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WATERSCAPES: POINT CLOUD AS A DESIGN METHODOLOGY

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The impact of climate change is strongly reflected in the movement of water. Ninety percent of all disasters are water related, and the frequency and intensity of water-related hazards is generally rising. By 2050, the number of people vulnerable to flood disasters is expected to increase to two billion. Climate change could force an additional 1.8 billion people to live in water-scarce environments by 2080.[1]

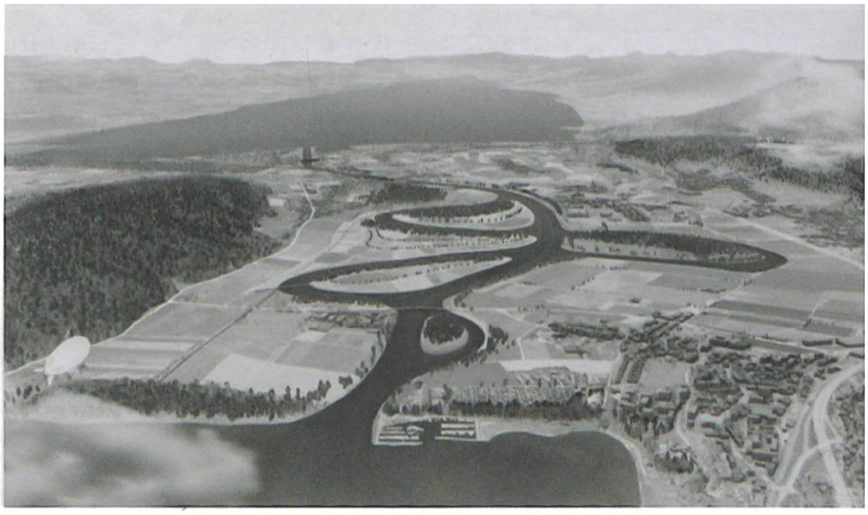
In a time of climate change and increasingly frequent natural hazards, causing global alterations and disruptions, we as landscape architects have the opportunity and responsibility to design resilient systems. To prevent or at least mitigate future natural calamities, our designs should not only please our sense of aesthetics but also be durable and sustainable. The methodology of designing with digital tools is an inevitable means to this end. Through tools which can process complex large-scale data sets, it is possible to create innovative topographic approaches while designing spaces for humans and nature.

Water represents a particularly pervasive threat: increased rainfall and melting glaciers as well as water scarcity will have an unimaginable impact on our environment and our lives. As the "water castle of Europe" with more than 1,500 lakes, rivers, and water bodies and numerous glaciers, water is a crucial resource in Switzerland. Yet water-related disasters have been increasing in frequency and intensity in the last twenty years.[2] In 2005 and 2007, major flood incidents took place throughout Switzerland due to increased rainfall, and such events have recurred almost annually since then.

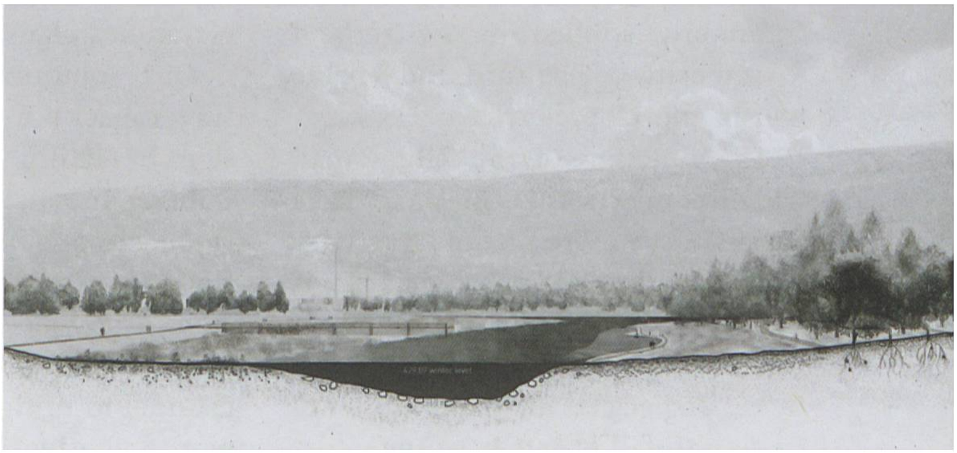
Tackling such challenges requires new methodologies that enable us to work efficiently and accurately on a potentially remote situation. Digital models allow us as designers to be directly confronted with topographical realities. By modeling and simulating directly in a digitized reality, an efficient design process can yield durable and resilient interventions that make a difference on a local as well as global scale. Large-scale solutions and strategies can be developed and tested computationally in the context of diverse and constantly changing land topologies.

