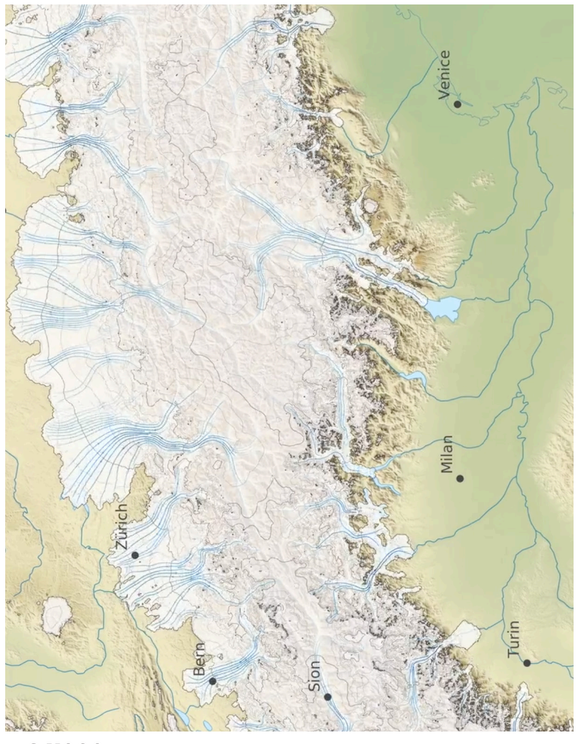
Jonas Kissling: River Acting

River Acting

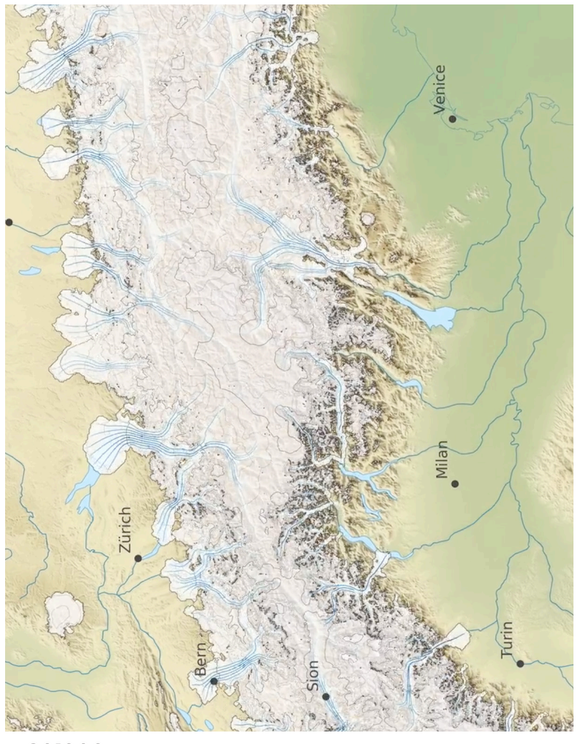
The river bed itseld is the place of bridging. The engagement with the river and its water flow arises a question: How do we deal with the constant and irreversible movement of the river and how do we use the water flow to build?

Deglaciation

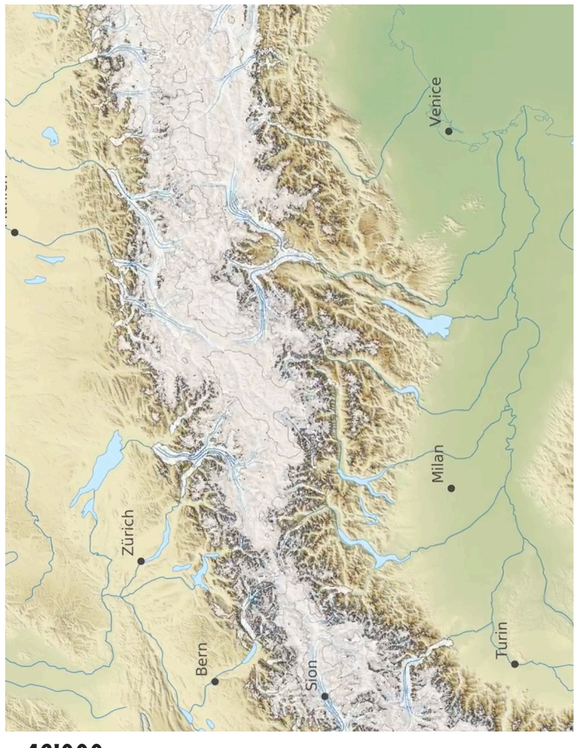
The stage of the river is becoming more unstable, due to the current continuous deglaciation. The disappearing glaciers lose the capacity of saving water and as a result stronger flood events occur.



