People’s Water and River Perceptions in the Selangor River Basin, Malaysia

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People’s Water and River Perceptions in the Selangor River Basin, Malaysia
（マレーシア国セランゴール川流域における人々の水と川に対する意識に関する研究）

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ABSTRACT

The Integrated River Basin Management (IRBM) of the Selangor River Basin or *Sungai* Selangor Basin (SSB: *sungai* = river) is challenging. The IRBM in Malaysia is with Islamic values, although there are many other religion believers, and people's water and river perceptions may be subjective and religion dependent. On the other hand, the Government has employed more objective figures such as scientific measurements and the Water Quality Index (WQI), paying less attention to lay people's subjective perceptions. For better IRBM communication, this dissertation aims to understand SSB, to understand its people's water and river perceptions, and to create SSB IRBM intelligence to propose some suggestions for effective IRBM policy, for the people's sustainable coexistence in peace and harmony.

To understand SSB, SSB's history was discussed focusing on the land and river administration the ethnic settlement pattern (ESP). Google Earth Pro aerial photos are overlapped with literature maps and clarified the administration's impact on land use.

The British changed the river-centered Sultanate to a land-centered State of Federation, creating a complex, authoritarian and top-down, Federation-centralized administration formally authorized by Sultan but actually dominated by bureaucrats, which the Malaysians succeeded. In 1999 the Selangor Water Management Authority (LUAS) was established for IRBM in Selangor, but the IRBM is still complex and challenging.

A basin-wide ESP was formed due to the colonial time ethnic group-industry association: tin-mining and rubber towns (mainly the Chinese and the Indians); plantation (mainly the Indians) and *Kampung*s (mainly the Malays). The Malay Reservation Enactment 1913 prohibited non-Malays to

own land in designated areas, the New Village Plan (1948-1960) and the New Economic Policy (1971-1991) moved mainly the Chinese to New Villages, and the New Economic Policy (1971-1991) built housing developments where the newly-born middle class Malays and other ethnic groups lived mixed. Consequently, there is a mosaic-like local ESP in an area: *Kampung*s (mainly Malays), plantations (mainly Indians), while old towns (mainly Chinese and Indians), New Villages (mainly Chinese) and housing developments (all ethnic groups). And, there is a basin-wide ESP reflecting the general land use: the downstream Kuala Selangor District is a *Kampung* and plantation area, while the upstream Hulu Selangor and Gombak Districts have many old towns, New Villages and housing developments. This pattern was confirmed by the principal component analyses of Census 2010's *Mukim* and Township level ethnic group population ratios.

To understand people's water and river perceptions, a questionnaire survey was done. Investigators visited towns in SSB and for comparison towns in/near Kuala Lumpur. The investigators mainly visited National Schools (teaching in the Malay language) and National-type Schools (Chinese and Tamil languages), Chinese and Indian temples, other schools, markets, offices, hotels, streets, *etc*, and successfully obtained religion samples of Islam and CBH (Christianity, Buddhism and Hinduism). An association was found between Religion (Islam and CBH) and sewerage treatment (Septic Tank and Sewerage System), which implies the local ESP.

Water Undrinkability Factor was Religion-dependent. Muslims were more likely to choose spiritual factors of 'Religious taboo' and 'Source,' while CBHs visual factors of 'Turbidity' and 'Color.' However, a hierarchical cluster analysis based on item choice ratio revealed both Muslims and CBHs have the same Sampling Site clustering pattern, which implies they share the same rivers.

River Water Drinkability was not Religion-dependent. Respondents with undrinkable river water tended to be more willing to pay for River Water Drinkability. At each Sampling Site, CBHs using 'Septic Tank' were more willing to pay, while Muslims were not. Respondents of higher

Household Gross Income (HGI) group tended to be more willing to pay regardless of Religion. And, while CBHs with Septic Tank were more willing to pay than those with Sewerage System in the same HGI groups, Muslims were not. This implies that CBHs were more sensitive to sanitary condition, implying the local ESP where CBHs tend to live in worse sanitary condition places. The expected willing to pay for River Water Drinkability was generally small (single digit RM/month), which implies that the demand of drinkable river water is small.

Worst Trouble of the river was associated with Religion: Muslims cared about ‘Pollution’ most in each Sampling Site, while CBH ‘Water-borne disease’ most except in BC+S. This implies the local ESP in SSB where CBHs tend to live in worse sanitary condition places than Muslims. However in towns in/near KL, their Worst Trouble are similar. On the other hand, a hierarchical cluster analysis based on item choice ratio showed that Muslims and CBHs have the Sampling Site clustering pattern, which implies that they share the same river in different ways. Consequently, there is the local ESP where CBH people tend to live in worse sanitary condition places. By the way, both Muslims’ and CBHs’ ‘Pollution’ ratios are not related to the DOE’s Water Quality Index (WQI); ‘Clean’ river water by the WQI are worried about ‘Pollution’ and ‘Water-borne disease’ in US(N) and US(S). This implies trash, garbage and debris in and around the rivers make people to judge the river water polluted.

Cramer’s V level comparisons among contingency tables indicate that Worst Trouble is a more complex problem than River Water Drinkability (RWD) and willingness to pay (WTP) for RWD, and the higher HGI is, the more regardless of Religion RWD is, which implies class-deriving living condition difference such as housing location and sanitary equipment; and the more regardless of Religion WTP for RWD is, too, which implies richer people have more leeway. Rich (HGI: 5,000 RM/month) people’s Worst Trouble is more regardless of religion than lower HGI groups.

Comparing the same respondent’s nearest rivers’ River Water Drinkability, Bathabiltiy and Religious Acts Usability revealed that regardless of Religion, drinkable river water is perceived clearest, bathable the second and religious act usable the third, although Islam and CBH's water and river related teachings and their water undrinkability factors are different.

IRBM policy makers should collect various people's opinions, because their perceptions may differ from each other and from more objective scientific measurements and the WQI-based water usability classification. People's perceptions may differ by religion, being associated with their ESP and sanitary conditions. Here there is a potential opportunity of river improvement and people's communication and cooperation.

There is little demand of directly drinkable river water for now. In its stead, the IRBM policy makers should prioritize the improvement of sanitary environments of old residential areas such as old towns, New Villages and living quarters of plantations, by *e.g.*, installation of better septic tanks or upgrading or cleaning drainages. Those who are rich, with 'undrinkable' river water, or using septic tank may be more willing to invest for the sanitary environment improvement projects. If drainage status and sewerage treatment are improved in the upstream, the river will be cleaner with less pathogens or trashes, thereby downstream people will be beneficiaries, too. If there is basin-wide communication among those who are willing to pay and beneficiaries, a stable flow of money and working force may occur, with which both economy and the environment will improve. This can contribute to people's co-working for the IRBM.

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Daigo Shimizu 清水大吾

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1. Introduction

This Chapter is the introduction of this research, describing the background (**1.1**), objectives (**1.2**), significance and contribution (**1.3**), and composition of this dissertation (**1.4**). The Integrated River Basin Management (IRBM) in Malaysia is, or at least is expected by the top level public sector stakeholders to be, based on Islam that is the constitutionally stipulated national religion. However, Sg. Selangor Basin (SSB) is a prime example of Malaysia's multi-ethnic, multi-religion society. Therefore, it is necessary for the IRBM to understand various people's water and river perceptions. And, Malaysia decides river water usability and pollution levels by more objective figures such as scientific measurements and the Department of Environment (DOE)'s Water Quality Index (WQI) for policy making, taking less care about people's subjective perceptions. However, the lay public do not judge water usability by scientifically analyzing the water or by calculating the WQI. The government's river water quality goals and people's actual use of the water may be detached from each other. This research aims to understand SSB and its people's subjective water and river perceptions, and to propose a suggestion for more effective integrated management of SSB, for people's sustainable coexistence in peace and harmony.

1.1 Background

1.1.1 Selangor River Basin Overview

The Selangor River Basin locates in northern Selangor, Malaysia, pouring into the Malacca Strait (**Figure 1.1.1-1**). The river name Selangor became the State's name since the first capital of the Selangor Sultanate was at the river mouth (Kuala Selangor).[1] The Selangor River (the main flow of the basin)'s length is about 110 km from the uppermost Fraser's Hill to the river mouth Kuala Selangor, and its basin area 2,200 km^2. The river is essential for Malaysia because it supplies 60% of water used in its most developed areas of Kuala Lumpur (KL) and Selangor.[2] 'River' is 'sungai' in Malay and the river is locally often called Sungai Selangor (Sg. Selangor). This dissertation adopts the local name and from now on calls the basin Sg. Selangor Basin (SSB). The SSB's water quality is monitored by Department of Environment (DOE), Malaysia,[3] and Sg, Selangor water is deteriorated due to agriculture, municipal and industrial wastewaters, *etc*.[4]

Figure 1.1.1-1 Selangor[5] and Sg. Selangor Basin[5,6]

Figure 1.1.1-2 shows SSB's sub-basins (sbs)[7] shown over Google Earth Pro's 2016 aerial photo with waters emphasized by 'Water Only'[8] available in Snazzy Maps and roughly classified land use. SSB has no natural lake but two dams (Sg. Selangor Dam and Sg. Tinngi Dam) and numerous ex-tin mining ponds. Towns are mainly in the ex-tin mining areas of the upstream, Bestari Jaya, and Kuala Selangor the ex-capital at the river mouth. SSB is adjacent to the capital area of Klang Valley that includes KL and Shah Alam. The upstream towns have been connected by railway from north to south to KL and then westward to Port Swettenham (renamed Port Klang in 1972) by railway since the end of the 19th century, originally for the tin mining industry.[9] The downstream Kuala Selangor sb is used mainly for agriculture (mainly for oil palm plantations). **Figure 1.1.1-3** shows a time series of Google Earth Pro aerial photos from 1996 to 2016, illustrating the rapid urbanization of SSB, particularly of Rawang sb.

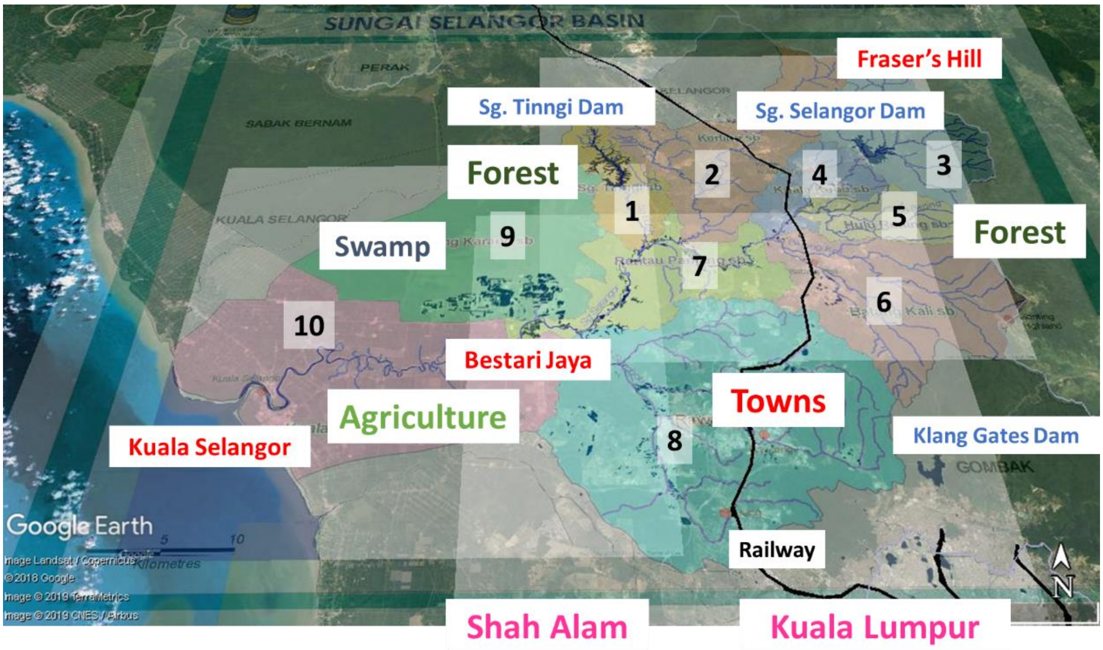

Figure 1.1.1-2 SSB's Sub-basins[7,8] and Land Use

1. Sg. Tinngi sub-basin (sb), 2. Kerling sb, 3. Ulu Selangor sb, 4. Kuala Kubu sb., 5. Rening sb, 6. Batang Kali sb, 7. Rantau Panjang sb. 8. Rawang sb, 9. Tanjung Karang sb. 10. Kuala Selangor sb

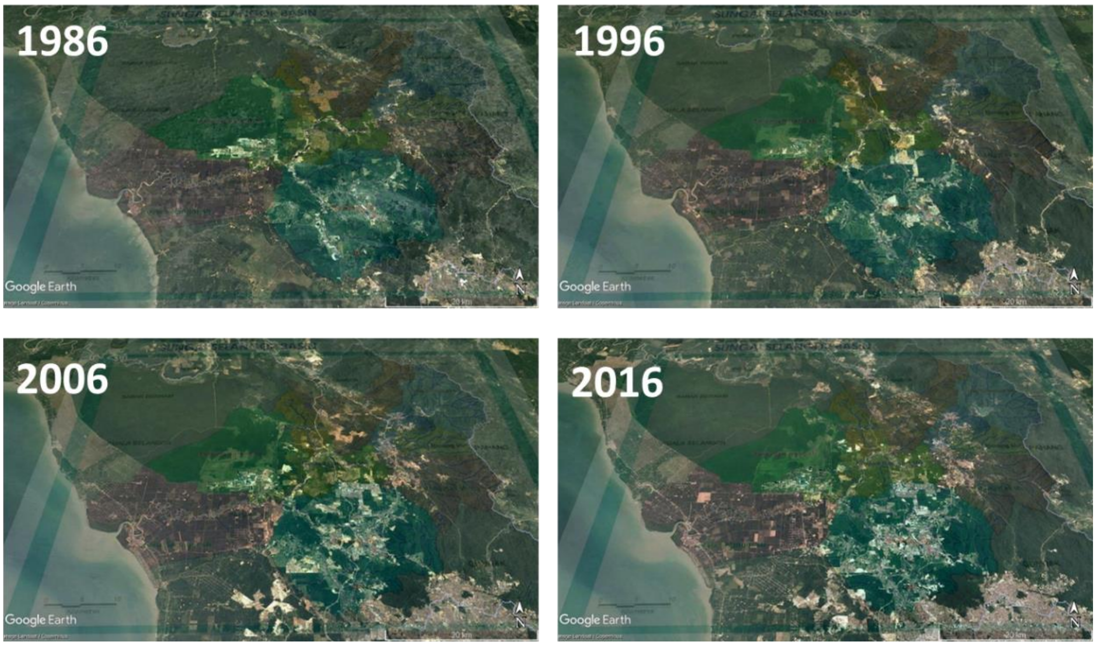

Figure 1.1.1-3 Historical Change of Land Use in SSB[7] (Aerial Photos by Google Earth Pro)

1.1.2 Integrated River Basin Management in Selangor, Malaysia

1.1.2.1 Definition and Aim

Integrated River Basin Management (IRBM) is the overall management of everyone and everything involved in the river basin. The IRBM in Selangor, Malaysia is characterized by the purpose of maximizing human welfare and the Government's religion of Islam. Malaysia regard IRBM as a subordinate concept of Integrated Water Resources Management (IWRM);[10] and the Department of Irrigation and Drainage (DID)[11], the Federal administration body in charge of IRBM in Malaysia, adopts the definition of IWRM of Global Water Partnership Technical Advisory Committee (GWP TAC)'s.[11] The DID's IRBM definition is:

> '*the process of coordinating conservation, management and development of water, land and related resources across sectors within a given river basin, **in order to maximize the economic and social benefits** derived from water resources in an equitable manner while preserving and, where necessary, restoring freshwater ecosystems.*[12]
>
> (Note: bold emphasis by author)

For clarifying the characteristic of the DID's definition of IRBM, let's compare it with that of World Bank:

> IRBM '*aims to establish a framework for coordination whereby all administrations and stakeholders involved in river basin planning and management can come together to develop an agreed set of policies and strategies **such that a balanced and acceptable approach** to land, water, and natural resource management can be achieved.*'[13]
>
> (Note: bold emphasis by author)

Although the descriptions means almost the same, comparing between the bold emphasized descriptions emboss that the DID's IRBM prioritizes the economy and the society over the nature.

1.1.2.2 Administration

It is not inappropriate to start discussing the IRBM of SSB with administration bodies, because they are very important stakeholders having legitimate public power and authority unlike other stakeholders such as ordinary people, universities, NGOs or NPOs. The IRBM administration in Selangor, Malaysia is extremely complex, which overwhelms even Malaysian IRBM researchers, who voice in unison '*Even Malaysians don't know*.' Therefore, briefly described here are the central IRBM administration bodies of Malaysia's (the Federal Department of Irrigation and Drainage, DID) and Selangor State's (the Selangor Waters Management Authority (SWMA) a.k.a. Lembaga Urus Air Selangor (LUAS)), respectively.

Malaysia is a constitutional monarchy Federation that consists of thirteen States and three Federal Territories, among which is the Selangor State. The Federal DID is the main Federal administration body responsible for IRBM, and there is a State DID in each State under the Federal DID.[14] Now the DID belongs to Ministry of Water, Land and Natural Resources. Malaysia's IRBM administration is extremely jurisdictionally complex. Ex-Federal DID Director General Dato' Ir. Haji Keizrul bin Abdullah says in his article in the DID Official Website that there are over 100 jurisdiction-conflicting and overlapping water and river-related laws in Malaysia which regulate mainly about use but less about protection of water resources.[15] The Dato' listed Malaysia's urgent river and water problems: water shortage, flooding, river water pollution, river sedimentation and suquatters,[15] each of which associates with every environmental, social or political issue, being unsolvable by one single law or administration body or a segmented administration system.

Selangor is a constitutional monarchy State of the Federation. Jurisdiction of 'rivers' totally within the State in in the State List in the Federal Constitution.[16][i] LUAS was established in 1999 to integrate river basin and water resources management by coordinating related Federal and State agencies.[17] LUAS is a statuary authority of the State, being Sultan's advisory body with its State's Menteri Besar (Chief Minister) as Chairman and the Director General of Federal DID as a permanent member.[18] LUAS's jurisdiction is limited within the State territory, although some river basins are inter-state; *e.g.*, the uppermost Fraser's Hill half belongs to the Pahang State. The 2005 amendment of the Federal Constitution transferred 'water supply and services' jurisdiction from the State List to the Concurrent List, by which the Selangor State lost the exclusive power of licensing and supervising water supply treatment and billing.[19] And by the Water Services Industry Act 2006 (WSIA 2006), water supply and sewerage services are licensed and supervised by the National Water Service Commission (a.k.a. Suruhanjaya Perhkidamatan Air Negara, SPAN) [20] under the Ministry of Energy, Green Technology and Water, Federal Government. However, the 2005 amendment of Federal Constitution did not touch 'water resources of states including rivers, water catchment areas and groundwater.'[19] In fact, the LUAS is licensing and supervising groundwater and surface water abstraction[21] that is regarded excluded from 'water supply and services.' This can be interpreted that groundwater and surface water are 'water resources' governed by the State just until abstraction, and then the water apart from the natural sources is subject to 'water supply and services' governed by the Federation.

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[i] As is explained in Chapter 2, a river was the unit of rule of a Malay sultanate. The British introduced bureaucracy and federal system. The Federal government seems to have been gradually penetrating the essential power of States.

Malaysia's administration is characterized as authoritarian, top-down and Federation-centralized, and virtually ruled by elite bureaucrats under the formal authority of the King and Sultans. This derives from the fusion of traditional Sultan's authority and the British-introduced systems of colonial bureaucracy and Federation that preserved and took advantage of the Sultans authority.[22]

1.1.2.3 Islam in IRBM

Islam is the religion of the Federation.[16] The above-mentioned Dato' Ir. Haji Keizrul bin Abdullah's article starts with '*RIVERS -A GIFT OF GOD!*.'[15] Recalling that the article was in the official website of the DID, a public office, his words clearly reflects not only his personal faith but also the stipulation of the Federal Constitution:

> '*Islam is the religion of the Federation; but other religions may be practised in peace and harmony in any part of the Federation*'[16]

Islam is the religion of the Selangor State, too.[23] The IRBM of SSB could be not only simply a secular matter but also a religious matter for the top level government stakeholders, *e.g.*, Sultan and Menteri Besar (Chief Minster). The LUAS is Sultan's advisory body whose Chairman is Menteri Besar,[18] and the State Constitution stipulates that both Sultan and Menteri Besar have to be Malay and Muslim,[23] and Sultan, in particular, is the head of Islam in the State.[16] His Majesty the Sultan Sharafuddin Idris Shah of Selangor announces that

> the LUAS '*must manage Selangor's water resources holistically for the welfare of the people. This is important to ensure there is sufficient water in all the dams so that water supply for homes and industries are not disturbed.*'[24]

And about water environmental preservation, the Sultan continues that he wants water environment protection to have

> '*the concept of man as Allah's caliphs on earth to be reflected in the preservation of the ecosystem, biodiversity, flora and fauna which are God's gift to mankind.*'[24]

According to a book "Islam, Wildlife Conservation & You" from Institute of Islamic Understanding Malaysia (IKIM) and World Wide Fund for Nature-Malaysia (WWF-Malaysia), human beings have to '*be kind to land and water*' as human beings are *caliph*s ('*who governs and manages the world*') and '*responsible to take care of the land or earth*' that God created.[25] The book tells Muslims that their faith teaches an Islamic world view and what they should and should not do for environment protection.

Islam teaches not only about the world view but also about daily life of Muslims, and Islam has restrictions and criteria of water use.[26] For example, Mokhtar *et al.* (2015) listed seven pure water sources: rain, sea, river, well, spring, snow and dew, and impurities which may ruin water purity: feces and blood, discharge of sperm and menses, odor, taste, and color.[26] Non-Muslims, including author, may get surprised at why Muslims' 'religion' teaches practical water use, but it is their 'religion' includes what non-Muslims call 'secular' matters. We have to understand what a 'religion' includes depend on its believers. And, it might sound strange and wired that an engineering dissertation brings up a religion topic, too. However, in Malaysia, being *halal* (religiously lawful) surely matters in water engineering. For example, powdered activated carbon for water treatment has to be certified as *halal*, because activated carbon may be made from pig manure which is unlawful in *Shariah*[ii] (Islamic Law).[27] Islam is the government's religion, and governs Muslims' world view and daily life. Therefore, the IRBM of SSB cannot ignore the religion, because, needless to say, the government is one of the most important stakeholders of the governance of the basin, and Muslims are the majority of the population there as described later in **1.1.3.2** . However, at the same time, Islam is a religion which is not for all individuals in Malaysia. Malaysian people live together with balancing various believers of various religions.

The Islamization of Malaysia has been getting stronger since the 1980s, which was symbolically visualized as Muslim women's swearing a *hijab* (headscarf).[28] When the author visited IKIM (Institute of Islamic Understanding Malaysia), a professor there proudly stated without hesitation that Islam was for everybody and the core of everything, which shocked and interested the author. This implies that there was a cultural gap between the faithful IKIM professor and an ordinary non-Muslim Japanese engineering student. For the author as a foreigner who walked around SSB towns and KL, seeing different religion people seriously praying in their respective ways, it is naturally unimaginable that all Malaysian individuals will be religiously united in any expectable future. A Malaysian scholar, Mohamed Mustafa Ishak, who propounds '*unity in diversity*,' writes that Islam is the most difficult Malay component to be adopted by non-Muslim Malaysians, compared with other political and cultural components.[29] However, of course, Islam should be respected in the IRBM in Malaysia as it is the government's and the majority's religion there (**1.1.3.2**).

Religions may cause problems.[29] Pig farming, for example, is a prime cause of inter-religion problem involving Muslims, since pigs are tabooed by Muslims. Husin Ali (2008) describes:

> '*if a Chinese peasant living upstream rear pigs, and the river is used by Malays far*

[ii] '*Shariah*' literally means the pathway to water.[26]

downstream for bathing and taking ablution, then a major and violent clash could easily happen.'[30]

There is no pig farm in SSB. According to "Sungai Selangor Basin Management Plan 2007-2012" (DID Malaysia, 2007), there used to be five '*zero-discharge*' pig farms in the basin in 2004.[31] This means that once the pig farming industry applied the '*zero-discharge*' technology, but the technology was technically or socially unsatisfactory there. In 2014, the authority decided that all pig farms in Selangor were to be relocated to a modern centralized farm in 2018 due to the contamination problem,[32] and Ladang Tumbuk in Kuala Langat, was chosen for the location.[33] Although there reported to be some protests regarding this controversial solution,[34,35] there was no critical inter-ethnic violence reported, which means that Malaysia's peacefulness is not seriously affected by such a thing today.

In Selangor, Malaysia, the IRBM by the government is characterized in its purpose of *'maximizing economic benefits social well-being*,'[12] and Islam. On the other hand, SSB is a multi-ethic, multi-religious society and there are inter-ethnic and inter-religious problems. Therefore, the IRBM of SSB also has to consider other religions '*in an equitable manner*'[12] to be able to sustain the peace and harmony there forever.

1.1.3 People in Sg. Selangor Basin

1.1.3.1 Ethnic Diversity in Sg. Selangor Basin

People are the stakeholders of IRBM, and SSB is a prime example of ethnic diversity of Malaysia. **Figure 1.1.3.1-1** shows the populations and Ethnic Group ratios of SSB-related Local Authorities ('SSB-LAs' in **Figure 1.1.3.1-1**) reported by Census 2010.[36] The SSB-LAs are Majlis Daerah Hulu Selangor (MDHS), M.D. Kuala Selangor (MDKS) and Majlis.Perbandaran Selayang (MPS) and M.D. Raub (MDR), Pahang that has a part of Fraser's Hill. The SSB-LA population is somewhat an overestimate of SSB population, because it includes populations of non-SSB parts of the SSB-LAs. Therefore, the SSB population is estimated to be somewhat less than 943,344, consisting of Malays (60%), Other Bumiputera (1%), Chinese (18%), Indians (18%), Others (1%) and Non-Malaysian citizens (Non-citizens) (7%). SSB is a little more Malay and Indian, and less Chinese than whole Selangor.

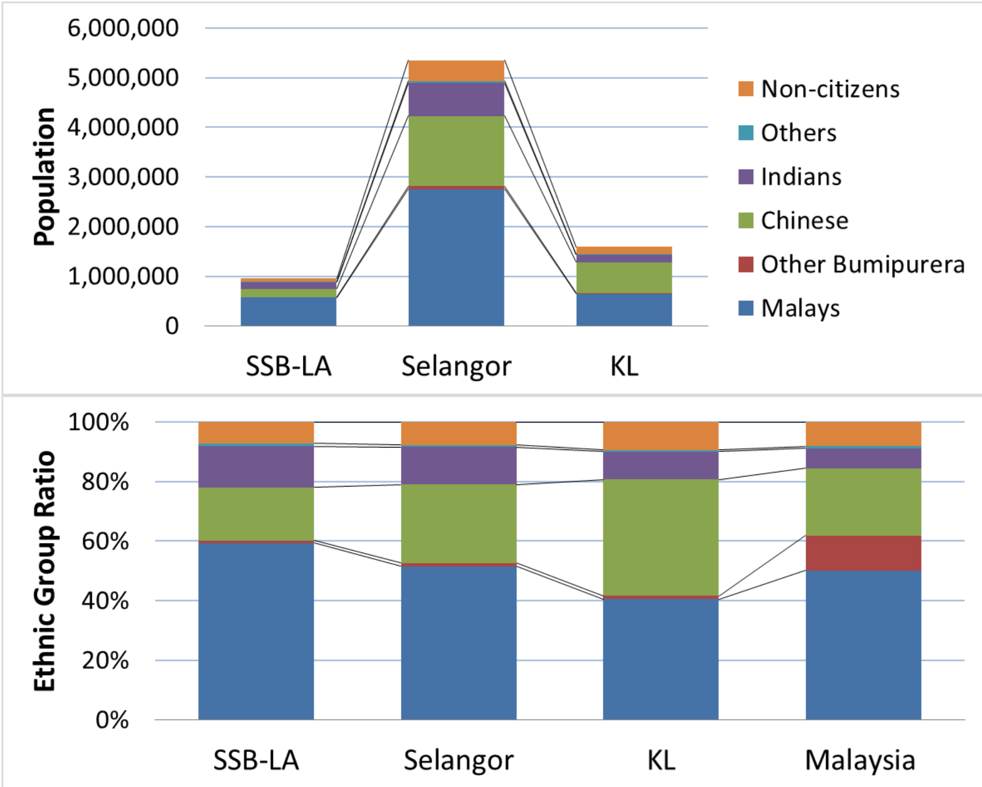

Figure 1.1.3.1-1 Population and Ethnic Group Ratio in Malaysia[36]

1.1.3.2 Religious Diversity in Sg. Selangor Basin

People are stakeholders of IRBM, and SSB is a prime example of religion diversity of Malaysia. **Figure 1.1.3.2-1** shows Ethnic Group-based Religion Ratio in Selangor.[37] The Malays are 100% Muslims, because the Federal Constitution's requires Malays to be Muslim,[16] and perhaps because the Census 2010 is strictly official. Chinese are mostly Buddhists[iii], and Indians Hindus. Christians include all ethnic groups except Malays.

[iii] Chinese Buddhism is in general a syncretism of Buddhism and other traditional Chinese religions such as Confucianism and Taoism. Therefore, the religion categorization in Census 2010 may be problematic for most of the Chinese. They may have preferred 'Buddhism' to 'Confucianism, Taoism and Tribal/folk/other traditional Chinese religion' when asked in Census 2010 about his/her religion, for 'Buddhism' sounds more religious. The 'Buddhist' Chinese in general have no reason for strictly avoiding Confucianism or Taoism.[38]

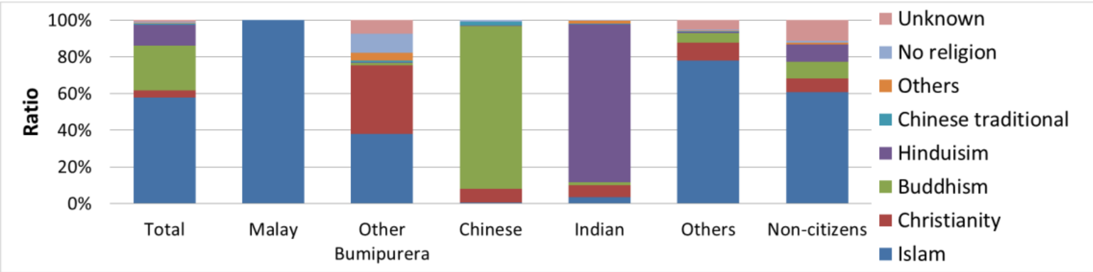

Figure 1.1.3.2-1 Ethnic Group-based Religion Ratio in Selangor[37]

SSB-LA's Religion-based populations and Religion ratios were estimated from Township-based ethnic group populations[36] and the Selangor's ethnic group-religion ratios (**Figure 1.1.3.2-1**), assuming that all Township have the ethnic group-religion ratios exactly the same as whole Selangor. As a result, in SSB-LA, Islam is 66%, Christianity 4%, Buddhism 17%, Hinduism 13%, Confucianism, Taoism and Tribal/folk/other traditional Chinese religion (Chinese traditional) 0.4%, Other religion (Others) 0.4%, No religion 0.3% and Unknown 1%. SSB-LA are a little more Muslim and less Buddhist than whole Selangor (**Figure 1.1.3.2-2**).

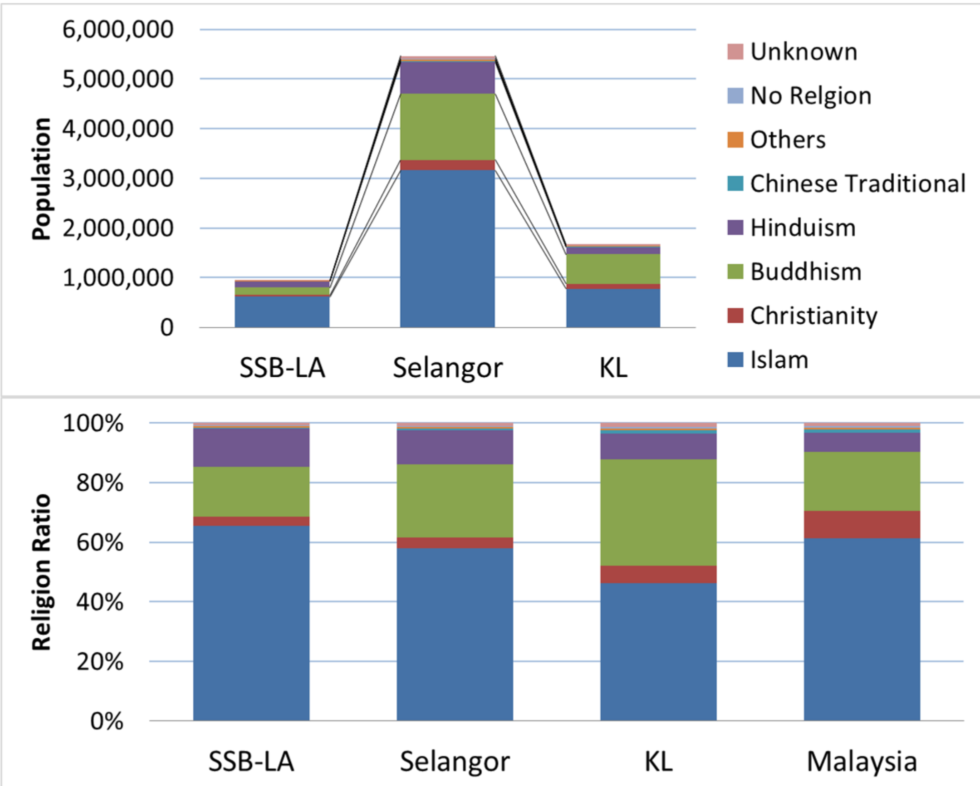

Figure 1.1.3.2-2 Population and Religion Ratio in Malaysia[37]

1.1.4 Water and River Perceptions

1.1.4.1 Subjective Perception

It is said that a person (subject) perceives a thing (object) subjectively (in the mind) and/or objectively (not in the mind or transcendentally) (**Figure 1.1.4.1-1**). Subjective perception may depend on the person's gender, ethnicity, culture, religion, custom, education, age, income level, condition and situation, *etc*., while objective perception may not. Some people may say that a subject and an object are completely opposite two, while others may say that a subject and an object are same and essentially one or zero. However, it is practically safe to think that being subjective/objective as in the same dimension, that there is no absolute subjectivity or objectivity and their relative difference is a matter of degree, and that being subjective/objective is not a matter of correct/wrong, true/false or majority/minority. This way of thinking is realistic, because it is in technique and perhaps also in principle impossible to strictly separate person's subjective and objective perceptions. For example, experts may have scientific measurement data in mind which are mixed with which his/her subjective perceptions; and lay people are more or less able to understand and accept experts' science. Here, due to the relativity of subjectiveness and objectiveness, we can, for descriptive purposes until bringing up more objective water quality perception such as WQI, regard a perception as subjective a perception and postpone degreeing its subjectivity/objectivity (**1.1.4.2**). In other words, without corresponding more objective perception (*e.g*., scientific measurement data), a perception is regarded and described as 'subjective perception' or simply 'perception.' We can practically think that there is no perfectly subjective/objective perception in human mind. This dissertation's Questionnaire Survey (QS) (**Chapter 3**) aims to know people's perceptions in this meaning (**Figure 1.1.4.1-1**).

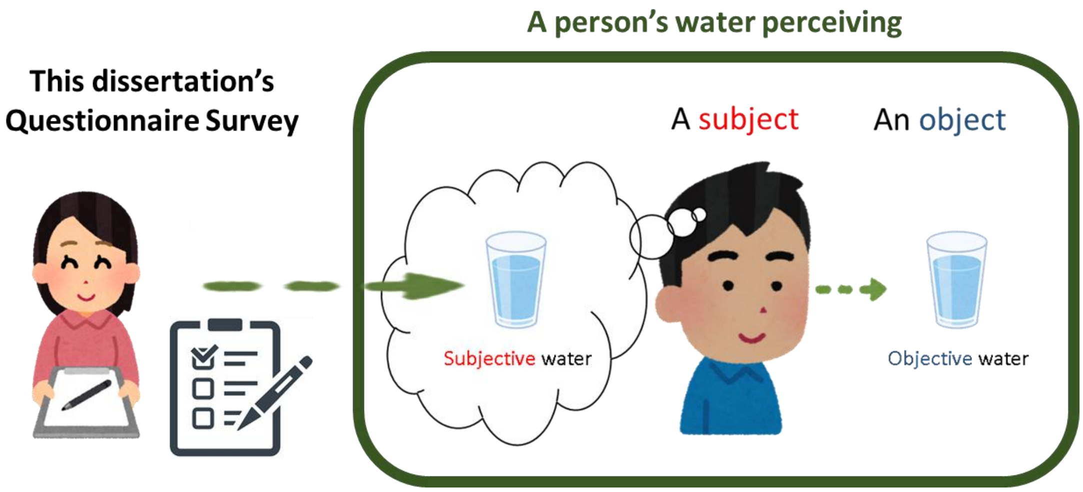

Figure 1.1.4.1-1 A Person's Water Perceiving and This Dissertation's Questionnaire Survey

1.1.4.2 Objective Perception

More objective judgement of usability of water and a river is often represented by a Water Quality Index (WQI)-based classification in policy making scenes. A WQI is a single number water quality indicator which represents water quality by integrating various physico- and bio-chemical and bacteriological water quality parameters.[39,40] The top advantage of WQI is that it is simple and useful for policy making communication, because it is difficult for non-water experts to understand various water quality parameters.[41] Malaysia's National Water Quality Index (NWQI) was established in 1985 by the government's project called Development of Water Quality Criteria and Standards for Malaysia that gathered multidisciplinary experts' opinions.[42] Although NWQI can be seen as a subjective perception of the collective experts, NWQI is more objective (more independent from personal bias) than raw human organoleptic senses, because NWQI is formulated based on parameters measured by certain methods following respective criteria and standards. NWQI is a linear sum of six sub-indices of respective parameters: dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD), ammoniacal nitrogen (AN), suspended solid (SS), and pH. NWQI is classified into five usability classes and three pollution classes (**Table 1.1.4.2-1**)[31,43]. An NWQI value is regarded as an objective perception of water usability and pollution levels, for the thresholds are fixed. A relative relationship of being subjective/objective among religions, senses, WQIs, measurements and tools are illustrated in **Figure 1.1.4.2-1**.

Table 1.1.4.2-1 Malaysia's National Water Quality Index and its Classifications[31,43]

Usage Classification

Class	Env. Cons.*	Water supply	Drinking	Bathing	Fishery	Livestook	Irrigation
I	OK	No treatment needed	OK	OK	Very sensitive spieces	OK	OK
II a		Conventional treatment		OK	Sensitve species	OK	OK
II b							
III		Extensive treatment			Common, torelant species	OK	OK
IV							OK
V							

Class	WQI	DO (mg/L)	BOD (mg/L)	COD (mg/L)	AN (mg/L)	pH	TSS (mg/L)	FC**	TC***
I	>92.7	>7	<1	<10	<0.1	>7	<25		
II a	76.5-92.7	5-7	1-3	10-25	0.1-0.3	6.0-7.0	25-50	100	5,000
II b								400	5,000
III	51.9-76.5	3-5	3-6	25-50	0.3-0.9	5.0-6.0	50-150		
IV	31.4-51.9	1-3	6-12	50-100	0.9-2.7	<5.0	150-300		
V	<31.0	<1	>12	>100	>2.7	<5.0	>300		

*Natural environment conservation.

**Fecal coliform (Counts/100mL; geometric mean)

***Total coliform (Counts/100mL)

WQI = (0.22* SIDO) + (0.19*SIBOD) + (0.16*SICOD) + (0.15*SIAN) + (0.16 * SISS) + (0.12 * SIpH)

where,

DO (%saturation)	SIDO
x ≤8	0
8<x <92	-0.395+0.030x^2-0.0002x^3
x≥92	100

BOD (mg/L)	SIBOD
x ≤5	100.4-4.23x
x>5	108*exp(-0.055x)-0.1x

COD (mg/L)	SICOD
x ≤20	-1.33x+99.1
x>20	103*exp(-0.0157x)-0.04x

AN (mg/L)	SIAN
x ≤0.3	100.5-105x
0.3<x <0.4	94*exp(-0.573x)-5*|x-2|
x ≥0.4	0

SS (mg/L)	SISS
x ≤100	97.5*exp(-0.00676x)+0.05x)
100<x <1,000	71*exp(-0.061x)-0.015x
x≥1,000	0

pH	SIpH
x <5.5	17.2-17.2x+5.02x^2
5.5 ≤x<7	-242+95.5x-6.67x^2
7 ≤x<8.75	-181+82.4x-6.05x^2
x>8.75	536-77.0+2.76x^2

Pollution Classification

	WQI	SIBOD	SIAN	SISS
Clean	81-100	91-100	92-100	76-100
Slightly Polluted	60-80	80-90	71-91	70-75
Polluted	0-59	0-79	0-70	0-69

Figure 1.1.4.2-1 Relative Relationship of Being Subjective/Objective

NWQI is not free from criticism. The simpleness is a two-edged blade. It may be too simple with only six parameters, lacking critical parameters such as phosphorus and toxic chemicals. Fulazzaky *et al.* (2010) suggests that alteration is needed for NWQI's not considering important parameters of oxidized organic matter, nitrogen matter, nitrate, phosphorous matter, suspended particles, color, temperature, mineralization, acidification, microorganisms, phytoplankton, mineral micropollutants in raw water, metals in bryophytes, pesticides in raw water, and organic micropollutants nonpesticides in raw water.[4] The simpleness of NWQI might have disadvantage in policy making communication. NWQI could become uncontrollable by water experts in a policy making scene, too, because the water experts' detailed science behind the WQI value may be just appendix for other non-water expert policy makers who just want the simple number as a goal. NWQI is indeed useful, but may need improvement itself and/or with other support parameters and/or with more subjective parameters.

1.1.4.3 Subjective and Objective Perceptions in Concert

To find a union of subjective-objective perceptions is the essence in IRBM. The IRBM have concepts of, say, being '*equitable,*[12]' '*balanced and acceptable*[13]' (**1.1.2.1**), which are more subjective rather than objective. However, people's subjective perceptions (*e.g.*, those from religions and senses, *etc.*) of water and river have been less emphasized than more objective perception (*e.g.*, measurements and WQI, *etc.*) in IRBM administration. Malaysia's NWQI, which considers objective parameters only, needs to be in concert with subjective perceptions of people who are with the river. Although NWQI was established by experts and is useful for policy makers, it does not reflect lay people's perceptions. NWQI analytically focuses on the six water quality parameters only and excludes other quality of water and its environment, but people's water and river perceptions may be more subjective and contextual. This may cause discrepancy between NWOI-based water usability classificatioon and people's actual use of the water. For example, if a glass of water is on a clean and desk a water expert explains that he/she has measured numerous water quality parameters and the water is safe in terms of sanitary, a lay person may drink it. However, if the same glass is beside a river with trash and debris and there is no expert beside it, the person may not drink it. If the glass is beside a filtering machine just next to a container labeled 'pig urine,' a Muslim may not drink it without a *Shariah* expert's opinion. If the same measured quality water, with no pig origin content or treatment, is in a sealed pet bottle labeled with a *halal* mark, the Muslim may drink it, trusting the certification. A rich person may drink imported pure mountain water only. A poor person may drink low quality river water which experts never recommend to do so, because he thinks it fairly drinkable. It is one thing that a glass of water is drinkable in sanitary terms, but it is quite another that a person perceives the water drinkable, and *vice versa*. Current NWQI-based water quality policy making takes less care about the subjectivity and context-dependency of water quality. Water environmental policy making should consider not only water but also people who live in the environment, for water quality goals and people's actual use of the water are possible to be detached from each other.

1.2 Objectives of This Research

Following the Background (**1.1**), the objectives of this research are: ①To understand SSB; ②To understand SSB people's subjective water and river perceptions; ③To create IRBM intelligence from ① and ② (illustrated in **Figure 1.2-1**). As explained in the previous Background section (**1.1**), Islam is a significant religion in the top level public sector stakeholders of the IRBM in Selangor, while SSB is a multi-ethnic and multi-religion river basin, where religions, Islam, in particular, may be playing practical roles in the people's subjective water and river perceptions. Malaysia's current water quality policy making should consider not only water but also people who live in the environment, because NWQI-based water quality goals and people's actual use of the water may be different from each other. The final goal of this dissertation is to contribute to the people's sustainable coexistence in peace and harmony.

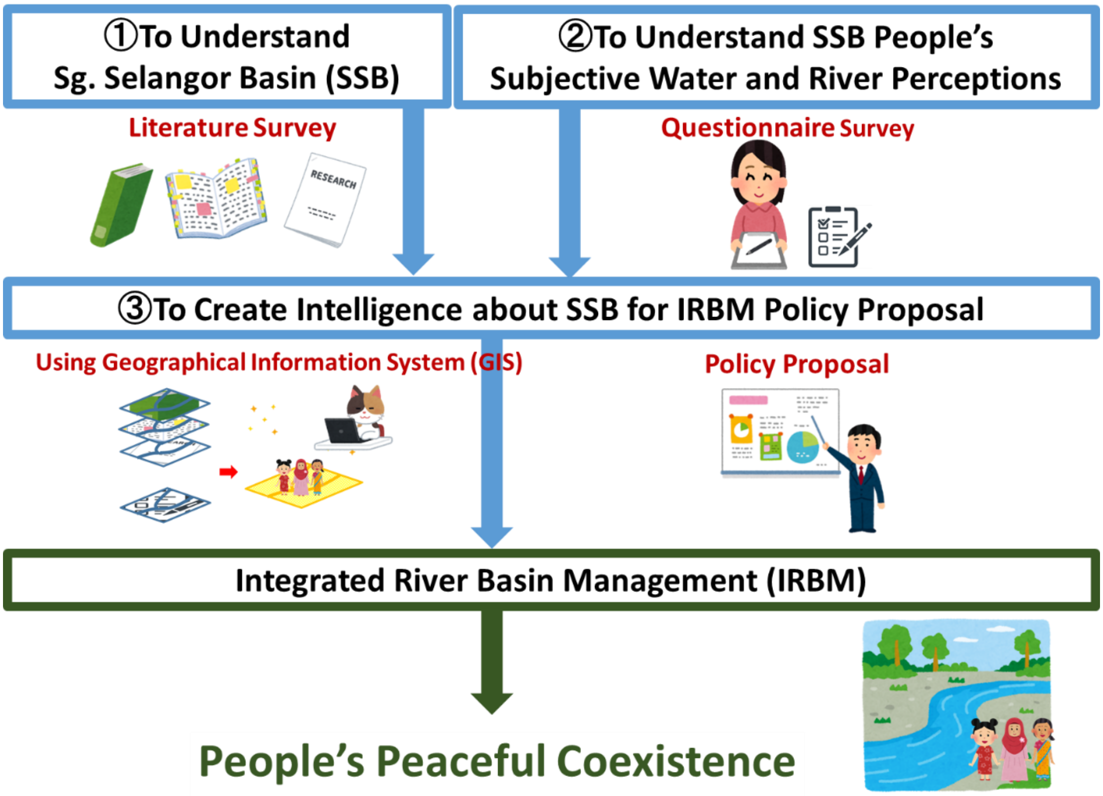

Figure 1.2-1 Objectives of This Research

1.3 Significance and Contribution

Malaysia's IRBM administration is done with Islamic values. However, in order to implement IRBM, *e.g.*, in comprehending people's risk and ecosystem services perceptions, it is essential to collect and consider various people's opinions. However, in Malaysia, there have been no research which geographically and demographically surveyed people's water and river perceptions based on religion and sanitary condition, with surveying historical background of the administration and people.

There have been subjective water perceptions studies in Malaysia mainly for tap water services evaluation purposes, but none of them directly compare religion samples. This research collected religion samples for comparing their water perceptions in the first place, which is unique in Malaysia. And, this research, as far as the author knows, is the first subjective water quality investigation in the world to include religion-related water quality factors such as 'Religious taboo' and 'Source' for directly comparing with traditional organoleptic items such as 'Taste,' 'Odor,' 'Turbidity,' 'Color,' *etc.* This is important, because people may regard water not only physical but spiritual existence.

This dissertation is expected to contribute to the IRBM of SSB by providing intelligence based on data of people’s water and river perceptions, which is a reference for inter-stakeholder communication.

1.4 Composition of This Dissertation

Following the above Objectives (**1.2**), the composition of this dissertation is illustrated in **Figure 1.4-1**.

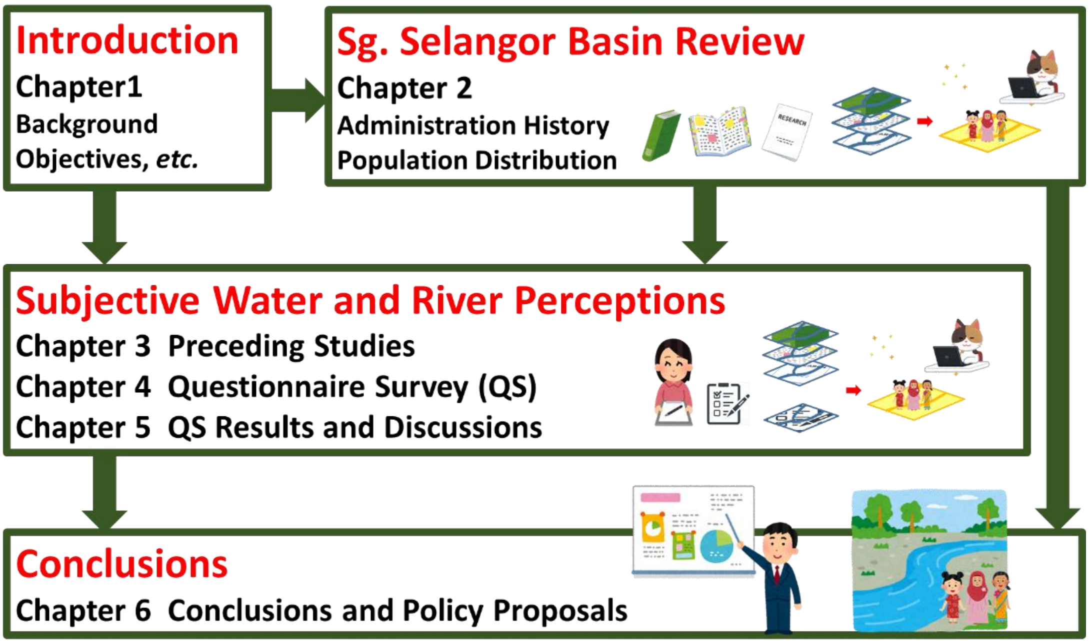

Figure 1.4-1 Composition of This Dissertation

This dissertation uses literature maps overlapped with Google Earth Pro’s aerial photos to clarify the administration’s impact on the land use of SSB, as shown in **Figure 1.1.1 2** and **Figure 1.1.1 3**.

Chapters 1-6 are formulated as follows.

Chapter 1 is the current Chapter and explains the background, objectives and composition of this dissertation

Chapter 2 describes a brief history of SSB from IRBM viewpoint, focusing on land use and river administration, and people’s ethnic settlement pattern, explaining the transition of Selangor from a pre-colonial river-centered Sultanate to a land-centered State, the complex, authoritarian and top-down administration and main IRBM administration bodies, and the ethnic settlement pattern in Census 2010.

Chapter 3 describes the literature review of preceding studies on subjective water and river perceptions and then the significance and originality of this dissertation. The immediately related preceding studies are of: engineering and psychology studies aiming to bridge subjective and objective water and river perceptions; risk perceptions studies aiming to manage by quantifying subjective and objective risks; ethnohydrology studies aiming to understand water in cultural context.

Chapter 4 describes "Questionnaire Survey on the People's Water and River Perceptions (QS)" implemented in SSB in July and August, 2017. The QS was done for understanding people's subjective water and river perceptions, and copies of Survey Sheet were handed to respondents in SSB and also in KL and its surroundings for comparison. The Survey Sheet questioned respondents about their water and river perceptions, geographic and demographic properties and sanitary condition such as Religion, Household Gross Income (HGI), Sewer Water Treatment (SWT), *etc.*

Chapter 5 describes the results and discursions of the QS based on Sampling Site, Religion, HGI and SWT. Comparisons were done between the QS results with the NWQI calculated from the monitoring by DOE and microbial pollution data by Shimizu and Kondo (2014).[44]

Chapter 6 describes the final conclusions and suggestions for the IRBM of SSB.

References

1. Gullick, J. M. *Glimpses of Selangor 1860-1898*. (The Malaysian Branch of the Royal Asiatic Society, 1996).
2. *Land Use Dynamics and Governance in the Sungai Selangor Watershed*. (University Malaya Press, 2015).
3. Daud, H. Water Quality (river) Monitoring System/Programme and Pollution Control. (2008).
4. Fulazzaky, M., Seong, T. & Masirin, M. Assessment of Water Quality Status for the Selangor River in Malaysia. *Water. Air. Soil Pollut.* **205**, 63–77 (2010).
5. Selangor. *Wikipedia* https://en.wikipedia.org/wiki/Selangor.

6. LUAS. Kawasan Lembangan Sungai, Tadahan Air, Had Pelabuhan, Empangan dan Pantai-pantai Di Selangor. *Portal Rasmi LUAS* https://www.luas.gov.my/index.php?option=com_content&view=article&id=695%3Akawasan-lembangan-sungai-tadahan-air-had-pelabuhan-empangan-dan-pantai-pantai-di-selangor&catid=86%3Apelan&Itemid=184&lang=en (2014).
7. LUAS. IRBM Approach in Water Quality Management - Case Study in Sungai Selangor River Basin. (2008).
8. Anonymous. Water Only. *Snazzy Maps* http://snazzymaps.com (2014).
9. Fisher, C. A. The Railway Geography of British Malaya. *Scott. Geogr. Mag.* **64**, 123–136 (1948).
10. Mokhtar, M. B., Toriman, M. E. H., Hossain, M., Abraham, A. & Tan, K. W. Institutional Challenges for Integrated River Basin Management in Langat River Basin, Malaysia. *Water Environ. J.* **25**, 495–503 (2011).
11. River Management - Activities - River Management. *Official Portal for Department of Irrigation and Drainage* https://www.water.gov.my/index.php/pages/view/461.
12. Global Water Partnership Technical Advisory Committee (TAC). Integrated Water Resources Management. *TAC Backgound Pap.* **4**, (2000).
13. Millington, P., Olson, D. & McMillan, S. *Integrated River Basin Management: From Concepts to Good Practice (English)*. 1–20

http://documents.worldbank.org/curated/en/965371468340137430/An-introduction-to-integrated-river-basin-management (2006).

14. DID Malayisa. Organisation Chart. *Official Portal for Department of Irrigation and Drainage* https://www.water.gov.my/index.php/pages/view/491?mid=229 (2018).

15. Dato' Ir. Haji Keizrul bin Abdullah. Integrated River Basin Management Report: Towards Realising Integrated River Basin Management in Malaysia. *Official Portal for Department of Irrigation and Drainage* https://www.water.gov.my/index.php/pages/view/708 (2018).

16. Malaysia. *Federal Constitution*. (The Commissioner of Law Revision, Malaysia, 2010).

17. LUAS. Integrated River Basin Management (IRBM) Plan. *Portal Rasmi LUAS* https://www.luas.gov.my/index.php?option=com_content&view=category&layout=blog&id=69&Itemid=154&lang=en (2017).

18. Selangor. *Selangor Waters Management Authority Enactment 1999*. (LUAS, 1999).

19. Mustafa, M. *Environmental Law in Malaysia*. (Kluwer Law International, 2011).

20. Malaysia. *Water Services Industry Act 2006*. (The Commissioner of Law Revision, Malaysia, 2006).

21. LUAS. Application of Groundwater and Surface Water Abstraction License. *Portal Lasmi LUAS* https://www.luas.gov.my/index.php?option=com_content&view=article&id=112&lang=en (2017).

22.萩原宜之. マレーシア政治論—複合社会の政治力学. (弘文堂, 1989).

23.Selangor. Constitution of the State of Selangor. (1959).

24.Panirchellvum, V. Selangor Ruler Calls for Amendments to Honorary Title Laws (updated). *The Sun Daily* (2016).

25.Yamin, R. A. M. & Yang, A. B. *Islam, Wildlife Conservation & You*. (Institute of Islamic Understanding Malaysia (IKIM), World Wide Fund for Nature (WWF-Malaysia), 2013).

26.Mokhtar, M. I., Abdullah, R. & Baharuddin, A. An Islamic Perspective on Water Quality: A Case of Malaysia. *Water Policy* **17**, 454 (2015).

27.Wibisono, Y., Sucipto, S., Perdani, C. G., Astuti, R. & Dahlan, M. Halal Compliance on Drinking Water Industries: A Future Perspective. in *Proceedings of the 3rd International Halal Conference (INHAC 2016)* (eds. Muhammad Hashim, N. et al.) 555–564 (Springer Singapore, 2018).

28.多和田裕司. マレー・イスラームの人類学. (ナカニシヤ出版, 2005).

29.モハメド・ムスタファ・イスハック. マレーシア国民のゆくえ　多民族社会における国家建設. (公益社団法人日本マレーシア協会, 2015).

30.Syed Husin Ali. *The Malays*. (The Other Press, 2008).

31.DID Malaysia. *Sungai Selangor Basin Management Plan, 2007-2012*. (DID Malaysia, 2007).

32.AU, E. All Pig Farms to Be Moved to Modern Pig Farms by 2018. *NST Online* https://www.nst.com.my/news/2015/09/all-pig-farms-be-moved-modern-pig-farms-2018 (2014).

33. Perumal, E. & Assembly, P. M. at the S. S. Site Picked for Modern Pig Farming Project - Metro News | the Star Online. *The Star Online* https://www.thestar.com.my/metro/community/2016/11/11/site-picked-for-modern-pig-farming-project/ (2016).
34. Administrator. Selangor Govt Under Fire for Approving Pig Farm. *Malaysia Today* https://www.malaysia-today.net/2008/04/15/selangor-govt-under-fire-for-approving-pig-farm/ (2008).
35. Protesters Angry Over Selangor’s Plan for Pig-Rearing Centre in Ladang Tumbuk - Nation | the Star Online. *Saturday, 19 Apr 2008* https://www.thestar.com.my/news/nation/2008/04/19/protesters-angry-over-selangors-plan-for-pigrearing-centre-in-ladang-tumbuk/ (2008).
36. Department of Statistics, Malaysia. *Population Distribution by Local Authority Areas and Mukims 2010*. (2011).
37. Department of Statistics, Malaysia. Population Distribution and Basic Demographic Characteristics 2010. (2011).
38. Tan, C.-B. Chinese Religion in Malaysia: A General View. *Asian Folk. Stud.* **42**, 217–252 (1983).
39. Poonam, T., Tanushree, B. & Sukalyan, C. Water Quality Indices-Important Tools for Water Quality Assessment: A Review. *Int. J. Adv. Chem.* **1**, 15–28 (2013).

40.Lumb, A., Sharma, T. C. & Bibeault, J.-F. A Review of Genesis and Evolution of Water Quality Index (WQI) and Some Future Directions. *Water Qual. Expo. Health* **3**, 11–24 (2011).

41.Bora, M. & Goswami, D. C. Water Quality Assessment in Terms of Water Quality Index (wqi): Case Study of the Kolong River, Assam, India. *Appl. Water Sci.* **7**, 3125–3135 (2017).

42.Naubi, I., Zardari, N. H., Shirazi, S. M., Ibrahim, F. B. & Baloo, L. Effectiveness of Water Quality Index for Monitoring Malaysian River Water Quality. *Pol. J. Environ. Stud.* **25**, 231–239 (2016).

43.LUSA. *State of River Report 2008 Sungai Selangor*. (LUAS, 2010).

44.Shimizu, Y. & Kondo, T. Evaluation of Microorganism Pollution in Selangor River Watershed, Malaysia 2013 - 2014. *Newsletter* **4**, (2014).

2. Sg. Selangor Basin Review

To understand Sg. Selangor Basin (SSB), this Chapter overviews the history of land and river administration and the ethnic settlement pattern (ESP) of Sg. Selangor Basin (SSB), which have influenced each other, embossing sharp land use contrasts on Google Earth Pro aerial photos, layered with literature maps.

People are historical, and so are their water and their river and water perceptions. Therefore, for researching them, it is no meaningless to tell how people live and act in the basin, the complex of the land, the river, people, and everything.

There are two main lines of people's activity: land and river administration and ethnic settlement pattern (ESP), which are entwined having numerous knots, such as taxing system, land system, tin mining, colonization, immigrants, railway, rubber, deforestation, irrigation, rice, *etc.* They are mutually connected with the main two lines, and each of them more or less has changed people's perceptions of SSB. In this context, the main administration bodies of SSB, such as the DID and LUAS, are introduced.

2.1 River and Land Administration

2.1.1 Pre-colonial River-Centered Selangor Sultanate

2.1.1.1 River-centered Administration

In pre-colonial Malay Peninsula and Sumatra, a river was the center of a kingdom[1] or *Kerajaan* (*ke-raja-an*, a state of having a *Raja*: a ruler, king, prince, lord or nobleman) and land borders between such kingdoms were ambiguous, which later overwhelmed the British.[2] *Raja*s were not interested in unpopulated jungle-clad border areas, for *Raja*s' power was demonstrated by manpower mobilization rather than by owing land, and their *Rakyat*s (subjects) identified themselves as belonging to their *Raja*s rather than to their lands.[3] A Sultan (king)'s royal capital was at the river mouth, being the prime *Kuala* and the external trading center of foreign goods and upstream goods such as tin and jungle products.[4] *Raja*s ruled their subjects with religious authority, providing subjects rather with order by awarding titles and articles than with material benefits.[3] People generally lived on the banks of a river which was a main traffic route; between rivers were deep jungles hard to pass through.[1] *Raja*s imposed trading tax and labor services on the people passing *Kuala*s (river mouths and confluences of rivers), and there was no concept of taxing on land (**Figure 2.1.1.1-1**).[1] People were highly volatile; a whole *Kampun*g (village) would evaporate if their *Raja*'s imposed intolerably heavy duty.[1] Due not only to the taxing system but also the volatile people whose population being scarce (3,000-12,000 in the mid-19th century Selangor[5]) and thir agriculture being mainly slush-and-burn[1], *Raja*s were not interested in a major or highly engineered irrigation.[6] Among such Malay kingdoms was Selangor.

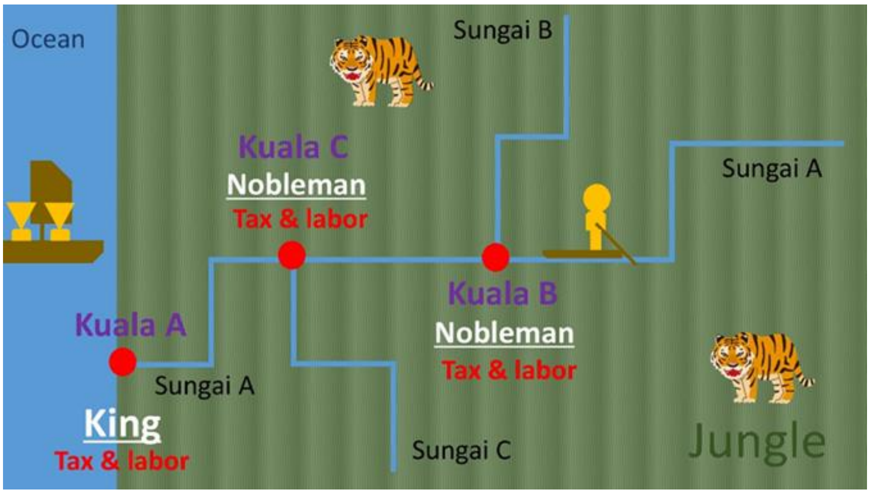

Figure 2.1.1.1-1 Pre-colonial Malay Kingdom

Selangor's written history starts in around 1720,[7] but the Bugis already had colonies in Selangor, Klang and Linggi in the end of 17th century.[8] The Selangor Sultanate was established in around 1776 when Raja Lumu the Bugis leader at Kuala Selangor was installed as Sultan Salahuddin of Selangor by Sultan Mahmud of Perak.[9] This was in the context of demise of the Johor Sultanate, the legitimate heir of Melaka (Malacca) Sultanate; the Bugis, having strong political and economic influence on the Johor Sultanate, gradually gained their presence in western Malay Peninsula, and finally built the independent Selangor Sultanate.[10] The new sultanate's name was after Sg. Selangor the capital river, like many other Malay sultanates in the peninsula.[11]

Like other Malay kingdoms, Selangor's land borders were ambiguous and using a river as border was unconventional until the British intervened. In the north, Sg. Bernam became the Selangor-Perak border in 1826 after the Selangor-Siam confliction that ended up with mediation by the British, splitting the cross-river Malay settlement; however, with the Perak-side half virtually staying under Selangor rule until the early colonial time.[9] In the south, the Selagor-Sungei Ujong (now within Negeri Sembilan) border was clarified by the advice of the British Resident in 1878.[2]

Unlike other Malay kingdoms, Selangor's river-centered administration was somewhat unique due to the geography and the Bugis custom: the five main river composition of Bernam, Selangor, Klang, Langat and Lukut;[7] the Bugis tradition of decentralization;[9] the scarce population that was unable to build a complicated multilayer political system;[9] and the weakness of local non-royal chiefs.[9] Since Sultan Salahuddin designated an *Orang Besar Daerah* (District Officer) for the administration of each river basin, it became a convention that princes (*Rajas*) were given control over the basins by the 19th century.[12]

2.1.1.2 Kuala Selangor as Capital

Kuala Selangor (KS), the first royal capital of Selangor was prosperous as a trading port competing with Dutch Malacca. KS collected tin from production areas such as Perak, Rembau and Linggi, and merchants from the Malay Archipelago brought commodities such as salt, sugar, textile and tobacco, and British[iv] country traders brought Indian textile and opium.[12] Rice and other foods are not recorded to have been imported in 1785 due to little demand from Selangor's small population.[9] In the reign of Sultan Ibrahim (r 1782-1826), the Dutch attacked KS in 1784 and drove the Sultan out to Pahang, obtaining Selangor's suzerainty and tin trading monopoly. In1785, supported by Pahang worriers and the British, Sultan Ibrahim regained KS from the Dutch[v].[9,13] However, 'everyone was a loser.' in this war.[9] The war declined Selangor's population and economy, and thus the Dutch never return to Selangor after 1786.[13]

Figure 2.1.1.2-1 Bukit Melawati, Kuala Selangor (March 2016, Taken by Author)

2.1.1.3 Tin mining, Klang War and Colonization

There had been a tin mine since around 1800 near Kuala Kubu, Hulu Selangor that is guessed by Gullick to have been a business by a Bugis leader and Sumatran workers.[9] In the reign of Sultan Muhammad (r 1826-1857), the Sultan and *Raja*s themselves had tin mines and leased the mines on a commission basis, because trading tax revenue had declined being defeated by the free ports of the Strait Settlements and by the steam boat penetration from the 1840s; they needed alternative revenue source for force strength to win power struggles.[7] The Sultan-owned European-capitalled Klang mine

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[iv] The British obtained trading bases of Penang Island in 1786, Singapore in 1819, Melaka (Malacca) in 1824, and made them customs-free trade ports. In the mid-19th century, the British aggressively advanced into inland Malaya for tin, because the Cornwall tin was in depletion while canned food was demanded for the Crimean War and the American Civil War and the post-war canned food industry growth. Tin was also demanded for tin roof and oil tin for the westward development in the U.S.[7]

[v] The forts of the fierce battles is now a tourist site in Bukit Melawati, Kuala Selangor (**Figure 2.1.1.2-1**).

failed, while Lukut mine, ran by Raja Jumaat, was successful. Kanching mine, near Rawang, in SSB, ran by Raja Abdul Samad and the Chinese, transferred tin ore through Sg. Selangor to KS.[12] On the other hand, Sultan Muhammad encouraged rice agriculture in the area from the capital KS to Batang Berjuntai (now called Bestari Jaya). Since Selangor already had sufficient rice for its scarce local population, the additional rice was mainly sold to the Chinese who were working in tin mines.[9] However, the rice farmers switched to coconut and fruits for the cattle plague in 1860.[14] In the reign of Sultan Abdul Samad (r 1857-1898), the Sultan lived in Langat for his own safety from inter-*Raja* power struggles.[9] The Klang War (1867-74) broke out involving various stakeholders over tin mining[vi] interests in Klang (Kuala Lumpur, KL). All the sultanate's tin mines along rivers were battlefields, and battles moved from a river to another[vii] (recall that there were people-avoiding jungles between rivers).[7] The British government, being afraid of German or Russian intervention, abandoned its no intervention policy, finished the simultaneous civil war in Perak in 1874 and installed a British Resident by the Pangkor Treaty. And then they, too, got the Klang War over by inviting Pahang forces. In 1874, the Sultan accepted a British Resident, who controlled Selangor's finance including tax collection, by which Sultan and *Raja*s lost their traditional trading tax revenue and obtained pension from the Government.[7] The six-year war steeply reduced the Selangor population, coconut fields desolated, and the upstream villages from Rantau Panjang to Kuala Kubu were looted and deprived, and the post-war recovery took years until the 1890s.[14]

In 1874, the river-centered kingdom was over, and the British land-based rule started. The British set the administration center in Klang, while the Sultan being in Langat[14], and the economic center of Sg. Selangor moving to the upstream tin mining area of Hulu Selangor.[12]

[vi] Note that it was tin deposited by rivers that brought wealth which attracted locals, traders, migrants and wars, and drove out the rivers from the center. Rivers, eroding tin-bearing granite of the mountains western Malay Peninsula, made a granite deposit layer over the limestone flatland. The granite-limestone meeting places made alluvial tin mines, of which Selangor and Perak are in abundance.[15] Ore sluicing needed an enormous amount of water and the sluiced ore were shipped to the market via a river. Thus, tin mines are close to rivers, flooded and polluted the river and changed the landscape, which was probably the first significant river environmental destruction in Selangor. Tin also made the prime foundation of the today's Malaysia's development. Infrastructure for tin mining such as railways and roads were also useful for developing rubber and oil palm agriculture.[13] After retiring from mines, the ex-tin mining places are today spending their second life as aquaculture ponds, flood mitigation ponds, alternative water resources, sand mines, landfills, amusement parks, golf courses, waterfront amenities, *etc.*

[vii] In the beginning of WW2, rivers with destroyed bridges obstructed the Japanese marching southward longitudinally through the peninsula to Singapore along the railway side road.[16] Although the operation aims differed between the two wars, this graphically tells the change of river use, too.

2.1.2 Colonial and Present Land-centered Selangor State

2.1.2.1 Selangor as a State of Federation

Selangor became a founding member of the Federated Malay States (FMS) in1895.[viii] The FMS was established for unification of Malayan administration, where practically in power were British Resident General and bureaucrats in the Federal capital of Kuala Lumpur (KL) and political influence of State Sultans kept declining although they kept formal authority.[10] In 1937, the FMS integrally introduced British laws.[18] Even after Independence (1957), Malaya (and Malaysia)'s administration is characterized as authoritarian, top-down, and Federation-centralized, and virtually ruled by elite bureaucrats, who took over the British, under the formal authority of Yang di-Pertuan Agong the constitutional monarch of the Federation and Sultans of the States. This order derives from the British ruling of the Federation and States where the British bureaucrats took advantage of Sultans' authority.[19] In the 1950s, elections started in Selangor (then including Kuala Lumpur), but today, Local Authority elections have been suspended since September 18th, 1964[20] for which no official reason was published by the Federal Government,[20] which seems to partly represent the authoritarianism. **Figure 2.1.2.1-1** simply illustrates Selangor's administration history and characteristics, behind the scene have been all countless individual events and persons involved, including SSB stakeholders (Sultan, bureaucrats, politicians, ordinary people, *etc.*), who have lived their life more or less being influenced and influencing the history, which is collectively described as 'Complex Interaction.' And, all demographic factors such as ethnic group, religion, class, *etc.* have deeply influenced the individuals and the 'Complex Interaction,' too. The IRBM of SSB should be told in this context.

[viii] There were three polity types in the British Malaya: the Federated Malay States (FMS: Selangor, Perak, Negeri Sembiran and Pahang); the Unfederated Malay States (UMS: Johor, Kedah, Kelantan, Perlis, and Terengganu); and the British territories of Strait Settlements (Penang, Province Wellesley, Malacca, Singapore and Dinkings. Dinking was retroceded to Perak in 1935[17]).

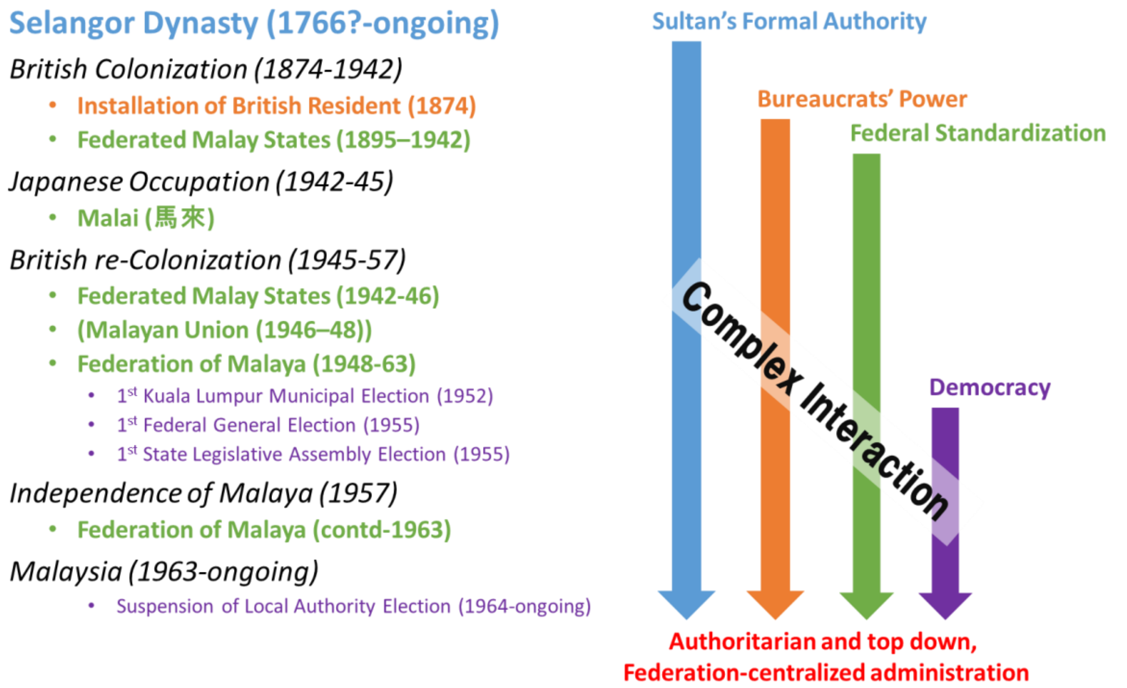

Figure 2.1.2.1-1 Selangor's Administration History and Characteristics

2.1.2.2 River Water Control by Government

The prime industry in British Malaya was tin mining that needed vast amount of river water. In 1878, the Mining Board was established,[21] and the Government (Inspectors of Mine) had the absolute control over river water. According to Swettenham (1907), a British colonial administrator;

> *'The most important and valuable rule laid down in the Malay States in connexion with land of any kind was that every stream and water-course in the country should remain under the absolute control of the Government, and no acquisition of any quantity of land, for any purpose, should give the lessee any rights whatever in regard to water. The most valuable mines are in large valleys drained by one or two streams, and it is therefore of the utmost importance for the workers at the tail of a valley that those with land at the head of it should not be able to shut off the water, or take more than their fair share. Government inspectors of mines see that the water is fairly apportioned and prevent disputes which, in times of drought, would inevitably lead to daily fights. It is impossible to over-estimate the value of this apparently simple but probably unique regulation. It gives the Government complete authority over the working of all.'*[22]

This seems to be the beginning of integrated control of land-use and river water in Malaya, although the concept of IRBM may have not been there. Today, the Federal Government body in charge of

IRBM is the DID (**2.1.3.3**) and Selangor State body LUAS that has Director General of the Federal as a permanent member (**2.1.3.2**).[ix]

As described in **Chapter 1** (**1.1.2.2.**), the 2005 amendment of the Federal Constitution transferred 'water supply and services' jurisdiction from the State List to the Concurrent List, by which the Selangor State lost the exclusive power of licensing and supervising water supply treatment and billing.[23] And by the Water Services Industry Act 2006 (WSIA 2006), water supply and sewerage services are licensed and supervised by the National Water Service Commission (a.k.a. Suruhanjaya Perhkidamatan Air Negara, SPAN) [24] under the Ministry of Energy, Green Technology and Water, Federal Government. However, the 2005 amendment of Federal Constitution did not touch 'water resources of states including rivers, water catchment areas and groundwater.'[23] In fact, the LUAS is licensing and supervising groundwater and surface water abstraction[25] that is regarded excluded from 'water supply and services.' This can be interpreted that groundwater and surface water are 'water resources' governed by the State just until abstraction, and then the water apart from the natural sources is subject to 'water supply and services' governed by the Federation.

