

阿尔卑斯山转型过程

——瑞士山区作为一种运行中的城市生态系统

Alps as Process

— Engaging Montane Switzerland as an Operating Urban Ecology

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摘要 ……

本项目从最初对瑞士的地下城市化和超大型基础设施的研究项目，演变为一个关注阿尔卑斯地区的毕业设计项目：从气候条件的显著变化、大量基础设施集约化，到集中的房地产热潮以及随之产生的废弃和衰退现象，一系列动态力量目前正在影响欧洲阿尔卑斯地区，并彻底改变其地理和区域关系。这些城市转型作为新兴但却不可避免的现象，对那些静态、孤立地将阿尔卑斯地区概括为风景如画及以自然景观为主的主流观点，以及观点背后的一系列保护和保存工作提出了质疑。本文通过对世界上最大最深的隧道——瑞士阿尔卑斯铁路隧道（又称阿尔卑斯枢纽计划）的研究，提出了对阿尔卑斯山脉认知的反思，该地区不仅是处于转型期间被全面城市化和受到人工干预的区域，而其本身也是一个运行中的城市生态系统：在该系统中，城市化、去城市化、增长和萎缩过程成为一种系统、灵活的设计方式的程序化向量。

关键词 ……

阿尔卑斯山；基础设施；阿尔卑斯铁路隧道；城市生态

Abstract …

What started as a research project on underground urbanization and mega-infrastructures in Switzerland became a thesis project on the Alps as a whole: from significant changes in climate conditions, heavy infrastructural intensification, to concentrated real-estate boom together with simultaneous abandonment and decline, a whole series of dynamic forces are currently pressing on the European Alps while thoroughly changing its geography and territorial relationships. As new yet indispensable phenomena, these urban transformations heavily question the predominant static and isolated view of the picturesque and natural alpine landscapes as well as the conservation and preservation efforts behind them. Through the lens of the new Transalpine Rail Tunnel in Switzerland (AlpTransit), the largest and deepest tunnel on earth, the paper outlines a radical rethinking of the Alps not only as an thoroughly urbanized and artificial territory in transition, but as an operating urban ecology itself where processes of urbanization, de-urbanization, growth and shrinkage become the programmatic vectors of a systemic and flexible design approach.

Key words …

Alps; Infrastructure; Alps Transalpine Rail Tunnel; Urban Ecology

阿尔卑斯山——转型中的城市区域

作为位于欧洲中心的一个跨国山脉系统，阿尔卑斯山目前正经历着前所未有的城市转型。由全球变暖引起的气候的显著变化，加上有限的客运和货运能力，以及对可再生能源不断增长的需求所导致的一场涉及物流、能源、运动和保护性基础设施的大规模集约化运动正在改造和重塑阿尔卑斯地区。在此次阿尔卑斯地区新一轮的基础设施改造中，最突出的当属即将竣工的世界上规模最大、最深的隧道——瑞士阿尔卑斯枢纽计划圣哥达基础隧道。作

为本研究项目的起点，阿尔卑斯枢纽计划案例研究成为我用以开展针对目前阿尔卑斯山地区城市转型的角度。这一全新的视角有助于打破孤立地看待阿尔卑斯地区的主流观点，进一步理解和阐述其作为更广泛的城市化进程的一部分。故此，不仅阿尔卑斯地区的城市化本质得到确认，其作为一个不断变化地、动态的实体也得到了认可。

阿尔卑斯枢纽计划——城市超大规模项目

作为瑞士有史以来最大规模的建设项

目，这条长57km、深2 300m的阿尔卑斯铁路隧道，通过一条贯穿整个山区范围的高原（图1）。作为欧洲高速铁路网的一部分，这个超大型项目作为阿尔卑斯货运和客运交通的重要组成部分，使该地区的货运和客运能力提升了两倍。同样地，这是一个高度政治化和国际化的城市开发项目，其表明了欧盟意在通过铁路促进北方（鹿特丹、巴黎、慕尼黑、汉堡、法兰克福）和南方（米兰、罗马）的主要大都市地区之间货物运输的决心（图2）。位于

