

INFLUENCE OF CLIMATE CHANGE ON WATER RESOURCES: A STUDY OF 2014 PROLONGED DRY SPELL IN THE STATE OF SELANGOR, MALAYSIA.

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Abstract

Water resources are one of the aspects of the environment that are showing signs of detriment as a result of climate change. Recent events have shown that in many parts of Malaysia water resources are becoming unpredictable as well as unreliable when it comes to getting the volumes at the times needed. The state of Selangor is the most developed as well as most populated state in Malaysia, as such its water resources are really overstretched in terms of its ability to meet the ever growing demand. The most critical sector is the domestic and industrial water supply, because this sector depends almost entirely on surface water. In February and March 2014, many parts of Peninsular Malaysia experienced hot and dry weather. The state of Selangor bore the hardest brunt of this dry spell. The extended period of this dry spell caused lowering of water levels in most rivers resulting in the dipping of dam levels. Since the water supply system of the state depends wholly on surface water, the decrease in dam levels resulted in decreased volume of water that could be treated for consumption. The water supply system of the state of Selangor could not hold on to its commitments, as such a water rationing exercise had to be implemented. This paper analyzes the dry spell incidence in terms of its effects on the water supply system of the state.

Introduction

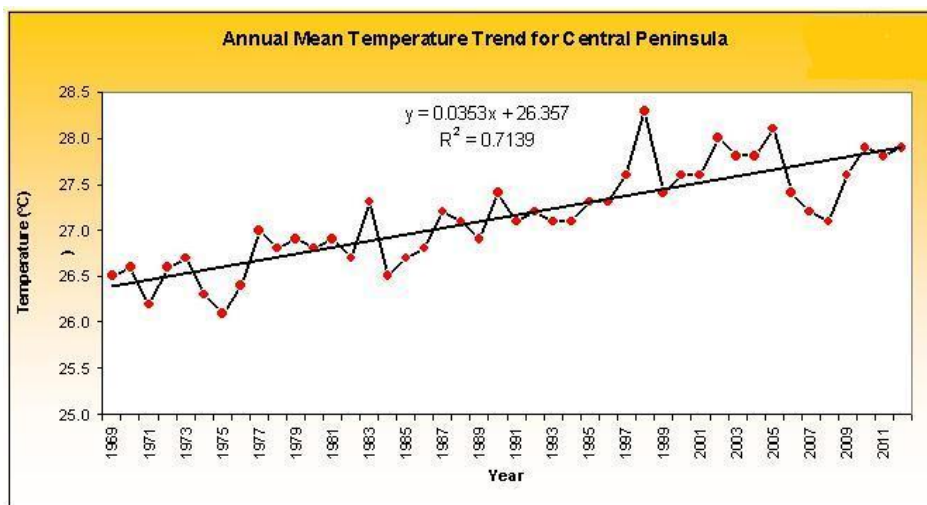
The IPCC in its 2007 report stated that the warming of the climate system is unequivocal (IPCC, 2007), as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global mean sea level. More specifically, eleven of the last twelve years (1995-2006) rank among the 12 warmest years ever recorded since global surface temperatures are measured (1850). Over the last 100 years (1906–2005), global temperature has increased by 0.74°C. Global sea level has risen by 17 cm during the 20th century, in part because of the melting of snow and ice from many mountains and in the polar regions. More regional changes have also been observed, including changes in Arctic temperatures and ice, ocean [salinity](#), wind patterns, droughts, precipitations, frequency of heat waves and intensity of tropical cyclones.

Recent meteorological and hydrological events in Malaysia may be revealing a departure from the normal trends (Wan Azli, 2010). The floods in the state of Johor in December 2006 and January 2007 resulted from unusually heavy rainfalls which could be related to growing trends of new forces acting in tandem with meteorological developments of the world. Tangang et al (2007) found that the Madden-Julian Oscillation (MJO), the El Nino-Southern Oscillation (ENSO) and the Indian Ocean Dipole (IOD) are the forces that act as controls of climate variability of Malaysia. They also concluded that consistent with other places, generally temperatures in Malaysia are rising and long-term trend of precipitation appears to be more variable.

