



时间 2016年11月25日 **地点** 海南省三亚市东岸湿地公园 **拍摄** 蒙明珠

由于历史上的无序开发，地处热带季风气候带上的三亚市中心地区曾面临河道拥塞、洪涝频发、水体污染、栖息地丧失、生态退化等严峻问题。景观设计师从珠江三角洲地区的传统桑基鱼塘和梯田中获得灵感，通过就地填挖方，营造基塘、梯田湿地和水上森林等景观，构建了一个城市绿色海绵系统，仅通过一年时间便有效改善了当地环境，并开启了自然生态修复的过程。

Date November 25, 2016 **Location** Dong'an Wetland Park, Sanya City, Hainan Province **Photographer** Mingzhu Meng

The center of Sanya, a city with a tropical monsoon climate, was suffering from river clogging, frequent floods, water pollution, habitat loss, ecological degradation, etc. due to the unplanned urban development. To solve these severe problems, landscape architects created an integrated urban sponge system with dike-ponds, terrace-like wetlands, and separated small tree-islands through cut and fill on site, inspired by traditional ecological wisdom applied in mulberry-fish ponds and terraces widely seen in the Pearl River Delta region. After only one year, the system has been proved a great success in environmental improvement with a continuing process of natural ecological restoration.

复兴古老智慧， 建设绿色基础设施

主编 俞孔坚

由钢筋混凝土制成的灰色基础设施尽管本意是连接我们所生活的世界，但很多时候却扼杀了人类与自然以及多种自然过程之间的深层联系。而与之相对的绿色基础设施或生态基础设施则凝结着古代农民的生态智慧。20多年来，我试图复兴这些古老的智慧，并把它们与现代科学技术相结合，以解决当今城市的生态问题。由此形成的解决方案既实施简单、造价低廉，又不失美观，并已在中国及其他国家和地区的200余座城市中进行了大规模应用。

灰色基础设施与破碎的连接

人们可能认为，由于脸书和微信等社交工具的迅速发展，以及无处不在的高速公路和管道设施，我们所处的世界在网络层面和物理层面的联系都比以往更加紧密。然而事实并非如此。很多研究已经表明，较之以往，人们与所属社区更为脱离，邻里之间或亲属之间亦愈发疏远。

在物理层面，供人们所栖居的景观之间似乎存在着显著关联，例如，马路连接着城乡居民的住所；输电线将发电站与单个家庭相连；排水管道连接起了厕所与污水处理厂；输送饮用水的管道将水库与厨房相连；发达的航运网络使得南半球的农产品能够迅速运抵北半球的冰箱中；高速公路上运载肥料和除草剂的卡车则将东部城市中的工厂与西部山区中种植稻谷的农民连接起来……我们创造了一个紧密相连的世界，但这种联系却是脆弱的：景观基质及其无形的演变过程已变得支离破碎。水、营养物质、食物、能源、各类物种及人类之间不曾间歇的迁移和循环过程已被打破。与此同时，空气、水、土壤、营养物质、各物种及人类之间的隐形关联也遭受了空前的不良扰动。

以水资源为例，在中国，已有超过75%的地表水遭受污染，全国有近一半的城市面临洪水和城市内涝的威胁，存在缺水问题的城市占比高达60%。华北平原的地下水位每年下降超过1m，过去50年间有50%的湿地消失。所有这些影响着城市和景观的问题——特别是与水循环相关的问题——实际上是相互关联的，但常规的解决方案却是碎片化的、孤立的和单一的，即只注重修建灰色基础设施。我们建设污水处理厂，清除了原本可以用作农作物肥料的营养物质；我们每年花费数十亿美元建造防洪堤、大坝和管道以控制雨洪，但最终却使得干旱、地下水位下降和栖息地消失等问题更加严峻。南水北调工程修建了数千公里的沟渠，意在从水资源丰富的南方引水到干旱缺水的北方，但却对长江中下游地区的生态造成了极大的破坏；装饰性花园与景观以及农田施肥过度，导致过剩的营养物质流入河流和湖泊，污染了整个水系统。以上问题常见的解决方案依旧是片面的——修建污水处理厂。可污水处理厂净水工序繁复且成本高昂，需要大量的能源（主要来自燃煤）来支持运行，这只会使空气污染和水污染问题更加严峻。

