MANAGING URBAN WATER SYSTEMS WITH SIGNIFICANT ADAPTATION DEFICITS – UNIFIED FRAMEWORK FOR SECONDARY CITIES: PART I - CONCEPTUAL FRAMEWORK

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ABSTRACT

~~The need to address the shortcomings of urban systems -- adaptation deficit -- and shortcomings in response to climate change -- 'adaptation gap' -- are both major challenges in maintaining the livability and sustainability of cities. However, the adaptation actions defined in terms of type I (addressing adaptation deficits) and type II (addressing adaptation gaps), often compete and conflict each other in the secondary cities of the global south. Extending the concept of the environmental Kuznets curve, this paper argues that a unified framework that calls for synergistic action on type I and type II adaptation is essential in order for these cities to maintain their livability, sustainability and resilience facing extreme rates of urbanization and rapid onset of climate change. The proposed framework has been demonstrated in Can Tho, Vietnam, where there are significant adaptation deficits due to rapid urbanisation and adaptation gaps due to climate change and socio-economic changes. The analysis in Can Tho reveals the lack of integration between type I and type II measures that could be overcome by closer integration between various stakeholders in terms of planning, prioritising and implementing the adaptation measures.~~

The lack of resilience of urban systems to weather and climate variability – termed type I adaptation – and also to climate change – type II adaptation – are both major challenges to the livability and sustainability of cities in the global South. However, there is often competition and conflict in these cities between actions that address existing adaptation deficits (Type I) and projected adaptation gaps (type II). Extending the concept of the environmental Kuznets curve, this paper argues that synergistic action on type I and type II adaptation is essential in order for these cities to maintain their livability and build resilience to climate variability and climate change in the face of growing urban populations. A proposed unifying framework has been demonstrated in Can Tho, Vietnam, where there are significant adaptation deficits due to rapid urbanisation and adaptation gaps due to climate change and socio-economic changes. The analysis in Can Tho reveals the lack of integration between type I and type II measures that could be overcome by closer integration between various stakeholders in terms of planning, prioritising and implementing adaptation measures.

INTRODUCTION

With a majority of the human population now living in urban areas, cities justifiably attract attention in national and global discourse on human development (Angel 2012). Until recently the place of and the challenges faced by secondary cities (non-capital cities with populations less than 5 million) has largely been ignored, although in terms of the total number inhabitants, secondary cities overshadow megacities (Roberts 2014). Many secondary cities in the global south (SCGS) are poised to undergo substantial economic growth and increase in population

(UNDESA 2013). Moreover UN-HABITAT (2007) estimated that in the developing world only some 5% of urban development is actually planned. It is very likely that such growth will result in severe stress on the environment and challenge the livability of the inhabitants (e.g. due to urban flooding, pollution, water scarcity). SCGS routinely embark upon infrastructure development plans to address major service deficits that are felt in the current time. However, SCGS are very likely to face the adverse impacts of a rapidly changing climate which also require adaptation actions (Tessler et al. 2015). A challenge they often face is the inability to integrate these many and diverse adaptation needs.

Debate on how to address climate change impacts has brought forth adaptation to the focus in the discussions on urban development. Two different drivers for adaptation are now being perceived: the need to address any current shortcomings of the urban system; and the need to address anticipated shortcomings of the system against future scenarios. These perspectives can result in two different types of adaptation actions. While in principle the goal of all adaptation actions should be unified, namely, to improve livability, sustainability and resilience of cities, at a practical level these two adaptation domains are often in conflict (Brown 2011). This is particularly the case in rapidly developing cities in the SCGS where significant shortcomings in current infrastructure and services are already evident (USAID 2013). However, this evidence should not preclude the understanding that these cities are likely to face even bigger shortcomings in the future (Tessler et al. 2015). In order to minimize contradictions and maximise benefits by promoting the multiple value arising from adaptation across the two domains, it is necessary to attempt to unify adaptation into a directed approach that addresses both domains synergistically. A conceptual framework that sets out how to unify adaptation in this way is presented here. The unified framework has been demonstrated by assessing the current adaptation efforts in Can Tho, the largest city in the Vietnamese Mekong delta.

