Amphibian Identity?
Waterspatial Resilience of *Khlong* in Bangkok

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ABSTRACT

More than 1.100 *khlong*[1] in Bangkok offer various opportunities for urban development. Over 2.200 km still exist in the Province of Bangkok alone. Transport and living space on the water are found only along certain parts of the system as *khlong* are predominantly used as open sewage, drainage and irrigation system. The particular urban structure creates complementary spaces that interface water with land. This article aims to understand the logic of structural elements of Bangkok in the Chao Phraya Delta of Thailand and to change the viewpoint, to look from the water to the city. To understand the research approach better the water space, consisting of the canal and the natural or planned flooded adjacent spaces, is disentangled and reconnected to the built landscape.

Definitions are refined for a clearer understanding of terms, especially because water is addressed interdisciplinary and hence needs a common language. Water spatial resilience is important because spatial variations influence a system's resilience. With the aim to identify the transformability of the spatial structure, waterspace characteristics are recognized. These characteristics are derived from studying complex adaptive systems, networks, the resilience-concepts, and innate properties of waterways, especially in the Chao Phraya Delta. The framework condensing urban development principles from an amphibian perspective is based on the adoption of space in Bangkok. Amphibious architecture, water-space urban design and water-use planning evolving from a water-space-perspective can lead to an amphibian living space.

Keywords: *Bangkok, khlong, Chao Phraya Delta, amphibian living space, social-ecological system, complex adaptive system, resilience, built landscape, waterspace, identity, urban morphology*

INTRODUCTION

The *khlong* (canal) in Bangkok are substantially important to the delta-city. The importance is derived from the spatial and thematic connectivity on different scales. Previously, on a local scale, researchers identified various positive effects on urban development of Bangkok when considering the reinvigoration of the *khlong* system. Transportation, urban green spaces and urban water management are the predominant issues (Nitichan 1988; Lucius 1992; Yordphol 1995; Assumption University 2008), Others focus more on the issue of heritage (Bunnag et al. 1982; DTCP 1998) or combine them with urban and community development (Montira 2013). Historical analyses of canal side developments

[1] khlong = waterway, canal

Figure 1:
Khlong Bangkok Noi

observe the social and socio-spatial changes (Chaweewan et al. 2000, 2002) and examine the indigenous commercial building typology as an interface of land and water (Nawit 2006). Recent investigations deal with the peri-urban conflict of urbanisation and agricultural use (Vudipong et al. 2012) and a proposed change of perception of waterscape into more favourable conditions by comparing *solid and liquid perception* (McGrath, Danai 2010; Danai et al. 2013) based on urban planning and design with *water urbanism* (cf. Shannon, Meulder 2008).

On the regional scale, subsidence is more threatening to Bangkok than raising sea levels. (see Fig. 3) It has to learn to live with water. Even by using maintenance and adaptation to keep the level of flooding or storm surges to a minimum there will be higher overall losses in coastal cities when a disaster strikes. This is due to further urbanisation and ongoing subsidence (Syvitski et al. 2009; Hallegatte et al. 2013). A delta-city is part of several specific processes and has characteristics which are relevant for urban design and planning. In addition to the water related threats mentioned above the following are important to consider: reduction of sediment by upstream construction of dams, dikes and embankments, highly dynamic geomorphologic processes, soft soils, water pollution due to downstream position, highest densities of populated places on earth, mostly fossil resources available and highest economic value on the delta rivers and estuaries of all ecosystems (Marchand et al. 2013).

The global landscape of Low-Elevation Coastal Zones (LECZ, 100km inland from coastline and 100m MSL) is characterized by a high proportion of inhabitants with 13% living on 2% of global land area. Significant for the water space is the fact that the most cities above 1 million inhabitants are lying below 10m MSL (Small, Nicholls 2003). Deltas form the biggest part of LECZ and are defined as land areas below 10m MSL. Approx. 500 Million people living on deltas, which are the most vulnerable regions, aside from the arctic region (McGranahan et al. 2007; Syvitski et al. 2009; Rogers et al. 2013). Megacities are mostly located in LECZ or deltaregions and are notably affected by climate change (Nicholls 1995, 2008; Weltbank 2010; Hallegatte et al. 2013). In megacities like Bangkok infrastructure for transport, utilities, and disposal or sanitation is often lacking (Niemczynowicz 1996; Yusuf 2007; Kraas 2007). Consequently water-infrastructure plays a pivotal role here (UN-Water 2010). While the regional and global perspectives place the water space in a broader context, it is inevitable to contrast the water entity and the land entity, especially in Bangkok.

The starting point for this research is Bangkok's particular setting of the city structure. Again, different scales helped to access the structural layers: the parcel or lot as the smallest unit of spatial production, the row or the block on the second layer, the *soi* (finite lane system) as urban living space, the city and then the territory or region. Intermediate levels of spatial configuration are left out for comprehensibility (e.g. *trok* and superblock). The dominant street space and the neglected waterspace connect the different layers. In addition, there are often compartmentalisations of spatial expressions in the urban *land*scape, which affects the resilience. In Bangkok this can be traced to the urban structure of *soi*-ecologies, which are differently resilient to perturbations, due to their enclosed nature. (see Fig. 11) The research is an ongoing research and uses the *resilience-thinking* to explore the building typology and the urban structure in the water space. The water space can be considered as a social-ecological system in the complex adaptive system of the delta-city Bangkok.