建设绿色基础设施或生态基础设施或许是更为合适的替代方案，它将在人与自然之间，以及多种自然过程和能量流动过程之间建立起更为深层的连接。

农民的智慧

人类文化与自然之间永恒的相互依存关系显著体现于农民与农田的联系之中。因此，重建人与自然之间深刻联系的另一种方法即是从农民的智慧——造田、灌溉、施肥、种植和收获中获取灵感。几千年来，这些农业生产活动在有效地维持人类生存和繁衍的同时，也已经大规模改变了景观。

其中一类典型的农民智慧是采用土方挖填（随挖随填）的方法造田。作为农务活动的一环，挖方和填方应被视为一个整体，而不是两道分开的工序，这意味着农耕过程中的土方工程都是现场即时行为，它最大限度地降低了劳动力成本，减少了现场物料运输量，因此，对该地区自然过程和格局的影响也降至最低。世界范围内几乎所有地区的农民都采用这种方法，将不适合耕种的环境转变为可生产和宜居的景观。

第二类古老的农民智慧蕴含在水资源管理和田地灌溉中。当代农业和城市绿化中的灌溉主要通过埋入地下的管道和水泵系统来实现，灌溉过程既不受周边地形的影响，也不涉及水资源的可利用与否。而传统农耕的灌溉方式却深深扎根于自然过程和格局之中。数千年的农业生产经验使得灌溉成为了农业社会中最先进的技术之一。利用重力作用灌溉是一种高超的智慧，在这一过程中，自然与微妙的人为干预之间的平衡能够将科学知识转化为一种艺术形式或社区建设的互动媒介，甚至是精神力量。

第三类农民智慧是施肥。这是传统农业系统中一个神奇的组成部分，是闭合人类生产和生活材料之循环过程的关键环节。来自人类生活和畜牧养殖的所有废弃物及植物材料都可作为肥料回收利用。但这种养分循环系统在城市化和工业化环境中已遭破坏。以往农民眼中的肥料如今却被定义为河湖“污染物”。

第四类农民智慧来自于农业种植和收获实践。与园艺中注重装饰效果的种植和修剪不同，农业种植方法更加注重作物的产量。在农业种植过程中，首先需要播种，接下来的管理过程则遵循大自然的节律，以求适应于周围的环境和条件。同时，传统农业经济自给自足的性质也要求每个家庭种植粮食、蔬菜、水果，以及可加工成纤维、药材、木材、燃料，甚至肥料等的多种作物。这些作物的产量需与各个家庭的季节性需求成正比，并且不应逾越自然承载力和人的能力范围。而农业活动中收获的意义也远不止于食物和产品的生产本身，它在保育土壤、净化水质、保持土壤健康等方面均成效不凡。换言之，农田是净生产者，而非能源和资源的净消费者。

尽管这并不意味着我们应该放弃舒适的城市生活，回归较为原始的农业生产生活，但传统农民的生产和生活方式中所蕴含的智慧是重塑自然与人类需求之间关系、平衡自然过程和文化干预的根本基础，它们将帮助恢复人与自然的和谐关系。

复兴古老智慧，建设绿色基础设施

试想一下，如果我们不通过管道和水泵排走雨水，而是借鉴农民在造田过程中运用的古老智慧来打造城市雨水管理系统，营造能留住雨水的绿色海绵，创造多样的栖息地，补给地下水，我们的城市会有怎样的面貌？通过这种方法，城市绿地将变为可用于调节城市环境、提供多种生态系统服务的生态基础设施，赋予城市韧性以应对洪涝和干旱等灾害；人们在城市中即可获取洁净的水源和食物；生物多样性大幅提高；城市居民可以在绿地系统中慢跑、通勤和休憩；房地产价值也会因优美的自然环境和更多接触自然的机会而相应升高。这就是过去20多年里我们在许多城市所做的尝试——将原有城市改造成海绵城市。

