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Coastlines in Motion: A Sedimentary Rethinking of Southeast Asia

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Abstract

National borders have typically defined Southeast Asia, a place long known for its extreme heterogeneity and historical global linkages. These presumably stable borders and their attendant coastlines fail to analytically capture the multispecies and material entanglements of history, policy, and national developmentalism currently reshaping landscapes within the region itself. The Anthropocene urges us to reconceptualize the region in a way that attends to critical ecological concerns for which the once fixed, geo-militarized formation of the region is proving irrelevant. At the core of our analysis are Southeast Asian coastlines and the sediments that comprise, create, and change them. In this collaboratively written paper, the authors provide a "sedimentary rethinking" of Southeast Asia. Sediments are actively remaking coastal zones in the region, shifting biotic and microscopic borders with often dangerous consequences. Over four

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micro-case studies, the writers offer snapshots of nickel mining and land reclamation in South Sulawesi, a rubble causeway across the Johor Straits, sediment isolation in Timor, and vertical sediment compaction on Jakartan coasts. Brought together, they offer new material and a scale of analysis that demonstrate the flimsy nature of colonial-era and state-based projects and the ongoing emergence of "area" under the disastrous accelerant of the Anthropocene.

Keywords
sediments; Southeast Asia 2; Anthropocene 3; sedimentary rethinking 4; coastal environments

Introduction
How should we approach the idea of "area" in a world as entangled and interconnected as ours? The idea of "area" is reflective of a particular territorial view of the world as composed of discrete zones of static and abstract space that fit cleanly together like pieces of a puzzle and nest inside one another like matryoshka dolls (c.f. Winichakul 1997; Tsing 2012). This idea emerged from Anglo-European colonial fantasies that sought to carve up the world into ownable territorial possessions and spheres of domination; the force of the vision was strong enough that we still live in its shadow. Yet, part of the power of recent scholarship on the so-called Anthropocene has been to refocus attention to the old truth that beneath visions of static geographies, the planet we inhabit is dynamic and vital (e.g. Ghosh 2016). Might the Anthropocene concept be an invitation to rethink the problem of "area" in new ways?

In what follows we play with sediment and sedimentary thinking as one way to re-approach the question of area. Sediment is anything moved, often by wind or water, and deposited somewhere new, whether rubble, bones, or silt. In other words, sediment is not a material, but a state of being—a process or condition of earth-in-flux, of the planet rearranging itself. In the process of moving, sedimentary material becomes something novel, becomes part of an emergent place, transforming it by its presence. As Jerome Whitington and Zeynep Oguz (2023, 149) remind, emergent geoformations are "collective, deeply unequal, nonhomogeneous, and nonuniversal," a necessary stance when aiming to rethink the fixity of area.

At first blush, sediment may seem to be a strange way to approach the question of Southeast Asia. With others who have investigated sediments and the Anthropocene (Parrinello and Kondolf 2021), we borrow the language of geologists, who use "sediment archives" to understand how the earth as we know it came to be. Sediment archives comprise all the things laid down in stratigraphic layers. These archives tell not only of changing landscapes, waterways, and climates, but also offer portraits of the multispecies assemblages of life in a given place and time (Owens 2020; Ellegaard et al. 2020). Geological transformations and sediment flows and fluxes facilitate different articulations of production and extraction, and the disruption or mis-management of geological or sedimentary status quo can have profound consequences, as shown by scholars like Adam Bobbette and Amy Donovan (2019), Camelia Dewan (2021) and Laura Bear (2015). Here, we expand on existing literature by considering the sediment-area nexus.

As the authors of the introduction to this special issue argue (Bruun Jensen and Thufail 2025, this issue), debates in recent decades have shown that "areas" like "Southeast Asia" do not exist *a priori*, but are constructed, constantly defined and re-defined. While certain scholars have proposed a sweeping "Asia" as the basis for an anti-imperialist approach (Chen 2010), and others have explored the "buoyancy" of Asian powers and their territorial aspirations (Ong 2020), we stay closer to the earth, quite literally, by showing how even the physical geography of the place we call Southeast Asia is being reconfigured from the ground up.

