The Sea Wall and the *Kampung*: A Debate on Architectural Cosmotechnics

Roi Salgueiro Barrio and Sasha McKinlay

MIT School of Architecture and Planning, US

Corresponding Author Email
rsalguei@mit.edu

ORCID
Roi Salgueiro Barrio https://orcid.org/0000-0001-8117-443X
Sasha McKinlay https://orcid.org/0009-0009-2448-6539

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Abstract
We propose that architectural responses to planetary environmental challenges are a crucial domain for cosmotechnical action. We explore the possibilities of cosmotechnical design by analysing two contrasting responses to the effects of anthropogenic climate change in Jakarta: defensive sea-wall construction and adaptive community action. Jakarta is an essential case for exploring cosmotechnics: a world city at the forefront of planetary environmental challenges, and a capital with a conflicted urban history, deeply shaped by colonisation and by its immersion in global circuits of capital and trade.

Keywords
Cosmotechnics, climate change, geo-engineering, territory, kampung

What is cosmotechnics for? And where does it work?
In *The Question Concerning Technology in China: An Essay in Cosmotechnics*, Yuk Hui explains the key condition where his proposed notion of cosmotechnics works: the Anthropocene – a planetary context that Hui reads as the universal imposition of technical modernity and global capitalism.[1] By defining cosmotechnics as the 'unification of the cosmic and moral order through technical activities', Hui seeks to counter the understanding of technology as an autonomous realm devoid of ideological content and implementable in any context across the world that has underlaid the emergence of the Anthropocene.[2] To the hegemonic technologies driving capitalist globalisation, Hui counterposes the possibility of creating a diverse and ecologically thriving world, characterised by technological plurality. In this sense, as Hui has repeatedly stated, cosmotechnics is, above all, a tool for planetary thinking.[3]

But Hui is also conscious that his proposal joins a dense and contested landscape of concepts seeking to reconfigure our forms of operating in the Anthropocene. In particular, Hui polemically situates cosmotechnics as a way to transcend the two contrasting ideological poles that are structuring most debates on the Anthropocene. On one hand the 'eco-modernist' thesis, which understands solving the ecological degradation produced by global capitalism as only requiring more technological ingenuity: new, cleaner, global eco-friendly technologies, hyper-efficient fabrication methods, green algorithms coupled with AI-powered data-science, or, why not?, geo-engineering. On the other hand, the position championed by the 'ontological turn' in Anthropology and the critical humanities, which states that to overcome our planetary ecological crises we need to radically abandon the modern conceptual edifice and its associated ways of categorising the world.[4] Without a doubt, Hui is critical of the eco-modernist approach. And yet, cosmotechnics is also, decidedly, an

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instrument to overcome the shortcomings of the ontological turn.[5]

Anthropologists Eduardo Viveiros de Castro, Marisol de la Cadena, Bruno Latour and Philippe Descola are some of the major 'ontological turn' thinkers. For Hui, Descola is a particularly crucial figure. In the same way than Hui's cosmotechnics posits that there is not a single technology, but a plurality of technics, Descola considers that there is not a single nature, but four types of human-nature relations, four 'ontologies': animism, totemism, naturalism, and analogism.[6] Of these, only naturalism corresponds to the dualistic split between culture and nature that dominates Western thought, whereas the rest characterise non-Western and indigenous societies. This idea of multinaturalism motivates ontological thinkers' central thesis: our current ecological crisis is the result of Western mononaturalism's forced conversion of the plural world into a universe. Their goal is to challenge this universalist framework by recuperating the multinaturalist logics of non-modern communities, fostering a world populated by a multiplicity of groups, each with their own, distinct ontology. For the ontological thinkers, there is neither a single humanity nor a single nature, but a plurality of life-worlds.

Hui certainly appreciates the ontological turn's pluralistic attitude: cosmotechnics also seeks a plurality of techniques. However, there are key divergences between cosmotechnics and multinaturalism. Hui is sceptical of the fascination with non-modern indigenous ontologies as viable alternatives to modern technology. He considers that modern, Western technology has so deeply shaped societies across the planet that there is no return from its effects. Similarly, he criticises the identitarian ideology of localism pervading ontological discourses, and its potential risks of 'metaphysical fascism'.[7] For Hui, the value of locality derives from its capacity to trigger new planetary forms, rather than from having an intrinsic value as an independent life-world.[8] Moreover, Hui comes close to eco-modernism by affirming that it is not possible to elaborate non-technological responses to the Anthropocene. Premodern solutions do not solve global challenges. The goal of cosmotechnics is thus to build upon the existing planetary technologies, by diversifying their forms and, crucially, by rethinking them as constituents of new reconciliations between the moral and the cosmic.

This attempted reunion of the cosmic and the moral via technology brings us to a last, key conceptual difference between Hui and the proponents of the ontological turn. The latter have articulated another major critical concept to operate in the Anthropocene: cosmopolitics.[9] Understood mostly as a branch of political ecology, cosmopolitics considers that interventions modifying ecology and environment should be the drivers of political debate between the different communities affected, each representing a different ontology. The hope of cosmopolitics is that the debate between these contrasting life-worlds would result in agreed solutions which, instead of extending once more the universal hegemon (that is, 'capitalism') would reconcile the needs and cultures of those involved. The planetary addition of all those local debates would result in a pluriverse, rather than in the supposedly existing, Western dominated, universe.

Hui's emphasis is on technics and poetics, not on politics. This techno-poetic character has a strong spatial component. When Hui talks about the technical integration of the cosmic and moral orders, his understanding of the cosmos is explicitly geographical or spatial. His constant point of reference on this aspect is Gilbert Simondon, whose book *On The Mode of Existence of Technical Objects* is a major theoretical inspiration. In it, Simondon traces the historical emergence of technicity in order to reveal how technical systems originate in relation to a geographical milieu and constitute a means to structure or 'reticulate' geography, imbuing it both with spatial order and cultural meaning. Cosmotechnics is a contemporary attempt to rehabilitate this vision of technology as a tool to culturally and spatially structure geography into a 'techno-geography'. Following Simondon, Hui understands that technics turns the geographic 'ground' into a 'figure'– only now, the geographic figure becomes a planetary one.

This contrast between cosmotechnics and the pair cosmopolitics-anthropological turn brings forward two major consequences of Hui's thinking for urban design. The first is his scepticism towards strictly local life-worlds and technics, and his interest in exploring how local and 'modern' technics inform each other to generate a different form of building the Anthropocene. The second consequence is Hui's inattention to the political procedures that are at the core of cosmopolitical practices, and his alternative emphasis on the role of technology to articulate our planetary, geographic milieus. Hui declines the political as a cosmotechnical question.[10] For him, the key to an alternative shaping of the cosmos is a new, pluralistic way of technical thinking.