2.1.2.3 River Traffic Declines and Land Traffic Rises

The river traffic declined as the land traffic developed, which tangibly made the river-centered kingdom a past forever. The land traffic was poor; for example, in 1879, from Bandar to Kuala Kubu, a wild jungle way along which Ulu Yam was the only village was the only way. In the 1880s, there was a steamship course connecting Kuala Selangor and Hulu Selangor.[14] In the colonial time, increasing tin mine tailing that shallowed rivers and caused floods hampered the river traffic, and land traffics took over the role.[26] Railways in Malaya originally built for the tin mining industry, though later used for various purposes.[27] In 1885, Malaya's first railway line was completed from KL to the Port Swettenham (renamed Port Klang in 1972). SSB upstream towns had been connected to KL in the end of the 19th century,[27] which is now a part of so called the Malay Railway from Bangkok to Singapore. In SSB, there were now-abandoned branch lines that were acting when the railways extension was at peak: the Kuang-Batu Arang-Batang Berjuntai (now called Bestari Jaya) branch that was removed by the Japanese for the construction of the Siam-Burma Railway during WW2; and the

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[ix] The DID's development has been in the same context as Malay Reservation (**1.1**) for preserving Malay land, culture and rice production with irrigation. The transition of river water administration seems to be due to the industrial transition from tin mining to agriculture, *i.e.*, rice, rubber and oil palm that needed irrigation, behind which the increasing immigrants (the Malays from Indonesian Islands, the Chinese and the Indians, *etc.*) and the British 'Divide and Rule' principle and the Malaysian 'Bumiputera Policy' that have perceived the Malays (and the indigenous) as special.

Klang-Kuala Selangor branch, closed in 1931 for losing to the road traffic.[27] Railway revenue, in addition to tin export tax and monopoly right subcontracts of *e.g.*, opium, made Selangor and Perak became the richest State Governments in Malaya.[1] Railway, too, made people, mainly migrants, who had lived only riverside start to live remote from rivers.[1] Roads were not of significance in Malaya until the 20th century automobile era from 1902; trunk roads in SSB were completed by 1910. There was few significant change in the road network in Selangor until 1958.[26]

2.1.2.4 Torrens System

In traditional Malay land conventions that were influenced by Hindu tradition, any land basically belonged to Sultan and people held the right to use a piece of land by 'animating' it (*i.e.*, cultivating, buying or inheriting the land),[28] perhaps due to which houses in a traditional *kampung* (village) have no clear public-private border.[29] Therefore, Sultan's subjects could not be squatters in principle, because they had 'free land' to animate.[30] Swettenham (1907) comments that;

> '*Land had no value in the Malay States in 1874, and it was the custom for any one to settle where he pleased on unoccupied and unclaimed land, and leave it when he felt inclined.*'[22]

The Torrens System was introduced (in 1891[31] or 1892[28] in Selangor) to stable legal land ownership regardless of the land's being animated or unanimated, which had been foreign to the locals.[28] The Torrens System clearly defined the areas, plots and borders to facilitate buying and selling land ownership by two land registration deeds: one held by the owner and the other stored in the registration office.[31] And, the Torrens System required land tax payment to own the land.[28] Although the British virtually took over from Sultan the State land control that was critical to land development,[28] it was difficult for the British to govern the Malays based on land ownership. The British assumed that local Malays were self-sufficient rice farmers who permanently owned their land, but the Malays were highly volatile and mobile in Malaya. This was the case particularly in Selangor where the Malay population included a great number of Malay immigrants from now called Indonesian Islands such as Sumatrans and Javanese.[32] However, land owners soon got adapted to the land system change. Swettenham (1907) says that Malay land owners of all classes became '*almost as ready to quarrel about their boundaries*,' as roads, towns and businesses grew and thereby land itself became recognized as money-making property.[22] Today's Malaysia basically succeeded the British system but have modified it for developing public infrastructure and economy. The National Land Code 1965 (NLC 1965), which united States' land enactments, stipulates that land belongs to the State Authority (Sultan or Governor), who has the right to dispose of State land in accordance with the law.[28] A person can own land alienated by State Authority, for which registration by the Torrens System is required.[28] On the other hand, the 1992 amendment of the Land Acquisition Act 1960's enabled State Authority to re-acquire alienated land in accordance with the law not only for public and unity purposes (*e.g.*, roads, schools, hospitals, *etc.*) but also for economic development purpose (*e.g.*, golf fields, *etc.*), and to change the purpose of use after the re-acquisition (*e.g.*, from a public school to a private hotel, *etc.*).[28] The Land Acquisition (Amendment) Act 2016 enabled developers to acquire underground land for development of underground infrastructure such as tunnels, drainage systems and railways.[33]

The British-introduced Torrens System (**2.1.2.4**) changed traditional Malay *Kampung* landscape (**Figure 2.1.2.4-1**). A traditional (pre-colonial) Malay *Kampung* had no clear separation between premises,[29] regular street pattern or even house arrangement.[34] Many of modern Malay *Kampung*s formed with lots in a line along a river, channel or road were developed in the last half of the 19th century or later.[8] clearly contrasts between traditional and modern *Kampung*s.

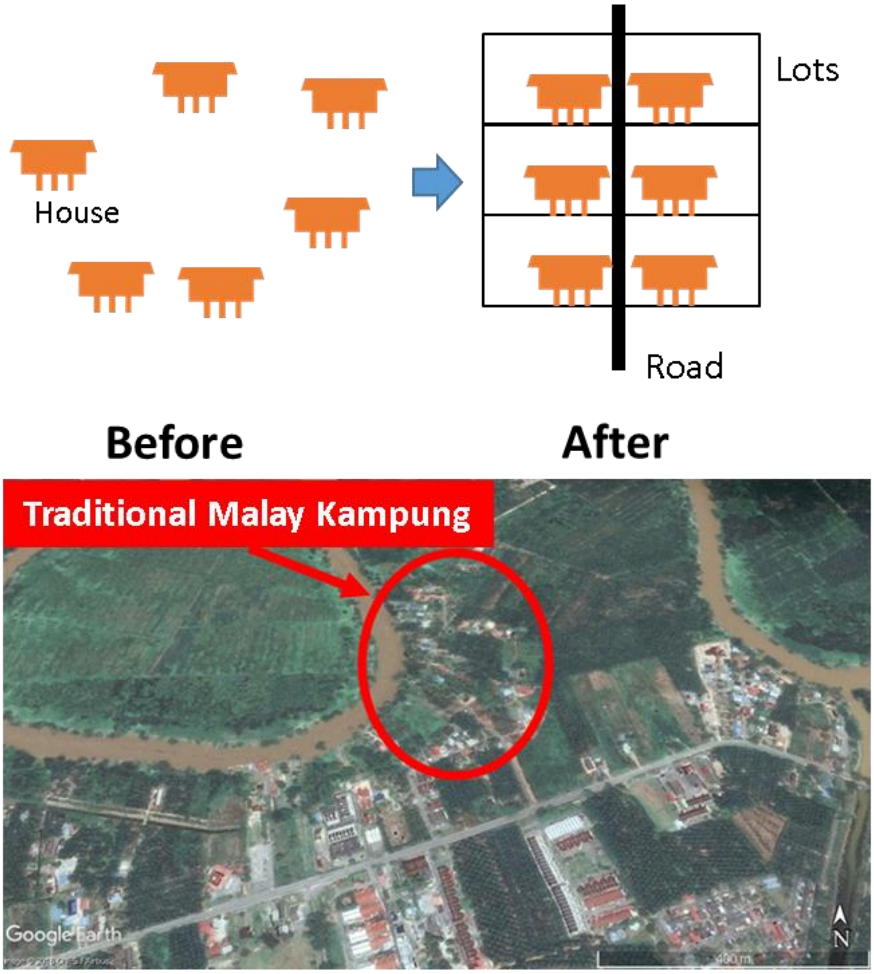

Figure 2.1.2.4-1 A Malay *Kampung* Landscape Changed by the Torrens System

2.1.2.5 District and *Mukim*

The British fundamentally transformed Malaya from a river-traffic line world to a land-sectioned area region.[32] In the 1880s, six Districts (*Daerah*s) with British District Officers were set up in Selangor: Kuala Lumpur, Ulu Langat, Kuala Langat, Ulu Selangor, Kuala Selangor and Klang.[35] The Districts were demarcated so that they were roughly up and down streams of the then three main river basins of Selangor (Sg. Selangor, Sg. Klang and Sg. Langat), respectively, which is the default structure of today's nine Districts and two Federal Territories of KL and Putra Jaya. This District arrangement was perhaps according to the Sultanate's river-centered administration, industry difference (agriculture in the downstream areas and tin mining in the upstream areas) and the ethic settlement pattern in the 1879 Census: one fourth of the Selangor population was in river mouth areas (90% were 'Malays,' mainly agriculture and fishery workers) and the rest three fourth in the inland areas ('Malays' and 'Chinese' were balanced, mainly tin mining workers).[35] 57% of 'Malays' were in the inland areas,[35] many of whom were supposedly Sumatrans.[xxi] The six Districts were subdivided into *Mukim*s (smallest administration areas) with *Penghulu*s as chiefs designated by District Officers. For being effective to the *Mukim* residents, *Penghulu*s were often *Raja*s or local lords in the river mouth area; and not uncommonly immigrant group leaders especially in the coast area (except river mouths, *e.g.*, Javanese and Banjarese) and the inland area (*e.g.*, Sumatrans). The '*Penghulu*' word had been a general noun, but it was prohibited to self-proclaim in 1899.[36]

In the 20th century, these *Penghulu*s were replaced with young bureaucrats who were better at regulating and documenting.[9] Shamsul (1986) describes that in the anonymous 'Malawati' District (most probably Kuala Selangor District), there was a *Penghulu* who under the British regime who, though being bureaucratized, was unofficially in great power in his *Mukim*.[37] The British-introduced administration procedures were too complicated for villagers, who thus had to depend on the *Penghulu* for land registration application, *etc*. It was not rare that villagers gave the *Penghulu* a present in return for administration procedures.[37] This villagers' dependency enabled the *Penghulu*s to be as powerful

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[x] These Chinese and Malay migrants are sometimes said to have come to the Malay Peninsula in the British colonial era. However, they were already in Selangor when the Klang War broke out, and they were stakeholders of the tin mining interests and actually joined battles by their own forces, as well as the *Raja*s. Wealthy British and Chinese merchants gave funds. The Klang War was not for religion or ethnicity but for tin mining interests, thus both sides includes the various background people.[1,9]

[xi] There were immigrant Malays as well as local Malays: Sumatrans (*e.g*., Minankabau, Mandailing, Batu Bara, Rawa, Kampar, Korinchi, and Achenese) who were first migrated as tin mine workers and tradesmen but later became settled farmers in the undulating areas of western Malay peninsula; Boyanese as mainly urban drivers, gardeners and peons; Javanese and Banjarese as farmers; Bugis;[26] and other Peninsular Malays (*e.g.*, Pahanese and Kerantanese)[35]. Immigrants from now Indonesian territory (Sumatrans, Boyanese, Javanese, Banjarese and Bugis) were distinct from 'local Malays' and called by the British 'foreign Malays.'[35] 95% of Indonesians (Sumatrans, Boyanese, Javanese, Banjarese and Bugis) who settled in Malaya were immigrants during the first half of the 20th Century, and majority of them were farmers.[26]

and wealthy as pre-colonial days. Immigrant heads were excluded from becoming *Penghulu*s, and instead became *Ketua Kampungs* or a natural village chiefs. A *Ketua Kampung* was an organizer of a *Kampung*, but he was not a bureaucrat, but rather stayed like a traditional head.[35] This hierarchy of District Officer (District) — *Penghulu (Mukim)* — *Ketua Kampung* (*Kampung*) is still present in Selangor.[xii]

A trace of river-centered administration tradition of pre-colonial Malaya remains even today as *Mukim* borders, although they were drawn by the British. **Figure 2.1.2.5-1 (top)** illustrates the Districts and *Mukim*s of the Sg. Selangor Basin in the 1880s[36] overlapped with the sub-basins of SSB[41], with dashed lines indicating District borders and dotted lines *Mukim* borders. It is clear that the *Mukim* borders are roughly associated with tributaries and sub-basins, particularly in the upper stream Hulu Selangor District. The straight dashed line, roughly along the sub-basin borders between Tanjung Karang and Sg. Tinggi sub-basins, divides Hulu Selangor and Kuala Selangor Districts. In Kuala Selangor District, straight *Mukim* borders are predominant probably it was difficult to draw natural sub-basin borders for the land is flat and low, and river side *Mukim*s consist of both bank areas. These rules reflect Malay traditions (**2.1.1.1**). The 1889s *Mukim* borders have been basically unchanged until today (narrower red lines) (**Figure 2.1.2.5-1 (bottom)**). The biggest difference between the two maps in **Figure 2.1.2.5-1** is *Mukim* Rawang. In February 1st 1974 when Gombak District was founded at the same time as the Kuala Lumpur became a Federal Territory, *Mukim* Rawang was transferred from Hulu Selangor District, and was then incorporated to the Klang Valley Regional Planning together with other three KL-surrounding Districts.[42] The British left behind the SSB-based Districts of Hulu and Kuala Selangors, but it was Malaysian political elites who cut off a part of SSB to prioritize the development of the capital region of Klang Valley.

[xii] *Mukim*:*Penghulu* ratio is not always 1:1. One *Penghulu* may superintend multiple *Mukim*s and multiple *Penghulu*s may divide one *Mukim*. For example, in Kuala Selangor District, *Mukim* Pasangan (pop. 7,312 in Census 2010[38]) has one *Penghulu*, while *Mukim*s Bestari Jaya (24,584[38]) and Ulu Tinngi (157[38]) share one *Penghulu*. *Mukim* Tanjung Karang (30,624[38]) is divided by two *Penghulu*s.[39] *Mukim*s are said to be not properly functioning as local administration entities.[40]

Figure 2.1.2.5-1 *Mukim* Borders in the1880s[36](Top) and Today[xiii] (bottom) in SSB[43]

Emphasized District borders and names are drawn by the current author.

Today, Districts' main roles are land administration and development management, with *Mukim*s being village-level assistants.[40] Headed by District Officers, the Land and District s Office (LDOs) implement District level administration.[40] Abolishment of LDOs was discussed in 1969 due to

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[xiii] Today's *Mukim* borders map was provided by Dr. Nisfariza Maris Mohd Noor at University of Malaya.

overlapping functions with Local Authorities (LAs, discussed later in **2.1.2.7**), but LDOs eventually survived the establishment of the Local Government Act 1976.[20] The LDOs implement: general coordination (evaluation of District level development activities, technical advice for State infrastructure construction, coordination with the Federation and LAs, hosting of memorial events, processing of applications for a theater and an amusement facility, office work for election and statistics, and handling residents' complaints about State administration); and land matters (planning of land use and development, organization of land information and statistics, office work for land ownership, tenancy and mortgage, implementation of land-related legal means such as compulsory execution). *Mukim*s play roles in office work for coordination of residents and institutions (coordination of *Mukim* level projects of the federation and local authorities, implementation of State development projects, status reporting for superagencies, support of field level office work of the LDO, and any other things the District Officer instructs).[20] Most of Federal and State administrative works are implemented at District level, and *Mukim*s are not properly functioning as local administration entities.[40]

A District border map clarifies the very sharp land use contrasts (**Figure 2.1.2.5-2**). For example, as to the straight line border between Kuala Selangor and Gombak Districts, the Kuala Selangor side is in agriculture use while the Gombak side urbanized. Considering that the pre-colonial time river-centered administration under which land borders are ambiguous (**2.1.1**), the perception shift to land-centered administration seems to have drastically changed the landscape of SSB.

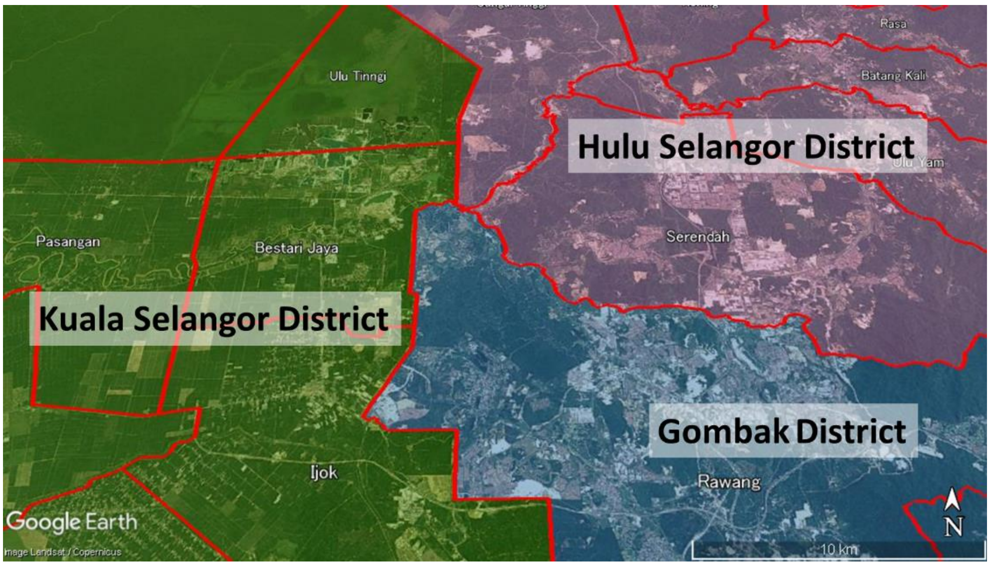

Figure 2.1.2.5-2 Land Use Contrast by District

2.1.2.6 *Kampung* and Village Development and Security Committee (JKKK)

In the 1960s, the Ministry of Rural Development was founded to develop Malay villages. With the Ministry as summit, Village Development and Security Committees (JKKKs: *Jabatankuasa Keselamatan dan Kemauan Kampun*g) became terminal bodies of local administration. JKKK aims to organize villagers[xiv] to implement development policies and to tighten the ties between the villagers and governmental institutions.[46] JKKK's main job is to help government agencies select sites to develop and carry out their projects that involves residents' life in general: economy, infrastructure, poverty eradication, *etc.*[40] A JKKK is headed by a *Ketua Kampung* designated by the State Government.[46] The staffs are designated by the *Ketua Kampung*,[46] and they are mostly volunteers and non-public servants[47]. With no fixed revenue, JKKKs may have to collect money to pay for utility bills of mosques and the community halls.[46] JKKKs are prone to be affected by politics and virtually were terminals of UMNO, the political party that ruled the Federal Government until May 2018 and a predominant component of BN, the alliance of then ruling parties.[48] In 2008, when PR, the alliance of then opposition parties, won the general election in Selangor, the BN-led Federal Government (Ministry of Rural and Reginal Development) and the PR-led State Governments set their respective JKKKs in the same village.[49] Similarly, the BN-led Federal Government (Minster of Housing and Local Government) re-organize Chinese New Village JKKKs to JKKK *Baru*s (JKKKBs) and distributed Federal funds for roads and drains through the JKKKBs.[49]

As for IRBM-related JKKK activities in SSB, there is a report by Wetland International Asia-Pacific from Kampung Kuantan, Kuala Selangor.[50] In 1995, the JKKK used to operate firefly ecotourism with financial support from the State Government through the District Office of Kuala Selangor. However, after a dispute between the JKKK and a private company, the District Council (Local Authority) took over the firefly tourism operation.[50]

2.1.2.7 Local Authority

Local Authorities (LA, a.k.a. Local Governments as legal name[20]) related to SSB are: Kuala Selangor District Council, a.k.a. Majlis Daerah Kuala Selangor (MDKS); Hulu Selangor District Council, a.k.a. Majlis Daerah Hulu Selangor (MDHS); Selayang Municipal Council, a.k.a. Majlis Perbandaran Selayang (MPS) (**Figure 2.1.2.7-1**); and Raub District Council, a.k.a. Majlis Daerah Raub (MDR) in Fraser's Hill. MDKS and the MDHS were responsible for the entire areas of Kuala Selangor District and Hulu Selangor District, respectively; MPS the northwest half of Gombak District (Ampang Jaya Municipal Council the rest of Gombak District and a part of Hulu Langat District.).[44]

[xiv] JKKK is inter-ethnically organized.[45]

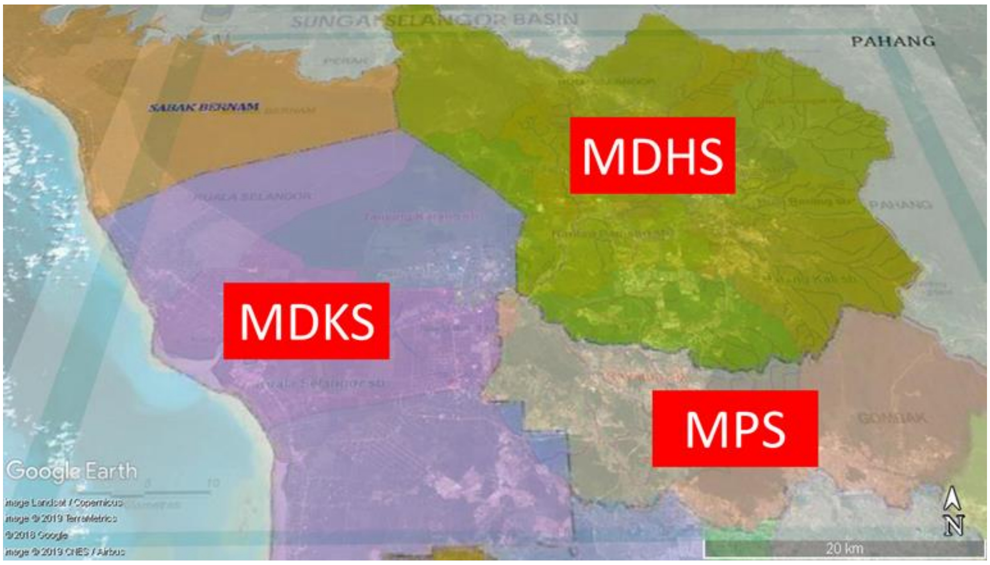

Figure 2.1.2.7-1 Local Authoritis[44] related to SSB[43]

The borders between LAs and Gombak District (**0**) is complicated (**Figure 2.1.2.7-2**[44]), even ignoring the slight layer fitting error; the MPS-MPAJ (Ampang Jaya District Council) LA border is not consistent with the Setapak-Ulu Kelang *Mukim* border.[xv]

[xv] Local Authority borders (originally for urban sanitary) may be regardless of District or *Mukim* borders (originally for land administration).[20] Similarly, *Mukim* (administrative village) borders may cut across a *Kampung* (natural village).

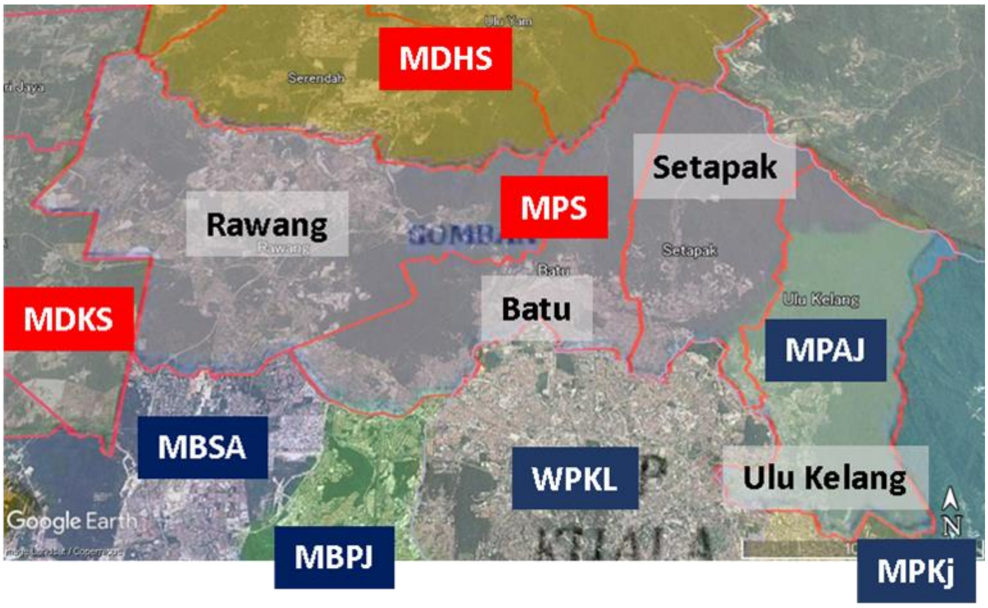

Figure 2.1.2.7-2 Gombak District and Local Authority Areas[44]

Colored areas: LAA,
Red line: *Mukim* border of SSB-related District.
Semi-translucent square: *Mukim* name,
Red square: SSB-related LA name,
Blue square: SSB-unrelated LA name

The prototype of LAs was the Committee of Assessors in Penang.[20] After Penang's colonization in 1786, its rapidly increasing urban population required sanitary and public peace, for which there was a plan that houses and shops were to be assessed by an official assessor to tax on. Then people demanded the assessment be done not by a single assessor but by a committee of residents, and in 1800 the Committee of Assessors was established, which the East India Company legally admitted in 1827. Selected by residents' representatives, the Committee of Assessors provided town plans and administrative services for residents, such as municipal tax assessment, road construction and drainage maintenance. The Committee of Assessors consisted of officially-appointed members only in 1835, but publicly-elected members re-participated in 1856.[51] In 1884, the Committee of Assessors was graded up to the Municipal Committee in 1884, and this kind of entities became common in the Strait Settlements. In1886, Municipal Committees grew up to Municipal Councils with a corporate capacity.[20] In the FMS, including Selangor, Sanitary Boards, the precursor of LAs, were founded in1907.[20] The Sanitary Boards' jurisdiction was broad; not only sanitation, but also examination of pre- and already-existing buildings, construction and maintenance of roads, management of town cleaning, canals and bridges, roadside planting, *etc.*[31] Sanitary Boards were renamed Town Boards in 1930. After World War II, Town Boards became Municipal Councils with elected Councilors in 1950, and Local Councils became able to be set up if the residents demanded in 1952.[20] Today, however, LA elections have been suspended since September 18th, 1964[20] for which no official reason was published by the Federal Government.[20]

Today, in the Peninsular Malaysia, the Local Government Act 1976, the Town and Country Planning Act 1976, and the Street, Drainage and Building Act 1974 are main laws that stipulate LA's administrative services, based on which LAs implement holistic town planning, developing and building.[20][xvi] LAs' main revenue sources are assessment rates (60%) and grants from the Federal and State Governments (20%).[40] Public health had been the *raison d'etre* of LAs, and sewerage treatment service was one of LAs' core roles. However, few LAs could successfully operate the service, and it was privatized in Peninsular Malaysia; a Federal Government-owned sewerage services company called Indah Water Konsortium Bhd (IWK) was established in 1994. However, IWK has been in the red because people's unwillingness to pay for the service and thus been subsidized by the Federal Government.[52] In 2000, the Federal Government, through Ministry of Finance Incorporated, bought out all the stocks of IWK.[53]

There is a hierarchy of Federation-States-LAs. Not only for States' constitutional jurisdiction of LAs, but also for LAs' limited revenue and staffs and State Governments' appointing LA headmen and Councilors (LA elections have been suspended), LAs are virtually 'extended arms' of the State Governments.[40] On the other hand, although LAs are constitutionally under State's jurisdiction, the same constitution stipulates the National Council for Local Government of the Federal Government whose policy the Federal and State Government shall follow.[54] [xvii]

LAs are in principle outside the District-*Mukim*-*Kampung* hierarchy. Their roles were different: LAs were originally built for urban sanitary;[20] while the District and *Mukim*s for land administration in communication with local headmen who became *Penghulu*.[35] And, since LAs were originally established in urban areas, their jurisdiction areas were limited to Townships and did not include rural areas and forests; while Districts and *Mukim*s cover the entire State. In LA-uncovered areas, the corresponding services are implemented by voluntary groups of the local communities or directly by the State Governments' agencies in the Districts.[20] In SSB, LA areas (LAAs) have expanded as urban areas expanded, and SSB was fully covered by the LAs by 2010. **Figure 2.1.2.7-3** illustrates LAAs in 2000 (**top**)[55] and 2010 (**bottom**)[38] with Google Earth Pro aerial photos from the respective times; the dark red areas are LAAs and the light red areas are Township areas. It is clear that LAAs and

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[xvi] LAs' town plan drafts are available online in their official websites.
[xvii] The Ministry of Housing and Local Government (and its Local Government Department) does the National Council's office works.[20]

Townships grew lager during the ten year period. And, two new Townships were developed in southeast Kuala Selangor District: Bandar Puncak Alam and Bandar Saujana Utama that are housing developments near Klang Valley.

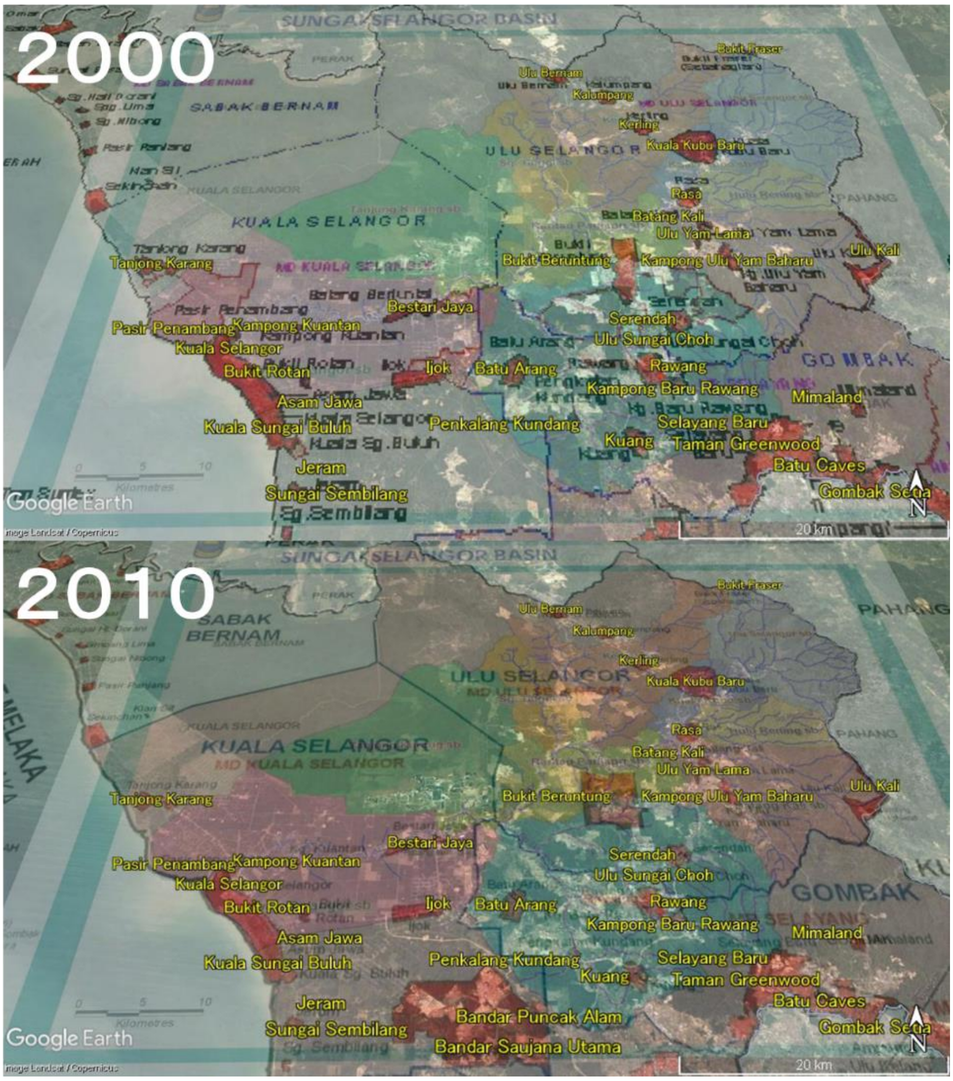


Figure 2.1.2.7-3 Local Authority Area in 2000[55] and in 2010[38] and SSB[43]

The Google Earth Pro aerial photos are from the respective years.

Light red fill: Local Authority area, Dark red patch: Township

Figure 2.1.2.7-4 shows the 2010 LAA and Township map[38] enlarged around the confluence of Sg. Selangor and Sg. Sembah. The LAA borders are the same as the District borders today. It is visualized that urbanized areas partly follows Township borders, and the urbanization is not be limited within the Township areas; while, Townships do not exist for a completely rural area.

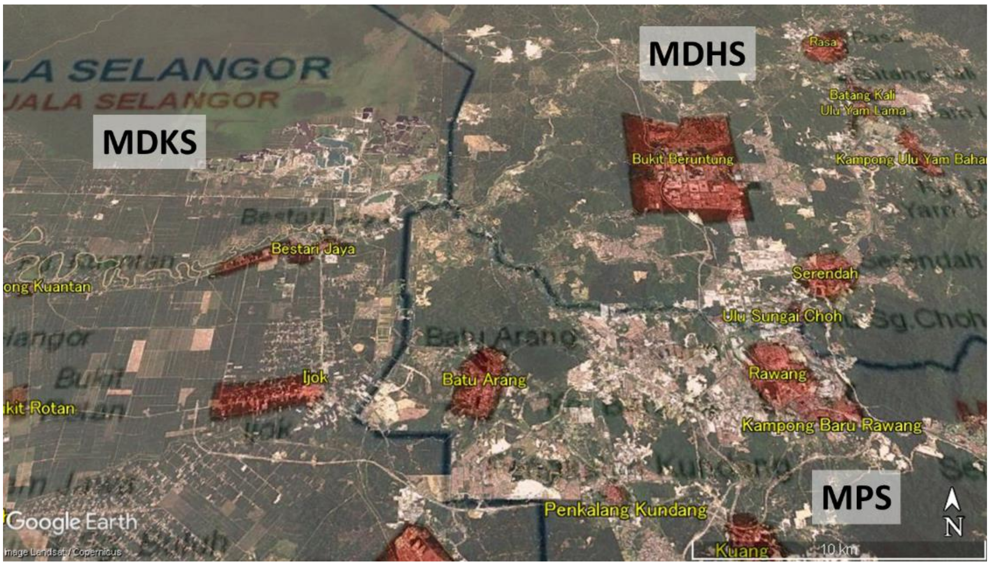
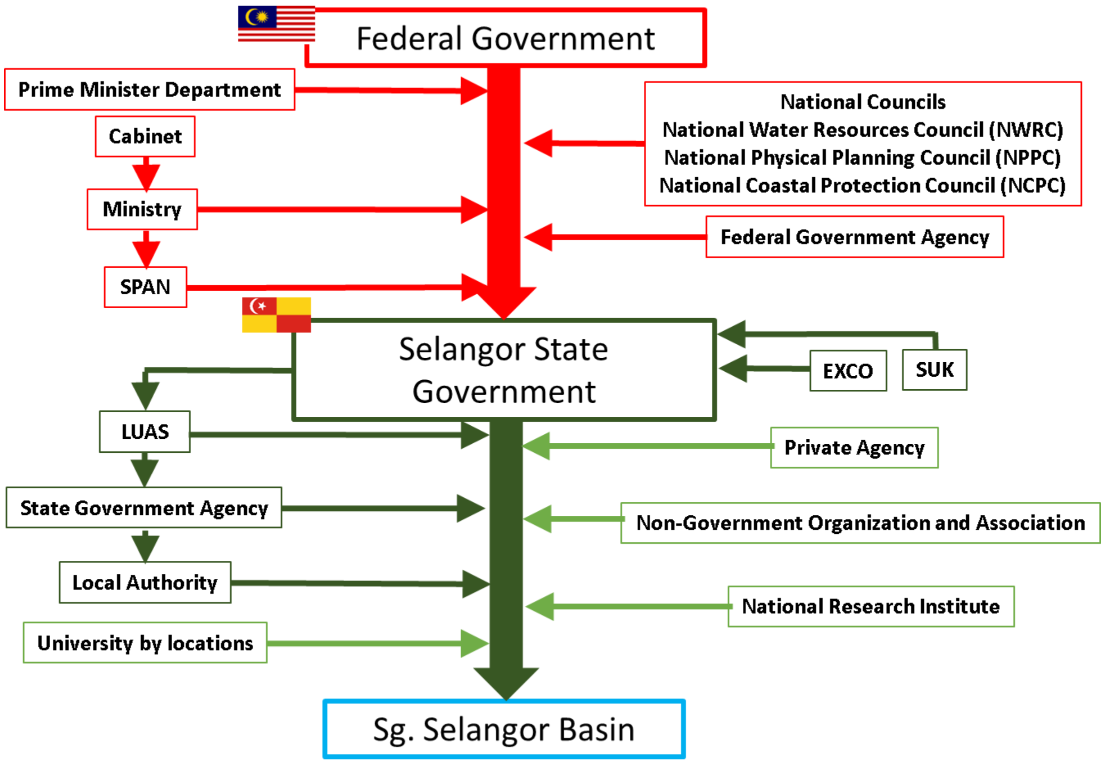


Figure 2.1.2.7-4 Local Authority Areas (light led) and Townships (dark red) [38]

2.1.3 Main IRBM Administration Bodies

Mokhtar *et al*. (2011) modeled the Sg. Langat Basin's IRBM institutional arrangement as straight, top-down Federal-State-Basin-ward arrows in which various bodies involved in order,[56] based on which **Figure 2.1.3-1** illustrates the institutional arrangement of IRBM of SSB.



Based on Mokhtar *et al.* (2012) Fig. 2 (Partly modified)

Figure 2.1.3-1 Hierarchy of IRBM Administration Bodies[56]

2.1.3.1 Sultan and Menteri Besar

The Selangor State is a constitutional monarchy that has Sultan as monarch, and the State's religion is Islam. Sultan has the collective characteristics of the supreme authority of the State and the supreme authority of Islam and Malay customs of the State.[57] The leader of general administration is Chief Minister (*Menteri Besar*, MB), whose decision is expected to be trusted by the majority of the State Legislative Assembly members, is appointed by Sultan from the State Legislative Assembly members. Both Sultan and MB have to be Malay and Muslim.[57]

2.1.3.2 Selangor Waters Management Authority (LUAS)

The Selangor Waters Management Authority (SWMA, a.k.a. *Lambaga Urus Air Selangor*, LUAS) is the statutory body of Selangor State for integrative management of rivers and water resources.[58] The LUAS was established to solve the problem of ambiguous jurisdiction of laws and involved Federal and State agencies, based on the Selangor Waters Management Authority Enactment 1999 (LUAS Enactment 1999).[59] The LUAS is Malaysia's first agency for integrated management of river basins and coast areas.[60] Khalid *et al.* (2012) criticizes that the jurisdiction problems stay unsolved, complicated and sensitive, while the institutional integration is slowly in progress.[60]

The LUAS is Sultan's advisory and executive body headed by MB as the Chairman. Sultan '*may, from time to time,*' give the LUAS '*general directions, not inconsistent with*' the LUAS Enactment 1999, and the LUAS '*shall, as soon as possible, give effect to such directions*.'[59]

LUAS members are: Chairman (MB); Deputy Chairman (State Secretary); State Legal Adviser (or his representative); and State Financial Officer (or his representative); EXCO members designated by the *Menteri Besar* (two persons); Federal Department of Irrigation and Drainage (DID) Director General; other members appointed by the Sultan with substantial expertise in the management and conservation of river basins, ground water and water sources (more than five persons) ; and the Director (LUAS Secretary).[59] The LUAS members are public servants.[59] The fact that Federal DID Director General is named as a permanent member here clarifies that the DID is essential to the LUAS.

The LUAS's jurisdiction is limited within the State territory. According to the LUAS Enactment 1999;

> '*all rivers wholly within the State of Selangor and to all river basins, catchment areas, wetlands, ground water, coastal waters and water bodies within the State of Selangor except those wholly within the Federal Administrative Centre of Putra Jaya.*'[59]

The Putra Jaya exception was necessary, since Putra Jaya became a Federal Territory in 2001.[54] The stipulation is now interpreted as;

> '*all rivers wholly within the State of Selangor and to all river basins, catchment areas, wetlands, ground water, coastal waters and water bodies within the State of Selangor*.'

This limitation makes IRBM difficult. For example, 30% of Lake Putrajaya's catchment area, being within the Sg. Langat Basin, belongs to the Selangor State and the remaining 70% to Putra Jaya Federal Territory, which makes the ILBM complecated.[61] As for Fraser's Hill the uppermost of Sg. Selangor, the LUAS says that the Sg. Selangor '*emerges from the foothill of Frasers's Hill and traverses the northeast region of Selangor for 110 km until the coast*,' although they limited related LAs to three Selangor ones (MDKS, MDHS and MPS), [43] excluding MDR of the Pahang State. Water resources accommodation of an inter-State river is done by the National Water Resources Council (NWRC).[62]

2.1.3.3 Department of Drainage and Irrigation (DID)

The Federal DID is the main Federal administration body responsible for IRBM, and there is a State DID in each States under the Federal DID.[63] The DID belongs to Ministry of Water, Land and Natural

Resources.[xviii]

The IRBM administration is extremely complex in jurisdiction. Ex-Federal DID Director General Dato' Ir. Haji Keizrul bin Abdullah says in his article in the DID Official Website, that there are over 100 jurisdiction-conflicting and overlapping water and river-related laws in Malaysia which regulate mainly about water resources use but less about their protection.[64]

In the colonial time, increased immigrant population caused chronic rice shortage, and rice for the immigrants was mainly imported from Thailand and Burma.[65] In 1913, the Irrigation Branch of the FMS Public Works Department (PWD) was established to newly develop water control infrastructure for rice production and Malay culture preservation.[6] For the same purpose in the same year, the Malay Reservation Enactment 1913 was issued (**1.1**). Deforestation for mining and agriculture caused soil runoff and subsequent river bed sedimentation and floods, like Kuala Kubu, Hulu Selangor, and the Irrigation Branch was incorporated into the newly established Hydraulic Branch of the PWD.[6]

In 1932, in the time Great Depression, the Department of Irrigation and Drainage (DID) was established.[6] DID’s jurisdiction was the development and maintenance of irrigation and drainage facilities for estates and farmers, which was taken over from the PWD. The DID seriously started in 1936 the Tanjung Karang development for rice production[xix] for rapidly increasing immigrants; where Indonesian immigrants, mainly the Javanese, settled.[65] The DID states that its goal then was to encourage rice cultivation in Malaya, for improving the rice situation and the economy in which rubber and tin industries were in recession.[66] Shiraishi (1965) guesses that the British aim of rice agriculture encouragement could not have been only for food self-sufficiency but also for correct the economic imbalance among ethnic groups by encouraging Malay rice farmers.[67] During World War II, under the Japanese occupation, the food shortage went further worse, because the irrigation facilities were devastated, and because rice import stopped because the Japanese lost its sea control.[65] Just after WW2 a great draught happened and the British had to take measures for food supply.[65] After the Independence in 1957, the DID broadened its jurisdiction: flood mitigation and hydrology after the 1970-71 great floods; coastal engineering in 1986; a section of river improvement was founded in 1990. Today, the DID is responsible for: river basin management and coastal zone, water resources

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[xviii] In 2004, the DID was transferred from the Ministry of Agriculture to the Ministry of Natural Resources and Environment (NRE) (Kementerian Air, Tanah dan Sumber Asli, KATS).

[xix] Tanjung Karang swamp area between Sg. Selangor and Sg. Bernam was investigated as a potential rice field in 1895, and from the mid-1910s immigrants from now-called Indonesia, such as Javanese, intermittingly came to the area. However, then the British did not seriously start the development of the area for financial, technical and rice demand and supply balance reasons. In the 1920s, Tanjung Karang swamp investigation was started for rice field development.[61]

management and hydrology, special projects, flood management, eco-friendly drainage' (in the order of the DID's official website).[66] The DID lists major problems of rivers in Malaysia: water shortage; flooding; river and water pollution; river sedimentation; and squatters.[64] When the LUAS was established in 1999, Federal DID Director General became a LUAS member.[59] In the IRBM of SSB, main problems are: water demand; water pollution, particularly in Rawang; local floods; and, firefly protection.[41]

As for the jurisdiction unclearness between the DID and other administration bodies, Jeyabalan (2009) reported an example of role division in Sg. Gombak[68]: the DID technically facilitates drainages of strategical importance; the Department of Environments (DOE) controls river pollution by industrial areas and sewer treatment plants; and, MPS, the LA, strengthens the enforcement of existing regulations about effluent into the river, and monitors civil engineering works which may pollute the river.[68] In the absence of a clear guideline of role division between the DID and MPS, the revenue- and expertize-richer DID: advises MPS about land development management and technical matters; often leads the preparation of drainage master plan; and may develop trunk drainages for MPS.[68] Jeyabalan (2009) is a case study, and thus other places and times may have other ways of dividing roles for which there is no clear guideline.

2.1.3.4 National Water Services Commission (SPAN)

The National Water Services Commission (Suruhanjaya Perkhidman Air Negara, SPAN) is a statuary body under the Ministry of Energy, Green Technology and Water of the Federal Government. The SPAN was founded by the National Water Services Commission Act 2006 (SPAN Act 2006) to supervise water supply and sewerage services in Peninsular Malaysia and the Federal Territories of Putra Jaya and Labuan[69], based on the Water Services Industry Act 2006 (WSIA 2006). SPAN members are designated by the Minister: Chief Executive Officer; and other members who are experts of such as finance, engineering, business or administration (8-10 persons).[69] The members are deemed to be public servants.[69]

The SPAN licenses and supervises water services operators recommended by the Minister.[24] In Selangor, Air Selangor the State-owned water supply company will be the sole water supplier for Selangor, KL and Putra Jaya from April 1, 2019.[70] Air Selangor is leased the assets from PAAB (Pengurusan Asset Air Berhad a.k.a. Water Asset Management Company) the Ministry of Finance Incorporated-owned company for the name's purpose.

The SPAN licenses and services sewerage service operators, too, and. Indah Water Konsortium (IWK), a company owned by the Federal Government (Minister of Finance Incorporated), operates sewerage services in Selangor, KL and other parts of Malaysia with some exception.[53] (about IWK, see also **2.1.2.7**)

2.1.3.5 Department of Environment (DOE)

The Department of Environment (DOE) controls environmental quality in accordance with the Environmental Quality Act 1974 (EQA 1974) and resolutions of international conventions.[71] Since the scope of the Waters Act 1920 was too limited to deal with complex environmental problems, the EQA 1974 was established, based on which Division of Environment was established in 1975. [72] [xx] The DOE's activities are at Federal and State levels, being diverse, among which major IRBM-related activities are river water quality monitoring [xxi] and pollution regulation. [xxii] The DOE licenses pollution materials discharging into the inland Malaysian waters,[72] and the license application form 'APPLICATION FOR A LICENCE UNDER SECTION 25(1), ENVIRONMENTAL QUALITY ACT, 1974 (Form AS.1A-4/95) is obtainable from the Official Website.[71] The form requires applicants to describe activities-to-do, operation schedule, a list of materials, a list of final products, a flow chart and description of production process, a flow chart of effluent starting from every source with the quality and quantity clearly indicated, *etc*. In Selangor, water pollution categories which are not stipulated in the EQA 1974 such as pollution from non-point sources (industry and STP, *etc*.) are under the LUAS jurisdiction.[74] The DOE publishes Environmental Quality Report every year.

2.1.3.6 Environmental Quality Council (EQC)

The Environmental Quality Council (EQC) was founded on the EQA 1974 by the Minister of Science, Technology and Environment for advising the Minister about preservation the environmental sanitation in 1977.[75] In order to balance development and the environment, the EQC has 14 members: Chairman appointed by the Minister; five Secretary Generals of related Ministries (or their representatives); Director General of Health (or his representative); ones from the Sabah and Sarawak State Governments, respectively; one from the oil industry; one from the palm oil industry; one from the manufactural industry, one form the rubber industry; and one academic staff from the Universities or Collages in Malaysia; and two members from registered environmental societies.[76]

2.2 Ethnic Settlement Pattern

SSB is a prime example of multi-ethnic, multi-religious society of Selangor. Today's ethnic settlement

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[xx] The Division of Environment was under the Ministry of Local Government and Environment, and was upgraded to the Department of Environment (DOE) and transferred to the Ministry of Ministry of Science, Technology and the Environment in 1983.[73] Now the DOE is under the Ministry of Energy, Technology, Science, Climate Change and Environment.

[xxi] DOE has 13 permanent monitoring stations in SSB.[74]

[xxii] In Sg. Selangor, PNSB the water supply concessionaire, has 35 monitoring stations, too.[74]

pattern (ESP) has two main lines: basin-wide ESP (**Figure 2.2-1**) and local ESP (**Figure 2.2-2**). The latter is a mosaic-like ESP corresponding settlement types: *Kampung*s (villages) mainly occupied by the Malays; old towns mainly by the Chinese and Indians; New Villages mainly by the Chinese Plantations mainly by the Indians; forests mainly by Orang Asli (indigenous people, classified 'Other Bumiputera' in Census); and housing developments by all the ethnic groups. The former, the basin-wide ESP derives from the rough distribution of the settlement types in SSB: old towns, New Villages, housing developments, and Orang Asli settlements are mainly in the upstream area (Hulu Selangor District and *Mukim* Rawang of Gombak District); while *Kampung*s and plantations are mainly in the downstream area (along the Selangor River: the central area of Kuala Selangor District). The ESP will be confirmed by Principle Component Analysis (PCA).

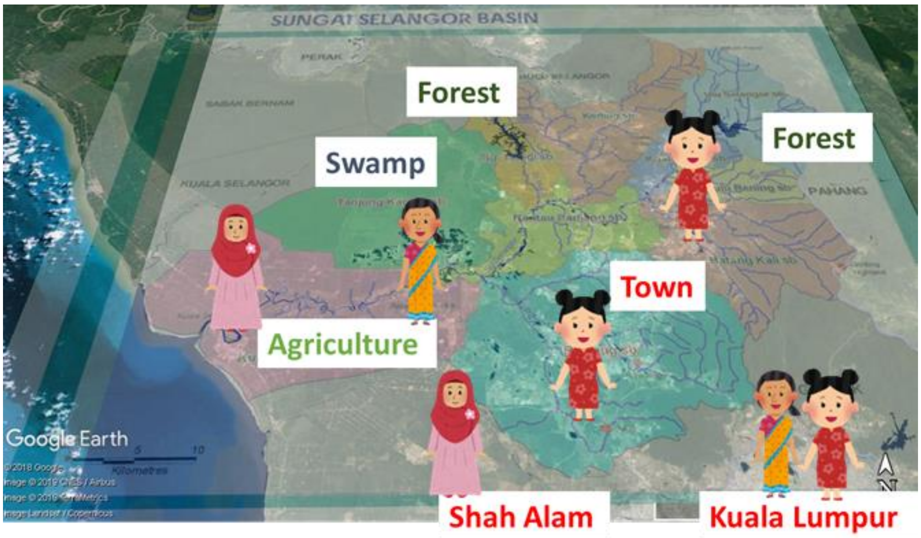


Figure 2.2-1 Basin-wide Ethnic Settlement Patten

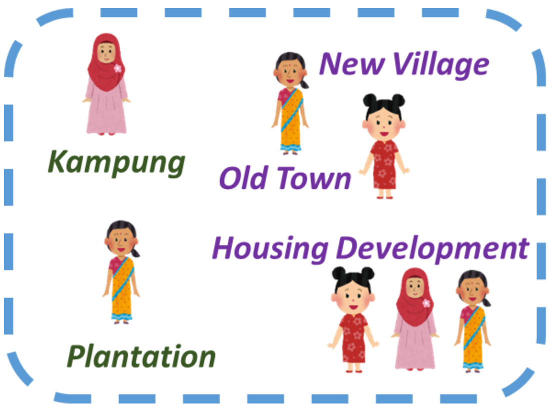


Figure 2.2-2 Local Ethnic Settlement Pattern

2.2.1 Colonial Time Industries

The basin-wide ESP in the pre-colonial times was as follows: the river mouth area was settled mainly by so by the British called the 'Local Malays' (the Bugis, *etc*.); the coast area except the river mouth the 'Foreign Malays' (the Javanese and Banjarese); inland (upstream) the Chinese[xxv] and the 'Foreign Malays' (the Sumatrans) (Footnote **xi** in Page 38).[35] Then, the number of immigrants rapidly increased: Indonesians mostly as agriculture workers (**xi** in Page 10), the Chinese, mostly as tin mining workers; and Indians [xxvi], mostly Tamils, as rubber[xxvii] plantation workers. Some of the immigrants just came, earned money and went home, while others settled and made root in Malaya. They lived in/near their working places, following the distribution of industries. which created the basin-wide ESP. **Figure 2.2.1-1** shows the Indonesian Settlement pattern in 1947[26] (**upper left**), the rubber planting area in 1971[26] (**upper right**) , and major ex-tin mining ponds[81,xxviii] (**bottom left**). Tin mines attracted railways that connected mines and ports, then the railways rubber plantation, and the industries immigrants, and towns developed for the industries. Therefore, the Chinese and the Indians were more prone to be urban dwellers than the Malays[77] who were mostly in *Kampung*s, which created the local ESP. This colonial ESP is still seen even today.

[xxv] The Chinese were mostly from South China: Cantonese (広東人), Hokkein (福建人), Hakka (客家人), Hainanese (海南人), Teochew (潮州人), Hokchiu (福州人), Henghua (興化人), Kwongsai (広西人), *etc*. They were mostly farmers in China, but each sub-ethnic group had characteristic occupation pattern in Malaya, because their languages are different and tended to come to Malaya relying on blood and homeland community relationships.[77] By 1901, the Chinese outnumbered the Malays in Selangor, and almost as equal-numbered as the Malays in the Federated Malay States.[26]

[xxvi] The Indians were not homogeneous: Indian and Sri Lankan Tamils, Telugu, Malayali, Sinhali, Indian Muslim or Malabari, Sikh, *etc*. They came to Malaya relying on their communities, [77] and each group has an occupation characteristic.[78] The plantation worker recruiting system called the Kangani system is one of the main way of Indian immigrants. The Tamils had a living habit that water had to be brought in to the house only once a day and the water could not to be stored for the day, which helped the Tamils be less affected by malaria and dengue fever than the Malays and the Chinese in the same labor condition in Malaysian plantation.[79]

[xxvii] Today, replacing rubber, palm oil plantation is the prime agriculture in SSB, especially Kuala Selangor District (the downstream area).[74] Indonesians compete with the Indians as palm oil plantation workers.[80] You can see the infinite field of regularly planted oil palm trees out of the window of the bus from KL for Bestari Jaya or Kuala Selangor.

[xxviii] Strictly speaking, 'waters' apparent in Google Maps, including other waters such as water treatment plants. But they are minor in number compared to ex-mining ponds.

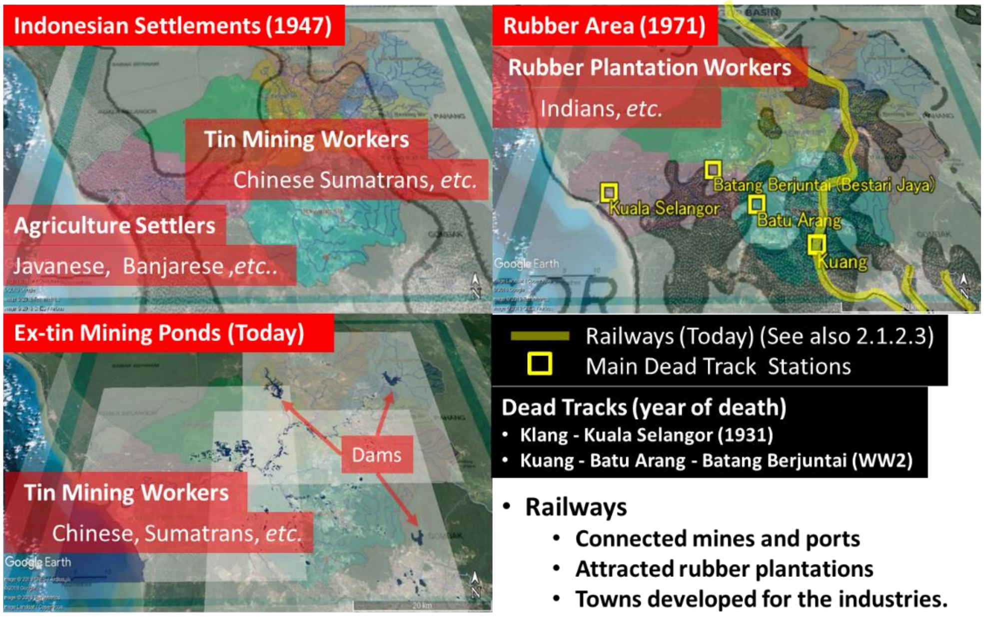


Figure 2.2.1-1 Indonesian Settlement Distribution (1947)[26], Rubber Areas (1971)[26] and Ex-Tin Mining Ponds[81] in SSB[43]

2.2.2 Malay Reservation

Malay Reservations were demarcated by the British for 'protecting' Malay land and culture. In the 1900s, the rubber boom fueled the Malays to sell their price-raised land or plant rubber trees themselves, against which the British introduced 'ancestral land' ownership concept in 1912, and Malay Reserves Enactment 1913[xxix] prohibited non-Malay land ownership and prevented rubber planting in designated areas to 'protect' Malays from losing land and thus their way of life,[32] and to produce rice, and to keep 'Divide and Rule' by the British[31].**Figure 2.2.2-1 (top)** illustrates the rough sketch of the location of Malay Reservations[31,82] under the British rule in SSB[43]. The precursor of the DID was established partly for preserving Malay land, culture and rice production, too, and Tanjung Karang, famous for the irrigation scheme, was in a Malay Reservation area (See also **2.1.3.3**). The Malay Reservations are rural settlements consisting of green-covered rectangle lots each of which has a house, which indicates that: it is a non-plantation area (**Figure 2.2.2-1 (bottom)**); and also is distinct from surrounding urban, plantation and forest areas.

[xxix] In 1913, the Irrigation Branch of the FMS Public Works Department (PWD), the precursor of the DID, was established to newly develop water control infrastructure for rice production and Malay culture preservation (**2.1.3.3**).[6]

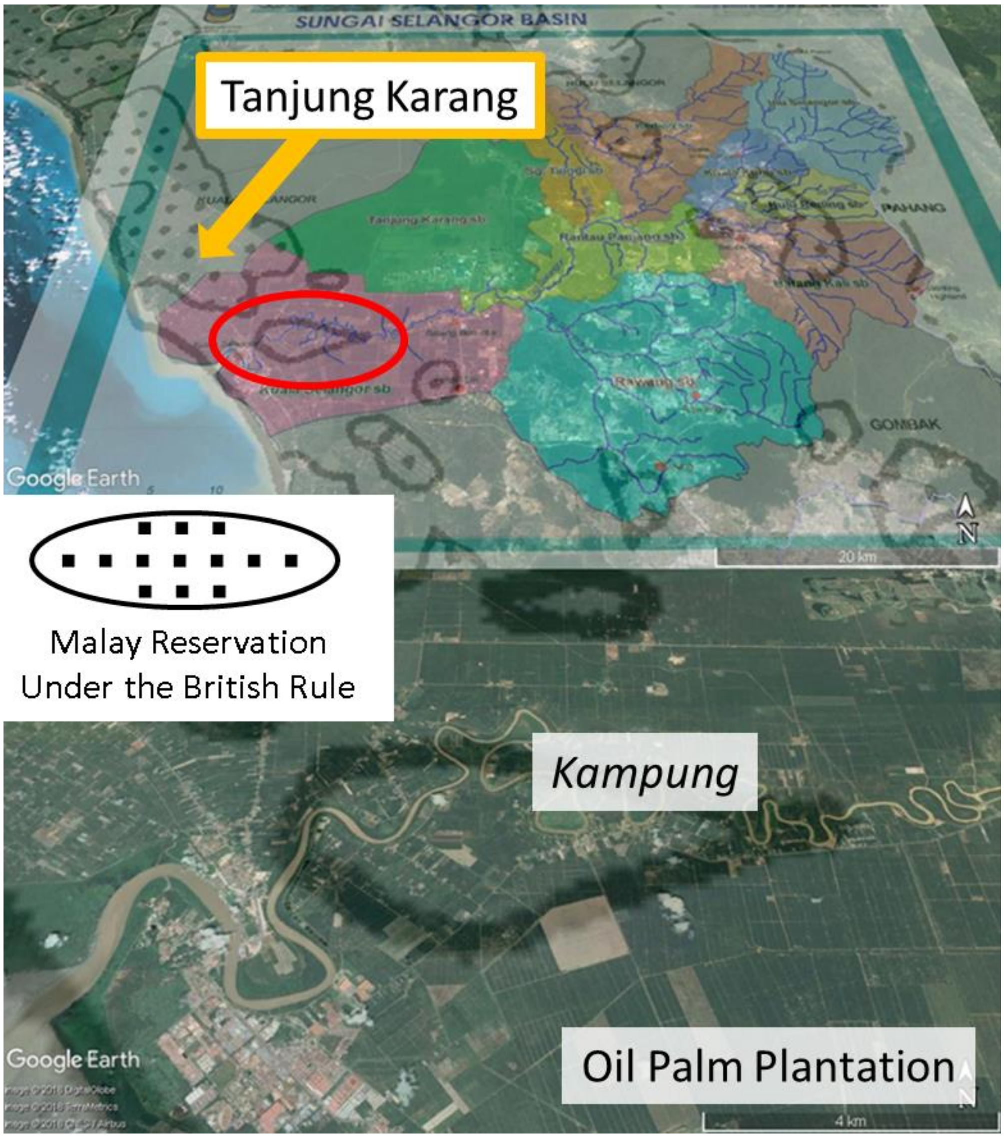


Figure 2.2.2-1 Rough Sketch of Malay Reservations Locations the Colonial Time in SSB

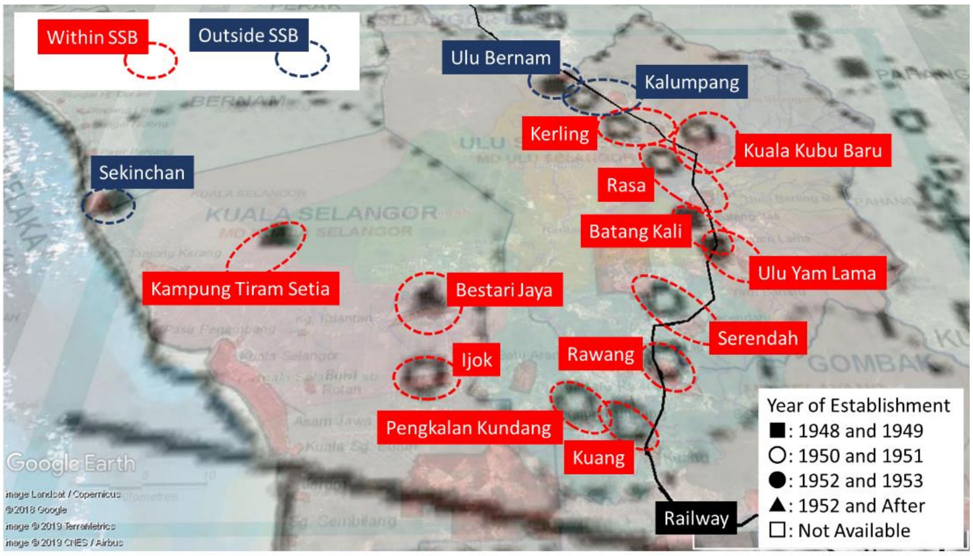
Malay Reserves Map by Voon (1987)[82] cited by Ikuta (2001)[31]

SSB Map by LUAS[43]

Today's acting successor of the Malay Reserves Enactment 1913 is the Malay Reservation Enactment (FMS Cap 142)[83], and the Malay Reservations have been one of the hottest issues considering modern Malaysia's land use. In May 2012, the Selangor Chief Minister stated that the State had 182,701 ha gazetted Malay Reserve land, within which Kuala Selangor District (7,474.5 ha), Hulu Selangor District (12,720.8 ha) and Gombak District (4,576.8 ha).[84]

2.2.3 New Village

The New Village Plan (1948-1954) built New Villages (*Kampung Baru*). The Briggs' Plan, a British military plan in the Emergency (1948-1960), relocated jungle-fringe squatters (mostly Chinese)[xxx], in order to insulate them from Communist guerillas (mostly Chinese) hiding in the jungle, because the squatters were suspected supporters of the Communists.[13] The New Villages were located along the railway, trunk roads and big tin mining remains, often near rivers for water supply.[85] New Villages were newly built in large lands or as extensions of existing towns or villages, where the ex-squatters were given lots the area twice as large as a tennis court.[86] The locations of the New Villages in SSB were illustrated in **Figure 2.2.3-1**,[38,43,87] which shows they are mostly built as extensions of existing towns for tin mining and rubber plantations which probably provided them with working places.



Note: The New Village locations by Centre of Chinese Studies are slightly departed from the real locations due to technical problems in map fitting, and thus the corresponding town areas are suggested by author.

Figure 2.2.3-1 New Villages[87] and Townships[38] in SSB[43]

2.2.4 Housing Development

The New Economic Plan (NEP) (1971-1991) encouraged the economically backward Malays to go out of *Kampungs* to towns, getting involved in capitalism and mixed with other ethnic groups. The NEP created urbanized middle class or new rich Malays, particularly in the capital area of KL,[xxxi] who bought houses in suburban housing developments, where they coexisted with other ethnic groups (**Figure 2.2.4-1**).[30]

[xxx] The squatters were in Forest Reservations, Malay Reservations, and private mines and plantations, having been there escaping from the food shortage, joblessness, military draft and persecution during the Japanese Occupation. It is also supposable that many of them had already started squatting, unemployed, since the Great Depression or earlier, and they supported the anti-Japanese guerillas consisting mostly of Chinese Communists during WW2.[13]

[xxxi] Census 2010 for the first time recorded that Bumiputera (Malays and indigenous people) outnumbered in KL the Chinese the traditional dwellers there,[88]

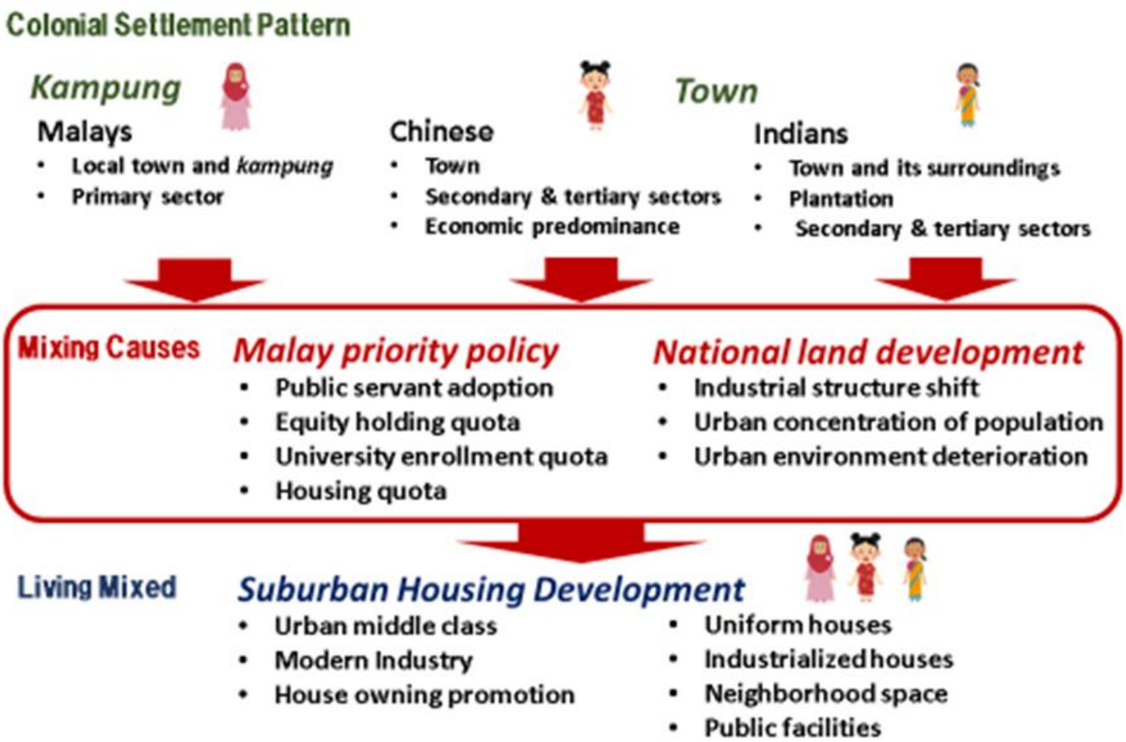


Figure 2.2.4-1 Ethnic Settlement Pattern Shift by NEP[45]

Housing developments, together with *Kampung*s, Plantations, old towns and New Villages, formed the local ESP. Udaka (2009) has macro and micro level observations in Malaysia: at a macro level every area is multi-ethnic; while at a micro level each area has uni-ethnic neighborhoods,[xxxiv] although it is rare that one neighborhood is completely uni-ethnic.[xxxv] This tendency is more or less common everywhere: urban blocks, housing developments, *Kampung*s, *etc.*[45] These uni-ethnic neighborhoods are not closed and loosely integrated to the whole area's multi-ethnic society.[45] This is also the case in SSB.

Figure 2.2.4-2 and **Figure 2.2.4-3** illustrate the local ESP examples of Kuang (Gombak District) and Rasa (Hulu Selangor District): they have distinct Malay *Kampung*s, Chinese New Villages, and housing developments. These Figures shows that people's housing locations and conditions roughly depend on their ethnic groups and household income levels. The Chinese New Villages are old areas from around the 1950s, where some houses have been rebuilt. The Indian areas, having Hindu

[xxxiv] There is no ethnic compartmentalization policy for housing development in Malaysia. The uni-ethic neighborhoods are naturally or informally formed by the residents and private companies.[45]
[xxxv] The only cases where ethnic groups were enclosed or bordered were a portion of barracks and Chinese New Villages.[45]

temples[xxxvii], are adjacent to Chinese areas. The housing developments consist of groups of monotonous houses, whose grades are at glance distinct. The housing developments are relatively remote from a river or steam, and, probably due to being newer, seem to have better drainage and sewerage treatment facilities than the other settlement types.

[xxxvii] You can sometimes see the Indians in Chinese temples, and *vice versa*, particularly in big temples.

Figure 2.2.4-2 Local Ethnic Settlement Pattern in SSB (near Kuang Station, Gombak District)

Figure 2.2.4-3 Local Ethnic Settlement Pattern in SSB

(near Rasa Station, Hulu Selangor District)

2.2.5 Population Statistics

As discussed earlier, *Mukims* (**2.1.2.5**) and LAs (**2.1.2.7**) have different origins: *Mukims* were for land administration; and LAs for urban sanitary and town planning. Therefore, their borders are basically regardless of each other (an example is shown in **Figure 2.1.2.7-2**). **Figure 2.2.5-1** shows areas of SSB-related Districts' *Mukims* (SSB-Ms) and Townships[38] in the SSB-related LAs (SSB-LAs)[43]. In order to characterize the ESP in SSB, we will analyze both *Mukim* and LA populations of Census 2010[38].

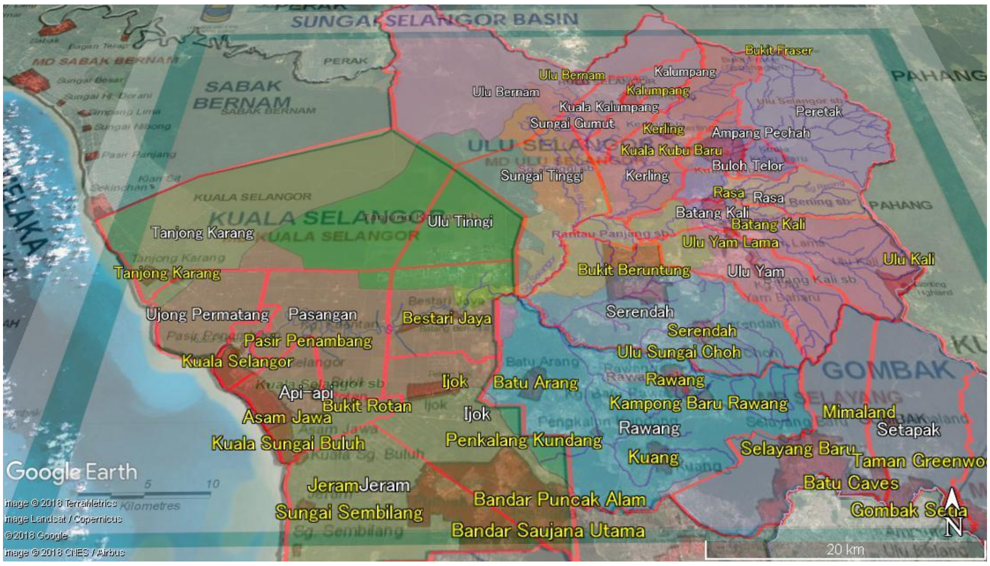


Figure 2.2.5-1 *Mukim*s and Townships[38] and SSB[43]

Red line: *Mukim* border, White label: *Mukim*,

Red patch: Township area, Yellow label: Township

2.2.5.1 *Mukim*

As discussed in **2.1.2.5**, *Mukim* is the smallest land administration area in Selangor. The British demarcated the land borders that have been basically succeeded by the Malaysians. In SSB, Mukims in the upstream Hulu Selangor District (HSD) and Gombak District (GmD) are roughly sub-basin-based; while the SSB Kuala Selangor District (KSD) *Mukim*s are cross-river.

