

关于暴洪与沙漠的思考

FLASH FLOODS AND DESERT CLAIMS

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1. 可视化效果图：自布劳利河冲积平原至萨萨比路南段的整个住区概览。
1. Visualization: overview of the whole settlement from the Brawley Wash to the South Sasabe Road.

① 阿尔塔河谷是我们本次景观设计研讨课程的研究场地，它全长72km，自南向北，从墨西哥边境一直延伸到图森山脉西侧的阿维拉山谷。布劳利河冲积平原上的季节性河流以阿尔塔河谷为源头，最终汇入圣塔鲁斯河。

摘要

美国亚利桑那州的索诺兰沙漠集潮湿与干燥、酷热与严寒、永恒与短暂为一身。瑞士苏黎世联邦理工大学克里斯托弗·吉鲁特教授的景观设计课程，正是选择在这样极端的环境下研究新的聚落类型。从初期的沙盘模型草图到后期的计算机模拟、数控模型和水动力模拟，该设计课程以动手实践的方式来了解该场地暴洪和侵蚀的自然过程。该课程要求学生构造聚落时囊括对自然过程和杰斐逊网格的双重考量，以期将基础设施、建筑与生态融合在一套设计方案之中。对于学生来说，针对形式及功能的聚落设计方案都源于这种对自然—人工双重规则的叠加；这片壮美的自然之地几乎找寻不到任何人为的痕迹，使索诺兰沙漠成为完美的试验场地。伴随着设计课程的推进，我们逐渐明晰：在这一洪水多发地区，生成聚落方案的唯一方法就是将山谷之大尺度与人的足迹之小尺度同时考量。该课程的最终方案呈现出了一种对构造学及类型学都具有清晰认知的新型沙漠环境聚落设计策略。

关键词

景观设计学；基础设施；沙漠；聚落；类型学

ABSTRACT

The landscape design studio of Professor Christophe Girod at the Swiss Federal Institute of Technology in Zurich, Switzerland investigated new settlement typologies within the extreme environmental condition of the Sonoran Desert in Arizona: wet and dry, hot and cold, permanent and ephemeral. From early sketches in sand models to computer simulations, CNC models and water dynamics, the studio took a hands-on approach in understanding the natural processes of flash floods and erosion on the site. The integration of infrastructure, architecture and ecology into a single design solution challenged the students to structure the settlements with respect to both natural processes and the Jeffersonian grid. For the students, both the formal and the performative settlement solutions arose from this superimposition where the sublime nature of the site, being exempt of almost any human artifact, proved to be the perfect testing ground. During the course of the studio, it became clear that the only way to solve a settlement principle in this flood prone area was to develop design solutions on the large scale of the valley and at the scale of a single step simultaneously. The final projects showed a clear understanding of the tectonic and topological expression for a new type of occupation in the desert.

