DUPC2 Deliverable

Enabling the assessment of alternative water supply systems to promote urban water security in the Global South (AltWater)

Water supply and demand in Surabaya, Indonesia: current situation and future scenarios

Janez Sušnik (IHE Delft), Adhi Yuniarto (ITS Surabaya), Wahyono Hadi (ITS Surabaya), Saroj Sharma (IHE Delft), Assela Pathirana (IHE Delft), Andres Cabrera (IHE Delft), Klaas Schwartz (IHE Delft), Françoise Bichai (IHE Delft and Polytechnic School of Montreal)

Executive Summary

Many cities in the global South are rapidly expanding, already facing water stresses, with the poorest often lacking access to reliable and safe water. There is a clear need to improve the sustainable sourcing and use of water in cities to secure supply in view of depleting resources, growing demands, and climate change pressures in the long term. Resilience to future change can be increased through diversification of supply sources. Alternative water supply systems represent an important opportunity in this respect.

The first stage of AltWater involves assessing the current and potential future water supply and demand situation (and thereby quantifying water balances) in AltWater Leader Cities (Maputo and Surabaya). Understanding current situations, and having an idea as the medium-term developments, is critical in water resources and water supply planning. This report presents the baseline and potential future assessments for Surabaya, Indonesia. It will form the critical basis for the work to be carried out in later stages of the project concerned with the identification and assessment of potential alternative water supply solutions, and their contribution to addressing current and future water shortage issues in the city.

The water system in Surabaya is fairly advanced, supplying water to almost all residents. However, the water resources used to supply Surabaya are becoming unsustainably used, all being nearly totally utilised. Expected population growth, lifestyle changes and expansion of commercial activities in Surabaya is expected to put increasing pressure on the resources and the supply system. At the same time, the current network, while extensive, is in places very old leading to high non-revenue water volumes.

At present, there is an apparent water supply-demand deficit in Surabaya of about 5 500 000 m^3 yr^{-1}. It is possible that some of this deficit is fulfilled with private vendors and through non-piped water supplies. Forecasts of supply and demand to 2030 suggest that the supply-demand gap will be closed through increasing supply and reducing non-revenue water. It is unclear where the extra supply will come from. Achieving the NRW reduction in full could be ambitious, and will require funding, capacity and political support.

Alternative water supply sources such as from rainwater harvesting, stormwater harvesting and wastewater collected, treatment and re-use could prove useful in helping to close the supply-demand gap and in reducing the pressure that the current traditional supplies are facing. Such water sources would expected to be used for non-potable uses.

By using alternative water supplies for traditionally non-potable water uses that currently consume potable resources, the demand on traditional water supplies is lowered, freeing up freshwater for a number of purposes including expanding potable service delivery and for ecosystem services.

Which alternative water supply systems would be feasible, affordable and acceptable in Surabaya, how much water they could *potentially* contribute, and how much water they might *realistically* contribute (which is a function of implementation and uptake depending on a wide range of factors) is still a matter of research, and is something that AltWater will actively investigate at later stages in the project.

Table of Contents

1. Introduction

Many cities in the global South are rapidly expanding, and already face water stresses, with the poorest often lacking access to reliable and safe water. There is a clear need to improve the sustainable sourcing and use of water in cities to secure supply in view of depleting resources, growing demands, and climate change pressures in the long term. Resilience to future change can be increased through diversification of supply sources. Alternative water supply systems represent an important opportunity in this respect.

AltWater will investigate ways to increase the self-reliance and sustainability of cities in the global South with regard to water supply by relieving pressure on traditional sources through the implementation of alternative water systems (for example rainwater harvesting, wastewater reuse, desalination). With partner cities in Mozambique and Indonesia, AltWater will develop a tailor-made approach in each city to evaluate the potential of alternative systems to contribute to urban water supply and security. Assessment of site-specific aspects of potential systems, including yield (water volume) and reliability, cost, institutional and socio-environmental factors across the city area will be carried out.

AltWater will address an important gap in the development and uptake of alternative water systems, which lies in the lack of assessment frameworks for these schemes. This project adopts a novel "Leader-Follower" City approach whereby Maputo and Surabaya are designated as leader cities. These two cities will then become primarily responsible for developing and training capacity in the Follower City (Beira and Gresik respectively). Local partners will gain knowledge and expertise in alternative supply assessment and planning through participation in the research. Collaboration and knowledge exchange between partners will be strengthened, increasing capacity and networks.

The first stage of the project involves assessing the current and potential future water supply and demand situation (and thereby quantifying water balances) in AltWater Leader Cities (Maputo and Surabaya). Understanding current situations, and having an idea as the medium-term developments, is critical in water resources and water supply planning. This report presents the baseline and potential future assessments for Surabaya, Indonesia. It will form the critical basis for the work to be carried out in later stages of the project concerned with the identification and assessment of potential alternative water supply solutions, and their contribution to addressing current and future water shortage issues in the city.

2. Case study setting and description

Indonesia is located in east-Asia (Figure 1). It covers about 1 910 931 km^2, and has a population of 260 581 000 (in 2016; http://data.un.org). Indonesia experiences a typical tropical climate. Rainfall is fairly uniform through the year, but with peaks in December-January and again in March-May, coinciding with monsoon season. Average annual rainfall across all Indonesia is c. 2800 mm. However, there is considerable variability around this average, with some regions receiving over 5000 mm yr^{-1}, while some receive around 1000 mm yr^{-1} (Suprapto, 2002).

