Cost benefit analysis

A cost-benefit analysis was carried out to evaluate whether the risk reduction resulting from the interventions justifies the investment costs. In a cost-benefit analysis the present value of future risk reduction is compared to the cost of the interventions. This information can be supportive for a decision maker to decide whether certain investments are feasible.

Current flood risk is estimated as a serious problem (on average about 45 million USD in damages per year according to our calculations). The damage will become larger in the future (as GDP is expected to increase). The reduction in damage by the interventions covers the costs of the interventions. It will obviously take several years until the cost of the interventions are matched in prevented flood damage. If wetland encroachment continues, the future benefits of the interventions will become larger. Intervention package II performs slightly better than package I – despite the higher costs. Whether these benefits justify the investment depends on the actual discount rate for Sri Lanka and on the benefits of potential alternative investment opportunities in the area.

The impact of potential future wetland encroachment

The urban wetlands are Colombo's life line in flood prevention. Up to 39% of the runoff volume from extreme storm events is stored in these nature conservation areas. However, due to both formal and informal urbanization, these wetlands are under threat. If these natural flood storage areas cannot be protected, Colombo's flood risk will only increase. Future urbanization, socio-economic growth and population growth may lead to encroachment of these wetlands. Therefore an analysis of the impact on the flood risk of Metro Colombo due to loss of storage was carried out. A worst case projection has been chosen to show what would happen if wetland degradation and encroachment would not be stopped. In this scenario it is projected that 90% of these wetlands below 2m+msl will be encroached in future and may be urbanized. Results of these predictions will be shown during the Public Event.

PROTECTING COLOMBO AGAINST FUTURE FLOODS

Metro Colombo is highly vulnerable to flooding and has experienced regular floods over the past 30 years, affecting a large number of people annually. Last May, Colombo, the capital of Sri Lanka, was hit by the worst flooding since 1989. Encroachment of valuable wetland systems, informal settlements and less efficient urban drainage systems contributed to the intensity of this flood. The micro drainage system experienced clogging and high backwater from the main canal system at their outfall locations. The Colombo Metrological Office recorded 256mm on May 15, approx. a 10 year return period storm event. The Kelani River, bordering the city center on the Northeast, reached the second highest discharge in 35 year. Combined with neap tide this led to the most devastating flood in almost three decades. In Colombo district alone, 185.000 people were directly affected by the floods, with 3 reported deaths. A consortium of Deltares, ADPC and CECB supports the government of Sri Lanka in the "Metro Colombo Urban Development Project" with a comprehensive assessment of the risks of flooding and a strategy to reduce those risks.

About the Project

Objective

The main objective of the project is two-fold: first, to assess the current and future flood risk in Colombo Metropolitan Region, and second, to develop a flood risk strategy in cooperation with targeted stakeholders in view of future land use scenarios.

Flood risk assessment

A detailed hydrodynamic computer model of the Metro Colombo region was used to carry out an analysis of the flood hazard. This is combined with an economic analysis of vital infrastructure, buildings of all types, and agricultural land use in order to estimate the potential damage resulting from floods of various types and magnitude. Important goals in the project are strengthening of the local capacity for risk assessments and mainstreaming risk information into urban development planning. During the project several dedicated trainings and workshops have been organized.

Flood risk strategy

The strategy will include flood risk reduction interventions such as improving the drainage systems, creating additional storage, enlarging the conveyance and outfall capacities as well as suggestions for improvement to flood early warning, formulation and implementation of necessary policies for land use management, building control, etc.. The results will be input to the upcoming City Development Strategy for the Colombo Metropolitan Region.

This handout

First, model simulations are presented of the November 2010 and May 2016 floods to analyse the impact of the interventions. Next, the method of flood risk assessment is introduced, which enables us to evaluate the mitigating impact of the proposed interventions in the water system to reduce the flood risk. With this method, we also show the potential flood damage with and without these interventions for the Colombo Metropolitan Region.

Interpretation of Historical Flood Events Experienced in Colombo City

Colombo city and the Kolonnawa region experience flooding due to two major climatological/hydrological phenomena. The first phenomenon is high-intensity rainfall with short-term duration in the city area. The second is high discharge through Kelani River due to high rainfall in the upper catchments of the Kelani River. When these two phenomena coincide the city of Colombo faces the worst flood conditions. During heavy rainfall, the rainwater is discharged under gravity through the urban water system into the Kelani River or directly to the ocean. However, when the Kelani River is high, the river outfalls are blocked and the water levels in Metro Colombo will rise.