欧洲中部、阿尔卑斯中心的瑞士拥有战略性的位置，利用这一机会可将其流动性基础设施的规模、容量和影响提升至一个新的层面。

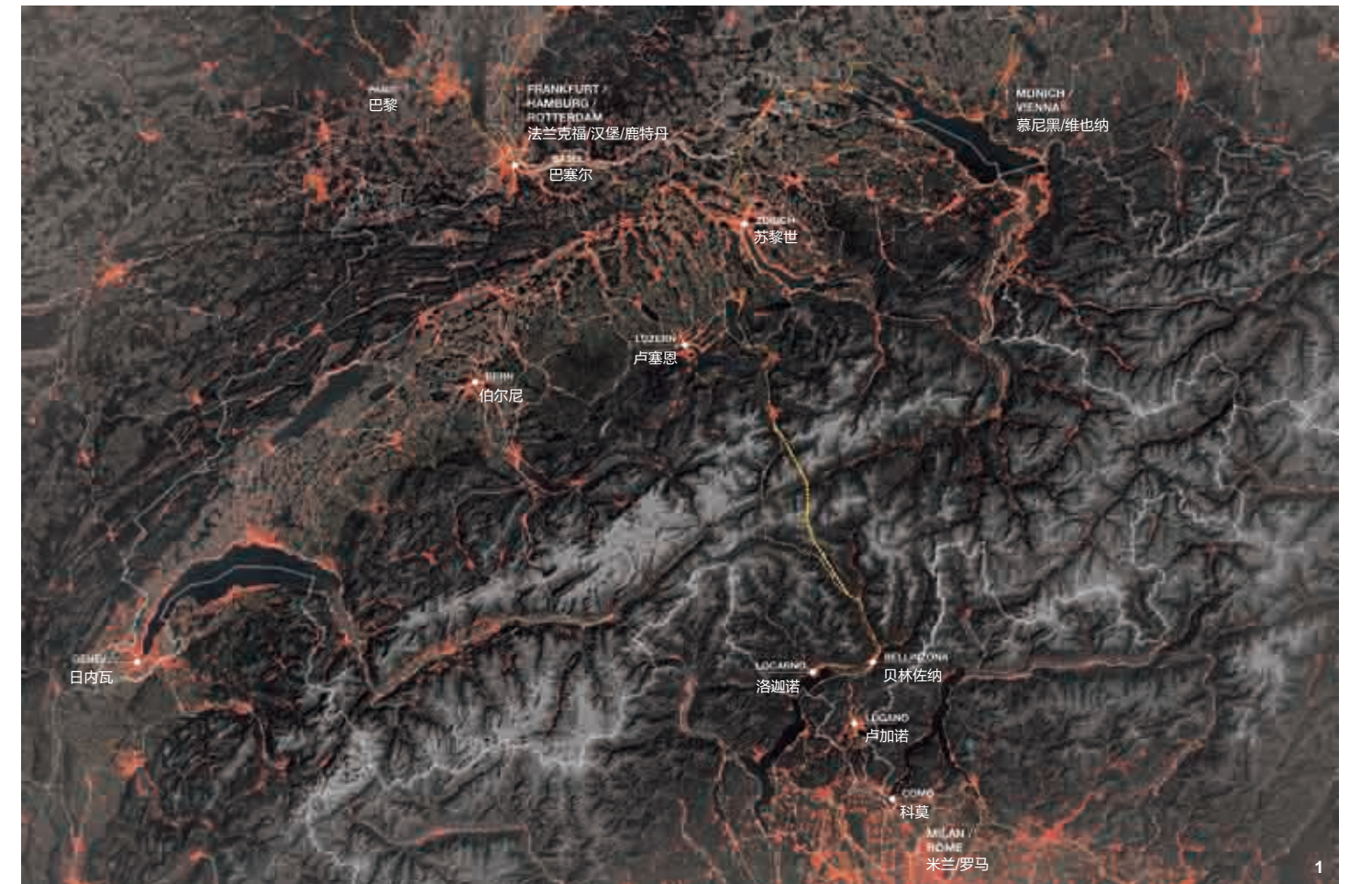
动态力量——从隧道到阿尔卑斯山

我曾多次听闻过阿尔卑斯枢纽计划——甚至早在2003年的一次高中班级旅行中，我曾参观过位于博迪奥的施工现场——但直到8年后我来到位于波士顿的哈佛设计学院留学，才将它与我对景观设计学的兴趣联系起来。在我后来的导师皮埃尔·比朗格尔教授的课堂上，我们了解到不断增长的“地下城市化”全球趋势和全球各地大量的地景移动现象^①。突然间，在那个远离瑞士的地方，阿尔卑斯枢纽计划再次出现在不同的语境中，这一基础设施的巨大规模及其与景观的互动方式

令我十分着迷：建设过程中所使用材料的数量，特别是经开采、处理、运输、回收和丢弃的大量岩石所带来的空间和组织方面的巨大挑战（图3）。在2012年夏天首次参观许多加工和安装工厂以及巨大的垃圾填埋场之后，我决定将这一强烈但模糊的兴趣转变为一个有关地下城市化的论文项目。但在最初几周的研究完成后，我开始意识到隧道建设包括一整套不同的景观运作方式，这些方式沿隧道的全部边界创造出一组特定的地面条件^②。这些被描绘成“与自然和谐共处”的看不见的地下工程，实际上正在促进其上方地表的城市化过程（图4）。随着对该项目具有的深远的经济、生态和社会意义的进一步了解——从大规模的地表土方移动、工人迁移、地下水和含水层的变化到整个区域能源和流动网络的重组——我的研究兴趣逐

步转向该项目通常被忽视的各种动态方面。在我看来，该项目不仅仅是一条穿越山脉的地下铁道，更多的是关于区域范围内特定的城市化进程。此外，我了解到隧道建设仅是影响阿尔卑斯山的众多动态力量之一^③。在此背景下，那些孤立而片面的仅从技术角度认知阿尔卑斯枢纽计划的观点让我越发不满——该观点试图排除任何复杂却有紧密关联的外部因素。然而直到2013年春季，我与导师皮埃尔·比朗格尔——他的工作中心是景观之中的流、网络和系统——共同深入而集中地对本项目

1. 穿越于山谷之间：阿尔卑斯铁路隧道贯穿整个瑞士阿尔卑斯山区，并将北部的中部高原与南部的提契诺州相连接。
1. Valley to valley: the AlpTransit tunnel crosses the entire Swiss alpine range and connects the Central Plateau in the North with the Ticino in the South.





