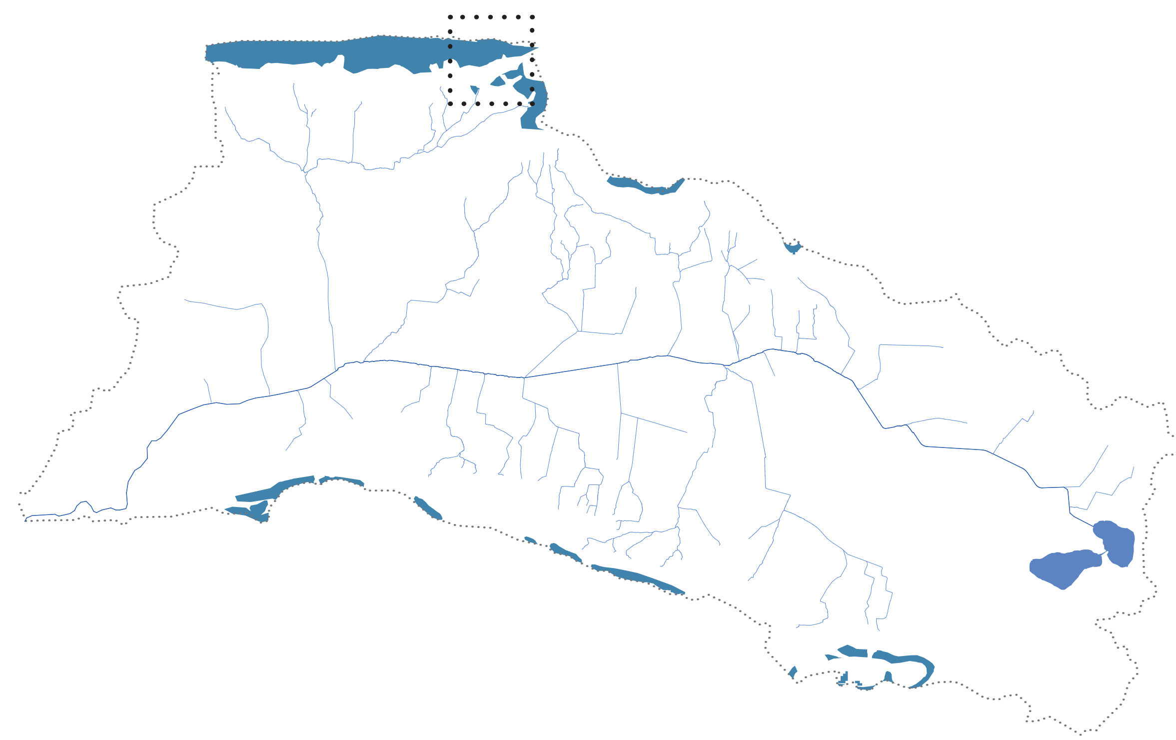
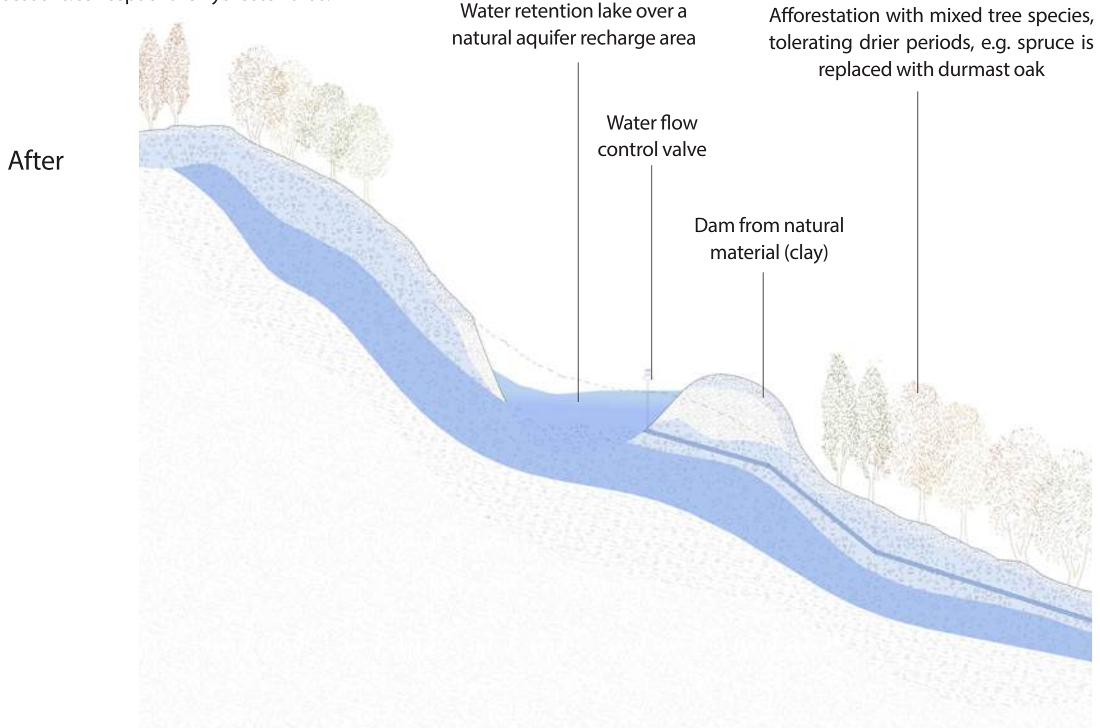


fig. 185 **Storing water in the hydrostewards**
Water retention lakes with dam operators on the higher altitudes of Lägern and Altberg serve as stormwater reservoirs during wet seasons.concept of the hydrostewards.



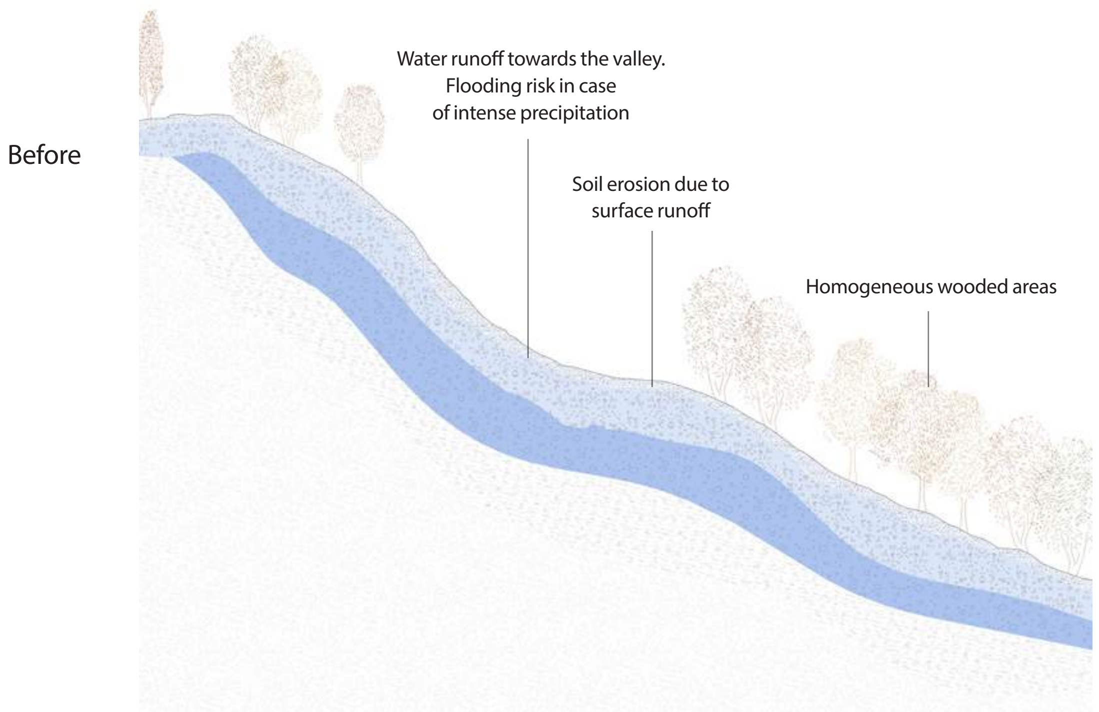


fig. 186 **Hydrostewards in the hydrological cycle**
Potential areas and the role of the hydrostewards in the hydroscopic Furt Valley.

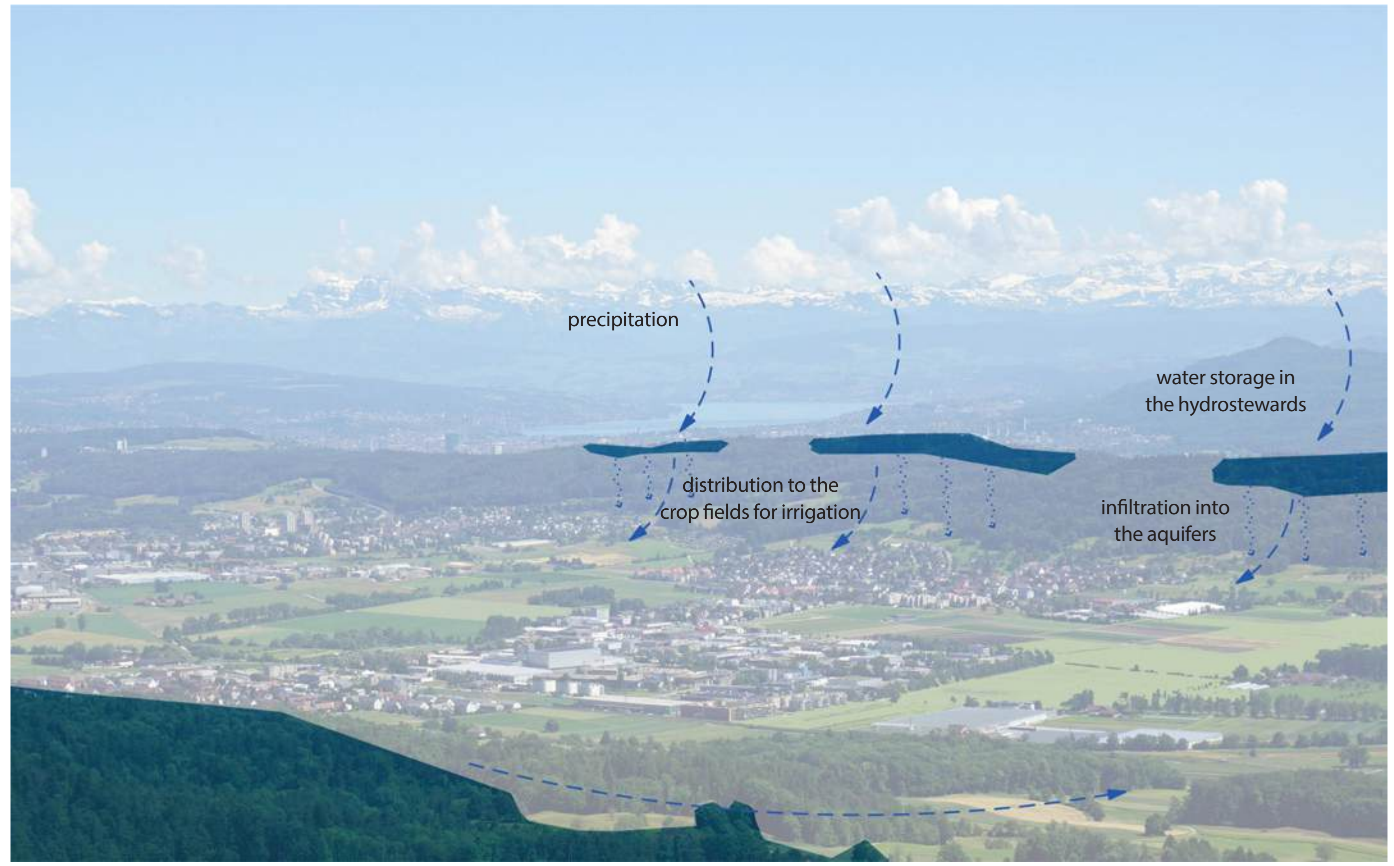


fig. 187 **Water retention on the higher altitudes**
According to the seasonal water level, the water flows in the streams, towards the Furt Valley.

