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Introduction

CLIMATE CHANGE AND CHANGING CLIMATES

IN EARLY JULY 1850 the German Sahara explorer Heinrich Barth undertook the arduous task of scaling the southern high plateau of the Libyan Desert. The expedition party had just finished pitching their tents in a particularly dry and barren camping spot when the North African guides pointed out a number of rock engravings to their European travel companions. Barth was exhilarated. On the spot, he drew the images portraying cows, gazelles, and hunting scenes and asked his guides to show him more of the artifacts. Barth also described the engravings in his travel journal, remarking on their possible provenance and their ethnographic and historical significance.[1]

The disconnect between the bodily experience of an arid, denuded desert and the evidence of past human habitation inspired Barth to spend a few lines on the images as "evidence of entirely different living conditions than we are currently observing in these lands." He wrote this without any indication of surprise at the drastic environmental and climatic changes he alluded to. The idea was not new, after all. Offering easily available sources on environmental conditions from antiquity to the present day, North Africa and the Mediterranean region had long been among the preferred sites for Europeans pondering potential climatic shifts. Had Barth still been alive by the last third of the nineteenth century, he might nevertheless have been surprised to witness the fate of his own brief reflections on the subject: his sketches of the Libyan engravings and his cursory notes about "different living conditions" in North Africa's past would become essential material for climatologists engaged in an extended debate on large-scale desiccation. And Barth would surely have been even more surprised had he been able to observe the growing interest not only in continent-wide or even global climate changes but also in large projects to actively modify climates or—closer to the words of the engineers involved in these projects—to make the desert bloom again.[2]

I recount this history, tracing the upsurge of climatic anxieties among French and German colonial practitioners, before examining how some planners

responded to these worries by proposing large engineering projects to counteract the perceived environmental decline. Europeans already had a long tradition of thinking about the effects of climates on both humans and their surroundings. From the late nineteenth century onward, however, they dramatically upscaled their climatic vision in two ways. First, practitioners now contemplated climatic changes affecting not just particular places and regions, but whole continents or even the entire planet; and second, engineers and planners used these ideas to design and justify large-scale, if ultimately unrealized, projects that would use the full force of industrial technology to halt or even reverse not only climatic but also societal and cultural decline. But what inspired Europeans to start thinking about extensive climatic shifts that could turn lush, forested environments into vast deserts? How, when, and where did engineers find inspiration in these theories to devise colonial engineering projects that attempted to transform those deserts back into forests? And how did the theories about both climate change and changing climates become embroiled in the political geography and the philosophies of cultural pessimism of the first half of the twentieth century?

In answering these questions, the book spans a wide arc, from the budding interest in large-scale climatic changes around the middle of the nineteenth century to Nazi plans to transform the climates and environments of war-occupied areas in the East. Connecting these chronologically and geographically distant places was the desert that Heinrich Barth had traversed in the 1850s. Whether conceptualized as a colonial repository for data, as a blank canvas for ambitious hydro-engineers, or as a symbol of environmental decline and desolation, the Sahara remained central to European, and particularly French and German, climatological concerns and designs throughout the period. First explorers and then climatologists theorized about its past and considered the possibility of widespread environmental and climatic changes that had shaped the history of landscapes and human habitation. The desert and its mutable ecology also inspired colonial officials and engineers to envision projects for an all-encompassing environmental and climatic transformation of the region or even the entire continent of Africa. Simultaneously, then, the Sahara was both a daunting representation of the awesome power of nature over humans and a surface on which to project designs that would reveal the newfound power of humans over nature in the era of industrial technology.[3]

Changing Climates

In the second half of the nineteenth century, popular science publications and magazines treated their readers to a continuous stream of reports by European travelers. These accounts told heroic stories about the adventurous feats of

white men, but usually also provided some information on the inhabitants and environmental conditions of faraway places. Reports about Sahara travels habitually closed with references to a once lush landscape that had turned into a barren wasteland through desertification processes that were possibly still at work. The theory and apprehensions that formerly fertile or habitable land could have transformed into desert was not only a standard ingredient of European exploration stories but closely linked to the scholarly study of climates. As an independent academic discipline, climatology was still a field in the making but had already reached a sizeable audience and achieved a sturdy academic infrastructure. With a motley crew of practitioners from various related fields, climatology also featured a diverse set of approaches and methodologies, borrowing from geology, physics, and chemistry. More often than not, however, nineteenth-century climatic researchers relied on historic and geographic data to make inferences about climatic phenomena. While the methods they used were clearly different from the model-driven and computer-based climate science of today, one of the most important objects of investigation—climatic variation in the past, present, and future—was the same.