The EPS in SSB-Ms is based the colonial time industry EPS where roughly: the Malays were in *Kampung* in KSD; the Chinese in towns in HSD and GmD; the Indians in plantations and towns in KSD. And, the effect of the NEP-generated ethnically-mixed housing developments are also there. This will be confirmed by the following analysis.

Table 2.2.5.1-1 shows the Census 2010 populations of SSB-Ms, whose ethnic group ratios (EGRs) being shown in **Figure 2.2.5.1-2**. *Mukims* Rawang (GB: *Mukim* codes are mapped in **Figure 2.2.5.1-1**) and Serendah (HI), (approximately Rawang sb) are the most populated *Mukims* in SSB. **Figure 2.2.5.1-3** is the Principal Component Analysis (PCA) biplot of SSB-Ms based on standardized EGRs. **Figure 2.2.5.1-3** shows that the first component (PC1): explains 37.0% of the total variance; being positively correlated with Indian and Non-citizens; and negatively with Malay, Chinese, Other Bumiputera and Others. The second component (PC2): explains 26.5% of the total variance; being positively correlated with Malay, Others, and non-Citizens; and negatively with Other Bumiputera, Chinese and Indian. The two PCs explain 63.5% of the total variance, which could mean that the SSB-Ms are so complex that they are difficult to explain with ethnic group compositions. However, considering the EGR values is from Census 2010[38] that is the official, non-estimated and full-count population data set with no sampling-derived uncertainty, the 63.5% explanation is sufficient for further discussion.

Table 2.2.5.1-1 SSB-related Districts' *Mukims*[38] and SSB Sub-basins[43]

District	Mukim	Code	EGR	Population	Sg. Selangor Basin's Sub-basin by LUAS
Hulu Selangor	Ampang Pechah	HA		13,649	◯ Kuala Kubu sb, Kerling sb
	Batang Kali	HB		32,783	◯ Batang Kali sb, Rantau Panjang sb, Hulu Rening sb
	Buloh Telor	HC	※	110	◯ Kuala Kubu sb
	Kalumpang	HD		2,444	●
	Kerling	HE		3,718	◯ Kerling sb
	Kuala Kalumpang	HF		3,605	△ Kerling sb
	Peretak	HG		1,418	◯ Ulu Selangor sb
	Rasa	HH		2,999	◯ Hulu Rening sb, Kuala Kub sb
	Serendah	HI		83,099	◯ Rawang sb, Rantau Panjang sb
	Sungai Gumut	HJ		1,703	△ Kerling sb
	Sungai Tinggi	HK	※	1,884	◯ Sunbai Tinngi sb, Tanjung Karang sb, Rantau banjang sb
	Ulu Bernam	HL		26,671	△ Kerling sb, Sungai Tinngi sb, Tanjung Karang sb
	Ulu Yam	HM		20,304	◯ Batang Kali sb, Rantau Panjang sb
Kuala Selangor	Api-Api	KA		21,628	△ Kuala Selangor sb
	Bestari Jaya (Batang Berjuntai)	KB		24,584	◯ Kuala Selangor sb, Ulu Tinggi sb, Rantau Panjang sb
	Ijok	KC		54,119	△ Kuala Selangor sb, Rawang sb
	Jeram	KD		45,352	●
	Kuala Selangor	KE		11,649	◯ Kuala Selangor sb
	Pasangan	KF		7,312	◯ Kuala Selangor sb, Ulu Tinggi sb
	Tanjong Karang	KG		30,624	△ Tanjung Karang sb, Kuala Selangor sb
	Ujong Permatang	KH		9,835	△ Kuala Selangor sb
	Ulu Tinggi	KI	※	154	◯ Tanjung Karang sb
Gombak	Batu	GA		285,288	●
	Rawang	GB		199,095	△ Rawang sb, Kuala Selangor sb, Rantau Panjang sb
	Setapak	GC		76,247	●
	Ulu Kelang	GD		108,064	●
Raub, Pahang	Teras	RA		4,989	△ Ulu Selangor sb

※: PCA outlier   EGR: Ethnic Group Ratio

◯: Inside SSB   △: Partly inside SSB   ●: Outside SSB

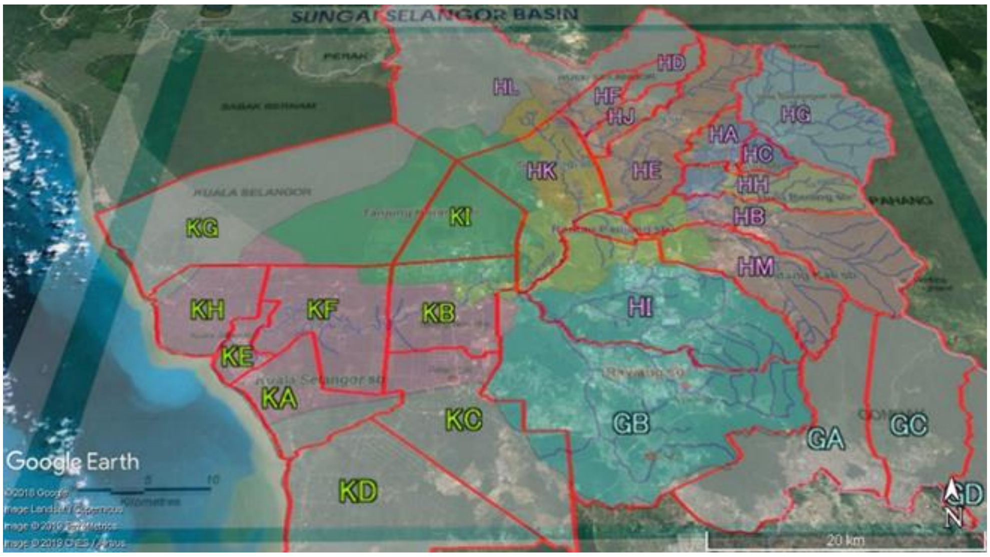


Figure 2.2.5.1-1 Map of *Mukims* in Code (Table 2.2.5.1-1) and SSB[43]

Figure 2.2.5.1-2 Ethnic Group Ratios of SSB-related Districts' *Mukims*[38]

Mukim codes and the marks below the codes: see **Table 2.2.5.1-1**

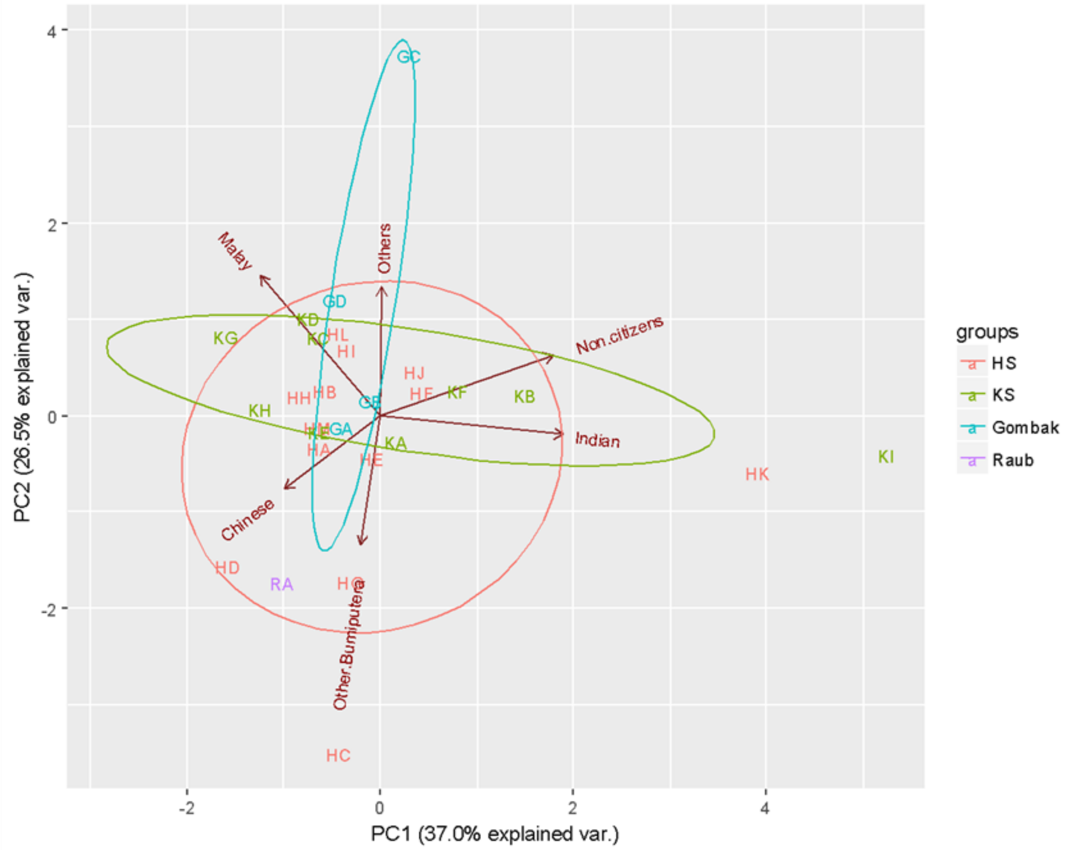


Figure 2.2.5.1-3 PCA Biplot of SSB-related Districts' *Mukim*s

Mukim names are in **Table 2.2.5.1-1**. The *Mukim* codes are mapped in **Figure 2.2.5.1-1.**

Let's compare the general trends of HSD and KSD *Mukim*s in the PCA biplot (**Figure 2.2.5.1-3**). The HS ellipse is roughly in the lower (PC2-nevative) quadrants; while the KS ellipse mostly in the upper (PC2-positive) quadrants. This indicates that HS *Mukim*s tend to be characterized mainly by their higher Other Bumiputera, Chinese and Indian ratios; while KS *Mukim*s mainly by their higher Malay, Others and Non-citizens ratios. And, the HS ellipse is roughly a sphere; while the KS ellipse collapsed nearly in the PC2 direction. This indicates that; within HSD, *Mukim*s' EGR variation is almost in any direction; while within KSD, *Mukim*s' EGR variation is more likely to be explained in the PC1 direction *i.e.*, mainly Indian, Non-citizens and Malay ratios. This general trends derive from the basin-wide ESP from the colonial time. The PCA biplots also suggests that the Indians and Non-citizens tend to coexist in the same working places in plantations, *etc.* [xxvii]

Keep eyes on the PCA biplot (**Figure 2.2.5.1-3**). Rawang has the largest population in SSB (**Table 2.2.5.1-1**) with an average EGR (near the origin) (**Figure 2.2.5.1-2**). This is because Rawang has many housing developments (the Google Earth aerial photo of **Figure 2.2.5.1-1**). Serendah (HI), Ijok (KC) and Jeram (KD) have relatively large populations (**Table 2.2.5.1-1**) of Malay-predominance (**Figure 2.2.5.1-2**) of housing developments (the Google Earth aerial photo of **Figure 2.2.5.1-1**). These trends derive from the local ESP after NEP.

*Mukim*s with extreme EGRs in SSBR-Ds (**Figure 2.2.5.1-3**) are of small population (**Table 2.2.5.1-1**). The smallest population *Mukim*s in SSB are Buloh Telor (HC) and Ulu Tinngi (KI), which are an Indian-predominant plantation and Other Bumiputera (Orang Asli)-predominant mountain areas, respectively (**Figure 2.2.5.1-3** and **Figure 2.2.5.1-1**). Sungai Tinngi (HK) is the Indian-predominant plantation area adjacent to Ulu Tinngi, which is also of small population (**Table 2.2.5.1-1**). Consequently, it can be said that in the SSB-related District, extreme EGR *Mukim*s are rural, of minority predominance. By the way, bringing up *Mukim* population density (whole *Mukim* population divided by whole *Mukim* area) values here may mislead sanitary administration (See also **2.2.6**). Plantation workers and Orang Asli[xxxviii] live in living quarters and villages, respectively, and the rest of the area almost deserted. Therefore, a living quarter or village-focused sanitation measures may be effective in plantations and Orang Asli villages, such as septic tanks.

In summary, *Mukim*s' ethnic group ratios reflect the basin-wide ethic settlement pattern, rather than their local ethnic settlement pattern.

2.2.5.2 Township

As discussed in **2.1.2.7** , A Local Authority (LA) basically is an urban sanitary service body, and Townships are the jurisdiction areas or centers of the LAs. In SSB, MDHS is in charge of KSD; MDKS KSD; and MPS *Mukim* Rawang of GmD.

The Census 2010 population distribution among SSB-related Townships (SSB-Ts) are shown in **Table 2.2.5.2-1**, whose ethnic group ratios (EGRs) being shown in **Figure 2.2.5.2-2**. And, the Principal Component Analysis (PCA) biplot of SSB-Ts based on standardized EGRs in **Figure 2.2.5.2-3**. **Table 2.2.5.2-1** shows that Bukit Beruntung (H02) is of the largest population within SSB, except which SSB-Ts have relatively small populations compared to those closer to Klang Valley. **Figure 2.2.5.2-3** shows that the first component (PC1) explains 40.1% of the total variance, being positively correlated with Indian and Non-citizens; and negatively with Malay, Chinese, Other Bumiputera and Others. The second component (PC2) explains 24.4% of the total variance, being positively correlated with Malay, Others, and non-Citizens ratios; and negatively with Other Bumiputera, Chinese and Indian. The two

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[xxxviii] Not only foreigners, but also Indians, particularly (ex-)plantation workers,[89] and Orang Asli[90] tend to be '*marginalized*' from the main stream Malaysian society. The IRBM of SSB needs to integrate them.

PCs explain 64.5% of the total variance, which indicates that SSB-Ts could be seen too complex for only the first two PCs to explain by EGR, like SSB-Ms (63.5%). However, considering the EGR is from Census 2010[38] the official, non-estimated and full-count population data set with no sampling-derived uncertainty, the 64.5% (more than half) explanation is sufficient for further discussion. Most of the SSB-Ts are plotted in the first and third quadrants, which means that SSB-T EGRs are roughly explained by ratios of Chinese and Bumiputera (Malay and Other Bumiputera).

Comparing to the SSB-M's (**Figure 2.2.5.1-3**), the SSB-T's ellipses of KS (MDKS) and HS (MDHS) are similar (**Figure 2.2.5.1-3** and **Figure 2.2.5.2-3**). This means that Townships' EGRs do not represent the rest of the areas, and but their local ESP characteristics. In general, Non-housing development Townships are Chinese and Indian majority, while housing development Townships are Malay majority. The SSB-Ts of MDHS, MPS and MDR generally do not derive from housing developments, being: old tin mining and rubber towns whose main populations were the Chinese and the Indians; New Villages of Kampung Baru Rawang (S04) and Pengkalan Kundang (S07); a hill station of Fraser's Hill (H03, R01); and an ex-coal mining town of Batu Arang (S01). Bukit Beruntung (H02) is a housing development Township. On the other hand, SSB-Ts of MDKS are: Kuala Selangor (K09) the ex-royal capital that is basically a Malay town; Indian-majority Townships of Bukit Rotan (K05) and Bestari Jaya (K04)[xxxix] in the plantation areas; Pasir Penambang (K04) the Chinese fishery town. Bandar Punkak Alam (K02) and Bandar Saujana Utama (K03) the Malay-predominant housing development Townships are outside SSB. The non-Township areas (Reminders of M.X.) are (ex-) non-urban areas: forests, *Kampung*s, plantations, and housing developments, *etc.*, which overall are Malay-majority (**Figure 2.2.5.2-2**).

[xxxix] Bestari Jaya is also known as Batang Berjuntai the old name. Batang Berjuntai's Chinese expression(八丁燕带) is probably the only Chinese expression for the place.

Table 2.2.5.2-1 SSB-related LAs' Townships[38] and SSB Sub-basins[43]

Local Authority Area	Township	Code	EGR	Population		Sg. Selangor Basin's Sub-basin by LUAS
M. D. Hulu Selangor (MDHS)	Batang Kali	H01		3,107	○	Batang Kali sb
	Bukit Beruntung	H02		40,877	○	Rantau Panjang sb, Rawang sb
	Bukit Fraser	H03		27	○	Ulu Selangor sb
	Kalumpang	H04		4,607	●	
	Kampong Ulu Yam Baharu	H05		6,918	○	Batang Kali sb
	Kerling	H06	※	1,588	○	Kerling sb
	Kuala Kubu Baru	H07	※	13,361	○	Kuala Kubu sb, Kerling sb
	Rasa	H08		8,412	○	Kuala Kubu sb, Batang Kali sb, Rening sb
	Serendah	H09		6,611	○	Rawang sb
	Ulu Bernam	H10		5,317	●	
	Ulu Kali	H11	※	1,021	○	Batang Kali sb
	Ulu Sungai Choh	H12	※	3,177	○	Rawang sb
	Ulu Yam Lama	H13	※	1,908	○	Batang Kali sb
	Reminder of M.D.	HR		97,456	△	
M. D. Kuala Selangor (MDKS)	Asam Jawa	K01	※	401	△	Kuala Selangor sb
	Bandar Puncak Alam	K02	※	28,201	●	
	Bandar Saujana Utama	K03		26,773	●	
	Bestari Jaya (Batang Berjuntai)	K04		8,218	○	Kuala Selangor sb
	Bukit Rotan	K05	※	168	○	Kuala Selangor sb
	Ijok	K06		4,926	△	Kuala Selangor sb
	Jeram	K07		849	●	
	Kampong Kuantan	K08		1,461	○	Kuala Selangor sb
	Kuala Selangor	K09		18,834	○	Kuala Selangor sb
	Kuala Sungai Buluh	K10	※	2,879	●	
	Pasir Penambang	K11	※	1,188	○	Kuala Selangor sb
	Sungai Sembilang	K12		419	●	
	Tanjong Karang	K13		6,348	●	
	Remainder of M.D.	KR		104,892	△	
M. P. Selayang (MPS)	Batu Arang	S01		5,633	○	Rawang sb
	Batu Caves	S02		2,058	●	
	Gombak Setia/Taman Perwira	S03	※	25,312	●	
	Kampong Baru Rawang	S04	※	1,834	○	Rawang sb
	Kuang	S05		7,187	○	Rawang sb
	Mimaland	S06	※	444	●	
	Pengkalan Kundang	S07	※	1,932	○	Rawang sb
	Rawang	S08		30,711	○	Rawang sb
	Selayang Baru	S09		150,733	●	
	Taman Greenwood/Taman Gombak	S10		50,423	●	
	Remainder of M.P.	SR		266,142	△	
M. D. Raub (MDR), Pahang	Bukit Fraser	R01		991	△	Ulu Selangor sb

※: PCA outlier EGR: Ethnic Group Ratio

○: Inside SSB △: Partly inside SSB ●: Outside SSB

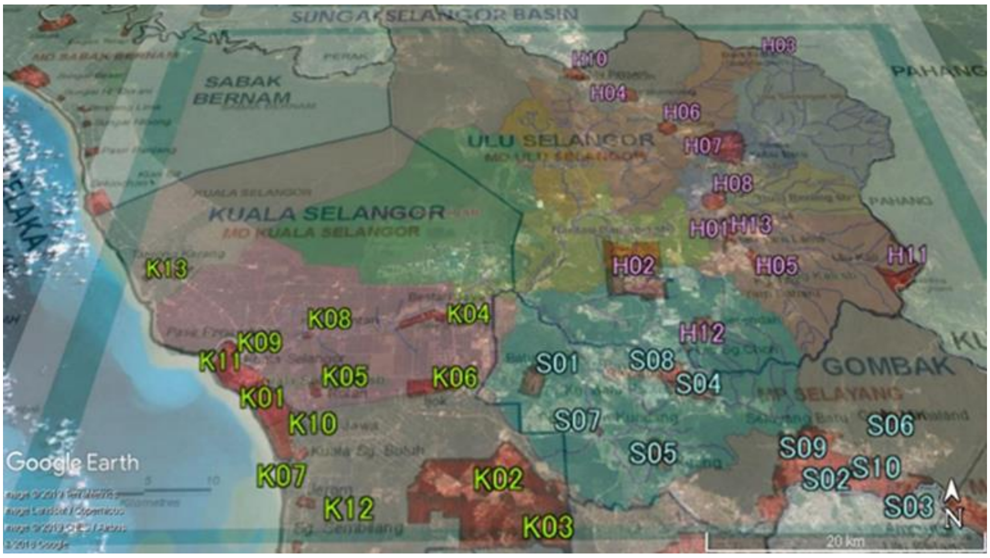


Figure 2.2.5.2-1 Map of Townships s[38] in Code (Table 2.2.5.2-1) and SSB[43]

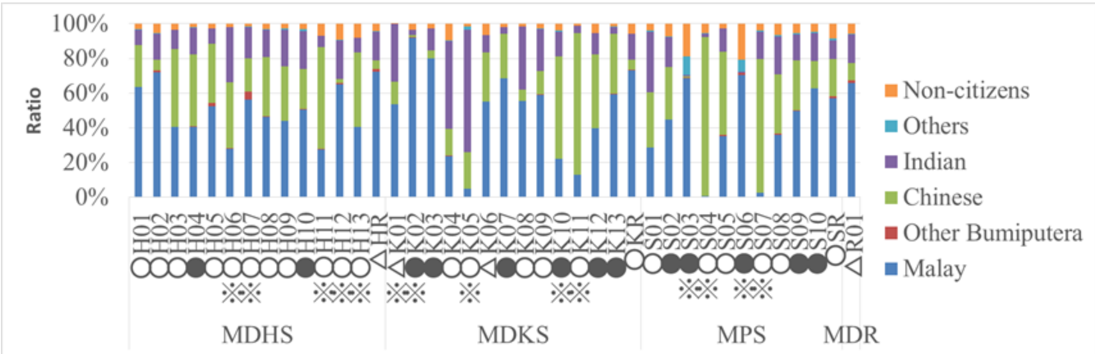


Figure 2.2.5.2-2 Ethnic Group Ratios of SSB-related LAs' Townships[38]

Township codes and the marks below the codes: see **Table 2.2.5.2-1**

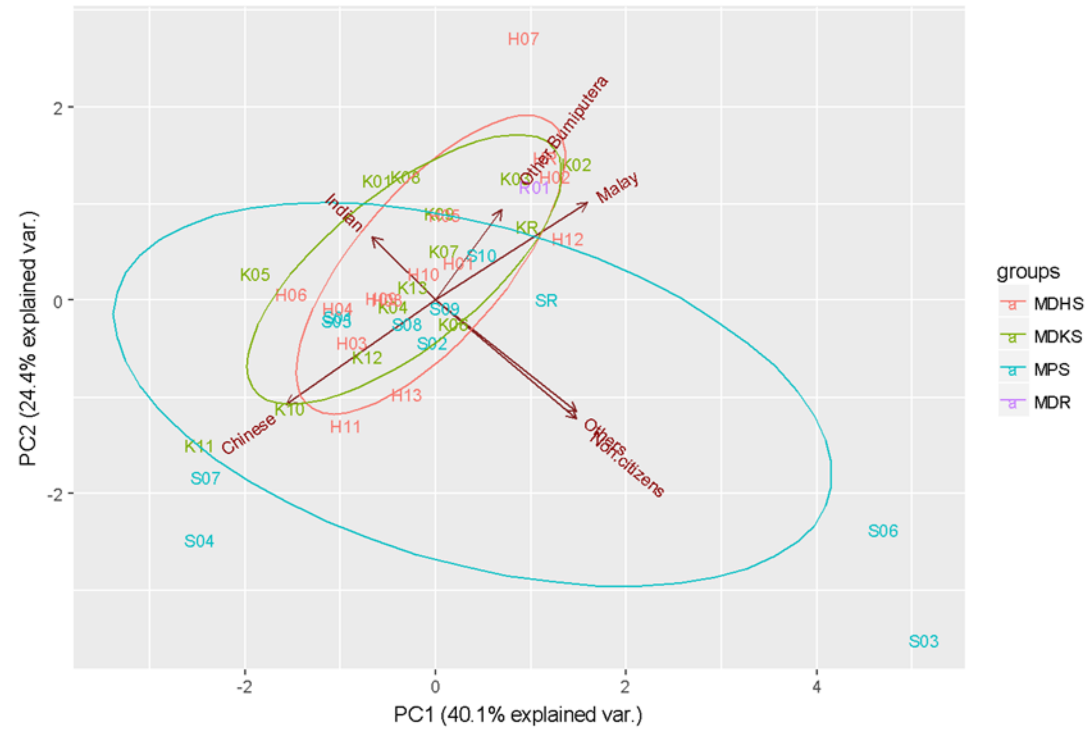


Figure 2.2.5.2-3 PCA Biplot of SSB-related LAs' Townships

Township names are in **Table 2.2.5.2-1**.

The Township codes are mapped in **Figure 2.2.5.2-1**

Let's compare the general trends of MDHS and MDKS Townships in the PCA biplot (**Figure 2.2.5.2-3**). The MDHS and MDKS ellipses are almost overlapping, which indicates that the overall EGR characteristics of the two Township groups are similar. The MDKS ellipse is slightly more in the fourth quadrat (of higher Indian ratios) than the MDHS ellipse, which indicates that MDKS has more Townships near plantations than MDHS. The MPS Townships within SSB are all in the third quadrat (of higher Chinese ratios), which indicates that these have traces of traditional mining town centers and Chinese New Villages.

Keep eyes on the PCA biplot (**Figure 2.2.5.2-3**). Selayang Baru (S09) is the closest to the origin (average). Selayang Baru is a KL-rim residential area (the Google Earth aerial photo of **Figure 2.2.5.2-1**) and has the largest population among the SSB-Ts (but S09 is out of SSB). Among the large population Townships within SSB (**Table 2.2.5.1-1**): Rawang (S08) is an average (close to the origin) EGR Township in the third quadrat (of higher Chinese ratio); Bukit Beruntung (H02) is Malay-predominant (**Figure 2.2.5.1-2**) housing developments (the Google Earth Pro aerial photo of **Figure 2.2.5.2-1**). Bukit Beruntung (H02), Bandar Puncak Alam (K02) and Bandar Saujana Utama (K03) are recently developed Malay-predominant (**Figure 2.2.5.1-2**) housing development Townships adjacent to Klang Valley (**Figure 2.2.5.2-1**). This implies that more Malay population would increase in SSB suburbs as Klang Valley develops. **Figure 2.2.5.2-4** shows the development of the Malay-predominant housing development Townships from 2000 to 2010.

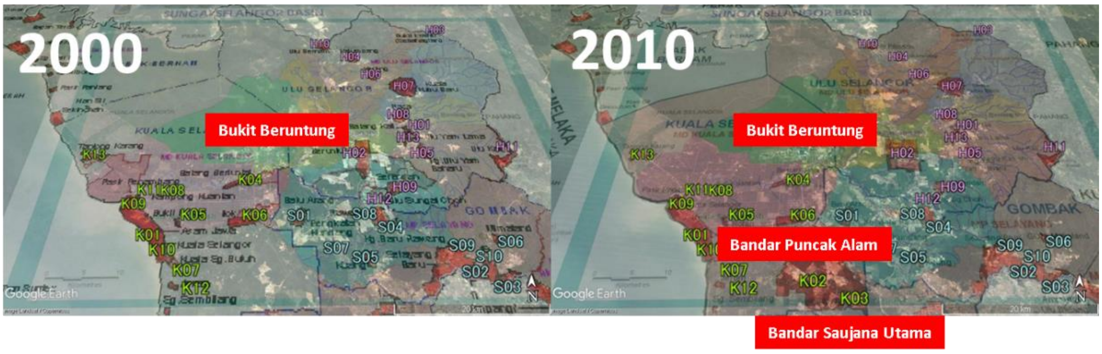


Figure 2.2.5.2-4 Recently Developed Housing Development Townships[38,55] and SSB[43]

Townships with extreme EGRs of the SSB-related LAs (**Figure 2.2.5.2-3**) tend to be of small population (**Table 2.2.5.2-1**). The smallest population Township in MDHS is Bukit Fraser (a.k.a. Fraser's Hill) (H03) and in MDKS Bukit Rotan (K05). Bukit Fraser (R01) is more Malay than Bukit Fraser (H03) (**Figure 2.2.5.1-3** and **Figure 2.2.5.1-1**). The other extreme EGR *Mukim* is Sungai Tinngi (HK) the Indian-predominant plantation area adjacent to Ulu Tinngi. Sungai Tinngi is also of small population (**Table 2.2.5.1-1**).

In summary, Township's ethnic group ratios reflect their local ethic settlement pattern, rather than their basin-wide ethnic settlement pattern. This is because the Township are limited to developed urban areas, which is the original character of Local Authority.

2.2.6 Population Density

Figure 2.2.6-1 shows the Google Earth Pro aerial photo of 2016 overlapped with the GIS-mapped population density by Sakai *et al*. (2017)[91], who obtained the population dataset from the Ork Ridge National Laboratory and mapped the population at about 1 km resolution.[91] It is eye-observable that: 1,000-5,000 (yellow) and 5,000- (red) person/km^2 population density areas are located in urban areas; 100-1,000 (green area) person/km^2 in urban and rural areas; and, 0-100 (no color) in plantation or forest areas. The red areas are (formerly) connected by railway to KL and the Klang Port (**Figure 2.2.1-1**).

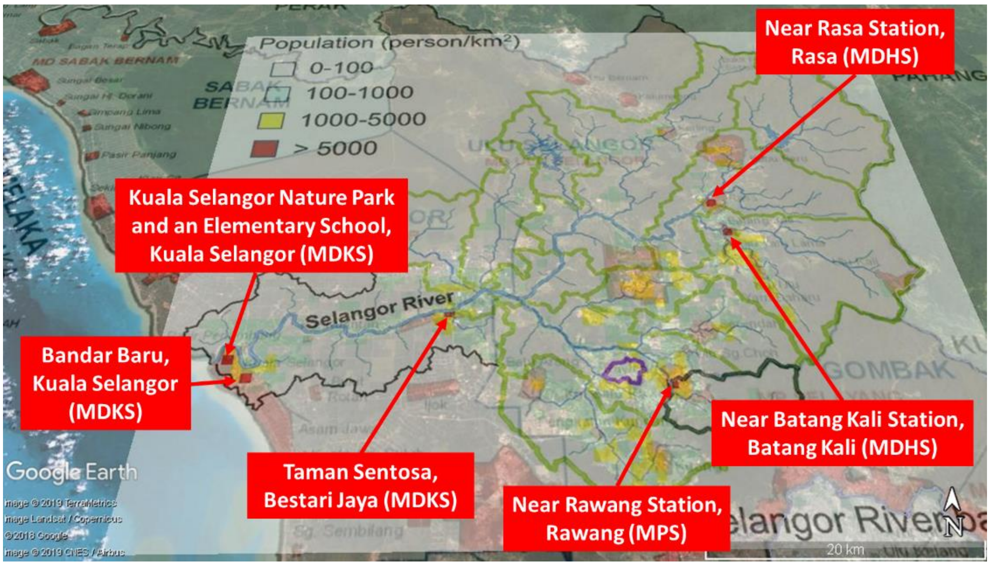


Figure 2.2.6-1 Population Density by Sakai *et al.* (2017)[92] and Townships[38]

Background light red patch: Township

According to the aerial photo, the two red-colored areas in the MDHS area Chinese residential areas near Rasa and Batang Kali Stations. The red area in the MPS area is a Chinese residential area near Rawang Station. The red areas in the MDKS area are: the Malay residential area of Bandar Baru; an area including Taman Alam Kuala Selangor (Kuala Selangor Nature Park) and SKJ(T) Vageesar (a Tamil elementary school), which is perhaps a mislocation for the surrounding residential areas; and the ethnically mixed residential area of Taman Sentosa, Bestari Jaya. Since the population is concentrated in towns, employing whole *Mukim* area-based population densities may mislead further environmental engineering discussion on such as sewerage system installation planning. This is clarified by overlapping the layers of the Sakai *et al.* (2017)'s grid population densities[91] and *Mukim* population densities.[93] All the arrow-indicated red areas (>5,000 person/km^2) are within the Township areas (See also), and *Mukim*s Rasa, Batang Kali and Bestari Jaya have town-centered populations while the rest of the *Mukim*s' areas being low population areas. If you employ the whole Mukim area-based population densities only, these high population density spots may be ignored. Dealing with population density needs some attention.

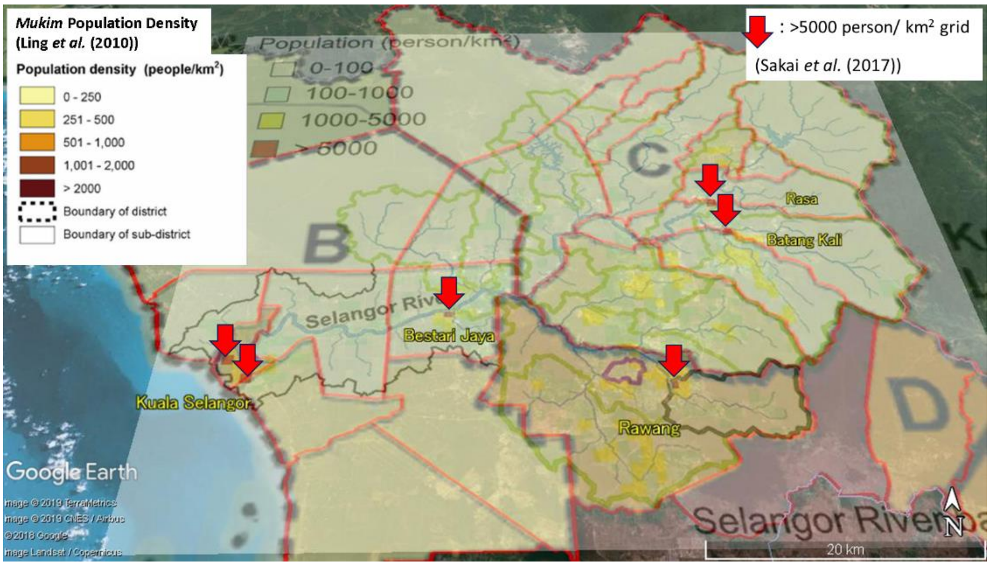


Figure 2.2.6-2 Population Densities by *Mulim*[93] and by Grid[92]

2.3 Conclusions

There are two main lines of Selangor's IRBM history: the land and river administration history and the ethic settlement pattern. These lines are mutually entwined with numerous knots: *e.g.*, land border, Sultan, the British colonization, taxation system, population, tin mining, agriculture, immigrants, railway, IRBM, *etc.*, which are key concepts to understand the SSB history.

The land and river administration history has two main lines: the British transforming of Selangor from a river-centered kingdom to a land-centered State of a federation; and their forming of the complex, authoritarian, top-down, Federation-centralized administration with formal authority of Sultan and actual power of elite bureaucrats, which the Malaysians succeeded. In order to solve the jurisdiction problems, the LUAS was established to coordinate numerous numbers of Federal and State bodies related to IRBM, within the Selangor State territory.

The ethnic settlement pattern (ESP) has two main lines: basin-wide ESP and local ESP. The latter is a mosaic-like ESP corresponding settlement types: *Kampung*s (villages) mainly occupied by the Malays; old towns mainly by the Chinese and Indians; New Villages mainly by the Chinese Plantations mainly by the Indians; forests mainly by Orang Asli (indigenous people, classified 'Other Bumiputera' in Census); and housing developments by all the ethnic groups. The former, the basin-wide ESP derives from the rough distribution of the settlement types in SSB: old towns, New Villages, housing developments, and Orang Asli settlements are mainly in the upstream area (Hulu Selangor District and *Mukim* Rawang of Gombak District); while *Kampung*s and plantations are mainly in the downstream area (along the Selangor River: the central area of Kuala Selangor District). The basin-wide and local

ESPs were confirmed by Principle Component Analysis (PCA) of Census 2010's of ethnic population ratios of *Mukim*s and Local Authorities, respectively.

References

1. 鶴見良行. マラッカ物語. (時事通信社, 1981).
2. Amoroso, D. J. *Traditionalisim and the Ascendancy of the Malay Ruling Class in Colonial Malaya*. (Strategic Information and Reserch Development Centre, 2014).
3. Milner, A. *Kerajaan; Malay Political Culture on the Eve of Colonial Role*. (Strategic Information and Reserch Development Centre, 2016).
4. 弘末雅士. 東南アジアの港市世界—地域社会の形成と世界秩序. (岩波書店, 2015).
5. 坪内良博. 東南アジア他民族社会の形成. (京都大学学術出版会, 2009).
6. Short, D. E. & Jackson, J. C. The Origins of an Irrigation Policy in Malaya: A Review of Developments Prior to the Establishment of the Drainage and Irrigation Department. *J. Malays. Branch R. Asiat. Soc.* **44**, 78–103 (1971).
7. 鶴見良行. アジアはなぜ貧しいのか. (朝日新聞社, 1982).
8. 東南アジア史Ⅱ 島嶼部. (山川出版社, 1999).
9. Gullick, J. M. *A History of Selangor*. (The Malaysian Branch of the Royal Asiatic Society, 2004).
10. マレーシアの歴史. (山川出版社, 1983).
11. Gullick, J. M. *Glimpses of Selangor 1860-1898*. (The Malaysian Branch of the Royal Asiatic Society, 1996).

12. Ariffin, A. K. & Mohamad, J. Early Socio-Economic Development in the Sungai Selangor Watershed. in *Land Use and Dynamics and Governance in the Sungai Selangor Watershed* 11–26 (University of Malaya Press, 2015).

13. Andaya, B. W. & Andaya, L. Y. *A History of Malaysia*. (Palgrave, 2017).

14. Gullick, J. M. Economic Recovery in the Selangor River Valley in the Late Nineteenth Century. *J. Malays. Branch R. Asiat. Soc.* **81**, 83–98 (2008).

15. 佐藤興平. 東南アジアの花崗岩と錫鉱床を訪ねて. 地質ニュース **353**, 20–36 (1984).

16. 防衛庁防衛研修所戦史室. マレー侵攻作戦. (朝雲新聞社, 1966).

17. Sandhu, K. S. *Indians in Malaya*. (Cambridge University Press, 1969).

18. 木原浩之. マレーシアにおけるイギリス法の継受 —「1956年(1972年改正)民事法」の検討を中心に—. 亜細亜法學 **41**, 77–113 (2006).

19. 萩原宜之. マレーシア政治論—複合社会の政治力学. (弘文堂, 1989).

20. マレーシアの地方自治. http://www.clair.org.sg/j/wp-content/uploads/2018/03/rep_313.pdf (2007).

21. Gullick, J. M. The growth of kuala lumpur and of the malay community in selangor before 1880. *J. Malays. Branch R. Asiat. Soc.* **63**, 15–38 (1990).

22. Swettenham, F. A. *British Malaya; an Account of the Origin and Progress of British Influence in Malaya*. (London, New York : J. Lane, 1907).

23.Mustafa, M. *Environmental Law in Malaysia*. (Kluwer Law International, 2011).

24.Malaysia. *Water Services Industry Act 2006*. (The Commissioner of Law Revision, Malaysia, 2006).

25.LUAS. Application of Groundwater and Surface Water Abstraction License. *Portal Lasmi LUAS* https://www.luas.gov.my/index.php?option=com_content&view=article&id=112&lang=en (2017).

26.Ooi, J. B. *Peninsular Malaysia*. (Longman, 1976).

27.Fisher, C. A. The Railway Geography of British Malaya. *Scott. Geogr. Mag.* **64**, 123–136 (1948).

28.藤本彰三. 第 7 章 マレーシアにおける経済発展と土地問題の変質. in 東南アジアの経済開発と土地制度 225–262 (アジア経済研究所, 1997).

29.Lim, J. Y. *The Malay House; Rediscovering Malaysia's Indinenous Shelter System*. (Institute Masyarakat, 1987).

30.*アジアの大都市[3] クアラルンプル・シンガポール*. (日本評論社, 2000).

31.生田真人. マレーシアの都市開発 —歴史的アプローチ—. (古今書院, 2001).

32.坪井祐司. 英領マラヤにおけるマレー人像の相克 : スランゴル州における対マレー人土地政策の展開. *マレーシア研究 Malays. Stud. J.* 72–87 (2013).

33.Malaysia - Key Changes Of The Land Acquisition (Amendment) Act 2016. | Conventus Law. *Conventus Law* http://www.conventuslaw.com/report/malaysia-key-changes-of-the-land-acquisition/ (2018).

34.Zaharah binti Hj. Mahmud. The Period and the Nature of ‘Traditional’ Settlement in the Malay Peninsula. *J. Malays. Branch R. Asiat. Soc.* **43**, 81–113 (1970).

35.坪井祐司. 英領期マラヤにおける「マレー人」枠組みの形成と移民の位置づけ—スランゴル州のプンフルを事例に—. 東南アジア －歴史と文化－ **33**, 3–25 (2004).

36.Tsuboi, Y. The Malay Society During the Transition of the Selangor Administration in the Late 19th Century. *Sarjana* **29**, 19–30 (2014).

37.Shamsul, A. B. *From British to Bumiputera Rule Local Politics and Rural Development in Peninsular Malaysia*. (Institute of Southeast Asian Studies, 1986).

38.Department of Statistics, Malaysia. *Population Distribution by Local Authority Areas and Mukims 2010*. (2011).

39.Kuala Sealngor District/Land Office. Portal Rasmi Pejabat Daerah/Tanah Kuala Selangor. http://www2.selangor.gov.my/kualaselangor.php?mid=152.

40.Siddiquee, N. A. 2. The public bereucracy - An analytical overview. in *Public Management and Governance in Malaysia - Trends and transformations* 31–49 (Routledge, 2013).

41.DID Malaysia. *Sungai Selangor Basin Management Plan, 2007-2012*. (DID Malaysia, 2007).

42.Gombak. Profail Daerah Gombak. *Portal Rasmi Pejabat Daerah/Tanah Gombak* http://www2.selangor.gov.my/gombak.php/pages/view/18?mid=61.

43.LUAS. IRBM Approach in Water Quality Management - Case Study in Sungai Selangor River Basin. (2008).

44.Selangor. *Rancanguan Struktur Negeri Selangor 2035*. vol. 70 (2017).

45.宇高雄志. マレーシアにおける多民族混住の構図　—生活空間にみる民族共存のダイナミズム. (明石書店, 2009).

46.Ahmad, A., Silong, A. D. & Abbasiyannejad, M. Competencies of Effective Village Leadership in Malaysia. *J. Asian Dev. Stud.* **4**, 7–21 (2015).

47.Ahmad, A., Silong, A. D., Abbasiyannejad, M. & Suandi, T. bin. Roles and Issues of Village Development and Security Committee (VDSC) Institution for Rural Development in Malaysia. *J. Asian Dev. Stud.* **3**, 51–62 (2014).

48.河野元子. マレーシアにおける地方行政と地方政府. in 永井史男・船津鶴代編『東南アジアにおける自治体ガバナンスの比較研究』調査研究報告書 (アジア経済研究所, 2010).

49.Loh, F. K. W. Restructuring Federal–State Relations in Malaysia: From Centralised to Co-operative Federalism? *Round Table* **99**, 131–140 (2010).

50.Hamzah, J. bin & Mohkeri, S. The Kampung Kuantan Firefly Reserve. (2010).

51.篠崎香織. プラナカンの誕生　海峡植民地ペナンの華人と政治参加. (九州大学出版会, 2017).

52.Singaravelloo, K. 11　Local government functions and intergovernmental relations. in *Public*

Managemnet and Governance in Malayisa; Trands and transfromatnions 199–216 (Routledge, 2013).

53. Indah Water Konsortium. Indah Water Portal | Corporate Profile. *Indah Water Portal* https://www.iwk.com.my/corporate-profile.

54. Malaysia. *Federal Constitution*. (The Commissioner of Law Revision, Malaysia, 2010).

55. Department of Statistics, Malaysia. *Population Distribution by Local Authority Areas and Mukims 2000*. (2001).

56. Mokhtar, M. B., Toriman, M. E. H., Hossain, M., Abraham, A. & Tan, K. W. Institutional Challenges for Integrated River Basin Management in Langat River Basin, Malaysia. *Water Environ. J.* **25**, 495–503 (2011).

57. Selangor. Constitution of the State of Selangor. (1959).

58. LUAS. Portal Rasmi LUAS. http://www.luas.gov.my/.

59. Selangor. *Selangor Waters Management Authority Enactment 1999*. (LUAS, 1999).

60. Khalid, R. M. *et al.* Constitutional Issues in Integrating Water Resources Management in Malaysia: A Case Study of the Selangor Water Management Authority. *OIDA Int. J. Sustain. Dev.* **3**, 11–18 (2012).

61. Noordin, N., Daud, M. F. & Hj. Majizat, A. Application of IWRM/IRBM Principles for Tasik Putrajaya Catchment. in (2008).

62.Mdm. Nor. ’Ani Abul Wahab. Overview of the Water Services industry in Malaysia. (2011).

63.DID Malayisa. Organisation Chart. *Official Portal for Department of Irrigation and Drainage* https://www.water.gov.my/index.php/pages/view/491?mid=229 (2018).

64.Dato’ Ir. Haji Keizrul bin Abdullah. Integrated River Basin Management Report: Towards Realising Integrated River Basin Management in Malaysia. *Official Portal for Department of Irrigation and Drainage* https://www.water.gov.my/index.php/pages/view/708 (2018).

65.石田章. マレーシア農業の政治力学. (日本経済評論社, 2001).

66.DID Malaysia. Our Background. *The Official Portal for Department of Irrigation and Drainage Malaysia* http://www.water.gov.my/home?lang=en.

67.白石代吉. マラヤ稲作の回顧と技術援助の経緯(<特集>マラヤ稲作シ ンポジウム特集号). *東南アジア研究（1965）* **2**, 170–175 (1965).

68.Jeyabalan, G. Intergovernmental Role and Cooperation in River Management: A Study in Gombak District. (University of Malaya, 2009).

69.Malaysia. *Suruhanjaya Perkhidmatan Air Megara Act 2006*. (2006).

70.Bernama. Air Selangor to Operate as Sole Water Supplier for Selangor, Kl and Putrajaya from April 1. *The Edge Markets* http://www.theedgemarkets.com/article/air-selangor-operate-sole-water-supplier-selangor-kl-and-putrajaya-april-1 (2019).

71.DOE Malaysia. Official Portal of Department of Environment.

http://www.doe.gov.my/portalv1/en/.

72.Ambali, A. R. 13　Environmental policy and governance. in *Public Management and Governance in Malaysia; Trends and transformations* 235–253 (Routledge, 2013).

73.Hezri, A. A. & Hasan, Mohd. N. Towards sustainable development? The evolution of environmental policy in Malaysia. *Nat. Resour. Forum* **30**, 37–50 (2006).

74.LUSA. *State of River Report 2008 Sungai Selangor*. (LUAS, 2010).

75.Arkib Negara Malaysia. Launching Of The Environmental Quality Council **-**. *Hari Ini Dalam Sejarah* http://hids.arkib.gov.my/en/peristiwa/-/asset_publisher/WAhqbCYR9ww2/content/majlis-pelancaran-mutu-alam-sekeliling/pop_up?_101_INSTANCE_WAhqbCYR9ww2_viewMode=print (2017).

76.Malaysia. *Environmental Quality Act 1974*. (1975).

77.アジア経済研究所. マラヤの華僑と印僑. (アジア経済研究所, 1961).

78.重松伸司. 国際移動の歴史社会学ー近代タミル移民研究ー. (名古屋大学学術出版会, 1999).

79.マクニール W. H. 疾病と世界史（下）. (中央公論新社, 2007).

80.Willford, A. C. *Tamils and the Haunting of Justice: History and Recognition in Malaysia's Plantations*. (NUS Press, 2014).

81.Anonymous. Water Only. *Snazzy Maps* http://snazzymaps.com (2014).

82. Voon, P. K. *Indebtedness and Land Use in Pre-war Malaya: With Special Reference to the Indigenous Society*. (Institute of Develop Economies, 1987).

83. Department of Director General of lands and Mines. Malay Reserves Enactment | Department Of Director General Of Lands And Mines. *Department of Director General of lands and Mines* https://www.jkptg.gov.my/en/content/malay-reserves-enactment.

84. More than 182,000ha in Selangor gazetted as Malay reserve land. *Edgeprop.my* https://www.edgeprop.my/content/more-182000ha-selangor-gazetted-malay-reserve-land (2012).

85. 山田悠未. マレーシア華人新村の成立背景とその概要 : 華人新村研究 その 1. 日本建築学会計画系論文集 **585**, 225–231 (2004).

86. ミラーハリー. マラヤのジャングルー独立風雲録ー. (鳳映社, 1958).

87. The Chinese New Villages in Malaysia: Impact of Demographic Changes and Response Strategies*. *Centre for Malaysian Chinese Studies* http://www.malaysian-chinese.net/publication/articlesreports/articles/7181.html (2005).

88. 鳥居高. マレーシア -- 「見えない?」それとも「隠された?」民族問題 (特集 人口センサスからみる東アジアの社会大変動). アジ研ワールド・トレンド **238**, 28–31 (2015).

89. 山田満. 多民族国家マレーシアの国民統合; インド人の周辺化問題. (大学教育出版, 2000).

90. 信田敏宏. 周縁を生きる人びと—オラン・アスリの開発とイスラーム文化. (京都大学学

術出版会, 2004).

91. Sakai, N. *et al.* Occurrence, Fate and Environmental Risk of Linear Alkylbenzene Sulfonate in the Langat and Selangor River Basins, Malaysia. *Chemosphere* **172**, 234–241 (2017).

92. Santhi, V. A., Sakai, N., Ahmad, E. D. & Mustafa, A. M. Occurrence of bisphenol A in surface water, drinking water and plasma from Malaysia with exposure assessment from consumption of drinking water. *Sci. Total Environ.* **427–428**, 332–338 (2012).

93. Ling, C. Y., Gruebner, O., Kramer, A. & Lakes, T. Spatio-Temporal Patterns of Dengue in Malaysia: Combining Address and Sub-District Level. *Geospatial Health* **9**, 131–140 (2014).

3. Proceeding Studies on Water and River Perception

This Chapter reviews proceeding studies on water and river perception, in order to how this dissertation's hypothesis that people's water and river perceptions can associate with demographic factors such as ethnicity and religion, *etc*. have been approached by researchers. No single study is perfectly unrelated to this topic, but directly and tightly related are engineering, phycology, and ethnohydrology, and risk perception, which mutually more or less overlap. River basin managers and philosophers should integrate all studies practically and academically, respectively, which is unfortunately beyond this dissertation. With the previous **Chapter 2**, this Chapter provides the reader with the background of the questionnaire survey described in the following **Chapters 3** and **4**.

People's water and river perceptions have been studied for decades mainly in the Western developed countries, whose knowledge and hypotheses may be unextrapolatable to developing countries.[1] Moreover, water perception is known to be dependent on religion (*e.g.*, definition of purity, baptisms, ablutions, and deluge).[1] Islam, indeed, has traditional water purity criteria.[2] Sg. Selangor Basin (SSB) is in Malaysia that is a non-Western developing country with Islam as the national religion. However, SSB is a prime example of religious and cultural diversity of Malaysia, where are other religions such as Christianity, Buddhism, Hinduism, *etc*. coexisting. For stakeholders' communication for the IRBM of SSB, it is necessary to figure out people's water and river perceptions in terms of religion as well as other demographic variable. However, although there are some water and river perception studies have been done in Malaysia, there is no one that analyzed and discussed religion as a main variable, which this dissertation aims to.

People's water and river perceptions studies are by nature case studies and thus basically case-specific, and it is difficult to compare and generalize diverse studies and/or reports. First, waters-people combinations are diverse. A person perceive a river together with the surrounding environment, and another person may perceive the same river in a different way (**Figure 3-1**). Statistics, by collecting multiple persons, would solve this problem if the diverse persons are regarded as one collective sample that unbiasedly represent the river-related people (*e.g.*, users or stakeholders) with an appropriate sample size. Or, a multiple number of samples are needed according to the research purpose. If there are multiple distinct cultures among the people, and our interest is in comparing the cultures concerning river perceptions, then each culture sample should be collected with an appropriate sample size. Second, survey and analysis methods are diverse. Researchers employ methods that they believe are suitable for the data obtained in their survey, thereby each report's hypothesis inherently and unavoidably incorporates or postulates a set of theoretical or technical assumptions of the methods employed, such as synonymity of certain words by respondents, mathematically equal distance intervals between described expressions *e.g.*, the intervals between 'strongly agree,' 'agree,' 'disagree,' and ‘strongly disagree’ on a rating scale, direct comparability of the ratings of different things (*e.g.*, between the agree/disagree levels of pollution and bathing suitability), constancy or linearity of a parameter on another, normal distribution. Different or even opposite hypotheses/conclusions might be generated from the same respondents depending on survey or analysis methods. Third, there may be reporting bias. When it comes to inter-report generalization, statistics may not work in the first place, due to reporting bias. For example, a report number-based generalization of the validity of a hypothesis may be independent of the validity of the hypothesis itself. Reports were written by researchers who are interested in common, non-random hypotheses. They choose survey sites that they believe are suitable for their purpose, of their interest or simply near them, and report what they believe is worth reporting. However, the number of unsurveyed or unreported cases are definitely much greater than reported cases, and therefore the representability of the existing reported cases must be discussed for hypothesis generalization, which is beyond supporters/unsupporters number based discussion. Therefore, ‘In general, Hypothesis X is supported/unsupported by the literature’ may be true, but it does not necessarily mean that the phenomena that (appear to) support/unsupport the Hypothesis X are really general.

Figure 3-1 People’s River Perceptions

Consequently, this Chapter does not aim to comprehend and generalize the vast amount of past case studies but to describe past-reported phenomena and hypotheses which may or may not be extrapolatable to SSB. This Chapter reviews proceeding studies, which we roughly categorize here into three: engineering and psychology, risk perception, and ethnohydrology, which are mutually overlapping and share the common purpose of inter-stakeholder communication and social management. However, there are respective main focuses. Roughly, engineering and psychology focus on subjective perceptions' supportive roles for scientific measurements; risk perception on calculation of the probability or likelihood of hazard occurrences and the hypothetical modeling of perception process; ethnohydrology on social and cultural factors. Researching people's water and river perceptions needs to have the three field's scopes, method and knowledge (**Figure 3-2**).

Chapter 2 can be re-interpreted as an IRBM portion of the ethnohydrology on SSB, Malaysia. Following sections will introduce potions of these studies that are particularly connected to this dissertation.

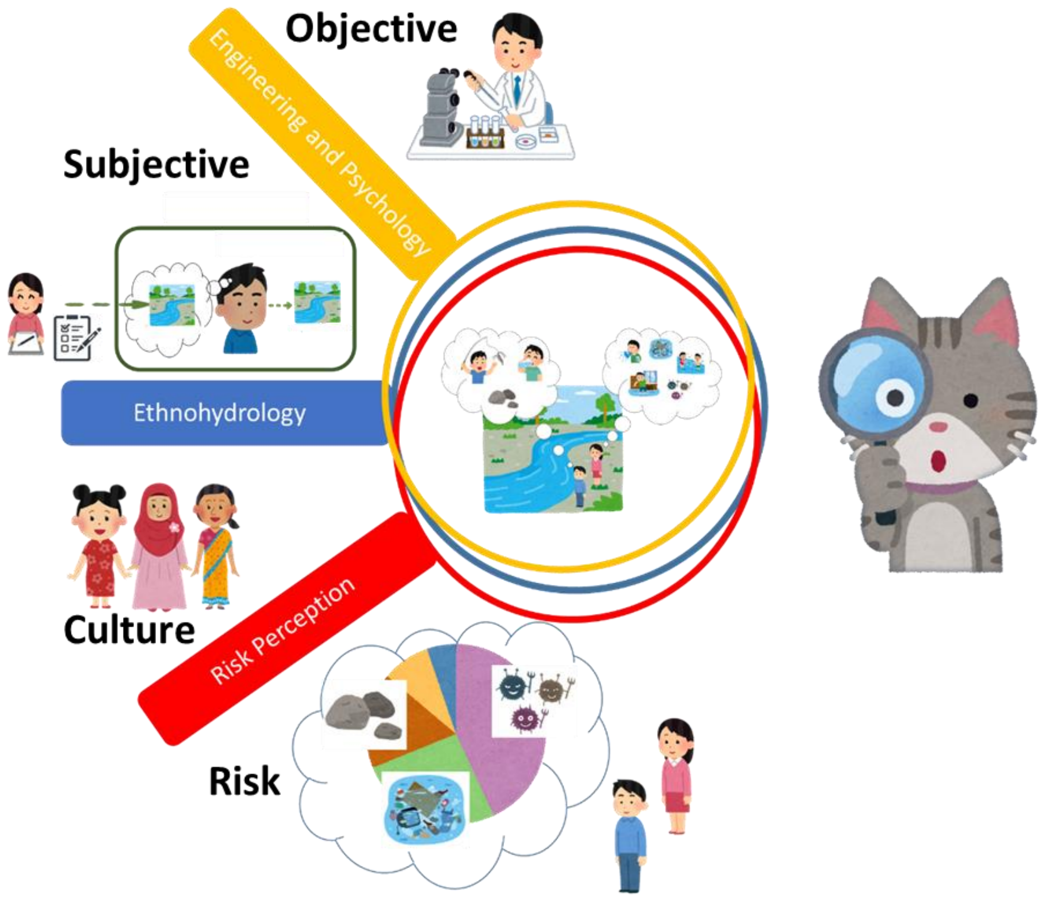


Figure 3-2 Preceding Studies

3.1 Engineering and Psychology

Frederickson and Magas (1968)[3] surveyed people's attitudes toward lake water pollution and other local problems such as education, law enforcement, police protection, *etc.* in Syracuse, New York, USA. Respondents were asked about: the problems' importance levels; desired order of their County's public money payment priority for the problems; and, agreement level about the County's cleaning up the lake water for swimming and boating recreations, and fish and animals protection. Respondents' demographics such as age, city/suburban residence, education, and income level were also asked. Frederickson and Magas (1968)[3] analyzed the percentage response profiles, finding: that water pollution was perceived as of middle level importance; that more highly prioritized by suburban respondents than city respondents; and, that richer respondents were more willing to pay for lake water cleaning. Respondents seemed to perceive water pollution as a serious problem that the public authority should deal with, and that people may be differently perceive water based on demographic factors.[3]

David (1971)[4] surveyed urban and rural people's surface water pollution perceptions in Wisconsin, USA, and analyzed percentage of responses. Their respondents judged water as polluted mainly by algae and green scum (40%), dark, cloudy, murky water (35%), smell (20%), floating debris (20%), sewage (10%), weeds (10%), and suds or foam (10%), and less by chemicals such as DDT or disease germs. Water-bottom cans and glass were not perceived as pollution, with which, however, respondents did not want to swim in the water. Weeds were not perceived as unpleasant as algae. Suds and foam were perceived as indicators of pollution by sewerage. Respondents were presumed to be hardly aware of things insensible by eye or nose and unaware of chemical pollution, due to non-existence of big chemical industry then in Wisconsin and their trust on public health authorities that dealt with chemicals and disease germs. David, referring to her past surveys in 1968 and 1969, said that respondents more tended to perceive as a problem; that women were more concerned about surface water pollution than men, and mothers than fathers; and that small town residents were more concerned than urban residents, probably because urban areas had other problems *e.g.*, air pollution. When David wrote the paper, it was 'only recently' when water quality had seriously started to be measured not only for public health but also for other environmental purposes and there had been chemical and biological measurements almost only dissolved oxygen, white disk visibility, temperature, toxicity, suspended solid, *etc*. There had been no systematic measurement of fecal coliform or biochemical oxygen demand.[4]

Kooyoomjian and Clesceri (1974)[5] investigated people's lake perceptions at four recreation-used lakes different in size (intermediate and large) and trophic status (oligotrophic and eutrophic) in New York State, USA. They examined the percentage response profiles of three respondent groups: recreationalist (the least sensitive, lowest frequency lake users), cottage ad homeowners (the most sensitive, highest frequency users), and fishermen (intermediately sensitive, intermediate frequency users). Comparing lake profiles, the recreationalists were more complaint about the eutrophic lakes than the oligotrophic; the intermediate (probably more productive) lakes than the large (probably less productive) about major problems. On the other hand, comparing respondent group profiles, cottage and homeowners were most unsatisfied with the large lakes, and the recreationalists least, apparently because that homeowners most frequently contacted to lake. The recreationists were least complaint about lakes, but were most prominently about water contact factors *e.g.*, coldness, clarity, and bottom conditions. The cottage and homeowners were most about shoreline, odor, color, and taste. The fishermen were complaint about water surface *e.g.*, surface roughness, films of gasoline and oil and crowdedness. And, respondent group profiles' differences appeared in ecological perceptions such as growth of algae, plants, or scum.[5]

Nicolson and Mace (1975) [6] surveyed people's water perceptions and water quality measurements in three state parks in Minnesota, USA. More than 90% of their recreationalist respondents judged water pollution by eye: algae and green scum (32%), murky, dark water (26%), floating debris (17%), suds or foam (2%), sewage (2%), weeds (1%) and others (10%). When the paper was written, water quality measurements were 'recently' started to be done not only for public health but also for recreation use and environmental preservation, and water quality standards were for chemical and biochemical parameters only. Nicolson and Mace (1975) suggested that organoleptic perceptions, such as appearance, smell, taste and touch, should be considered as well.[6]

Dinius (1981) [7] conducted an experiment called Visual Perception Test. Subjects in a projection room saw photo slides of water sites which had been artificially polluted in stages with dye (murky brown or gray) and litter, and were asked about the water pollution of each slide (trash, cans, food residue, *etc*.). The subject rated on a 7-point Likert scale each desirability of use: '*boating, municipal drinking water, camp drinking water (no water purification), fishing, fish propagation, industrial, navigation, navigation, picnicking, scenic beauty appreciation, swimming, waterskiing, and wildlife propagation*'; possible pollution sources (*'human industry, and natural'*); and physical characteristics ('*presence of bacteria, scenic beauty, quality of surrounding environment, presence of odor, water clarity, and water color'*). The lay subjects regarded litter and color as water pollution indicators, with which they judged water site's usability for picnicking, *etc*. Furthermore, the subjects saw litter as an indicator water *per se*'s pollution. Darius suggested that cleaning be effective to increase the site's expenditure value. A stepwise multiple regression analysis indicated 73% of the variance of lay subjects' judgement of pollution was explained by water color, scenic beauty appreciation, quality of the surrounding environment and if they perceived the pollution source were the industry rather than human and natural sources. A factor analysis generated two key variable: an Overall Pollution Factor and a Boating Use Factor.[7]

Moser (1984) [8] surveyed water perceptions of campers (one homogeneous populations) along River Loing (sites within one area), France. Comparing the subjective and objective water pollution evaluations by respondents and based on the water monitoring authority's measurements, respectively, Moser found that the objective evaluation was judged significantly worse than the subjective, and the subjective evaluation was neither associated with recreational activity types (swimming, fishing, boating and walking) nor pollution judgment criteria (color, water plants, floating debris, odor, movement and clarity). The judgement criteria were explained stepwise: floating debris was first checked, and then color, odor, the presence of algae and water plants, *etc*. were considered.[8]

Note that Moser (1984)[8] had a thought that the objective evaluation based on the authority's chemical and biological measurements were correct and real, and campers' perceptions were not. Considering that it is users who finally judge the water's usability, evaluation based on objective measurements of water *per se* only evaluation may be insufficient.

Heiskary and Walker (1988)[9] aimed to establish lake-specific phosphorus criteria for practical lake management in Minnesota, USA. Using data of Minnesota lakes, Heiskary and Walker cross-tabulated total phosphorous concentration, nuisance algal level frequencies or risks (the number counts of excess chlorophyll a concentration and deficient Secchi disk transparency levels) and users' ratings of perceived physical appearance (clarity, algal color, odor, floating scum, and fish kill) and recreational suitability (for swimming, boating, and aesthetic enjoyment).

Heiskary and Walker[9] found that both of the nuisance algal level frequencies of chlorophyll a concentration and Secchi disk transparency had non-linear relationships with thresholds on total phosphorus concentration. One-way analyses of variance (ANOVA) indicated that levels of total phosphorus, chlorophyll a, and Secchi disk transparency were significantly associated with users' ratings of perceived physical appearance and recreational suitability; and, ANOVA F statistics indicated that transparency most strongly with the two user perception ratings. In addition, these measurement values had distinct difference between the physical appearance ratings of 'definite algae' and 'high algae.' Cross-tabulation between the two perception ratings and the three measurement values indicated that probability of any perception ratings could be estimated from the measurement values.

From these results, Heiskary and Walker[9] suggested two types of criteria: nuisance criterion setting threshold measurement values and/or perception ratings; and acceptable risks or probabilities of nuisance conditions occurrence. Calibration may be needed to each lake: from literature review, Heiskary and Walker[9] discovered regional variations of users' acceptability or objectionality perception to lake water quality, which probably derived from respondents' experience and expectation regarding lakes, which were assumable to be so in Minnesota's various lakes according to the regional trophic and morphometric conditions.[9]

Smith *et al.* (1991)[10] aimed to develop a lay water users' perception-based water quality index (WQI) that would complement water experts' measurement-based WQIs. They related interviewed bathers and bystanders' river and lake bathability perceptions (color, clearness, weeds, beach, accessibility, facilities, shade, dogs, quiet, ducks, litter) to corresponding field observations and measurements (horizontal black disk transparency, intrinsic color, turbidity and temperature, *etc.*) in the North Island of New Zealand.

Smith *et al.* (1991)[10], although admitting some uncertainty, stated that the most important water perception factors were visual factors of clearness and color. Most (87%) of their lay respondents judged bathing water by eye; 11% by external information such as media reports and hearsay in addition to visual observation; and few by external information only. There was a strong linear relationship between respondents' mean ratings of perceived clearness and color: turbid water appeared brown (Munsell yellow) and clear water blue. This was perhaps because water *per se*'s color was not always easily eye-observable in the environment due to such as shallow depth and sky color reflection, and the respondents did not strictly separate the concepts of color and turbidity. The relationship with bathability perceptions and technical measurements indicated that the respondents considered the water environment as a whole: water *per se* and its surroundings, inseparably.[10]

Although gender, age and ethnicity were recorded, these demographics were just for checking the unbiasedness of sampling respondents

Gregory and Davis (1993)[11] in England, saying that woody debris could be seen aesthetically undesirable while playing an important role in the natural river ecosystem, aimed to know how much people prefer riverscapes with/without debris in woodland areas.

Gregory and Davis[11] showed 20 projected photographs of channels to three lay sample groups with supposedly different experience levels (phycology undergraduates, geography undergraduate, and geography academics) and had them rate how much the riverscapes attracted them. Gregory and Davis[11] found that the three lay groups considerably agreed in their ratings and that female respondents tended to give lower scores than male ones. Then, in order to obtain experts' judgement of naturalness of the 20 scenes, two independent operators, who had expert knowledge of the river basins and channels of the 20 photographs but had not participated in the previous rating, rated the 20 photographed scenes' naturalness, and then the two operators consulted to reach agreed scores.

Gregory and Davis[11] found that debris was unattractive to the lay respondents no matter how natural the channels were from the operators' viewpoint. On the other hand, the 20 photos' scenic and geomorphologic characteristics were analyzed, and Gregory and Davis found that color, channel bank stability and average depth were the top three characteristics influential to the attractiveness to the lay respondents, among which color was predominant. The most attractive woodland riverscape was a debrisless, fast-flow stream; the least a concrete-channelized, color-poor, depositional stream. The lay respondents may have had no clear understanding of unpolluted natural rivers and of the fact that being ecologically natural is not always being aesthetically desirable.[11]

Smith *et al.* (1995a)[12] in New Zealand related their bankside respondents' subjective river and water perceptions (ratings of clarity, color, bathability, and aesthetic pleasantness) to measured horizontal black disk transparency and Munsell color (hue), reflectance, Munsell-yellow absorption (at 340, 440 and 740 nm, for brown-looking humic substance) of 0.45 μm filtrates (at 340, 440 and 740 nm), air and water temperature, cloud and wind. The sampling sites were recreational rivers and lakes that were various in terms of appearance. Respondents' age, sex and apparent ethnicity just for indicating the mixed population.

Smith *et al.* (1995a)[12] found that their respondents perceived that pleasant-looking waters were also suitable for bathing, probably as long as temperature was not felt too cold. Clarity and color were correlated with each other. Color seemed to more dominant as to turbid, blue water; while clarity as to clear, brown water, probably because waters looking natural were preferred, although natural waters with turbid and brown appearance could be exceptions. The monotonically increasing concave eye-fitting curves of bathing suitability rating and percentage of respondents on black disk transparency suggested that 1.2 m black disk transparency water was the acceptable limit of bathing suitability for 80% respondents; and a critical black disk transparency was estimated, considering past studies, to be 0.9-1.6 m. The eye-fitting curves of color rating and percentage of respondents on Munsell color suggested that a Munsell unit just under 30 (10Y) was perceived by 80% of respondents unsuitable for bathing, and thus a bathing-suitable Munsell unit for the respondents was estimated to be greater (bluer) than 32.5 (2.5GY, a yellowish-green). According to the descriptive questions about what was important for bathing, the respondents regarded personal safety (*e.g.*, to turbulence and fast currents) the most important (65% of respondents in average); water appearance, hygiene, and water quality in general (45%, categorized "water") being the second, around half of which optical qualities such as clarity, clearness, "see bottom." As for water pleasantness, the respondents gave importance on the surroundings (45%), quiet (35%), the presence of trees (for escaping sun glare or wind) (25%), and cleanliness of the area (20%). Water *per se* was rarely perceived important (10 - 15% in average). The ambiguous liner relationship between overall site rating and black disk transparency suggested that measured clarity was not so much influential to overall site evaluation for bathing. On the other hand, a more linear relationship was observed between overall site rating and water clarity rating, which indicated that perceived clarity could be more influential to overall site evaluation for bathing than measured clarity. Recalling that clarity is related to color, Smith *et al.* (1995a)[12] guessed that a complex interaction of clarity and color perceptions ("visual quality perception") had affected the overall site rating.[12]

Smith *et al.* (1995b)[13], following the above article, analyzed their lay respondents' ability to eye the

Munsell color (hue) of water *per se* in the environment where surroundings, sky reflection, sun glittering, *etc*. were expected interfering factors. And, people's color perceptions were possible to be affected by their perceptual sets (personal factors which produce subjective perceptions such as experience, true or false external information, personal observation, *etc*.).

Bankside recreationalists were asked to describe the water's clarity and color, and at the same time the black disk transparency and the Munsell color (hue) of the water were measured. Waters were selected this time for being optically so deep that water *per se* was observed. Respondents description of water were summarized case by case: *e.g.*, by assuming that 'dirty,' 'muddy,' and 'silty' indicated the same 'yellow' condition.

The respondents successfully described the hues of waters: with high levels of suspended solids that made water less bright; with humic substances that made saturation high; with a bright, spectrally neutral color substrate; and with a sufficient optical depth. However, the respondents were likely to fail to describe water color due to spectrally unneutral color substrate and possibly nearby waters' colors. Many respondents perceived water color as bluer than Munsell hue due to blue sky reflection. Some only 10% of the respondents described that water 'changed color' according to sky reflection (*e.g.*, due to weather change). Consequently, Smith *et al*. (1995b)[13] argued that even though admitting the inaccuracy of people's color perceptions in some circumstances, their color change perception change are still reliable, which is worth noting for water management.

The respondents' perceptions depended on their perceptual sets. Comparing two lakes with similar color and pleasantness, one being urban and the other rural, the rural lake was perceived as more suitable for bathing and having better clarity, color, and overall site pleasantness. The rural lake may be preferred simply because it tends to be perceived more natural, or the samples of the two lakes have respective different characteristics. At a river, respondents who knew that the yellow color (humic stain) was from a natural source judged the water more suitable for bathing than those did not. At a lake, blue water color and a mountain environment seemed to positively affect bathing suitability judgement of turbid waters. Consequently, Smith *et al*. (1995b)[13] suggested that perceived naturalness could be important for water management: if informed as natural, people may more tend to bathe the water than if not.[13]

Davies-Colley and Smith (2001)[14] in New Zealand reviewed turbidity, suspended sediment concentration (SSC) and visual clarity, arguing that there was conceptual confusion even among experts. In natural waters, predominant light attenuators are suspended particles which are in general of low Stokes' law settling velocity, including: mineral particles the size from 0.2 to 5 μm (*e.g.*, clay minerals: about 1 μm) and some organic particles from 1 μm to 20 μm (*e.g.*, plankton cells: about 5 μm).

Turbidity is an optical phenomenon that results from light scattering by particles in water, causing light attenuation or reduced clarity. Turbidity, often used as an index of clarity, is measured (*e.g.*, as nephelometric turbidity in NTU) and visually (*e.g.*, Secchi or black disk transparency). However, turbidity is potentially suitable for continuous *in situ* monitoring by a portable device.

SSC is measured in the lab as the per volume dry weight of solids too large to pass through a filter, whose precision is generally around 10% coefficient of variation, depending on the amount of filtered sample. Unlike turbidity, SSC measurement is stable (for several days, stored chilled and dark). SSC is suitable for sediment studies, but less straightforward than visual clarity for interpreting light attenuation effects on the ecosystem in the water. Mass or molar concentration does not correctly indicate light attenuation, for particles' cross-sectional area is the first contributor of light attenuation, the shape the second. The relationship between SSC and light penetration is in general non-linear and empirically determined for the water of interest. Visual clarity is more directly related to the water environment in terms of aesthetics, recreations and fish habitats, *etc*. Main causes of light attenuation in environmental waters are suspended sediment, water molecules, and humic substances; and main effects are the reduction of photosynthesis and transparency or eye visibility.

Visual clarity has been often measured by Secchi disk transparency that results from a complex combination of light absorption, scattering and diffuse (irradiate) attenuation and depends on incident lighting conditions (*e.g.*, the sun and clouds, etc.), reflectance (upward part of irradiance) of water and reflectance of the disk's white portion and the observers' eye contrasting ability. However, the subjective human eye measurement is 'surprisingly' invariant (4% coefficient of variation with normal vision observers). Horizontal black disk transparency is theoretically better, being dependent almost only on absorption and scattering, independent of incident lighting conditions. In addition, a transparency tube is a simple tool that is useful to raise the lay public's awareness of water clarity, although the actual optical condition of the water is unreplicable in the tube. Visual clarity measurements can be implemented *in situ*, and the interpretation for aquatic ecosystem and human activities is sensuously straightforward.