The flooding in 2011, which was the most severe flood on record, raised an awareness of the importance of living with water. The results of the

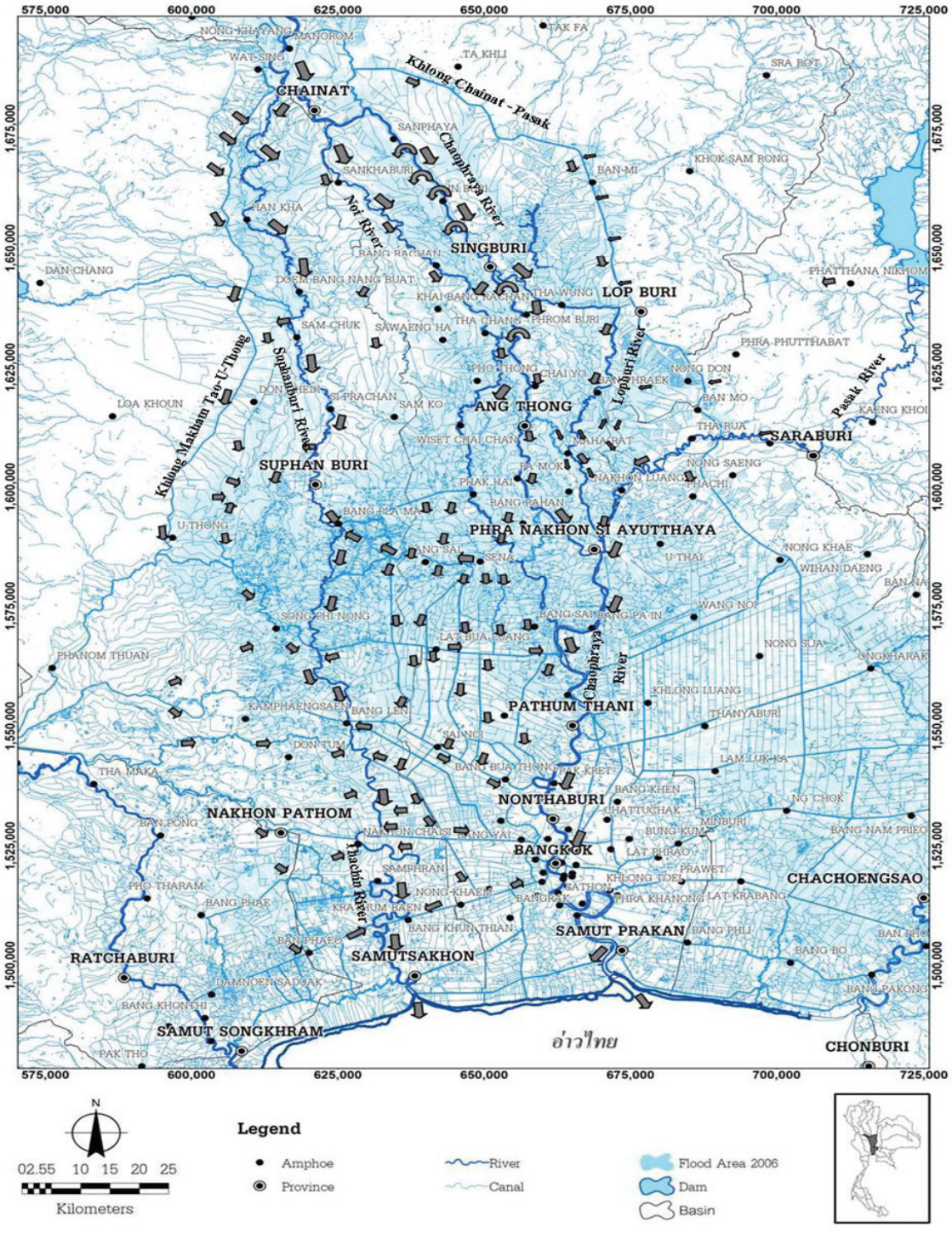

Figure 2a:
Lower Chao Phraya River Basin, flow directions of flood water (Prajamwong 2009)