Western ideas about the variability of climates in the nineteenth century grew out of the confluence of new theories about the earth's geological past, imperialist expansion around the globe, desert exploration in North Africa, and the rise of geography and geology as established academic disciplines. Together, these developments prepared the ground for a lively scholarly discussion about the existence and possible causes of large, sometimes even global, climatic shifts in the past and present. The theories were as diverse as the evidence used to support them: from progressive warming to cooling, and from stable climates to short-term climatic oscillations. Eduard Brückner, one of the leading climatologists of the late nineteenth century, likened an overview of the competing theories to "walking through a veritable labyrinth without the benefit of Ariadne's thread." In the early twentieth century, the labyrinth was still just as difficult to navigate: the field remained without the stable framework of a generally accepted causal explanation that could have convinced a majority of the practitioners to adopt one among the many competing hypotheses. This did not mean, however, that large-scale climate change languished in the back pages of barely read journals. The debate elicited ideas and terminology that had already left the confines of academia and started to inspire public concerns over the possibility of environmental decline or even future climatic catastrophes that could destabilize colonial and even metropolitan economies and polities. Magazines published hyperbolic warnings of impending climatic doom, science fiction writers used climate change as both a setting and a plot device, philosophers ruminated on the connections between

environmental and civilizational decline, and planners sketched afforestation schemes to counteract a looming environmental catastrophe.[4]

The emergence of ambitious engineering plans to counteract desiccation and desertification, whether regarded as man-made or "naturally" occurring, was one of the most striking manifestations of these growing climate anxieties. From the middle of the nineteenth century, some explorers, engineers, and colonial officials in arid parts of the world developed projects that would use the might of industrial technology to transform desert environments into fertile landscapes with climates fit for European settlement and agriculture. In the following chapters, I examine the designs proposed by three individuals and the implications of their projects: the French colonial engineer François Roudaire, who developed a plan in the 1870s to create large water surfaces in the Sahara to change climates; the pan-Europeanist architect Herman Sörgel, who proposed to completely reconfigure the Mediterranean to expand European climates, settlements, and culture to North Africa in the 1920s; and the German landscape architect Heinrich Wiepking-Jürgensmann, who pushed for his ideas of counteracting desertification through large-scale planning to be included in the official plans to Germanize the Nazi-occupied eastern territories during the Second World War.

Reflecting and refracting the debates on extensive climate change, the climate-engineering designs exhibited a deep environmental and cultural pessimism paired with a similarly powerful technological optimism, mixing narratives of crisis with those of redemption. Deserts—both as a powerful threat to be contained and as an inviting playground for the modern engineer's ambition—became coveted environments for climate modification projects. As different as the projects and their contexts were, their creators used and developed a common vocabulary forged in the climate change debate of the late nineteenth century, focusing on the Sahara as the quintessential desert in the European imagination. They also shared a deep techno-colonial impetus, promoting the use of modern industrial machines and tools to create productive landscapes for the benefit and habitation of non-indigenous populations, be they French, British, pan-European, or Germanic. To varying degrees, the schemes to convert desert environments became projects of social engineering. For the planners and their supporters, anxiety over encroaching deserts was always laden with cultural significance: environmental and climatic decline came to signify societal decline and vice versa. This added even more urgency to the fight against the purportedly encroaching deserts, but it also meant that engineering an amelioration of nature could potentially lead to an enhancement of culture or civilization in return—or at least to what the planners considered an enhancement.[5]

