Sustainable Design of Alpine Infrastructures

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Abstract

This ongoing research project shows how, based on GIS data systems, inherent landscape features can be described, visualized and analysed, and through the use of scripting based design methodologies, a suitable approach for the integration of sustainable infrastructures in complex landscapes can be developed.

1 Introduction

It is a fact that the pressures on the alpine area and its utility value increases as a result of climate change.

The necessary structural interventions have the potential to transform and threaten the natural environment in an unprecedented way, without proper consideration. Due to the intensive use, it is a risk that the typical character of the landscape and its topographic uniqueness will be lost. The theme of sustainable design is essential in order to not generate, in the near future, a landscape that is no longer recognizable.

These facts raise the question of how far a social discussion about an altered image of nature must be conducted and how humans perceive landscape. So far, the integration and interaction of buildings with the surrounding natural environment in the mountains has not been properly considered.

Our research takes up this task and examines the design of the Alpine region through a geomorphological approach. To develop the criteria for a sustainable architectural language, an intense research in the areas of landscape perception, its topologies, and morphologies is required.

The goal of this field of research is to sustain the ecological and economic value of the natural landscape in alpine regions.

2 Analysing and Describing the Landscape

This area of research deals with the spatial and aesthetic quality of landscape, based on its topography respective to geomorphology.

Analysis of the landscape and how it is perceived is key to the development of progressive sustainable design. To understand the spatial quality of the landscape, it is necessary to work in three-dimensional diagrams.

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- Analysis of spatial and aesthetic qualities of the landscape based on their topography and geomorphology.

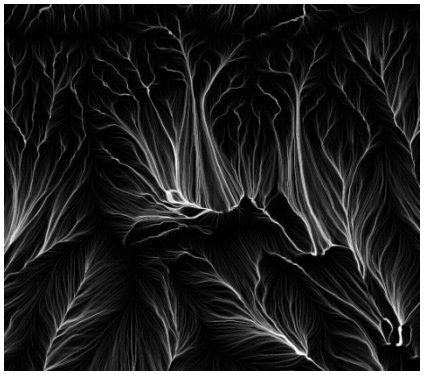

Fig. 1:
Visualization of the terrain by slope lines – describing the dynamics of the landscape

- Identification of the elements of landscape composition that play an active role in formal interaction with the terrain.

Fig. 2:
Visualization of the uniqueness of geological form compositions

- Parameters describing the shape in terms of size, location, relationship, materiality, curvature, slope and exposure.

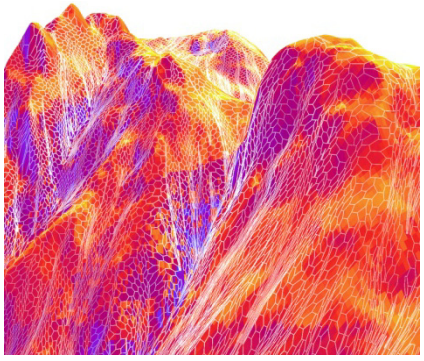

Fig. 3:
Visualization of the degree of southward exposure

- Surface characteristics and vegetation subsystems correspond to variables and are subjected to cyclical phenomena such as seasons, solar radiation, growth and erosion.

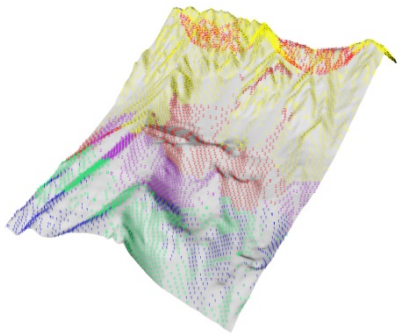

Fig. 4:
Visualization of surface conditions

Through this approach, it is possible to analyse the composition of the landscape according to a set of organizational formal elements. We can determine the elements of this spatial composition that play an active role in the interaction between form and territory. Through this approach, landscape can be perceived as a sort of figure-ground relationship. The determining parameters of the form are size, relative position, materiality, curvature, slope and exposition, as well as the guiding geometry of the formal element. The precise form of this element varies, but can be generalized through geometric abstraction. A series of formal principles such as formation, territory, rhythm, layering, texture and axis can be extracted and examined. The definition of these elements and relationships make it possible to differentiate between them, and analyse their meaning relative to landform. Visual relationship, distance, and polarity between the interior and the horizon must also be understood and considered, as they play an important role in the perception of landscape.

3 Field of Application and Design Proposals

3.1 Alpine Hybrid

It is the aim of these studies to develop suitable combinations of function, conceive utilization concepts specially designed for the Alpine area, and implement a reference project. It should become possible to integrate the different necessary functions into one structure.

The Alpine Hybrid is a concept for an alpine structure composed of various functions or processes. The function of alpine infrastructures is combined with functions that are attractive in terms of tourism.

Energy Experience Protection

Fig. 5: Idea functional combination

Total Value Added

Alpine infrastructures are combined with renewable sources of energy to form self-sufficient systems. Through functional diversification, year-round use becomes possible. This scenario can be imagined for protective and cable car structures, as well as for power plants.

