

STRATEGY OF DRAINAGE AND FLOOD CONTROL IN PALEMBANG CITY

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ABSTRACT

Located \pm 100 km from the estuary of Musi River, Palembang city has been dominantly influenced by tidal. Many areas in Palembang are below the water level in the wet season which makes the area prone to the flood due to the high tide of Musi River. Most of the area in Palembang is in depression area, so that without a proper drainage system the area is subjected to the inundation due to the rainfall.

It is a challenge for Palembang which has program to improve the performance of the city as an interesting, safe and a beautiful waterfront city and attractive to be visited with the best urban drainage system in Indonesia. Besides, to support national program of food self sufficiency, Palembang government has to improve the agricultural output in order to ensure the food self sufficiency at least for Palembang city itself. To reach the goals, flood and inundation problem need to be solved in advance.

Several strategies both structural and non-structural have conducted to overcome the flood and inundation problem in the area. Structural measures include installing water control structures and pumping stations, proper operation and maintenance of urban drainage system, normalization of the urban drainage main system, and also setting up levee and dike system. The efforts should be environmentally sound and involve the society and all the related stakeholders. Several rules and regulations made and implemented with a consistent way. If necessary, penalty system has to be introduced for whom over treed the rules. Next to that, continuously information and training to the society how important a good water management system and its operation and maintenance in relation to the public health and flood problem in Palembang will be needed.

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INTRODUCTION

Palembang, the capital city of South Sumatra province is passed by Musi River which is the fourth biggest river in Indonesia. The upstream of the river is located in three provinces which are Lampung, Bengkulu and Jambi with the total catchment area $\pm 60,000 \text{ km}^2$. Located $\pm 100 \text{ km}$ from the estuary of Musi River, Palembang city has been dominantly influenced by tidal. In the wet season, the highest water level was +3.7 m+MSL with average high tide was +2.0 m+MSL and the lowest water level was +1.8 m+MSL. Meanwhile, in the dry season, the highest water level was +1.2 m+MSL with the average water level was +0.00 and the lowest water level were -1.2 m+MSL.

Palembang has low and flat topography and the elevation of the area is between +1.6 m+MSL and +36.0 m+MSL, with the average level between +3.0 m+MSL and +4.0 m+MSL. The condition shows that the area below +3.7 m+MSL was the area which prone to the flood due to the high tide of Musi River in the wet season.

Flood is a relatively high flow or water level in a river, markedly higher than the usual, including the inundation of lowland which may result there from. A body of water, rising, swelling and overflowing land not usually covered with water (Duivendijk, 2005). While flooding or inundation is an overflowing by water of the normal confines of a river, stream, lake, sea or other body of water, or accumulation of water by lack of drainage over areas, which are not normally submerged. Inundation normally means only a few dm and this does not have to originate from a flood (Van Alphen et.al., 2005)

Most of the area in Palembang is in the depression, so that without a proper drainage system the area is subjected to the inundation due to the rainfall and high tides. Besides having about 15% of area as lowlands, Palembang also has several retention basins which function to store the water temporarily before they can be discharged into the main river system. Both of them are considered to have big contribution in controlling the flood and inundation in Palembang.

ACTUAL CONDITIONS OF PALEMBANG AREA

Administratively, Palembang has total area $\pm 400,610 \text{ ha}$ and divided into 16 districts. It has 19 drainage systems, of which 17 are ending in Musi River, 1 in Ogan River and another in Keramasan River. See Figure 2.

