SOLUTIONS FOR *SMART* FLOOD CONTROL

DASHBOARD JAKARTA
Flood Mapping App

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INFO

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CONTENT

1 INTRODUCTION

1.1 GENERAL

In this report we describe the work done during the visit for the Flood Control 2015 Dashboard Jakarta project from May 22 – 28, 2011.

The mission was done by Klaas-Jan van Heeringen and Arnejan van Loenen from Deltares department Operational Water Management.

1.2 OBJECTIVE AND DELIVERABLES

The objective of the mission was to make a pilot flood map, available through HTML and to be presented at the dashboard http://www.banjironline.com. Flood mapping information should be available to all kind of users:

- govermental organisations,
- business companies,
- NGOs like Red Cross
- and general public.

This means that the flood maps should cover both a global scale (view on whole Jakarta) next to very local scale (Kelurahan, street). The accuracy of the flood maps should be that at least a proper estimate will be provided that shows if the water level will reach:

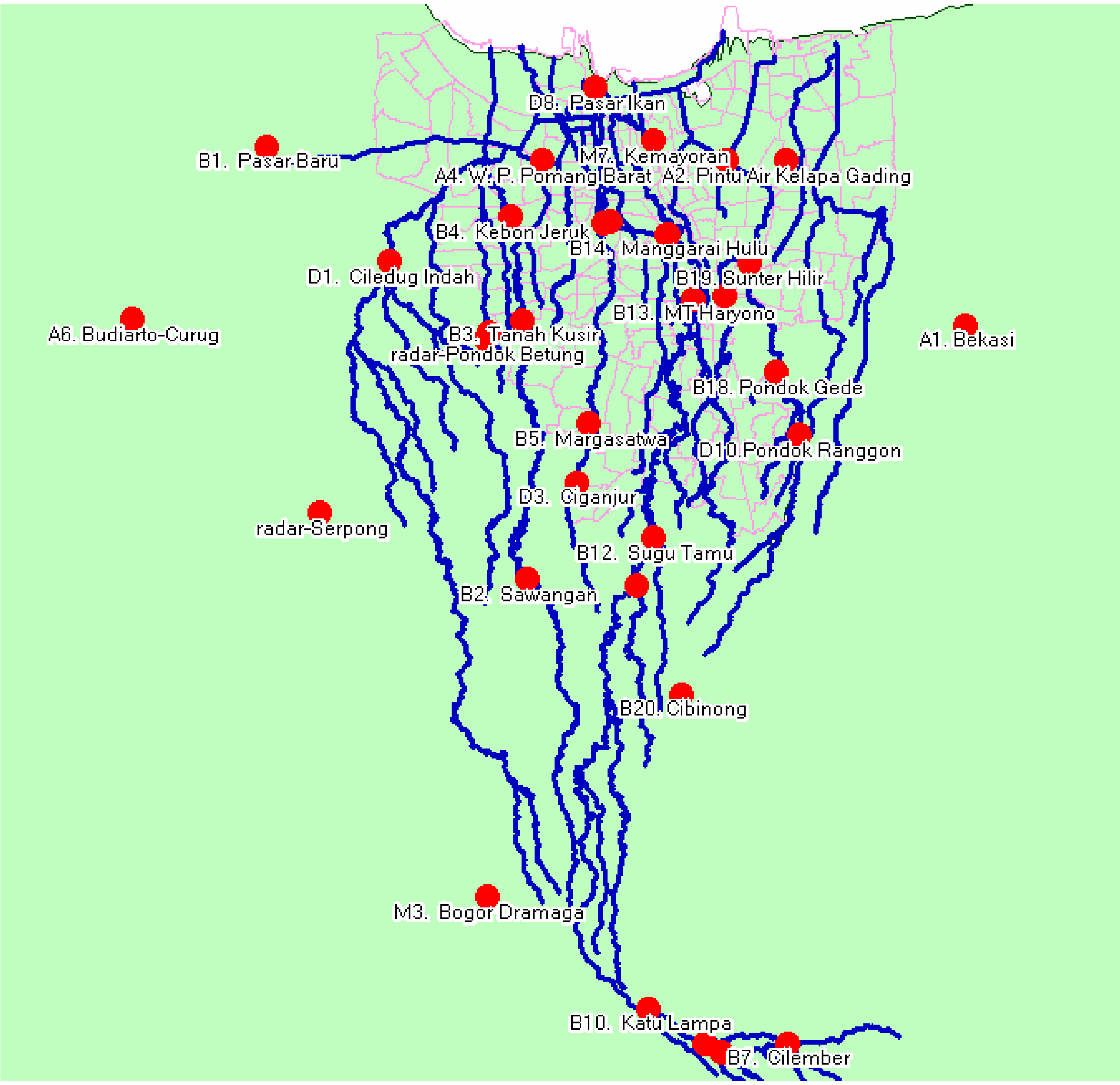
- a level of about 30cm: knee level, still traffic possible
- a level of about 100 cm: navel level, no traffic possible any more but still possible to “walk”
- a level of more than 150: large scale and serious flooding

Based on real-time available water level measurements a simple correlation is used to select a flood map from a set of hydraulic simulation results. The resulting flood map is presented in the dashboard, together with some expected water levels.

1.3 STRUCTURE OF THE REPORT

In the next chapter we describe our approach to generate flood maps, both for the short-term during this year 2011 and for the long term. Chapter 3 describes our current implementation, where chapter 4 focuses on the scope and accuracy of the product. In chapter 5 we discus some possible improvements, that probably will improve the quality of flood maps. Conclusions and recommendations are finally presented in Chapter 6.

Flood Control 2015

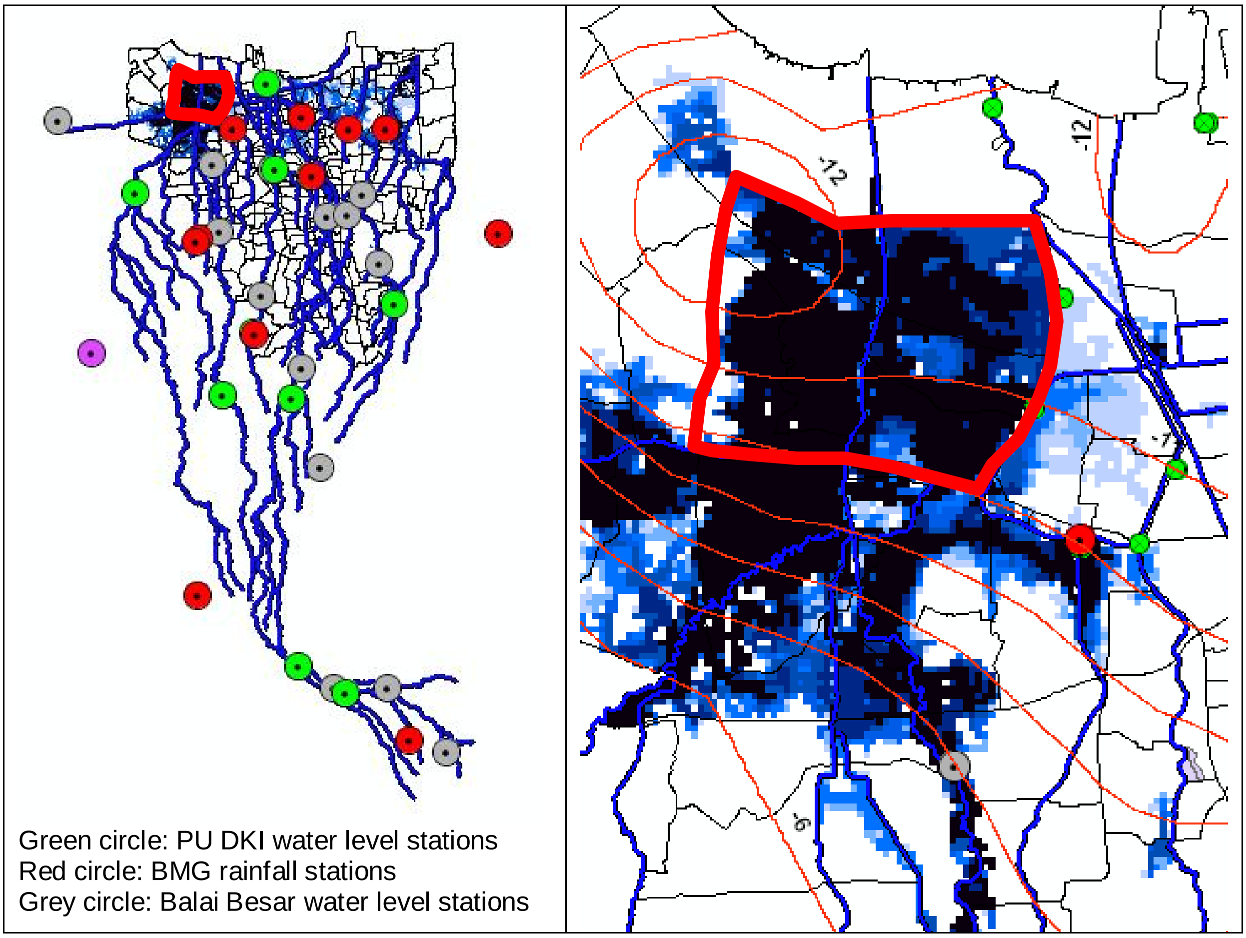


2 APPROACH

2.1 GENERAL

The objective to present detailed information on the expected floods requires also detailed and accurate hydrological and hydraulic 1D2D models. Although the modeling framework is already available, the actual models are still not accurate enough to compute flooding at a detailed and local scale. The available Digital Elevation Map (DEM, available from FHM2) has a grid size of 100 meter, which is too large to compute local drainage effects and flood patterns.

During the pilot of 2011 we focus at a pilot area, named Mookervaart / Kali Angke.