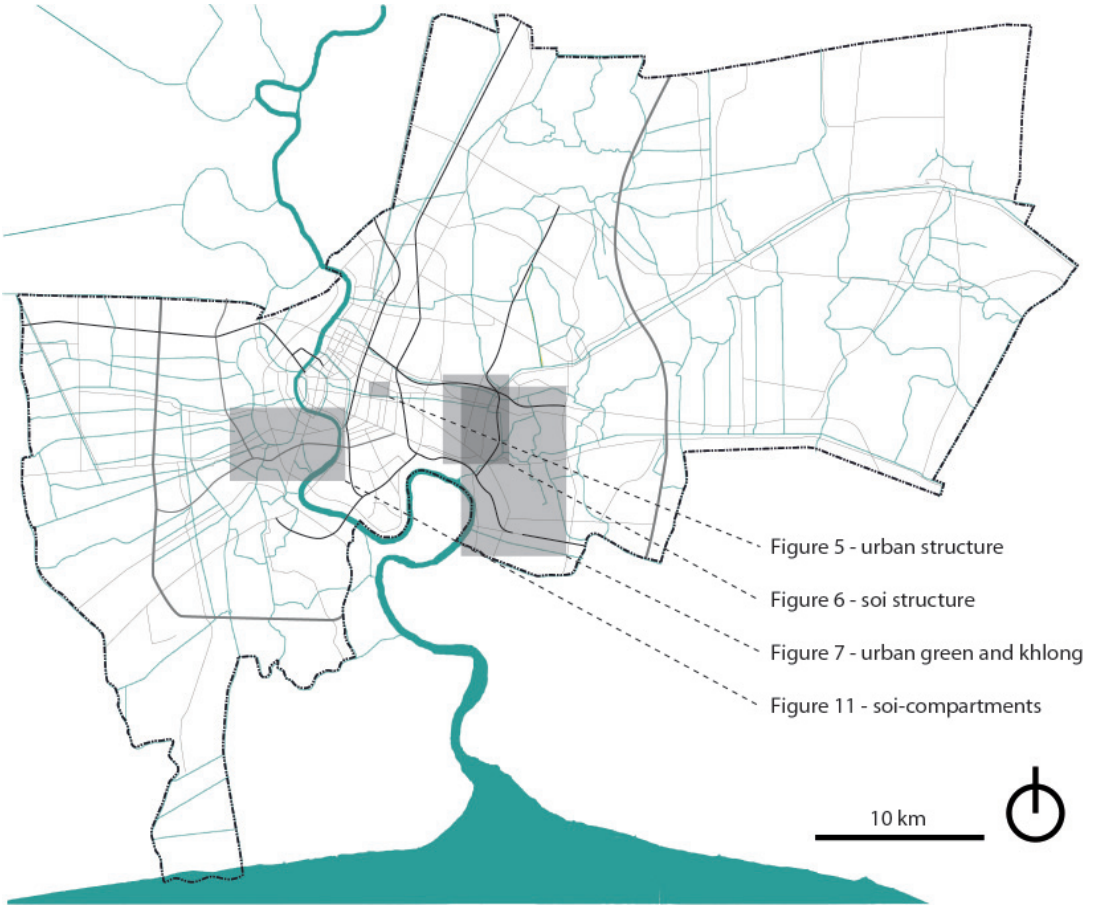

Figure 2b:
An overview of the maps: Bangkok Metropolitan Area with location of sample maps

flood had global repercussions because of supply-chain disruptions from hard-disks to automotive body parts. Nevertheless a 350 bn Baht Water-Management Project (approx. 8.75 bn €) has been projected with new canals for floodwater diversion, new dams, and water monitoring systems. But the project was stopped by the junta after taking power in May 2014. They plan to finish a nationwide water management plan by October 2014 that includes wastewater management, issues of drought and setting up a water resource policy and planning agency (Patsara 2014; Yuthana 2014). In addition to the mega-project, which shall solve a great many governance problems of land use and water resources management, another issue must be addressed: The challenge to define basic principles for designing and planning for the water spaces embedded in the urban landscape within a megacity is very important.

LANDSCAPE AS A CREATION BY HUMAN ACTION

Initially, resilient landscapes evoke an image about a strong ecological system to deal with high diversity of species, an intermediate connectivity with other ecological systems and adaptable spatial variations. A resilient landscape is a state at a certain moment, like an architectural cross section or a financial balance sheet, be it a good result or a bad one. High resilience is not necessarily a good state of a system. Accordingly resilience of landscapes should be seen as a process rather than an outcome and needs exact definitions of the system framework that is under investigation (Cumming 2011). Landscape can be seen as a social-ecological entity of people, biotic and abiotic variations and interactions between them, cohesively defined in space and time (Cumming 2011), thus it can be regarded as being

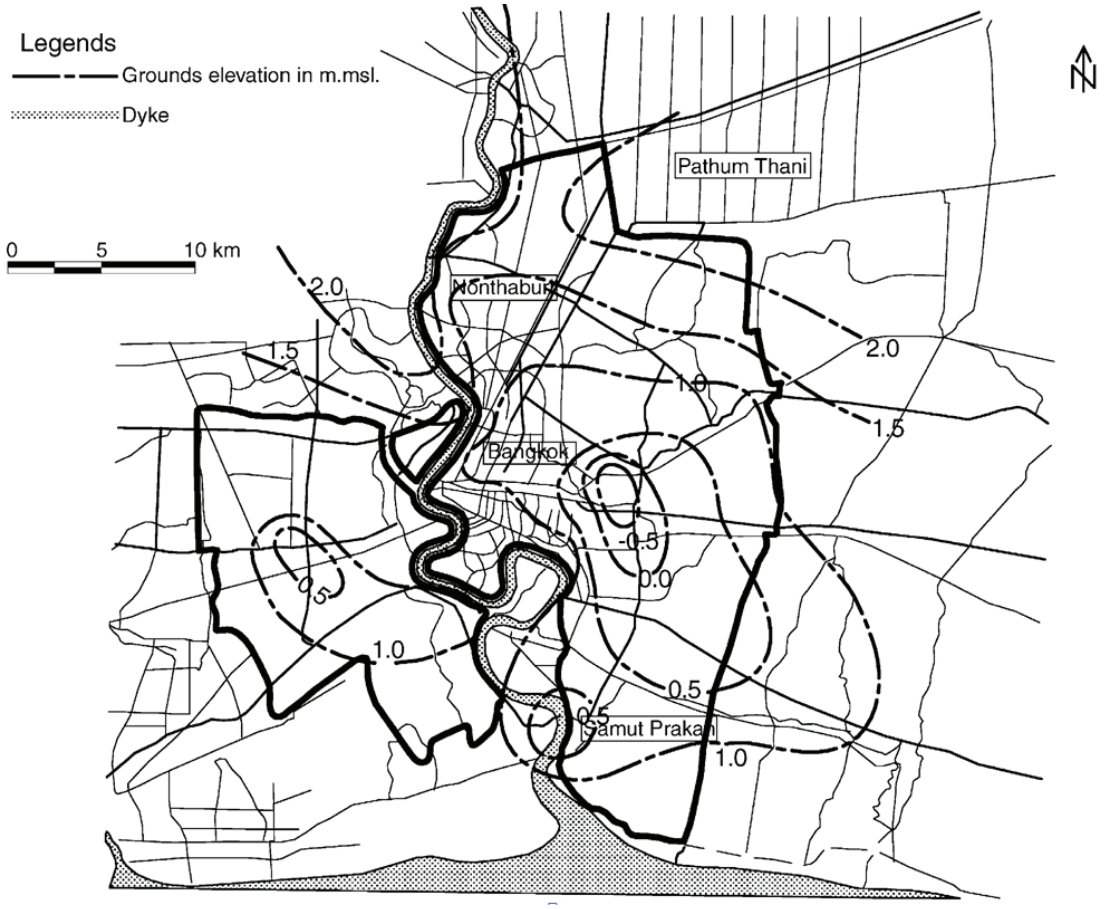

Figure 3:
Greater Bangkok Region: Height above MSL (Phien-wej 2006)

influenced by human actions. Indeed the word *scape* is derived from the Indo-German word *scapjan* which means *to create something* (Müller 1977). In its use as a suffix it can be understood as a term showing the relatedness of something which has been created by human activity. The creation of additional space through architecture and urban design and the alteration of existing space through infrastructure, agriculture and the utilisation of ecosystem services by human actions alter the habitable surface of the planet profoundly.