试想一下，如果我们不再使用坚硬的混凝土防洪高墙，而重拾农民的古老智慧，在河岸构建由植被覆盖的梯田，以适应水流的起伏变化，我们的城市将会如何？诸如陂塘、低堰等生态友好型举措有助于减缓水流，让自然实现自我滋养；同时，植被和野生动物在多样化的栖息

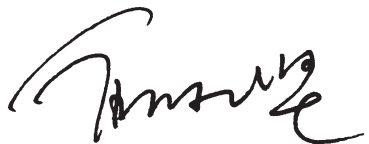
地中繁育生长，并通过生物过程吸收养分！这就是我们在许多中国城市中为修复母亲河所做的尝试。

试想一下，如果富营养化的河湖可以通过作为生活基础设施的景观进行清洁——就像农民回收有机废物一样，而无需利用污水处理厂这类昂贵的设施来去除营养物质，我们的城市将会如何？在获取洁净水源的同时，植被的生长也会更加繁茂，当地的生物多样性将会大幅改善，同时为城市居民开辟大量休憩空间。如此，城市绿地将成为能源和水资源的生产者，而非消费者。这就是我们为缓解水污染问题而创造的生命的景观。

试想一下，如果工业棕地能够通过自然过程变为绿意盎然的城市绿地，其间借鉴古老智慧构建的陂塘－堰坝系统可用于收集雨水（而非通过管道排放）、滋养植被，被污染的土壤也在这一过程中得以修复，那么我们的城市将会如何？与此同时，工业构筑物也将作为文化遗产保留在城市肌理中。由此，一种极具特色的景观应运而生，它既包含生机勃勃的乡土植被，又便于人们触摸过去的记忆。这对城市居民而言有着极大的吸引力，不仅因为它的美丽，也因为它在城市中保留了多样的野生生命气息。这就是我们在工业城市中所做的努力。

试想一下，如果我们将一些城市土地恢复为生产性景观，而不是昂贵的草坪或观赏花园，那么食物将不再需要长途运输便可轻易获得，那时，我们的城市将会如何？让水稻、向日葵和豆类在城市中生长，让太阳和月亮告诉人们播种和收获的时间，让城市居民注意到节律的变化，让年轻人了解作物生长的过程，让庄稼的美丽得到欣赏！这不仅能使我们的城市更加丰产和可持续，而且还滋养了一种新的美学和新的关于土地和食物的伦理。这就是我们在一些中国城市中所做的尝试。

通过重拾造田、灌溉、施肥、种植和收获等古老农业智慧，并将这些智慧与当代科学及艺术相结合，我们能够建立一种新型基础设施——以自然为本的、替代传统灰色基础设施的绿色基础设施——以解决当今城市环境所面临的各种问题，尤其是与水资源管理相关的问题。人类与自然的相处是一门生存的艺术，它应当成本低廉又简便易行、惬意而美好。



注释

本文根据作者在美国艺术与科学院院士大会上的特邀报告整理而成，英文原文发表于2017年《美国艺术与科学学院公报》中。

GREEN INFRASTRUCTURE THROUGH THE REVIVAL OF ANCIENT WISDOM

CHIEF EDITOR Kongjian YU

Gray infrastructures made of steel and concrete, which we built to connect our physical world, are fragile constructs that are destroying the real and deep connections between human beings and nature, and among various natural processes and flows. The alternative is green infrastructure or ecological infrastructure, the construction of which can be inspired by the ancient wisdom of peasantry. For the past twenty years, I have tried to revive such wisdoms, and combine them with modern sciences and technologies to solve some of the most vexed environmental problems in today's cities, particularly around water. The solutions are simple, inexpensive, and beautiful, and have been applied on a massive and extensive scale in over two hundred cities in China and beyond.

Gray Infrastructure and Broken Connections

Some people may think that our world, through built infrastructure, is more connected digitally and physically than ever before: we have Facebook and WeChat on the one hand, and ubiquitous highways and pipelines on the other. But actually the opposite is true. Research has proved that more than ever we are disconnected from the communities we belong to, and we have alienated ourselves from our neighbors and from those we love.