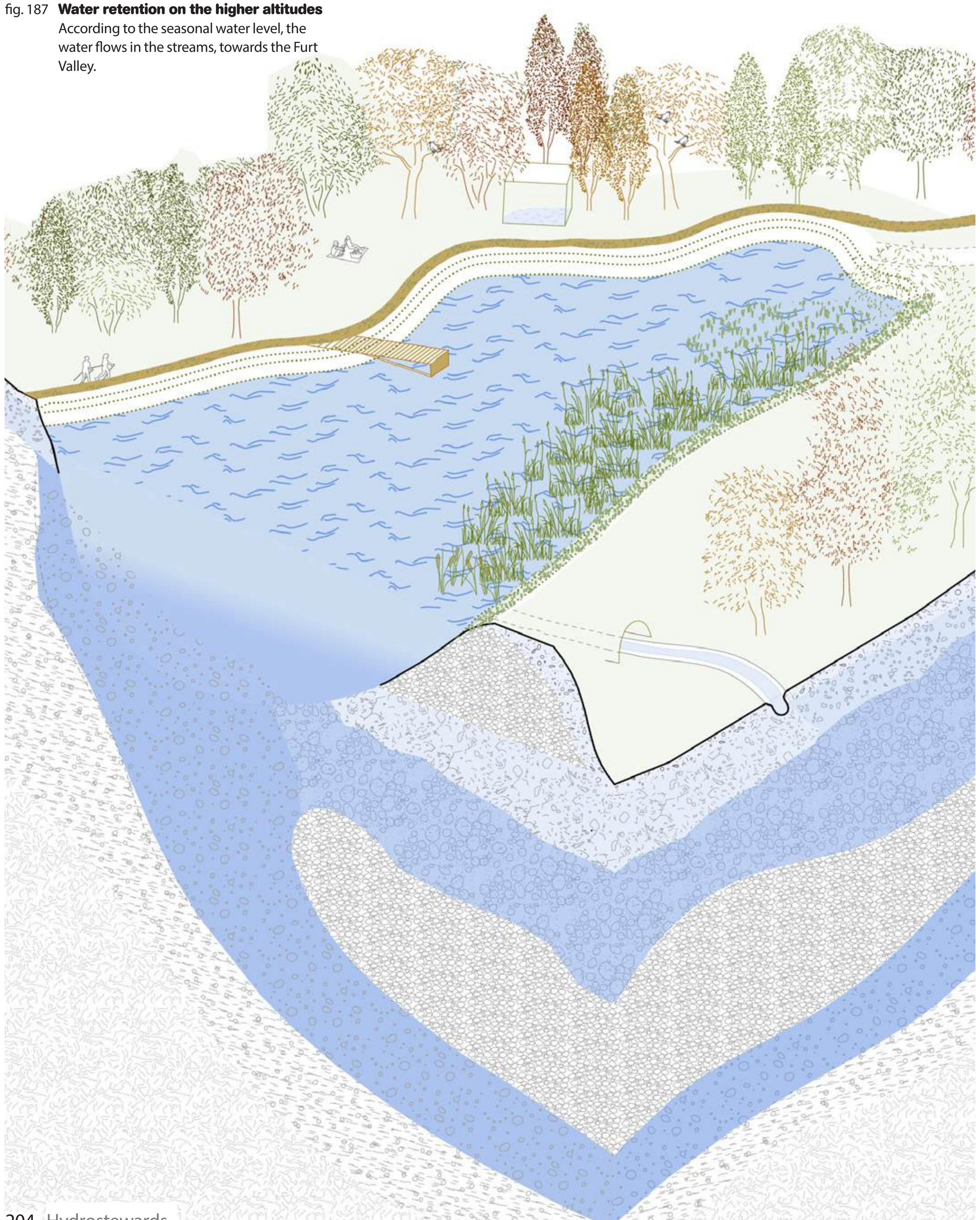
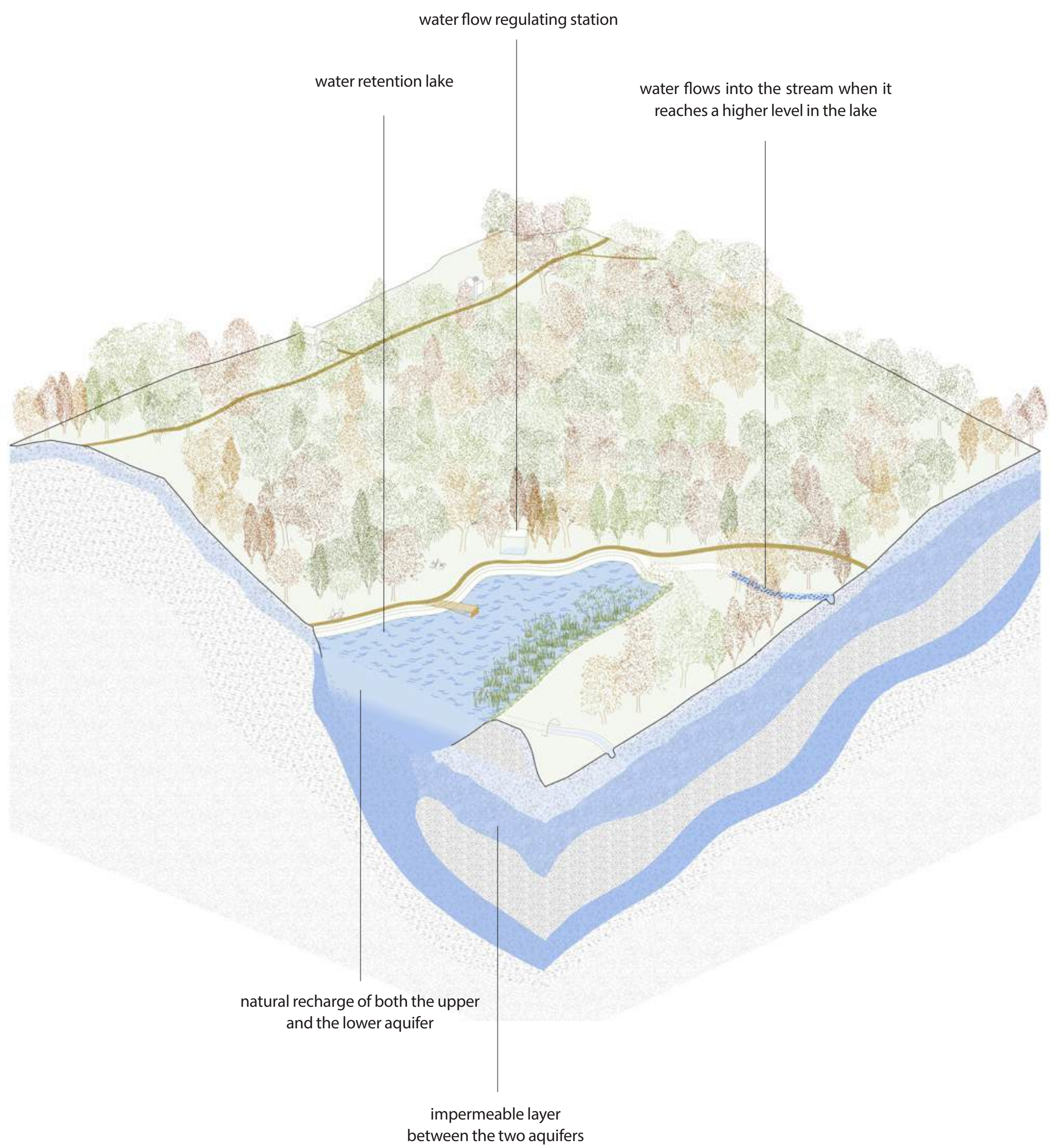


fig. 188 **Hydrostewards on the Lägern**
Isometric drawing



2. Hydrocultures
Climate resilient and water preserving cultivation

Water in the rivers springing from the higher altitudes of Lägern and Altberg flows through the agriculture fields in the foothills. Taking advantage of the flatter topographic slope, the water flow is delayed by the construction of terraces. In this way, peak flows are reduced and potential soil erosion is avoided. All the while, enough time is given to the farmers to collect and store the water, if it is not used directly for the irrigation of the crops. Another benefit of such terraces is that they will prevent the flooding of the side streams and sensitive crops that would not tolerate high amounts of water.

Hydrocultures welcome water with three different landforms: mound, terrace, and creek. The terraces are shaped in the Lägern and Altberg foothills on fields that currently do not have a defined agricultural use - as the steep topography acts as a limiting factor - or on agriculture fields which are not declared as crop rotation areas (FFF). Following the natural descending topography, the depth of the terraces decreases. During dry seasons, they are used for the cultivation of crops which can tolerate temporary flooding conditions - such as oats or soybeans - or are covered with grasses and welcome dynamic programs of public activities along the smaller rivers. It is an opportunity to celebrate water by making it visible to the public. Seasonal flooding also naturally fertilizes soil, and therefore less chemical fertilizers are needed.

Crops cultivated on soil where water infiltrates and naturally recharges the underlying aquifer (deep percolation areas) have to follow strict rules of conservation agriculture principles where no use of chemical pesticides or excess amount of fertilizers is allowed. By letting clean water infiltrate into the aquifer and taking into account the natural underground movement of water, the upper aquifer's water quality can be restored and therefore used again for the drinking water supply of the Furttal. Permaculture principles, mixing the crops cultivated on these fields will enhance the infiltration of rainwater, increase the organic nutrients in the soil and reduce evapotranspiration, keeping the soil on a cooler temperature, thus able to absorb more water.

fig. 189 **Potential land use in the hydrocultures**
The chosen case study and further areas for the implementation of climate resilient and water preserving cultivation.

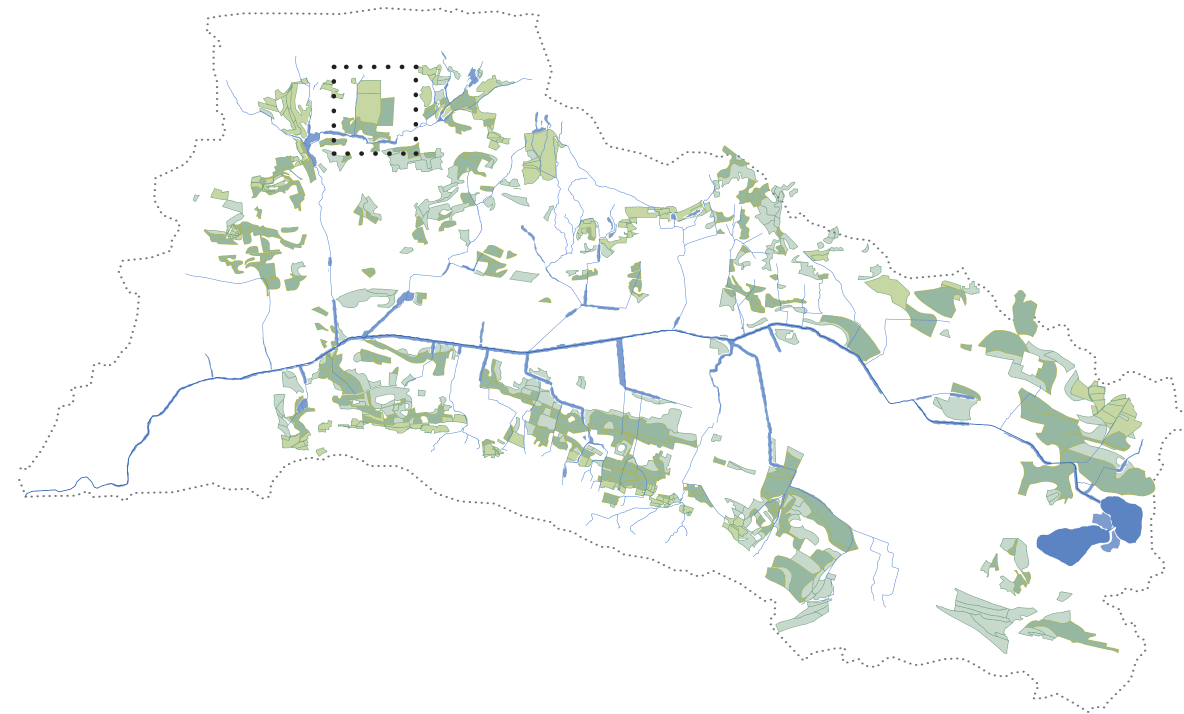


fig. 190 **Bringing water for the hydrocultures**
Water stored in the hydrostewards flows in terraces in the foothills, where it is distributed to the crops for irrigation.

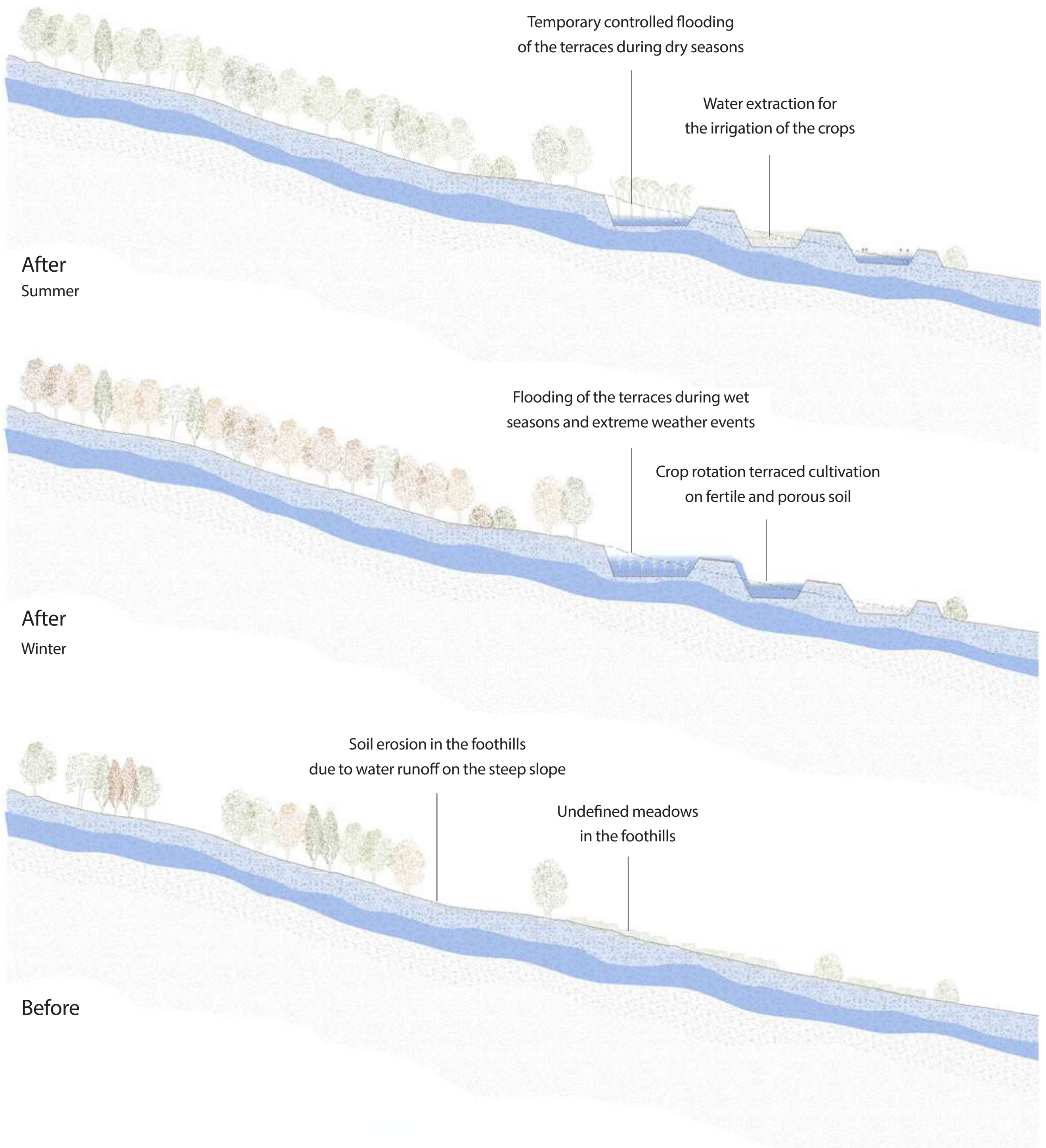


fig. 191 **Hydrocultures in the hydrological cycle**
As the Furt Valley is mostly used for cultivation, hydrocultures play an important role for the amount and quality of water infiltrating into the aquifer.