BACKGROUND

In order to maintain livability, SCGS need to continuously adapt to ongoing changes (e.g. environmental, social/political and climatic). IPCC defines 'adaptation need' as the gap between what might happen under climate change and 'desired outcomes' (Noble et al. 2014) which depends both on forcing scenarios and on (urban) growth. The difference between any pre-agreed adaptation target (adaptation need) and the actual or anticipated state of adaptation is defined as 'adaptation gap' (UNEP 2014) (Fig Fig 1).

Defining Adaptation Deficit

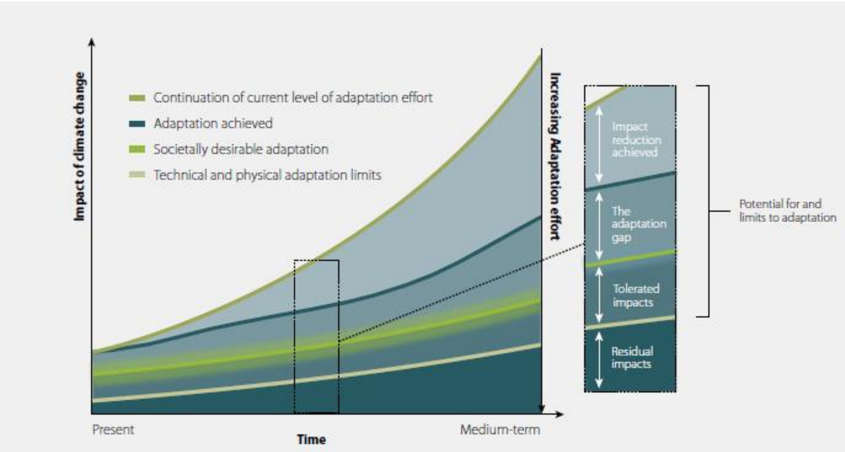

Fig 1 : Impact, Adaptation and Adaptation Gaps adapted from UNEP (2014)

Many SCGS have major shortcomings in urban water system services (management of drinking water, sanitation and surface/flood water) with respect to societally desirable levels. This can be framed using Burton (2004) definition of 'adaptation deficit': "*Failure of current adaptation to keep pace with development*". For example, water scarcity in a city can be caused due to an increase of water demand at a more rapid pace than the implemented improvements to the water supply. This increase of demand could be due to (among others): 1. Increasing urban population; and 2. Increase of per capita water demand due to increased heat. According to Burton's definition driver 1 leads to an adaptation deficit. Confusingly, the WorldBank (2010a) uses the term 'development deficit' to differentiate deficits in climate focused action (which they term 'adaptation deficit') within the context of general adaptation actions. According to the WorldBank (2010a) definition, driver 1 above leads to a 'development deficit', whereas driver 2 leads to an 'adaptation deficit'.

The term adaptation could be used in a more general sense (than only related to climate) to denote all types of actions to cope with changes in both external (e.g. climate, socio-economic) and internal (e.g. pollution, higher runoff resulting from urban growth) forcings. Later in this paper it is shown that this type of generalized use is in fact desirable for creating a unified view of adaptation. Therefore our definition of adaptation deficit is "the gap between the current state of a system and a state that limits the current impacts from existing external (e.g. climate) and internal (e.g. urban development driven) forcings to a tolerable level". Later in the article it is suggested that it is particularly useful to look at adaptation actions in the context of adapting to the consequences of internal and external forcings, as well as addressing current and future gaps in adaptation.

Type I and Type II Adaptation actions

Burton (2004) discusses two types of adaptation actions: Type I adaptation, the everyday adaptation to weather and climate that has always been a feature of human life; and Type II adaptation, the adaptation to (climate) change usually as mandated under the UN Framework Convention on Climate Change (UNFCCC). Type I Adaptation is promoted as part of sustainable development, while Type II Adaptation relates to anthropogenic climate change and is driven by the rules and practices under the Convention. Burton's view (Burton 2004) provides the means to consider adaptation activities as addressing the change and variability in the current state of the forcing system (Type I adaptation action, addressing adaptation-deficit) and those addressing long-term global climate change impacts and long-term anticipated internal changes due to urban growth (Type II adaptation actions addressing adaptation gap) as two points in a continuous spectrum of activities, towards improving and sustaining livability. This view is useful in setting adaptation planning in SCGS in an appropriate perspective, where adaptation becomes a process which is closely related to the historical development, needs and aspirations of these cities rather than a superposed concept exclusive to the climate change debate.

