

EXECUTIVE SUMMARY

DRR Mission to Bangkok, Thailand

The mission

From 20 – 26 November, 2016, a five person expert team visited Bangkok and the surrounding areas of the Chao Phraya river basin on request of the Thai Department of Water Resources and the Bangkok Metropolitan Administration (BMA), in order to discuss with the Thai authorities the nature of Bangkok's flood problems and provide recommendations on a flood risk reduction strategy on the basis of Dutch experience.



Figure 1: Bangkok Central Area

With reference to the devastating floods of 2011, that caused a total damage of 46 billion USD nationwide and around 8 billion USD in Bangkok alone, as well as to severe flooding problems within the center of the city, the team investigated both local and basin-wide causes and the potential for improvement.

Flooding problems of Bangkok have two separate causes. The 2011 floods were caused by overland flow from the north of Bangkok, precipitated by breaches of the levees to the north of the city in the Ayutthaya area, a well-known site of cultural interest, in combination with a bottleneck in the river profile comparable to that of the river Waal at Nijmegen before the bypass was constructed. This year's June flood in the city, which caused severe disruptions, originated from a rainfall event of a magnitude that the city's drainage system could not cope with.

During the mission the team was briefed extensively and in detail by the Department of Water Resources, the Royal Irrigation Department and by the relevant departments of the Bangkok Metropolitan Administration. Open discussions took place with the Department of Drainage and Sewerage of the BMA as well as a visit to one of the large drainage tunnels in operation. Visits to the Chao Phraya dam and the Rama VI dam gave insight into the hydraulic regulatory capacity upstream of Bangkok. Discussions were also held at the Hydro and Agro Informatics Institute and the Ministry of Science and Technology. Finally, in a meeting held at the Residence of the Netherlands' Ambassador to Thailand, the team presented its preliminary findings to an audience including high officials of the mentioned government departments and institutes.

The team that carried out the mission consisted of:

1. Ben Lamoree (LamoreeConsult) – Team Leader, Urban Water Management Expert
2. George van der Meulen (Compuplan Knowledge Institute) – Flood Risk and Protection Levels Expert
3. Mathijs van Ledden (Royal HaskoningDHV) – Flood Protection Infrastructure Expert
4. Adri Verweij (FloodConsult) - Urban Water System Modelling Expert
5. Anurat Kaeocha (Arcadis Thailand) – Urban Water Systems Expert

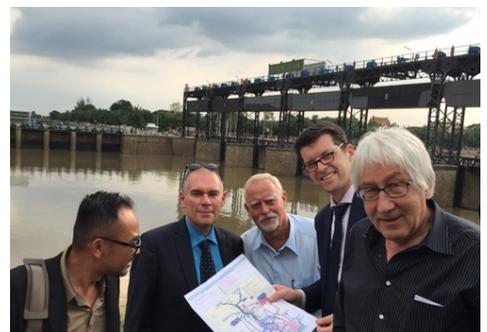


Figure 2: DRR-Team Members

The mission benefitted from the strong operational support provided by the Netherlands Embassy, Mr. Martin van Buuren and Ms. Pantipa Sutdhapanya, under the guidance of Chargé D’Affaires Mr. Guillaume Teerling.

Floods in the Chao Phraya Basin

Flood events in the Chao Phraya Basin are triggered by the passings of (multiple) tropical depressions from east to west dumping a substantial amount of rain. Man-made interventions such as reservoirs, control structures, drainage channels, but also deforestation have resulted in significant changes in the original response of the system to these large-scale rain events. After the 2011 flood, various interventions have been proposed for the Chao Phraya Basin. Based on our analysis, we recommend the following:

- Speed up planning, design and execution of flood risk reduction works, since the current probability of flooding remains high
- Execute existing no-regret interventions in an appropriate sequence to prevent possible temporarily increased flood risks
- Investigate the possible benefits of additional flood risk reduction options, such as deepening Chao Phraya River in the highest flood risk zone downstream and enhancing runoff infiltration in the upstream basin with the additional benefit of reducing drought problems
- Taking up basin-wide flood risk mapping using state-of-art models to identify hotspots and prioritize/justify investments for flood risk reduction, preferably as part of a renewal of the outdated Chao Phraya Basin Master Plan

Figure 3: Chao Phraya basin flooding 2011

Local Urban Flooding

Built in the Chao Phraya River Delta, the Bangkok Metropolitan Area is a highly urbanized city with a registered population of 5.7 million at an area of 1500 km². Localized heavy rainfall events (e.g. June 2016), primarily of convective nature and aggravated by increasing urban heat due to ongoing urban expansion and densification, regularly cause significant flooding in certain parts of Bangkok. Although the exact damage is not known, the impact on the citizens and the local business is very clear: very severe traffic congestion, flooded houses and shops and a standstill of parts of the city for a few days. There is no space left for new primary drainage channels or large retention basins, emphasizing the need to search for peak runoff reduction options. The current Urban Drainage Master Plan is outdated and it is recommended that this plan is renewed to address the following priority issues:

- Review and optimize the use of the existing drainage system capacity (e.g. find ways to divert storm water from the most vulnerable areas, improve maintenance, etc.)