KEY WORDS

Landscape Architecture; Infrastructure; Desert; Settlement; Typology

译 刘姝 陆小璇

TRANSLATED BY Shu LIU Xiaoxuan LU

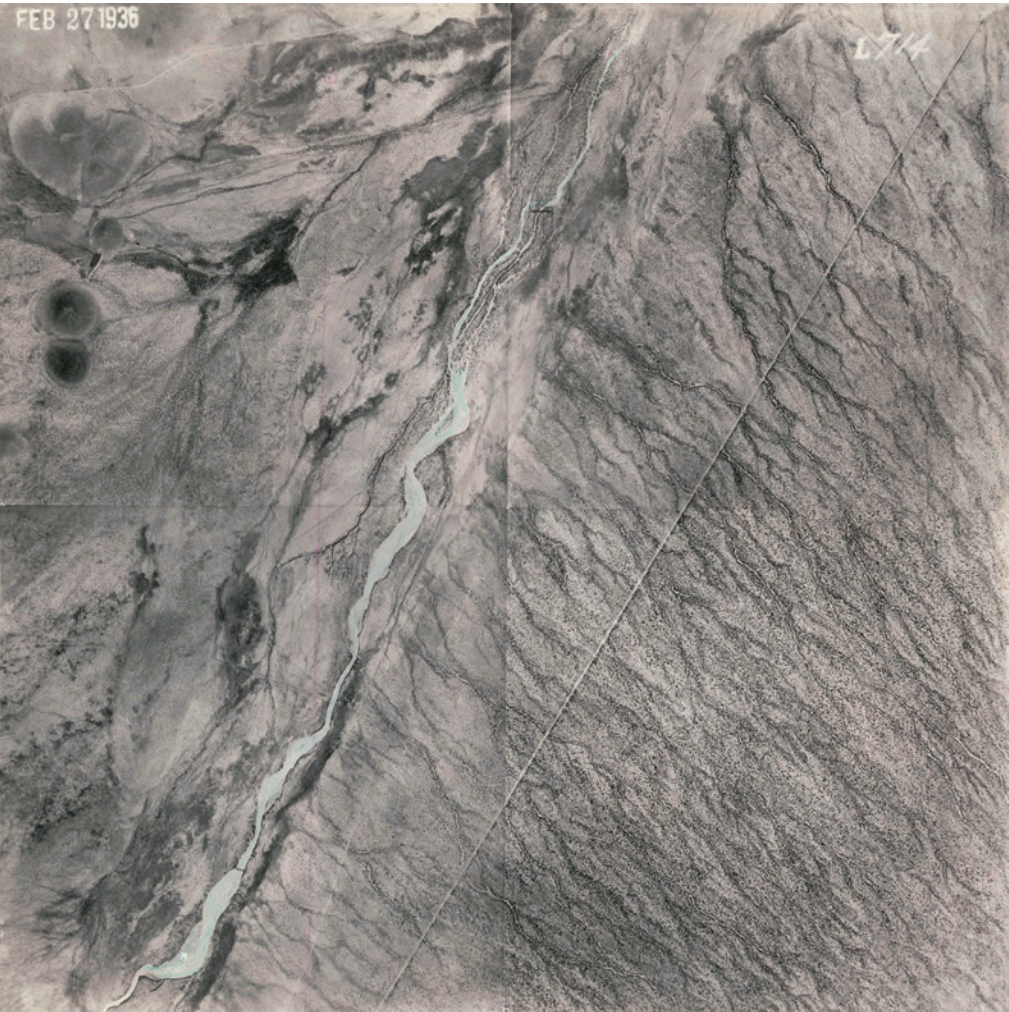
是什么让景观如此美丽而令人难忘？因为景观并不树立道德榜样，也不标榜生态与社会教育。景观告诉我们另一种度量时间的方法，让我们意识到这一事实：“当下”实为一个跨度巨大的时空体，其所包纳的——无论是最为原始的还是最新的——人工构筑物都同样古老亦同样年轻^[1]。

开端

美国亚利桑那州的索诺兰沙漠集潮湿与干燥、酷热与严寒、永恒与短暂为一身。瑞士苏黎世联邦理工大学克里斯托弗·吉鲁特教授的景观设计课程，正是选择在这样极端的环境下研究新的聚落类型。通过对“中央亚利桑那调水工程”——从科罗拉多

河向凤凰城和图森市调水——这类大型基础设施项目所遇到的困境进行分析，本设计课程试图采取一种与之不同的设计策略。研究团队从亚利桑那州本土的采水和储水方法中汲取灵感，以期设计一种基于本地生态足迹、适于阿尔塔河谷^①的新型聚落形式。值得庆幸的是，通过重新学习那些曾在洪泛区管理和旱作农业中应用的古老技术，我们演变出一些可供替代的模式，尽管这些替代模式的实施需从大型农作和官僚主义向偏于田园化的小型农作，甚至是向以绵羊、山羊、牛等牲畜为基础的游牧经济与小型手工艺和工业等生计相结合的形式转变^[2]。

