



1. 气候观测站：向东穿过逐渐恢复生机的茫茫草原，可以看到一个固定在地面上的小型探测器——这是一种对不断变化的气候的直观记录。
1. Climate station. Walking east through the recovering prairie a small probe is seen embedded in the ground — a visible record of a changing climate.

神庇佑了耕作……耕作只是人类征服自然的一种表现，而通过这个伟大的发明，土地得到了丰富的降雨……（耕作的出现）是野蛮文明与现代文明的分界点；（正是耕作的出现）将这世上的荒漠变作了农场与花园……实现这一转变的最大功臣是农业的发展。简言之，雨随耕作而来。^[1]
—— 查尔斯·达纳·威尔伯，土地投机家，1881年，于内布拉斯加州

美国大平原原本人烟稀少，1870年，当地气候突变，得益于丰沛的雨水，农业生产能力大幅提升。仅一个雨季之后，干旱的草原就变身为茵茵草场。美国大平原气候的快速转变让权威气候学家赛勒斯·托马斯和著名地理学家费迪南德·范德威尔·海登信心满满地得出结论：大平原近期农垦的增加与该地区气候突变存在内在联系。^[2]当时的土地销售人员为了鼓励更多人来西部定居，大力宣传并夸大这一“科学”论调。身为土地投机家和作家的查尔斯·达纳·威尔伯首先提出了“雨随耕作而来”这一说法，他乐观地认为人类在“美国大荒漠”上进行的农耕行为会改变地域气候，而这句话也迅速成为了那个时代广为流传的一个大平原神话。^[2]
直到北美地区最严重的环境危机之

弹性的大平原 ——开启“丰产时代” PLAIN RESILIENCY — TOWARD A MERIDIAN OF FERTILITY

里德·菲兰鲍姆 / Reid FELLEBAUM

——沙尘暴——的出现才最终打破这个大平原神话，并给美国上了关于生产性景观的弹性的重要一课。这场沙尘暴席卷了整个大平原75%的区域，平均每英亩土地流失了480吨土壤，这也让人们对该地区独特的生态系统有了新的认识。^[3]前所未有的特大干旱接踵而至，在罗斯福总统富有远见的新政的影响下，通过将农业实践与该地区的自然系统更紧密地结合，大平原的生产性景观才慢慢得以恢复。具体措施包括根据具体的地形设定犁沟的等高耕作、建立防风护林带以保护土地、通过轮耕轮作使土地得以休养生息等。在这些举措之下，美国得以成功孕育出一个全新的、充满弹性的农业系统。

然而，美国大平原发展弹性农业的脚步却戛然而止，因为在20世纪40年代末，人们发现在尘土飞扬的大平原草场之下竟然蕴含着貌似深不见底的水源。在不久之后的20世纪50年代，当时发明的深水井技术和枢轴灌溉系统等技术创新可以前所未有地将水输送到任何地方。这种人为方式导致地下水位大幅下降，但同时却将大平原变成了世界上最具生产力的景观之一。

对地下水毫无节制地开采一直持续到今天，这导致大平原含水层迅速下降，几近枯竭。据现有模型的预测，含水层到2080年时

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摘要

根据目前的模型预测，美国大平原地区的含水层将于2080年枯竭，该地区即将面临考验其生产性景观复原能力的关键临界点。基于此，本项目提出未来的景观将根据超本地化的气候预测而每年进行重组，以根据微观地形和土壤类型采取相应调整——这与杰斐逊网格的模式截然不同。一系列动态景观基础设施将对数据进行收集和解读，用以划定一条“丰产的子午线”——寸草之原的时代即将终结，而有保障的丰产时代即将开启。

关键词

气候；弹性；生产景观；数据收集；解读大平原

ABSTRACT

With current models predicting aquifer depletion as early as 2080, the American Great Plains region approaches a critical threshold that will test the resilience of its productive landscape. In response, this project challenges the Jeffersonian grid by speculating that the future landscape will be annually reorganized by hyper-local climate prediction that responds to micro-topography and soil typologies. A series of dynamic landscape infrastructures collect and interpret data to define a Meridian of Fertility where short grass prairie ends and insurable productivity begins.

KEY WORDS

Climate; Resiliency; Productive Landscape; Data Collecting; Interpreting Great Plains

译 刘姝 田乐

TRANSLATED BY Shu LIU Tina TIAN

将会彻底枯竭；与此同时，气候模型也向我们发出了警告：未来含水层不断下降这一趋势将逐步向美国东部蔓延。大平原面临着考验其生产性景观复原能力的关键临界点。^[4]现如今，后含水层灌溉的农学家将再次受到不确定的气候因素的影响，认为生产将大幅下降，对景观丰产能力的信心也开始动摇。

丰产的子午线

含水层枯竭已迫在眉睫，农业将无法继续从含水层抽水灌溉，在此背景下，“丰产的子午线”作为一个探索性项目，其主张回归后沙尘暴时代早期的弹性规划，且对这种规划进行完善，并通过客观数据对大平原景观进行深入理解——大到生态地区，小至微观地貌。该项目推测，在未来，具体景观的农业组织可能将由超本地化的气候预测来决定。

生产性景观的重组

当前的景观形态仍然受到杰斐逊网格——托马斯·杰斐逊于1785年制定这一

土地条例，这种标准化的网格在美国中西部和大平原地区实行——的强烈影响。杰斐逊网格将土地划分成以160英亩（约65hm²）为单位的网格状结构——160英亩被视为理想的自耕农场面积——这一规模非常适合美国东海岸较为湿润的大陆性气候。^[3]但是杰斐逊标准化忽略了美国广袤的国土之上拥有不同的生态系统，而是一味地推行同一套开荒模式、在不同的地域上开展相似的农业耕作。地质学家兼探险家约翰·卫斯理·鲍威尔在1878年发表的报告中强调，160英亩的标准化农业模式并不适合大平原，农场规模需要因地制宜，根据土地实际情况“量体裁衣”；最重要的是，要考虑供水是否便利。^[5]鲍威尔的这项建议并没有引起当时的注意，半个世纪以来，大平原在一个个受限的网格中大量实践着东海岸的耕作方式，现在大平原生态系统的稳定性已走到了摇摇欲坠的崩溃边缘。

“丰产的子午线”项目借鉴了约翰·卫斯理·鲍威尔的观点，设想今后的生产性景观将打破刚性的网格结构，采用超本地化的气候预测、回归以往大平原上土著人采用的可持续的游牧农耕方式。据现有的气候模型

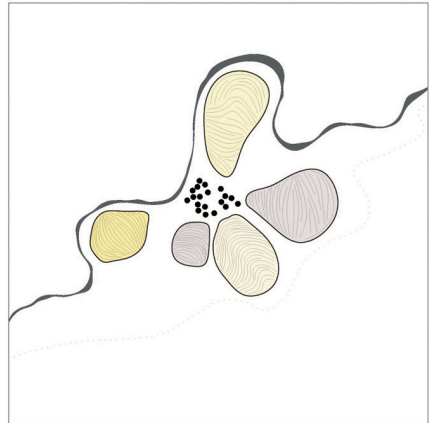
预测，适合旱作农业的土地区域将稳步向美国东北部迁移。通过开发和利用一种由干盐盆地、防护林和气候观测站组成的一种不断变化的基础设施，气候模型在整个大平原地区为我们绘制出了一条“丰产的子午线”，这条线划定了一条全新的边界：寸草之原的时代即将终结，而有保障的丰产时代即将开启。