During the last decade, the ontological turn has led to several theoretical speculations on the possibility of 'cosmopolitical design', albeit with barely any actual impact on architectural or urban practices.[11] The conceptual changes Hui proposes – going from the ontological privilege of a diversity of natures to the privilege of a diversity of techniques, from the emphasis on non-modern life-worlds to a possible convergence between modern and non-modern techniques, from the political to the geographic – may suggest valuable paths to overcome the cosmopolitical impasse. And yet, this possible approximation between

architecture and cosmotechnics must also contend with the fact that architecture is not merely a technology, at least not in the sense that Hui prioritises (machines, digital systems). Architecture is usually motivated by several layers of cultural, formal and spatial intentionality that exceed mere technical rationality and impede equating architecture to technology. As a result, we cannot simply assert that architecture *is*, at all levels, a cosmotechnics. We can, however, adopt a more partial approach: to interrogate what particular areas of architecture can be relevant *as* a cosmotechnics. As Hui has himself done by thinking art *as* a cosmotechnics, we can use cosmotechnical reasoning to interrogate, and develop some crucial dimensions of architectural production.

We propose approaching architecture as cosmotechnics through two main conceptual moves. First, by singling out as an object of reflection those aspects of the architectural practice with a determining technical component. In this sense, cosmotechnics becomes a call for deeply rethinking architecture's technical logics. Second, by paying special attention to those architectural technics directly involved in the response to planetary challenges. In the same way that Hui's recent writing focuses on cybernetics and programmability, because these are key technical dynamics shaping contemporary planetarisation, we propose that the crucial realms for cosmotechnical thinking are those architectural, urban or territorial interventions that need to contend with, and shape, planetary phenomena; primarily, climate change.

Our point of entry to explore the possibility of architectural cosmotechnics is to discuss contrasting architectural strategies responding to sea-level rise: defensive sea-walls and flexible adaptation. Our space to do so is Jakarta, a multifaceted case for cosmotechnical analysis: a world-city at the forefront of the Anthropocene's environmental challenges; a capital with a conflicting urban history, deeply shaped by colonisation and by its immersion in global circuits of capital; a human geography that pressingly needs to contend with the combined effects of sea-level rise and land subsidence.

Jakarta is, in fact, the scenario of contending visions to address the Anthropocene's effects. The national administration intends to protect the city by building a kilometric sea wall, accompanied by a huge coastal urban development. In this project, we see at play the implementation of well-settled technologies of coastal protection, refined during modernity, and which are being implemented worldwide to avoid coastal flooding. Alternatively, Jakarta is also the site of hundreds of *kampung*s. These are semi-autonomous 'villages', often built without state support, that respond to sea-level rise through a changing, flexible relation to the aquatic medium that is at the centre of the residents' social and economic lives. Through the Sea-Wall and the *kampung* we can debate how contrasting techniques of environmental response can become potential components of an architectural cosmotechnics, components whose relation is not necessarily either/or, and which may have the capacity to articulate, anew, our geographic milieus.

The technical organisation of Jakarta's hydrological systems

Jakarta is a city severely affected by climatic hazards, threatened by water from two sides: the sea in the north, and its overwhelmed rivers carrying water from mountains to its south. A significant part of the city is built under sea level, occupying the space of a delta where thirteen rivers converge into Jakarta Bay. The intense monsoon rains, coupled with the difficulties of drainage, causes frequent flooding of significant areas of Indonesia's capital. The city's worst inundation, in 2007, affected more than 300 000 inhabitants, while similar events had already happened in 2002 and 1996.[12] The flood risk is only exacerbated by anthropogenic climate change. The possibility of torrential floods has increased, and the expected sea level rise will augment the possibility of flooding from the sea. As a result, protecting the city from flooding has become a logical concern for Indonesian authorities.

The city's responses to flooding are heavily influenced by its colonial history. The Dutch colonisation of Indonesia resulted in a complete modification of Jakarta Bay's environment, and in the creation of the system of water management that still characterises the contemporary city. Prior to the arrival of the Dutch, indigenous populations situated their settlements on higher terrain, reserving the delta's marshy, flood-prone areas for agriculture.[13] This techno-geographic logic was neglected by the Dutch East India Company, whose dominion over their own low-lying coastal deltas emboldened them to settle at the mouth of the Ciliwung River.[14] The fort of Batavia, the germ of current Jakarta, was built directly on the coast as an export-oriented port-town. To tame the delta's volatile hydrological conditions, the colonists relied on the technical logics formed in their own milder, more compliant environment: by the early seventeenth century, the bay's rivers and their tributaries had been transformed into a system of canals.[15] The limitations of this technic of water management in a new geographical context and a forbidding tropical climate soon became evident: mere canalisation was incapable of properly handling the water flows. Siltation was a recurring problem, often clogging the city's canals and rivers, while sedimentation complicated the port's use.[16]

Dutch Batavia turned into Jakarta after 1945, when the city became the capital of independent Indonesia.

Jakarta's massive urban growth is a post-colonial phenomenon. Between 1960 and 2010 the population grew from 2.7 to almost ten million people, turning Jakarta into one of the largest megalopolises in Southeast Asia.[17] This drastic growth has exacerbated the city's hydrological problems. The few remaining floodable buffer zones were occupied by settlements, while the ecosystems mediating between land and water, such as mangroves, diminished.[18] In addition, construction proceeded without piped water provision, leaving 53 per cent of Jakarta's population to rely on water obtained from private deep-water wells. Meanwhile, the reduction of permeable green areas from 40 per cent in 1985 to only 9 per cent by 2002 prevents the natural repletion of aquifers.[19] The consequence is an extended phenomenon of land subsidence. 40 per cent of Jakarta is now below sea level, and land subsidence rates range from three to twenty-five centimetres per year: a rate up to ten times that of sea level rise.[20]

We situate ourselves in a city affected by monsoon rains, land subsidence and the sedimentation of its canals, by climatic hazards and sea level rise. Can cosmotechnics help us rethink the city's response to these challenges?

