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前瞻观点 Viewpoint

Trends in Vegetation and Water Management: the Imperative to Link Local Practices to the Regional Hydrologies of Catchments

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Water underpins the ambit of processes that deliver hugely valuable ecosystem services across the surface of the Earth. We rely on water to enable production of food，fodder and fuel，and we depend on it to sustain the functioning of our ecologies and environments.

At the soil surface there are critical water-partitioning mechanisms that are controlled by plants and vegetation. Incident rainfall，or irrigation，is partitioned either into transpiration of water by plants，or it is despatched by drainage past the roots to groundwater and surface-water reservoirs. Root water-uptake，vascular flows within plants，and stomatal control of transpiration are the critical determinants of either there is water loss to the atmosphere，or water gain by terrestrial water bodies. Our changing climate is changing these processes. However，presently，in many parts of the world，how we manage our plants and vegetation is having a much greater impact on the sustainability of our water resources，than is climate change.

Arid regions cover nearly half the globe. Water is critical in these dry zones，which house some 2.5 billion people，yet produce around 45% of the world's food. Some 70% of the world's freshwater-use is by agricultural plants. This use of irrigation and the other drawdowns on our water resources are depleting the natural capital stocks of our groundwater，lakes，and rivers. In many parts of the world，contemporary vegetation-management practices are having a greater impact on our water reserves than is climate change. We are using more water to produce today's food than is being recharged naturally，such that 15% of the today's groundwater drawdowns are coming from water reserves that will not be replenished in time for use tomorrow. Rising salinity of our water reserves through water drawdowns is degrading the utility of our remaining water stocks，and around 50% of the world's arable lands are destined to become affected by salinity through mid-century.

We are gaining economic value from today's water-use and vegetation-management practices. However，new procedures and technological innovations，whilst necessary，will certainly not be sufficient on their own to ensure that our water-use and vegetation-management practices are sustainable into the future. Simply increasing the on-farm efficiency of irrigation will not protect our water stocks. Rather we need to adopt a broader perspective that acknowledges the complexity and connectedness of the hydrological water cycle. We need better understanding of the trade-offs and impacts of water-resource policies and vegetation-management practices. This requires that we acknowledge how our water-drawdown practices con-

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sume water, either productively or non-productively, and how the return flows back to the environment might either be re-useable, or non-reusable. The scientific challenge is to generate knowledge that can 'join' all of this together across larger spatial and temporal scales: from the field, through the farm, to the catchment and beyond, and over decades.

The governance of our water resources will be critical for the global good. Half the United Nations Sustainable Development Goals (SDG) rely on the health and functioning of the global water cycle. To achieve these water-related Goals by 2030, and indeed all the others, will require coordinated and adaptive governance of our lands, vegetation, and water resources to ensure that we retain, sustain, and regenerate the healthy functioning of the world's freshwater cycles.

The knowledge and understanding generated by our current and future scientific endeavours will provide the critical underpinnings needed to realise the shared SDG blueprint of bringing 'peace and prosperity for people and the planet, now and into the future'. I'm an optimist. And my optimism is buoyed by the insightful assertion of the American novelist, Kurt Vonnegut, who said that 'science is magic that works'. Water management requires that we use this 'magic of our science' to develop new governance policies and local vegetation-management practices to ensure that we sustain regional water resources for the benefit of all into the future.

Suggested Further Reading

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植被和水管理趋势——将局域管理实践与流域水文关联的必要性(英文)

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水是地球表面支撑生态系统服务的重要基础。我们依赖水来生产粮食、饲料和燃料,同时也依赖水来维持生态和环境的正常功能。

在地表,植物和植被控制着一些关键的水分分配机制。降雨或人工灌溉的水分要么通过植物蒸腾消耗,要么渗漏到根系以下,进入地下水或地表水储存系统。植物根系的吸水、体内维管系统的液流传输以及气孔对蒸腾的调控,都是决定水分是散失到大气中,还是补充到陆地水体的重要因素。气候变化正在逐步改变这些过程。然而,在当今世界的许多地方,植被管理对水资源可持续性的影响远大于气候变化的影响。

干旱地区几乎覆盖了全球陆地面积的一半。这些地区的水资源至关重要,那里居住着近25亿人口,生产了全球约45%的粮食。世界上大约70%的淡水被用于农业植物。农业灌溉用水及其他水资源的过度提取,正在迅速耗尽我们的地下水、湖泊和河流等自然资源储备。在世界许多地方,现行的植被管理实践对水资源储备的影响已经超过了气候变化带来的影响。如今,我们为了生产粮食所消耗的水量已经超过了自然补给速度,大约15%的地下水提取量来自于短期内无法补充的水资源储备。这种过度提取导致水体盐度上升,逐渐降低了剩余水资源的可利用性。到本世纪中叶,全球约50%的耕地将受到盐渍化的威胁。

尽管当前的用水和植被管理方式为我们带来了经济收益,但新方法和技术创新虽然必要,却远远不足以确保未来的水资源利用和植被管理实践的可持续性。单纯提高农场灌溉效率,并不能真正保护我们的水资源储备。相反,我们需要从更广阔的视角出发,认识水文循环的复杂性及其连通性。我们需要更深入地了解水资源政策和植被管理实践之间的权衡和影响。这要求我们理解既往的用水行为是如何消耗水资源的,无论是生产性的还是非生产性的,以及回流到环境中的水是否可以再利用。我们面对的一个科学挑战是产生跨越更大空间和时间尺度且将这些方面结合在一起的新认知:从田间到农场,再到整个流域乃至更广范围,并覆盖数十年的时间。

水资源的治理对全球利益至关重要。联合国可持续发展目标(SDG)中有一半要依赖于全球水循环的健康与功能性。要在2030年实现这些与水相关的目标,以及其他所有目标,需要对土地、植被和水资源实施协调且适应性的治理,以确保全球淡水循环的健康性、可持续性和再生能力。

我们当前和未来的科学研究将提供关键知识和理解,支撑“为现在与未来的人类和地球带来和平与繁荣”的可持续发展目标蓝图的实现。我对此充满信心。美国小说家库尔特·冯内古特(Kurt Vonnegut)曾深刻的说过:“科学是有效的魔法”。水资源管理要求我们利用这种“科学的魔法”来制定新的治理政策和地方植被管理实践,以确保未来区域水资源的可持续利用,造福所有人。