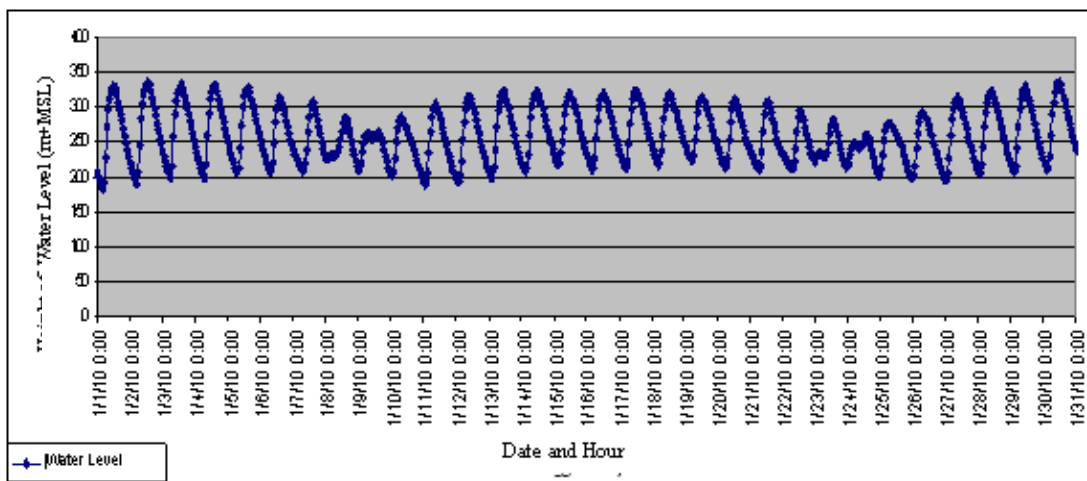
The development of the lowlands by reclamation will change its function as natural retention basins. To eliminate and avoid flood and other environmental problems, Palembang has set up the regulations (City Regulation number 5 year 2008) in order to control the use and development of lowlands (BAPPEDA, 2005 and BAPPEDA, 2006). There are three categories of lowlands in Palembang, which are conservation lowlands 2,106 ha, cultivated lowlands 2,811 ha and reclaimed lowlands (mainly for settlement) 918 ha. The conservation lowlands are strictly not allowed to convert into other land use.

For conservation purposes, Palembang has the regulation related to flood plain boundary which has to be free from any land use activities under the Major Decree No 46 year 1998.

The Data of the river/sub river/drainage channel length in Palembang in 2008 are:

1. River / Primary channel : 55,600 m
 - Natural river/ channel : 11,500 m
 - Permanent : 44,100 m
2. Sub river / Secondary channel : 184,195 m
 - Natural river/ channel : 105,510 m
 - Permanent : 78,685 m
3. Tertiary canal : 118,970 m
 - Natural river/ channel : 41,000 m
 - Permanent : 77,970 m

Figure 1 shows the water level fluctuation in January 2010 in Sekanak Sub River, one of the sub rivers of the Musi River Basin system, where the average water level is about +2.50 m+MSL and the highest water level is about +3.40 m+MSL. From this figure it is clear that many area in Sekanak catchment area where the ground elevation below 3.4 m+MSL is subjected to flood from the river water.



Source : Balai Besar Wilayah Sungai Sumatera VIII, 2010

Figure 1. Water level fluctuation in Sekanak Sub River, January 2010

Existing retention basins

Up to present, there are 19 retention basins in Palembang which are presented in Table 2.

Drainage system in Palembang has 19 sub-systems which presented in Figure 2.

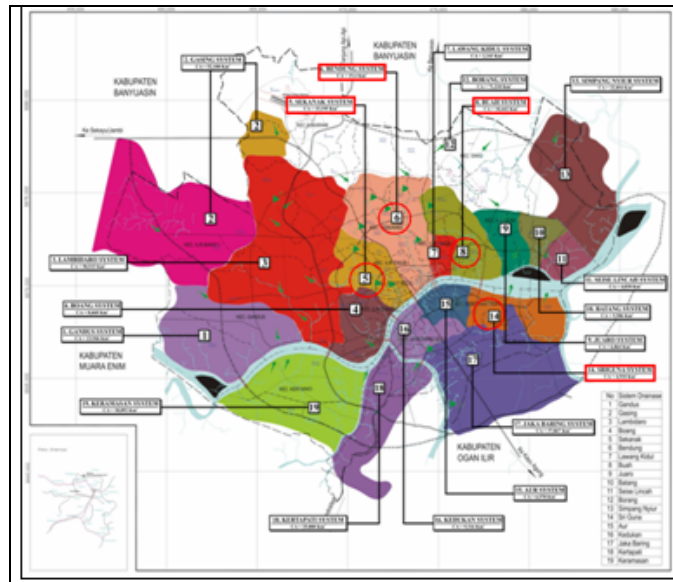


Figure 2. Drainage system in Palembang

Table 2. Existing retention basins in Palembang (PemKot Palembang, 2006)

