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In dialogue with, within, and beyond depletion

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This dialogue brings together geomorphologist David R. Montgomery and landscape architect Seth Denizen to explore ideas of depletion in soil and deltaic landscapes. Moderated by Laura Thomas, the conversation considers depletion both as a physical condition at different scales and as a situated judgment.

Across deltas, megacities, and agricultural hinterlands, the participants discuss soil as both an ecological foundation and a site where social relations are produced. Both speakers highlight how soils are shaped by complex social and material processes that actively contribute to their formation. They raise caution that reducing all questions of soil health to a single number is reductive, and that the way scientific problems around soil health are framed can obscure the bigger picture. Moments of synthesis, they suggest, require interdisciplinary collaboration to connect political ideas to their ecological foundations.

The dialogue also emphasizes that urban soils are not isolated but connected to rural hinterlands. Linking urban planning, soil science, and health, they argue, could help reduce conflicts over scarce resources and support urban adaptation.

In closing, the conversation turns to regenerative futures. If depletion signals systems pushed beyond their limits, what possibilities emerge when it is treated as a starting point? The speakers reflect that rethinking our relationship with soils involves paying close attention to the processes that brought us here: processes that are deeply political and can only be addressed through conversation and collective action.

DAVID R. MONTGOMERY

David R. Montgomery is a MacArthur Fellow and professor of geomorphology at the University of Washington where he studies landscape evolution and the effects of geological processes on ecological systems and human societies. He has investigated geological controls on the height of mountain ranges, how forestry practices affect landsliding on steep slopes, and how farming practices that degrade soils limit the longevity of human civilizations. His award-winning popular-science books include Dirt: The Erosion of Civilizations, The Hidden Half of Nature, Growing a Revolution, and most recently What Your Food Ate: How to Heal Our Land and Reclaim Our Health. Combining ancient wisdom with modern science, his books show how regenerative practices are good for farmers, consumers, and the environment.

SETH DENIZEN

Seth Denizen is a researcher and design practitioner trained in human geography, evolutionary biology, and landscape architecture. He holds a PhD in geography from the University of California, Berkeley, and has taught at the University of Hong Kong, Harvard University, and Princeton University, where he was a Princeton-Mellon Fellow in Architecture, Urbanism, and the Humanities. He is a recipient of the 2019 SOM Foundation Research Prize. Currently, he is an assistant professor of landscape architecture in the Sam Fox School of Design at Washington University in St. Louis.

LAURA THOMAS

Laura Thomas is a PhD candidate at TU Delft, specializing in soil-inclusive spatial planning and design as part of the European Horizon project Spatial Planning and Design with Soils (SPADES). Her research focuses on integrating alternative soil knowledges into spatial planning and design practices. Prior to returning to academia, she worked as an urbanist at PosadMaxwan, a firm for urban design and strategy in The Hague, where she investigated how soil considerations can inform urban projects. Laura is particularly interested in bridging theoretical frameworks with practical applications, developing approaches that recognize the agency of environmental systems within social and spatial contexts.

PART I — DEFINING DEPLETION

Laura Thomas: *To begin, how do you each understand depletion, and how does it appear in your work?*

David R. Montgomery: I tend to think of degradation more than depletion when it comes to soils. There are two major ways soils get degraded over time. Both could be seen as forms of depletion, but depletion as most people understand it is only a part of the story. The first is degradation of the soil itself: its erosion and loss. The second aspect is the loss of soil properties, such as organic matter or the structure of the soil microbial community. These changes degrade the soil's ability to support ecological functions and are much more important than I was taught in graduate school. So, in my understanding, soil degradation can be thought of in two ways: the physical loss of soil, and the degradation of its properties. The emerging concept of soil health helps us think about the latter.

Seth Denizen: I think what David is saying is really important. Understanding soil degradation versus depletion is crucial for grasping how soil actually performs the functions we want it to, and what destroys its capacity to do so. I would add that depletion isn't universal: it is a human value applied to soil. Soil knowledge exists at the intersection of human, political, cultural, and ecological goals: the ways we measure and understand soil are shaped by those goals - or "soil-based desires" as I call them. If we care about human thriving, we need to understand the soils and chemistries that support it—and call soils that fail to support it "depleted." But it's important to recognize these values aren't universal: some species flourish in depleted soils, even if they aren't useful for human purposes.