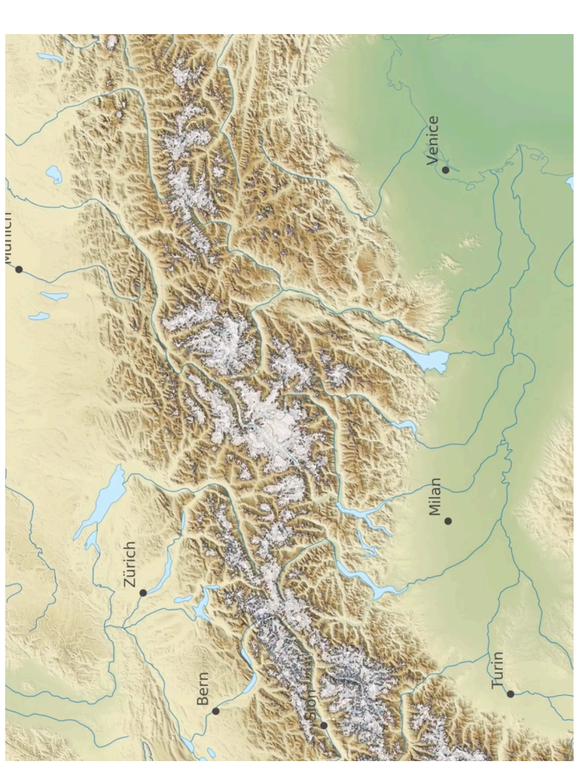
24'000 years ago



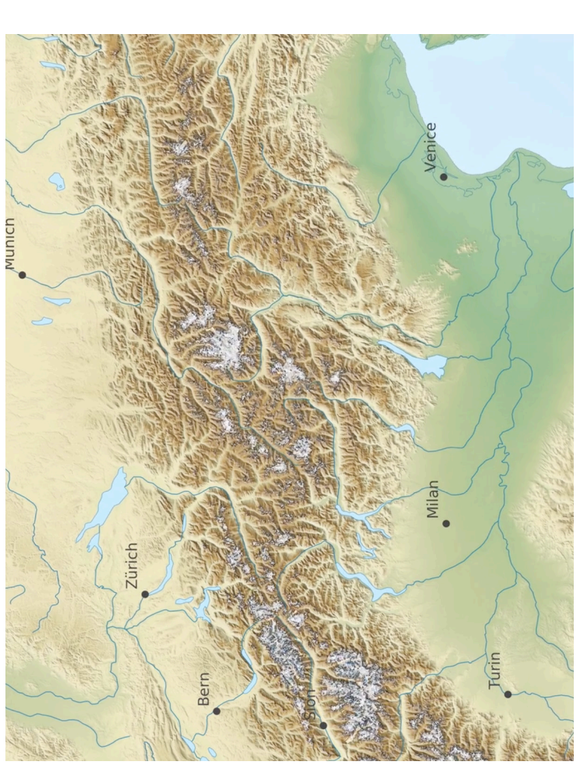
20'000 years ago



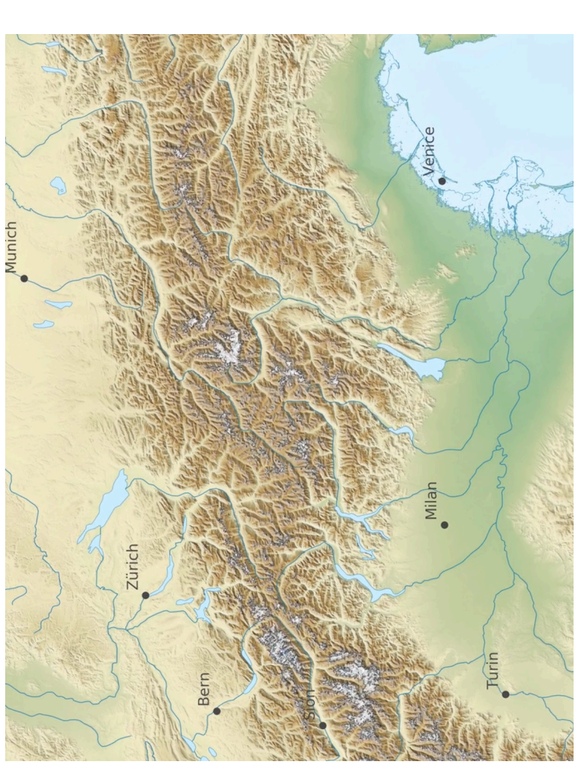
16'000 years ago



12'000 years ago



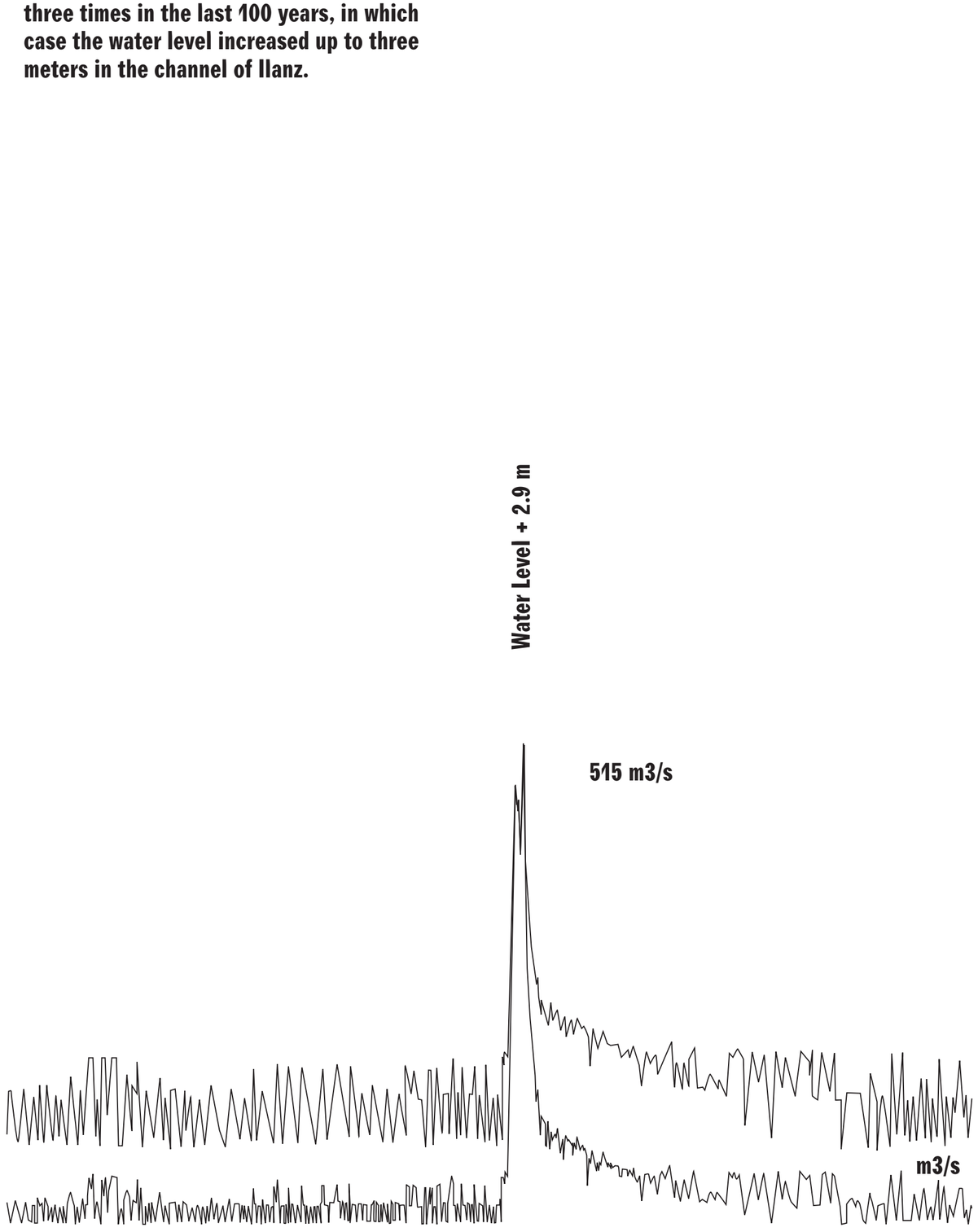
8'000 years ago

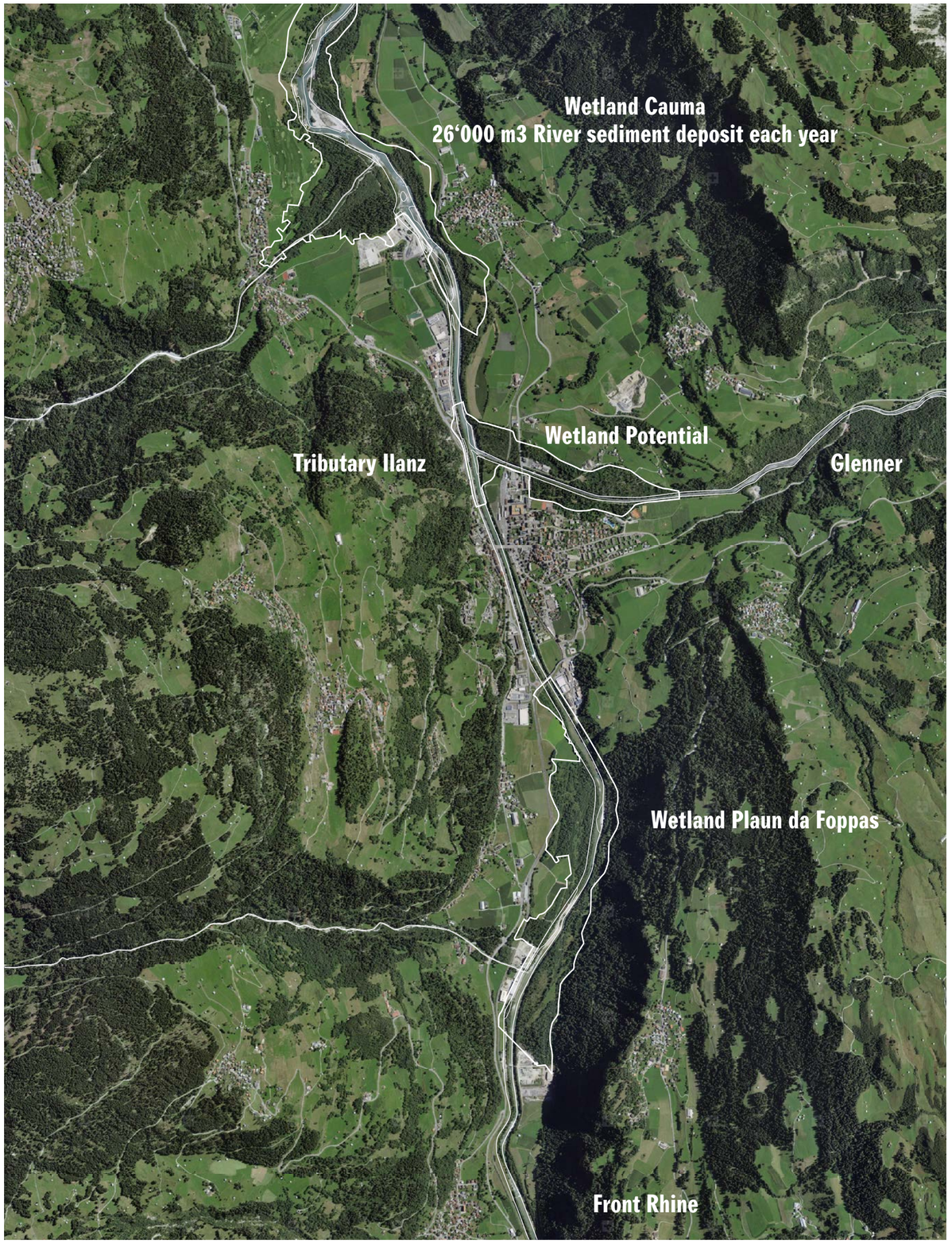


4'000 years ago

Video: Seguinot J.; Advance and retreat of the Alpine glaciers during the last glacial cycle, 2018

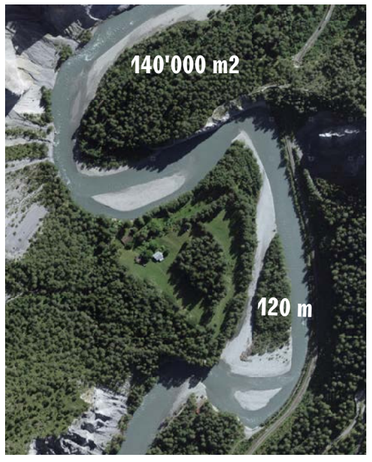
The 100-year flood has allready taken place three times in the last 100 years, in which case the water level increased up to three meters in the channel of Ilanz.



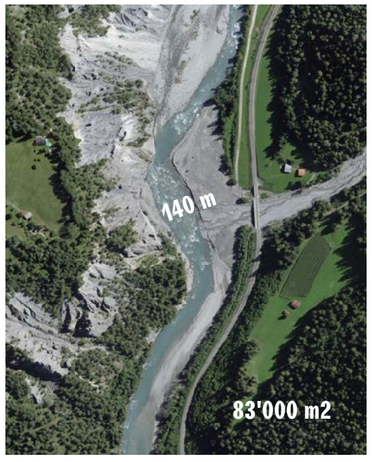


Site Ilanz Scale 1:25’000 N

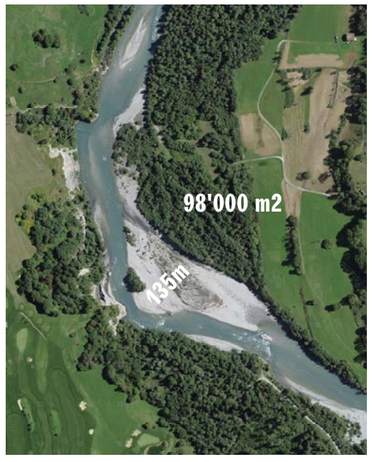
Weaker flood events which provoke morphological river bed changes take place every two to five years. We can identify those areas where the river bed has not been intervened (dynamical river bed) along the front Rhine and observe that the unchanneled river bed area has an impact on the amount of sediment deposit and natural development of landscape.