Literature review

Temperature. Analysis of five regional annual mean temperatures records by Malaysian Meteorological Department (MMD) in various parts of Malaysia indicated warming trends.

Figure 1: Annual Mean Temperature Trend, Central Peninsular Malaysia



Source: MMD, 2014

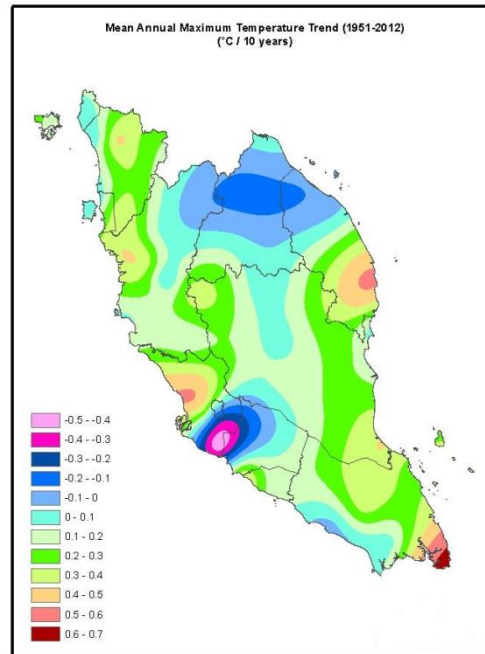
Figure 1 shows an upward trend of the mean annual temperature since 1969. Another analysis of temperature for the past 50 years by the MMD (Wan Azli, 2010) shows that there is an upward trend of temperature in Malaysia as indicated by Table 1.

Table 1 . Temperature Trends in Malaysia

Annual Temperature (°C) Trend in Malaysia per 50 Years				
	Max	Mean	Min	Indicator
Peninsular	1.1	1.1	1.5	Increasing
Sabah	1.0	1.2	2.0	Increasing
Sarawak	0.7	0.6	1.1	Increasing

(Source: Wan Azli, 2010)

During the months of February through May 2010, temperatures soared in many parts of the country, with Kuala Lumpur registering temperatures in the region of 35°C.

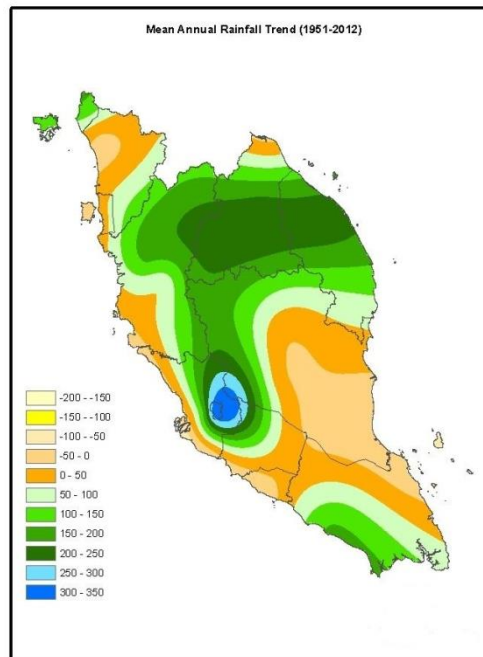
Map 1. Map of Temperature Trend of Peninsular Malaysia (1951-2012)

(Source: MMD, 2014)

Temperature Characteristics During the Dry Months.

Rainfall. Analysis of rainfall trends in Malaysia shows little discernible pattern as opposed to the pattern demonstrated by temperatures. Rainfall trends show both upward as well as downward movement over the observation period (1951-2005).

