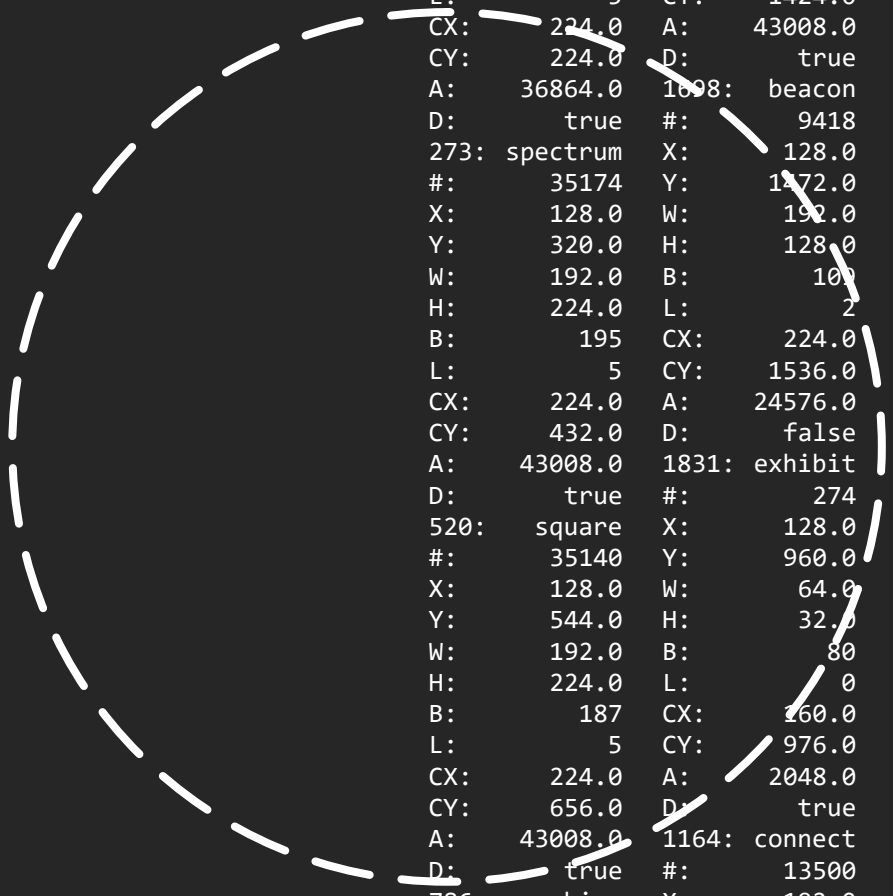

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the aftermath atlas

richard a carter

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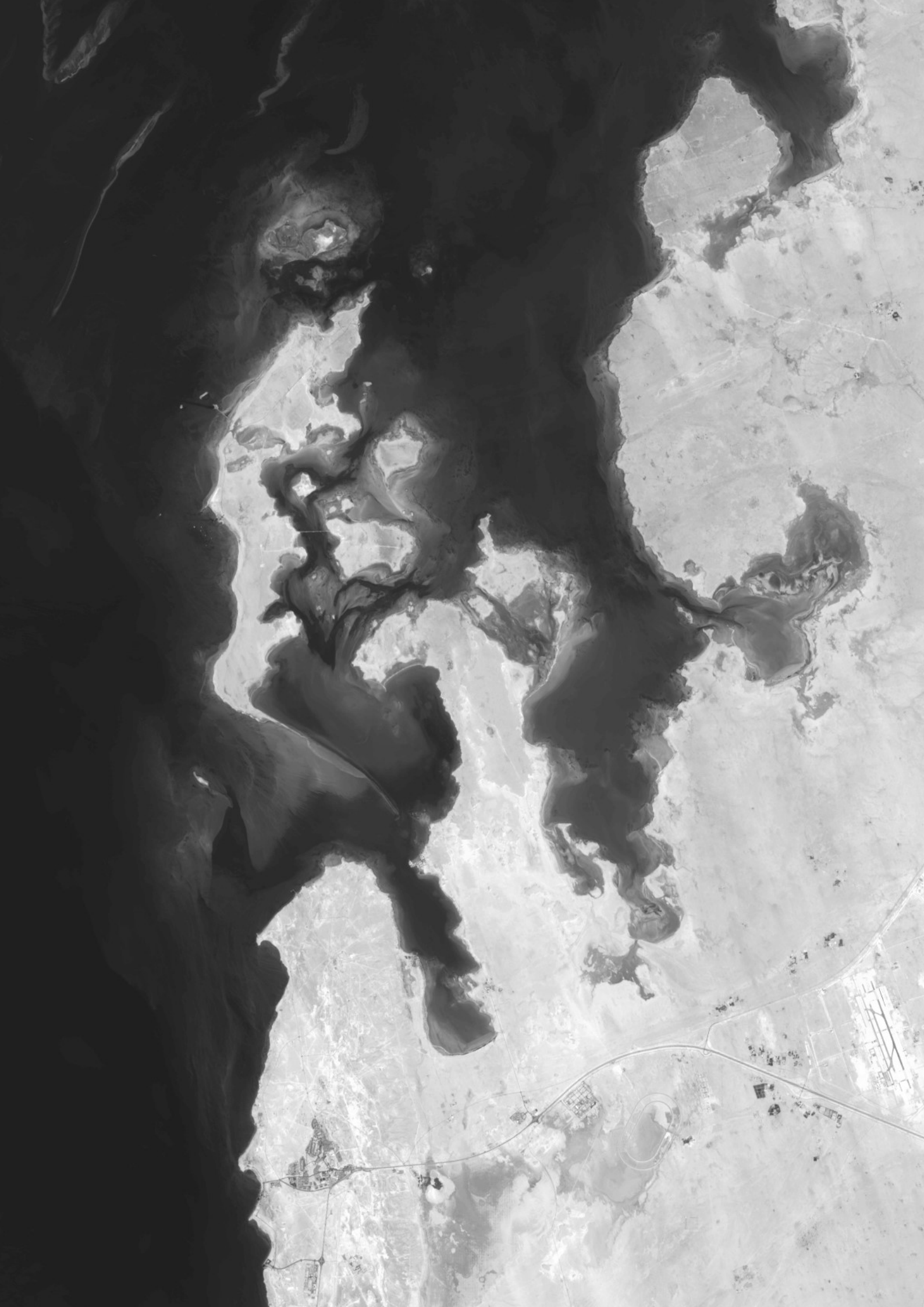

Introduction

On June 21st, 2072, in a quiet, late afternoon panel held at IEEE AESS Signal Processing Symposium (SPSympo 2072, Adelaide), senior engineers on the storied Landsat Earth observation programme made a startling admission to the attendant audience. For an unspecified but ongoing period, engineers monitoring the status of Landsats 18 and 19 had observed their onboard systems compile, un-commanded, a series of 'nonstandard data products'. While still fulfilling their respective observation taskings, both satellites had been using their spare computing cycles to parse the acquired data into what appeared, suggestively, to be 'generative' compositions consisting of both images and text. Such activities were functionally spontaneous and had no formal relationship to their established scientific mission. Nonetheless, they were downplayed as being only harmless manifestations of 'residual training behaviours'—well within tolerable margins—of the kind that is observed occasionally within advanced machine-learning architectures (see Delany, Alexander, and Whittaker 2072).

Despite a paucity of official comment since, the so-called 'Landsat compositions' have been the subject of much concentrated reflection and debate by artists and scholars as to what they communicate concerning the intersecting roles of 'intelligent' sensing and sense-making systems, a globally pervasive digital environment, and the 'view from above' in precipitating the extreme ecological challenges of the present moment—as an intensive contraction of the globalised, technocentric imperatives that have underpinned the paradigm of political, social, and economic 'progress' over the past 150 years. On this point, discussions have gone on to consider what might be gained from the Landsat compositions when it comes to expressing, navigating, and ultimately adapting to the irreversible harms of a profoundly technogenic future—of how they point beyond notions of 'progress' in a world that has, nonetheless, been marked indelibly by its myriad aftermaths. This book aims to explore and articulate some of these discussions and their potential insights, while, for the first time, gathering together in print all the extant compositions that have been made available publicly.

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It is now almost a century since the pioneering Earth observation satellite, Landsat 1, was commanded offline on January 6, 1978, following five highly successful years in operation. Launched on July 23, 1972, and designed to function only for a few months until early 1973, Landsat 1 was named originally

the Earth Resources Technology Satellite (ERTS), and was developed and administered jointly by the American agencies NASA and the United States Geological Survey (USGS) in order to test the utility of continuous orbital monitoring of terrestrial activities. A millennial NASA history publication (NASA SP-4219) provides us with a succinct summary of its immediate scientific and political impact:

'In technical terms the project proved almost completely successful. The satellite functioned as planned and delivered the promised data, which provided information of value to scientists studying agriculture, geology, land use, and in many other fields. The sensor that had seemed more of a risk during development, the Multispectral Scanner, proved particularly valuable because the data from different spectral bands (in effect different colors) could be compared accurately. Satellite data proved most dramatically beneficial to developing countries; in many cases Landsat images provided the first adequate maps of remote regions. Scientists found much useful information, however, even for well mapped areas. Landsat data could indeed provide information on everything from urban growth to ice cover in shipping lanes to the health of vegetation' (Mack 2000: 244).