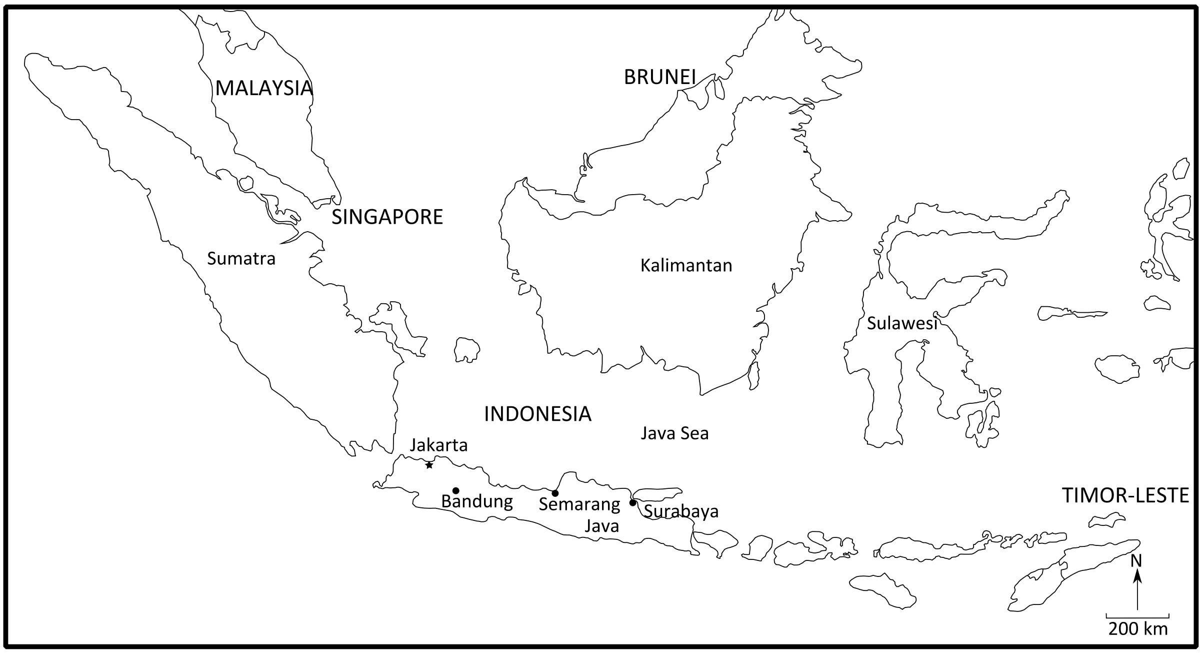

Figure 1: map showing Indonesia and the location of Surabaya. Gresik (the follower city) lies just west of Surabaya. Note: Papua lies off the east of the map. Numerous smaller islands are not shown.

Due to its substantial annual rainfall totals and topography, Indonesia has an abundance of surface and groundwater sources which are exploited for water supply for numerous economic sectors. It has over 8000 watersheds, managed in 131 river basins (Asian Development Bank, 2016). It is reported that only about 10% (on average) of rainfall infiltrates to groundwater (Suprapto n.d.), meaning that most water resources are surface water. This translates to a large potential resource if managed well. The average cumulative water resources across all Indonesian islands are estimated at 3 906 476 x 10^6 m^3 yr^{-1} (Asian Development Bank, 2016). Indonesia has an average of 55 m^3 cap^{-1} water stored in reservoirs across the nation, with plans to grow this capacity in the near future. However, rising water demand, inappropriate land management, erosion, population growth, groundwater overexploitation and inefficient irrigation practices mean that certain parts of Indonesia experience water supply problems (Suprapto n.d.). However, there are numerous water resources development and management policy initiatives in place in an attempt to remedy the situation including: water conservation measures, reforestation, promoting efficient agriculture practices and anticipating and adapting to the challenges of climate change. In addition to water quantity challenges, many Indonesian basins suffer from water quality issues, leading to high treatment costs. In addition, it is projected that between 2013 and 2020, the Indonesian population will grow by 15 million, with an increasing trend towards urbanisation (Asian Development Bank, 2016). This increase will lead to expected increases in water demand across all sectors, further stressing the water resources.

Against this context, Surabaya (Figure 2), lying in the east of the island of Java, has a population of 2.7 million (2010 census data; www.data.un.org). Surabaya has an average annual rainfall of c. 1650 mm, with December-April being very wet months and July-September being very dry. Surabaya covers an area of 330 km^2. Surabaya is a major services and infrastructure hub in Java, and is being developed as a conference and meeting centre (ITS, 2017. *Pers. Comm.*). The river Kalimas splits the city, and is used for water supply and for recreation.

Figure 2: map of Surabaya city (source: ITS, Surabaya).

Surabaya's population is projected to grow until 2030 and beyond. This increase will lead to a greater domestic water demand, even if per-capita demand remains stable. The growth of the city as a convention centre also implies additional water resources for these services. A changing east-Javan climate could put already stressed water resources under even greater pressure. At the same time, network inefficiencies need to be addressed and demand management campaigning needs to be fully implemented. Alternative water supply sources could act locally to reduce the pressure on traditional surface water sources considerably, with their main application being for non-potable water requirements. By relying on multiple water sources, not only is the pressure reduced on traditional water resources (leading to the benefit of increased sustainability of these resources in the future), but the resilience of the whole system increases as not 'all eggs are in one basket'. By having more sources, options are increased for water supply during times of stress. Additionally, water supply agencies will be better placed to serve a growing demand from all sectors.