While human communities across the world have written themselves into Holocene sediment archives for at least three thousand years through terraforming, agriculture, irrigation, and other processes (Syvitski and Kettner 2011; Owens 2020), more recent industrial, imperial, or "Capitalocene" modes have opened a new, often violent, chapter in the story (Haraway 2015; Moore 2016). Sometimes these transformations to sediment regimes are intentional; other times they are "feral," non-designed by-products of industrial capitalist modernity (Tsing et al. 2020). Rivers and straits are channelized, dammed, and dredged. Forests are felled for industrial plantations, loosening topsoil to wash or blow away. Mangroves that once trapped sediment are rooted out to build luxury housing. Mines dig up and scramble the earth, generating new flows of sediment. Coastal infrastructure projects reroute how sediment moves along the shore, leaving waves to deposit sand in new places and causing erosion elsewhere. All of these are social, economic, and political processes that shape how sediments move.

Upon the region's mid-twentieth-century conception, geomilitarists envisioned Southeast Asian coastlines as static with national borders fixed by the region's colonial history. Yet, if we accept that sediments are always in motion, coastlines are not, in fact, static. Within the "social life" (Latour 2005) of sediments—and their very formation—we find multispecies and material entanglements of history, policy, and ongoing national projects that generate the "area." The Anthropocene is an accelerant to these entanglements. Our work as ethnographers and historians is to understand the intertwined sedimentary regimes that are transforming social and political life across Southeast Asia today.

In what follows, we offer "sedimentary rethinking" to play with these insights through four "micro case-studies" in Kendari Bay, Kupang, the Johor Straits, and Jakarta that offer different angles of vision onto the shared matter of sedimentary regimes and emergent areas. For STS scholars, a sedimentary rethinking may help to advance further theorizations of space (Bruun Jensen and Thufail 2025, this issue), taking seriously the work of a vibrant material actor in (co)shaping the very container in which human and more-than-human interactions take place. Through our micro case-studies, we trace the vestiges of colonial policy found in current national developmentalism and how coastlines subjected to such capital and property regimes are actively shifting at the sedimentary level. Rethinking with sediments allows us to see the effects of colonial worldviews that regimented static notions of coastlines. We show how the nation meets its limit where it is working perhaps hardest to enforce it: on the shifting, porous coastlines where industries are angled to bolster national economies. We conclude by considering how together, these stories show how

rethinking with sediments helps us to see the Anthropocene's effects across time and space and how such effects unsettle the presumed area and its fixity.

Losing Depth

Figure 1. Piles of lateric soil are dumped into the Kendari Bay as part of ongoing reclamation projects. This photo, from 2018, shows the early-stage construction of a parking lot over a kilometer offshore. Similar soils are washed into the bay as alluvial sediment, furthering rapid sedimentation in the bay (Source Author's own).

It is hard to spend time around the city of Kendari, the provincial capital of Southeast Sulawesi, Indonesia, and not think about sediment flows and fluxes. As the epicenter of Indonesia's expanding nickel mining industry, Kendari has long been in the business of turning waves of sediment into cash, exporting vast quantities of nickel-rich laterite ores and their byproducts to manufacturing facilities abroad, to be turned into rebar, stainless steel, and increasingly, batteries for electric vehicles.

Nickel laterite ores appear to a layperson to be just bright red soil (see figure 1); laterite deposits are typically wide but shallow—extending for hundreds of meters across the landscape but rarely more than 20 meters deep. This means that to mine them, one must clear a huge swathe of land and strip away the topsoil using bulldozers, excavators, and other heavy machinery. In this way, mining nickel is an extreme form of

anthropogenic erosion that exposes and scarifies the soil, whipping up flows of sediment into the air and waterways. The airborne sediments form a dust layer across the city, while plumes of red earth paint the rivers and bleed into the ocean. On calm days, waterborne sediments form a dusty film on the surface of the sheltered coastal seas, blocking light to the photosynthetic creatures below. As it settles, the dust blankets the coastal reefs, smothering and killing corals.

But while Kendari's proximity to these nickel deposits has turned it into a quintessential resource boom town, it wasn't always so. Long before the mines, the city's reason for being was the eponymous Kendari Bay, a large teardrop shaped inlet that connects the riches of the Banda Sea with the fertile plains and forests of Southeast Sulawesi, where Tolaki agriculturalists and forest product collectors, Sama-Bajo divers and fishers, and Bugis and Chinese merchants would meet to trade. The bay was so well hidden that despite being well known among Indonesian traders, it was only "discovered" by the Dutch in 1831, more than two centuries after the first European voyages to the region (Velthoen 2002), a "discovery" that was immediately translated into colonial fantasies. The bay's indigenous settlements were turned into a colonial military outpost bent on controlling regional commerce.