通过研究和改造当地地形以促成一种基于新型洪泛区管理的极端环境聚落方案，是本设计课程关注的重点。在深入研究不同类

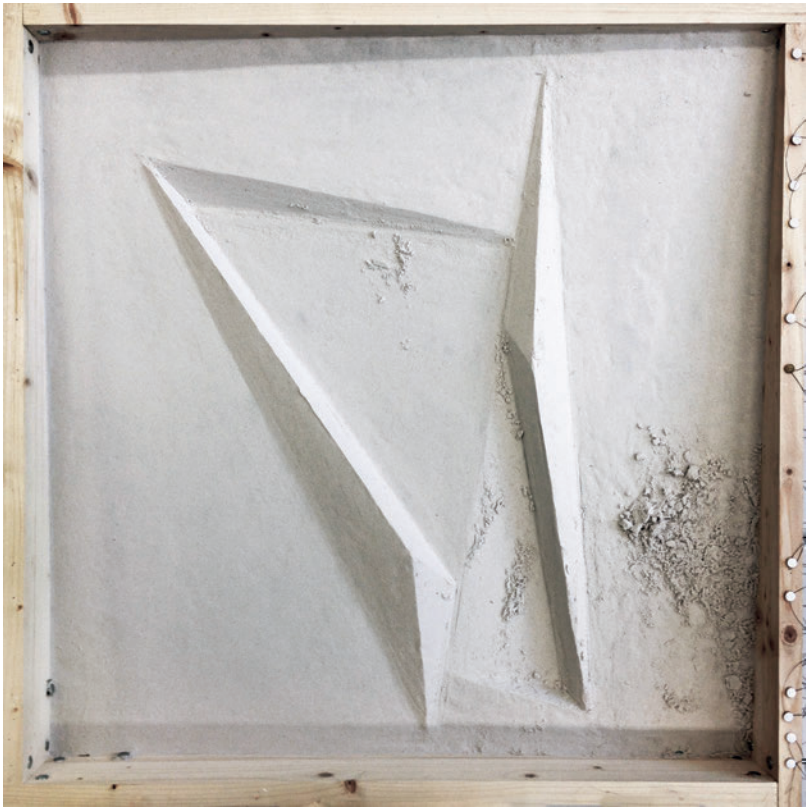


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② 这里的沙漠建筑指的是西塔里埃森，是建筑师弗兰克·劳埃德·赖特的冬日住所，同时也是一所坐落于沙漠中的学校。自1937年起，赖特常居于此，直至1959年逝世，终年91岁。如今这里已经成为了弗兰克·劳埃德·赖特建筑学院的主校区，同时也是弗兰克·劳埃德·赖特基金会的所在地。请访问https://en.wikipedia.org/wiki/Talesin_West以了解关于西塔里埃森的更多信息。
③ 请访问<http://elkhornranch.com/>以了解关于埃尔克霍恩牧场的更多信息。

2. 布劳利河冲积平原与萨萨比路南段航拍图（摄于1936年）
3. 沙盘模型训练作业

2. Aerial photo of the Brawley Wash and the South Sasabe Road, 1936.
3. Sand box exercise



3 © Coralie Bernhoff and Nihilus Niemcewicz

别的沙漠地形之前，我们首先做了一个简单的练习：选取一块1km见方、连续坡度为6%的区域，首先在斜坡上划出两条直线并形成一处低于地表的下切面。随后，将这个下切面与周边地形重新连接，并确保下切面两侧与周边地形重新连接形成的坡面的最大坡度不超过2/3。

这一练习让学生们了解到景观与建筑的区别：景观处理中无法使用垂直墙体，且需要面对松散材料所造成的限制，这使得景观中的一切都具有坡度。这项强调地形形态的练习，为该课程随后的设计表达奠定了基础，即在这个类似于大地艺术的简单地形处理的基础上，继续拓展其功能和绩效。

洞察

实地考察使学生们对这一项目产生了更

加切实的体验^[3]。我们带领学生来到亚利桑那州进行了为期两周的研讨学习，乘坐租赁的越野车带他们领略美国西部最神奇的景观。除了科罗拉多大峡谷和弗兰克·劳埃德·赖特的沙漠建筑^②等主要景点，我们还参观了从1945年一直运营至今的位于阿尔塔河谷的埃尔克霍恩牧场^③。该牧场位于巴博基瓦里山脚下，其下方是由流淌于阿尔塔河谷中的布劳利河形成的冲积平原。除了沿袭传统的度假牧场模式（一种农业旅游的形式）外，牧场对包括卵石堤坝和沙漠植物等用以控制并减少侵蚀的方法进行实验，以防止阿尔塔河谷干涸。其中，“溯源侵蚀”尤其容易造成干旱加剧：疏松的沙土随水流失并形成沟壑；在暴雨时，这些深沟会不断向上坡方向延伸。这种溯源侵蚀可通过一种名为“祖尼碗”的传统方法来消除——在侵蚀部位的土壤中放置大块的岩石，以减缓水流、沉积岩