3. Present-day water supply and demand of Surabaya

3.1 Description of the Surabaya water system

In Surabaya, water users get water both from piped and non-piped sources and from public and private vendors. Piped supply is managed by PDAM and by private operators. Non-piped supply is from wells and tankers. In 2014, 71% of the Surabaya population (c. 2.5 million people) had access to safe drinking water supply (Department of Population and Civil Registration, 2014). PDAM covers 79% of total water supplied, while private operators make up 2% of supply. The remaining 19% is from wells and/or tankers.

3.1.1 PDAM water supply services

PDAM supplies water to almost all areas in Surabaya. To meet demand, water is sourced from three main supplies:

1) Kali Surabaya river, representing 97% of PDAM Surabaya water source;

2) Umbulan Spring;

3) Pandaan Spring.

The springs make up the remaining 3% of water supply source for PDAM. Raw water intake from Kali Surabaya is taken at Karangpilang and Ngagel (Figure 3), and water supply allocation ranges from 11-12 $m^3 s^{-1}$.

Figure 3: raw water intake (left) and flood gates (rights) at the Ngagel water treatment plant.

In addition to the main supply of Kali Surabaya, the Umbalan and Pandaan springs (Figure 4) are exploited for water supply. Umbulan has a capacity of 5 $m^3 s^{-1}$, but is currently utilised at about 0.3 $m^3 s^{-1}$ by PDAM (Surabaya and Pasuruan). Umbuluan is exploited to irrigation and fisheries. The total utilisation is about 0.5 $m^3 s^{-1}$. The capacity of Pandaan is about 0.22 $m^3 s^{-1}$, most of which is utilised.

Figure 4: the Umbulan (left and centre) and Pandaan (right) springs.

From these three main sources, the installed raw water intake capacity varies by source. Table 1 summarises the water source, treatment plant installed and production capacities.

Table 1: installed, potential and production capacities of water treatment plants for Surabaya. Production capacities are 2013 values. Kayoon WTP was moved to Ngagel WTP prior to 2011. Data from PDAM Surabaya, 2014.

Description	Installed capacity ($m^3 s^{-1}$)	Production capacity ($m^3 s^{-1}$)	Potential capacity ($m^3 s^{-1}$)
Kali Surabaya			
Ngagel I WTP[1]	1.8	1.353	1.8
Ngagel II WTP	1	0.759	1
Ngagel III WTP	1.75	1.574	1.75
Karangpilang I WTP	1.45	1.112	1.45
Karangpilang II WTP	2.5	2.441	2.5
Kayoon WTP	0.1	-	-
Karanpilang III WTP	2	1.562	2
Kali Surabaya total	*10.5*	*8.812*	*10.7*
Other water sources			
Pandaan spring	0.22	0.22	0.227
Umbulan spring	0.11	0.11	0.3
Other water source total	*0.33*	*0.33*	*0.527*
TOTALS	**10.83**	**9.108**	**11.227**

[1]WTP = Water Treatment Plant.

Table 2 summarises the available capacity (expressed by the flow rate) of the various water resources currently used by PDAM. It can be seen by comparing production totals and resource capacities (Table 1), that there is some, but fairly limited room for expansion of these resources, especially if environmental considerations and climate change impacts are to be accounted for. At present, the gap between production and supply is c. 2.9 $m^3 s^{-1}$, while if potential capacity was fully utilised, the gap would be only 0.78 $m^3 s^{-1}$.

Table 2: summary of Surabaya water resource flow rate capacities (data from PDAM Surabaya; 2014 values).

Resource	Capacity ($m^3 s^{-1}$)
Umbulan Spring	4
Kali Surabaya river	0.00002
Brantas river	4
Bengawan Solo river	4
Boezem Morokrembangan	0.00096
TOTAL	**12.00098**

Total annual production using these data for 2013 amounts to **287 229 888 m^3** from the three main sources.

Prior to distribution, raw water is treated though pre-sedimentation, flash mixing, aeration, clarification, filtering and finally reservoir settling. Figure 5 shows a schematic of the water flows from Pandaan and Umbulan springs though treatment stages and to distribution. Reservoirs, both ground and elevated, are located throughout Surabaya. After leaving treatment plants, water moves to these reservoirs, from which it is distributed to consumers. There are currently 27 reservoirs serving the city, with a capacity of 61 775 m^3 (RISPAM Surabaya, 2014).