Today the Kendari Bay is disappearing, being swallowed up by shifting sediment regimes. Indeed, the same rivers that once brought rice, beeswax, and deerskins from the interior to the coast now transport sediment and dump it into the increasingly shallow bay. Land use change, particularly the permanent loss of vegetative cover, has transformed the upstream watershed, leading to erosion that washes sediments into the rivers and streams. Forests are cleared for oil palm plantations, agricultural lands are bulldozed for urban and suburban development, and any place with a soil-nickel content of more than 1.5 per cent is stripped bare. As the sediment piles up, the rivers become more shallow, making them prone to flooding during the twice-annual monsoon rains. The homes of many of the city's most vulnerable are now regularly inundated.

All this is neither a surprise, nor a secret: researchers in Kendari have known for at least 20 years that anthropogenic erosion and land use change upstream were dumping millions of cubic meters of sediment into the bay, causing it to lose depth—as much as 20 centimeters annually, possibly more (Iswandi 2003). Despite this knowledge, Kendari's government continues to build infrastructure, such as the enormous Kendari Bay Bridge, that further traps the sediment. Because the bay is so sheltered, there is very little coastal wave action that might carry some of that sediment out to sea. Indeed, so much sediment is being dumped and trapped that already much of the bay is no longer navigable to ships of any substantial draught. Anticipating the problem, the government subsidized the dredging and construction of "Kendari Newport" on a stretch of coast outside of the bay. In many ways, the bay has been politically and materially abandoned. Ironically, the same calm, sheltered waters and narrow inlet that made the bay an attractive place to live and created a social landscape amenable to political control, may be the thing that makes the bay disappear entirely.

As a case study, Kendari highlights the relationship between geography and power. What does it mean for a place to become unmoored from the political geomorphology upon which it was constituted? And if

Kendari's new political order is based not on control of the bay and its tributaries, but on control of the laterite sediments in its hinterlands, then what will happen when both the bay and the nickel are gone? As sediment flows shift, so does power, making emergent regions in the process.

Kendari is not unique: it is emblematic of how power is made by place, and in turn remakes the political landscape. Power, we show, is often sedimentary; that is, shifting political-economies are not just reshaping landscapes, but transforming the very earth systems and geomorphological processes that generate those landscapes and regions as the basis of territorial power. In Singapore, a strip of rubble in brackish waters marks one of the world's most consequential political borders, while state sovereignty is crystalized in projects of industrial salt accretion in Kupang Bay, and the literal foundations of Indonesian state institutions rest on rapidly compressing clays in Jakarta; in this latter case, the threat of recalcitrant sediments is so severe that the entire political geography of Indonesia's central government is being reworked to avoid it. Salt *is* sovereignty; nickel *is* capital; clay *is* anarchy; and as we will see next, rubble *is* the state.

Staying with the Rubble[1]

Spanning the midsection of the Johor Straits—a 30km-long channel of water between Singapore and Malaysia—is a 1,056-meter mound of crushed stone and granite. Constructed in 1924 with a motorway, railway tracks, and watermains, this mound became an arterial causeway for the colonial export economy. Today, the causeway is one of the world's busiest border crossings and remains a vital nexus between Malaysia and Singapore—a bilateral dependency made palpable by COVID-19 travel restrictions, which devastated Johor's economy while casting Singapore's lack of food sovereignty into stark relief (see figure 2). These relations are remnants of colonial policy, revealing how successive capital and political regimes effect significant changes at the sedimentary, social, and even microbial level.

With a burgeoning port-economy at Singapore, more efficient means were needed to convey increasing volumes of cash crops, tin, freshwater, and other resources extracted from the Malay peninsula to the British port in Singapore. When the causeway was proposed in 1917, disruptions to the tidal and water flow of the Straits was debated but concerns about this "tidal compartmentalization" (Alphonso et al. 2011) were addressed by incorporating a lock channel, electric lift-bridge, and ten five-foot culverts. Had they not suffered disrepair from damages in World War II and neglect, or fell into obsolescence, these mitigating features might have worked to manage the altered tide and allow the passage of small vessels. Instead, the choked causeway compartmentalized the Johor Straits, displaced local waterborne communication networks, and altered the socioecological landscape.

[1] Riffing off Donna Haraway's (2016) *Staying with the Trouble*, to emphasize responsibility for the effects of anthropogenic interventions by cultivating an ethical and relational approach with non-human entities.