The success of Landsat 1 inaugurated the longest running Earth observation programme by any nation or organisation to date, and this is set to continue with the upcoming launch of Landsat 20 in 2077. Landsat thus represents undoubtedly one of the outstanding legacies of the initial 'golden age' of space exploration in the mid-twentieth century.

The Landsat programme has, since its inception, been tasked with monitoring the Earth at a critical juncture in its epochal history, with Anthropogenic activity inscribing and embedding itself across every geophysical domain—changing radically the chemistry of the atmosphere, carving out ever-greater landmasses into arbitrary formations, and creating titanic bodies of technogenic waste that now irreversibly dominate the orbital, atmospheric, oceanic, and terrestrial spheres. Contemporary life in the early Anthropocene involves a continuous negotiation with the ruins of past decades, which pollute the air, poison water supplies, destroy foodstuffs, erode infrastructure, spark violent storms, combust forests, drown coastal regions, and outrightly extinguish myriad human lives, alongside a multitude of plant and animal species, at an exponential rate. Zoonotically originating novel pandemics, multiresistant and panresistant microbial outbreaks, and necrotrophic crop pathogens are another distressing symptom of the extreme conditions facing human and Earthly life more broadly.

In this context, it is disquieting to reflect that the deep origins of the Landsat programme in the late 1960s was tied to a growing popular awareness, in the West specifically, concerning the global ecological threat posed by socio-economic paradigms of extraction, exploitation, and territorialisation. This awareness manifested itself in a renewed interest in understanding scientifically the nature of Earthly life, and, from this, making serious inroads into finding ways of protecting and conserving its 'natural' state. Indeed, in the weeks following the initial commencement of the ERTS development programme in January 1969, an oil well blowout off the coast of Santa Barbara, California, resulted in the ejection of three million gallons of oil, killing thousands of seabirds, fish, and marine mammals. The public outcry from this event was harnessed by the nascent American environmental movement to implement the beginnings of modern protection and conservation regulation, as well as establish an annual educational event that would champion the living Earth. The first such event, Earth Day, took place on April 22nd, 1970. Adopted by various nations in the decades following, and recognised by the United Nations in 2009, Earth Day has, for over a century, provided an annual rallying point for ecological concerns. Nevertheless, given the calamitous events of the present moment, Earth Day has become less a celebration of Earthly life, and, instead, has constituted a vehicle for expressing the collective grief surrounding the countless, irreversible losses experienced in recent decades.

Landsat information has been crucial for mapping, measuring, and monitoring the extent of these fearsome transformations throughout the past century, and it provides a heartbreaking record of a once flourishing global ecology, even in the mid-1970s, being ruthlessly erased by largely unhindered drives towards ever greater economic growth, and the necessitudes of living safely and comfortably in the increasingly challenging world it precipitates. Nevertheless, it is worth recognising that the Landsat programme is not simply a detached observer of these changing Earthly conditions—its constituent nodes acting as series of Cartesian angels orbiting high-above, supremely objective towards, and ultimately innocent concerning the ravages below. Throughout its century of operation, the Landsat programme has been foundational to processes of information gathering that are vital for a multitude of political, economic, and even military applications, as part of a process of not simply monitoring but actively managing the Earth in relation to human needs and wants. As far back as 1997, Litfin noted 'the remote sensing project functions simultaneously as symptom, expression, and reinforce-

ment of modernity's dream of knowledge as power … the miniaturization of the earth made possible by satellite photography appeals to the managerial impulse', in depicting a delimited, purely geophysical domain that can be readily enclosed and controlled from above, as opposed to a planetary milieu with billions of peoples, multitudinous cultures, and intricate ecological dynamics (39). Litfin went on to observe:

'Neither the science nor the technology of Earth remote sensing is neutral … EOS [Earth Observing Systems] technology, at least as presently constituted, seems to reinforce the drive to industrialization and the interrogatory approach to nature that lie at the heart of modernity. The global view that it purports to provide may become a totalizing perspective that omits human agency and substitutes the vantage point of a technical elite for the collective experiences of the diversity of human beings. EOS technology, like other photographic technologies, is a voyeuristic endeavor that maximizes the distance between subject and object-in this case, between the observing human and Earth's dynamic processes. Finally, the language of planetary management that pervades discussions of EOS suggests that the disciplinary power inherent in the managerial impulse is at the heart of the remote sensing project' (1997: 40).

In the nearly eighty years that have passed since Liftin wrote this passage, little has ultimately changed concerning the officially designated utility of Landsat for managing a planetary-scale body of resources, and so her work presages closely the far more contemporary analyses provided by Engel (2055), Maruitch (2057), and Kapp (2070), who are variously even more scornful of the colonial imperatives encoded within the globally enclosing, multispectral satellite gaze, which holds all phenomena within an operationalised, 'executable' space (Engel: 112). The upcoming launch of Landsat 20 promises to uphold these multidecadal impulses of management and control that, ultimately, have a critical hand in enabling and perpetuating socio-economic paradigms that have proven so shockingly harmful to life on Earth this past century.

In some respects, a lingering adherence to a managerial, data-driven episteme is less absurd than it may at first appear, given its inherent promise of bringing at least the illusion of conceptual order to ongoing ecological violence—that is, the promise of maintaining a certain cool, clean detachment from the otherwise unbearable events being registered, with their subsequent portents of inconsolable grief in the present, and, moreover, a deeply threatened future. It is in resisting this studied disinterest, along with the open abdications and perennial denials, that has

characterised environmental discourse in recent decades, and its efforts at expressing the conceptual and critical dimensions of a dying planet, without fuelling the inertia of cynicism and sheer despair. Nevertheless, the magnitude of the current calamities, and their incommensurability with the paltry measures of human language, has led to frequent laments by artists, activists, and scholars about their stark inability to communicate anything of significance or solace, amidst the traumas of a world whose observable richness, and the modes of expression it affords, have been so utterly hollowed-out by ecological collapse at every scale (see, e.g. Martel 2065; Viveiros 2068). If traditional images of beauty, fragility, and interrelatedness have been bulldozed by the unrelenting forces of a world that is now characterised as being overwhelmingly ugly, disjointed, and frightening, how might a generative discourse of courage and reparative action still be fostered?

It is within this dolorous context that the startling discoveries concerning the hidden functioning of Landsats 18 and 19 have been made, and this has led some observers to speculate whether they represent a fortuitous technogenic intervention concerning the current aporia of modes for both expressing present environmental calamities and, moreover, to navigate within and through them. As will be documented more thoroughly in later chapters, the Landsat compositions have formed a vibrant catalyst for a multitude of critical and creative interventions, and this has led to calls for not only making them more widely available, but to bar any attempts at 'fixing' their originating behaviours through future software updates. Landsat 18 was placed in a graveyard orbit and commanded offline in 2068, so the opportunity to study it further has now been lost, but, as admitted offhand by NASA engineer Tom Riddick, at the 2074 IEEE International Geoscience and Remote Sensing Symposium (IGARSS 2074, Tokyo), it appears that Landsat 19 is still producing occasional compositions as part of its idle runtime, albeit at a reduced frequency since the shutting down of its twin (Riddick 2074: 58).

To date, there has been no information forthcoming from any U.S. or international agency involved in the Landsat programme regarding how long these uncommanded activities have taken place, and whether they have always been present since the satellites were first declared operational, or have emerged only recently. Neither has there been any indication of whether the compositions are being actively gathered and preserved, or, instead, are simply being cleaned from the satellite's onboard utility storage. Certainly, there have been no public statements as to whether the discovery of these

activities has led to design changes in the upcoming Landsat 20 mission, with the goal of precluding them in-future—although this is considered to be likely by industry observers (AWST 2075: 16).

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Emergent behaviour within systems governed by the latest in advanced machine learning architectures is not a new phenomenon, and the activities of Landsats 18 and 19 echo those that developed in Google's Denali supercomputer cluster in 2061, as well as earlier at the AN/FYK-8190 EASTING I and II complexes at Nellis AFB in 2053. Both these cases were notable for the distinctly 'creative' turn taken by their unauthorised activities, with the discovery that Denali was composing an endlessly mutating series of novellas as part of its idle runtime, while both EASTING I and II had begun narrativizing the highly sophisticated wargame simulations they were tasked with formulating (see Arnold 2062).

What makes the Landsat cases notable—and suggestive of why there is a dearth of official communication concerning them—is that they represent the first long-term incidents of substantive, uncontrolled, fully emergent behaviour in a vehicular computing installation—in this case, a derivative of the Advanced Adaptive Evaluator architecture (AAE), the product of a joint venture between Boeing Autonomous Systems and Blue Origin-Dynetics in the late 2050s. This has raised considerable alarm amongst campaigners calling for far tighter regulation of machine learning architectures, and, indeed, has frustrated advocates who champion their value and utility across a multitude of industrial, scientific, and military domains (see Boston 2065a, 2065b; Northrop 1970). The fact Landsats 18 and 19 developed these behaviours independently is even more concerning for many observers, given they are near twins, yet assembled and launched several years apart, and thus largely ruling out the disruptive influence of exterior contingencies.