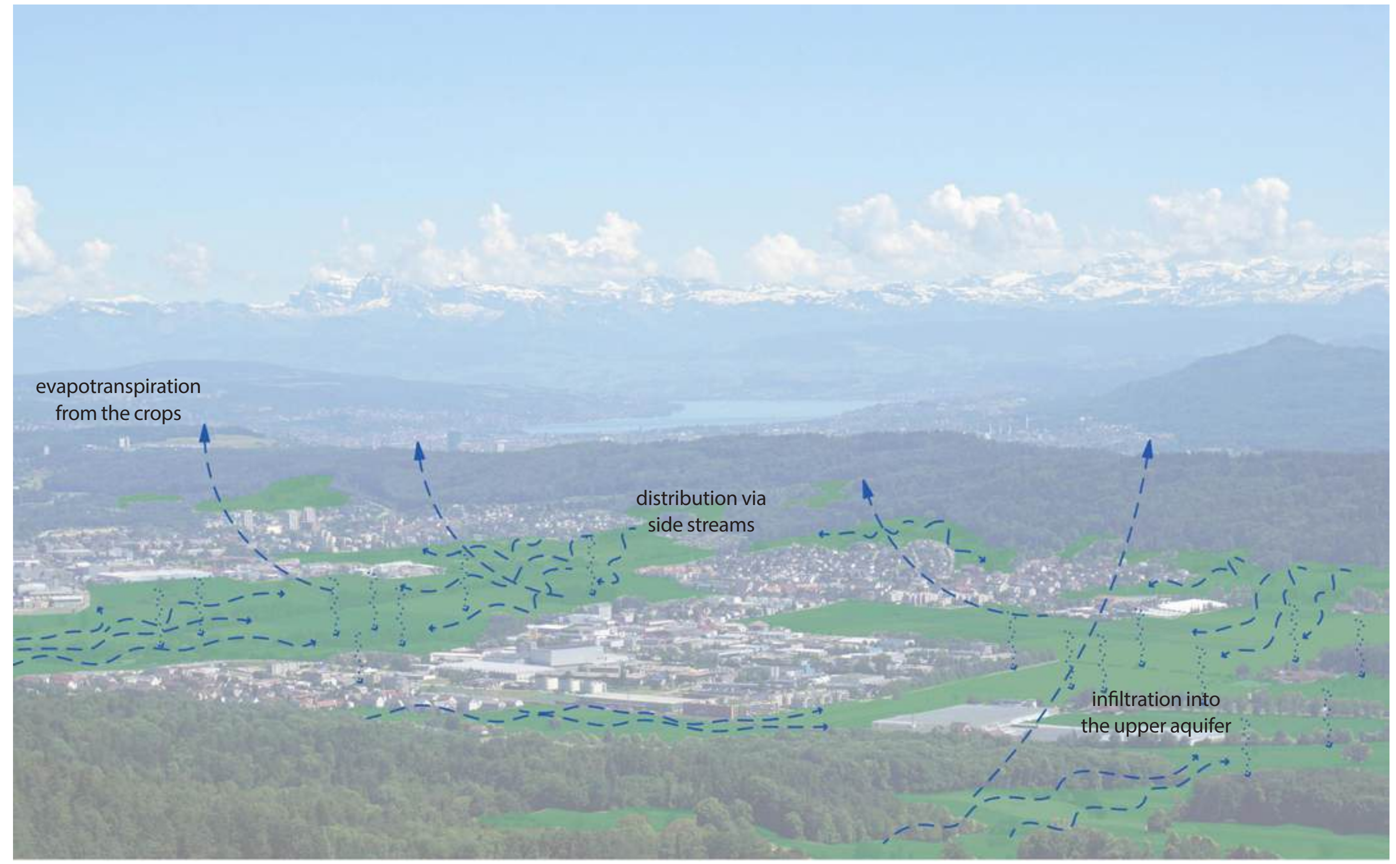


fig. 192 **Preserving water in the hydrocultures**
Terraces allow cultivation on the foothills and will be used by the public during wet and dry seasons. All the while, permaculture principles enhance the water infiltration and natural recharge of the aquifer.

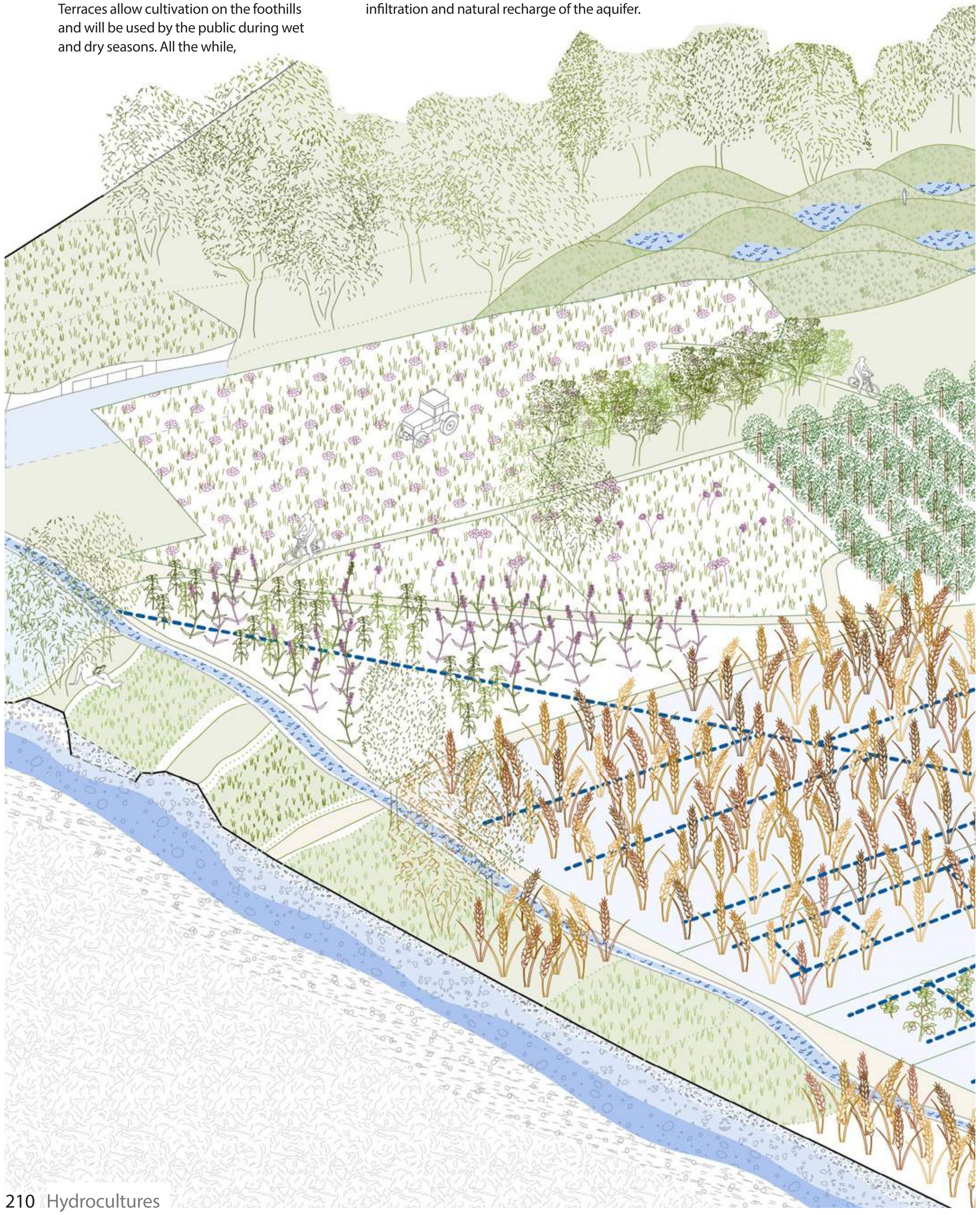
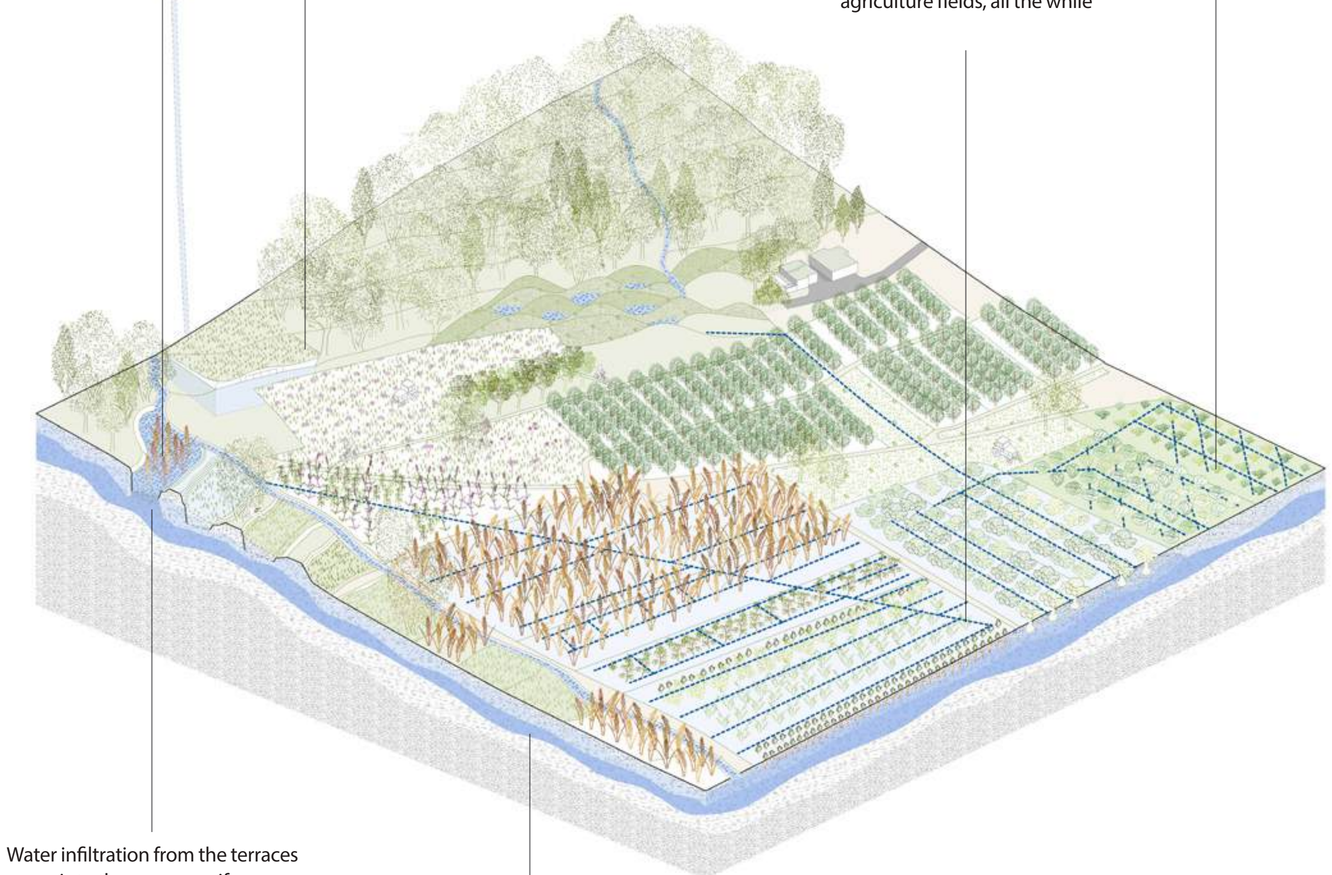


fig. 193 **Hydrocultures in the Lägern foothills**
Isometric drawing



3. Hydrohabitats
Rainwater cycles in residential areas

Any residential hydroscopic landscape aims for rainwater harvesting, localized flood control and prevention of too much surface water runoff. The main landscape element introduced by the hydrohabitats are bioretention facilities either in the form of raingardens or road parallel swales.

Rain gardens are gardens of native schrubs, perennials and flowers,planted in small depressions, mostly on the downside of natural slopes. Owing to their indigenous vegetation, raingardens need no fertilizers and require only minimal maintenance. Aim is to collect rainwater runoff from the lawn, roof and/or the driveway. Once water collects in the rain garden, infiltration may take up to 48 hours after a major rainfall. In this way, rainwater that would normally run off towards the nearest water stream, collecting various pollutants on its way, can in the hydrohabitats naturally recharge the upper unconfined aquifer and improve the water quality by naturally filtering out the pollutants via the different soil layers. Raingardens will be organized and constructed either by private initiative on one's own property or by a common initiative of neighboring plots of land. In the second case, the raingarden can be constructed at adjacent property borders, so that every owner gains a semi-private garden view. A third possibility is the construction of a community raingarden - on a communal residential property - which will be open to the public and serve as a leisure area for the inhabitants of the community. In every case the rain garden constitutes an aesthetically pleasing addition to private gardens and may contribute to urban habitats for native butterflies, birds, and beneficial insects.

Another strategy followed by the hydrohabitats are the water reservoirs for stormwater storage. Specially designed water storage modules will serve at the same time as garden miniatures for the cultivation of herbs or flowers on the top, while offering a sitting area in front. The modules will be equipped with water taps and the water will be used for garden irrigation, car washing or for the toilet flushing.

All the while, bioretention swales seperating the car lane from the pedestrian lane and planted as well with native shrubs, perrenials and flowers will collect the stormwater runoff from the sealed road surfaces and let it naturally filter and infiltrate in the soil.

fig. 194 **Potential areas for the hydrohabitats**
The chosen case study and further areas for the implementation of rainwater cycles across the Furt Valley.

