(RE)FORMING CANTHO’S AS FOUND CANAL-LANDSCAPE
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Abstract:
The French colonial enterprise in Indochina (1876-1954 in the Mekong Delta) radically transformed the watery landscape of the Delta. The water-logged delta was drained and became an irrigated territory known as the ‘rice basket’ of Vietnam; the regional landscape was transformed into a colonized urban nature. Today, as found, the impressive canal network (with more than 4000 kilometers of main and auxiliary canals) is an important part of the region’s structure, hence identity – an identity that is being seriously challenged by new development practices and realities. The water-based territoriality is recently being juxtaposed systematically with a road-based logic. The canal and natural river system form a warp-and-woof, together constituting a hybrid water system. Master-plans (which remain the legal planning tool in the top-down communist system) are continually being revised to accommodate the changing population dynamics – from an agricultural region to a promiscuous territorial urbanity-rurality. As well, development of the landscape is confronted with evolving agriculture practices, the need for modernization, changing water management, a rising sea and salination problems. Complicating the matter further is the fact that may nations up-stream are manipulating the flow of water through the delta with engineering works (and China refuses to join the regulating Mekong Delta Commission).

This paper will develop the notion of as found infrastructure – the majestic canal-landscape of the Mekong Delta – as active relics in the contemporary reconfiguration of the regional territory. Evidently, the Delta’s local identity needs to be kept, but must also be part-and-parcel of an ongoing dialectical construction with new elements which respond to the multitude of demands and changes in the use and regulation of man-made and natural landscapes. In the Vietnamese context, heritage, in general, and the system of French-era canals, in particular, must be seen as a step-stone within a very dynamic and ad-hoc development process. The as found canals have the potentiality to give direction to waves of development over the territory; can provide a rhythm of calm in an environment that is becoming increasingly hectic; and can maintain a spatial structure across the landscape that is becoming progressively illegible by promiscuous juxtapositions of various programs and forms – of which a tissue of small elements is the most repeated morphology.

The case study city of Cantho (1.2 million population) is presently in the midst of such an incredible dynamic process of transformation and its 2006 master-plan is under revision. Its own component of the Delta’s canal network is a strong spatial structuring element that must be rethought in light of the pressures of modernization – and must consider, as well, a large World Bank canal up-grading and dyke system that would superpose an entirely new logic on the territory. A series of readings of the as found canal-landscape will be presented and possible territorial interventions will be explored.
Feudal As Found Landscape of the Mekong Delta

The southern region of the Mekong Delta, unlike the north and center of Vietnam, has only been occupied by Vietnamese for approximately three centuries. South Vietnam (also called Nam Bo and Cochinchina) was known as a frontier region and the multi-layered landscape of the Mekong Delta has been in constant evolution with regards to the intimately interwoven aspects of nature, engineering and everyday life. According to Southeast Asian historian, Milton Osborne, the delta was ‘a largely waterlogged world of black mud and mangrove trees, bordered by thick tropical forests where the land rose away from the flooded plain. Drainage canals had only slowly begun to ensure that some areas were protected from the annual floods that came with the rainy season and the steady rise of the Mekong’s level, its volume swollen both by the rains and by the melting of snows in faraway Tibet’ [Osborne 2000:21].

The difficult geography led to a particular image and settlement structure. Since its earliest times, the region was renowned as a place of exile – ‘a place of banishment for criminals or a place of refuge for political dissidents or malcontents generally’ [Li 1998:22].

Although the French colonial interventions are often regarded as the major transformations of the hydrological landscape, drainage canals enabled a ‘river-water’ or ‘canal-creek’ civilization to exist long before their reign [Biggs 2004]. Prior to seventeenth century settlement by the Vietnamese, non-Vietnamese settlers – including Khmer, Cham, southern Chinese and Malay had occupied the Mekong Delta [Li 1998]. Anthony Reid has credited the birth of Cochinchina to the fact that it coincided with Southeast Asia’s ‘age of commerce’ where regional trade thrived [Reid 1988]. A heterogeneous culture materialized, wherein a number of ideologies and religions co-existed. During the later part of the Le Dynasty (1428 – 1788), the Nguyen Lords – who consolidated their control on the southern half of the country – promoted a policy of ‘breaking fresh ground to create villages’ [Le 2002:137] and Vietnamese settlers, frequently supplemented by armed force, occupied the territory. The building of canals was part-and-parcel of a defense system (at the western frontier with Cambodia), a transport system and part of an irrigation network. Canals often reformed existing watercourses and organized work units for the large infrastructures were paralleled by local farmers in working to control soil and water regimes at a local level.