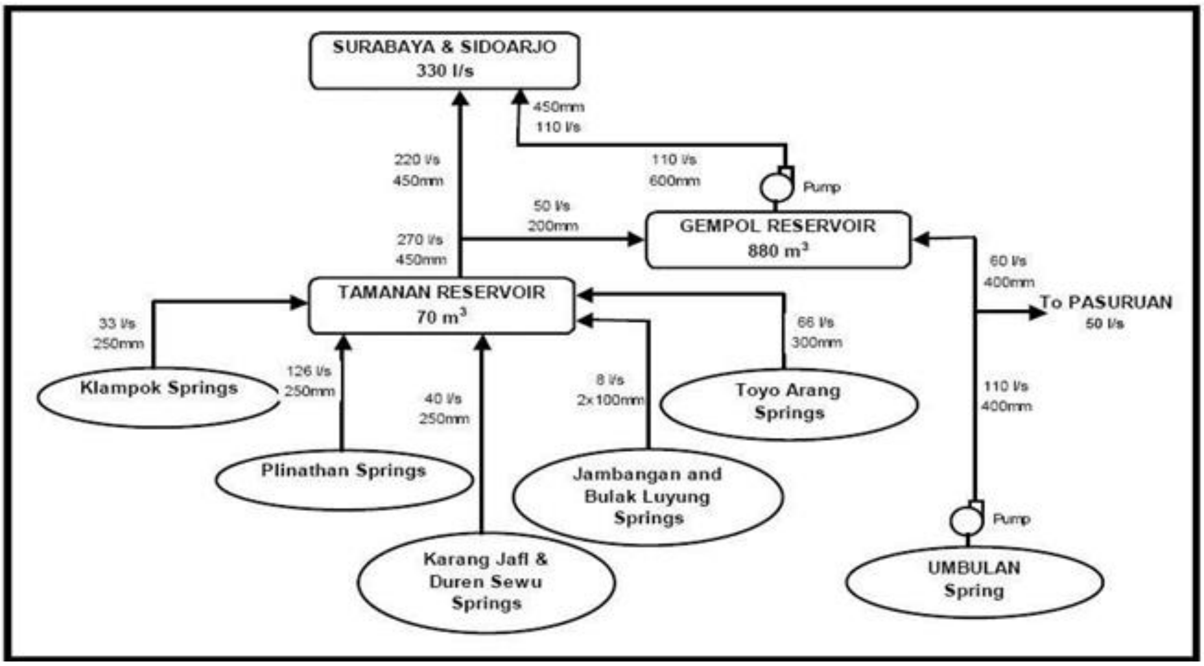

Figure 5: schematic of the water resource flows from Umbulan and Pandaan springs through to distribution.

In terms of water distribution, water demand is estimated nationally according to location and size. For example, urban domestic demand is estimated between 90-190 l cap^{-1} day^{-1}, depending on whether the urban area is classed as a small, medium or large city, or a metropolitan area. Rural domestic demand is estimated as 60 l cap^{-1} day^{-1}, while non-domestic urban demands are estimated as domestic estimate plus 15% (according to the criteria set by Peraturan Menteri Pekerjaan Umum (Regulation of Public Work Minister) Number 18/2007 or RSNI T-01-2003.

In 2016, PDAM Surabaya supplied water to 3 128 064 households, 38 089 industries, 404 business centres, 3794 public buildings, 2163 social buildings and six harbour installations. Table 2 summarises the 2013 annual average consumption of these categories (more recent data are not available). It is shown that the annual average per-capita household water consumption rate in Surabaya is 183 l cap^{-1} day^{-1} (Table 3) – towards the top of the national estimated values given above. It is shown that in 2013, PDAM Surabaya supplied 203 649 940 m^3 of water.

Table 3: average annual consumption of different water users in Surabaya based on 2013 data. Data from RISPAM Surabaya, 2014.

Unit type	Average annual water consumption rate (l cap^{-1} day^{-1} or l $unit^{-1}$ day^{-1})	Total annual water consumption (m^3)
Households	183	153 739 230
Institution	2710	5 918 830
Business	456	27 859 540
Industry	2426	1 738 560
Public	660	4 245 620
Social	2789	9 742 650
Harbour	45053	405 480
TOTAL	**-**	**203 649 940**

There are currently nearly 5.5 million m of distribution piping in Surabaya, with a capacity of nearly 192 000 m^3. However, the condition of some of this network is questionable, and maintenance is of ongoing concern. This is largely due to an aging infrastructure, some of which is over 100 years old. This results in some residents experiencing low pressure in their household connections. To date, the network reaches 80% of Surabaya residents. Figure 6 shows the water service distribution map for Surabaya. In terms of water losses, the average loss rate in Surabaya in 2011 was 35%, while in 2013 it was 29% (287 245 744 m^3 produced, 204 048 585 m^3 traded; PDAM Surabaya). The main reported source of loss is from leakage in the old pipe network.

The main obstacles to supply currently affecting PDAMs operations are:

i) Raw water, and the dependency on three main sources that are almost fully utilised. It is estimated that in 2030, demand will be 12.3 m^3 s^{-1}, which is greater than can be safely supplied from existing sources.

ii) Production units. Incoming raw water is observed to have poor quality, which in turns affects the treatment processes and the quality of the produced water. High levels of suspended sediment and grit means high levels of treatment are needed. This implies higher treatment and maintenance costs.

iii) Service and supply. Due to perceived poor quality drinking water, it has been observed that fewer people buy water from PDAM, instead turning to other water vendors.

Figure 6: water distribution map of Surabaya.

3.1.2 Private water supply services

In addition to the above-described water system of PDAM, the private sector also supplies water to customers in Surabaya. These suppliers are largely private housing developers and companies who have been granted groundwater utilisation rights in some cases. Five main areas are covered in this manner. These are:

1) Citra Raya Residence. This residence has its own WTP, and the raw water source is the Kali Surabaya river. The extraction rate is 0.16 $m^3 s^{-1}$, and services 4000 households, with an average of 4-5 people per household.

2) Pakuwon Indah Residence. This residence neighbours Citra Raya and is integrated with a shopping mall and golf course. The site-specific WTP has a capacity of 0.1 $m^3 s^{-1}$, and is producing 0.055 $m^3 s^{-1}$ (55% of capacity). Raw water source is the Kali Surabaya river. 2100 households and 600 apartments are serviced, representing 10500 consumers.

3) Royal Residence. For this residence, raw water is sourced from the Kali Kedurus river, and treated on-site. The supply is currently 0.015 $m^3 s^{-1}$. About 2750 consumers are served.

4) Graha Family housing complex. Raw water for this complex comes from the Gunungsari River at a rate of 0.1 $m^3 s^{-1}$. About 2000 households (about 10000 people) are served who use on average 70 m^3 $month^{-1}$ $household^{-1}$.

