Possibilities for additional discharge of water using gravity in the Northern border area of kota and kabupaten Pekalongan.

Thijs Willem de Bruijn
Institution for building and Environment
Rotterdam University of Applied Sciences
G.J. de Jonghweg 4-6, 3015 GG Rotterdam
The Netherlands
Email: 0889842@hr.nl

Received: 20 January 2017

Abstract

Tidal floods are a threat for the residents of Pekalongan. Urban areas in the North of Pekalongan got inundated during high tide of the Java sea. Residents of the inundated areas told that the height of the daily tidal floods in getting higher year to year. These tidal floods occur as a result of land subsidence and open connections between the Java sea and urban areas. The aim of this study is to investigate the possibilities to drain water from inundated areas with use of gravity. The researched area was the Northern border area of kabupaten and kota Pekalongan. Drainage using gravity is draining water during low tide with use of intakes. Methods which are used in this research are interviews and literature and field research. This research showed that drainage using gravity is possible on five locations in Pekalongan. Intakes to drain water are available on 3 of the 5 researched locations. The impact of the inundation can be reduced with the use of drainage using gravity.

Key words: Drainage using gravity, Pekalongan, tidal flood, coastal area.

Introduction

Coastal areas are the most vulnerable areas effected by climate change (Marfai & King, 2007). The coastal area of Pekalongan becomes inundated as a result of a rising sea level, higher intensity of rainfall, land use changes, ground water extractions and a bad maintenance of waterways and water infrastructures (Nashrrullah, Aprijanto, Pasaribu, Hazarika, & Samarakoon, 2013). As a result of the groundwater extractions in the clay soil the ground land subsidence occur (Wilms, 2016). Drainage using gravity is not possible when the land is lower than the sea. Because river Meduri and canal Bremi are in open connection with sea these rivers could not drain water during high tide of the Java sea. The water level in the rivers will rise and they will overtop eventually.

Groundwater extractions have shorted the shore of Pekalongan with 10.5 meter between 2003-2009. The shore is disappeared under sea and fertile soil for rice is replaced for fishponds (Marfai M. , 2014). Because of a lack of maintenance of water infrastructures, these fishponds are influenced by the tidal range of the Java sea. During high tide, the water level in the fishponds is raising and the settlement areas get inundated. The height of the water in the inundated areas is variating from 10 centimetres in the south till 30 centimetres in the north. Figure 2 illustrates the inundation of urban areas. The extend of the affected area increases year to year (Nashrrullah, Aprijanto, Pasaribu, Hazarika, & Samarakoon, 2013).

Because the water system of Pekalongan is changing fast due to land subsidence and urbanisation, it is researched what the possibilities are to use the differences in water level between the river Meduri and canal Bremi and the inundated areas around them to drain water. The research question which is answered in this article is: 'Where in Tirto and kota Pekalongan are the possibilities to drain water using gravity with (present) water infrastructures?'. This study will only investigate where possibilities to drain water using gravity arise and if there are water infrastructures available. The researched area is the Northern border area of kota (city) and kabupaten (regency) Pekalongan, shown in figure 1. This area is researched because tidal inundation occur in the border area and this makes it more difficult to find proper solutions to reduce the impact of the inundation (Rumingsih, Wisnugroho, & Anita, 2016).

The objectives of the study is to investigate the possibilities to drain water to canal Bremi and river Meduri using gravity during low tide of the Java sea. Based on this study it is concluded that there are possibilities to drain water from the inundated areas to the rivers.