The Sea Wall

The Giant Sea Wall. Or The Great Garuda. These two names popularised, in the international press, an ambitious project of geo-engineering with a less bombastic, more bureaucratic, official title: the National Capital Integrated Coastal Development (NCICD). The initiative was announced by the Indonesian government in 2014 to protect Jakarta from sea-induced flooding events, and contemplates enclosing a significant part of Jakarta Bay by building a thirty-two-kilometre-long dyke, parallel to the city's northern coast. [Fig. 1] Although the project has received justified criticism for its dramatic social, ecological, and economic costs, the construction of the sea wall still appears to many in the Indonesian government as the optimal solution to protect Jakarta. If built, the city would follow an increasing number of sites across the world that are building massive coastal barriers. Caused by a necessary concern with sea level rise and extreme climatic events, over the last three decades sea walls have increasingly become a global technology to protect land, implemented with similar technical procedures across different geographic and cultural contexts.

But protection may not be the only rationale behind the project. The NCICD culminates a series of previous projects to reconfigure the city's coastline. In the 1990s, Sukarto's authoritarian regime already proposed a massive land reclamation project for Jakarta Bay. Similar land reclamation measures were conceived during the 2000s, after Sukarto's resignation, and captured in the 2010–2030 Spatial Plan for Jakarta.[21] All these plans had ambitions to utterly transform the existing socio-spatial fabric of Jakarta's coast line (a mix of port and industrial activities, warehouses, and traditional stilt housing for the city's fishing communities) into the clichéd repertoire of the global city: business centres, leisure spaces, offices, and housing for the accommodated classes. The NCICD project would be the last, even more ambitious, turn of the screw. It is the excuse for an enormous urban operation to transform Jakarta into an eminent coastal city on the global stage. The design contemplates creating a freshwater lagoon between the existing city and the wall, and the construction of seventeen artificial islands full of new offices and housing, capable of absorbing two million people. Toll roads, a railway, a seaport and new beaches would top the operation, adding the necessary amenities and services to fulfil the well-established image of the global city.

Opportunistically, the NCICD's vision of a global city aims to adjust the expectations of transnational capital to local mythology, thus replacing the existing inhabitants of the area by their presumed beliefs. The NCICD replicates previous coastal projects in Singapore, Shanghai and, especially, Dubai. Since the fall of the Berlin Wall, architects helped build the image of neoliberal globalisation by distributing interchangeable architectural icons across the world. Dubai's waterfront initiated a new inflection of this global trend. The iconic character of the buildings was translated to the urban plan: its well-known islands compose figurative images of palm trees and planispheres. The Jakarta project replicates the operation on an even larger scale. Seen from the air, the sea wall and the islands form the image of a Garuda, Indonesia's mythical bird and national emblem. Mythology is instrumentalised to reconcile the transnational needs of the global city with local traditions, while also producing a capital-attraction image, consumable worldwide.

Sea walls are a millennial technology that has been thoroughly refined in the last one hundred years, thanks to the perfection of engineering methods and the better understanding of coastal behaviour. In this period, sea walls became a global technology, increasingly needed to protect urban areas from sea level rise. Their construction has gone hand in hand with the consolidation of global nodes of engineering expertise, capable of exporting their technical know-how. The NCICD is a collaboration between the governments of Indonesia and the Netherlands – the former colonising power, and the country responsible for Jakarta's existing, problematic, system of canals – but the project was entirely designed and largely financed and managed by Dutch corporations. Backed by the state, Dutch engineering firms present themselves as experts on dyke-construction, an affirmation sustained by the

Fig 1: Visualisation of the NCICD plan. Image: Kuiper Compagnons.

country's successful history of protection from the North Sea. The model for the NCICD is the 1932 Afsluitdijk, the Netherlands' longest dyke, whose length of thirty-two kilometres matches Jakarta's wall exactly. In the NCICD we thus see the conflation of some key aspects of neoliberal globalisation. Global engineering expertise, coupled with globalised technology, aimed at the production of global cities, whose new plans and constructions circulate across the planet as symbolic, easily consumable images.

The NCICD is not the most efficient way to solve Jakarta's flooding problems, or the best response to their urgency. The heavy monsoon rains, and the incapacity of the heavily sedimented, colonial-era canals to channel the same volume as the older rivers had been, cause floods that are not related to the sea. Jakarta's land subsidence is equally independent from sea-level rise. The lowering of the terrain and the insufficient drainage won't be solved by the sea wall. Solving those issues requires technical measures such as building a city-wide water infrastructure to avoid ground water extraction, implementing efficient measures to reduce the waste and sediments deposited in the canals, and increasing the permeable surfaces for water absorption. Such measures are more urgent than the construction of a sea wall.

In addition, local critics of the project have correctly highlighted the devastating ecological and social transformations the NCICD would produce. If built, the intervention would turn a vast area of Jakarta Bay into a freshwater reservoir, eliminating the area's biodiversity and the few remaining mangroves that have survived urban development, themselves a natural protection against sea-induced floods. The NCICD would also suppress the fishing livelihoods of a significant part of Jakarta's communities. As a result, the project would cause the eviction of the existing communities, whose lives are fundamentally linked to the sea, to be replaced by citizens who can afford living and working in new, upper-class islands. Ultimately, the need for protection masks plain and simple gentrification.

We fully support these criticisms, and the need to utterly rethink the NCICD. And yet, in the light of the expected sea level rise and associated climate change, the future need for a sea wall may remain. While the city should prioritise the measures to avoid land subsidence and increase the canals' draining capacity, the expected increase of cataclysmic sea-related hazards may support the idea of building a sea wall to protect a vast city in which radical measures such as abandoning flood-prone areas seem impossible to execute. If that is the case, how could the construction of a sea wall be approached differently?

Dipesh Chakrabarty has suggested that the emergence of a 'geological consciousness' derived from anthropogenic climate change implies the coming 'of a point in history where the global discloses to humans the domain of the planetary'.[22] The NCICD is a clear example of a globalised construction ethos, mobilising transnational engineering expertise to produce capital-driven global imaginaries. Yet, can the need for environmental protection, characterising life in the Anthropocene, be altered to play a cosmotechnical role? Can a globalised technology responding to planetary challenges be turned into a cosmotechnical one?

Indonesia is the largest archipelago in the world. Its culture and livelihoods have historically maintained an intense relation to water. This intensity of relations is captured by the Indonesian term *tanah air*, whose literal meaning, 'land-water', translates into English as 'homeland' and is used to refer to the entire archipelago.[23] We see, in this notion, an entanglement of biophysical media and social conditions, rather than a clear distinction between them. Across the archipelago, few places are considered truly 'inland' and so a large part of Indonesia's communities have a meaningful connection to the coast, in Indonesian, *pantai*. This is a highly polysemic term. In addition to meaning coast and beach, *pantai* also expresses, in Abidin Kusno's words, cultural and political 'aspirations for connection, integration and expansion' coupled with the 'pre-national "oceanic feeling" of Southeast Asia and the Pacific Rim at a time when the maritime polity united all the islands and waters in the region'.[24] For its part, Jakarta historically maintained a close relation to its beach (now disappeared) and to the bay's Thousand Islands, severed due to metropolitan growth. This relation has been both cultural and economic, and is still present in the fishing communities that currently inhabit the city's coast. Any cosmotechnical project in the bay should elevate these multiple relations to the sea.