Platform and Avalanche Barrier

The structure may serve as viewing platform, avalanche barrier and, under ideal conditions, an energy-producing system. It, therefore, combines function and attraction. From the platform, the ongoing scenario can be observed. The construction interacts with the environment, with both elements influencing and shaping one another. The building is not in contradiction to the landscape, but rather cooperates with it.

3.2 Sustainable Design of Alpine Power Plants

We have now reached a turning point regarding our energy supplies. For quite some time, industry across the globe has been showing a strong tendency towards renewable forms of energy to replace fossil fuels and nuclear power.

With the advantages of renewable energy now widely known, large parts of the population strongly support its promotion. While in non-Alpine areas it is relatively easy to plan and build such plants, the integration of renewable sources of energy in a sensitive and environmentally-friendly manner, considering for environmental design ideas, presents a great challenge in mountainous regions.

These research studies have undertaken this mission with the goal of maintaining both the ecological and economic value of the natural environment present in the living and economic environment of mountain regions.

It is the aim of this applied research to develop suitable forms of energy production, conceive utilization concepts specially designed for the mountainous region, and implement a reference plant.

To achieve integration in harmony with nature, similarities to the diversification of natural vegetation, stone formations, and rock distributions are not only desirable, but must be the main criterion and core competence of environmental design for green power plants.

3.2.1 Photovoltaic

Photovoltaic plants are frequently perceived as massive structures that do not belong in the natural environment. For the purpose of organising these systems, it is of primary importance to take into account the diverse features determining the landscape, given that photovoltaic systems can also be mounted with a high degree of efficiency even on less exposed sites.

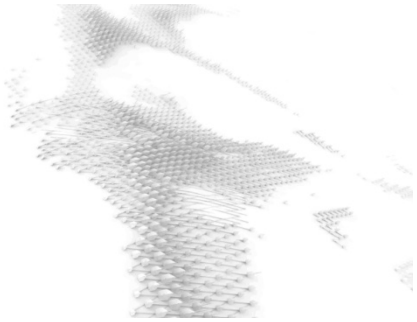

Fig. 6: Distribution pattern of the solar panels in the terrain. Created by scripting-based design methods.

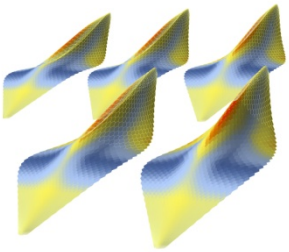

Fig. 7: Optimization studies of the solar panels

3.2.2 Wind Power

From an aesthetic point of view, most known wind turbine systems are generally unacceptable in a mountain scenery. In order to develop sustainable solutions for the Alpine region, the use of alternative wind power systems must be considered, and solutions regarding their geographical positioning in areas of thermal and fall winds must be sought.

The goal of this research is to develop a zoning plan for renewable energy sources as an instrument for regional planning.

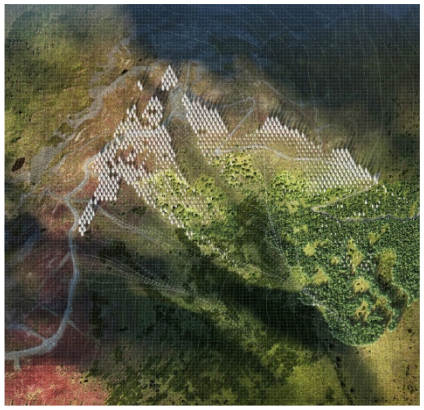

Fig. 7: Visualization of the distribution

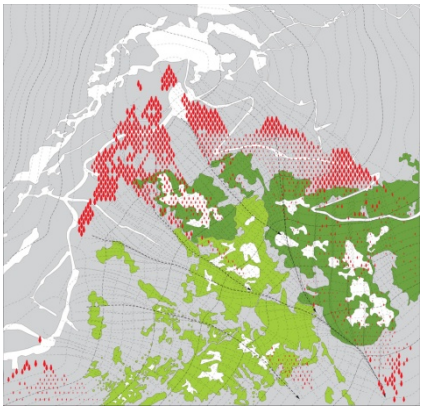

Fig. 8: Zoning Plan for renewables resources

4 Outlook

This project, as it stands, is meant to explore an intersection between conceptual design proposal and scientific research study. As the goal is to develop, not only novel design approaches to building in Alpine regions, but also highly calibrated methodologies based on scientific study, further development of this work will require both additional funding and specialized research partners to move forward.

Bibliography

GUALLART, V. (2008), Geologics, Geography Information Architecture.
HALLAMA, D. (2013), Schön und sicher? der Blick auf die Alpen. Die Bedeutung von Sicherheitstechniken für die Betrachtung und Darstellung alpiner Landschaften.
LANDESMUSEUM FERDINANDEUM (2012), Blickwechsel, Landschaft zwischen Bedrohung und Idylle, exhibition catalog.
SHIABATA, T., Landscape 1 and 2.
STEENBERGEN, C. (2008), Composing Landscapes.

Software

RHINOCEROS, accurate 3D freeform modeling Software, McNeel
RHINO TERRAIN, Rhinoceros Plug In
GRASSHOPPER, Graphical algorithm editor for Rhino
AUTODESK ECOTECT ANALYSIS

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