气候观测站

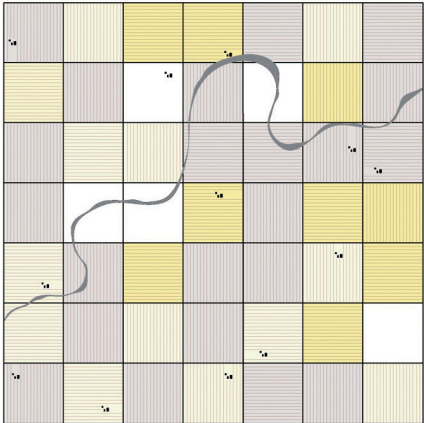
气候观测站是确保“丰产的子午线”得以实现的主要组织节点，它既是收集数据并向气候模型反馈的工具，也是向土地所有者和大众传播模型结论的前哨站。通过不断改进气候模型，最新收集到的数据每年将不断更新“丰产的子午线”，随后游牧农业将根据该模型进行调整。在每一个新年度播种之前，都将对最新的子午线进行重新划定，气候观测站也将仪式性地向东逐渐迁移——作为宣传该气候模型的标志。气象站会把其嵌入式核心留在原地，其不仅仅是景观中的一个坐标，还将继续在下一个地点从土壤中提取本地化数据，并建立区域气候变化的可视化纪录。

- 2. 大平原各时期的生产性景观组织形态。
- 3. 历史性分析：美国在机械方面表现出的乐观态度和坚定信心，使得在科学和不确定性之间，各种意识形态、仪式、仪器层出不穷，这造成了一种“自然可控”的假象。

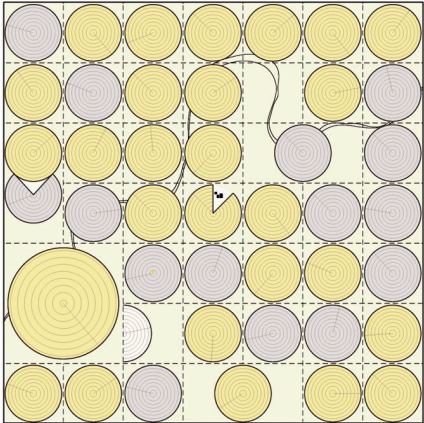
- 2. Periods of great plains productive landscape organization.
- 3. Historical analysis. Fostered through American optimism and faith in the machine, the gap between science and uncertainty is filled with ideologies, rituals and instruments whose illusions suggest a rationalized control of nature.



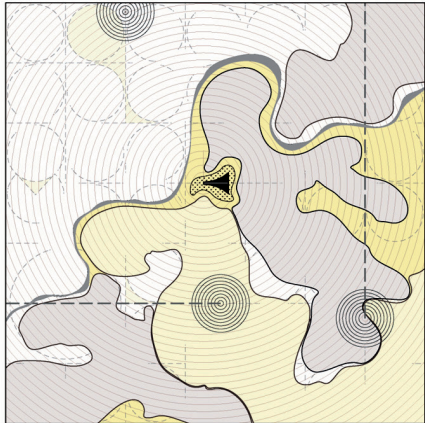
Pre-colombian productive landscape organization (~1800)
前哥伦布时期的生产性景观组织形态（ ~1800年）
- Nomadic dry-farming 游牧旱作农业
- Floodplain 洪泛平原
- Hoe stick 锄头



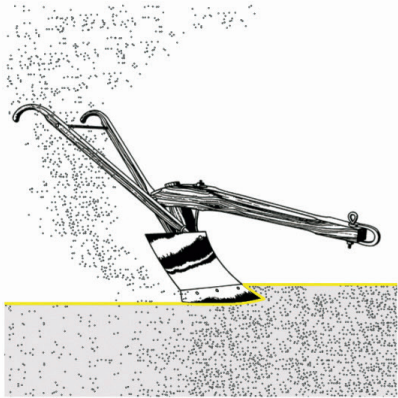
Jeffersonian Grid (1800-1960)
杰斐逊网格（1800–1960年）
- Sedentary irrigated farming 固定旱作农业
- Continuous 连续耕作
- Plow, horse, tractor 犁、马、拖拉机



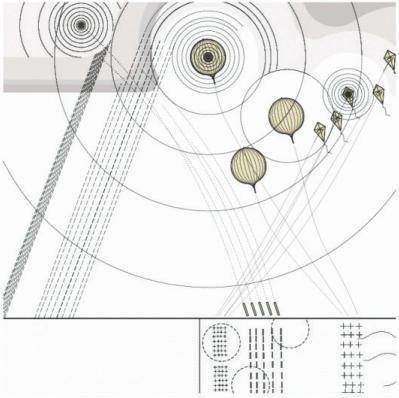
Aquifer (1960-2050)
含水层灌溉（1960–2050年）
- Sedentary irrigated farming 固定灌溉农业
- Aquifer 含水层灌溉
- Pivot irrigation, plow, tractor 枢纽灌溉、犁、拖拉机



Post-aquifer (2050-) 后含水层灌溉（2050年–）
- Nomadic dry farming 游牧旱作农业
- Hyper-local climate data + Crop insurance 超本地化气候数据+农作物保险
- Weather Chapel, plow, tractor 气候观测站、犁、拖拉机 2



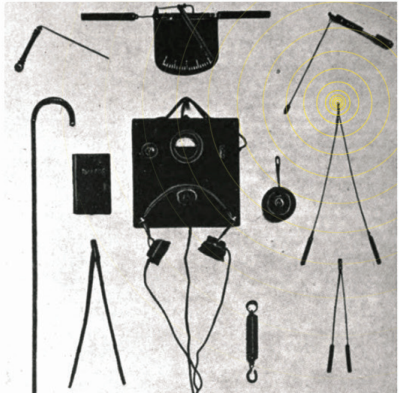
1750-1850:
“Rain follows the Plow”
“雨随耕作而来”



1890:
US Government explosive balloon rainmaking experiment
美国政府爆破气球人工降雨实验



1895
Rainmaking Laboratory car — Chicago Rock Island & Pacific Railroad
人工降雨实验室车厢——芝加哥岩石岛与太平洋铁路



1890-2014:
Various dowsing instruments used to locate ground water
多种用于寻找地下水的探测仪器



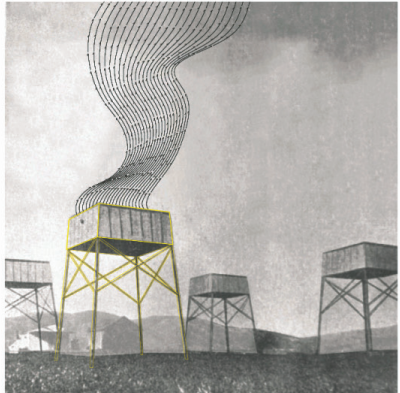
1893:
Kansas newspaper advertising traveling rainmaker
堪萨斯州报纸刊登旅行人工降雨师的广告



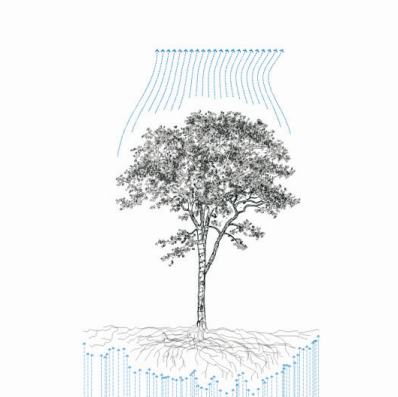
1893:
Hatfield the Rainmaker
人工降雨师哈特菲尔德



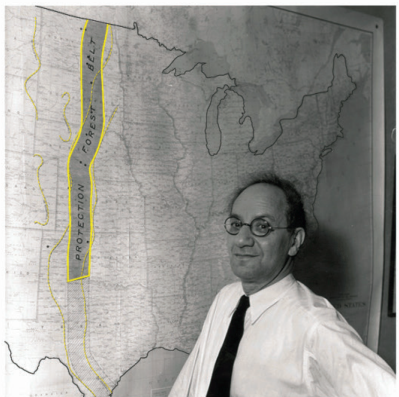
1890:
Rainmaking Funnels, Nebraska
内布拉斯加州人工降雨漏斗



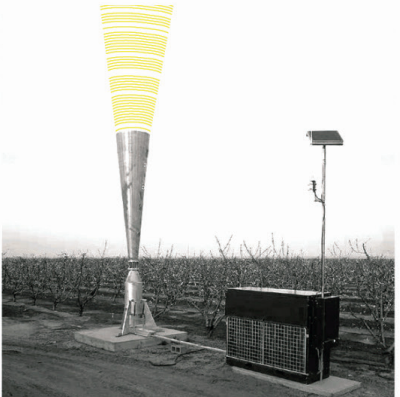
1890-1900:
Hatfield's rainmaking towers
哈特菲尔德建造的人工降雨塔