The extreme floods that hit the region in November 2010 and May 2016 were different in terms of climatological conditions. We calculated flood inundation maps using computer simulation models for these recent extreme flood events to understand the system behavior during such flood events.

Figure 5 shows a map of the flood risk for the current Reference situation. Figure 6 shows the difference between flood risk for Package II and the Reference. The difference map shows that most risk reduction is achieved in the Metro Colombo area, with the dark green areas achieving the highest risk reduction.

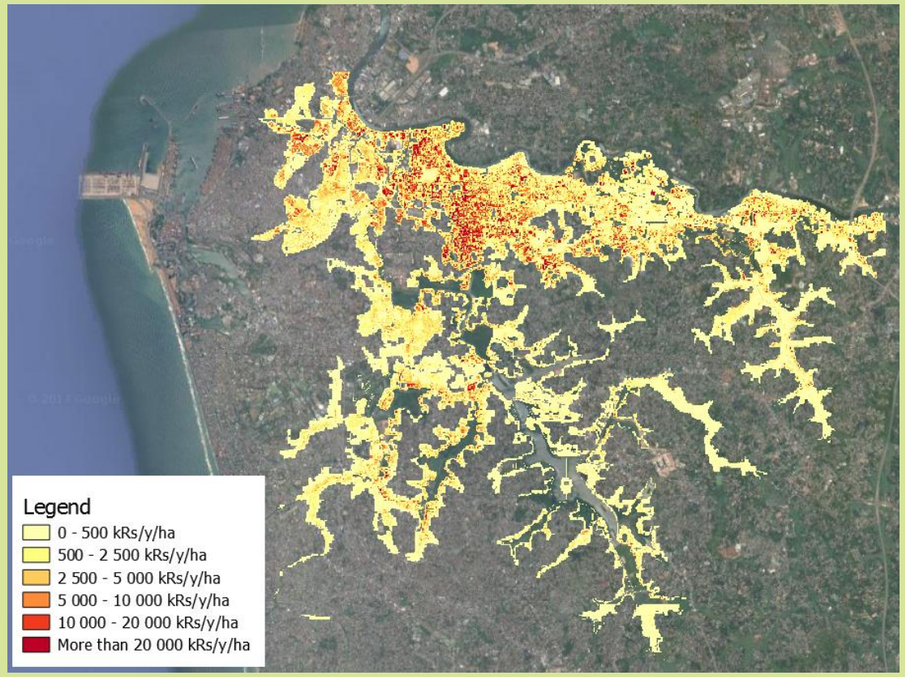

Figure 5: Flood risk, expressed in Rs' 000 per year per hectare if a flood with 50 year return period, i.e. similar to the flood event shown in Figure 3, occurs today