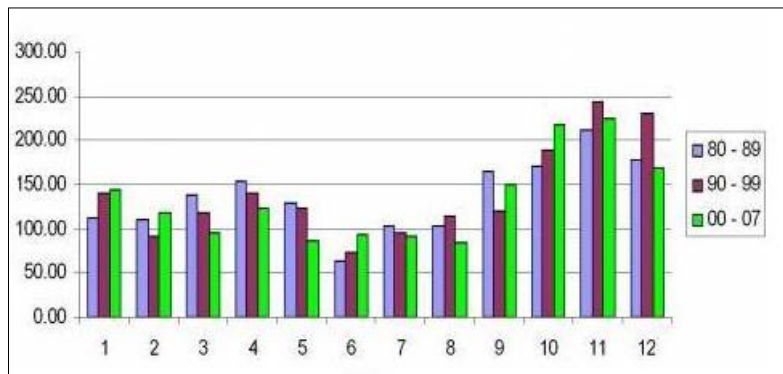
Map 2. Rainfall Trend in Peninsular Malaysia (1951-2012)



(Source: MMD, 2014)

However, on a more localized scale, the rainfall amount may change, as indicated by the Barat Laut region of the state of Selangor. The Agricultural Department of the state of Selangor (Selangor State, 2009) conducted an observation on rainfall pattern in Barat Laut Selangor area found that even though the rainfall amount for the past 30 years remain stable, that is not the case if data for the last ten years is considered. It seems that rainfall amount decreased slightly as shown by the diagram below. This is a worrying tendency in terms of water resources.

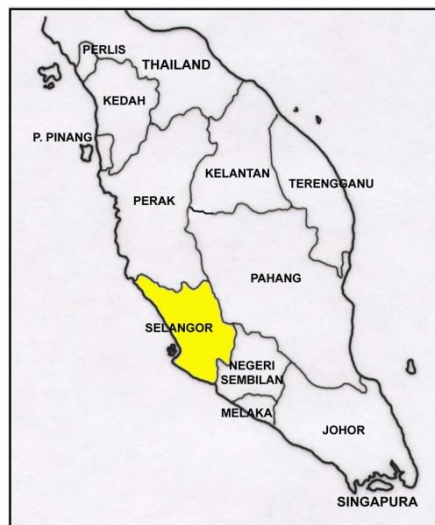
Figure 1. Rainfall Amounts (mm) in Barat Laut Selangor 1980-2007



The Study Area

The study area is the state of Selangor which is the most developed and richest state in Malaysia. In terms of water supply, the service area of the Selangor water supply system includes the state of Selangor and the federal territories of Kuala Lumpur and Putrajaya.

Map 3. Location of the state of Selangor, in Peninsular Malaysia



The current population of service of the Selangor water supply system is estimated at more 6 million people, with the majority of the people concentrated in areas known as Greater Kuala Lumpur which alone has about 5.7 million people in 2010 (MFTUW, 2013).

Table 2 . Estimated Population of Greater Kuala Lumpur, 2010

Local Government	Population [10⁶]
DB Kuala Lumpur	1.723
MP Klang	0.747
MP Kajang	0.743
MB Subang Jaya	0.583
MB Petaling Jaya	0.577
MP Selayang	0.559
MB Shah Alam	0.528
MP Ampang Jaya	0.142
Putrajaya	0.089
MP Sepang	0.082
Greater KL	5.773

Source: MFTUW, 2013

Since the study area is densely populated, and at the same time it remains the attraction centre for people to move into the area for economic and other reasons, the population is on a perpetual steep upward increasing trend. This situation therefore places a heavy burden on the water supply system to make sure that the population is adequately supplied with treated water.

Statement of the Problem

To put it very simply, on a normal hydrometeorological condition, the water supply situation of Selangor, Kuala Lumpur and Putrajaya is in a precarious situation. This means that the present capability of the supply system is just about able to meet its obligations, but should some unforeseen situation crops up, such as poor raw water quality at intake points, then the system is most likely to grapple in order to supply water to consumers. The water supply situation of Selangor is explained by Table 3 below.

Table 3. Water Supply Situation in Selangor

Year	Demand	Supply
2010	4000	4500
2011	4100	4500
2012	4200	4500
2013	4400	4500
2014	4500	4500

A more sinister scenario can happen if the meteorological condition deviates from its normal and expected pattern. This happened in 1998 when the area was hit by a combination of unexpected weather pattern and the launching of mega projects which gobbled huge amount of treated water, and as a result, the study area was hit by its worst water crisis (Ithnin, 2004).