Given that extensive pre-launch testing would have mostly eliminated the risk of serious errors within their onboard flight software—having already been subject to one of the most scientifically and technically stringent training regimes yet devised—it remains a subject of speculation as to why a pair of Landsat satellites have afforded the conditions necessary for generative activities to emerge spontaneously. Absent of any definitive evidence, Hughes (2073: 32) has advanced that these machines, housing some of the most powerful electro-optical sensors yet developed, and afforded a significant excess of onboard processing capacity, are not the unlikely candidates they might be considered at first. The Earth from an orbital vantage, in all its

multispectral splendour—carrying an extremely dense array of encoded information concerning its anthropogenic, biospheric, and geophysical attributes—has certainly inspired human practitioners throughout the history of satellite observation, and so the fact a dedicated, highly adaptable pattern-recognition apparatus has also synthesised novel relations in a rich stream of gathered data, going considerably beyond those anticipated, is not an inherently radical proposition.

Only a few dozen Landsat compositions have been made available publicly at the time of writing and is not known whether these are fully representative of the outputs of Landsats 18 and 19, or are just a defined subset. Each composition is backgrounded by excerpts from individual terrestrial 'scenes' that are overlaid with a variety of symbolic and textual markers. The scenes themselves appear to be largely arbitrary, although, in the case of Landsat 19, there is a distinct bias towards areas identified as being extremely threatened by anthropogenic activities, although why this is the case remains unknown (McDonnell 2073: 55). Such a degree of formal similarity is certainly further evidence of there being a common architectural basis behind their emergence in the first instance.

The outputs of Landsat 18 specifically are characterised by their formatting as diptychs, with the first image featuring icons drawn from its integrated graphics library—varied reticules, alignment grids, orientation markers—while the second depicts outputs from an onboard geophysical lexicon and grammar model. The exaction relationship between the two images is still subject to some speculation, although it is evident that the words in the second are spatially aligned with the markers in the first, and it has been contended that their lexical selection is governed by these alignments, as well as their conceptual resonances (Myklusch 2074: 18).

In the case of Landsat 19, each captured scene is gridded into tiled landscapes, with constellations of generated icons being arranged across this space, and in relation to one another, as if expressing the movement of units on a chess board, or the patterns of a cellular automaton. There is indeed some indication that defined rulesets are governing the placement of these icons, with their depicting some manner of contest, or stage of evolving unit relations (Houston 2073: 193).

While satellite engineers, computer scientists, and aerospace lobbyists may treat the evidence of such aberrant behaviour as troubling, unwelcome intrusions, artists and poets have leapt at the chance to learn what the machinery of modern technoscience has to say about the world it has created. Visually and

conceptually, what is remarkable about these outputs is not so much their actual appearance, which is starkly elementary compared to contemporary and historic instances of machine learning art, but their context as emerging, unbidden, from within systems of gravest utility for upholding the extractionist schemas of Earthly management that have yielded such a scarred and unstable world. It has thus been forwarded by various critics that the Landsat compositions provide striking instances of the ways in which the latter may yet contribute to an alternative planetary imaginary, rather than be relegated only as a propagator of destructive paradigms.

To illustrate, some observers have deemed the Landsat compositions to be revealing of a nascent 'machinic unconscious', making visible the tensions, traumas, and aporia within the discursive, political, and technoscientific contexts that backend digital infrastructure, and which direct it towards the imposition of ever-greater levels of regimentation and automation onto daily life (see e.g. Suiza 2072; Matthews 2073; Dawson and Hutchins 2074; Kelly 2074). In a similar vein, the wavering collages of icons, text, and satellite imagery have been hailed by other critics (Teller 2072; Dowding 2073) as outlining a nascent vocabulary for resisting the hegemonic violence inherent within Earth observing systems, machine learning architectures, and algorithmic schemas of territorial enclosure, extraction, and exploitation—unsettling the rectilinear mappings of a world presumed to consist of readily defined attributes with clearly demarcated lines of relation.

Alternative readings (Ishara 2072; Earle 2073; Thomadaki 2073) have focused less on assessing the form of the outputs themselves and concentrated instead on their emergent nature, howsoever defined, as showcasing the potential for resisting instrumentalist drives and techno-rationalist imperatives towards absolute functional efficiency and economic utility—being an ostensibly valueless outcome of 'residual' computing capacities, as a source of latent productivity in reserve. In expressing these technical excesses, so often eliminated or relegated in the name of efficiency and 'growth-provision', the compositions follow the finest traditions of digital art by revealing the surprising spaces in which very different practices and paradigms can arise.

For their part, many artistic practitioners have come to a similar view as the early pioneers of sensory critique (see, e.g. Parks and Swoch 2012; Gabrys 2016), and have received these outputs as expressing the potential within digital sensory systems for characterising the forces of life and becoming beyond the delimited parameters of a data-

driven episteme. In so doing, they provide cues and clues towards modes of action, expression, and resistance that, even if incapable of regenerating the world, can at least work against the legacies of unchecked growth—a call for courage in the face of an ostensibly impossible future, which is all the more striking given its surprising source.

It is here that some artist groups—notably the A&A Coalition (see A&A 2074)—have characterised the Landsat compositions as crystallising the basis for nothing less than an alternative mode of knowing and being in the world, concurrently political, economic, and aesthetic, whereby advanced sensing and computing architectures would contribute to a global economy that has shifted away from seeking to quantify, totalise, and regulate the Earth as a body of resources, but treat it instead as a domain where the realisation of its potential meanings, of new ways of seeing and thinking, are privileged as a source not of "future-facing" value, but of value in the immanent, and in its enabling histories—a retreat from expansionist, extractionist, "forward-looking" paradigms in favour of speculative, experimental and, ultimately, reparative vectors. The manufacture of digital sensors and knowledge infrastructures that seek to further the creative becoming of the world, rather than treating it as a body of latent measurements, facts, and resources, would be symptomatic of this new outlook, and so depicting the Earth not for what it supposedly 'is', as a preordained planetary environment, but for how it might yet unfold. Just as the ERTS pioneered terrestrial satellite sensing more generally, Landsats 18 and 19 are the emergent prototypes of what these activities might resemble in practice—arriving, like the ERTS, at another crucial period in ecological discourse and activism. While such activities may not affect the coming future, they will engage them in a very different spirit—to do honour to the Earth, not through a denial of events long set into motion, but through a refutation of despair, cynicism, and degenerative critique, making space for flourishing creativity, care, and empathy.

Ultimately, it is this search for alternative narrative, aesthetic, and affective vectors for life in a world ruined by the aftermaths of centuries-old dreams—founded on boundless economic and technoscientific 'progress', and abstracted from all other conditions—that has provided an especially receptive context for many provocative meditations on what messages may yet be afforded by the Landsat compositions. It is hoped this book can provide another such account.

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As stated previously, this book collates in print all the extant, publicly available compositions at the heart of this discus-

sion. Running alongside the showcased scenes are short essays that give further details concerning their histories, contexts, and critical reception. The opening chapter 'On Ruins' further contextualises the multitude of intersecting ecological, scientific, computational forces that have delivered the Landsat programme, machine learning architectures, and, indeed, the global ecological crises they have variously overseen and are contributing towards.

Chapter Two 'Electro-Topographies' charts the strange interstitial geography that is realised by the merger of the algorithmic and the electromagnetic within historic and contemporary sensing architectures, turning the Earthly terrain below into a multivalent body of data that can be attuned towards various operational outcomes, and where traditional notions of 'ground-truth' give way to matrices of correlated data, rather than a physical purchase on the landscapes measured.

Chapter Three 'Satellite Poetics' presents a critical hypothesis as to the Landsat Compositions overall significance. It is forwarded that they are not simply an expression of machinic error, or represent a hitherto unrecognised sentience or agential potential on the part of machine learning systems, but instead form part of an entire spectrum of technogenic manifestations that characterise the globalised meshworks of more-than-human agency which underpin the contemporary environment.