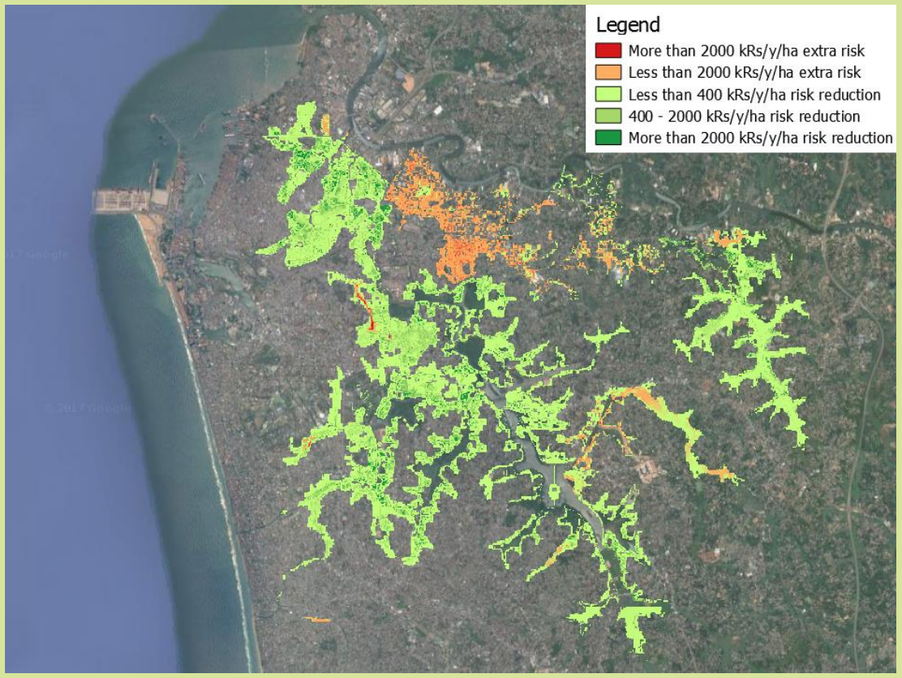

Figure 6: Difference in flood risk (kRs/y/ha) before and after implementation of the intervention package, including Madiwela South diversion.

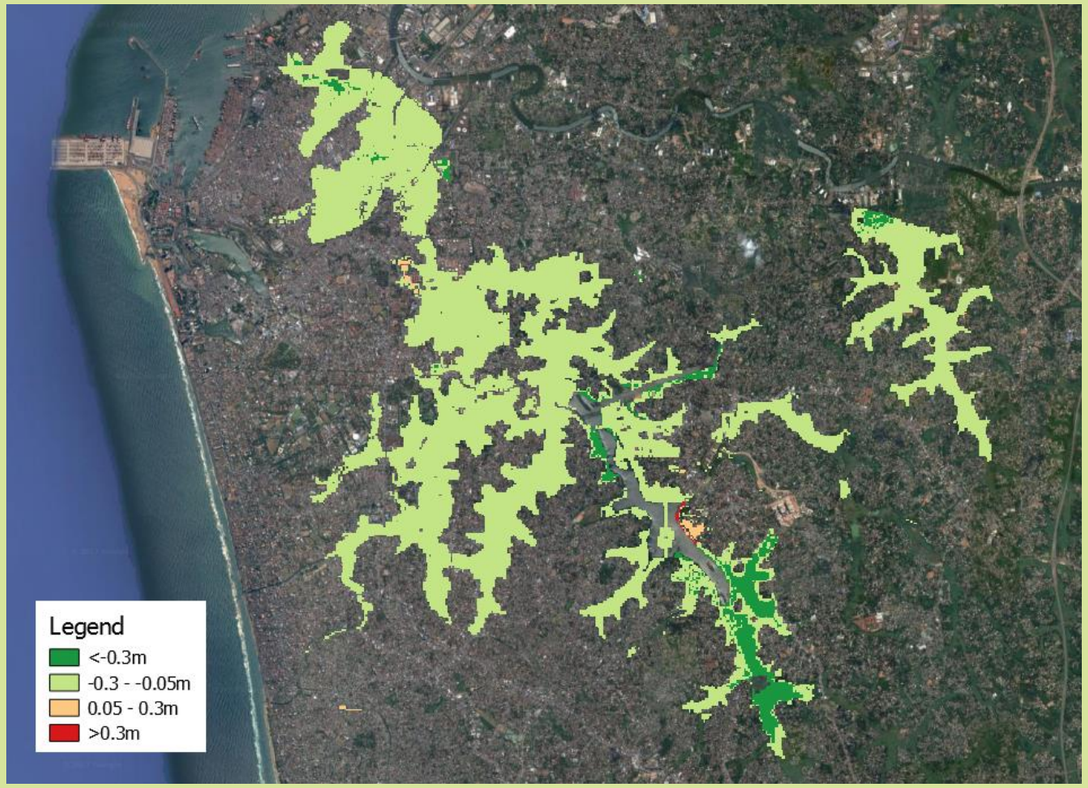

Figure 4: Reduction in flood depth, in a flood event with a return period of 50 years, with the implementation of interventions including the Madiwela East Diversion. Negative values indicate locations where the interventions have resulted in a decrease in flood depth.

Impact of the interventions on flood damage and risk

The damage calculations for different return periods before and after implementation of the contracted interventions (Package I) and after the additional implementation of Madiwela South Diversion (Package II) show reductions in the order of 10%. The interventions generally have more impact under more extreme conditions. The calculations also show that the Madiwela South Diversion results in 2-3% additional damage reduction.