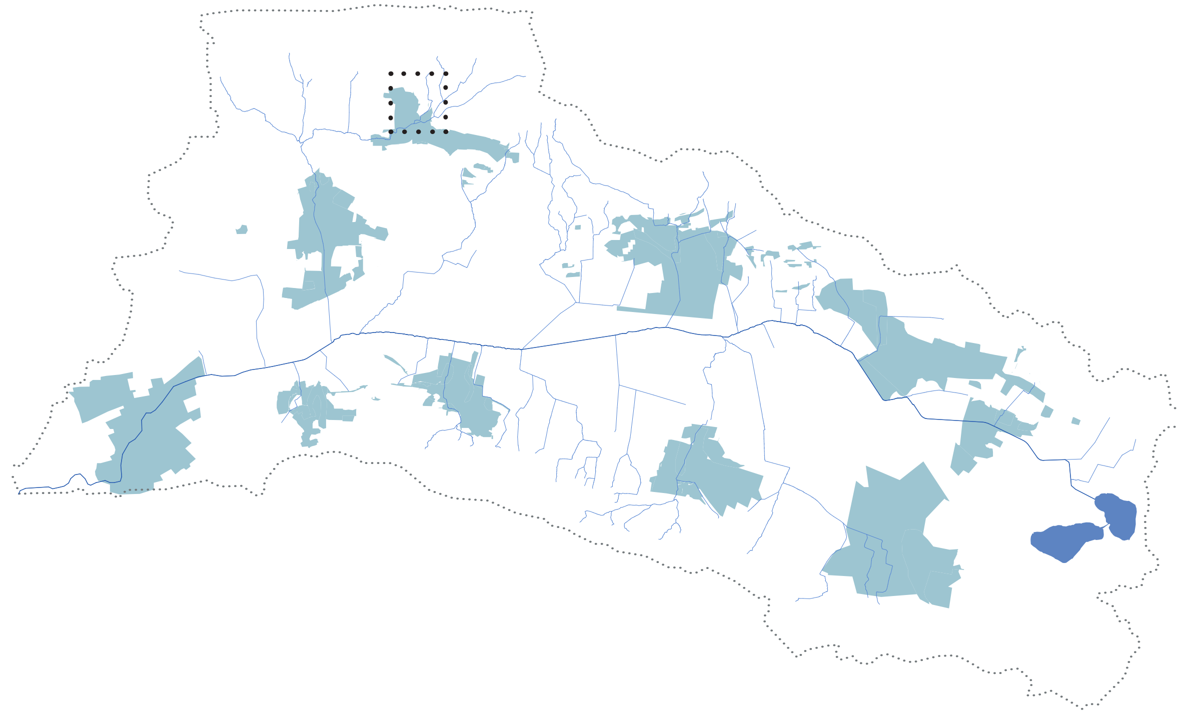


fig. 195 **Keeping rainwater in the hydrohabitats**
Stormwater harvesting, infiltration and reuse via water reservois, raingardens and bioretention swales.

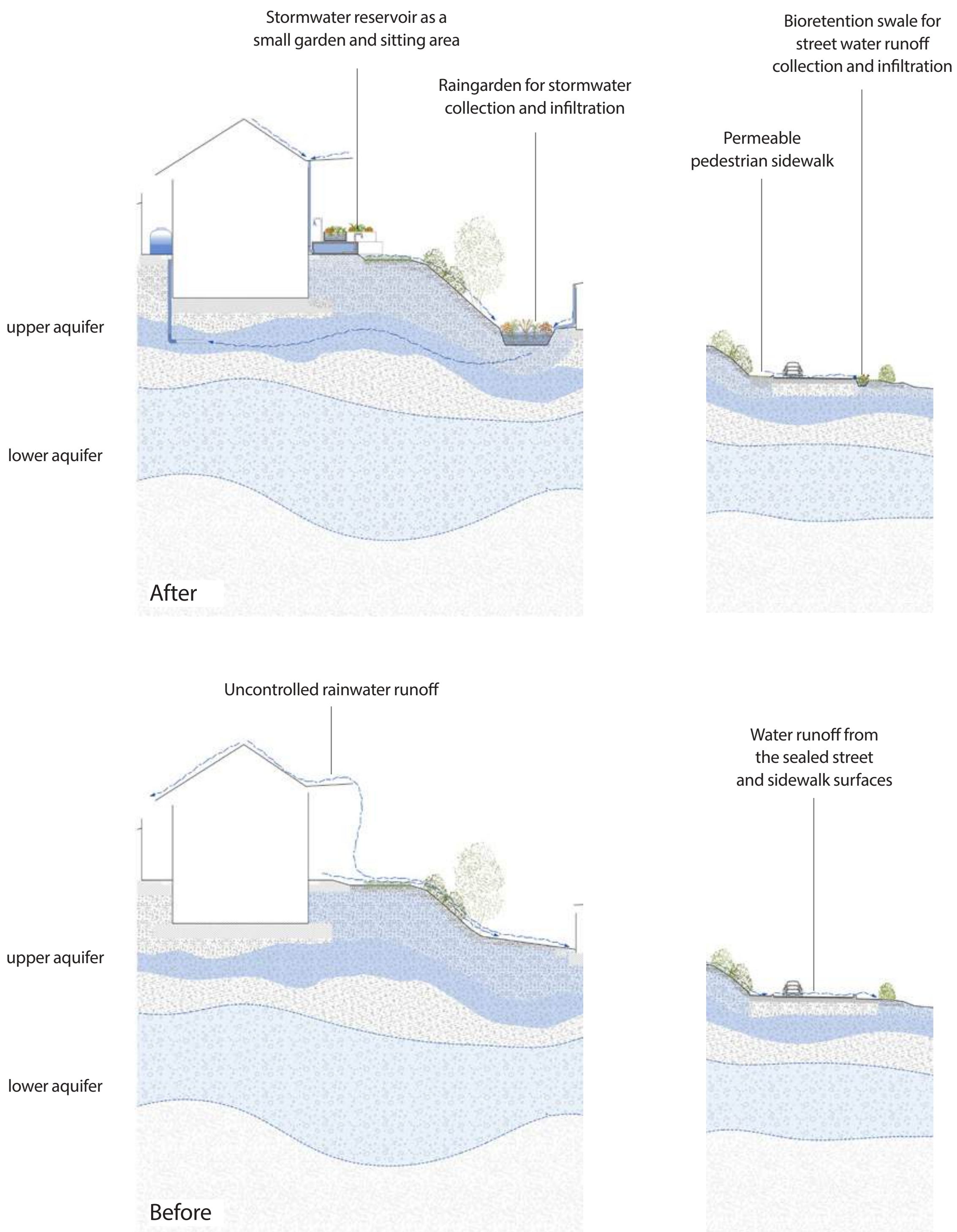


fig. 196 **Hydrohabitats in the hydrological cycle**
Closed loop rainwater cycles are completed locally in the hydrohabitats.

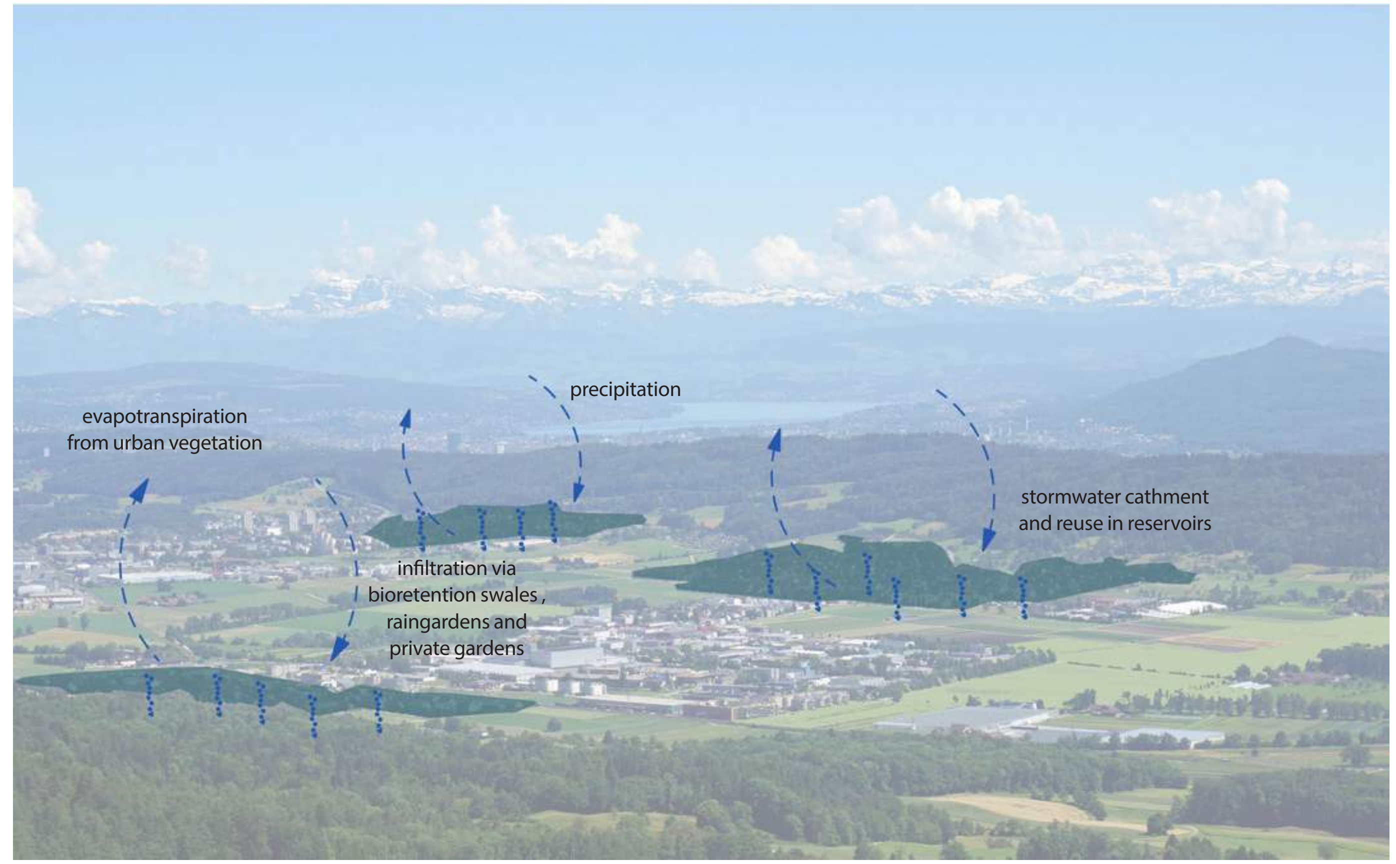
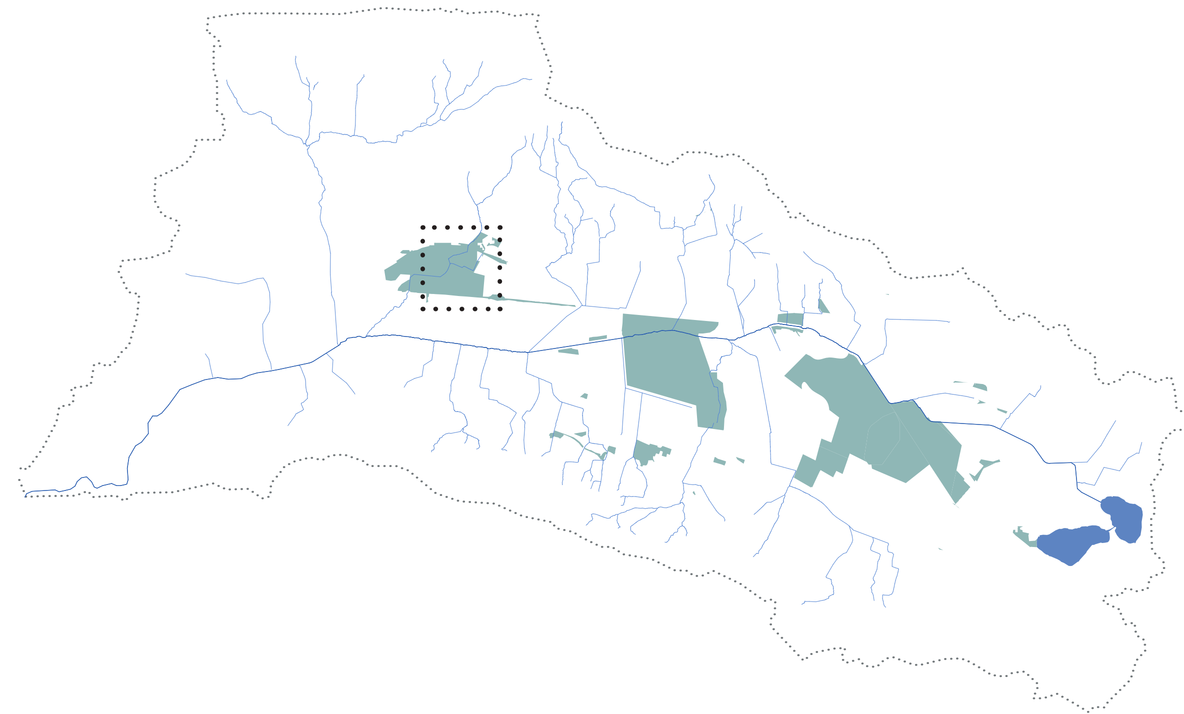


fig. 197 **Rainwater cycles in the hydrohabitats** Public and semi-private raingardens constitute local recreational opportunities for the inhabitants, while they collect and filter rainwater, thus naturally recharge the aquifer. New buildings should have an integrated stormwater harvesting system, such as an inverted roof with green facades.

fig. 198 **Hydrohabitats in Boppelsen**
Isometric drawing

fig. 199 **Potential areas for the hydrologistics**
The chosen case study and further areas for the design of more permeable and cooler industrial landscapes across the Furt Valley.



4. Hydrologistics
Cooler, more permeable industrial landscapes

Industrial clusters among most of the Furtbach riverbanks increase urban stormwater runoff significantly with extensive asphalt surfaces sealing most of the permeable ground. Water here flows - after accumulating many pollutants found in an industrial area - directly into the Furtbach. Hydrologistics aim at minimizing stormwater runoff, all the while creating a more pleasant working atmosphere. Characteristic of these extensive clusters of logistics across the Furtbach are the large patches of uniform asphalt surfaces used as parking lots or maneuvering space for transport vehicles. Hydrologistics aim at breaking up these uniform sealed areas wherever possible and restoring permeable areas in between. This is realised in the form of shallow water ponds, gathering rainwater runoff of the surrounding sealed surface. Another type of ponds is dug up in the "anonymous" spaces between the larger buildings. These areas are turned into rainwater collectors while at the same time serve as pleasant recreation areas for the people working in the area.