Physically, the landscapes that we inhabit are visibly interconnected: motorways connect urban and rural settlements; power lines that transport energy connect power stations to individual families; pipelines that drain waste water connect our toilets to sewage treatment plants; aqueducts that transport drinking water connect reservoirs to our kitchens; airlines that transport food connect the farm in the southern hemisphere to the refrigerators in the north; trucks that carry fertilizers and herbicides on the highways connect city factories in the east with the peasants who farm in the rice paddies in the mountainous west. We have created a connected world, but these connections are false: the landscape matrix and its invisible processes are fragmented and disconnected. The movement and cycles of water, nutrients, food, energy, species, and people are broken. The interconnected relationship between air, water, soil, nutrient, species, and people is being disturbed, and in a harmful way, more than ever before.

Let me offer an example concerning water. Over 75 percent of the surface water in China is polluted; half of China's cities are facing floods and urban inundation; and over 60 percent of China's cities do not have enough water for drinking and for other uses. The groundwater table in the North China Plain drops over one meter each year; and over 50 percent of the wetland habitats have been lost in the past fifty years. All these water-cycle related issues that impact our cities and our landscapes are actually interconnected, but the conventional infrastructural solutions designed to solve these problems are fragmented, isolated, and single-minded. We build water treatment plants to remove the nutrients that could be used in fertilizers for farming; billions of dollars are spent yearly on the construction of concrete dikes, dams, and pipes to control floods and stormwaters, but these structures eventually result in fiercer droughts, declines in groundwater levels, and habitat loss; a thousand-mile-long aqueduct built to divert water from Southern to Northern China caused serious damage to the ecosystem in the lower and middle reaches of the Yangtze River Basin; ornamental gardens and landscapes as well as agricultural fields are over-fertilized and all those nutrients flush into the water system, polluting the rivers and the lakes. And again, the conventional solution is single-minded-build expensive water treatment plants that consume huge amounts of energy (mainly from coal burning) to operate, which in turn create more air pollution and water pollution.

An alternative solution might be the construction of green infrastructure, or ecological infrastructure, which creates a deep and true connection between man and nature and among various natural processes and flows.

The Ancient Wisdom of Peasantry

The connections between peasants and their farmlands demonstrate the timeless interdependence of human culture and nature. One alternative to rebuilding deep connections between human beings and nature and among various natural processes comes from the wisdoms of peasantry, such as field-making, irrigating, fertilizing, growing, and harvesting, which have transformed landscapes on a large scale and sustained humanity for thousands of years.

One category of peasantry wisdom is the making of fields through a cut-and-fill action. The peasants' approach to cut and fill is one integrated action, meaning the earthworks created for farming happen on-site, with minimum costs for labor and minimum material transportation. It has, therefore, a minimum impact on the natural processes and patterns in the region. This tactic has been implemented by peasants in almost all parts of the world as a way to transform their otherwise unsuitable environments into productive and livable landscapes.

The second category of ancient peasantry wisdom lies in managing water and irrigating the fields. Modern methods of irrigation used in both farming and landscaping are represented by a system of pipes and pumps that is nearly invisible. It does not relate to surrounding terrain and available water resources. The peasants' approach to irrigation is deeply rooted in natural processes and patterns. Thousands of years of farming experience has made irrigation one of the most sophisticated techniques in agricultural societies. The use of gravity to irrigate the field requires precise knowledge, and the harmony between nature and subtle human intervention can turn such a serious science into an art form, an interactive medium of community building, and even a spiritual force.

The third category of peasantry wisdom is fertilizing. It is a magical component of traditional farming and a critical link, closing the circle by reusing the materials of human living. All wastes from humans and domestic animals as well as vegetative materials are recycled into fertilizers. Such a nutrient cycle is broken in our urbanized and industrialized settings. What peasants call fertilizers is today defined as "pollutants" in our lakes and rivers.