THE BUILT LANDSCAPE IN BANGKOK

Human control over space is performed by subdividing land into parcels. The agrarian parcel sizes and possible readjustments by administrative regulations and laws are constituent for the type of built-up form and the connected open space. Land links the building scale to the city scale and the parcel links the built space to the open space. The urban form, the city form and the built environment can be merged into the term *built landscape* because it marries concepts of built and open space and connotes materiality (Moudon 1994).

There are three implications with the built landscape in terms of definition:

First, landscape can be seen as an infrastructure providing access to ecosystem services and is a medium through which all ecological transactions must pass (Weller 2006). The design of landscape-

infrastructure should be understood as a means to combine the multifunctional serving character of infrastructure with the ecological processes. The *khlong* in Bangkok could emerge as a second spatial system (with the street as the complimentary system) for the following urban infrastructural interfaces:

- It could be used as water-parks or as leisure-space and playgrounds in the dry and hot season.
- During the monsoon season it can be water-retention space
- The wetlands that are between *khlong* and agricultural or residential areas might be use for reducing trophic levels or surface water cleaning
- A decentralized wastewater treatment, one that employs the urban structure of *soi*-compartments with their often agrarian land use or fallow land on the bordering *khlong*-side.
- The wastewater, for instance, could be treated and cooled down, with the use of combined heat and cool power, for a district's cooling system to substitute air-conditioning in buildings.

Second, landscape can be explored with the resilience concept. The spatiality or rather the influence of and on spatial variations of landscape is an important factor for analyzing resilience.[2] Landscape as a social-ecological system can be studied from different perspectives (e.g. agent-based models, Panarchy, Complexity Theory Framework or Sustainability Framework) and is considered as a complex adaptive system with related concepts: networks, asymmetries, information processing, non-linearities, emergences and thresholds (Cumming 2011). The development of metaphors out of such terms is an important part of conceptualizing design theoretical processes, especially by using the transformability of complex adaptive systems in the sense of changing stability landscapes and regimes (cf. Roggema et al. 2012; Geels 2006). Even with those topics in a somewhat elusive combination (complex adaptive systems, resilience and spatial variations) it can be seen as a starting point to question ongoing planning principles and methods. Transformation can happen deliberately or forced from external perturbations. A deliberate transformation needs to assess the current stability domain and its values and merits versus the alternative potentially more favourable stability domain (Folke et al. 2010).

The adaptation measures proposed in 2009 by the Climate Change Impact and Adaptation Study (e.g. raise dike crest elevation; increase pumping capacities and ground elevation of building sites) for Bangkok Metropolitan Region (Babel et al. 2009) and in 2013 by the 350-bn-Baht-Water-Management-Plan are seen solely from the water sector's perspective. Based on the presumption that Bangkok's water management is on the rim to tip into a degraded stability domain and considering the high ability of Thai society to adopt new influences and adapt to changed settings, are these measures sufficient to keep the stability domain broad enough to cope with future perturbations? Social-ecological and cultural memory might help to identify indigenous knowledge as one foundation pillar - also in its very literal sense - to transform the water space. It is crucial then to identify also the transformability of the building typology and the urban structure to find starting points either for planned system failures or for catalyst implementation. The *khlong* and its water spaces are predestined for a sustainable development in its very sense and the resilience concept reveals the key components to measure the spatial transformability: building typology, urban structure, social-ecological and cultural memory, and institutional and jurisdictional structure.

Third, water is, unsurprisingly, a fundamental part of landscape. Water drives geomorphologic processes (besides volcanoes, glaciers and earthquakes) and thus forms the space we live in. Water can be a threat in several dimensions for the built landscape: flooding, storm water, storm surge, and, considering saltwater intrusion or the depletion, also the groundwater, and scarcity of water. Within or under the built landscape water, as a procedural

[2] Carpenter et al. 2001 suggest that resilience consists of (1) the amount of disturbance that a system can absorb while still remaining within the same state or domain of attraction; (2) the degree of self-organization (versus lack of organization or organization forced by external factors); and (3) the degree of adaptive capacity, which can be related to the existence of institutions that facilitate experimentation, discovery, and innovation.

product, has been dealt with and a waterscape has been formed. This has been done mostly by sanitizing, canalizing, hiding, processing and covering the water with engineered infrastructure. Even without the water "controlled", be it in slum-agglomerations, in neglected, abandoned or shrinking settlements or due to poorly maintained or inadequate infrastructure, the waterscape would be a part of that locality. When water is perceptible with all senses in an urban, peri-urban or agrarian area, then the waterscape with its defined borders, usages and processes can be understood and be dealt with in an urban design perspective. Notwithstanding the necessity to include the urban water cycles into planning and design, it is important to understand the dynamic and procedural nature of water especially in urban waterways.

The waterspace is defined here as the space within the canal banks and the possibly inundated space, be it the actual or the intended (planned) urban floodplain. The urban floodplain obviously needs to be integrated into the built landscape. The urban flood scape as a necessary part of procedural urban transformation in Bangkok would raise awareness and resilience of floodplain-residents to water-related hazards, because they will learn to live with water. This social-ecological resilience would not increase, if it is not embedded in a corresponding built landscape. The spatial resilience of the built landscape in the planned floodplain considers several characteristics, which can quantify the identity of the waterspace-system: variability, flexibility, adaptability, modularity, transformability and connectivity.