Relationships among turbidity, SSC and visual clarity depend on the optical properties and the amount of particles in the water and the instrument employed. It is recommended that measurements be done according to the objectives, with understanding of the characteristics of the methods.[14]

"Guidelines for Drinking-water Quality, Fourth Edition" by World Health Organization (WHO) (2011) [15] highlights that;

> '*The appearance, taste and odour of drinking-water should be acceptable to the consumer. Water that is aesthetically unacceptable can lead to the use of water from sources that are aesthetically more acceptable, but potentially less safe.*'[15]

Aesthetics such as appearance, taste and odor depend on personal or cultural factors; therefore,

> '*Guideline values have not been established for constituents influencing water quality that have no direct link to adverse health impacts.*' [15]

According to WHO, appearance, taste and odor are not directly related to safety, and *vice versa*, although admitting that these aesthetics may indicate some harmful substances and organisms.[15] However, there are additional comment values for some substances that may cause taste or odor at much lower levels than the health-based guideline values. For example: monochloramine, whose health-based guideline value is 3 mg/L (3000 μg/L), has an additional comment '*Most individuals are able to taste chloramines at concentrations below 5mg/l, and some at levels as low as 0.3 mg/l.*' ; and, ethylbenzene, whose guideline value 0.3 mg/L (300 μ g/L), '*The guideline value exceeds the lowest reported odour threshold for ethylbenzene in drinking-water (0.002 mg/l).*' [15]

Given the obvious fact that most people in the world are not water experts, people do not judge water by scientific measurement instruments, data and criteria. And, according to above cited articles, it could be said that people's water perceptions are their major water usability judgement factors. Although visual factors of water *per se* and its surroundings seem dominant to judge the water's usability, it is difficult to extrapolate the knowledge to an arbitrary water, because each water has its special natural characteristics, uses and users. For example, New Zealand and U.S. rivers are different from Peninsular Malaysian ones in terms of climate conditions and people's ways of life. Therefore, for people's river water safety in SSB, it is important know SSB and its people's perceptions.

3.2 Risk Perception

Slovic *et al*. (1980)[16] discussed risk perceptions in general, and water-related items were also included in the discussion. Although focusing on a specific river basin, an IRBM is indeed a part of overall management of a nation, region and the world. A part includes the whole and everything is more or less inter-related. Discussing the IRBM inevitably involves all things in a region, nation, the world, and even the universe, physical or mental, or objective or subjective. It is the research scope that exclude out-of-scope things.[16] Slovic *et al*. (1980)[16] provides a good example of discussing risk perceptions, and also some hints for future research including issues not seemingly having direct connection with water and river issues.

Slovic *et al*. (1980)[16] discussed the psychology of subjective risk judgements by experts and lay people, starting with saying '*People respond to hazard they perceive.*' Risk perception may vary from one hazard/person to another, depending on such as data availability, familiarity and "hardness." On the other hand, proper risk assessments on things such as hazards and technologies are required for policy making, where somebody must judge risks in some way, and the assessed risks have to be properly communicated about with the rest of the community that includes various people having various perceptions.

Slovic *et al.* (1980)[16] noted that experts had data and trained ability, while lay people often do not. Lay people then rely mostly on *e.g.*, self-observation, external information, and past experience. Psychologists discovered some rules or heuristics of people's subjectively simplifying their mental complex when judging risks of things: availability, overconfidence, desire for certainty, and 'It Won't Happen to Me,' which may not be based on objective facts. Heuristics may cause judgement biases, although even experts may not be perfectly free from heuristics. Slovic *et al.* (1980)[16] classified heuristics: availability, overconfidence, desire for certainty, and 'It Won't Happen to Me.'

Availability is a heuristic concerning things that are easy to imagine or recall, such as those frequent or impressive. Rare or spectacular things such as car accidents and floods may be judged riskier than common or unspectacular things such as smallpox vaccination and diabetes. The mass media may evoke people's availability heuristic by reporting rare, spectacular events more often than common, unspectacular events.[16]

Overconfidence concerns people's being likely to judge things on their own bases. People's self-confidence may be just psychological based on unreliable bases such as media report frequency. Experts may be overconfident in technical risk assessment, too.[16]

Desire for certainty concerns people's difficulty balancing or gambling uncertain risks and benefits of things. People may deny uncertainty to be released from uneasiness. For example, people may assume that a flood will never occur with a dam, denying the existing of other flood-causing factors. Lay people often dislike probability discussions and get frustrated with risk assessors and policy makers' intrinsic gambling.[16]

'It Won't Happen to Me' concerns people's overconfidence or optimism of personally having nothing to do with hazards of which even though they know the risks. For example, people tend to overestimate their driving skills to avoid accidents. And, people may misbelieve that only others cause accidents with frequent accident reports from the media. As for technologies, experts and lay people's risk perceptions are quite distant from each other, and would not easily get confluent, being so conservative that first impression is one of strong determinants of perceived risks.[16]

Slovic *et al.* (1980)[16] further discussed risk perception determinants with a survey conducted. They collected four groups of respondents (three lay and one expert groups): college students, members of the League of Woman Voters (LOWV); business and professional members of the "Active Club"; and, risk assessment professionals (experts). First, the respondents were asked to count up all potential ways of dying caused by 30 items consisting of various activities, substances and technologies, and gave their perceived annual death tolls in USA of each item (of a disastrous year). Second, they were asked to rank the 30 items by perceived risks in ascending order. Third, they were asked to rate the risk of each item.

Slovic *et al.*(1980)[16] found that the lay and expert groups' risk judgements were different. For example, according to the group geometric mean risk ratings, college students and LOWV members gave nuclear power the first place (most risky), Active Club members 8th, while experts 20th, respectively, while the experts gave the first place to motor vehicle. Although expert respondents' perceived risks were highly related to collected statistical or technically calculated death tolls (called "technical fatality estimates"), lay respondents' perceived risks (of a disastrous year) were not very related to the "technical fatality estimates" (25 items were compared), particularly nuclear power that were perceived as having an extremely high death toll compared to the technical estimate. Then, additional college students and LOWV members respondents were asked to give the death tolls of the next year (assuming it was an average year), which were called "subjective fatality estimates." The correlation between lay respondents' perceived risks and their subjective fatality estimates were similar to the correlation between their perceived risks and the technical fatality estimates. Consequently, Slovic *et al.*(1980)[16] hypothesized that lay people's risk perceptions consider not only death tolls but also some other things. Note both lay groups' nuclear power perceptions: lowest subjective fatality estimate (of an average year) and the highest perceive risk (of a disastrous year).

Slovic *et al.* (1980)[16] then asked students and LOVW respondents for their perceived multipliers by which a disastrous year's death tolls were calculated from an average year's one, and the group geometric means were compared. The geometrically average multipliers are small (1.3-9.3), except for nuclear power (87.6 for LOWV, 107.1 for students). Disaster potential seemed to be dominant factor for nuclear power risk perception, while other factors were seemed potentially important for other items' risk perceptions. Slovic *et al.* (1980)[16] then introduced each item's "Risk profiles" featured by mean ratings on nine characteristics by the two lay respondent groups (students and LOVW members). Overall, dread and severity ratings were related to the lay respondents' risk judgements. Nuclear power was profiled as '*involuntary, delayed, unknown, uncontrollable, unfamiliar, potentially catastrophic, dreaded, and severe (certainly fatal)*.' However, expert respondents' risk profiles featured no characteristic. The lay respondents' judged relative seriousness to society of a death from each item was similar among the 30 items, and it was not very associated with their perceived risk of death.[16]

Then, Slovic *et al.*(1980) [16] extended the above study from 30 items to 90 and from 9 profile characteristics to 18 (the controllability rating was divided into preventability and consequence controllability ratings, and added other 9 characteristics), with college students only as respondents. The respondents were divided into three groups for reducing burden: one group for risk judgement; one for benefit judgement judging benefits; and one for profiling the items on 5 out of the 18 risk characteristics. After rating the risks, they were asked to rate the degrees to adjust the perceived risks to socially acceptable levels. A factor analysis generated three factors named 'Dread,' 'Familiarity,' and the number of people exposed. This three dimensional structure was quite different from the two dimensional (dread and severity) structure from the previous survey, which suggested that choosing hazards and characteristics of interest would differ the resulting basic risk evaluation space in which hazards are positioned by characteristics. Perceived risk was the prime determinant of adjustment rating: the more a risk was perceived, the further it is from a socially unacceptable level. On the other hand, the famous voluntariness hypothesis by Starr that risks of more beneficial or voluntary activities tend to be more acceptable was questioned; Slovic *et al.* (1980)[16] suggested that other factors such as catastrophic potential be considered, with their data and analytical methodology, but also a thought experiment as follows:

> '*Suppose that you own and ride in two automobiles. One is needed for your work and when you ride in it, you are chauffeured (thus your exposure to risk is involuntary and relatively uncontrollable). The second auto is driven by you for pleasure, thus the risks you take while driving it are voluntary and somewhat controllable. Consider the standards of safety you would wish for the two vehicles. Would you demand that standards be much safer for the first car than for the second? If you are like us, then you would desire equivalent safety standards for both vehicles.*'[16]

Slovic *et al.* (1980)[16] then discussed (perceived) catastrophic potential. It is difficult to manage hazards of rare occurrence and high catastrophic potential such as nuclear power, LNG, pesticides, industrial chemicals, and DNA editing, because the rarity of catastrophic events' data results in conjectures, and "perception gaps" between experts and lay people.[16] In order to weigh catastrophes and judge signal values or imformativeness of their consequences, respondents were asked to rate events accompanied with their death numbers in terms of informativeness, suffering and grief and events, need for awareness, effort to prevent reoccurrence, and worry.)[16] Suffering and grief were closely related to death number, while other items being rather to information content. Slovic *et al.* (1980)[16] hypothesized risk perceptions were insensitive to the severity of hazards with well-known mechanisms and limited consequences, although sensitive to hazards with perceived potential of future consequences.[16]

Doria (2010)[1] reviewed a number of hypothetical factors that affect people's drinking water perceptions, and that a complex of diverse, mutually interacting factors are involved in people's perceiving drinking water quality in the context of consumer satisfaction in water management.

People's perceptions may play a more important role than scientific water quality in their safety or risk judgement, and standards are desired for healthy and accessible water. Therefore, water managers should understand public perceptions in order to keep or improve inter-stakeholder communication to prevent troubles that may even disrupt water supply. Water perception research has been in progress since the late 1960s without unification of paradigms, methodologies and conceptual approaches. And, these studies has been done mainly in developed countries with better water supplies and standards, which may not be directly applicable to developing countries.[1]

Organoleptics are related to people's health risk perceptions, or people want water supply to be not only as satisfactory for basic needs but also as aesthetically enjoyable. Organoleptics, often, have close psychological interactions and have the same chemical origins, depending on time and culture: *e.g.*, taste is regarded more important in Western countries, probably due to being sensible at a lower concentration. Tap water risks are in general perceived low, but its pollution and stability are pessimistically perceived. However, details of the perceived health risks of such as stomach and intestine disorders and water-borne diseases have not been studied enough.[1]

Other than organoleptics, drinking water risk perceptions are hypothesized to be affected by various factors such as '*trust in institutions, external information, familiarity, demographics and perceived control*,' Risk perception studies have discussed such hypothetical factors as '*heuristics and biases, risk characteristics (e.g. uncertainty, voluntary exposure, fairness) and personal/societal level of exposure*.' However, these factors have been studied on relatively attention-gathering hazards, but not sufficiently on drinking water, although a few number of case studies exist.[1]

Chemical composition of water affects organoleptics and health risks. For example, mineral content level is linearly related to taste intensity, and high mineral content is generally more preferred. Anions (*e.g.*, chlorine) are more preferred than cations (*e.g.*, sulfates). Relationships between color perceptions and chemical contents are almost unknown. People may dislike chemicals in water even if the levels are scientifically safe: *e.g.*, chemophobia in the 1970s and 80s. Lay people may tend to be afraid of mere exposure to chemicals probably because in general they do not have knowledge of dose-response relationship in toxicology terms. However, few chemical contents are of public interests: *e.g.*, chlorine, limescale and hardness, and lead. Chlorine taste is perceived ambivalently: objectionable taste or safety indicator, but excess amount may be disliked. Risk perception studies have dealt drinking water chlorine as one of risk concerns. Limestone and water hardness cause scaling affect organoleptics. No risk perception studies has quantified limestone and hardness. Lead, mostly from old pipes, having neurotoxicological effects, relatively has collect public concerns. Both scientific and perceived risks of microorganisms in drinking water has been reduced by chlorination. People may sometimes be interested in '*fluoride, nitrates, pesticides, heavy metals and industrial chemicals*.'[1]

Contextual indicators or cues such as taps, pipes, bottles and the water site's characteristics indirectly may affect people's drinking water perceptions. However, research on this topic is rare and often restricted. Studies on other beverage suggest that bottle design or labels affect taste, satisfaction and preference. As for river and lake waters, contextual factors such as fish and rubbish can be main influencers on people's water quality perceptions. If people perceive their living places have serious environmental health problems, they may perceive larger drinking water risks. People's perceptions are affect by their past personal experience, and organoleptics of water are no exceptions. People are known to be conservative in preference, thus, in general, familiarity is a key factor. Impersonal information from such as the media and interpersonal information from such as friends and relatives may influence people's drinking water perceptions. There is a hypothesis that impersonal information predominantly affect a society, while interpersonal information predominantly a person. Scientific or technical information by experts, impersonally or interpersonally, may not very much affect people's perceptions and behaviors. Overall, in general, external information's influence on perceptions seems not strong. However, it may be possible that large population amplify complaints and enquiries to water suppliers or authorities[1]

Concerning trust in water institutions, scientists and environmental NGOs are in general the most trusted groups in many countries, also such trust is in crisis. The next trusted are mass media and government, the third commercial companies, except water companies when issuing a water contamination emergency. Effects of trust in companies and institutions on people's perceptions is case by case and unclear, also often mentioned. Water users, who, in general, cannot control drinking water, may perceive that well communicating with water suppliers as a kind of controlling water quality. Demographics are often weak but significant water perception factors, influencing risk perceptions, organoleptic perceptions, knowledge, and information sources. However, it is difficult to identify what are main demographic factors, because demographics are not independent from each other. Furthermore, other factors such as perceived control and context mask demographic factors. Gender, age, education and income level, ethnicity, culture, religion (*e.g.*, baptisms, ablutions, deluge, 'purity') have been hypothesized to be affect water perceptions.[1]

The above discussed hypotheses cited by Doria (2010) need checking whether they are extrapolatable for policy making in another place, particularly a developed country where demographics are very different from western developed countries.

Paek and Hove (2017)[17] defined a risk as '*the probability of experiencing harm or hazards*,' where hazards being '*threats to people and the things they value.*' and probability '*the likelihood of a harm's or hazard's occurrence*.' Risk perception is '*people's subjective judgement about the likelihood of negative occurrence such as injury, illness, disease, and death*,' which includes '*the cognitive dimension, which relates to how much people know about and understand risks*,' and '*the emotional dimension, which relates to how they feel about them*.'

Paek and Hove (2017)[17] discusses that risk perceptions are first steps to subsequent decisions and behaviors, rejecting and accepting the risks to some degrees. Risks contain uncertainty, and people are not happy with uncertainty. Lay people are likely to aware of and evaluate risks mostly by subjective perceptions, intuitions, external information including the media coverage. There are risk perception models to explain the information process and decision making in the people's subjective risk judgements. Risk perception studies commonly assume that people's risk perceptions are determined by people's knowledge and certainty about the risks, based on the rational choice model where people are presumed as rational costs-benefits calculators. Experts, being scientific and objective, may be modeled by the rational choice model. However, lay people are commonly assumed to be subject to heuristics and other non-rational ways of thinking. For example, awareness of a certain risk may make people overestimate the frequency of the risk (availability heuristic). Another example of heuristic is optimistic bias or unrealistic optimism: one tends to think themselves more immune to risks than others. Additionally, lay people may overestimate risk, being dread and fear (affect heuristic). The risk-as-feeling hypothesis says that in lay risk evaluation, emotions work independently from and more strongly than cognitions. Risk communication is *'the process of informing and persuading the public about risks so that they will be able to perceive them accurately and make appropriate decisions*.'[17] Risk communication researchers, separately from psychologists studying emotion factors, also found that lay people's risk perceptions tend to depend on subjective factors rather than objective ones that they are unlikely to know about. This hypothesis is consistent with the psychologists' claiming importance of emotions in risk evaluation. Paek and Hove cited Sandman' definition of risk is a combination of hazards (technical or rational constituents) and outrage (non-technical or emotional constituent that is '*an amalgam of voluntariness, control, responsiveness, trust, dread*,' *etc.*[17]). This definition comprises both objective and subjective aspects of risks. There are several theoretical risk perception models comprising cognitive and emotional characteristics, and among them are approaches focusing on social and cultural factors influencing people's risk perceptions and responses. For example, the social amplification of risk framework (SAFR) is a theoretical framework to see the relationships between science and culture of risk perceptions.[17] SAFR assumes psychological, social and cultural factors amplitude or attenuate people's risk perceptions and responding behaviors. There are several theories on factors of formation and change of perceptions and behaviors including health-related ones such as vaccination, hand washing, *etc.* One of the factors is information, being impersonal or interpersonal, from such as the media, friend and families, *etc*.[17]

The media is Peak and Hove (2017)'s main interest, seeking for appropriate and effective message design and processing for risk communication, and the above review on lay people's risk perceptions was for that purpose. Afroz *et al.* (2015)[18] surveyed along Gombak River, Selangor, and found that water the pollution information sources of their respondents (Malay 65%, Chinese 17%, Indian 11% and others 7%) were newspaper (48%), TV (29.4%), the internet (6.9%), friends (6%), advertisement (3.2%), and community (6.5%),[18] and it is hardly expectable that SSB people's figures are very much apart from these. On the other hand, Malaysian people have their own language media such as newspapers and TV programs. If the Chinese-language mass media's coverage is different from those of Malay-language, people's water perceptions can be different by language.

Risk perception may vary according to all things from their physical bodies, internal psychology to external environment and information. Therefore, to find out what is the major risk perception factors for groups of people then and there is essential and not easily generalizable. SSB people may have their own water and river risk perceptions, which has not yet been studied.

3.3 Ethnohydrology

Back (1981)[19] studied hydromythology and ethnohydrology on North and South Indians (Native Americans), describing the rises and falls of civilizations relating to hydrology and gods. He defined the term 'hydromythology' as '*a study of hydrologically inspired folklore, myths, or legends that can be used to deduce beliefs of early people concerning water*,' and 'ethnohydrology' as '*is concerned with the science of hydrology in the broadest sense to include both the observation and interpretation of phenomena and the application of knowledge so gained to the practical problems of water use and management by ancient people.*' In some ways, gods, myths and rituals are equivalent to science and engineering: both aimed to explain and solve water phenomena and problems; for example, Back found no conceptual difference among a modern dam, a cray pot carried by women or a ritual praying for rain.[19]

Herbst *et al.* (2009)[20] investigated people's perceptions and behaviors related to water, sanitation and health together with their cultural and religious background in An Binh, Can Tho, a city in the Mekong Delta, Vietnam, where safe drinking water access was limited.

Herbst *et al.* (2009)[20] found that religion, tradition and culture had no effect on their respondents' water perceptions and behaviors concerning hygiene, although all the respondents showed courtesy to their house shrines, 38% of the respondents thought themselves religious, and there were water-related rituals in special places like Buddhist pagodas. The water god worshipped in the region was for waterways safety. Herbst *et al*. (2009)[20] advised that there it is not necessary to care about spirituality for household sanitary water management.

Herbst *et al*. (2009)[20] found that about half (64/120) of the respondents had piped water from the water supply station. Respondents valued various drinking water sources: bought purified water (38% respondents), rain water (34%), and water from the supply station (treated groundwater) (14%). This order was due to hygiene concerns (87%), socioeconomic situation (2%), spiritual reasons (1%) and other (10%). Rain water was the most utilized drinking water source in the rainy season, while bought purified water in the dry season. Rain water was perceived the tastiest, and longer-stored rain water even tastier. The supplied water was perceived to taste unpleasant, unnatural or chemical, although treated by rapid sand filtration and activated charcoal; thus was used mainly for cooking, washing, cleaning, *etc*. Herbst *et al.*(2009)[20] advised that the household water management separate water sources into at least two: a safe and tasty water source for drinking and a fairly safe water source for other purposes. Herbst *et al.* (2009)[20] also advised that safe methods for rain water harvesting and storing be promoted since people prefer rain water for drinking. Despite they thought their drinking water good, respondents treated water: *e.g.*, by boiling water from all sources, by a cloth filter for rain water, by aluminum sulfate for drilled well water. However, respondents did not apply these treatments in proper ways, believing that such treatments eliminate health risk. Respondents judged drinking water by visible contamination (43%), turbidity (18%), odor (18%) and other factors (20%).

They perceived river water most hazardous as disease source (81%) due to being polluted by sewerage, solid wastes and fish pond toilets. Although being aware that fish pond toilets, whose waste water being released to rivers or canals untreated, were causing water contamination, respondents, even those who were relatively wealthy, were fond of fish pond toilets. On the other hand, they regarded river water as favorable water for tea after treated for a long time, and bathed the polluted water in the river (44%) or in the bathroom (86%), probably without proper hygiene knowledge about microbial pollution causing water-borne diseases. Herbst *et al.*(2009)[20] hypothesized that the respondents saw fish pond toilets not as a sanitary problem but simply as an environmental contamination source, and recommended that people be discouraged to use river water. Respondents' sanitary facilities (75% owned, of which 41% were exclusively for the households) were fish pond toilets (64%), pit latrines (17%) and flush toilets (13%). Some owners (6%) had both a fish pond toilet and a more improved one. Generally, respondents were satisfied with their sanitary facilities, but still want to improve them if they had enough money. Herbst *et al.*(2009) [20] recommended that fish pond toilets finally be abolished, commenting that people were '*victims of their habits*.'[20]

Vietnamese Buddhists' attitudes and behaviors reported by Herbst *et al*. (2009)[20] could be referred to for examining Malaysian Chinese Buddhists ones.

West *et al.* (2016a) [21] reviewed literature optical and visual water quality measurements and people's perceptions of water quality.

The term 'ethnohydrology' had been introduced by William Back in 1981 whose definition was '*the study of culturally constructed knowledge and understanding of water*,' which is now expanded to include '*investigations that seek similarities and differences in cultural knowledge, evaluation, and perceptions of water quality*.' (cited in West e*t al.* (2016a)[21]). West *et al*.(2016a)[21] suggested that ethnohydrology, being interdisciplinary with other physical and social sciences, would help various stakeholders get aware of, communicate and participate in water resource management.

Visual features of color and clarity most affect water quality perceptions, whose cognitive process involves people's spirituality, culture and personal experiences. Water molecules absorb red light and scatter blue, which makes purer water look blue. Main contributors to water color and clarity are: mineral and organic suspended sediments (scattering light and absorbing light); non-algal organic matter (absorbing short wavelength light and scattering light); phytoplankton (scattering green and yellow light); chlorophyll a (green color); and chromophoric dissolved organic matter (brown color). Main measurements related to color and clarity are: Secchi and horizontal disk transparencies; nephelometric turbidity; and Munsell color (hue). Main non-optical contributors are odor and other aesthetics: the presence of algae and water plants; landscape; sewage and related solids; and, litter and debris. On the other hand, people's perceptions depend not only on the water but also the persons including their cognitive process involving, *e.g.*, religion, culture, age, gender, special relationship with water, personal experience, exposure to water, physical and mental health conditions, *etc.*[21]

Environmental policies started to consider human perceptions: the European Union encourages public participation in water management; the USA protects waters from degradation of esthetic and recreational values; Queensland, Australia values social and spiritual significance in environmental protection; New Zealand integrates social and spiritual values in freshwater management. However, there still remain a vast amount of questions.[21]

West *et al*. (2016a)[21] suggested that future works would identify cultural factors and their influence on people's visual criteria for judging water and associating with them optical measurements.[21]

West *et al.* (2016b)[22] emphasized the rarity and importance of water management studies that quantify and integrate stakeholders' cultural, spiritual and aesthetic perceptions and physical science. In order to examine whether stakeholders' water judgement similar and whether the similarity was connected to scientific measurements, West *et al.*(2016b)[22] investigated in Ozarks, Arkansas, USA, water experts and non-experts' cultural cognitive structures to judge waters in the environment. At five rivers in southwestern Ozarks were measured *in situ* horizontal black disk transparency, turbidity, total suspended solids, suspended chlorophyll a, particulate phosphorus concentration, and taken photos of wrist-depth waters with their backgrounds and substrates. Twenty six photos were selected to represent the optical water quality diversity of the rivers, one of which was of water artificially stirred up ("staged"). Munsell color (hue), brightness and saturation of water photos selected were measured. Respondents took a written survey to be equally get aware of the research topic, and pile-sorted the 26 photos by their own criteria that were asked about as well as levels of education, knowledge about river water quality, experience of river recreation, importance of river water clarity.

Nonmetric multidimensional scaling (NMDS) plots based on the pile-sort: with property fitting analysis vectors of the *in situ* measurements; and with photo groups generated by hierarchical cluster analysis were presented. The plots and interview descriptions revealed that: respondents' age, gender, experience, education were not related to their optical water perceptions; and respondents' visual water perceptions were related to optical water quality measurements. Clarity was the predominant visual criterion stronger than color. Black disk transparency, turbidity, total suspended solids, and particulate phosphorus were related to visual water perceptions. Periphyton was also an influential factor to visual perceptions. West *et al.*(2016b) [22] argues that "public ignorance" is not a communication barrier, and suggested that scientific measurements and visual perceptions play a meaningful role in intercultural communication.[22]

Water use is culture dependent, and all demographic groups, not only ethnic groups but also gender, age, expert and lay groups, *etc.*, are presumed to have respective cultures. The cultures include not only physically observable water uses but also mental and spiritual background such as religion and myths. In order to understand the water use cultures, ethnohydrologists may apply engineering, psychology, and risk perception approaches. Such ethnohydrological viewpoint is essential for the IRBM of SSB, because SSB is a prime example of multi-cultural and multi-religious society in Malaysia and ethnohydrological viewpoint is essential.

3.4 Malaysian People's Water and River Perceptions

3.4.1 General Perceptions

Lat, a Malaysian cartoonist born in Perak in 1951, drew his childhood experience in the 1950s and the 60s drawn in "the Kampung Boy" series. Lat, learned how to swim in the river, unlike today's children do in the pool; his father threw him into the river.[23] Boys would after Quran class dove into the river and play and caught fish, naked.[24] His Quran teacher instructed how to take a pre-prayer minor ritual ablution or *wudu*; the teacher and boys washed their face, hands and feet with water from the same water pool in a big bathtub.[24] Lat would go to the river to bathe in the early morning after getting up and check his fish trap before going to school, and after school go fishing in the river[24] He would bathe cold well water, too.[23] He joined illegal *dulang* washing or tin mining using a pan near the Monster dredge.[24] , Lat's memories are common and nostalgic to most Malaysians.[25]

Kadir (2015) [26] published a book called "Pasangan; Pulse of a Riverine Community" that reported the relationship between people and Sg. Selangor in the Kuala Selangor *Mukim* of Pasangan. With plenty of pictures, the book covers a wide range of river-related life of the people, from traditional cooking, *atap* crafting, fishing, festivals to modern environmental activities such as the firefly ecotourism. A 70 year old lady says, when she was young, she went to the school by *sampan*; would drink the surface water directly; would enjoy chatting with friends at the jetty. The book is mainly about Malay cultural experience, but it also covers some Chinese and Indian lives. For example, Indians there use tap water for ritual bathing, because the river is too polluted to bathe now. The book attaches a small pamphlet that introduces tourism attractions in the area such as firefly watching and restaurants.[26] This book is an indispensable ally to review the ethnohydrology of Sg. Selangor.

The above books tell us that rivers used to be close to people. However, as time passed, the people became far from rivers; rivers are no longer the main traffic routes; are polluted; tap water are available in their houses.[xli] Fishing is still a popular activity; we still can find people fishing or catching prawns by rod or net (**Figure 3.4.1-1**), at the riverside or in the yellow-turbid river, even at or in the rank Sg. Klang in KL, and at black-stagnated water near factories discharging poorly treated affluent. A fishing gear store worker in Rawang recommended pond fishing, saying that a river was dangerous because of robbery. A river is a trash area. Poon *et al.* (2016)[31] reported that 27% of their Klang River basin respondents threw garbage in the river.[31] People throw trash and garbage to the pond, drainage, and river, which deteriorate the landscape and flow to the river mouth (**Figure 3.4.1-2**). People drive all the way to the upstream for playing in the river (**Figure 3.4.1-3**). A local woman in Serendah told that children once played in the river but got scared by lions. Therefore, the lions were fenced in the front square of Hock Leng Keng Temple (福灵宫) (**Figure 3.4.1-4**). Now do children play in the river, even though the fenced lions do not scare them?

[xli]Aini *et al.* (2007) [27] listed five drinking water accessing means for Malaysian people: tap water, bottled water, water filters (home purification systems and vending machines), and home wells in rural areas,[27] which matter-of-factly excluded river water. Now Selangor scores 100% penetration of in in-house water supply except for Orang Asli.[28] Ithoi *et al.* (2011) reported that all residents in Sungai Batu and majority of Sungai Congkak, Selangor, did not have safe water supply facilities. Even those with safe water supply were said to choose river water for daily use *e.g.*, swimming, bathing, washing, even cooking and drinking, avoiding using supplied water for low quality and rust color. Ithoi *et al.* saw locals defecating and in the rivers.[29] In SSB, Goh et al. (2015) reported that because of unreliable water supply and technical support, Kampung Gerachi Jaya residents drew water from the mountain source.[30] Not only Orang Aslis but also general Malaysian people do not seem to perceive tap water as directly drinkable. Poon *et al.* (2016) surveyed Sg. Langat and Sg. Klang basins, Selangor, and found there that although most (80-85%) of their respondents used tap water for drinking water, but their tap water was treated: 84-90% boiled and 49-53% filtered tap water before drinking.[31] SYABAS the water supply company states that their water has been meeting the National Standard For Drinking Water Quality.[32] SYABAS attributes tap water's continuous yellowish/brownish color to old pipes and tanks in the residential area or the house.[33] The percentage of households owing water filter in 2016 is 51.1% in Selangor and 76.7% in Kuala Lumpur,[28] which means at least those percentages of households are not satisfied with their raw tap water.

Figure 3.4.1-1 A person Catching Fish in the River (Rawang, SSB)

(Taken by Author in August, 2017)

Figure 3.4.1-2 Trash

Upper left: Pond in Serendah (Taken by Author in July 2017), Upper right: Engine Oil Container in Kuala Selangor Nature Park, located at the river mouth (Taken by Author in August), Bottom left and right: Floating Trash in a Firefly Ecotourism Site (Taken by Author in May 2015)

Figure 3.4.1-3 Sungai Chiling Fish Sanctuary (Taken by Author in May 2015)

The people playing in the river are researchers.

Figure 3.4.1-4 Lions of Hock Leng Keng Temple, Serendah (Taken by Author in July 2017)

Aini *et al.* (2007)[27] stated that in general Malaysian people have access to WHO standards-safe tap water and water-borne diseases have declined, but proper water safety education was needed. Remaining tap water problems were such as '*untreated water, inadequate, water treatment, chemicals used in water treatment and distribution systems*.' People complaint about tap water with air contained, turbidity, color, particles, taste and odor (of chlorine), while they do not know about harms of chemicals (*e.g.*, lead, arsenic and benzene) or microorganisms (*e.g.*, *Vibrio cholera*, hepatitis A and *Cryptosporidium parvum*). Their means to improve tap water quality are: sealing storage tanks; drinking water from the mains only; using small container for refrigeration; and boiling tap or bottled water. Malaysian people, mainly urban residents, filter tap water, and increasing number of them buy bottled water. Water vending machines are available in market places. Home wells are used in some rural areas, but the use is declining. The1998 water crisis in Selangor and Kuala Lumpur broke out due to factors such as wasteful spending, non-revenue water, river pollution and basin destruction. Insufficient management, insufficient enforcement, indifferent attitude can also reduce available water resource. Household level water resource management, women play an essential role. Using water-efficient fixtures and appliances, preventing leakage, changing personal habits are efficient means for water conservation.

Aini *et al.* (2007)[27] surveyed 100 women's awareness on water issues, drinking water perceptions, household means to improve water quality, and sustainable water practices in Seremban, Negeri Sembilan State. The respondents obtained water issues information mainly via newspapers, television, radio and magazines. Most (94%) of them were gauged aware of polluted rivers and raised demand for water. 87% did not know water shortage outside Malaysia. All were aware of that everybody has to do something for the environment for future generations, but half (50%) of them thought it was entirely the government that should keep the environment. The respondents thought water quality in Malaysia is 'poor,' scoring 1.81 in average ('very good (4),' 'good (3),' poor (2),' and 'very poor (1)'), air 2.09 and sound 2.25. The respondents thought the environment was deteriorated due to industry/factory (92%), development (77%), themselves (58%), agriculture (43%), and livestock farming (43%). Seventy percent rated tap water quality 'poor' and 16% 'very poor. Their drinking water perception criteria were color (93%), odor (81%), taste (75%), floating debris (64%), foamy (51%) oily (36%), and test kit (38%, but 6% use), and their tap water problems were color (90%), odor (64%), taste (75%), floating debris (64%), and foamy (25%) and oily (4%). Eighty five percent had water filters, 41% boiled water, and 17% purchase bottled water (about RM 140/month, 3,000 times more expensive than water tariff). The filters were installed: to remove color (72%), remove inorganic waste (clay, sand, heavy metals) (66%), chlorine (61%), microbes (56%), organic waste (48%), pesticides (41%), add minerals (42%), and Do not know (6%); and for the reasons of health conscious (67%), perception of poor water quality (60%), Increasing water pollution and contamination (44%), family members suffered water-borne disease (9%), influenced by others (2%). Aini *et al.* (2007) [27] concluded that their female respondents were unsatisfied with tap water.[27]

Although Aini et al. (2007) reported the respondents' demographics (mean, youngest and oldest ages, marriage status, mean household number of members and income level, and ethnicity, they had no discussion on the relationships between demographics and drinking water perceptions.

Mokhtar *et al.* (2011)[34] listed the challenges of water resource management in Malaysia:

> '*water demand management in major urban centres, rain water harvesting, pollution control of point sources and nonpoint sources, solid waste management, efficient water use, water tariff setting based on stakeholders' decisions, reduction of nonrevenue water loss, business opportunities for new investments, planned urbanization and active participation of stakeholders for decision making.*' [34]

Mokhter *et al.* (2011)[34] mentioned that the Integrated River Basin Management (IRBM) in Malaysia was a subordinate concept of the Integrated Water Resources Management (IWRM). The IRBM is just arranging institutions in a makeshift manner and it lacks political will. Mokhtar *et al.* analyzed the institutional arrangement of various bodies related to the IRBM of Langat River Basin (LRB)[xlii]: various bodies are involved in the complex, hierarchical, top-down process of decision making (**Figure 2.1.3-1**). Malaysia has no all-including Federal water policy. However, river basin organizations (*e.g.*, LUAS) and policy dialogue forums fill the blank.

Mokhter *et al.* (2011)[34] classified Stakeholders into two types: primary stakeholders who did not belong to the IRBM-related bodies; and secondary stakeholders who belong to the IRBM-related bodies. Note that secondary stakeholders not at work are regarded as primary stakeholders.

Mokhter *et al.* (2011)[34] classified action arenas into three categories: Category 1 for interactions among secondary stakeholders, Category 2 for interactions between primary and secondary stakeholders, and Category 3 for interactions among primary stakeholders. Category 1 is in the structure of decision making process shown in (**Figure 2.1.3-1**) that is proactive itself but unreacheable for primary stakeholders. Category 2 includes interactions between LUAS and water users and local communities, and those between SPAN and water users and water forum members. However, in practice, only organizational stakeholders joined the interactions. Category 3 includes interactions among water users and those among local communities. However, actually, the water users and local communities threw almost everything at the government agencies.

Mokhter *et al.* (2011)[34] conducted an interviewed 181 respondents in the upstream, middle stream and downstream of LRB in order to understand the institutional challenge. Mokhter *et al.* (2011)[34] described the LRB people as follows:

> '*In LRB, a homogenous social structure with certain shared norms of behaviours, common understanding about actions, homogeneity of individual preferences and uniform and abundant distribution of resources was observed. These attributes indicated the ability of the community to interact for decision on desired policy outcomes. Besides ethnicity, religion, culture and history were also favourable in defining incentive structures for interaction among the members of the community.*'[34]

Mokhter *et al.* (2011)[34] found that 96% of their respondents knew the river system. Twenty nine percent of their respondents knew what LUAS was and what LUAS did. Thirty six percent agreed about that sewerage systems' standards were fair. Respondents perceived that administration enforcement was consistent with their river water quality, and those of the downstream were less satisfied with enforcement on river water quality than those of the upstream. Respondents' priority

[xlii] Lake Sg. Selangor Basin, Sg. Langat Basin is an important water source for the basin itself and Klang Valley.

environmental problems were water quality deterioration and solid waste management. Some 82% were interested in joining IRBM decision making and a social learning program.

Mokhter *et al.* (2011)[34] argued that although their respondents were interested in joining IRBM decision making and a social learning program, for which, however, there was no adequate written legal legitimation in section-specific laws. Mokhter *et al.* (2011)[34] recommended IRBM-related institutions and individual stakeholders join an iterative social learning in policy making, which be coordinated by LUAS.[34]

We have to be careful about the way of questioning people about an environmental issue. It is well expected that people answer that they are ‘interested in’ it if simply asked by environmental researchers like ‘Are you interested in joining IRBM decision making?,’ because it is socially regarded good and easy to be ‘interested in’ anything good with no responsibility. Recall that Mokhter *et al.* (2011)[34] themselves mentioned about people’s leaving almost everything to the government in the Category 3 action arena.[34] People may not have a will to really spend their time and effort joining the IRBM decision making at any cost. If we want to know the degree of people’s interest in an environmental issue, we should not ask them such a ‘yes’-guiding question. If Mokhter *et al.* (2011)[34] did so, their political argument for written legal legitimation of public involvement in IRBM decision making could lose its ground. They should have asked their respondents in words and figures about how much time and effort they were willing to spend for joining the IRBM decision making.

Khattab and Wahid (2015)[35] conducted a pilot survey on tap water users’ perceptions of tap water concerning water quality and health risk, and willingness to pay for water quality and service improvement, in the context of the potential rise of water tariff following the Federal government’s policy abolishment of subsidies or full cost recovery. The pilot survey was conducted in the state of Penang, where people are paying the lowest water tariff in Malaysia: RM 0.22/m^3 (for 0-20 m^3) and RM 0.42/ m^3 (for >20-40 m^3).

Any statistic conclusion cannot be inferred from the pilot survey due to the small number of respondents, but Khattab and Wahid (2015) [35] established some hypotheses for the future main survey. There were respondents who were unsatisfied with taste, suspended solids, and chlorine content of tap water, while odor and color did not seemed to be that big problems. Although respondents were likely to assume that their tap water cleared WHO or Malaysian drinking water standard, they tend to perceive their tap water as unsafe and health-risky, which may be related to their being prone to install a home water filter or buy bottle water. Many of the respondents did not want water tariff to be raised at all: up to RM 5 per 2 months.

Gender and income level may affect people’s perceptions of tap water. Khattab and Wahid (2015)[35] discussed the relationship between demographics and WTP. Gender may be a factor of drinking water perception, health risk perception and WTP.[35]

Afroz *et al.* (2015)[18] surveyed, along Gombak River, Selangor, Malaysian household heads' water pollution perception, awareness, knowledge, attitudes and behaviors, and human health impacts, by asking them to rate items on a Likert scale, and demographics and socio-economics: gender, age, education, income level, and ethnicity.

Their respondents (248 persons) were asked yes-no question like *'Do you aware about causes of water pollution?'* They answered they were aware of water pollution causes (96.8%), think water pollution is harmful to health (95.6%), and it transmits water-borne diseases (72.2%). Among them, 16.1% attended water pollution health risk programs and 19.4% had experienced a visit of somebody who explained water situation in the area.

The respondents obtained water pollution information via newspaper (48%), TV (29.4%), the internet (6.9%), friends (6%), advertisement (3.2%), and community (6.5%).

The most serious water-borne diseases chosen by the respondents were diarrhea (45.2%), dengue fever (13.3%), malaria (12.9%), typhoid (12.1%), malaria (12.9%), hepatitis (9.3%), and hair diseases (2%). The respondents' drinking water sources were purchased (40%), city water (30%), individual well (16%), community well (6%), don't know (5%) and rivers (3%). They store water in plastic buckets (68%), earthen ware (16%), stainless steel containers (10%), and others (6%). Use of a special glass for taking water from the container was rare. Villagers, children in particular, did not behave hygienically, *e.g.*, they did not wash hands before taking water from the container. Children (0-12 years old) tend to suffer diarrhea, while the old (60 or above) did not, which may be attributed to the old's often taking traditional medicines.

Afroz *et al.* (2015)[18] analyzed the contributions of gender, age, education, income level, attitude, awareness, and knowledge to water pollution risk perception by multiple linear regression, and the regression coefficients were t-tested. They found that the high education, high income level, high water pollution awareness, high knowledge, and better attitudes causes higher water pollution risk perception.[18]

Note that ethnicity was not considered in the regression analysis, although Afroz *et al.* (2015)[18]'s respondents were Malay (65%) Chinese (17%), Indian (11%) and others (7%). The respondents whose drinking water sources are rives may have been from the 'others'(data not shown), because in Selangor, tap water penetration is 100% except Orang Asli.[28]

Poon *et al.* (2016)[31] surveyed, from an ergonomics viewpoint, human activities' influence on water and fish resources and human well-being in Langat River Basin (LRB) and Klang River Basin (KRB), Selangor. Although polluted by such as sewerage, septic tanks, effluents form oil palm, logging, food processing, and factories of semi-conductor and chemicals, there are villagers who consume fish from the rivers. Poon *et al.* (2016)[31] sampled the rivers' water and fish muscle and surveyed village residents in the upstream (U), midstream (M) and downstream (D) areas of the basins.

From the water samples, arsenic (in LRB and KRB), selenium (LRB's D), and iron (KRB's U and D) were detected above the allowable levels of Canadian Water Quality Guidelines for the Protection of Aquatic Life. From the fish muscle samples, arsenic (LRB's U and KRB) and selenium (KRB's M and D) were detected above the maximum permitted levels by the Australian Food Standards Code; and lead (KRB) was detected above the standard by the European Communities Commission.

In the survey in LRB, 100% used tap water. Seventy one percent of respondents had flush toilets and 44% had septic tanks in their households. There were respondents suffering from chronic illnesses (*e.g.*, heart disease, asthma and cancer), one of whose root was poor hygiene. All LRB respondents were aware of potential water contamination, and 2% of LRB respondents directly drank groundwater and used it for cooking. Although 90% of LRB respondents knew potential health effects of toxins, 5% agreed the river's heavy metal pollution. 2% had heard warnings of heavy metals in the river and 56% consumed fish from the river (7% did not). Eighty percent used tap water (tap water had no significant heavy metal contamination), which was complaint by the respondents of yellow color. 90% boiled tap water before drinking, and 49% had filters. Thirty seven percent used the refuse collection service, but 46% threw garbage in the river.

In the survey in KLB, 96% used tap water. 69% of respondents had flush toilets and 62% had septic tanks in their households. There were respondents suffering from chronic illnesses: high blood pressure (22.2%), diabetes (17.7%) and asthma (2%). Four percent of KRB respondents directly drank groundwater and used it for cooking. The respondents neither drink river water nor use for cooking nor eating purposes. Twenty nine percent of KRB respondents knew potential health effects of toxins, 0% agreed the river's heavy metal pollution. Two percent had heard warnings of heavy metals in the river and 56% consumed fish from the river (7% did not). Fifty three percent filtered and 84% boiled tap water before drinking. No respondent was aware of their exposure to heavy metals.87% used the refuse collection service, but 27% threw garbage in the river.[31]

Heavy metal contamination is often invisible and unrecognizable while trash and garbage are visible and uncomfortable. Lay people may eat fish from a heavy metal-contaminated river without knowing it while they may not drink safe water with high turbidity and/or trash and garbage. We can see people fishing in Kuala Selangor of SSB that has upstream an industrial area in Rawang. People's perception research is very important for their health.

Wahid *et al.* (2017)[36] reviewed drinking perception studies. Malaysian people educate their children to boil tap water before drinking, expecting it to be directly drinkable. They do not perceive that their tap water is actually at a directly drinkable level. Some people are reported to believe that tap water is contaminated with health-harming substances such as salts, chlorine, and insecticides. Some research reported that their respondents were unsatisfied with tap water due to color, floating debris, odor and taste. However, there is no evidence that these complaints represent the whole Malaysian population's opinions; as even reported in the very same articles, people in general are satisfied with tap water. Past incidents such as high ammonia concentration in the intake water, which were covered by the news media, are the possible causes of the negative perceptions. Malaysian people who are unsatisfied with tap water may buy bottled water and/or install water filters. Some researchers say that people's tap water perceptions comprise subjective and objective aspects. Their subjective perceptions of convenience, price, and environmental attitudes may play a role in choosing what water to drink. Foreign drinking water consumption research have focused on water components and their effects on people's perceptions, consumption patterns, or trust in water suppliers, suggesting: that people may pay bottled water which is much more expensive than drinking tap water they perceive unsafe or of poor quality; that people may drink tap water if they perceive it safe; that people's socioeconomic status and age, bottled water's convenience and perceived purity. Malaysian people are reported to stress the convenience or easy accessibility of drinking water. In general, drinking water is chosen according to water quality and willingly payed for being healthy and pure.

Wahid *et al.* (2017)[36]. hypothesized that people's choosing drinking water depends on their perceived quality, convenience, price and environmental attitude, and employed the Attribution Theory to create a framework model. A questionnaire survey was conducted, and respondents were asked to rate agree/disagree levels of item statements. Pass coefficients of the hypothesized items indicated that perceived quality, convenience and price positively to drinking water choice in this order, while environmental attitude negatively.[36]

Although Wahid *et al.* (2017)[36] reported the demographics of the respondents (gender, Penang residency, age, Malaysian citizenship, ethnicity, and monthly income), there is no discussion between the relationships between the demographics and the survey results.

There have been some water and/or river perception studies in Malaysia, but there is no religion-based analysis, although Islam, that has water use criteria, is the national religion of Malaysia. From this dissertation's IRBM viewpoint considering ethnohydrology, it is essential to understand Muslims and other religion believers' similarities and differences in water and river perception.

3.4.2 Islamic Perceptions

The Malaysian Federation and the State of Selangor adopt Sunnah Islam and mainly the *Shafii* school *Shariah* (not exclusive to other Sunnah *Shariah* schools). Islam is constitutionally under State jurisdiction and in Selangor authorized by Sultan. Islam practicing at administration level may vary among States in such as *Fatwa* (a religious decree) issuing.[37] And, as well known, Muslims' ways believing and practicing Islam basically depend on themselves or their cultures and societies. As an non-Muslim foreign engineering researcher, I agree with Nakamura (1997)[38]'s approach that researchers must regard all ways of believing and practicing Islam as true and equal, defining a Muslim as a person who him/herself believes at least ‘God is only one and Muhammad is God’s apostle’ and Quran.[38] Therefore, I see all Muslims equal and true as long as they claim they are, no matter what they do or do not. And, of course, I also see Muslims and non-Muslims as true and equal, no matter what they believe or do not.

“Islam, Wildlife Conservation & You”[39] by Rosmidzatul Azila May Yamin and Abu Bakar Yan (2013) is authorized by IKIM and WWF-Malaysia. This book introduces basic Islamic view of the environment protection with plenty of photos and Quran verses. It says about water, for example:

> God ‘*has emphasized in al-Quran that water is a very important natural resource and that water is a source of life, because life cannot be sustained without water, as stated by*’ God[39]

> ‘*We have to realise that water is a gift from’* God ‘*which we need to be grateful for.*’ [39]

This book [39] teaches Muslims that water should be clean, be used properly, not to be wasted, *etc.*, on the ground of Quran verses.[39]

Muslims cite Quran verses when they authorize what they state, because they believe Quran verses are God’s words and absolutely true. It is their traditional custom and the book shows us one example that environmental conservation can be derived from Quran, too. The book’s readers seem to be mainly Muslims, although the IKIM professor who kindly gave me the book said ‘Islam is for all people.’ ‘Quran reads…’ may not interest or attract non-Muslims, although all people can share the idea of proper use of water. It might be possible that without citing Quran verses, the importance of environmental protection is more widespread and shared. However, anyway, the book is helpful for non-Muslims who are interested in an Islamic way of thinking about environmental conservation.

According to the book titled “Halal: All that You Need to Know Vol.1” [40] originally published in Malaysia in 2014, good water quality water is required for *Halalan Toyyibban* (*halal* and good) food production. Some restaurants use filtered water for cooking, while many restaurants directly use tap water, believing that the water is certified as safe. The Malaysian government considers that *halal* certification is not for religion but for hygiene and quality management. In addition to religiously restricted things such as pig-derived materials, it is necessary for food production water to consider:

> ‘*1. Sensorial characteristics such as smell and taste,*

2. Physiological characteristics (pH, impurities mixed in water),

3. Chemical components such as toxins (heavy metals, pesticides, herbicides, hydrocarbons, etc.),

4. Excess minerals components such as nitrates and sodium sulfate, and

5. Biological pollution (bacteria, algae, viruses).'[40]

Modern technology may be employed to certify food *halal*ness: Gas Chromatography (GC) (FAC/FAME and TAG analyses); GC-MS; microscopic measurement; FTIR spectrophotometry; E-Nose; DSC; microbiological approach; and, chemical tests. The food industry follows the Hazard Analysis and Critical Control Points (HACCP) approach, which is now also applied for drinking water treatment, particularly that of bottled water.[40]

The books' concept of *halal* is based on both religion and modern food sanitation. Therefore, *halal* products are safe not only for Muslims but also for non-Muslims. With the *halal* standard certification, everybody can eat food and drink water with security.

The certification of being *halal* affects Muslims' water perception. Muslims may not drink the scientifically identical water if it is labeled 'Not halal, but sufficiently drinkable in terms of sanitary.' Inter-Muslim trust is also important. Muslims may eat and drink at Muslim-owned shops and restaurants without checking the *halal* mark.

Ang and Marsuki (2014)[41] surveyed people's perceptions of the Malacca River. Dr. Marsuki is an environmental ethics lecturer at Faculty of Science and Technology Studies, University of Malaysia and Ang seems to be one of his students. Ang and Marsuki (2014)[41] at times cite Quran verses in the article; for example, in the Results and discussion part:

> *'[...] Respondents realize that water is important for all living and non-living beings. They are aware that humans need water to continue living their lives. Allah s.w.t. says which means (Ismail, 2012):*
>
> *"He who made the earth unfold, the sky as a canopy for you, and He sends down rain from the sky, and producing fruits as food for you." - Surah al-Baqarah, ayat22*
>
> *In other words, it's important for human to thankful for water resources. Management or sustainability of water resources is very important to done wisely to avoid facing the problems associated with water. [...]'*[41]

The relative pronoun 'which' seems to indicate '*that humans need water to continue living their lives.*' Thus, the second sentence can read that the respondents, half of whom being non-Muslims, are aware of what God says. In other words, Ang and Marsuki (2014)[41] intended to directly support their hypothesis with what they believe is absolute truth. Malaysia' science education has been impacted by the Islamization.[42] Quran verses are Muslims' value source and communication means shared and may play an important role in the IRBM of SSB by connecting environmental science with Muslims' basic values. However, excessively frequent citing of Quran in a science context could exclude non-Muslims from discussion.

Mokhtar *et al.* (2015)[2] introduced the *Taharah-Najasah* (purification-pulluted/polluting, T-N) standard based on Islam practiced in Malaysia. Seven water sources were regarded as pure: rain, river, well, spring, snow and dew. Odor, taste and color are the main criteria for judging water, and several factors are also considered: quantity (2 *qullah* or 270 L is needed to be *Tahur* pure and capable of purifying); content; situation (flow, temperature); use (*e.g.*, ablution); and health implications (*e.g.*, skin condition or disease). The Islamic standard has water quality classes such as: *Tahur* (pure and capable of purifying, no changes in smell, color or taste from the source water, cleaning dirtiness, *e.g.*, feces and menstrual blood, for ablution); *Tahir* (pure but incapable of purifying, no changes in smell, color or taste from the source water, not for ablution); and *Najas* (impure, changes in smell, color or taste from the source water). More detailed classification is considered. Compared to the Malaysian National Water Quality Index (NWQI), the *Tahur* level (ablution usable) is thought cleaner than Class I (directly drinkable); the NWQI-based Class I water is *Tahir* but may not be *Tahur*, pure enough for religious ablution.[2]

General Malaysian Muslims take ablution with tap water which they think needs boiling or filtering before drinking. This could be because they regard a water tap as a pure water source, while the water may have unpleasant appearance, odor or taste. The relationship between religious and hygiene perceptions seem to be complex, and this is not a right-or-wrong question.

Suratkon *et al.* (2015)[43] proposed a closed-loop ablution water recycling system called 'SmartWUDHU' in a mosque. The system fulfills religious quantity and quality requirements by an engineering approach. Tap water is stored in a tank (2,000 L) and used for pre-prayer ablution, and the used water is mixed with rain water from the rooftop. Then the mixed water is pumped up to another tank (2,500 L) with a chlorine dispenser. The chlorinated water is used for the roof sprinkler, flushing toilets, and watering plants.[43]

Recalling the T-N standard by Mokhtar *et al.* (2015)[2] discussed above, it is interesting that the pre-prayer ablution water is raw tap water, while drinking water is RO-treated tap water; drinking water is cleaner than tap water. This may be because tap water is regarded as a pure water source in Islam, while the water may have unpleasant appearance, odor or taste. In SSB, an ablution water recycling system is installed in a mosque in Kuala Kubu Bharu (**Figure 3.4.2-1**).

Figure 3.4.2-1 Ablution Water Recycling System in a Mosque in Kuala Kubu Bharu MOSTI: Ministry of Science, Technology and Innovation (Taken by Author in May 2015)

3.5 Discussion and Conclusions

We discussed three domains of science that deal with people's water and river perceptions for inter-stakeholder communication where, roughly: engineering and psychology studies focus on basic on perception differences that may exist among various groups having different cultures; risk perception studies on risk calculation, theory and application for real communication. These domains have no clear border among them, and the IRBM include them for the purpose of basin management.

Religion is based on something beyond what humans experience and explain, while science is based on what humans experience and explain. There are religions that respectively provide their own world views, while there are domains of science that respectively provide methodologies and applications. Although borders among domains of science are flexible, while those among religions are for now practically difficult to be flexible. This is because religious experience is more difficult to share than physical one. Humans' physical bodies are basically same, but what they believe are different. This situation will not change in any expectable future, and anyway we have to share this physical world, no matter what we believe, for the sustainable development of humans.

There are multiple religions in Malaysia, among which Islam is constitutionally given a special status, being the majority's religion as well. Islam is often believed by Muslims to be holistic religion that covers everything from the world view to daily life. In Institute of Islamic Understanding Malaysia (IKIM), I met Muslim researchers who said that Muslim engineers are Muslims before being engineers and Islam should control engineering. From this religious view, Islam is supreme and comparable to nothing. It may be so, but it is practically true that the faith is not shared by everybody, and will not be in any expectable future. However, people in the country, except at some tragic times, basically have kept their peace for a long time. They know how to get along with each other without sharing religious experience, to which Islam, of course, must have been one of main contributors. And, one of other main contributors of Malaysian people's peaceful coexistence seems to their general attitude of not interfering each other's religions, which foreigners who visit there can observe and feel.

From ethnohydrology point of view, every group of people is assumed to have a water-related 'culture' of its own, among which is a culture of Islam. There also assumed to be cultures of such as experts and lay people, Malay, Chinese, Indian and Orang Asli, wealthy and modest people, septic tank and sewerage system users, *etc*., all of which are regarded as mutually comparable. There could be an opposing opinion about validity of this view from Muslims that religion is so supreme that it should not be comparable with such lower factors. The answer is that this dissertation compares phenomena and data for the practical purpose of IRBM. Although it would be my great pleasure if an IRBM administrator read this humble dissertation, this dissertation is for academic discussion in the first place. The Questionnaire Survey was done 'for academic purpose only,' which was explained in the first page of the questionnaire sheet, and people who agreed that only joined the survey as respondents. This dissertation has no intension of compromising Islam and its constitutional status in Malaysia. Rather, Islam cannot be ignored in the IRBM of SSB, since its presence would be more prominent with the increasing Muslim population and the Islamization of Malay Muslims. Therefore, comparing perceptions with other religions and cultures is necessary for mutual communications for their coexistence in harmony with Islam.

Past water and river perception studies indicate that people perceive water and river mainly by visual factors, and people may not be aware of invisible contaminants such as heavy metals. However, since these studies are by nature case studies, their hypotheses' validities in SSB are unknown. Moreover, there are ethnohydrological suggestions that people's water and river perceptions may depend on religions that may have strong restrictions about insensible things. Moreover, as discussed in **Chapter 2**, SSB people have a settling patterns according to ethnic groups that are associated with religions. The IRBM decisions should be made after considering the cultures of stakeholders. However, although there have been vast amount of literature on water and river perceptions, and Malaysia is a multi-cultural, multi-religious society, there has been no research which directly focused on religion as one of water and river cultures as other demographics in Malaysia. This dissertation contributes to the IRBM of SSB by providing data and discussion on people' water and river perceptions and their similarity/difference with respect to cultural aspects of religions. For example, if water resource managers know what people perceptionally prioritize, the knowledge help them set a goal of policy making, such as choosing cleaning the river water to drinkable, bathable or religious use level. If Ecosystem Services (ES) or risk managers consider people's perceptions vary according to cultures and religions or their overall world views, and then discuss whose ES or risks they calculate, the calculation of the ES will be more plausible.[xliii]

References

1. Doria, M. de F. Factors Influencing Public Perception of Drinking Water Quality. *Water Policy* **12**, 1 (2010).
2. Mokhtar, M. I., Abdullah, R. & Baharuddin, A. An Islamic Perspective on Water Quality: A Case of Malaysia. *Water Policy* **17**, 454 (2015).
3. Frederickson, H. G. & Magnas, H. Comparing Attitudes Toward Water Pollution in Syracuse. *Water Resour. Res.* **4**, 877–889 (1968).
4. David, E. L. Public Perceptions of Water Quality. *Water Resour. Res.* **7**, 453–457 (1971).
5. Kooyoomjian, K. J. & Clesceri, N. L. Perception of Water Quality by Select Respondent Groupings in Inland Water-Based Recreational Environments. *JAWRA J. Am. Water Resour. Assoc.* **10**, 728–744 (1974).
6. Nicolson J. A. & Mace A. C. Water Quality Perception by Users: Can It Supplement Objective Water Quality Measures?1. *JAWRA J. Am. Water Resour. Assoc.* **11**, 1197–1207 (1975).
7. Dinius, S. H. Public Perceptions in Water Quality Evaluation. *JAWRA J. Am. Water Resour. Assoc.* **17**, 116–121 (1981).

[xliii] Or, in the first place, the Semitic monotheist world view of ES itself where human beings are served by the environment and shepherd it as the lords of creation might be unsuitable to religions such as Buddhism and Hinduism.

8. Moser, G. Water Quality Perception, a Dynamic Evaluation. *J. Environ. Psychol.* **4**, 201–210 (1984).

9. Heiskary, S. A. & Walker, W. W. Developing Phosphorus Criteria for Minnesota Lakes. *Lake Reserv. Manag.* **4**, 1–9 (1988).

10. Smith, D. G., Cragg, A. M. & Croker, G. F. Water Clarity Criteria for Bathing Waters Based on User Perception. *J. Environ. Manage.* **33**, 285–299 (1991).

11. Gregory, K. J. & Davis, R. J. The Perception of Riverscape Aesthetics: an Example from Two Hampshire Rivers. *J. Environ. Manage.* **39**, 171–185 (1993).

12. Smith, D. G., Croker, G. F. & McFarlane, K. Human Perception of Water Appearance; 1. Clarity and colour for bathing and aesthetics. *N. Z. J. Mar. Freshw. Res.* **29**, 29–43 (1995).

13. Smith, D. G., Croker, G. F. & McFarlane, K. Human Perception of Water Appearance; 2. Colour judgment, and the influence of perceptual set on perceived water suitability for use. *N. Z. J. Mar. Freshw. Res.* **29**, 29–43 (1995).

14. Davies-Colley, R. J. & Smith, D. G. Turbidity Suspended Sediment, and Water Clarity: A Review. *JAWRA J. Am. Water Resour. Assoc.* **37**, 1085–1101 (2007).

15. World Health Organization. *Guidelines for Drinking-water Quality*. (WHO Press, 2011).

16. Slovic, P., Fischhoff, B. & Lichtenstein, S. Facts and Fears: Understanding Perceived Risk. in *Societal Risk Assessment: How Safe is Safe Enough?* (eds. Schwing, R. C. & Albers, W. A.) 181–

216 (Springer US, 1980). doi:10.1007/978-1-4899-0445-4_9.

17.Paek, H.-J. & Hove, T. Risk Perceptions and Risk Characteristics. *Oxf. Res. Encycl. Commun.* (2017) doi:10.1093/acrefore/9780190228613.013.283.

18.Afroz, R., Banna, H., Masud, M. M., Akhtar, R. & Yahaya, S. R. Household's Perception of Water Pollution and Its Economic Impact on Human Health in Malaysia. *Desalination Water Treat.* 1–9 (2015) doi:10.1080/19443994.2015.1006822.

19.Back, W. Hydromythology and Ethnohydrology in the New World. *Water Resour. Res.* **17**, 257–287 (1981).

20.Herbst, S. *et al.* Perceptions of Water, Sanitation and Health: A Case Study from the Mekong Delta, Vietnam. *Water Sci. Technol.* **60**, 699–707 (2009).

21.West, A. O., Nolan, J. M. & Scott, J. T. Optical Water Quality and Human Perceptions: A Synthesis. *Wiley Interdiscip. Rev. Water* **3**, 167–180 (2016).

22.West, A. O., Nolan, J. M. & Scott, J. T. Optical Water Quality and Human Perceptions of Rivers: An Ethnohydrology Study. *Ecosyst. Health Sustain.* **2**, e01230 (2016).

23.Lat. *Kampung Boy: Yesterday & Today*. (MPH Group Publishing Sdn Bhd, 2014).

24.Lat. *the Kampung Boy*. (MPH Group Publishing Sdn Bhd, 2014).

25.マレーシアの文化＆習慣がよくわかる『カンポンボーイ』. マレーシア政府観光局 オフィシャルブログ http://blog-tourismmalaysia.jp/archives/51970076.html (2014).

26. Kadir, S. N. A., Nasaruddin, A., Musa, M. N., Ong, B. & Mohamad, Z. F. *Pasangan; Pulse of a Riverine Community*. (UM Sustainablity Science Research Cluster and JSPS Asian Core Program, 2015).

27. Aini, M. S., Fakhrul-Razi, A., Mumtazah, O. & Chen, J. C. M. Malaysian Households' Drinking Water Practices: A Case Study. *Int. J. Sustain. Dev. World Ecol.* **14**, 503–510 (2007).

28. Department of Statistics, Malaysia. *Household Income and Basic Amenities Survey Report by State and Administrative District: Selangor 2016*. (Department of Statistics, Malaysia, 2017).

29. Ithoi, I., Jali, A., Mak, J. W., Wan Sulaiman, W. Y. & Mahmud, R. Occurrence of Blastocystis in Water of Two Rivers from Recreational Areas in Malaysia. *J. Parasitol. Res.* **2011**, 8 (2011).

30. Goh, H. C., Mohamad, J. & Syarilla, S. 'Save Sungai Selangor' and the Indigenous People: Looking Back, Moving Forward. in *Land Use Dynamics and Governance in the Sungai Selangor Watershed* 85–103 (University of Malaya Press, 2015).

31. Poon, W. C., Herath, G., Sarker, A., Masuda, T. & Kada, R. River and fish pollution in Malaysia: A green ergonomics perspective. *Spec. Issue Hum. Factors Sustain. Future* **57**, 80–93 (2016).

32. SYABAS. Water Quality Monitoring. *Syarikat Bekalan Air Selangor Sdn. Bhd.* https://www.syabas.com.my/consumer/water-quality-monitoring (2018).

33. SYABAS. Frequently Asked Questions (FAQs). *Syarikat Bekalan Air Selangor Sdn. Bhd.* https://www.syabas.com.my/consumer/frequently-asked-questions-faqs (2018).

34.Mokhtar, M. B., Toriman, M. E. H., Hossain, M., Abraham, A. & Tan, K. W. Institutional Challenges for Integrated River Basin Management in Langat River Basin, Malaysia. *Water Environ. J.* **25**, 495–503 (2011).

35.Khattab, T. H. & Wahid, N. A. Penang User's Perception of Domestic Water, Healthy Risk Concern and Willingness to Pay: A Pilot Study. *J. Teknol.* **72**, 93–107 (2015).

36.Wahid, N. A. Investigating Consumers' Objective and Subjective Knowledge on Perceived Household Water Issues. *Sci. Int. J.* **29**, 205–209 (2017).

37.多和田裕司. マレー・イスラームの人類学. (ナカニシヤ出版, 2005).

38.中村廣治郎. イスラームと近代. (岩波書店, 1997).

39.Yamin, R. A. M. & Yang, A. B. *Islam, Wildlife Conservation & You*. (Institute of Islamic Understanding Malaysia (IKIM), World Wide Fund for Nature (WWF-Malaysia), 2013).

40.ハラルをよく知るために. (公益社団法人日本マレーシア協会, 2015).

41.Ang, K. hua & Marsuki, M. Public Perception Towards Environmental Awareness. Case Study: Malacca River. *Int. J. Acad. Res. Environ. Geogr.* **1**, 53 – 61 (2014).

42.杉本均. マレーシアにおける国際教育関係—教育へのグローバル・インパクト—. (東信堂, 2005).

43.Suratkon, A. SmartWUDHU': Recycling Ablution Water for Sustainable Living in Malaysia. *J. Sustain. Dev.* **7**, 150 (2014).

4. Questionnaire Survey

This Chapter describes the “Questionnaire Survey on People’s Perception of Rivers and Water” (Questionnaire Survey, QS). The purpose of the QS was to understand people’s water and river perceptions for the inter-stakeholder communication and policy making in the IRBM of SSB. SSB is a prime example of multi-religious, multi-cultural Malaysia, and the IRBM communication may involve inter-religion, inter-cultural dialogues. For providing them with a discussion material, the QS was designed to check the hypothesis that people’s water and river perceptions vary according to geographic and demographic factors, location and religion in particular.

In Malaysia, religions are associated with ethnicity: roughly, Muslims are mainly Malays, Christians mainly Chinese and Indians, Buddhists mainly Chinese, and Hindus mainly Indians (Chapter 1). The ethnic groups reside in a historically formed settlement pattern: before the NEP, roughly, Malays were in Kampungs, Chinese in towns, Indians towns and their surroundings; because of the NEP, they started to live in suburban housing developments, mixed, where they are likely to form loose uni-ethnic neighborhoods. In SSB, towns locate mainly in the upstream, most of which were originally tin-mining Chinatowns and housing developments, and the downstream area is mainly for agriculture such as palm oil plantations (**Chapter 2**). Consequently, if there are perception differences according to religions, they are possibly thought to be due to 1) their water and river use cultures, and/or 2) the settlement pattern.

4.1 Survey Sheet

A structured questionnaire survey with a Survey Sheet was designed. In order to obtain intuitive perceptions, the Survey Sheet was designed as follows.[xliv] The questions were designed to be answered by average adults within their experience with neither explanation nor instruction by the investigator(s), considering cases where respondents were remote from the investigator(s); for example, situations of sending the Survey Sheets by mail to or leaving the Survey Sheets with respondents and collecting them later.

To make a Survey Sheet answerable within a short time without learning anything beforehand or deep thinking. To achieve this, the author tested pilot version sheets in English was tested and revised again and again: researchers and students at Research Center for Environmental Quality Management, Kyoto University and those who visited there from Malaysia; in University of Malaya with cooperative students and professors and in SSB towns with several people the author encountered in January 2017. With the returned sheets, opinions and advices from the kind cooperators, the author made a pre-survey version of Survey Sheet with 26 question and assumed 15 minute response time. The pre-survey

[xliv] Reading social survey textbooks[1–4].

version Sheet, which was almost identical to the main-survey version, was translated into Malay and tested in Kampung Kuantan, SSB, by 25 cooperative respondents in June 2017, and it was confirmed that the questions were easy to answer within 15 minutes. With details and languages checked, the main survey version of Survey Sheet was established. Then, the English version was translated into Chinese (Mandarin), and totally three language versions were prepared: English, Malay and Chinese (**Appendix**).[xlv]

The Survey Sheet consists of the front page, three sections: water perceptions (**Q1-Q4**), river perceptions (**Q5-Q6**), and respondents' geographics and demographics (**Q16-Q25**). For quick and intuitive answering, all questions has choices with checkbox, except **Q6** and **Q26** that ask for descriptions.

The front page was designed to quickly explain the survey's purpose, content, expected binding time and privacy policy, and then confirm the respondent's good will to finish answering the subsequent questions. In the first two perception sections (**Table 3.5-1**), respondents are asked to select the mostly likely only one from the choices to clarify the respondent's priority, contrast potential choice differences, and facilitate statistics; if they select multiple answers, the answer is counted as 'Multiple answers' which indicates the respondent's being having no sharp perceived priority in the mind.

The highest written value of the willingness to pay (WTP) in the choices *i.e*., 'RM 20.00 or above (RM____/month),' was set to compare the answer with average monthly household expenditure for mineral water, soft drinks, fruit and vegetable juice (RM 21.42 in Selangor Total)[5], assuming that respondents' WTP for river water drinkability (RWD), bathability (RWD) and religious acts usability (RWRAU) would be mostly up to the amount actually paid in addition to that for tap water. If the respondent has strong will to pay, they will select the highest value choice and may fill the number. The pre-test in Kampung Kuantan proved that the value setting had no problem.

[xlv] Although Tamil version was ideally desired, and actually sometimes asked by Indian respondents if it was, but finally was not realized, unfortunately.

Table 3.5-1 Questions in the Questionnaire Survey (Water and River Perceptions)

Section	Question	Content	Choice
Water perception	Q1	'Water' in family-spoken language	Air, 水, தண்ணீர், Water, or Other
	Q2	Water Undrinkability Factor	Taste, Odor, Turbidity, Color, Container, Source, Living things, Religious taboo, or Other
	Q3	Water Unbathability Factor	
	Q4	Water Religious Acts Unusablity Factor	
River perception	Q5	'Riverr' in family-spoken language	Sungai, 河, நதி, River, or Other
	Q6	Nearest river's name	Name description or 'I do not know the name.'
	Q7	River water drinkability of the river	Yes, No, or I do not know.
		and willingness to pay for it (RM/month)	0, 0.01-9,99, 10.00-19.99, or 20.00 or above
	Q8	River water bathability of the river	Yes, No, or I do not know.
		and willingness to pay for it (RM/month)	0, 0.01-9,99, 10.00-19.99, or 20.00 or above
	Q9	River water religious acts usability of the river	Yes, No, or I do not know.
		and willingness to pay for it (RM/month)	0, 0.01-9,99, 10.00-19.99, or 20.00 or above
	Q10	Place at which the Q6 river is most benefical	Your place, The upstream, The downstream, The opposite river bank, Kuala Lumpur and its surroundings, Other, or I do not know.
	Q11	The worst trouble about the river	Flood, Drought, Water-borne disease, Pollution, Lack of safety, Other, or I do not know.
	Q12	Floodlessness of ther river	Yes, No, or I do not know.
		and willingness to pay for it (RM/month)	0, 0.01-9,99, 10.00-19.99, or 20.00 or above
	Q13	Droughtlessness of the river	Yes, No, or I do not know.
		and willingness to pay for it (RM/month)	0, 0.01-9,99, 10.00-19.99, or 20.00 or above
	Q14	Water-borne disease freeness of the river	Yes, No, or I do not know.
		and willingness to pay for it (RM/month)	0, 0.01-9,99, 10.00-19.99, or 20.00 or above
	Q15	Place at which the Q6 river is most harmful	Your place, The upstream, The downstream, The opposite river bank, Kuala Lumpur and its surroundings, Other, or I do not know.
	Q16	Most important core in managing the river basin	Economy, Politics, Administration, Development, Law, Nature, Science/Engieering, Religion, Tradtion, Human life, or other

For the geogaphics/demographics section (**Table 3.5-2**) is the final section in order to relax respondents when they are answering questions about water and river perceptions that we want to know most in the QS. Plus, each of the third section's question has a choice of '*I do not want to answer.*' for the same reason, confirming that giving every single piece of personal information is at the respondent's will. Extra question (**Q25'**) about detailed ethnicity or sub-ethnic group was in the last page. This question was in order to check the diversity of respondents and if a certain custom or tradition affects people's water or river perceptions.

Table 3.5-2 Questions in the Questionnaire Survey (Geographics and Demographics)

Section	Question	Content	Choice
Geographics/ demograhpics	Q17	Gender	Male, Female or *I do not want to answer.*
	Q18	Local Authority area and mukim	Local Authority and mukim names, None of abvoe, I do not know., or I do not want to answer.
	Q19	Age	20-24, 25-29, …, 70-74, or 75 or more, or I do not want to answer.
	Q20	Household sewer water treatment	Communal septic tank, Private septic tank, Public sewerage system, Private seweregae system, No treatment, Othor, I do not know, or I do not want to answer.
	Q21	Religion	Islam, Christianity, Buddhism, Hinduism, Confucianism, taoism or traditional Chinese religion, No religion, Other, or I do not want to answer.
	Q22	Household gross income(RM/month)	0-2000, 3000-4999, 5000-6999, 7000-9999, 10000 or more, I do not know, or I do not want to answer.
	Q23	Environmental body membership	Yes, No, I do not know., or I do not want to asnwer.
	Q24	Education	Pre-primary, Primary school, Lower secondary, Upper Secondary, Pre-university, Certificate programms in specific trades and technical skill, Tertiary (certificate/diploma level), Tertiary (degree/advanced diplomat and above), Never attended school, Unknown, *I do not want to answer.*
	Q25	Ethnic Group	Malays, Other Bumiptera, Chinese, Indians, Other ethnic group (Malaysian citizen), Non-Malaysian citizen, I do not know. I do not want to answer.
	Q26	Favorate water/river related proberb and sayings and their meanings	free description (any language will do)
Extra	Q25'-1	Malay sub-ethinc group	Selangor Malay, Other peninsular Malay, Achenese, Banjarese, Batak, Batu Bahra, Boyanese, Bugis, Javanese, Kampar, Kerinchi, Mandailing, Minankabau, Pekan, Rawa, Sundanese, Other, I do not know, or I do not want to answer.
	Q25'-2	Other Bumiputera sub-ethnic group	Negrito, Senoi, Melayu Asli, Sabah, Sarawak, Other, I do not know, or I do not want to asnwer.
	Q25'-3	Chinese sub-ethnic group	Hainanese, Henghua, Hokchia, Hokchiu, Hokkein, Cantonese, Hakka, Kwongsai, Teochew, Other, I do not know., I do not want to answer.
	Q25'-4	Indian sub-ethnci group	India Muslim/Malabari, Malayali, Punjabi, Sikh, Sinhala, Tamil India, Tamil Sri Lanka, Telgu, Other, I do not know., I do not want to answer.