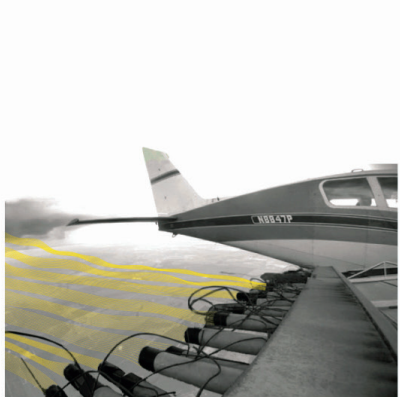
1800-1940:
Belief that trees create water
相信树能产水



1934:
Forester Rafael Zon leads New Deal Shelterbelt Program
福利斯特·拉斐尔祖恩领导的防护林新政计划



1938:
Automatic Gas Hail Cannons
自动冰雹大炮



1940:
GE invents “cloud seeding” using dry ice and silver iodine
美国通用电气公司使用干冰和碘化银来“播雨”

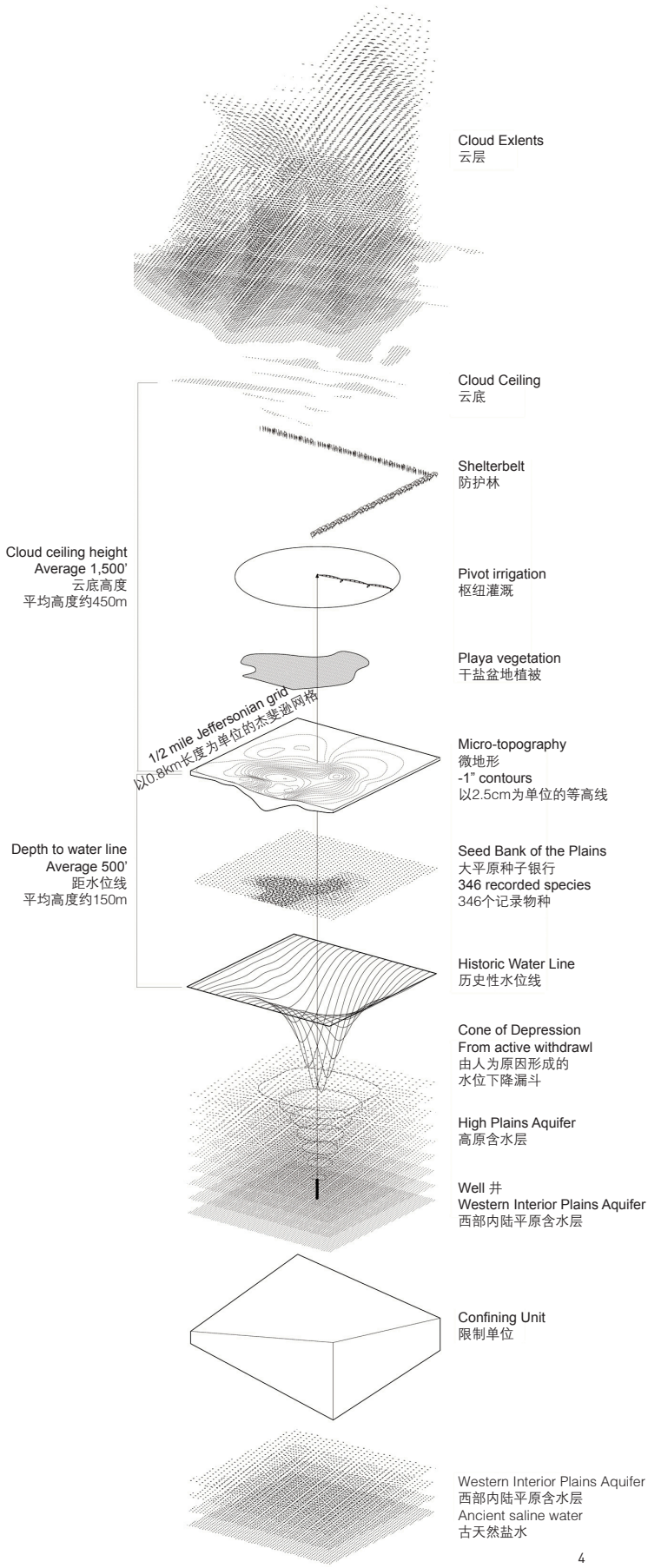
项目地址：
美国大平原
项目面积：
130 0000 km²（大平原地区面积）
项目导师：
Rania Ghosn
所获奖项：
2014美国景观设计师协会学生组分析与规划类卓越奖

LOCATION:
Great Plains, USA
AREA (SIZE):
1.3 million km² (Great Plains Region)
PROJECT ADVISOR:
Rania Ghosn
AWARD:
2014 ASLA Student Award of Excellence in Analysis and Planning

美国能源部在大平原南部设立的气候研究设施部发明了大气遥感仪器用于大气辐射测量（ARM），而“气候观测站”的设计灵感正是源于这一富有创新性的仪器。在形式上，气候观测站与19世纪90年代大平原的求雨装置和求雨表演类似，当年这个著名的求雨器所展现出的丰富的想象力令很多人都相信人类是可以创造天气的。而气候观测站并不会“创造”天气，其以一种异想天开、未来式的外观，力求使人们相信其预测结果的准确性。在功能上，气候观测站更像一个信息处理中心，它对收集到的数据进行分析处理，并发送给农场主，提醒他们根据预测的天气，决定下一季在哪里耕种、种植哪些作物。

结语

我们不应该要等到灾难发生后才开始弹性规划。预计在不久的将来，极端气候事件将更加频发，我们必须确保我们最脆弱的生产性景观成为具有弹性的景观系统。我们要使生产性的农业景观能够与当地原有的、具有弹性的、仅需要极少人工维护的生态系统相适应，这样的农业景观才能够世代地发展下去。也许通过进一步根据土地条件开发和定制气候预测模型，大平原未来的耕作有可能真正能够实现“雨随耕作而来”。**LAF**



4. 环境分析（堪萨斯州巴顿县的水圈分解图）。通过分解，我们可以看到大平原平坦的地表所包含的变化极大的水文地形。但这些水域的感知距离还捉摸不定，在精确绘图方面也存在诸多问题，这为伪科学论调得以宣扬提供了机会。

4. Environmental analysis (exploded hydrosphere of Barton County, Kansas). In section, the flat ground plane of the Great Plains reveals a dramatic topography of water. Yet the perceived distance to these great containers of water is mysterious and challenging to accurately map, leaving many opportunities for psuedoscience.

5. 区域性平面图。根据美国海洋及大气管理局对于2080年平均降雨量的预测和土壤地质情况，来划定堪萨斯州每年的“丰产的子午线”。以气候观测站为分水岭，“子午线”以西为矮草平原，以东为有保障的丰产农田。

5. Regional site plan. Projected average rainfall for 2080 (NOAA) and soil geology determines the annual Meridian of Fertility across Kansas. Punctuated by an infrastructure of climate chapels, the Meridian defines the edge between western short grass prairie and eastern insurable productivity.