When Europeans went to the tropics, they often saw soils as "depleted" because these soils functioned in ways that European soil scientists, trained in temperate climates, weren't equipped to understand. There are many other examples of this—when concepts of "good soil" travel across climates and geographies, those values don't always translate.

David R. Montgomery: That's a huge point. The export of European agricultural techniques—systematized in the 17th to 19th centuries—to tropical regions, was disastrous for agricultural production. It highlights how crucial it is to understand how soils function differently across climates.

PART II — THE MAKING AND UNMAKING OF DELTAS

Laura Thomas: *So, depletion, understood more broadly, is both a physical condition at different scales and a situated judgment. Building on the importance of context-specific understandings, let's turn our attention to deltas. What can you tell us about these particular landscapes?*

David R. Montgomery: Deltas are a special case because of their physical geography and human adaptations. Large-scale agriculture emerged in deltas once the sea level stabilized about 6,000 years ago. Before that, deltas hadn't formed, and only with stable sea levels could sediment accumulate at the mouths of rivers like the Nile or the Tigris and Euphrates, creating environments ideally suited for agriculture.

What sets deltas apart is their relative resilience to physical agricultural disturbance. Geologically, upland areas erode down to sea level, while deltaic areas build up as sediment is deposited. This natural replenishment of mineral matter makes deltas robust against tillage, unlike upland soils, which are much more vulnerable to erosion. Chemical disturbances, such as those from agrochemicals, are another matter, but physically, deltas are remarkably resilient.

This has important implications for the history of societies and the application of agricultural techniques. Just as Seth pointed out differences between temperate and tropical soils, we also need to consider the landform and landscape context. Principles of soil depletion, degradation, or regeneration are useful, but they must be applied with knowledge of both the physical and social context—how the land is formed, how it functions, and what farmers want from it. Deltas require a distinct approach because of these unique spatial and social characteristics.

Seth Denizen: Well, David, what you said about a world without deltas is beautiful—I'd never thought about that. I think the *Journal of Delta Urbanism* should explore that world.

I don't have much to add, because that was such a great answer, but one point I want to underline is how our resistance to flooding shapes our approach to land. Flooding has long been seen as inconvenient, a threat to property values, and an obstacle to forms of capital accumulation, since shifting land interrupts property boundaries. Historically, this posed real problems for expanding empires, colonial projects, and modernity as it spread into new territories.

What's striking is how hard it has been to recognize that flooding is fundamentally soil-building, not antithetical to agriculture. We are still grappling with what we've sacrificed by canalizing rivers and interrupting these natural soil-building processes. Much of the land once nourished by deltas is no longer replenished naturally. When farmers face soil challenges in these areas, the solutions offered—fertilizers, machines, technologies—rarely address the root problem: we've foreclosed the possibility of rivers rebuilding our soils.

PART III — SOIL & SOCIETY

Laura Thomas: *So in deltas, depletion is as much about the rules and assumptions we impose as it is about the soil itself—about how we define "good soil", and which natural processes we choose to permit or suppress, as our discussion about flooding made clear. Building on this, I'd like to take a step back and ask a broader question about soil's role in shaping society. Could you expand on how that relationship appears in your work?*

Seth Denizen: In my most recent project, *Thinking Through Soil*, I examine soil-society relationships in Central Mexico, just outside Mexico City, focusing on a wastewater irrigation system that serves roughly twenty-two million people. Here, I trace every social and material process that contributes to soil formation. This requires grappling with the full complexity of a contemporary megacity's urban metabolism: pharmaceuticals, antibiotics, plastics, light industry, global supply chains—all of which cycle through the city and end up in the soil.

By thinking of soil not as a passive container but as a site where social relations are produced, we can ask what kinds of social relations we want to encourage. Decisions about how we live, the economies we participate in, even beauty standards, directly shape soils and the food we grow from them.

