DECEMBER 2012
PHNOM PENH
City of Water

[Image of a flooded street with a tuk-tuk and a motorbike in the water]
SAHMAKUM TEANG TNAUT
DECEMBER 2012

AUTHOR: Shelby Doyle
EDITOR: Nora Lindstrom

Cover Photo: Shelby Doyle

STT would like to thank Shelby Doyle for writing this report and sharing it with the organisation. The views and opinions expressed are those of the author and do not necessarily represent the views of STT, nor does the organisation take any responsibility for the quality of the content found within, nor any conclusions drawn by the author.

Supported by a grant from
Norwegian People’s Aid

www.teangtnaut.org
This is an excerpt from Fulbright research conducted during 2011-2012 and entitled City of Water: Architecture, Infrastructure and the Floods of Phnom Penh. This research aims to document the relationship between water, architecture and infrastructure in Phnom Penh, Cambodia. The objective of this project is to record the architectural and urban conditions sustained by and subject to the cyclical floods of the city’s rivers. For additional research please see cityofwater.wordpress.com
Cambodia’s capital, Phnom Penh, is located at the confluence of the Mekong, Tonlé Sap, and Bassac rivers, an intersection known as the ‘Four Faces’ or ‘Chaktomuk’. (Figure 2) The city is home to 1.5 million people, many of whom live and work along its riverbanks. Millions more Cambodians are sustained by these rivers, their flood cycles, and the accompanying deltaic landscape. The result is a topography defined by an intense interdependence between the inhabitants of the region and its rivers.

More than a third of the population of Cambodia, Laos, Thailand and Vietnam – nearly 60 million people – live in the Lower Mekong Basin, using the river for drinking water, food, irrigation, transportation and commerce. Additionally, millions more in China, Myanmar and beyond the Basin benefit from Mekong River hydroelectric power production. Beyond these human connections the river also powerfully demonstrates the scope for shared interest and competition. The Mekong has influenced political boundaries and conflicts for thousands of years including the Angkorian Empire, which once included the entire Lower Mekong Basin. (Figure 1)

Most notably, the 12th century Khmer capital of Angkor was home to approximately one million people and to an elaborate water management network, including flood-control infrastructure. Although there is no consensus among scholars regarding the reasons for Angkor’s demise, one argument is that the Empire’s collapse was brought on by the economic consequences of substantial modifications to the landscape, and unpredictable events such as flooding and warfare.

The Flood Pulse

Each year, monsoons and snowmelt cause the Mekong River to flow into the Tonlé Sap with such force at their intersection in Phnom Penh, that the Tonlé Sap reverses flow and floods the surrounding region to roughly four times its dry season area and depth, resulting in one of the most delicate and diverse ecosystems in the world (Figure 3).

This seasonal flood pulse sustains the region. The Basin’s fisheries are replenished, floodwater is stored for use in the dry season, flood-deposited sediments improve soil fertility across the Mekong flood plains, and groundwater aquifers are recharged. Conversely, severe flooding results in the loss of life, damage to agriculture, property and infrastructure, and can cause the disruption of social and economic activities throughout the Lower Mekong Basin.

According to the Mekong River Commission the economic benefits of this flood pulse far outweigh its consequences. Average annual flooding costs range from $60-70 million while the benefits of the flood annually range from $8-10 billion (Mekong River Commission, 2012). Therefore, flood management must achieve a delicate balance: to preserve the benefits of the flooding while reducing the costs and impacts to life and property. As Phnom Penh rapidly urbanizes in the flood plain, achieving this balance becomes increasingly urgent.
Figure 1. The Mekong River begins in the hills of Tibet and flows down through China, Myanmar, Laos, Thailand, Cambodia, and Vietnam and into the South China Sea. River is shown in black, the areas in blue indicate the flood plain and tributaries.

Figure 2. Cambodia’s capital, Phnom Penh, is located at the confluence of the Mekong, Tonlé Sap, and Bassaac rivers, an intersection known as the ‘Four Faces’ or ‘Chaktomuk’.
2011 Floods

The 2011 floods were the worst Cambodia has seen since 2000 and far exceeded their typical reach. The flooding displaced more than a million Cambodians, leaving hundreds dead, destroying thousands of acres of crops and stranding many without aid for weeks due to lack of governmental and NGO coordination (Figure 3).