展开研究后，我才开始理解瑞士阿尔卑斯枢纽计划与其景观之间存在的根本矛盾：

保护和保存——构建的风景

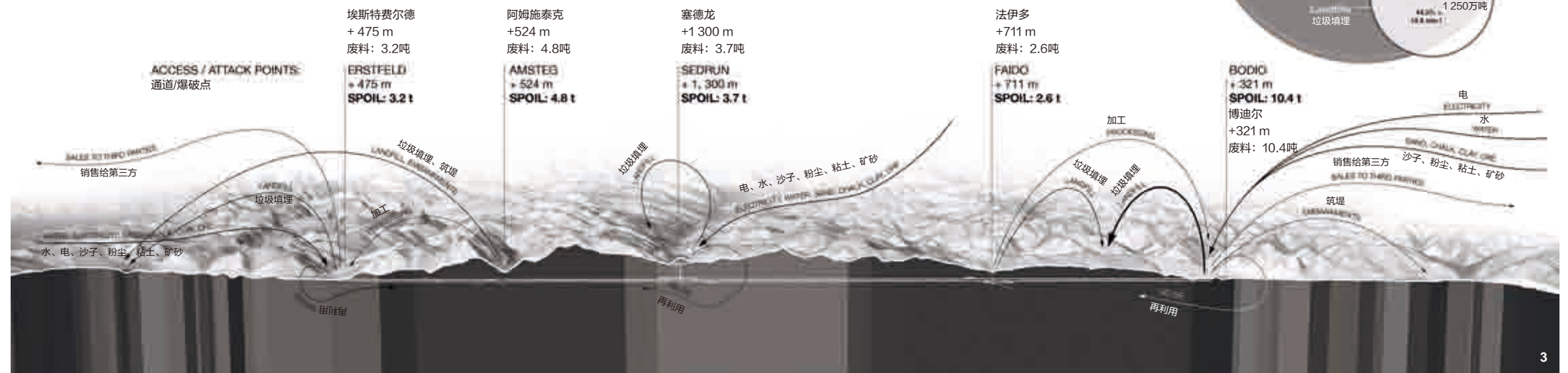
一方面，瑞士的地表物质（岩石、砾石、沙子和土壤）所发生的移动多于任何其他事物^④（例如食物、水、石油），与此同时，瑞士不遗余力地想要保存其景观的现状。例如，瑞士制订了一系列工具和规定以维持著名的“海蒂景观”不变，忽略并否定改变该景观的经济和环境力量。阿尔卑斯山的基础设施集约化项目正是这一矛盾的典型表现，它试图同时促进（道路、铁路、高架桥项目）及削弱（水坝、屏障、固定桩建设）动态的物流和人流。同时，其旅游业正在推广一种“到处都是神奇的、未受破坏的大自然”的天然而质朴的景观形象。2004年，我曾在瑞士的一家园艺公司参与过一个大规模的保护性湿地的恢复项目，依照曾经的经验，我能够

得知瑞士所谓的“自然”景观及如诗如画的风光不仅仅是受到高度管控的人工建构，而且需要人力进行维护和隔离。但是直到这次研究项目我才开始对这些原理产生质疑。这些不同的工具所推广的有关景观的固定和静态的观点本质上是错误的，因为它们所提及的是过时的、不再存在的自然或文化景观形象。为何瑞士仍然将“建成环境”和“自然”当作两个独立的系统？难道阿尔卑斯枢纽计划不能深入介入其将要改变的生态区域之内，通过与之互动成为其中的一部分？答案是肯定的；我也将之视为我从该研究工作中所得到的基本经验。

从静态到不断变化——反思阿尔卑斯地区的形象

因此，我知道自己需要将研究重心转向将阿尔卑斯地区作为一个整体进行认知，因为我看到了一种从根本上改变我们

看待和了解阿尔卑斯地区的方式的迫切需求：摒弃固定的、静态的观点，转向运行的、具有影响的、不断变化和前进的动态城市景观观点——阿尔卑斯枢纽计划正是其重要的一部分。资源、商品、水、人和资本流共同形成了一个复杂的区域系统，该系统及其所有的生物和非生物组成部分



均需要通过以上观点来重新认识。以下假设在我的研究中变得越来越核心：通过合并由大规模基础设施（如阿尔卑斯枢纽计划）引发的变革力量和时间过程，将它们与水文、地质和其他生物物理过程相结合，将有可能建立全新而有趣的关系、协同效应和经济效益。具体而言，这意味着真正运用“动态过程”这一概念，并提出一种处于不断变化中的景观。由此，这一区域将承载有效的动态过程，同样也将获得经济、生态和社会效益。