WATERSPATIAL RESILIENCE OF BANGKOK

Urban waterways are an anthropogenic infrastructure and offer a space-accessing network, of which the connecting lines of exchange constitute a spatial (three-dimensional) entity. Thus planning, adaptation and transformation are possible in, next to, around and on the waterspace. The spatial extents, variations of the system to be explored (waterspace) and its characteristics have been defined. The framework for a waterspatial resilience needs to define further the

- different scales in which the system is operating
- very elements of this building block (in a spatial-structural sense) of a Bangkok
- timeframe, which is the *zeitgeist* of the places and its spatial equivalent of the *genius loci* as a palimpsest of imprinted history in place
- institutional and jurisdictional structure, with its overlapping responsibilities on the ridge of the bank border
- technical and infrastructural merging with the environment
- geomorphologic and climatic foundations for the system
- economical structure
- policy and planning level
- social-ecological characteristics

With this framework there could be possible answers to the question "... resilience of what, to what" (Carpenter et al. 2001). With the resilience being increased in one part, it can be lowered in another part. Even if it is an essential task and a common aim in policy and planning agendas, it would not help Bangkok to make the built landscape adjacent to urban waterways resilient only to flooding. The spatial design of fixed flood-defences can lead to less sensibility about the potential risks. These risks are still persisting and thus lead to a lowered resilience of the community to a sudden disturbance of perceived safety.

The typological and urban morphological configuration, inside and outside the waterspace, influences the waterspatial resilience. The urban design and its connectivity and modularity in the waterspace determine how robust the urban structure can deal with changes on the subjacent level of architecture. The architecture needs variability, flexibility and adaptability. Both architecture and urban design play an important role in forming the identity of a place. Identity is an important and connecting characteristic of complex adaptive systems and resilience. "Within the system, cohesion would be lost and the system would lose its identity if the forces that hold the system elements together (centripetal forces) [e.g. social capital or trade] were weaker than those that pull or push system elements apart (centrifugal forces) [e.g. habitat destruction or conflict].... Complete removal or elimination of a system, even if it is replaced by a very similar system, constitutes a loss of identity" and "Identity derives from the maintenance of key components

and relationships, and the continuity of these through time. If resilience is low, identity may be lost; and correspondingly, if identity is lost, we can conclude that resilience was low. Resilience can thus be operational by quantifying identity and assessing the potential for changes in identity." (Cumming 2011, pp. 10 and 13).

Amphibian architecture (stilted, floating, on a dike, on a dwelling mound or with waterfront , cf. Nillesen et al. 2011) is well-known and can be found in the Chao Phraya Delta. Amphibian architecture requires a certain level of water quality, which might appear as a daunting task for Bangkok, but considering the positive effects, which can be gained by partial amphibious urban structures; those of urban climate, amenities of water-transportation for leisure or for mobility, water-based commerce and businesses, local urban agri- and aquaculture. An amphibian identity could emerge even though it was not planned.

The level of urban planning deserves a closer look. Transposing the concept of green belts to blue belts and determining an agenda for waterspace planning with its *bluefields* (Pinch, Munt 2002) could tackled at the planning level if it is in combination with hydrology based district or even province borders (Dircke et al. 2010). For a more substantial shift in planning with social-ecological systems the consideration of waterspaces as complex adaptive systems with a network characteristic and panarchic adaptive cycles can also generate starting points for interventions. One way is to induce abnormal system ends; to simulate the crash of the system by setting predetermined breaking points. Thus leaving the paradigm for safety-planning and use the different weak points of the different system-scales as starting points to possibly accept the failure. For example, it could be more efficient and cost-saving to let spaces be inundated than to build ever higher dams (Roggema 2012).

In Bangkok, planning would need to start at the *soi*-level, setting up community-based planning principles for an emerging distinctness of *soi*-development. The next higher level could start from line-based axes, *khlong* and street, planning the adjacent spaces. This would correspond to the urban configuration and to the development pattern of Bangkok and could handle system failures in the line-based axes with the local actors in the surrounding areas to design morpho-logical and socio-spatial acceptable solutions.

BANGKOK'S TEAM[3] CONFIGURATION

Spatial variability is high in the *desakota*[4] of the mega-urban region of Bangkok. In this peri-urban area contradictory juxtapositions of land-uses are driven by urban development dominated market-forces. Bangkok has within its administrative boundaries of around 1.570 km² an extensive waterway-network of 1.161 *khlong* with a total length of about 2.200 km (Department of Drainage and Sewerage 2010). The *khlong* are basic for the terrestrial accessibility, they frame and guide the road system development. The co-evolution of street and *khlong* produced finite, diverse and mostly not interconnected cluster-like settlement-structures (*soi*-ecologies). These are often spatially limited by the *khlong* and strung at "development axes" forming so-called superblocks with sizes around 20 km². These superblocks mostly run parallel to *khlong* and are sparsely intersected by streets without a secondary road-network. Therefore, high spatial densities are framing the superblocks, with the skytrain-infrastructure boosting the built frames. The lack of secondary road networks with an intersecting *khlong*-infrastructure helps keeps the inner area to maintain low densities of orchards or paddy-fields. This overall configuration does not apply to the highly densified structures of the central areas of the eastern bank of Bangkok, but keeps valid in the peri-urban areas.