Next to this, the current dashboard and modeling framework is still in a pilot phase. Therefore we have decided not to use the current hydraulic 1D2D model operationally. Instead of that we implemented a more basic approach, which we discuss in the next paragraph. This approach will be followed during the pilot phase. For the long term (final implementation) we suggest to implement a full scale, detailed model. We discuss this in the last paragraph of this chapter.

2.2 PILOT 2011

The approach for the 2011 pilot version of the Flood Control Dashboard is to optimally use currently available information and models:

- Use real-time water level monitoring data, available through the websites of PU DKI
- Add a few new real-time water level monitoring stations (see FHM2 Telemetry, pg 28/29). This will be done by Fugro, but can not be implemented in the current version of the flood mapping tools.
  To be able to improve the insight in the actual situation, we suggest to implement new gauges in the river Cengkareng at :
  - Mouth of Cengkareng FW, U/S of proposed salinity barrier (nr. 2 in picture)
  - Gate of Cengkareng FW, D/S Daan Mogot (nr. 3 in picture)

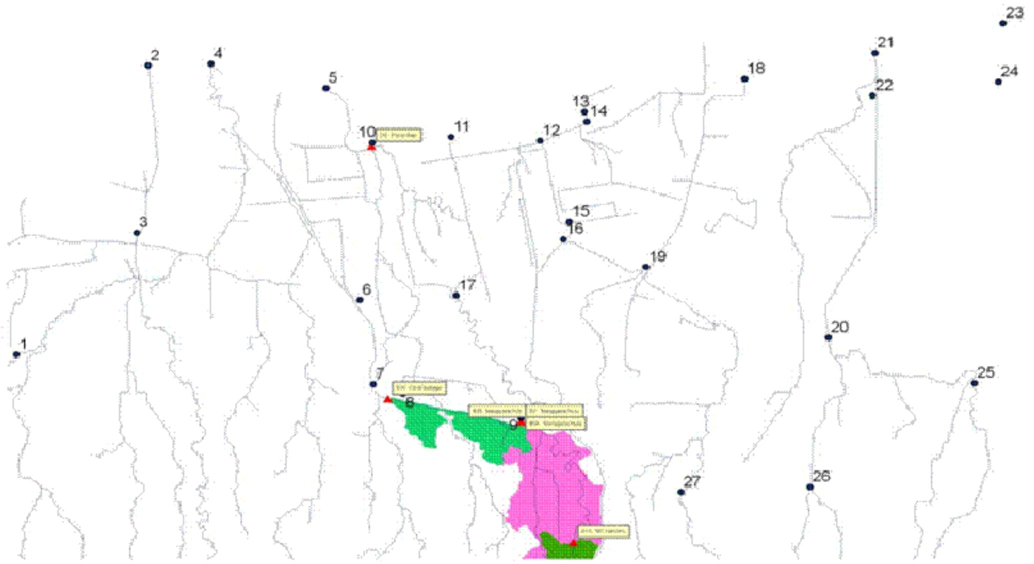


Figure 2.1 Proposed additional water level monitoring gauges (FHM2 project)

- Correlate the upstream monitored water levels to get a roughly forecasted water level at the downstream gauge Kebon Jeruk and Manggarai Hulu
- Select the best fitting flood map out of a set of 7 flood maps, ranging return periods from 1 year, 2, 5, 10, 25, 50 and 100 years. The flood maps were extracted from the available flood modeling framework.
- Also select the flood map with a lower return period (worst case): this map will be displayed in gray below the actual flood map.
- Prepare the “actual” flood map, that presents the currently expected maximum flood extent.
- Present this map in the dashboard, together with actual and forecasted water levels at the fluvial gauges.

The framework to generate the floodmaps consists of Delft-FEWS in a stand-alone configuration, that automatically imports and processes the observed water levels and generates the flood maps.

2.3 LONG TERM IMPLEMENTATION

For the long term we advise to follow the next approach:

- Use Delft-FEWS in a client-server configuration as a real-time information and modeling framework
- Run a global SOBEK 1D2D model that computes the flood extent for the whole Jakarta district.
- Run – if needed – detailed local models (e.g. at a Kelurahan scale) to compute detailed local flood maps

3 TECHNICAL IMPLEMENTATION

3.1 OVERVIEW OF PILOT FRAMEWORK

The figures below show the infrastructure of the dashboard. Figure 3.1 gives a total overview. All kind of data is provided or collected to the dashboard, where the data is validated and processed to relevant information. The information is disseminated through for example the banjironline website, iGoogle gadgets or Android apps. Currently the Dashboard is hosted at servers of HKV in Lelystad (NL).

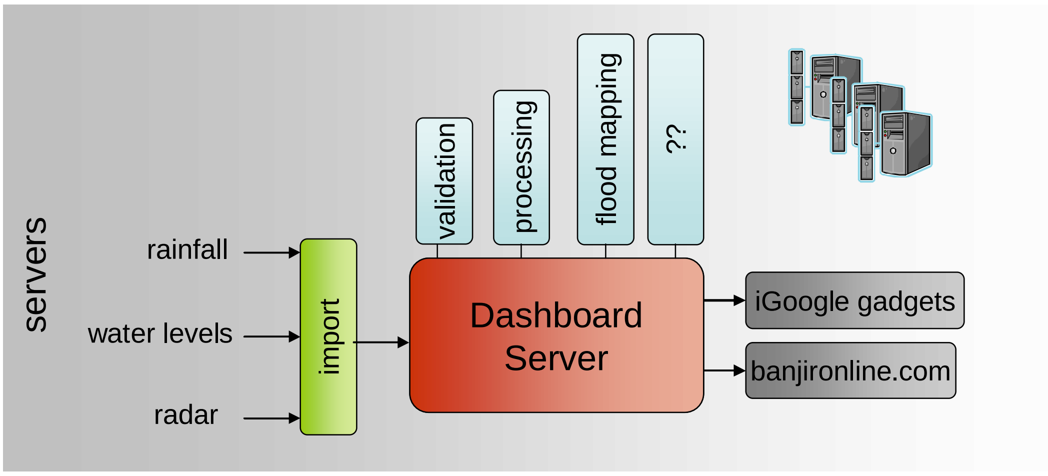


Figure 3.1 Overview of current Dashboard Framework

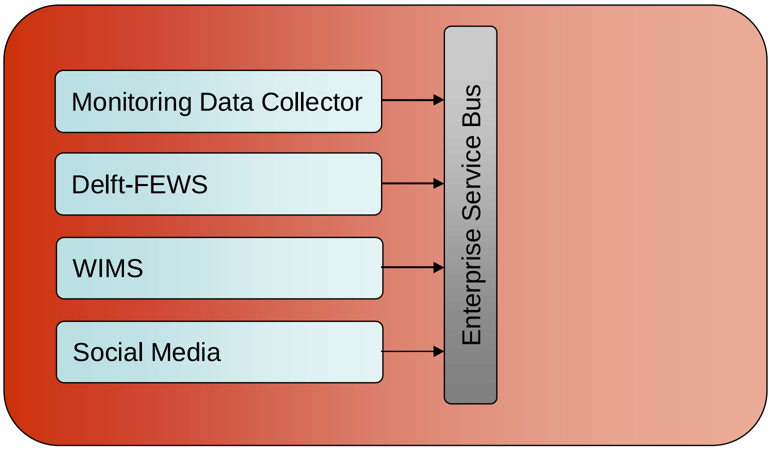


Figure 3.2 Detail of current Dashboard Framework

The core of the Dashboard (see figure 3.2) contains several modules. Relevant modules for the flood mapping tool are the Monitoring Data Collector and Delft-FEWS.

These are described in the next paragraphs.

3.2 MONITORING DATA COLLECTOR

Currently the monitoring data at the fluvial and meteorological gauges are collected through a module that continuously reads the next websites:

- http://aws-online.bmkg.go.id/bmg/login.php
- http://www.bmkg.go.id/jabodetabek6jam.bmkg
- http://www.dpudki.info/

Detailed information of this module is available through [##HKV ref##].

3.3 DELFT-FEWS

3.3.1 General

We use Delft-FEWS (Delft Hydraulics) as framework to:

- Import monitoring data (actually only water levels)
- Make an estimate of the water levels to be expected (as listed in Appendix 2)
  - o Manggarai based on Panus Depok and Katu Lampa
  - o Kebon Jeruk based on Katu Lampa, Panus Depok and Manggarai
- Compute discharges through QH relations (FHM1 report, Annex B):

Katu Lampa:

$$\text{for } 0.33 < H_{AWLR} < 1.05 : Q = 95.34(H_{AWLR} - 0.33)^{2.310}$$

$$\text{for } 1.05 \leq H_{AWLR} \leq 3.50 : Q = 76.76(H_{AWLR} - 0.27)^{2.145}$$

Panus Depok: $Q = 31.52(H - 0.160)^{1.805}$

- Selection of flood map that fits best to the actual situation.
- Export to dashboard service bus:
  - o PI XML file with timeseries of forecasted water levels and discharges.
  - o HTML files with graphs of observed and forecasted water levels and discharges
  - o PNG of expected flood map (with background map)
  - o In future (fall of 2011) a PNG file with expected flood map (without background map) to be used as overlay on dynamic map server, like Google Maps. Currently this functionality is not available in Delft-FEWS, but will be implemented.