The fourth category of peasantry wisdom is growing and harvesting. Unlike planting and pruning in gardening to create a pleasant ornamental form, the peasants' approach to planting is focused on productivity. Planting begins with the sowing of seeds, and the management process follows nature's rhythm as a strategy of adaptation to the surrounding climate and conditions. Again, the self-sufficient nature of ancient agricultural economies requires each household to grow diverse crops, including grains, vegetables, and fruits, and those which could be processed into fibers, medicines, timber, fuel, and even fertilizers proportionately to families' seasonal needs, and within the limits of nature and human capabilities. The meaning of harvest goes far beyond the production of foods and products. Harvests are productive in terms of their capacity to enrich the soil, purify the water, and make the land healthy. In other words, the peasants' fields are net producers instead of net consumers of energy and resources.

This is not to say that one should give up the comfort of urbanization and go back to a peasant's primitive life. These essential features of peasantry illuminate the underlying basis for rebuilding the connections between nature and human desires and balancing natural processes and cultural intervention, and help us reclaim the harmonious relationships between human beings and nature.

Revival of the Ancient Wisdom to Create an Alternative Infrastructure

Imagine what our cities would look like if we did not drain rainwater away through pipes and pumps, but instead used the ancient wisdom of peasantry in field-making to create a green sponge in the city that retains

the rainwater, supporting diverse habitats and recharging the aquifer. In this way, the green spaces in the city become an ecological infrastructure that provides multiple ecosystem services, regulating the urban environment to be resilient to flood or drought and allowing clean water and food to be produced right in the middle of the city. Biodiversity would be enhanced dramatically; urban residents would have a green network for jogging, commuting, and relaxing; and real estate values would increase because of the beauty of, and access to, nature! That is what we have tried to do in many cities in the past twenty years: to transform the city into a sponge city.

Imagine what our cities would look like if we abandon the high and rigid concrete flood walls, and instead revive the ancient wisdom of peasantry and create vegetated terraces at the river banks that adapt to the up and down of the water flow. Eco-friendly solutions like ponds and low weirs are designed to slow down the flow of water and let nature take time to nourish itself, so that diverse habitats can be created that enrich vegetation and wild life, allowing nutrients to be absorbed by the biological processes! That is what we have done to restore rivers and lakes in many Chinese cities.

Imagine what our cities would look like if the nutrient-rich (eutrophic) river and lake water could be cleansed through the landscape as a living system, in the way that peasants have recycled organic waste, instead of using expensive sewage plants to remove the nutrients. We could produce clean water and nourish the lush vegetation. Native biodiversity could be improved. We could turn recreational spaces into urban parks and, in this way, urban green spaces could become producers instead of consumers of energy and water. That is what we have done to transform polluted water bodies into landscapes as living systems.

Imagine what our cities would look like if industrial brown fields are recovered by the processes of nature, where the ancient wisdom of the pond-and-dyke system is adapted to create a terrain that collects rainwater (instead of draining it away through pipes) and initiates the evolution of a plant community, remediating the contaminated soil during this process. At the same time, the industrial structures are preserved as sites of cultural heritage in the city. A unique landscape is created, featuring dynamic native vegetation and a touchable memory of the past, which attract urban residents for its beauty as well as the diverse wild life. This is what we have done in several industrial cities.

Imagine what our cities would look like if we turn some of the urban land back into productive landscapes instead of into expensive lawns or ornamental gardens, so that the long-distance transportation of food can be reduced. Let the rice, sunflowers, and beans be grown in the city, let the sun and moon tell the time for sowing and harvesting, let the seasonal changes be noticed by the urban residents, let the process of food growing be known to the young, and let the beauty of crops be appreciated! This will not only make our city more productive and sustainable, but nourish a new aesthetic and a new ethics of land and food. This is what we have done in some Chinese cities.

By reviving the ancient wisdoms of field making, irrigating, fertilizing, growing, and harvesting, and integrating these wisdoms with the contemporary sciences and arts, we are able to build alternative infrastructures, nature-based green infrastructures to replace the conventional gray infrastructures, to solve some of the problems in today's urban environment, particularly around water. Living with nature is inexpensive and easy, comfortable and beautiful, and is an art of survival.

Yukongjian

NOTE

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