Historically across the world, walls have been an essential instrument to define urban and architectural boundaries, structuring the relation between human artifice and nature. In Indonesia, the construction of stone walls mostly pertains to the domain of monumental architecture, rather than housing and villages; the wall's solidity marking permanence and importance. Also in Indonesia, the land taking rituals that used to precede the act of building served to create a system of geographic references, an overall frame each architecture then responded to.[25] Walls marked and differentiated space, and carried with them the capacity to order or, in Simondon or Hui's words, reticulate, geographic space. They constitute, following Gilles Deleuze and Elizabeth Grosz's geological reading of art, keyframing mechanisms, while frames are 'what establishes territory out of the chaos that is the earth'.[26]

In the NCICD the construction of the wall is the primordial hidden gesture, the problematic technical operation carefully obscured by the superficial image of the Garuda.

Reacting against the appeal to mythology, the primary element of cosmotechnical reflection should be the consideration and problematization of the wall, taking it as the element that will regulate the cultural and social relations between land and sea. Focusing the design on the definition of the sea-wall replaces the NICID's character as an act of image-making. Instead, it pays attention to the wall's role as an element that will define the area's social and ecological conditions, and frame its geographic and planetary relations. In this regard, a cosmotechnical approach to the sea wall should prioritise this infrastructure's territorial and ecological performance as an element shaping the 'techno-geographic milieu', rather than image-making.

The mythological reference to the Garuda strictly operates at the level of the plan view. The cosmotechnical approach to the sea wall requires, in turn, a careful understanding of the project's section in order to treat the infrastructure as a *tanah air*, land-water mechanism. Defining the project's section implies considering the sea wall's construction methods, its materiality, the possible coexistence of hard and soft engineering techniques and, crucially, its potential permeability to sea water, something Dutch engineers are about to implement in the Afsluitdijk, and that would allow the preservation of part of Jakarta Bay's ecosystem and the livelihoods of existing fishing communities.[27] This approach to the project also necessitates extending the section geographically, well beyond the wall, to trace the infrastructure's relation to the area's geology, bathymetry and ecology. The geographic section is a tool to measure the wall's functional and visual behaviour. It serves to calibrate the relations between city, wall and horizon, and to frame the ways in which communities can elaborate new ways of accessing the sea. The Garuda-shaped NCICD is a nationalistic emblem operating in plan. Cosmotechnics can promote a planetary-oriented element, operating geographically and in section.

Undoubtedly, a project like the NCICD is more than its section. Our emphasis on this infrastructural element comes from its being the project's technical core; the concealed nucleus from which the rest of the urban operations emanate. Cosmotechnics allows us to deeply question the generic technical rationality behind the project, and to open up new possible entanglements between culture, space and society. The current construction of the wall, and the the clear-cut divisions it produces between land and sea, between fresh and sea water, represent globalised technical methods that are being similarly implemented worldwide. The cosmotechnical interrogation of the seawall's section opens a door to rethink the Jakarta Bay project, but also begins to probe similar infrastructural projects across the world.

The *Kampung*

The term '*Kampung*' has no direct translation in the English language. It is often loosely translated as 'village', with connotations of rural or peri-urban contexts that have limited contact to modernity. In certain political rhetoric, 'kampung' is synonymous with 'slum'. In the case of the international coverage of Jakarta's environmental challenges, 'kampung' is used to refer to poor, over-populated, 'informal' urban settlements. In fact, a kampung is a heterogeneous category of settlement that more closely describes its social organisation and underlying cultural mores, rather than any particular architectural form. In abstract terms, the kampung is a traditional mode of collective living that implies a deep relationship to one's community and one's environment. In a country that encompasses countless geographies, ethnicities and cultures, kampung mores represent a scarce few core values that resonate across the Indonesian archipelago.

Contemporary kampungs have their roots in historic agricultural communities: traditional kampungs governed by customary law, or *adat*, which guides the community's culture and moral structure.[28] Adat is closely related to the community's cosmology, forming the framework by which it understands the world and its place within it. Adat life-worlds are frequently described as 'indigenous', however, already contested notions of indigeneity are particularly complex in the Indonesian context: most Indonesians are indigenous to their area, but given the thoroughly diverse make-up of the national population, even the most remote communities frequently take in 'local' migrants. Local organisations have instead adopted the term 'adat communities', which acknowledges the specific underlying social code rather than a reference to origin.[29] These sites are generally named 'kampung adat [area]', revealing the innate link between the kampung, as a settlement typology, and the social contract encompassed by adat.

While specific cosmological beliefs and adat laws vary across the archipelago, common threads span the entire nation. Broadly, adat communities have some version of a worldview that divides the cosmos into upper, middle and lower realms. Humans share the physical world (middle stratum) with other active and dynamic agents, including animals, earth; and importantly, water. This cosmology describes a relationship between communities and the world they share, with a distinct appreciation for Indonesia's geography, where natural elements (primarily earth and water) are often erratic and severe environmental events common.[30]

Notably, adat values assert three key community principles: flexibility, participatory engagement and mutual aid. These are legitimated by a worldview that acknowledges that nature is neither static nor unstable but behaves in

a predetermined, cyclical trajectory. There is an acceptance of the flow of nature and an understanding that it is resilient, as long as it is kept within the limits of its predetermined course. Adat therefore proposes a cooperative relationship between the community and its territory. Compliance to dynamic environmental cycles necessitates communal monitoring and encourages kampung members to participate in the evaluation of risk within the traditional agricultural system. Given the doctrine of mutual aid, kampung inhabitants can rely on a social code that distributes this risk throughout the community and will take individual action based on an assessment of particular social relations. [31]

Traditional adat practices of environmental management are exemplified by the Subak irrigation system of Balinese farmers. Here, rice farmers situate themselves within a cooperative socio-environmental system at the scale of the watershed. Harvest cycles are punctuated by adat rituals that entail collective environmental monitoring, resource evaluation and the synchronisation of agricultural activity. Subak farmers therefore conduct their agricultural operations based on a moral framework structured around spiritual, communal and environmental harmony, rather than purely for economic gain.[32] The Subak, therefore, is an ancient water management technic that aligns with the cosmic and moral order of adat.