Adaptation in two different worlds

Adaptation capacities, the limits to adaptation (Adger et al. 2009) and hence the progress of adaptation are strongly influenced by socio economic, political, cultural and psychosocial factors such as access to financial capital, human capital, technology, information, infrastructure, institutions and entitlements, kinships, health and well-being, political capital, social capital, property rights, perception, attitudes and power differentials (Garschagen 2014; O'Neill et al. 2014). Challenges to adaptation comprise of the collection and integration of: (i) socio-economic factors such as population, economic growth, urbanisation; (ii) bio physical factors like temperature, rainfall, geology; (iii) factors that span across scales, such as spatial and temporal variation of vulnerability and the heterogeneity and structure of society (O'Neill et al. 2014; Rothman et al. 2014). Although there is an obvious difference between the aforementioned factors influencing adaptation in the mature cities of developed countries and SCGS, a stark difference of another kind in adaptation could also be noticed between these. In a general sense, many mature cities in the developed nations do not have significant adaptation deficits (WorldBank 2010b), needing little Type I adaptation action. Further, they are not likely to undergo significant expansion or densification, largely needing only to address the external (climate) forcings in the domain of Type II adaptation. Coincidently, current literature on climate adaptation largely if not exclusively, focuses on type II adaptation (Haasnoot et al. 2013; Pillai et al. 2010; Preston et al. 2011; Tanner et al. 2009). Frequently climate adaptation is framed in the national policies of developing countries as an issue isolated from the type I adaptation (addressing adaptation deficit) (GoI 2008; PM 2011 among others). This is despite Type I adaptation being critically important in SCGS and developing countries (Revi et al. 2014). While this can be appropriate in the context of developed nations and mature cities, where adaptation deficit is often small, it is a serious error in planning, given the current realities of the challenges faced by SCGS, and can lead to failure of Type II adaptation. The lack of understanding of the need to integrate Type I and Type II adaptation in SCGS, in our opinion, is a major reason for the current lack of buy-in of climate adaptation by a broad a range of stakeholders in SCGS. In the next section, a framework that could exemplify the need to integrate Type I and Type II adaptation, is formulated.

UNIFIED FRAMEWORK FOR ADAPTATION

The history of growth of many cities in the developed world shows a remarkably consistent pattern indicating that the severe degradation of the environment (**Error! Reference source not found.**~~Fig 2a~~) has invariably been linked with the initial phase of growth (Bennett 1985; 1997). Inspired from the work on Kuznets (1955) in economics, the historical process of human-environment interaction has been explained using an Environmental Kuznets Curve (EKC) (Grossman and Krueger 1991). Many of today's stable cities (many cities in Europe, North America and Oceania are stable in terms of population and growth) have gone through an initial growth pace that accompanied a severe rate of environmental degradation to be followed by a 'stabilizing state' and then a levelling off of environmental degradation (fig 2a) due to mitigatory actions. These were largely autonomous adaptation actions (IPCC 2007), in the sense cities were reacting to an unlivable environment.

The historical narrative of urban development that inspired the EKC (**Error! Reference source not found.**Fig 2a), will not be replicated for SCGS in the future due to non-stationary external (climate change), rapid urbanisation and the unique population growth dynamics in SCGS. The falling limb of the EKC, which signifies the reduction in negative impact with increasing economic growth, generally attributed to autonomous adaptation action accompanying economic growth, is likely to be less effective in SCGS. Compared with the historical experience, the falling gradient of EKC will be much gentler. It is even possible for the 'EKC' of SCGS not to have a falling limb if the rate of increase of forcings is very high. This idea is illustrated in Fig 2b and is described in detail in the next paragraph. The future-oriented view of UNEP(2014) (Fig Fig 1), although comprehensive in framing the discussion on climate that lead to type II actions, is incomplete in representing the adaptation deficit's impact on future adaptation and livability. Hence it is suggested here that the SCGS will benefit from a unified conceptual framework for adaptation that comprehensively brings together: (a) the significance of adaptation on livability in the context of historical and current situations; (b) short and medium-term impacts anticipated from explosive urban growth; and (c) ensure the sustainability of improvements attained through the climate adaptation measures. This unified framework for adaptation is in-line with the integrated approaches (e.g. Revi et al. (2014), Serrao-Neumann et al. (2015)) proposed by the climate change research community and addresses the concerns highlighted in the outcome based narratives of recent SSP approaches such as O'Neill et al. (2014).

