CTCN assistance in Thailand

Strengthening Bangkok's Early Warning System to respond to climate induced flooding

Deliverable 5 (Activity 1.5) Recommendations for future directions and financing options

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This report has been prepared under the DHI Business Management System certified by Bureau Veritas to comply with ISO 9001 (Quality Management)

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1 Introduction and recommendations

The collaboration between BMA and DHI has been supportive and constructive. The directly engaged BMA staff have demonstrated pro-active engagement. Due to the relatively short implementation period, we decided to make some short cuts, especially related to the IT data flow implementations.

1.1 Overall Project Objectives

- To develop a demonstration system for early flood warning for a part of the Sukhumvit district. The demonstration system makes use of the existing sensor and SCADA system. A 1D/2D hydraulic model use monitored rain- and level data combined with forecasted radar rainfall data to predict street flood. Web pages displays flood maps with predicted floods, locations, extent and time.

- To enhance the competences at BMA within hydraulics, including modelling benefits and limitation

- To transfer knowledge and experience to BMA in using model based forecast to enhance the daily operation of the drainage system

1.2 Results

The demonstration system is established and in operation. DHI in Denmark host the system and selected data are transferred using web scraping and ftp-sites. HAII provides radar data, using Royal rain radars. It was decided not to use data from the BMA radars, as the radars are not calibrated and the forecast feature is not enabled. At the hosting site, a fast, dedicated computer produces flood forecasts. The forecasts are published on a website, accessible by BMA. The system is designed to make an updated 3 hours forecast every 60 minutes. Due to a number of practical implications, including the relatively short implementation period, the primary focus has been to implement a complete system and less focus on fast and quick performance. The forecast interval could be shorter if the overall system is optimized.

An important component of the early warning system is the hydraulic model. The model includes description of pipes, pumps, canals and the surface (streets/houses) in the demonstration area. Various research projects have used the base model previously. The updated model provides a relative accurate description of the hydrology and hydraulics within the demonstration area.

The project included three practical training courses and workshops. 1) A one-week training course in December 2016, introduced the modelling concept, hydraulics and flood for selected BMA staff. After the training course, BMA had a time limited full software license for further internal work. 2) A systematic introduction to the dataflow and forecast components was discussed and presented at a workshop in March. 3) Finally, a one-week workshop was organized at DHI Denmark for two senior BMA staff, with focus on the operational warning system.

1.3 Possible development areas for BMA

The recommendations below are both of general character and relevant/required if BMA decides to implement a citywide early warning system.

Drainage network – detailed and updated data. The demonstration project uses an existing model for the Sukhumvit district. A significant effort was spent into updating this model to secure an improved representation of the drainage conditions. Accurate data on pipes and pumps are needed to build reliable models for other parts of Bangkok. A complete data inventory will also help BMA to better plan for future asset management, which again can help in planning and budgeting the continued rehabilitation of the systems. It is therefore recommended that BMA review the asset databases and if necessary initiative a systematic update.

Increased hydrology and hydraulic competence. The engineering staff base within BMA is primarily electrical and mechanical graduated engineers, with some post-graduate acquired skills within hydrology and hydraulics. While the competences within electrics and mechanics are essential to maintain and operate the complex drainage network, it is recommended that BMA also recruit staff with core hydraulic competences. Some short-term gains may be achieved by offering scheduled training, e.g. in collaboration with a relevant university. However, by starting to include new staff with expertise in hydraulics, BMA will be much better positioned to fully understand, document and over time improve the hydraulic capacity of the large and very complex network.

Modelling expertise. At the modelling training course, the BMA staff formulated different ideas for how to use hydraulic models for other projects. This illustrates that once the modelling competences are build-up within BMA, relevant use on projects will immediately be identified. Using modelling tools in the feasibility and design phases will contribute to better systems. Models and modelling competences will also allow BMA to improve operation of the existing drainage network. Hence it is recommended that BMA form a modelling team, that can support both planning and operations.