屑、遮蔽阳光，继而为各种沙漠动植物创造湿润的生存环境。此外，还要在下坡的位置用松散的岩石建成垂直水坝，进一步减缓水流，从而将河谷作为一个整体进行管理。
每当阿尔塔河谷的冲积平原上新修一条道路或新建一个设施，水流都会随之改变，并且通常造成以这类溯源侵蚀形式出现的严重侵蚀情况。因此，基于合理布局的道路及建筑物修建模式，即综合考量货物和人的流动而非仅仅缓解干旱的策略，成为了设计方案所强调的部分内容。合理布局意味着建造与径流方向相垂直的构筑物或设施，或是建设透水堤道——水流可被暂时存储并沿着下坡方向缓慢释放——而非沿着河堤方向由排水渠排放。
最终，我们认识到杰斐逊网格虽然规模大、效益高，但对于小尺度的河谷却未能发挥出它的作用。在阿尔塔河谷中，地形应

该成为指导聚落格局的基础。在最终的项目中，为了顺应阿尔塔河谷的独特地貌，学生们对杰斐逊方格网进行了变形和扭曲。

设计

美洲原住民帕帕戈人发明了一种适用于冲积平原灌溉的古老技术，这种技术使他们在干旱的索诺兰沙漠中繁衍生息了数千年。这个简单的采水—储水—释水系统被称为“阿罗约之口”或“阿克钦耕作”，其工作原理如下：暴雨汹涌着冲向沙质河床……洪水汇集到一个临时汇水区后，或立刻渗入土壤，或形成水塘以待日后分流。河道两侧生长着白杨、柳树和白刺果豚草，其中有些是印第安人作为篱笆而特意栽植的。这些或野生或栽种的植物减缓了水流，既使水散溢至宽阔平坦的地表，又使悬浮的泥沙沉积为肥沃的土壤。随后，在洪水形成的泥滩中，帕帕戈人耕耘播种，希望在土地干硬之前能够有所收获^[4]。

以这一古老的灌溉系统为基础，本设计课程提出一种假设，即在阿尔塔河谷中营造一种新型聚落，其不必再依赖500km以外科罗拉多河的水源。

布劳利河每年以数场暴雨的形式为这一地区带来丰沛的水量。本设计课程方案试图以此为契机截获暴雨带来的部分水量。堤坝状的构筑物伸至布劳利河的河床，使一部分河水分流到平原上。我们建立了沙盘模型以更好地理解这一水流疏导过程。这种实践方式使学生得以了解该场地中暴雨和侵蚀的自然过程。在某一设计方案生成后，需要再利用数控模型提高方案的精确度：通过对填挖方作业进行控制，实现设计场地内材料运输的最小化。

一旦洪水被分流，我们必须设法减缓并存储水流。先将水流引导至宽阔区域下渗，再引向池塘或高科技水库中存储。水存储的关键是要通过灌木或简单的顶棚结构防止水分蒸发。这些储水方案无疑成为聚落方案



4 © James Melson

设计核心，因为水对于干旱区而言是最宝贵的资源。聚落点由住宅与农场等设施组成，其位置经过合理布置，精心分布在采水—储水—释水系统沿线上。只要有可能，道路便与低堰相结合，而建筑则与透水堤相结合，以实现对于冲积平原上的聚落点的干扰最小化。在灌溉系统方面，灌溉水渠和田田的布局方式与缓慢的水流相适应；农田可用于旱作农业和放牧养殖。这些新的聚落类型的设计，试图使大量水流得以返回布劳利河中，为下游聚落所利用。

本设计课程的最后一项训练，是设计方案的可视化，要求学生们将这些新设施融入阿尔塔河谷的原始景观中。之前用于制作物理数控模型的电子模型，在这项训练中被试验性地应用于种植设计。我们建立了本地物种的电子数据库，并在模型中大量使用本地物种。这项训练使学生把景观设计项目从虚拟带入现实，从而获得更加直观的感受。与此同时，设计方案可视化使该项目由抽象变得具体，从而便于当地社区对设计方案的理解与认知。课程最后生成的可视化图像，呈现出一种重拾并发展本土智慧的景观结构构建策略。