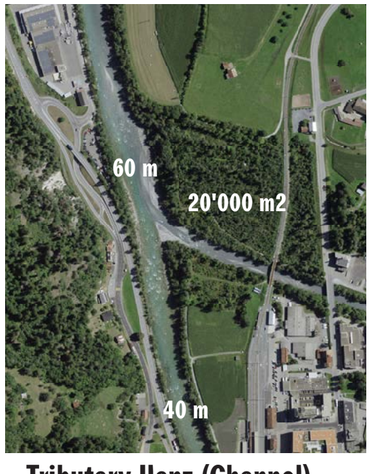
Wetland Ruinaulta



Tributary Nitz

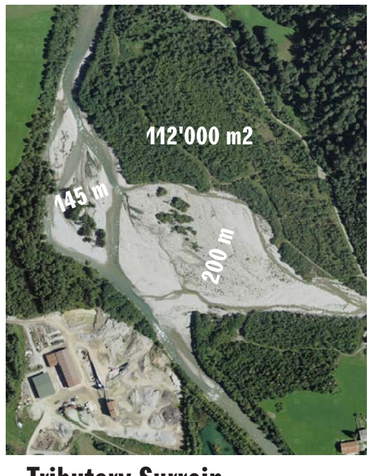


Wetland Cauma

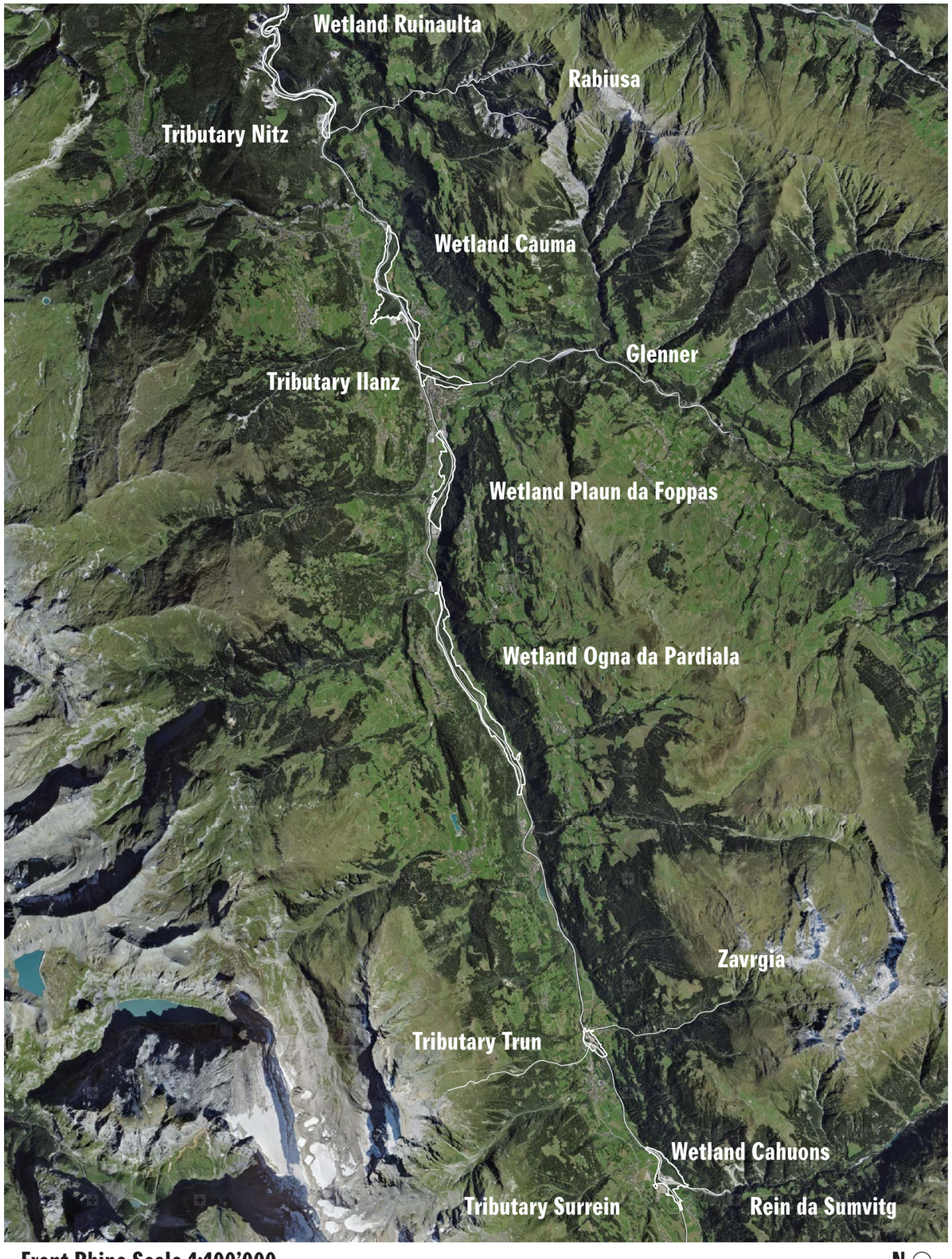


Tributary Ilanz (Channel)

Tributary Trun



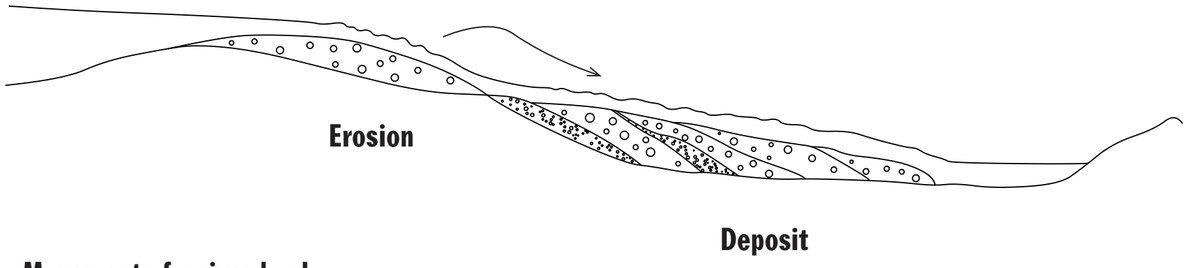
Tributary Surrein



Front Rhine Scale 1:100’000

River Sediment

The average river sediment transport that is passing the tributary in Ilanz and got deposit in the Wetland of Cauma during the flood events was measured as 26'000 m3/ year between 2005 and 2009 by Canton Graubünden. (Morphological Changes on the right).



Movement of a river bank

1985

1990

1997

2003

2005

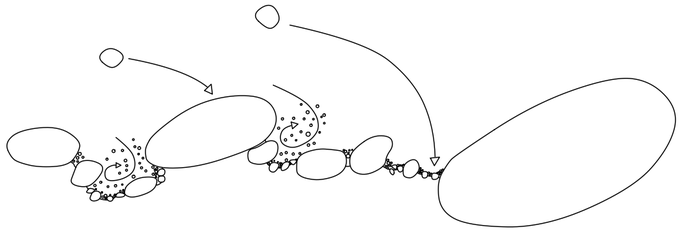
2008

2011

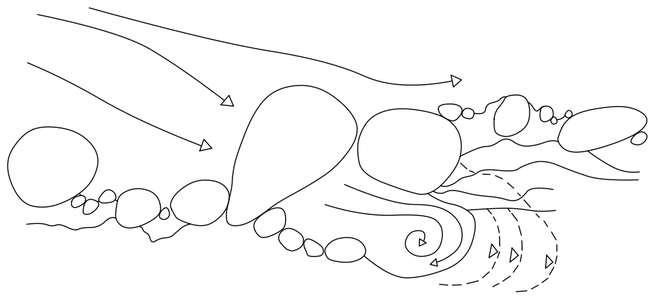
2015

2019

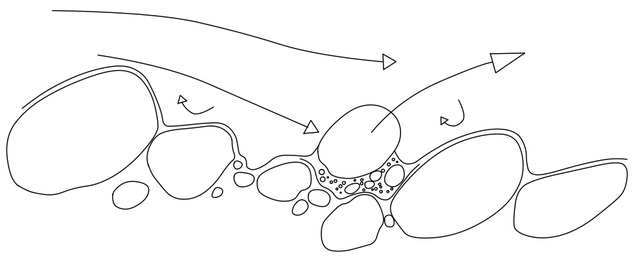
Sand is mostly transported as suspended load, whereas gravel, stones, blocks are trasported by rolling and sliding along the river bed. During strong floods gravel and stones can change the behavior of their movement and join the sand in the suspended field.