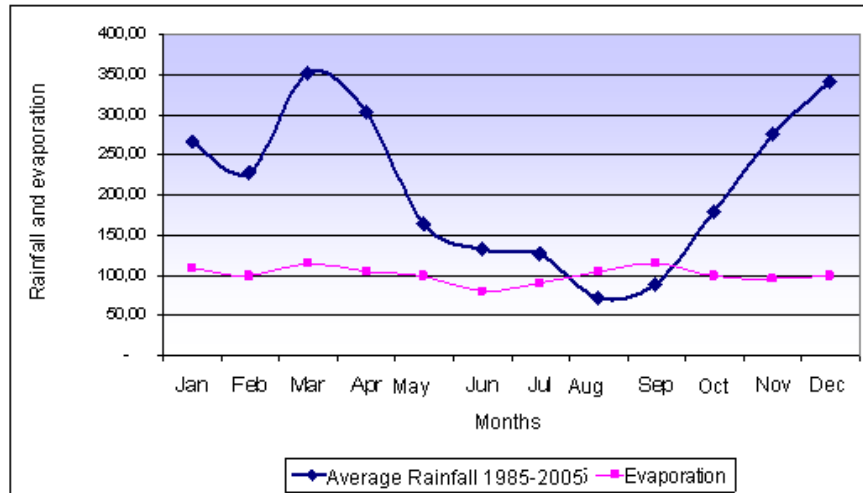
No	Retention basin	Area (m ²)	Depth (m)
1.	Siti Khodijah	11,085	0.8 – 1.5
2.	Simp.POLDA	5,655	0.8 – 1.5
3.	Taman Purbakala	5,393	
4.	Ario Kemuning	16,267	0.8 – 1.5
5.	Talang Aman	16,898	0.8 – 1.5
6.	Seduduk Putih	22,590	0.8 – 1.5
7.	Patal	5,202	
8.	IBA	12,037	0.8 – 1.5
9.	Sport Hall	8,070	0.8 – 1.5
10.	Kambang Iwak Besar	22,126	2
11.	Kambang Iwak Kecil	7,886	0.8 – 1.5
12.	Sei.Unggas	15,619	
13.	Taman Ogan Permai	22,217	3 – 5
14.	GOR Jaka Baring	20,000	3
15.	Perumahan Poligon	5,000	0.8 – 1.5
16.	Lapangan Golf	2,000	3 – 5
17.	Pertamina Golf	15,000	3
18.	Punti Kayu	10,000	1-1.5
19.	Sungai Aur	10,000	2 – 4

These retention basins have to be maintained (by dredging) in order to optimize their storage capacity.

DATA ANALYSIS

a. Rainfall

The average rainfalls in year 1985 up to 2005 are presented in Figure 3.



Source: BMG, 2008

Figure 3. Average rainfalls and evaporations in Palembang 1985 to 2005

Figure 3 shows that the flood and inundation may happen during wet season from October to July, in which December and March are the peak of the high rainfall intensity. August and September are the dry season and rainfall is less than evaporation.

High tide

Palembang government through the local Public Works Office of Bina Marga and Water Resource Management has installed staff gauges at several points along the rivers and sub rivers in Palembang as presented in Figure 4. The recorded water level data are analyzed in order to evaluate the highest water level which can be used in the planning activities of the drainage system in Palembang.



Figure 4. Staff gauge at the river bank

Topography

Flood may occur in many areas in Palembang which have low elevation related to the high water level in the river system. The topographical condition of Palembang area is presented in Figure 5.