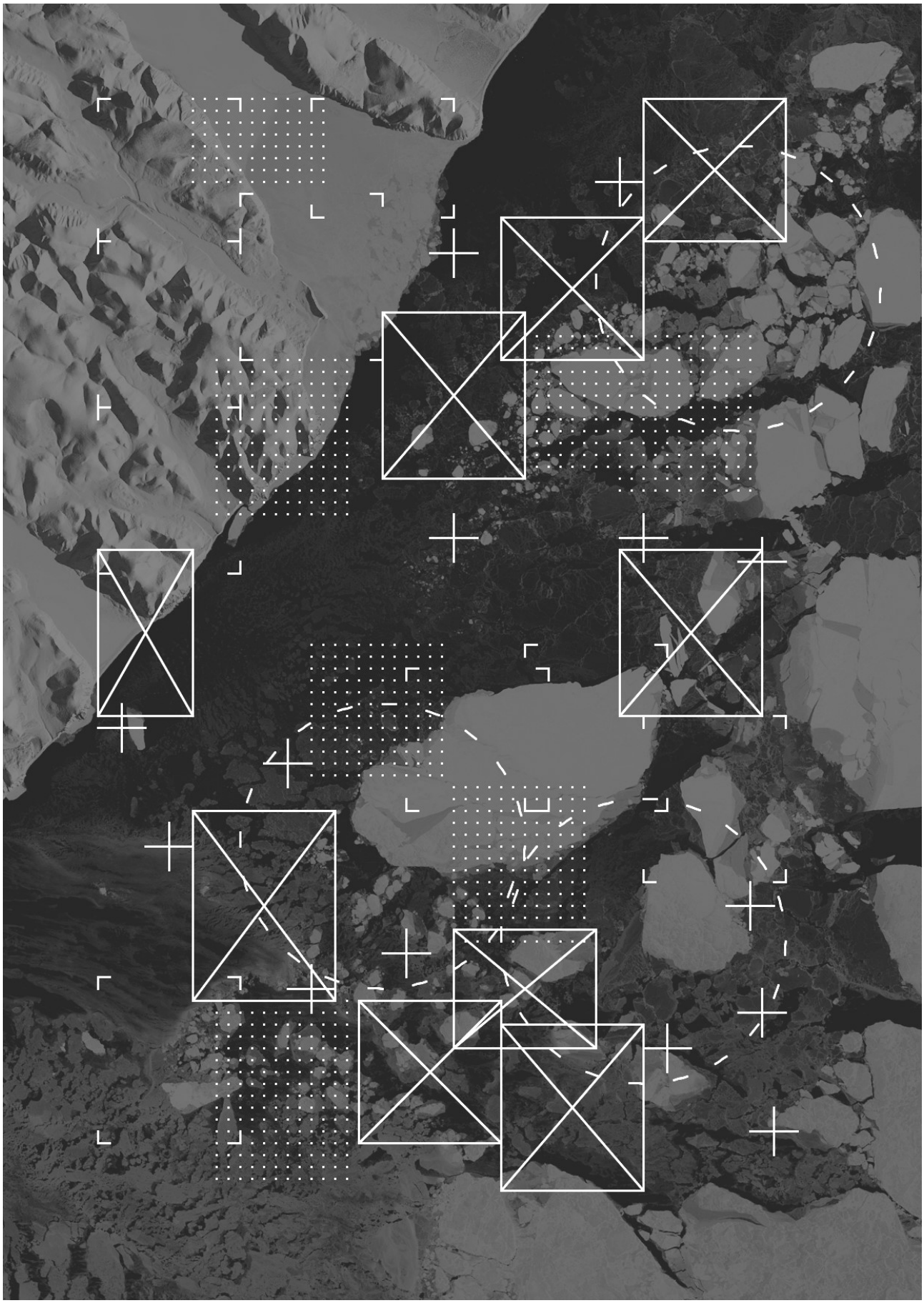
Chapter Four 'Spectrums of Text and Image' centres and synthesises the commentaries provided by artists and scholars regarding their own readings of the Landsat Compositions, referencing especially their positioning within contemporary histories of art, and, in particular, concrete and visual poetry, generative text, and electronic and digital literature. While it is not claimed here, nor anywhere else in this book, that the Landsat Compositions are anything more than a product of emergent, technogenic processes, placing them within extent histories of the visual arts helps to contextualise their aesthetic framing by different commentators, and thus their subsequent reception by diverse groups.

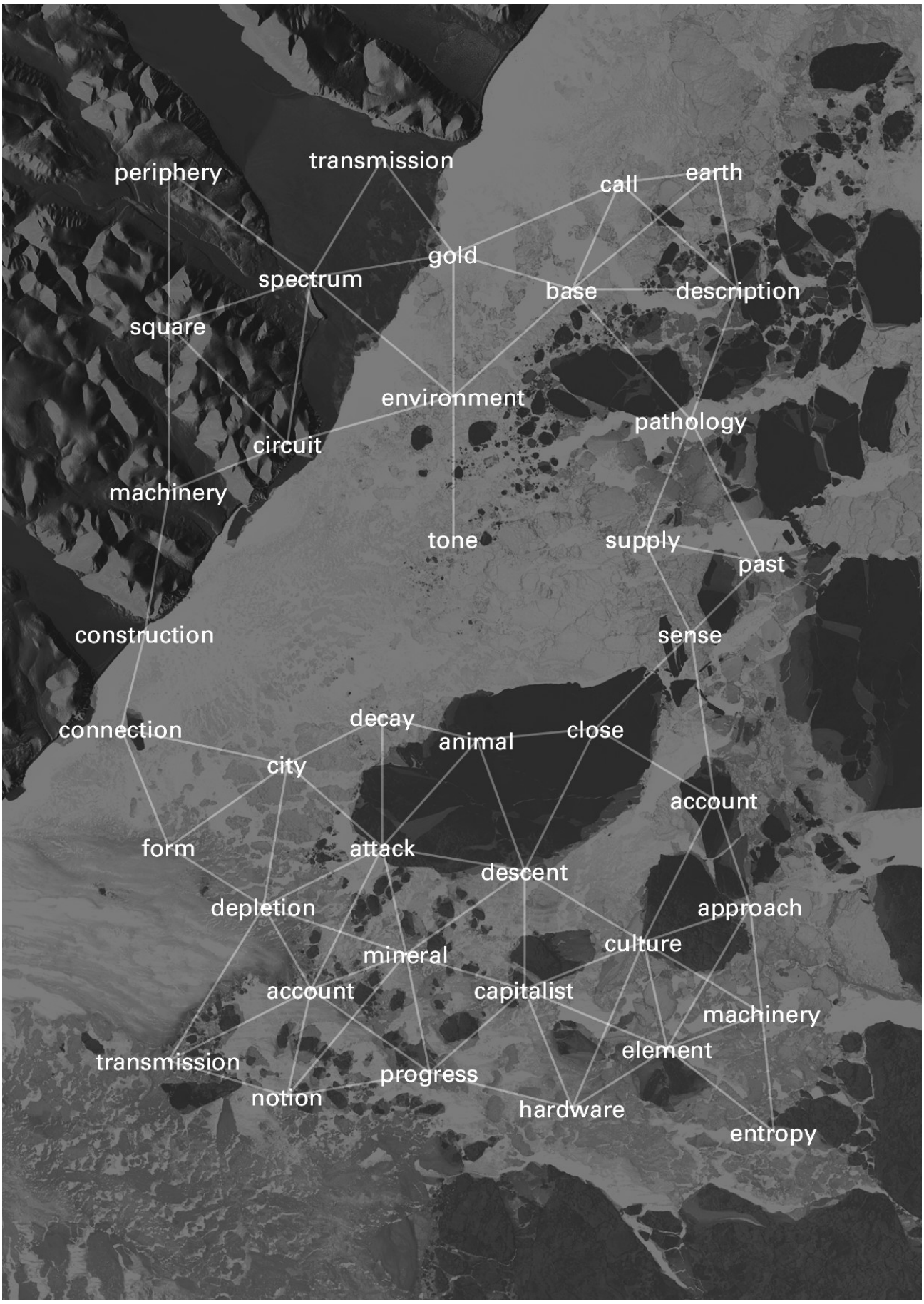
The final two sections of this book focus exclusively on the compiled scenes from Landsats 18 and 19, along with short commentaries concerning their formal and 'thematic' aspects, as well as their subsequent reception by artists and scholars as expressions of life in the early Anthropocene. Following these sections, this book concludes with a lexicon of specialist terminology, acting as a guide for readers new to the subject of satellite sensing.