However, it is important to note that adat also remains foundational to contemporary Indonesian ways of life. These social codes and moral order are exercised, to varying extents, by the full spectrum of the Indonesian population: from the most traditional adat community to the most reformed urban household. In this way, the kampung further subverts notions of indigeneity by disrupting its preconceived association with 'pre-modern' societies. This coexistence of contemporary conditions and adat practices distinguishes Jakarta's kampungs, some of them dating back to the seventeenth century, as sites offering distinctly Indonesian cosmotechnics.[33]

Jakarta is the site of hundreds of urban kampungs, composed of 'indigenous' Javanese and migrants from across the archipelago alike.[34] These take an array of architectural forms, having been assembled with various of amounts of capital and degrees of formal planning support from the local government. [Fig. 2] Given the historically aggressive commercial land development in Jakarta, its most financially vulnerable inhabitants have only been able to thrive on cheap, undesirable land. In fact, those kampungs at the forefront of Jakarta's environmental challenges are enabled by legislation prohibiting development on the fifty-metre selvage of the city's waterways.[35] This exclusion from the purview of commercial and administrative influence provides convenient parcels of land for growing kampung communities to settle by Jakarta's rivers, canals and shoreline. Here, informal kampungs do not have to compete with commercial land acquisition, but rather with the hysterics of an overburdened environmental system.

In an attempt to regularise the kampung into the administrative presence of the city, the Jakarta kampung has been absorbed into an otherwise Western model of urban administration. Officially, the kampung is interchangeable with the smallest administrative level of land: the *Rukun Tetangga* (RT), or neighbourhood.[36] This condition lends the kampung a partial autonomy, preserving a capacity for self-regulation and flexible coexistence with changing environmental conditions, including increasingly capricious flooding.

The urban *kampung*, like its rural village counterpart, is self-organised, administered by an elected RT chief who acts as intermediary between the residents and the wider world. The village chief's primary responsibility is to uphold the kampung's social code: *gotong royong* or 'mutual self-help'. This unwritten code is foundational to the Indonesian way of life, encompassing the adat principles of mutual-aid and flexibility. In the kampung, it drives a hybrid system of land tenure, which allows tenants to adjust their original plot boundaries with incremental, often unspoken negotiations. Though notions of ownership still exist in the kampung, flexibility in the practice of occupying space enables residents to temporarily adjust their spatial boundaries to accommodate personal, communal and environmental flux.[37] Similarly, adaptations to private property also frequently lend value to the community, such as easy evacuation points, raised platforms for community meetings and even occasionally bamboo supports to buttress more vulnerable homes.[38] [Fig. 3]

In this way, gotong royong is a tangible means of communal risk sharing, counter-balancing the potential for catastrophe during unpredictable climate patterns. In point of fact, many communities have been known to take cohabitation with climate risk into their own hands completely, communicating directly with watergate attendants to assess flood risks in real time, and acting through self-administered early warning systems at the local level.[39] These exploit contemporary technologies, such as WhatsApp, to foster collective consultation and action.[40] This brand of flexibility and mutual aid can be seen to be authorised by a foundation of adat cosmology. In this life-world, residents are motivated to help fellow community members weather (temporary) hardships, understanding that fates and fortunes take a predestined, cyclical course. Thus, the gotong royong social code's most valuable by-product is a culture of interdependence in increasingly uncertain environmental conditions, suggesting possible cosmotechnical paths to respond to anthropogenic climate change.

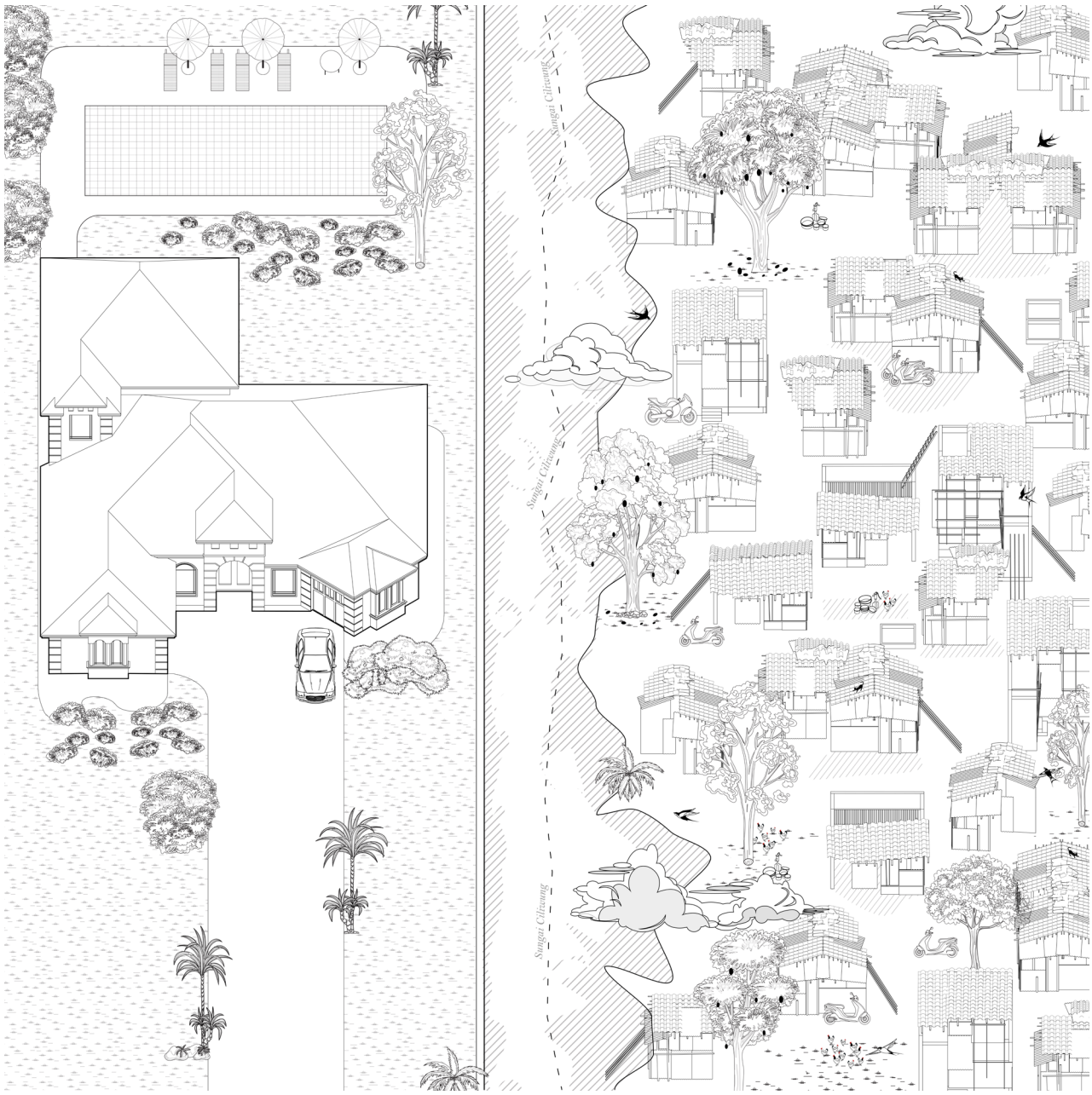

Fig. 2: Diptych of Jakarta's kampung and neighbouring gated community. Image: Sasha McKinlay.