The table below compares the flood risk, expressed in monetary terms (millions of Rupees per year) as the Expected Annual Damage, between the current Reference situation and Package and Package II. This shows that Package I reduces the flood risk in the Metro Colombo area with 290 million and Package II with 510 million Rupees each year. Package II hence leads to a reduction of 26%.

Flood risk for the Metro Colombo Region (in millions of Rupees per year) for the current situation (Reference), for the contracted interventions (Package I) and for the contracted package including Madiwela South Diversion (Package II).

Reference	Package I	Package II
1 960	1 670	1 450

November 2010 Event

The November 2010 event has recorded the highest rainfall event in the recent history with 440mm rainfall per day, approximately a 40 year return period storm event. Water levels in the Kelani River were low. A large part of the city was flooded, including the Sri Lankan Parliament premises.

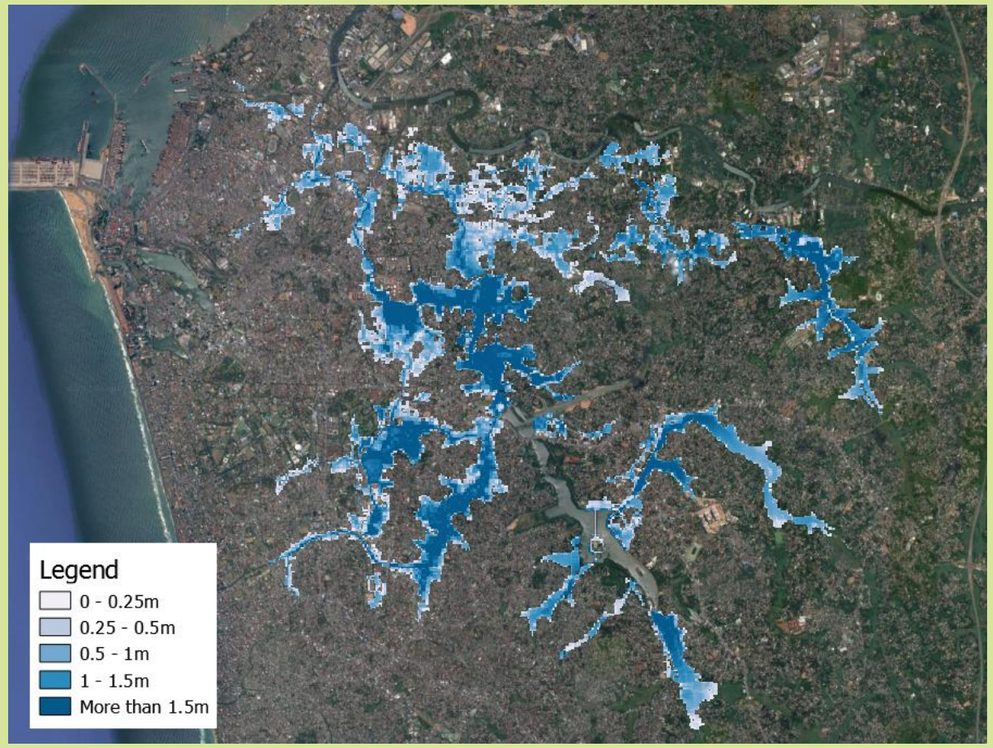

Figure 1: Flood inundation depth (m) in November 2010

May 2016 Event

The Colombo Metrological Office recorded 256mm on May 15, which is a storm event that occurs on average every 10 years. The Kelani River, bordering the city center on the Northeast, reached very high water levels with the second highest discharge in 35 years. Combined with neap tide this led to the most devastating flood in the Kelani flood plain, including Kolonnawa region, in almost three decades.

Current Flood Risk in the Metro Colombo Region

All relevant hydrological and climatological conditions were analyzed that can possibly lead to flood events in the Metro Colombo region. It was calculated how these events may lead to flooding (depth and extent) of the city. This was done for a large number of different possible events that together form flood hazard maps. Such maps were calculated for specific return times, indicating the severity of the events.