Another characteristic of these mostly sealed areas are the wide roadways and the lack of pedestrian sidewalks. In contrast, hydrologistics have bioretention swales parallel to the wider roadways, which will collect the rainwater that otherwise would flood the asphalt lanes. The planted swales will simultaneously serve as a barrier seperating the track lanes from new pedestrian and bike lanes.

In order to mitigate the local heat island formation caused by the greater sealed surface and intensified by the metal facades, hydrologistics integrate green roofs and indirect green facade systems on the buildings. The presence of water in the ponds in parallel to the green roofs and facades of the buidings aim to improve the local microclimate, creating a more pleasant atmosphere for the people working in the Furt Valley and for the indigenous vegetation as well. Owing to the larger surface turned into green roofs, the otherwise unutilised tops of the buildings are flexible to host a variety of recreational activities. Sport fields on the roof of the sports center or an outside event space for the many wholesalers are some characteristic examples. The most prominent roof of the Furt Valley is the roof of the Globus warehouse in Otelfingen. Following the hydroscopic principles, it will be transformed into a recreation area connected with a new water landscape via a green, overhanging structure extending over the rail lines and integrating it into a new central green space for the valley.

fig. 200 **More permeable hydrologistics**
Bioretention swales collect stormwater runoff from the impermeabe streets and filter out the pollutant before recharging the xx aquifer. Green roofs and indirect green facade systems collect stormwater and improve the local microclimate by cooling down the extensive sealed surfaces.

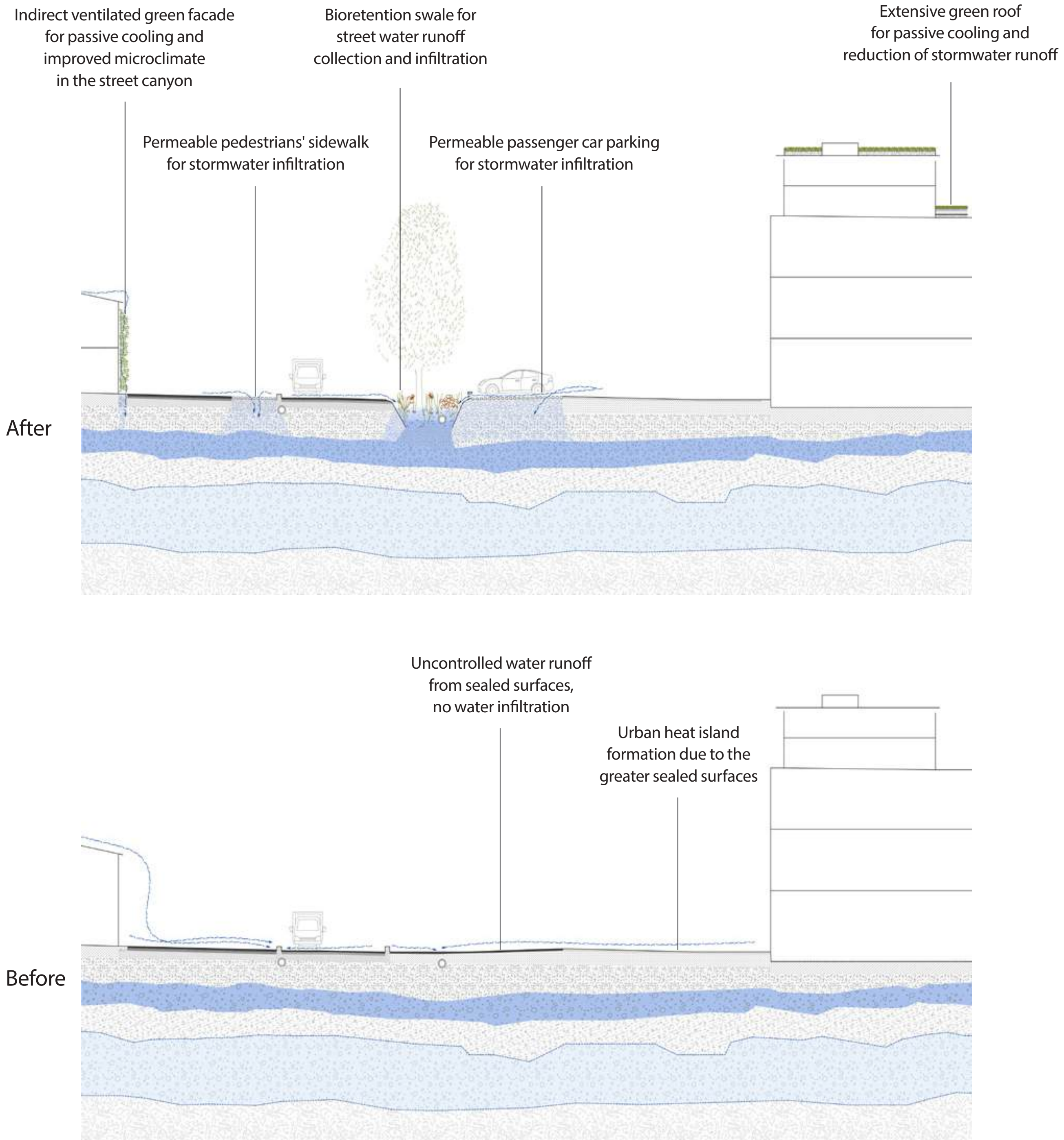


fig. 201 **Hydrologistics in the hydrological cycle**
Closed loop industrial water cycles are completed in the hydrologistics.

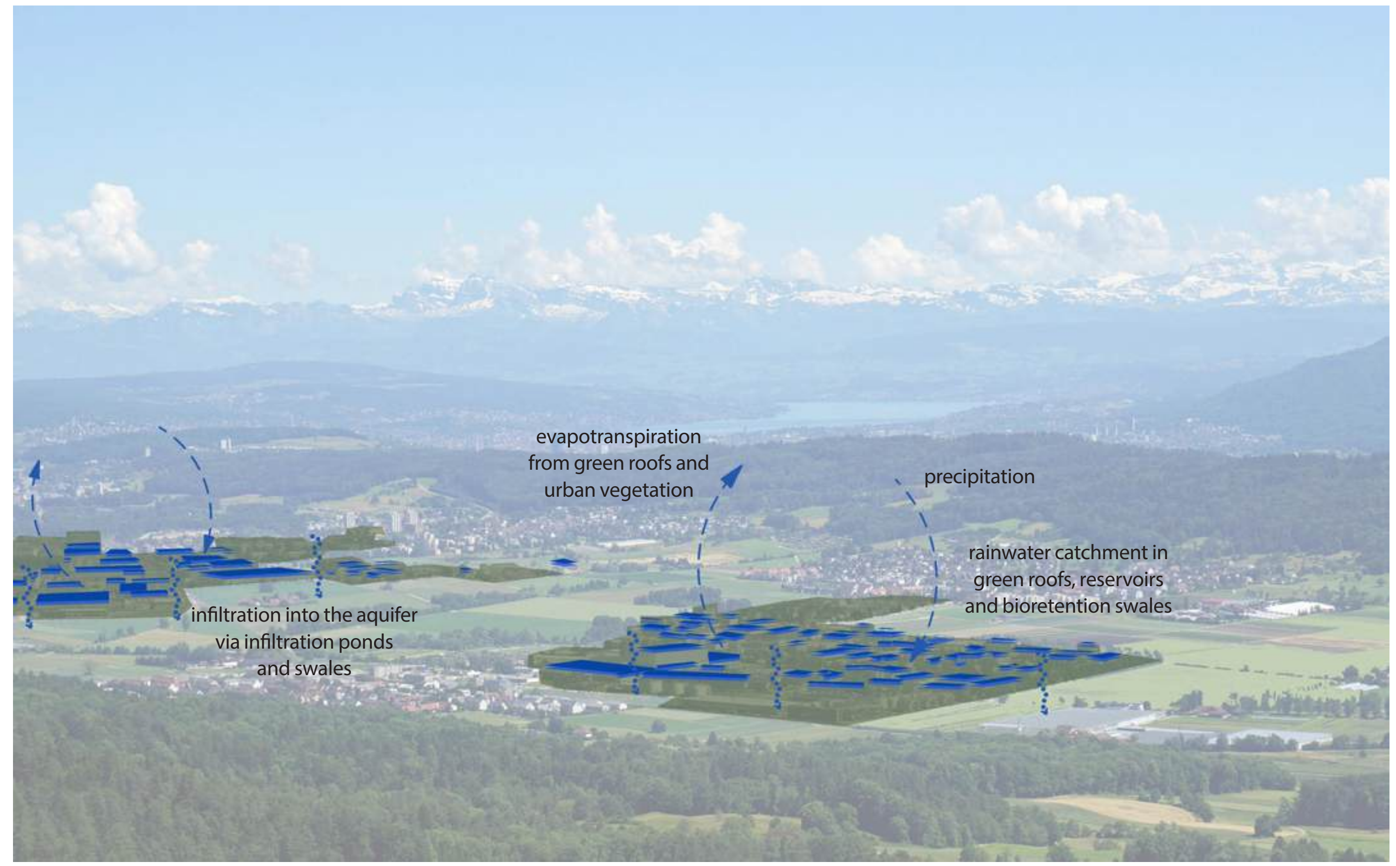


fig. 202 **Water infiltration in the hydrologistics**
Green roofs accomodate at the same time various recreational activities, creating a more pleasant working atmosphere.

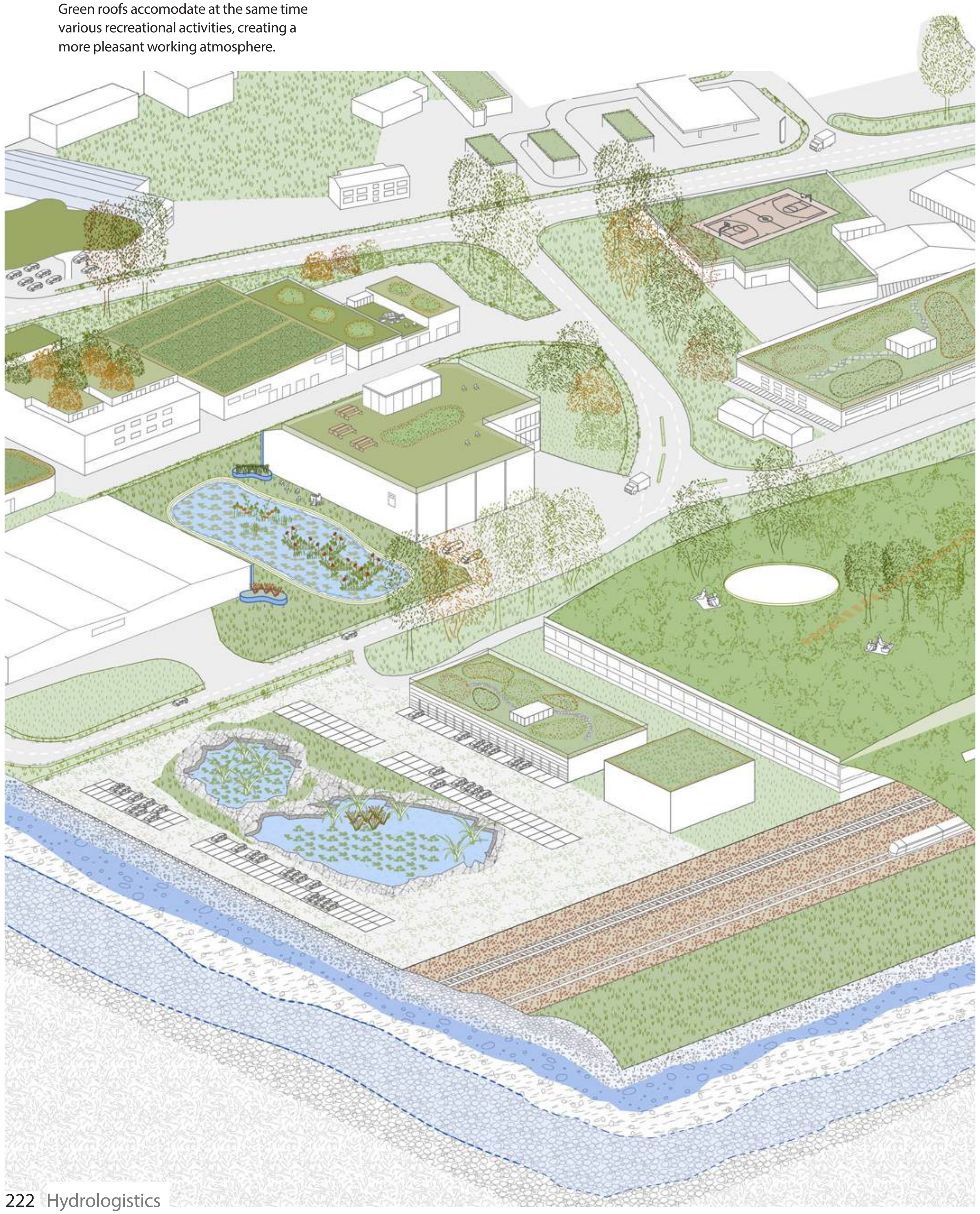
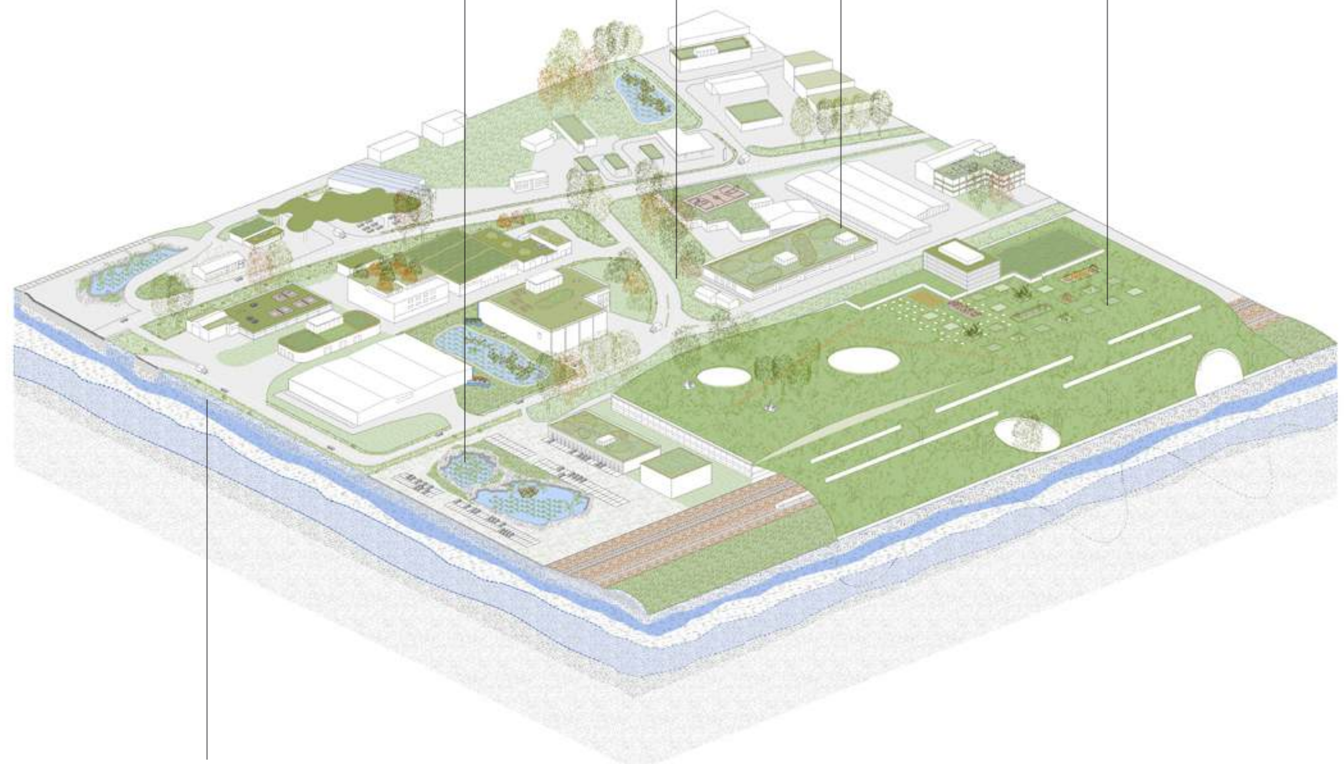