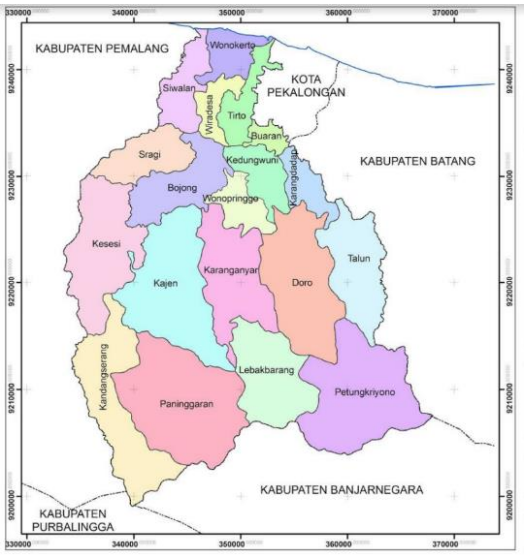

Figure 1, kabupaten Pekalongan is shown above. In the north east is kota Pekalongan shown in white (Diponegoro, 2012)

Figure 2, the inundation of urban areas during high tide of the Java sea

Material and Methods

Connections between river Meduri and canal Bremi and the inundated urban areas are searched. Data about the fluctuation in water level is measured during field research. Divers from Eijkelkamp SWS technology are used to measure this data. More specific, two DI501-10m divers and one CTD-Diver 50mm are used. The DI501-10m divers measure the water and air pressure above them. The CTD-Diver 50mm has to possibility to measure the conductivity of the water.

During preliminary investigation 7 interviews to gather more knowledge about the water system of Pekalongan and working in a different culture are done. Interviewed (formal) employees of the waterboard of Schieland and the Krimpenerwaard had expertise in about working in different cultures, the water system of Pekalongan and water systems in general. Interviews in Jakarta followed to gather more information about the culture differences about how fieldwork could be done. A method to inventory waterways and water infrastructures is developed in Semarang. This method describes the strategy how gathered data of fieldwork in Pekalongan is processed in Excel, ArcGIS and Word.
A second method to measure differences in water level is developed in Semarang. This method includes a strategy how the differences in water levels could be measured with the use of the DI501-10 and CTD-Diver 50mm divers. The locations for measurements are investigated and assessed on their change to drain water using gravity. These divers measure the height of the water level above them. These divers were placed in canal Bremi or river Meduri and the inundated areas next to the rivers. To make sure this data is reliable, a supervisor was on sight to watch the divers for 24 hours. Figure 3 illustrates how the three divers were placed during fieldwork.

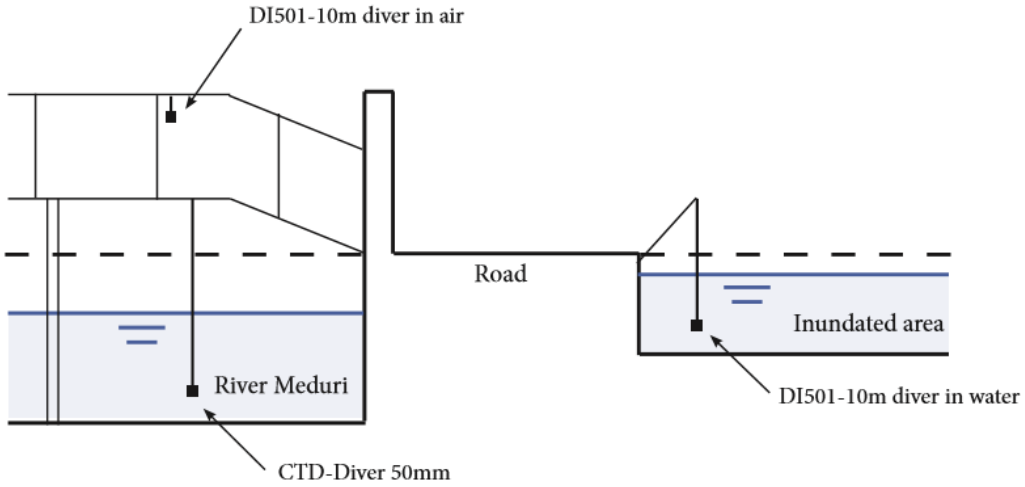

Figure 1, this figure illustrates how the divers are used during fieldwork. The road is used as referential point to compare the data correctly. The diver which is placed in the air is placed on a bridge.