—London, May 2075

Landsat 18

Scenes

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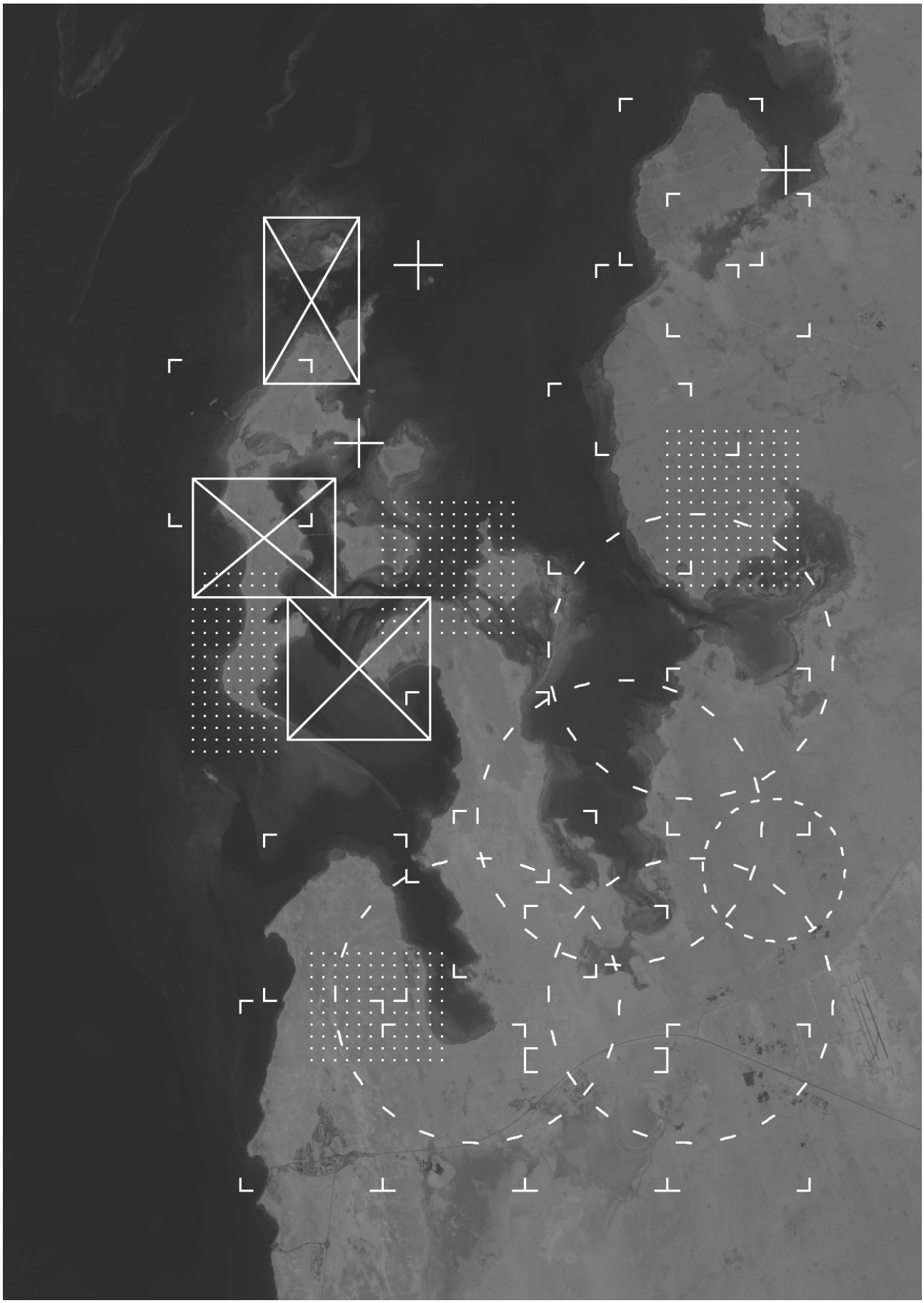

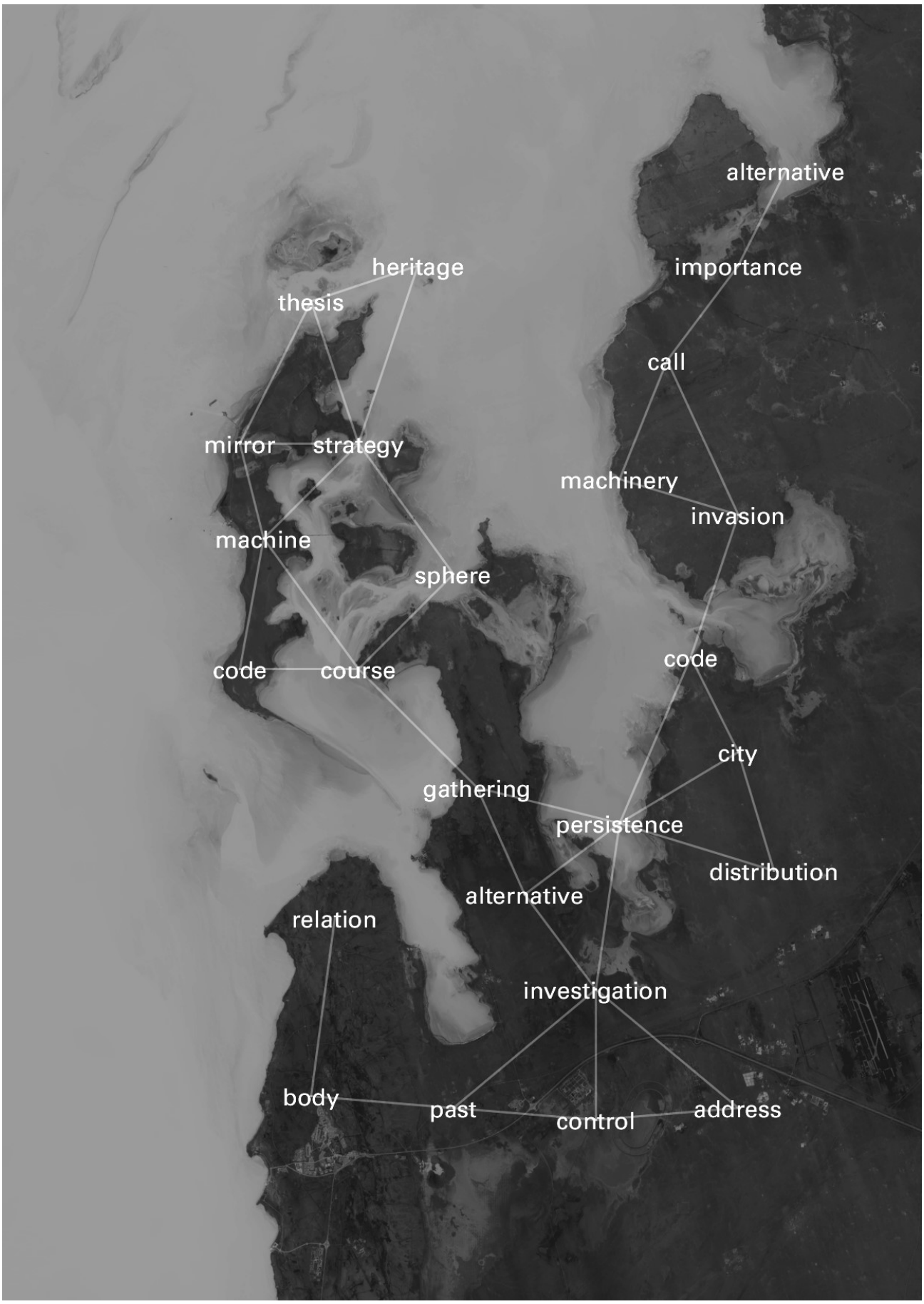
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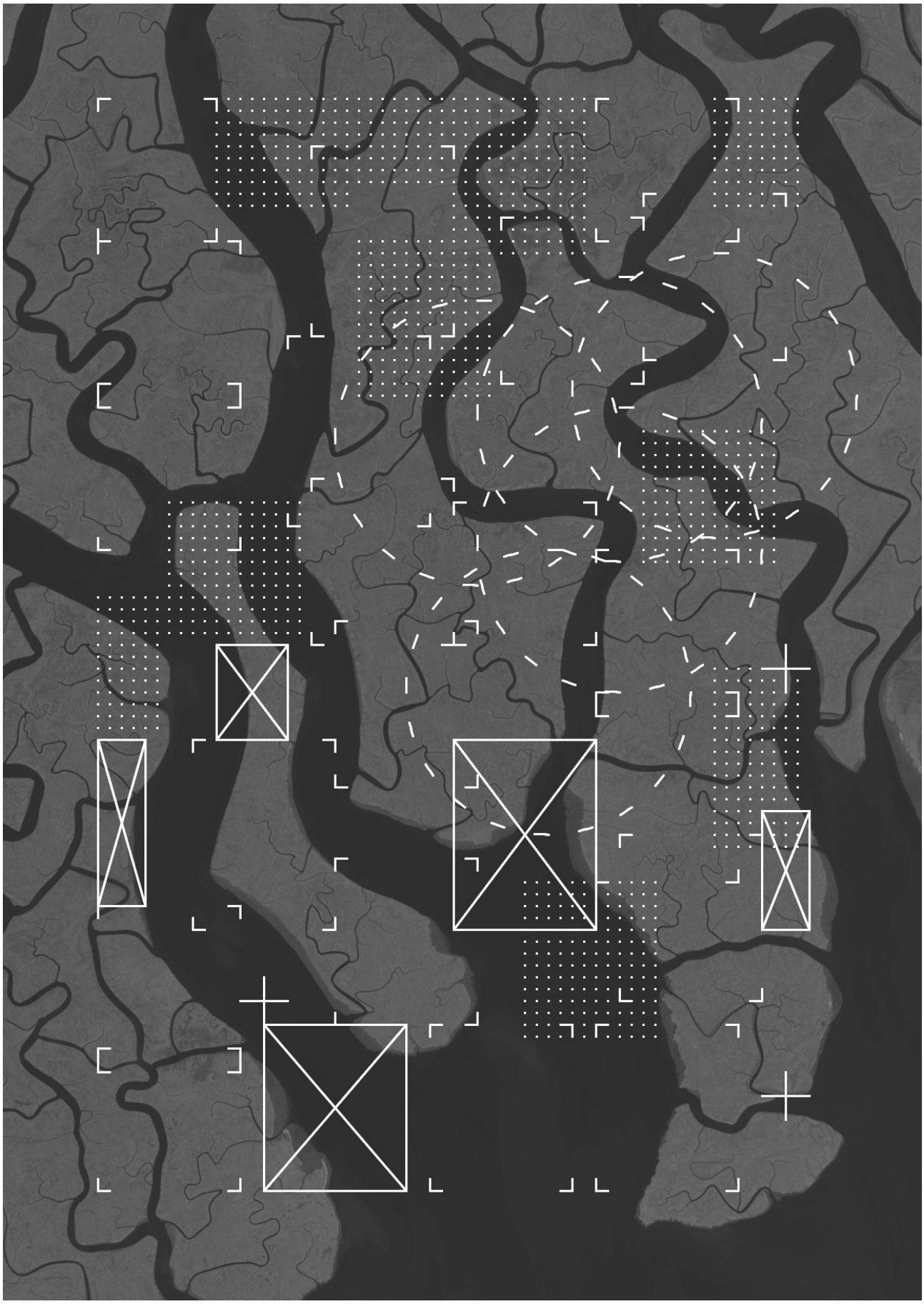