Figure 2. In this image, Malaysian workers employed across the causeway form long queues to enter Singapore on March 17, 2020—a day before Malaysia's lockdown of the border—while light traffic trickles into Malaysia (Source Catherine Lai/Agence France-Presse via Getty Images).

In the past few decades, the causeway's dam-like effects have also turned the straits into a "giant toxic sink" (Low quoted in *Taipei Times* 2006). Industrial discharge, erratic freshwater river and dam outflows, palm oil effluents, and fish farm waste—externalities of national economic restructuring projects—aggregate near the causeway's stagnant waters. Indeed, the closer scientists get to the causeway to sample water, the lower the rate of water exchange and oxygen levels, and the higher the concentrations of nutrients, heavy metals, and algal biomass (Chai et al. 2021; Mohd-Din et al. 2020; Goh et al. 2017; Tan et al. 2016; Gin et al. 2001).

Unprecedented harmful algal blooms (HABs) in the Straits further implicate the causeway in environmental disturbances, but has also made it a strange companion for puzzling out how complex, increasingly global phenomena become emplaced. HABs are sudden overgrowths of algal species that produce toxins, deplete oxygen levels in water, or damage biotic and abiotic matter. While bloom events are proliferating with warming oceans and increased nutrient loads from human activities, the Johor Straits—with its sluggish, warm, and eutrophic waters—has long been an ideal host for HABs. Yet, scientists first recorded HABs in the straits in 1987 and it was not until 2009 that HABs occurred again—with unprecedented intensity and frequency, but not always on both sides (Trottet et al. 2021). The straits' compartmentalization allows scientists to puzzle out these curious conditions.

Global factors, such as the monsoon wind system and El Niño Southern Oscillation, superimpose on local conditions specific to each compartment. For instance, the perennial westward flow of the Singapore Straits likely carries sewage and ballast discharge—potential sources of nutrients and invasive species—into the western Johor Straits (WJS) (Sun et al. 2017). During the northeast monsoon, however, stronger currents flush higher rates of the Singapore Straits' waters into the WJS, while stronger winds and spring tides churn nutrients and sediments from the bottom to the surface. The coincidence of this nutrient enrichment with torpid circulation in the WJS and high light penetration during neap tide are favorable conditions for blooms. Additionally, deadly algal species potentially lying dormant as cysts in bottom sediment, and the resistance of cysts to ballast water treatment in a busy shipping lane (Trottet et al. 2018), further accentuates the significance of global atmosphere and ocean regimes on local coastal circulation, nutrient regimes, and HABs. Meanwhile, higher incidence of blooms occurring exclusively in the eastern straits further hints at different localized sources of anthropogenic disturbance, which are further distinctly compartmentalized. Staying with the rubble, scientists parse the scope and scale of environmental effects on the straits' more-than-human entanglements, increasing the resolution at which scientists understand a complex, increasingly planetary phenomenon like HABs (e.g. Wijaya et al. 2023).

An appropriate resolution could not come soon enough. Humans and nonhumans are trying to survive in shrinking living spaces encircled by the causeway, coastal development projects, and a maritime boundary enforced by coast guards and passports—all within the dire straits of an unpredictable microbial environment. Sedimentation, at the scale of a rubble causeway, extends the effects of colonial extraction into the present, structuring the flow of goods and labor in uneven ways. While facilitating these uneven exchanges, sedimentation also disrupts the circulation of water to noxious effects, and in ways that permeate imaginary territorial boundaries at all scales of life.

Isolating Sediments

One of two major tidal wetlands in the Wallacea region is located in Timor Island's Kupang Bay, and it is being converted into salt ponds. The wetland is a critical habitat for migratory birds, estuarine crocodiles, fish, crabs, penaeid shrimp, and invertebrates (Trainor and Hidayat 2014); and the health of the wetland's ecosystem is critical to vernacular livelihoods. However, since the 1980s—and with intensifying pace—a state-supported commercial salt industry is changing the shape of Kupang Bay's coastline. Government plans for Kupang Bay aim to emulate the Madurese industrial model, pictured above (see figure 3), which dates back to the Dutch colonial salt monopoly. Yet while Madurese saltworks are lauded for their large contribution to Indonesia's national stocks, the detrimental environmental and dispossessory effects of these operations is rarely mentioned. In Kupang's coastal zone, all but 300 hectares of the approximately 4,000 hectares of intertidal mudflats, fringing mangroves, and beaches in the 9-kilometer stretch of land encircling the bay were included in a 1990s concession for commercial salt. The result has been desecrated landscapes, dispossessed human-nonhuman residents, and environmental degradation that impacts the biophysical system in and around Timor.

