

Requalifying a Hinterland Through Indigenous Flows: Caogong Canal and Ad-Hoc City, Kaohsiung

Throughout history, the evolution and mutation of Kaohsiung city has been entangled with hydraulic works, water practices and management schemes that have shaped and reshaped its urbanity in the making of the city. While port development is one of the major forces that propels the modernization and industrialization of contemporary Kaohsiung, the Caogong Canal has developed a support system that conveys lifeblood to territorial water ecologies, sustenance and economies.

THE MANDARIN CANAL SYSTEM AND THE HYDRAULIC LEGACY

The construction of the Caogong Canal reflects the challenging precondition of Kaohsiung plain in sourcing fresh water for cultivations. The habitable terrain emerged from an ancient lagoon 3000 years ago and was interlaced with remnant basins, marshes and short flows [Hou 2007:13]. Due to the lack of large watersheds, the rivers on the plain were too short to retain and provide consistent fresh water for irrigation. In addition, low hills (50-350 meters) that delimit the boundary of the plain separate its catchment from the Kaoping River watershed, the largest watershed in Taiwan¹ suitable for tapping perennial flow.

As an integral part of reclamation for the earliest Han settlers, the irrigation system built during Chin Dynasty was conceived as the first evolution of agricultural development in Taiwan [Chen 2013:4]. The typologies of irrigation and water retention varied in scales and water sources, with formations determined by the geographical context and the amount of capital input. Lakes or deep pools were natural basins with perennial springs rarely seen on Kaohsiung plain; ponds were hydraulic constructions more prevailing in southern Taiwan to retain inconsistent rainwater or divert streams with simple embankments. As a linking medium, canal systems were the connective component of the entire irrigation system but seldom built in a large scale before the early 18th century due to the high social costs and degree of organized mobilization [Chen 2013:5].

The construction of the irrigation systems often directs the pattern of early settlements [Wen & Shannon 2013: 178] and reflects regional differences in adaptation to local hydro-geological and climatic preconditions. For

YISHENG YANG

KU Leuven

southern Taiwan, subtropical monsoons induce extremely uneven rainfall distribution to date still challenges the territorial capacity for water retention. Ninety per cent of yearly precipitation is concentrated between June to September, creating an intensive flood season and a nearly eight-month drought on the region [Wen & Shannon 2013: 176; Hsu 2007:107]. Without a consistent water source, paddy cultivation was a risky livelihood, relying solely upon summer rains for growing one-crop per year. The increase of yearly yields and the stable provision of irrigation water for spring ploughing thus became critical for the development of the early agricultural societies [Hsu 2007:107]. Nevertheless, large-scale intervention of irrigation canals in Taiwan was mostly hindered by the lack of funding, skilled manpower and the rooted superstitions under the passive ruling of the Mandarin Empire.

An exception to the inactive management of the Chin dynasty was the establishment of Caogong Canal (1837-1843). It marked one of the three distinguished Mandarin-built irrigation systems in Taiwan [Hsu 2007:107]. The intervention and planning logic of the Caogong Canal system implied the influence of Confucianism adopted by the newly posted magistrate Caojing. According to the pragmatic philosophy of Confucianism, water governance was an integral part of political practice. The construction of the hydraulic system provided a final solution towards extending social instability and it was the responsibility of a governor to prepare for floods and droughts via proper hydraulic works and interventions [Yu & Lin 2010:10]. Following the fundamental principle of Confucius water management, design of Caogong Canal system aimed to work with topography and rhythm of Mother Nature.

Operating with the contour trending westwards, the Caogong Canal system diverts water from Kaoping River at higher ground and plugs into three tidal rivers² that alters and extends the hydrological network of the plain. It marries territorial watersheds with short flows of Kaohsiung Plain and connects the water resources and ecology of the region. The design of canal orientation utilizes the micro gradient of the terrain to convey the water via height differences that involved calculated manipulation. The flow volume and water level in different sections of the canal are systematically controlled by sluices to ensure continuous water conveyance and equal distribution among irrigated fields. [Chen 1997:30]³

CAOGONG CANAL AS THE DECENTRALIZED RETENTION SYSTEM AND MEDIUM FOR TERRITORIAL INTEGRATION

The extensive canal system was composed of nearly 90 canals with total length of 171 kilometers, stringing up wetlands, ponds, marshes and basins that turned the dry fields of Kaohsiung plain into two-crop paddies and re-modulated the regional hydrology with decentralized retentions. Unlike other irrigation systems in Taiwan, there is no major reservoir to support and regulate the water source of Caogong Canal; thus each connected open water is part of the decentralized retention system essential for feeding tertiary channels and ditches that tie closely with the settlements. In light of managing the irrigation scheme, the diverted water is first conveyed to fill these decentralized reservoirs and timed for synchronizing the water apportioning.