There is good chance that the water supply concessionaires and the water authorities in the state of Selangor as well the federal government of Malaysia must have underestimated the influence of climate change on water resources during the months of February and March of 2014. Even though they have the full knowledge of the constraints of the water supply system in Selangor, this research is of the view that none of the parties expected the severity of the dry spell.

Justification of the study

In December 2013, a water disruption occurred in Selangor affecting the lives of about 500,000 people. Luckily, the problem was resolved in two weeks (Ithnin, 2014a). This disruption was bad enough for the affected people to experience. The dry months of February and March 2014 were much more severe and as such water cuts were exercised without choice with a much more larger population being affected. The huge number of people affected by the water cuts in Selangor is the basis for this study.

Methodology

The research used participant-observation method in some portion of the study which necessitated the researcher to interview as well as observe the subjects . At the same time data was obtained from authoritative sources which was used in this study.

Results

A severe dry weather. In 2014, Malaysia experienced a hot and dry weather during the month February which extended up to the middle of March. Even though it is a usual condition during the last phase of the Northeast Monsoon, but during this period, the condition was more severe than usual. One of the factors causing this condition was due to the tropical weather system in the eastern part of the country which has moved far to the west of the Pacific Ocean. At the same time, the atmosphere was very stable causing less rainfall in the Peninsula and Sarawak. More than 60 percent of rainfall distribution over the Peninsula and Sarawak were below average (MMD, 2014). The characteristics of the dry months are explained by Table 4 below.

Table 4. Temperature ($^{\circ}$ C) Characteristics in Selangor in 2014

	Dec 2013	Jan	Feb	Mar	Apr
MAX	34	34	36	37	34
MEAN	31.4	31.29	34.2	34.3	32.5
SD	1.72	1.48	1.06	1.53	1.37

In short, the months of February and March 2014 were severely hot.

Decreasing dam levels. As a result of the prolonged dry weather condition, the hydrology of the state of Selangor was greatly affected. Water level in the rivers decreased drastically, so much so that dam levels decreased at a rate faster than expected.

Table 5 : Dam Levels in Selangor and Kuala Lumpur in mid February 27, 2014 (m)

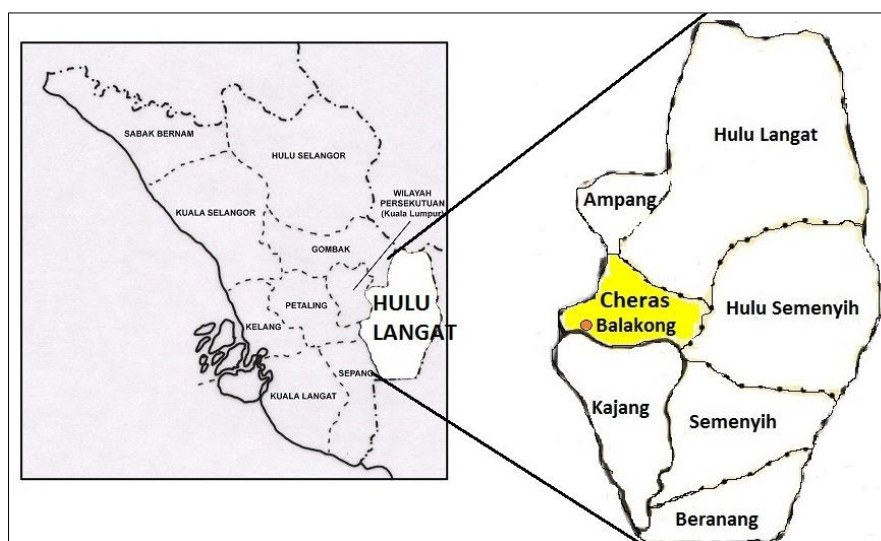
Dam	Location	Normal Level (m)	Minimum Level (m)	Maximum Level (m)	Dam Level (m) (Real-Time)	Storage (mil. m ³)	Storage (% mil. m ³)
Langat	Selangor	220.96	204.21	220.96	216.06	24.00	72.14
Sungai Selangor	Selangor	220.00	184.63	192.50	197.15	110.00	48.25
Tasik Subang	Selangor	38.56	34.75	38.56	38.11	4.00	95.32
Sungai Tinggi	Selangor	59.50	45.03	48.90	55.93	96.00	79.17
Batu	FTKL	102.00	79.00	107.30	100.59	27.55	64.44
Genting Kelang	FTKL	94.00	84.00	98.00	89.96	14.79	41.77

By the middle of February, the water supply concessionaire in Selangor was convinced that a water crisis could not be averted.