Colonial Science, Global Science, Desert Science

Both the climate engineering projects and the climate theories behind them were deeply embedded in colonial structures: explorers were on the payrolls of colonial offices, scientists used colonial infrastructure to conduct their research, and the engineers and planners of large-scale projects either worked directly for colonial governments or sought their favor and support. As Europeans occupied other lands during the age of High Imperialism in the last third of the nineteenth century, colonial officials paid greater attention to climatic conditions and, especially, to potential climatic changes in non-European environments. The possibility of climatic instability added to the sense of "unreadability" of little-known and environmentally alien overseas landscapes. Colonial planners also claimed climatic instability as a means to legitimize their colonial occupation and control, which involved deploying not only colonial agents but also colonial and colonizing science and technology.[6]

In many ways, this dynamic continued earlier colonial discourses and efforts to make colonial climates more agreeable and healthier for white settlers and administrators. At the same time, however, the nineteenth-century climate projects and theories were also part of the emergence of global science, a developing trend especially in geographical and geological disciplines, which built upon the collection and exchange of data from around the colonial world of the nineteenth and early twentieth centuries. In fact, the colonial and the global went hand in hand. Over the second half of the twentieth century, the data gathered by colonial governments and agents over decades gave modern climate scientists material to develop intricate numerical models of worldwide weather and climate forecasting. Today, climate science has become the most global science—or at least the most visible branch of global science—dealing with arguably the most far-reaching issue of all: anthropogenic global warming. But long before the last third of the twentieth century, climatology and climate anxieties had already scaled up to the global, with some European practitioners pondering and fearing the existence of environmental processes that affected the entire earth.[7]

Hypotheses about extensive climatic variability were part of public discourse long before the late nineteenth century—from Comte de Buffon's musings on climate amelioration in North America to Alexander von Humboldt's ideas about large-scale desiccation in South America. And yet scientists in the early nineteenth century still largely conceptualized climate as an essentially stable environmental feature that human action could only alter to a modest extent. This, however, was not to last. The gradual acceptance of the ice age theory around the middle of the nineteenth century opened the way to a reconceptualization of climate as a powerful and dynamic force shaped by and

actively shaping environments from the poles to the equator. If, as proponents of the theory argued, the world had experienced substantial or even full glaciations in the past, what spoke against large climatic shifts in the more recent past, the present, and the future of the earth? Some climatologists, among them those working on extra-European, colonial environments, started to argue that the local or regional climatic changes they had described could be understood as part of much larger processes that spanned the entire globe. The exchange of climate data that took off in international conferences and journals in the second half of the nineteenth century aided the development of these large-scale theories of climate.[8]

Based on the musings about large-scale climatic phenomena, climatologists began to develop something resembling a global view of the environment, or what Mary Louise Pratt has called a "planetary consciousness." Theories about climate change—both anthropogenic and natural—played a central role in this development, as scientific practitioners increasingly portrayed environments as connected, inherently instable, and potentially malleable. Not just the Darwinian theory of evolution but also ideas and hypotheses of climatic variability and change made the nineteenth-century world and its environments appear increasingly variable or even unstable. In a recent study, Deborah Coen has traced the development toward a dynamic and multiscalar climate science in Central Europe over the last decades of the long nineteenth century, in which the varied environments of the Habsburg Empire provided the sites for research, data collection, and methodological innovation.[9]

The provinces of Austria-Hungary were certainly not the only colonial sites of climatological development. Some European practitioners interested in issues of climatic variability looked beyond their own continent and chose deserts as their primary field of research. With cave paintings, dry riverbeds, abandoned cities, and exposed geological features, arid landscapes provided an abundant source of evidence for long-term climatic changes. As powerful representations of danger, adventure, and desolation, deserts also played an important role in disseminating and popularizing ideas about environmental change and catastrophe. In the late nineteenth century, many of the deserts that climatologists studied, from Central Asia to Africa and South America, were either colonial or barely postcolonial environments and frequently represented territories that central governments situated in less arid places had claimed but not fully controlled.[10]