3.3.2 Configuration

The stand-alone configuration contains the following locations:

- PU DKI Water level gauges (see appendix 1)
- Forecast locations for the pilot: Kapuk Selatan Pump station and Kebon Jeruk

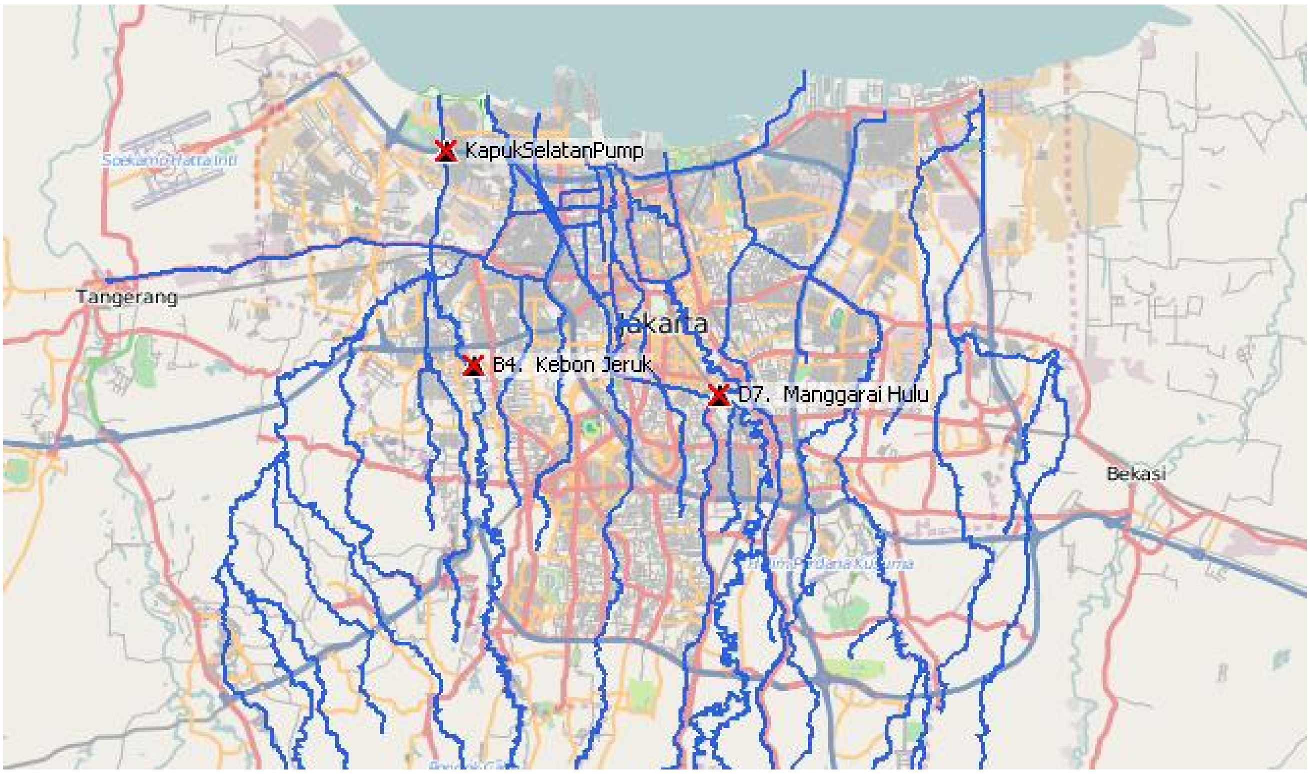


Figure 3.3 Water level forecast locations

For each location water levels for several return periods are extracted from the available flood modeling framework. These levels now form the threshold levels which show the severity of a (forecasted) water level.

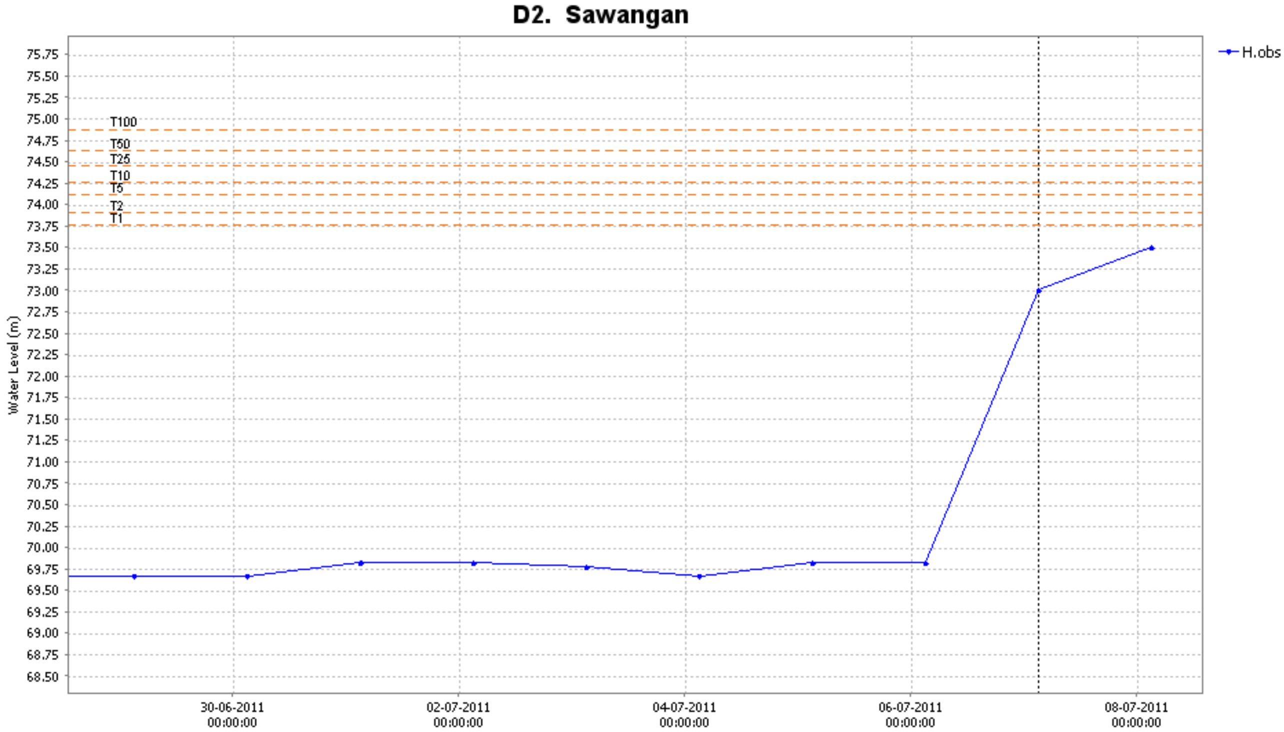


Figure 3.4 Levels for different return periods

The configuration contains one main workflow: “Forecast”. It performs the following tasks:

Task	Description
IMPORTPUDKI	Import water level measurements from PU DKI website
TRANSFORMATIONS	Calculates discharges base don QH relations
TRANSFORMATIONS_FORECAST	Calculates expected water levels based on correlations
WATERLEVELCORRELATION	Selects the correct flood map based on expected water levels
EXPORTMAP	Exports the flood maps to png files.

The workflow “Forecast” can be started outside of FEWS by executing …`\FEWS\JFM\Workflowbatch\Auto_generate_inundationmap.bat`, for example by the Windows Task Scheduler. The tasks performed are explained in the following paragraphs.

3.3.3 Import and processing of data

Delft-FEWS reads the water level measurements from data files that are in PI file format. The files should be put in the folder:
…`\FEWS\JFM\Import\PUDKI`

After reading the files, the datafiles are moved to a backup folder:
…`\FEWS\JFM\ImportBackup\PUDKI`

The water level measurements are imported as a non-equidistant timeserie.

The external location ID's are saved in column "IDMAP" in the locations table (gauges.dbf). Using this table the external ID's are mapped to the ID's used within FEWS. The external parameter ID is "waterlevel", while the internal parameter ID is "H.obs". The mappings are described in
…\FEWS\JFM\Config\IdMapFiles\IdImportDKI.xml

The water levels are measured against a local datum. In the import they are not converted to global (Indonesian) datum. But when displayed in graphs, the water levels are shown in global datum. For each location the level of the local datum is stored in the locations table (gauges.dbf), column "Z".

After the import of the measured water levels, discharges are calculated for Manggarai Hulu and Panus Depok (see paragraph 3.3.1). The configuration is stored in
…\FEWS\JFM\Config\ModuleConfigFules\Transformations.xml

3.3.4 Forecast

In the forecast task, for three locations forecasted water levels are calculated based on five correlations. The correlations are described in Appendix 2. The configuration is stored in
..\FEWS\JFM\Config\ModuleConfigFules\Transformations_forecast.xml. The tables in which the correlations are stored, can be found in:
..\FEWS\JFM\Config\CoefficientSetFiles\HH_relaties.xml