The morphology, rhythm and location of the early settlements in agricultural society were largely determined by water accessibility and utilization tied to reclamation processes [Wen & Shannon 2013: 178]. Before completion of the



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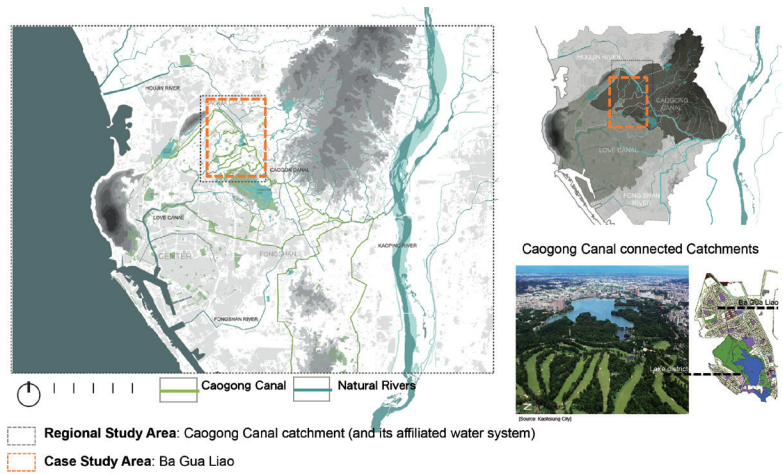
Caogong Canal system, each pond defined an independent irrigation territory collectively owned by villages within. Without integration of the water system, the irrigation capacity was limited by separate (water) resources and thus restricted reclamation for new settlements. The increasing scale and sophistication of the irrigation system after the construction of Caogong Canal required a more systematic water management scheme and social mobilizations, thus motivating the formation of autonomous organizations to manage the irrigation works and maintain hydraulic orders. A preliminary set of rules was drafted by social consensus to stipulate various irrigation assignments and tasks such as surveillance, dredging, diverting, distributing, repairing waterways and collecting water rent [Hsu 2007:108]. The collective management and shared interests among farmers and landlords conduced to the territorial integration and generated new compact villages along the densely interlinking waterways on the center of the plain and anchored bases for subsequent urbanization⁴. In light of regional development, the Caogong Canal system formulated an integral irrigation web that delivered maximum hydraulic capacity for further growth of production and population [Hung et al. 2010:142] that, in turn, propelled the development of the port and its adjacent settlements, leading to rapid modernization and urbanization of the region [Hung et al. 2010:144].

URBANIZATION OF THE HINTERLAND AND THE AD-HOC DISTRICT

The area of Bao Gua Liao is the confluence of three water systems, namely Love River, Houjing River and the Caogong Canal connected artificially with

Figure 1: 1905 Mandarin water topography map of the Caogong Canal system © Kaohsiung Museum of History.

The map illustrates (not in scale) the man-made Caogong Canal systems, fortified settlements, and hills, leaving out the tidal rivers that are not part of the water resource.



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hierarchical waterways and existing ponds. Located at the foot of the eastern hills, the primitive precondition of the low-lying terrain was hardly habitable due to frequent floods and inundations. The reclamation of Ba Gua Liao thus tied fundamentally with the hydraulic intervention of the Caogong Canal which systematically modulated local flows and created a relatively stable living environment and a productive hinterland for the new settlements.

During Japanese colonial times (1895-1945), the contemporary Kaohsiung started to take shape as a modern port city by the waterfront via reclamation of the Love River estuary. The designation of Kaohsiung as ‘the base of the southern advance’ of the Japanese empire was translated into major constructions of ports, trunk railway line, and the affiliated export-oriented industrialization supported by the hydraulic cultivation at the hinterland. Rivers and canals were re-engineered as supportive infrastructures to enhance the industrial transportation and production. In the hinterland, the Caogong Canal systems were extended and upgraded with powered pumps and concrete linings to increase the flow efficiency and unit productivity of each plot, most notably in crops of rice and sugar.