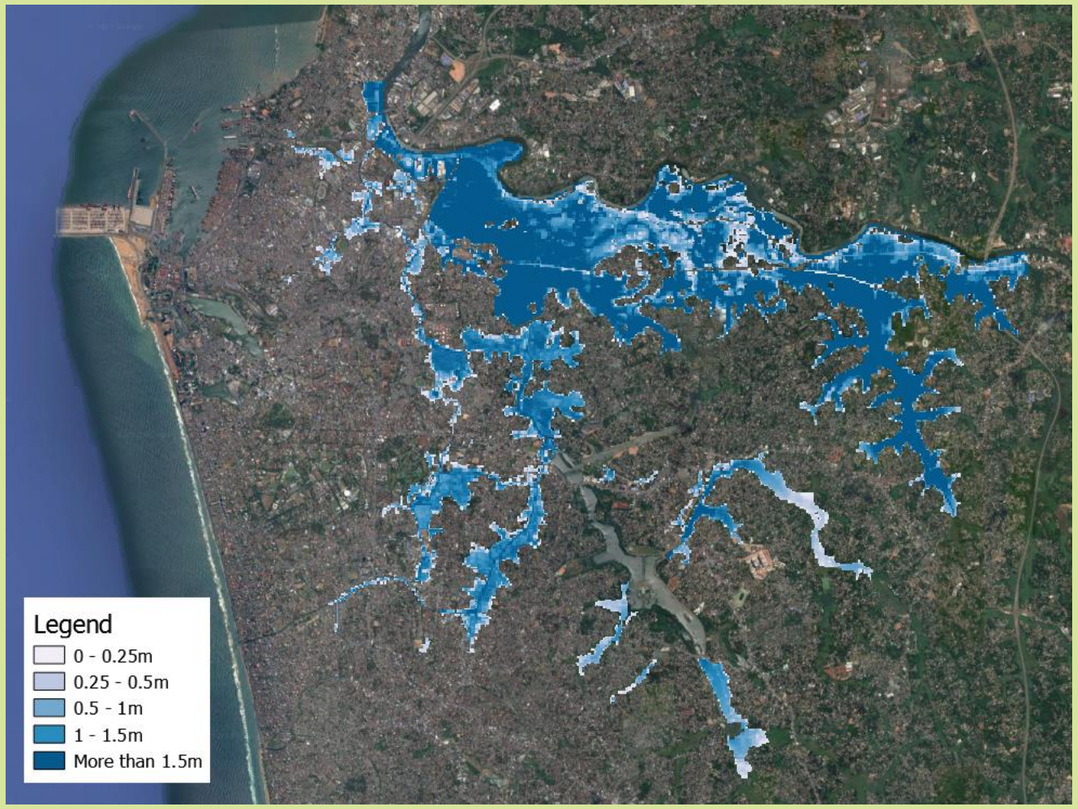

Figure 2: Flood inundation depth (m) in May 2016

Figure 3 shows the flood hazard for the Colombo Metropolitan Region with a return time of 50 years, indicating that on average such flooding may happen every 50 years. Data were collected on practically everything that is exposed to flooding (buildings, infrastructure, agricultural crops, etc.), assessed the so-called vulnerability of each of these exposed categories and converted this into Colombo-specific flood depth-damage curves. On the basis of this information the amount of damage was computed that can be expected on an average annual basis as a result of the floods. This was then expressed as flood risk.

Impact of mitigation interventions as proposed by MCUDP

MCUDP proposes various interventions in the water system of the Metro Colombo region that all aim to mitigate the flood risk for the city.

Many of the proposed interventions increase the basin outfall capacity, such as the construction of the Kolonnawa connection canal. This canal will increase the capacity to divert run-off during extreme events from Colombo basin to the Kelani River via the Kolonnawa basin. Widening the existing North Lock gate and placing a pumping station, construction of the new Mutwal tunnel and placement of new pumping station at Ambathale and St. Sebastian south canal will also increase the basin outfall capacity.

Another option is increase of rainwater storage. Since the Metro Colombo basin is densely populated and urbanized, increasing the water storage capacity is a challenge. However, MCUDP proposes to increase storage capacity under the intervention “Madiwela East Diversion”. Under this intervention, storage capacity will be increased by upgrading the Averihena weir crest level and adding a control structure to Talangama Tank.