Figure 3. At an industrial scale salt operation in Madura pumps carry brine and bittern between human-made ponds. The liquid bittern, a by-product of salt production, will be released into surrounding waterways. New commercial salt operations in Kupang Bay, Timor are made to emulate the Madurese model, which dates back to the Dutch colonial salt monopoly (Source Author's own).

Geologist Warren Hamilton (1979, 121) referred to Timor Island as "tectonic chaos." The collision of the Banda Arc with the Australian shelf forged the island, characterized by its "chaotic mélange," where deep and shallow sediments ranging from the Permian to Quaternary ages imbricate with one another. Hulking stones sit in the landscape, a reminder that the geological formation of the island was and is an emergent, relational process; it is forged through movement, collision, and interpenetration (Satyana 2012). Sedimentary rethinking attends to how islands and coasts are constituted by rocks and sediments that are variously in flux—sediment being compacted into rock, rock being eroded into particles then sent in motion—and affected by abiotic and anthropogenic processes, like those used to isolate sediments for commercial salt farming and cement or nickel mining, or those used to extract and channel water, as in the Johor Straits and Jakarta.

By backhoe buckets, hands, channels, winds and pulsing waterways, sediments are on the move. In Timor, limestone hills feed the Kupang Bay coast downstream with sediment by way of rivers and estuaries. In this catchment-coastal process riverine inputs combine with oceanic forces to shape the coast and resources available there (Salomons et al. 2005). The abundance generated by these processes has for centuries brought fishers, foragers and traders to the coast to make livelihoods, much like in Kendari. In the early-nineteenth century, colonial desires to extract these resources and control regional trade led the Dutch to claim a government territory along the coast where they forcibly settled people from neighboring Rote

Island to be mercenary-agricultural workers (Fox 1977). Descendants of these settlers are today being enrolled as smallholding salt farmers to support Indonesia's national salt initiative.

Commercial solar salt evaporation requires a network of ponds and flats referred to as tambak. Tambak are constructed by shaping dense mud found in situ into discrete pans bounded by 2-meter-high embankments. Even at the scale of one hectare, excavators are the machine of choice for terraforming these earthen compartments in the intertidal mudflat, but in smallholder flats routine maintenance is done by hand. Water is drawn into brine ponds at spring tides or from estuaries, then moved through a series of tambak successively higher in salinity. Kupangese salt farmers describe this process of isolating sediments to draw out NaCl as "aging the water."

Some salt farmers monitor salinity with a baume hydrometer that measures density or osmotic potential of the water. When salinity reaches 7 baume it is ushered into condenser flats, then two flats and a few weeks later, at 30 baume, it is ready to be harvested from the crystallization flat. But in the process of isolating salt, a product the national government deems a strategic commodity, other materials found in seawater, like magnesium, are concentrated in a liquid by-product of solar salt production known as bittern. At 50 per cent concentration bittern has been shown to inhibit the growth of the robust, salt-tolerant mangrove species Avicennia marina, and in higher concentrations bittern can kill a mangrove in just weeks (Apriani et al. 2018). In Indonesia there is little oversight over bittern disposal. It is often pumped into seawater and estuaries, killing mangroves, altering ecologies, and transforming local livelihood possibilities. The residues (Hecht 2023) of salt making and economic nationalist projects are not a problem for residents of Kupang or Indonesia alone: contaminants and nutrients flow into currents and are carried along, not contained by regional or national bounds. Moreover, tambak for salt and aquaculture cover an increasing number of Southeast Asia's coastlines as ocean fish populations struggle to regenerate and people turn to fish farming even more.

The hardening of Timor's coast through the construction of tambak in Kupang, with its emergent industrial patchwork saltscape, may be the result of uncoordinated government development schemes, but even as it is patchy and haphazard, it has systemic effects throughout the region. The force of coastal engineering and development projects may not be as powerful as shifting tectonic plates, but in aggregate, human practices of isolating and moving sediment contribute to the shifting morphology of coasts and the aquatic spaces beyond them.