While the indigenous agro-villages remain dominant on the Kaohsiung plain, a new form of city was imposed at the waterfront as the attachment of a port construction project and an experiment of westernized urban planning. The first city plan was drafted in 1908 that established a rational grid-patterned street layout for efficient harbor accessibility and rapid land consolidation. Since then, the pattern of road-based, urban geometries were embedded in the planning language and urbanization of Kaohsiung, followed by extensive normalization of waterways and the centralization of water management scheme.

The urbanization of Kaohsiung rapidly evolved after the war for its strategic importance as the primary industrial port city and the engine of Taiwan’s economic development. The population of the city surged from 300 thousands to over one million in merely 20 years (-80s), turning Kaohsiung the second largest city of the island. In light of spatial configuration, economic growth and industrialization were prioritized in urban-rural development that transformed the immediate hinterland into a fragmented landscape.

With infrastructural-catalyzed urban expansion in the 70s, the hinterland of Caogong Canal system was rapidly subsumed as land reserve for the metropolization of Kaohsiung. Based on a high-growth population projection, now proven overly estimated, new town programs were demarcated at the urban periphery

Figure 2: Situating Ba Gua Liao: the convergence of 3 water systems.

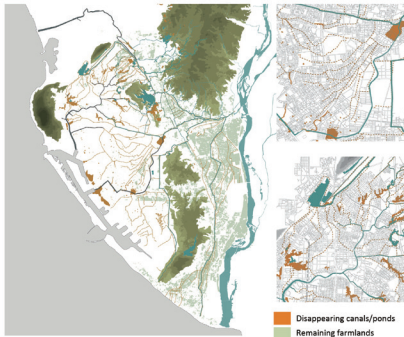
that overlaps with the indigenous water systems and paddy landscape. Implanted zoning plans, industrial platforms and dispersing small factories, motorways, and express corridors have fundamentally overridden the productive peri-urban territory with concrete and asphalt. In addition to the degenerative environment caused by industrialization, the extensive land filling irreversibly sealed the water-retaining paddies and irrigation basins that critically disrupted the absorbent capacity of the soft surface and cut off the flow from indigenous water ecologies.

Propelled by the economic restructuring from heavy manufacturing to technique-intensive and service industries since the 80s, the quantity-based spatial development of Kaohsiung was rethought in the context of post-industrial society pursuing sustainability and environmental quality. Water is revisited as the strategic subject for the making of post-industrial Kaohsiung with a series of redevelopment projects on harbors, rivers and wetland restorations. However, in the mean time, the neo-liberal and market-driven urbanization continues to unfold along the urban periphery, producing yet another road-based urban matrix that substantially alters the water/landscape dynamics of the city.

As part of post-war new town program, namely Cheng Chin Lake Special District, the case study area of Ba Gua Liao narrates a form of peri-urban edge layered with complex indigenous canal system, crossing motorways and a western urban pattern of Neighborhood Unit. Cheng Chin Lake Special District encompasses large part of the Caogong Canal catchment and irrigation zone, originally planned to conserve the designated scenic area of Cheng Chin Lake and accommodate the growing population from the industrial mobilization in the 60s-70s. It comprises 3,095 hectares with projected population of 150,000, overlaying the agricultural green fields with patchworks of urban grids. Evolving from an irrigation pond to an industrial water supply plant to the reservoir today, the Cheng Chin Lake and its environs were interlaced with a series of major constructions tied to Developmental State⁵ and Cold-War ideology after the 50s. Prioritizing rapid economic development, the government under the Nationalist Party conducted a series of state-led interventions to demonstrate Taiwan's competitiveness in the globalizing market with US-aid funding and techniques. Modern water work of the Cheng Chin Lake symbolized the advancement of market economy led by the Free China regime as opposed to the planned economy of Soviet socialist model adopted by Communist China [Lee 2011:5-7].

The notion of 'special district' has implications beyond the conservation of water resource and scenery due to the preference of Chiang Kai-Shek's family and authoritarian regime during the 50s. Despite the development of the lake watershed was restricted, Chiang Kai-Shek Chateau, golf course, clubs and a Grand Hotel accessible only for the privileged class were erected and rooted exclusivity and elite culture of the district [Wu 2009:67-73]. In contrast to the purpose of water conservation, water-retentive textures of wetlands, agrarian fields, orchards, and fishponds around the lake were replaced by a bulky mass of baseball field, parking lots, hospital, university and institutions in the name of building public spaces, resulting in frequent (internal) floods both locally and regionally.