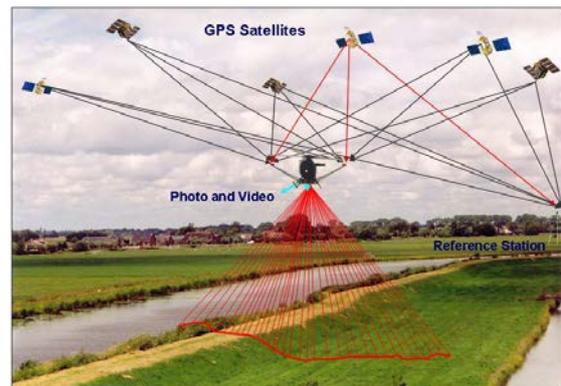
Figure 4: Drainage Tunnel Pumping Station

- Speed up the development of Hydro-informatics support to flood risk management and planning in Bangkok by expanding the water related database and data exchange, numerical simulation modelling support and early warning to the public
- Continue and speed up investments in the deep drainage tunnel system to release pressure on the limited capacity of the existing canal system
- Optimize the use of macro-scale retention and involve local stakeholders to raise awareness for the implementation of micro-scale multi-purpose retention options
- Update the outdated Drainage Master Plan for Bangkok by re-defining flood frequency standards, flood hazard and risk mapping, providing the basis for identifying/prioritizing flood reduction investments for the next decade.

Potential areas of Thai-Dutch cooperation

During the meetings, reflections have been made on how the situation in the Chao Phraya Basin, in particular the delta area, and that of the Dutch river deltas, with a view on the many common problems both countries are facing, could lead to a continued exchange of experience and cooperation. The Netherlands spends yearly approximately 75 billion Baht (2 billion Euros) specifically on water management (2012 numbers) next to other water-related expenditures (e.g. drinking water, waste water treatment). For comparison, Bangkok, with a population of approximately one third of the population of the Netherlands, spends yearly 1 billion Baht on flood management. In conclusion, per head of population, Bangkok spends only 4 % of the budget of the Netherlands on flood management, while the Bangkok area is of enormous strategic importance for Thailand.

In the Netherlands, these very large investments are prioritized and managed with extensively developed data management, methodologies, such as flood risk mapping, numerical modelling, and flood forecasting and early warning. Most of the Hydro-informatics products used have been developed by parties in the Netherlands.



This knowledge, experience and set of tools can be attractively combined with the knowledge Thai agencies have about their water systems and flood management infrastructure. Potential areas of cooperation could be:

- **Dikes.** The Netherlands has approximately 3,500 km of primary and 25,000 km of secondary dikes, which have been constructed partly hundreds of years ago and inspected and maintained over centuries. These dikes are located in a deltaic area, similar to the Lower Chao Phraya Basin. There are common problems, such as **dike stability issues, piping, dike design height, dike inspection**, etc. which form a rich basis for joint studies. Hydro-informatics support is playing an important role in the current management of dikes (see figure);
- **Flood management infrastructure planning.** The Netherlands is under flood threat along their coasts, rivers and in the urban environment. Planning of new infrastructure is based on a systematic analysis of required protection criteria and optimum investment strategies following prioritization of the execution of works. Planning is supported by tools, such as

hydrological and hydrodynamic modelling systems which have been developed in the Netherlands to support the large investments and which are being used over the whole world. For example, the Delft3D modelling system is the hydrodynamic simulation tool of preference in the USA. The Netherlands has played a key role in the flood protection planning of the City of New Orleans after the devastating passage of Hurricane Katrina. Jointly with Thai agencies, the best strategy for the flood development of flood infrastructure, such as diversion canals, newly designed canals, retention basins, dredging, etc. for the Chao Phraya Basin could be further detailed. Similarly, the problems of the metropolitan area of Bangkok could be addressed. Usually such analysis is based on **Master Plan development**, where the strategy for investments and institutional arrangements for a few decades is set out;

- **Flood forecasting and early warning.** Flood threats in the Netherlands have led to the need to develop generic flood forecasting systems. The principal product is the generic flood forecasting platform Delft-FEWS, which allows for the connection of a wide variety of sources of meteorological data, such as ground stations, weather radar, numerical weather model results and satellite images. It also allows for the connection of a large variety of hydrological and hydrodynamic models, including, for example, the MIKE suite, InfoWorks, SOBEK, HEC-RAS, etc. This platform would allow Thailand to use all of their systems and products developed so far, while enabling further developments of the forecasting tools with lower investment costs. The **Delft-FEWS** platform forms the basis for flood forecasting systems covering the complete area of, e.g. the USA, Australia and the UK;
- **Micro-retention options in the urban environment.** Cities in the Netherlands have benefitted from a systematic search for local retention possibilities for storm water, by investigating the potential of a multiple use of space. While already applying this approach as a common principle in urban storm water management, the Netherlands have developed methodologies to **involve local communities** in such search, realizing that public support is essential in the realization of sufficient retention volume. With many contributions of this kind the need for large infrastructural works, such as additional pump capacity, can be reduced or delayed. The methodology has been applied successfully in New Orleans, for example. The joint participation of Bangkok, Thailand and Rotterdam, the Netherlands in the 100 Resilient Cities program may provide opportunities for enhanced cooperation;
- **Dredging.** The continuous attention in the Netherlands for managing flood risk reduction, problems even more severe than in Thailand as most flood occur during cold winter periods with much more risk to life than under similar hazard conditions as in Thailand, has led to the development of dredging technology which ranks among the highest in the world. The Dutch expertise could be very useful to reduce flood risks for the Lower Chao Phraya Basin with its high density population and industrial zones. Joint expertise could be built up with the Thai private sector to arrive at cost-effective flood management