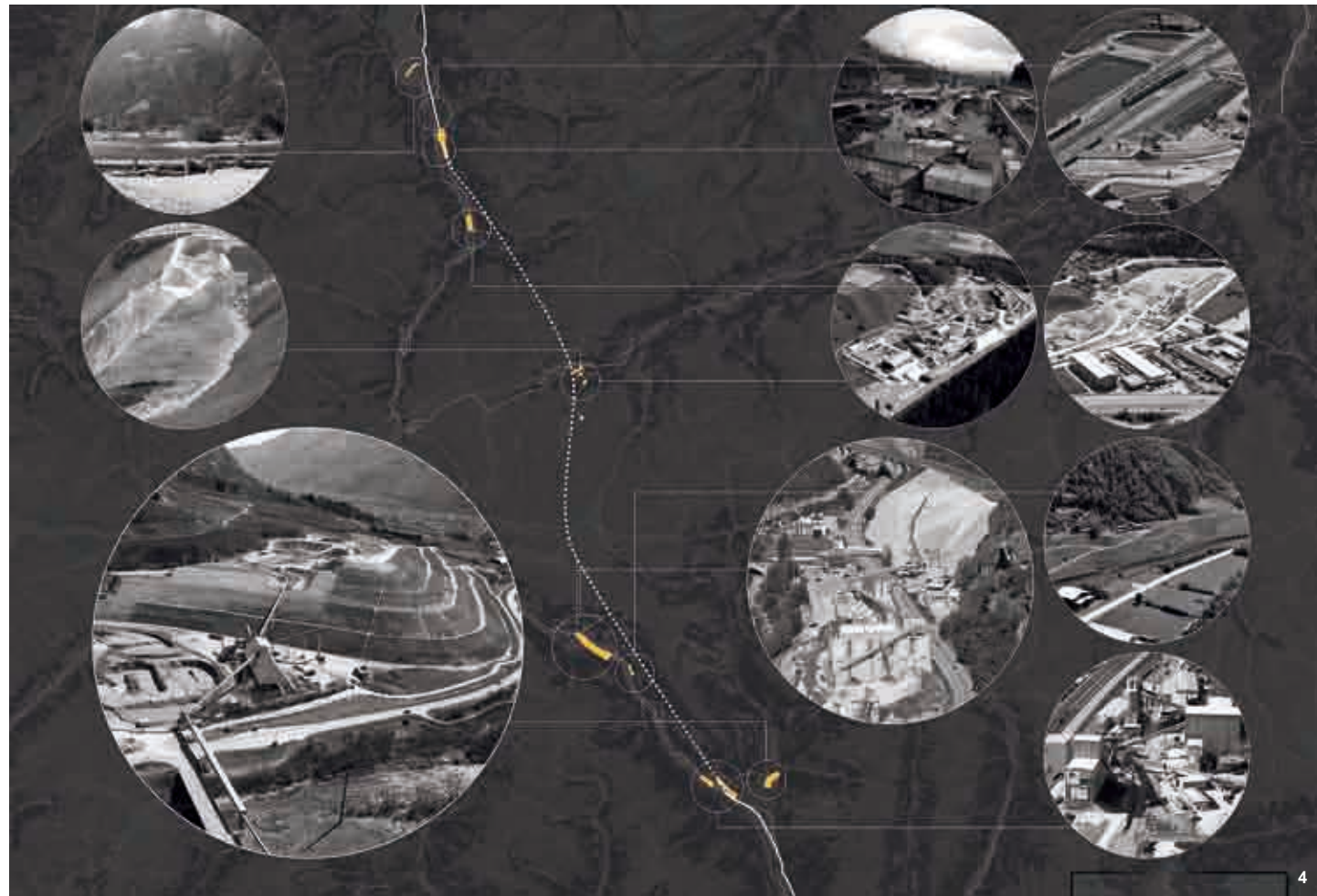
设计项目——阿尔卑斯山作为运行中的城市生态系统

研究的最后阶段，我开始在位于阿尔卑斯山脉中部的“苏尔塞瓦”山谷地区对这一理念进行验证，阿尔卑斯枢纽计划中的一个挖掘竖井位于该地区（图5）。生活在山谷地带的人们一直积极建议将竖井转变成连接山谷与欧洲高速铁路网的永久站点这一做法。这将对整个内阿尔卑斯

山区产生重要影响，因为该计划能够使这一区域在2小时内到达苏黎世或米兰等主要城市。我提议将这个站点变为现实，并利用它作为启动程序来引发苏尔塞瓦积极融入城市区域的潜力，在这里，旅游、休闲、食品生产和资源开采可以同时发生（而非分而治之），并相互受益。在对该地区的地形及其生物物理、社会、生态和经济潜力的深入分析的基础上，我开发出一系列可能的场景（图6），综合了原材料和能源生产、生态复兴与培育、山地旅游、灾难控制与保护、生活、工作与休闲的各种利益。建立在这些方案基础之上的是我的基本理念：政策和传统规则上一些主要但却简单的变化（例如取消当前的分区规划以及严格的森林保护或采矿禁止政策）与阿尔卑斯枢纽计划带来的潜力相结合，将能够开启苏尔塞瓦成为未来城市生态系统的全部潜力。我的愿景包括将森林的不同演替阶段与定居点、农业生产、森林采伐和畜牧养殖进行混合：森林中拥有