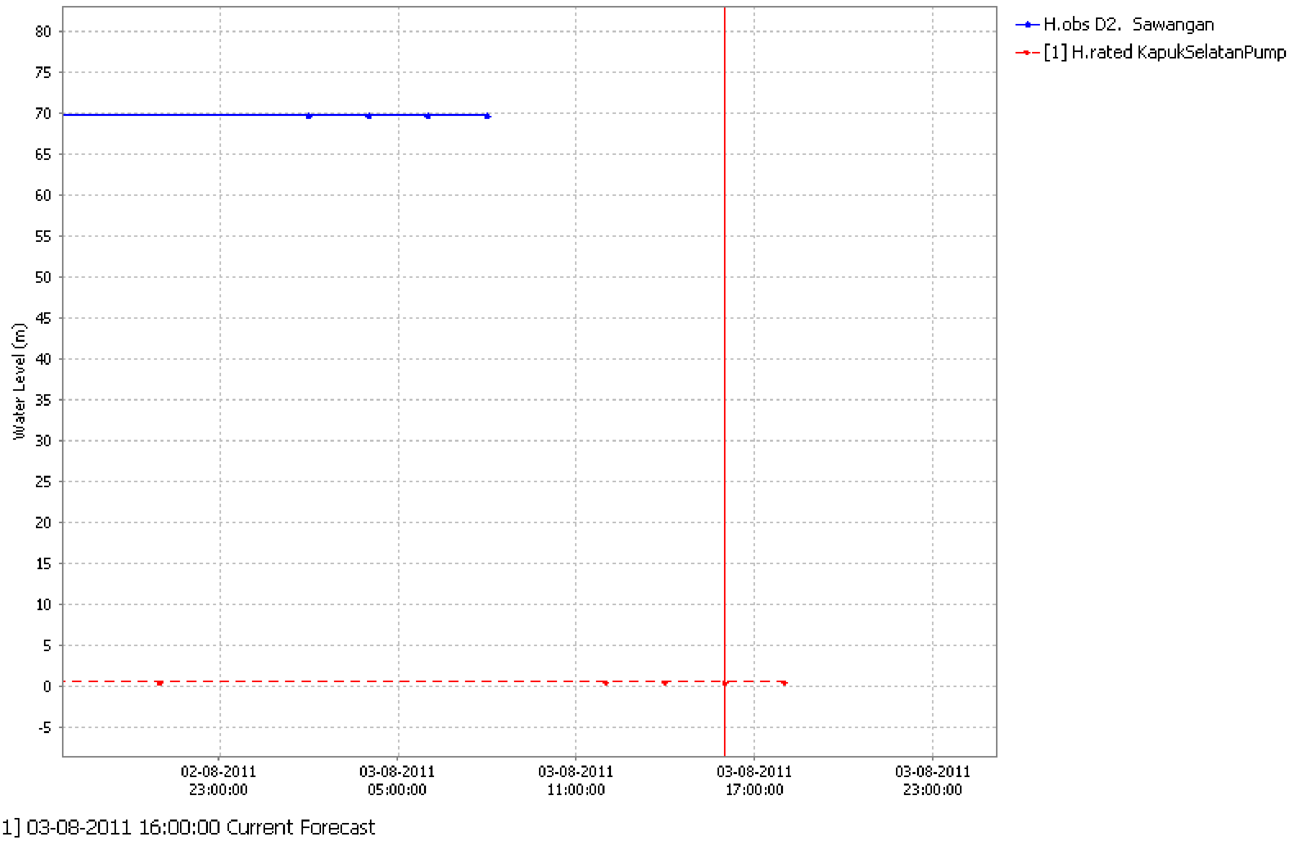


Figure 3.5 Water level measurements at Sawangan and water level forecast at Kapuk Selatan based on correlation (with a delay).

The forecasted water levels at Kapuk Selatan and Maggarai Hulu are used to select flood maps for Mookervaart and for Ciliwung. The selection of the flood map takes place within a separate module, named "WaterLevelCorrelation". Exported to the module are the timeseries with water level forecasts, and returned to FEWS are flood maps for both areas, for each time step. In the table below for both locations the water level ranges are shown for which a flood map is selected. If a forecasted water level is below the first minimum level, no flood level is returned. For each timestep in the output timeseries a flood map is returned.

InundationCorrelation (2)

	LocationID	OutputLocation	OutputParameter	Prefix	InundationCorrelationLevel	MinLevel	MaxLevel	InputMap
1	D7. Manggarai Hulu	SOBEK_mang	H.simulated.forecast	Mang	1	8.654143	8.86701	SOBEK_mang_T1.asc
					2	8.86701	9.079877	SOBEK_mang_T1.asc
					3	9.079877	9.381204	SOBEK_mang_T2.asc
					4	9.381204	9.577497	SOBEK_mang_T5.asc
					5	9.577497	9.809988	SOBEK_mang_T10.asc
					6	9.809988	9.939548	SOBEK_mang_T25.asc
					7	9.939548	10.11426	SOBEK_mang_T50.asc
					8	10.11426	20	SOBEK_mang_T100.asc
2	KapukSelatanPump	SOBEK_all	H.simulated.forecast	All	1	2.163453	2.204889	SOBEK_all_T1.asc
					2	2.204889	2.246325	SOBEK_all_T1.asc
					3	2.246325	2.317703	SOBEK_all_T2.asc
					4	2.317703	2.38294	SOBEK_all_T5.asc
					5	2.38294	2.477196	SOBEK_all_T10.asc
					6	2.477196	2.717031	SOBEK_all_T25.asc
					7	2.717031	2.770674	SOBEK_all_T50.asc
					8	2.770674	10	SOBEK_all_T100.asc

3.3.5 Report generation

In the report task the flood maps are exported. There is both for Mookervaart and for Ciliwung a map export. The maps are saved as png files in the folder `..\FEWS\JFM\Reports`. For the maps an extent is chosen that fits the selected are best. Because of the characteristics of OpenStreetMaps (used as backgroundmap), it is not possible to precisely define the extent. Next to the actual flood levels, also a worst case flood is drawn in the maps in grey.

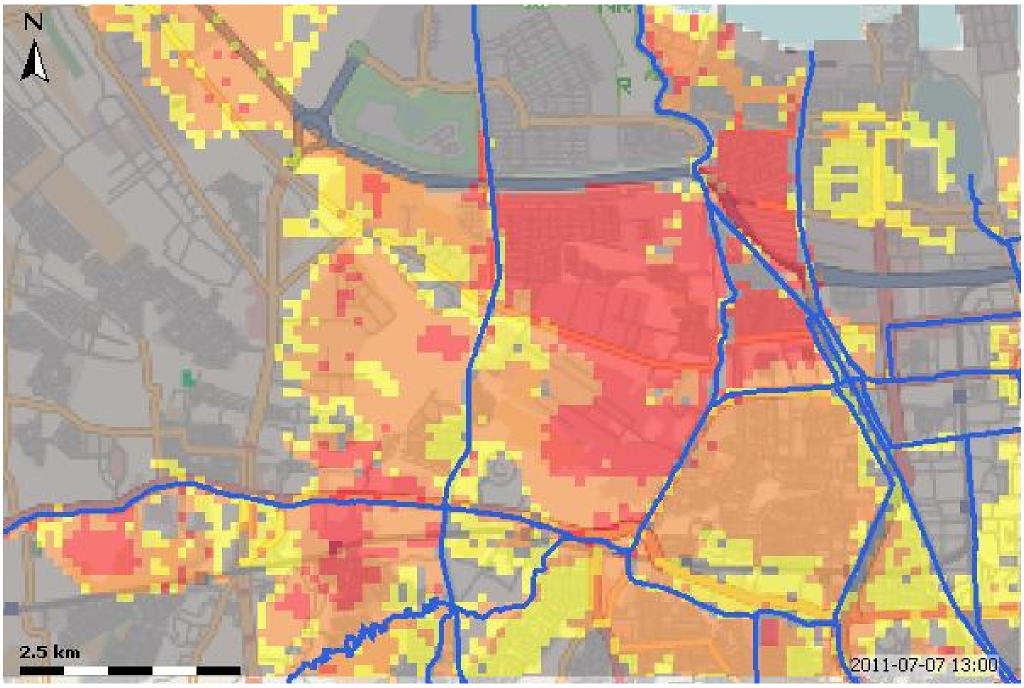


Figure 3.6 Example of an flood map as exported by FEWS for Mookervaart

3.4 DASHBOARD COMPONENT

The exported flood maps can be viewed in one of the app of the BanjirOnline dashboard. The gadget shows the forecasted flood level in the area.

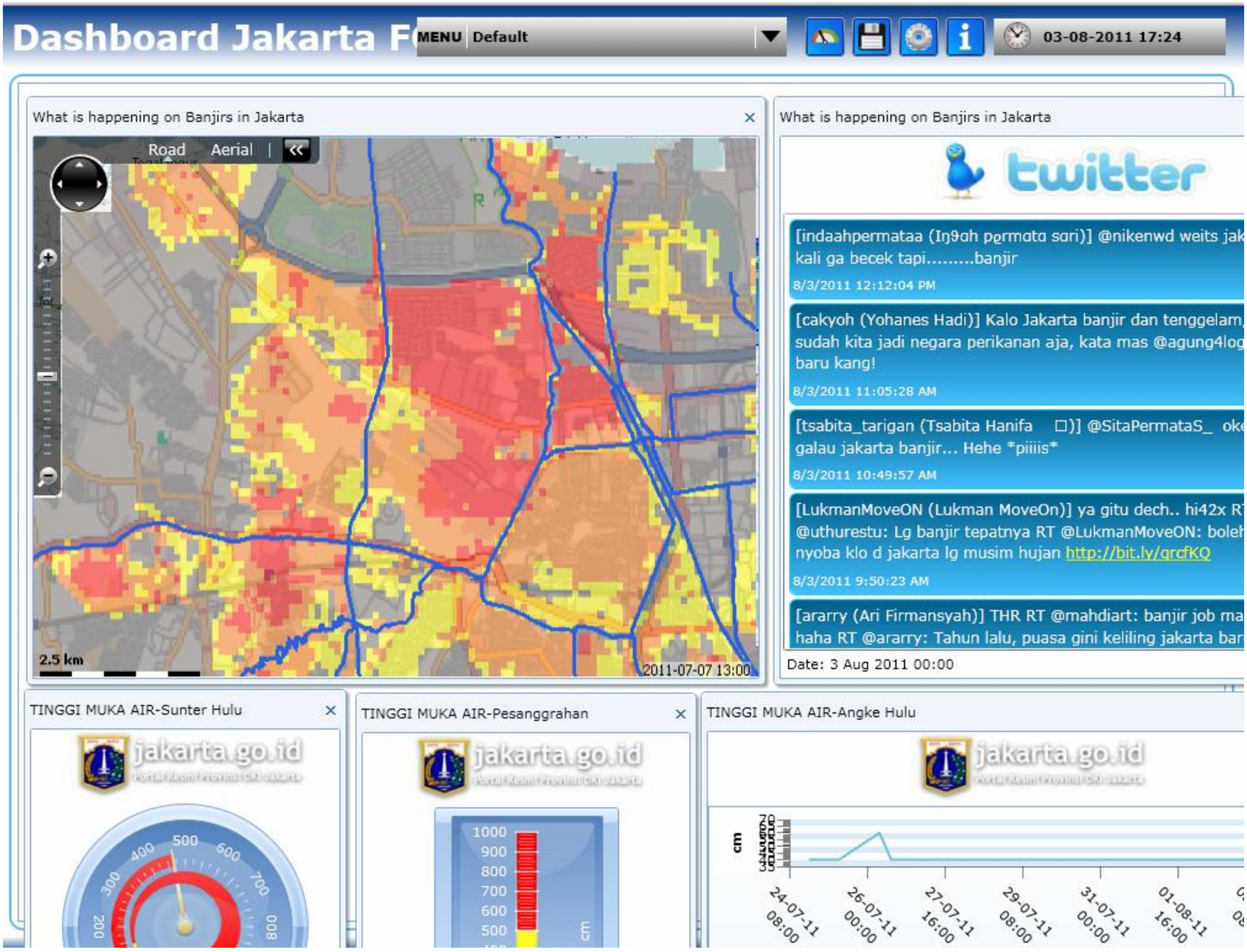


Figure 3.7 Dashboard Jakarta FC2015 including the flood mapping app.