Error! Reference source not found. Fig 2b illustrates the conceptual framework that has been developed by extending the idea of EKC. The historically anticipated behaviour of EKC (path 1) will not be a reality in the future of SCG|S. An extreme (negative) trajectory, where neither type I nor II adaptation actions are taken, would be path 2 and the negative impacts would keep increasing in spite of economic growth. In the case of path 2, the initial falling limb of EKC – attributed to autonomous adaptation – will be very shallow as depicted in the figure or will not fall at all. Simply autonomous adaptation is not adequate to keep up with the rapid increase of external and internal forcings. Implementation of the type I adaptation actions (as the case with many SCGS today) may lead to a drop in the negative impacts in the short-term, but would soon rise due to climate change impacts (path 3). Even by taking adequate type I adaptation actions, SCGS may not be able to constrain negative impacts on livability over the long-term.

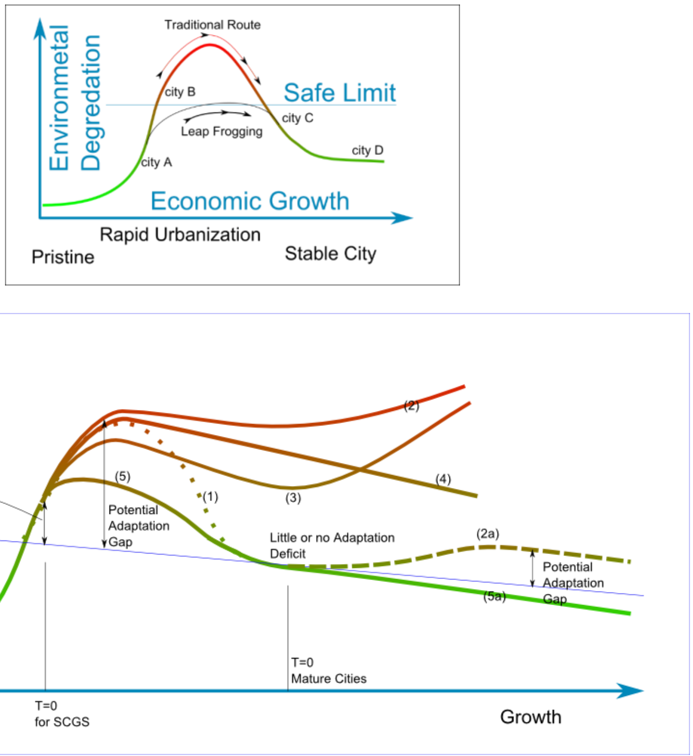

Fig 2: (a) Urban Development and its consequences often resemble an Environmental Kuznets Curve (EKC). Many SCGS today are on the rising limb of the curve (A and B), poised to reach an extremely high degree of degradation of the environment, regardless of climate change; negatively affecting livability (Bennett 1985; Ekins 1997).

(b) A unified view of climate impact and adaptation. In the case of SCGS the negative impact on livability is already greater than the socially acceptable level (T=0), creating an adaptation deficit. The 'historical' view of Environmental Kuznets Curve (EKC) is (1). However, due to climate change and very rapid urban growth, this is no longer likely to be applicable in the future. Rather, the 'business-as-usual' future would be (2), where there is neither type I nor type II adaptation but only autonomous adaptation. Addressing only adaptation deficits though Type I adaptation would result in (3). Addressing only adaptation gaps through type II adaptation would result in (4). The ideal trajectory would be (5) which can only be achieved by combining Type I and Type II adaptation actions.

For mature cities that have already reached a stable state, the scenarios collapse into only two paths as they do not have significant adaptation deficits: path (2a) if adaptation gaps are not addressed through Type II adaptations and path (5a) if effective Type II adaptation actions are taken.