The problem is that most people simplify soil as "good" or "bad." In reality, the soils we produce today are far more complex. To truly unravel these relationships, we need interdisciplinary collaboration between soil scientists, geomorphologists, environmental chemists, and others to explore how soil chemistry, social practices, and political futures intersect.

David R. Montgomery: That's a very interesting take, Seth. I tend to think about how soil shapes societies through two complementary lenses. The first is the "zoomed-in" perspective, which Seth was just describing: tracing the processes and mechanics of how human activities affect soil, and in turn, how those changes feed back to shape us individually and collectively.

The second is a broader, 40,000-foot view, which comes from my geological perspective. I see soils as foundational to society—literally what our societies rest upon. The relationship between human societies and soils can be ecological and mutually beneficial, or one-sided and exploitative. The big challenge is determining which side of that spectrum we want to occupy. Right now, our cities largely parasitize the countryside. Nutrients derived from soils are exported to urban areas, while waste, fossil fuels, and other forms of pollution degrade soils—through erosion, contamination, or removal of organic matter. This is far from a commensal relationship.

But there's no reason we couldn't rethink our relationship with soils. By reframing what we want from them and how we manage agricultural and urban systems, we could design ways to return materials to the soil and restore fertility. Farms may never be "natural," but we can treat soils as ecosystems we are connected to—ecological partners on which society depends.

PART IV — THE POLITICS OF METRICS

Laura Thomas: *So, just as social processes contribute to soil formation, we also have the capacity to reshape these relationships. In some ways this is already underway, with the importance of soil increasingly recognized in policy environments. Yet a challenge remains, and I'd like to ask you both to reflect on it. Policy often demands simplification, yet soil is inherently complex and context-dependent. How do we balance the need for clear metrics or scientific abstraction with the reality that soil systems can't always be reduced to simple categories?*

Seth Denizen: Well, I think there's always a tension between the need for synthesis and the need for specificity. And that tension exists even within the production of scientific knowledge itself. It's not just that we have to simplify things for politicians so they can understand; moments of synthesis occur all throughout the chain of knowledge production, even in generating empirical data.

What matters, I think, is being able to articulate clearly the relationship between the political futures we want and their ecological basis. And we're very bad at that. Right now we're in a moment of global paralysis because the form of life and the economic foundations we rely on turn out to rest on an ecological basis that's unsustainable, which means we need to change the way we live, and that is profoundly inconvenient.

So at every stage of producing scientific knowledge, one thing I'd ask for is that scientists take a more active role in connecting specific political ideas to their ecological foundations in ways that are concrete and understandable. Without making these connections, we forget that many political ideas quietly depend on ecological functions like, for example, the way soil is essential for cleaning the water we drink from the tap.

In the 20th century it was possible to ignore these connections because, for the most part, things kept functioning. But in the 21st century we can't assume that. Bringing the dependence of political ideas on functioning ecological processes to light, and recognizing our role in supporting them, is, I believe, the fundamental shift required for the 21st century.

David R. Montgomery: Absolutely. As a society, we approach this backwards. Our agricultural subsidies aren't designed to enhance ecological functionality or maintain our long-term ability to produce food; they're designed to produce a lot of cheap food fast. And that brings downstream ecological impacts we're essentially handing off to future generations.

What's missing is a kind of guiding philosophy for soils. If agriculture were guided by building soil health while

maintaining intensive production, everything would shift. Modern conventional agriculture clearly degrades soil health, however we define it. Soils rich in organic matter and microbial diversity tend to be healthier than soils depleted of both. That simple framing would reshape what we consider good or bad farming practice.

Seth Denizen: Laura, I want to tease something else out here because I see something in your question that might help us get to the heart of what you're asking. And it's something I want to ask David about.

Right now, in Europe, there's an initiative to start paying farmers to increase the amount of organic matter in their soils. This is, in a sense, one of those moments of simplification you were talking about. We've managed to teach politicians something—that organic matter is important. And then they say, "OK, fine, I'll create a subsidy, and you'll get more money the more organic matter your soil contains."