Nevertheless, this bedroom community featuring the 'rear garden of Kaohsiung' continues to draw real estate development of deluxe maisons and condos which are clearly incompatible with urban water management. The leading Caogong Canal waterways within the district are revised to accommodate the sewage and stormwater discharge with a cross-section design that prioritizes minimum use of



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Figure 3: The lost of historical irrigation system and hydrological capacity.

developable urban space instead of integrative planning of water and urbanity. The result is the vertical separation of irrigation flows and drainage within a deep channel flanked by dyke walkways, dissociating the canal from the urban public landscape and farmland ecology.

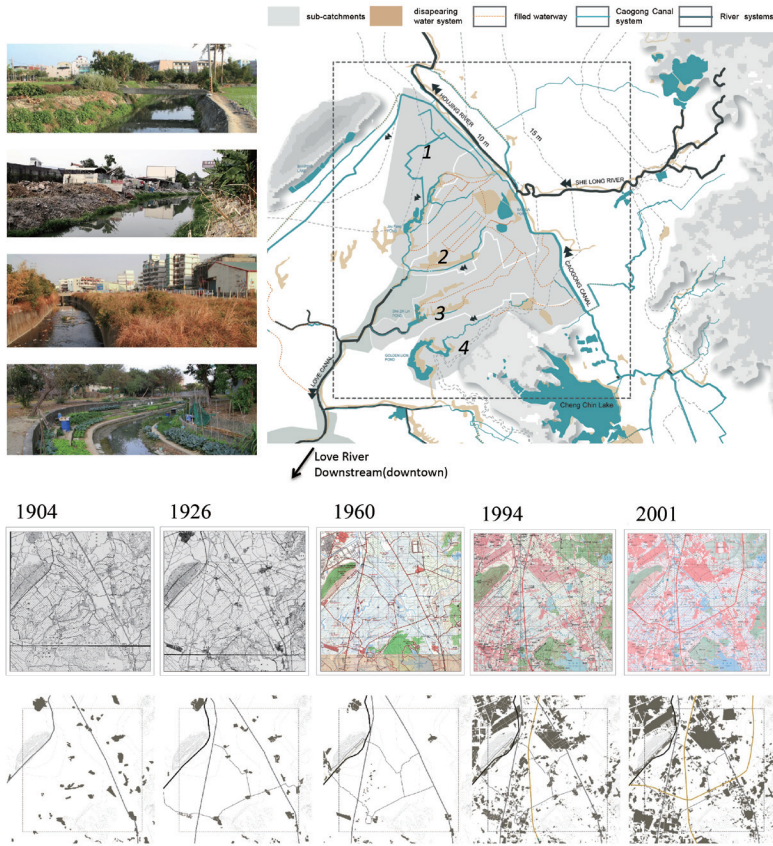
REDEFINING PERI-URBAN PROBLEMS AND WATER-BASED RE-QUALIFICATION

For more than 170 years, the Caogong Canal served as the nurturing arteries of the territory, conserving underground water and regulating regional hydrology in terms of water volume and quality. With new urban expansion, the irrigation area of the Caogong Canal system has reduced to 6,000 hectares, less than half of its pervious scale [Hsieh 2007: 31]⁶ with 1/10 of the total length of the canals remain [Kuo 2008:144]. With the shrinking agricultural economy in the post-industrial society, the loss and fragmentation of agrarian lowlands in an urban context has larger impact on the hydrological and ecological aspects of the city. It calls for reformation of the future operation of the canal system and its new role in the urbanized and urbanizing environment. Today, without cross-scalar and cross-sectoral thinking, the remaining canals are either left unattended or exploited to be urban drainages despite their potentiality in re-constituting territorial ecologies and hydrological security. The omission and mismatch of the indigenous water system in the zoning plan reiterate the prevailing issue of planning that the derivative urbanity continues erasing the cultural and ecological dynamics of the region.

Since the 2000s, massive land consolidation induced by neo-liberal speculations has extended to the Ba Gua Liao area where is known for its flood-prone topography intertwining with lateral channels of Caogong Canal system, the Love River and the Houjing River. In its primitive conditions, the district hosts several major basins that serve to modulate regional water volume and quality, particularly the center district at the downstream of the Love River. In early years, water systems and paddies on Ba Gua Liao retained and absorbed large portion of the stormwater runoff at upstream, and replenished urban rivers, now major drainages, with basic flows to maintain self-cleansing capacity during dry seasons. The urbanization of northern Kaohsiung generated by the high-speed railway station, Kaohsiung Arena and new business district established in the 2000s accelerates the development of the adjacent Ba Gua Liao area. In merely 10 years, 440 hectares (around 40% of the area) of paddies, basins or wild fields was filled to be new urban platforms, rapidly compromising the permeability and percolation of the area.