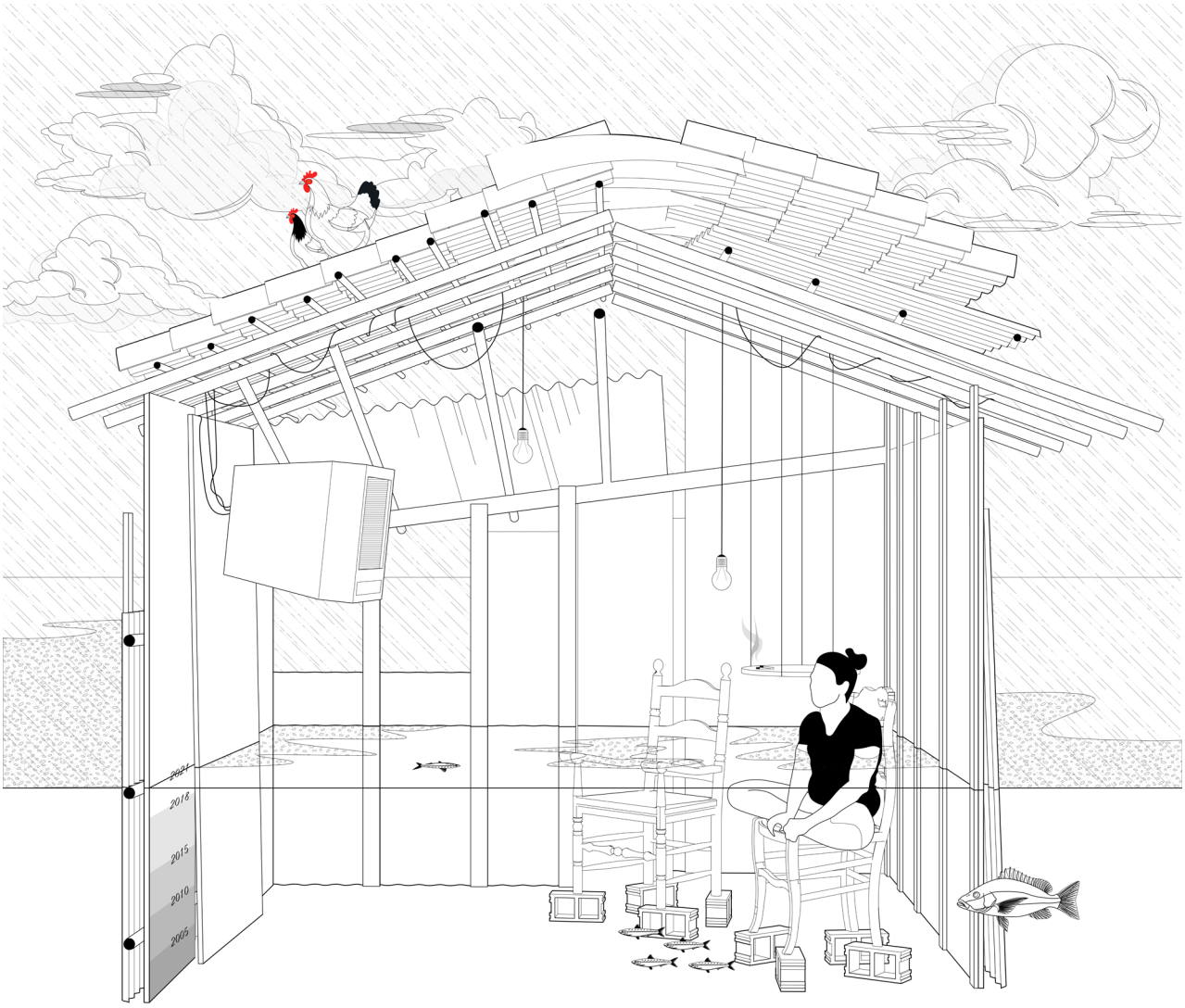

Fig 3: Gotong Royong system of mutual self-help in the kampung. Image: Sasha McKinlay.