fig. 203 **Hydrologistics in Otelfingen**
Isometric drawing



5. Hydrocommons
Wetland restoration as leisure landscapes

Hydrocommons describe a new water recreational landscape designed with the aid of partial restoration of the ecological integrity of the previous wetland. An ecosystem with integrity is a resilient and self-sustaining natural system able to accommodate stress and change. By restoring parts of the wetland with the least natural water storage capacity, water which would normally be drained away from the center of the valley through underground pipelines is held on the surface. Water accumulated in the wetlands will slowly infiltrate and naturally recharge the upper aquifer. When the aquifer is saturated the excess water will remain in the wetlands, where it is visible to the public and will be celebrated through various recreational activities. Inserting a new water cycle where the water is naturally filtered in the wetlands combined with the appropriate vegetation, the restored water ponds will offer swimming opportunities to the public during summer or even ice-skating events during winter. What is more, the hydrocommons will serve as a buffer area which will be allowed to flood during extreme events. However, people will still have the opportunity to celebrate the water within the system of bridges and shelters-hills above the maximum water level.

Water accumulated in the wetlands will have additional quantifiable benefits to specific sectors or stakeholders, such as the cost of water for agricultural production, or the value of fish to fisherfolk. When needed, the water can be used by the farmers for the irrigation of the crops - in that way they don't need to extract water from the aquifer and the surface water streams nor from the drinking water supply network and put further stress on these water resources. Additionally, at the sites of the Furt Valley where hydrocommons are realized on top of the lower aquifer, the accumulated water - after it is naturally filtered and has a higher water purity - will be injected artificially by accordingly designed injection wells into the lower aquifer. In this way, the recharge cycle of the deeper aquifer can be accelerated - especially in dry year

All the while, restored ecological integrity means providing wildlife habitat to indigenous flora and fauna species. The Furt Valley is home to many today endangered bird species, such as the kingfisher, which will find a new habitat to nest. Improved water security, capacity to mitigate and adapt to the changing climate are additional benefits gained from the partial wetland restoration. Besides flood control, wetlands capture and store carbon, thus reducing the atmospheric greenhouse gases. Finally, restored wetlands constitute urban cooling islands, a pleasant recreational landscape all year round.

fig. 204 **Potential areas for the hydrocommons**
The chosen case study and further areas for wetland restoration across the Furt Valley.

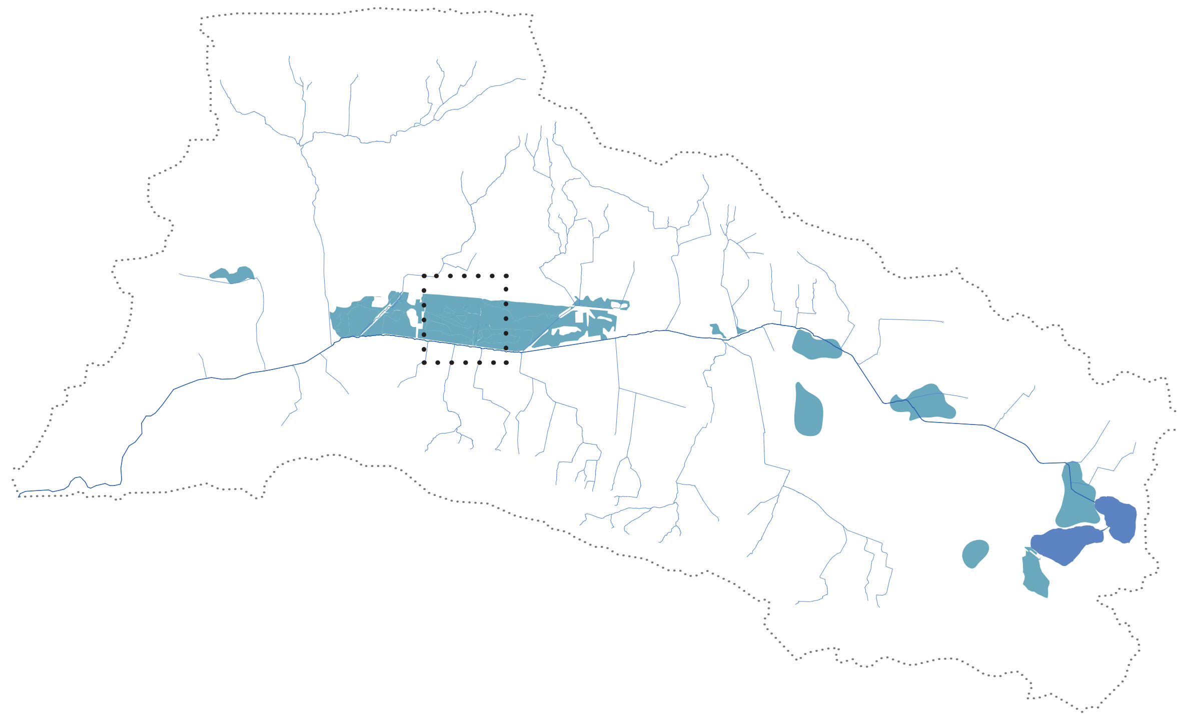


fig. 205 **Celebrating the seasons of water**
Partly restoration of the previous wetland keeps excess water in the valley and allows the Furtbach and certain areas of the valley to flood according to the different seasons and levels of water.

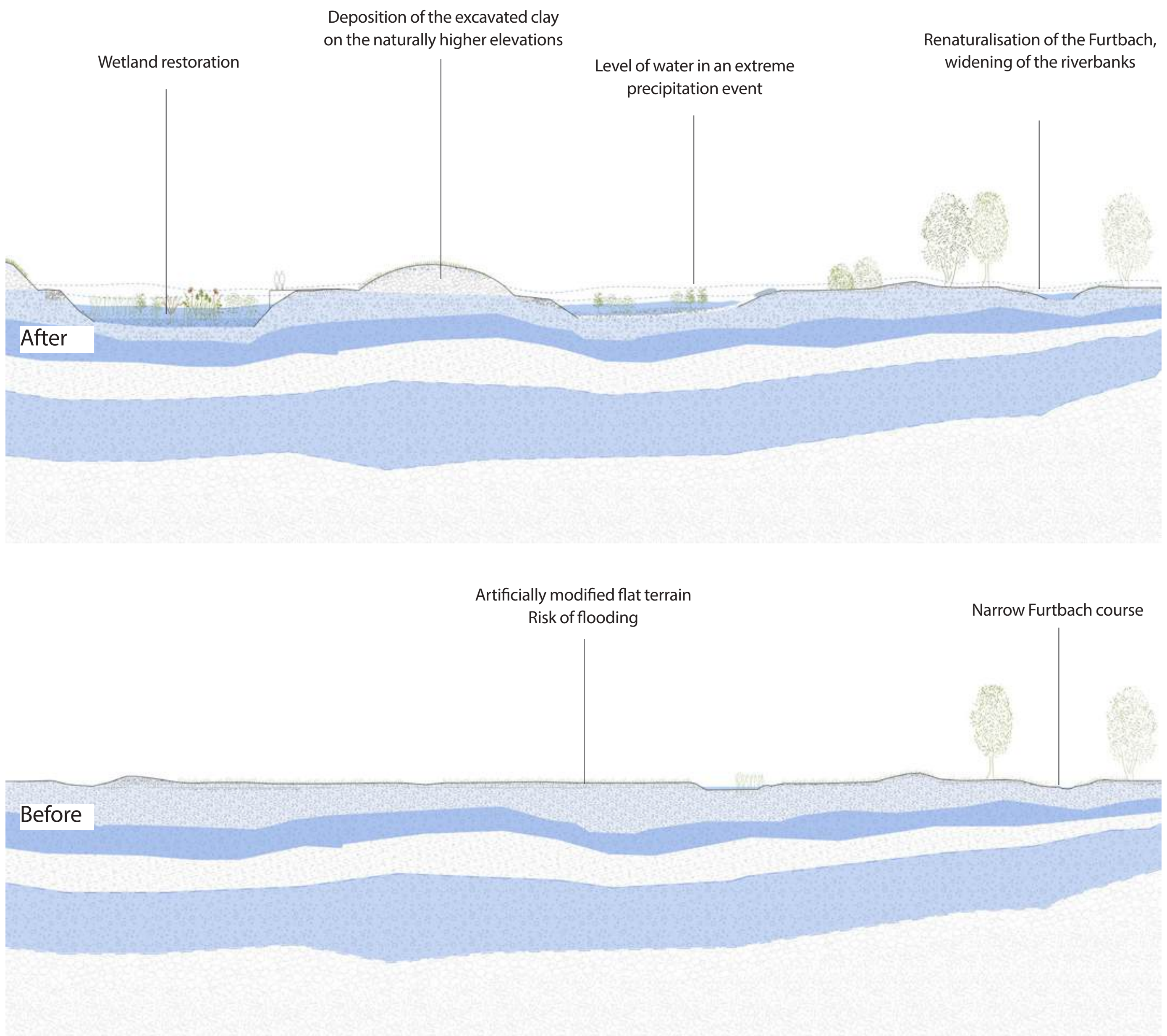


fig. 206 **Hydrologistics in the hydrological cycle**
The restored wetlands serve as a buffer zone and prevent the flooding of the valley. Evaporation from the restored wetlands completes the hydrological cycle.

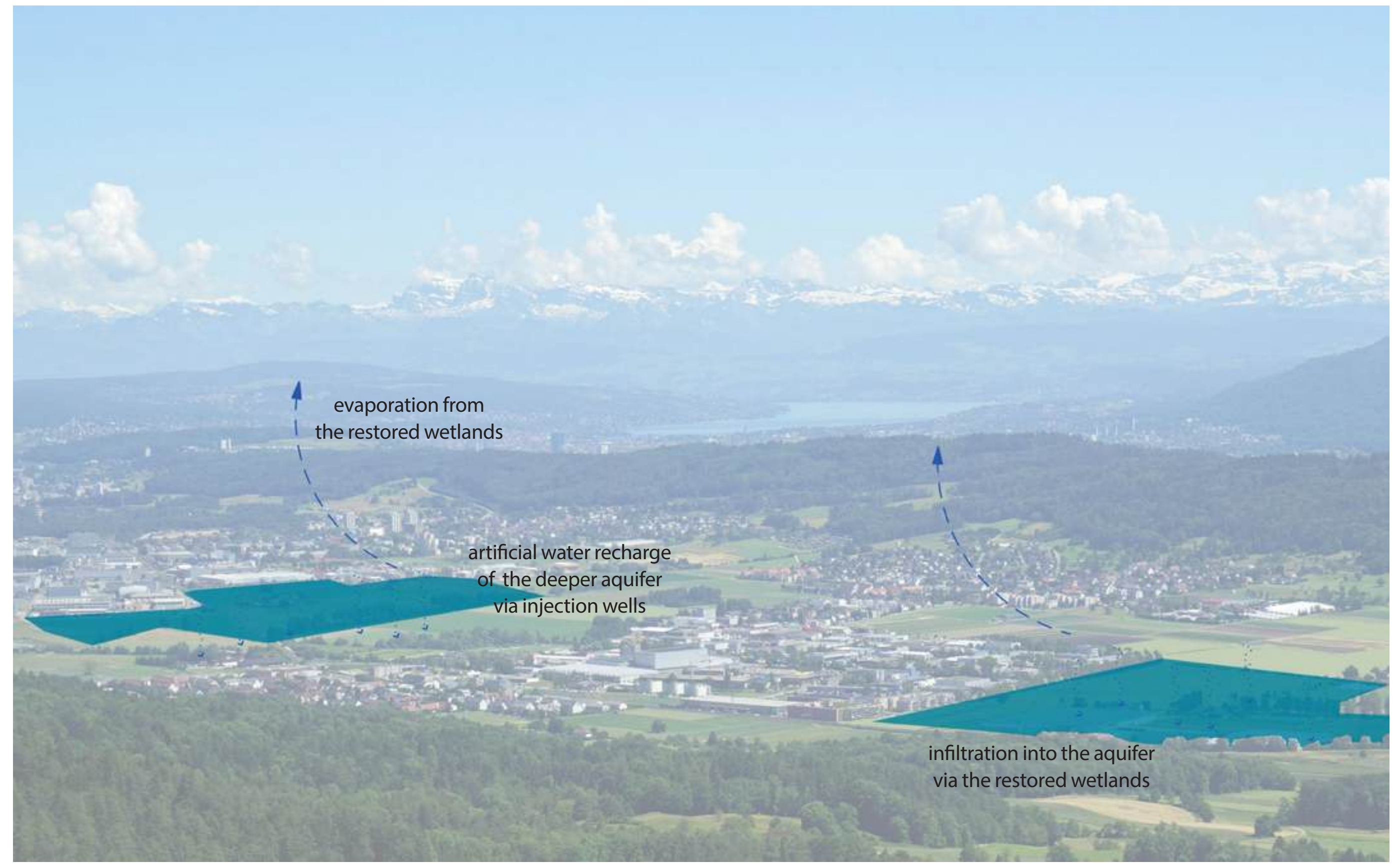


fig. 207 **Recreational hydrocommons**
The restored wetlands are leisure landscapes for the visitors and habitats to the indigenous flora and fauna of the Furt Valley.