Upgrade of existing radar system. The existing BMA rainfall radars have been in operation for some years, and produce rainfall maps published on web. The radar images display nicely the relative intensity. The radars are not calibrated in real-time, implying that the absolute intensity values are very uncertain. Consequently, the radars are not suitable for flood predictions. The existing BMA radars do not include a continuous calibration, nor do they have any sort of short-term forecast (or now cast) activated. High-resolution rainfall data with no time delay and forecasts is important for a stable and reliable flood forecast system. It is recommended that BMA update the radars to include continuous calibration and forecast, and that dedicated staff are allocated to support the radars. BMA may also outsource such an activity to other organizations with relevant experience. An alternative is a more direct access to the Royal Rain radar data, which may reduce the time delay in getting updated data.

Keeping the demonstration system alive. Now where the demonstration system is established, it is recommended that BMA secure a continued operation for the next couple of years to further gain experience with the system. The CTCN financed technical assistance have no additional funds for maintaining the system in operation after 15 November 2017. By keeping the system running, BMA will accumulate more experience with the value and the challenges of using this type of systems. A continued operation of the demonstration system will also help BMA to decide how a future system should work, if BMA decides to implement a citywide early warning system.

Allocate and commit dedicated staff. An early warning system is a living system, and requires continued attention. If, for some reason, input data are missing, the operators shall find the problem and solve it. It is comparable with a SCADA system, it needs to be managed well to secure a continued un-interrupted operation. For a future citywide system, it will be important that some staff be allocated to monitor the performance, and intervene if something is not working. It is recommended that BMA create a permanent task force with focus on operation and use of the warning system. As an alternative to operate such a system within BMA, it may also be outsourced to an external organization with the relevant competence and capacity. It is recommended that BMA review the two different options, internal or outsources solution.

2 The organisational challenges

BMA is a huge organisation, reflecting the many tasks undertaken by the administration. The focus division, The Drainage Department, is responsible for the daily operation of sewerage and drainage for almost 10 million people, including planning, rehab, maintenance and urgent call-outs in case of failures. The Drainage department has close interactions with other departments, like the IT Department. IT assumes responsibility for the large citywide SCADA system, including sensors and data loggers as well as the web-system publishing the data. The IT department is also responsible for operation and maintenance of the two weather radars, owned by BMA. The interdepartmental coordination works apparently well, so in the daily work things operates smoothly. When discussing and formulating future priorities, the department boarders are more challenged. The IT department delivers services and data to the drainage department and each department operates with its own budget. When the drainage department has specific needs and wishes, the priority process may be slow and cumbersome, because they first need to convince IT about the relevance, and then IT should request the necessary budget as part of the budget planning, which sometime extends over years for larger investments. This issue is not unique, but it slows down the processes, which in turn delay advantages for the benefit of the customers: the city people.

2.1 Internal competences

The Drainage Department have a strong, dedicated and apparent efficient staff. Most of the engineers are trained professionals in Electrical and Mechanical Engineering. They have very good skills in structural issues and operational aspects, like pump station management. Several of the professional staff also have some, but rather superficial, knowledge and skills in urban hydrology and hydraulics. In a huge and flat city like Bangkok, a thorough understanding of the complex hydraulics is an important prerequisite to develop, plan and operate the city in an optimal way from a hydraulic perspective. It is therefore recommended that the Drainage department upgrade their skills and competences within hydraulics, either through recruitment of trained hydraulic engineers or by a systematic upgrade of competences within some of the existing staff members.

3 The technical challenges

The Technical Assistance had its prime focus on demonstrating the concept of an early warning system for floods in the Sukhumvit district in Bangkok. Additional objectives included knowledge and technology transfer. The project results have confirmed that early warning is feasible and valuable, although a few important things need to be prepared before the demonstration system can be expanded to the entire flood exposed parts of the city.

3.1 The drainage challenge

Bangkok is very flat, with a high year round groundwater table and a large tidal influenced river cutting through the centre of the city. The combination of the topography and the high water levels, forces the city to drain the build-up areas using a large number of pumping station. The Sukhumvit demonstration area is quite characteristic for most of the city: long, flat pipes draining to downstream pump station, where pumps move the water into the canals (khlongs). The canals are connected to the river, often controlled by operational sluice gates. The drainage principles are illustrated in the sketch bellow.