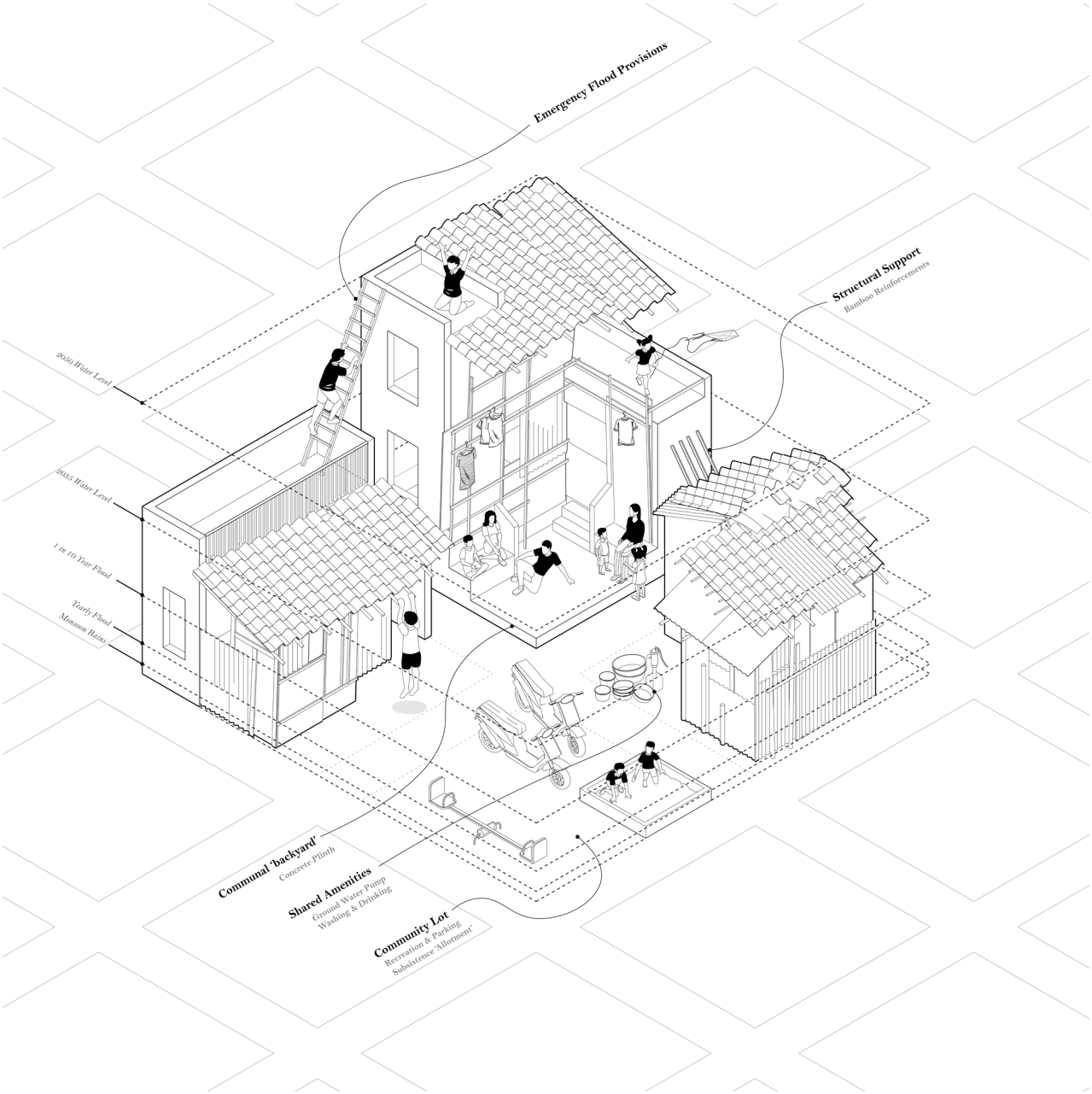

Fig. 4: Adat spatial hierarchy in flood-prone kampung homes. Image: Sasha McKinlay.

These kampungs are often ad hoc, patchwork constructions of plywood, corrugated metal and salvaged construction lumber. Homes may be raised on stilts, an architectural technic that harkens back to traditional adat kampungs. In a traditional kampung, settlements would organise themselves in step with the inhabitants' conceptions of cosmic order: elevating sacred spaces and allowing less important zones to lie below.[41] This arrangement occurs both at the scale of the settlement within its topography, and the home. It is this adaptation that is usually credited with passive climate control, sanitation, water management and protection from environmental disasters across scales of the vernacular kampung. Within its urban counterpart, the kampung's stilts have much the same effect. Raising the level of the home is a key adaptation adopted across Jakarta's kampungs, especially in response to flooding. It is also a well-known practice to keep and evacuate valuables to higher, drier zones of the house and the settlement, replicating a spatial order that closely resembles the traditional adat kampung.[42] [Fig. 4]

Many of Jakarta's rivers are fringed with stilted kampung constructions, homes balancing precariously over the edge of the river. Though natural waterways have largely been erased from the conventions of modern living, they are still critical to everyday life in Jakarta's waterside kampungs. Residents here will encounter their home waters daily as a space for washing, bathing, waste disposal and on the coast, fishing.[43] This profound dependence on land and water indicates a form of living that integrates a custodianship of the natural environment. [Fig. 5]

Indeed, Kampung community action has centred on environmental restoration of the river. In line with an underlying adat moral code, residents of the modern urban kampung continue to engage with environmental monitoring. Examples include conducting studies of fish species in the Ciliwung river, mapping industrial polluters across the watershed, and documenting land-use patterns along the bank. The urban kampung also demonstrates an inclination towards participatory engagement in addressing the pollution crisis of the water: organising regular river clean-ups.[44]

That said, the kampung has engaged in their own 'geo-engineering' projects. Kampung residents have been known to construct small dams and dykes, as well as platforms to lift public and private spaces away from the floods.[45] The key difference in these engineering adaptations are their alignment with an acceptance of natural flows. Kampung technics are centred on localised and temporary ways to manage the flow of water into their communities, using sandbags and compacted earth.[46] The fishing communities of Northern Jakarta also deployed rubble and mussel shells, widely available materials in their area, to raise a public coastal road and their homes, acknowledging the benefits of allowing the water to drain through and take their predestined course.[47]

Jakarta's kampungs offer a possibility of a cosmotechnical rationality, motivated by a shared moral order. Gotong royong can perhaps be simplistically described as a 'benefit-of-the-doubt' community posture and a 'margin-of-error' mode of occupying space. With negotiation and mutual understanding at the core of kampung culture, residents are better able to navigate unprecedented planetary challenges. Certainly, kampung adaptations are not blanket recommendations, but are demonstrations of technics deployed by an ethical logic in response to the kampung's tanah air, its earth-water. These 'techno-geographic' sentiments acknowledge the profound collective responsibility we have in the Anthropocene, to the environment and to one another.

Conclusions: a cosmotechnical debate

The sea wall and the kampung represent contrasting responses to the effects of anthropogenic climate change and, more broadly, of anthropogenic environmental modifications. They also represent different openings for cosmotechnical design. The sea wall is a more normative technical solution, based on the physical construction of a long-term infrastructural element aimed at stabilising human relations with the environment. The kampung, in turn, privileges the dynamism of responsive social practices. Kampungs show the existing vitality of adat and gotong royong values that link Indonesian cosmologies to social codes, producing strategies for an adaptive cohabitation between humans and environments. These social practices require coordination, negotiation, and flexibility.