God speed the plow.... By this wonderful provision, which is only man’s mastery over nature, the clouds are dispensing copious rains... (the plow) is the instrument which separates civilization from savagery; and converts a desert into a farm or garden.... The chief agency in this transformation is agriculture. To be more concise, rain follows the plow.^[1]

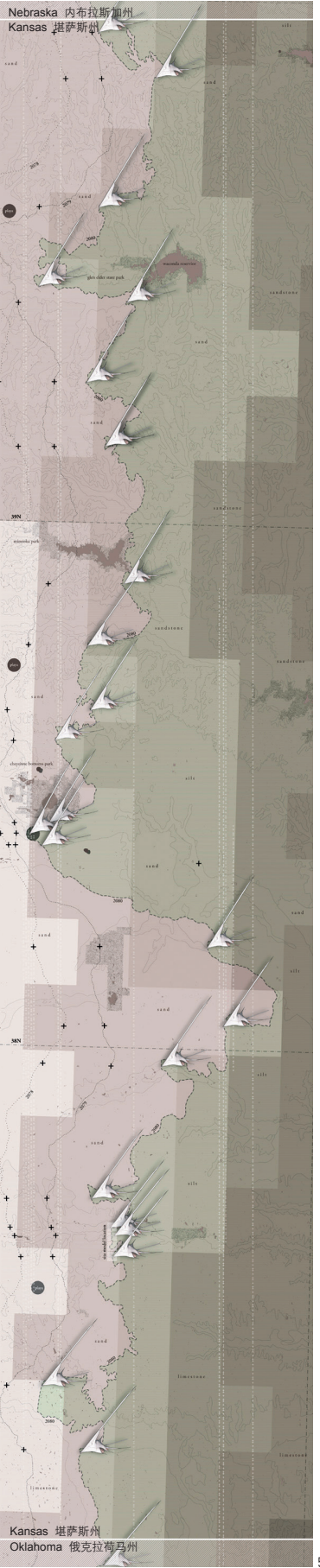
— Charles Dana Wilber, Land Speculator, Nebraska, 1881

A sudden change in climate during the year 1870 brought a great increase in agricultural productivity to the sparsely settled prairies of the American Great Plains. Within a single wet season the dry prairies were transformed into lush green meadows. The rapid transformation led prominent climatologist Cyrus Thomas and noted geographer Ferdinand Vandever Hayden to confidently conclude that the recent increase in agricultural settlements of the Great Plains were intrinsically linked to this abrupt change in climate.^[2] Land promoters of the time advertised and exaggerated this “scientific” notion to encourage increased western settlement. “Rain follows the Plow”, a phrase coined by land speculator and author Charles Dana Wilber, quickly became the popular Great Plain myth of the period, optimistically claiming that

man’s cultivation of the so called “Great American Desert” would modify the regional climate.^[2]

It would take one of the most severe environmental crises in North America — the Dust Bowl — to finally dispel this myth and teach the United States critical lessons about productive landscape resiliency. The crisis, which blew away an average of 480 tons of soil per acre across 75% of the region, encouraged a new understanding of the region’s unique ecosystem.^[3] Following the unprecedented drought, the productive landscapes of the Great Plains slowly recovered under President Roosevelt’s visionary New Deal, which brought an enlightenment of new strategies adjusting agriculture practices to align closer with the natural systems of the region. Contour plowing tailored furrows to their immediate topography, shelterbelts protected fields from wind, and crop rotations allowed soils to gradually rebuild. America was well positioned to nurture a new, resilient system of agriculture.

Yet further resiliency progress was halted by a discovery in the late 1940s. A seemingly bottomless system of aquifers was discovered just beneath the dusty Great Plain’s prairies. Soon technological innovations of deep wells and pivot irrigation systems in the 1950s allowed unprecedented distribution of water to



fields. This artificially induced precipitation transformed the Great Plains into one of the world's most productive landscapes.

The relentless mining of ground waters continues today and is forcing the High Plains Aquifer to rapidly approach exhaustion. With current models predicting significant aquifer depletion by 2080, and climate models warning that the future precipitation isohyets will gradually migrate to the east, the Great Plains approaches a critical threshold that will test the resilience of its productive landscape.^[4] At this

moment, the post-aquifer agriculturalist will once again be at the mercy of the uncertain climate, forcing yields to decline dramatically and faith in the landscape's fertility to falter.

The Meridian of Fertility

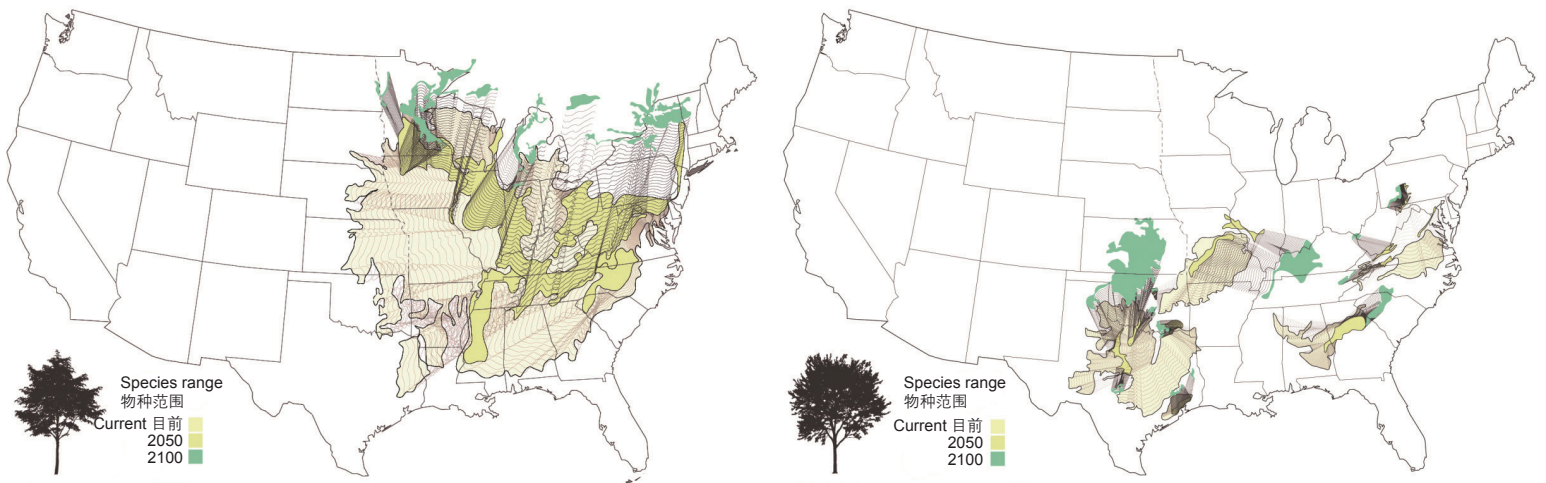
Positioning itself after the looming collapse of aquifer irrigation, The Meridian of Fertility is a speculative project that calls for a return to early post-Dust Bowl resiliency planning through a more refined,

data-driven understanding of the Great Plains landscape — from its eco-regions down to its subtle micro-topography. The project speculates that future agricultural organization might be determined by hyper-local climate predictions that are tailored to the landscape.