5) PT Pelino. PT Pelino operates the Surabaya port, and is responsible for supplying ships with clean water. Service is in partnership with three water providers. The average water provided is 75 000 m^3 $month^{-1}$. Water is used mostly for on-ship activities, and some dock-based supporting activities.

3.1.3 Non-piped water supply

Aside from the piped water supply, some water in Surbaya is provided through non-piped supplies. The main sources of non-piped water supply are wells, bottled water, and tap water known locally as Keran Air Siap Minum (KASM). KASM is essentially a communal tap water supply (Figure 7). In 2014 there were 13 known KASM supply points.

Figure 7: example of some KASM tap water supplies in Surabaya.

3.2 Present day urban water supply and demand for Surabaya

This section of the report analyses present day water supply and demand figures for the Surabaya case study in AltWater. Knowledge of the current state of the water system is critical in understanding where the main gaps and issues lie, how it might evolve in the future, and how alternative supplies could play a role.

Current annual water supplied amounts to about 205 000 000 m^3, although around 310 000 000 m^3 is produced annually. The difference reflects water lost in the system (non-revenue water - NRW). Of the consumption, the vast majority (over 150 000 000 m^3) is from households, with businesses making up most of the rest. Table 4 summarises the 2017 monthly estimated water supply and demand statistics for Surabaya using data provided by ITS, Surabaya (based on estimations from PDAM Surabaya).

Table 4: estimated monthly 2017 water supply and demand balance for Surabaya (data from ITS).

Surbaya water supply and demand statistics	
Description	**Statistics**
Total Surabaya population	2,867,493
PDAM service	2,698,023
Non-PDAM service	86,025
Service level	97%
Water supply statistics	
Water produced monthly (m^3; 2013 value)	23 935 824
Water supplied monthly (traded, m^3; 2013 value)	16 970 828
Monthly NRW volume (m^3)	6 964 996 (29%)
Water demand statistics	
Water consumption (m^3 cap^{-1} day^{-1})	0.2
Monthly domestic water demand (m^3)	16 188 138
Non-domestic demand (m^3; 35% of domestic demand)	5 665 848
Domestic + non-domestic demand (m^3)	21 853 986
Other demand (m^3; 5% of domestic)	809 406
Domestic, non-domestic + other demand (m^3)	22 663 392
% water loss	27
Monthly water loss (m^3)	6 119 115
Annual monthly demand (m^3)	28 782 507
Monthly water supply:demand balance (m^3)	-5 692 564

4. Potential future water supply and demand scenarios

Based on data provided by ITS (and sourced from PDAM Surabaya), Table 5 outlines the projected Surabaya monthly water supply and demand balance from 2020 to 2030 at 2-year intervals.

Table 5: projected water supply and demand statistics for Surabaya from 2020 to 2030 at 2-year intervals. (Data from ITS and PDAM Surabaya).

Surbaya water supply and demand statistics						
Description	**2020**	**2022**	**2024**	**2026**	**2028**	**2030**
Total Surabaya population	2 915 937	2 948 687	2 981 804	3 015 294	3 049 160	3 083 406
PDAM service	2 915 937	2 948 687	2 981 804	3 015 294	3 049 160	3 083 406
Non-PDAM service	-	-	-	-	-	-
Service level	100%	100%	100%	100%	100%	100%
Water supply statistics						
Water produced monthly (m^3)	-	-	-	-	-	-
Water supplied monthly (traded, m^3)	32 400 000[1]	32 400 000[1]	33 696 000[2]	34 992 000[3]	34 992 000[3]	37 584 000[4]
Monthly NRW volume (m^3)	-	-	-	-	-	-
Water demand statistics						
Water consumption (m^3 cap^{-1} day^{-1})	0.21	0.21	0.22	0.22	0.22	0.22
Monthly domestic water demand (m^3)	18 370 403	18 567 728	19 679 906	19 900 940	20 124 456	20 350 479
Non-domestic demand (m^3; 35% of domestic demand)	6 429 641	6 498 704	6 887 967	6 965 329	7 043 559	7 122 667
Domestic + non-domestic demand (m^3)	24 800 044	25 066 432	26 567 873	26 866 269	27 168 015	27 473 146
Other demand (m^3; 5% of domestic)	918 520	928 386	983 995	995 047	1 006 222	1 017 523
Domestic, non-domestic + other demand (m^3)	25 718 564	25 994 818	27 551 868	27 861 316	28 174 237	28 460 669
% water loss	24	23.2	22	21	20	20
Monthly water loss (m^3)	6 172 455	6 030 797	6 129 489	5 850 876	5 634 847	5 692 133
Annual monthly demand (m^3)	31 891 019	32 025 615	33 861 357	33 712 192	33 809 084	34 152 802
Monthly water supply:demand balance (m^3)	508 981	374 385	-165 357	1 279 808	1 182 916	3 431 198