领悟

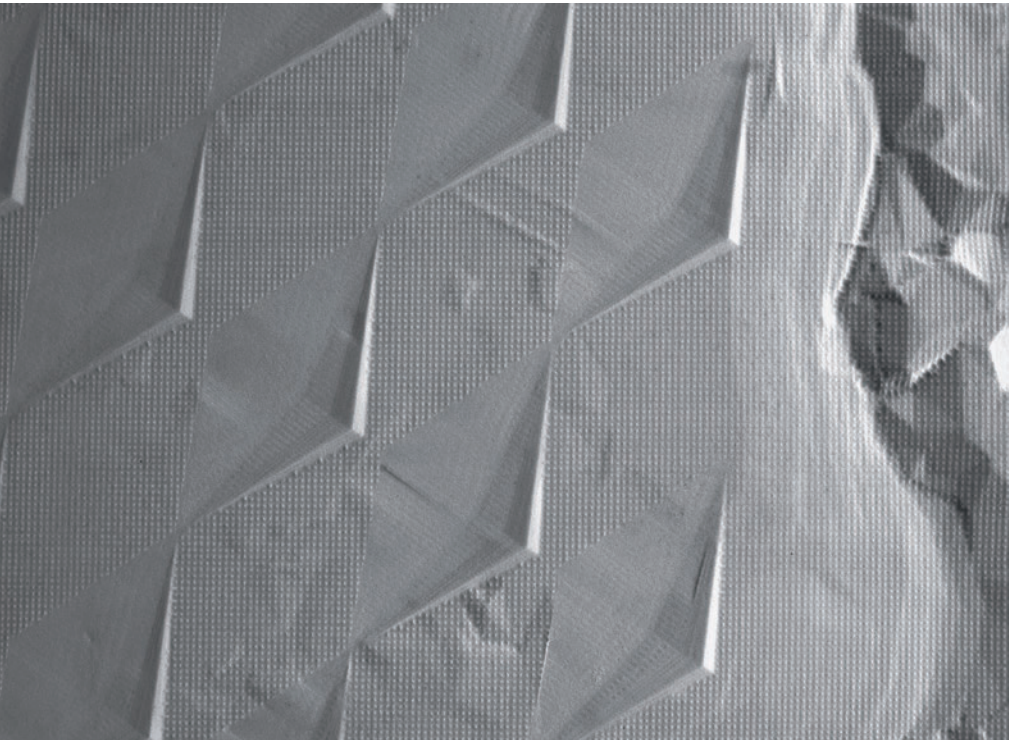
伴随着设计课程的推进，我们逐渐明晰：在这一极度干旱且洪水多发的地区，生成聚落方案的唯一方法就是将山谷之大尺度与“祖尼碗”之小尺度同时考量。该课程要求学生在构造居住环境时囊括对自然过程和杰斐逊网格的双重考量，以期将基础设施、建筑与生态融合在一套设计方案之中。对于学生来说，针对形式及功能的聚落设计方案都源于这种对自然—人工双重规则的叠加；这片壮美的自然之地几乎找寻不到人为的痕迹，使索诺兰沙漠成为完美的试验场地。学生们提出的干旱区聚落方案，不仅要降低暴雨的风险，实际上还依赖并利用洪水以实现后续发展。该课程的最终方案呈现出了一种对构造学及类型学都具有清晰认知的新型沙漠环境聚落设计策略。**LAF**