Some soil scientists are actually quite critical of this policy, arguing that raising soil organic matter past a certain point can become antithetical to certain regenerative agricultural practices. Instead they propose that if farmers simply engaged in regenerative practices, we would produce far fewer carbon emissions—because we'd spend less energy moving food around the world—and more food could be grown locally. The soils themselves would become more productive, and there are all kinds of additional benefits.

And so, they feel that reducing all questions of soil health to one number—the percentage of organic matter in the soil—is reductive and doesn't really capture the complexity of soil health that David was describing. So I'd love to hear your opinion, David: what do you think about a policy that pays farmers to increase soil organic matter on their farms?

David R. Montgomery: That's a great question. It's a complicated question, and yet it's very pertinent to policy choices going forward. There are many different ways to build organic matter. Addressing what practices are used to build organic matter seems to be (to me) the central missing point in most accounting systems that simply want to pay farmers for carbon in the ground. How it's done matters.

A major problem with paying farmers to increase soil carbon is the accounting. How would you measure carbon on every square meter of every farm in Europe to determine who gets paid for what? That's an unmanageable system. What I favor is paying farmers to put carbon in the ground, but not by monitoring every square inch. Instead, use demonstration farms to experiment with regenerative techniques and determine, for different cropping systems and regions, how much carbon can reasonably be expected to accumulate over time. Then subsidize farmers to adopt those practices and do some monitoring to ensure compliance. It's far easier to monitor behavior than to track carbon, which varies seasonally and annually.

I've never seen a regenerative farm build organic matter so high, through good practices, that it compromised soil health or production. That risk is more likely when overapplying compost, sewage sludge, or other inputs. I'm not especially worried about an upper limit to applying organic matter. I'm more concerned about the methods people use, the sources of organic matter, and how they're applied. None of that is captured in simple carbon accounting. But the general goal of putting more carbon into agricultural soils is extremely worthwhile.

Seth Denizen: I find the whole carbon debate really fascinating. On the one hand, I associate this kind of fixation on carbon with a really healthy turn toward a better metric than we've been using. Maybe even a turn toward our first genuine care for soil instead of just thinking about yields. But on the other hand, I wonder what we would sacrifice or lose sight of if we became laser-focused on organic matter.

David R. Montgomery: I agree, most studies on soil organic matter and farming practices focus on just one element, whether no-till, cover crops, crop rotations, or crop diversity. What I learned from talking to farmers around the world for Growing a Revolution is that successful regenerative farmers don't just practice one of these—they combine all of them. When I went back to the scientific literature to see how many studies examined that combination over time, I found almost nothing. Most research breaks the system into pieces, studying individual practices rather than the integrated, interrelated system that actually drives soil health. This shows that the way we frame scientific problems can sometimes blind us to the bigger picture.

PART V — DESIGN AND ENVIRONMENTAL IMAGINARIES

Laura Thomas: *So we've seen that scientific frameworks guide what we pay attention to. I'd like to argue that, in much the same way, cultural frameworks shape how we imagine landscapes. Let me give you an example: in the Dutch Green Heart, we celebrate open grasslands with grazing cattle—even though maintaining these drained polder landscapes contributes to subsidence and peat oxidation. Proposals to rewet the land to address climate change or infrastructural damage often clash with our ideas of how the landscape 'should' look, and alternatives like reforestation or different crops are frequently dismissed. Could you reflect on this? How do assumptions about landscape aesthetics shape soil and water, and what planning practices might help us adapt?*

Seth Denizen: Well, the first thing I want to say is that a lot of what I think about studying Mexico in a colonial context reflects what happens when one environmental imaginary is imposed on a landscape that can't sustain it. For example, 17th-century Europeans encountered wetlands and lakes in Mexico, and their idea of "improving" that land had disastrous consequences.

This connects to your question: how could we do things differently today? Soil is fascinating because it's a kind of "back-to-the-future" domain. Ancient agricultural techniques we once discarded are being rediscovered for their wisdom. But our contemporary environmental problems are very different, so we also need new technologies, soil chemistry, and planting strategies.

In places like the Netherlands, the pastures with cows may be inadequate for the current environmental moment. That raises the question: how do we invent soil practices that respond to today's challenges while achieving the soil-based desires we have?