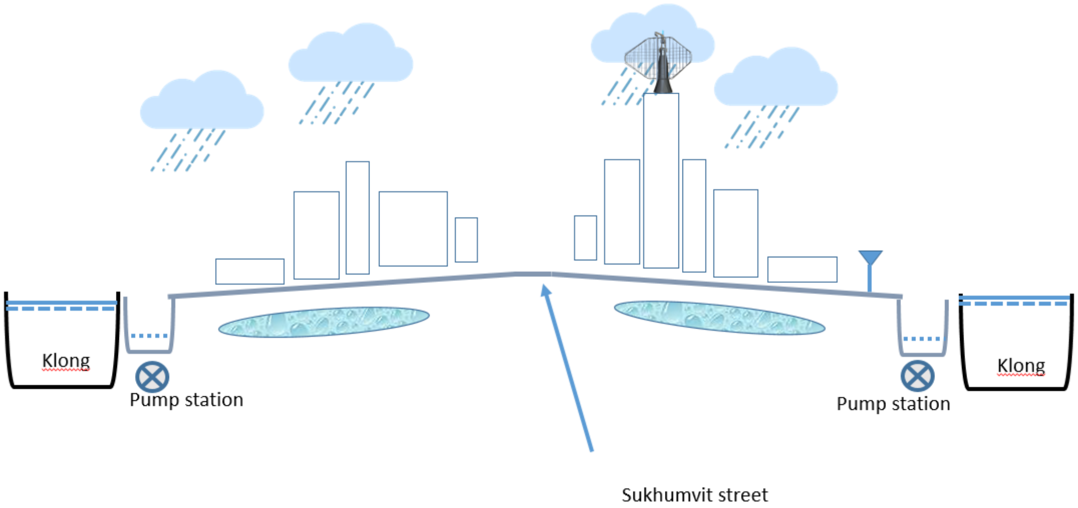

Figure: Principle sketch of cross section in the demonstration area. The flows are drained to the sides and via pumps into the canals, who further drain to Chao Phraya river.

The pipes are probably partly clogged by siltation and other debris, and the drainage capacity is in general insufficient to evacuate all the water during heavy downpours. While the flood warning system is intended to provide the citizens with an early alarm, it appears that all significant rainstorm will create flood, the drainage capacity is simply insufficient. The illustration below shows results from model calculations of flood area (m2) and volume (m3) in the demonstration area for the severe rainstorm 13th October 2017 (return period around 25 years, according to BMA). There are two set of numbers, one for the existing system and one for a system with an in-principle unlimited pump capacity. The latter implies that neither the pumps, nor the canals limit the flow capacity. The limitation is controlled only by the pipe diameters and invert slopes.