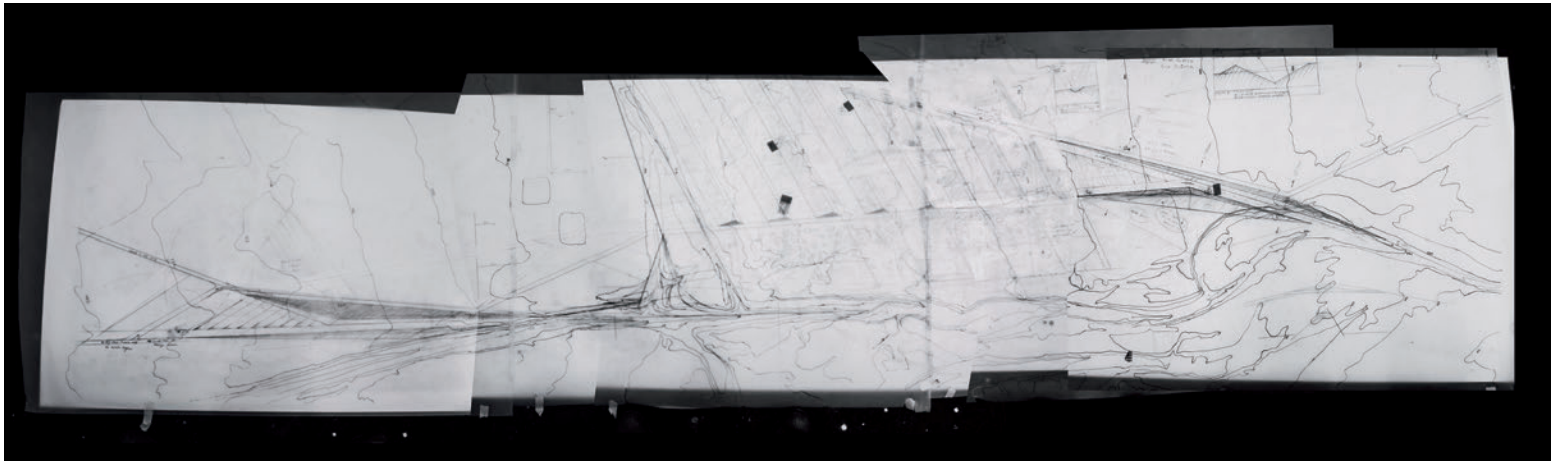
5 © Mathias Nierwinski

- 与沙漠的第一次接触：学生们步行穿越内华达州的沙谷。
- 数控模型：延伸至布劳利河冲积平原的集水大坝。
- 数控模型：位于布劳利河冲积平原周边扩展区域的集水区模型。

- First contact with a desert: students walking through the Sandy Valley, Nevada.
- CNC model: water catchment dams reaching into the Brawley Wash.
- CNC model: water catchment modelling on an expanded field near the Brawley Wash.



6 © Summa Meier and Anne Seiler



For what makes the landscape so impressive and so beautiful is that it teaches no copybook moral, no ecological or social lesson. It tells us that there is another way of measuring time, and the present is, in fact, an enormous interval in which even the newest of man-made structures are contemporary with the *primaeval*^[1].

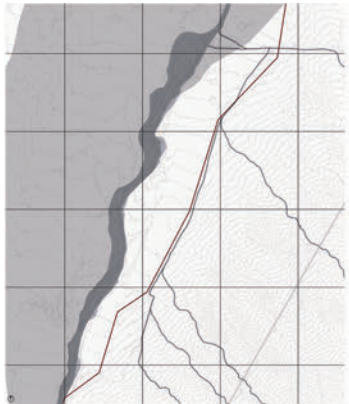
Onset

The landscape design studio of Professor Christophe Girot at the ETH in Zurich, Switzerland investigated new settlement typologies within the extreme environmental condition of the Sonoran Desert in Arizona: wet and dry, hot and cold, permanent and

ephemeral. Having analyzed the troubles of big infrastructural projects like the Central Arizona Project (CAP) that brings water from the Colorado river to Phoenix and Tucson, the studio embraced local water harvesting and storage to study how a local ecological footprint for a new settlement in the Altar Valley^① could take form. Fortunately, there are alternatives that base themselves on relearning old, discarded techniques of floodplain management and dry farming. Although there would have to be a shift from big agricultural farming and bureaucracy to a more pastoral, maybe even nomadic economy based on sheep, goats and cattle combined with small crafts and industrial

livelihoods^[2]. The prime concern of the studio was the study and manipulation of local topography to enable a settlement that is shaped by a new type of floodplain management. But before we dived deep into the various desert terrain typologies we began with a simple exercise: Take an area of 1 by 1 km with a constant slope of 6%. Design two straight lines within this slope and let these two lines define an incision below ground. Reconnect this incision with the surrounding slope. Make sure that the cuts on both sides are sloped with a maximum of 2/3.

Here the students learned that landscape is something different from architecture. One



Status quo: "Public Land Survey System," One-Mile Grid System
现状：“美国公共土地测量系统”——一英里网格系统



Principles: Shifting of the One-Mile Grid, road infrastructure, channel near the Brawley Wash
原则：对布劳利河冲积平原周边的一英里网格、道路基础设施及沟渠进行改造



Adaption: Subdivision of the new grid, growth starting from the existing road
调整：新网格结构的分支在现有道路的基础上进行延伸



Extension: "Wash gardens" in between the settlements, agriculture near Brawley Wash
扩展：位于布劳利河冲积平原周边的聚落区和农业区之间的“冲刷花园”



Growth: Development of settlement structures alongside washes up the Altar Valley
发展：聚落区结构沿阿尔塔河谷水流方向发展