The Ammonia Menace. On January 29, 2014, two water treatment plants, the Cheras Batu 11 and the Bukit Tampoi were closed due to high ammonia content in the raw water (NST, 2014). The allowable ammonia level is 1.50 parts per million (ppm), but the raw water had a level of between 5 and 3 ppm. 36 areas in Hulu Langat and Kuala Langat were affected by the closure.

The Balakong Incidence. On February 7, 2014 the Batu 11 Cheras water treatment plant was again closed (Syabas, 2014a; The Star, 2014) and about 20,000 households were affected, in the meanwhile the Bukit Tampoi Plant continued to be closed down due to the persistent high ammonia level in its raw water. The closure of those two plants only signalled the worst was yet to come.

Map 4. The Balakong area which is in the subdistrict of Cheras, in the district of Hulu Langat was the first area to be hit continuously for 19 days without water.



Balakong is a light industrial as well residential area within the Cheras *mukim* or sub-district in the district of Hulu Langat. The households in the area were without running water for a continuous period of 19 days as a result of the closure of the Cheras Batu 11 water treatment plant (Ithnin, 2014b).

The Water Rationing.

When the water situation did not improve, it became necessary that a water rationing exercise be implemented in the areas affected. On February 24, water intake from the Selangor River was authorized to be reduced by 200 million litres per day, effectively reducing the output of five water treatment plants. These plants are the Sungai Selangor Phase 1, Sungai Selangor Phase 3, Sungai Rasa, Sungai Selangor Phase 2 and the Rantau Panjang . As a result of the reduction of raw water intake, seven regions began to experience low water pressure and trickling of water supply . These regions were Gombak, Kuala Lumpur, Petaling, Klang/Shah Alam, Kuala Selangor, Kuala Langat and Hulu Langat (Syabas, 2014a). On February 27, a water rationing plan was implemented (Malaysian Insider, 2014; The Star, 2014) affecting three regions and on March 2, 2014 the area covered by the rationing exercise widened. The affected areas would have the taps running for two days, and dry taps for the next two days (Syabas, 2014a).

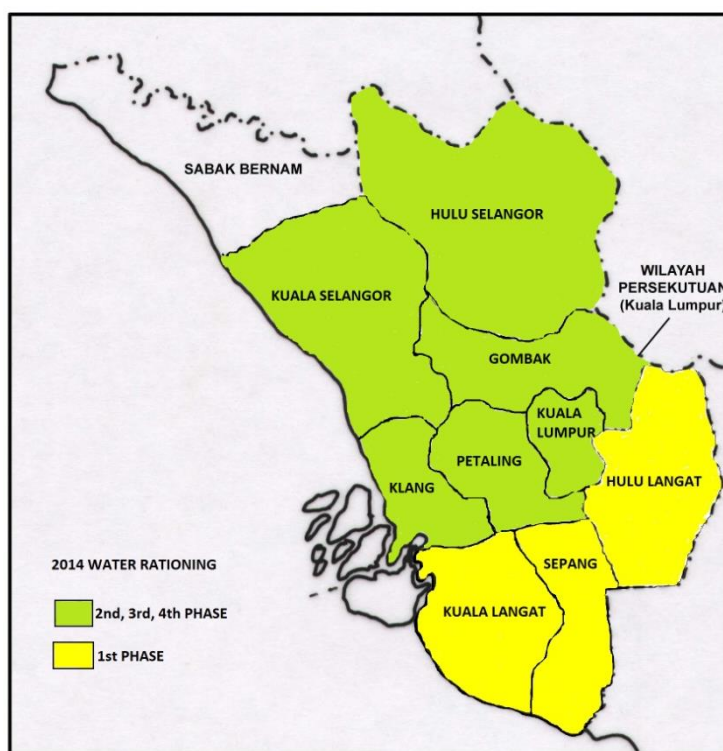
Analysis of Results

As a result of the long dry spell, rivers started to record decreased levels. As the water supply system of Malaysia depends heavily on surface water, as much as 97 percent in total, the decreased stream levels mean that reduced amount of water that can stored, but at the same time, water has to be drawn from the dams for the

purpose of supplying the water treatment plants of their raw water intakes. The dam levels went dangerously low and as such measures had to be taken in order to make sure that the dams do not run dry.