Reorganization of the Productive Landscape

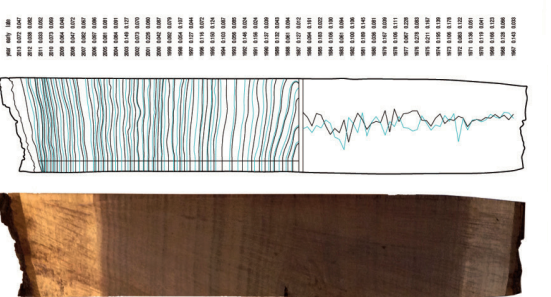
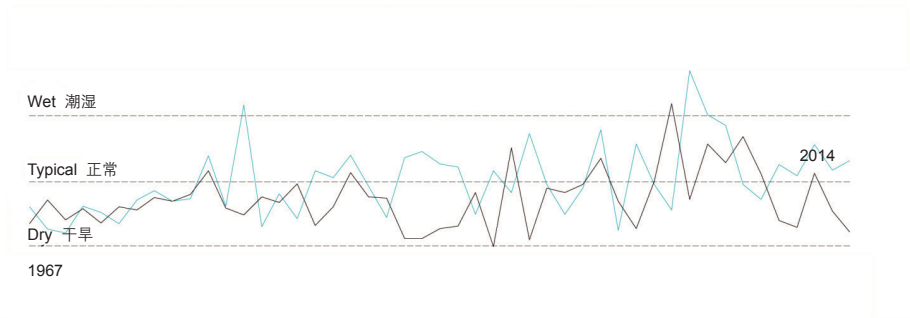
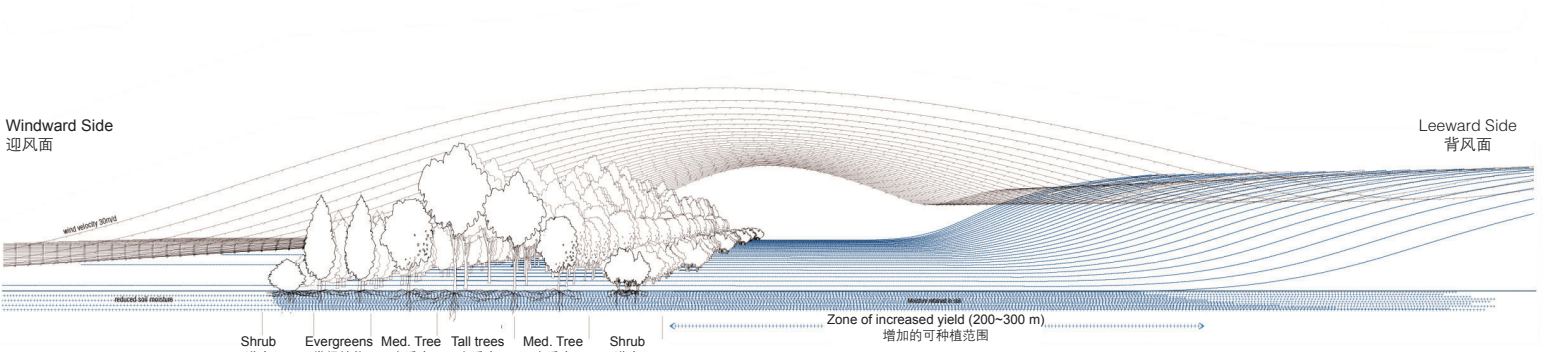
Current landscape organization is still strongly influenced by the Jeffersonian grid

- 6. 干盐盆地：气候数据处理和种子银行。仅堪萨斯州西部地区就包含超过2.2万个小型的、季节性湿地——干盐盆地。每一个干盐盆地都可以收集地表径流，形成当地化的汇水区；同时，其对土壤饱和度的微小变化也十分敏感。土壤样本显示了粘土的分层，其可以提供历史性的、超本地化的气候数据。干盐盆地中的湿度使其成为大平原上最大的、物种最丰富的种子银行。
- 7. 防护林。基础设施防护林的种植位置根据地区中特定物种的迁入或迁出的预测而确定。防护林具有两大功能：第一，通过保护土壤湿度的微气候环境来减缓“子午线”的迁移速度；第二，采集未来超本地化的气候数据，这将有助于模型的改善。
- 6. Playa: climate data extraction + seed bank. Western Kansas alone contains over 22,000 small, ephemeral wetlands called playas. Each playa functions as the runoff collection point for a localized watershed and as such is very sensitive to minor fluctuations in soil saturation. A soil core sample reveals clay stratifications that can provide historical, hyper-local climate data. The moisture maintained in a playa contributes to its function as the largest and most diverse seed banks of the Great Plains.
- 7. Shelterbelt. An infrastructure of shelterbelts is planted with the anticipation that certain species are also migrating to and from the region. The shelterbelt serves two purposes, first slowing the migration of the Meridian by preserving microclimates of soil moisture, and second by planting future hyper-localized climate data that will further refine the model.



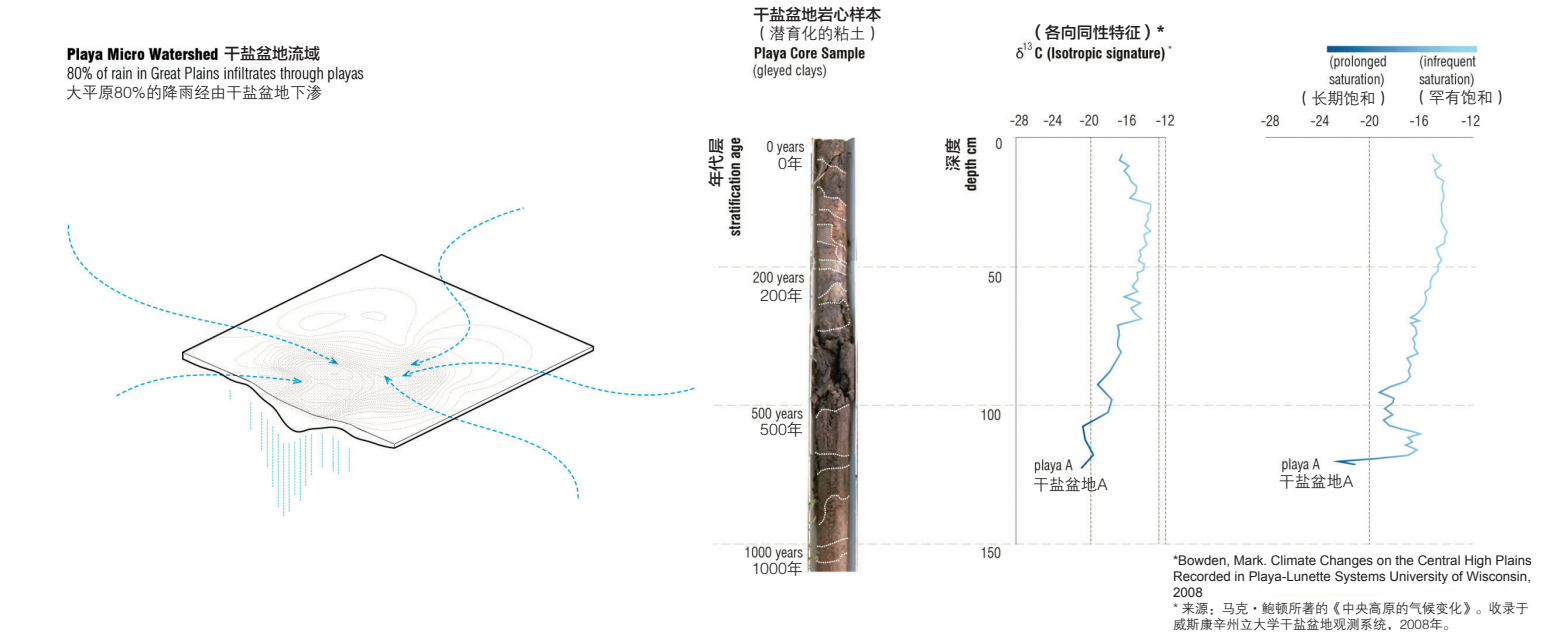
Juglans nigra — Black Walnut
黑核桃 (Juglans nigra)
Projected Migration out of Kansas
据预测，该物种将从堪萨斯州中迁出

Bumelia lanuginosa — Gum Bumelia
鼠李属植物 (Bumelia lanuginosa)
Projected Migration into Kansas
据预测，该物种将从堪萨斯州中迁入



Black Walnut — dendrochronology — hyper-local climate analysis through tree ring
黑核桃——树木年代学——通过年轮进行超本地化的气候分析

Measurement 测量
Black — latewood (summer) 黑色线条——晚材 (夏)
Bule — earlywood (spring) 蓝色线条——早材 (春)