4.2 Sampling

4.2.1 Sampling Sites

Sampling sites were selected to cover SSB from the uppermost to the downstream: towns within SSB and Fraser's Hill (the hill station partly within SSB, Uppermost (UM)), and those in KL and its surroundings for comparison. The within-SSB Sampling Sites within SSB included towns: Kuala Kubu Bharu, Rasa and Batang Kali (Upstream (North), US(N)); Serendah, Rawang and Kuang (Upstream (South), US(S)); and, Bestari Jaya, Kuala Selangor (Downstream, DS). The KL and its surroundings sampling sites included near the railway stations of Batu Caves and Sentul (BC+S). Sampling Sites of UM, US(N), US(S), DS and BC+S are used as analysis units later in Chapter 5. The locations of sampling sites and DOE monitoring stations are mapped in **Figure 4.2.1-1**.

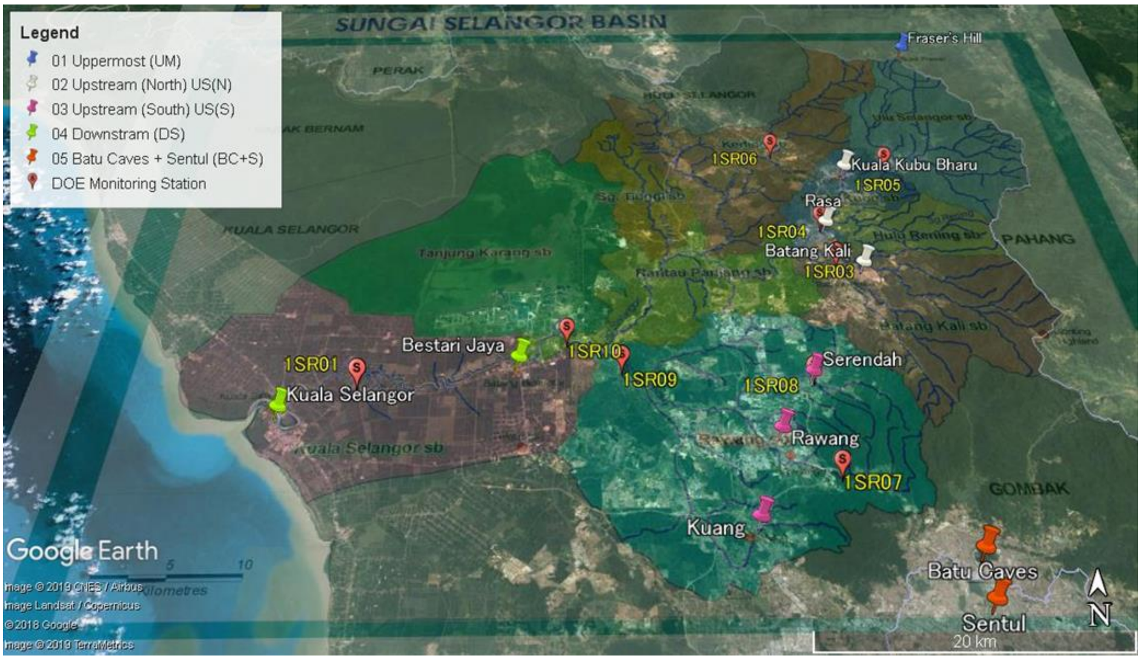


Figure 4.2.1-1 Sampling Sites and DOE Monitoring Stations on a SSB Map[6]

4.2.2 Sample Size

In order to effectively compare people's water and river perceptions based on cultures of religions (or ethnic groups deeply associated with religions), a power analysis[7]in which an effect size (Cramer's V) of a contingency table would be the main indicator of the variables' effect in the table of interest. Considering the main purpose of the QS, an appropriate total sample size for Chi-square independence test was estimated, using 'pwr'[8] the 'R' package. The estimated appropriate total sample sizes of contingency table of **Q21** variables (8 religions including 'Ido not want to answer.') and Q16 (11 choices for the core of river management is 387, assuming Cohen's $\omega = 0.3$, significance level α=0.05 and Power $1\text{-}\beta = 0.8$. If 'No answer' is included in the contingency table, the estimated total sample size is 427 which is the largest among the religion-perception contingency tables in the QS.[xlvi] Consequently, roughly adding potential losses, collecting around 500 answered Survey Sheets was set as a goal: Fraser's Hill (50); Kuala Kubu Bharu (100),and, Rasa and Batang Kali (50); Serendah (50), Rawang (50) and Kuang (50); Bestari Jaya (50) and Kuala Selangor (50); and, Batu Caves and Sentul (50).

4.2.3 Data Analysis

Cramer's V is an effect size of the degree of mutual association/dependence between the row and column categorical variables in a contingency table.[7,9,10] Cramer's V is expressed as follows:

$$V = \sqrt{\frac{\chi^2\ (r-1, c-1)}{\min(r-1, c-1) \times N}} \qquad (0 \leq V \leq 1)$$

where, $\chi^2\ (\mathrm{r}-1, \mathrm{c}-1)$ is a test statistic of Pearson's χ^2 test with a degree of freedom of $(\mathrm{r}-1, \mathrm{c}-1)$; $\min(\mathrm{r}-1, \mathrm{c}-1)$, where r and c are the smaller number of the row or column, respectively; and N the total sample size of the table.

Cramer's V is an effect size insensitive to sample size, unlike p-values of null hypothesis tests. Thus, Cramer's V is more suitable than p-values to compare the degrees of association/dependence between the categorical variables of contingency tables. A smaller/larger value of Cramer's V indicates a weaker /stronger mutual association/dependence between the row and column variables.[7] In other words, Cramer's indicates the degree of disproportion of values in the table.

Let's see examples of Cramer's V and p-values of Pearson's χ^2 test with fictional contingency tables (**Table 4.2.3-1**).[xlvii] Table ① shows a perfectly proportional distribution, where V=0 and p=1. This implies an meaningless categorization. Table ② is a table with the third row modified to spoil the proportionality of ① without changing the total sum, where V=0.14 and p=0.75. Table ③a table with the first row modified to spoil the proportionality of ② without changing the total sum, where V=0.13 and p=082. Table ④ a table whose cells have numbers 10 times larger than ②, where V=0.14 and p=0.0006. Table ⑤ a table with a disproportion, with the same total sum as ④, where V=0.25 and p= <.0001. Table ⑥ with a further disproportion, with the same total sum as ④ and ⑤, where V=1 and p=<.0001. This implies a perfect categorization. As **Table 4.2.3-1** clearly show, Cramer's V is suitable to compare the tables' association with their variables'. Cramer's V is

[xlvi] The largest possible sample size for combination of demographic and perception questions was that for **Q25'-1** (19 choices) and **Q16** (11 items), being 585 (assuming ω=0.3, α=0.5 and 1-β=0.8). However, this extra question was for chasing a specific custom or tradition later if possible. The detailed Township and Mukims of **Q18** were for locating purpose.
[xlvii] Calculation was done using VassarStats: Website for Statistical Computation[11]

insensitive to sample size, while *p*-value very sensitive even with the same proportion of data distribution (see ② and ④). With *p*-value, collecting a larger sample size immediately results in a more 'significant' difference, which is practically meaningless. Furthermore, observed χ^2 may be difficult to be approximated to a theoretical distribution if there are many cells with small numbers (*e.g.*,<5). Besides, practically, a software may not give a precise *p*-value if too small. However, Cramer's V is calculable if there is a contingency table, and thus there is no need to worry about approximation or too small value. Consequently, Cramer's V is employed as the main analysis parameter to check the meaningfulness of inter-variable differences.

Table 4.2.3-1 Fictional Contingency Tables

①

	a	b	c
x	1	2	3
y	2	4	6
z	5	10	15
N=	48	V=	0
χ^2=	0	p=	1

②

	a	b	c
x	1	2	3
y	2	4	6
z	10	10	10
N=	48	V=	0.14
χ^2=	1.9	p=	0.75

③

	a	b	c
x	2	2	2
y	2	4	6
z	10	10	10
N=	48	V=	0.13
χ^2=	1.5	p=	0.82

④

	a	b	c
x	10	20	30
y	20	40	60
z	100	100	100
N=	480	V=	0.14
χ^2=	19	p=	0.0006

⑤

	a	b	c
x	80	40	40
y	40	80	40
z	40	40	80
N=	480	V=	0.25
χ^2=	60	p=	<.0001

⑥

	a	b	c
x	160	0	0
y	0	160	0
z	0	0	160
N=	480	V=	1
χ^2=	960	p=	<.0001

Some people may argue hat 'p-value is the first priority to check for the validity of Cramer's V value.' But this is not be necessarily true. It may be true that a large sample size (to obtain small a p-value) has authenticity of the evidence. However, it is unpractical and meaningless to collect an extremely large sample size to obtain a small p-value, for a trivial, useless difference with a very small effect size. The opposite may also be able to say: 'If you find a large Cramer's V value by a small sample size, then collect a larger sample to check if the Cramer's V value is stable with a larger sample (a smaller p-value).' If the sampling is biased, the Cramer's V value may change with increasing sample size, but even in this case, the decreased *p*-value tells nothing about the practicality or usefulness of the categorical variables in the contingency table. This QS focuses first on practically detectable potential differences of people's water and river perception.

There is no universal standard of classification of what Cramer's V value indicates weak or strong association or dependence. And, there is no existing classification standard for this very research, either. Thus, just for the sake of wording convenience, we now employ the standard in the Esumi Standard (**Table 4.2.3-2**).[10]

Table 4.2.3-2 Cramer's *V* Level Classification by Esumi[10]

Cramer's V	Association	
0.80 ≤ V ≤ 1	Very strong	Associated
0.50 ≤ V <0.80	Somewhat strong	
0.25 ≤ V <0.50	Somewhat weak	
0 ≤ V <0.25	Very weak	Not associated

4.2.4 Sampling Method

Sampling was done in July to August, 2017. In order to compare location and religion samples, it is ideal that each sampling site's each religion sample is of equal size. However, considering the SSB's population (**Chapter 1**), it is practically difficult to collect such samples if sampling is random. Therefore, in order to balance the each religion's sample size, at each sampling site, the investigators visited mainly National and National-tpye Schools whose populations were ethnically characteristic.[xlviii] And, investigators also visited schools, temples, markets, offices, hotels, streets, *etc.*

The essence of the sampling is to obtain answered survey sheets. In other words, the way of answering was not controlled as long as respondents answered a question(s) within the Survey Sheets. Potential respondents were explained about the survey by the front page of the Survey Sheet. If they agreed to answer, they were left with the Survey Sheets, which were collected right there or later.

Basically, languages were chosen by respondents from the three languages: Malay, Chinese and English. Respondents preferred their own language versions of the Survey Sheet,[xlix] but when the desired language version was out of stock, other langue version was used, mostly the Malay version

[xlviii] Malaysia has two types of elementary schools: National Schools where Malay is spoken; and National-type Schools where Chinese (Mandarin) or Tamil is spoken. Children can enter any of them, but the majority is Malays in National Schools and Chinese and Indians in National-type Schools of Chinese and Tamil languages, respectively.

[xlix] Tamil and English versions should be sufficiently prepared if many Indian respondents are expected.

which had been prepared most.[1]

Even if the respondents' answer were affected by surroundings, such as the environment, friends, family and colleagues, their answers were theirs after all; perceptions are more or less affected by surroundings, from which both the affecters and the affected gained no benefit. Statistics would show the overall interactions between respondents and the Sheets, including everything involved there. After the respondents finished answering, the University of Malaya-logoed ball-point pen the respondents used to write answers with was given to the respondents as rewards for cooperation.

Totally 513 Survey Sheets were returned. The recovery rate is unknown, because it was difficult on-site to count the Sheets: some were rejected intact and immediately reused for another prospective respondents. However, the recovery rate seemed to be well higher than a survey by mail and the Internet, because the Survey Sheets were directly hand-delivered to the (representatives of) representatives, and people were unexpectedly very cooperative, and rejection rate seemed very small. Note since 'No answer' was attempted to be counted as an answer for each question, the 513 Survey Sheets finally returned from the respondents were all regarded as completed, assuming that they had been not simply rejected. Data aggregation was done question by question, because the QS's purpose was to compare geographic and demographic categories: not individuals.

4.3 Summary

A Questionnaire Survey (QS) was conducted to understand people's water and river perceptions for the inter-stakeholder communication and policy making in the IRBM of SSB, and to check the hypothesis that people's water and river perceptions vary according to geographic and demographic factors, location and religion in particular. The QS was structured with a Survey Sheet that intended to have respondents intuitively answer about their water and river perceptions intuitively. Cramer' V values of the contingency tables are to be employed for comparing the contingency tables. For the purpose of comparing the water and river perceptions of religion samples, the total sample size goal was decided to end up with being large enough for the purpose, and sampling was done so that sample sizes of ethnic groups, deeply associated with religions, would be balanced in each sampling site. Survey Sheets were distributed to respondents and 513of them returned.

[1] Most Malaysians understand basic Malay. Oral explanation and translation was done when necessary if a Malaysian investigator was there.

References

1. マン P. H. 社会調査を学ぶ人のために. (世界思想社, 1982).
2. 大谷信介, 木下栄二, 後藤範章, 小松洋 & 永野武. 社会調査へのアプローチ; 論理と方法. (ミネルヴァ書房, 2005).
3. 原純輔 & 浅川達人. 社会調査. (財団法人　放送大学教育振興会, 2005).
4. 井上文夫, 井上和子, 小野能文 & 西垣悦代. よりよい社会調査をめざして. (創元社, 2000).
5. Department of Statistics, Malaysia. *Household Expenditure Survey Report 2016*. (Department of Statistics, Malaysia, 2017).
6. LUAS. IRBM Approach in Water Quality Management - Case Study in Sungai Selangor River Basin. (2008).
7. 大久保街亜 & 岡田謙介. 伝えるための心理統計　効果量・信頼区間・検定力. (勁草書房, 2012).
8. Champely, S. *et al. Basic Functions for Power Analysis*. (2018).
9. 柳井晴夫 & 岩坪秀一. 複雑さに挑む科学　多変量解析入門. (講談社, 1976).
10. 菅民郎. すべてがわかる　アンケートデータの分析. (現代数学社, 1998).
11. Lowry, R. Chi-Square, Cramer’s V, and Lambda. *VassarStats: Statistical Computation Web Site* Available at: http://vassarstats.net/newcs.html? (Accessed: 5th July 2019)

5. Results and Discussions

To understand people's water and river perceptions, this Chapter show the results of and discuss the Questionnaire Survey (QS). The Questionnaire Survey (QS) was done to understand people's water and river perceptions and check if they are associated with geographics or demographics. The degrees of associations were measured by the Cramer's V of a contingency table consisting of two set of variables, and other parameters and analyses were employed to support the discussion. **Table 4.3-1**explains symbols and colors used afterward.

Table 4.3-1 Symbols and Colors

Symbol	Meaning	Cell Color				Bar
Freq.	Frequency					
Pct.	Percentage					
z	Adjusted standard residual	$z < -1.96$	$-1.96 \leq z \leq 1.96$		$z > 1.96$	
N	Total sample size		$N \leq N'$		$N > N'$	
N'	Estimated optimun total sample size (α=0.050, 1-β= 0.80)					
df	Degree of freedom					
χ^2	χ^2					
V	Cramer's V	$0 \leq V < 0.25$	$0.25 \leq V < 0.50$	$0.5 \leq V < 0.80$	$0.80 \leq V \leq 1$	
ω	Cohen's ω					
1-β	Power (α=0.050), α: significance level		$1-\beta \leq 0.80$		$1-\beta > 0.80$	
p_P	p-value of Pearson's $\chi 2$ Test (one sided)	$p_P < 0.050$		$p_P \geq 0.050$		
p_F	p-value of Fisher's Exact Test (two sided)	$p_F < 0.050$		$p_F \geq 0.050$		

*Numbers appearing in following **Tables** were rounded off.

Before going to the next Sampling discussion, it is recommended to first read **5.2.1.2.3** , because Religion* (Islam, Christianity, Buddhism and Hinduism) was re-grouped into Religion (Islam and CBH) based on the WUDF discussion.

5.1 Sampling

5.1.1 Religion and Sampling Site

Respondents' religion and Sampling Site are tabulated (**Table 5.1.1-1**).The response rate of the religion question (**Q21**) was 93% (475/513, discounting 'I do not want to answer.' and 'No answer.'). Since the sample sizes of 'Confucianism, Taoism or tradition Chinese religion (Chinese Traditional),' 'No religion,' 'Other' and 'Multiple answers' were very small (3% of the responses) and thus it seemed difficult to find further concrete characteristics about them, they are not to be compared with other major religions (Islam, .Christianity, Buddhism and Hinduism (CBH) , 97%). And since the sample size of 'Islam' was much larger, and Christian, Buddhist and Hinduist samples showed similar Water Undrinkability Factor perceptions (**5.2.1.2.3**), river perceptions were compared based on two Religions: Islam and CBH.

Religion and Sampling Site were 'not associated' with each other in terms of the Esumi Standard (V = 0.18). This means that the sampling, which had intended to do size-balanced religion samples to compare, was successful. Note that the Religion sample sizes do not need to reflect the real SSB

Religion populations for calculating Cramer's V that is sample size-insensitive at least in theory: Cramer's Vcompares variables in an equal basis.[li]

Table 5.1.1-1 Religion and Sampling Site

	UM		US(N)		US(S)		DS		BC+S		**Total**	
	Freq.	Pct.	Freq.	Pct.	Freq.	Pct.	Freq.	Pct.	Freq.	Pct.	Freq.	Pct.
Islam	33	70%	79	63%	64	51%	54	63%	59	46%	**289**	**56%**
Christianity	1	2%	9	7%	15	12%	5	6%	4	3%	**34**	**7%**
Buddhism	3	6%	19	15%	22	17%	7	8%	22	17%	**73**	**14%**
Hinduism	7	15%	7	6%	12	10%	11	13%	29	23%	**66**	**13%**
Chinese Tradirional	0	0%	0	0%	3	2%	2	2%	3	2%	**8**	**2%**
No religion	0	0%	0	0%	2	2%	0	0%	2	2%	**4**	**1%**
Other	0	0%	0	0%	0	0%	0	0%	0	0%	**0**	**0%**
Multiple answers	0	0%	1	1%	0	0%	0	0%	0	0%	**1**	**0%**
I do not want to answer.	0	0%	7	6%	8	6%	3	3%	7	5%	**25**	**5%**
No answer	3	6%	4	3%	0	0%	4	5%	2	2%	**13**	**3%**
Total	**47**	**100%**	**126**	**100%**	**126**	**100%**	**86**	**100%**	**128**	**100%**	**513**	**100%**
Response	**44**	**94%**	**115**	**91%**	**118**	**94%**	**79**	**92%**	**119**	**93%**	**475**	**93%**

Response: Total - ('I do not want to answer.' + 'No answer')

	UM		US(N)		US(S)		DS		BC+S		**Total**	
	Freq.	Pct.	Freq.	Pct.	Freq.	Pct.	Freq.	Pct.	Freq.	Pct.	Freq.	Pct.
Islam	33	75%	79	69%	64	57%	54	70%	59	52%	**289**	**63%**
CBH	11	25%	35	31%	49	43%	23	30%	55	48%	**173**	**37%**
Total	**44**	**100%**	**114**	**100%**	**113**	**100%**	**77**	**100%**	**114**	**100%**	**462**	**100%**

Chinese Traditional: Concianism, Taoism or traditional Chinese religion **V=** **0.18**

CBH: Christianity, Buddhism and Hinduism

5.1.2 Household Gross Income and Sampling Site

Respondents' Household Gross Income (HGI) and Sampling Site are tabulated (**Table 5.1.2-1**).The response rate of the HGI question (**Q22**) was 88% (449/513, discounting 'I do not want to answer.' and 'No answer.'). There was no respondent who checked multiple boxes. For balancing the sample sizes, three groups were created: Modest (0-2,999 RM/month), Middle (3,000-4,999 RM/month) and Rich (5,000 RM/month or more). Note that respondents' occupation is somewhat biased: sampling was done mainly at elementary schools where teachers and school employees were main respondents. In UM (Fraser's Hill), the number of teachers was small. Aini *et al.* (2003) reported that their respondents (teachers in Selangor) were in average USD 440.00/month [1] (No date was reported. about RM/1,800/month on July 9, 2019).

HGI and Sampling Site were 'somewhat weakly associated' with each other in terms of the Esumi Standard (V = 0.25). This seems natural; the Rich sample size at the most rural UM is the smallest and that at the urban area in/near KL is the largest.

[li] This also means that Cramer's V is more sensitive to one minority group member's answer than that of one majority group member.

Table 5.1.2-1 Household Gross Income (RM/month) and Sampling Site

	UM		US(N)		US(S)		DS		BC+S		**Total**	
	Freq.	Pct.	Freq.	Pct.	Freq.	Pct.	Freq.	Pct.	Freq.	Pct.	Freq.	Pct.
0-2,999	23	49%	20	16%	22	17%	26	30%	18	14%	**109**	**21%**
3,000-4,999	10	21%	42	33%	58	46%	18	21%	46	36%	**174**	**34%**
5,000-6,999	1	2%	8	6%	6	5%	6	7%	25	20%	**46**	**9%**
7,000-9,999	1	2%	5	4%	7	6%	5	6%	14	11%	**32**	**6%**
10,000 or more	1	2%	21	17%	16	13%	12	14%	13	10%	**63**	**12%**
I do not know.	2	4%	10	8%	6	5%	5	6%	2	2%	**25**	**5%**
I do not want to answer.	5	11%	16	13%	11	9%	10	12%	8	6%	**50**	**10%**
No answer	4	9%	4	3%	0	0%	4	5%	2	2%	**14**	**3%**
Total	**47**	**100%**	**126**	**100%**	**126**	**100%**	**86**	**100%**	**128**	**100%**	**513**	**100%**
Response	**38**	**81%**	**106**	**84%**	**115**	**91%**	**72**	**84%**	**118**	**92%**	**449**	**88%**

Response: Total - ('I do not want to answer.' + 'No answer')

	UM		US(N)		US(S)		DS		BC+S		**Total**	
	Freq.	Pct.	Freq.	Pct.	Freq.	Pct.	Freq.	Pct.	Freq.	Pct.	Freq.	Pct.
Modest	23	64%	20	21%	22	20%	26	39%	18	16%	**109**	**26%**
Middle	10	28%	42	44%	58	53%	18	27%	46	40%	**174**	**41%**
Rich	3	8%	34	35%	29	27%	23	34%	52	45%	**141**	**33%**
Total	**36**	**100%**	**96**	**100%**	**109**	**100%**	**67**	**100%**	**116**	**100%**	**424**	**100%**

Modest: 0-2,999 (RM/month) **V= 0.25**
Middle: 3,000-4,999 (RM/month)
Rich: 5,000 or more (RM/month)

5.1.3 Sewer Water Treatment and Sampling Site

Respondents' Sewer Water Treatment (SWT) and Sampling Site are tabulated (**Table 5.1.3-1**). The response rate of the SWT question (**Q20**) was 94% (483/513, discounting 'I do not want to answer.' and 'No answer.'). 'I do not know.' was the most frequent (148/513, 29%). Since the sample sizes of 'No treatment' was very small (3% of the responses) and thus it seemed difficult to find further concrete characteristics about them, they are not to be compared with the samples with sewer water treated. For balancing the sample sizes, two groups were created: Septic Tank (Communal septic tank and Private septic tank), and Sewerage System (Public sewerage system and private sewerage system).

SWT and Sampling Site were 'somewhat weakly associated' with each other in terms of the Esumi Standard (V = 0.092). This is somewhat surprising, because the sampling was done so that religion samples' sizes would be balanced, but the sampling ended up collecting more SWT sample size-balanced respondents than Religion (V = 0.18). This is because Religion was associated with SWT (discussed later).

Table 5.1.3-1 Sewer Water Treatment and Sampling Site

	UM		US(N)		US(S)		DS		BC+S		**Total**	
	Freq.	Pct.	Freq.	Pct.	Freq.	Pct.	Freq.	Pct.	Freq.	Pct.	Freq.	Pct.
Communal septic tank	7	15%	37	29%	55	44%	24	28%	16	13%	**139**	**27%**
Private septic tank	2	4%	6	5%	1	1%	6	7%	14	11%	**29**	**6%**
Public sewerage system	14	30%	25	20%	20	16%	17	20%	22	17%	**98**	**19%**
Private sewarage system	7	15%	4	3%	1	1%	2	2%	31	24%	**45**	**9%**
No treatment	3	6%	1	1%	5	4%	1	1%	6	5%	**16**	**3%**
Other	1	2%	0	0%	0	0%	1	1%	0	0%	**2**	**0%**
Multiple answers	0	0%	3	2%	1	1%	1	1%	1	1%	**6**	**1%**
I do not know.	10	21%	42	33%	38	30%	26	30%	32	25%	**148**	**29%**
I do not want to anwer.	0	0%	4	3%	4	3%	4	5%	3	2%	**15**	**3%**
No answer	3	6%	4	3%	1	1%	4	5%	3	2%	**15**	**3%**
Total	**47**	**100%**	**126**	**100%**	**126**	**100%**	**86**	**100%**	**128**	**100%**	**513**	**100%**
Response	**44**	**94%**	**118**	**94%**	**121**	**96%**	**78**	**91%**	**122**	**95%**	**483**	**94%**

Response: Total - ('I do not want to answer.' + 'No answer')

	UM		US(N)		US(S)		DS		BC+S		**Total**	
	Freq.	Pct.	Freq.	Pct.	Freq.	Pct.	Freq.	Pct.	Freq.	Pct.	Freq.	Pct.
Septic Tank	9	30%	43	60%	56	73%	30	61%	30	36%	**168**	**54%**
Sewerage System	21	70%	29	40%	21	27%	19	39%	53	64%	**143**	**46%**
Total	**30**	**100%**	**72**	**100%**	**77**	**100%**	**49**	**100%**	**83**	**100%**	**311**	**100%**

Septic Tank: Communal septic tank + Private septic tank **V= 0.092**

5.1.4 Religion and Household Gross Income

Respondents' religion and Sewer Water Treatment (SWT) are tabulated (**Table 5.1.3-1**). The response rate for answering both of the questions was 86% (438/513). Religion and SWT were 'not associated' with each other (V = 0.23).

Table 5.1.4-1 Religion and Household Gross Income

	Modest	Middle	Rich1	Rich2	Rich3	DK	DW	NA	**Total**	**R**	**RR**
Islam	66	78	27	20	51	15	31	1	**289**	**257**	**89%**
Christianity	9	17	3	2	3	0	0	0	**34**	**34**	**100%**
Buddhism	18	41	4	5	4	0	1	0	**73**	**72**	**99%**
Hinduism	13	34	11	2	4	1	1	0	**66**	**65**	**98%**
Chinese Traditional	2	2	0	0	0	2	2	0	**8**	**6**	**75%**
No religion	0	2	0	0	0	2	0	0	**4**	**4**	**100%**
Other	0	0	0	0	0	0	0	0	**0**	**0**	**–**
Multiple answers	0	0	1	0	0	0	0	0	**1**	**1**	**100%**
I do not want to answer.	1	0	0	3	1	5	15	0	**25**	**10**	**40%**
No answer	0	0	0	0	0	0	0	13	**13**	**0**	**0%**
Total	**109**	**174**	**46**	**32**	**63**	**25**	**50**	**14**	**513**	**449**	**88%**
Response	**108**	**174**	**46**	**29**	**62**	**20**	**35**	**1**	**475**	**439**	**92%**
Response rate	**99%**	**100%**	**100%**	**91%**	**98%**	**80%**	**70%**	**7%**	**93%**	**98%**	

Resonse rate (both questions) = 86%

Rich1: Modest: 0-2,999, Middle: 3,000-4,999, 5,000-6,999, Rich2: 7,000-9,999, Rich3: 10,000 or more (RM/month)
DK: I do not know., DW: I do not want to asnwer., NA: No answer, R: Resonse, RR: Response rate
Response: Total - ('I do not want to anwer.' + 'No answer')

	Modest	Middle	Rich	**Total**
Islam	66	78	98	**242**
CBH	40	92	38	**170**
Total	**106**	**170**	**136**	**412**

5.1.5 Religion and Sewer Water Treatment

Respondents' religion and Sewer Water Treatment (SWT) are tabulated (**Table 5.1.3-1**). The response rate for answering both of the questions was 91% (465/513). Interestingly, 40 % (115/289) of Muslim respondents did not know their houses' SWT, while 9% (15/173) of CBH ones did not: 6% (2/33) of Christian ones, 15% (11/73) of Buddhist ones, 3% (2/64) of Hindu ones. And, 78% (115/148) of the respondents who did not know their houses' SWT were Muslims. CBH respondents may tend to live in places where they have to care about SWT, while Muslim respondents relatively may not. And, Religion and SWT were 'somewhat weakly associated' with each other (V = 0.35), where there is a trend that Muslim respondents were Sewerage System users, while CBH ones Septic Tank users. And, as discussed in Chapter 2, there is an ethnic group-based settlement pattern in SSB. Consequently, it is the Islam-CBH difference of awareness or perception of SWT may be explained by the settling pattern: Muslim (mostly Malay) respondents live mainly in housing developments and *Kampung*s, while CBH ones mainly in old towns, New Villages and plantations; and each place has loose uni-ethnic neighborhoods. Recall that the sampling sites were towns. HGI and SWT were 'not associated' with each other

Table 5.1.5-1 Religion and Sewer Water Treatment

	CST	PST	PuSS	PrSS	NT	Other	MA	DK	DW	NA	**Total**	**R**	**RR**
Islam	43	13	65	29	9	2	6	115	6	1	**289**	**282**	**98%**
Christianity	21	2	5	2	1	0	0	2	0	1	**34**	**33**	**97%**
Buddhism	40	5	14	1	2	0	0	11	0	0	**73**	**73**	**100%**
Hinduism	31	9	9	10	3	0	0	2	2	0	**66**	**64**	**97%**
Chinese Traditional	2	0	4	0	0	0	0	2	0	0	**8**	**8**	**100%**
No religion	1	0	0	0	1	0	0	2	0	0	**4**	**4**	**100%**
Other	0	0	0	0	0	0	0	0	0	0	**0**	**0**	**-**
Multiple answers	0	0	0	0	0	0	0	1	0	0	**1**	**1**	**100%**
I do not want to answer.	1	0	1	3	0	0	0	13	7	0	**25**	**18**	**72%**
No answer	0	0	0	0	0	0	0	0	0	13	**13**	**0**	**0%**
Total	**139**	**29**	**98**	**45**	**16**	**2**	**6**	**148**	**15**	**15**	**513**	**483**	**94%**
Response	**138**	**29**	**97**	**42**	**16**	**2**	**6**	**135**	**8**	**2**	**475**	**465**	**98%**
Reesponse rate	**99%**	**100%**	**99%**	**93%**	**100%**	**100%**	**100%**	**91%**	**53%**	**13%**	**93%**	**96%**	

Resonse rate (both questions) = 91%

CST: Communal septic tank, PST: Private septic tank, PuSS: Public sewerage system, PrSS: Private swerage system
NT: No treatment, MA: Multiple answers, DK: I do not know., DW: I do not want to asnwer., NA: No answer, R: Response, RR: Response rate
Response: Total - ('I do not want to anwer.' + 'No answer')

	ST	SS	**Total**
Islam	56	94	**150**
CBH	108	41	**149**
Total	**164**	**135**	**299**
		V=	0.35

5.1.6 Household Gross Income and Sewer Water Treatment

Respondents' HGI and SWT are tabulated (**Table 5.1.6-1**). The response rate for answering both of the questions was 86% (440/513). HGI and SWT were 'not associated' with each other (V = 0.17). Living place or housing location seems to more associate with SWT rather than HGI; for example, a housing development or a New Village has various grade houses, planed or unplanned (Chapter 2). A newly developed housing development may have a sewerage system, while an old New Village may not.

Table 5.1.6-1 Household Gross Income and Sewer Water Treatment

(RM/month)	CST	PST	PuSS	PrSS	NT	Other	MA	DK	DW	NA	**Total**	**R**	**RR**
0-2,999	34	1	28	6	3	1	2	33	1	0	**109**	**108**	**99%**
3,000-4,999	74	12	28	19	7	1	1	29	3	0	**174**	**171**	**98%**
5,000-6,999	12	7	9	6	3	0	0	8	1	0	**46**	**45**	**98%**
7,000-9,999	5	1	8	5	0	0	1	11	0	1	**32**	**31**	**97%**
10,000 or more	12	3	13	6	2	0	2	23	1	1	**63**	**61**	**97%**
I do not know.	1	2	4	1	1	0	0	15	1	0	**25**	**24**	**96%**
I do not want to answer.	1	3	8	2	0	0	0	28	8	0	**50**	**42**	**84%**
No answer	0	0	0	0	0	0	0	1	0	13	**14**	**1**	7%
Total	**139**	**29**	**98**	**45**	**16**	**2**	**6**	**148**	**15**	**15**	**513**	**483**	**94%**
Response	**138**	**26**	**90**	**43**	**16**	**2**	**6**	**119**	**7**	**2**	**449**	**440**	**98%**
Ressponse rate	**99%**	**90%**	**92%**	**96%**	**100%**	**100%**	**100%**	**80%**	**47%**	**13%**	**88%**	**91%**	

Resonse rate (both questions) = 86%

CST: Communal septic tank, PST: Private septic tank, PuSS: Public sewerage system, PrSS: Private swerage system, R: Response, RR: Respose rate
NT: No treatment, MA: Multiple answers, DK: I do not know., DW: I do not want to asnwer., NA: No answer
Response: Total - ('I do not want to anwer.' + 'No answer')

	ST	SS	**Total**
Modest	35	34	**69**
Middle	86	47	**133**
Rich	40	47	**87**
Total	**161**	**128**	**289**
		V=	**0.17**

5.1.7 Summary

In order to comprehend how much Sampling Site, HGI, Religion and SWT depend on/associate with each other, Cramer's V values after being rounded off were tabulated (**Table 5.1.7-1**) and network charted by the Fruchterman-Reingold algorithm using 'R' Package 'igraph' [2] with the edge widths being proportional to the corresponding Cramer's V values (**Figure 5.1.7-1**). The left-hand side graph of **Figure 5.1.7-1** shows an association network of all the Cramer's V values from **Table 5.1.7-1**, and the right-hand side values equal to or more than 0.25 (pre-rounded off). **Figure 5.1.7-1** indicates what geographics/demographics are essential to pay attention to in implementing the IRBM of SSB: hubs that are relatively strongly connected to various demographics. As a result, Sampling Site-HGI and Religion-SWT pairs are 'associated' ($V \geq 0.25$ before rounded off).

Table 5.1.7-1 Cramer's V of Sampling

	Sampling Site	HGI	Religion	SWT
Sampling Site		0.25	0.18	0.092
HGI			0.23	0.17
Religion				0.35
SWT				

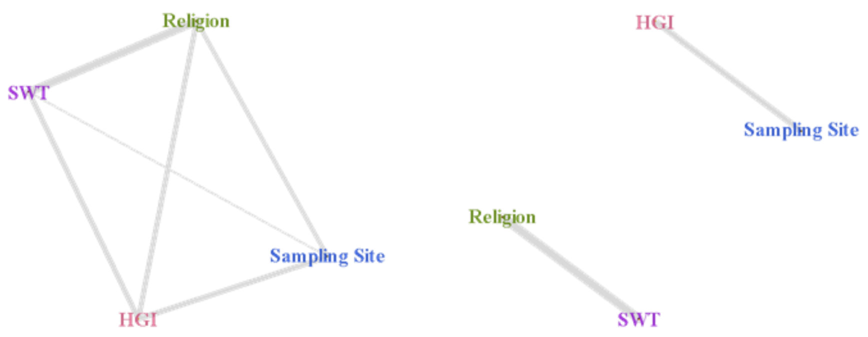


Figure 5.1.7-1 Association Networks

Left: all associations, Right: associations with V≥0.25 only

In summary, the sampling was successful: Religion was not associated with Sampling Site. Religion and SWT were associated with each other. However, HGI was associated with Sampling Site, which may reflect rural and near-KL income levels. Sampling Site and HGI were not associated with Religion or SWT. And, roughly, Muslim respondents were SS users and CBH respondents ST users, which may be due to the ethnic group-based settlement pattern (**Figure 5.1.7-2**).

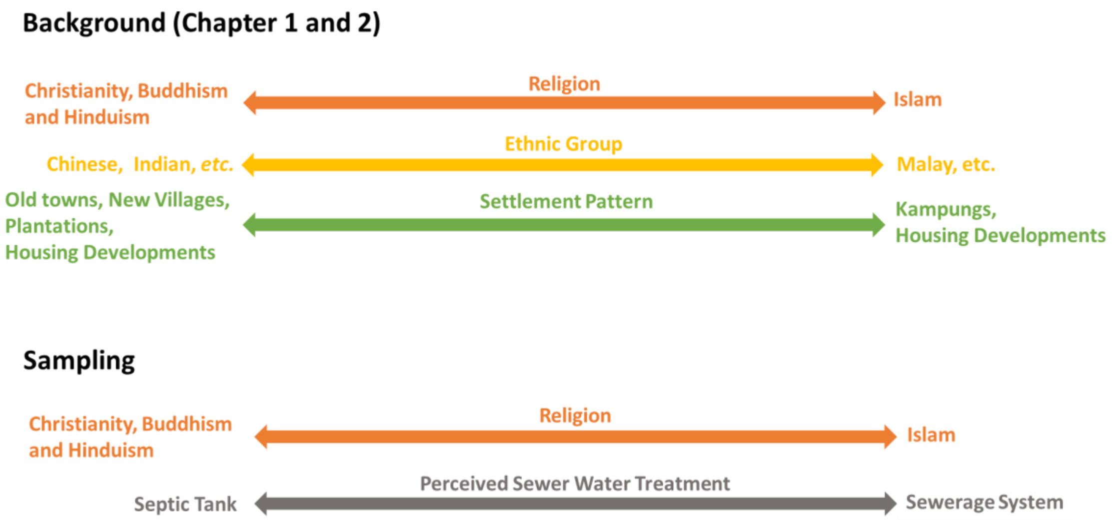


Figure 5.1.7-2 Settlement Pattern and Sewer Water Treatment

5.2 Drinking Water Perceptions

Respondents' nearest river's River Water Drinkability (RWD), their Willingness to Pay (WTP) for the RWD, and their Water Un***ablilty Factors (WUXFs, Water Undrinkability Factor (WUDF), Water

Unbathability Factor (WUBF)), were analyzed based on the geographics and demographics: Sampling Site and the respondents' Household Gross Income (HGI), Religion, and Sewer Water Treatment (SWT). The analyses were separately done on Islam and CBH, respectively, and compared. The Questions used for these purposes were **Q7** and **Q2-Q4**.

Q7. The nearest river water is **<u>directly drinkable</u>**. (Please select **<u>only one</u>**.)

☐Yes ☐No ☐ I do not know.

You are willing to pay extra **RM_____☑_____/month** if the nearest river water stays/becomes **<u>directly drinkable</u>**.

☐0 ☐0.01- 9.99 ☐10.00-19.99 ☐20.00 or above (RM__________/month)

Q2-Q4. You judge water **<u>un***able</u>** most likely by its _____☑_____.

(Please select **<u>only one</u>**.)

☐Taste ☐Odor ☐Turbidity ☐Color ☐Container ☐Source

☐Living things ☐Religious taboo ☐Other______________

The choices of 'Container', 'Living things' and 'Other,' and 'Multiple answers' were combined to 'Other*,'because of their small frequency and conceptual continuity: 'Other' included written answers such as 'All above.' The 'Taste' frequency was relatively small, but it remained uncombined because is an important organoleptic factor.

With tap water 100% penetrated, people in Selangor do not need to river water except Orang Asli (Chapter 3), thus, in almost all cases, it seems to be tap water when asked about drinking, bathing and using for religious acts in the beginning of the Survey Sheet.

A contingency table was created on the Microsoft Excel® spreadsheet, and from which were calculated statistics: χ^2; effect sizes (Cramer's V, Cohen's ω); $1-\beta$ the power of Pearson's χ^2 test at the significance level of $\alpha = 0.050$ with no continuity correction; p-values of Pearson's χ^2 test ($\mathrm{p_P}$) and Fisher's exact test ($\mathrm{p_F}$)[lii]; and N' the estimated optimum sample size for Pearson's χ^2 test significance ($\alpha = 0.050, 1-\beta = 0.80$) . The χ^2 and p-values were calculated by 'R' (ver. 3.4.3 or earlier)[3], the $1-\beta$ and N' by an 'R' Package 'pwr' (ver. 1.2.2 or earlier)[4], and from the χ^2 value were generated the effect sizes V and ω by Excel®. Adjusted standardized residuals (z) of individual cells' frequencies were calculated by 'R' to determine whether the cell frequencies were significantly

[lii] In this dissertation, the p-value of Fisher's exact test (P_F) is checked, because the p-value of Pearson's χ^2 test may be incorrect due to incorrect χ^2approximation. Since the *p*-value and power of Pearson's χ^2 test have such a limitation, they are just for reference and not used for comparison.

larger ($z > 1.96$)/smaller ($z<-1.96$) than expected in the contingency table.

In order to roughly compare the WTP values, Expected Willingness to Pay (EWTP), an estimated minimum WTP of the level of the categorical variable, was calculated as follows (**Equation 5.2-1**):

$$
\begin{aligned}
\mathrm{EWTP}_i \left(\frac{\mathrm{RM}}{\mathrm{month}}\right)
&= \left[0\left(\frac{\mathrm{RM}}{\mathrm{month}}\right)\right] \times \left[\frac{\mathrm{Freq.}_{i,0}}{\mathrm{Freq.}_{\mathrm{i}}}\right] \\
&+ \left[0.01\left(\frac{\mathrm{RM}}{\mathrm{month}}\right)\right] \times \left[\frac{\mathrm{Freq.}_{i,0.01-9.99}}{\mathrm{Freq.}_{i}}\right] \\
&+ \left[10\left(\frac{\mathrm{RM}}{\mathrm{month}}\right)\right] \times \left[\frac{\mathrm{Freq.}_{i,10.00-19.99}}{\mathrm{Freq.}_{i}}\right] \\
&+ \left[20\left(\frac{\mathrm{RM}}{\mathrm{month}}\right)\right] \times \left[\frac{\mathrm{Freq.}_{i,20.00\ \mathrm{or\ above}}}{\mathrm{Freq.}_{i}}\right]
\end{aligned}
$$

Equation 5.2-1

where, EWTP_i, $\mathrm{Freq.}_i$ and $\mathrm{Freq.}_{i,***}$ are the EWTP, total frequency and WTP frequency of the level i of the categorical variable (e.g., UM of Sampling Site), respectively. WTP may often be defined as a potential maximum amount of money for the goal, but it is safe to estimate WTP as minimum for practical IRBM in which overestimation of potential revenue should be avoided. In fact, some respondents chose ‘0-0.01 RM/month’ saying ‘minimum’ out loud.

5.2.1 Total

5.2.1.1 Sampling Site

5.2.1.1.1 River Water Drinkability

The statistics of Sampling Site-RWD relationship are tabulated (**Table 5.2.1.1.1-1**) and charted (**Figure 5.2.1.1.1-1**).

Table 5.2.1.1.1-1 Sampling Site and River Water Drinkability (Total)

	Yes (Drinkable)			No (Undrinkable)			I do not know.			**Total**	
	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.
UM	13	29%	6.8	17	38%	-4.6	15	33%	1.2	**45**	**100%**
US(N)	5	4%	-1.0	80	66%	-0.8	37	30%	1.4	**122**	**100%**
US(S)	4	3%	-1.5	92	74%	1.6	28	23%	-0.9	**124**	**100%**
DS	1	1%	-2.0	64	76%	1.7	19	23%	-0.7	**84**	**100%**
BC+S	7	6%	-0.2	88	71%	0.7	29	23%	-0.7	**124**	**100%**
Total	**30**	**6%**		**341**	**68%**		**128**	**26%**		**499**	**100%**

N	df	χ^2	V	ω	$1-\beta$	p_P	p_F
499	8	55.7	0.24	0.33	0.999977	0.0000000033	0.0000030

N'
138

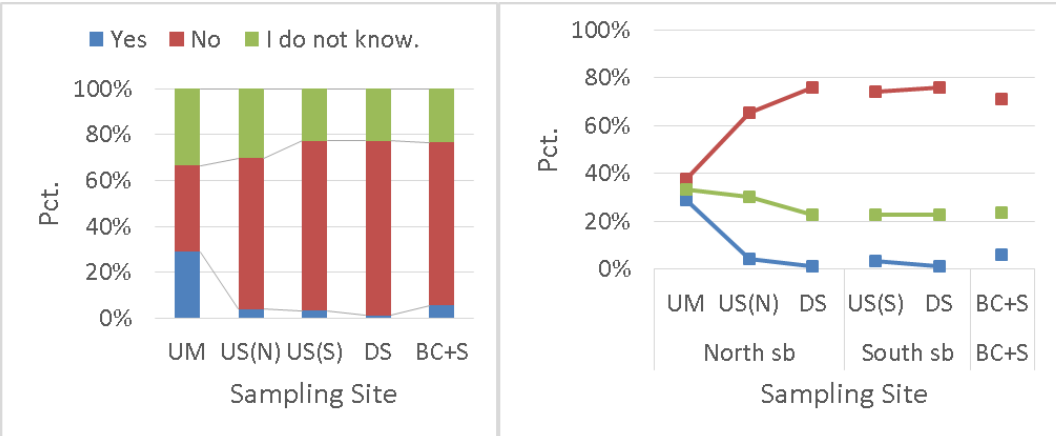


Figure 5.2.1.1.1-1 Sampling Site and River Water Drinkability (Total)

The 'Yes (drinkable),' 'No (undrinkable)' and 'I do not know.(drinkability-uncertain)' percentages (pcts.) were compared among the Sampling Sites flow-wise: in the North sb sub-basin (sb) from UM via US(N) to DS; in the South sb from US(S) to DS; and at BC+S. Few respondents judged their nearest river water drinkable except at UM (29%, 13/45). The 'Yes' pct. monotonically decreases flow-wise: in the North sb from UM (29%) via US(N) (4%) to DS (1%); and in the South sb from US(S) (3%) to DS (1%). At BC+S it is 6% that is the second highest following UM. The 'No' pct. monotonically increases flow-wise: in the North sb from UM (38%) via US(N) (66%) to DS (76%); and in the South sb from US(S) (74%) to DS (76%). At BC+S it is 71% that is the third highest following DS and US(S). The 'I do not know.' pct. monotonically decreases flow-wise in the North sb from UM (33%) via US (N) (30%) to DS (23%). It stays unchanged in the South sb from US(S) (23%) to DS (23%). At BC+S it is 23%, as the same as US(S) and DS. The 'Yes' pct. is always highest at the Sampling Site; the 'I do not know.' the middle; and the 'No' the largest.

Whether an answer frequency (freq.) is significantly higher/lower than expected was determined by

adjusted standardized residual (ASR,z). Viewed from RWD side: the ‘Yes’ z value is significantly higher at UM ($z = 6.8 > 1.96$) while lower at DS ($z = -2.0 < -1.96$); the ‘No’ significantly lower at UM ($z = -4.6$); and the ‘I do not know.’ has no significantly higher or lower z value throughout the Sampling Sites. Viewed from Sampling Site side: UM has a significantly higher ‘Yes’ z value and lower ‘No’; DS a lower ‘Yes’; and US(N) , US(S) and BC+S no significantly higher or lower z value among RWDs.

The Cramer’s V value ($V = 0.24$) indicates a ‘very weak’ or no association between RWD and Sampling Site. The p-value of Fisher’s exact test (p_F) is significantly low ($p_F = 0.0000030 < 0.050$) and the power is sufficiently higher ($1 - \beta = 0.999977 > 0.80$). The sample size is sufficiently large ($N = 499 > N' = 138$).

Most respondents judge their nearest river undrinkable except those at UM, and the RWD declines flow-wise in SSB. The names[liii] of rivers with ‘drinkable’ water were: Sg. Jeriau (10, 33%), ‘I do not know the name.’ (5, 17%), No answer (3, 10%), Sg. Hijau (2, 7%), Sg. Klang (2, 7%), Sg. Perak (2, 7%), Sg. Buloh (1, 3%), Sg. Kinta (1, 3%), Sg. Kuala Kubu Baru (1, 3%),Sg. Muda (1, 3%), Sg. Riverfront (1, 3%), and Sg. Tua Baharu (1, 3%). The first two named rivers (Sg. Jeriau and Sg. Hijau) are in Fraser’s Hill. Fraser’s Hill has unpolluted mountain water, and as the river runs down, the water gets polluted. However, even Fraser’s Hill has odorous roadside ditches that lead water polluted by nearby human activities into rivers, which may have split UM respondents’ RWD judgement. The other named rivers, such as Sg. Klang, a river running across Kuala Lumpur (KL), are thought to be only at the upper streams with ‘drinkable’ water. A minority of BC+S respondents could really have ‘drinkable’ river water. Afroz *et al*. (2105) reported that 3% of their Sg. Gombak respondents used river water as drinking water source.[5]

There are two major possible reasons for not knowing one’s nearest RWD status: (1) he/she actually senses the water unjudgeable to drink; or (2) he/she is geographically or emotionally far from the river. In the case of (1), the river water is sensed fresh – or at least no unpleasant, and only then one can wonder whether it is drinkable. The judgement is strict, because one drinks river water for fun rather than for survival, because he/she normally has safer drinking water such as filtered tap water and bottled water. In this case, the ‘I do not know’ respondents’ RWD judgement are probably based on the same factors as the ‘Yes’ and ‘No.’ respondents. In the case of (2), the ‘I do not know.’ respondents are simply ignorant or unconcerned about their nearest RWD. Unfortunately, it is impossible to numerically separate the two reasons, but UM and US(N) respondents’ answering ‘I do not know.’

[liii] **Q6**. The nearest river from your current house is Sg._______. ☐Sg.______ ☐I do not know the name

may be somewhat higher than the flat pcts. of US(S), DS and BC+S for the reason (1), if the flat 'pcts form a baseline for reason (2).

5.2.1.1.2 Willingness to Pay for River Water Drinkability

The statistics of Sampling Site-WTP for RWD relationship are tabulated (**Table 5.2.1.1.1-1**) and charted (**Figure 5.2.1.1.2-1**).

Table 5.2.1.1.2-1 Willingness to Pay for River Water Drinkability and Sampling Site (Total)

WTP	UM			US(N)			US(S)		
(RM/month)	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.	z
0	18	41%	2.7	25	21%	-1.0	41	33%	2.6
0.01-9.99	13	30%	1.1	28	23%	0.1	24	19%	-1.2
10.00-19.99	12	27%	-0.8	39	33%	0.0	46	37%	1.1
20.00 or above	1	2%	-3.1	28	23%	1.1	14	11%	-2.8
Total	**44**	**100%**		**120**	**100%**		**125**	**100%**	

WTP	DS			BC+S			**Total**	
(RM/month)	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.
0	10	12%	-2.8	26	21%	-0.9	**120**	**24%**
0.01-9.99	17	21%	-0.6	32	26%	0.9	**114**	**23%**
10.00-19.99	32	39%	1.3	32	26%	-1.7	**161**	**33%**
20.00 or above	23	28%	2.0	32	26%	2.0	**98**	**20%**
Total	**82**	**RM3**		**122**	**100%**		**493**	**100%**

N	df	χ^2	V	ω	$1-\beta$	p_P	p_F
493	12	38.2	0.16	0.28	0.9961	0.00014	0.000038

N'
222

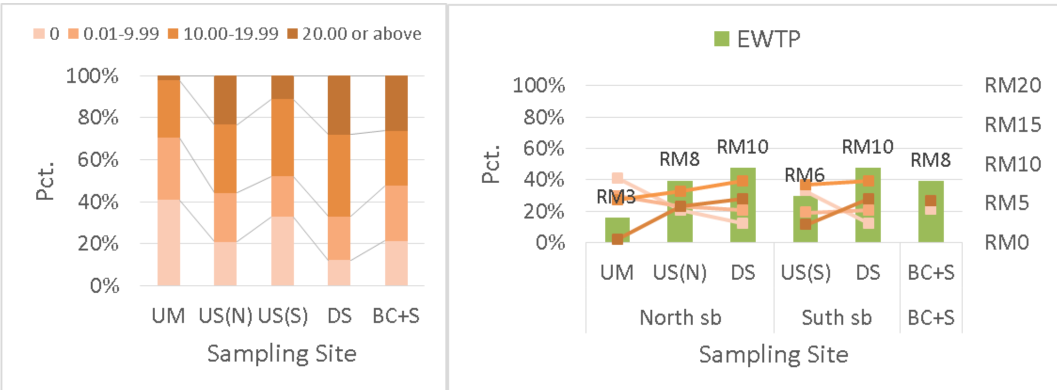


Figure 5.2.1.1.2-1 Willingness to Pay for River Water Drinkability and Sampling Site (Total)

The '0,' '0.01-9.99,' '10.00-19.99' and '20.00 or above' pcts. were compared among the Sampling Sites: in the North sb from UM via US(N) to DS; in the South sb from US(S) to DS; and at BC+S. The '0' pct. monotonically decreases flow-wise: in the North sb from UM (41%) via US(N) (21%) to DS (12%); and from US(S) (33%) to DS (12%). At BC+S it is 21% that is the third highest following

US(S) and the same level as US(N). The ‘0.01-9.99’ pct. monotonically decreases flow-wise in the North sb from UM (30%) via US(N) (23%) to DS (21%); in the South sb it increases from US(S) (19%) to DS (21%); and at BC+S it is 26% that is the second highest following UM. The ‘10.00-19.99’ pct. monotonically increases flow-wise: in the North sb from UM (27%) via US(N) (33%) to DS (39%); and from US(S) (37%) to DS (39%). At BC+S it is 26% that is the lowest. The ‘20.00 or above’ pct. monotonically increases flow-wise: in the North sb from UM (2%) via US(N) (23%) to DS (28%); and from US(S) (23%) to DS (28%). At BC+S it is 26% that is the lowest. The EWTP increases flow-wise: in the North sb from UM (3 RM/month) via US(N) (8 RM/month) to DS (10 RM/month); in the South sb from US(S) (6 RM/month) to DS (10 RM/month). At BC+S it is 8 RM/month.

Whether an answer frequency is significantly higher/lower than expected was determined by ASR (z). Viewed from WTP for RWD side: the ‘0’ z value is significantly higher at UM ($z = 2.8 > 1.96$) and US(S) ($z = 2.6$) while lower at DS ($z = -2.8 < -1.96$); the ‘20.00 or above’ significantly lower at UM ($z = -3.1$) and US(S) ($z = -2.8$) while higher at DS ($z = -2.0$) and BC+S ($z = -2.0$); the ‘0.01-9.99’ and ‘10.00-19.99’ have no significantly higher or lower z value throughout the Sampling Sites. Viewed from Sampling Site side: UM and US(S) have significantly higher ‘0’ z values, while lower ‘20.00 or above’; DS lower ‘0’ while higher ‘20.00 or above’; and BC+S has a higher ‘20.00 or above.’ Consequently, UM and US(S) respondents are less willing to pay for RWD, while DS and BC+S more.

The Cramer’s V level ($V = 0.16$) indicates a ‘very weak’ or no association between RWD and Sampling Site. The p-value of Fisher’s exact test (p_F) is significantly low ($p_F = 0.000038 < 0.050$) and the power is sufficiently high ($1 - \beta = 0.9961 > 0.80$). The sample size is sufficiently large ($N = 493 > N' = 221$).

UM and US(S) respondents are less willing to pay for RWD, while DS and BC+S more. However, it is possible that richer respondents were sampled in Sampling Sites of higher WTP for RWD, so that they are willing to pay more. However, this is not the case. **Figure 5.2.1.1.2-2** shows the pcts. of the Modest, the Middle and the Rich and EWTP on Sampling Sites, indicating that EWTP increases flow-wise, although the respondents’ HGI does not necessarily increase flow-wise in SSB. The UM respondents’ lower EWTP is probably due not only to the lower HGI respondents but also to their having drinkable river water, while DS respondents’ EWTP is the highest despite the Modest pct. is the highest there. At BC+S, the EWTP is smaller than DS, although the BC+S respondents are relatively richer. This may be because BC+S respondents, being in the capital urban area, are less interested in drinking river water than DS respondents. Consequently, the EWTP’s Sampling Site difference seems unlikely to be related to HGI.

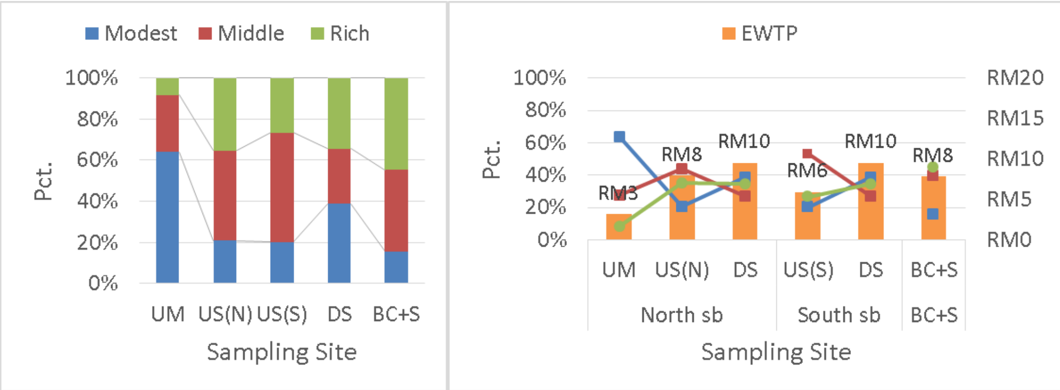


Figure 5.2.1.1.2-2 HGI, Sampling Site and EWTP (Total)

5.2.1.1.3 Water Undrinkability Factor

The statistics of WUDF-Sampling Site relationship are tabulated (**Table 5.2.1.1.3-1**) and charted (**Figure 5.2.1.1.3-1**). As discussed later (**5.2.1.2.3**), only Muslim respondents chose 'Religious taboo' as WUDF, and the clustering pattern was common in the Islam only and CBH only HCAs. A religion-based analysis is needed to avoid the direct effect of Islam sample size collected in the QS that is not intended to reflect the real population's Muslim ratio. Therefore, this Total's WUDF section (**5.2.1.1.3**) is for reference purpose.

Table 5.2.1.1.3-1 Water Undrinkability Factor and Sampling Site (Total)

	Taste			Odor			Turbidity			Color		
	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.	z
UM	3	7%	0.4	8	18%	0.7	3	7%	-3.1	5	11%	-0.6
US(N)	7	6%	0.2	16	13%	-0.6	26	21%	-1.6	21	17%	0.9
US(S)	4	3%	-1.3	22	18%	1.0	42	34%	2.0	17	14%	-0.4
DS	2	2%	-1.3	13	15%	0.2	22	26%	-0.1	9	11%	-1.1
BC+S	11	9%	1.9	15	12%	-1.0	41	33%	1.7	21	17%	0.8
Total	**27**	**5%**		**74**	**15%**		**134**	**27%**		**73**	**15%**	**-0.4**

	Source			Religious taboo			Other*			**Total**	
	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.
UM	12	27%	2.2	4	9%	-0.1	9	20%	1.5	**44**	**100%**
US(N)	18	15%	-0.3	19	16%	2.6	15	12%	-0.3	**122**	**100%**
US(S)	13	10%	-1.9	6	5%	-2.1	21	17%	1.4	**125**	**100%**
DS	16	19%	1.0	11	13%	1.2	11	13%	0.0	**84**	**100%**
BC+S	19	15%	-0.1	8	6%	-1.4	10	8%	-2.0	**125**	**100%**
Total	**78**	**16%**		**48**	**10%**		**66**	**13%**		**500**	**100%**

N	df	χ^2	V	ω	1-β(α =0.05)	p_P	p_F
500	24	43.6	0.15	0.30	0.9935	0.0084	0.0047

N'
250

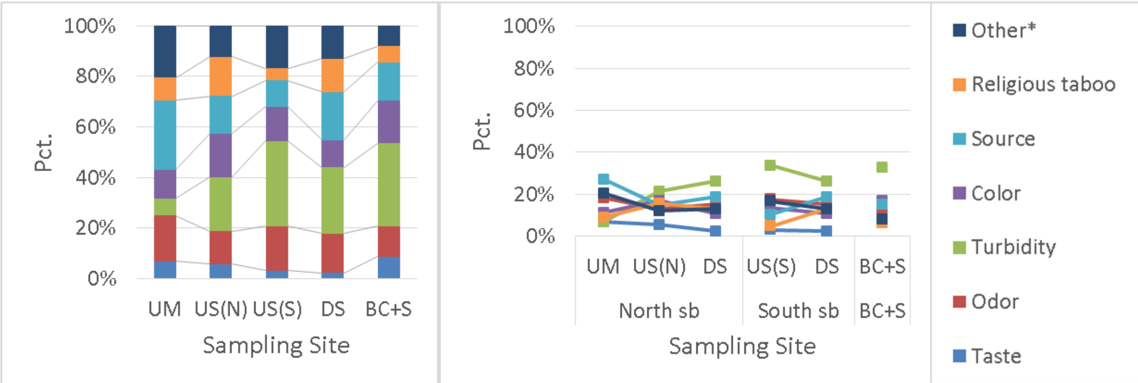


Figure 5.2.1.1.3-1 Water Undrinkability Factor and Sampling Site (Total)

The WUDF pcts. were compared among the Sampling Sites: in the North sb from UM via US(N) to DS; in the South sb from US(S) to DS; and at BC+S. The 'Taste' pct. monotonically decreases flow-wise in SSB: UM (7%) via US(N) (6%) to DS (2%); and from US(S) (3%) to DS (2%). At BC+S it is 9% that is higher than those of the other Sampling Sites. The BC+S respondents may generally drink tap water which may taste bad or rarely river water.[liv] The 'Odor' pct. decreases from UM (18%) to US(N) (13%) and increases at DS (15%). The 'Turbidity' pct. monotonically increases flow-wise in the North sb; from UM (7%) via US(N) (21%) to DS (26%), while decreases in the South sb; US(S) (34%) to DS (26%). The 'Color' pct. in the North sb increases from UM (11%) to US(N) (17%) then decreases to DS (11%); in the South decreases from US(S) (14%) to DS (11%); and at BC+S (17%) it is as the same level as US(N) (17%). The 'Source' pct. in the North sb decreases from UM (27%) to UN (N) (15%) and increased to DS (19%); in the South sb it increases from US(S) (10%) to DS (19%); and at BC+S it is 15% that is as the same level as US(N) (15%). The 'Religious taboo' pct. in the North sb increases from UM (9%) to US(N) (16%) and decreases to DS (13%); in the South sb increases from US (S) (5%) to DS (13%); and at BC+S it is 6% that is the second lowest next to DS (5%). The 'Other*' pct. in the North sb decreases from UM (20%) to US(N) (12%) and increases to DS (13%); in the South sb decreases from US(S) (17%) to DS (13%); and at BC+S it is 8% that is the lowest.

Whether an answer freq.is significantly higher/lower than expected was determined by adjusted standardized residual (ASR,z) (**Table 5.2.1.1.3-1**). Viewed from WUDF side: the 'Turbidity' z value is significantly lower at UM ($z = -3.2 < -1.96$) while lower at DS ($z = -2.0$); the 'Source' higher at UM ($z = 2.2 > 1.96$); the 'Religious taboo' higher at US(N) ($z = 2.6$) while lower at US(S) ($z = -2.1$); and the 'Taste,' 'Odor,' 'Color' and 'Other*' have no significantly higher or lower z value throughout the Sampling Sites. Viewed from Sampling Site side: UM has a significantly lower

[liv] Afroz *et al.* (2105) reported that 3% of their Sg. Gombak respondents used river water as drinking water source.[5]

‘Turbidity’ z value and a higher ‘Source’ z value; US(S) a higher ‘Turbidity’ z value and a higher ‘Religious taboo’ z value; BC+S a lower ‘Other*’ z value; and US(N) and DS no significantly higher or lower z value in RWD; US(S). Consequently, the UM respondents judge water undrinkable less likely by Turbidity while more likely by Source; the US(N) more likely by Religious taboo; the US(S) more likely by Turbidity and less likely by Religious taboo; and the BC+S less likely by Other*.

The Cramer’s V level ($V = 0.15$) indicates a ‘very weak’ or no association between RWD and Sampling Site. The p-value of Fisher’s exact test (p_F) is significantly low ($p_F = 0.0047 < 0.050$) and the power is sufficiently high ($1 - \beta = 0.9935 > 0.80$). The ample size is sufficiently large ($N = 500 > N' = 250$).

Figure 5.2.1.1.3-2 shows the WUDF rate-based Pearson correlations diagram of the Sampling Sites by ‘R’ Package ‘qgraph’ (ver. 1.5)[6] (**left**) and the hierarchical cluster analysis (HCA) dendrogram (Euclidean distance, Ward’s method) by ‘R’ (ver.3.4.3) [3] (**right**). UM is the most characteristic among the five Sampling Sites. The HCA dendrogram (**right**) shows a major clusterings: Mountain Area (MA: UM), Suburban North Area (SNA: US(N) and DS) and Urban South Area (USA: US(S) and BC+S) nearer or within KL. The clusterings were mapped and the WUDF pct. is radar-charted in **Figure 5.2.1.1.3-3**.

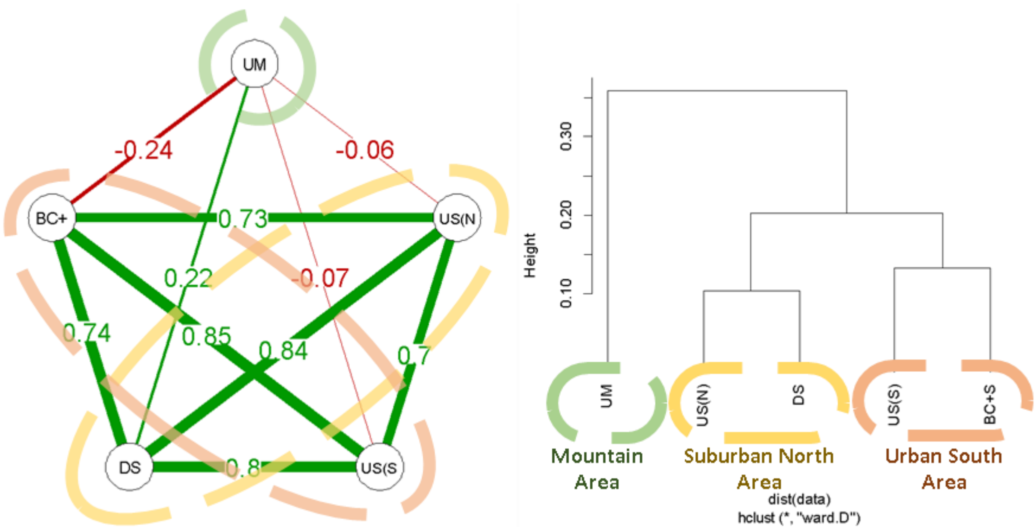
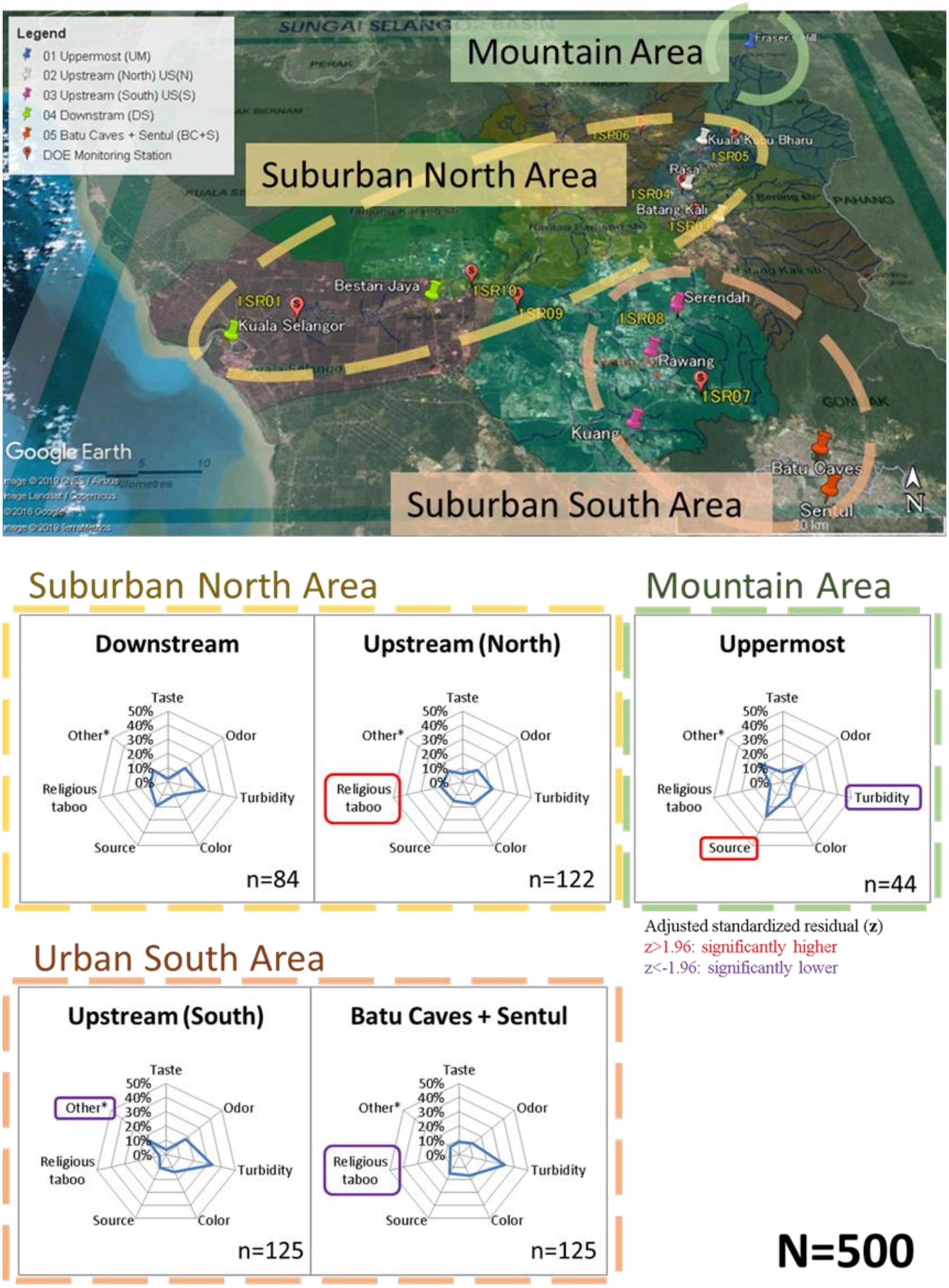


Figure 5.2.1.1.3-2 WUDF-based Correlation Diagram and HCA Dendrogram (Total)

As discussed later (**5.2.1.2.3**), only Muslim respondents chose ‘Religious taboo’ as WUDF, and the clustering pattern was common in the Islam only and CBH only HCAs. A religion-based analysis is needed to avoid the direct effect of Islam sample size collected in the QS that is not intended to reflect the real population’s Muslim ratio. Both in Islam (**5.2.1.3.3**) and CBH (**5.2.3.1.3**), the same clustering pattern appeared, although WUDFs were different particularly in whether choosing ‘Religious taboo.’ Probably, Muslims’ WUDF pattern can be regarded an Islam-considered water perception, while that of CBHs as secular water perception.



Other* = Other + Multiple answers

Figure 5.2.1.1.3-3 Map[7] of Clusterings and Rader Charts of WUDFs (Total)

5.2.1.2 Religion

5.2.1.2.1 River Water Drinkability

The relationship between RWD and Religion was analyzed based on two religion groups: Islam and CBH (Christianity, Buddhism and Hinduism). This grouping is based on their WUDF patterns discussed later in **5.2.1.2.3**) The statistics of RWD-Religion relationship are tabulated (**Table 5.2.1.2.1-1**) and charted (**Figure 5.2.1.2.1-1**).

Table 5.2.1.2.1-1 River Water Drinkability and Religion (Total)

	Yes (Drinkable)			No (Undrinkable)			I do not know.			**Total**	
	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.
Islam	20	7%	0.7	195	68%	-1.5	73	25%	1.2	**288**	**100%**
CBH	9	5%	-0.7	127	74%	1.5	35	20%	-1.2	**171**	**100%**
Total	**29**	**6%**		**322**	**70%**		**108**	**24%**		**459**	**100%**

N	df	χ^2	V	ω	$1-\beta$	p_P	p_F
459	2	2.2	0.070	0.070	0.25	0.33	0.35

N'
1,977

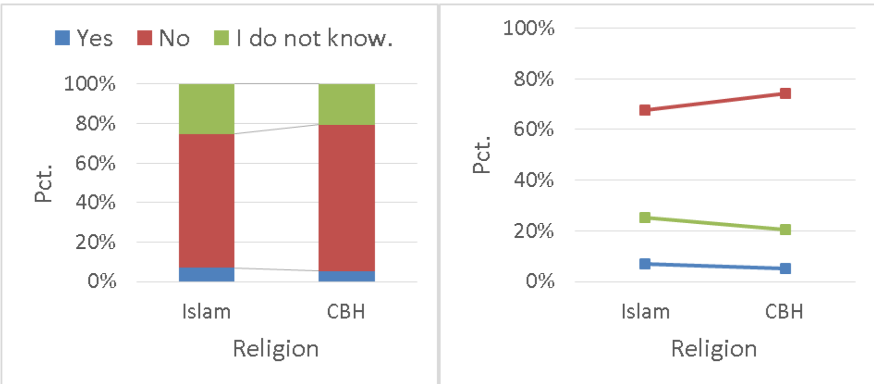


Figure 5.2.1.2.1-1 Religion and River Water Drinkability (Total)

The ‘Yes (Drinkable),’ ‘No (Undrinkable)’ and ‘I do not know.’ pcts. were compared between the Religion groups: the ‘Yes’ is higher in Islam (Islam 7% and CBH 5%); ‘No’ higher in CBH (Islam 68% and CBH 74%); and ‘I do not know.’ higher in Islam (Islam25% and CBH 20%).

Whether an answer frequency (freq.) is significantly higher/lower than expected was determined by adjusted standardized residual (ASR,z). Viewed from RWD side: there is no significant difference between the Religion groups in ‘Yes,’ ‘No’ or ‘I do not know ($-1.96 < z < 1.96$). Viewed from Religion side: there is no significant difference in answering ‘Yes,’ ‘No’ or ‘I do not know.’ either in Islam or CBH. Consequently, Religion does not have any significant difference in RWD.

The Cramer's V level (V = 0.070) indicates a 'very weak' or no association between RWD and Religion. The p-value of Fisher's exact test (p_F) is significantly high ($p_F = 0.35 > 0.050$) and the power is insufficient ($1 - \beta = 0.35 < 0.80$). The sample size is too small to obtain a significantly small p-value (p_P) with a sufficiently large power ($N = 459 < N' = 1{,}977$).