In addition, the distribution, rhythm and scale of floods in recent years have reflected a reality that the existing water management infrastructure, which builds on the Caogong Canal irrigation system and appropriates its right of way, could no longer cope with new stresses from massive land-filling and changing water regimes. Possibly due to the influence of climate change,⁷ the rainfalls of recent storm events often exceeded the recurrence interval of 200 years that easily surpasses the design standard (10-25 years recurrence interval) of the built drainage systems⁸ originally designed merely for overflows from agricultural fields.

Moreover, the form of the new urbanization that follows the road-based designs of the special district plan and land use programs interrupt the water ecology in various ways. Situated in between the privileged lake district and large industrial platforms at the north, the real estate of the Ba Gua Liao area is branded as the urban villa district for the white-collar population, featuring mid-density town houses and gated communities. The urban form of the western neighborhood units with public space placed at the center continues prevailing over the



region. Disregarding the ecological and cultural value of the indigenous flows, the planned road system in circular pattern disrupts organic logic of waterways and produces a disorienting world of asphalt with repeated street front and unidentifiable quarters. The canals and ponds that once defined the area are fragmented, concealed or filled that ultimately disappear from the everyday landscape.

Surrounding the district is a mixed landscape of agriculture and industrial patches with contested demands for lands and water(way)s. As part of the urban green system, paddy fields offer buffers, flood retentions and ecological corridors that define the quality of the district. Cutting through the west part of Ba Gua Liao, the north-south Freeway No.1 dissected the continuum of the green fields and blue corridors stretching from the Love River and the Caogong Canal system. The large infrastructural work re-articulates the urban boundary, generating edges and corners that complicate the management of canals and basins situated in between.

NEW PERI-URBAN PROPOSITIONS: HYBRIDIZED ECOLOGIES AND WATER-BASED URBANISM

To address the shifting water regimes and increasing floods of Ba Gua Liao, the municipality proposed a series of interventions based on an upgraded simulation in 2007. While the new water management plan urged the adoption of the integrated approach via decentralized measures[Kaohsiung County 2007:5-1], the suggested projects were mostly conventional hard-engineering solutions highlighting the employment of culvert system and drainage regulation.

This research proposes a decentralized water retention system by reusing/recovering the existing Mandarin canals and basins primarily to address the imperative

Figure 4: The layered reading and the evolution of the (peri-)urban-water landscape.

ENDNOTES

1. The area of Kaoping River watershed is 3,257 km² (Water Resources Agency, Taiwan).
2. Love River, Houjin River and Fongshan River.
3. The leading canal follows the 17-meter contour along the foothills in the east and connects existing ponds and stream fragments on the plain. It is then elevated (15m) by an embankment at Ba Gua Liao (12.4m) to maintain the midway flow and

branches out to connect with major ponds at the upstream of the Love River (8-10 m) and Lotus Lake (9.9m) [Lin 2010:62-63] now critical for regulating the urban floods.