As found feudal canal landscape

The largely waterlogged region of the Mekong Delta has been subjected to continuous transformations throughout its history. The rich variety of watercourses, ranging from rivers to creeks and canals, characterizes everyday life in close relation with the landscape. From the feudal era onwards, canals have been built as part-and-parcel of defense, transport and irrigation systems.

[source: Photographie d’après un négatif au gelatino-bromure d’argent sur plaque de verre, numérisé et converti en positif, 18x24-Musée national des Arts asiatiques-Guimet, no. AP12025; Aubenas 2001:112]

Throughout the various dynasties of Vietnam's history, the imperial bureaucracy distinguished four categories of land: state land, land grants, communal land and private land. Communal land was an ancient land category in Vietnam that was used as a powerful instrument by the centralized monarchy for levying taxes and conscripting men to the army [Nguyen 1984]. Villages were corporate communities that regulated their own affairs and held land for common use. Economically almost self-sufficient, the communes paid taxes, provided corvée labor for

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public works (including the regular maintenance of dykes and irrigation canals) and furnished recruits for the army. Otherwise, the communes had a high degree of autonomy in which structures of kinship and production and religious ties were inseparably linked and developed rich and heterogeneous local traditions. The Mekong Delta cities were (and, to a certain degree, remain) representative of what Karl Wittfogel, the renowned Frankfurter Schüle sinologist, referred to as 'hydraulic civilizations' – a particular type of urban/rural social formation founded upon centralized state water engineering and control. The productive water works (for irrigation and drainage) and protective water works (for flood control) also provided drinking water and communication conduits. Wet-rice cultivation requires a relatively equitable distribution of water and necessitates a system of canals, dykes, irrigation canals, terraces and locks to regulate water levels. Strong and well-organized power structures that coordinated and imposed public works were the answer at the time. This despotic 'traditional' way of managing the region appears impossible today in a regime with more decentralized and loosened organizational system (that sometimes seems primarily driven by the woes of the market economy) [Wittfogel 1956, 1957].

Vietnam’s ‘march to the south’ (from 1558) with its accompanying vast territorial expansion (known as namtien and necessary to provided new lands for a growing population) was a major achievement of the Le Dynasty. As Li Tana has claimed, ‘Nguyen Cochinchina was not only central to the process of southern expansion, it was also its most spectacular product’ [Li 1998:155]. During this period, an era of cultural confrontations was initiated which in turn led to the formation of regional identities that would have long-term effects of the development of the nation and its urban places [Douglass et al. 2002:1-12]. The Nguyen lords were extremely flexible in governing the population of Nam Bo and settlers were allowed to freely occupy land. Many of the ancient regulations regarding property were not applied and inhabitants often moved from area to area, motivated by the possibility to cultivate new lands. Throughout the region a constellation of cities were established, serving as either administrative or military centers for the expanded territory. In 1739 the Nguyen lords established four districts in the delta: Long Xuyen, RachGia, Tran Giang (Cantho) and Tran Di (Soc Trang). As well, market cities were established along the natural waterways and trade flourished. Buildings were commonly on stilts, similar to constructions in Cambodia, Malaysia, the Philippines and Vietnam’s own hill-tribes [Balderstone and Logan 2003:137]. A network of market places, transient stations for traders, service stations for the repair and maintenance of boats and supply of fresh water and areas for rice processing (oriented towards export) was quickly established. Many of the aforementioned places were floating on the inter-connected waterways.