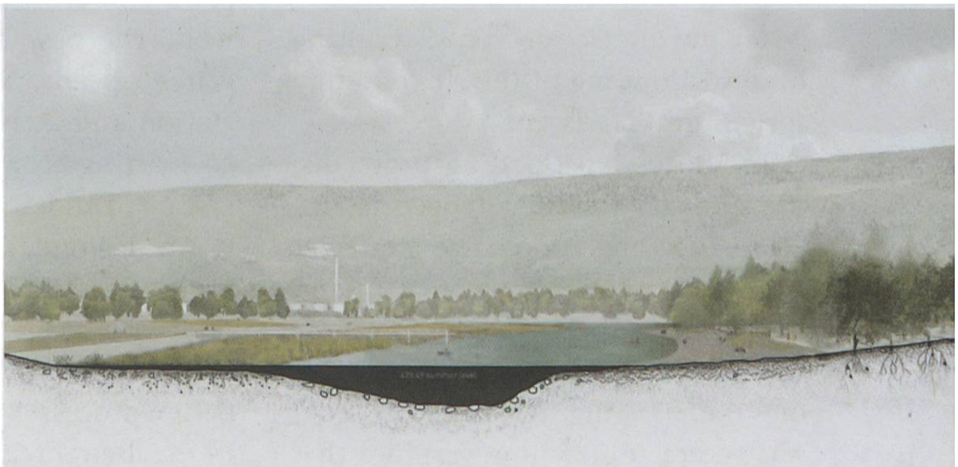
Point cloud modeling, a technology that originated in geodesic land surveying, is commonly used in industry for analysis, inventorization, and monitoring in the fields of geomorphology, archaeology, agriculture, and forestry to capture large-scale landscape areas. Point cloud modeling has become a key component of the design and analysis methods that are employed and explored at the Chair of Landscape Architecture of Christophe Girot at ETH Zurich. This technology allows millions of data points to be processed simultaneously, with amazing precision, in models that enable boundless movement through virtual space. Through filtering and classification, such models can not only be used to analyze topographic situations with high precision, but at the same time provide a digital basis for design. Working with point cloud models makes it possible to generate beautiful images and enables us to anchor visions and topographic interventions directly in a digitized reality. In this way, large-scale solutions and strategies can be developed and tested, especially in relation to water crises driven by climate change in diverse and constantly changing land topologies.