The 2012 rainy season began in May and heavy rains and flooding have already caused damage. According to the National Committee for Disaster Management recent storms killed 10 people, injured 60 people, destroyed almost 700 houses and damaged many more (Yuthana and Freeman, 2012). These numbers present an important question: Are floods of this magnitude increasing in frequency and does Cambodia have the emergency infrastructure to respond?

Climate Change

According to the World Wildlife Federation, “The Greater Mekong is one of the most vulnerable places on Earth to the impacts of climate change.” For the Mekong, climate change compounds existing and projected threats affecting the region’s people, biodiversity and natural resources. This is likely to have cascading effects, such as water scarcity leading to reduced agricultural productivity, leading to food scarcity, unemployment and poverty (World Wildlife Fund, 2009a).

Among lower Mekong Basin countries, Laos and Cambodia are identified as the most vulnerable in part because of their limited capacity to cope with climate related risks. In all countries, climate change complicates existing problems such as poverty and lack of infrastructure.

According to a recent United Nations report, “Warming temperatures and changes in precipitation patterns will significantly impact Cambodia and, specifically, Phnom Penh. A recent mapping assessment identified Cambodia as being particularly vulnerable to climate change because of climate impacts such as droughts, floods, and sea level rise and the country’s relatively low adaptive capacity. While Phnom Penh has slightly more financial capacity to respond to climate change impacts, its relatively low elevation, proximity to the ocean and the Mekong River make it particularly vulnerable” (World Wildlife Fund, 2009b).

Unfortunately, flooding is not the only threat to Phnom Penh and its residents. Changing precipitation patterns may also adversely affect the quantity and quality of water supplies to the city and result in negative consequences for millions of people. Other threats include the impact of tropical cyclones, which have increased over the last few decades and are projected to further increase in frequency and intensity. Rising sea levels will also affect Phnom Penh’s fresh water availability by increasing saltwater inundation of low-lying areas and contributing to coastal erosion. Unfortunately, loss of natural coastal land, including mangrove forests, will lead to further erosion and damage as mangroves provide a buffer against storms and storm surges (World Wildlife Fund, 2009b).

Upstream Damming

Another pressure on the development of Phnom Penh is upstream damming of the Mekong River. While hydropower presents great economic and energy gains, concerns have intensified over the potential cumulative impacts that proposed schemes have on the environment, fisheries and people’s livelihoods in the Lower Mekong Basin (Figure 4).
Figure 3. Left: Map of a typical Tonlé Sap Flood Surge. Right: Map of the 2011 floods redrawn by author from a United Nations Map

Figure 4. Map showing Existing, Under Construction and Proposed Mekong Dams. Source: CGIR Water & Food Conference

Figure 5. Kampong Khleang a floating and stilted village on the Tonlé Sap Lake during dry season. These villages are dependent upon the Tonlé Sap flood surge for food production, primarily fishing and agriculture. Photo by author.
2 Water in Phnom Penh
Rapid Population Growth

In 1979, communist Vietnam invaded Democratic Kampuchea and toppled the Khmer Rouge regime. Vietnamese occupation continued until peace talks began in Paris in 1989 under the State of Cambodia, culminating two years later in October 1991 in a comprehensive peace settlement. The United Nations Transitional Authority in Cambodia (UNTAC) mandated to enforce a ceasefire, address refugees and disarmament. A new Cambodian government was installed in 1993, a constitutional monarchy operated as a parliamentary representative democracy. (Sahmakum Teang Tnaut Website, 2012) Since a full cadastre map of the city does not exist, evictees often do not hold ‘hard title’ and have little if any political or judicial recourse. Often they are relocated to sites without economic opportunity or basic infrastructure and inadequately compensated for their lost property.

Lake Infilling

A network of wetlands, streams and ponds, which are currently being filled with earth to create developable land, surrounds Phnom Penh. This process raises both human rights and environmental concerns. One motivation for this infilling is that water is not a constructible area since it belongs to the State. For a waterway to become eligible for infill it must be officially declared to be of no public value. Therefore, developers in partnership with officials fill in waterways, transforming them into land that is physically and legally suitable for construction. (Law On Water Resources Management Of The Kingdom Of Cambodia).