4 ACCURACY AND SCOPE

4.1 ACCURACY

The current pilot implementation of the flood mapping control in the Dashboard is based on available monitoring data and correlated water level forecasts. The flood mapping is done by selecting a pre-simulated flood map that best fits to the actual situation. Currently a more detailed approach is not feasible.

This means that:

- monitoring data is only available at a daily timestep through internet website of PU DKI. As the catchment is fast responding and travel times are short, this will be not accurate.
- Water level forecast is done by correlations of monitored water levels. No rainfall monitoring data, rainfall-runoff modelling and hydraulic modelling is performed yet. This means that the forecasted levels are only a rough estimate.
- The largest forecast period is 13 hours. This means that, by a daily timestep, for half a day there is no forecast available.
- Flood mapping is done by a selection of the best fitting flood map out of a set of 7 available floodmaps. The presented flood map is only one of these floodmaps. No verification is done with the actual situation and flood extent.
- The presented flood map is only a map that presents the maximum extent of the flooding. No flood mapping during a period of days (an animation) is provided.

4.2 SCOPE OF PRACTICAL USE OF THE FLOOD MAP DASHBOARD CONTROL

The above mentioned accuracy makes that the current flood mapping control at the dashboard should not be used operationally. It should only be used for demonstration purpose. At best, the presented flood maps should be used to get a rough idea of what could be expected.

5 POSSIBLE IMPROVEMENTS

5.1 GENERAL

From the previous chapter it is clear that lots of improvements are required and possible. These will be discussed in this chapter.

5.2 FLOOD MAPPING IMPROVEMENTS

We see the next possible improvements for the flood extent mapping tool. They are listed in sequential order as most of the improvements require that the beforementioned improvement is effectuated.

- The actual datafeed of water level monitoring data is done via an internet website of PU DKI. This approach should be changed to a continuously reading and feeding monitoring system
    - Add at least the Kebon Jeruk station to the datafeed.
    - Record the waterlevels with a frequency of preferably 15 minutes.
    - Provide these through an automated service to the Dashboard and within that, Delft-FEWS
- Install and maintain automatic water level recorders and rain gauges. See report FHM2 – Telemetric system for suggested new monitoring stations. For the pilot area at least the next stations are preferred:
    - Mouth of Cengkareng FW, U/S of proposed salinity barrier
    - Gate of Cengkareng FW, D/S Daan Mogot
- Add radar reflection information to have detailed information on the spatial and temporal distribution of the rainfall.
- Make use of a full scale flood modelling framework like SOBEK to simulate actual and forecasted hydraulics and flooding. This modelling framework can be included in the Delft-FEWS framework.

5.3 OTHER IMPROVEMENTS

The next step from calculating accurate flood levels is to present them to the public and to professional organizations. The dashboard is one means of disseminating information, but this can only be displayed on desktop computers. In Jakarta most people use smartphones for accessing internet data: the flood information should therefore also be viewable on smartphones. Therefore a mobile framework could be added to the dashboard framework. This could consist of, for example, iGoogle gadgets, or lightweight Android and Iphone apps.

6 CONCLUSIONS

The demonstration Flood mapping App, as integrated in Dashboard BanjirOnline, is a good example of how to present simple flood maps to the general public. The development shows that, for a realistic flood forecast and mapping, more measurement data are required and implementation of hydraulic models is necessary. The aim of the demonstrator was to get experience with calculating and presenting flood maps for Jakarta, and that goal is reached. The inundation maps are added as app to the FC2015 dashboard and with that the dashboard contains one more example of the many uses of the dashboard.

7 LITERATURE

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H.J.M. Ogink, G.F. Prinsen, E. Verschelling, Hydrology & Hydraulics - Model Development, Flood Hazard Mapping 2, Jakarta Flood Management 2, Partners for Water, March 2009, Deltares, project Q4743