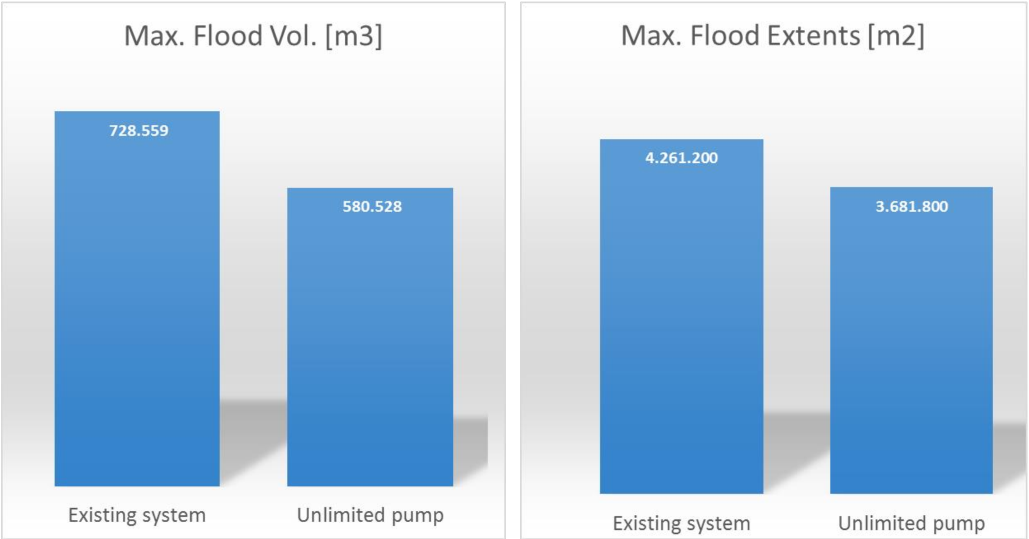

Figure: 25 years return period rain, 13. Oct 2017. With “free” outflow from the streets (soi), the flood volume is reduced with around 20% and the flooded area with around 15%.

The calculations show that for major storms, the drainage capacity is insufficient and floods are unavoidable in the more exposed areas. The solution to resolve the flood issue is local storage or increased pipe capacities – or a combination. The TA did not address this issue, but the simulations show that this is one of major challenges for Bangkok.

3.2 Data-on-time and computational power

At project start, it was the intention to incorporate the two BMA radars as rainfall data sources. For various practical reasons it appeared inconvenient, and an alternative solution was established through collaboration with HAII and Royal Rain department. There are, however, some unwanted side effects in this solution. The forecast calculation is quite time consuming and in combination with a multiple step data flow path, the forecast data are around 90 minutes old when the data arrives to the early warning system. This is a major drawback, as rainfall forecast is a key to produce reliable flood forecasts. Most of this delay, although not all can be eliminated by implementing a different solution – to use the BMA radars as data providers for both now- and short-term –forecasts. This activity was not feasible to include in the TA, both from a timing and financial perspective it exceeds the boundaries of the current project. However, we recommend BMA to upgrade the radar system as a top priority. The upgrade should include two components: 1) continuous calibration, and 2) forecast features.

The demonstration system calculates a new flood forecast every 60 minutes, and produces and publishes the associated web pages. At heavy rainfall, the streets get flooded very quickly. It may only last some 10-20 minutes from the rain starts until the pipe capacity is exceed and the water start to pile up on the streets. With such short response time, it is obvious that both a relative accurate short-term rainfall forecast as well as frequent releases of new forecasts are important. The selected one-hour interval between forecasts should be reduced to, say every 10 minutes. This is from a technical point a relatively simple process; it is only a matter of including more hardware in the system setup.

4 The financial challenges

BMA have in the course of the project developed an increased interest in discussing how to further benefit from the interim project results and conclusions, with the goal of setting up a citywide flood warning system, using the concept introduced through the TA.

Without having estimated or budgeted the actual costs for a citywide system, it is surely an investment in the order of several millions USD.

In addition to the costs of implementing a large system, BMA also need to prepare for such a system. A number of necessary elements are currently not at a state where a citywide system could be implemented.

Information about the physical drainage system including asset and maintenance databases, are at a relatively immature level. A significant investment (time, money, patience) is required to get a reliable digital image of the current system.

Another issue is the understanding of the hydraulics. BMA will not be able to benefit fully from a major warning system, until a thorough understanding of the complex hydraulics is established. As discussed above, this is one of the recommendations to BMA, and they have already started to discuss how to upgrade these skills.

The weather radar is another issue to be resolved. An effective flood warning system depends on an effective rainfall forecast system. BMA have recognised this need, and are considering how to establish the necessary funding.

Given the need for several activities requiring a major capital investment, we briefly looked into possible external financial resources to supplement the normal investment schedule from BMA.

Two meetings with STI and CTCN clarified the Green Climate Fund (GCF) in principle is a feasible source. However, the road towards a serious application is long and complex, and requires an effort exceeding available resources within BMA. Further, it is far from certain that the terms and conditions are suitable. This leaves BMA to continue their work with the normal financial resources, primarily an annual budget granted by the local Government.