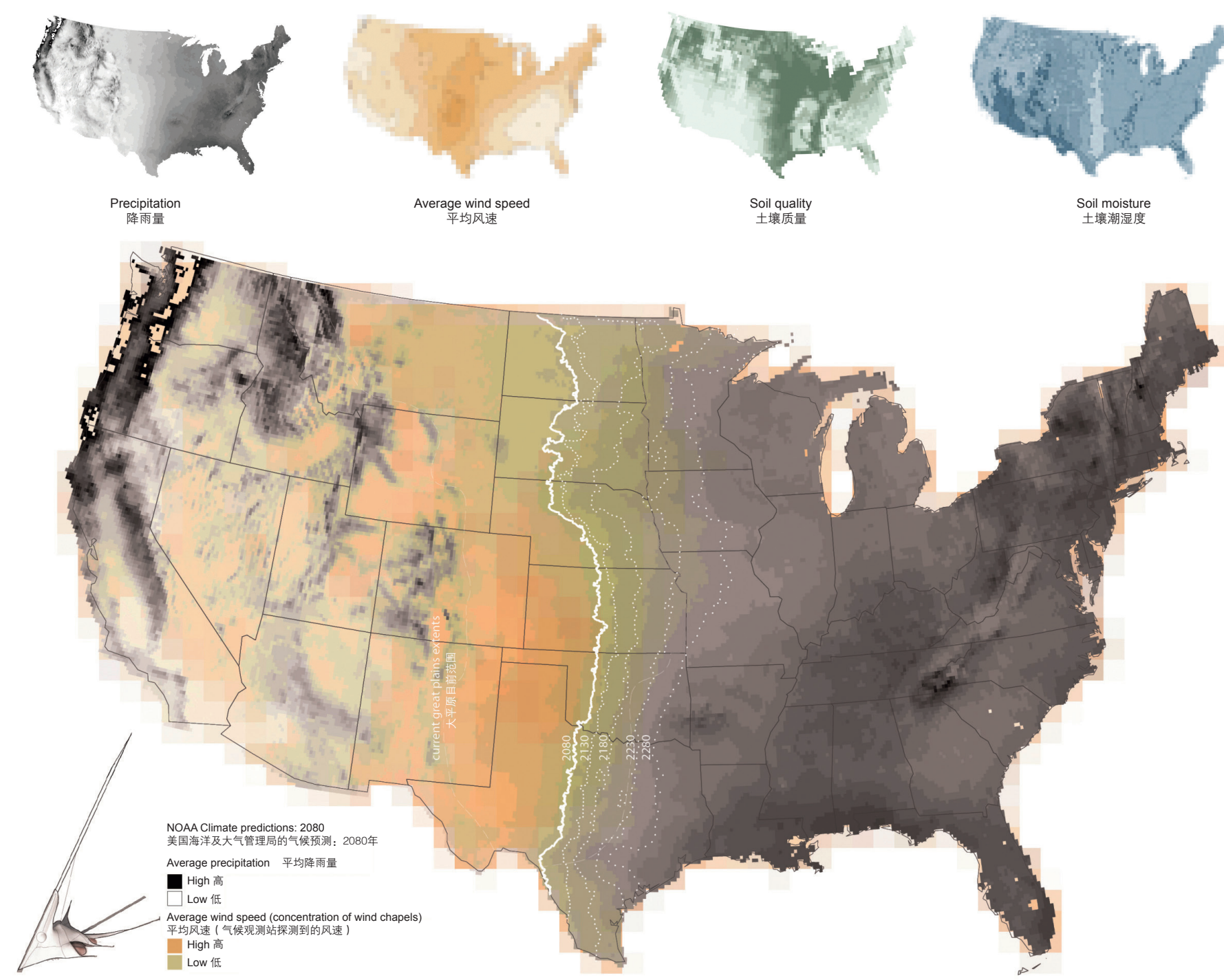
*Bowden, Mark. Climate Changes on the Central High Plains Recorded in Playa-Lunette Systems University of Wisconsin, 2008
*来源：马克·鲍顿所著的《中央高原的气候变化》。收录于威斯康辛州立大学干盐盆地观测系统，2008年。



8.

“子午线”每年的变迁。
50cm的年降雨量预测线——这是维持旱作农业所需的最小降雨量——正在缓慢地向东迁移，“子午线”亦是如此。通过不断收集新数据而进行自我改进，该气候模型利用大量的变量来分析预测的变化，并决定哪些生产性土地在来年中将无法保证能够获得丰收。
8.

Annual Meridian migration.
As the projected 20" annual precipitation line—minimal quantity of rain required to dry farm—slowly migrates east so does the Meridian Line. Continuously refining itself with newly harvested data, the climate model analyzes projected changes in numerous variables to determine the productive land that cannot be insured for the upcoming year.



9.

微地形。过去的生产实践在堪萨斯平坦的景观中留下了微地形的改变。这些层层叠加的痕迹造就了微地形，这些微地形在种植某些农作物方面具有地形优势，因此也就可以保证丰产的实现。
9.

Micro-topography. Past productive practices have been inscribed in micro-topographic alterations of the flat Kansas landscape. These various palimpsests provide microclimates that are advantageous to certain crops and therefore are identified and productively utilized.

— a standardized grid that was imposed across the Midwestern and Great Plains landscape by Thomas Jefferson’s 1785 land ordinance. The grid was based on a 160 acre section that was regarded as the ideal yeoman farm — a scale appropriate for the humid continental climate of the East Coast.^[3] The desire for standardization ignored the varied ecosystems of the country by imprinting a settlement template that encouraged similar farming practices regardless of location. Geologist and explorer John Wesley Powell’s 1878 report famously insisted that 160 acres could not support agriculture in the Great Plains where farm size needed to conform to land and, most importantly, to the availability of water.^[5] Powell’s advice was ignored and

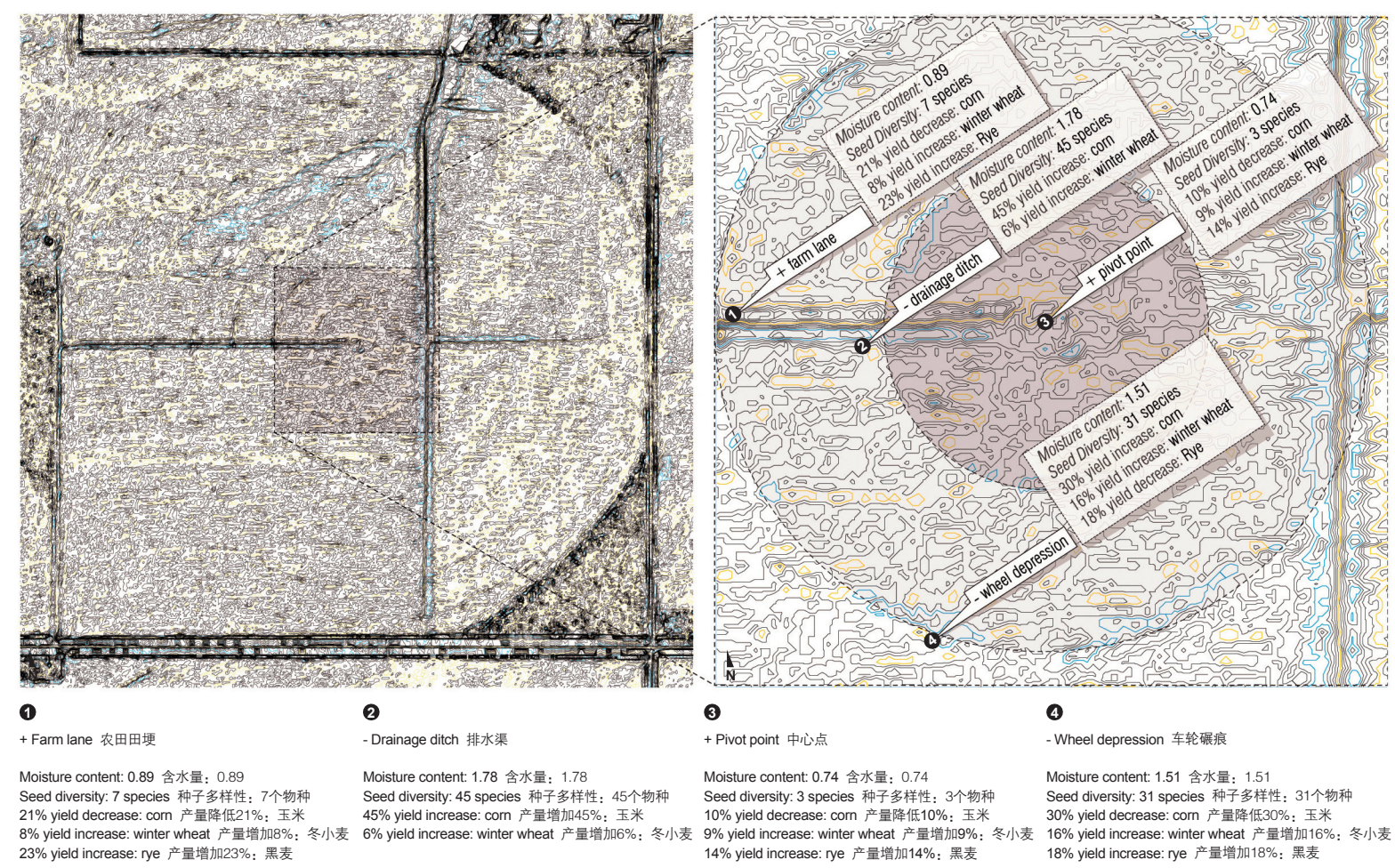
within a half century of intensive, East Coast farming practices on constricted plots of prairie soil, the stability of the Great Plains ecosystem was teetering on the edge of disaster.