[1]Calculated based on 12 500 l s^{-1}

[2]Calculated based on 13 000 l s^{-1}

[3]Calculated based on 13 500 l s^{-1}

[4]Calculated based on 14 500 l s^{-1}

Analysis of potential future water supply and demand balances indicates that for the most part, Surabaya is expected to have a (small) surplus of water (expected supply relevant to expected demand), in contrast with the present situation where a more than 5 000 000 m^3 yr^{-1} deficit is shown. The main factor behind this anticipated improvement is a planned reduction in NRW from a current level of 27% to 20% by 2030. This 7% decrease in NRW will more than offset demand increases caused by a slight expected increase in average per-capita demand (from 0.2 to 0.22 m^3 cap^{-1} day^{-1}) and an expected increase in population of 215 913. In addition, PDAM expect an increase in production from a current level of 9.108 m^3 s^{-1} to 14.5 m^3 s^{-1} (14500 l s^{-1}). However, this increase could be optimistic. Table 2 shows that current capacity of the main utilised water resources is about 12 m^3 s^{-1}. The additional supply is stated as to derive from a combination of the Brantas and Bengawan Solo rivers, however it is unclear how feasible or sustainable such an increase from these sources would be. In addition, a 7% improvement in NRW in 12 years seem ambitious, but is of course not impossible provided sufficient financial, human and institutional resources are made available to upgrade existing networks. In summary, closing the saupply-demand gap is ambitious, but could be possible with concerted effort.

Assuming that water supply is resource-limited at 12 m^3 s^{-1} (Table 2), then in 2030, the potential supply would amount to 31 536 000 m^3 $month^{-1}$, resulting in a deficit of 2 616 802 m^3 $month^{-1}$ assuming the NRW has decreased to 20%. From this analysis, critical factors identified in order to achieve and maintain a future water supply surplus are:

1) Enhancing existing supplies. However, finding sustainable additional resources could prove problematic. Alternative water resources for non-potable use could be very beneficial in this sense by reducing the demand on the traditional freshwater resources, which are already heavily exploited.

2) A concerted city-wide effort in NRW reduction.

3) Complementary to the above, maintain or reducing average per-capita water demand.

5. Institutional baseline

Six laws regarding water quality and 13 laws on water quantity have been identified, along with four laws on water treatment and distribution and four laws on wastewater collection, treatment and discharge. This section will summarise these laws and the main obstacles faced.

5.1 Water quality

The main water quality legislation documents are:

1) PP No. 82/2001 tentang Pengelolaan Kualitas Air dan Pengendalian Pencemaran Air (Government Regulation No. 82/2001 regarding on Water Quality Management and Water Pollution Control). This regulation deals with controlling and protecting source water quality, monitoring and assessing the quality of source water and classifying water into four categories depending on its condition, going from potable-quality water to water to be used for irrigation only and other similar uses. This law is the responsibility of national and regency governments.

2) Peraturan Menteri Negara Lingkungan Hidup No. 01 Thn. 2010 tentang Tata Laksana Pengendalian Pencemaran Air (Regulation Of the Minister of Environtment No. 01/ 2010 Concerning the Procedures of Water Pollution Control). This regulation is mainly aimed at inventorising polluted waters, stiulating water quality standards, licensing, monitoring of water quality, guidance and provision of information. It is again a national law to be implemented at Regency level.

3) Peraturan Menteri Kesehatan No. 492 Tahun 2010 Tentang Persyaratan Kualitas Air Minum (Regulation of Health Minister No. 492/ 2010 regarding on the Requirements for the Quality of Drinking Water). This regulation states that all supplied drinking water must meet a minimum water quality standard, set against a number of measurement parameters. It is overseen at the national level.

4) Perda Provinsi Jawa Timur No. 2/2008 tentang Pengelolaan Kualitas Air dan Pengendalian Pencemaran Air di Provinsi Jawa Timur (Provincial Regulation No. 2/2008 regarding on Water Quality Management and Water Pollution Control in East Java Province). Specific to East Java, this regulation includes procedures on water utilisation planning, designing the water classes, monitoring water quality, and determining targets. It also deals with pollution control activities. It is therefore complimentary to (1), (2) and (3) above, and is carried out at Provincial level.

5) Peraturan Gubernur Jawa Timur No. 61/2010 tentang Penetapan Kelas Air pada Sungai (East Java Governor Regulation No. 61/2010 regarding on the establishment River Water Class). This regulation is largely concerned with the development and definition of water classes. It is also carried out at Provincial level.

6) Perda Kota Surabaya No. 2/2004 tentang Pengelolaan Kualitas Air dan Pengendalian Pencemaran Air (Municipal Regulation of Surabaya No. 2/2004 regarding on Water Quality Management and Water Pollution Control). This is a Municipal-level regulation, concerned with water quality management and water pollution control. The water quality classes are defined in a local context, but may clash with national targets.

5.2 Water quantity

1) UU 11/1974 tentang Pengairan (Law No. 11/1974 regarding on Water). This national level law pertains to planning, operation, maintenance and protection of water resources. The societal value of water is explicitly mentioned, as is that water should be used for the prosperity of the people.

2) PP No. 20/2006 tentang Irigasi (Government Regulation No. 20/2006 regarding on Irrigation). This national law concerns irrigation and related activities. Using irrigation to boost food productivity is a main goal, to be achieved by efficient and sustainable use and re-use of water resources. Another key aim is to boost farmers' income via an efficient and well maintained irrigation system. As this law consists largely of resource exploitation, it could come into conflict with law (1), as well as some water quality laws.

3) PP No. 42/2008 tentang Pengelolaan Sumber Daya Air (Government Regulation No. 42/2008 regarding on Water Resources Management). This law at national level deals with water conservation, and could clearly conflict with (2) above. Again, the policies are enacted at national Ministerial level, but are to be implemented at Regency or District level.

4) PP No. 43/2008 tentang Air Tanah (Government Regulation No. 43/2008 regarding on Ground Water). This is a national law (to be implemented locally) on groundwater exploitation. It should be managed in an integrated and sustainable manner for all uses.