By the 18th century, according to Biggs, the typical social landscape of the Mekong Delta was divided into loosely connected enclaves in forests of the interior regions and along waterways. The rivers had become a trading crossroads for Malay, Dutch, and Portuguese as well as the Chinese, Khmer and Vietnamese [Biggs 2004:30]. At the same time, the swampy area of Nam Bo was transformed into fertile alluvial plains for wet paddy cultivation. The compact village structure of the northern Vietnamese was abandoned, as settlements developed linearly, following the alluvial, non-salted high land banks of rivers and canals. During this era, three significant large-scale canals (BaoDinh, Vinh Te and Thoai Ha) were constructed to efficiently link inland passageways from Mekong to the East Sea [Biggs 2004:43-44]. Villages advanced following the advancement of the canal system. From 1787 to 1802, Nguyen military campaigns resulted in the establishment of a larger infrastructure of government barracks, rice granaries, and garrisons in the delta [Biggs 2004:34]. During the Nguyen dynasty (1802 – 1945), ‘the relative degree freedom in development disappeared. Emperor Gia Long (the first ruler of the Nguyen Dynasty) sought to develop the land and create villages in an organized manner. Central authority was increased and a top-heavy administrative system was established. Land productivity was increased vis-à-vis the recruitment of soldiers and poor families who developed previously unused lands. A policy of land reclamation and new settlements was established through ‘agricultural colonies’ (dinhdien) and ‘military colonies’ (don dien) – the latter in which colonizers subject to military discipline combined westward expansion with a readiness to act for the government in time of war. Vietnamese settlers, soldiers, adventurers and criminals moved into the Mekong River Delta’ [Osborne 1997:13]. Many poor were attracted to such groups, since they were also given a 7-year tax exemption. The feudal waterworks inscribed Vietnamese, Chinese and Khmer workers – who faced poor working conditions, famines and droughts.
Canal network embedded in natural hydrological system
The 3 most important canals from the Nguyen-era (BaoDinh, Vinh Te and Thoai Ha; shown in the lighter color) served as efficient inland links from the Mekong River to the sea. A much greater number of canals were dug during the French colonial era (shown in the darker color); they transformed the territory into a highly productive agricultural region.
[source: adapted from colonial era map (source unknown)]
Engineered Waterways & Colonial Granary

The scale and scope of state works increased substantially during the colonial era. The French considered the Mekong Delta as the ‘river road’ – or commercial route to China (a belief dispelled by the epic and disastrous 1866-8 French Mekong Expedition, led by Francis Garnier, in which the Khone Falls (in present-day Laos) proved an insurmountable barrier to navigation). Nonetheless, in 1867 the French they took possession of all six provinces of Cochinchina (the first part of the country to be colonized). The French sought to increase wet-paddy production in the delta primarily though the means of immense colonial landholdings and extensive state-funded irrigation and water-transport works. The projects of exploitation took on political and spatial importance and differentiation from that of the indigenous waterworks. According to Biggs, ‘colonial engineers worked almost exclusively within the conceptual spaces of topographic maps and the political spaces of the colonial métropole, Saigon. Their goal was to link the capital with colonial towns in the delta, drawing canals as lines across a blank representational space on the maps. Over time, they envisioned that these “blank” spaces would be filled with plantations, roads, waterways, and homesteads. Public Works engineers wanted to convert the blank spaces of the delta into an endless horizon of rice’[Biggs 2004:68-69].

In 1871, the French governor of Cochinchina established a permanent commission for the construction of canals (the commission des arroyos), which significantly accelerated the canal building process – further aided by the introduction of mechanical dredgers in the 1890s [Miller 2006; Biggs 2004]. The most important and expensive water project was the Cho Gao Canal, which initially established a direct link to Saigon but was compromised by the formation of so-called dos d’âne (bars of silt). Such sites were ‘dead points’ for the colonial engineers. However, the local population developed them into strategic nodes in the delta’s networks [Biggs 2004]. An exemplary case of such ingenious adaptation is the seven-way waterway junction in Phung Hiep (in 1916), which became an important floating market. Another noteworthy infrastructure was the construction of the Xa No canal (completed in 1904), connecting Cantho and RachGia (in the west of the delta, on the Gulf of Thailand). The construction of the delta’s canal landscape developed with state-of-the-art techniques while, at the same time, internally restructured the specific condition of the Mekong Delta’s complex interwoven system of natural rivers and man-made canals.

Building the Cho Gao (Duperre) Canal

The Cho Gao was an important French-built canal (1875) constructed with corvée labour (unpaid workers) and under the governance of Le Myre de Vilers.Communes of the delta maintained dykes and canals in return for relative autonomy, functioning as what Karl Wittfogel termed ‘a hydraulic society’.