During fieldwork in Pekalongan, My Maps is used to pinpoint the location and Google Forms is used to gather the needed data about the water infrastructures and waterways.
Organisations which have responsibilities in water management in the research area are interviewed. PSDA and BAPPEDA kabupaten Pekalongan and DPU and BAPPEDA kota Pekalongan are interviewed. Presentations delivered by these organisations gave more insight in the strategy of kota and kabupaten in reducing the impact of the inundation. (Rumingsih, Wisnugroho, & Anita, 2016) (Ismanto, Penanganan Banjir Dan Rob Pada Sub Sistem Bandengan Kota Pekalongan, 2016) (Ismanto & Niftah, Interview Public Works Kota Pekalongan, 2016) (Antayo & Prawukanto, 2016) (Astu, 2016).

The gathered data and knowledge during interviews is processed using Word. The findings which are done during field research about the waterways and water infrastructures are processed with the use of Excel, ArcGIS and Google Earth. The measured data of the divers is processed and analysed with the use of Diver Office and Excel. With use of Excel, an overview of all the measured waterways and water infrastructures is made. A map is made in ArcGIS. The overview of measurements in Excel is connected with ArcGIS by using the latitude and longitude coordinates of the measurements

The inventory of the water infrastructures was done by two students of the Rotterdam University of Applied Sciences. Miscommunication is a possible mistake during the measurements. Data about the water infrastructures which could drain water is checked twice because this is important data for the study. To prevent miscommunication during interviews, an interpreter joined the interviews to make sure that the interviewer and the interviewee where talking about the same topic.
The methods which are used to investigate the possibilities of drainage using gravity are in accordance with the purpose of this research. Only one measurement is done on each location, with more researched location as a result.

The aim of this study was to investigate if there are possibilities to drain water using gravity (with use of current water infrastructures). To answer this question one measurement is on each location is enough.

Results

Differences in water level between river Meduri and sub system 1.1, 1.2 and 2.2 fishponds are measured during this study. Between canal Bremi and sub system 3.3 and the fishponds is also a difference in water level measured. These differences in water level describe that the water level in river Meduri and canal Bremi is for a constant period lower than the water level of the inundated rural and urban areas around these waterways. A minimum difference of 2 mm is needed to drain water using gravity. During the measurements on 29th November, it is observed that drainage using gravity

was possible with a difference in water level of 2mm. This water level difference is measured with the use of two DI501-10m divers and one CTD-Diver 50mm.

The water level in river Meduri and canal Bremi is fluctuating as a result of the tide of the Java sea. One place is discovered where drainage using gravity is used. Figure 4 and 5 illustrate the intakes at this point (point 1). More information about point 1 is given in appendix 1. By opening the intakes, water is drained from the inundated rural areas to the sea. During high tide of the Java sea, these intakes are closed to prevent water from flowing in.

Figure 4, intakes are open during the day when drainage using gravity is possible to river Meduri

Figure 5, intakes are closed at night when the river Meduri is to high

As a future result of drainage using gravity, the water level in the inundated areas will drop variating from 7 centimetres in sub system 3.3 till 23 centimetres in sub system 1.2. Data about the depth of the fishponds was not available during this research, so it is unknown how much surface will be dry using drainage using gravity. It is clear that the impact of the inundation will be reduced because the water level will drop in the inundated areas as a result of drainage using gravity. But this method is not suitable to make areas permanent dry and solve the inundation. During a high water level in river Meduri and canal Bremi, it is not possible to drain water using gravity.

Besides the locations where drainage using gravity is possible, it is also researched which location are responsible for the inundation of Pekalongan. Figure 6 below illustrate the locations where water intrudes the fishponds during high tide. These locations are shown with red dots. It is likely that fisherman are responsible for these openings. They have interest in salt water in their fishponds. This is how the Java sea contributes to the inundation of Pekalongan. Two examples of these openings are shown in figure 7 and 8.

Figure 6, red dots show the locations where sea water intrudes the fishponds during high tide. The red arrows illustrate the connections with the fishponds. The white arrow with sub system 1.1, the blue arrows with sub system 2.1 and the yellow arrow with sub system 4.1.