5) PP No. 38/2011 tentang Sungai (Government Regulation No. 38/2011 regarding on Rivers). This law specifically relates to rivers, their use and exploitation, and includes policies on licencing and community empowerment. However, it is explicitly mentioned that rivers belong to the state, and that river management is conducted thoroughly and in an integrated manner, with environmentally sounds objectives.

6) PP No. 37 Tahun 2012 tentang Pengelolaan Daerah Aliran Sungai (Government Regulation No. 37/2012 regarding Management of River Flow). This law focusses on river flows with an emphasis on good upstream catchment management practices to maintain hydrological flow characteristics to ensure a sustainable and continuous supply.

7) PP No. 33/2011 tentang Kebijakan Nasional Pengelolaan Sumber Daya Air (Government Regulation No. 33/2011 regarding on Water Resources Management). This national law is concerned with water resources management in the period 2011-2013, and includes aspects on conflicts in water use, overlapping the roles of different water related institutions and rectifying data limitation issues.

8) Peraturan Menteri Pekerjaan Umum No. 11A/PRT/M/2006 tentang Kriteria dan Penetapan Wilayah Sungai (Minister of Public Works Regulation No. 11A / PRT / M / 2006 regarding on Criteria and Determination of River Region). This law helps define a river region and any defining/important characteristics to be addressed when managing these regions. This can include considerations for setting minimum environmental flows and water access rights. Threatened species must be protected and minimum statistical flow volumes must be accounted for.

9) Peraturan Menteri Pekerjaan Umum No. 50/PRT/M/2015 tentang Izin Penggunaan Sumber Daya Air (Minister of Public Works Regulation No. 50 / PRT / M / 2015 regarding on Water Resources Use Permits). This final national law deals with water use permitting, specifying who can apply, for which uses and for how much water. Several water users are defined.

10) Perda Provinsi Jawa Timur No. 16/2001 tentang Pajak Pengambilan dan Pemanfaatan Air Bawah Tanah dan Air Permukaan (Regional Regulation of East Java Province No. 16/2001 concerning Tax on

Collection and Utilization of Underground Water and Surface Water). This provincial law deals with setting and collecting taxes for surface and groundwater exploitation. Setting rates and collecting taxes is the responsibility of Provincial governments.

11) Perda Provinsi Jawa Timur No. 12/2011 tentang Pengelolaan Air Tanah (Provincial Regulation of East Java No. 12/2011 concerning on Groundwater Management). This is a Provincial groundwater management law, and includes issues on planning, monitoring and evaluating groundwater exploitation areas. Again, an emphasis is placed on sustainability and continuity of supply.

12) Perda Provinsi Jawa Timur No.5/2011 tentang Pengelolaan Sumber Daya Air (Provincial Regulation of East Java No. 5/2011 concerning on Water Resources Management). This East Javan law is for water resources management, and concerns local-level formulation of management policies and plans, the implementation and maintenance of water infrastructure, conservation and licencing. An emphasis is placed on protecting resources.

13) Perda Kota Surabaya No. 16/2003 tentang Pengelolaan Air Bawah Tanah (Municipal Regulation of Surabaya No. 16/2003 concerning on Underground Water Management). Finally, this Surabaya-specific law relates to the technical management of groundwater resources including inventorising, planning, conserving, allocating and licencing water.

5.3 Water treatment and distribution

1) PP No. 122/2015 tentang Sistem Penyediaan Air Minum (Governmental Regulation No. 122/2015 concerning on Drinking Water Supply System). This national law concerns drinking water supply and associated systems. Drinking water must be supplied to supply peoples' basic needs, and should be managed so as to deliver it at an affordable price. Efficient and sustainable services should be aimed for. This national law is implemented at the local level.

2) Peraturan Menteri Dalam Negeri No. 23/2006 tentang Pedoman Teknis dan Tata Cara Pengaturan Tarif Air Minum Pada Perusahaan Daerah Air Minum (Minister Regulation of Interal Affairs No. 23/2006 concerning on Technical Guidelines and Procedures for Regulating Drinking Water Tariffs at Regional Water Company). This national law specifically concerns the setting of water tariffs, and is based on concepts of affordability and service, cost recovery, transparency and the protection of raw water. While a national law, PDAM is charged with setting appropriate rates given the context and location.

3) Peraturan Menteri Pekerjaan Umum No. 13/PRT/M/2013 tentang Kebijakan dan Strategi Nasional Pengembangan Sistem Penyediaan Air Minum (KSNP-SPAM) (Minister Regulation of Public Works No. 13 / PRT / M / 2013 on National Policy and Strategy for Development of Drinking Water Supply System. This national level law concerns policies and strategies for upgrading and extending existing drinking water supply services and for developing new supplies. PDAM is responsible for implementing the policies. Special attention is given to funding, improving water access, and fulfilling raw water requirements.

4) Peraturan Menteri Pekerjaan Umum No. 27/PRT/M/2016 tentang Penyelenggaraan Sistem Penyediaan Air Minum (Minister Regulation of Public Works No. 27 / PRT / M / 2016 concerning on the Implementation of Drinking Water Supply System). This law complements number (3), and relates to implementing drinking water supply systems and plans. PDAM is ultimately responsible for provision of drinking water.

5.4 Wastewater collection, treatment and disposal

1) Peraturan Menteri Lingkungan Hidup RI No. 5/2014 tentang Baku Mutu Air Limbah (Regulation of the Minister of Environment RI No. 5/2014 concerning on Wastewater Quality Standard). This national law sets minimum standards for treated wastewater quality. However, local conditions are to be accounted for when setting locally-relevant targets. It is the responsibility of the provider to meet the targets. At present however, standards are not necessarily suited to different wastewater-producing activities, causing conflict and uncertainty.