The First Phase of Water Rationing. Due to the shut down of the Cheras Batu 11 and Bukit Tampoi water treatment plants, the supply of treated water to their respective service areas were affected and (Syabas, 2014b) that signalled the first phase of water rationing in Selangor.

Map 5. Areas Affected by the 2014 Water Rationing in Selangor



The Cheras Batu 11 plant were operating on and off, while the Bukit Tampoi plant was out of operation since January 28, 2014. The ammonia level at the Cheras Batu 11 plant hit a level of 6.40 ppm while that of the Bukit Tampoi was 4.20 ppm at the time of SYABAS press release number 5 (Syabas, 2014b). As a result, the regions of Hulu Langat, Kuala Langat and Sepang were the first to be hit with water rationing affecting 60,185 households.

The Second Phase of Water Rationing. Due to the severity of the dry spell, additional cuts to the raw water intake had to be implemented. Apart from reducing as much as 200 million litres per day from the Sungai Selangor, additional cuts of 30 million litres per day from the Klang Gate Dam was imposed, and as a result

413,671 households in six regions were affected. The six additional regions were Gombak, Kuala Lumpur, Petaling, Klang/Shah Alam, Hulu Selangor and Kuala Selangor (Syabas, 2014c).

The Third Phase of Water Rationing. The continuing hot and dry weather had affected streamflow greatly so much so that water levels in the dams kept on decreasing. In order to keep abreast with the mounting pressure of decreasing water reserves in the dams, a third phase of water rationing was put into effect. The third phase had to be implemented due to the fact that raw water withdrawal from the Sungai Selangor Dam has to be reduced further by 200 million litres per day making the total amount of raw water intake reduction to 500 million litres per day. In this case, the phase two water rationing exercise was replaced by the third phase affecting the same regions but actual accounts affected were enlarged to 722,424 amounting to about 2.9 million people being affected.

At this stage, the combined first and third phase stages affected a total of 664 areas with 782,609 accounts which translated to about 3.13 million consumers (Syabas, 2014d).

The Fourth Phase of Water Rationing. Even though rain did fall in a number places since the middle of March, the amount was not sufficient to alleviate the shortage. As such a further reduction of water intake from the Selangor River Dam was implemented in which the reduction amounted to 1,000 million litres per day. With this reduction, a fourth phase of water rationing came into being and was enforced on April 4, 2014 (Syabas, 2014e). The phase affected 633 extra areas in addition to the areas already affected by the third phase, covering 626,233 accounts which translated to about 3.13 million consumers.

Even though it is envisaged that the water rationing exercise will end on April 30, 2014, there was no guarantee that it will surely materialize. The reason being there is still not enough raw water storage in the dams in Selangor because the dams need time and huge amount of rainfall to bring the levels back to the pre-crisis situation.

Discussion

Many parties opined that that this water crisis in Selangor was far more severe as compared to the one which took place in 1998. A total of 6.7 million consumers were affected by the water rationing exercise, and it took longer time than expected with no concrete date as to when it will be lifted. Rain had been falling since the middle of March but the severity of the dryspell made it difficult for the situation to get back to normal in just short period of time. The parties concerned in the water supply system in the state of Selangor knew very well that its condition is very precarious as shown by Table 3. There was a water scare in December 2013 (Ithnin, 2014a) but the situation was overcome in about two weeks. The severity of the February and March 2014 dryspell was beyond the expectation of most people, even the water authorities in Selangor must have least expected to have a situation of this stature. The extremely hot weather in Selangor as shown by Table 4 dealt a severe blow to the water resources as the rate of evapotranspiration could increase due to high temperature. Very few people expected the extent of climate change on water resources in Selangor to be very profound, and as a result, when it actually happened, the water supply system grappled in order to cope with the situation.