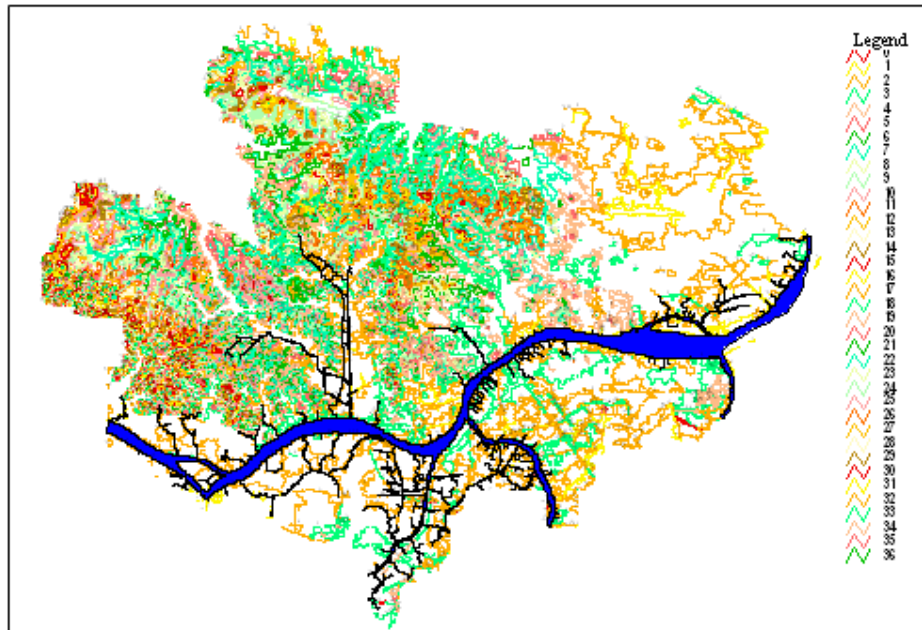


Figure 5. Topographical map of Palembang (all elevation is +MSL)

Infrastructure conditions

There are several problems related to the existing infrastructure conditions in Palembang, which are :

- sedimentation, because of garbage, and solid waste;
- insufficient flow capacity of the infrastructure;
- flow direction in the drainage system network;
- area and capacity of the retention basins.

Land use change

The change of the lowlands from retention basins into other use has reduced the area for water storage. Moreover, the change of the land use from the green area which can infiltrate the run off into other use which will reduce this capacity. Next to that, the change of the land use into settlement, industrial, business area etc has caused the increase of the run off and reduces the infiltration capacity of the land system.

Social conditions

The awareness of the society/developer and other stakeholders about the importance of the drainage system has to be improved. Most of inhabitants in

Palembang should have a good motivation about the function of the drainage systems. All the stakeholders have to be involved in the operation and maintenance of the drainage systems in Palembang.

Coordination among all the related stakeholders

The utility belongs to private company, society, or government has obstructed drainage infrastructure such as the pipe of Water Supply Company, electrical company, etc. A proper coordination among the related stakeholders has to be taken into consideration seriously.

GOALS

Palembang has an important program in order to improve the performance of the river side and be attractive for socio-economic activities. Therefore, Palembang has started to improve its urban drainage systems by regular operation and maintenance in order to maintain its flow capacity and to be clean. Palembang will be an interesting, safe and a beautiful waterfront city and attractive to be visited with the best urban drainage systems in Indonesia. Besides, to support national program of food self sufficiency, Palembang government has to improve the agricultural output in order to ensure the food self sufficiency at least for Palembang city itself. To reach the goals, flood and inundation problem need to be solved in advance and a proper attention to the agricultural development in the surrounding areas of Palembang has to be paid (Marlina, 2009).

ACTION PLAN

To manage the drainage and flood problems in Palembang, the Municipality of Palembang has tried to conduct several strategies of drainage and flood control with eco-drain approach. The rainfall should not flow to the river immediately but retain as long as possible underground and this can be done by using several ways such as retention basin or infiltration wells. The drainage canals also are made as such not only function to flow water but also to retain water.

Several efforts have been conducted by the Municipality of Palembang related to the drainage and flood problems, which are (Sukarto Haryono, 1999):

Non Structural

- Non structural activities have the goal to avoid and to eliminate the drainage and flood problems. The contribution from the inhabitants and all related stakeholders is very important in order to reach the goal. There are several efforts have been done:
- Keep and maintain the quality of water and prevent the inundation with Clean River Programme (*Program Kali Bersih*);

- Socialization and communication with the inhabitant and stakeholders by using mass media, banners, billboards, and movable information system (by using cars). An example of this socialization activity is presented in Figure 6 where the purpose is to improve the community awareness in keeping the rivers and water management system clean;



Figure 6. Banner for clean river socialization

- Coordination among related agencies, for example for the implementation of city regulation on lowlands and also coordination among them such as between Public Works Office and Urban Management Office, Regional Development Planning Agency, Public Sanitation and Cemetery areas (*Dinas Kebersihan dan Pemakaman*), Sub-Districts (*Kecamatan*), villages (*Kelurahan*), Drinking Water Supply Company (*Perusahaan Air Minum*), State Electrical Company (*Perusahaan Listrik Negara*), etc.
- Enforcement City Regulation number. 5 year 2008 about lowlands, by:
 - Land reclamation and development permit will be issued carefully in Palembang related to the function of the lowland areas.
 - Strengthening of the related institutions, i.e. Local Public Works Service (Bina Marga and Water Resource Management) which covers Water Resource Management Section and Drainage and Flood Control Section.
- There is a letter from the Major of Palembang No 362/000360/PU dated 17 February 2009 about the establishment of the infiltration wells which contents the following:
 - The establishment of the infiltration wells not only for government and private company building areas but also in settlement area. The drainage system with infiltration wells can be seen in Figure 7. The establishment of the infiltration wells is considered to be important in area located in high

elevation spots where the ground water level in the related area is relatively low;

Having sand bags to every car wash business in Palembang.