Compressing Clays

Muara Angke, a coastal *kampung* (urban village) of small-scale fishers in Jakarta, has sunken more than two meters in the last two decades. Some residents raise their homes using bamboo stilts. In other homes, the ground floors have become squat, pinched as people add layers of cement to their floors to keep above floodwaters. People continually add fill material like construction rubble to stabilize the soft estuarine ground (see figure 4). Perhaps most notably, mussel fishers have expanded the coast by incrementally

adding Asian Green Mussel (*kerang hijau*) shells, serving the dual purpose of keeping neighborhoods above water and creating new land for informal settlement (Keller 2023).

Figure 4. Shoreline made of mussel shells, Muara Angke, North Jakarta, 2020 (Source Author's own).

Coastal *kampung* like Muara Angke are disproportionately impacted by Jakarta's subsidence. Subsidence refers to soil compaction and sinking land. Notorious in Jakarta where coastal areas are sinking below sea level, subsidence is a common problem for soft-soiled urban deltas. While sea-level rise is an earth systems-scale climate phenomenon with locally specific coastal manifestations, subsidence is a place-based phenomenon that emerges largely from local landscape histories. Subsidence is often due to anthropogenic subsurface extractions, in deltas often exacerbated by sediment starvation and urbanization.

Heavy groundwater pumping from deep confined aquifers drives Jakarta's subsidence. The city is built over an alluvial fan of soft, compressible soils, sediments once carried coastward by the Ciliwung River. A system of confined aquifers lies about 40–200 meters deep. As groundwater is extracted, deep aquifers lose volume, and soils compact. This causes vertical displacement, or subsidence. Deep groundwater pumped by an estimated 15,000 private borewells provides at least 70 percent of Jakarta's water (Batubara, Kooy, and Zwarteveen 2023). Jakarta's surface waters are so polluted that expanding the piped water network would require expensive sewage infrastructure that the megacity lacks, and private pumping largely supplants centralized piped water and sewage infrastructure.

The patchiness and inequality of property and water management in Jakarta are key to the form of subsidence. Entrenched histories of inequality produced through water management and property regimes shape contemporary patterns of who pumps high volumes of deep groundwater and who subsidence harms. Dutch colonizers designed Batavia to be segregated, and a racialized land tenure system became differentiated by water infrastructures. Europeans owned property with access to water infrastructure while locals lived in self-built *kampung* without land rights or pipe connections (Kooy and Bakker 2008). Today *kampung* are often squeezed into polluted, flood-prone spaces with unstable land tenure, and many are excluded from piped water infrastructure on the basis of their informality. Property developers and industries can dig deep wells and consume unregulated groundwater. Enormous upscale malls and high-rise buildings privately manage their water provision and sewage treatment, which usually entails pumping groundwater and dumping wastewater back into rivers.

This patchy inequality above ground is interpolated by the patchy uncertainty of the subsurface geology. Jakarta has a lot of clay. Clay is porous but not very permeable, meaning that it can hold a lot of water between its grains, but water does not easily pass through. Jakarta's aquifers are confined by and/or consist of clay. Rather than being underground tanks with easily defined boundaries, aquifers are relationships between flows of water and the porosity of rock (Ballestero 2019). Clay can confine an aquifer made of more permeable material *and* store a large amount of water itself. With heavy pumping, water can be extracted from clay. But once extracted, it is hard to get water back in. Unlike shallow aquifers, confined clayey aquifers are not replenishable on a human timescale. Jakarta's subsidence is irreversible.

The varied distribution and behavior of clay makes subsidence spatially and temporally heterogeneous in Jakarta (Lees, Knight, and Smith 2022). Not all clay is equally compressible, and the impacts of groundwater

pumping can be displaced in space and time. Extraction in Central Jakarta might manifest as subsidence in North Jakarta. Sinking can continue decades after pumping has ceased.

The properties and interbedding of Jakarta's clays are not well understood, and long-term, comprehensive subsidence monitoring data are lacking (Hendarto and Standing 2019). Incomplete knowledge about clay hydrogeology and groundwater pumping means Jakarta's subsidence is difficult to model and predict (Kooi and Erkens 2021). Uncertain models can justify coastal development plans that require *kampung* eviction. *Kampung* residents, meanwhile, counter subsidence and eviction by adding materials like shells and rubble to the coastline, resulting in geomorphological change. Jakarta's rampant property development generates huge quantities of expensive-to-dispose-of rubble, which finds a new home in geologically and proprietarily unstable coastal *kampung* like Muara Angke. Like in Singapore, the rubble tells us something about the state. In Jakarta the production of space and social differentiation has long been bound up in the tension and mutually-constitutive relationship between formal property development and 'informal' *kampung* life. As Henk Kooi and Gilles Erkens (2020) argue, colonial rationalities and governmentalities are built into the contemporary fragmentation of water supply. They are also irreversibly inscribed into the city's sediments. Subsidence of clays has uneven, fickle consequences that do not align with the spatiality of groundwater extraction but *can* reproduce existing structures of inequality—with landscape-transforming effects.