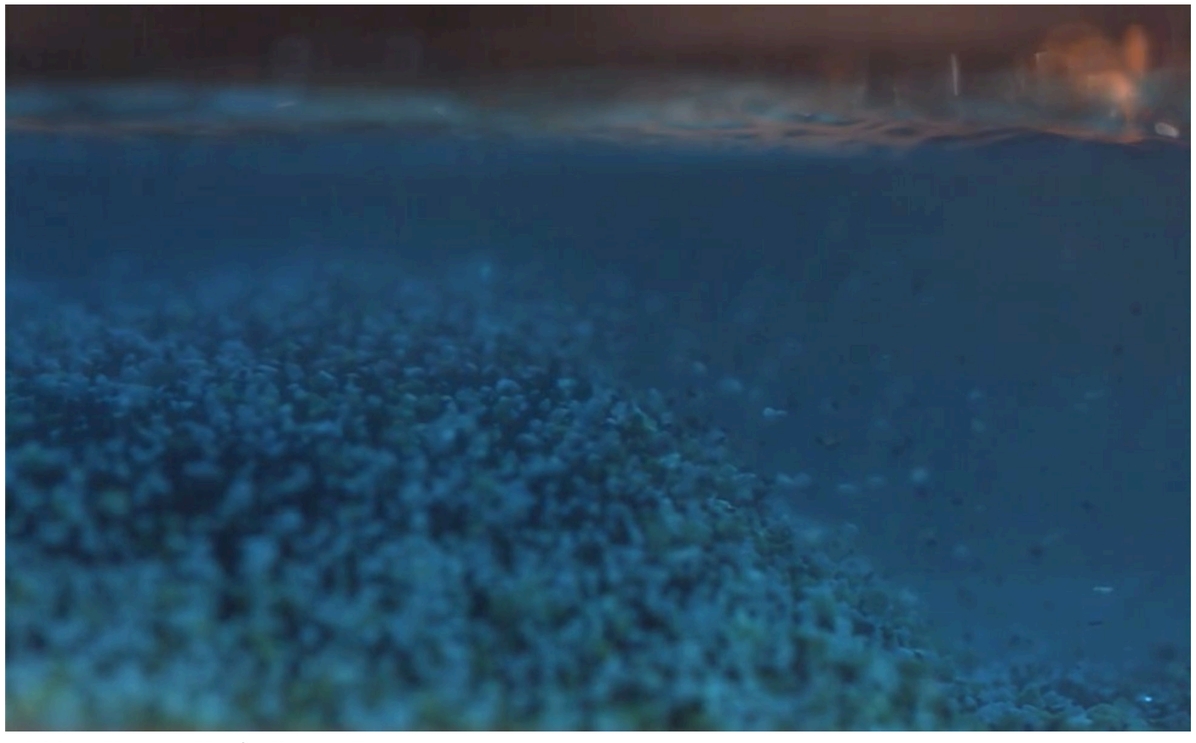
Transport process



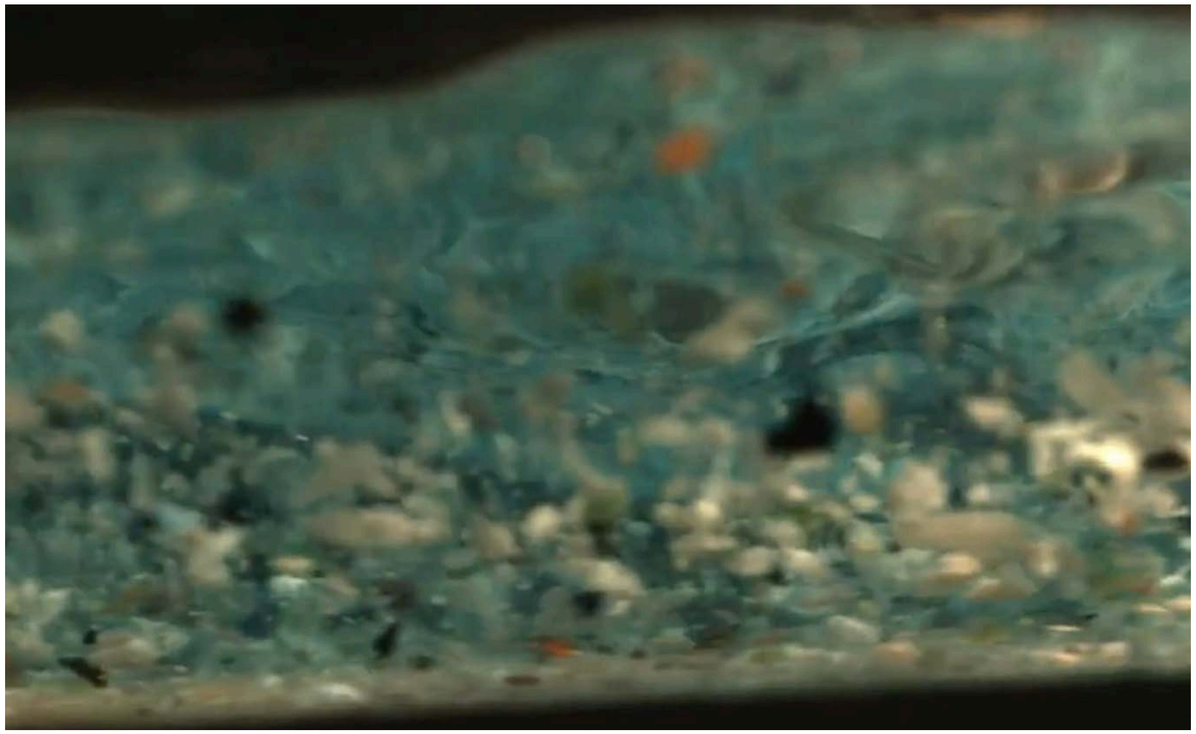
Baring by water



Dissolving of a cobble



Video: Kuchta M., Sediment Transport

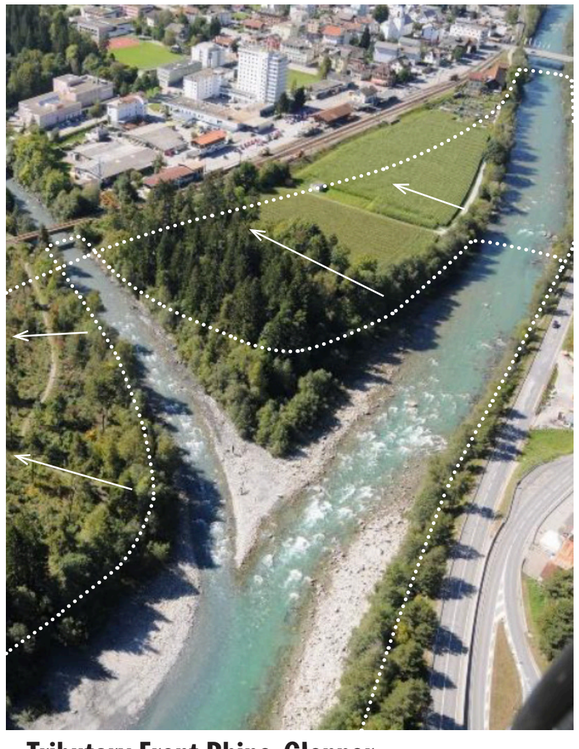


Video: Kuchta M., Sediment Transport in Turbulent Flow

The past intervention of channeling in Ilanz led to a controlled state but isolated the river at the same time. The fixed width reduces the sediment deposit, the development of biological diversity and the possibility to safely entering the river bed.

If the river sediment that is being brought by the river will be used as the material of intervention, the river bed should be widened in the tributary area where the city Ilanz has already a plan for renaturation.

Channeling of Ilanz



Tributary Front Rhine-Glenner

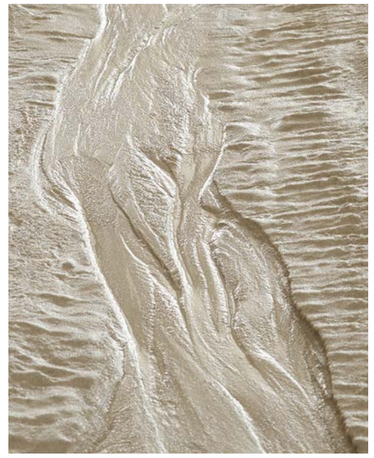
Site Ilanz

How does the river sediment move with the water flow and how can it be manipulated? The first test under a constant water flow shows the lateral movement of a dynamical river bed.

A Deposit
B Erosion
C Pool
D Low water flow
E High water flow

0 Min

30 Min

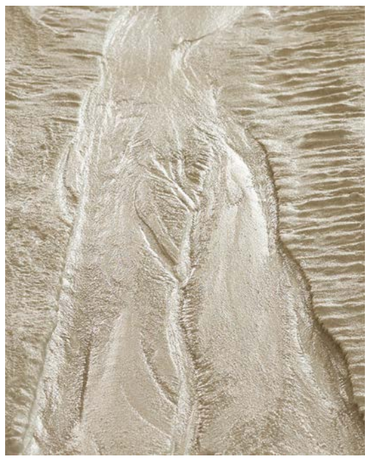


30 Min

60 Min

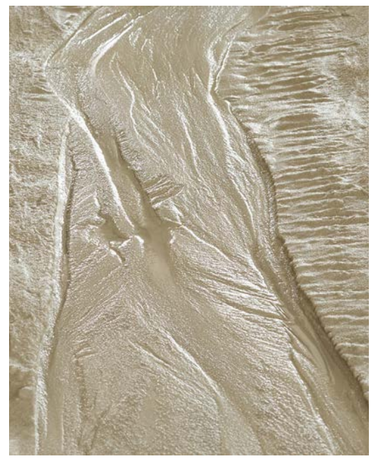
60 Min

90 Min



90 Min

120 Min



120 Min

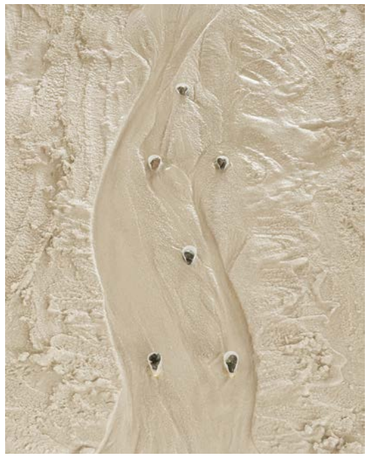
The alternate setting of fixed resistant points before water flood show how they construct a turbulent center.

A Resistant point
B Erosion
C Deposit
D Acceleration through mini channel
E Scouring

0 Min

0 Min

30 Min



30 Min

60 Min

60 Min

90 Min

120 Min

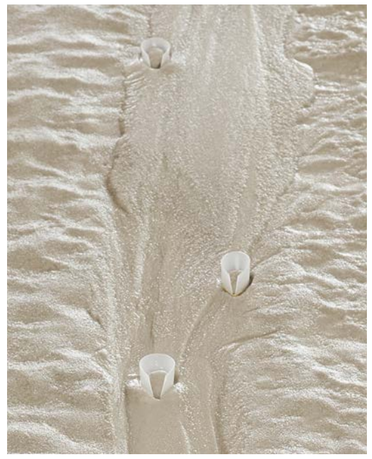
120 Min

The top point placed in an observed sediment accumulation changed the direction of the primary drain to the left and increased erosion on one side.

A Primary Drain
B Erosion
C Deposit
D Acceleration through mini channel

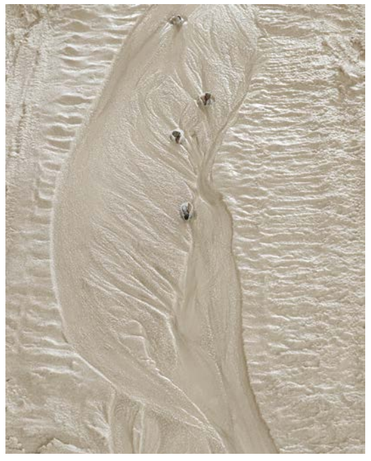
0 Min

30 Min (Zoom in)



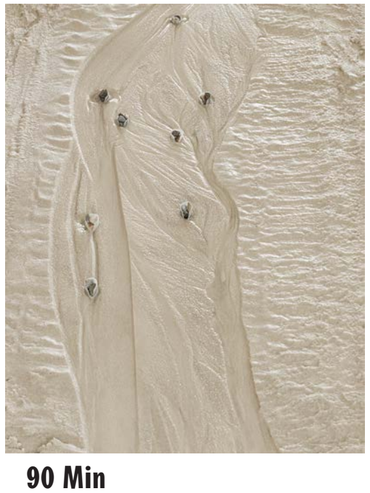
30 Min (Zoom in)

60 Min



60 Min

90 Min



90 Min

120 Min

120 Min

Manipulating the flow direction through spur dikes forces a controlled erosion on the counterpart while stabilising the shore in the current shadow.

A Spur Dike
B Erosion
C Deposit
D Stable Shore (Current shadow)

2 Min

2 Min

30 Min

30 Min

60 Min

60 Min

90 Min

90 Min

The erosion increases by increasing the spur dike size, however this also increases the pressure of water flow affecting the spure dike and it can cause a collaps.

A Spur dike
B Erosion
C Deposit
D Pool

2 Min

2 Min

30 Min

30 Min

60 Min

60 Min

90 Min

90 Min

Using several small spur dikes have the similar erosive effect as one big, but they rather guide the water from the side to the center in a more controlled way and erosion takes more time.

A Spur dike
B Erosion
C Deposit
D Pool

0 Min

2 Min

30 Min

60 Min

60 Min

90 Min

90 Min

120 Min

120 Min

In the existing tributary in Ilanz, the secondary drain of Glenner prevents the erosion on the left side and shows a similar effect of a spur dike with the water flow to resist the primary drain of the Front Rhine.