Strong climate adaptation (type II) action would yield results in the longer term (path 4). However, type II actions alone would not result in significant reductions in the short-term impact for SCGS. Even by taking significant Type II adaptation actions, the initial effect in containing negative impacts on livability will be small. Simultaneous action in both Type I and Type II adaptation would result in a path (path 5) that is similar to leap-frogging of EKC (**Error! Reference source not found.**~~Fig 2a~~). Type I adaptation essentially reduces impacts short term, whereas type II adaptation reduces the impact over the longer term.

An important secondary issue is that the social acceptance of impacts on livability also reduces as development proceeds. There are numerous examples for this phenomenon. Citizens of mature cities have lower acceptance for non-catastrophic flood events as compared with citizens in many SCGS. This non-acceptance can be due to many factors: incompatibility with an (expected) higher quality of life and higher (financial) risk due to concentrated wealth, among others. Current levels of risk acceptance often shift in accordance with socio economic and human development of the country, like in case of Viet Nam where cities such as Can Tho and Ho Chi Minh city aspiring to become as safe as Rotterdam (Garschagen (2014), p. 247). Adaptive measures such as increase in numbers of dikes and heightening of existing dikes, which reduce the frequency of flooding, could also provide a sense of security – levee effect – and might discourage people to continue with the established practice of taking personal precautions (Tobin 1995). The levee effect creates a sense of complacency, which reduces the level of preparedness and creates incentives to build structures in flood prone areas (Pielke 1999). This is why we depict the socially accepted level of adaptation as diminishing over time. This is in contrast to the view of UNEP (2014), which takes the 'tolerated impact' as largely unchanging (fig 1).

It is clear that at the current time (T=0) many mature cities (mainly in the global North) are at a different point in the development scale. They arrived at this point with largely Type I adaptation (which can be seen as autonomous), in a context with no significant climate change forcing. However, it is equally important to understand the consequences of this positioning. Having little or no adaptation deficit, the impact-development trajectories for the mature cities can be explained using only two paths. There is little need for type I adaptation in these cities (although there are needs for proactive operational level actions such as deferred maintenance in case of infrastructure asset management). The focus in these cities to a large extent is exclusively on the medium-term and long-term impacts on livability caused due to climate change (Type II adaptation). Non-action in this domain would result in path 2a, where the impact on livability would increase above the socially acceptable limit, due to an adaptation gap, whereas proactive action in the form of Type II adaptation would keep the medium and long-term impacts below or at a socially acceptable level.

Cities in The Netherlands such as Dordrecht and Rotterdam follow the trajectory 5a in **Error! Reference source not found.**~~Fig 2b~~. Adaptation deficits do not arise in these cities as there a continuous flood protection plan in these cities as they are under the aegis of the various Delta Plans, the latest of which assures maximum safety levels for every citizen against a 1 in 100,000 year flood event (Deltacommissaris 2014). Hence at current time T=0 there is no adaptation deficit in many Dutch cities. Dutch cities take a proactive view on climate adaptation (Buuren et al. 2013). Projects like room for the river(Zevenbergen et al. 2015a) are largely planned to address impacts of climate change and can be seen as Type II adaptation measures.

It is not only in the flood risk domain that mature cities follow pathways as illustrated in **Error! Reference source not found.**~~Fig 2b~~. Despite being one of the most mature of global cities, (UK) has had a complex response to environmental degradation. Whilst largely cleaning up the aquatic and land environments, successive policies have effectively ignored the chronic air pollution in the city, despite international regulations censuring the lack of clean-up action. In this respect, early improvements, such as the Clean Air Acts in the 1950-1960s that removed the worst of the air pollution – known as 'smog', the less obvious but as equally damaging to residents health that has built since then, is pollution from vehicle emissions (Samoli et al, 2016) that has not been tackled. This suggests that in ~~Figure 3~~Figure 2b, London is following trajectory, being somewhere on the second rising limb of the plot in terms of air pollution. Although being especially damaging to the population of London, this pollution may be affecting communities on a wider scale (Committee on Air Pollution Effects Research (CAPER), 2016).

CASE STUDY OF CAN THO, VIETNAM

In this section the proposed framework (**Error! Reference source not found.**~~Fig 2b~~) is is explained using the case study of Can Tho city, the largest city in the Vietnamese Mekong Delta.