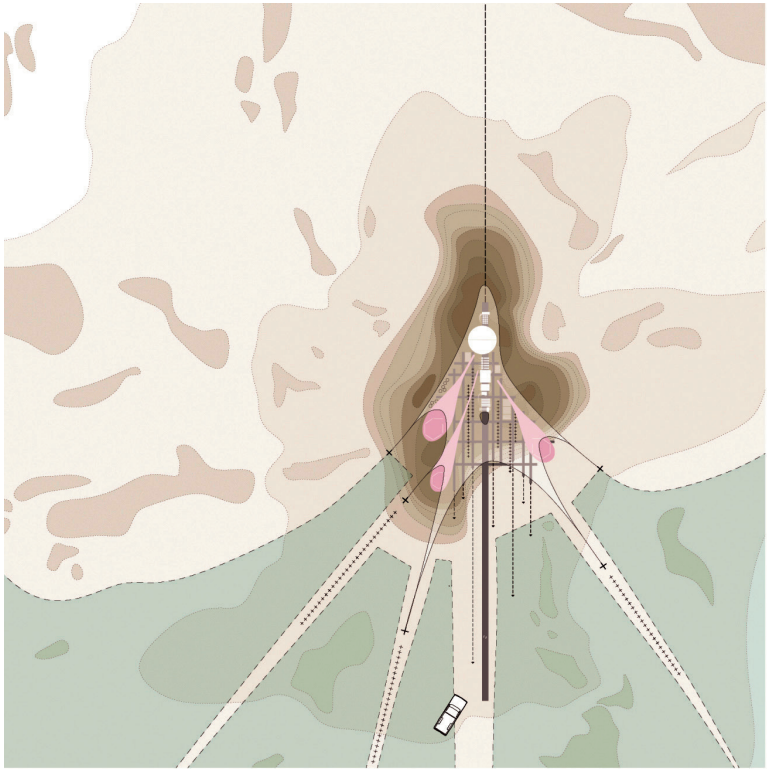
The Meridian of Fertility borrows Powell’s thinking by envisioning that the next stage of productive landscape organization will break from its rigid, sedentary practices to embrace hyper-local climate prediction and a return to the sustainable, nomadic agricultural practices of the Plains Native Americans. Current climate modeling predicts that the realm of land suitable for dry farming will steadily migrate to the Northeast. By deploying and utilizing a shifting infrastructure of playa, shelterbelts and climate chapels, the climate model

inscribes a new line, the Meridian of Fertility, across the Great Plains, defining the edge where insurable productivity ends and short grass prairie begins.

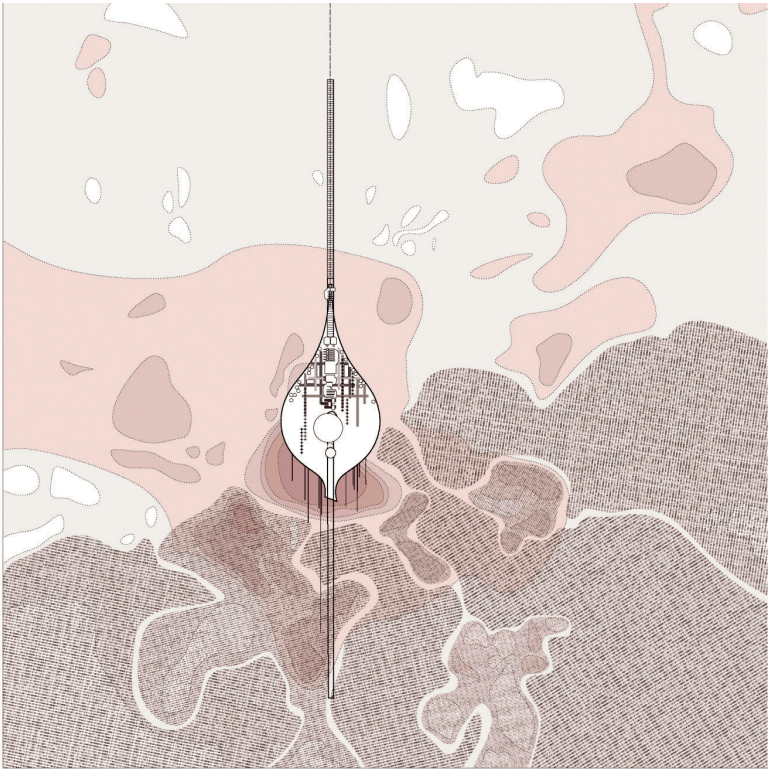
The Climate Chapel

The main organizational node securing the Meridian is at once an instrument harvesting and feeding data to a climate model and an interpretation outpost disseminating model conclusions to the land owners and public. Through a constantly refining climate model, the Meridian of Fertility, and the nomadic agriculture that follows, is annually updated with the latest harvested data. Before each new year’s crop planting, the updated line is determined





Plan: WIND station
平面图：气候观测站——“风”



Plan: VAROP station
平面图：气候观测站——“瓦罗普”

10

10.

气候观测站。沿着每年的子午线布设的主要组织性节点采用了活性张拉膜表皮，其内部包括一种采集数据的仪器，仪器的内部中心区设有帐篷。气候观测站分为两类：“风”和“瓦罗普”；它们架设在干盐盆地或湿地之上，经过严谨的地域性选址，它们可以针对某一专项进行数据采集。
11.

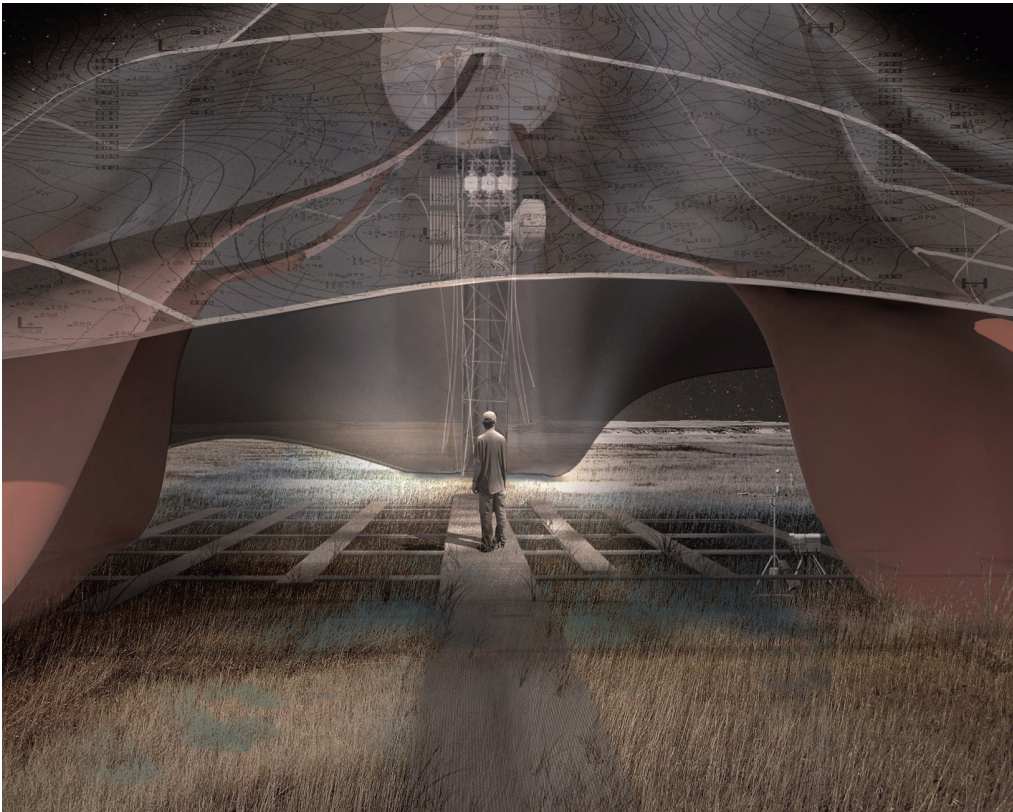
丰产的子午线。处于某个干盐盆地的气候观测站。垂直布设的防护林在微气候环境中被更为广泛地种植——其可以种植在风速更快的地区，或土壤更易发生干旱的地区。
12.