A Primary Drain
B Erosion
C Deposit
D Secondary Drain

0 Min

5 Min

30 Min

30 Min

60 Min

60 Min

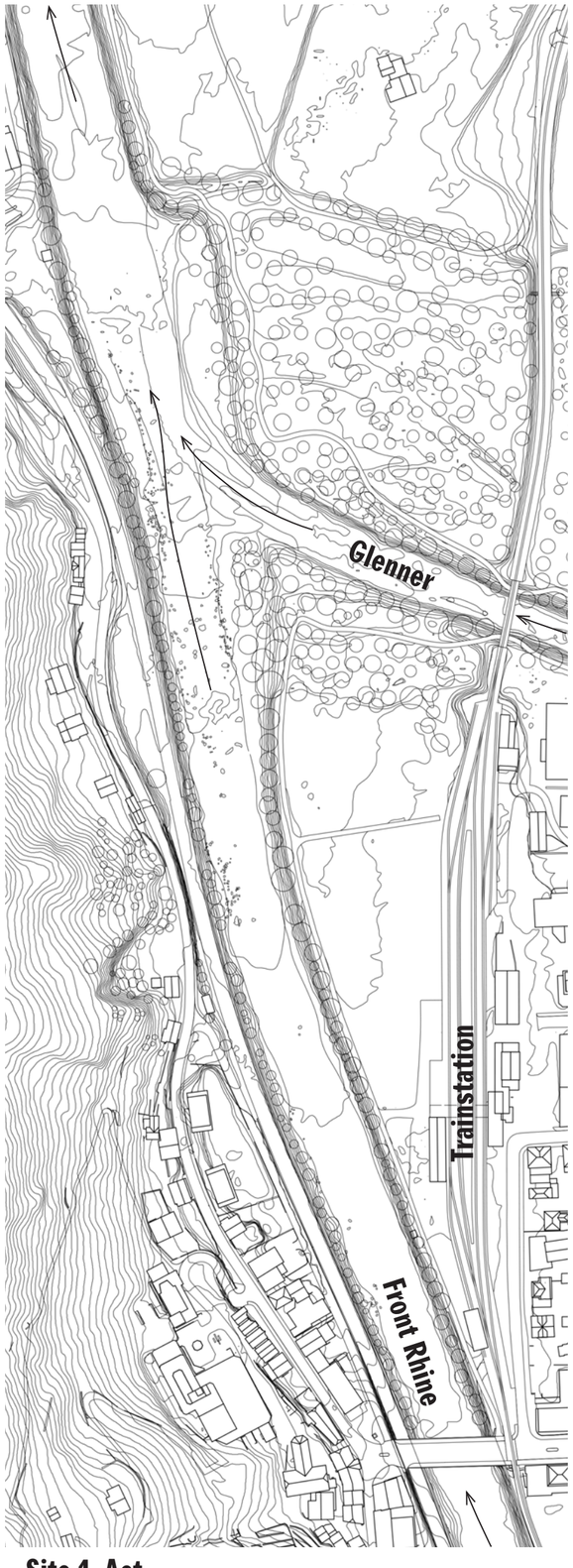
90 Min

90 Min

90 Min

Spur Dike

The spur dikes showed the biggest impact on forcing erosion on one side but at the same time controll the shores. They will help changing the current river bed situation in Ilanz to set the river free to act.



Site 1. Act

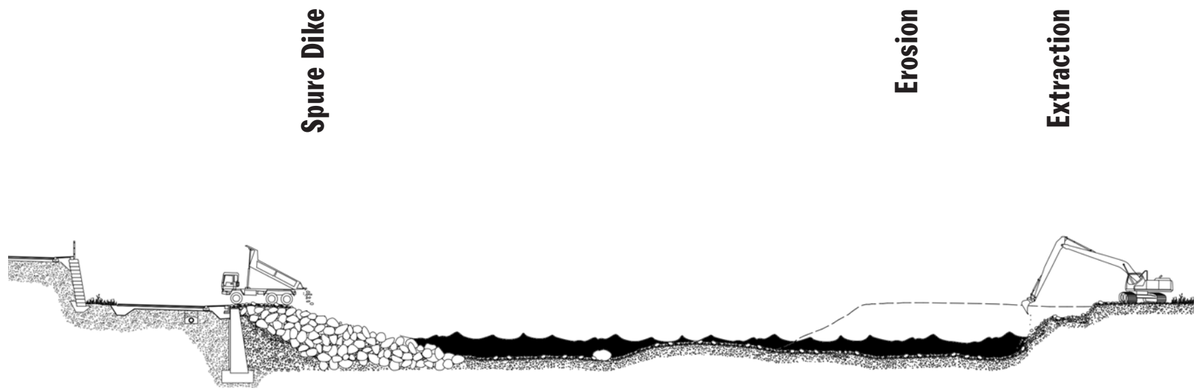
N

Section 1. Act

Water Level max 2.9 m

1. Act (0 Year): Since the channeling increases the drain and the force of the water flow, it prevents the river sediment deposit. The channel has to be dissolved.

Site 2. Act

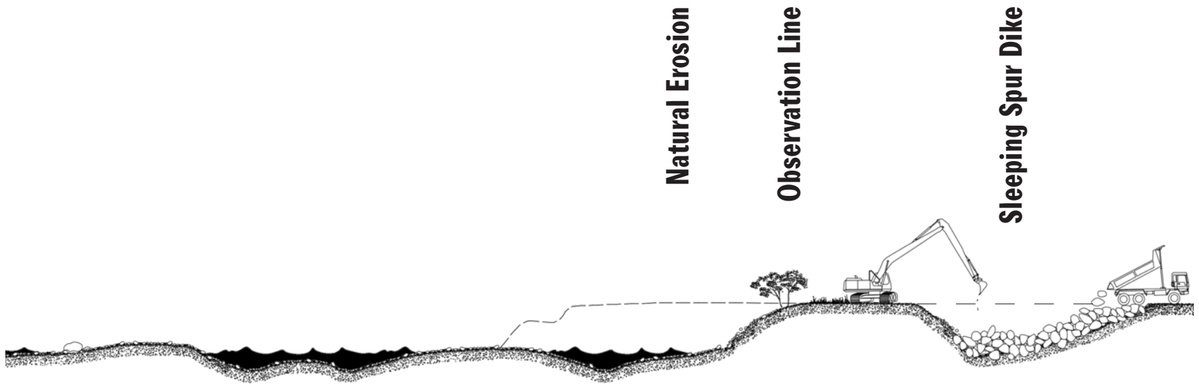


Section 2. Act

Water Level max 2.1 m

2. Act (1 Year): Widening the river bed with spur dikes will particularly promote the erosion on the right side by allowing the deposit on the left in the current shadows of spur dike.

3. Act (5 Years): When the ongoing dynamical widening reaches the observation line, the shore will be stabilized with sleeping spur dikes to protect the built envirenment.



Section 3. Act

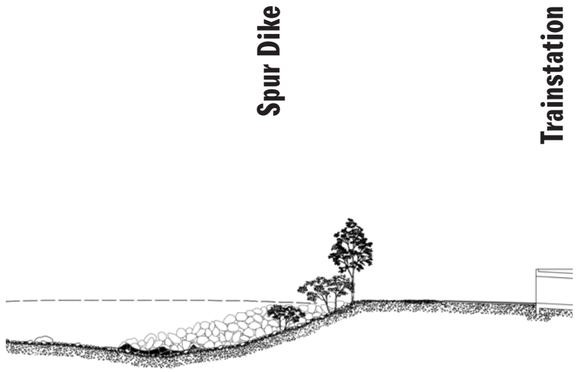
Water Level max 1.4 m

Site 3. Act

N

4. Act (10 Years): The process of the River Acting enables a dynamical morphology between the controlled shores in the course of time and it reduces the max level of water.