无与伦比景致的高塔将成为阿尔卑斯山区的新标志。森林管理道路和贡多拉船可以将不再受泥石流或雪崩威胁的新的城市群体相连接。森林将成为动态基础设施，既能够提供木材和防护，又能够带来各种不同类型的栖息地，并赋予场地以适应性、灵活性和生态弹性。由于林木草场和农林间作结合了农业、木材生产和畜牧，耕地和森林之间的边界消失，而草原的生态管理会有目的地在特定的时间段内运用火

2. 缺失的环节：作为欧洲高速铁路网的一部分，阿尔卑斯枢纽计划将使连接北方（鹿特丹、巴黎、慕尼黑、汉堡、法兰克福）和南方（米兰、罗马）的主要大都市地区之间的重要的鹿特丹-热那亚货运走廊的货物运输能力提升两倍。
3. 物质输入与输出：往返于建筑工地和垃圾填埋场之间的巨大物质流剖面示意图。
2. Missing Link: as part of the European High-Speed Rail Network, the AlpTransit will triple the capacity of the crucial Rotterdam - Genoa freight corridor between the major metropolitan regions in the North (Rotterdam, Paris, Munich, Hamburg, Frankfurt) and South (Milano, Rome).
3. Inputs and outputs: sectional overview of massive material streams from and to the construction sites and landfills.



焚，以促进岩石斜坡上土壤的生成。村庄附近危险的洪水区将被转变为地下水位波动的临时湖泊，小规模的水力发电站的建立将提供能源，又通过新的“海岸线”提供休闲和娱乐。泥石流和岩崩不再受到阻止，而是或按预案引发，或由隧道弃渣形成的偏转屏障相抵消。黄金和皂石矿场将被用于建立具有不同条件的临时地貌，分阶段与动植物的生命周期同步，为不同的动植物提供宝贵的栖息地。总而言之，该景观变成多功能的、递增的和短暂的——描绘了建立一个积极的、参与性的、混合的和动态的高山地区的美好愿景。该愿景打破了瑞士对于固定和秩序的追求、对于控制最大化与确定性的根深蒂固的信念。相反，偶然性和时间性占据了重要地位，并成为推动景观演变的核心力量。

本项目的所有部分，从阿尔卑斯枢纽

计划到风车，从森林到草场，从火灾到住宅，从水坝到矿井，苏尔塞瓦的城市化景观成为一个生态过程。这对于积极地参与整个阿尔卑斯地区的各个过程而言十分重要（图7）。最后，在对瑞士的地下城市化和超大型基础设施持续一年的思考并将其转变为一个有关整个阿尔卑斯地区的毕业设计项目的时刻——这些场景代表了我尝试改变现有对该地区城市化景观理解及处理方式的虽不成熟但用心进行的探究过程。至此，我意识到，这一系列探究过程便是该项目的全部。LAF

注释

① 2012年是人类开采、运输、转移、处理和再生产的土壤和矿物的历史顶峰。在投入方面，混凝土和金属的生产都需要开采、运输和改良大量的土壤、砂砾和沙子。在产出方面，来自工地的回收物以及来自拆除建筑的矿物废料必将产生数十亿吨的矿物垃圾。因此，该矿物质是目前地球上最大的物质流。

② 这包括粉碎、冲洗、筛选、磨圆、分类、贮存、堆放、测试、灌溉、混合、提炼、运输、安装、管理、供应、分级、灌溉、接入、保持、覆盖、堆积、种植、排水、倾倒和通风——在此仅列举建成隧道所需的部分措施。更多信息请参见：马蒂亚斯·克鲁斯所著《在圣哥达基础隧道准备开挖料》，图恩：阿尔卑斯枢纽计划圣哥达隧道股份有限公司，2002年出版。

③ 这包括气候条件的显著变化、大量的基础设施集约化、集中的房地产热潮，以及废弃耕地和萎缩村庄重新变成大面积的荒野。更多信息请参见http://issuu.com/daiapaco/docs/alpsasprocess_issuu。

④ 全球的沙子和砾石消费以2012年最高，在开采、加工、运输和处理各方面都是地球上最大的物质流。这一惊人的发现不仅对于本研究具有极大的开创性，对于理解景观及其背后的城市化进程也同样重要。更多信息请参见莫妮卡·迪特里希等所著《全球绿色经济？》，维也纳：欧洲可持续发展研究所，2012年出版。

4. 城市化表面：阿尔卑斯铁路隧道沿线分布的挖掘和安装工地、加工厂和垃圾填埋场。

4. Urbanized surfaces: excavation and installation sites, processing plants and landfills along the AlpTransit's perimeter.

The Alps — an Urban Territory in Transformation

As a multi-national mountain range system in the heart of Europe, the Alps are currently experiencing an unprecedented urban transformation. Triggered by significant changes in climate conditions due to global warming, coupled with capacity constraints in transportation of people and goods as well as increasing demands for renewable energy sources, a massive intensification of mobility, energy, sports and protective infrastructures is currently reshaping and reorganizing the alpine territory. Most prominent of this new cycle of infrastructural upgrading in the Alps is the nearly-finished construction of the AlpTransit Gotthard Base Tunnel in Switzerland, the largest and deepest tunnel in the world. As the starting point of this research project, the AlpTransit case study became the lense through which I was looking at the urban transformations currently shaping the Alps. This new perspective helped me to break the prevalent isolated view on the alpine territory and to further understand and articulate it as part of much larger urban processes. With that, the Alps are not only identified as intrinsically urban, but as an ever-changing and dynamic entity which needs to be recognized as such.