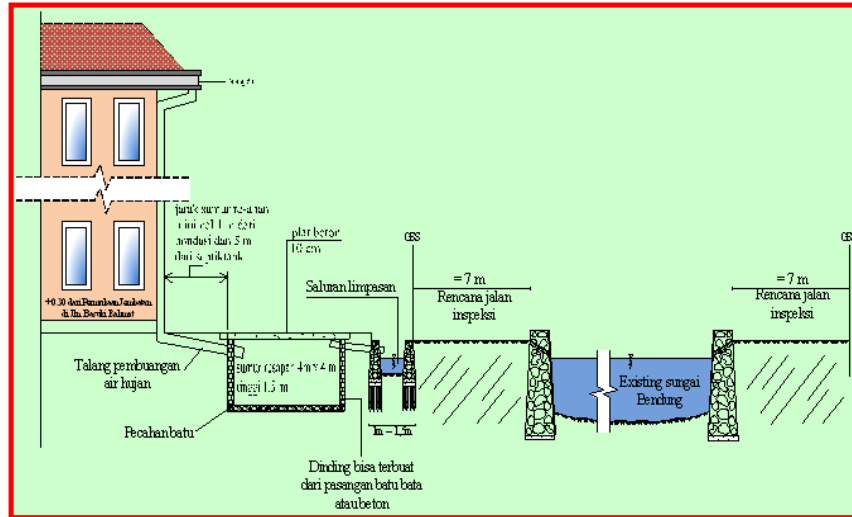


Figure 7. Drainage system with infiltration well

- Keep the existing retention and infiltration areas and river flood plain areas by following the Ministry Regulation No 63/1993 and Palembang Major Decree No 46/1998. Next to that, provide a warning system to the inhabitants if flood may occur and set up billboards on the flood plains where are flood prone areas as presented in Figure 8;



Figure 8. Billboard for guiding inhabitants what and how to do with the river flood plain

- Give the service to the society/inhabitants/private companies/developers in planning the drainage systems in Palembang. See Figure 9
- Cooperation between related agency, when and after the flood occurs;



Figure 9. Some facilities that recommend by the government to avoid or minimize inundation problem

Structural

- a. Establishment of the drainage infrastructure in the settlement areas.

New drainage infrastructure

This measure will be implemented in the areas where there is no drainage system infrastructure yet. In general, all catchment areas in Palembang have already primary drainage systems but for the secondary drainage systems still have to be improved. The establishment of the secondary drainage systems in the related area is conducted as the response to the very fast development of Palembang city where if it is not properly controlled, it may lead to the uncontrolled land use and development which may affect the flood and inundation problems to the Palembang area in general and to the city centre in particular.

Short cut

Short cut is one of the structural measures which is considered and used to divert run-off from the upper part in order to reduce the flood discharge to the related area.

- b. Rehabilitation and maintenance of the drainage infrastructure

The daily maintenance of the existing drainage systems periodically is conducted by the Municipality through the local Public Works Office. In present, the local Public Works Office of Palembang has 11 trucks and 2 excavators with 110 workers. Every Monday morning all the workers are given direction by the Head of Drainage and Flood Control Section in order to improve their performance. See Figure 10. To reach the target as the city with the best drainage system in Indonesia, the number of trucks, workers and other facilities need to be improved. At least 53 additional trucks completed with the workers have to be realized. Periodically maintenance is not only conducted to the drainage, sub river and river systems, but also to other drainage facilities such as pumping stations and retention basins.



Figure 10. Drainage and Flood Control Team



Figure 11. Social activities by the municipality of Palembang

Figure 11 shows an example where the Municipality of Palembang through the Local Public Works Service (Bina Marga and Water Resource Management) together with the Indonesian army and the local inhabitants conducted social activities periodically. These activities include cleaning and rehabilitation of the drainage canals in order to maintain the flow capacity on the urban drainage systems.

c. Normalization of urban drainage systems.