Since Religion is not associated with Sampling Site (V = 0.18) (**5.1.1**), there is little Sampling Site bias in the above results. Therefore, Islam and CBH have a similar RWD perception, regardless of Sampling Site.

5.2.1.2.2 Willingness to Pay for River Water Drinkability

The statistics of WTP for RWD-HGI relationship are tabulated (**Table 5.2.1.2.2-1**) and charted (**Figure 5.2.1.2.1-1**).

Table 5.2.1.2.2-1 WTP for River Water Drinkability and Religion (Total)

	Islam			CBH			**Total**	
RM/month	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.
0	75	27%	2.3	29	17%	-2.3	104	**23%**
0.01-9.99	66	23%	0.4	37	22%	-0.4	103	**23%**
10.00-19.99	85	30%	-1.9	66	39%	1.9	151	**33%**
20.00 or above	57	20%	-0.7	39	23%	0.7	96	**21%**
Total	**283**	**100%**		**171**	**100%**		**454**	**100%**

N	df	χ^2	V	ω	$1-\beta$	p_P	p_F
454	3	7.1	0.12	0.12	0.55	0.069	0.067

N'
758

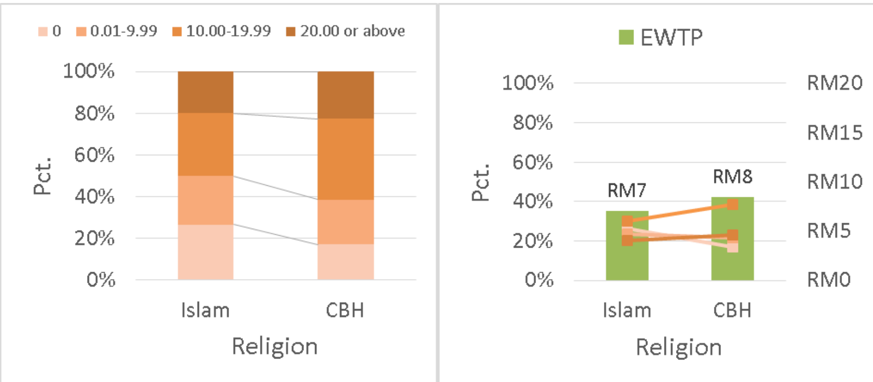


Figure 5.2.1.2.2-1 WTP for River Water Drinkability and Religion (Total)

The '0,' '0.01-9.99,' '10.00-19.99' and '20.00 or above' pcts. were compared between the Religion groups: the '0' pct. is higher in Islam (27%) than CBH(17%); the '0.01-9.99' higher in Islam (23%) than CBH (22%); the '10.00-19.99' higher in CBH (39%) than Islam (30%); and, the '20.00 or above' higher in CBH (23%) than Islam (20%). The EWTP value are higher in CBH (8 RM/month) than Islam (7 RM/month).

Whether an answer frequency (freq.) is significantly higher/lower than expected was determined by adjusted standardized residual (ASR,z). Viewed from WTP for RWD side: the '0' ASR is significantly higher in Islam ($z = 2.3 > 1.96$) while lower in CBH ($z = -2.3 < -1.96$); and, the '0.01-9.99,' the '10.00-19.99,' and the '20.00 or above' have no significantly higher/lower z value. Viewed from Religion side: Muslim respondents have a significantly higher '0'; and CBH ones lower.'

The Cramer's V level ($V = 0.12$) indicates a 'very weak' or no association between WTP for RWD and Religion. The p-value of Fisher's exact test (p_F) is significantly high ($p_F = 0.067 > 0.050$) and the power is insufficient ($1 - \beta = 0.55 < 0.80$). The sample size is too small to obtain a significantly small p-value (p_P) with a sufficient power ($N = 454 < N' = 758$).

Since Religion is not associated with Sampling Site ($V = 0.18$) (**5.1.1**), there is little Sampling Site bias in the above results. Therefore, Islam and CBH have a similar WTP for RWD perception, regardless of Sampling Site.

5.2.1.2.3 Water Undrinkability Factor

This part is essential, because Religion* (Islam, Christianity, Buddhism and Hinduism) was re-grouped into Religion (Islam and CBH) for river perception discussions based on the following discussion. The statistics of WUDF-Religion* relationship are tabulated (**Table 5.2.1.2.3-1**) and charted (**Figure 5.2.1.2.3-1**).

Table 5.2.1.2.3-1 Water Undrinkability Factor and Religion* (Total)

	Taste			Odor			Turbidity			Color		
	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.	z
Islam	10	3%	-1.9	37	13%	-1.8	62	22%	-4.3	27	9%	-4.8
Christianity	1	3%	-0.5	8	24%	1.5	15	45%	2.2	8	24%	1.4
Buddhism	6	8%	1.4	15	21%	1.4	25	34%	1.2	18	25%	2.3
Hinduism	6	9%	1.6	10	15%	0.0	29	44%	3.0	19	29%	3.2
Total	**23**	**5%**		**70**	**15%**		**131**	**29%**		**72**	**16%**	

	Source			Religious taboo			Other*			**Total**	
	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.
Islam	60	21%	4.5	46	16%	5.5	45	16%	4.7	**287**	**100%**
Christianity	1	3%	-2.0	0	0%	-2.0	0	0%	-2.0	**33**	**100%**
Buddhism	6	8%	-1.8	0	0%	-3.1	3	4%	-1.9	**73**	**100%**
Hinduism	2	3%	-2.9	0	0%	-2.9	0	0%	-3.0	**66**	**100%**
Total	**69**	**15%**		**46**	**10%**		**48**	**10%**		**459**	**100%**

N	df	χ^2	V	ω	1-β	p_P	p_F
459	18	110.2	0.28	0.49	1.0	0.0000000000000029	≤0.00000050

N'
84

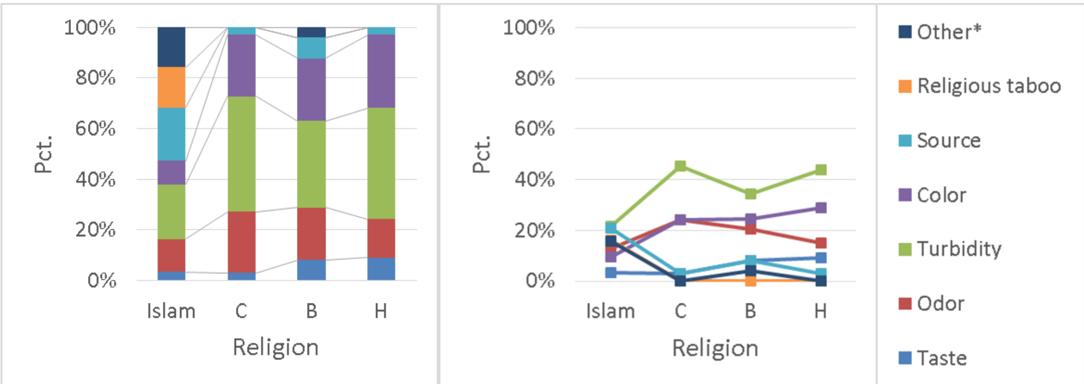


Figure 5.2.1.2.3-1 Water Undrinkability Factory and Religion (Total)

The WUDFs pcts. were compared among the religions: the ‘Taste’ pct. has the highest level in Hinduism (9%) and the second in Buddhism (8%), and the third and lowest in Islam (3%) and Christianity (3%); the ‘Odor’ the highest in Christianity (24%), the second in Buddhism (21%), the third in Hinduism (15%) and the firth and lowest in Islam (13%); the ‘Turbidity’ the highest in Christianity (45%), the second in Hinduism (44%). the third in Buddhism (34%) and the forth and lowest in Islam (22%); the ‘Color’ the highest in Hinduism (29%), the second Buddhism (25%), the third Christianity (24%) and the fourth and lowest in Islam (9%); the ‘Source’ the highest in Islam (21%), the second Buddhism (8%), the third lowest in Christianity (3%) and Hinduism (3%); the ‘Religious taboo’ the highest in Islam (16%) and the second and lowest in Christianity, Buddhism and Hinduism (0%); and, the ‘Other*’ the highest in Islam (16%), the second in Buddhism (4%) and the third and lowest in Christianity and Hinduism (0%). The ‘Turbidity’ and ‘Color’ pcts. are higher in CBH while the ‘Religious taboo,’ ‘Source’ and ‘Other*’ are higher in Islam.

Whether an answer frequency (freq.) is significantly higher/lower than expected was determined by adjusted standardized residual (ASR,z). Viewed from WTP for RWD side: the ‘Taste’ and ‘Odor’ have no significantly higher/lower z value among the four religions; the ‘Turbidity’ z value is significantly lower in Islam ($\mathrm{z} = -4.3 < -1.96$) while higher in Christianity ($\mathrm{z} = 3.0 > 1.96$) and Hinduism ($\mathrm{z} = 2.0$); the ‘Color’ lower in Islam ($\mathrm{z} = -4.8$) while higher in Buddhism ($\mathrm{z} = 2.3$) and Hinduism ($\mathrm{z} = 3.2$); the ‘Source’ higher in Islam ($\mathrm{z} = 4.5$) while lower in Christianity ($\mathrm{z} = -2.0$) and Hinduism ($\mathrm{z} = -2.9$); ‘Religious taboo’ higher in Islam ($\mathrm{z} = 5.5$) while lower in Christianity ($\mathrm{z} = -2.0$), Buddhism ($\mathrm{z} = -3.1$) and Hinduism ($\mathrm{z} = -2.9$); and ‘Other*’ higher in Islam ($\mathrm{z} = 4.7$) while lower in Christianity ($\mathrm{z} = -2.0$) and Hinduism ($\mathrm{z} = -3.0$). It can be said that Muslim respondents are more likely to care about non-organoleptic quality of drinking water than CBH respondents, while CBH ones more about visual quality. Viewed from Religion side: Islam has lower z values in ‘Turbidity’ and ‘Color’ while higher values in ‘Source,’ ‘Religious taboo’ and ‘Other*’; Christianity higher in ‘Turbidity’ while lower in ‘Source,’ ‘Religious taboo’ and ‘Other*’; Buddhism higher in ‘Color’ while lower in ‘Religious taboo’; and, Hinduism higher in ‘Turbidity’ and ‘Color’ while lower in ‘Source,’ ‘Religious taboo’ and ‘Other*. Consequently, it can be said that Muslim respondents are more likely to care about non-organoleptic quality of drinking water than CBH respondents, while CBH more about visual quality.

The Cramer’s V level ($\mathrm{V} = 0.28$) indicates a ‘somewhat weak’ association between WUDF and Religion. The p-value of Fisher’s exact test ($\mathrm{p_F}$) is significantly low ($\mathrm{p_F} \leq 0.00000050 < 0.050$) and the power is insufficient ($1 - \beta = 1.0 > 0.80$). The sample size is sufficient to obtain a significantly small p-value ($\mathrm{p_P}$) with a sufficient power ($\mathrm{N} = 459 > \mathrm{N}' = 84$).

It is interesting that Buddhist nor Hindu respondents did not select ‘Religious taboo’ at all. This is probably because they have no or little religious restriction in drinking water. On the other hand, Muslims have some religious restrictions and criteria for water quality.[7] For example, Mokhtar *et al.* (2015) listed seven pure water sources: rain, sea, river, well, spring, snow and dew, and impurities which may ruin water purity: feces and blood, discharge of sperm and menses, odor, taste, and color.[7] Pig-origin contaminants could be tabooed by Muslims, and sensitive among Malaysian people. Syed Husin Ali (2008) exemplified a cause of inter-ethnic tension: ‘*if a Chinese peasant living upstream rear pigs, and the river is used by Malays far downstream for bathing and taking ablution, then a major and violent clash could easily happen*.’[8] According to “Sungai Selangor Basin Management Plan 2007-2012” (DID Malaysia, 2007), there used to be five ‘zero-discharge’ pig farms in the basin in 2004.[9]

The WUDF rate-based Pearson Correlations of the Religions by ‘R’ Package ‘qgraph’ (ver. 1.5)[6] and the hierarchical cluster analysis (HCA) dendrogram (Euclidean distance, Ward’s method) by ‘R’ (ver.3.4.3)[3] were shown in (**Figure 5.2.1.2.3-2**). The HCA dendrogram (**Figure 5.2.1.2.3-2**, **right**) shows major clusterings of: Islam and CBH (Christianity, Buddhism and Hinduism).

Rader charts of the WUDF of Islam and CBH (**Figure 5.2.1.2.3-3**) show that the most characteristic mainly by the higher ‘Source,’ ‘Religious taboo’ and ‘Other*’ and lower ‘Turbidity’ and ‘Color’ (This can also be checked in **Table 5.2.1.2.3-1**). The possible interpretations are: (1) that Muslim respondents’ drinking water may be less turbid or colored than those of CBH ones’, and/or CBH respondents are more turbidity and color sensitive in drinking water, and/or (2) that Muslim respondents are more ‘Source’ and ‘Religious taboo’ sensitive than CBH ones. The interpretation (2) seems more possible because the Islamic religion has some water use criteria.[7] It can be said that Muslim respondents are more likely to care about non-organoleptic quality of drinking water than CBH respondents, while CBH ones more about visual quality.

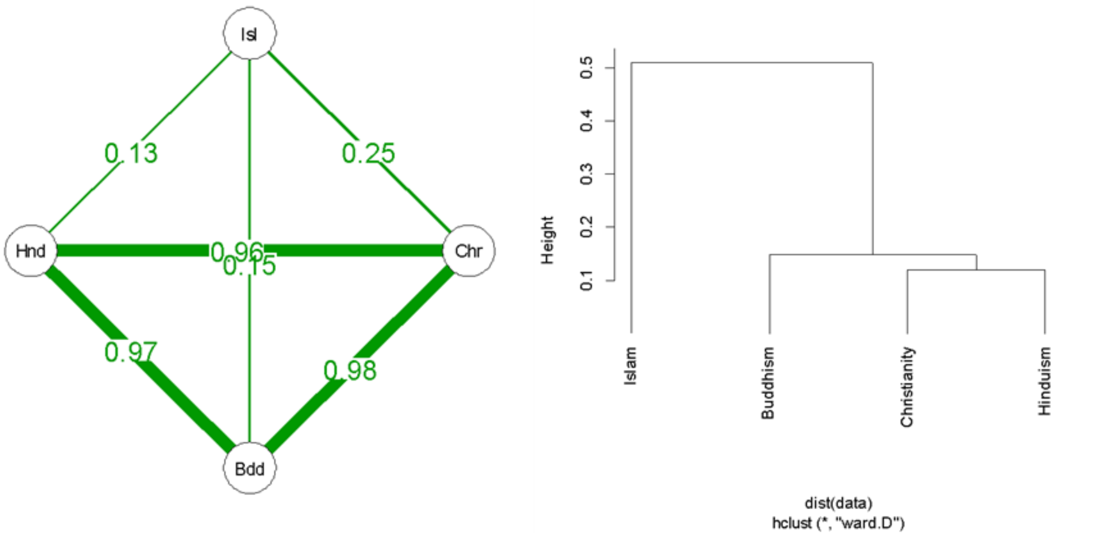


Figure 5.2.1.2.3-2 WUDF-based Correlation Diagram (left) and HCA Dendrogram of Religion (right) (Total)

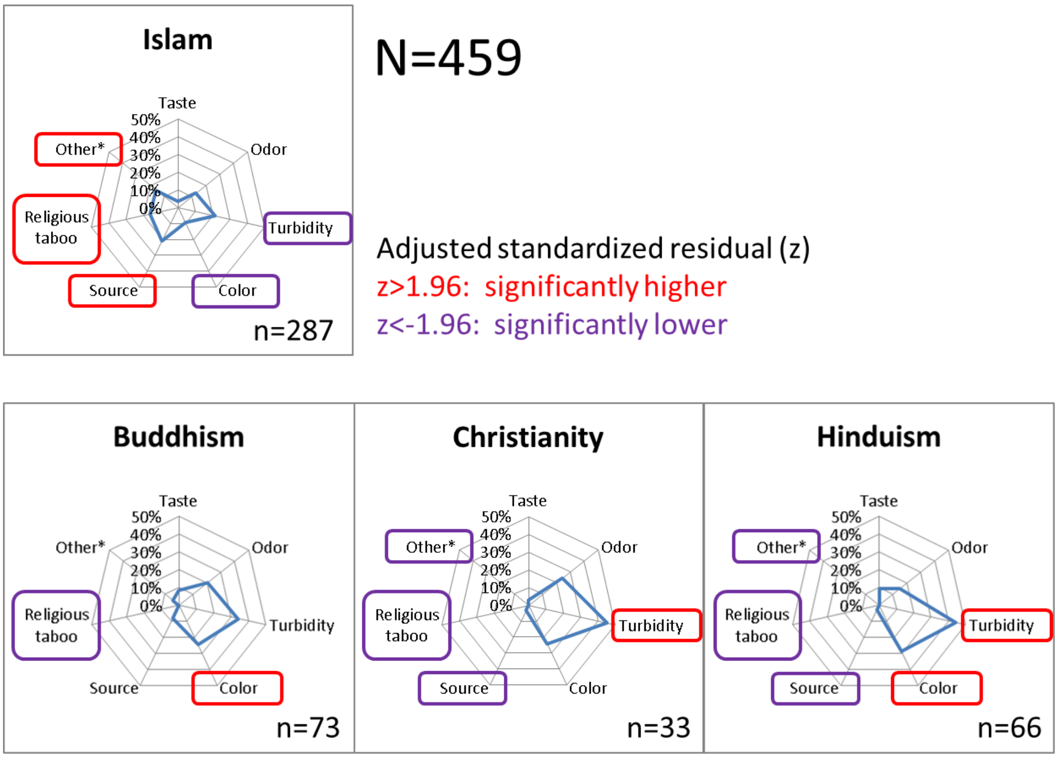


Figure 5.2.1.2.3-3 Rader Charts of WUDF of Islam and CBH

In short, WUDF is associated with Religion* (V = 0.28), and the HCA generated the groups of Islam and CBHs. The WUDFs significantly different between Islam and CBN were religious ('Religious taboo' and 'Source') and visual factors ('Turbidity' and 'Color').

5.2.1.3 Household Gross Income

5.2.1.3.1 River Water Drinkability

The statistics of RWD-HGI relationship are tabulated (**Table 5.2.1.3.1-1**) and charted (**Figure 5.2.1.3.1-1**).

Table 5.2.1.3.1-1 River Water Drinkability and Household Gross Income (Total)

	Yes (Drinkable)			No (Undrinkable)			I do not know.			**Total**	
	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.
Modest	17	16%	4.7	63	58%	-3.0	29	27%	0.5	**109**	**100%**
Middle	6	3%	-1.9	129	75%	2.2	37	22%	-1.3	**172**	**100%**
Rich	3	2%	-2.4	99	71%	0.5	38	27%	0.8	**140**	**100%**
Total	**26**	**6%**		**291**	**69%**		**104**	**25%**		**421**	**100%**

N	df	χ^2	V	ω	$1-\beta$	p_P	p_F
421	4	25.5	0.17	0.25	0.9924	0.000040	0.00017

N'
191

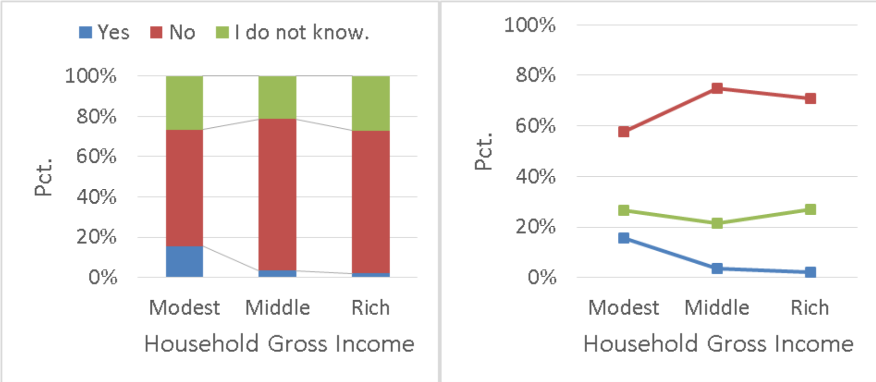


Figure 5.2.1.3.1-1 River Water Drinkability and Household Gross Income (Total)

The 'Yes (Drinkable),' 'No (Undrinkable)' and 'I do not know.' pcts. were compared among the HGI groups: the 'Yes' pct. monotonically decreases as HGI increases (Modest 16%, Middle 3% and Rich 2%); 'No' the lowest in Modest (58%), the highest in Middle (75%) and the second highest in Rich (71%); and 'I do not know.' the highest in Modest and Rich and the lowest in Middle. The Modest respondents are supposed to drink river water more than the Middle and the Rich.

Whether an answer frequency (freq.) is significantly higher/lower than expected was determined by adjusted standardized residual (ASR,z). Viewed from RWD side: the 'Yes' z value is significantly higher in the Modest respondents ($z = 4.7 > 1.96$) while lower in the Rich ($z = -2.4 < -1.96$); 'No' significantly lower in the Modest ($z = -3.9$) and higher in the Middle ($z = 2.2$); and 'I do not know.' no significantly higher/lower z value among the three HGI groups. Viewed from HGI side: the Modest respondents have a significantly higher 'Yes' while lower 'No'; the Middle higher 'No'; and the Rich lower 'Yes.' Consequently, the Richer, the less 'drinkable' judgements. The Middle are more likely to judge their nearest river water undrinkable, while the Modest are less.

The Cramer's V level ($V = 0.17$) indicates a 'very weak' or no association between RWD and HGI. The p-value of Fisher's exact test (p_F) is significantly low ($p_F = 0.00017 < 0.050$) and the power is sufficiently high ($1 - \beta = 0.9924 > 0.80$). The sample size is sufficiently large ($N = 421 > N' = 191$).

Possible interpretations of this results that the richer, the less river water drinkable is that (1) Modest respondents are more likely to be from Sampling Sites where rivers are clean and the rich unclean or (2) Rich respondents do not think of drinking their nearest river water. Both (1) and (2) seem to be true. **Table 5.2.1.3.1-2** shows that among 26 respondents who answered 'Yes (Drinkable)' to the RWD question (**Q7**), 11 are sampled from UM (Fraser's Hill), among whom 9 are Modest. And, no Rich respondents thinks their river water drinkable except BC+S. Two of the Rich respondents named their river: Sg. Klang and Sg. Riverfront. Probably they are from upstream lands.

Table 5.2.1.3.1-2 Number of Respondents with 'Drinkable' River Water (Total)

	UM	US(N)	US(S)	DS	BC+S	**Total**
Modest	9	3	2	1	2	**17**
Middle	2	1	1	0	2	**6**
Rich	0	0	0	0	3	**3**
Total	**11**	**4**	**3**	**1**	**7**	**26**

5.2.1.3.2 Willingness to Pay for River Water Drinkability

The statistics of WTP for RWD-HGI relationship are tabulated (**Table 5.2.1.3.2-1**) and charted (**Figure 5.2.1.3.2-1)**.

Table 5.2.1.3.2-1 WTP for River Water Drinkability and Household Gross Income (Total)

	Modest			Middle			Rich			**Total**	
RM/month	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.
0	31	30%	2.1	41	24%	0.7	20	14%	-2.7	**92**	**22%**
0.01-9.99	31	30%	1.9	29	17%	-2.5	35	25%	0.8	**95**	**23%**
10.00-19.99	32	30%	-1.1	64	37%	0.8	49	35%	0.1	**145**	**35%**
20.00 or above	11	10%	-2.9	39	23%	0.9	35	25%	1.7	**85**	**20%**
Total	**105**	**100%**		**173**	**100%**		**139**	**100%**		**417**	**100%**

N	df	χ^2	V	ω	1- β	p_P	p_F
417	6	19.6	0.15	0.22	0.942	0.0033	0.0021

N'
282

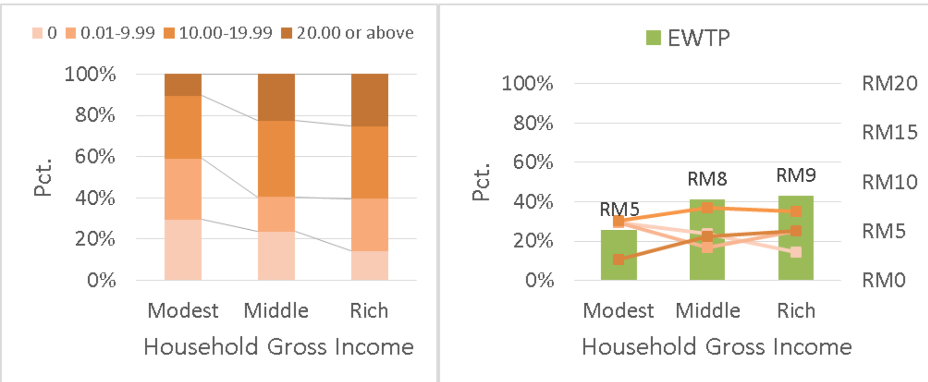


Figure 5.2.1.3.2-1 WTP for River Water Drinkability and Household Gross Income (Total)

The '0,' '0.01-9.99,' '10.00-19.99' and '20.00 or above' pcts. were compared among the HGI groups:

the ‘0’ pct. monotonically decreases as HGI increase, *i.e.*, the Modest (30%), the Middle (24%) and the Rich (14%); the ‘0.01-9.99’ decreases from the Modest (30%) to the Middle (17%) and then increased to the Rich (25%); the ’10.00-19.99’ decreases from the Modest (30%) to the Middle (37%) and then increased to the Rich (35%); the ‘20.00 or above’ monotonically increases from as HGI increases *i.e.* the Modest (10%), the Middle (23%) and the Rich (25%). The WTP for RWD seems to increase as HGI increases. In every HGI group, the most frequent WTP is ‘10.00-19.99.’ The EWTP value increases HGI-wise: from the Modest (5 RM/month) via the Middle (8 RM/month) to the Rich (9 RM/month).

Whether an answer frequency (freq.) is significantly higher/lower than expected was determined by adjusted standardized residual (ASR, z). Viewed from WTP for RWD side: the ‘0’ z value is significantly higher in the Modest respondents ($\mathrm{z} = 2.1 > 1.96$) while lower in the Rich ($\mathrm{z} = -2.7 < -1.96$); the ‘0.01-9.99’ significantly lower in the Middle ($\mathrm{z} = -2.5$) and higher in Middle ($\mathrm{z} = 2.2$); the ’10.00-19.99’ no significantly higher/lower z value among the three HGI groups; and the ‘20.00 or above’ significantly lower in the Modest ($\mathrm{z} = -2.9$). Viewed from HGI side: the Modest respondents have a significantly higher ‘0’ while lower ’20.00 or above’; the Middle lower ‘0.01-9.99’; and the Rich lower ‘0.’ Consequently, the Richer, the more willing to pay for RWD. This is quite reasonable.

The Cramer’s V level ($\mathrm{V} = 0.15$) indicates a ‘very weak’ or no association between WTP for RWD and HGI. The p-value of Fisher’s exact test ($\mathrm{p_F}$) is significantly low ($\mathrm{p_F} = 0.0021 < 0.050$) and the power is sufficiently high ($1 - \beta = 0.942 > 0.80$). The sample size ($\mathrm{N} = 417$) is sufficiently large ($\mathrm{N'} = 282$).

It appears that the richer, the more willing to pay for RWD, although the association between HGI and WTP for RWD is very weak. In addition, within the same HGI group, it appears that Septic Tank (ST) using respondents are more willing to pay for RWD than Sewerage System (SS) using ones (**Figure 5.2.1.3.2-2**). This may be because ST users are more aware of river water quality deterioration (See also **5.2.1.4.2**). However, this tendency mainly contributed by CBH respondents (**5.2.3.2.2**) because Muslim respondents do not have such a simple tendency (**5.2.2.2.2**).

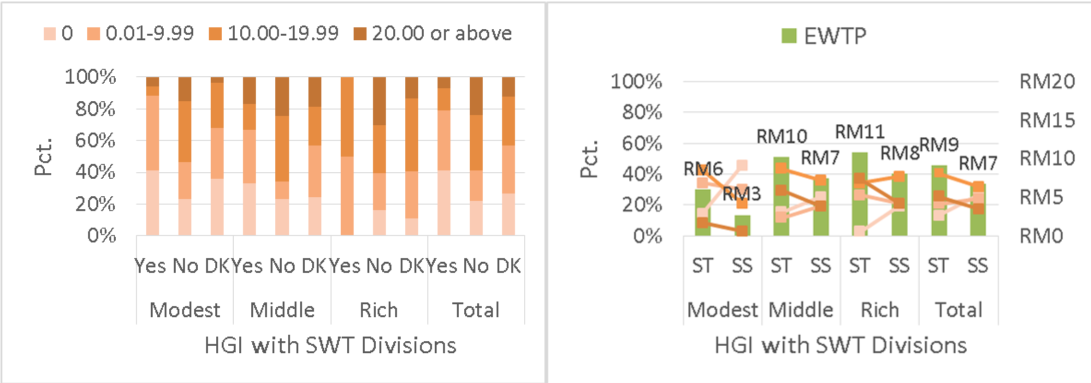


Figure 5.2.1.3.2-2 WTP for RWD and HGI with SWT Divisions (Total)

5.2.1.3.3 Water Undrinkability Factor

Because only Muslim respondents selected ‘Religious taboo,’ the result was affected by the number of Muslim respondents collected that does not necessarily reflect the real population’s Muslim ratio. Therefore, religion-separated analyses was done for Islam and CBH, respectively.

The statistics of WUDF-HGI relationship are tabulated (**Table 5.2.1.3.3-1**) and charted (**Figure 5.2.1.3.3-1**).

Table 5.2.1.3.3-1 Water Undrinkability Factor for River Water Drinkability and HGI (Total)

	Taste			Odor			Turbidity			Color		
	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.	z
Modest	10	9%	1.6	15	14%	-0.6	24	22%	-1.6	11	10%	-1.9
Middle	9	5%	-0.7	28	16%	0.2	62	36%	2.8	36	21%	2.1
Rich	7	5%	-0.7	23	16%	0.3	33	24%	-1.5	21	15%	-0.4
Total	**26**	**6%**		**66**	**16%**		**119**	**28%**		**68**	**16%**	

	Source			Religious taboo			Other*			**Total**	
	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.
Modest	20	19%	1.6	14	13%	1.4	14	13%	1.0	108	**100%**
Middle	15	9%	-2.7	11	6%	-1.9	13	7%	-1.7	174	**100%**
Rich	24	17%	1.3	15	11%	0.6	17	12%	0.8	140	**100%**
Total	**59**	**14%**		**40**	**9%**		**44**	**10%**		**422**	**100%**

N	df	χ^2	V	ω	1-β	p_P	p_F
422	12	25	0.17	0.24	0.934	0.012	0.012

N'
301

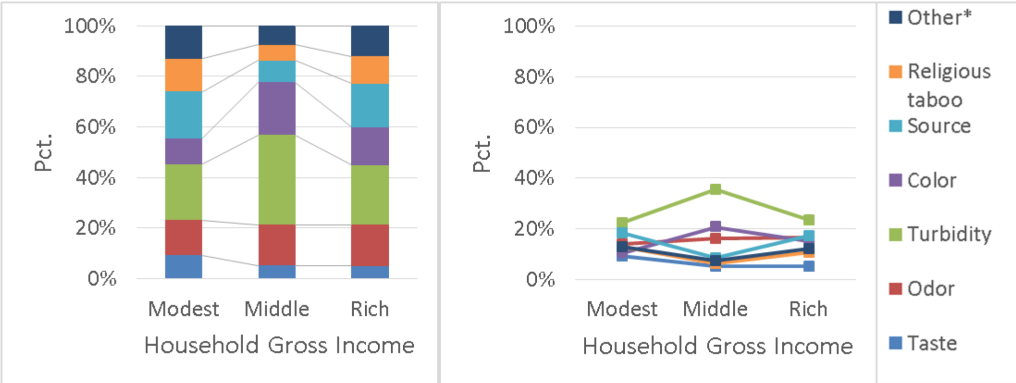


Figure 5.2.1.3.3-1 Water Undrinkability Factor for River Water Drinkability and HGI (Total)

The WUDFs pcts. were compared among the HGI groups: the 'Taste' pct. decreases from the Modest (9%) to the Middle (5%) and stays unchanged to the Rich (5%); the 'Odor' increases from the Modest (14%) to the Middle (16%) and then increased to the Rich (16%); the 'Turbidity' increases from the Modest (22%) to the Middle (36%) and then decreases to the Rich (24%); so does the 'Color' *i.e.* the Modest (10%), the Middle (21%) and the Rich (15%); the 'Source' decreases from the Modest (19%) to the Middle (9%) and then increases to the Rich (17%); so does the 'Religious taboo' *i.e.* the Modest (13%), the Middle (6%) and the Rich (11%); and the 'Other*' *i.e.* the Modest (13%), the Middle (7%) and the Rich (12%).

Whether an answer frequency (freq.) is significantly higher/lower than expected was determined by adjusted standardized residual $(\mathrm{ASR}, \mathrm{z})$. Viewed from WUDF side: the 'Taste' z value has no significantly higher z value; the 'Odor,' either; the 'Turbidity' has a significantly higher z value in the Middle $(\mathrm{z} = 2.8 > 1.96)$; the Color a higher in the Middle, too $(\mathrm{z} = 2.1)$; the 'Source' a lower in the Middle $(\mathrm{z} = -2.7 < -1.96)$; 'Religious taboo' has no significant z value among the HGI groups; and the 'Other*,' either. Viewed from HGI side: the Modest and the Rich have no significantly higher/lower z value among the WUDFs; the Middle has significantly higher z values in 'Turbidity' and 'Color' and a lower in 'Source. ' Consequently, the Middle is different from the Modest and the Rich, with larger 'Turbidity' and 'Color' z values and a smaller 'Source' z value, due to its lower Islam/CBH ratio. The small Islam/CBH ratio of the Middle may have been depend on the sampling method of visiting Chinese and Tamil National-type schools and temples of the site as well as National schools.

The Cramer's V level $(\mathrm{V} = 0.17)$ indicates a 'very weak' or no association between WUDF and HGI. The p-value of Fisher's exact test $(\mathrm{p_F})$ is significantly high $(\mathrm{p_F} = 0.012 < 0.050)$ and the power is insufficient $(1 - \beta = 0.934 > 0.80)$. The sample size $(\mathrm{N} = 422)$ is sufficiently large $(\mathrm{N'} = 301)$.

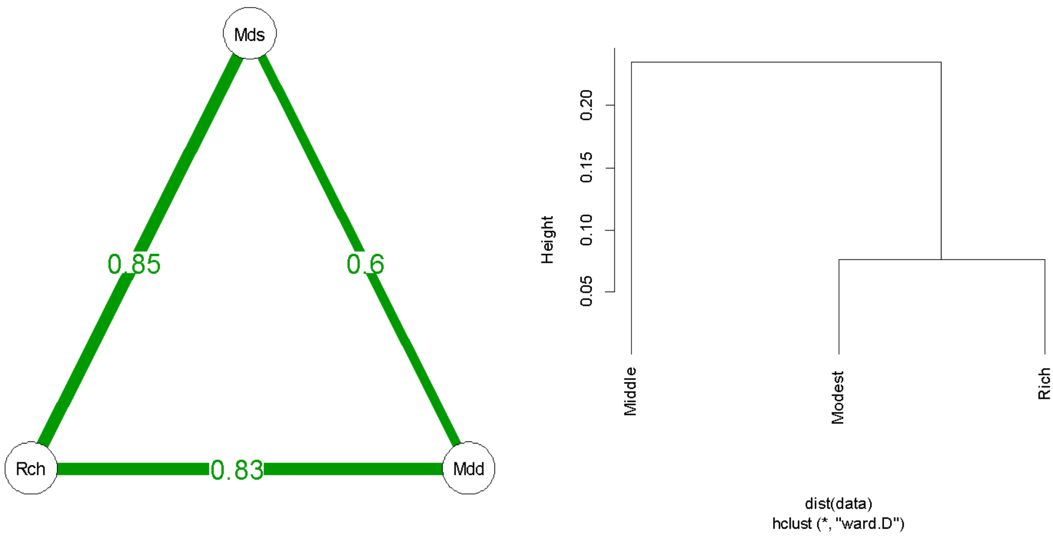


Figure 5.2.1.3.3-2 WUDF-based Correlation Diagram and HCA Dendrogram of HGI (Total)

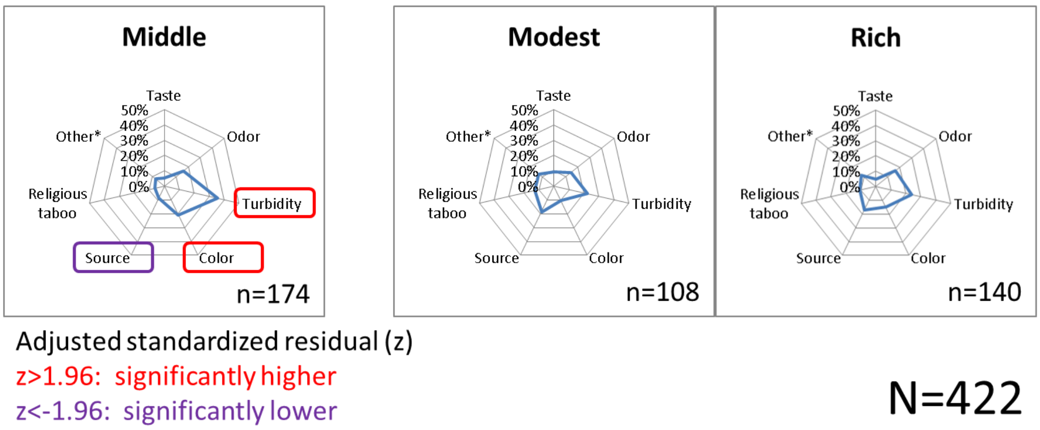


Figure 5.2.1.3.3-3 Water Undrinkability Factor and Household Gross Income (Total)

5.2.1.4 Sewer Water Treatment

5.2.1.4.1 River Water Drinkability

The statistics of RWD-SWT relationship are tabulated (**Table 5.2.1.4.1-1**) and charted (**Figure 5.2.1.4.1-1**).

Table 5.2.1.4.1-1 River Water Drinkability and Sewer Water Treatment (Total)

	Yes (Drinkable)			No (Undrinkable)			I do not know.			**Total**	
	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.
Septic Tank	10	6%	-0.1	124	75%	2.0	32	19%	-2.1	**166**	**100%**
Sewerage System	9	6%	0.1	91	64%	-2.0	42	30%	2.1	**142**	**100%**
Total	**19**	**6%**		**215**	**70%**		**74**	**24%**		**308**	**100%**

N	df	χ^2	V	ω	$1-\beta$	p_P	p_F
308	2	4.6	0.12	0.12	0.45	0.10	0.10

N'
670

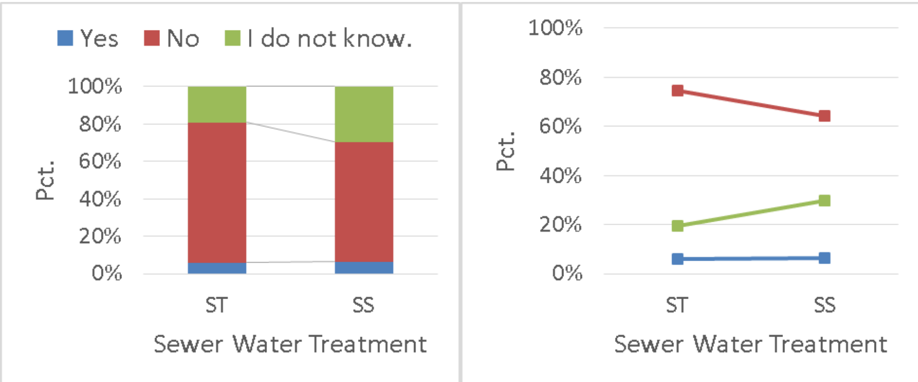


Figure 5.2.1.4.1-1 River Water Drinkability and Sewer Water Treatment (Total)

The ‘Yes (Drinkable),’ ‘No (Undrinkable)’ and ‘I do not know.(Drinkability-uncertain)’ pcts. were compared between the SWT groups: the ‘Yes’ is the same between the SWT groups (6%); ‘No’ higher in ST (ST 75% and SS 64%); and ‘I do not know.’ higher in SS (ST 19% and SS 30%). The SS-using respondents’ nearest river water may be cleaner than that of ST respondents, and/or the SS respondents may be less concerned about RWD than the ST respondents.

Whether an answer frequency (freq.) is significantly higher/lower than expected was determined by adjusted standardized residual (ASR, z). Viewed from RWD side: the ‘Yes’ has no significantly higher/lower z value between ST and SS; the ‘No’ has a significantly higher z value in ST ($z = 2.0 > 1.96$) while lower in SS ($z = -2.0 < -1.96$); the ‘I do not know.’ lower in ST ($z = -2.1$) while higher in SS ($z = 2.1$).Viewed from SWT side: ST has a higher ‘No’ and lower ‘I do not know.’; and SS a lower ‘No’ and higher ‘I do not know.’.

The Cramer’s V level ($V = 0.12$) indicates a ‘very weak’ or no association between RWD and SWT. The p-value of Fisher’s exact test (p_F) is significantly high ($p_F = 0.10 > 0.050$) and the power is insufficient ($1 - \beta = 0.45 < 0.80$). The sample size is too small to obtain a significantly small p-value (p_P) with a sufficiently large power ($N = 308 < N' = 670$).

It appears that ST using respondents are likely to be more interested in RWD than SS using respondents. This may be because ST users live in places which are more sensitive to river water quality deterioration.

5.2.1.4.2 Willingness to Pay for River Water Drinkability

The statistics of WTP for RWD-SWT relationship are tabulated (**Table 5.2.1.4.2-1**) and charted (**Figure 5.2.1.4.2-1**).

Table 5.2.1.4.2-1 WTP for River Water Drinkability and SWT (Total)

	Septic Tank			Sewerage System			**Total**	
RM/month	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.
0	22	21%	-2.0	38	31%	2.0	**60**	**26%**
0.01-9.99	34	24%	0.7	34	21%	-0.7	**68**	**23%**
10.00-19.99	67	34%	1.1	45	28%	-1.1	**112**	**31%**
20.00 or above	42	21%	0.2	25	20%	-0.2	**67**	**20%**
Total	**165**	**100%**		**142**	**100%**		**307**	**100%**

N	df	χ^2	V	ω	$1-\beta$	p_P	p_F
301	3	4.1	0.12	0.12	0.39	0.25	0.26

N'
758

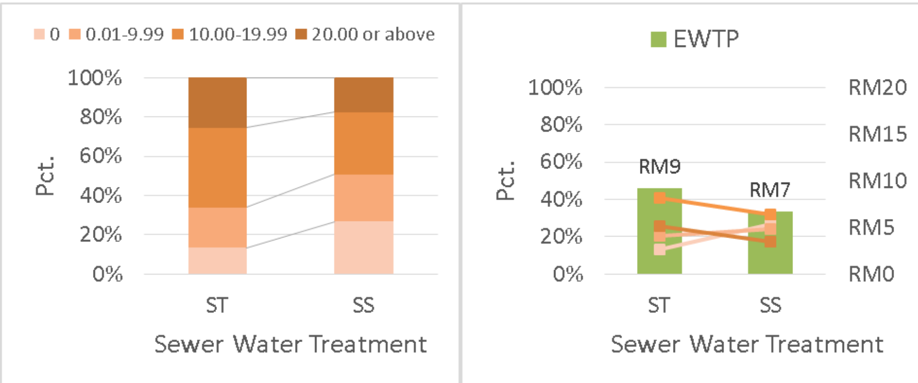


Figure 5.2.1.4.2-1 WTP for River Water Drinkability and SWT (Total)

The ‘0,’ ‘0.01-9.99,’ ‘10.00-19.99’ and ‘20.00 or above’ pcts. were compared between the SWT groups: the ‘0’ pct. is lower in ST (21%) than SS (31%); the ‘0.01-9.99’ higher in ST (24%) than SS (21%); the ’10.00-19.99’ higher in ST (34%) than SS (28%); and, the ‘20.00 or above’ higher in ST (21%) than SS (20%). The EWTP value is higher in ST (9 RM/month) than in SS (7 RM/month). Consequently, it can be said that the ST users have higher WTP for RWD than the SS users.

Whether an answer frequency (freq.) is significantly higher/lower than expected was determined by

adjusted standardized residual (ASR,z). Viewed from WTP for RWD side: the ‘0’ ASR is significantly lower in ST ($z = -2.0 < -1.96$) while higher in SS ($z = 2.0 > 1.96$); and, the ‘0.01-9.99,’ the ’10.00-19.99,’ and the ‘20.00 or above’ have no significantly higher/lower z value. Viewed from SWT side: ST has a significantly lower ‘0’while the SS higher.’ Consequently, the ST respondents are more willing to pay for RWD.

The Cramer’s V level ($V = 0.12$) indicates a ‘very weak’ or no association between WTP for RWD and SWT. The p-value of Fisher’s exact test (p_F) is significantly high ($p_F = 0.26 > 0.050$) and the power is insufficient ($1 - \beta = 0.39 < 0.80$). The sample size is too small to obtain a significantly small p-value (p_P) with a sufficient power ($N = 454 < N' = 758$).

It appears that ST using respondents are more willing to pay for RWD than SS using respondents. This may be because ST users live in places which are more sensitive to river water quality deterioration (See also **5.2.1.3.2**).

By the way, with respect to EWTP, ST using respondents generally appear more willing to pay for RWD than SS using respondents at each Sampling Site, except at DS (**Figure 5.2.1.4.2-2**). This trend is not observed in Muslim respondents (**5.2.2.3.2**), while the trend is clearer in CBH respondents (**5.2.3.3.2**).

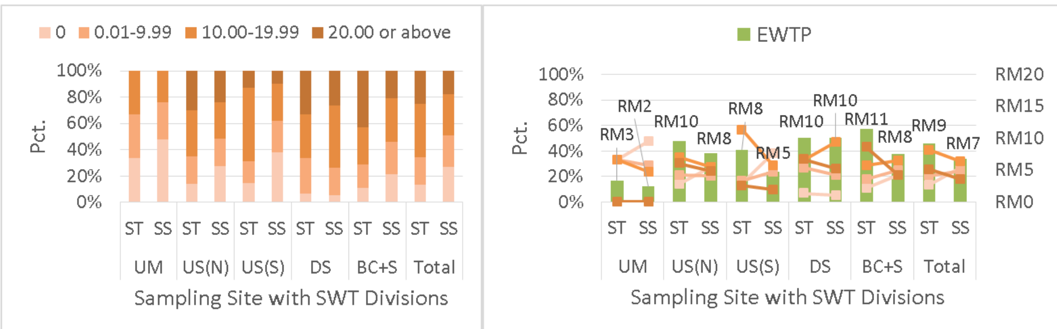


Figure 5.2.1.4.2-2 WTP for RWD (Sampling Site with SWT Divisions) (Total)

5.2.1.4.3 Water Undrinkability Factor

Because only Muslim respondents selected ‘Religious taboo,’ the result was affected by the number of Muslim respondents collected that does not necessarily reflect the real population’s Muslim ratio. Therefore, religion-separated analyses was done for Islam (**5.2.2.1.3**) and CBH (**5.2.3.1.3**), respectively.

The WUDF answers are tabulated (**Table 5.2.1.4.3-1)** and charted (**Figure 5.2.1.4.3-1**).

Table 5.2.1.4.3-1 Water Undrinkability Factor and Sewer Water Treatment (Total)

	Taste			Odor			Turbidity			Color		
	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.	ASR	Freq.	Pct.	z
Septic Tank	8	5%	-1.9	33	20%	1.4	58	35%	1.3	41	25%	3.3
Sewerage System	15	10%	1.9	20	14%	-1.4	40	28%	-1.3	15	10%	-3.3
Total	**23**	**7%**		**53**	**17%**		**98**	**32%**		**56**	**18%**	

	Source			Religious taboo			Other*			**Total**	
	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.
Septic Tank	12	7%	-2.7	5	3%	-2.5	8	5%	-1.7	**165**	**100%**
Sewerage System	25	17%	2.7	14	10%	2.5	14	10%	1.7	**143**	**100%**
Total	**37**	**12%**		**19**	**6%**		**22**	**7%**		**308**	**100%**

N	df	χ^2	V	ω	1-β	p_P	p_F
308	6	29.7	0.31	0.31	0.9931	0.000044	0.000037

N'
142

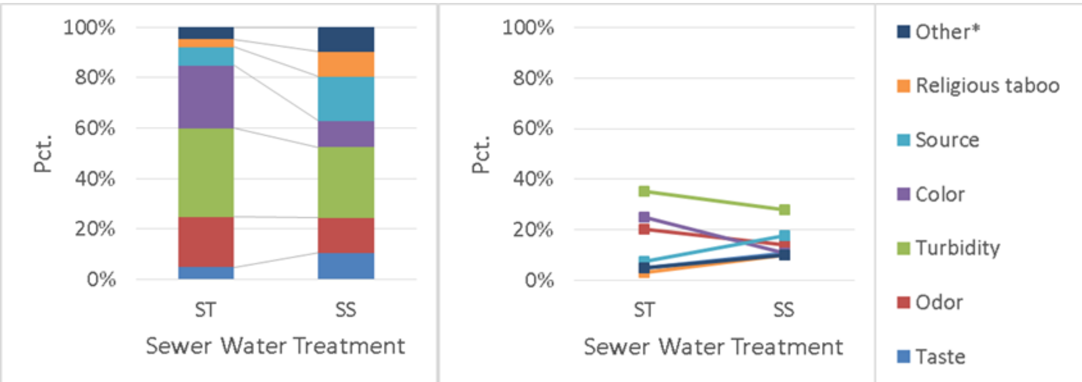


Figure 5.2.1.4.3-1 Water Undrinkability Factor and Sewer Water Treatment (Total)

The WUDFs pcts. were compared between ST and SS: the 'Taste' pct. is higher in SS (10%) than ST (5%); the 'Odor' higher in ST (20%) than SS (14%); the 'Turbidity' higher in ST (35%) than SS (28%); the 'Color' higher in ST (25%) than SS (10%); the 'Source' higher in SS (17%) than ST (7%); the 'Religious taboo' higher in SS (17%) than ST (7%); and, the 'Other*' higher in SS than ST. the second and lowest in Christianity, Buddhism and Hinduism (0%); and, the 'Other*' higher in SS (10%) than ST (5%). The 'Odor,' 'Turbidity,' 'Color' pcts. are higher in ST, while the 'Taste,' 'Source,' and 'Other*' higher in SS.

Whether an answer frequency (freq.) is significantly higher/lower than expected was determined by adjusted standardized residual (ASR,z). Viewed from WUDF side: the 'Taste,' 'Odor,' 'Turbidity' and 'Other*' have no significantly larger/smaller z value; 'Color' higher in ST ($z = 3.0 > 1.96$) while lower in SS ($z = -3.0 < -1.96$); 'Source' higher in SS ($z = -2.7$) while lower in ST ($z = 2.7$); and, 'Religious taboo' higher in SS while lower in ST. Viewed from SWT side: ST has a significantly higher

'Color' while lower 'Source' and 'Religious taboo'; and, SS a lower 'Color' and higher 'Source' and 'Religious taboo.' As discussed above, the religion composition of the ST and SS respondents is thought to affect this results. The significantly lager 'Religious taboo' of SS using respondents are because of Muslims who are majority of the SS using respondents.

The Cramer's V level ($V = 0.31$) indicates a 'somewhat weak' association between WUDF and SWT. It is two points higher than that of Religion ($V = 0.28$), meaning that WUDF depends more on SWT (ST or SS) than on Religion (Islam, Christianity, Buddhism or Hinduism). The p-value of Fisher's exact test (p_F) is significantly high ($p_F = 0.000047 < 0.5$) and the power is insufficient ($1 - \beta = 0.9931 > 0.80$). The sample size ($N = 308$) is sufficiently large to ($N' = 142$).

The WUDF pcts. in ST and SS were radar-charted (**Figure 5.2.1.4.3-2**). 'No treatment' was just for reference due to the small sample size; 'Odor' seems to be the most likely WUDF.

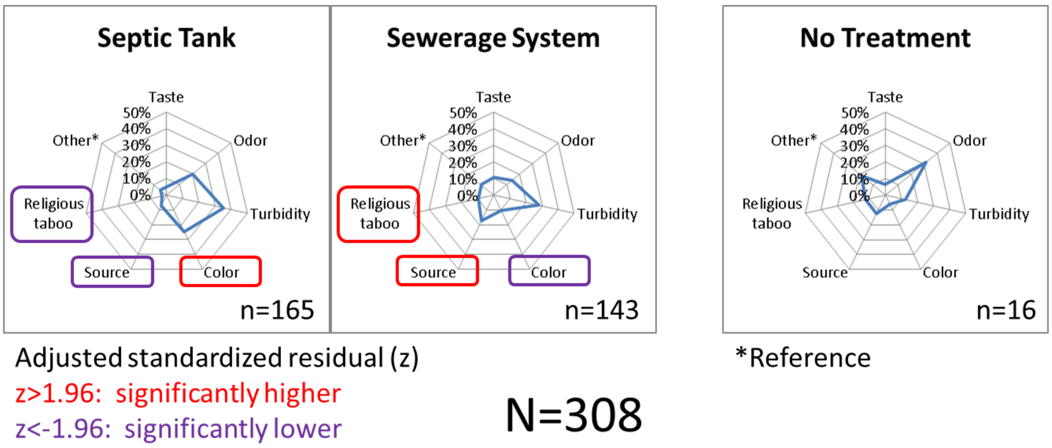


Figure 5.2.1.4.3-2 Water Undrinkability Factor and Sewer Water Treatment (Total)

5.2.2 Islam

5.2.2.1 Sampling Site

5.2.2.1.1 River Water Drinkability

The statistics of RWD-Sampling Site relationship are tabulated (**Table 5.2.2.1.1-1**) and charted (**Figure 5.2.2.1.1-1**).

Table 5.2.2.1.1-1 River Water Drinkability and Sampling Site (Islam)

	Yes (Drinkable)			No (Undrinkable)			I do not know.			**Total**	
	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.
UM	9	27%	4.9	10	30%	-4.9	14	42%	2.4	**33**	**100%**
US(N)	5	6%	-0.3	53	67%	-0.1	21	27%	0.3	**79**	**100%**
US(S)	2	3%	-1.4	53	83%	2.9	9	14%	-2.4	**64**	**100%**
DS	1	2%	-1.6	42	78%	1.8	11	20%	-0.9	**54**	**100%**
BC+S	3	5%	-0.6	37	64%	-0.7	18	31%	1.1	**58**	**100%**
Total	**20**	**7%**		**195**	**68%**		**73**	**25%**		**288**	**100%**

N	df	χ^2	V	ω	$1-\beta$	p_P	p_F
288	8	41.6	0.27	0.38	0.99932	0.0000016	0.000012

N'
105

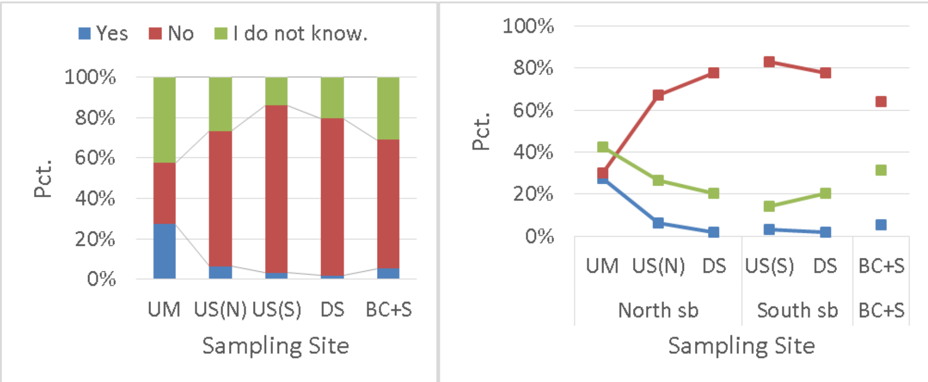


Figure 5.2.2.1.1-1 River Water Drinkability and Sampling Site (Islam)

The ‘Yes (Drinkable),’ ‘No (Undrinkable)’ and ‘I do not know.’ pcts. were compared among the Sampling Sites flow-wise. The ‘Yes’ pct. monotonically decreases flow-wise in SSB: in the North sb from UM (27%) via US(N)(5%) to DS(1%); and, in the South from US(S) (3%) to DS(2%). At BC+S it is 7% that is the second largest next to UM. The ‘No’ pct. monotonically increases in the North sb from UM (10%) via US(N) (67%) to DS (78%), while in the South decreases from US(S) (83%) to DS (78%). The ‘I do not know.’ pct. monotonically decreases in the North sb from UM (42%) via US(N) (27%) to DS (20%), while in the South increases from US(S) (14%) to DS (20%).

Whether an answer frequency (freq.) is significantly higher/lower than expected was determined by adjusted standardized residual (ASR,z). Viewed from RWD side: the ‘Yes’ z value is significantly higher in UM ($z = 4.9 > 1.96$); the ‘No’ significantly lower at UM ($-4.9<-1.96$) while higher at US(S); and, the ‘I do not know.’ higher at UM ($z = 2.4$) while lower at US(S) ($z = -2.4$). Viewed from Sampling Site side: UM has significantly higher z values in ‘Yes’ and ‘I do not know.’ while lower in ‘No’; US(S) lower in ‘Yes’ while higher in ‘No’; and the other Sampling Sites have no significant z value throughout the RWD answers. UM is the best while US(S) the worst among the Sampling Sites in terms of RWD.

The Cramer's V level ($V = 0.27$) indicates a 'somewhat weak' association between RWD and Sampling Site. It is higher than that of Total respondents ($V = 0.24$), meaning that Muslim respondents' RWD is more Sampling Site-dependent than that of Total. The p-value of Fisher's exact test (p_F) is significantly low ($p_F = 0.000012 < 0.050$) and the power is sufficiently high ($1 - \beta = 0.99932 > 0.80$). The sample size ($N = 288$) is sufficiently large ($N' = 105$).

In short, Muslim's RWD decreases flow-wise in SSB.

5.2.2.1.2 Willingness to Pay for River Water Drinkability

The statistics of WTP for RWD-Sampling Site relationship are tabulated (**Table 5.2.2.1.2-1**) and charted (**Figure 5.2.2.1.2-1**).

Table 5.2.2.1.2-1 Willingness to Pay for River Water Drinkability and Sampling Site (Islam)

	UM			US(N)			US(S)		
RM/month	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.	z
0	13	41%	1.9	20	25%	-0.3	22	35%	1.7
0.01-9.99	9	28%	0.7	20	25%	0.5	12	19%	-0.9
10.00-19.99	9	28%	-0.3	22	28%	-0.5	20	32%	0.3
20.00 or above	1	3%	-2.5	17	22%	0.4	9	14%	-1.3
Total	**32**	**100%**		**79**	**100%**		**63**	**100%**	

	DS			BC+S			Total	
RM/month	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.
0	7	13%	-2.4	13	23%	-0.7	**75**	**27%**
0.01-9.99	10	19%	-0.8	15	26%	0.6	**66**	**23%**
10.00-19.99	19	37%	1.1	15	26%	-0.7	**85**	**30%**
20.00 or above	16	31%	2.1	14	25%	0.9	**57**	**20%**
Total	**52**	**100%**		**57**	**100%**		**283**	**100%**

N	df	χ^2	V	ω	$1-\beta$	p_P	p_F
283	12	19.7	0.15	0.26	0.85	0.072	0.049

N'
257

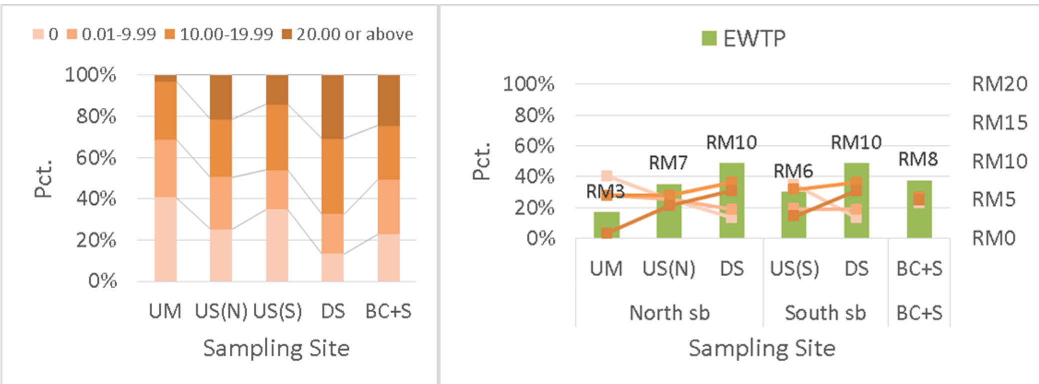


Figure 5.2.2.1.2-1 Willingness to Pay for River Water Drinkability and Sampling Site (Islam)

The ‘0,’ ‘0.01-9.99,’ ‘10.00-19.99’ and ‘20.00 or above’ pcts. were compared among the Sampling Sites. The ‘0’ pct. decreases flow-wise: in the North sb from UM (41%) via US(N) (25%) to DS (13%); and, in the South from US(S) (35%) to DS (13%). At BC+S it is 23% that is the second lowest next to DS. The ‘0.01-9.99’ pct. in the North sb decreases from UM (28%) via US(N) (25%) to DS (19%); and, in the South it stays unchanged from US (S) (19%) to DS (19%). At BC+S it is 26% that is the second highest next to UM. The ‘10.00-19.99’ pct. in the North sb it stays unchanged from UM (28%) to US (N) (28%) and increased to DS (37%); and, in the South it increases from US (S) (32%) to DS (37%). At BC+S it is 26% that is the lowest. The ‘20.00 or above’ pct. monotonically increases flow-wise: from UM (3%) via US(N) (22%) to DS (31%); and, from US(S) (14%) to DS (31%). At BC+S it is 25% that is the second highest next to DS. The EWTP value increases flow-wise: in the North sb from UM (3 RM/month) via US(N) (7 RM/month) to DS (10 RM/month); in the South sb from US(S) (6 RM/month) to DS (10 RM/month); at BC+S it is 8 RM/month the second largest following DS. Consequently, it can be said that downer stream respondents are more willing to pay for RWD.

Whether an answer frequency (freq.) is significantly higher/lower than expected was determined by adjusted standardized residual (ASR, z). Viewed from WTP for RWD side: the ‘0’ z value is significantly lower at DS ($z = -2.4 < -1.96$) while hgher in SS ($z = 2.0 > 1.96$); and, the ‘0.01-9.99,’ and the ‘10.00-19.99,’ have no significantly higher/lower z value; Viewed from Sampling Site side: and, the ‘20.00 or above’ has a lower value at UM ($z = -2.5$) while a higher at DS ($z = 2.1 > 1.96$). Consequently, the DS respondents are more willing to pay for RWD.

The Cramer’s V level ($V = 0.15$) indicates a ‘very weak’ or no association between WTP for RWD and Sampling Site. The p-value of Fisher’s exact test (p_F) is significantly low ($p_F = 0.049 < 0.050$) and the power is insufficient ($1 - \beta = 0.805 > 0.80$). The sample size ($N = 283$) is sufficiently large ($N' = 257$).

The EWTP order where DS is the highest and UM the lowest seems to be related to RWD that is consistent with DOE’s WQI-based drinkability (**5.6.1.2**).

5.2.2.1.3 Water Undrinkability Factor

The statistics of WUDF-Sampling Site relationships are tabulated (**Table 5.2.2.1.3-1**) and charted (**Figure 5.2.2.1.3-1**).

Table 5.2.2.1.3-1 Water Undrinkability Factor and Sampling Site (Islam)

	Taste			Odor			Turbidity			Color		
	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.	z
UM	1	3%	-0.1	5	16%	0.5	2	6%	-2.2	2	6%	-0.6
US(N)	4	5%	0.9	7	9%	-1.3	14	18%	-1.0	9	11%	0.7
US(S)	1	2%	-1.0	10	16%	0.7	18	28%	1.4	8	13%	1.0
DS	1	2%	-0.7	7	13%	0.0	13	24%	0.5	2	4%	-1.6
BC+S	3	5%	0.8	8	14%	0.2	15	26%	0.9	6	10%	0.3
Total	**10**	**3%**		**37**	**13%**		**62**	**22%**		**27**	**9%**	**-0.3**

	Source			Religious taboo			Other*			**Total**	
	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.
UM	11	34%	2.0	4	13%	-0.6	7	22%	1.0	**32**	**100%**
US(N)	17	22%	0.2	18	23%	1.9	10	13%	-0.9	**79**	**100%**
US(S)	9	14%	-1.5	6	9%	-1.6	12	19%	0.8	**64**	**100%**
DS	13	24%	0.6	10	19%	0.6	8	15%	-0.2	**54**	**100%**
BC+S	10	17%	-0.8	8	14%	-0.5	8	14%	-0.4	**58**	**100%**
Total	**60**	**21%**		**46**	**16%**		**45**	**16%**		**287**	**100%**

N	df	χ^2	V	ω	1-β	p_P	p_F
287	24	24.2	0.15	0.29	0.84	0.45	0.39

N'
268

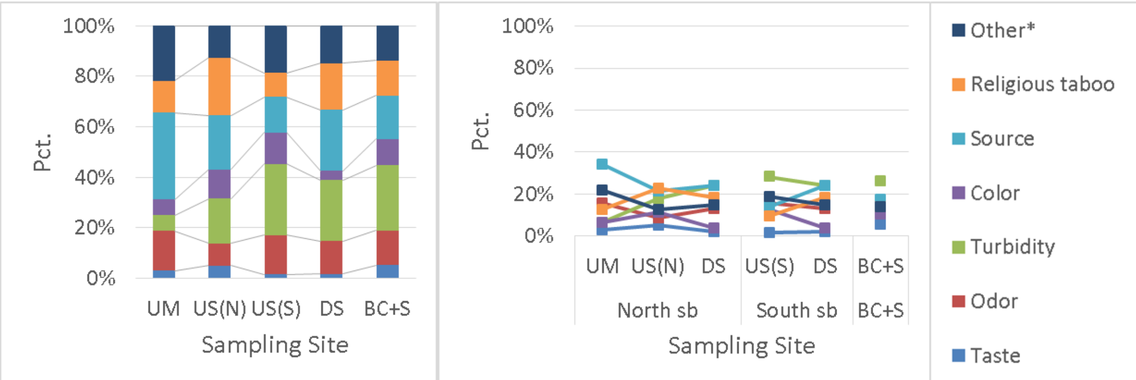


Figure 5.2.2.1.3-1 Water Undrinkability Factor and Sampling Site (Islam)

The WUDF pcts. were compared among the Sampling Sites. In the North sb the ‘Taste’ pct. increases from UM(3%) to US(N) (5%) decreases to DS (2%); in the South stays unchanged from US(S) (2%) to DS (2%). At BC+S it is 5% that is the highest and as the same as US(N). The ‘Odor’ pct. in the North sb increases from UM (16%) to US(N) (9%) decreases to DS (13%); in the South decreases from US(S) (16%) to DS (13%). At BC+S it is 14% the third highest next to UM and US(S). The ‘Turbidity’ pct. in the North sb monotonically increases from UM(6%) via US(N) (18%) to DS (24%); in the South decreases from US(S) (28%) to DS (24%). At BC+S it is 26% that is the second highest next to US(S). The ‘Color’ pct. increases from UM (6%) to US(N) (16%) and decreases to DS (4%); in the South decreases from US(S) (6%) to DS (4%). At BC+S it is 10% that is third highest following US(S) and US(N).The ‘Source’ pct. decreases from UM (34%) to US(N) (22%) and increased to DS (24%); in the South increases from US(S) (14%) to DS (24%). At BC+S it is 17% that is second lowest next to US (S). The 'Religious taboo' pct. increases from UM (13%) to US(N) (23%) and decreases to DS (24%); in the South increases from US(S) (19%) to DS (24%). At BC+S it is 14% that is the middle of the five Sampling Site. The 'Other*' pct. decreases from UM (22%) to US(N) (13%) and increases to DS (15%); in the South decreases from US(S) (19%) to DS (15%). At BC+S it is 14% that is the second lowest next to US (N).

Whether an answer frequency (freq.) is significantly higher/lower than expected was determined by adjusted standardized residual (ASR, z). Viewed from RWD side: the 'Turbidity' z value is significantly lower at UM ($z = -2.2 < -1.96$); and the 'Source' lower at UM ($z = 2.0 > 1.96$); and the rest of the WUDFs have no significantly higher/lower z value throughout the Sampling Sites. Viewed from Sampling Site side: UM has a significantly lower 'Turbidity' z value and higher 'Source'; the rest of the Sampling Site have no significantly higher/lower z value throughout the Sampling Sites. The (UM) respondents seem to have multiple drinking water source options such as filtered tap water, unpolluted mountain water and bottled water which are unlikely to be turbid.

The Cramer's V level ($V = 0.15$) indicates a 'very weak' or no association between RWD and Sampling Site. The p-value of Fisher's exact test (p_F) is significantly high ($p_F = 0.39 > 0.050$) and the power is sufficiently high ($1 - \beta = 0.804 > 0.80$). The sample size ($N = 287$) is sufficiently large ($N' = 268$). Consequently, it is can be statistically said that Muslim respondents' WUDF has overall no significant Sampling Site difference.

The WUDF rate-based Pearson Correlations of the Sampling Sites by 'R' Package 'qgraph' (ver. 1.5)[6] and the hierarchical cluster analysis (HCA) dendrogram (Euclidean distance, Ward's method) by 'R' (ver.3.4.3)[3] were shown in **Figure 5.2.2.1.3-2**. **Figure 5.2.2.1.3-2 (left)** shows that UM is the most characteristic among the five Sampling Sites. The HCA dendrogram (**Figure 5.2.2.1.3-2**, **right**), as well as the Total respondents, shows a major clustering of: Mountain Area (UM), Suburban North Area (SNA: US(N) and DS) and Urban South Area (USA: US(S) and BC+S) nearer or within KL. The WUDF pct. is radar-charted for each Sampling Site and grouped. (**Figure 5.2.2.1.3-3**). The NSA and the USA are different in higher 'Religious taboo' and 'Source,' in NSA, which can also be checked by commonly positive/negative z values in **Table 5.2.2.1.3-1**, probably due to higher 'Turbidity' in USA. The Mountain Area is most characteristic, and its characteristics were 'Turbidity' and higher 'Source.'

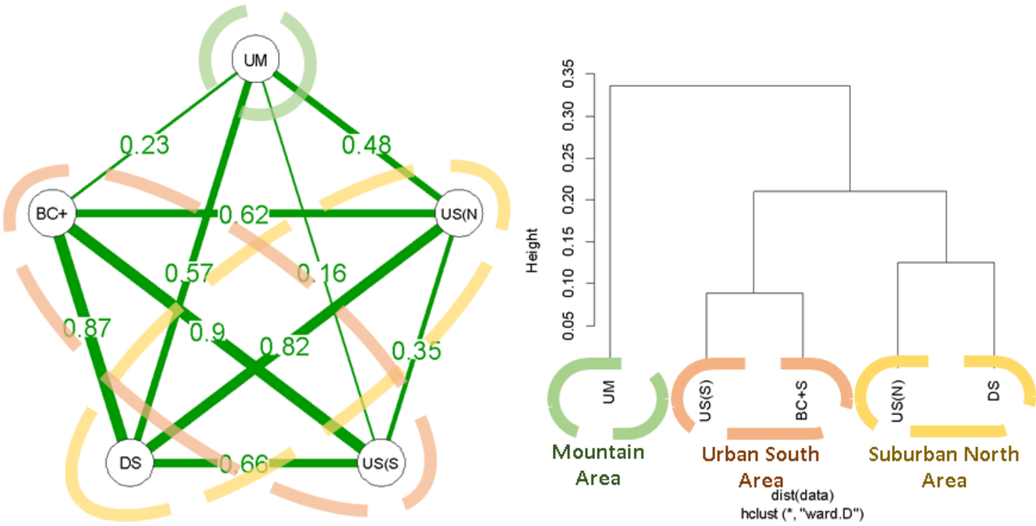


Figure 5.2.2.1.3-2 WUDF-based Correlation Diagram and HCA Dendrogram of Sampling Site (Islam)

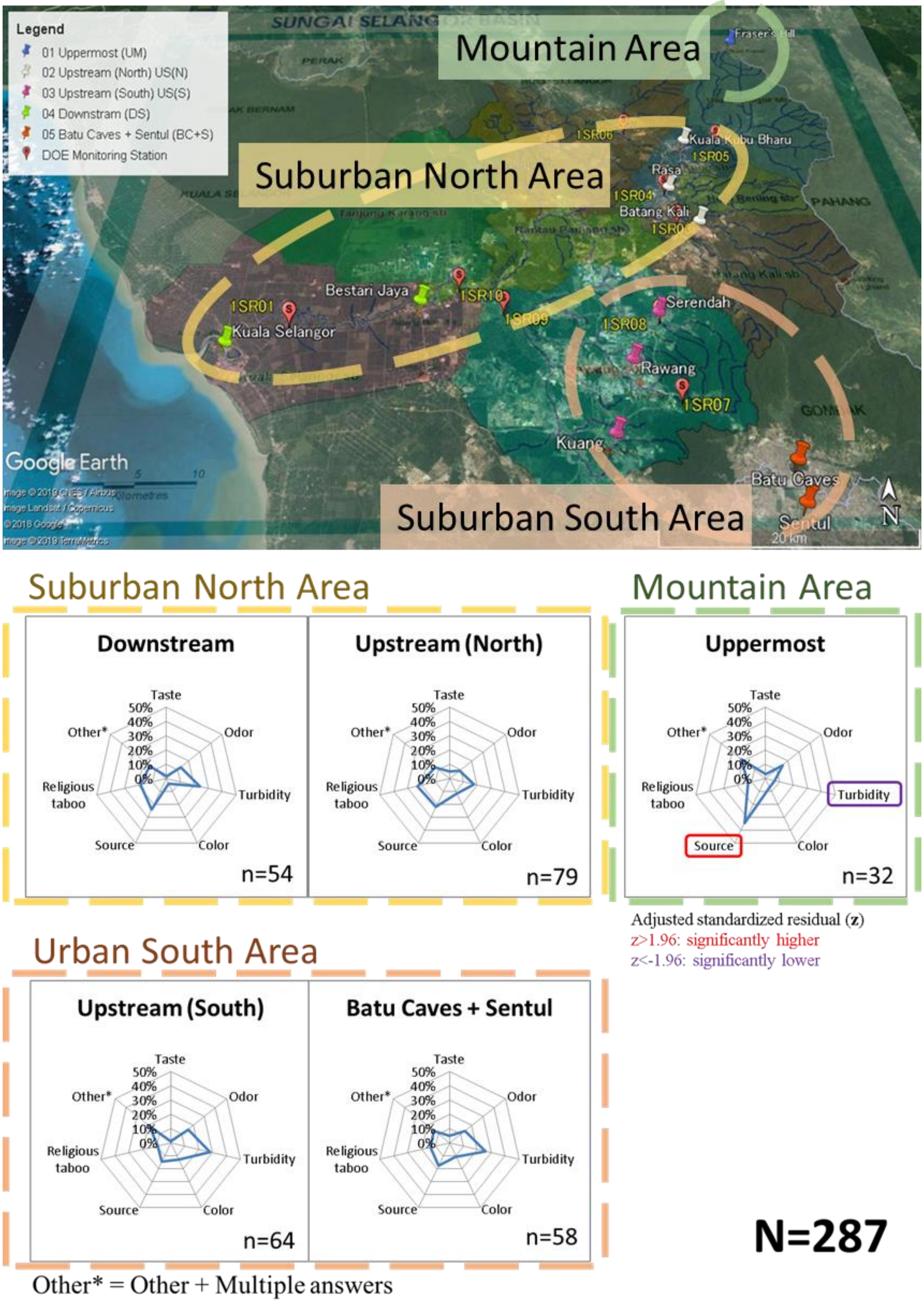


Figure 5.2.2.1.3-3 Map[7] of Clusterings and Rader Charts of WUDFs (Islam)

5.2.2.2 Household Gross Income

5.2.2.2.1 River Water Drinkability

The statistics of RWD-HGI relationship are tabulated (**Table 5.2.2.2.1-1**) and charted (**Figure 5.2.2.2.1-1**).