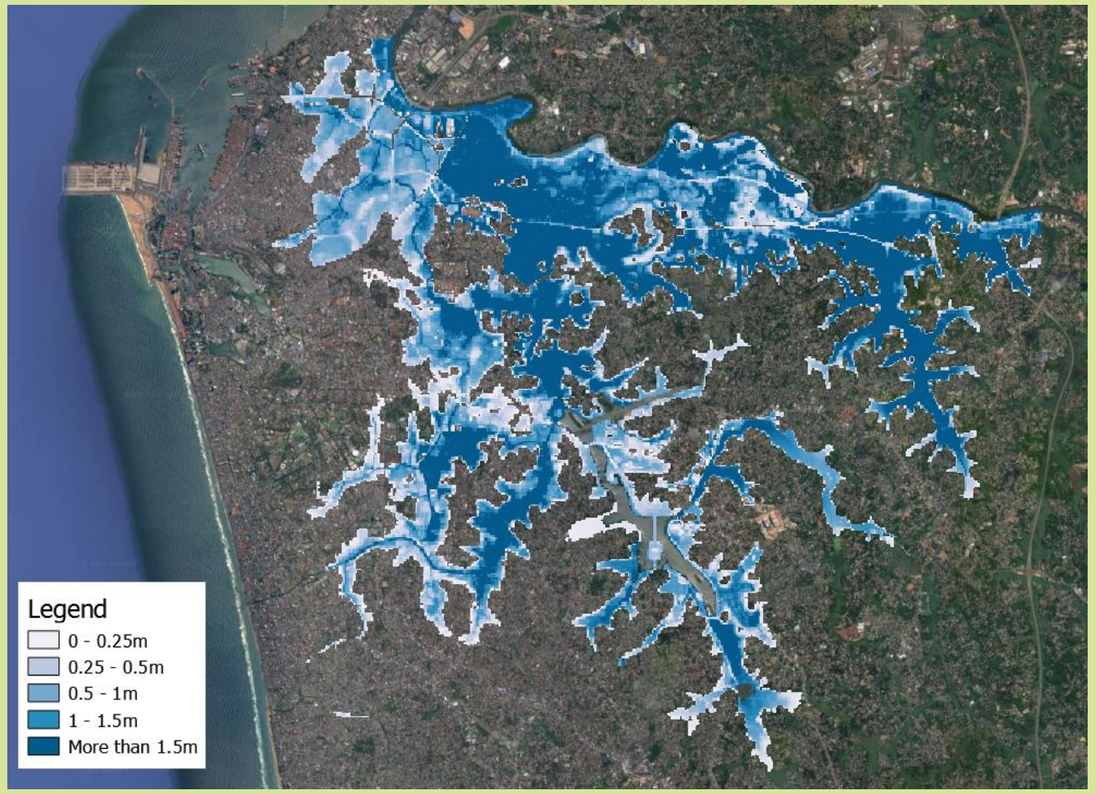

Figure 3: Flood hazard map with a return time of 50 years

All of the above interventions have been contracted already. This set of measures is called ‘Intervention Package I’. A newly proposed intervention is Madiwela South diversion, which will reduce the inflow of runoff into the Colombo basin. Specific attention will be given to this additional measure. Package I including Madiwela South is called ‘Intervention Package II’.

These interventions are dedicated to reduce flood risk in the Colombo Metropolitan region. Another project, implemented under the CRIP (Climate Resilient Improvement Project; Irrigation Department) is dedicated to mitigate flood risk in the Kolonnawa region and the Kelani flood plain.

Impact of the interventions on flood inundation

The impact of the proposed interventions for a 50 year return period flood can be shown as follows. First, we calculated the flood hazard for a situation in which all proposed interventions are implemented in the water system. This results in a map similar to the one in Figure 3. Figure 4 then shows the impact of the contracted interventions (Package I) – by showing the differences in flood depth between the two maps for a return period of 50 years. Also shown is the additional impact of the Madiwela South Diversion. Negative values indicate locations where the interventions have resulted in a decrease in flood depth. Most locations have a green color, indicating a decrease in water depth caused by the package of proposed interventions. As a result of those measures, the flood extent decreases for the full study area of Metro Colombo region with 2-8% for Package I and 5-10% for Package II.