Currently the *khlong* in Bangkok are used as a drainage and sewage system with some functionality for transport. Generally, in Europe, inland waterways have been identified by researchers as a multifunctional and multidimensional entity and are understood as a catalyst for

- urban and rural renewal processes
- strategic and dynamic planning to connect places along the waterways

[3] terrestrial-amphibian

[4] Desakota is a term used for the interlocking of desa=village and kota=city as a typical spatial phenomena in Southeast Asia McGee, Robinson 1995; McGee 2009

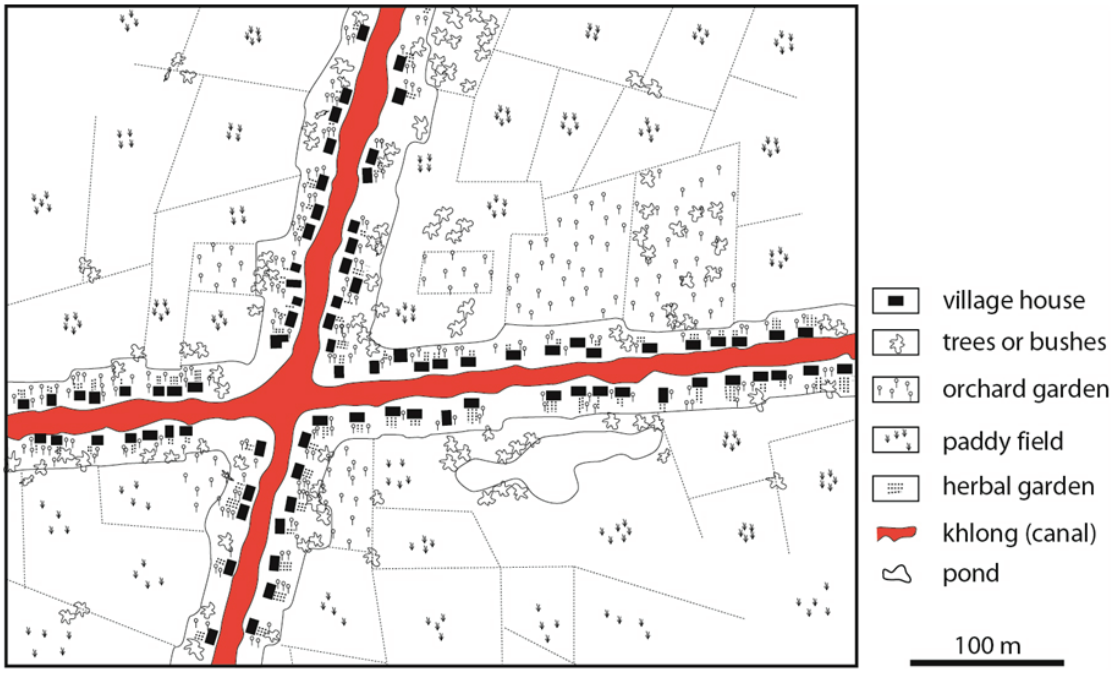

Figure 4:
Typical delta-based canal settlement, location not specified, can be found alike at Khlong Saen Saeb in Chachoengsao Province, source: Nitichan 1988

Figure 5:
The land based shophouse-rows and the detached houses and high-rise are the usual building blocks of the terrestrial urban structure in Bangkok

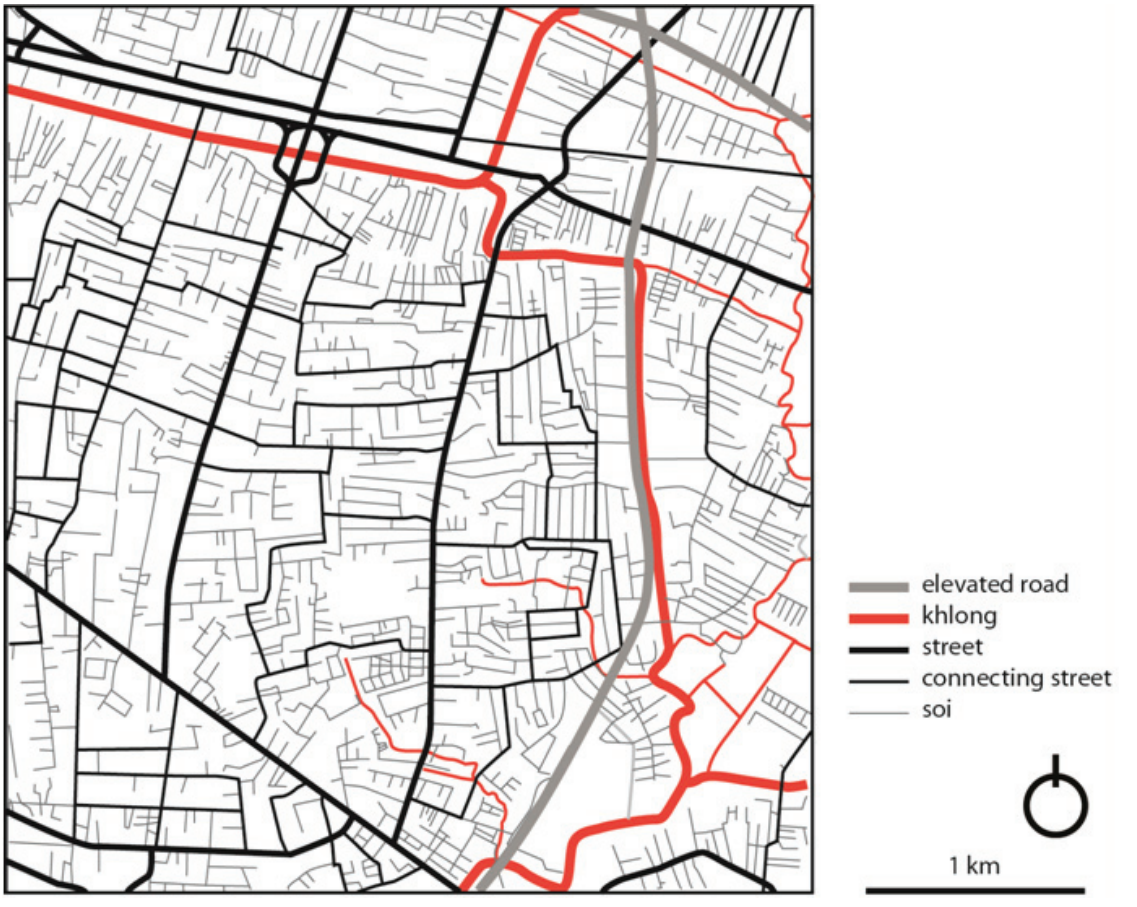

Figure 6:
Highly urbanized area (Sukhumvit) with persisting khlong-network

- private sector investments
- giving identity and thereby deliver a key factor for city marketing