From 1866-1930, colonial engineers initiated a series of waterway projects that required dredging more than 165 million cubic meters of earth; this was comparable in scale to projects at Suez and Panama (260 and 210 cubic meters respectively) [Biggs 2004:66]. The dredging occurred through peat bogs, salt marshes, mangroves and forests. From 1890-1936, 1,360 kilometers of main canals and 2,500 kilometers of auxiliary canals were dug by a combined effort of machines and manual labor – in addition to 3,000 kilometers of inter-provincial land routes between 1880-1913 [Nguyen 1996:46]. Prior to 1880, the total cultivated area in Cochinchina was estimated at
552,000 hectares and between 1880-1937, irrigation increased this to 2,200,000 hectares [Hickey 1964:15]. Commercial exploitation was pursued under the veil and justification of la mission civilisatrice [Wright 1991]. However, despite the subsequent French attempts, the dredging campaign in the Mekong Delta never achieved a ‘final form’ to the water network, though the (hydraulic) landscape was dramatically altered. ‘From the air, the astonishing Cartesian geometry of the Mekong Delta’s canal system is readily apparent. The hydraulic engineering of the delta bears the imprimatur of French colonialism’ [Taylor 2001:5]. And, as Duiker has concluded ‘the end result of the French colonial experience in Vietnam was not the creation of a society on the verge of rapid economic development, but a classic example of a dual economy, with a small and predominantly foreign commercial sector in the cities surrounded by a mass of untrained and often poverty-stricken peasants in the villages’ [Duiker 1995:133].

**Inland waterway traffic in the Mekong Delta (1938)**

The canals functioned as important transport routes and were extensively used for both the flows of goods and of people. A clear link was sought between the cities in the delta and Saigon (now Ho Chi Minh City), capital of the Cochinchina and the base of the French colonizers.

[source: adapted from UN 1959:annex II]

**Lost and (re)Found**

Evidently, the delta’s complex hydraulic web was both made and contested by indigenous and foreign landowners, entrepreneurs, engineers and various political alliances. Grassroots-based, urban and rural unrest grew in the late 1920s and Vietnam’s ‘land to the tiller’ movement (primarily against absentee landownership) in the 1930s rode on the sentiments of growing nationalism and communism. As well, there were devastating floods in the delta in 1923, 1929 and 1937, which destroyed thousands of hectares of crops and exacerbated famines. Displaced farmers, abandoned plantations and farms and rising ethnic tension underlined flaws in public works, social crises in labor practices and land tenure [Biggs 2004:118]. The confluence of a number of events in the 1940s – the arrival of the Depression in Indochina, the Vichy government rule (1940-45), the Japanese presence in Cochinchina since 1941 and the founding of the Indochine Communist Party – led to the delta literally becoming a battleground. Social and ecological crises were left the great water infrastructure (the dikes, pumping stations, canals and flushing basins) in a state of disrepair. New modes of production were tested following imported models based on small ‘Toinkinois casiers’ (cells of dykes, canals, fields and villages) of the northern Red River Delta; the new restructuring met with failure [Biggs 2004]. With their guerrilla tactics, the Viet Minh were active
and popular in the delta, due to their land distribution policies. However, to expand their power, they ‘cut canals, destroyed bridges, and sabotaged roads to prevent penetration by enemy forces’ and ‘used floods and natural processes of sedimentation in the canals to their advantage. ... The colonial dredging contract expired in 1939 and there was little effort for their maintenance. Dos d’àne blocked many of the major waterways by 1950.’ [Biggs 2004:177,187]

**Cantho as colonized marshlands**

*The inland delta has been transformed into a cultivable paddy landscape. The map of Cantho in 1923 illustrates how new canals interconnect existing rivers, allowing a better water system to serve as the base for a renewed agricultural logics.*

[source: Archives Nationales d’Outre-Mer, Aix-en-Provence, No. Asie-165234]