AlpTransit — Scales of an Urban Mega-project

As Switzerland's largest construction project ever, the 57 km long and up to 2,300 m deep Alp Transit tunnel connects the northern and southern Plateaus of Switzerland via a flat rail route through the entire alpine range (Fig. 1). The mega-project is part of the European High Speed Rail Network and represents a major component in the transalpine freight and

passenger traffic, whose capacity is going to be tripled through the project. As such, it is a highly political and international urban development, as it stands for the EU's agenda to foster cargo transportation between the major metropolitan regions in the North (Rotterdam, Paris, Munich, Hamburg, Frankfurt) and South (Milano, Rome) via rail (Fig. 2). Switzerland, strategically located in the middle of Europe and in the heart of the Alps, takes this opportunity to lift its mobility infrastructure to a new dimension in terms of scale, capacity and impact.

Dynamic Forces — from the Tunnel to the Alps

I heard from the AlpTransit many times — even visited the construction site in Bodio during a high-school class trip back in 2003 — but I did never link it to my interests in Landscape Architecture until I went studying abroad at the Harvard GSD in Boston 8 years later. There, in a class taught by my later advisor Prof. Pierre Bélanger, we learned about the increasing global trend of “underground urbanization” and the massive amounts of ground being moved around all over the globe^①. Suddenly, far away from Switzerland, the AlpTransit reemerged in a different context: The massive scale of this infrastructure and the way it interacts with landscape fascinated me: The sheer amount of materials that are being used and especially the huge amount of rock that has been excavated, processed, transported, recycled and dumped posed enormous spatial and organizational challenges during the construction process (Fig. 3). After visiting the many processing and installation plants as well as massive landfills for the first time in the summer of 2012, I decided to turn this strong yet vague interest into a thesis project on underground

urbanization. Soon after the first weeks of research though, I started to realize that the tunnel construction included a whole set of different landscape operations which create a particular set of surface conditions along the tunnel's entire perimeter^②. What is being portrayed as an invisible underground project “in harmony with nature” is actually urbanizing the surface quite extensively (Fig. 4). Slowly but surely, while learning more about its far-reaching economical, ecological and societal implications — from the massive earth movements, workers' migration, the change of groundwater flows and aquifers to the recalibration of the whole regional energy and mobility networks — my interests shifted more and more towards the various yet often disregarded dynamic aspects to it. It appeared to me that the project it less about an underground tube through the mountains, but about particular urbanization processes on a territorial scale. Moreover, I learned that the tunnel construction is just one out of many dynamic forces pressing on the Alps^③. Yet the AlpTransit was still being marketed from an isolated, one-sided and technocratic perspective that excludes any inconvenient externality — something I found more and more disturbing. However, it was not until working intensively on the project during Spring 2013 together with my advisor Pierre Bélanger — who is work focuses on flows, networks and systems—that I started to understand the fundamental paradox in the AlpTransit's case within Switzerland's relationship to its landscape:

Conservation and Preservation — the Picturesque as a Construct

On the one hand, Switzerland is shifting around more ground (rock, gravel, sand and soil) than anything else^④ (for example, food, water, oil) while at

the same time, it is sparing no effort to preserve the landscape in a status quo. A whole series of instruments and regulations have been set up to keep the well-known “Heidi-Landscape” in a fixed state, neglecting and negating the economic and environmental forces transforming it. The infrastructural intensification in the Alps is very exemplary for this paradox in the sense that it simultaneously tries to foster (roads, rails, lifts) and undermine (dams, barriers, anchors) dynamic flows of materials and people. At the same time, the tourism industry is promoting the image of a natural and pristine landscape with “magical, unspoiled nature all around”. Working on large-scale renaturation and restoration projects of protected wetlands at a horticulture firm in Switzerland back

in 2004, I knew from my own experiences that so-called “natural” landscapes and their picturesque sceneries are not only highly regulated and artificial constructs, but maintained and isolated by human hands. However, it was not until this research project I started to question these principles. The fixed and static view of landscape promoted by the different instruments are inherently wrong, as they refer to an outdated image of nature or cultural landscape that does no longer exist. Why is Switzerland still treating the built environment and “nature” as two separate systems? Is not the AlpTransit heavily intervening and interacting with the very ecology of the territory it is about to change, thus becoming part of it? It certainly is; and I regard this to be a fundamental lesson I

learned during this research work.

From Static to Progressive — Rethinking the Image of the Alps

Consequently, I knew I needed to shift my focus on the Alps as a whole, as I saw a pressing need to radically change the way we look at and understand them: Away from a fixed and static view towards an operating, working, ever-changing and progressive urban landscape in flux — with the AlpTransit being an important part of it. Flows of resources, commodities, water, people and capital form a complex territorial system which needs to be recognized as such — with all its biotic and abiotic components. The following hypothesis became more and more central: By incorporating the transformative

forces and temporal processes evoked by large-scale infrastructures (such as the AlpTransit), and combining them with hydrological, geological and other biophysical processes, it is possible to establish new and interesting relationships, synergies and economies. Concretely, this would mean to take the concept of dynamic processes literally and propose a landscape that is in constant change. With that, the territory could become performative, equally benefiting economical, ecological and social interests.