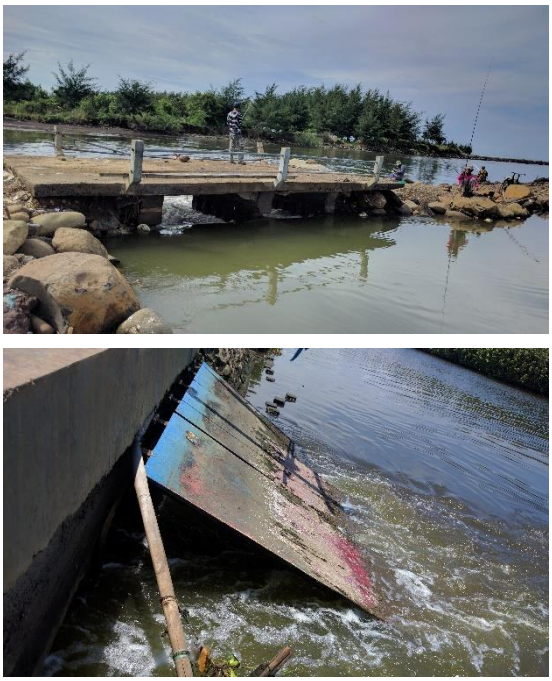

Figure 7 and 8 are pictures made by the two upper red dots. During high tide of the Java sea, water is able to flow into the fishponds. Wooden shields are installed, shown in figure X, to prevent to water from flowing in. As a result of bad maintenance these shields cannot block water anymore.

Conclusion

Results showed that during low tide of the Java sea, drainage using gravity is possible on five locations in the Northern border area of kota and kabupaten Pekalongan. On these locations the water level of the river Meduri and canal Bremi is for a constant period 2mm or more lower than the inundated areas around them. The five locations where drainage using gravity is possible are shown in appendix 1. In three cases, current water infrastructures could be used to drain water using gravity. Drainage using gravity will reduce the impact of the inundation by lowering the water level in the inundated areas. It is unlikely that this method will solve the inundation. During a high water level (during high tide and rainfall) in river Meduri and canal Bremi, water cannot be discharged using gravity. Inundated areas cannot rely on drainage using gravity because the capacity of the drainage is depending on the weather. That is the reason why drainage using gravity must be seen as an additional discharge for water besides the pumps.

An applicable solution which should be taken based on the outcome of this research is the installation of intakes between the sub systems 1.2 and 2.2 and river Meduri. In addition, intakes should be installed between sub system 3.3 and the fishponds and canal Bremi. To increase the efficiency of the intakes, further research about the dimensions, specific locations and use of the intakes is required. It is recommended to use ArcGIS for processing height and surface data.

Discussion

The divers have measured for 24 hours on the five locations. In this short time, the influence of extern factors on the measurements is big. Trash can remove the position of the divers and rainfall can cause different values than expected. Absurd high or low water levels are scrapped in this study to make the results more reliable. The current method can be improved by measuring longer on each location and measure the water levels in dry season. Measurements needs to be done in all sub systems so a considered consideration can be made. To investigate the results of drainage using gravity more

precisely, the height of the surface and the depth of the inundated areas is required. It is recommended to use ArcGIS to proceed height and surface data.

The research question is formulated in a way it can be answered during this three-months long study. The second step is developing a long term strategy about the future use of the intakes. It is highly recommended to investigate how the intakes function the most efficient.

Acknowledgement

The completion of this research could not have been possible without the assistance of the following people: Internship coordinator Jonathan Lekkerkerk for his professional view and tips during my research. Johan Helmer for providing an assignment and space to work at the Waterboard of Schieland and the Krimpenerwaard. My on-sight internship coordinator Imam Wayhudi for sharing his knowledge about Pekalongan. Bupati of Pekalongan, Asip Kholbi, for arranging all the needed facilities in Pekalongan and treating me as his son. At least, to all friends and colleagues who in one way or another shared their knowledge and support which helped me finishing this research successfully.
I hope that the result of this study will help the residents of Pekalongan to a more sustainable future.