The First Indochine War ensued and once the country was divided by the Geneva Accord in 1954, the delta’s infrastructure was severely compromised. There were two (re)settlement programs that were then pursued in the delta, which had social and political goals in addition to military importance. Ngo Dinh Diem’s ‘agroville’ program (1959-61), which forced peasants to resettle in self-contained and protected, camp-like communities (each for several thousands of persons) – and where peasants were given low quality sites-and-services and had to drain the land and construct a grid of new canals – met with great local opposition. By 1961, there were a mere 23 agrovilles in the delta [Osborne 2002:24]. The failed program was succeeded by the ‘strategic hamlet’ program (1962-63) of the Americans. This program developed from existing settlements which would be fortified – intentionally limiting contact with insurgents via physical barriers and attempting to increase villagers’ loyalty to the government through the provision of services [Osborne 2002:26]. During the American War, not only were all new canals works shelved, but also the network was further damaged and the waterways again became battlegrounds. Canals were fractured and from 1961-70, the extensive use of chemical defoliant caused severe ecological damage and brought fear to local inhabitants. A number of ‘desk studies’ were carried out by a wide alliance of engineers and although projects were not realized, they altered the manner in which development of the delta and its irrigation system would be pursued in the post-war period [Biggs 2004].
Riverine warfare: the canals as battlefields
A U.S. navy ships intensively patrolled the delta’s canals to combat the guerrilla tactics of the Viet Cong. By the end of the American War, the canal landscape was severely fractured and ill-maintained.
[source: Photograph VA042051, No Date, Arthur Price Collection, The Vietnam Archive, Texas Tech University.]

Vi Tanh Agrovillle and airstrip (1965)
An important agroville was built along the Xa No Canal, serving as a camp-like community where people lived closer to collective services but further away from their crops. This ‘modern’ organization of the countryside was an attempt by the Diem government to control and provide security to the peasantry.
[source: U.S. Army Mapping Service. "Viet Nam 1:25,000" L8021 Pictomap Supplement Series, Sheet 6028 1 South.]

Active Relics in Contemporary Territorial Reconfiguration
Cantho, a first class city (meaning it is considered of national importance and directly controlled from Hanoi) is an interesting case study with regards to the contemporary pressures of the region’s as found waterway network. The city, in the heart of the Mekong Delta and known as the 'Western capital' in the pre-colonial era, is rapidly urbanizing (due primarily to urban-rural migration) and the predicted effects of climate change are daunting. The city was found at the confluence of the Hau (lower branch of the Mekong River) and Cantho Rivers. Its modernization process includes the development of road-based urbanism and new engineering methods to regulate the hydraulic landscape. The accessibility and new connectivity afforded by the new roads – including the recently opened Hau River Bridge – are radically enhancing the strategic location of Cantho. The transition from a water-based urbanism towards a road-based urbanism is no doubt inevitable. Yet, it should be remembered that in the delta (where the carrying capacity of the soil is quite low), the construction is significantly more expensive than that of canals [Palmer 2003]. As well, the ecological advantages of inland water transport (more energy-efficient, lower emissions) compared to roads and railways are yet another important issue to take into account in the search for expansion of transport networks. The water versus rail/road system is not new in the delta. In 1880, Charles Combier, engineer of Ministry of the Navy and Colonies in Paris, proclaimed that rail construction in the delta was more than triple the cost of water transportation [Biggs 2004:80]. Cantho is presently investigating the possibilities of rail/light rail and water networks as a public transport system.

In addition to the large infrastructural support, Cantho's expanding hybrid territories have spatial limitations due to the intermingling of built-up environments and open landscape, which, in turn, leads to conflicting claims on the territory (urban functions versus natural or controlled floodplains, location of wastewater treatment infrastructure, water management functions versus ecological purposes, etc.) and complicated drainage networks. One of the city's largest threats is the loss of absorptive low lands, which are inadvertently filled (with up to 2 meters of soil) to support urbanization. The natural absorptive capacity of the land is diminished as the amount of paved areas increase – with the side effects of faster rainfall run-off and a lowering of the natural groundwater table. Water quantity problems are mainly related to hydrological extremes: high flow discharges and related flood risks along rivers and urban drainage systems (sewer systems), and low flow discharges along rivers. Ultimately, there is usually a far from optimal balance between hydraulic, ecological, agricultural and urban (housing, industry, recreation) uses of space. As well, the entire drainage and sewerage system (often unhygienically mixing) of Cantho is over-stressed and its integrity jeopardized. Illegal encroachment of water-bodies alters ecologies and inevitably affects the severity and frequency of flooding, not to mention an increase in

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environmental degradation and pollution – due to domestic and industrial water pollution, dam and road construction, dredging, over-fishing and destructive fishing techniques, and intensive aquaculture.