A recent and politically contentious example is Boeung Kak Lake, a lake of nearly 90 hectares, filled in by Shukaku Incorporated, owned by Cambodian People’s Party Senator Lao Meng Khin, to create a site for a “multi-purpose living and recreation center.” Nearly 3,500 (nearly 20,000 people) of 4,200 households have been evicted to make room for the development. In a recent protest 13 former residents were demonstrating peacefully on Village 1 of the Boeung Kak site. They were subsequently arrested, held without charge, tried without due process, sentenced to 2½ years in prison and only released after pressure from the international human rights community (Yuthana and Freeman 2012).

During the 1990s land ownership rights were gradually restored to Cambodians thereby releasing Phnom Penh from the evolutionary stasis of the previous 20 years. Since the 1975 evacuation, development of the city was hindered, and nearly halted, by war and occupation. As Cambodia began to politically stabilize the people of Phnom Penh began to physically and economically rebuild. Since 1997 Phnom Penh has grown from a city of 500,000 to 1.5 million. If current or even accelerated growth rates continue and as people migrate from the provinces seeking economic opportunities, the city could double or triple in size by 2030.

Lack of Master Plan

In 2005, the French Bureau of Urban Affairs proposed a Master Plan for Phnom Penh: a 330-page document entitled the “Livre blanc du développement et de l’aménagement de Phnom Penh” commonly referred to as “The White Book”. The document provides a comprehensive description of both historical and current characteristics of the capital, ending with a strategic master plan leading up to year 2020. However, as 2020 approaches the master plan has yet to be formally adopted by the government and therefore remains a set of suggestions and recommendations rather than a force guiding the city’s development.

The result is rapid uncontrolled development characterized by a lack of building code, no zoning enforcement, and few development laws and regulations. (Figure 14) The suburbs in particular are experiencing sweeping changes in land use, as former agricultural land is bought up and rapidly developed into built projects.

For example, there is no required flood mitigation for individual buildings. While in the surrounding provinces buildings are still being built in response to the floods - raised, floating and stilted homes - such constructions, though once common in the city as well, have nearly disappeared from Phnom Penh. (Figure 12) Rather, the ground floor, often enclosed, has become a valuable economic space for selling goods. Sidewalks have become parking space and nearly the entire city is paved, with few existing or planned parks to absorb seasonal rains. (Figure 13)

As the city changes, its most vulnerable residents are being displaced by development. Rights groups report over ten percent of Phnom Penh’s population has been displaced in the past two decades. These evictions, both legal and illegal, are extremely disruptive to the lives and livelihoods of the evictees and their families. (Sahmakum Teang Tnaut Website, 2012) Since a full cadastre map of the city does not exist, evictees often do not
Public Parks + Open Space

Compounding the issues of lake infilling is the lack of park space or open space to absorb rainy season waters. The inner khans (districts) are home to a series of formal parks and gardens but they are often hardscaped, formally planted and home to decorative, rather than functional water features. (Figure 16 and 17)

Figure 16: Phnom Penh 4 inner khans. Public Parks and green space shown in green. Map drawn by author through survey.

Figure 17: Parks in Phnom Penh. Top to Bottom: Sihanouk Boulevard, Sisowath, Russian Boulevard, Monivong Boulevard. Photos by author.
Wastewater Treatment

A network of wetlands, streams and ponds into which over 1 million cubic meters of the city’s household wastewater and storm water are discharged daily surrounds Phnom Penh. There is no formal wastewater treatment in the city. Instead, sewage and other wastewaters from households, businesses and industries combine in a series of covered and open canals that flow through the city and combine with seasonal rainwater and floods (van der Hoek, 2005). (Figures 18-22)

Boeung Cheung Ek (BCE) Lake is the largest of these water bodies, covering 3,400 hectares of land, 5 kilometers south of the city center. The lake receives 80% of the wastewater from the city along with untreated effluent from 3,000 small and large-scale industrial enterprises. The lake is an effective, low cost means of biological treatment of the city’s wastewater through its aquatic vegetable production (van der Hoek, 2005).