The colonial encounter with deserts was never a one-way street: as Europeans colonized desert environments, deserts also began to colonize European thought. This is visible not only in European ideas about and fears of deserts expanding but also in the work of early climate engineers, who often looked to create new Gardens of Eden in the arid zones of the world. They did not

attempt to directly engineer the atmosphere, as some of today's geoengineers envision. Some early climate engineers nevertheless aimed to transform environments and climates beyond the local scale, designing lesser-known and unrealized, but certainly noteworthy, projects in colonial regions to halt the feared expansion of desert climates. These technological attempts to change environments and climates are a prime example of the early entanglement of climate science and colonial politics, representing the techno-political dimension of climate change ideas. While European practitioners often conceptualized deserts as empty spaces, climatological theories were never separate from the colonial contexts of their production. Rather, climate scientists took part in political debates and contributed to the search for solutions to perceived climatic and environmental issues in colonized spaces. Whether as proponents or critics of climate engineering, they frequently considered the possibility of continent-wide or even global climatic effects of human interventions. And climate scientists—along with climate engineers—theorized the effects of both natural and man-made climate changes on the social, economic, and cultural trajectories of both colonized and colonizing societies.[11]

Correcting Nature and Society

Climate engineering was not a new idea in the nineteenth century, and to many contemporary observers the concept did not seem out of the ordinary. After all, ideas about climatic instability were widespread among colonial planners and scientists. And if climates were indeed inherently unstable, the mental leap to attempting to change them intentionally was not that great—particularly with the tools of industrial technology and colonized deserts as testing grounds at the disposal of colonial engineers. Planners who proposed ambitious climate engineering projects in the nineteenth century were thus responding to mounting anxieties over environmental and climatic decline and expressing a growing belief in the possibilities of modern technology to reorder environments as well as societies. The scope of technological possibilities and the related scale of engineering projects reached new heights and new spheres of activity in the late nineteenth century. The German geographer Emil Deckert expressed the self-assurance of the age when he commented on a French climate-engineering project in the Sahara: "The unbound action of humankind [will] correct a number of critical mistakes of nature." And, as he added rhetorically, "to whom should this thought not appear beautiful and—if indeed feasible—tempting?"[12]

Deckert's words from 1884 seem to prefigure what is generally believed to be a recent phenomenon: the close link between climate change and macrotechnology, which is exemplified by current geoengineering projects to halt

and reverse anthropogenic global warming. As Deckert's comment reveals—and as I show in the following chapters—climate and macro-technology have actually had a long-lasting relationship, reaching back deep into the nineteenth century. In fact, climate engineering had already seemed tempting in the eighteenth century, when the Comte de Buffon declared that mankind would be able to "alter the influence of its own climate, thus setting the temperature that suits it best." In the nineteenth century this dream seemed to move into the realm of feasibility: steam-powered machines and both metropolitan and colonial labor reserves provided new potential energy for large projects, while the planetary perspective of environmental interconnectedness provided a new scale for Western engineering ambitions.[13]

Deckert's comment is also noteworthy for its description of environmental transformation. Rather than positing a contentious relationship between engineering and nature, Deckert, along with many of his contemporaries, emphasized the use of technology to "correct," or readjust, nature.[14] Once again, engineering as a means to restore natural perfection and harmony was not a new idea: earlier colonial climate improvement projects had often followed a similar logic, attempting to restore local climates to an allegedly prior and more perfect state. It is remarkable, however, that planners and commentators in the late nineteenth and early twentieth centuries tended to frame even revolutionary projects aiming to create new climates, change geographies, and connect continents as conventional and, for lack of a better term, "natural." Engineers planning far-reaching interventions into environments and climates tended to express their own role as that of a repairman tackling natural flaws resulting from geological, cosmic, or anthropogenic processes. In the plans of the early "geoengineers," nature and technology did not stand in opposition; nor did they even belong to different conceptual frameworks. Climate engineers from the late nineteenth century to the first half of the twentieth often saw the large-scale use of technology merely as a tool to perform a kind of maintenance of nature, mirroring the effects of physical forces such as tides, streams, winds, erosion, and climatic changes.[15]