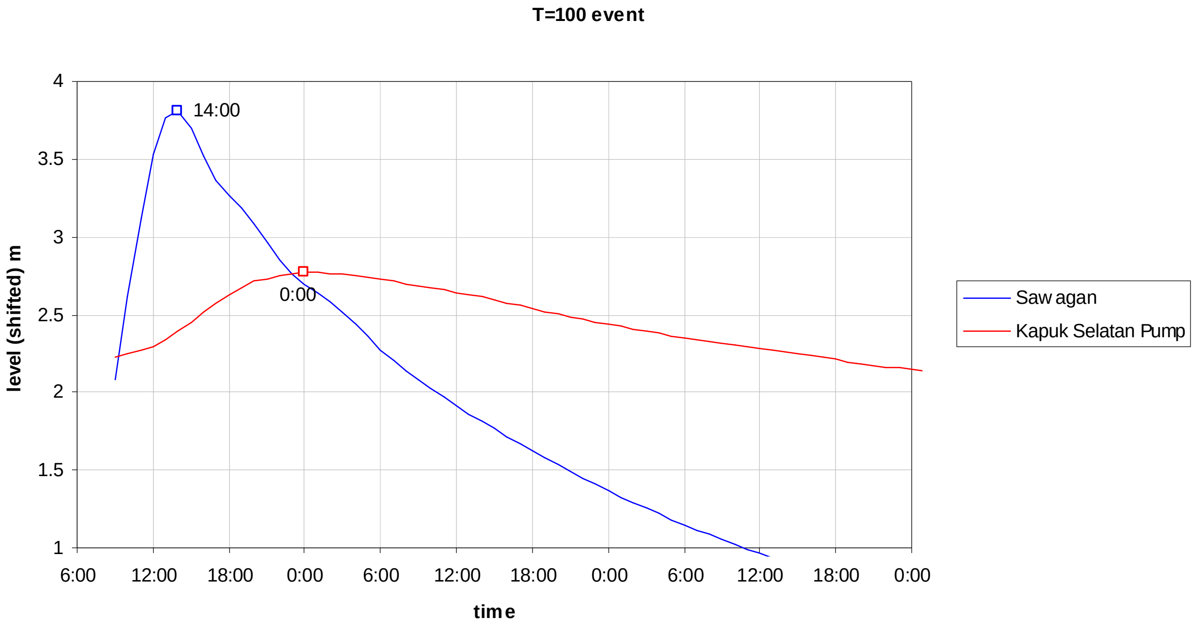
LIST OF FLUVIAL GAUGES

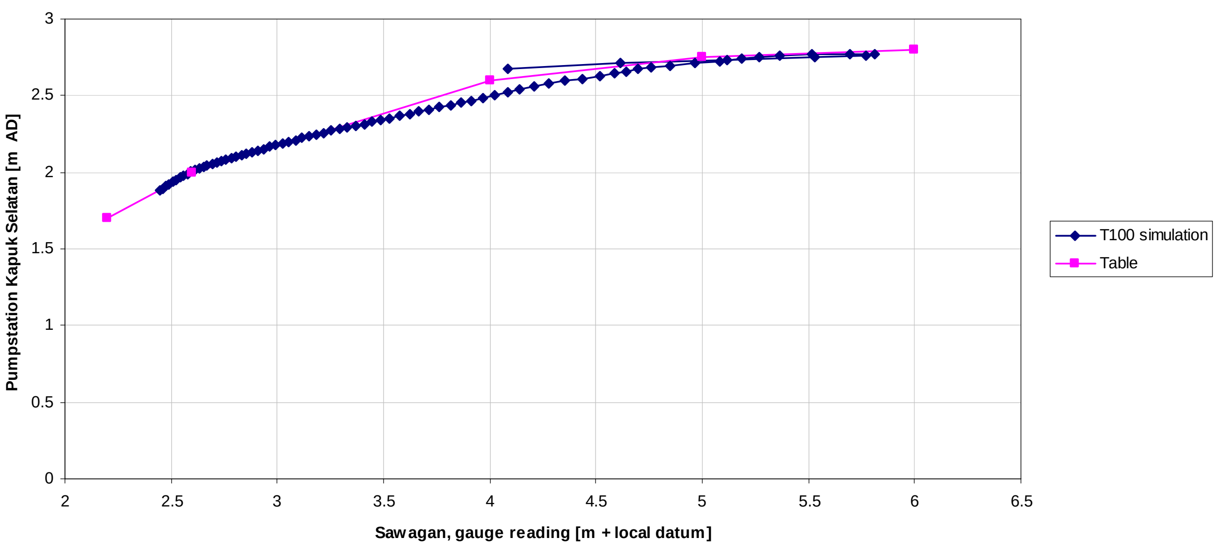
Station	River	Operator	Lat	Long	Ref.level
B2. Sawangan	Pasanggrahan	Balai Besar	-6.397250000	106.7717667	69.071
B3. Tanah Kusir	Pasanggrahan	Balai Besar	-6.254933333	106.7687000	0.000
B4. Kebon Jeruk	Pasanggrahan	Balai Besar	-6.197616667	106.7628000	-0.369
B5. Margasatwa	Krukut	Balai Besar	-6.311666667	106.8055500	0.000
B8. Cibogo	Ciliwung	Balai Besar	-6.657833333	106.8790500	0.000
B10. Katu Lampa	Ciliwung	Balai Besar	-6.633683333	106.8385333	366.990
B11. Panus Depok	Ciliwung	Balai Besar	-6.400483333	106.8318000	68.671
B12. Sugu Tamu	Ciliwung	Balai Besar	-6.374316667	106.8412000	0.000
B13. MT Haryono	Ciliwung	Balai Besar	-6.242716667	106.8624333	14.375
B14. Manggarai Hulu	Ciliwung	Balai Besar	-6.207500000	106.8486500	-1.239
B15. Manggarai Hilir	West Banjir Canal	Balai Besar	-6.207500000	106.8486500	0.000
B16. Karet barrage	West Banjir Canal	Balai Besar	-6.200916667	106.8139167	-0.980
B18. Pondok Gede	Sunter	Balai Besar	-6.283566667	106.9086833	0.000
B19. Sunter Hilir	Sunter	Balai Besar	-6.223133333	106.8936167	0.000
D1. Ciledug Indah	Angke Hulu	PP-DKI	-6.222233333	106.6960000	0.000
D2. Sawangan	Pasanggrahan	PP-DKI	-6.397200000	106.7718333	69.071
D3. Ciganjur	Krukut	PP-DKI	-6.344000000	106.7989167	0.000
D4. Cibogo	Ciliwung	PP-DKI	-6.657833333	106.8790500	0.000
D5. Katu Lampa	Ciliwung	PP-DKI	-6.633683333	106.8385333	366.990
D6. Panus Depok	Ciliwung	PP-DKI	-6.400483333	106.8318000	68.671
D7. Manggarai Hulu	Ciliwung	PP-DKI	-6.207500000	106.8486500	-1.239
D8. Pasar Ikan	Coast/Java Sea	PP-DKI	-6.126816667	106.8093333	-0.615
D10.Pondok Ranggon	Sunter Hulu	PP-DKI	-6.317983333	106.9209167	0.000

APPENDIX 1 : HYDRAULIC CORRELATIONS

Pump station Kapuk Selatan from Gauge Sawagan (Pesanggrahan)

Average travel times during floods: 10 hours

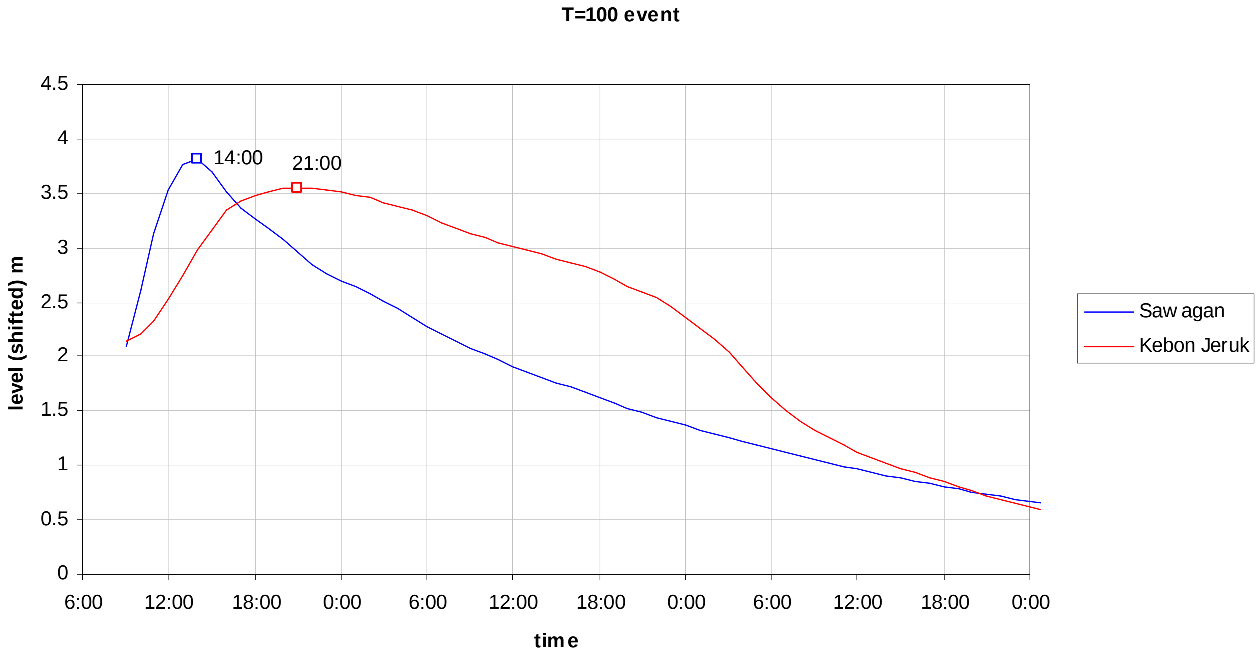


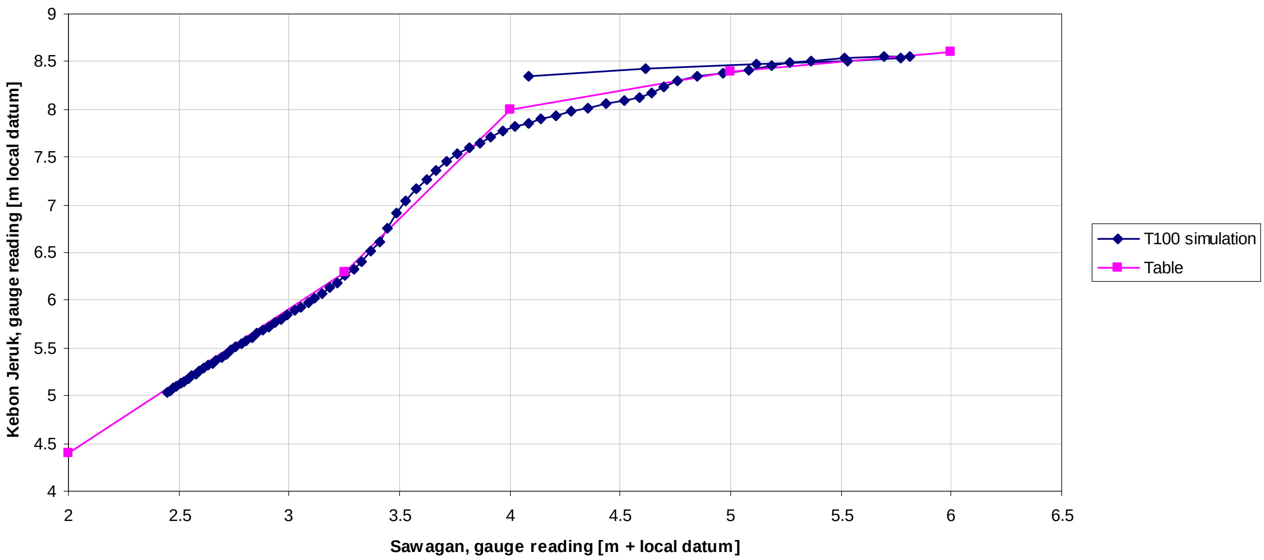


Sawagan (ref=69.071 m MSL)	Pump station Kapuk Selatan (MSL)
2.2	1.7
2.6	2
4	2.6
5	2.75
6	2.8

Kebon Jeruk from Gauge Sawagan (Pesanggrahan)