Design Project — the Alps as an Operating Urban Ecology

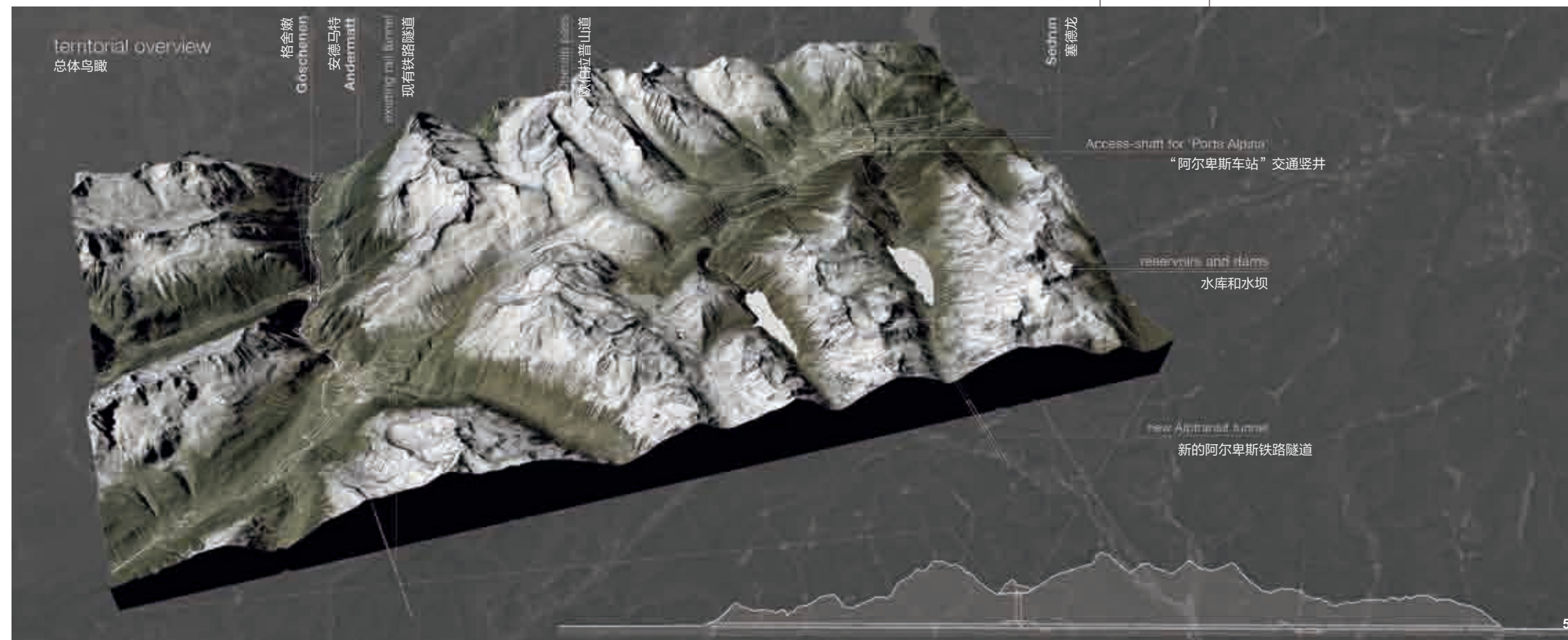
In the last phase of my research, I started to test this principle in the region of “Surselva”, a valley in the middle of

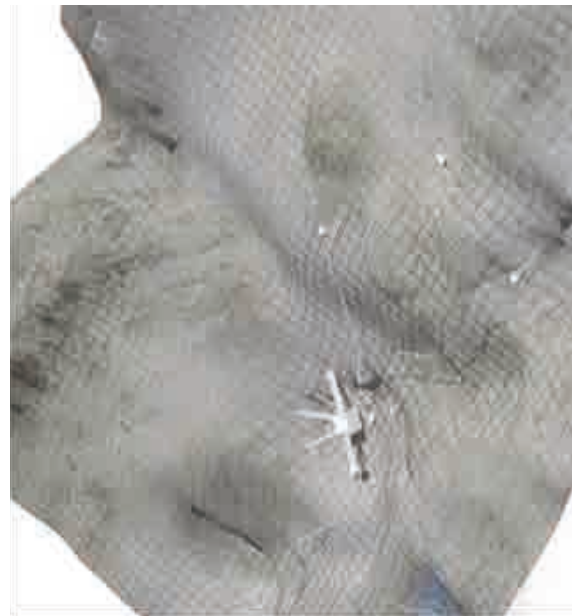
the Alps where one of the AlpTransit excavation shafts is located (Fig. 5). The people in the valley are actively advocating the idea of turning the shaft into a permanent station to connect the valley to the European High-Speed-Rail-Network. It would have a major impact on the whole inner-alpine region, as it would be linked to major cities like Zurich or Milano in less than 2 hours. I propose to realize the station and use it as an initiator to trigger the potentials of the Surselva as an actively engaged urban territory, where tourism, leisure, food production and resource extraction happen simultaneously (rather than being separated) and take advantage of each other. Based on a thorough analysis of the terrain and its biophysical, social, ecological and economic potentials, I developed a series of possible scenarios (Fig. 6), bringing together interests of raw material and energy production, ecological revitalization and cultivation, alpine tourism, disaster control and protection, living, work and leisure. At the basis of these schemes lies my belief that some major but simple changes in policies and traditions, for example, the dismissal of current zoning plans and various rules such as the strict protection of forests or the banning of mining could tap — in combination with the potentials brought by the AlpTransit — the full potential of the Surselva as a future urban ecology. My vision is to mix various successional stages of forests with settlements, agricultural production, timber harvesting and livestock breeding: Towers in the forest with unparalleled views would become the new standard for occupying the Alps. Forest management roads and gondolas could connect the new urban clusters which would be no longer endangered by mudslides or avalanches. The forest would act as