Between 2023 and 2024, the mussel shore in the photograph above became inundated—not with water, but with sediment of mysterious origin. The coastal edge, now comprised of sediment and garbage, extends 25 meters further out into the sea. The new land is ambiguous ground for property claims by both kampung dwellers and the government. As the latter pursues a development agenda focused on transforming the sinking waterfront into the "new face of Jakarta," largely through reclamation, kampung dwellers fear displacement. The shifting, ambivalent sediments recontour not only the material form of the waterfront, but also the way that entrenched inequalities are reconstituted spatially on a rapidly changing urban coast.

Conclusion: Shifting Grounds

Sediment flows and fluxes—made and unmade by entanglements of human and planetary processes—offer a chance to rethink the meaning of an emergent area. The sites herein described open up the "national" rubric so common to Southeast Asian studies without suggesting a newly reoriented idea of *area* fixity. Historically, soft-soiled Southeast Asian deltas have often been sites where colonial and nation states endeavor to establish themselves as symbolic centers and economic powers. It is the problem of the nation today that contributes to the conditions for hydrogeological management. Sediments, however, point to the slow dissolution or unexpected reshaping of the nation itself, especially along coastlines. If "trade was (Singapore's) lifeblood" (Lee 2019), then the rubble causeway of the Johor Straits was *arterial* to the city-state's astronomic success from a colonial entrepot—one that shipped the Malay peninsula's hinterlands to the world.

Just as nickel-mining in Kendari Bay and salt-production in Kupang Bay alter the morphology of coastlines into the foundations of particular political-economic projects, the placement of sediments in the middle of the Johor Straits literally trafficked the circulation of colonial economies and its structural inequalities into the postcolonial era. The placement of rubble in the Straits cauterized fish migration channels, water exchange, and literally halved the possibilities of livelihoods and mobility for coastal and indigenous Orang Seletar communities. As the case of compressed clays in Jakarta further shows, sediments entrench ecological disturbance and social difference in highly spatial and material ways.

The project of stabilizing sediments and rationalizing water flows is ongoing and becomes inscribed in sediment (Biggs 2012). Unlike how we might imagine histories inscribed in geological formations, the sedimentary structure of places like Jakarta is not neat, horizontal stratigraphic layering. Under "natural" conditions delta formation entails complicated patterns of cross-bedded soft soils, further complicated by centuries of heavy anthropogenic manipulation. In Jakarta, subsidence is the outcome of histories of articulation between inequality and the control of the relationship between water, sediment, and property. Recursions of colonial property and water management structure urban space and class relations in Jakarta today (Li and Semedi 2022). This is inscribed in vertical soil compression and its differential impacts.

Tidal wetlands, coasts, and island formations, like nation-states and other kinds of political units, are not eternal but made and unmade through dynamic geological and political processes. In many cases the effects of political projects, like the national salt initiative in Kupang, have compounding social and environmental consequences that are acutely felt by coastal residents who rely on baylands for their livelihoods and survival. The widespread construction of *tambak* for commercial salt production has catalyzed the destruction of mangrove and wetland ecosystems, while the by-products and residues of salt production cause further mangrove loss and ecological disturbances in the tidal wetland and littoral. The hardening of Kupang Bay's coast for salt marginalizes, in both a material and social sense, more-than-human livelihoods that do not fit with state-sanctioned forms of productivity.

With the Anthropocene, a universalism emerges that throws into question the place of Southeast Asia—its contributions to planetary demise, its resilience in spite of it, and its vulnerabilities in the present. Scholars have pointed out how a major "turning point" in the Anthropocene happened during the acceleration of militarization and neo-empire during the Cold War (e.g. Ebron and Tsing 2017)—the same milieu in which area studies was created. As we approach another decisive moment during the Anthropocene—a turning of the tide that is pressed to address our endangered state of environmental affairs—what might the *emergent* area now respond with?

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