A 2007 study by the Royal University of Agriculture of Phnom Penh entitled “Food, Incomes and Urban Waste Water Treatment in Phnom Penh, Cambodia” estimated that 20% of the total daily vegetable consumption of Phnom Penh comes from these lakes and wetlands within the city. Therefore these wastewater-fed aquatic vegetables are, despite their potential health risks, very important in supplying the city’s vegetable markets and thus meeting the demands of the growing population of Phnom Penh.

However, as these lakes are infilled, the city’s wastewater is discharged more rapidly into the Mekong without treatment and the need for a more formalized system grows. An infrastructure retrofit of this scale would be extremely costly and is unlikely to happen, threatening the health of the Mekong, Phnom Penh, and its downstream neighbors.

Floods of Phnom Penh

Flood events in Phnom Penh are twofold – almost daily rainy season flood events and episodic larger scale flood plain events. During the rainy season (May-October) monsoon rains fill low-lying streets, some to nearly 1.5 meters deep. The Japan International Cooperation Agency (JICA) has conducted over $325 million of infrastructure upgrades in Phnom Penh including drinking water supply facilities, flood protection, drainage improvements and the rehabilitation of the Phnom Penh port (JICA Website, 2012). This work is ongoing and retrofitting the city is a slow and costly proposition. Although JICA’s work has reduced flooding in some areas of the city, it cannot be relied upon to eliminate all of Phnom Penh’s drainage problems or to prevent future flooding in areas developed without flood protection.

The near daily rain floods during the rainy season reframe the experience of inhabiting the city, altering its landscape and blurring the distinction between water and land. Roads become waterways and sidewalks disappear beneath the muddy waters. Curbs and tree roots are hidden from view, hindering walking and driving. Businesses unfurl overhangs, open umbrellas, and hang tarps, expanding available dry space. The streets become a patchwork of bright ponchos and headlights. Traffic slows to a near stop as cars, motos, and bicycles navigate the water and intermittently stall out or dip into deep unseen potholes. (Figure 23)

The population anticipates the rains and has adapted to the accompanying flooding and its perceived cleansing effects. Nonetheless, the floods disrupt the flow of daily business and activity. Additionally, flooded streets carry potential disease as the storm water mixes with human waste and street drains are blocked by municipal trash, slowing drainage and posing a possible public health threat.

As for larger scale flood events, Phnom Penh was founded in the alluvial plain of the Mekong River, which varies upwards of 12 meters in depth between the dry and wet seasons. The most devastating flood risk comes from the Mekong River cresting over its natural berm into the city. The volume of water produced by a Mekong flood could take weeks or even months to recede, evaporate or penetrate into the ground.

However, the greater threat comes from the areas north and west of Phnom Penh, which absorb a huge volume of monsoon rains. This water presses southward to the Tonlé Sap and Mekong, through the land, the city and a network of tributaries passing around and through Phnom Penh. A combination of both flooding events could be catastrophic for Phnom Penh: the Mekong River flooding from the east and flooding from oversaturated lands to the west and north. Although unlikely, the potential convergence of the two events is within the realm of possibility.

The factors contributing to the potential for increased flooding in Phnom Penh are: deforestation, the unknown impacts of climate change, overbuilding in catchment areas, the damming and diversion of natural waterways, and the infill of canals and lakes, combined with no formally accepted or followed master plan. The four central khans, or districts are protected by a series of semi-concentric dykes built westward from the rivers that protect the most densely developed areas from inland flooding, virtually transforming downtown Phnom Penh into an island and leaving the outer khans under-protected.

Vann Molyvann (2003) writes in New Khmer Cities: “The maintenance of dikes of Phnom Penh, as well as the preservation of the National Routes established on the banks and dikes, are crucial to the containment and control of floodwater. Canals created after the Protectorate have been calibrated to absorb the floodwaters and to allow excess ground water to drain towards the river. This hydraulic system has been virtually without maintenance over the last three decades. Indeed, it is astonishing that the system still functions today given these decades of neglect. The capacity to oversee and manage this hydraulic system must be re-established, supported and expanded.”
Figure 19: The Street 105 sewage canal approaches overflow during a heavy rain mixing sewage, gray water, and trash with

Figure 20: Vegetables are cultivated on the wetlands in the south of Phnom Penh.

Figure 21: Effluent flows from a canal into a stream south of the city.