Cosmotechnics is allowing us to approach urban solutions to anthropogenic climate change and, more specifically, to Jakarta Bay's controversy in a novel fashion. Cosmotechnics operate in a non-dualistic manner, by investigating the compatibility between global and local technics (in both directions) and by bringing to the foreground the techno-geographical logics that should lead any approach to climate. Cosmotechnics thus opens ways to interrogate the sea wall and the kampung, and to start conceiving new, diverse modes of structuring Jakarta's techno-geographic milieu. If it is necessary to build a sea wall, the design should explicitly address its role as an element framing Jakarta Bay's geography. The existing focus on the plan and on mythological imaginary should be replaced by a more careful calibration of the wall's section, allowing a dynamic interchange of water bodies and ecological conditions. The kampung shows the potential role that adat values and gotong royong practices could play in the construction of a sea wall. These notions question the value of infrastructural stability. Currently, the sea wall project aims to fix, permanently,

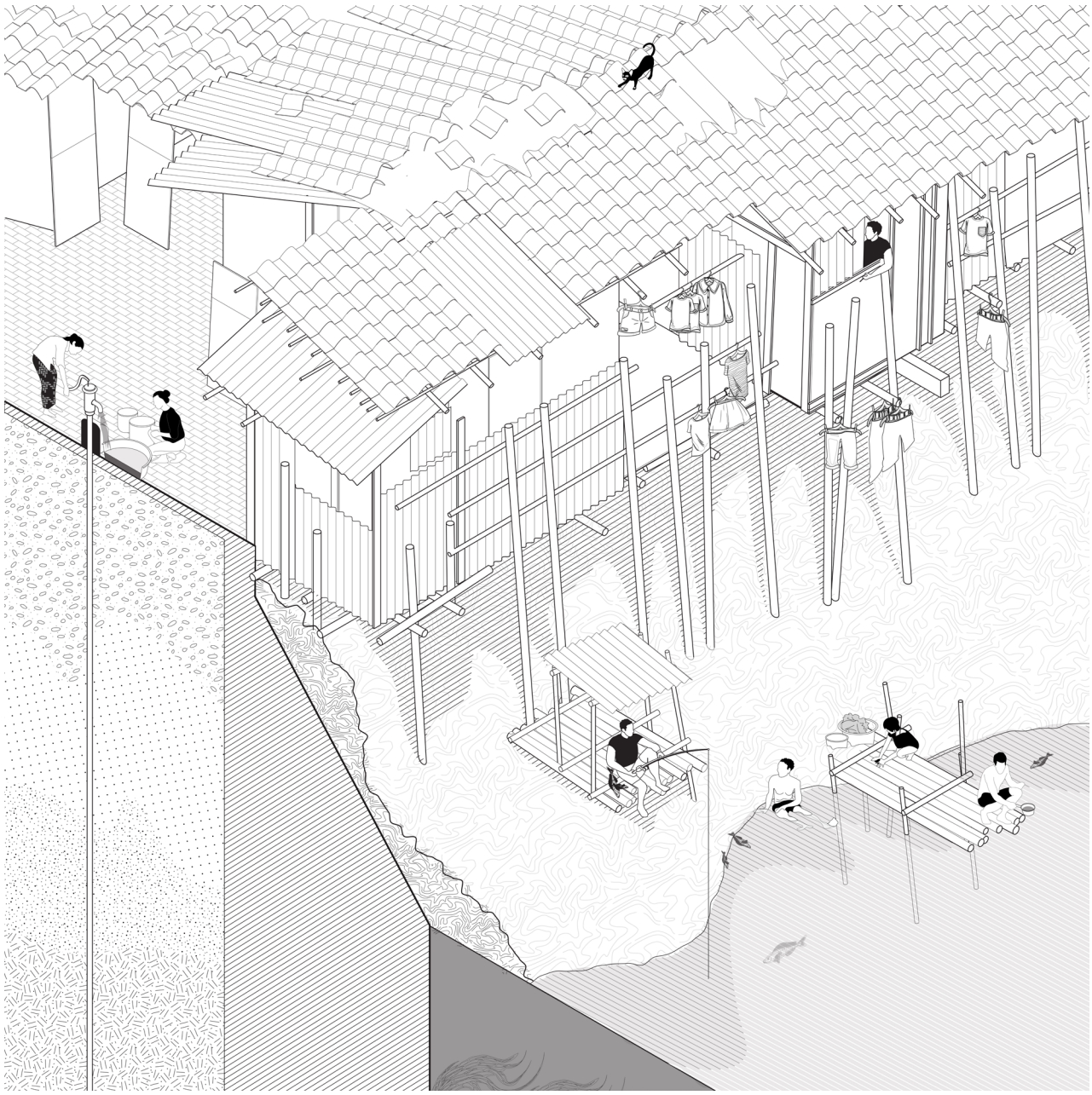

Fig 5: Kampung residents' stewardship of water. Image: Sasha McKinlay.

Jakarta's relation to the environment. Kampung strategies show that more flexible infrastructural operations are possible, supplemented by the influences of adaptive social practices.

These social practices can engage not only physical but also digital cosmotechnics. Coordination between kampung inhabitants already utilises diverse digital means. Jakarta's responses to climatic events can elevate this capacity for coordination. Hui has referred to the need to cosmotechnically rethink smart city technologies, which he considers part of a broader trend towards programmability as a planetary technology. The possible coupling of monitoring technologies with a more robust articulation of the kampung's digital practices reveals a possible path to a less technocratic, more cosmotechical approach to urban digitalisation.

Cosmotechnics opens a debate about Jakarta's attitudes towards anthropogenic climate change, both through the reinforcement of the kampung logics, and through the problematisation of the sea wall. Our complement to Hui's thought comes from the fact that, while he tends to separate cosmotechnics from political debate, the actual spaces for the practice of cosmotechnics are deeply entangled in political controversies. In that regard, our approach shows that a crucial value of cosmotechnics is its capacity to reformulate the technical procedures that are at the heart of the increasingly present political conflicts associated with responses to anthropogenic climate change.

One thing is clear. The history of Jakarta's infrastructural interventions exposes how problematic the unmediated, direct transposition of infrastructural techniques can be. The Dutch system of canals has always been an inappropriate solution for Indonesia's extreme and capricious conditions. A cosmotechnical approach to design requires avoiding the errors of hasty translation. By no means is this a negation of the value of interchanging cross-geographic knowledge, nor does it hold local technics to be unquestionably superior. On the contrary, cosmotechnics enables a dialogue between technical practices and helps us question existing global technologies. Finally, it offers a next step: to reintegrate them, in a considered manner, in our constant, planetary processes of technical interchange.

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Biography

Sasha McKinlay is an English-Indonesian architectural designer whose work investigates the intersection between traditional practice and modern technological systems. She holds a Master of Architecture from Massachusetts Institute of Technology and a Bachelor of Architecture (Hons) from the University of Bath. Sasha is currently a researcher at the Self Assembly Lab at MIT.

Roi Salgueiro Barrio is a lecturer in architecture and urbanism at the MIT Department of Architecture, and the curatorial director of the MIT Morningside Academy for Design. He is the author, with Hashim Sarkis and Gabriel Kozlowski, of *The World as an Architectural Project* (MIT Press: 2020), and the founder of architecture studio RSAU.