Can Tho, the largest and a fast growing city in the Mekong Delta in Vietnam, fits well to the description of a secondary city. The City is emerging as an economic hub and is likely to play an important role in the future of the Mekong Delta (MDP 2013). Can Tho also has issues such as flooding during high tides, inadequate drainage systems, ground water extraction and land subsidence (SCE 2013). Further, Can Tho is likely to be affected by climate change impacts such as increase in intensity of rainfall causing fluvial and pluvial floods; increase in runoff due to increased imperviousness due to urban growth (Huong and Pathirana 2013). In addition the rapidity of urban development in Can Tho has also led to unplanned growth, increase in real estate prices, widespread water pollution and flooding issues and prevailing social disparities in terms of availability of housing stocks and access to services among the residents (Garschagen 2014). Garschagen (2014), on vulnerability and adaptation to climate change in Can Tho, highlights the following: (i) Social dimensions of climate change adaptation and vulnerability remain neglected in Can Tho; (ii) Macroeconomic success and reform process such as - *Doi Moi* (Chu et al. 2014), have not brought inclusive development at all levels of society; (iii) although there is a central political command and control structure, the implementation of projects and ways of administration is driven by local and personal interests; (iv) there is an interplay between the adaptive actions taken by state and non-state actors that has to be understood (for more details refer to (Radhakrishnan et al. Under Review)); and (v) There is (disjoint) multiple adaptation in Can Tho, i.e adaptation towards urban development, socio economic changes (Type I) and adaptation towards climate change (Type II).

Adaptation Deficits in Can Tho with respect to Flooding

There are existing city level plans and region level plans that address the adaptation deficit in Can Tho through structural measures such as improvements to critical infrastructure such as drainage system, dikes and roads; and non-structural measures such as risk based land use planning, increasing awareness among people, community engagement , data sharing and communication on flood risk (MDP 2013; SCE 2013; SIWRP 2011; VIAP-SUIP 2013). Assessment of the drainage improvement measures proposed in the World Bank plan (SCE 2013) for a small area in Ninh Kieu district (densely urbanized center) of Can Tho revealed that these measures would not be as effective as originally planned (Analysis done using the hydraulic model of Ninh Kieu district developed by Quan et al. (2014) and Radhakrishnan et al. (Under Review)), largely due to the increased river-levels (driven by sea-level and increased upstream flow).

The drainage options for protection against pluvial flooding in the World bank plan (SCE 2013) and subsequent analysis of these by Radhakrishnan et al. (Under Review) is based on the assumption that an effective dike system would be in place as recommended by the plan to protect Can Tho against fluvial floods. However, the annual maximum water levels already show an increasing trend resulting in the current annual maximum level exceeding the design standards, i.e. 10 year ARI water level (page 111, Appendix of (SCE 2013)). The increase in river water levels necessitates the usage of additional pumping capacity, larger scale retention systems and household retention measures. Also the current dike levels are below the increasing river water levels leading to flooding during high tides (Radhakrishnan et al. Under Review). Hence it could be concluded that Can Tho has a significant adaptation deficit against variability of river levels (an external forcing). The drainage plan (SCE 2013) addresses the current adaptation deficit (Type I adaptation), but not the adaptation gap. The future climate adaptation measures (Type II adaptation) such as green-blue infrastructure recommended by the plan may not be effective unless the Type I measures are put in place.

Adaptation gap in Can Tho

There is a unanimous agreement among the various studies regarding the existence of an adaptation gap in Can Tho due to climate change, as the city is located in a region susceptible to climate change (Garschagen 2014; Huong and Pathirana 2013; MDP 2013; SCE 2013; WorldBank 2104). However, the adaptation measures for climate change in Can Tho (SCE 2013) such as land infill and elevation of infrastructure; construction of dikes; improvement of drainage infrastructure; and adjustments to building regulations are inadequate since the thresholds for these measures do not consider projected changes due to climate change (Section 6.1.3.3 Garschagen (2014)). The increasing trend in river water levels and uncertainties in sea level increase, illustrate that only some and not all of the planned flood protection systems such as dikes, land use planning (MDP 2013; SCE 2013; SIWRP 2011; VIAP-SUIP 2013),etc. have the capacity to ensure protection against river flooding (Radhakrishnan et al. Under Review). This indicates that the measures proposed to address the adaptation gap actually address the adaptation deficit (Type I adaptation) and not the adaptation gap (Type II adaptation), which is part of the stated, actual target, i.e. to remain safe in the event of climate change.