I once spoke with a soil scientist in South China whose department was in the same building as the urban planning department at Sun Yat-sen University. It made me think: what if urban planning and soil science were inherently connected, because you can't plan a city without understanding soil. Urban planning is ultimately about how matter and energy flow through a city, and everything—extraction, waste, refuse—returns to the soil. Urban planning and soil science are inseparable, and imagining them as fully integrated could shape a future of more resilient landscapes.

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David R. Montgomery: That reminds me of a vision Lady Eve Balfour put forward in the 1940s, about having soil scientists stationed in hospitals to link public health and soil science. I'd love to see public health, urban planning, and soil science at least talking to each other, if not in the same building, because there's so much progress to be made through better communication between these fields. I like your "Back to the Future" analogy, Seth. My work has tried to couple ancient wisdom with modern farming. The challenge is designing systems that merge ancient wisdom—diversity, cover crops, polycultures—with modern tools.

Laura Thomas: *So we don't necessarily need new practices, but we need to apply what we know in new ways?*

Seth Denizen: Exactly. The "Back to the Future" idea is that we can't farm exactly as we used to, because the world has changed. But we can apply those same principles in new ways.

Laura Thomas: *How about engaging with soil in cities or peri-urban areas? Are we equipped to improve urban soil conditions with our current principles?*

David R. Montgomery: Well, to start with, I think urban soils aren't being treated as soils at all—they're often just seen as "sub-pavement." Take street trees: planted in small soil boxes. I've seen cases where the city decided to pave over the soil around them. The trees drop leaves every year to refresh the soil, and now that process is being blocked. We are basically starving them. Why would we design urban landscapes this way?

Seth Denizen: I agree, urban soils are an untapped form of infrastructure for resilience: they can help absorb peak stormwater during intense rainfall events and store water to sustain trees and vegetation, which provide shade and reduce heat stress. Our cities were designed with 20th-century weather in mind, and current infrastructure is ill-equipped for 21st-century climate extremes. Soil could offer a flexible, low-impact way to adapt.

Thinking Through Soil is largely about this question, even though it focuses on the connection between urban and rural environments because urban soils aren't isolated—they're connected to rural agricultural hinterlands. In arid regions, cities often compete with rural areas for freshwater. One potential solution is wastewater agriculture: if urban wastewater is clean enough to avoid contaminating fields, it can be reused for irrigation. This approach gives a "two-for-one" benefit: it reduces urban health risks by limiting contamination and supports agriculture by providing a reliable water source.

Addressing urban soil and water management isn't just about local resiliency—it's also about reducing conflicts over scarce resources and creating systems that work for both cities and surrounding rural areas.

PART VI — TOWARDS REGENERATION?

Laura Thomas: *Listening to both of you, I can't help noticing a shared thread: the sense that depletion arises when systems, landscapes, and even people are driven beyond their limits. So if we take that sense of depletion as a starting point, what possibilities does it open up for imagining regenerative futures?*

Seth Denizen: This question, in a sense, invites us to summarize much of what we've been discussing. One of the key connections we're exploring is between human health, ecological health, and the ways in which we produce food—they are all deeply interconnected. How we grow food affects not only our nutrition, but also the cleanliness of our environments and the trajectory of global warming.

The first step toward reversing depletion is to pay close attention to the processes that brought us here. Only by understanding these processes can we begin to imagine alternatives. And because these processes are deeply political, changing them requires conversation and collective action.

It is as dangerous to depoliticize the technical and scientific work of soil as it is to imagine a political future in which soil knowledge plays no role. Ultimately, what we are doing in this conversation is tracing the political consequences of scientific ideas. That is precisely the process required to envision and enact a future in a world currently defined by depletion.

David R. Montgomery: To add to that, I think that we already understand many of the processes that have led us to this point. There are principles for regenerating soil fertility, but applying them in practice—socially, politically, and economically—is the real challenge. It's urgent that we succeed, because there is no Plan B. We've already degraded roughly a third of the planet's arable land. Reversing that trend through regenerative practices is not just a possibility—it's a necessity.

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