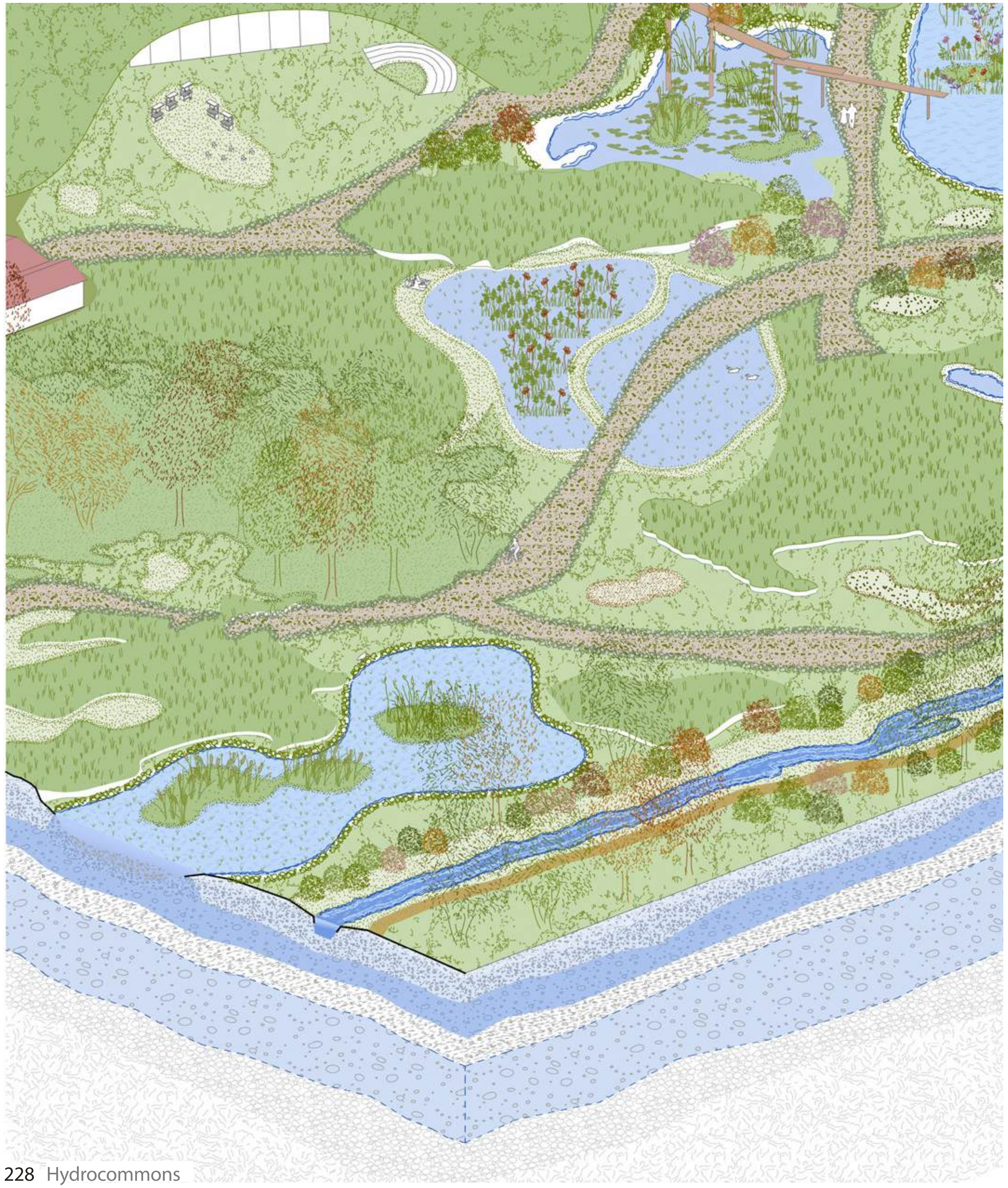


fig. 208 **Hydrocommons as a restored ecosystem**
Isometric drawing

fig. 209 **Flooding Hydrocommons**
Flooding event once per year.

fig. 210 **Extreme flooding scenario**
Extreme, unpredictable precipitation event, expected during the winter season due to the changing climate.

fig. 211 **Artificial groundwater recharge example**
Example of the artificial groundwater recharge facility on the Arve Riverbanks in Geneva.

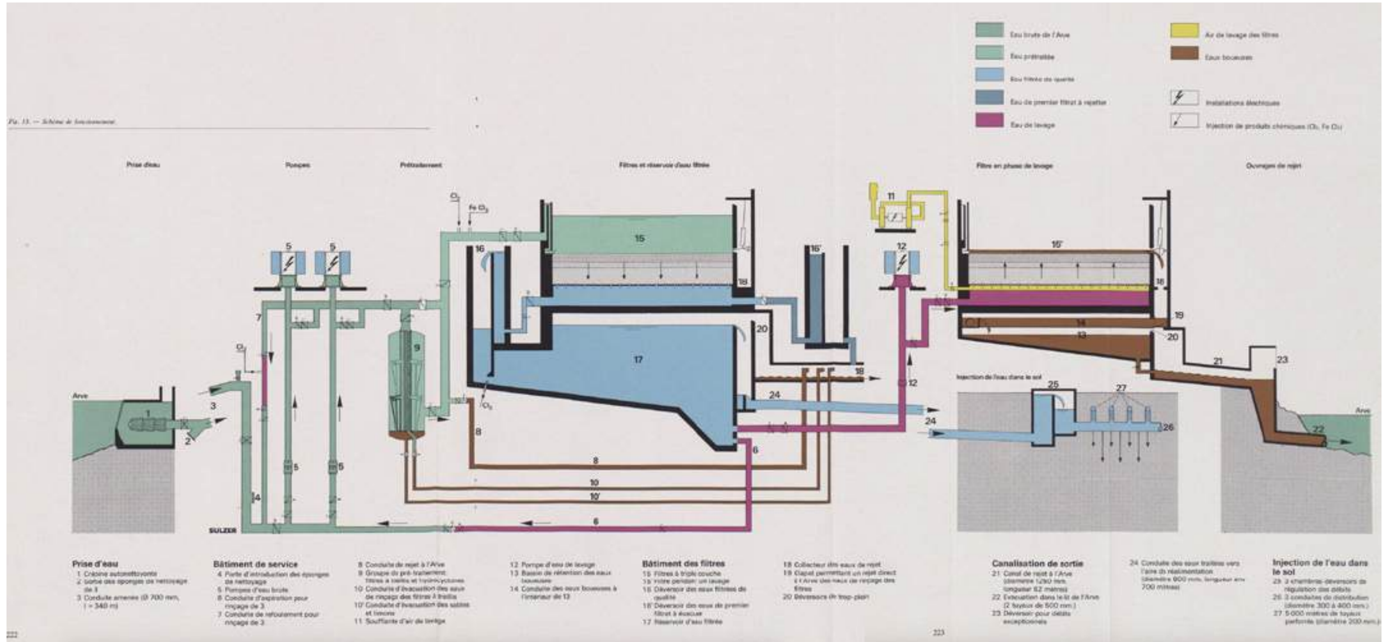


fig. 212 **Artificial deeper Furttal aquifer recharge**
Drained areas of the Furt Valley over the deeper aquifer could be transformed into hydrocommons and artificially inject water into the deeper aquifer.

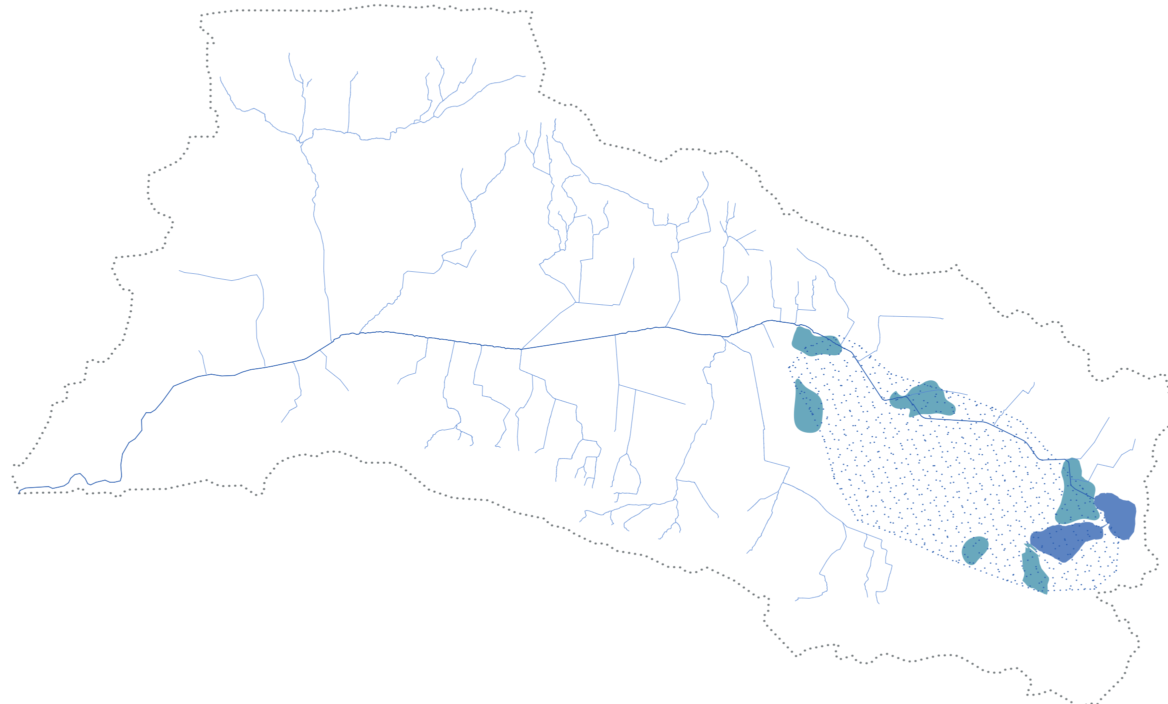


fig. 213 **Current soil erosion on the Lagern**
Water runoff causes soil erosion on the steep slopes of Lägern.

fig. 214 **References for the Hydrostewards**
i. Egelsee, Bergdietikon, Canton Zurich
ii. Voralpsee, Grabs, Canton St. Gallen
iii. Water reservoir Grabs, Canton St. Gallen

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fig. 215 **Currently undefined Furttal meadows**
Many meadow fields towards the fringes of the Furt Valley have no specific agricultural purpose.

fig. 216 **References for the Hydrocultures**
iv. Terraced landscape, Val Poschiavo, Canton Graubünden
v. "Wasserschutzbrot", groundwater protection initiative, Unterfranken, DE
vi. Permaculture community garden, ETH Hönggerberg, Zurich

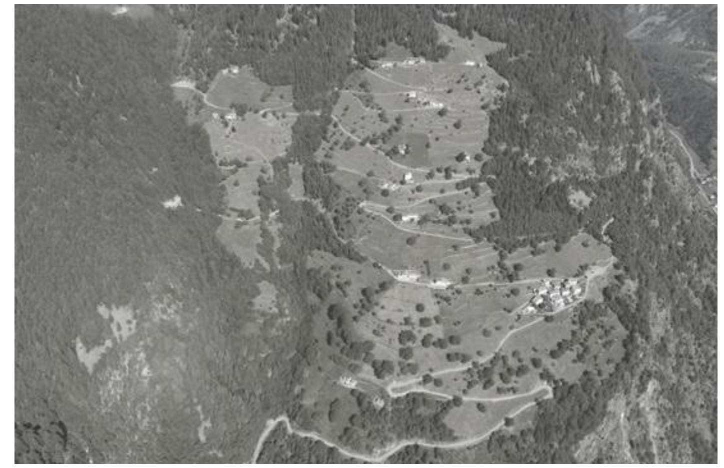

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fig. 217 **Typical residences in the Furt Valley**
View of the residential Dänikon.

fig. 218 **References for the Hydrohabitats**
iv. Residential project Paradies, Unterengstringen, Gössi Architekten
v. King's Cross Pond Club, London, UK, OOZE
vi. Ricola Marketing, Laufen, Vogt Landscape Architects

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fig. 219 **Unutilised extensive roofs in Furttal**
Example of the biggest roof in the Furt Valley - roof of the Globus logistics center in Otelfingen.

fig. 220 **References for the Hydrologistics**
x. Roof terrace of ZHDK (Zürcher Hochschule der Künste), Zurich
xi. Green roof at Delft University, Netherlands, Mecanoo Architecten
xii. The Roof Gardens of the European Patent Office, by Copijn Tuin-en Landschapsarchitecten, Rijswijk, Netherlands

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fig. 221 **Currently straight, narrow Furtbach**
After the multiple corrections, the Furtbach flows today in a straight, narrow course with uniform riverbanks.