Unified view of adaptation in Can Tho

Implementation of type II measures alone in Can Tho may not yield the expected results as there are adaptation deficits which should be addressed by Type I measures. Implementation of both Type I and Type II measures currently proposed for the city might not make it possible for the city to follow the (most desirable) path 5 in Fig. 3. The currently proposed Type II measures do not address adaptation gaps adequately. Further the factors that exacerbate the adaptation deficit will have to be clearly understood. The adaptation deficit in Can Tho is not only as a result of the deficiency in the capability of the existing systems against current climate extremes, but also due to changes in the socio-economic scenario(s) in Can Tho. Doi Moi reforms along with liberalization have created a social disparity in Can Tho – disparity in incomes, increased land prices - and have increased the vulnerability of socially disadvantaged groups such as migrant laborers (Garschagen 2014). As it stands today, even with both Type I and Type II actions that have been proposed are implemented, the best case scenario would be that Can Tho will follow a trajectory that is a mix between path 3 and path 4 in Fig. 3. In order to address the needs of adaptation of Can Tho more comprehensively, it is necessary to understand the features of Type I and Type II adaptation proposals in Can Tho.

A comprehensive vulnerability assessment using an approach similar to the 'MOVE framework'[1] suggested by Birkmann et al. (2012) may be undertaken in order to harmonize the socio-economic adaptation measures with the infrastructure adaptation measure that are needed to follow a trajectory similar to path 5 in ~~Figure 3~~Figure 2b. This is needed before defining type I and type II adaptation measures for Can Tho in order to gain the benefits of integrating the two types. Assessment, sequencing, prioritization and implementation of type I measures (PM 2013; SCE 2013) and type II measures (MDP 2013; PC-CanTho 2014; WorldBank 2104), if done under a unified adaptation framework, could lead to a comprehensive understanding of the adaptation deficits and adaptation gaps and, more importantly, the synergies between type I and type II adaptation measures. Table 1 shows a summary of features of type I and type II measures that are based on the assessment of proposed in plans such as SCE (2013), MDP (2013) and PM (2013).

Table 1: Nature of type I and II adaptation actions in Can Tho City, Viet Nam

Features of adaption actions	**Type I – actions that help in overcoming adaptation deficit**	**Type II – actions that narrow down the adaptation gap**
Proponents	Mainly local government (or sometimes central government) – bottom-up pressure.	Mainly scientists and international organizations (sometimes central government) – top-down pressure
Ownership	Local departments (Department of Agriculture and Rural development – DARD, Department of Construction – DOC) and utility companies..	Unclear and complex
Required linkages with other development plans	Low	Medium
Required Stakeholder consultation	Medium	High
Influence on day to day development activities	High	Low
Existence of legislation	Medium	Low
Current budget allocation	High	Low
Implementation timeframe	5 – 10 years	10 – 30 years
Presence of effective Governance/institutional mechanisms	Medium	Low
Current Technological gap (As defined by UNEP (2014))	Low	High
Existing knowledge gap As defined by (UNEP 2014)	Low	High

[1] MOVE Framework is a vulnerability assessment framework based on system theory. This framework aims at holistic assessment of various dimensions of vulnerability such as social, economic, environmental and institutional vulnerability.

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One of the major challenges for unifying type I and type II adaptation plans is that they are mostly isolated from each other from the viewpoint of institutions/governance. For example in Can Tho the responsibility for type I adaptation actions is delegated to departments like construction, water supply and sewerage, Type II action is the purview of the Climate Change Coordination Office (CCCO). Attempts are being made to have a dialog between these agencies in the context of climate-adaptation, but not very successfully. Agencies like CCCO which acts as a coordinator of actions related to climate change are only advisory in nature and its advice is not binding on agencies implementing these actions (Clemens et al. 2014).

Can Tho needs to improve its adaptation plans both in Type I and Type II domains. At the same time the city (like many SCGS) faces difficulties in allocating resources for adaptation in a context of competing needs. Can Tho cannot afford to follow a siloed, disconnected approach for addressing adaptation deficits and adaptation gaps. There is a necessity to integrate together Type I and Type II adaptation actions within the city's master plans. Further it is important to see ways of making synergy between Type I and Type II actions. For example, plans that can be implemented in a flexible fashion so that they can initially address adaptation deficits predominantly while retaining the possibility to evolve to addressing adaptation gaps at a later stage.