Table 5.2.2.2.1-1 River Water Drinkability and Household Gross Income (Islam)

	Yes (Drinkable)			No (Undrinkable)			I do not know.			**Total**	
	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.
Modest	12	18%	4.1	32	48%	-3.6	22	33%	1.5	**66**	**100%**
Middle	5	6%	-0.2	58	75%	2.0	14	18%	-2.0	**77**	**100%**
Rich	0	0%	-3.5	70	71%	1.4	28	29%	0.6	**98**	**100%**
Total	**17**	**7%**		**160**	**66%**		**64**	**27%**		**241**	**100%**

N	df	χ^2	V	ω	$1-\beta$	p_P	p_F
241	4	26.3	0.23	0.33	0.9923	0.000027	0.000011

N'

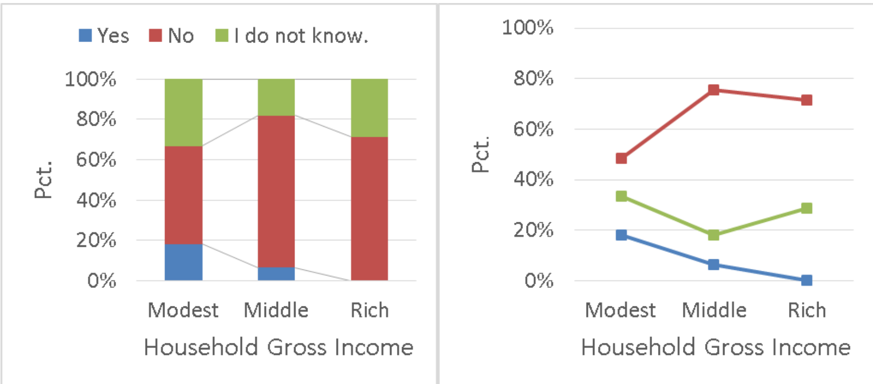


Figure 5.2.2.2.1-1 River Water Drinkability and Household Gross Income (Islam)

The 'Yes (Drinkable),' 'No (Undrinkable)' and 'I do not know.' pcts. were compared among the HGI groups: the 'Yes' pct. monotonically decreases as HGI increases (Modest 18% Middle 6% and Rich 0%); the 'No' pct. increases from Modest (48%) to the Middle (75%) and decreases to the Rich (71%) ; and the 'I do not know.' pct. decreases from the Modest (33%) to the Middle (18%) and increases to the Rich (29%). The richer, the less respondents judge drinkable the nearest river water (**Figure 5.2.2.2.1-1**) at each Sampling Site (**Table 5.2.2.2.1-2**).

Table 5.2.2.2.1-2 Number of Respondents with ‘Drinkable’ River Water (Islam)

	UM	US(N)	US(S)	DS	BC+S	**Total**
Modest	5	3	1	1	2	**12**
Middle	2	1	1	0	1	**5**
Rich	0	0	0	0	0	**0**
Total	**7**	**4**	**2**	**1**	**3**	**17**

Whether an answer frequency (freq.) is significantly higher/lower than expected was determined by adjusted standardized residual (ASR,z).Viewed from RWD side: the ‘Yes’ z value is significantly higher in the Modest respondents ($z = 4.1 > 1.96$) while lower in the Rich ($z = -3.5 < -1.96$); ‘No’ significantly lower in the Modest ($z = -3.6$) and higher in the Middle ($z = 2.0$); and ‘I do not know.’ lower in the Middle ($z = -2.0$). Viewed from HGI side: the Modest respondents have a significantly higher ‘Yes’ while lower ‘No’; the Middle higher ‘No’ while lower ‘I do not know.’; and the Rich lower ‘Yes.’ Consequently, the Richer, the less ‘drinkable’ judgements. The Middle are more likely to judge their nearest river water undrinkable, while the Modest are less.

The Cramer’s V level ($V = 0.23$) indicates a ‘very weak’ or no association between RWD and HGI. The p-value of Fisher’s exact test (p_F) is significantly low ($p_F = 0.000011 < 0.050$) and the power is sufficiently high ($1 - \beta = 0.9923 > 0.80$). The sample size ($N = 241$) is sufficiently large ($N' = 110$).

5.2.2.2.2 Willingness to Pay for River Water Drinkability

The statistics of WTP for RWD-HGI relationship are tabulated (**Table 5.2.1.3.2-1**) and charted (**Figure 5.2.1.3.2-1**).

Table 5.2.2.2.2-1 WTP for River Water Drinkability and Household Gross Income (Total)

	Modest			Middle			Rich			**Total**	
RM/month	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.
0	31	30%	2.1	41	24%	0.7	20	14%	-2.7	**92**	**22%**
0.01-9.99	31	30%	1.9	29	17%	-2.5	35	25%	0.8	**95**	**23%**
10.00-19.99	32	30%	-1.1	64	37%	0.8	49	35%	0.1	**145**	**35%**
20.00 or above	11	10%	-2.9	39	23%	0.9	35	25%	1.7	**85**	**20%**
Total	**105**	**100%**		**173**	**100%**		**139**	**100%**		**417**	**100%**

N	df	χ^2	V	ω	$1-\beta$	p_P	p_F
417	6	19.6	0.15	0.22	0.942	0.0033	0.0021

N'
282

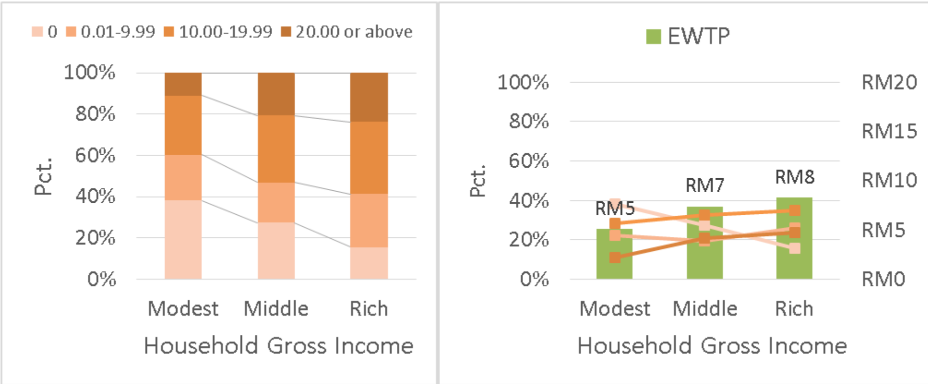


Figure 5.2.2.2.2-1 WTP for River Water Drinkability and Household Gross Income (Islam)

The '0,' '0.01-9.99,' '10.00-19.99' and '20.00 or above' pcts. were compared among the HGI groups: the '0' pct. monotonically decreases as HGI increase, *i.e.*, the Modest (30%), the Middle (24%) and the Rich (14%); the '0.01-9.99' decreases from the Modest (30%) to the Middle (17%) and then increased to the Rich (25%); the '10.00-19.99' decreases from the Modest (30%) to the Middle (37%) and then increased to the Rich (35%); the '20.00 or above' monotonically increases from as HGI increases *i.e.* the Modest (10%), the Middle (23%) and the Rich (25%). The WTP for RWD seems to increase as HGI increases. In every HGI group, the most frequent WTP is '10.00-19.99.' The EWTP value increases HGI-wise: from the Modest (5 RM/month) via the Middle (8 RM/month) to the Rich (9 RM/month). It appears that the richer, the more willing to pay for RWD.

Whether an answer frequency (freq.) is significantly higher/lower than expected was determined by adjusted standardized residual (ASR, z). Viewed from WTP for RWD side: the '0' z value is significantly higher in the Modest respondents $(z = 2.1 > 1.96)$ while lower in the Rich $(z = -2.7 < -1.96)$; the '0.01-9.99' significantly lower in the Middle $(z = -2.5)$ and higher in Middle $(z = 2.2)$; the '10.00-19.99' no significantly higher/lower z value among the three HGI groups; and the '20.00 or above' significantly lower in the Modest $(z = -2.9)$. Viewed from HGI side: the Modest respondents have a significantly higher '0' while lower '20.00 or above'; the Middle lower '0.01-9.99'; and the Rich lower '0.' Consequently, the Richer, the more willing to pay for RWD. This is quite reasonable.

The Cramer's V level $(V = 0.15)$ indicates a 'very weak' or no association between WTP for RWD and HGI. The p-value of Fisher's exact test (p_F) is significantly low $(p_F = 0.0021 < 0.050)$ and the power is sufficiently high $(1 - \beta = 0.942 > 0.80)$. The sample size $(N = 417)$ is sufficiently large $(N' = 282)$.

It appears that the richer, the more willing to pay for RWD, although the association between HGI and

WTP for RWD is very weak. However, as **Figure 5.2.1.3.2-2** shows**,** within the same HGI group, it appears that Septic Tank (ST) using respondents are more willing to pay for RWD as HGI increases, while Sewerage System (SS) using respondents are not necessarily so: Unlike the other HGI groups, Middle ST using respondents are less willing to pay than Middle SS using respondents, which affects the Total WTPs. Rich ST using respondents are most willing to pay for RWD.

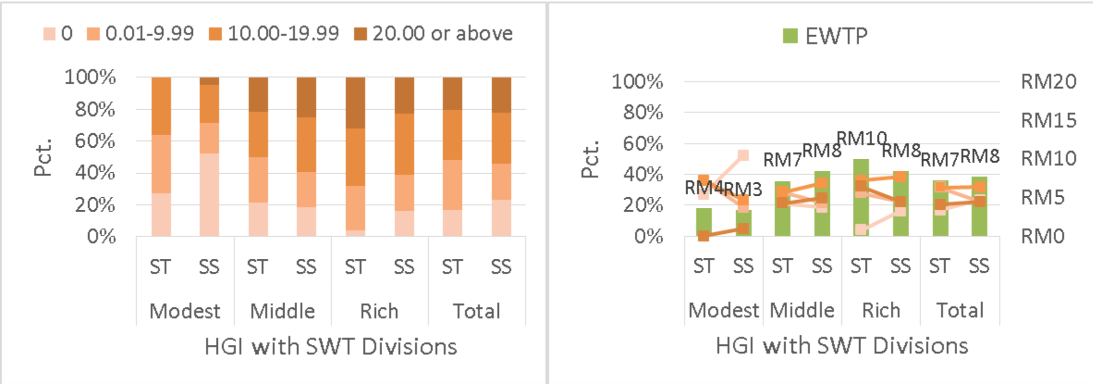


Figure 5.2.2.2.2-2 WTP for RWD and HGI with SWT Divisions (Islam)

5.2.2.2.3 Water Undrinkability Factor

The statistics of SWT-WUDF relationship are tabulated (**Table 5.2.2.2.3-1**) and charted (**Figure 5.2.2.2.3-1**).

Table 5.2.2.2.3-1 Water Undrinkability Factor and Household Gross Income (Islam)

	Taste			Odor			Turbidity			Color		
	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.	z
Modest	4	6%	0.9	9	14%	0.0	10	15%	-1.4	2	3%	-2.1
Middle	4	5%	0.5	9	12%	-0.7	21	27%	1.5	12	15%	2.1
Rich	2	2%	-1.3	15	15%	0.7	20	21%	-0.2	9	9%	-0.1
Total	**10**	**4%**		**33**	**14%**		**51**	**21%**		**23**	**10%**	

	Source			Religious taboo			Other*			**Total**	
	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.
Modest	17	26%	1.3	13	20%	1.0	11	17%	0.3	**66**	**100%**
Middle	10	13%	-2.0	11	14%	-0.5	11	14%	-0.4	**78**	**100%**
Rich	22	23%	0.7	14	14%	-0.5	15	15%	0.0	**97**	**100%**
Total	**49**	**20%**		**38**	**16%**		**37**	**15%**		**241**	**100%**

N	df	χ^2	V	ω	1-β	p_P	p_F
241	12	14.8	0.18	0.25	0.73	0.25	0.22

N'
274

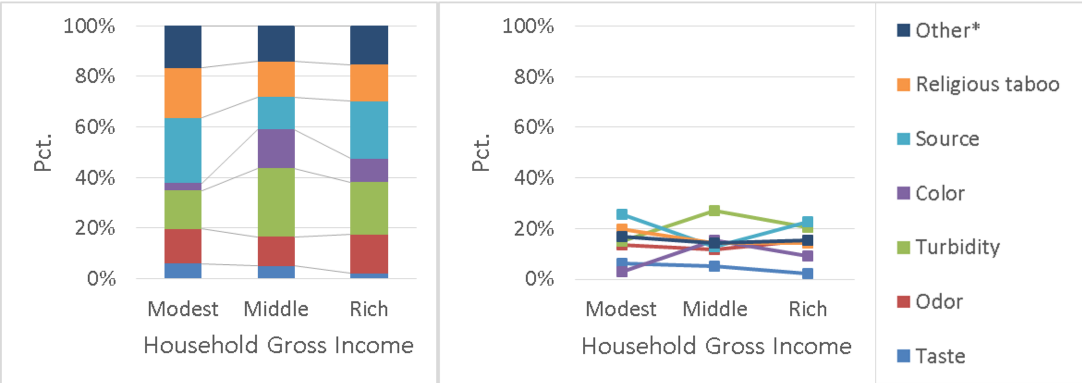


Figure 5.2.2.2.3-1 Water Undrinkability Factor and Household Gross Income (Islam)

The WUDF pcts. were compared among the HGI groups: in the Modest: the 'Taste' pct. decreases as HGI increases (the Modest 6%, the Middle 5% and the Rich 2%); the 'Odor' decreases from the Modest (14%) to the Middle (12%) and then increases the Rich (15%); the 'Turbidity' increases from the Modest (15%) to the Middle (27%) and then decreases to the Rich (21%); so does the 'Color' (the Modest 3%, the Middle 15% and the Rich 9%); the 'Source' decreases from the Modest (26%) to the Middle (13%) and then increases to the Rich (23%); the 'Religious taboo' decreases from the Modest (20%) to the Middle (14%) and stayed unchanged to the Rich (14%); and the 'Other*' decreases from the Modest (17%) to the Middle (14%) and then increases to the Rich (15%). The EWTP value increases HGI-wise: from the Modest (5 RM/month) via the Middle (7 RM/month) to the Rich (8 RM/month). Consequently, it can be said that the more HGI increases, the more WTP for RWD increases.

Whether an answer frequency (freq.) is significantly higher/lower than expected was determined by adjusted standardized residual (ASR,z). Viewed from WUDF side: the 'Color' z value is significantly lower in the Modest ($z = -2.1 < -1.96$) while higher in the Middle ($z = 2.1 > 1.96$); and the 'Source' lower in the Middle ($z = -2.0 < -1.96$); and the rest of the WUDFs have no significantly higher/lower z value throughout the Sampling Sites. Viewed from HGI: the Modest has a significantly lower 'Color' z value; the Middle higher 'Color' while lower 'Source'; and the Rich no significantly higher/lower z value throughout the HGI groups.

The Cramer's V level ($V = 0.18$) indicates a 'very weak' association between RWD and HGI. The p-value of Fisher's exact test (p_F) is significantly small ($p_F = 0.22 > 0.050$) and the power is sufficiently high ($1 - \beta = 0.73 < 0.80$). The sample size is too small to obtain a significantly small p_P value at $\alpha = 0.05$ and $1 - \beta = 0.8$ ($N = 241 < N' = 274$).

The WUDF rate-based Pearson Correlations of the HGI groups by 'R' Package 'qgraph' (ver. 1.5)[6] and the hierarchical cluster analysis (HCA) dendrogram (Euclidean distance, Ward's method) by 'R' (ver.3.4.3)[3] were shown in (**Figure 5.2.2.2.3-2**). **Figure 5.2.2.2.3-2** (**left**) shows that their WUDF patterns are positively correlated. The HCA dendrogram (**Figure 5.2.2.2.3-2**, **right**) shows a major clustering of: the Middle; and the Modest and the Rich. And they are radar-charted for each HGI group (**Figure 5.2.2.2.3-3)**. The Middle is most characteristic mainly by the higher 'Color' and the lower 'Source.'

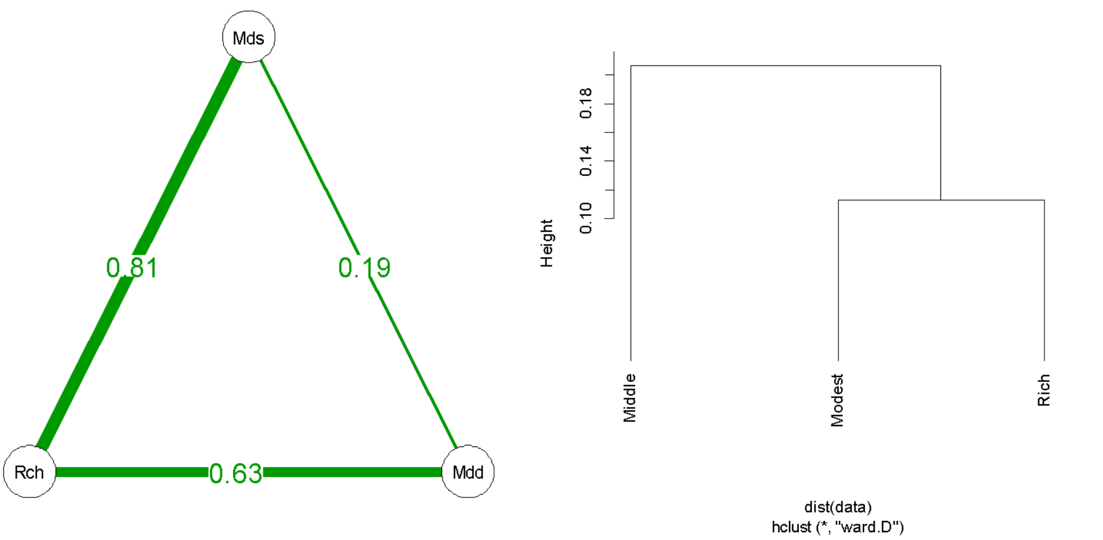


Figure 5.2.2.2.3-2 WUDF-based Correlation Diagram and HCA Dendrogram of HGI (Islam)

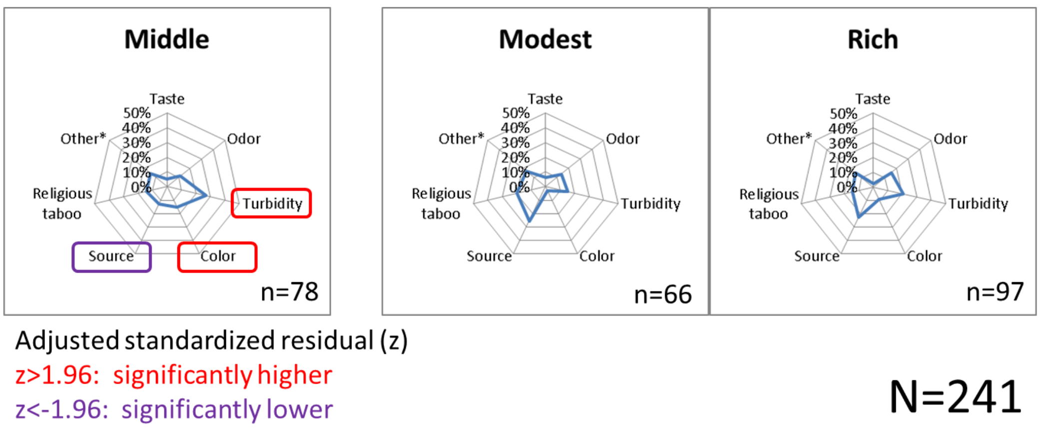


Figure 5.2.2.2.3-3 Water Undrinkability Factor and Household Gross Income (Islam)

The above results can be described that Muslim Middle respondents are more color sensitive and/or their water is more likely to be colored, and their drinking water quality is source independent and/or they are less interested in drinking water source. The reasoning behind this is considered that Muslim Middle respondents are not likely to drink their nearest river water, and thus they are likely to drink (filtered) tap water and/or bottled water about which they do not need to care about the source. (1) If Muslim respondents' water color sensibility is similar regardless of HGI, the Middle's (filtered) tap water and/or bottled water is more likely to be colored than the other HGI groups' likely drinking water. The Rich may have cleaner drinking water, having a better tap water filter or drinking bottled water only. The Modest may have better drinking water source options such as mountain water. (2) If Muslim respondents' water color sensibility depends on HGI, the Modest are more likely to drink water regardless of color; for the Modest, the 'Color' pct. is the lowest among the WUDFs: even lower than the 'Taste.'

5.2.2.3 Sewer Water Treatment

5.2.2.3.1 River Water Drinkability

The statistics of RWF-SWT relationship are tabulated (**Table 5.2.2.3.1-1**) and charted (**Figure 5.2.2.3.1-1**).

Table 5.2.2.3.1-1 River Water Drinkability and Sewer Water Treatment (Islam)

	Yes (Drinkable)			No (Undrinkable)			I do not know.			**Total**	
	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.
Septic Tank	6	11%	1.2	39	70%	0.6	11	20%	-1.4	**56**	**100%**
Sewerage System	5	5%	-1.2	60	65%	-0.6	28	30%	1.4	**93**	**100%**
Total	**11**	**7%**		**99**	**66%**		**39**	**26%**		**149**	**100%**

N	df	χ^2	V	ω	$1-\beta$	p_P	p_F
149	2	2.9	0.14	0.14	0.31	0.23	0.22

N'
492

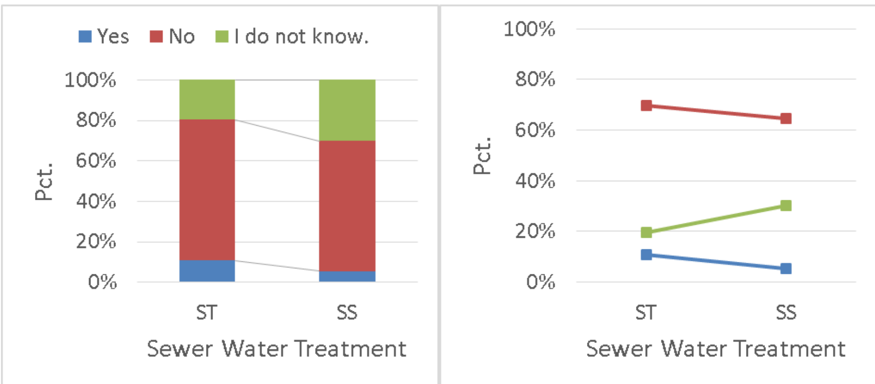


Figure 5.2.2.3.1-1 River Water Drinkability and Sewer Water Treatment (Islam)

The 'Yes (Drinkable),' 'No (Undrinkable)' and 'I do not know.' pcts. were compared between the SWT groups: the ‘Yes’ pct. is higher in ST (11%) than in SS (5%); the ‘No’ higher in ST (70%) than in ST (65%); and the ‘I do not know.’ higher in SS (30%) than in ST (20%). It is possible that the ‘I do not know.’ pct. is coupled with the ‘Yes’ and ‘No’ pcts. *i.e.*, the SS-using respondents are less familiar with their nearest river than the ST-using respondents.

Whether an answer frequency (freq.) is significantly higher/lower than expected was determined by adjusted standardized residual (ASR,**z**). There is no freq. with a significantly higher/lower z value in **Table 5.2.2.3.1-1**.

The Cramer’s V level ($V = 0.14$) indicates a ‘very weak’ or no association between RWD and SWT. The p-value of Fisher’s exact test (p_F) is significantly low ($p_F = 0.22 > 0.050$) and the power is insufficient ($1 - \beta = 0.31 < 0.80$). The sample size is too small to obtain a significantly small p_P value ($N = 149 < N' = 492$).

Sewerage Systems are installed in only in urbanized areas, where directly drinkable river water may be less available than rural areas. Note that Muslim respondents who have ‘drinkable’ are mostly from upstream Sampling Sites (16/20): UM (9/20), US(N) (5/20) and US (2/20).

5.2.2.3.2 Willingness to Pay for River Water Drinkability

The statistics of WTP for RWD-STP relationship are tabulated (**Table 5.2.2.3.2-1**) and charted **(Figure 5.2.2.3.3-1**).

Table 5.2.2.3.2-1 Willingness to Pay for River Water Drinkability and SWT (Islam)

	Septic Tank			Sewerage System			**Total**	
RM/month	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.
0	9	17%	-1.0	22	23%	1.0	**31**	**21%**
0.01-9.99	17	31%	1.2	21	22%	-1.2	**38**	**26%**
10.00-19.99	17	31%	-0.1	30	32%	0.1	**47**	**32%**
20.00 or above	11	20%	-0.3	21	22%	0.3	**32**	**22%**
Total	**54**	**100%**		**94**	**100%**		**148**	**100%**

N	df	χ^2	V	ω	1- β	p_P	p_F
148	3	1.9	0.11	0.11	0.18	0.59	0.61

N'
902

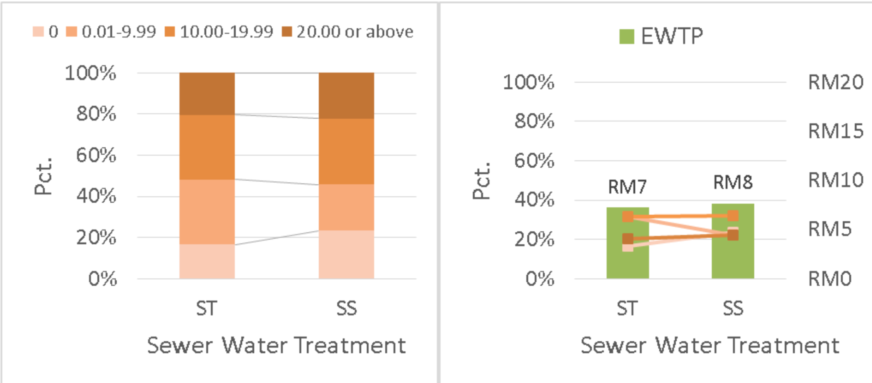


Figure 5.2.2.3.2-1 Willingness to Pay for River Water Drinkability and SWT (Islam)

The '0,' '0.01-9.99,' '10.00-19.99' and '20.00 or above' pcts. were compared between the SWT groups: the '0' pct. is higher in SS (22%) than in ST (17%); the '0.01-9.99' higher in ST (31%) than in SS (22%); the '10.00-19.99' higher in SS (32%) than in ST (31%); the '20.00 or above' higher in SS (22%) than in ST (20%). The EWTP value is higher in SS (8 RM/month) than in ST (7 RM/month).

Whether an answer frequency (freq.) is significantly higher/lower than expected was determined by adjusted standardized residual (ASR,z). There is no freq. with a significantly higher/lower z value in **Table 5.2.2.3.2-1**.

The Cramer's V level ($V = 0.11$) indicates a 'very weak' association between WTP for RWD and SWT. The p-value of Fisher's exact test (p_F) is significantly high ($p_F = 0.61 > 0.050$) and the power is insufficient ($1 - \beta = 0.18 < 0.80$). The sample size is too small to obtain a significantly small p-value (p_P) with a sufficient power ($N = 148 < N' = 902$).

Within Muslims, The WTP could be said similar between SS and ST. This is similar with the result from the Total respondents ($V = 0.12$).

By the way, with respect to EWTP, DS respondents, both ST and SS using ones, appear most willing to pay for RWD in SSB (**Figure 5.2.2.3.2-2**).

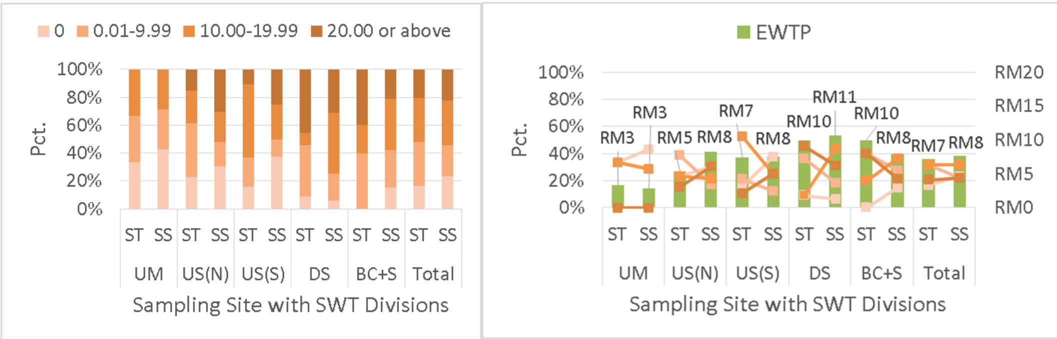


Figure 5.2.2.3.2-2 WTP for RWD (Sampling Site with SWT Divisions) (Islam)

5.2.2.3.3 Water Undrinkability Factor

The statistics of SWT-WUDF relationship are tabulated (**Table 5.2.2.3.3-1**) and charted (**Figure 5.2.2.3.3-1**).

Table 5.2.2.3.3-1 Water Undrinkability Factor and Sewer Water Treatment (Islam)

	Taste			Odor			Turbidity			Color		
	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.	z
Septic Tank	2	4%	-0.9	11	20%	1.23	15	28%	0.59	9	17%	2.0
Sewerage System	7	7%	0.9	12	13%	-1.23	22	23%	-0.59	6	6%	-2.0
Total	**9**	**6%**		**23**	**16%**		**37**	**25%**		**15**	**10%**	

	Source			Religious taboo			Other*			**Total**	
	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.
Septic Tank	6	11%	-1.8	5	9%	-1.0	6	11%	-0.1	**54**	**100%**
Sewerage System	22	23%	1.8	14	15%	1.0	11	12%	0.1	**94**	**100%**
Total	**28**	**19%**		**19**	**13%**		**17**	**11%**		**148**	**100%**

N	df	χ^2	V	ω	1-β	p_P	p_F
148	6	9.5	0.25	0.25	0.60	0.15	0.16

N'
218

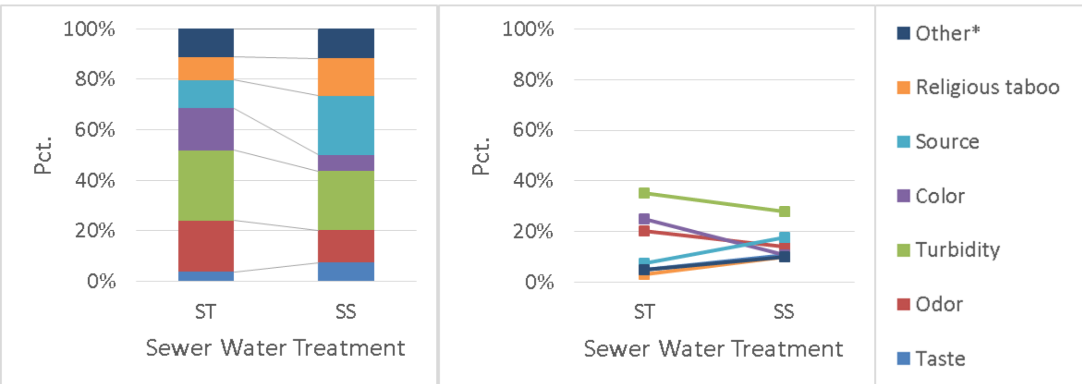


Figure 5.2.2.3.3-1 Water Undrinkability Factor and Sewer Water Treatment (Islam)

The WUDF pcts. were compared between ST- and SS-using respondents: the ‘Taste’ pct. is higher in SS (7%) than in ST (4%); the ‘Odor’ higher in ST (20%) than in SS (13%); the ‘Turbidity’ higher in ST (28%) than in SS (23%); ‘Color’ higher in ST (17%) than in SS (6%); the ‘Source’ higher in SS (23%) than in ST (11%); the ‘Religious taboo’ higher in SS (15%) than in ST (9%); and the ‘Other*’ higher in SS (11%) than ST (10%). Within Muslims, the SS users have more clean water; they are more care about Taste and non-organoleptic WUDFs then the ST users.

Whether an answer frequency (freq.) is significantly higher/lower than expected was determined by adjusted standardized residual (ASR,z). Viewed from SWT side: the ST using respondents’ z value is significantly higher ‘Color’ ($z = 2.0 > 1.96$); the SS significantly lower ($z = -2.0 < -1.96$). Viewed from WUDF side: the ‘Color’ z value is significantly higher in ST; lower in SS. Consequently, the WUDF profile difference is mainly due to ‘Color.’

The Cramer’s V level ($V = 0.25$) indicates a ‘somewhat weak’ association between WUDF and HGI. The p-value of Fisher’s exact test (p_F) is significantly low ($p_F = 0.15 > 0.050$) and the power is sufficiently high ($1 - \beta = 0.60 < 0.80$). The sample size is too small to obtain a significantly small p-value (p_P) with a sufficiently large power ($N = 148 < N' = 218$).

The WUDF pcts. in ST and SS were radar-charted (**Figure 5.2.2.3.3-2**). ‘No treatment’ was just for reference due to the small sample size; ‘Odor’ seems to be the most likely WUDF.

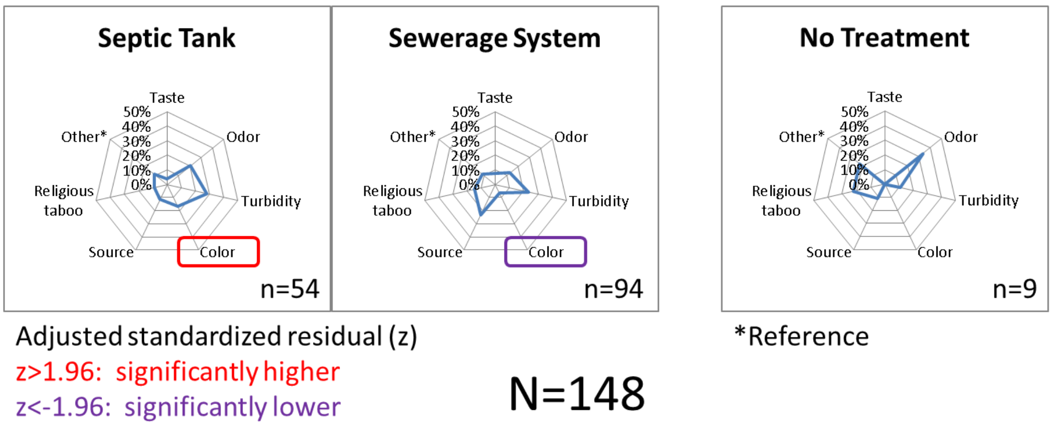


Figure 5.2.2.3.3-2 Water Undrinkability Factor and Sewer Water Treatment (Islam)

5.2.3 Christianity, Buddhism and Hinduism

Christianity, Buddhism and Hinduism (CBH) respondents were combined, because their WUDFs are similar and distinct from those of Muslims, as discussed in **5.2.1.2.3** .

5.2.3.1 Sampling Site

5.2.3.1.1 River Water Drinkability

The statistics of RWD-Sampling Site relationship are tabulated (**Table 5.2.3.1.1-1**) and charted (**Figure 5.2.3.1.1-1**).

Table 5.2.3.1.1-1 River Water Drinkability and Sampling Site (CBH)

	Yes (Drinkable)			No (Undrinkable)			I do not know.			**Total**	
	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.
UM	4	36%	4.8	6	55%	-1.5	1	9%	-1.0	**11**	**100%**
US(N)	0	0%	-1.6	27	77%	0.4	8	23%	0.4	**35**	**100%**
US(S)	1	2%	-1.2	36	75%	0.1	11	23%	0.5	**48**	**100%**
DS	0	0%	-1.2	16	70%	-0.6	7	30%	1.3	**23**	**100%**
BC+S	4	7%	0.9	42	78%	0.7	8	15%	-1.2	**54**	**100%**
Total	**9**	**5%**		**127**	**74%**		**35**	**20%**		**171**	**100%**

N	df	χ^2	V	ω	$1-\beta$	p_P	p_F
171	8	28.3	0.29	0.41	0.986	0.00042	0.016

N'
90

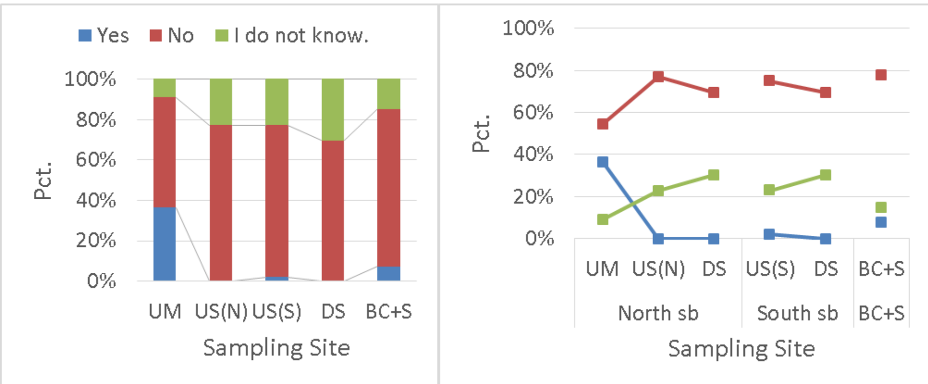


Figure 5.2.3.1.1-1 River Water Drinkability and Sampling Site (CBH)

The ‘Yes (Drinkable),’ ‘No (Undrinkable)’ and ‘I do not know.’ pcts. were compared among the Sampling Sites flow-wise. The ‘Yes’ pct. in the North sb decreases from UM (36%) to US(N) (0%) and then stay unchanged to DS (0%); in the South sb decreased flow-wise from US(S) (2%) to DS (0%). At BC+S it is 7% that is the second highest following UM. The ‘No pct. in the North sb. from UM (55%) via US(N) (77%) to DS (70%); in the South sb decreases flow-wise to US(S) (75%) to DS (70%). At BC+S it is 78% that is the highest among the Sampling Sites. The ‘I do not know.’ pct. increases flow wise: in the North sb from UM (9%) via US (23%) to DS (30%); in the South sb from US(S) (23%) to DS (30%). At BC+S it is 15% the lowest among the Sampling Sites.

Whether an answer frequency (freq.) is significantly higher/lower than expected was determined by

adjusted standardized residual (ASR,z). Viewed from RWD side: the 'Yes' z value is significantly higher in UM ($z = 4.8 > 1.96$); the 'No' and 'I do not know.' z has no significantly higher/lower z value throughout the Sampling Sites. Viewed from Sampling Site side: UM has significantly higher z values in 'Yes,' while the rest of the Sampling Sites have no significantly higher/lower z value.

The Cramer's V level ($V = 0.29$) indicates a 'somewhat weak' association between RWD and Sampling Site. It is higher than those of Total ($V = 0.24$) and Muslims ($V = 0.27$), meaning that CBH respondents' RWD is more Sampling Site dependent than those of Total and Muslims. The p-value of Fisher's exact test (p_F) is significantly low ($p_F = 0.016 < 0.050$) and the power is sufficiently high ($1 - \beta = 0.986 > 0.80$). The sample size is sufficiently large ($N = 171 > N' = 90$).

5.2.3.1.2 Willingness to Pay for River Water Drinkability

The statistics of WTP for RWD and-Sampling Site relationship are tabulated (**Table 5.2.3.1.2-1**) and charted (**Figure 5.2.3.1.2-1**).

Table 5.2.3.1.2-1 WTP for River Water Drinkability and Sampling Site (CBH)

	UM			US(N)			US(S)		
RM/month	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.	z
0	5	45%	2.6	3	9%	-1.5	9	18%	0.3
0.01-9.99	4	36%	1.2	6	17%	-0.7	10	20%	-0.2
10.00-19.99	2	18%	-1.4	15	43%	0.6	25	51%	2.1
20.00 or above	0	0%	-1.9	11	31%	1.4	5	10%	-2.5
Total	**11**	**100%**		**35**	**100%**		**49**	**100%**	

	DS			BC+S			**Total**	
RM/month	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.
0	2	9%	-1.1	10	19%	0.4	**29**	**17%**
0.01-9.99	6	26%	0.6	11	21%	-0.2	**37**	**22%**
10.00-19.99	10	43%	0.5	14	26%	-2.2	**66**	**39%**
20.00 or above	5	22%	-0.1	18	34%	2.3	**39**	**23%**
Total	**23**	**100%**		**53**	**100%**		**171**	**100%**

N	df	χ^2	V	ω	$1-\beta$	p_P	p_F
171	12	25.0	0.22	0.38	0.938	0.015	0.014

N'
121

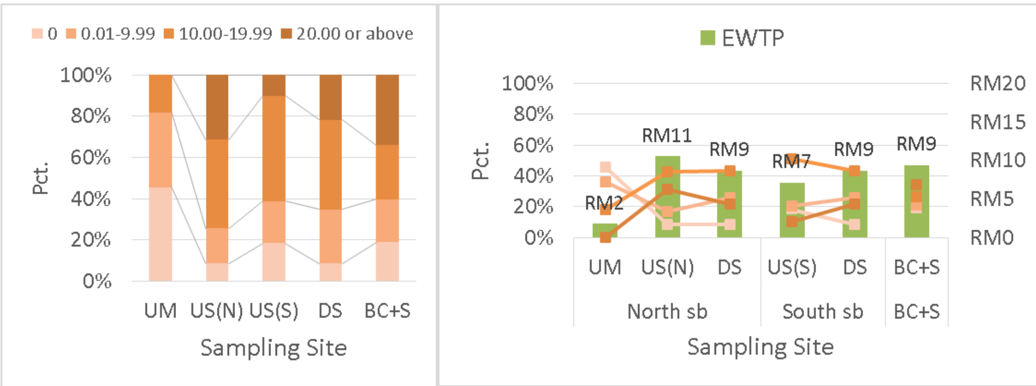


Figure 5.2.3.1.2-1 WTP for River Water Drinkability and Sampling Site (CBH)

The '0,' '0.01-9.99,' '10.00-19.99' and '20.00 or above' pcts. were compared among the Sampling Sites. The '0' pct. in the North sb decreases from UM (45%) via US(N) (9%) and then stays unchanged to DS (9%); in the South sb decreases from US(S) (18%) to DS (9%). At BC+S it is19%. The '0.01-9.99' pct. in the North sb decreases from UM (36%) to US(N) (17%) and then increases to DS (26%); in the South sb increases from US(S) (20%) to DS (26%). At BC+S it is 21%. The '10.00-19.99' in the North sb increases from UM (18%) to US(N) (43%) and then stays unchanged to DS (43%); in the South sb decreases from US(S) (51%) to DS(43%). At BC+S it is 26%. The '20.00 or above' pct. in the North sb increases from UM (0%) to US(N) (31%) and then decreases to DS (22%); in the South sb increases from US(S) (10%) to DS (22%). At BC+S it is 34%. The EWTP value in the North sb increases from UM (3 RM/month) via US(N) (11 RM/month) to DS (9 RM/month); in the South sb increases from US(S) (7 RM/month) to DS (9RM/month); at BC+S it is 9 RM/month.

Whether an answer frequency (freq.) is significantly higher/lower than expected was determined by adjusted standardized residual (ASR, z). Viewed from WTP for RWD side: the '0' z value is significantly higher at UM ($z = 2.6 > 1.96$); the '0.01-9.99' has no significantly higher/lower z value among the Sampling Site; the '10.00-19.99' z value is significantly higher at US(S) ($z = 2.1$) while lower at BC+S ($z = -2.2 < -1.96$); and the '20.00 or above' z value is significantly lower at US(S) ($z = -2.5$) while higher at BC+S ($z = 2.3$). Viewed from Sampling Site side: UM has a significantly higher '0'; US(S) higher '10.00-19.99' while lower '20.00 or above'; BC+S lower '10.00-19.99' while higher '20.00 or above.'

The Cramer's V level ($V = 0.22$) indicates a 'very weak' or no association between WTP for RWD and Sampling Site. It is lower than those of Total ($V = 0.28$) but higher than Muslims ($V = 0.15$), meaning that CBH respondents' WTP for RWD is less Sampling Site dependent than that of Total but more than of Muslim respondents. The p-value of Fisher's exact test (p_F) is significantly low ($p_F = 0.014 < 0.050$) and the power is sufficiently high ($1 - \beta = 0.938 > 0.80$). The sample size is sufficiently large (N = 171 > N′ = 121).

The EWTP order where US(N) is the highest and UM the lowest seems to be related to RWD that is consistent with DOE's WQI-based drinkability (**5.6.1.2**).

5.2.3.1.3 Water Undrinkability Factor

The statistics of WUDF-Sampling Site relationship were tabulated (**Table 5.2.3.1.3-1**) and charted (**Figure 5.2.3.1.3-1**).

Table 5.2.3.1.3-1 Water Undrinkability Factor and Sampling Site (CBH)

	Taste			Odor			Turbidity			Color		
	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.	z
UM	2	18%	1.4	2	18%	-0.1	1	9%	-2.2	3	27%	0.1
US(N)	3	9%	0.3	9	26%	1.1	11	31%	-1.2	12	34%	1.2
US(S)	2	4%	-1.0	10	21%	0.3	24	50%	1.6	9	19%	-1.4
DS	1	4%	-0.6	6	26%	0.9	8	35%	-0.6	7	30%	0.5
BC+S	5	9%	0.5	6	11%	-1.9	25	45%	1.0	14	25%	-0.1
Total	**13**	**8%**		**33**	**19%**		**69**	**40%**		**45**	**26%**	

	Source			Religious taboo			Other*			**Total**	
	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.
UM	1	9%	0.6	0	0%	NA	2	18%	4.3	**11**	**100%**
US(N)	0	0%	-1.6	0	0%	NA	0	0%	-0.9	**35**	**100%**
US(S)	3	6%	0.4	0	0%	NA	0	0%	-1.1	**48**	**100%**
DS	0	0%	-1.2	0	0%	NA	1	4%	1.0	**23**	**100%**
BC+S	5	9%	1.6	0	0%	NA	0	0%	-1.2	**55**	**100%**
Total	**9**	**5%**		**0**	**0%**		**3**	**2%**		**172**	**100%**

N	df	χ^2	V	ω	1-β(α =0.05)	p_P	p_F
172	20	38.7	0.24	0.47	0.985	0.0072	0.038

N'
95

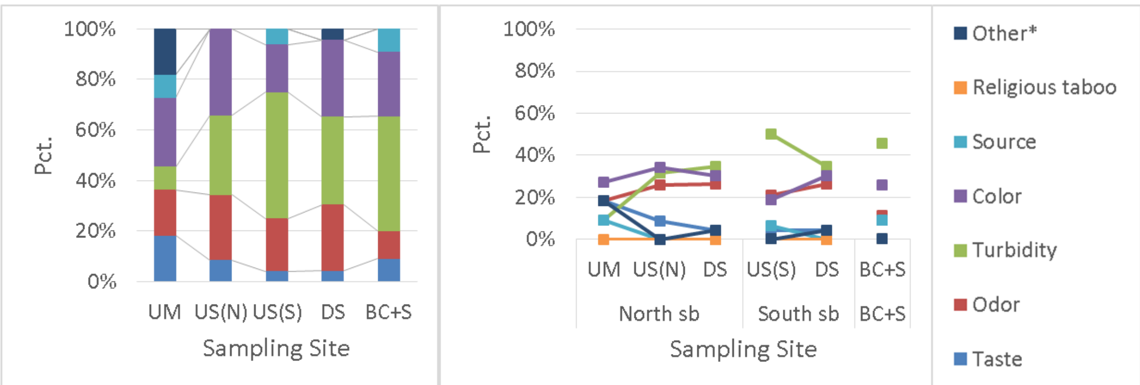


Figure 5.2.3.1.3-1 Water Undrinkability Factor and Sampling Site (CBH)

The WUDF pcts. were compared among the Sampling Site. The 'Taste' pct. in the North sb decreases flow-wise from UM (18%) via US(N) (9%) to DS (4%); in the South sb stays unchanged from US(S)

(4%) to DS (4%); at BC+S it is 9%. ‘Odor’ increases from UM (18%) to US(N) (26%) and then stays unchanged to DS (26%); in the South sb increases from US(S) (21%) to DS (26%); at BC+S it is 11% that is the lowest. The ‘Turbidity’ pct. increases flow-wise in the North sb from UM (9%) via US(N) (31%) to DS (35%); in the South sb decreases from US(N) (50%) to DS (35%); at BC+S it is 45% the second largest. The ‘Color’ pct. in the North sb increases from UM (27%) to US(N) (34%) and then decreases to DS (19%); in the South sb from US(S) (19%) to DS (30%); at BC+S it is 25%. The ‘Source’ pct. in the North sb decreases from UM (9%) to US(N) (0%) and stays unchanged to DS (0%); in the South sb decreases from US(S) (6%) to DS (0%); at BC+S it is 9% that is the highest and the same as UM. The ‘Religious taboo’ pct. is zero throughout the Sampling Site. The ‘Other*’ in the North sb decreases from UM (18%) to US(N) (0%) and then increases to DS (4%); in the South sb increases from US(S) (0%) to DS (4%); at BC+S it is 0%. It can be said that for CBH respondents the organoleptic factors matter while non-organoleptic factors do not so much.

Whether an answer frequency (freq.) is significantly higher/lower than expected was determined by adjusted standardized residual (ASR, z). Viewed from WUDF side: the ‘Turbidity’ z value is significantly lower at UM ($\mathrm{z} = -2.2 < -1.96$); and the ‘Other*’ higher at UM ($\mathrm{z} = 4.3 > 1.96$), the ‘Other*’ being Multiple answers (‘Taste,’ Odor,’ ‘Turbidity’ and ‘Source’) and ‘After filter’ by two Buddhists; and the rest of the WUDFs have no significantly higher/lower z value throughout the Sampling Sites. Viewed from Sampling Site: UM has a significantly lower ‘Turbidity’ z value while higher ‘Other*’; the rest of the Sampling Sites have no significantly higher/lower z value.

The Cramer’s V level ($\mathrm{V} = 0.24$) indicates a ‘somewhat weak’ association between WUDF and Sampling Site. The p-value of Fisher’s exact test ($\mathrm{p_F}$) is significantly low ($\mathrm{p_F} = 0.038 < 0.050$) and the power is insufficient ($1 - \beta = 1.0 > 0.80$). The sample size is sufficiently large ($\mathrm{N} = 172 > \mathrm{N}' = 95$).

The WUDF rate-based Pearson Correlations of the Sampling Sites by ‘R’ Package ‘qgraph’ (ver. 1.5)[6] and the hierarchical cluster analysis (HCA) dendrogram (Euclidean distance, Ward’s method) by ‘R’ (ver.3.4.3)[3] were shown in **(Figure 5.2.3.1.3-2)**. **Figure 5.2.3.1.3-2** (**left**) shows that UM is the most characteristic among the five Sampling Sites. The HCA dendrogram **(Figure 5.2.3.1.3-2**, **right**) shows a major grouping of: Mountain Area (UM), Suburban North Area (SNA: US(N) and DS) and Urban South Area (USA: US(S) and BC+S) nearer or within KL. This trend is the same as Muslims (**5.2.2.1.3**). The WUDF pct. is radar-charted for each Sampling Site and grouped (**Figure 5.2.3.1.3-2**). **Figure 5.2.3.1.3-2** shows: that The Mountain Area is the most characteristic at a glance, with lower ‘Turbidity’ The SNA and the USA are different in higher ‘Turbidity’ and ‘Source,’ and lower ‘Color’ in NSA, which can also be checked by commonly positive/negative z values in **Table 5.2.3.1.3-1**, probably due to higher ‘Turbidity’ in SUA.

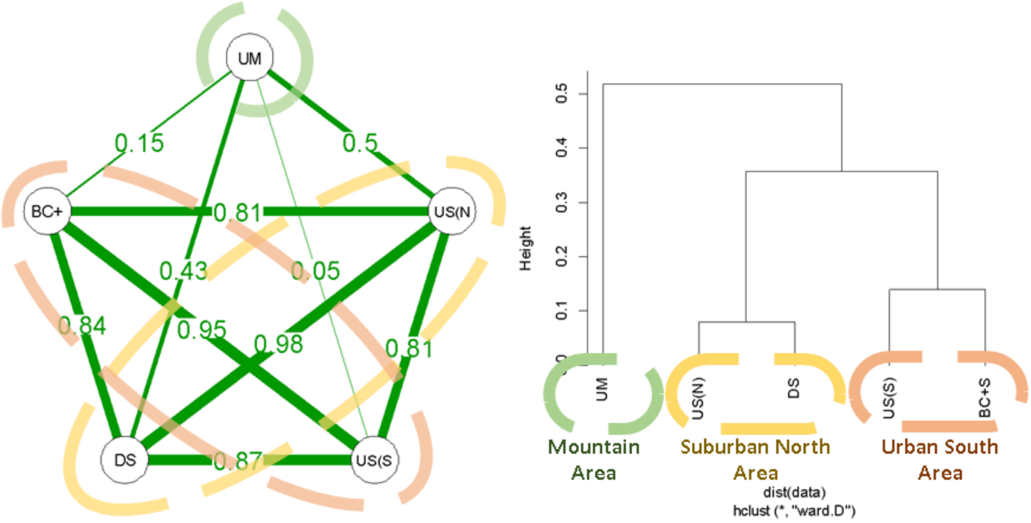
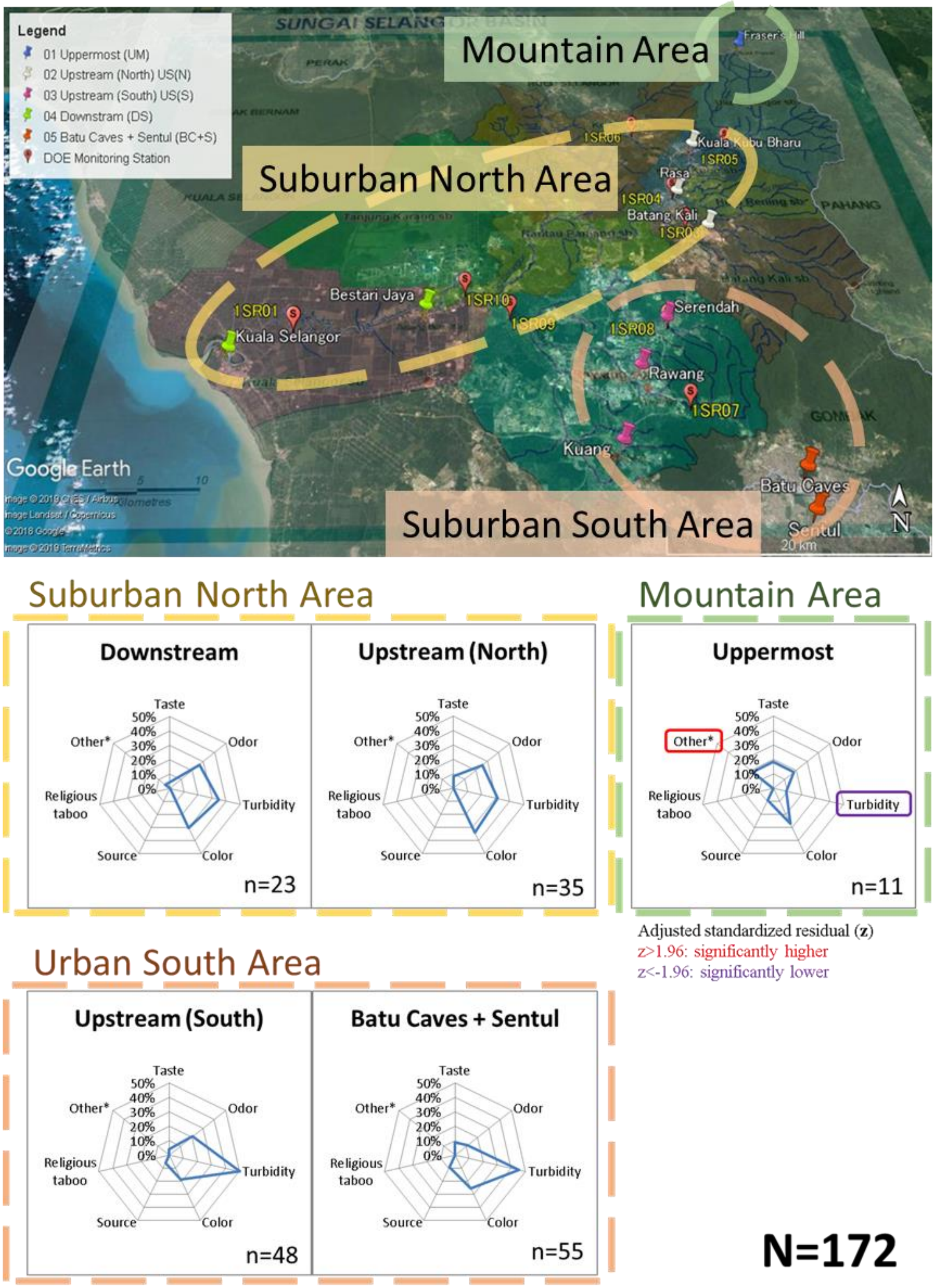


Figure 5.2.3.1.3-2 WUDF-based Correlation Diagram and HCA Dendrogram of HGI (CBH)



Other* = Other + Multiple answers

The Cramer's V is smaller than that of Islam (V = 0.27), meaning that CBH's WUDF priority is less Sapling Site dependent than that of Muslims. On the other hand, **Figure 5.2.2.1.3-2** and **Figure 5.2.3.1.3-2** show the same Sampling Site clustering in Islam and CBH, meaning that inter-Sampling

Site relationships are common between Islam and CBH. This may be because Muslims and CBHs at the same Sampling Site have different drinking water quality standards from each other. In fact, at least in this Survey, CBH have no observed 'Religious taboo' in drinking water, while Muslims do have sophisticated criteria[7]. And Muslim respondents are supposed to be flexibly practicing the drinking water criteria according to the water condition.

5.2.3.2 Household Gross Income

5.2.3.2.1 River Water Drinkability

The statistics of RWD-HGI relationship are tabulated (**Table 5.2.3.1.1-1**) and charted (**Figure 5.2.3.2.1-1**).

Table 5.2.3.2.1-1 River Water Drinkability and Household Gross Income (CBH)

	Yes (Drinkable)			No (Undrinkable)			I do not know.			**Total**	
	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.
Modest	5	13%	2.3	28	70%	-0.6	7	18%	-0.6	**40**	**100%**
Middle	1	1%	-2.7	69	76%	0.6	21	23%	0.8	**91**	**100%**
Rich	3	8%	0.8	27	73%	-0.1	7	19%	-0.3	**37**	**100%**
Total	**9**	**5%**		**124**	**74%**		**35**	**21%**		**168**	**100%**

N	df	χ^2	V	ω	1- β	p_P	p_F
168	4	2.2	0.081	0.11	0.17	0.090	0.069

N'
987

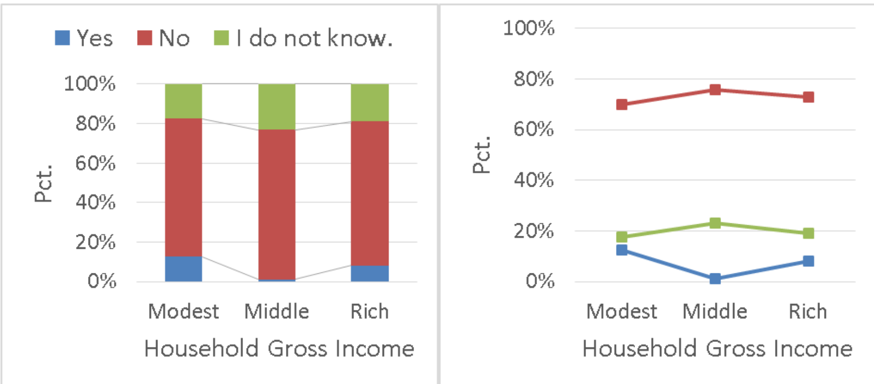


Figure 5.2.3.2.1-1 River Water Drinkability and Household Gross Income (CBH)

The 'Yes (Drinkable),' 'No (Undrinkable),' and 'I do not know. (Drinkability-uncertain)' were compared among the HGI groups: the 'Yes' pct. decreases from the Modest (13%) to the Middle (1%) and then increases to the Rich (8%); the 'No' pct. increases from the Modest (70%) to the Middle (76%) and then decreases to the Rich (73%); the 'I do not know.' pct. increases from the Modest (18%) to the Middle (23%) and then decreases to the Rich (19%). The richer, the less respondents judge drinkable the nearest river water (**Figure 5.2.3.2.1-1**). **Table 5.2.3.2.1-2** shows the numbers of respondents whose nearest river water is drinkable. Most (8/9) of them are from UM (4) ad BC+S (4). The BC+S respondents may be from upstream areas of their rivers.

Table 5.2.3.2.1-2 Number of Respondents with 'Drinkable' River Water (CBH)

	UM	US(N)	US(S)	DS	BC+S	**Total**
Modest	4	0	1	0	0	**5**
Middle	0	0	0	0	1	**1**
Rich	0	0	0	0	3	**3**
Total	**4**	**0**	**1**	**0**	**4**	**9**

Whether an answer frequency (freq.) is significantly higher/lower than expected was determined by adjusted standardized residual (ASR,z). Viewed from RWD side: the 'Yes' z value is significantly higher in the Modest ($z = 2.3 > 1.96$) and lower in the Middle ($z = -2.7 < -1.96$); the 'No' and 'I do not know.' have no significantly higher/lower z value among the HGI groups. Viewed from HGI side, the Modest has a higher z value in 'Yes'; the Middle in 'No': 'I do not know.' has no significantly higher/lower z value. The Modest 'Yes' are from Teras (3), Ulu Bernam (1) and 'None of the above' (1). Thus, it might be possible that upstream rural CBH respondents' HGI tends to be low, it could be said that RWD is not significantly different by HGI.

The Cramer's V level ($V = 0.080$) indicates a 'very weak' or no association between RWD and HGI. The p-value of Fisher's exact test (p_F) is significantly low ($p_F = 0.069 > 0.050$) and the power is insufficient ($1 - \beta = 0.17 < 0.80$). The sample size is too small to obtain a significantly small p_P value ($N = 168 < N' = 987$). It can be said that within CBH there is little association between HGI and RWD.

5.2.3.2.2 Willingness to Pay for River Water Drinkability

The statistics of WTP for RWD-HGI relationship are tabulated (**Table 5.2.3.2.2-1**) and charted (**Figure 5.2.3.2.2-1**).

Table 5.2.3.2.2-1 Willingness to Pay for RWD and Household Gross Income (CBH)

	Modest			Middle			Rich			**Total**	
RM/month	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.
0	6	15%	-0.4	18	20%	0.9	5	14%	-0.7	29	**17%**
0.01-9.99	16	41%	3.4	12	13%	-2.9	8	22%	0.0	36	**21%**
10.00-19.99	14	36%	-0.4	39	42%	1.1	12	32%	-0.9	65	**39%**
20.00 or above	3	8%	-2.5	23	25%	0.8	12	32%	1.6	38	**23%**
Total	**39**	**100%**		**92**	**100%**		**37**	**100%**		**168**	**100%**

N	df	χ^2	V	ω	$1-\beta$	p_P	p_F
168	6	17.1	0.23	0.32	0.90	0.0089	0.010

N'
134

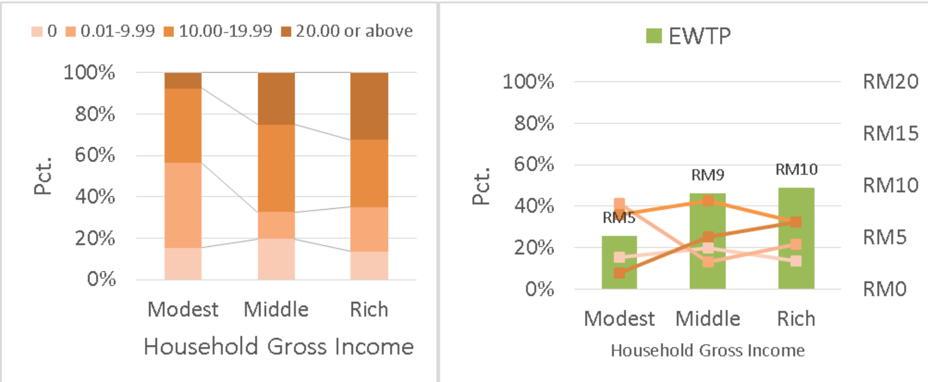


Figure 5.2.3.2.2-1 Willingness to Pay for RWD and Household Gross Income (CBH)

The ‘0,’ ‘0.01-9.99,’ ‘10.00-19.99’ and ‘20.00 or above’ pcts. were compared among the HGI groups. The ‘0’ pct. increases from the Modest (15%) to the Middle (20%) and then decreased to the Rich (14%). The ‘0.01-9.99’ pct. decreases from the Modest (41%) to the Middle (13%) and then increased to the Rich (22%). The ‘10.00-19.99’ increases from the Modest (36%) to the Middle (42%) and then decreases to the Rich (32%). The ‘20.00 or above’ increases as HGI increase: the Modest (8%), the Middle (25%) and the Rich (32%). The EWTP value increases HGI-wise: from the Modest (5 RM/month) via the Middle (9 RM/month) to the Rich (10 RM/month). Consequently, it can be said that the richer, the more willing to pay for RWD.

Whether an answer frequency (freq.) is significantly higher/lower than expected was determined by adjusted standardized residual (ASR, z).Viewed from WTP for RWD side: the ‘0.01-9.99’ is significantly higher in the Modest ($z = 3.4 > 1.96$) while lower in the Middle ($z = -2.9 < -1.96$); the ‘20.00 or above’ z value is significantly lower in the Modest ($z = -2.5$); the ‘0’ and ‘10.00-19.99’ have no significantly higher/lower z value among the HGI groups. Viewed from the HGI group side: the Modest have significantly higher ‘0.01-9.99’ z value while lower ‘20.00 or above’; the Middle lower ‘0.01-9.99’; the Rich has no significantly higher/lower z value among the WTP levels.

The Cramer's V level ($V = 0.23$) indicates a 'very weak' or no association between WTP for RWD and Sampling Site. It is larger than those of Total ($V = 0.15$) and Muslims ($V = 0.15$), meaning that CBH respondents' WTP for RWD is more HGI dependent than that of Total and Muslim respondents. The p-value of Fisher's exact test (p_F) is significantly low ($p_F = 0.010 < 0.050$) and the power is sufficiently high ($1 - \beta = 0.90 > 0.80$). The sample size is sufficiently large ($N = 168 > N' = 134$).

It appears that the richer, the more willing to pay for RWD, although the association between HGI and WTP for RWD is very weak. In addition, within the same HGI group, it appears that Septic Tank (ST) using respondents are more willing to pay for RWD than Sewerage System (SS) using ones (**Figure 5.2.1.3.2-2**). This may be because ST users are more aware of river water quality deterioration (See also **5.2.1.4.2**). However, this tendency should be moderated in Total (**5.2.1.3.2**) because Muslim respondents do not have this tendency (**5.2.2.2.2**). It could be said that CBH respondents' WTP for RWD are more sensitive to their sanitary environment than Muslim ones.

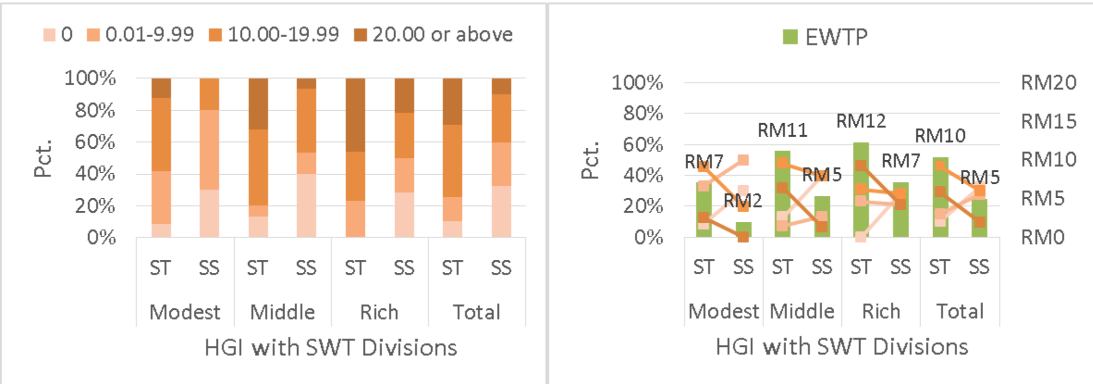


Figure 5.2.3.2.2-2 WTP for RWD and HGI with SWT Divisions (CBH)

5.2.3.2.3 Water Undrinkability Factor

The statistics of WUDF-HGI relationship are tabulated (**Table 5.2.3.2.3-1**) and charted (**Figure 5.2.3.2.3-1**).

Table 5.2.3.2.3-1 Water Undrinkability Factor and Household Gross Income (CBH)

	Taste			Odor			Turbidity			Color		
	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.	z
Modest	6	15%	2.1	6	15%	-0.6	13	33%	-0.9	9	23%	-0.6
Middle	4	4%	-1.8	18	20%	0.2	41	45%	1.4	24	26%	-0.2
Rich	3	8%	0.1	8	21%	0.4	13	34%	-0.8	12	32%	0.8
Total	**13**	**8%**	**33%**	**32**	**19%**	**-4%**	**67**	**40%**	**-27%**	**45**	**27%**	**0.0**

	Source			Religious taboo			Other*			**Total**	
	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.
Modest	3	8%	0.8	0	0%	NA	2	5%	1.8	**39**	**100%**
Middle	4	4%	-0.6	0	0%	NA	1	1%	-0.7	**92**	**100%**
Rich	2	5%	0.0	0	0%	NA	0	0%	-0.9	**38**	**100%**
Total	**9**	**5%**	**11%**	**0**	**0%**	**0%**	**3**	**2%**	**13%**	**169**	**100%**

N	df	χ^2	V	ω	1-β	p_P	p_F
169	10	10.5	0.18	0.25	0.57	0.40	0.44

N'
260

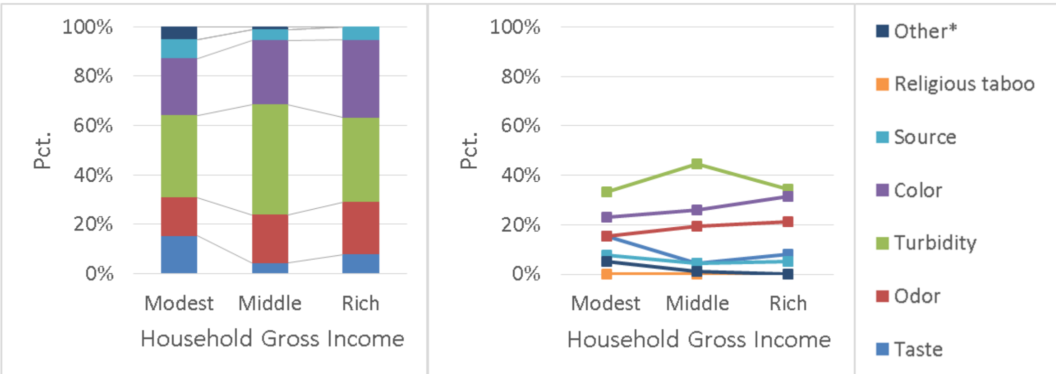


Figure 5.2.3.2.3-1 Water Undrinkability Factor and Household Gross Income (CBH)

The WUDF pcts. were compared among the HGI groups: the ‘Taste’ pct. decreases from the Modest (15%) to the Middle (4%) and then increases to the Rich (8%); the ‘Odor’ pct. increases as HGI increases (the Modest 15%, the Middle 20% and the Rich 21%); the ‘Turbidity’ pct. increases from the Modest (33%) to the Middle (45%) and then decreases to the Rich (34%); the ‘Color’ pct. increases as HGI increases (the Modest 23%, the Middle 26% and the Rich 32%); the ‘Source’ pct. decreases from the Modest (8%) to the Middle (4%) and then increases to the Rich (5%); the ‘Religious taboo’ pct. is zero throughout the HGI groups; the ‘Other*’ pct. decreases as HGI increases (the Modest 5%, the Middle 1% and the Rich 0). Organoleptic WUDFs of ‘Turbidity,’ ‘Color’ and ‘Odor’ are high priority WUDFs throughout the HGI groups, while non-organoleptic WUDFs of ‘Source,’ ‘Religious taboo,’ and ‘Other*’ are low priority WUDFs.

Whether an answer freq. is significantly higher/lower than expected was determined by adjusted standardized residual (ASR,z).There is a significantly higher z value (z = 2.1) in the ‘Taste’ of the

Modest that is the only significant z value in the table. The Modest 'Taste'-selecting respondents are various in Sampling Site, living place, ethnicity, religion, gender, education, age, *etc.*, but they all do not belong to an environmental body. But not belonging to an environmental body is very common. Thus, the significance is considered to be due most probably to their Modest HGI status. The reasoning may be (1) the Modest are more likely to have clean water with no other WUDFs, and/or (2) the Modest respondents are likely to drink somewhat unclean water with other WUDFs. It is hard to select one from the two reasonings.

The Cramer's V level ($V = 0.18$) indicates a 'very weak' or no association between WUDF and HGI. It is larger than those of Total ($V = 0.17$) and the same as Muslims ($V = 0.18$). This means that WUDF-HGI association level is the same between Islam and CBH. The p-value of Fisher's exact test (p_F) is significantly high ($p_F = 0.44 > 0.050$) and the power is sufficiently low ($1 - \beta = 0.57 < 0.80$). The sample size is too small to obtain a significantly large $p_P$value ($N = 169 < N' = 260$).

The WUDF rate-based Pearson Correlations of the HGI groups by 'R' Package 'qgraph' (ver. 1.5)[6] and the hierarchical cluster analysis (HCA) dendrogram (Euclidean distance, Ward's method) by 'R' (ver.3.4.3)[3] were shown in (**Figure 5.2.3.2.3-2**). **Figure 5.2.3.2.3-2** (**left**) shows that the three groups are similar in WUDF rates. The HCA dendrogram (**Figure 5.2.3.2.3-2**, **right**) shows that the Modest is the most characteristic among the three HGI groups. The WUDF pcts. of each the HGI group is radar-charted (**Figure 5.2.3.2.3-3**), showing that lower 'Odor' and higher 'Other*' pcts. are the characteristic of the Modest (this can also be checked by the ASRs in **Table 5.2.3.2.3-1**). The difference between the Middle and Rich is by the higher 'Taste' and 'Color,' and the lower 'Turbidity' of the Rich. (These can also be checked by the ASRs in **Table 5.2.3.2.3-1**).