Section 4. Act



Water Level max 1.0 m

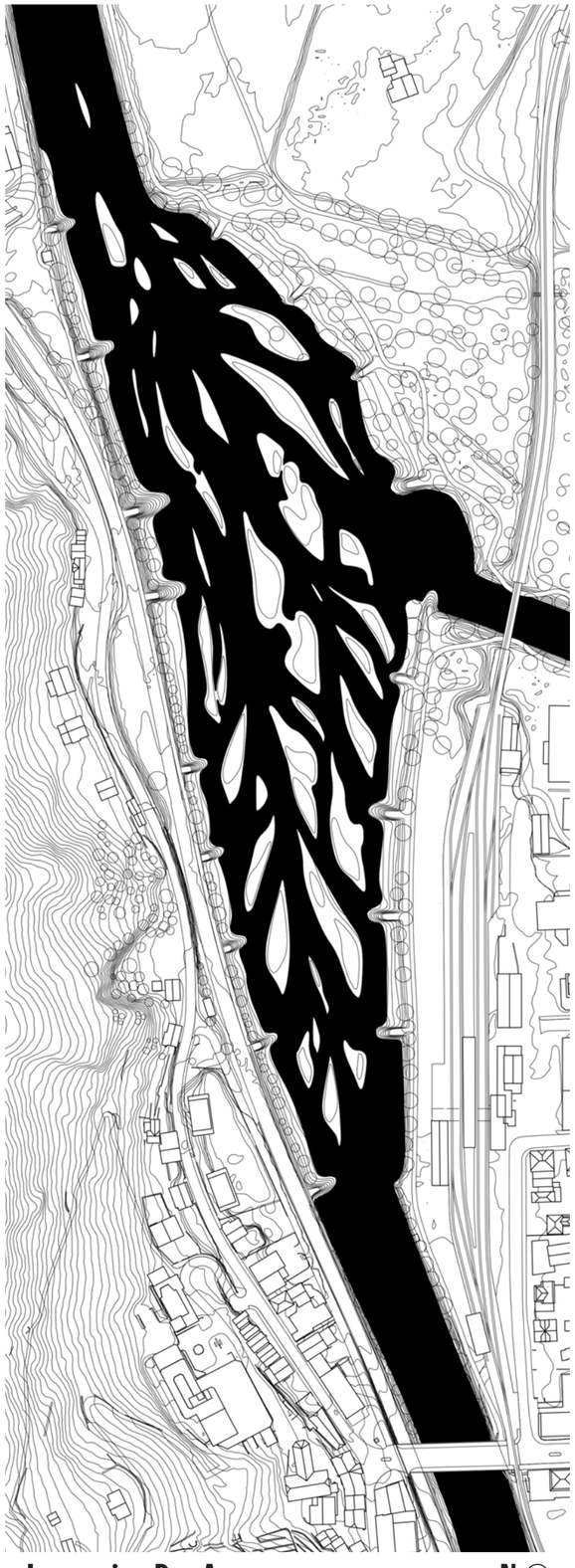
Site 4. Act **N**

Low Water 4 Acts

Increasing Dry Areas

N

Flood 4 Acts



Increasing Dry Areas

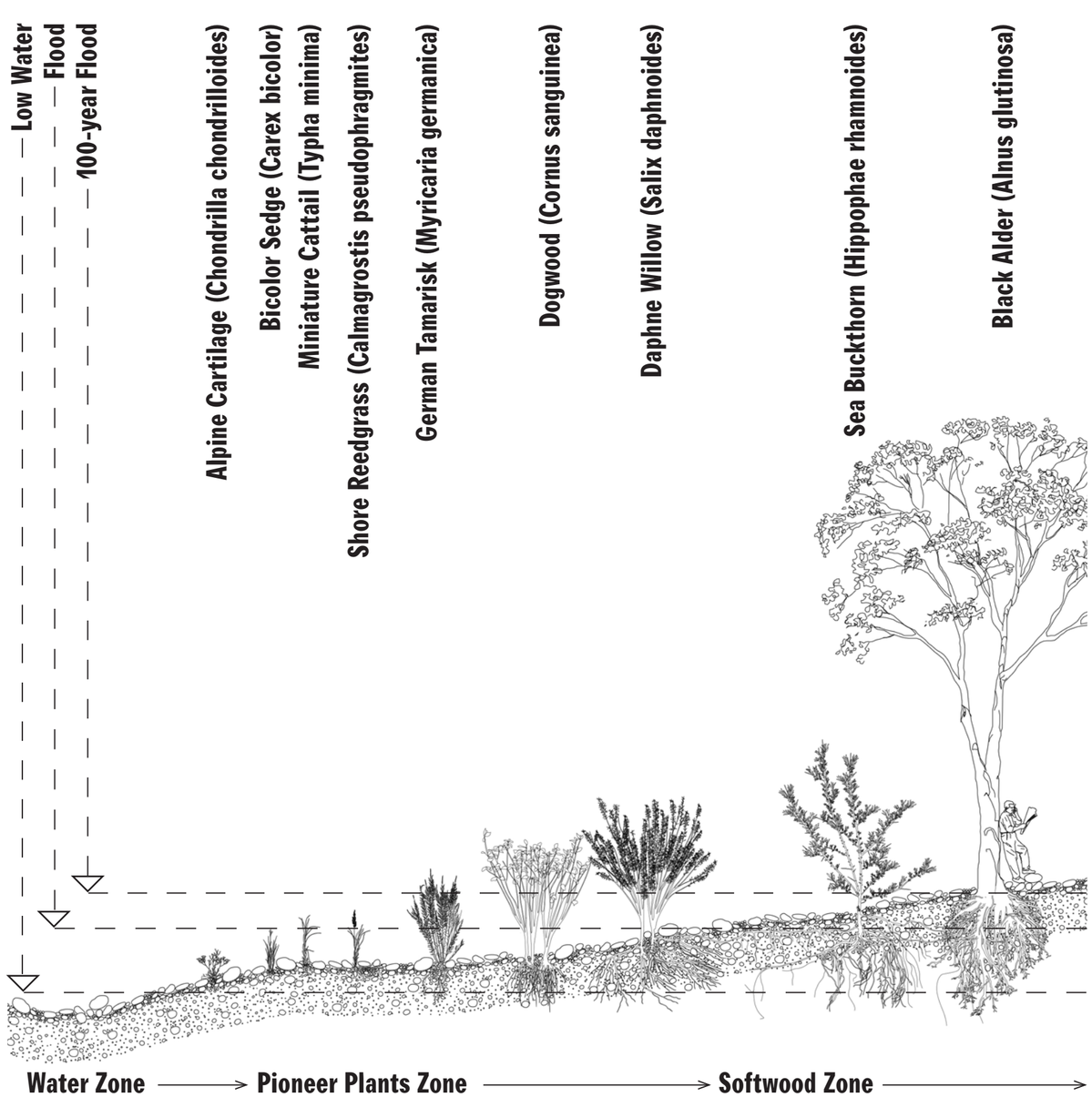
N

100-year Flood 4 Acts

Increasing Dry Areas

N

The new flatter shores will support the development of biological and zoological diversity (wetland). The water, the wind and the birds will distribute seeds and the plants will start to grow by themselves depending on the different water levels. A process activated by the River Acting!



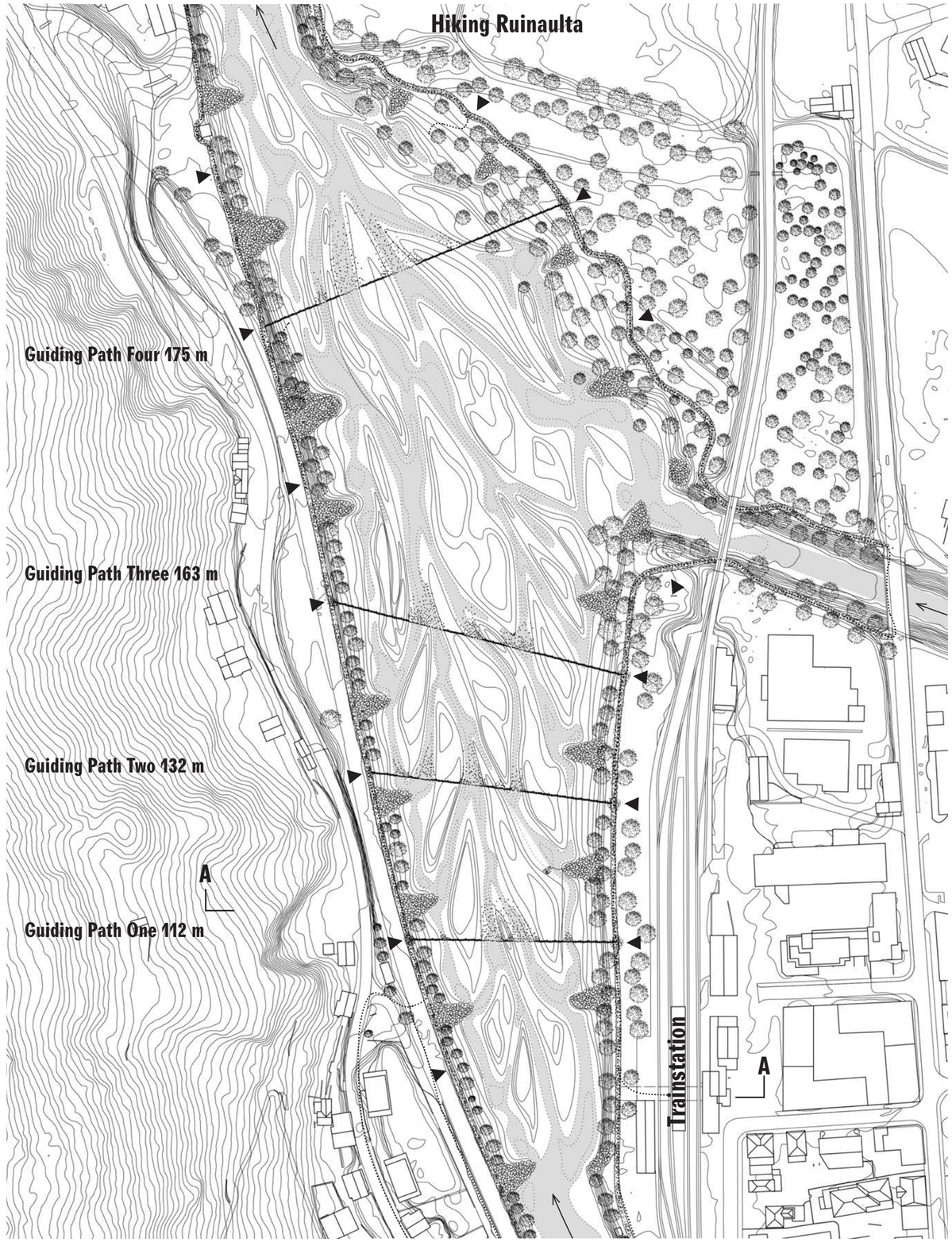
Shore Plants

River Bridging

After laying the fundation of a dynamical river bed, the question of bridging arises: How do we bridge through a space defined by resettling banks and coexistence of different development stages of the wetland ecosystem next to each other?

By defining guiding paths; possibilities of bridging, sitting areas and a river bed access from the shore can be visualised. The stones from the site are used for guiding paths so that the structure can dissolve during strong floods without disturbing the river dynamics.