2) Peraturan Menteri Pekerjaan Umum No. 16/PRT/M/2008 tentang Kebijakan dan Strategi Nasional Pengembangan Sistem Pengelolaan Air Limbah Permukiman (KSNP-SPALP) (Minister Regulation of Public Works no. 16 / PRT / M / 2008 concerning on National Policy and Strategy of Development of Waste Water Management System of Settlements). This national policy concerns the development new wastewater management systems. It states that issues should be identified, objectives should be set, and challenges should be stated. Ultimately local governments will implement strategies.

3) Peraturam Menteri Pekerjaan Umum dan Perumahan Rakyat RI No. 04/PRT/M/2017 tentang Penyelenggaraan Sistem Pengelolaan Air Limbah Domestik (SPALD) (Minister Regulation of Public Works and Public Housing RI. 04 / PRT / M / 2017 concerning on the Implementation of the Domestic Wastewater Management System). Complementary to (2), this policy concerns the implementation of wastewater management systems, including all aspects on organisers, planning, construction, operation, institutional arrangements, financing and staff coaching. One key issue is that at present wastewater and drainage systems are not separated.

4) Peraturan Gubernur Jawa Timur No. 72 tahun 2013 tentang Baku Mutu Air Limbah Bagi Industri dan/atau Kegiatan Usaha Lainnya (East Java Governor Regulation no. 72 of 2013 concerning on the Quality Standard of Waste Water for Industry and / or Other Business Activities). This provincial regulation sets out water quality standards for industrial activities in East Java. The intention is to limit the negative impact of these activities that may result from poor wastewater quality discharge. It is the responsibility of companies to meet locally set wastewater quality standards.

6. Conclusions and further work during the AltWater project

The water system in Surabaya is fairly advanced, supplying water to almost all residents. However, the water resources used to supply Surabaya are becoming unsustainably used, all being nearly totally utilised with little room for expansion. There are few other traditional water resources available for exploitation. This has the implication that the water supply is at-present resource-limited. Expected population growth and lifestyle changes in Surabaya is expected to put increasing pressure on the resources and the supply system by increasing average per-capita demand and by extension, total domestic demand. Likewise, expansion of commercial activities will also increase city wide water demand. At the same time, the current network, while extensive, is in places very old (>100 years old), leading to high NRW (27-29%) largely due to leakage from the aging network.

At present, according to 2013 figures, there is a water supply-demand deficit in Surabaya of about 5 500 000 m^3 yr^{-1}. It is possible that some of this deficit is fulfilled with private vendors and through non-piped water supplies, and so go 'unaccounted' for in official figures. Quantifying exactly how much water is supplied in these other means is not trivial however. Therefore, it is likely that most, if not all residents receive sufficient water, but the supply in some cases may not be of suitable pressure, may not be 24 hours a day and/or may not be seven days a week.

Forecasts of supply and demand to 2030 show some interesting features. On the supply side, the supplied volume is estimated in 2030 to be higher than the combined capacity of currently utilised water sources, and it is unclear where the extra supply will come from. On the demand side, population is expected to increase along with per-capita demand, leading to a demand increase. However, it is also expected that a reduction in NRW from 27% to 20% will also be achieved across the city. If this is achieved, then the NRW reduction will more than compensate the increase in demand from population and per-capita demand growth. Combined with the projected supply increase, by 2030 Surabaya could attain water supply surplus. Achieving the NRW reduction in full could be ambitious, and will require funding, capacity and political support.

Alternative water supply sources such as from rainwater harvesting, stormwater harvesting and wastewater collected, treatment and re-use could prove very useful in helping to close the supply-demand gap and in reducing the pressure that the current traditional supplies are facing. While it is not anticipated that such sources would be used to replace or augment potable supply, they would likely play a role in replacing/augmenting non-potable water uses. Therefore by using alternative water supplies for traditionally non-potable water uses (e.g. flushing toilets, watering gardens, vegetable patches and municipal parks) that still consume potable resources, the demand on traditional water supplies is lowered, freeing up water for a number of purposes including: i) expanding potable service delivery; ii) returning water for environmental flows and; iii) recharging aquifers (where applicable). The traditional supplies are less pressured, and can be returned to a state of being more sustainably utilised.

Which alternative water supply systems would be feasible, affordable and acceptable in Surabaya, how much water they could *potentially* contribute, and how much water they might *realistically* contribute (which is a function of implementation and uptake depending on a wide range of factors) is still a matter of research, and is something that AltWater will actively investigate at later stages in the project.

7. Acknowledgements

We gratefully acknowledge all ITS staff and students who in part contributed to the data collected and presented in this survey. This study was funded by DUPC2, the programmatic cooperation between the Directorate-General for International Cooperation of the Dutch Ministry of Foreign Affairs and IHE Delft Institute for Water Education in the period 2016-2020. The study was carried out by IHE Delft and ITS Surabaya. It has not been subjected to peer and/or policy review by DGIS or IHE Delft, and, therefore, does not necessarily reflect the views of these institutions.

8. References

Asian Development Bank. 2016. Indonesia: Country water assessment. Mandaluyong City, Philippines. 114pp.

Suprapto A. 2002. Land and water resources development in Indonesia. FAO, Rome. In: Investment in Land and Water. FAO RAP Publication 2002/09. ISBN: 974-7946-17-3. Available at: http://www.fao.org/docrep/005/ac623e/ac623e0g.htm