The challenges are immense and the government is tackling them as best it can. Line-ministries in Vietnam now have climate change departments within them and research into adaptation measures are underway. In 2008 the government released a National Target Program to respond to Climate Change (NTP-CC) which indicates the country's vulnerability to climate change impacts and set directions for responses to the issues. The NTP-CC summarizes the most important consequences of climate change for Vietnam as a rise in temperature of 2°C for 2050 (3°C for 2100), an increase of rainfall up to 10% in wet season together with a decrease of up to 5% in dry season and a sea level rise of 1m by 2100 [NTP-CC 2008:10]. The rise in seawater level will worsen saline water intrusion not only in coastal zones, which is already a problem in some areas due to fresh water extraction for irrigation and drinking water, but also well inland – including Cantho. The construction of new canals in the delta and upstream dams exacerbates the problem. Water resource management has become a central concern at the national scale.

Given the speed of development, the effective management of water resources is vital. A new engineering paradigm has been developed for the delta and has been partially implemented in the vicinity of Cantho (the O Mon-Xa No sub-basin) by the World Bank. Developed in 1999, the project consists of three super dyke compartments to more effectively manage irrigation, drainage, flood protection and salinity intrusion control and to guarantee three crops of rice yearly. The project includes the construction of 41 main sluices and 125 secondary sluices to regulate the canal networks, and the dredging and/or enlargement of 483 km of main canals and 586 km of secondary canals – resulting in significant improvement in freshwater supplies for irrigation, the ability to regulate brackish water supplies for aquaculture, and the drainage capacity of the system when flushing at low tide [World Bank 2008]. The project is indicative of a new engineering approach, as Mira Käkönen indicates: ‘the last decades, actions toward the environment have shifted strongly from adaptation to control and, at the same time, from decisions made at the farm level to centralized decisions on greater scale’ [Käkönen 2008:205]. Despite new techniques, however, the question then remains whether such an enormous control strategy is the better option, knowing that indigenous solutions where rather based on adaptation, as Miller calls it ‘shaking hands with the floods’ [Miller 2006:176].

A synchronous action plan for Cantho to develop as a resilient and adaptable city and landscape with regards to climate change is necessary and requires innovation in design, engineering and management. New stakeholder coalitions will become necessary. For instance, both small-scale irrigation works by local farmers and large scale government managed works of irrigation and flood control, need to be based on a deep understanding of water-related natural characteristic and ecosystem performances, in order to ensure survival in such unpredictable natural conditions. As well, given the imperative of designing a more sustainable water system, deeper knowledge of the landscape, its ecology and water technology are required. The development of engineering, designing and planning activities in-tandem could eventually create an urban waterscape with a clear structural interweaving of topography, hydrology and soil conditions and a new urban morphology that works with landscape for water retention, discharge and treatment. A first action could be to start coordination between hydraulic and civil engineers and urban planning, followed by a second action to organize the involvement of until now (largely) unused disciplines: urban design and landscape architecture, then enforce the relationship between urban design/landscape architecture, on the one side, and geography/geology, on the other side. Once there is a multidisciplinary set-up to tackle the constructive interplay between the water system and territory/urban system, then one still needs coordination of different levels of governance, etc. By reuniting engineered and natural processes, there may be new logics identified which point towards a more resilient development of an infrastructured landscape, which in turn could become a base for a new regional and urban form. Through properly planned and projected space, a ‘soft engineering’ approach could work with nature to reduce or mitigate the likely impacts of natural disasters, such as floods and typhoons. Mitigation can become proactive rather than reactive if urban design and planning anticipate risk and exposure – designing for resilience by remolding landscape and [re]constructing settlements to bend from hazards, but not break.

There is a pressing need to develop an innovative (and integrated multi-governed/ multi-disciplinary) approach to Cantho’s urban water design, engineering and management in relation to the predicted consequences of climate change. Most generally, future projects should be ones that develop innovative, contextually embedded approaches to urban waste/storm water and urban flood mitigation. Such projects could inform planning which, in turn, could inform policy (instead of the usual opposite direction), they could integrate the approaches of design, engineering and management, thereby challenging business-as-usual in contemporary city and infrastructure development.
New challenges – Cantho as representative
The shift from the water-based urbanism towards a road-based urbanism requires new morphologies and landscape/infrastructure/urbanism relationships. Coupled with such a challenge is a host of new issues that are linked to climate change (flooding, crop vulnerability, saline intrusion, etc.)
[source: OSA, KU Leuven]

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