Moment of Access

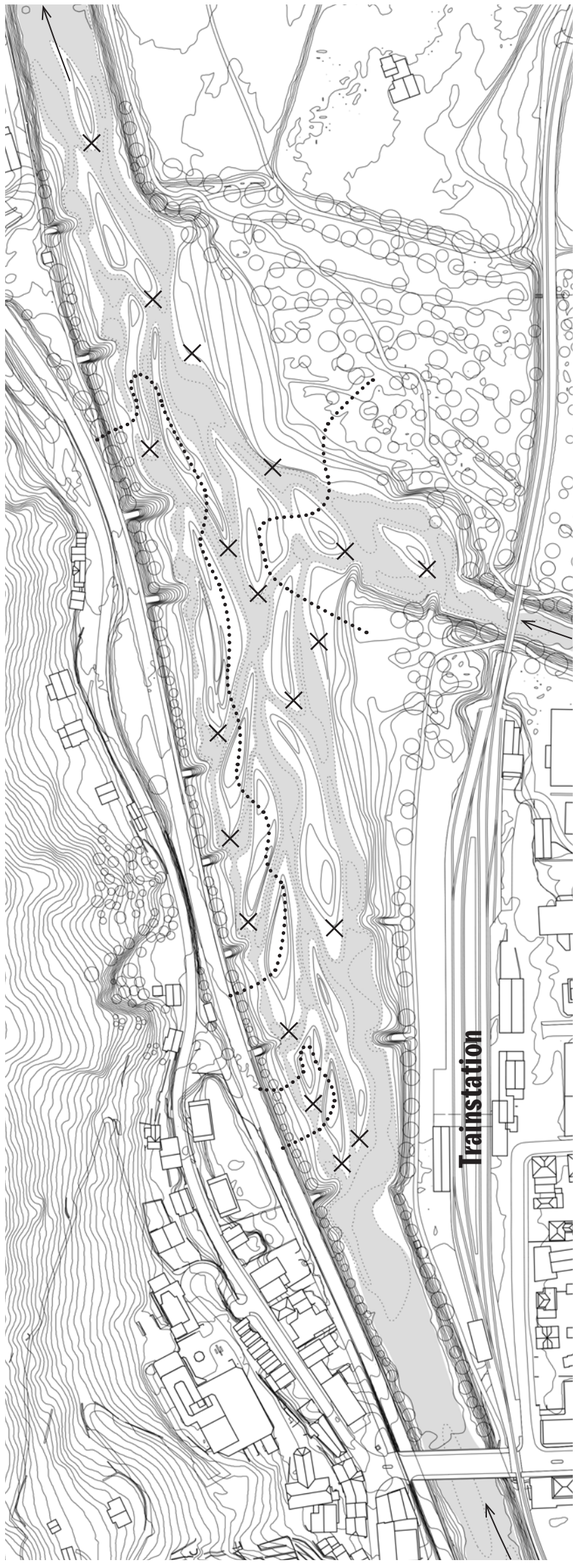


Site: Access Scale 1:2000

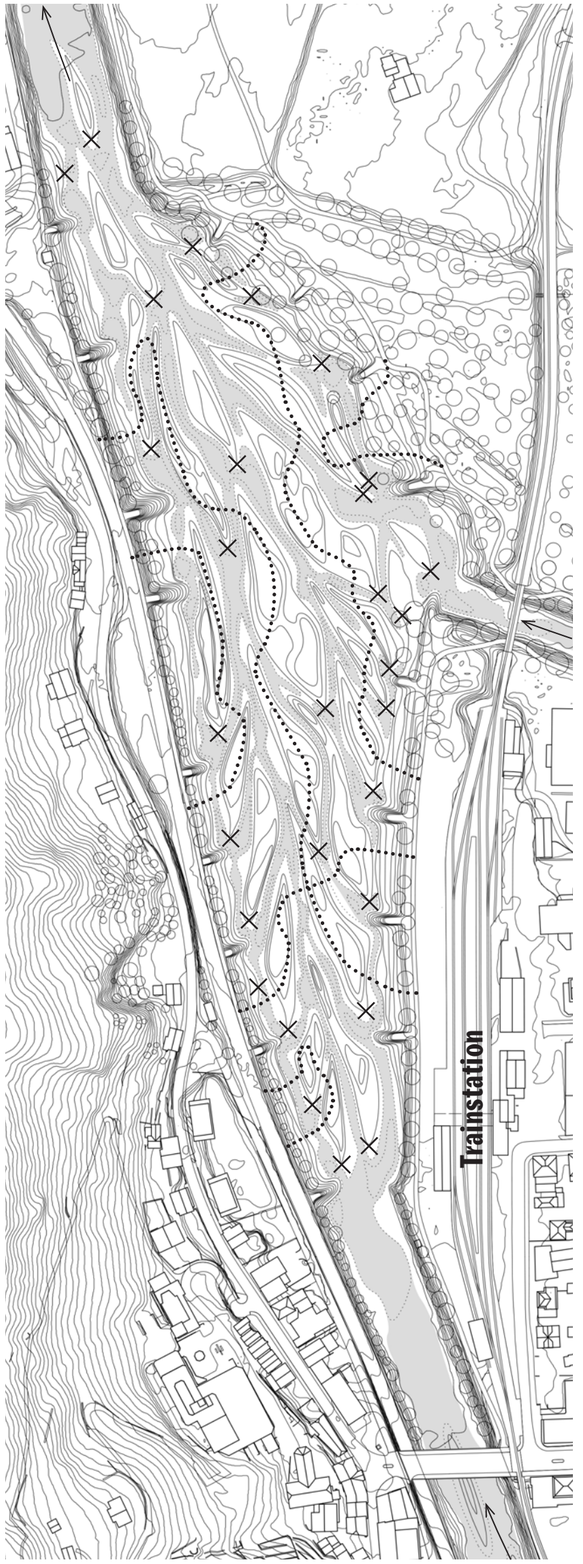
The river bank morphology will remain nearly the same for one to five years and in this way its pattern can be analysed. The widening act increases the number of river banks that are nearer to each other and this leads to more bridging possibilities situated behind the river bank starting points.

River Bank Starting Points (×)

Site 2. Act



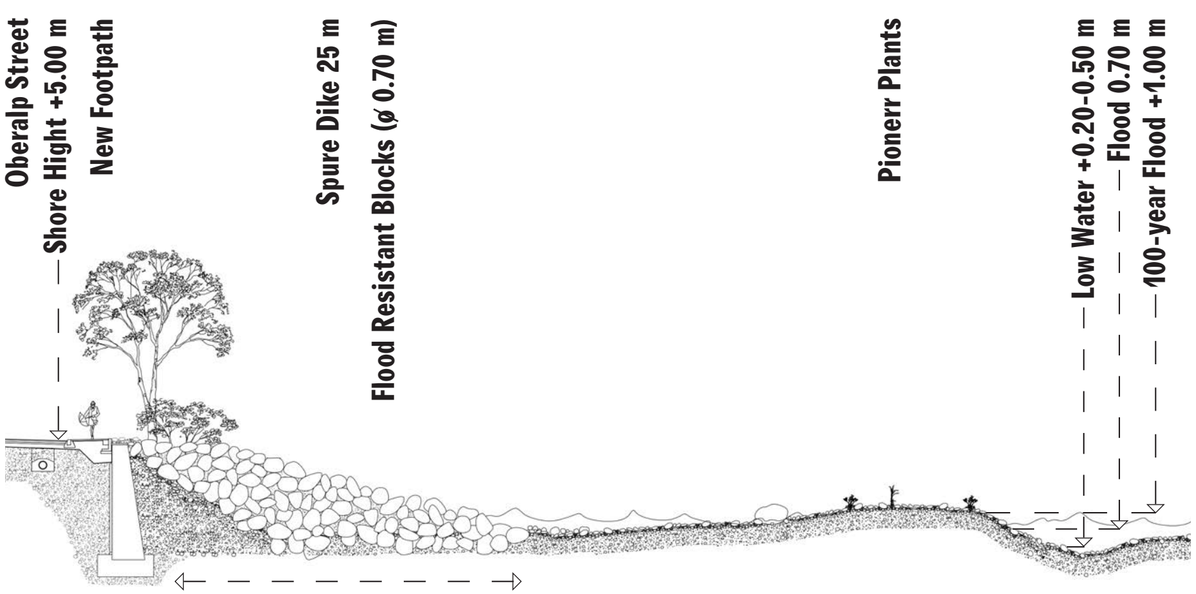
Site 3. Act



Site 4. Act

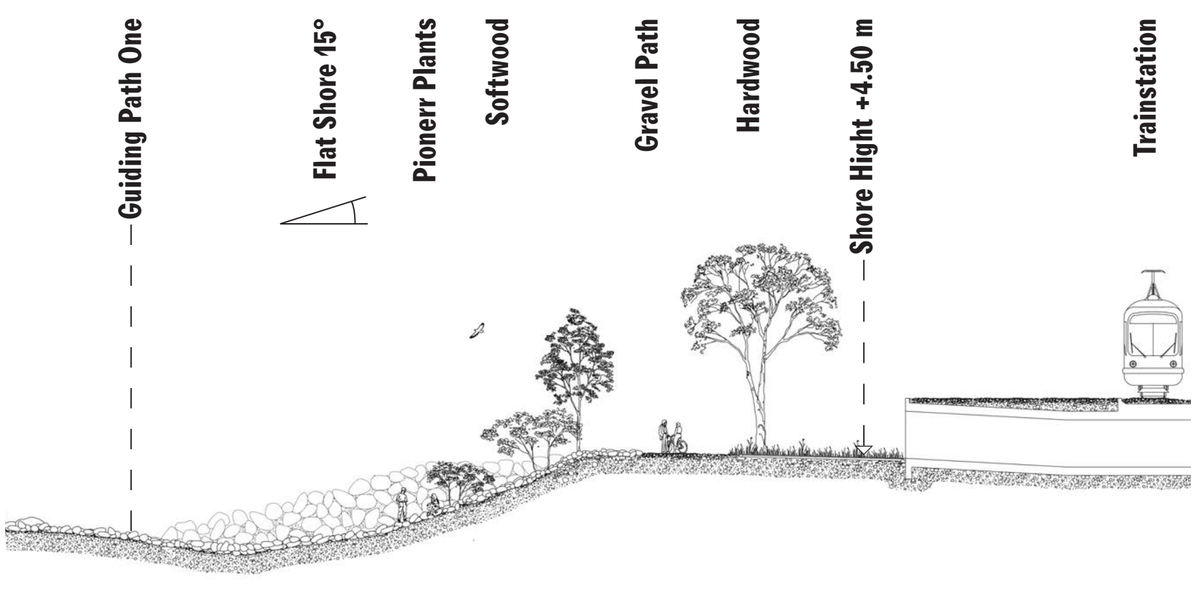
N

A dynamical landscape can be formed in between spure dikes and walking paths on the shores. All flat shores are the potential access points for bridging from the river shore to the river banks.



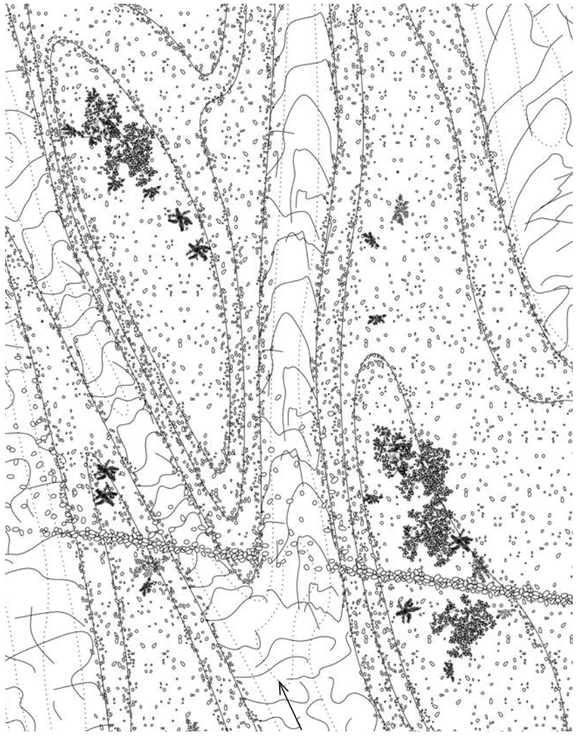
Section A-A: Shore Oberalp Street Scale 1:200