If waterspaces are accepted with their cultural and historic relevance, they can also serve the tourism and construction-sectors attracting creative industries and social services. By considering the planning of waterspaces health-related, educational and free-time-activities could also take place in these areas. These planned waterspace activities could put a positive character onto the *image of the city* (after Kevin Lynch) for residents. The spaces and activities foster social cohesion and connect cultural and natural spaces. The broad and deep connectivity at the structural (institutional), spatial and individual level of the waterspace establishes a sounds basis for identification and identity (Pinch, Munt 2002; O'Gorman et al. 2009; EU 2012). This list of qualities should not be understood as a normative goal for the *khlong* development, instead it sums up possible planning directions.

In Bangkok there are specific elements relevant to integrate the khlong-network into the urban fabric; the existence of historic canal settlements and canal markets and vernacular architectural design (stilted, floating) for a living with water (Montira 2013).

The cultural urban heritage would add an important part to the investigation-scheme of *khlong* in Bangkok by also considering the *khlong* themselves and the two other building blocks of traditional settlement structures in the Chao Phraya Delta, which are often found adjacent to *khlong*: the temples and the markets. In contrast, modern building blocks are the malls, the skyscrapers and the skytrains, often disconnected from the ground by skywalks, or

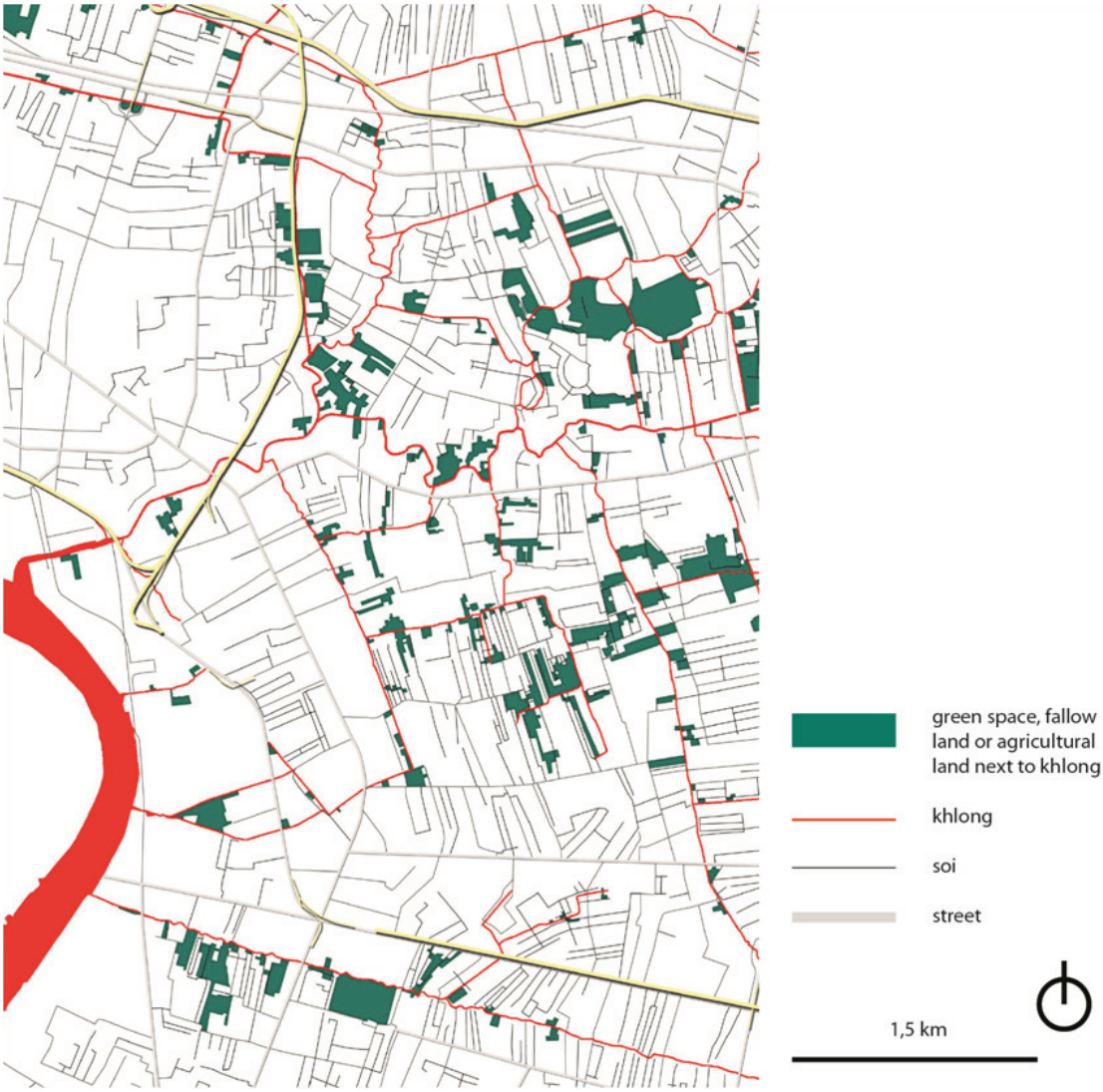

Figure 7:
Canal system in East-Bangkok and green spaces, agrarian use or fallow land with connection to khlong

car-park levels over the ground. Moving further on the lot-layer of Bangkok, the shophouse appears as a highly adaptive container for urbanity. This typology can be well retrofitted to future demands for individual housing and working (Casper 2009) and might even be able to adapt to constant flooding by using the constructed additional height of the ground floor as a flexible space for living with water.