While proposing some of the most extreme uses of industrial technology in their time, early climate engineers also tended to not distinguish between the "natural" and the "social" spheres, a separation that has had a firm grip on some of the most durable conceptions of modernity and the technical imagination in the twentieth century. The separation was never complete and has been questioned by both sociologists and historians. Nineteenth-century ideas about climate change and climate engineering represent another powerful empirical argument against the overdrawn contrast between a stable "natural" and a dynamic "social" sphere. In fact, in the following chapters I suggest that nature was at times brought more and more into the social sphere *through*

technology: after all, climate engineering proposed to offer mechanisms to steer and control climates similar to economic, political, and cultural parameters. François Roudaire, the engineer behind the Sahara Sea project, represents a striking example of the desire to revitalize and control nature as part of the French colonial project in North Africa.[16]

Conversely, climate engineers also voiced their hope that changing climates would engender social and cultural transformations. This was particularly visible in the first half of the twentieth century, when neo-Malthusian anxieties about the intrinsic limits to food production and widespread notions of civilizational decline combined with the fears of climatic change and desertification. Herman Sörgel's pan-European Atlantropa project, which aimed to transform European civilization alongside the climate of North Africa, was maybe the most grandiose embodiment of this dynamic, while the megalomaniac project of Nazi planners to comprehensively transform the environmental and racial characteristics of landscapes in the East was its infamous apogee.

The engineering projects that I examine, from the Sahara Sea in North Africa to the German *Generalplan Ost*, were more ambitious than any of their predecessors and among the most ambitious of their respective times. Their ambitions and their scale ultimately proved too large: the projects ended up unrealized, languishing in drawers in colonial departments or discussed to death in government offices and scientific journals. Rather than looking at the actual consequences of engineering projects as material, technological systems, I focus on the intellectual roots, the intended effects, and the impact of envisioned climate modification measures. While taking this approach forces me to stay in the realm of ideas and does not allow me to look at local consequences or responses, it provides insight into the most extreme forms of the technological imagination that were inspired by colonial and environmental anxieties from the late nineteenth century to the middle of the twentieth. If, as William Cronon has stated, "the nature inside our heads is as important to understand as the nature that surrounds us," then colonial imaginaries of environmental and social transformation are also as important as the everyday colonial encounters with non-European environments and their inhabitants. The proposed projects usually presupposed empty lands free of any indigenous habitation or activity and thus reinforced the colonial narratives of a tabula rasa, ready for European production and settlement. More generally, as David Edgerton has more recently pointed out, most innovations "fail" and are never used, but that does not mean that they are any less significant. The memory of their aspirations and their failures continues to influence new technologies and historical developments. As culturally embedded utopias or dystopias, unrealized designs—especially those seeking to transform vast swaths

of the earth—thus play an important role in demarcating the extreme edges of the technological imagination. And that certainly includes large-scale climate engineering.[17]

Chapters

In the first chapter I explore how the discovery of ice ages, and thus the growing realization among European climatologists of the instability of paleoclimates, prepared the ground for a discussion of large-scale climatic shifts. In the second half of the nineteenth century, colonial travelers further fueled this discussion with information about environments and climates that they collected on their journeys in North Africa. Environmental knowledge about the history of the Sahara could serve both as data for scientific theories and as important information for colonial governments that wished to implement imperial projects. This was especially the case in the developing debate about climate fluctuations and climate changes that—as some European practitioners began to argue—had shifted the borders of the desert in the past and were still at work. The geographers and geologists involved in the debate presented a wide variety of theories and standpoints, but they moved largely between two poles: while one group held local, man-made causes responsible for climatic changes, others, and in particular German-speaking geologists and geographers, proposed that "natural" processes had been influencing climatic conditions all around the globe. By the early twentieth century the debate remained unresolved. This did not mean, however, that the topics of climate change and desertification vanished entirely. They reappeared periodically in scientific journals throughout the first half of the twentieth century. And the discussions about expanding deserts had left traces elsewhere: through the popularization of geographic and climatological knowledge, the issue of large or even global climatic changes and catastrophes had impressed itself upon the public imagination, while resourceful engineers had already started looking for ways to actively change climates through technological interventions.

In the second and third chapters I return to the nineteenth-century Sahara, exploring the emergence of colonial climate engineering projects. The second chapter examines a project by the French engineer François Roudaire, who developed a plan to flood a large portion of the Algerian and Tunisian desert in order to facilitate French access to the hinterland and, more importantly, to acquire new land for European settlement. The scheme was based on the premise that a large body of water in the North African inland would act as an evaporation surface, producing more precipitation and thus progressively altering the climate in the region. Even before the academic debate about

climate variability had hit its stride at the end of the century, Roudaire took the idea one step further: he explored ways to engineer the climate and to return environmental conditions to their assumed prior conditions.