Gravel Path



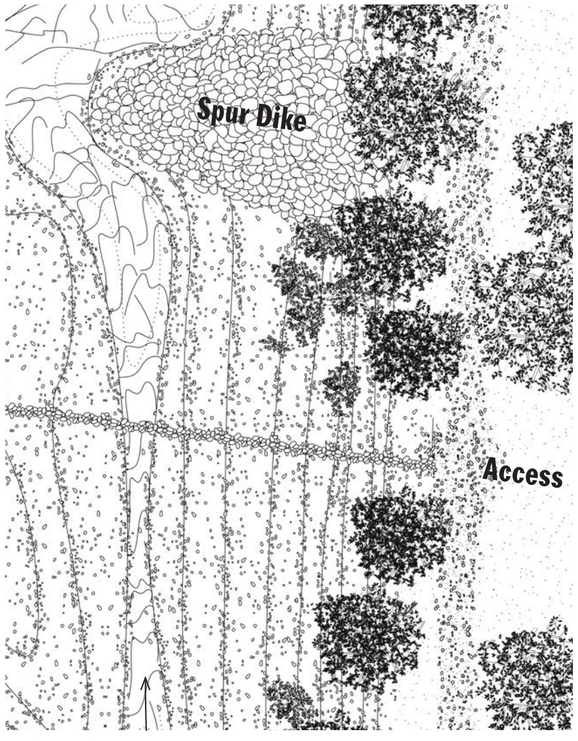
Section A-A: Shore Trainstation Scale 1:200

Plants and the Guiding Path

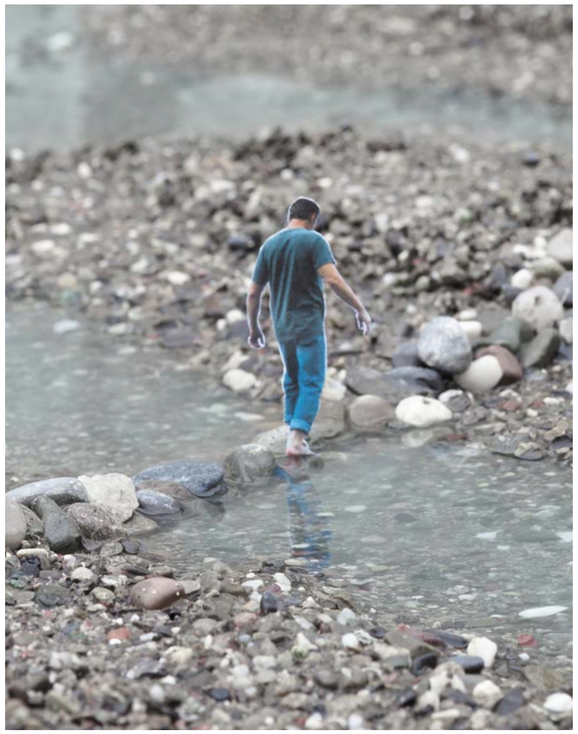


Site: Guiding Path Two Scale 1:400

Voids are generated by using bigger stones and blocks so that sand, mud and other organisms can pass through. The guiding paths can be build by hand due to the sizes of the grain which is found on site. The distribution of the river sediment in the alpine area of Ilanz: 12 % 0-0.25 cm (sand), 46 % 0.25-6 cm (gravel), 34 % 6-20 cm (stones), 8 % 20-30 cm (blocks).



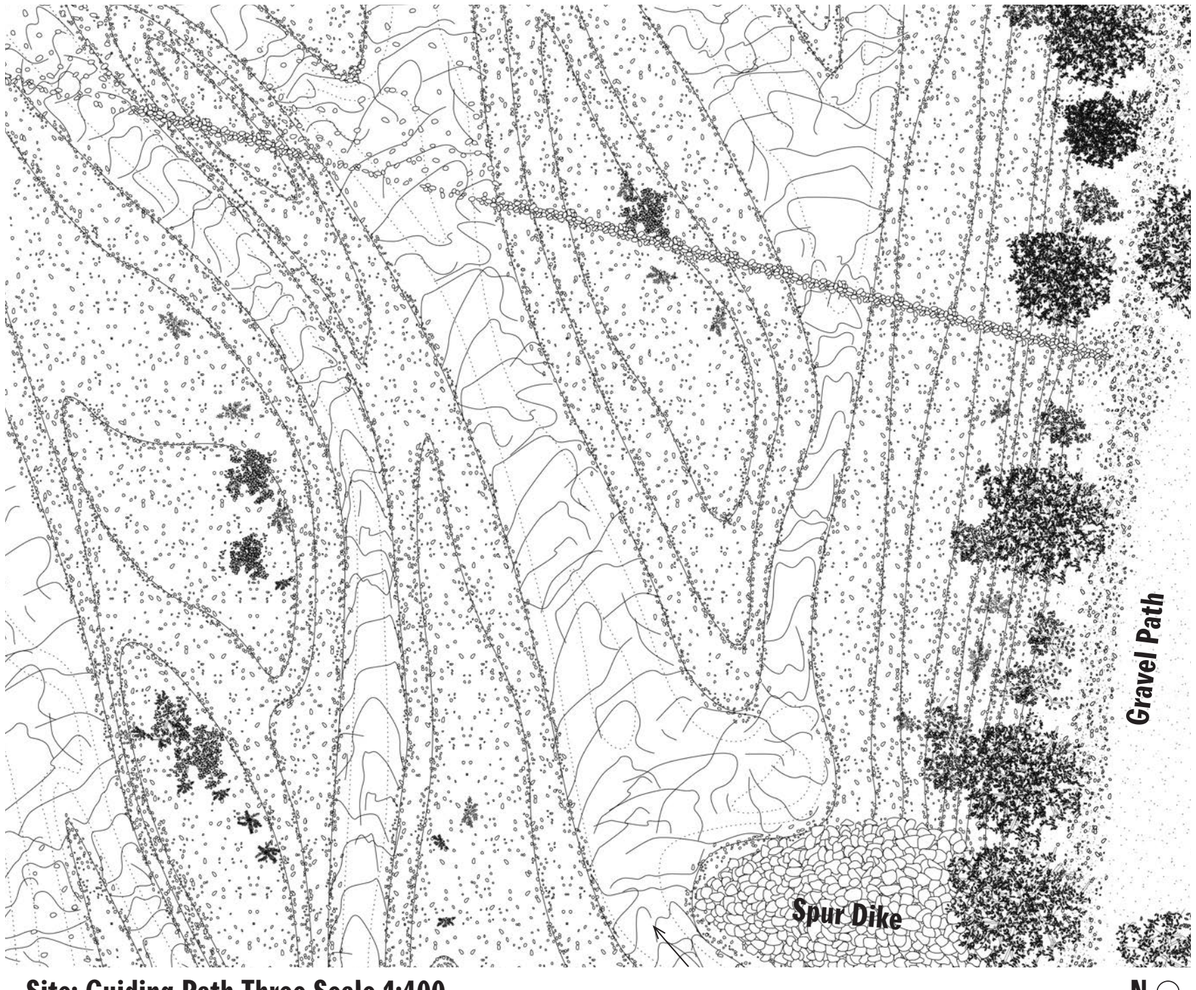
Site: Guiding Path Two Scale 1:400



Moment of Bridging

N

This includes a care taking approach, in which the constant maintainance is a part of the bridging event. An event which takes place after stronger floods.



Site: Guiding Path Three Scale 1:400

Moment of Care Taking

I see River Acting as a site specific engagement, which can bring locals closer to the dynamical river, the river sediment and its manipulation with spur dikes. An artistic but at the same time an infrastructural intervention for preventing future flood damages.

I want to thank

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for the support.

Sources:

Hinderer M.; Late Quaternary denudation of the Alps, valley and lake fillings and modern river loads; Institute für Angewandte Geowissenschaten, Darmstadt University of Technology, Germany, 2000

Hinderer M.; Large to Medium-Scale Sediment Budget Models - the Alpenrhein as a Case Study; Institute für Angewandte Geowissenschaten, Darmstadt University of Technology, Germany, Springer- Verlag, 2003

Hinderer M.; River loads and modern denudation of the Alps - A review; Institute für Angewandte Geowissenschaten, Darmstadt University of Technology, Germany, Earth-Science Reviews, 2013

Kuhlemann J., Frisch W., Szekely B., Dunkl I., M. Kazmer; Post-collisional sediment budget history of the Alps: tectonic versus climatic control; Springer-Verlag, 2002

Kuhlemann J., Frisch W., Szekely B., Dunkl I.; Quantifying tectonic versus erosive denudation by the sediment budget: the Miocene core complexes of the Alps, Institute für Geologie und Paläontologie, Universität Tübingen, Germany , 2000

Kuhlmann J., Kempf O.; Post-Eocene evolution of the North Alpine Foreland Basin and its response to Alpine tectonics, Institute für Geologie und Paläontologie, Universität Tübingen, Germany, 2001

Kantonaler Forstgarten Graubünden, Pflanzenkatalog, 2020/21

Garcia Lugo G.A., Bertoldi W., Henshaw A. J., Gurnell A.M.; The effect of lateral confinement on gravel bed river morphology, School of Geography, Queen Mary, University of London, UK, 2015

Wohl E., et al.; The Natural Sediment Regime in Rivers: Broadening the Foundation for Ecosystem Management, Oxford University, 2015

Kondolf G. M.; Hungry Water: Effects of Dams and Gravel Mining on River Channels, University of California, 1997

Zeh H.; Ingenierubiologische Bauweisen im naturnahen Wasserbau, Bundesamt für Umwelt BAFU, 2010

Graf F., Rickli C.; Beitrag von Pflanzen und Mykorrhizapilzen zum Schutz vor flachgründigen Rutschungen, Ingenieurbiologie,

Graf F., et al.; Effects of Mycorrhizal Fungi on Slope Stabilisation Functions of Plants, WSL Institute for Snow and Avalanche Research, Davos, 2019

Bezzola G. R.; Lecture Flussbau, ETH Zürich, HS 2020

Schächli U., Vischer D. (Hrg.); Die Komation von Fliessgewässersohlen: Prozesse und Berechnungsgrundlagen, ETH Zürich, 1993

Zarn B., ... , Vischer D. (Hrg.); Geschiebehaushalt Alpenrhein, ETH Zürich, 1995

Friedl F.; Laboratory Experiments on Sedimend Replenishment in Gravel-Bed Rivers, Diss. ETHZ No. 24826, 2017

Hunziker, Zarn & Partner; Morphologie und Geschiebehaushalt Alpenrhein, 2001

Hunziker, Zarn & Partner; Vorderrhein: Morphologische Beurteilung, Domat/Ems, 2014
Gewässerentwicklungskonzept Surselva, Gemeinde Ilanz/Glion, 2018

BAFU; Faktenblätter Auen, Bern, 2008

Die Auen der Schweiz, 2005

Video: Seguinot J.; Advance and retreat of the Alpine glaciers during the last glacial cycle, Vimeo, Vimeo, 2018

Video: Kuchta M.; gx8 1917-Emflume9-sed-trans, Vimeo, (upload 2013)

Vodep: Kuchta M.; Sediment Tranport in Turbulent Flow, Vimeo, (upload 2012)

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