The Langat 2 Project. In order to address the problem of insufficient water supply in the coming years in Selangor, an inter-state water transfer was envisaged. Under this scheme, water from the neighbouring state of Pahang is stored in a dam called Kelau Dam on the Kelau river which is a tributary of the Semantan river. Water released from the dam will then be drawn at intake points near Kampung Kuala Pertang on the banks of the Semantan river. The water will then be transferred to Kampung Kuala Pangsun in Hulu Langat, Selangor via 44.6 km tunnel before it is treated at water treatment plants in Selangor. This scheme will be able to supply 1,890 million liters per day of additional water to Selangor. The project was projected to be completed in 2014 (Ismail, 2009).

The 2008 general election saw a change in the government of the state of Selangor, and the political party which now controlled the state had earlier embarked on an election manifesto to provide free 20 m³ of water to consumers, and that there would be no water tariff hike within their tenure of administration. The completion and implementation of the inter-state water transfer will certainly result in a water tariff hike, as raw water from this project is to be processed at a yet-to-be-built water treatment plant called Langat 2 in Hulu Langat, Selangor. Since the plant is to be placed in Selangor, and under the Federal Constitution of Malaysia, land is state matter, therefore the present administration of the state is reluctant to agree to a completion of the project unless another issue of water services restructuring is also solved concurrently. Neither parties in this contention expected a dry spell so severe as the one that hit Selangor in February and March 2014, because had the interstate water transfer be completed according to schedule, such a severe drought could have been dealt with less pain to the consumers.

Facilities not Upgraded. On December 29, 2012 an unscheduled water supply disruption occurred in 82 areas in Kuala Lumpur and Gombak. The disruption was blamed on faulty pumps at Wangsa Maju pump house. By early January 2013, the number of consumers affected swelled to 500,000 as another pump house at Pudu Hulu Baru went out of order (Ithnin, 2014a). In the current episode of dry spell, the water treatment plants of Batu 11 Cheras and Bukit Tampoi were forced to cease operation temporarily due to high level of ammonia in the raw water. Had the filter system of the treatment plants been upgraded so that raw water with ammonia level greater than 1.5 ppm could be processed safely, then the water disruptions in the first phase of the rationing exercise could have been avoided.

The condition of the pipes in the reticulation system need urgent upgrading. There are far too many cases in which bursting pipes caused unnecessary water supply disruptions. On April 22, 2014, the situation was made worst by bursting pipes in rationing area in Zone 3 in Kepong. This caused residents in a number of housing areas such as Taman Usaha Jaya, Taman Bukit Desa, Taman Nesan and Taman Desa Jaya in Kepong to have unscheduled water disruptions (Syabas, 2014f).

Environmental Awareness of the Population. Apart from very severe dry weather, the water supply system in Selangor, and for that matter in Malaysia is beset with environmental problems. People seem to could not care less for the well being of the rivers and the raw water for that matter. At the beginning of the water crisis in Selangor, the temporary closure of the two water treatment plants of Cheras Batu 11 and Bukit Tampoi was

blamed on high level of ammonia in the raw water. On April 22, 2014 the Cheras Batu 11 plant had to withhold operation for 2 days due to diesel pollution in the Langat River which supplies the raw water (Syabas, 2014f). The problem of diesel pollution is not new to the water supply system in Selangor, it has happened many times before, and there is a good chance it happen again in the future.

Conclusion

Climate change influenced water resources to a very great extent with regard to the water crisis in the state of Selangor in Malaysia. The hot and dry weather experienced during the months of February and March 2014 was so severe that very few people expected water levels in the dams to go down so swiftly in such a short duration of time. At the same time the management of water supply in Selangor ought to embark on more prudent strategies in order to avert such a crisis to ever happen again, given the recurrent nature of the weather pattern. The water crisis of 2014 has been a very expensive affair in many aspects.

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