fig. 222 **References for the Hydrocommons**
xiii. Revitalisation of the Alte Aare, Canton of Bern
xiv. Revatilised River Aire, Canton of Geneva
xv. Novartis Campus Park, Basel, Vogt Landscape Architects

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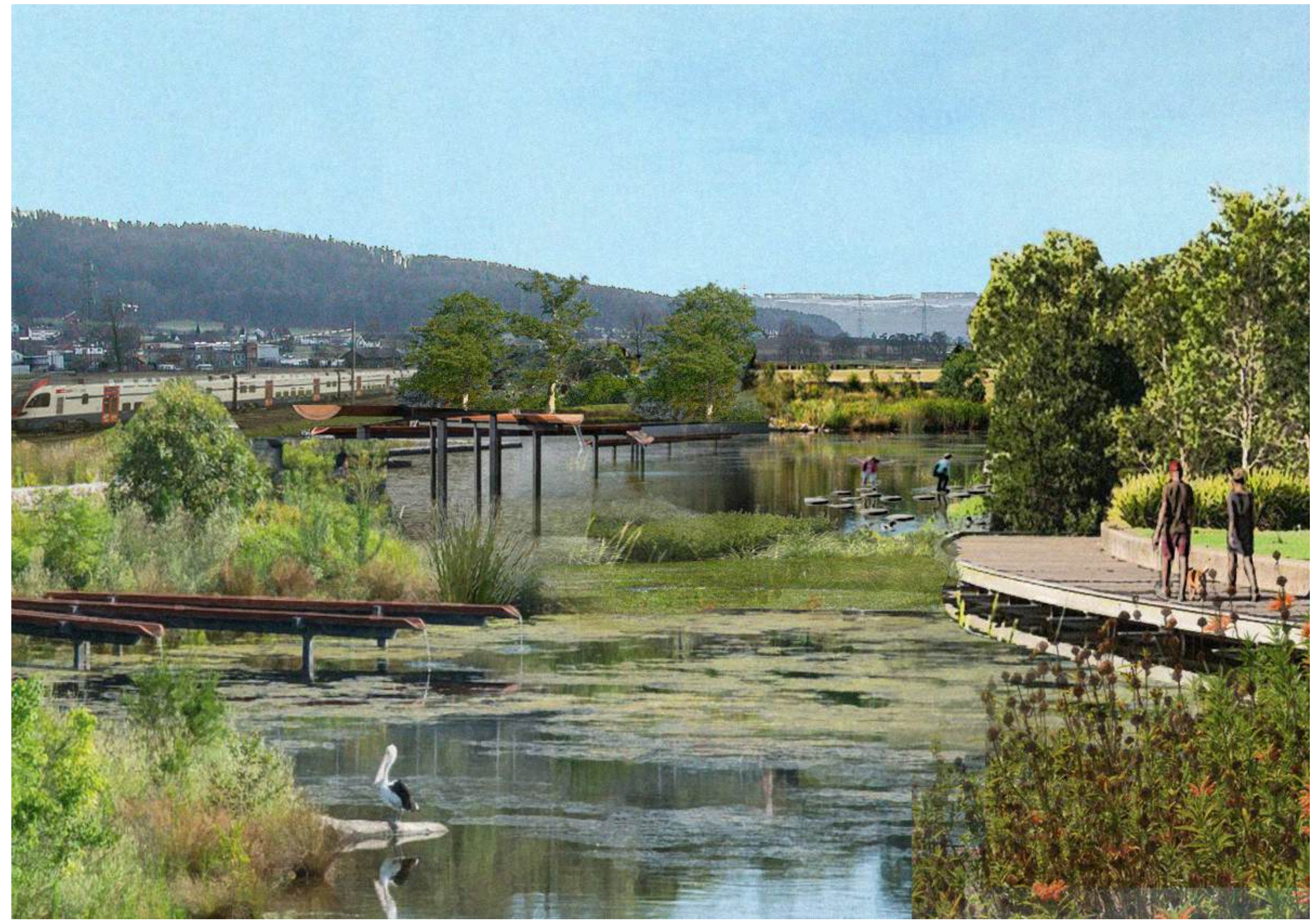
fig. 223 **Hydrocultures**
Collage of the water preserving cultivations in the Furt Valley.

fig. 224 **Hydrohabitats**
Collage of the rainwater harvesting inhabitants of the Furt Valley.

fig. 225 **Hydrocommons**
Collage of the new water leisure landscape in the Furt Valley.



Extrapolation
Hydroscopic ecology in other valleys of the Swiss midland plateau

The principles followed in the hydroscopic approach of the Furt Valley can be extrapolated to valleys with similar conditions across the Swiss Midland Plateau. The Furttal is only one example of the many valleys north of the Alps which are currently faced with water scarcity due to unsustainable exploitation of local water resources. As a result, especially smaller regions become all the more dependent on the more extensive group water supply networks. This implies significant investment costs for the necessary connecting water supply network and higher water supply costs for the residents of the valley.

An example of a valley comparable to the Furttal is that of the Wehntal, located on the other side of the Lägern. Wehntal is depending almost completely on its own aquifer, assisted by local spring sources. However, the extremely dry summer of 2003 brought up the need for external additional water supply of the valley. In order to have, as suggested by the Canton of Zurich, "two legs to stand on", and at the same time avoid similar water supply deficits, the municipalities of Wehntal are encouraged via cantonal subsidies to connect to the group water supply network of the Furttal. However, such a decision would cost many millions which will have to be financed through a corresponding water price. The municipalities of Wehntal search at the moment for other alternatives, while they are envisioned to be part of the Cantonal water supply network in the next 30 years.

Current water supply strategies tend to rely on the bigger water resources, which because of their magnitude seem to be infinite. The hydroscopic approach proposed in this master thesis could serve as an alternative in order to achieve a more resilient water supply based mainly on the regeneration of the local water resources. While both approaches are costly, current policies tend to ignore ecological issues such as the pollution of local water resources and the risk of local ecosystem collapse. The hydroscopic approach aims at the protection and resilient use of local water resources over time, all the while restoring and conserving the ecological integrity of each hydroscopic landscape.

The principles of the hydroscopic ecology to be applied and enchanced in other similar valleys:

1. Water retention in higher altitudes
2. Water preserving agriculture practices
3.Rainwater harvesting in residential areas
4. More permeable industial landscapes
5. Water leisure landscapes

fig. 226 **Current focus on 3 water resources**
Current water supply strategies focus on the protection and future dependence on 3 main bigger water resources.

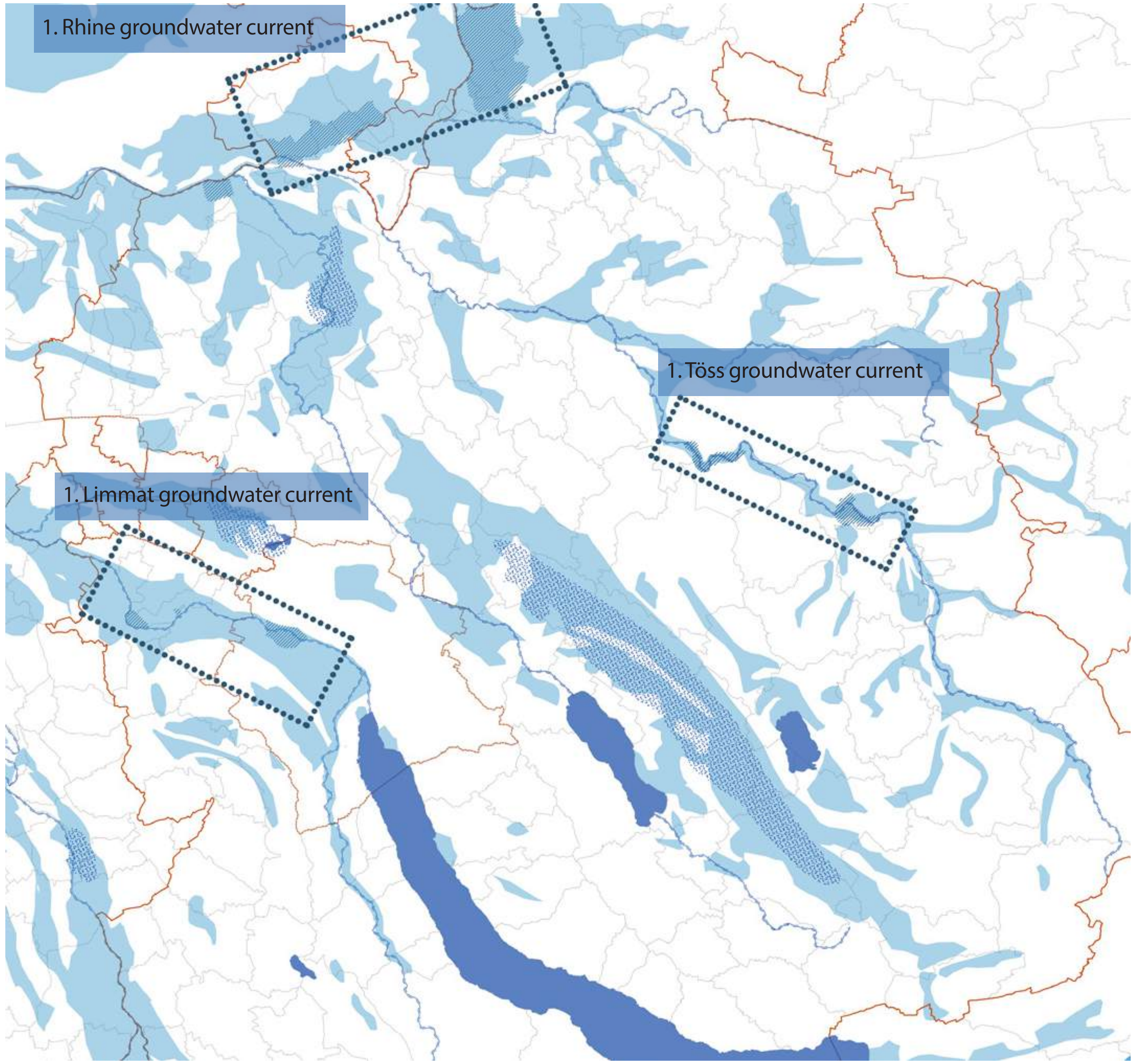
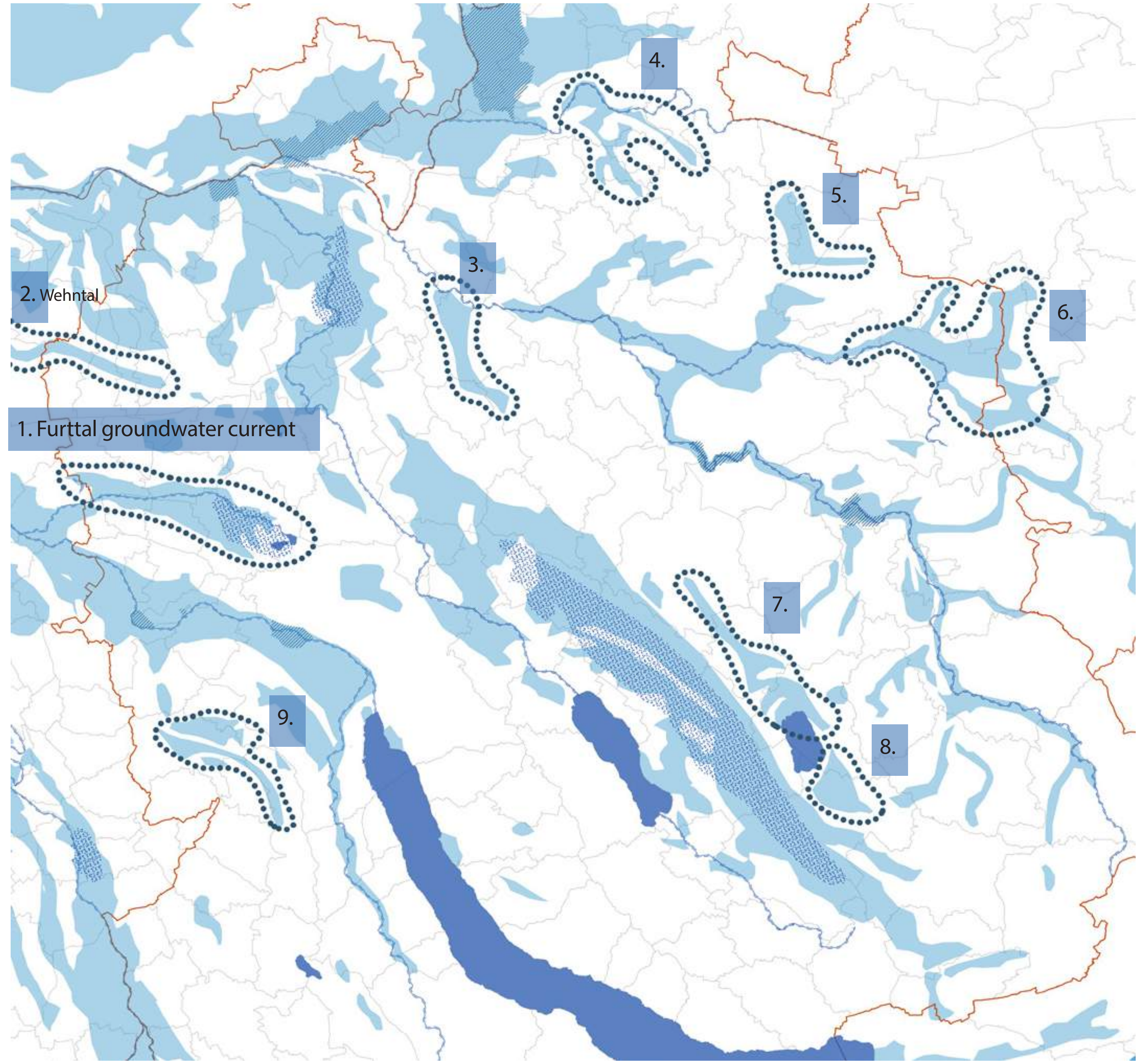


fig. 227 **Future more resilient water supply**
Future water supply may equally protect and rely on the smaller, locally available water resources.



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