气候观测站。架空的多孔金属网格通道是体现了干盐盆地微妙的微地形的水平基准面。这个通道被嵌在草原上，与景观融为一体。
10.

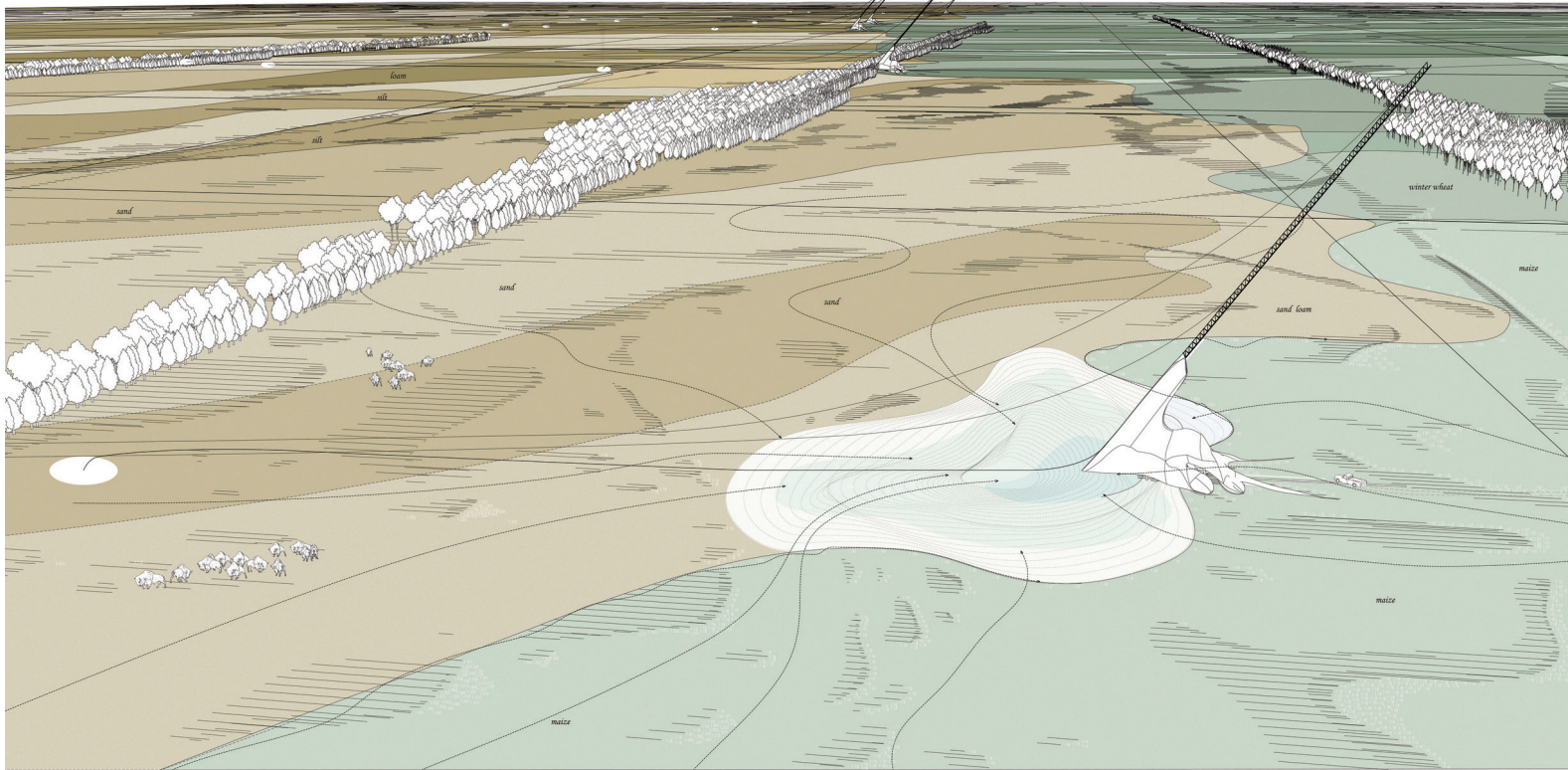
Climate station. The main organizational node marking the annual Meridian features an active tensile skin that is at once an instrument absorbing data and a veil over the central core of instruments inside. The two stations, Wind and Vapor, hover above a playa or wetland and are tailored to a specific realm of data collection which is reflected in their careful regional sitting.
11.

Meridian of Fertility. Climate stations are sited on a playa. Orthogonal shelterbelts are planted wider in microclimates that experience higher wind speeds or in soils that are more vulnerable to drought.
12.

Climate station. The hovering expanded-metal pathway is a level datum accentuating the subtle playa microtopography. The path is beginning to blur with the landscape as it becomes embedded in the grasses.



12



11

and the stations reluctantly coordinate in a ritual of eastwardly retreat, a sign of the advancing climate model. The stations leave their embedded core behind, not just a coordinate in the landscape, to continue extracting localized data from the soil and to establish a visible record of regional changing climate.

The design of the “climate chapels” was inspired by the innovative atmospheric sensing instruments of the Department of Energy’s Climate Research Facility (Atmospheric Radiation Measurement — ARM) in the Southern Great Plains. Their form recalls the fantastical instruments and performances of the Great Plains rainmakers in the 1890s whose famous imaginations convinced many that man could indeed create weather. While the chapels would not “create” weather, their

fantastical, futuristic appearance strives to provide reassurance and faith in their forecasting accuracy. The chapel also functions as an interpretation center that analyzes its collected data to advise farmers what type of crop should be planted and where based on the climate predicted for the upcoming season.

Conclusion

Resiliency planning should not need to wait for disaster. With climate extremes expected to intensify in the near future, we must ensure that our most vulnerable productive landscapes are resilient systems. Productive agrarian landscapes that are able to synchronize with their local, inherently resilient ecosystems with minimal reliance on artificial support will

persist for generations. Perhaps by further developing and tailoring predictive climate models to the land, the future plow of the Great Plains might indeed be able to anticipate the rain. **LAF**

REFERENCES

- [1] Wilber, C. D. (1881). The Great Valleys and prairies of Nebraska and the Northwest. Omaha, Nebraska: Daily Republican Printing Company.
- [2] Burns K. (Producer). (1996). The Geography of Hope (1877-1887) [DVD]. In The West, Episode Seven. Available from www.pbs.org.
- [3] Wishart, D. J. (Ed.). (2004). Encyclopedia of the Great Plains. Lincoln, Nebraska: University of Nebraska Press.
- [4] Steward, D. R., et al. (2013). Tapping unsustainable groundwater stores for agricultural production in the High Plains Aquifer of Kansas, projections to 2110. Proceedings of the National Academy of Sciences of the USA, 110(37):E3477-86. doi: 10.1073/pnas.1220351110.
- [5] Stegner, W. (1954). Beyond the Hundredth Meridian: John Wesley Powell and the Second Opening of the West. Boston: Houghton Mifflin Company.