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- ① The Altar Valley was the site of study for our landscape design studio. It is a 72 km long north-south valley that runs from the Mexico border to the Avra Valley west of the Tucson Mountains. The Brawley Wash is the ephemeral stream that has its source in the Altar Valley before joining the Santa Cruz River.
- ② The architecture refers to Taliesin West. It was architect Frank Lloyd Wright's winter home and school in the desert from 1937 until his death in 1959 at the age of 91. Today it is the main campus of the Frank Lloyd Wright School of Architecture and houses the Frank Lloyd Wright Foundation. Please visit https://en.wikipedia.org/wiki/Taliesin_West for more information about Taliesin West.
- ③ Please visit <http://elkhornranch.com/> for more information of Elkhorn Ranch.
7. 铅笔素描：布劳利河冲积平原上接连不断的集水大坝和溢洪道。
8. 随着时间的推移，杰斐逊网格与聚落区开发模式不断相互适应。
9. 集水区、聚落区及农业用地的规划。
7. Pencil drawing: successive water catchment dams and spillways aligning the Brawley Wash.
8. Adaptation of the Jeffersonian grid and settlement development over time.
9. Plan of water catchment, settlement and agricultural fields.

cannot use vertical walls and is restrained by the property of loose material; everything becomes a slope. Being a formal exercise, it drove the expression of the projects during the rest of the semester by adding function and performance to a simple, almost land-art like intervention.

Insights

The field trip is the moment when the project becomes tangible in the minds of the students^[3]. So we took them to Arizona, rented off road vehicles and showed them the most amazing landscapes in the American west during a two-week workshop. Aside from main attractions like the Grand Canyon and the desert architecture of Frank Lloyd Wright^②, we visited the Elkhorn Ranch^③ that has been working in the Altar Valley since 1945. It is situated at the foot of the Baboquivari Mountains just above the alluvial plain of the Brawley Wash that runs

through the Altar valley. Apart from carrying on the tradition of a dude ranch (a form of agritourism), they experiment with stone embankments and desert flora in order to control and counteract the ongoing erosion that would dry-out the valley. Especially "head cuts" form a real threat to drought. Loose sandy soil is eaten away by water and create deep gullies that rapidly travel uphill under heavy rainfall. These head-cuts are negated by so called Zuni bowls; larger rocks that are put down on the soil at the place of the head cut in order to slow down the water, deposit debris, and provide shade to create a humid environment for various desert fauna and flora. Further downhill these can be accompanied by perpendicular dams of loose rocks to slow down the water flow even more, managing the valley as a whole.

Whenever a new road or structure landed on the alluvial plain of the Altar Valley, it altered the flow of water and often created



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severe erosion in the form of these head cuts. Part of the solution then became the construction of intelligently placed road and buildings, that would combine the movement of goods and people but ameliorate drought. This would mean to build perpendicular to the water runoff direction and to construct permeable causeways that can store and slowly release water downhill instead of channeling it along its embankments.

Ultimately this made us realize that the Jeffersonian Grid, however big in scale and efficiency, does not perform in the small scale of a valley. Here, topography should have steered the direction of settlement. In the final projects of the students the grid was skewed and distorted to compensate for the specific topological condition of the Altar Valley.

Conception

There exists an old technique of floodplain irrigation developed by the Papago people which enabled them to survive the arid Sonoran Desert over millennia. It consisted of a simple catch, store and release system and was called arroyo-mouth or ak-chin farming. It worked like this: a flash flood comes soaring down the

sandy riverbed.... It surges into a temporary catchment basin, where it immediately soaks into the soil or forms a pond for later diversion. Cottonwoods, willows, and burro bushes, some of them artificially planted by the Indians in fence rows along the watercourse, slow the current, spreading the water over a broad, flat surface and trapping the suspended silt for fertilizer. Then, in the mud left by the flood, the Papago plant their seeds, expecting to harvest them before the earth turns brick-like again^[4].

This irrigation system became the basis of the studio hypothesis that would allow a new settlement to survive in the Altar Valley without having to rely on water from the Colorado watershed 500 kilometers away.