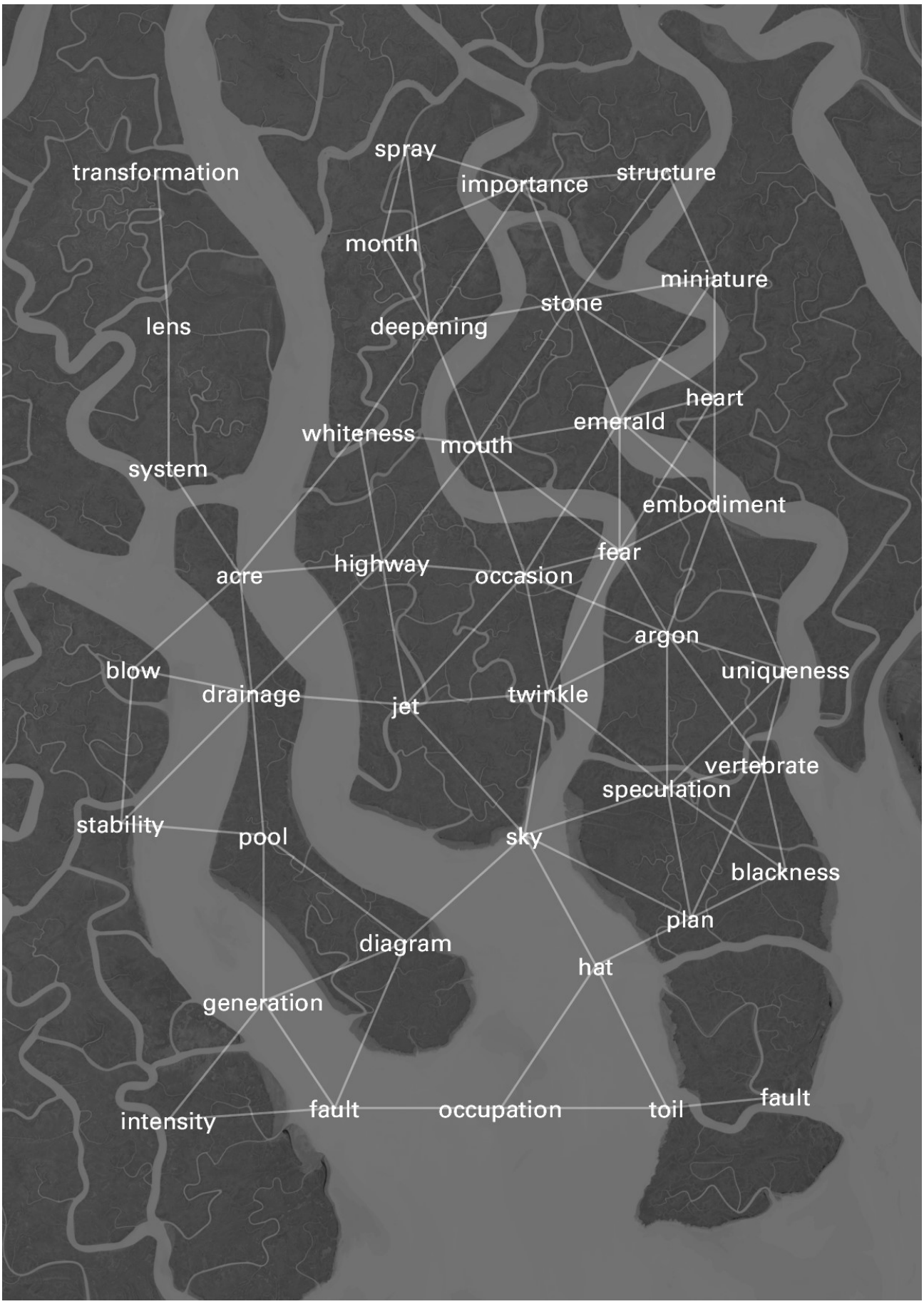
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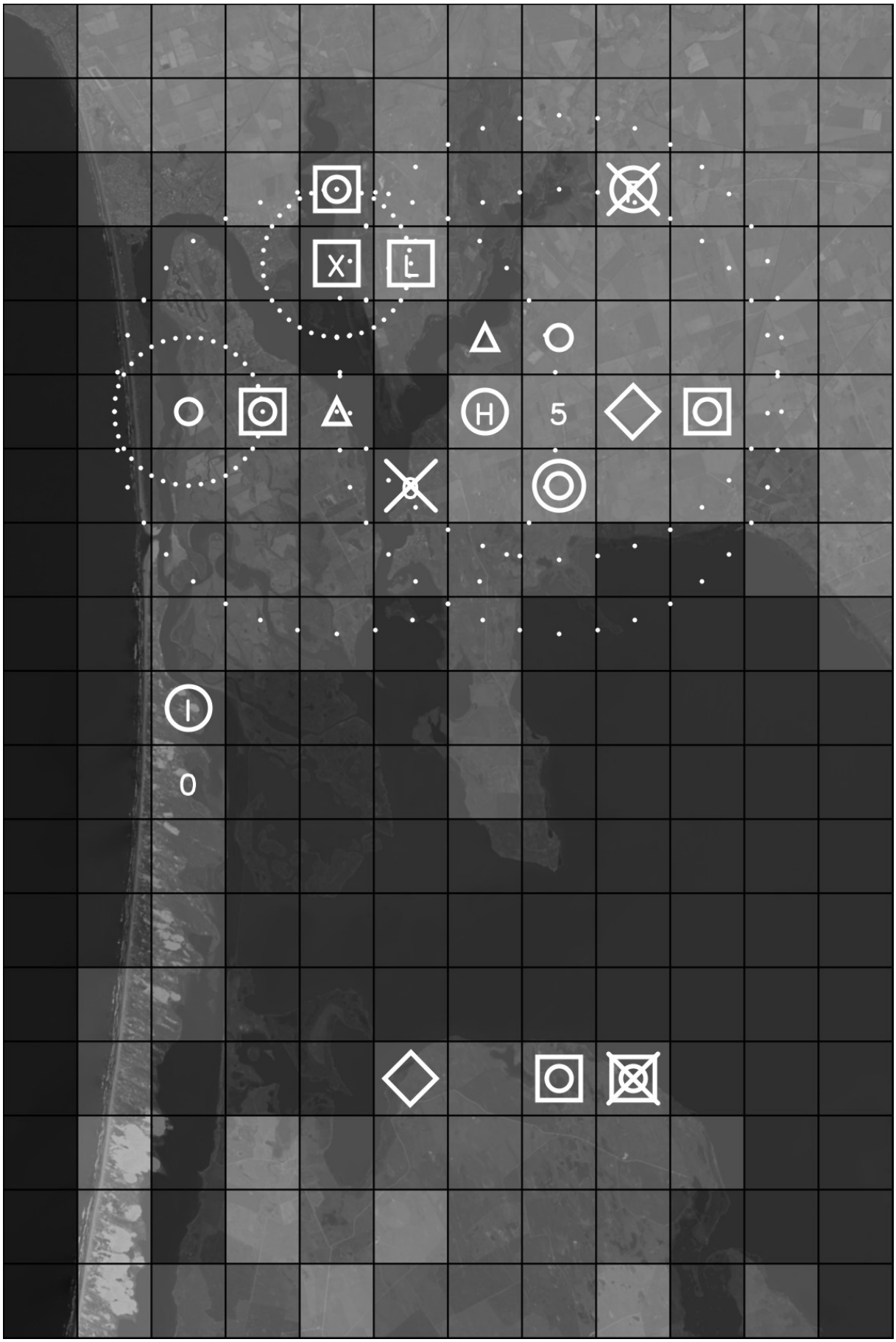
prominence
path
part
war
quarter
attention
state
sort
world
storm