Average travel times during floods: 7 hours

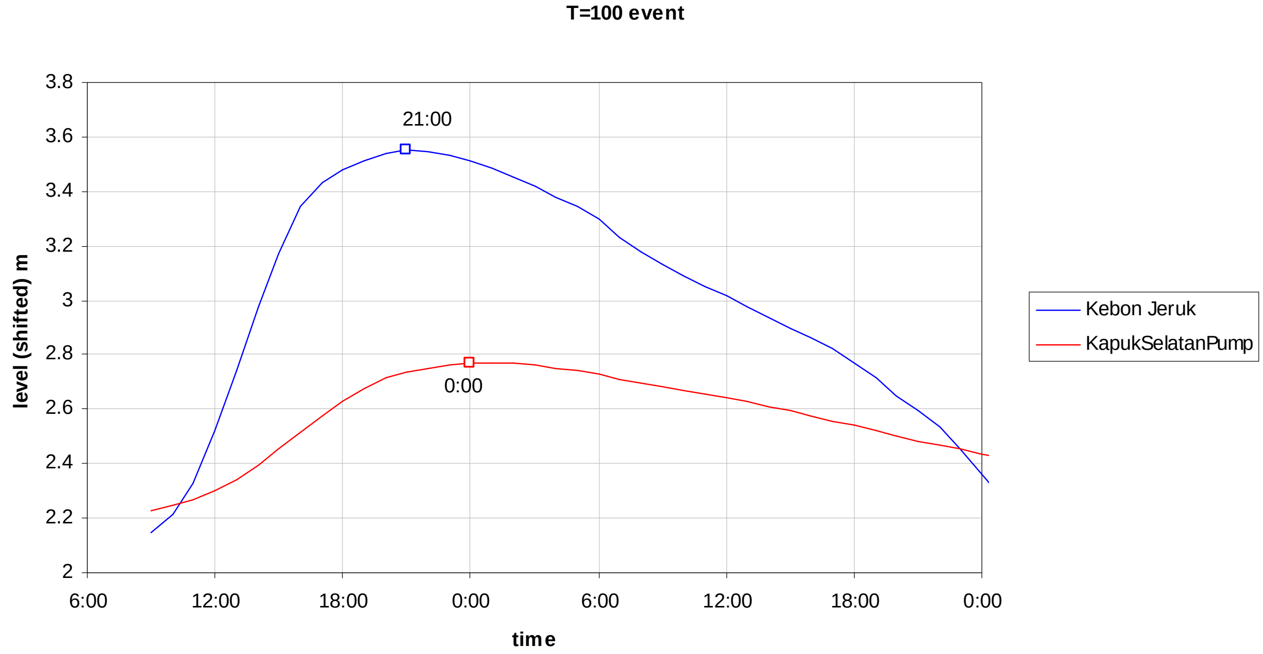


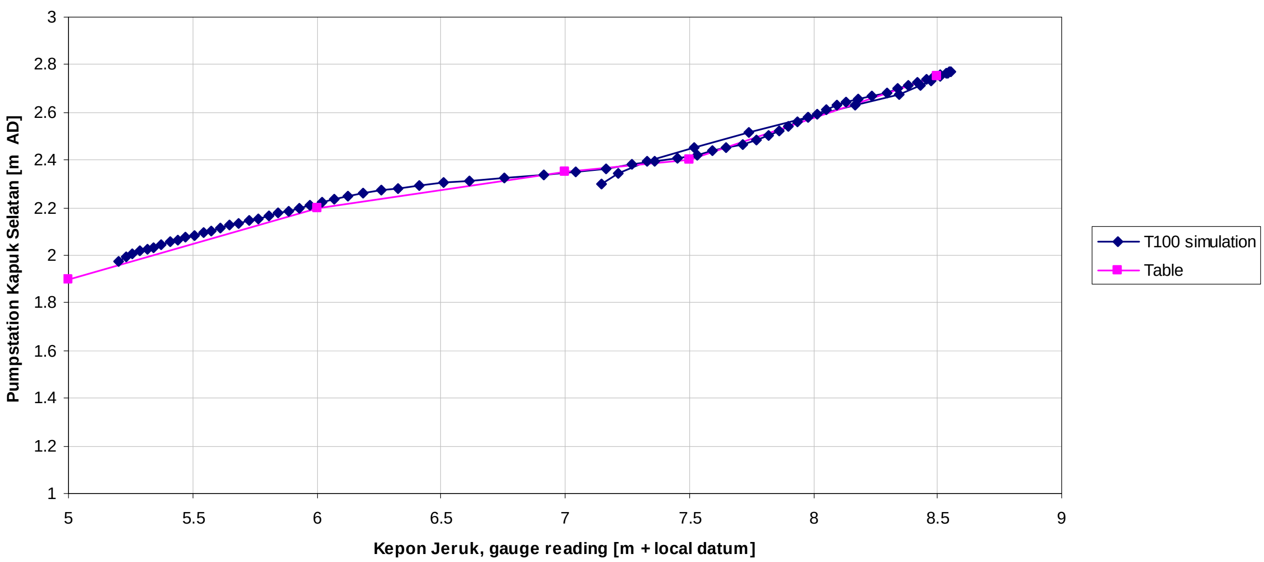


Sawagan (ref=69.071 m MSL)	Kebon Jeruk (ref=-0.369 m MSL)
2	4.4
3.25	6.3
4	8
5	8.4
6	8.6

Pumpstation Kapuk Selatan from Kebon Jeruk

Average travel times during floods: 3 hours

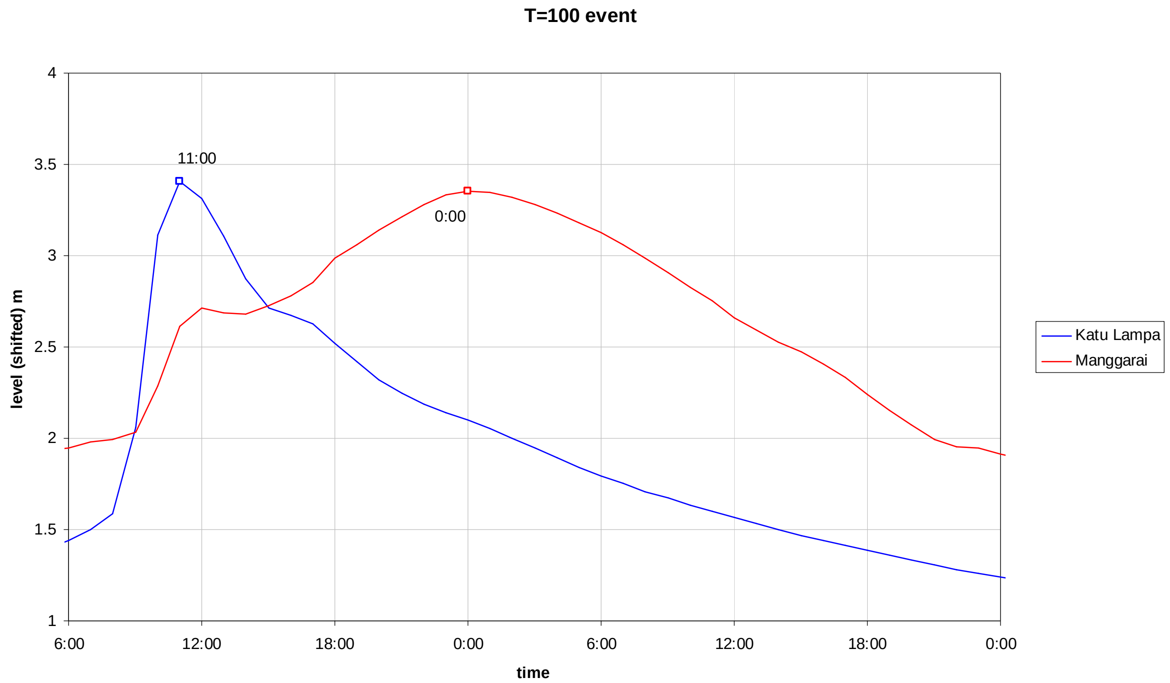




Kebon Jeruk (ref=-0.369 m MSL)	Pump station Kapuk Selatan (MSL)
5	1.9
6	2.2
7	2.35
7.5	2.4
8.5	2.75

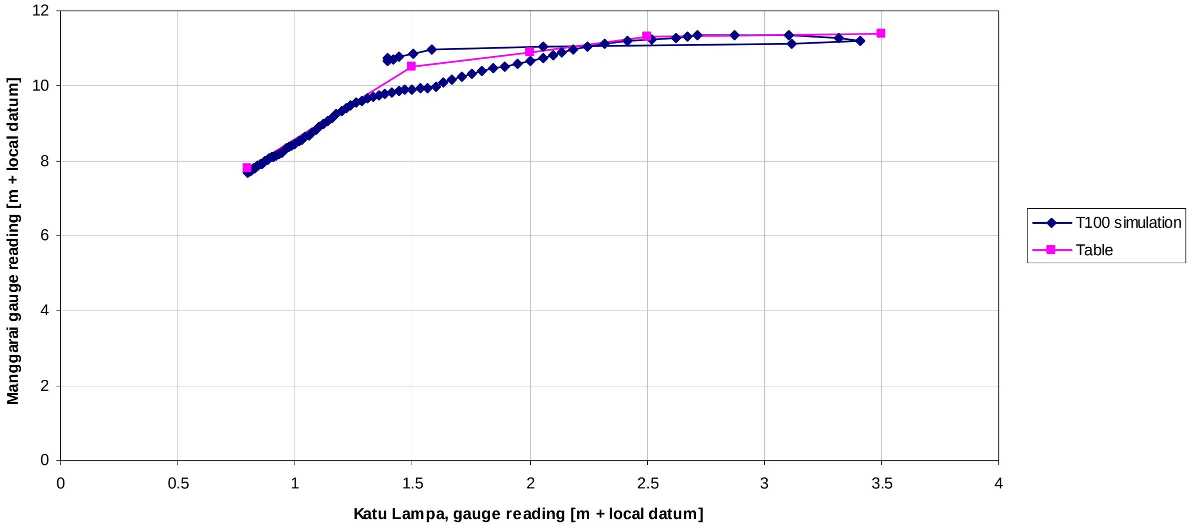
Manggarai from Katu Lampa

Average travel times during floods: 13 hours



Travel times correspond with FHM2 study (table 8.2, page 24)