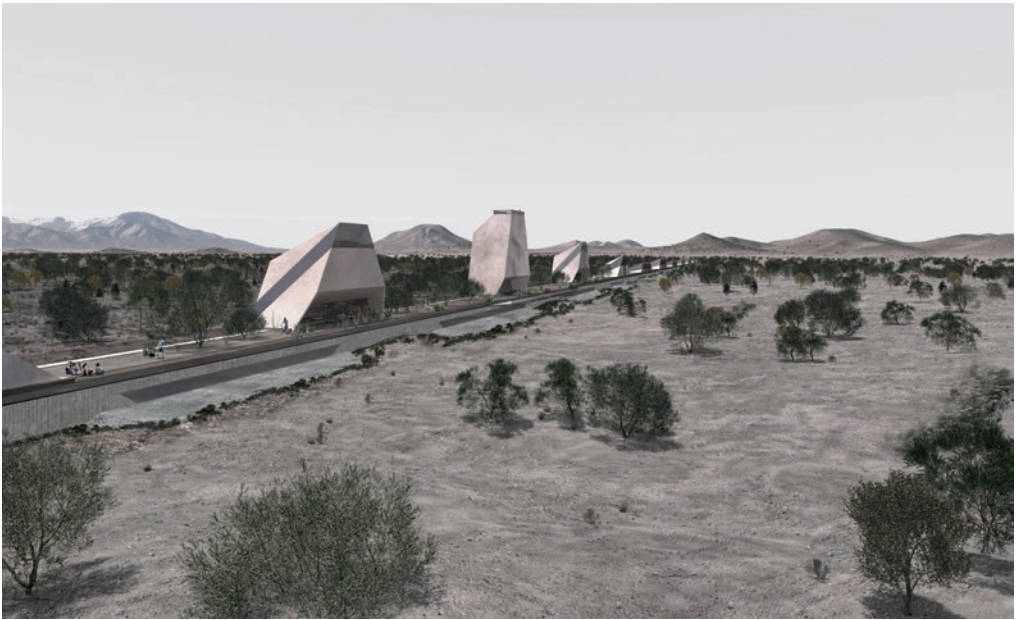
A few times per year the Brawley Wash carries a lot of water in the form of a flash flood. This opportunity was exploited by the projects to catch part of the water rushing down. These dam-like structures reached just into the riverbed, diverting part of the water horizontally away from wash and onto the plain. In order to understand this process, sand models were constructed. This hands-on approach informed the students on the natural processes of flash floods and erosion on the site. When a particular solution was found, CNC models advanced the precision of the intervention, minimizing the transport



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- 10. 可视化效果图：堤道与分流。
- 11. 可视化效果图：兼具堤道与住区功能的堰。

- 10. Visualization: causeway and water diversion.
- 11. Visualization: the weir functioning as a causeway and settlement.



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of material on the site by controlling the volume of cut and fill operations. Once the water is diverted it has to be slowed-down and stored. The water was spread over a large area to infiltrate and be directed towards storage tanks, either as ponds or high-tech reservoirs. The key here was to prevent evaporation by providing shade in the form of bushes or simple roof structures. These water storage solutions naturally became the heart of the settlements being its most precious commodity. The settlement consisted of dwellings and farm like structures that were placed strategically along this system of catching, storing and releasing water. Whenever possible, roads were combined with low weirs, and buildings with permeable embankments to foster a small footprint on the alluvial plain as a whole. When we now move further down the irrigation system, irrigation canals and field were modelled to accompany the slow movement of water. These fields would now serve the proposal of dry agricultural methods and for cattle grazing. These topologies were modelled in such a way that it would allow an abundance

of water to overflow back into the Brawley Wash, serving settlements downstream. The final study consisted in the visualization of these new structures into the pristine landscape of the Altar Valley. The same digital model that was used to make the physical CNC models now became a testing ground for the plantation. A library of local plants was made digitally and planted by the thousands in the model. This allowed the students to relate more directly to their interventions by taking their projects into reality. At the same time, it served as proof for the local community by shifting the projects away from abstraction. The intelligence of the landscape structure naturally emerges from these images by envisioning a (re-)found approach to desert settlement.

Comprehension

During the course of the studio, it became clear that the only way to solve a settlement principle in this dry but flood prone area was to develop design solutions on the large scale of the valley and at the

scale of a Zuni bowl simultaneously. The integration of infrastructure, architecture and ecology into a single design solution challenged the structure of the settlements with respect to both natural processes and the Jeffersonian grid. For the students, both the formal and the performative solutions arose from this superimposition where the sublime nature of the site, being exempt of almost any human artefact, proved to be the perfect testing ground. The settlement solutions that were proposed not only diverted the dangers of flash floods, but were actually dependent on them. They exhibited wide range of tectonic and topological solutions for a new type of occupation in the desert. **LAF**

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