a dynamic infrastructure that provides both wood, protection and a variety of different habitats, giving momentum to adaptivity, flexibility and resilience. The border between arable land and forest dissolves, as Silvi-pasture and Agro-forestry combines both agriculture, wood production and livestock while fire is used to ecologically manage the grasslands in certain timeframes and to build up soil on rocky slopes. Hazardous flood-zones near villages would be turned into temporal lakes with fluctuating water tables, providing both energy via small-scale hydro-power plants and new shorelines for leisure and amusement. Mudslides and rockfalls are no longer prevented and stabilized, but either launched by prescription or neutralized by deflection barriers made out of spoil from tunneling. Gold and soap-stone mines would be used to set-up temporal topographies with divers conditions, phased and synchronized with life-cycles of flora and fauna to provide valuable habitats for different animals and plants. Overall, the landscape becomes multifunctional, incremental and ephemeral — depicting a vision of an active, engaged, hybrid and dynamic alpine territory. It breaks with the deeply embedded Swiss conviction of maximal control and determination, of fixation and order. Rather, contingency and temporality stand in the foreground and become programmatic forces.

In all its parts, from the Alptransit tunnel to the windmills, from the forests to the pastures, from the fires to the housings, from the dams to the mines, the urbanized

5. 城市生态：“苏尔塞瓦”——一个位于阿尔卑斯山脉中部的高度基础设施化景观，阿尔卑斯枢纽计划挖掘竖井即位于此地——总体鸟瞰。
5. Urban ecology: Territorial overview of the “Surselva”, a highly infrastructuralized landscape in the middle of the Alps where the main AlpTransit excavation shaft is located.





Mining the Alps 采矿



Burning the Alps 焚烧



Logging the Alps 伐木



Suburbanizing the Alps 郊区化



Blasting the Alps 爆破



Flooding the Alps 洪水

landscape of the Surselva becomes an ecological process itself. And this is important to actively and socially engage with the multiple processes underlying the entire alpine territory (Fig. 7). Finally, at the end of a year-long thinking process about underground urbanization and mega-infrastructures in Switzerland — to become a thesis project on the Alps as a whole — these scenarios stand for my still naive but serious endeavor to change the way of thinking and dealing with urbanized landscapes. In the end, I realized that this is what it was all about. **LAF**

NOTES

- ① Never before in history has humankind extracted, transported, shifted, processed and reproduced more soils and minerals than in 2012. On the input-side, the production of both concrete and metals requires huge amounts of soil, gravel and sand to be excavated, moved and refined. On the

- output-side, extractions from construction sites as well as mineral wastes from demolitions of buildings entail billions of tons of mineral waste. As a result, today, minerals represent the largest material stream on earth.
- ② This includes crushing, washing, screening, rounding, sorting, storing, piling, testing, irrigating, mixing, refining, transporting, installing, managing, supplying, grading, irrigating, access, retaining, covering, stacking, vegetating, draining, dumping, and ventilating — to name just a few actions that are needed to make this tunnel happen. For more infos, see: Matthias Kruse. *Preparing the Excavated Material at the Gotthard Base Tunnel*. Thun: AlpTransit Gotthard AG, 2002. Print.
- ③ This includes significant changes in climate conditions, heavy infrastructural intensification, concentrated real-estate boom and spreading wilderness that reclaim the abandoned cultivated lands and shrinking villages. For more infos, see http://issuu.com/daipaco/docs/alpasprocess_issuu.
- ④ The global consumption of sand and gravel has never been higher than in 2012 while representing the largest material stream on earth, both in excavation, processing, transportation and disposal. This astonishing finding was fundamentally groundbreaking not only for this research, but for my very own understanding of landscape and its underlying urbanization processes. For more infos, see Monika Dittrich, et al. *Green Economies around the World?* Vienna: Sustainable Europe Research Institute (SERI), 2012. Print.

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- 6. Alps as Process: logging, burning, mining, flooding, blasting and suburbanizing the Alps as possible future scenarios.
- 7. Multi-national system: the Alps as a whole need to be recognized as a shared urban territory with various dynamic processes at work.