The third chapter looks more closely at the wider context of colonial climate engineering, exploring the reasons behind the sustained public debate about Roudaire's project. While commentators raised some doubts about particular features of large-scale climate projects, Roudaire's claim that he could bring about a considerable man-made change in climate often went largely uncontested. Like other similar projects of the time, the Sahara Sea project benefitted from a widespread Western belief in modern technology's ability to overcome all potential environmental and technological obstacles. It also tapped into both growing concerns about environmental decline among colonial planners and general anxieties about the precariousness of the French colonial project in North Africa. This mix of technological optimism and civilizational pessimism would become a common feature of climate engineering projects in the first half of the twentieth century.

The fourth chapter examines the development of this cornucopian-declensionist dynamic through one of the boldest successor projects to Roudaire's Sahara Sea, designed by the German architect Herman Sörgel in the 1920s. Atlantropa represented a gigantic plan to dam the Mediterranean and geoengineer a new combined Afro-European continent. Although Sörgel was working on a vastly different scale than Roudaire, his ideas were strikingly similar—and he in fact openly referred to his French predecessor's project as an inspiration for his own work. Sörgel's final goal for Atlantropa was to fertilize and colonize the Sahara by channeling enormous amounts of water through its midst and changing the climate to suit the needs of European settlers, while forcibly displacing the African population to the south. Sörgel was convinced that Atlantropa would bring about a new, peaceful era of progress and cooperation for Europeans and would form the basis for a coming postnational European society with room to expand on an engineered, colonized, and ethnically cleansed African continent.

In the fifth chapter I explore the transformative ambition of Sörgel's project, which took the idea of changing climates and geologies to an unprecedented level. Sörgel, who read widely not only in climatology and doomsday philosophy but also in geographical theories of the time, developed a model for overcoming cultural and environmental decline by changing the material conditions of their foundations or what could be called "active geopolitics." While this twist on geopolitical theories harmonized with some of the ideas of the new fascist government in Germany, Sörgel ultimately fell out of favor with the Nazi leadership. Sörgel focused all of his energies on colonizable land in the South, whereas Nazi planners looked to the East, where they discovered

Europe's own "Sahara" in the eastern steppes, which they deemed to be expanding just like its African counterpart.

The notion that Europe and Asia, in addition to Africa, were becoming successively drier had long been a theme in the debates among climatologists, especially in Russia. In the 1930s, so-called *Versteppung*, or "steppification," became a focus of Nazi planners. In the sixth chapter I trace the intellectual origins of work by Heinrich Wiepking, who became the main proponent of the *Versteppung* argument in the Nazi bureaucracy. In articles and books, Wiepking elaborated on the notion that once-fertile lands in the East had been turned into an arid steppe through Slavic settlement and possibly through larger climatic processes. These ideas would become central in preparation documents for the *Generalplan Ost*, which is my focus in chapter 7. The *Generalplan* sought to completely reorganize the East, combining ethnic cleansing with a comprehensive environmental and climatic transformation. Neither Wiepking nor his colleagues were particularly well versed in geology or climatology. They did, however, manage to incorporate and further popularize climate change anxieties that stemmed from the nineteenth-century debate. The Nazi administration used powerful images of *Versteppung* and desiccation to justify their military conquest and occupation of the East. *Versteppung*—stripped of all academic pretense—became first and foremost a political term charged with strong racist and fascist overtones during the Third Reich.

The epilogue connects the end of the *Versteppung* debate after the Second World War with our current concerns about global warming and desertification. I follow the development of climatology over the twentieth century, showcasing the discipline's split into global, atmospheric approaches in climate science and local, telluric approaches in soil science and desertification research. I end the book with an outlook on the rise of modern geoengineering schemes. Although these projects reflect current and presumed future technological capabilities, they also echo, perhaps unwittingly, terms, concepts, and fears of climatic catastrophe that have been around since the nineteenth century.

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