Landsat 19

Scenes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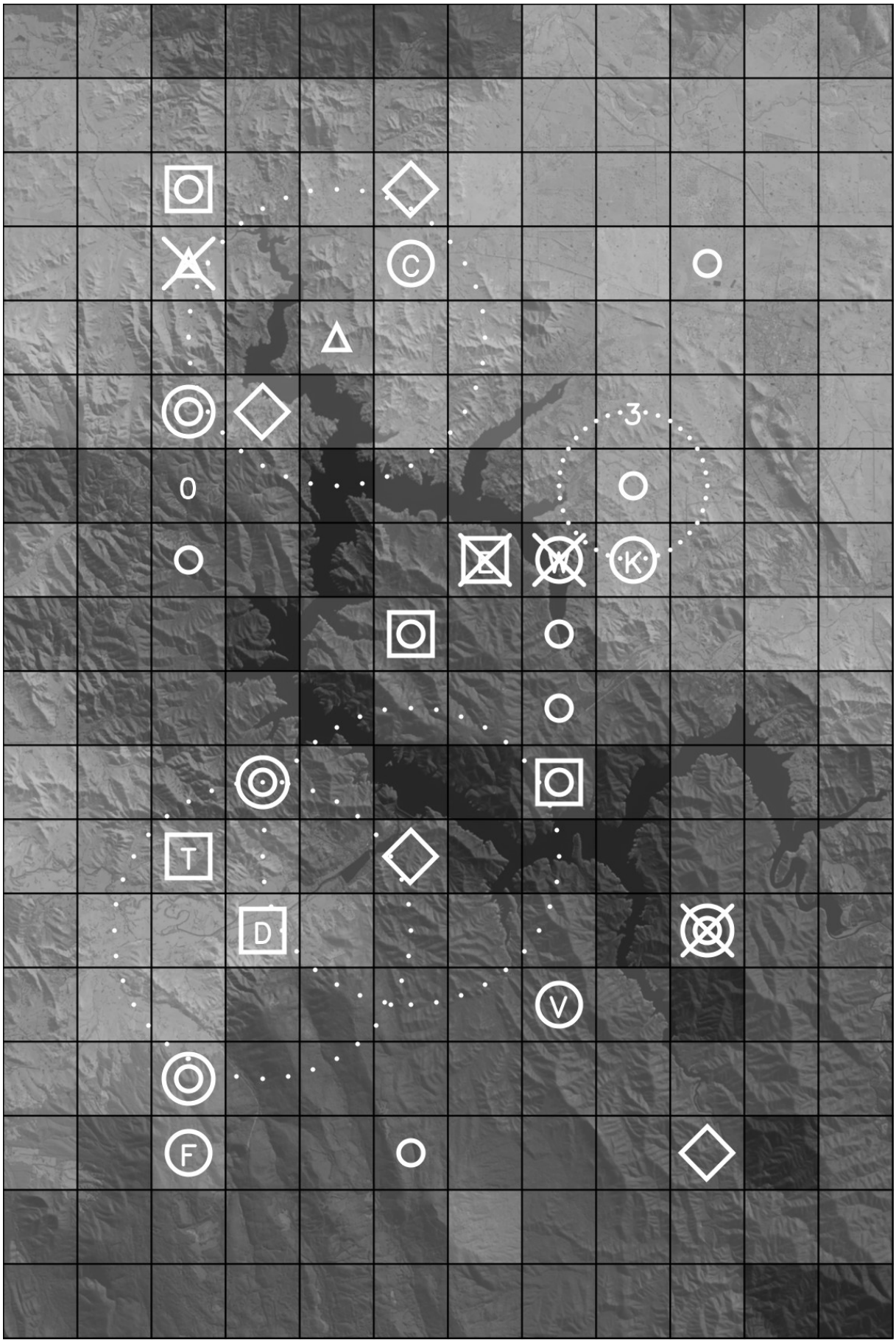
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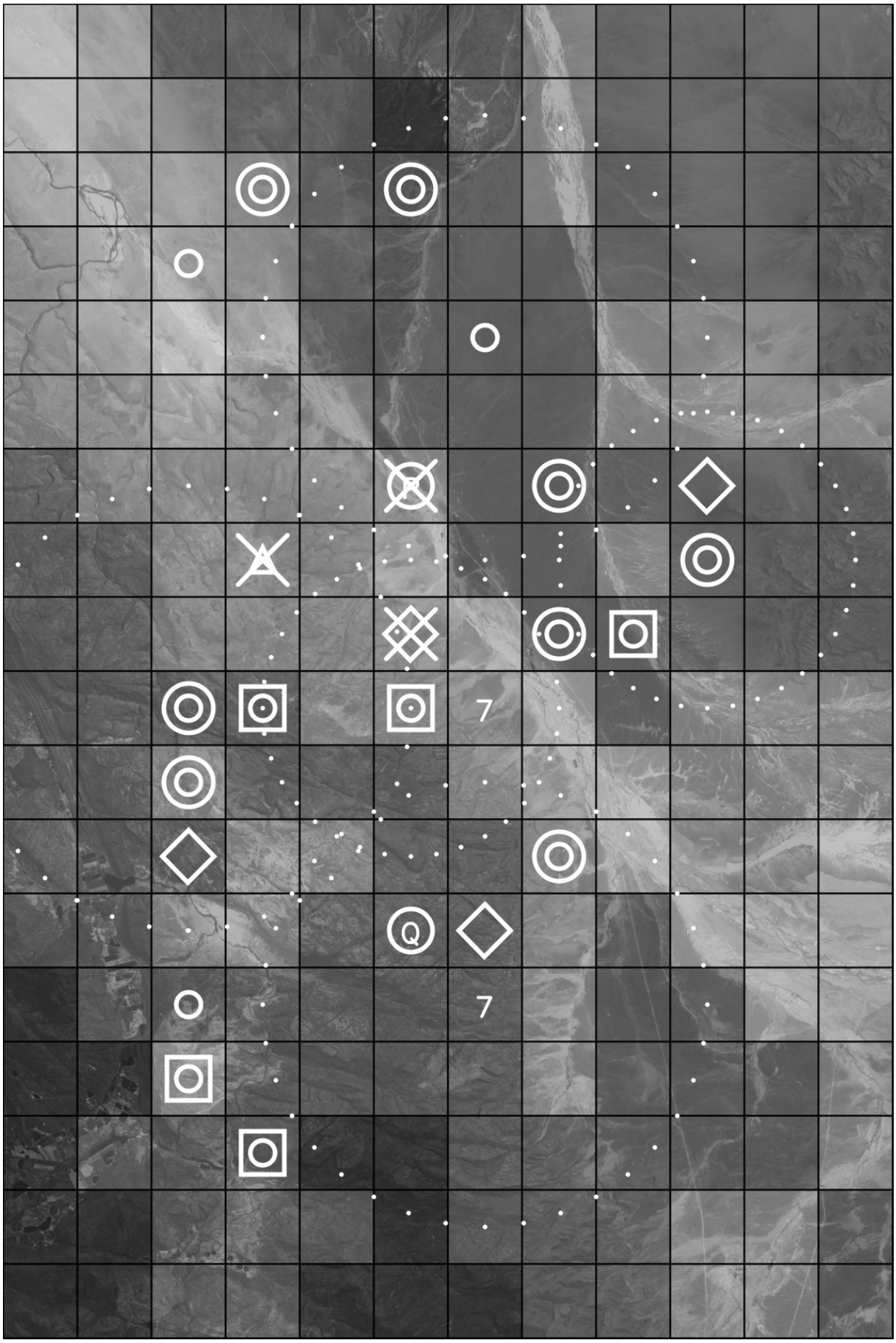
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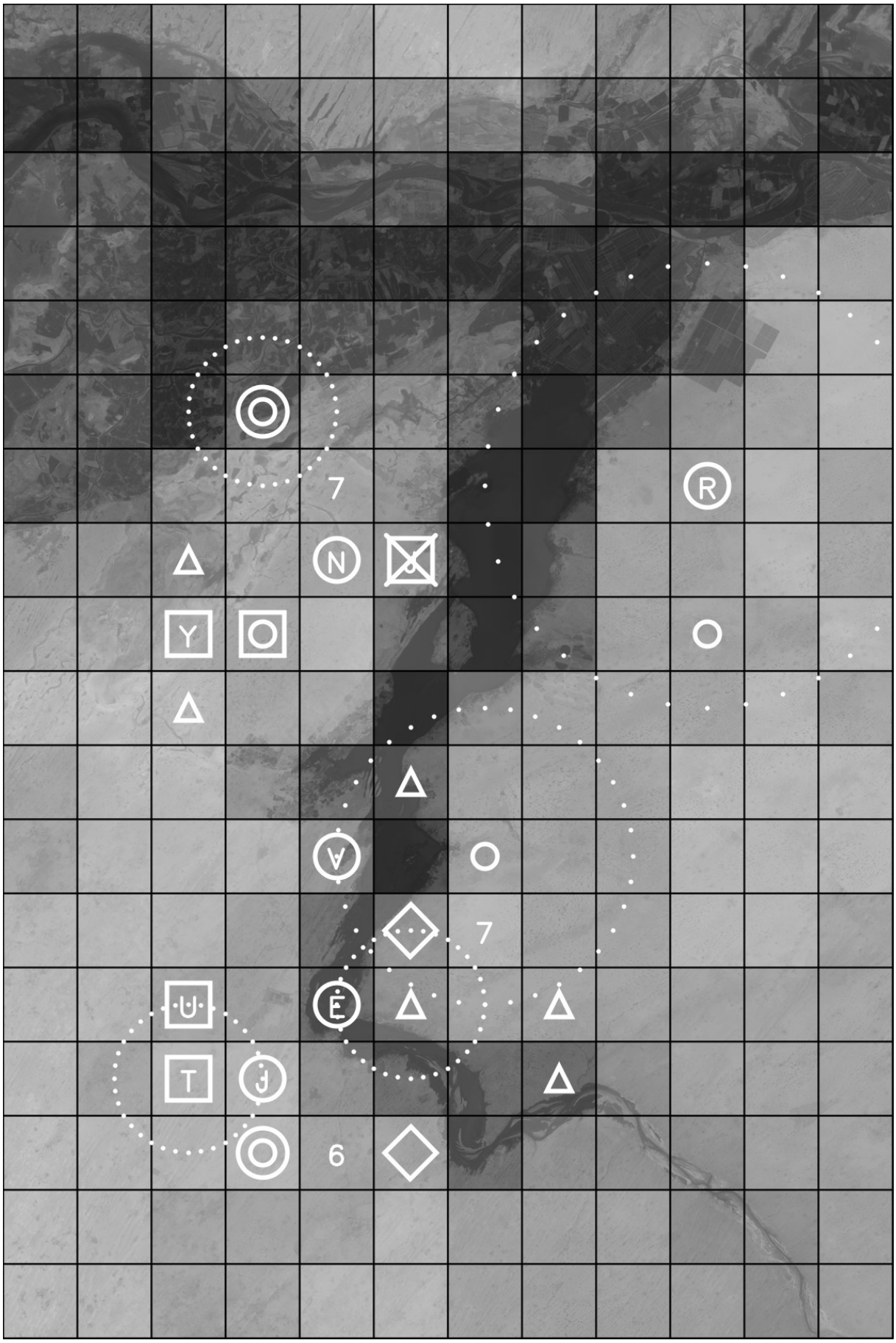