Figure 22: A toilet over Boeung Tra Bek the southern termination of the Street 105 sewage canal.

Figure 18
Left: An open sewage canal runs the length of Street 105 and passes beneath Boeung Trabek Market. Right: The Street 105 Canal terminates on Street 288 and Monivong Boulevard.
3 Elevation Maps

(Elevation > 10 m)
Area outside the area of major risk of flooding of the Mekong River

(Elevation > 7.5 meters)
Area outside the floodplain drainage pattern, after implementation of drainage scheme

(Elevation < 7.5 meters)
Floodplain, including after completion of drainage scheme: necessary to backfill the areas of land for construction to a height of 7.5 meters

Map from the proposed 2020 Master Plan Le Livre Blanc.
4 Flooding Maps

Map Key:
Reports from Sep 1, 2010 to Nov 30, 2012. All reports on this map fall under one or more of the following categories.

Flooding
Early open source efforts to accurately portray the extent of rain event flooding in Phnom Penh.

To the left: Urban Voice Cambodia www.urbanvoice.net generated from user submitted flooding reports with Open Street Map as a base map www.openstreetmap.org

Above: A screenshot (November 2012) of an Interactive flash flood mapping for Phnom Penh www.flooddemo.estil-jennyl.com as described on the website:

This is an interactive map showing the estimated flood extents for Phnom Penh, Cambodia in a user friendly interface. You will be able to pan and zoom around and use a range of background map layers. You can also switch between predicted flood extents generated using a range of DEM inputs (30m SRTM, 90mASTER, 100m DTM and 7m DTM which produces much better results).

You can also view the depicted flood areas resulted from different rainfall events. The flood extents were generated using ISIS-FAST. It is an innovative flood inundation modelling tool designed to allow quick assessment of flooding using simplified hydraulics. It provides results in seconds or minutes as opposed to hours or days, which is up to 1,000 times faster than traditional two-dimensional models.

Click on the following link for a detailed information about ISIS-FAST.
http://www.halcrow.com/isis/isisfast.asp

Important:
The accuracy of the model results depends mainly on the degree of accuracy of the topography (DEM) data that were used in the flood simulation. It should also be noted that method employed is very simple and has not been calibrated; and other factors like infiltration, drainage, and the likes were not incorporated in the model.
5 Conclusions

There have been clear benefits from development in Cambodia, including relative stability, economic opportunity, improved quality of life, access to education and healthcare. However, the price of urbanizing a deltaic landscape cannot be ignored. A major, sustained flood in Phnom Penh could undo much of the progress achieved during the last twenty years.

The scope and complexity of urbanization touches upon those issues, both internal and external, ranging from land tenure to health and climate change to human rights. Consequently, Cambodia once again must call upon its history of adaptation and resilience to create a Phnom Penh focused on the continual effort to find new solutions and strategies to these evolving challenges.

Many of the advancements necessary in Phnom Penh - an agreed upon master plan, redeveloped flood and sanitation infrastructure, a building code - rely upon thoughtful governance, careful law making and independent lobbying.

The following are proposals for the future of urban development in Phnom Penh.

Make clear, understandable and publicly available information in Khmer and English:

Elevation and topographic maps demonstrating at-risk flood areas

Lake infill environmental impact reports and information regarding future planned infill.

Disaster management plan for future flooding events. Particularly an emergency response plan for high-risk areas.

Information about current flood protection projects and reports on the effectiveness of these projects.

Public discussion and feedback regarding this information

Master Plan and Build Code updates:

Require existing and new projects to have a certain percentage of penetrable surfaces designed to absorb the impact of rainwater

Require additional open public space and parkland in dense areas of the city.

Include long term infrastructure proposals. For example, the city could purchase high-risk flood areas, prevent future development in these areas and create nature preserves.

Access to Education:

Improved Urban Planning and Urban Design training in Cambodian universities

Introduction of Landscape Design programs to Cambodian universities

Develop workshops, exhibitions and competitions focused on urban development and water in Phnom Penh
Benham, Sally and Ben Caddis (2008) Boeung Kak Area Drainage and Flooding Assessment.


Grant Ross, Helen and Darryl Leon Collins’ Building Cambodia: ‘New Khmer Architecture’ 1953-1970,