4. After the completion of the canal system, 72% of the new settlements emerged along the full-operative Caogong Canal system in merely 50 years (1845 to 1894), indicating a shift of regional development from historical citadels to the belly of the Kaohsiung plain.
5. The model of development derived from the Japanese experience of post-war reconstruction was swiftly re-adapted by other newly industrialized countries in Asia and drove the urban-rural spatial restructuring of the emerging city-regions. Endnotes.
6. In the early 60s, the irrigation area of the Caogong Canal system once reached an unprecedented scope of 14,000 hectares with 63.5% increase of rice production [Fengshan Cultural Workshop 2007:128].
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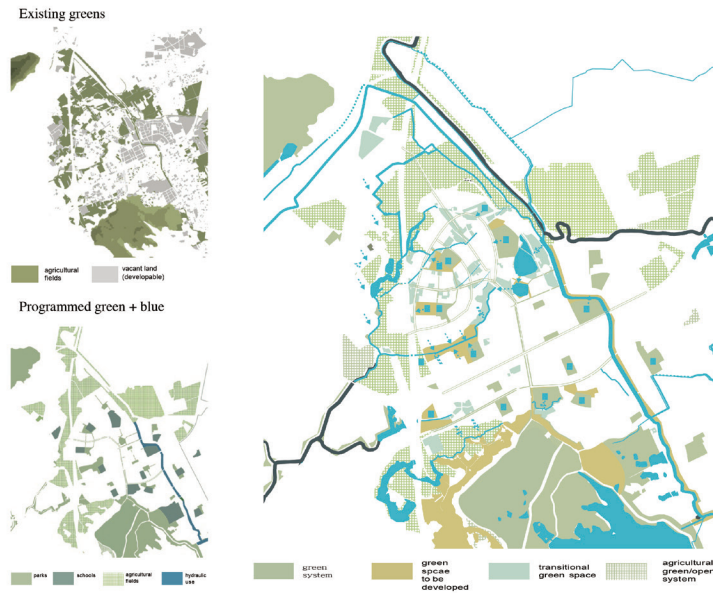
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issues of (reverse) flooding at downstream due to decreased permeability and climatic variability. The rich histories and hydrological significance of the Caogong Canal lend the post-industrial urbanization great cultural and ecological potentialities. The design proposition revisits the inherent flow characteristics and social dynamics generated from the canal system, and works with the existing water mosaic system. At the territorial scale, the proposal establishes Caogong Canal system as a blue-green structure that could reconstitute the ecological network via reattaching and reconstructing associated wetlands and tributaries. In light of a necessary water management scheme, the stable and perennial water supply to the major rivers of the city is suggested to maintain the ecological base flow by transferring water through canal system during non-irrigation season or reusing the recycled water from treatment plants or constructed wetlands. The cultural significance of the Caogong Canal system in structuring settlements offers a cohesive frame to collect or invite public realms at the waterfront, while simultaneously renovating urbanized interface with diverse water programs. A sequence of strategic interventions along the canal delivers blue/green corridors that aim to regenerate the long-industrialized environment.

Ba Gua Liao's mandate—to mitigate the flood downstream and transform the road-based urbanity towards water-adaptive urbanism—is central to the planning scheme at local scale. The proposal seeks to re-embed the Caogong Canal system and its lateral waterways in the new spatial regime as a hybrid cultural-natural infrastructure and spines of urban re-qualification. The plan aims that each sub-catchment develops the capacity to fully absorb the runoff from the new urbanization and water regime. The exploration for the 'space for water' however is challenged since large part of the area is already built; thus each urban program is obliged to share its part in the adaptation system. The proposal adopts strategies based on the primacy of the indigenous water system and centered on the notion of hybrid ecologies, reversing the road-based development to water-bound urbanism. Original ponds, with reference to historical maps, are to be restored in terms of the volume and form as hinges for ecological corridors. The lateral canals interlinking the ponds are re-naturalized with thick layering of ecotones and partially widened as urban creeks to articulate the flow. The plan is to deepen the connection between the canals and everyday lives via re-attaching various forms of public spaces to the waterfront. Amongst land programs by the canals, the agricultural fields are reviewed for their significant roles in restoring urban water ecologies and connecting regional open space system.

Threatened by the dispersal urbanization, the paddy fields at the edges of the district are critical lowlands for flood safety, green buffer and local microclimate. Embedded with the naturalized canals, the paddies become integral part of the regional open space system and ecological corridors that (re-)qualifies the new development via integrating urban platforms in the landscape and blurs the edge formed by the free-way. The paddies in-between the platforms and the canals are selectively mixed with constructed wetlands, aquaculture ponds and farmlands to formulate a vibrant urban-natural transition combining water purification system, new urban farming and public landscape. The conservation of agricultural fields and canal system within this (peri-)urbanizing area mirrors an evolution of other remediation projects in the post-industrial Kaohsiung. The historical irrigation system is recycled to regenerate and adapt to the new urbanization and hydrological conditions.

In recognizing Ba Gua Liao's built tissue and the programmed public spaces, the overlaying of indigenous water mosaic system and stereotypic allotment creates



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interstices and perforations within the consolidated district framed by traffic infrastructures. In the proposal, part of the perforated vacant plots transform to be diverse spaces as urban sponges by integrating the real estate block with water-sensitive components and via manipulations of the micro-topographies that works simultaneously with long drought (water quality) and flash storms (water volume). The decentralized interventions reflect on seasonal demands and essentially revise public realms adaptable to occasional floods while maintaining urban functionality. Major roads that disrupt canal systems are soft-engineered to be stormwater infrastructure with water-sensitive measures that simultaneously renders quality and discernible streetscapes.

Figure 5: Planned urban texture and the water-based revision/ re-adaptation.

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