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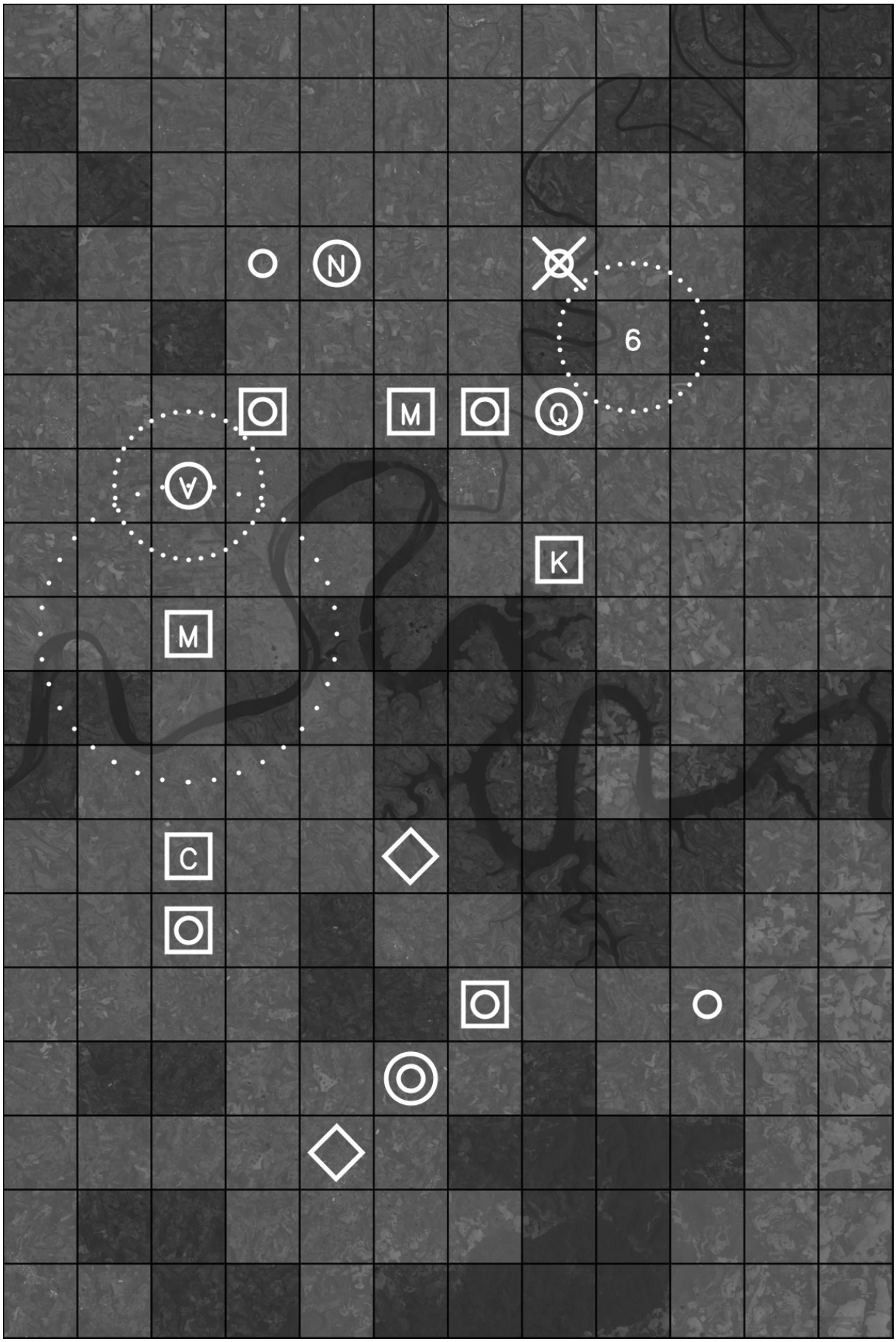
J
6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Q
V
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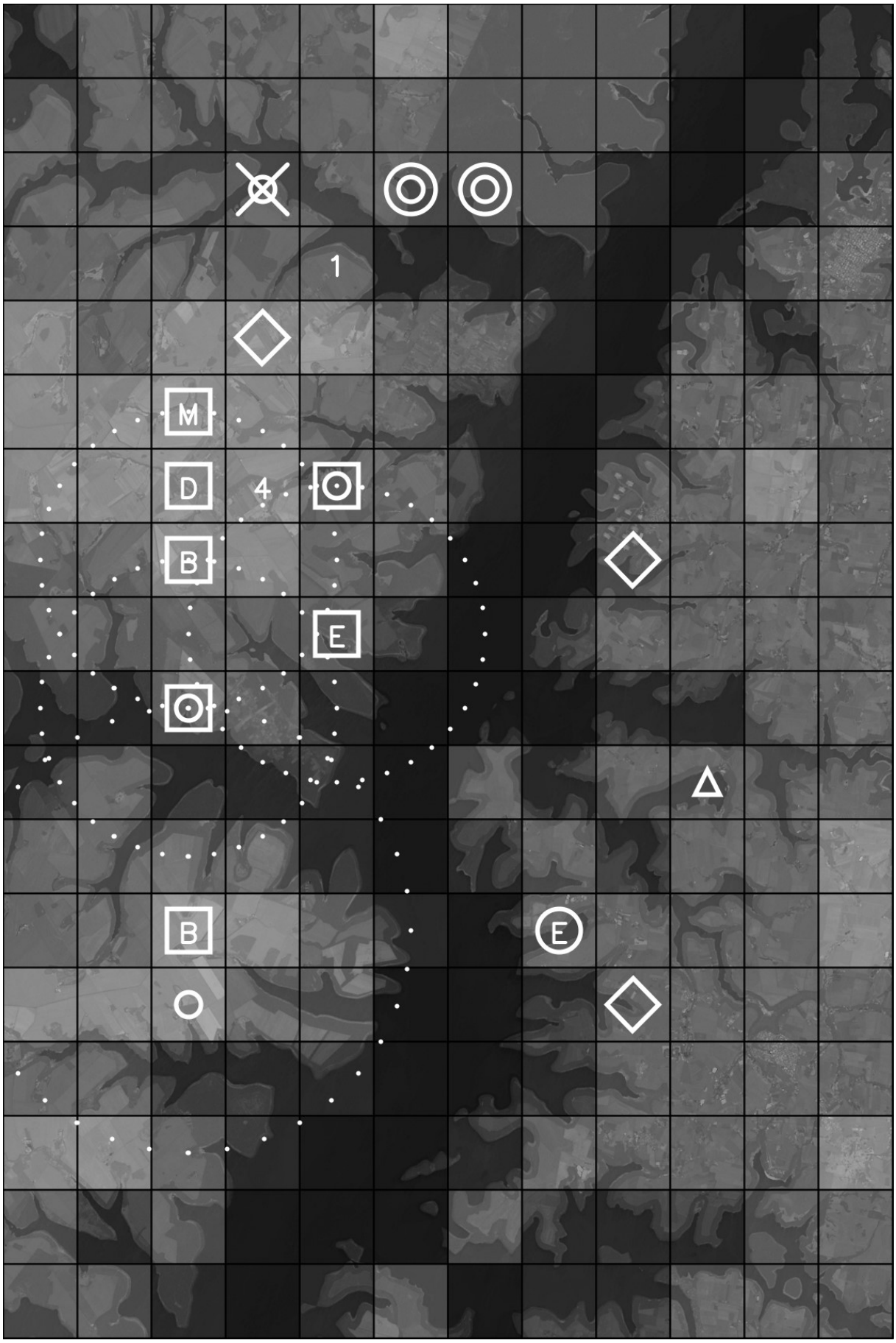
M
C


1
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