SYNTHESIS

This paper has set out a framework for and an example of how to harmonize: (i) the often disconnected approaches to dealing with adaptation-gaps and adaptation deficits; and (ii) type I and type II adaptation actions that are needed to address these gaps. It has been argued that such harmonization is of particular importance for addressing adaptation needs of Secondary Cities of Global South (SCGS). In cities like Can Tho, Viet Nam – the case study presented – there is a clear disconnection between type I adaptation actions addressing the adaptation-deficit and type II actions addressing the adaptation-gap. This disconnect is evident from existing development/adaptation plans, organizational and governance arrangements and the delegation of responsibility for each type of action. It can be seen that Can Tho, like many other SCGS, is making efforts in trying to integrate Type I and II actions (Clemens et al. 2014), but the success is limited due to the inherently fragmented nature of responsibilities and implementing agencies. Further, amongst the organizations responsible for each type of adaptation, there is a culture of ignoring the efforts of the other domains (Garschagen 2014). This, according to the authors, is largely due to the lack of a unified conceptual view of adaptation that is accepted by all stakeholders of the city. The current paper is a contribution towards overcoming this gap.

The framework that is presented in this paper is not exclusive for SCGS. However, the practical importance of a unified conceptual view is greater for SCGS compared with what is needed in mature cities. This is due to the fact that SCGS has a number of possible futures many of which are divergent based on the relative effectiveness of adaptation actions to address Type I and Type II adaptation needs. Some of these futures may lead to greater negative impacts on livability than the others. It is also clear that addressing only Type I or Type II adaptation needs alone will not provide a positive impact on livability in a sustainable fashion. Therefore, having a common understanding based on the views of policy-makers and as well as the stakeholders in general, on Type I and Type II action is useful. Decision makers, policy makers and planners need to be assisted to understand that Type I and Type II adaptation actions, while addressing adaptation-deficits and adaptation-gaps respectively, both have the same ultimate goal – sustainable reduction of the adverse impact on livability in cities. As the adaptation-deficits and gaps are different in different cities, the optimal combination of Type I and Type II actions also differs from city to city. However, in the case of SCGS, the significant needs of addressing both types together should not be ignored.

SCGS have difficulties in allocating adequate resources for adaptation. One of the ways to optimize the resource allocation for Type I and Type II adaptation actions is to propose adaptation plans that can evolve from addressing adaptation deficit in the short-term to addressing adaptation gaps in the medium and long-term. With significant advancements made on flexible and multiple benefit planning, such innovative approaches have technically matured enough to be of practical use in adaptation of cities (e.g. pathway appraisal (Young and Hall 2015); BeST tool (Digman et al. 2016)). These flexible and multiple benefit planning approaches could be a means of achieving the required level of Type I and Type II adaptation actions in SCGS within the context of limited resources.

Providing a unified conceptual framework is only the first (albeit essential) step in achieving harmony and synergy between type I and type II adaptation actions. As was evident from the case Study of Can Tho City, the major challenge for integrating type I and type II adaptation actions is the lack of collaboration between different agencies implementing diverse adaptation actions. The cities have to fundamentally change the way the adaptation planning is done. This requires institutional reform, or at least better coordination between different sector organizations, the sharing of responsibilities and spanning of the inter-sectoral boundaries of power.

In the domain of planning today, one of the certain realities is the existence of uncertainty. This reality has to be faced when impacts of planning actions on adaptation-deficits and gaps are assessed. This calls for broad stakeholder agreement on which tools, virtual-worlds (e.g. models) to be used to ascertain the impact of different planning alternatives, and how these instruments should be updated when they (invariably) become outdated. City stakeholders learning from experiences of similar cities from around that world will also help to invigorate the adaptation discourse among stakeholders within a city (Zevenbergen et al. 2015b) In the contexts of severely limited budgets, resources and rapidly changing environments, SCGS need support to maximize the scope of adaptation actions (covering both type I and type II) and increasing flexibility of adaptation measures in terms of planning and implementation. The unified conceptual framework presented herein sets a broad outline and scope for further context specific or action research in the realm of urban adaptation.

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