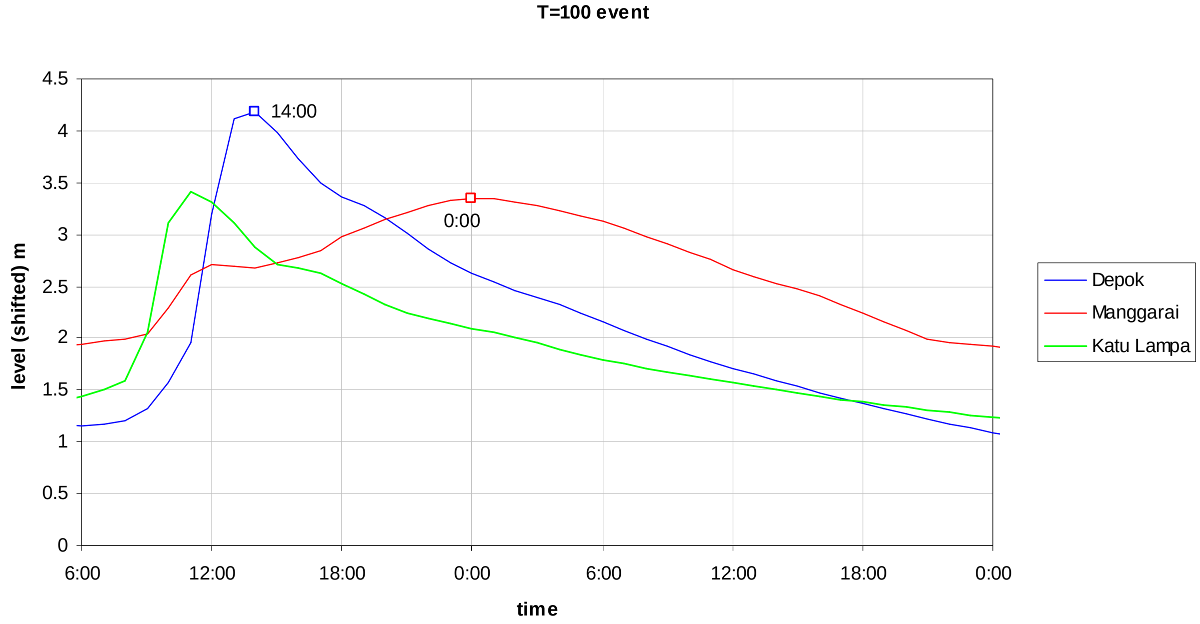
	Reach Distance (km)	Travel time (hrs)
Katu Lampa – Depok	41	3-4
Depok – MT Haryono	40	8
MT Haryono - Manggarai	1.8	2
Total:		13-14

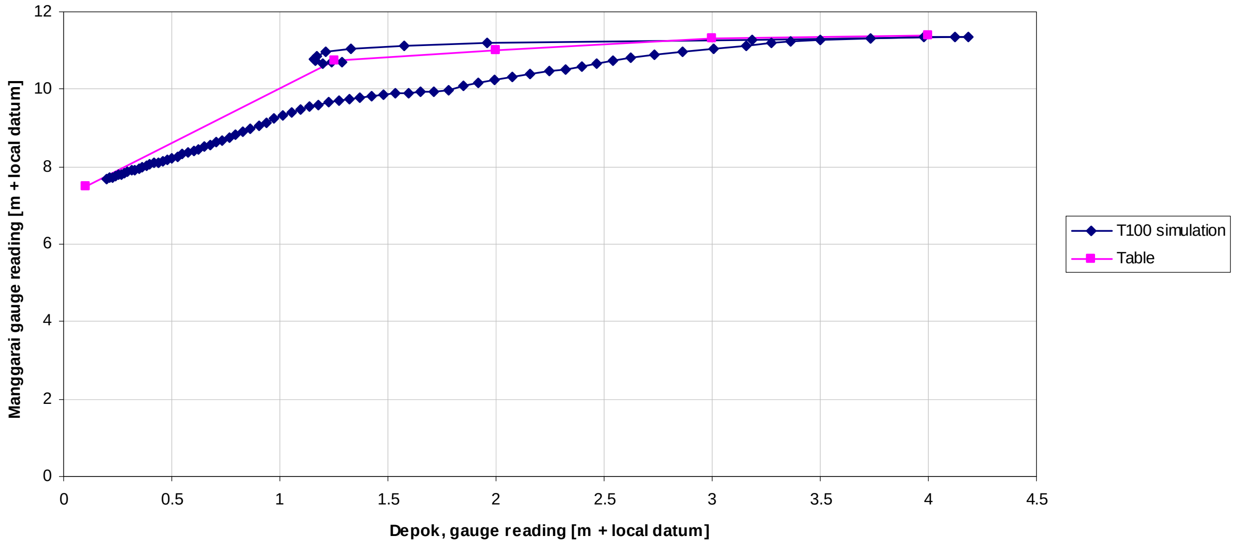


Katu Lampa (ref=-366.99 m MSL)	Manggarai (ref=-1.2385 m MSL)
0.8	7.8
1.5	10.5
2	10.9
2.5	11.3
3.5	11.4

Manggarai from Panus Depok

Average travel times during floods: 10 hours (See also the abovementioned table 8.2 from FHM2)

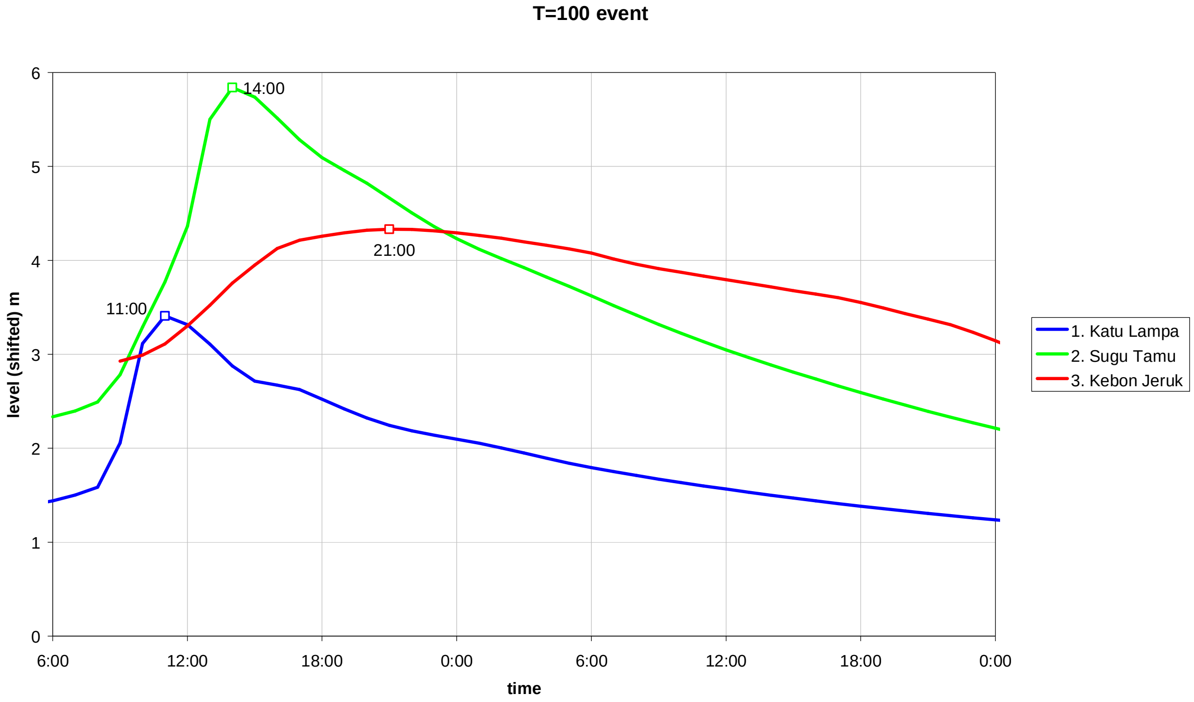


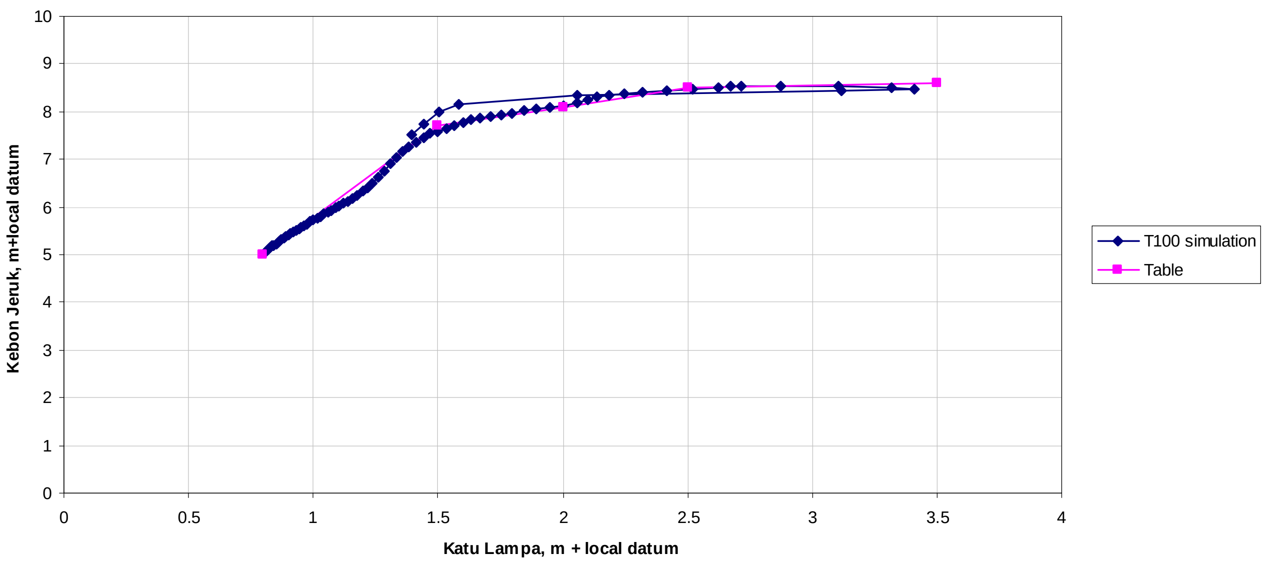


Panus Depok (ref=55.00 m MSL)	Manggarai (ref=-1.2385 m MSL)
0.8	5
1.5	7.7
2	8.1
2.5	8.5
3.5	8.6

Kebon Jeruk from Katu Lampa

Notice that Kebon Jeruk is only from a parallel river and is not influenced by Katu Lampa directly.
Average travel times during floods: 12 hours





Katu Lampa (ref=-366.99 m MSL)	Kebon Jeruk (ref=-0.369 m MSL)
0.8	5
1.5	7.7
2	8.1
2.5	8.5
3.5	8.6