Considering the three-dimensionality of the waterspace, it is useful to define the adoption and perception of space. The adoption and perception illustrate the transformation of the urban society in Bangkok: the aquatic, amphibian, terrestrial, planar (*planare lat.:* to flatten/ to smooth sth) and for future visions the volaric adoption of space. The waterspace in the areas of possible inundation can understood to be amphibian. The street level is terrestrial and the skytrain is on the planar level. The adoptions of space are in constant flux. The flow of material as a process for construction has measurable effects on the amphibian landscape and hence on the amphibian identity. With an infill of about 5,700m³/km²/year in the Bangkok region, the

delta's ground subsidence cannot be levelled, but the amphibian waterspace is constantly reduced and transformed to terrestrial (Hara et al. 2008).

This is one of the variables changing the conditions of living in the waterspace, very slowly but with possible influence on the stability domain in the long run.

TEAM-STRATEGIES

The amphibian identity of Bangkok is a process, which needs long-term visions, transformed planning procedures and urban design principles for waterspace planning.

The mutations of the lots and the urban morphology can identify the forming language of waterspace through time. The issue of urban structural transformations by changing use of basic energy forms (solar etc.) and changing modes of mobility (electric boat, copter technologies, cable cars etc.) is basic variable for change of cities by innovation. Bangkok could pursue accelerated transformation by innovations in water-mobility. The urban morphological approach helps to identify adaptive urban form for such innovations. It is important to note that in the morphological approach, the built form has a partial autonomy over the utilization (Curdes 1997; Raith 2000). However, the utilization of the built landscape can identify its potential of modification:

Figure 8:
Khlong Saen Saeb, Wat Theep Lila

To deduce metaphors for operationalising an urban morphological approach on waterscapes further exploration is necessary. The ongoing research does not yet got into detail concerning the socio-spatial, the institutional and the jurisdictional issues. A better understanding of the dynamics of urban development in Bangkok would help to evaluate transformability.

Possible outcomes are developing water-use planning parallel to land-use planning, generating a basis for definition of hydrological districts and/ or provinces, understanding bluefield strategies, principles for waterspace design and encouraging indigenous amphibian architecture to establish an amphibian living space.

Innate (non-)utilization or facilities act...	(actively operating) transformative by...	(stays passive, holds) persistent by...
dynamic by...	functioning as central	location in the city-grid
inert by...	high density / lack of space	unchanging land tenure

(Example for temples (wat) with different potentials of modification due to local characteristics of the system with changeable attitudes depending to temporal occurrence)

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Figure 9:
Khlong Bang Chak

Figure 10:
Khlong Saen Saeb

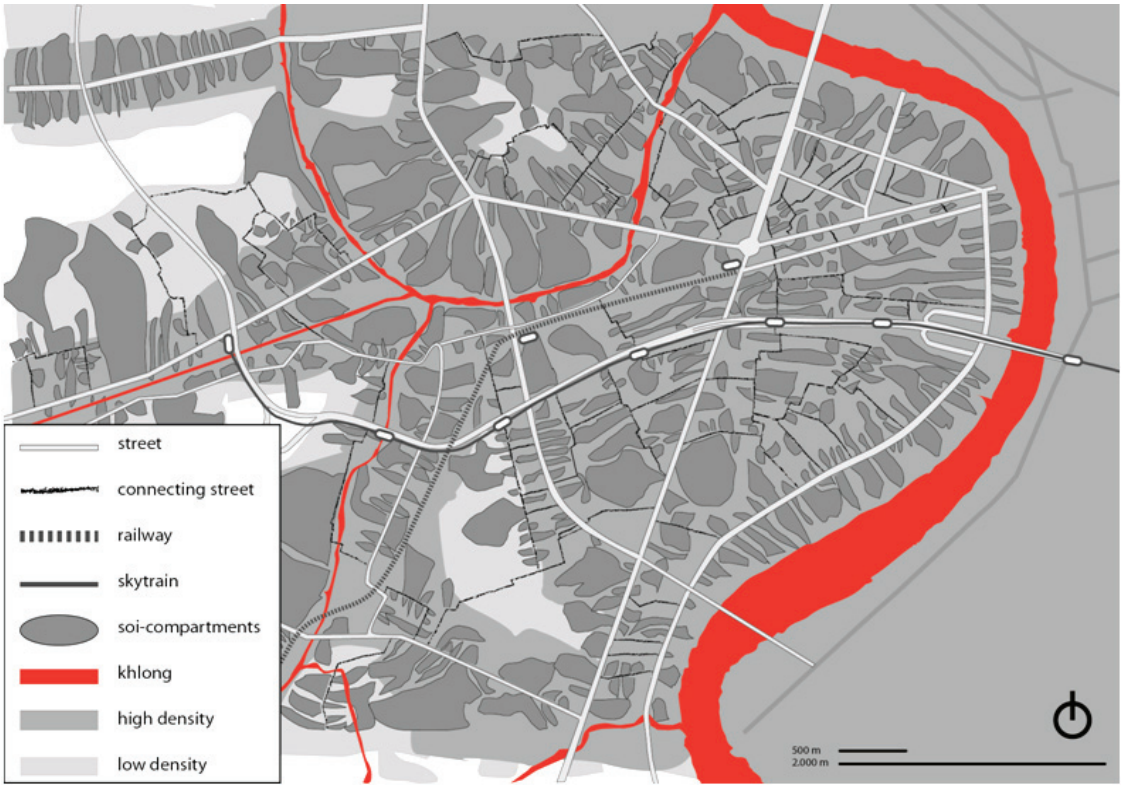

Figure 11:
Thonburi, a metaphorical image of the compartmentalization of soi-ecologies

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