Cleaning and normalization of the drainage systems will be conducted in order to maintain the drainage capacity of the infrastructure (see Figure 12). Prior to this activity, a proper hydraulic, hydrologic and sediment transport analysis have to be done as well. To normalise and improve the flow capacity of the water management systems and its control structures, most of the time the land acquisition will be needed. Therefore, next to this, a study on socio, and economic (included land compensation) aspects related to all inhabitants and stakeholder of the areas will be needed in order to find a best solution for carrying out this measure.



Figure 12. Normalization activity of the drainage system

d. Pumping system

Special drainage system often needs to evacuate water from the flooding area due to the inappropriate drainage system performance. An alternative with pumping system can be considered when drainage by gravity will not be possible. One of example of pumping stations in Palembang is presented in Figure 13.



Figure 13. Pumping system for Bendung Sub-cathment

e. Periodic maintenance of the existing retention basins by dredging and the setting up of new retention basins

By having retention basin which stores the run off temporarily, the peak of the flood can be reduced. The level of flood reduction is depended on the flood hydrograph characteristics, retention basin volume and the capacity of the outlets. The dredging activities at Siti Khodijah retention basin is presented in Figure 14.



Figure 14. Dredging activity at Siti Khodijah retention basin

f. The activity of making and rehabilitating dike for flood protection

Because the influence of the Musi River tide is significant to several areas in Palembang, levee and dikes need to be constructed to protect the vicinity area from the flood due to the high water level (Land and Water Management Tidal Lowlands, 2005). The construction of the levee and dikes need to be completed with the construction of the inspection roads. The inspection roads will be used for maintenance activities of the rivers, urban drainage and flood protection systems (levee and dikes).

FINAL REMARKS AND CONCLUSIONS

Based on the analysis and the discussions in the previous parts, the final remarks can be presented as follows:

- Drainage and flood control in Palembang city is conducted environmentally sound;
- Operation and maintenance of the Palembang urban drainage system has to be planned and carried out with the participation of the society and the sense of belonging of the society will be very important to make a success of the performance of the urban drainage system in Palembang;
- The action that taken by the government to control the flood and inundation is not only structural but also non structural;
- Implementing all the rules and regulations with a consistent way. If necessary, penalty system has to be introduced for who over treed the rules;
- Next to the infrastructure of the urban drainage system, capacity building and human resurces development related to urban drainage system are very important in order to have a sustainable urban drainage system;

- Continuously information and training to the society how important a good water management system and its operation and maintenance in relation to the public health, development of Palembang metropolitan area and to avoid flood problem in the area;
- Besides urban drainage system of Palembang, the next component should get a proper attention is the management of the solid waste and waste water treatment systems.

Related to the effect of climate change phenomena where in case of urban drainage system in Palembang, sea level rise and change in rainfall pattern will be relevant to be monitored, analysed and evaluated.

This monitoring system should be carried out as soon as possible in order to prepare and to take any action or measure related to that phenomena.

REFERENCES

- BAPPEDA Kota Palembang, 2006, Rencana Desain Tata Ruang Kota Palembang, Palembang, Indonesia.
- BAPPEDA Kota Palembang, 2004, Master Plan Sistem Drainase Kota Palembang.
- Departemen Pekerjaan Umum, 2005, Modul Diklat Teknis, Perencanaan, Pemrograman, Operasi dan Pemeliharaan, Sektor Drainase, Jakarta, Indonesia.
- Kodoati Robert J. & Sugiyanto, 2002, Banjir Penyebab dan Metode Pengendaliannya dalam Perspektif Lingkungan, Pustaka Pelajar, Yogyakarta, Indonesia.
- Land and Water Management Tidal Lowlands, 2005b, Technical Guidelines on Tidal Lowland Development. Volume II, Water Management, Report of the Joint Indonesia – Netherlands Working Group, Jakarta, Indonesia.
- Marlina Sylvia, R.A. 2009. Options for Water Management and Flood Protection of Agropolitan Gandus for Agricultural Development. MSc thesis, UNESCO-IHE Delft, the Netherlands and Sriwijaya University, Palembang, Indonesia.
- Pemerintah Kota (PemKot) Palembang, 2006, Palembang dalam Angka, Palembang, Indonesia.
- Sukarto Haryono, 1999, Drainase Perkotaan, Departemen Pekerjaan Umum, Jakarta, Indonesia.
- Van Alphen, J, Van Beek, E. and M. Taal, Editor, 2005, Floods, from Defence to Management, Taylor&Francis Group plc, London, UK.