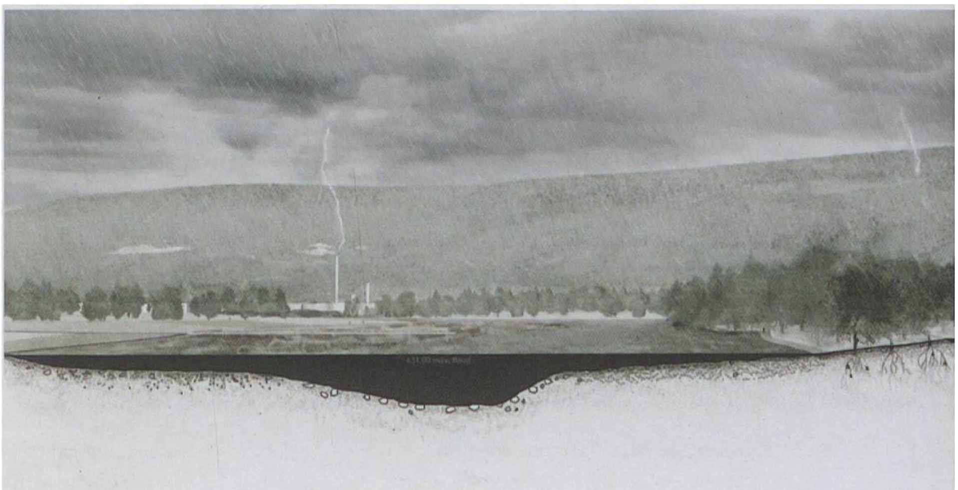
As a concrete example of using point cloud modeling, in 2020 we presented students at the Chair of Landscape Architecture with the task of using it to address the vulnerability of the Seeland region to flooding. About 15,000 years ago, this landscape was shaped by the retreat of the Rhone glacier. The flooding of the Aare resulted in wetlands that stretched across the area, with the three lakes of Morat, Neuchâtel, and Bienne being connected through the "Grand Marais" (the great marsh). To cultivate the land for agriculture and at the same time protect it against the frequent floods, the wetlands were drained by several river corrections during the twentieth century. Such flood management measures were



"Co-Existence" bird's-eye perspective, project by Philip Meile and Michael Zuber







"Co-Existence" section perspectives during winter (429.70 meters above sea level), summer (429.49 meters above sea level), and flood (431.00 meters above sea level) project by Philip Meile and Michael Zuber commonly applied in Switzerland to intensify agriculture and enable housing developments.

The function of the Zihl Canal, which connects Lake Biel and Lake Neuchâtel, is more that of an estuary than of a river. One particularity is its dual-flow direction, which equalizes the water level during floods. Increasing glacial melt and more extreme rainfall events have put additional stress on the system, triggering the discussion of a third correction of the canal. The flow capacity of the channel cannot regulate the excess water during flood events, resulting in local flooding of the surrounding agricultural landscapes.

In addressing flooding problems, the students were challenged to develop new and innovative strategies to increase water flow capacity and create more space for the canal by analyzing and topologically altering the existing terrain. The goal was to create new topographies that are compatible with existing structures and to develop site-specific scenarios at different scales. The basis of the design was a point cloud model, which allowed the students to quickly analyze and understand the correlations between topography, river network, and vegetation and to test initial interventions directly in the model. The modified model was then used to create elaborate sections, elevations, plans, and visualizations.

One solution to enhance water flow capacity was proposed in a design by Philip Meile and Michael Zuber. It distinguishes between floodable and protected areas (defined by exact topographical heights from a point cloud model) and introduces an additional meandering channel to mitigate fast-rising water by distributing it to multiple channels. The excavated material is redistributed locally by creating three islands which rise above the floodplain and are therefore protected as well. The new bypass offers slower water speeds, enabling new vegetation and activities in a landscape co-existing between agriculture, riverscape, and leisure.

An exemplary landscape design project treats a natural event not as a disaster but as a part of a reality that needs to be fully incorporated in the design process. By anchoring a project in the digital reality of a point cloud, designing and testing on a grown terrain can reach utmost precision. This ultimately enables a design to not only bring cultural benefits and aesthetic value to the landscape, but at the same time provide an approach to a specific problem. Therewith, a design becomes more than a "nice gesture"; it offers the basis for a sustainable solution.

1 Henk Ovink, "Water by Design," Bioneers Conference 2015, talk recorded on October 17, 2015, https://www.youtube.com/watch?v=NtAZ9ikZdQk (accessed January 31, 2023).

2 "2021 State of Climate Services," World Meteorological Organization, No. 1278, 2021, https://library.wmo.int/index.php?lvl=notice_display&id=21963 (accessed February 5, 2023).