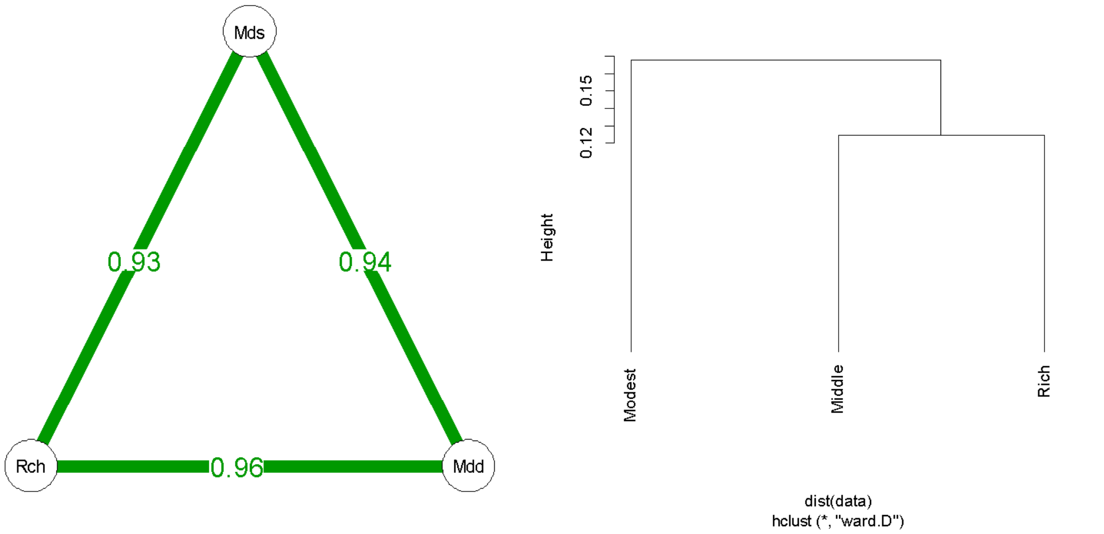


Figure 5.2.3.2.3-2 WUDF-based Correlation Diagram and HCA Dendrogram of HGI (CBH)

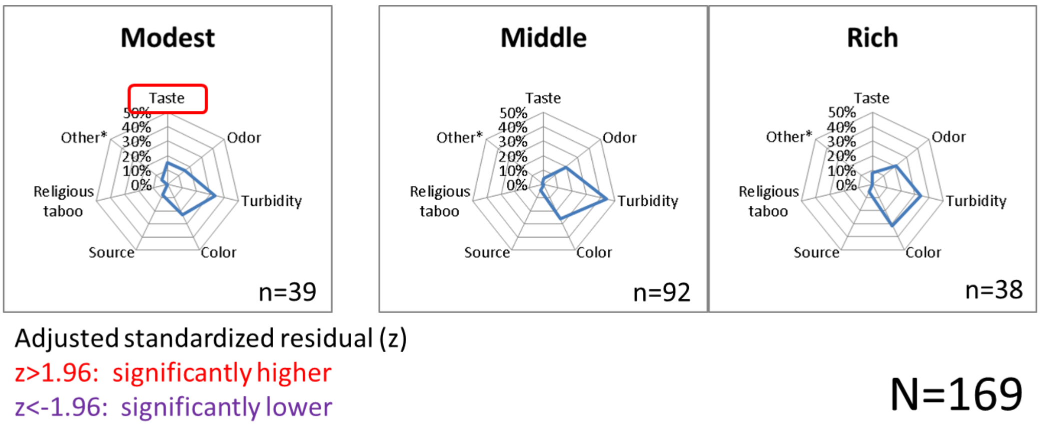


Figure 5.2.3.2.3-3 Water Undrinkability Factor and Household Gross Income (CBH)

5.2.3.3 Sewer Water Treatment

5.2.3.3.1 River Water Drinkability

The statistics of RWD-SWT relationship are tabulated (**Table 5.2.3.3.1-1**) and charted (**Figure 5.2.3.3.1-1**).

Table 5.2.3.3.1-1 River Water Drinkability and Sewer Water Treatment (CBH)

	Yes (Drinkable)			No (Undrinkable)			I do not know.			**Total**	
	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.
Septic Tank	4	4%	0.6	82	77%	0.6	21	20%	-1.2	**107**	**100%**
Sewerage System	3	7%	-0.6	28	68%	-0.6	10	24%	1.2	**41**	**100%**
Total	**7**	**5%**	**0%**	**110**	**74%**		**31**	**21%**		**148**	**100%**

N	df	χ^2	V	ω	$1-\beta$	p_P	p_F
148	2	1.4	0.10	0.10	0.18	0.50	0.42

N'
964

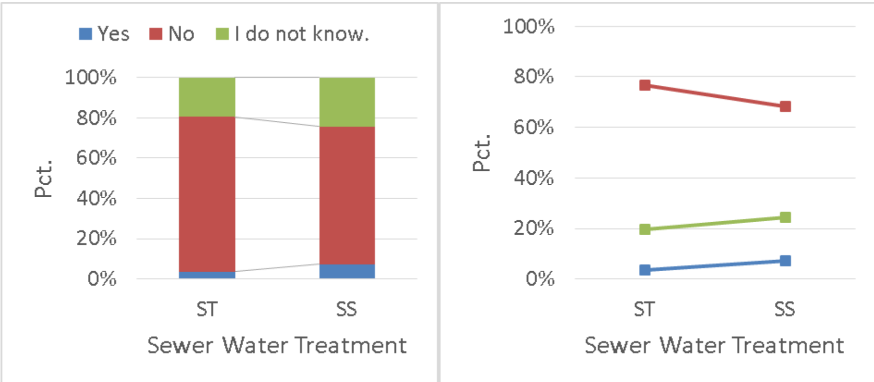


Figure 5.2.3.3.1-1 River Water Drinkability and Sewer Water Treatment (CBH)

The 'Yes (Drinkable),' 'No (Undrinkable),' and 'I do not know.' pcts. were compared between SS and ST: the 'Yes' pct. is higher in SS (4%) than in ST (7%); the 'No' pct. higher in ST (77%) than in SS (66%); the 'I do not know.' pct. higher in SS (24%) than in ST (20%).

Whether an answer freq. is significantly higher/lower than expected was determined by adjusted standardized residual (ASR, z); there is no significantly higher/lower z value in **Table 5.2.3.3.1-1**.

The Cramer's V level ($V = 0.10$) indicates a 'very weak' or no association between RWD and SWT. It is smaller than those of Total ($V = 0.12$) and Muslims ($V = 0.14$), meaning that CBH's RWD is less HGI dependent than that of Muslims, meaning that CBH's condition/habit of drinking water is more regardless of HGI than Muslims. The p-value of Fisher's exact test (p_F) is significantly high ($p_F = 0.42 > 0.050$) and the power is sufficiently low ($1 - \beta = 0.18 < 0.80$). The sample size is too small to obtain a significantly large $p_P$value ($N = 148 < N' = 946$).

There is no observed significant difference between ST and SS in CBH.

5.2.3.3.2 Willingness to Pay for River Water Drinkability

The statistics of WTP for RWD-SWT relationship are tabulated (**Table 5.2.3.3.2-1**) and charted (**Figure 5.2.3.3.2-1**).

Table 5.2.3.3.2-1 WTP for River Water Drinkability and SWT (CBH)

	Septic Tank			Sewerage System			**Total**	
RM/month	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.
0	11	10%	-3.2	13	33%	3.2	**24**	**16%**
0.01-9.99	16	15%	-1.7	11	28%	1.7	**27**	**18%**
10.00-19.99	49	46%	1.7	12	30%	-1.7	**61**	**41%**
20.00 or above	31	29%	2.4	4	10%	-2.4	**35**	**24%**
Total	**107**	**100%**		**40**	**100%**		**147**	**100%**

N	df	χ^2	V	ω	$1-\beta$	p_P	p_F
147	3	17.5	0.34	0.34	0.948	0.00057	0.00067

N'
95

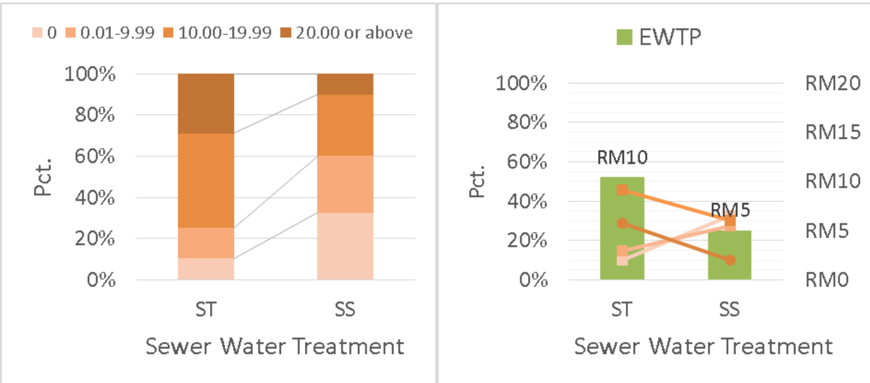


Figure 5.2.3.3.2-1 WTP for River Water Drinkability and SWT (CBH)

The ‘0,’ ‘0.01-9.99,’ ‘10.00-19.99’ and ‘20.00 or above’ pcts. were compared between the SWT groups: the ‘0’ pcts. is higher in SS (33%) than in ST (10%); the ‘0.01-9.99’ pct higher in SS (28%) than in ST (14%); the ‘10.00-19.99’ pct. higher in ST (46%) than in SS (30%); the ‘20.00 or above’ pct. higher in ST (29%) than in SS (10%). This WTP distribution clearly shows that the ST-using respondents are more willing to pay for the SS-using respondents.

Whether an answer freq. is significantly higher/lower than expected was determined by adjusted standardized residual (ASR, z). Viewed from WTP for RWD side: the ‘0’ z value is significantly lower in ST ($z = -3.2 < -1.96$) while higher in SS ($z = 3.2 > 1.96$); the ‘0.01-9.99’ and ‘10.00-19.99’ has no significantly higher/lower z value between ST and SS; the ‘20.00 or above’ is significantly higher in ST ($z = 2.4$) while lower in SS ($z = -2.4$). Viewed from SWT side: the ST z value is significantly lower in ‘0’ while higher in ‘20.00 or above’; the SS lower in ‘20.00 or above’ while higher in ‘0.’

This shows that the ST-using respondents are more willing to pay for RWD.

The Cramer's V level ($V = 0.34$) indicates a 'somewhat weak' association between WTP for RWD and SWT. It is larger than those of Total ($V = 0.12$) and Muslims ($V = 0.11$), meaning that CBH's WTP for RWD is more SWT dependent than that of Muslims. The p-value of Fisher's exact test (p_F) is significantly low ($p_F = 0.00067 < 0.050$) and the power is sufficiently high ($1 - \beta = 0.948 > 0.80$). The sample size sufficiently large ($N = 147 > N' = 95$).

By the way, with respect to EWTP, ST using respondents appear more willing to pay for RWD than SS using respondents at each Sampling Site (**Figure 5.2.2.3.2-2**). This clear trend is not observed in Muslim respondents (**5.2.2.3.2**).

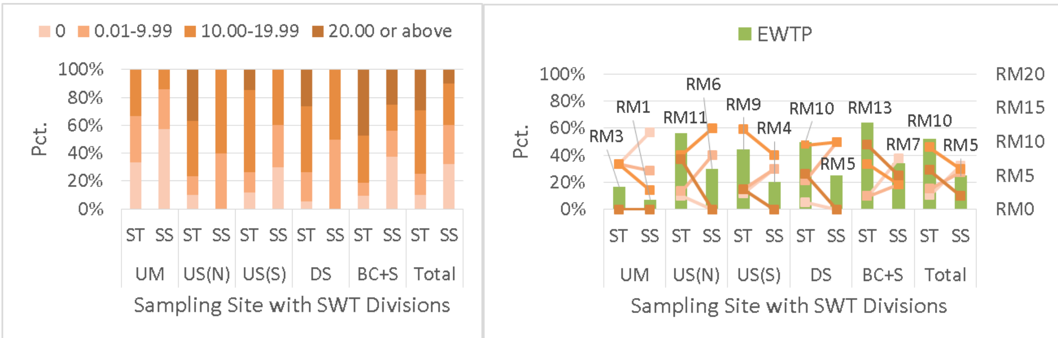


Figure 5.2.3.3.2-2 WTP for RWD (Sampling Site with SWT Divisions) (CBH)

5.2.3.3.3 Water Undrinkability Factor

The statistics of WTP for RWD-SWT relationship are tabulated (**Table 5.2.3.2.3-1**) and charted (**Figure 5.2.3.1.3-1**).

Table 5.2.3.3.3-1 Water Undrinkability Factor and Sewer Water Treatment (CBH)

	Taste			Odor			Turbidity			Color		
	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.	z
Septic Tank	5	5%	-1.6	21	20%	0.13	43	40%	0.13	32	30%	1.0
Sewerage System	5	12%	1.6	8	20%	-0.13	16	39%	-0.13	9	22%	-1.0
Total	**10**	**7%**		**29**	**20%**		**59**	**40%**		**41**	**28%**	

	Source			Religious taboo			Other*			**Total**	
	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.
Septic Tank	4	4%	-0.3	0	0%	NA	2	2%	-0.2	**107**	**100%**
Sewerage System	2	5%	0.3	0	0%	NA	1	2%	0.2	**41**	**100%**
Total	**6**	**4%**		**0**	**0%**		**3**	**2%**		**148**	**100%**

N	df	χ^2	V	ω	1-β	p_P	p_F
148	5	3	0.15	0.15	0.24	0.65	0.59

N'
571

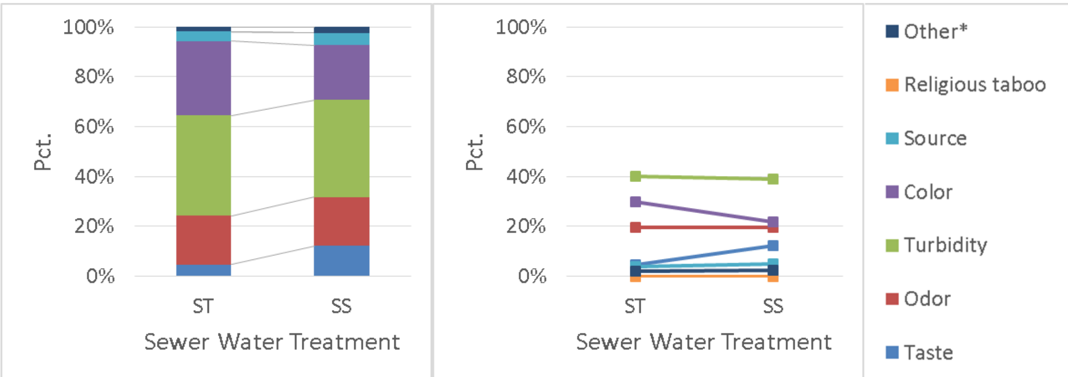


Figure 5.2.3.3.3-1 Water Undrinkability Factor and Sewer Water Treatment (CBH)

The WUDF pcts. were compared between the SWT groups: the ‘Taste’ pct. is higher in SS (12%) than ST (5%); the ‘Odor’ the same in SS (20%) and in ST (20%); the ‘Turbidity’ higher in SS (40%) than ST (39%); the ‘Color’ higher in ST (30%) than SS (22%); the ‘Source’ higher in SS (5%) than in ST (4%); the ‘Religious taboo’ the same in SS (0%) and in ST (0%); the ‘Other* the same in SS (2%) and in ST (2%). It can be said the pct. difference between ST and SS is due mostly to ‘Taste’ and ‘Color,’ though the difference is small. The EWTP value is higher in ST (10 RM/month) than SS (5 RM/month). Consequently, it can be said that the ST using respondents are willing to pay more than the SS using respondents.

Whether an answer freq. is significantly higher/lower than expected was determined by adjusted standardized residual (ASR, z). There is no significantly higher/lower z value in **Table 5.2.3.3.3-1**.

The Cramer’s V level (V = 0.15) indicates a ‘very weak’ association between WUDF and SWT. It is larger than those of Total (V = 0.12) while smaller than Muslims (V = 0.25), meaning that CBH’s

WTP for RWD is less SWT dependent than that of Muslims. The p-value of Fisher's exact test (p_F) is significantly high ($p_F = 0.59 > 0.050$) and the power insufficient ($1 - \beta = 0.24 < 0.80$). The sample size is too small to obtain a significant p_P value with a sufficiently large power ($N = 148 < N' = 571$).

The SS and ST's WUDF pcts. were radar-charted (**Figure 5.2.3.3.3-2**). The ST-SS difference is due mainly to 'Taste' and 'Color,' which can also be checked by the corresponding ASR values in **Table 5.2.3.3.3-1**.

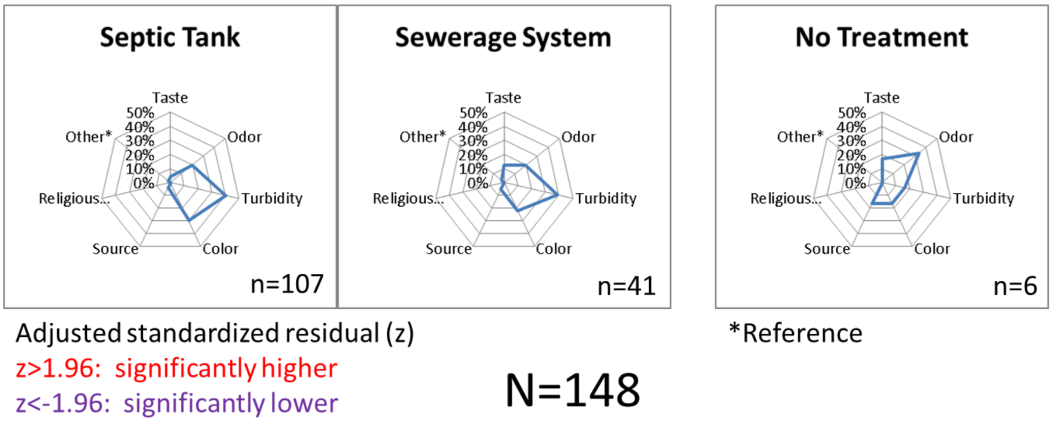


Figure 5.2.3.3.3-2 Water Undrinkability Factor and Sewer Water Treatment (CBH)

5.3 Worst Trouble

In order to comprehend people's trouble regarding their nearest river, Worst Trouble (WT) was asked in **Q11** of the Survey Sheet:

Q11. <u>The worst trouble</u> about the nearest river is ____☑____? (Please select **<u>only one</u>**.)

☐Flood ☐Drought ☐Water-borne disease ☐Pollution ☐Lack of safety

☐Other ______________ ☐I do not know.

The 'Other' was combined with multiple-choice answers, because the 'Other' frequency is small and it included written answers such as 'All,' *etc.* (Other* = Other + Multiple answers).

5.3.1 Total

5.3.1.1 Sampling Site

The statistics of Worst Trouble (WT)-Sampling Site relationship are tabulated (**Table 5.3.1.1-1**) and charted (**Figure 5.3.1.1-1**).

Table 5.3.1.1-1 Worst Trouble and Sampling Site (Total)

	UM			US(N)			US(S)		
	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.	z
Flood	3	7%	-0.8	10	8%	-0.8	20	16%	2.4
Drought	1	2%	-0.2	4	3%	0.4	5	4%	0.9
Water-borne disease	3	7%	-2.3	27	22%	0.9	33	26%	2.2
Pollution	11	24%	-3.3	60	49%	0.4	45	36%	-3.1
Lack of safety	11	24%	5.6	5	4%	-0.9	4	3%	-1.5
Other*	11	24%	4.4	7	6%	-1.0	10	8%	0.1
I do not know.	5	11%	1.4	9	7%	0.5	9	7%	0.4
Total	**45**	**100%**		**122**	**100%**		**126**	**100%**	

	DS			BC+S			Total	
	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.
Flood	8	10%	-0.2	10	8%	-0.9	51	**10%**
Drought	2	2%	-0.3	2	2%	-0.9	14	**3%**
Water-borne disease	18	21%	0.5	16	13%	-2.1	97	**19%**
Pollution	40	48%	0.0	83	67%	4.9	239	**48%**
Lack of safety	8	10%	1.6	1	1%	-2.7	29	**6%**
Other*	5	6%	-0.7	6	5%	-1.4	39	**8%**
I do not know.	3	4%	-1.2	6	5%	-0.8	32	**6%**
Total	**84**	**100%**		**124**	**100%**		**501**	**100%**

N	df	χ^2	V	ω	1- β	p_P	p_F
501	24	94.1	0.22	0.43	0.99999980	0.00000000030	≤0.00000050

N'
122

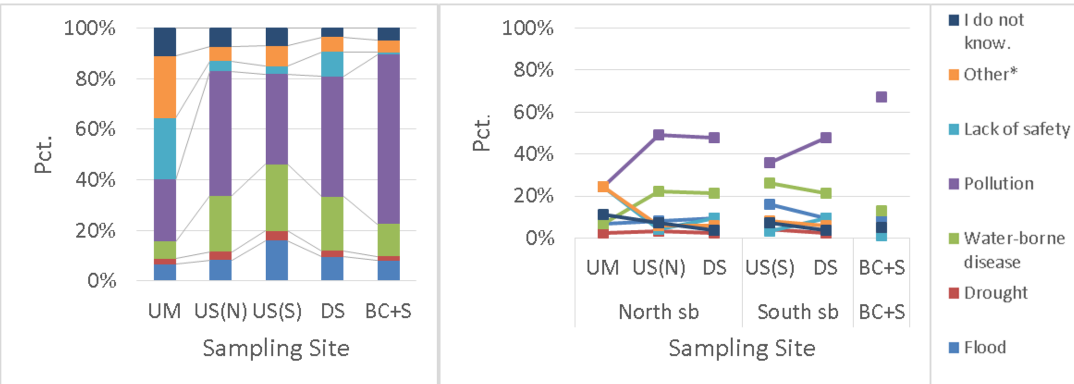


Figure 5.3.1.1-1 Worst Trouble and Sampling Site (Total)

The ‘Flood’ pct. in the North sb increases flow-wise from UM (7%) via US(N) (8%) to DS (10%); in the North sb decreases from US(S) (16%) to DS (10%); at BC+S it is 8%. The ‘Drought’ pct. increases from UM (2%) to US(N) (3%) and then decreases to DS (2%); in the South sb decreases from US(S) (4%) to DS (2%); at BC+S it is 2%. The ‘Water-borne disease’ pct. increases from UM (7%) via US(N) (22%) and then decreases to DS (21%); in the South sb decreases from US(S) (26%) to DS (21%); at BC+S it is 12%. The ‘Pollution’ pct. increases from UM (24%) to US(N) (49%) and then decreases to DS (48%); in the South sb increases from US(S) 36% to DS (48%); at BC+S it is 67%. The ‘Lack of safety' decreases from UM (24%) to US(N) (4%) and then increases to DS (10%); in the South sb increases from US(S) (3%) to DS (10%); at BC+S it is 1%. The 'Other*' decreases from UM (24%) to US(N) (6%) and then stay unchanged to DS (6%); at BC+S it is 5%. The 'I do not know.' pct. decreases flow-wise: in the North sb. from UM (11%) via US(N) (7%) to DS (4%); in the South sb from US(S) (7%) to DS (4%). At BC+S it is 5%. 'Pollution' pct. is the highest throughout the Sampling Sites. 'Water-borne disease' pct. the second worst throughout the Sampling Sites except UM.

Whether an answer frequency (freq.) is significantly higher/lower than expected was determined by adjusted standard residual (ASR, z). Viewed from WT side: the 'Water-borne disease' z value is significantly lower at UM (z =-2.3<-1.96), at US(S) ($z = -2.3$) and BC+S ($z = -2.1$); the 'Pollution' lower at UM ($z = -3.3$) while higher at BC+S ($z = 4.9 > 1.96$); the 'Lack of safety' higher at UM ($z = 5.6$) and at US(S) ($z = 2.1$) while lower at BC+S ($z = -2.7$); 'Other*' higher at UM ($z = 4.4$); 'Flood,' 'Drought' and 'I do not know.' have no significantly higher/lower z value throughout the Sampling Sites. Viewed from Sampling Site side: UM has higher z values in 'Lack of safety,' 'Other*' while lower in 'Water-borne disease' and in 'Pollution'; US(S) higher in 'Lack of safety' while lower in 'Water-borne disease'; BC+S higher in 'Pollution' while lower in 'Water-borne disease' and in 'Lack of safety'; US(N) and DS has no significantly higher/lower z value throughout the WTs.

At UM, rivers are generally clean, thus there 'Pollution' and 'Water-borne disease' are significantly lower, in whose stead 'Lack of safety' and 'Other*' seem to be selected. The eleven UM 'Other*' included one 'Multiple answers' ('Flood' and 'Pollution') and ten 'Others,' whose written answers are: 'No' 'No problem' and 'No trouble' (6 people), 'Too far' (2), 'No water' (1) and no description (1). The 'Lack of safety' significant largeness at UM may be because of wild and steep mountain streams; at US(S) may be because of robbery (a local fishing tackle shop person said that there were robberies riverside).

The Cramer's V level ($V = 0.22$) indicates a 'very weak' association between WT and Sampling Site. The p-value of Fisher's exact test (p_F) is significantly low ($p_F \leq 0.00000050 < 0.050$) and the power sufficiently large ($1 - \beta = 0.99999980 > 0.80$). The sample size sufficiently large ($N = 501 > N' = 122$).

The WT rate-based Pearson Correlations of the Sampling Sites by 'R' Package 'qgraph' (ver. 1.5)[6] and the hierarchical cluster analysis (HCA) dendrogram (Euclidean distance, Ward's method) by 'R' (ver.3.4.3)[3] were shown in (**Figure 5.3.1.1-2**).**Figure 5.3.1.1-2** (**left**) shows that UM is the most characteristic among the five Sampling Sites. **Figure 5.3.1.1-2** (**right**) shows HCA a stairs-like clustering of the Sampling Sites. The closest two (DS and US(N)) can be classified as Suburban North

Area (Suburban North); US(S) in addition to the SNA makes Sg. Selangor Basin Core Area (SSBCA); BC+S and UM are the basin's external and peripheral and areas (urban and mountain areas), respectively. **Figure 5.3.1.1-3** shows radar charts of WT at the Sampling Sites, visualizing that 'Pollution,' 'Water-borne disease (Disease),' 'Lack of Safety' and 'Other*' are the key factors, while 'Flood' and 'Drought' are not. In SSB pollution particularly from Rawang (US(S)) is considerable, but flood is generally '*not a major issue*' but locally in flood prone areas it may be an issue.[9]

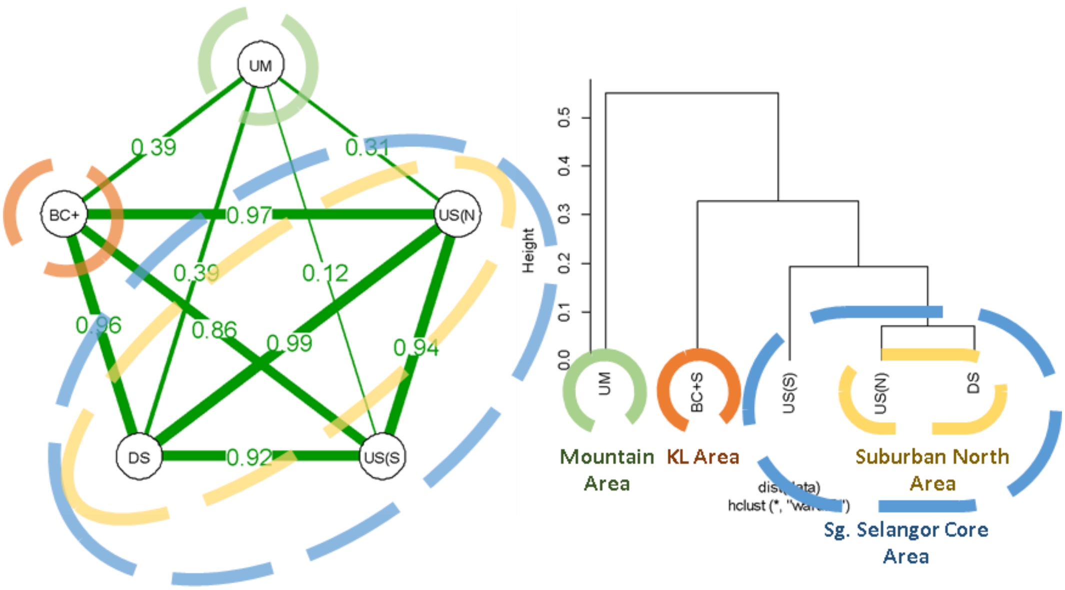
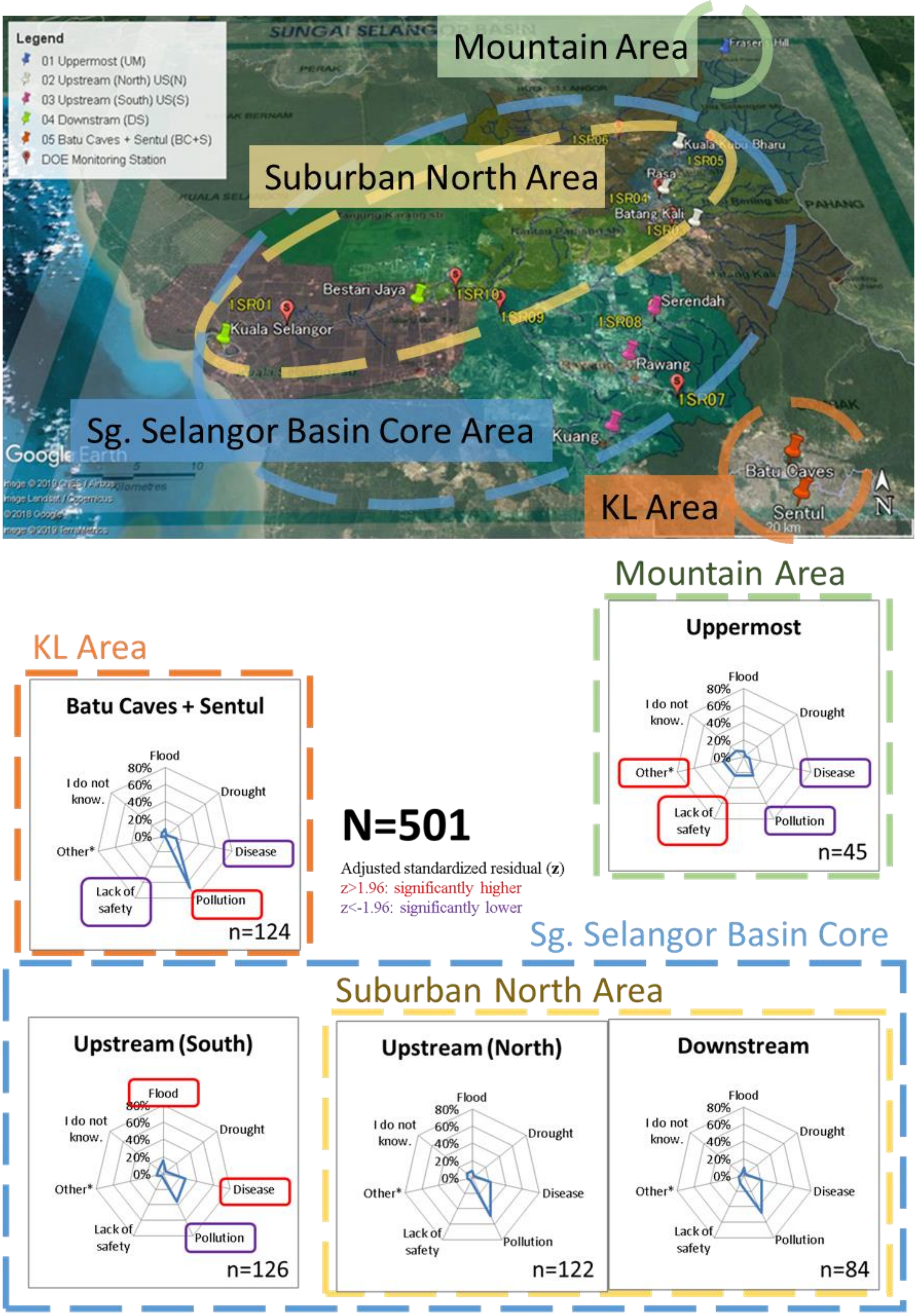


Figure 5.3.1.1-2 WT-based Correlation Diagram and HCA Dendrogram of Sampling Site (Total)



Other* = Other + Multiple answers

Figure 5.3.1.1-3 Map[7] of Clusterings and Rader Charts of Worst Troubles (Total)

5.3.1.2 Religion

The statistics of WT-Religion relationship are tabulated (**Table 5.3.1.2-1**) and charted (**Figure 5.3.1.2-1**).

Table 5.3.1.2-1 Worst Trouble and Religion (Total)

	Islam			CBH			**Total**	
	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.
Flood	28	10%	-0.5	19	11%	0.5	47	**10%**
Drought	9	3%	0.1	5	3%	-0.1	14	**3%**
Water-borne disease	20	7%	-9.1	72	42%	9.1	92	**20%**
Pollution	168	58%	5.1	58	34%	-5.1	226	**49%**
Lack of safety	18	6%	0.4	9	5%	-0.4	27	**6%**
Other*	28	10%	2.0	8	5%	-2.0	36	**8%**
I do not know.	17	6%	2.8	1	1%	-2.8	18	**4%**
Total	**288**	**100%**		**172**	**100%**		**460**	**100%**

N	df	χ^2	V	ω	1- β	p_P	p_F
460	6	90.6	0.44	0.44	1.0	<0.00000000000000022	<0.00000000000000022

N'
71

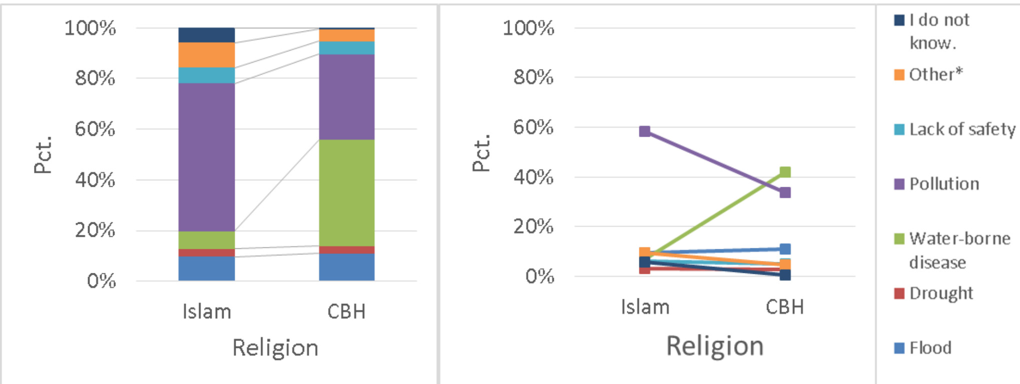


Figure 5.3.1.2-1 Worst Trouble and Religion (Total)

The 'Flood' pct. is higher in CBH (11%) than in Islam (10%); the 'Drought' the same in Islam (3%) and in CBH (3%); the 'Water-borne disease' higher in CBH (42%) than in Islam (6%); the 'Pollution' higher in Islam (58%) than in CBH (34%); the 'Lack of safety' higher in Islam (6%) than in CBH (5%); the 'Other*' higher in Islam (10%) than in CBH (5%); the 'I do not know.' higher in Islam (6%) than in CBH (1%). It is clear that the main factors are 'Pollution' and 'Water-borne disease.'

Whether an answer frequency (freq.) is significantly higher/lower than expected was determined by adjusted standard residual (ASR, z). Viewed from WT side: the 'Water-borne disease' has a significantly higher z value in CBH ($z = 9.1 > 1.96$) while lower in Islam ($z = -9{,}1 < -1.96$); the 'Pollution' higher in Islam ($z = 5.1$) while lower in CBH ($z = -5.1$); the 'I do not know.' higher in

Islam ($z = 2.8$) while lower in CBH ($z = -2.8$); 'Flood,' 'Drought,' 'Lack of safety' and 'Other*' have no significantly higher/lower z value.

The Cramer's V level ($V = 0.44$) indicates a 'somewhat weak' association between WT and Religion. The p-value of Fisher's exact test (p_F) is significantly low ($p_F =< 0.000000000000000022 < 0.050$) and the power sufficiently large ($1 - \beta = 1.0 > 0.80$). The sample size is sufficiently large ($N = 460 > N' = 71$).

Figure 5.3.1.2-2 shows radar charts of WT of Islam and CBH, respectively.

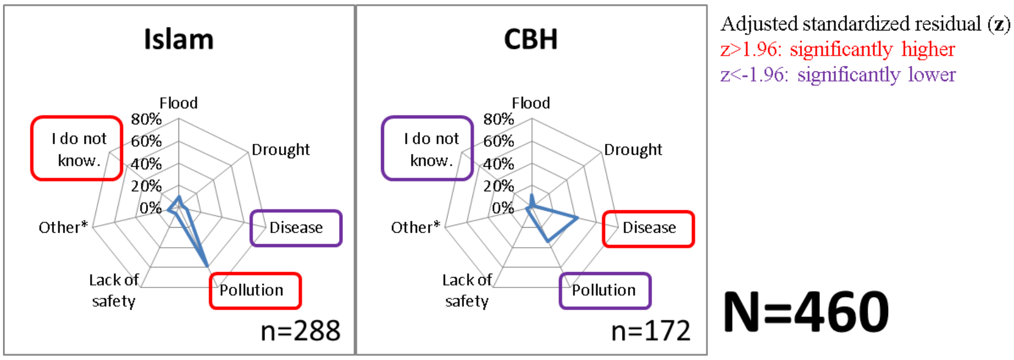


Figure 5.3.1.2-2 Worst Trouble and Religion (Total)

CBH respondents may suffer water-borne disease more often than Muslim respondents, probably because of which CBH respondents are more concerned about river. It is possible that Muslim respondents' rivers are more disease-free than CBH respondents, or Muslim respondents live more distant from their rivers than CBH ones. It could be possible that the Islamic water use criteria[7] are effective for preventing water-borne disease from rivers.

5.3.1.3 Household Gross Income

The statistics of WT-HGI relationship are tabulated (**Table 5.3.1.3-1**) and charted (**Figure 5.3.1.3-1**).

Table 5.3.1.3-1 Worst Trouble and Household Gross Income (Total)

	Modest			Middle			Rich			**Total**	
	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.
Flood	12	11%	0.4	17	10%	-0.1	13	9%	-0.3	42	**10%**
Drought	7	6%	2.1	3	2%	-1.5	4	3%	-0.4	14	**3%**
Water-borne disease	25	23%	0.2	55	32%	3.9	14	10%	-4.2	94	**22%**
Pollution	40	37%	-2.7	74	43%	-1.8	88	63%	4.5	202	**48%**
Lack of safety	8	7%	1.3	10	6%	0.6	3	2%	-1.9	21	**5%**
Other*	11	10%	1.1	13	7%	-0.1	8	6%	-1.0	32	**8%**
I do not know.	6	6%	0.9	2	1%	-2.5	9	6%	1.8	17	**4%**
Total	**109**	**100%**		**174**	**100%**		**139**	**100%**		**422**	**100%**

N	df	χ^2	V	ω	$1-\beta$	p_P	p_F
422	12	43.1	0.23	0.32	0.9986	0.000022	0.0000060

N'
170

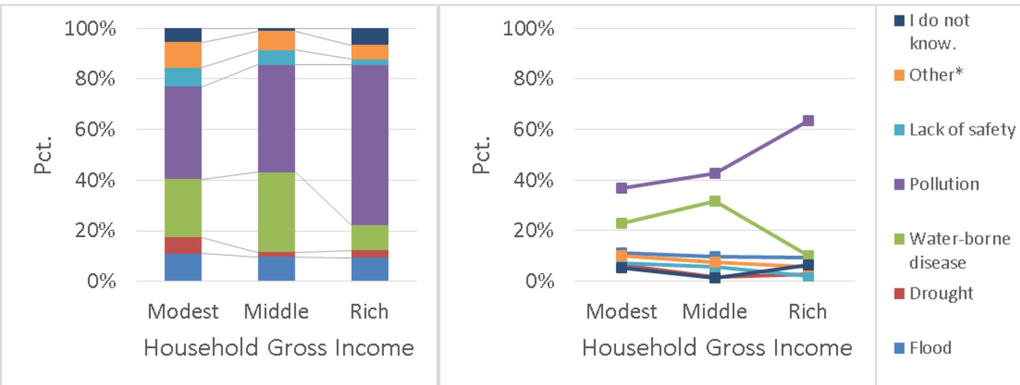


Figure 5.3.1.3-1 Worst Trouble and Household Gross Income (Total)

The ‘Flood’ pct. decreases HGI-wise from the Modest (11%) via the Middle (10%) to the Rich (9%); the ‘Drought’ pct. decreases from the Modest (6%) via the Middle (2%) and then increases to the Rich (3%); the ‘Water-borne disease’ pct. increases from the Modest (23%) to the Middle (32%) and then decreases to the Rich (10%); the ‘Pollution’ increases HGI-wise from the Modest (37%) via the Middle (43%) to the Rich (63%); the ‘Lack of safety’ pct. decreases HGI-wise from the Modest (7%) via the Middle (6%) to the Rich (2%); so does the ‘Other*’ pct. from the Modest (10%) via the Middle (7%) to the Rich (6%); the ‘I do not know.’ pct. decreases from the Modest (6%) to the Middle (1%) and then increases to the Rich (6%). The largest two pcts of ‘Pollution’ and ‘Water-borne disease’ increase together from the Modest to the Middle and then the ‘Pollution’ acceleratingly increases to the Rich while the ‘Water-borne disease’ decreases. This may indicate that the Rich relatively do not suffer a disease from their nearest river, so their interest goes toward ‘Pollution.’ The pcts of the rest are relatively stable and small compared to the top two.

Whether an answer frequency (freq.) is significantly higher/lower than expected was determined by

adjusted standard residual (ASR,z). Viewed from WT side: the 'Drought' z value is significantly higher in the Modest ($z = 2.1 > 1.96$); the 'Water-borne disease' higher in the Middle ($z = 3.9$) while lower in the Rich ($z = -4.2 < -1.96$); the 'Pollution' lower in the Modest ($z = -2{,}7$) while higher in the Rich ($z = -2.7$); the 'I do not know.' lower in the Middle ($z = -2.5$); the 'Flood,' 'Lack of safety,' and 'Other*' have no significantly higher/lower z value throughout the HGI groups.

The Cramer's V level ($V = 0.23$) indicates a 'very weak' association between WT and HGI. The p-value of Fisher's exact test (p_F) is significantly low ($p_F = 0.0000060 < 0.050$) and the power sufficiently large ($1 - \beta = 0.9986 > 0.80$). The sample size is sufficiently large ($N = 422 > N' = 170$).

The WT rate-based Pearson Correlations of the HGI groups by 'R' Package 'qgraph' (ver. 1.5)[6] and the hierarchical cluster analysis (HCA) dendrogram (Euclidean distance, Ward's method) by 'R' (ver.3.4.3)[3] were shown in (**Figure 5.3.1.3-2**). **Figure 5.3.1.3-2** (**left**) shows that t the three are similar. **Figure 5.3.1.3-2** (**right**) shows that the Rich is the most characteristic among the three, too. **Figure 5.3.1.3-3** shows radar charts of WT in the HGI groups, visualizing that 'Pollution,' 'Water-borne disease (Disease),' 'I do not know.' and 'Drought' are the key factors, while 'Flood,' 'Lack of safety,' and 'Other*' are not.

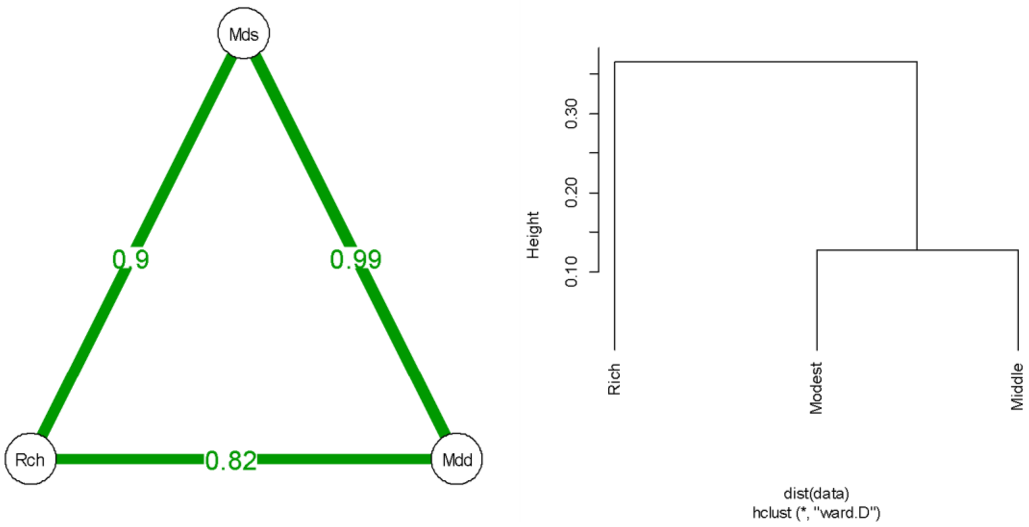


Figure 5.3.1.3-2 Worst Trouble-based Correlation Diagram and HCA Dendrogram of HGI (Total)

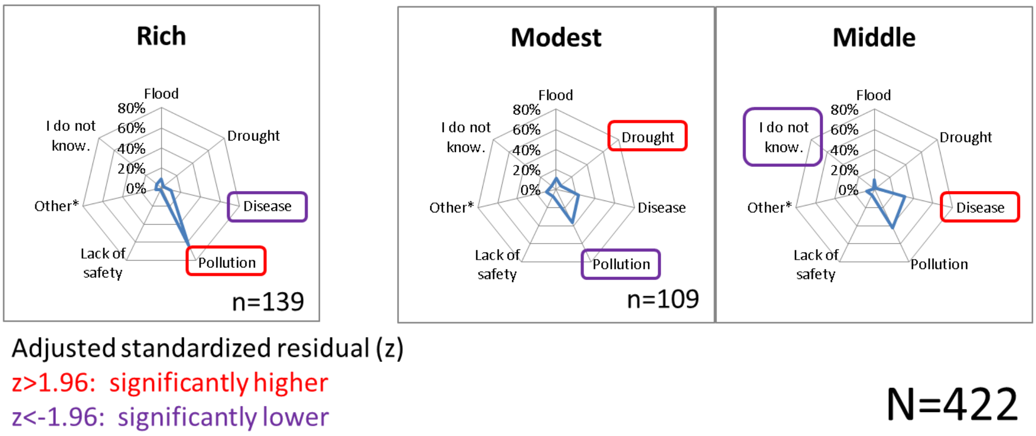


Figure 5.3.1.3-3 Worst Trouble and Household Gross Income (Total)

5.3.1.4 Sewer Water Treatment

The statistics of WT-SWT relationship are tabulated (**Table 5.3.1.4-1**) and charted (**Figure 5.3.1.4-1**).

Table 5.3.1.4-1 Worst Trouble and Sewer Water Treatment (Total)

	Septic Tank			Sewerage System			**Total**	
	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.
Flood	23	14%	1.5	12	8%	-1.5	35	**11%**
Drought	7	4%	0.7	4	3%	-0.7	11	**4%**
Water-borne disease	64	39%	5.5	16	11%	-5.5	80	**26%**
Pollution	51	31%	-5.4	88	62%	5.4	139	**45%**
Lack of safety	8	5%	-0.8	10	7%	0.8	18	**6%**
Other*	12	7%	0.9	7	5%	-0.9	19	**6%**
I do not know.	1	1%	-2.1	6	4%	2.1	7	**2%**
Total	**166**	**100%**		**143**	**100%**		**309**	**100%**

N	df	χ^2	V	ω	$1-\beta$	p_P	p_F
309	6	46.6	0.39	0.39	0.999930	0.000000023	0.0000000037

N'
90

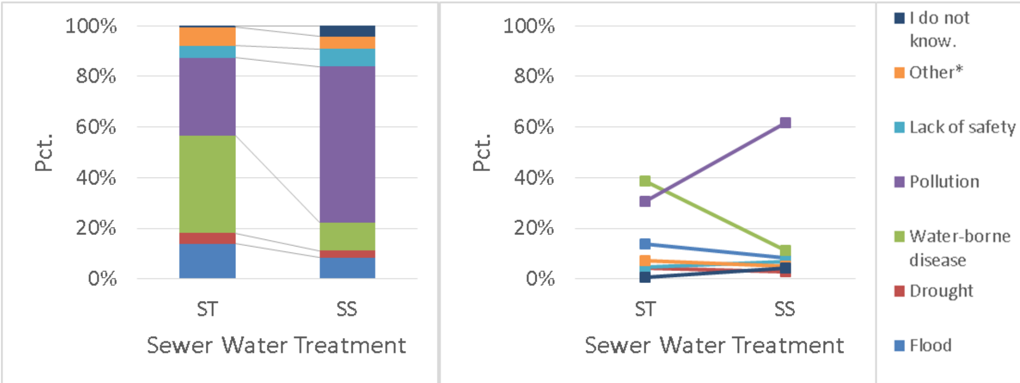


Figure 5.3.1.4-1 Worst Trouble and Sewer Water Treatment (Total)

The ‘Flood’ pct. is higher in ST (14%) than in SS (8%); the ‘Drought’ higher in ST (4%) and in SS (3%); the ‘Water-borne disease’ higher in ST (42%) than in SS (6%); the ‘Pollution’ higher in SS (62%) than in ST (31%); the ‘Lack of safety’ higher in SS (7%) than in ST (5%); the ‘Other*’ higher in ST (7%) than in SS (5%); the ‘I do not know.’ higher in ST (4%) than in SS (1%). It is clear that the main factors are ‘Pollution’ and ‘Water-borne disease.’

Whether an answer frequency (freq.) is significantly higher/lower than expected was determined by adjusted standard residual (ASR, z). Viewed from WT side: the ‘Water-borne disease’ has a significantly higher z value in ST $(z = 5.5 > 1.96)$ while lower in SS $(z = -5.5 < -1.96)$; the ‘Pollution’ higher in SS $(z = 5.4)$ while lower in ST $(z = -5.4)$; the ‘I do not know.’ higher in SS $(z = 2.1)$ while lower in ST $(z = -2.1)$; ‘Flood,’ ‘Drought,’ ‘Lack of safety’ and ‘Other*’ have no significantly higher/lower z value.

The Cramer’s V level $(V = 0.39)$ indicates a ‘somewhat weak’ association between Worst Trouble and Sewer Water Treatment. The p-value of Fisher’s exact test (p_F) is significantly low $(p_F = 0.0000000037 < 0.050)$ and the power sufficiently large $(1 - \beta = 0.999930\ 1.0 > 0.80)$. The sample size is sufficiently large $(N = 309 > N' = 90)$.

The WT pcts. in ST and SS were radar-charted (**Figure 5.3.1.4-2**).

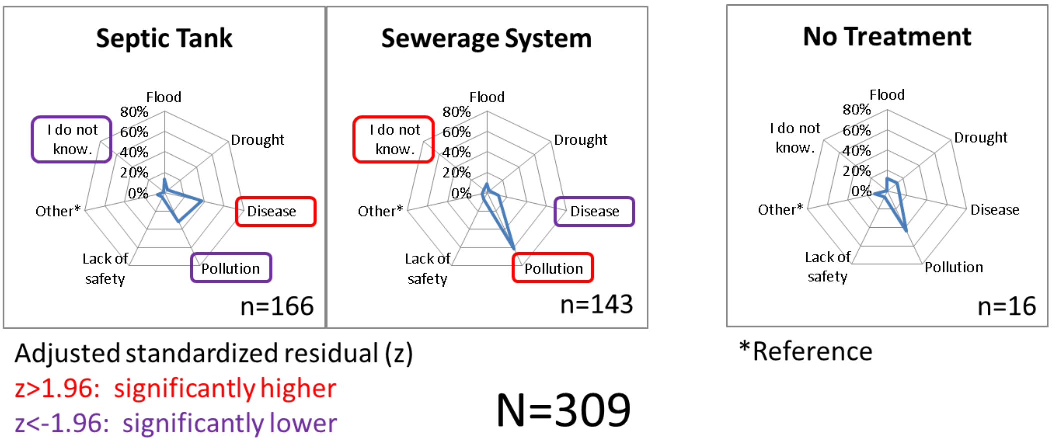


Figure 5.3.1.4-2 Worst Trouble and Sewer Water Treatment (Total)

The ST respondents may suffer water-borne disease more often than the SS respondents, probably because of which the ST are more concerned about river. It is possible that the SS respondents' rivers are more disease-free than ST respondents, or Muslims live more distant from their rivers than the STs.

5.3.2 Islam

5.3.2.1 Sampling Site

The statistics of WT-Sampling Site relationship are tabulated (**Table 5.3.2.1-1**) and charted (**Figure 5.3.2.1-1**).

Table 5.3.2.1-1 Worst Trouble and Sampling Site (Islam)

	UM			US(N)			US(S)		
	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.	z
Flood	2	6%	-0.8	8	10%	0.1	9	14%	1.3
Drought	1	3%	0.0	3	4%	0.4	4	6%	1.6
Water-borne disease	2	6%	-0.2	3	4%	-1.3	8	13%	2.0
Pollution	10	30%	-3.5	52	66%	1.6	32	50%	-1.5
Lack of safety	7	21%	3.8	4	5%	-0.5	1	2%	-1.8
Other*	7	21%	2.4	6	8%	-0.7	7	11%	0.4
I do not know.	4	12%	1.6	3	4%	-0.9	3	5%	-0.5
Total	**33**	**100%**		**79**	**100%**		**64**	**100%**	

	DS			BC+S			**Total**	
	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.
Flood	6	11%	0.4	3	5%	-1.3	28	**10%**
Drought	1	2%	-0.6	0	0%	-1.5	9	**3%**
Water-borne disease	4	7%	0.1	3	5%	-0.6	20	**7%**
Pollution	31	57%	-0.2	43	74%	2.7	168	**58%**
Lack of safety	6	11%	1.6	0	0%	-2.2	18	**6%**
Other*	4	7%	-0.6	4	7%	-0.8	28	**10%**
I do not know.	2	4%	-0.8	5	9%	1.0	17	**6%**
Total	**54**	**100%**		**58**	**100%**		**288**	**100%**

N	df	χ^2	V	ω	$1-\beta$	p_P	p_F
288	24	49.7	0.21	0.42	0.9978	0.0015	0.0016

N'
128

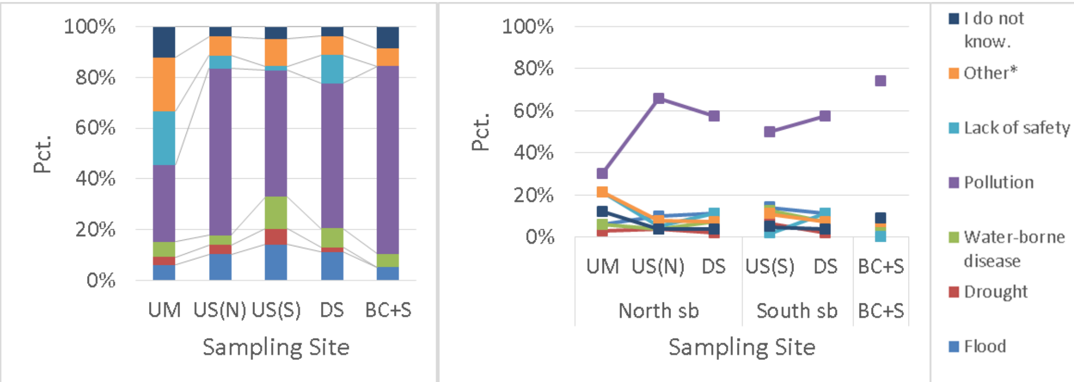


Figure 5.3.2.1-1 Worst Trouble and Sampling Site (Islam)

The ‘Flood’ pct. in the North sb increases flow-wise from UM (6%) via US(N) (10%) to DS (11%); decreases in the South sb from US(S) (14%) to DS (14%); at BC+S it is 5%. The ‘Drought’ pct. in the North sb increases from UM (3%) to US(N) (4%) and then decreases to DS(2%); at BC+S it is 0%. The ‘Water-borne disease’ pct. decreases in the North sb from UM (6%) via US(N) (4%) and then increases to DS (7%); at BC+S it is 5%. The ‘Pollution’ pct. increases from UM (3%) via US(N) (66%) and then decreases to DS (57%); in the South sb increases from US(S) (53%) to DS (57%); at BC+S it is 74%; the ‘Lack of safety’ pct. decreases from UM (21%) to US(N) (5%) and then increases to DS (11%); in the South sb increases from US(S) (2%) to DS (11%); at BC+S it is 0%. The ‘Other*’ pct.in the North sb from UM (21%) to US(N) (5%) and then increases to DS (7%); in the South sb decreases from US(S) (11%) to DS (7%); at BC+S it is 7%; the 'I do not know.' pct. in the North sb decreases from UM(12%) to US(N) (4%) and then stays unchanged to DS (4%); in the South sb decreases from US(S) (5%) to DS (4%); at BC+S it is 9%. It is clear that the main Worst Trouble for Muslims is 'Pollution.'

Whether an answer frequency (freq.) is significantly higher/lower than expected was determined by adjusted standard residual (ASR,z). Viewed from WT side: the 'Water-borne disease' z value is significantly higher at US(S) ($\mathrm{z} = 2.0 > 1.96$); the 'Pollution' lower at UM ($\mathrm{z} = -3.5 < -1.96$) while higher at BC+S ($\mathrm{z} = 2.7$); the 'Lack of safety' higher at US ($\mathrm{z} = 3.8$) while lower at BC+S ($\mathrm{z} = -2.2$); 'Flood,' 'Drought,' 'Other*,' and 'I do not know.' has no significantly higher/lower z value throughout the Sampling Site. Viewed from Sampling Site side: UM has a significantly lower z value in 'Pollution' while higher in 'Lack of safety' and 'Other*'; US(S) higher 'Water-borne disease'; BC+S higher 'Pollution' while lower 'Lack of safety'. US(N) and DS have no significantly higher/lower z value. The significantly higher/lower z values are from the external and peripheral areas, except that of 'Water-borne disease' at US(S) and the dendrogram clusters the SSBCA (**Figure 5.3.2.1-3**), which means that the SSBCA's Sampling Sites have relatively similar trend in Worst Trouble and within the SSBCA 'Water-borne disease' in US(S) is particularly characteristic.

The Cramer's V level ($\mathrm{V} = 0.21$) indicates a 'very weak' association between WT and Sampling Site. The p-value of Fisher's exact test ($\mathrm{p_F}$) is significantly low ($\mathrm{p_F} = 0.0016 < 0.050$) and the power sufficiently large ($1 - \beta = 0.9978 > 0.80$). The sample size sufficiently large ($\mathrm{N} = 288 > \mathrm{N}' = 128$).

The WT rate-based Pearson Correlations of the Sampling Sites by 'R' Package 'qgraph' (ver. 1.5)[6] and the hierarchical cluster analysis (HCA) dendrogram (Euclidean distance, Ward's method) by 'R' (ver.3.4.3)[3] were shown in (**Figure 5.3.2.1-2**). **Figure 5.3.2.1-2** (**left**) shows that UM is the most characteristic among the five Sampling Sites. **Figure 5.3.2.1-2** (**right**) shows a stairs-like HCA clustering of the Sampling Sites. The closest two (DS and US(N)) can be classified as North Suburban Area (NSA); US(S) in addition to the NSA makes Sg. Selangor Basin Core Area (SSBCA); BC+S and UM are the basin's external and peripheral and areas (urban and mountain areas), respectively. **Figure 5.3.2.1-3** shows radar charts of WT at the Sampling Sites, visualizing that 'Pollution,' 'Water-borne disease (Disease),' 'Lack of Safety' and 'Other*' are the key factors, while 'Flood' and 'Drought' are not.

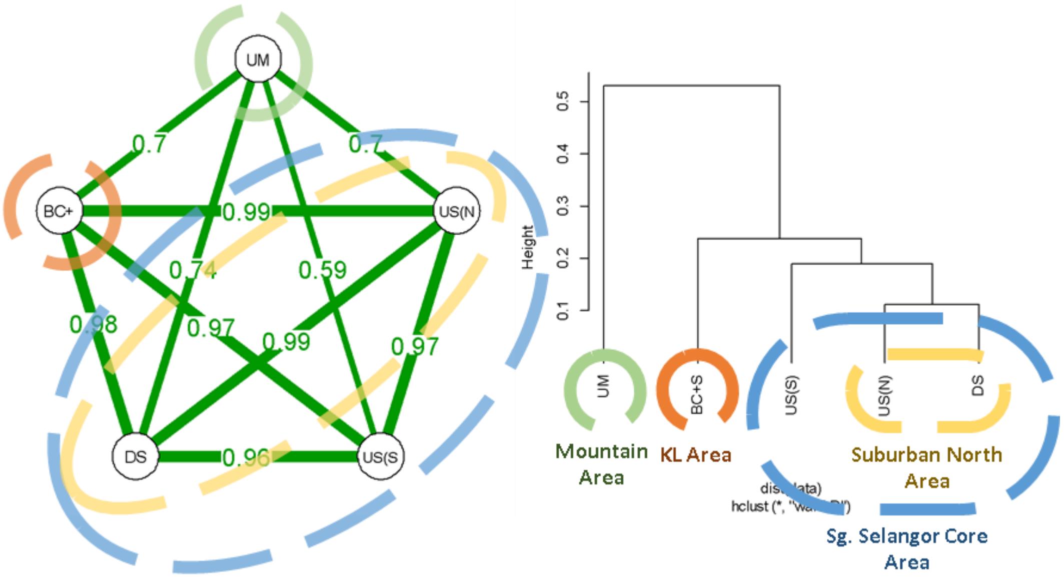


Figure 5.3.2.1-2 WT-based Correlation Diagram and HCA Dendrogram of Sampling Site (Islam)

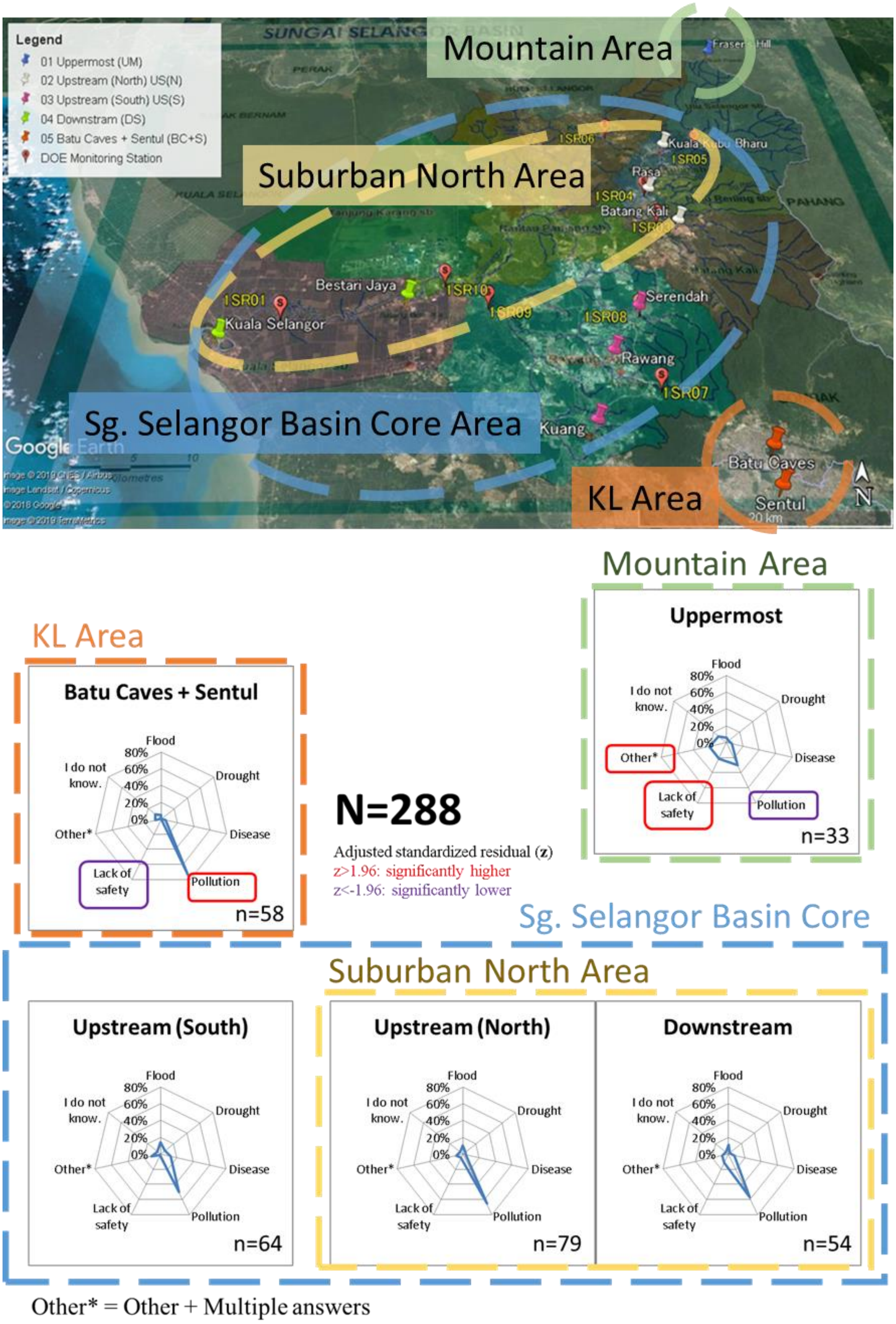


Figure 5.3.2.1-3 Worst Trouble and Sampling Site (Islam)

5.3.2.2 Household Gross Income

The statistics of WT-HGI relationship are tabulated (**Table 5.3.2.2-1**) and charted (**Figure 5.3.2.2-1**).

Table 5.3.2.2-1 Worst Trouble and Household Gross Income (Islam)

	Modest			Middle			Rich			**Total**	
	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.
Flood	9	14%	1.3	7	9%	-0.2	7	7%	-1.0	23	**10%**
Drought	6	9%	2.7	1	1%	-1.4	2	2%	-1.1	9	**4%**
Water-borne disease	6	9%	0.8	6	8%	0.3	5	5%	-0.9	17	**7%**
Pollution	29	44%	-2.9	49	63%	0.9	64	66%	1.8	142	**59%**
Lack of safety	4	6%	0.5	5	6%	0.7	3	3%	-1.1	12	**5%**
Other*	7	11%	0.3	9	12%	0.7	7	7%	-1.0	23	**10%**
I do not know.	5	8%	0.5	1	1%	-2.2	9	9%	1.6	15	**6%**
Total	**66**	**100%**		**78**	**100%**		**97**	**100%**		**241**	**100%**

N	df	χ^2	V	ω	$1-\beta$	p_P	p_F
241	12	20.1	0.20	0.29	0.87	0.065	0.061

N'
207

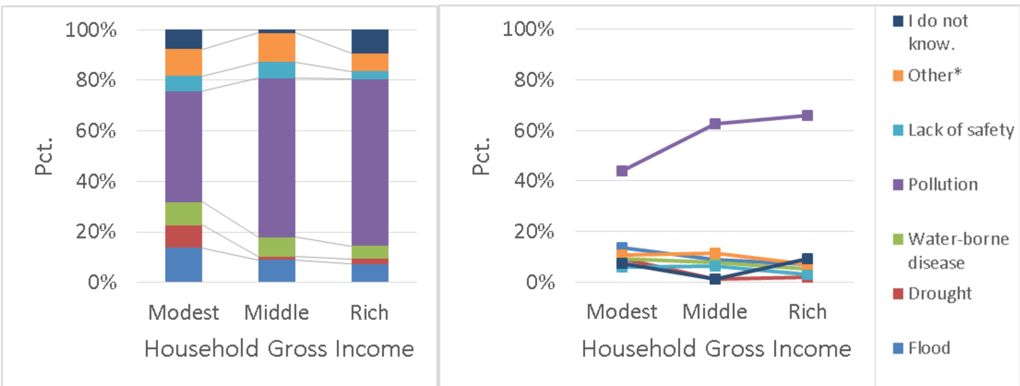


Figure 5.3.2.2-1 Worst Trouble and Household Gross Income (Islam)

The ‘Flood’ pct. decreases HGI-wise from the Modest (14%) via the Middle (9%) to the Rich (7%); the ‘Drought’ pct. decreases from the Modest (9%) to the Middle (1%) and the Rich (2%); the ‘Water-borne disease’ decreases HGI-wise from the Modest (9%) via the Middle (8%) to the Rich (5%); the ‘Pollution’ pct. increases HGI-wise from the Modest (44%) via the Middle (63%) to the Rich (66%); the ‘Lack of safety’ stays unchanged from the Modest (6%) to the Middle (6%) and then decreases to the Rich (3%); the ‘Other*’ pct. increases from the Modest (11%) to the Middle (12%) and then decreases to the Rich (7%); the ‘I do not know.’ pct. decreases from the Modest (8%) to the Middle (1%) and then increases to the Rich (9%). It is clear that ‘Pollution’ is the most likely worst trouble and it increases HGI, which means that the Richer Muslim respondents are, the less likely they suffer from troubles other than ‘Pollution.’

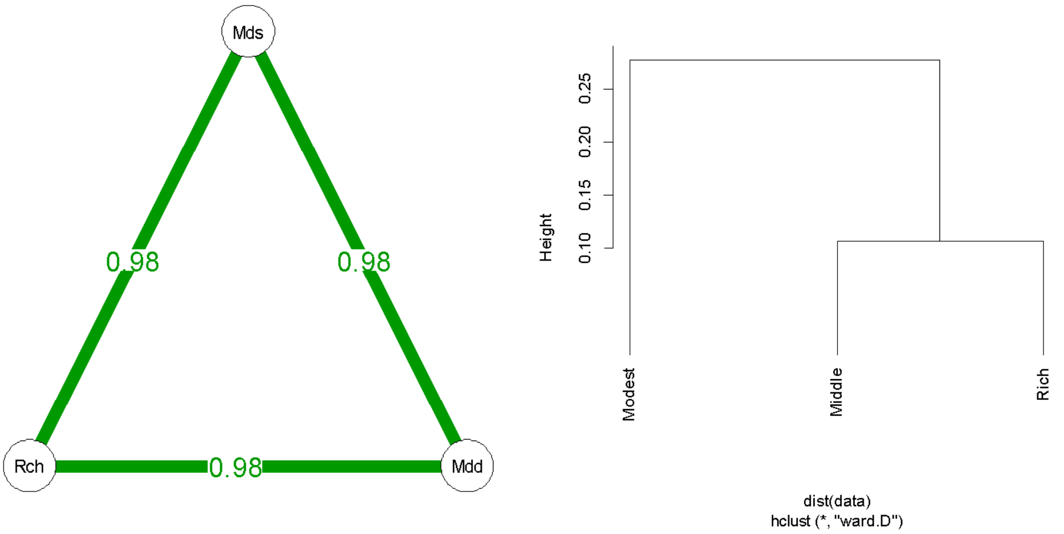


Figure 5.3.2.2-2 Worst Trouble-based Correlation and HCA Dendrogram of HGI (Islam)

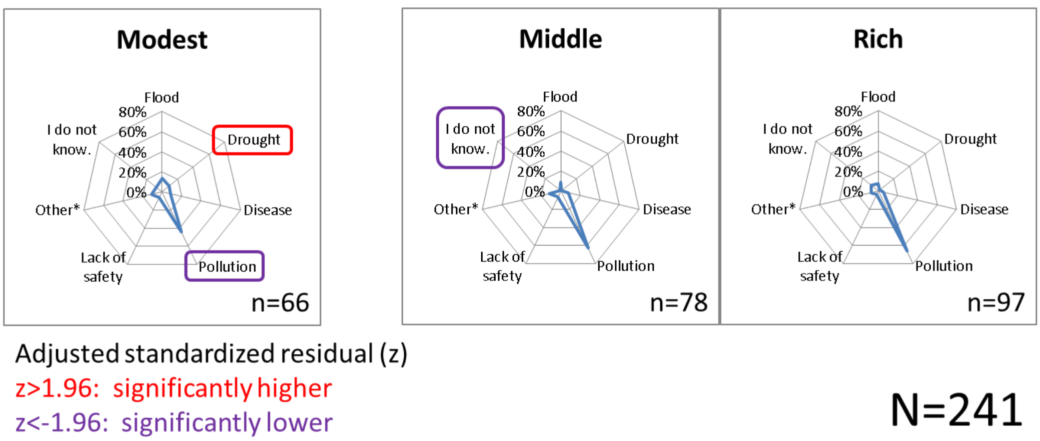


Figure 5.3.2.2-3 Worst Trouble and Household Gross Income (Islam)

The WT rate-based Pearson Correlations of the HGI groups by 'R' Package 'qgraph' (ver. 1.5)[6] and the hierarchical cluster analysis (HCA) dendrogram (Euclidean distance, Ward's method) by 'R' (ver.3.4.3)[3] were shown in (**Figure 5.3.2.2-2**).**Figure 5.3.2.2-2** (**left**) shows that the three HGI groups are equally correlated to each other. **Figure 5.3.2.2-2** (**right**) shows the HCA clustering of the HGI groups, clarifying that the Modest is the most characteristic, with a higher 'Drought' pct. and a lower 'Pollution.'

Whether an answer frequency (freq.) is significantly higher/lower than expected was determined by adjusted standard residual (ASR,z). Viewed from WT side: 'Drought' is significantly higher in the Modest ($z = 2.7 > 1.96$); 'Pollution' lower in the Modest ($z = -2.9 < -1.96$); the rest of the WTs have no significantly higher/lower z value among the HGI groups. Viewed from HGI side: the Modest has a significantly higher z value in 'Drought' while lower in 'Pollution.'; the Middle and the Rich have no significantly higher z value throughout the WTs.

The Cramer's V level ($V = 0.20$) indicates a 'very weak' association between WT and HGI. The p-value of Fisher's exact test (p_F) is significantly high ($p_F = 0.061 > 0.050$) while the power sufficiently large ($1 - \beta = 0.87 > 0.80$). The sample size sufficiently large ($N = 241 > N' = 207$).

5.3.2.3 Sewer Water Treatment

The statistics of WT-SWT relationship are tabulated (**Table 5.3.2.3-1**) and charted (**Figure 5.3.2.3-1**).

Table 5.3.2.3-1 Worst Trouble and Sewer Water Treatment (Islam)

	Septic Tank			Sewerage System			**Total**	
	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.
Flood	10	18%	2.0	7	7%	-2.0	17	**11%**
Drought	5	9%	1.9	2	2%	-1.9	7	**5%**
Water-borne disease	9	16%	2.9	3	3%	-2.9	12	**8%**
Pollution	21	38%	-3.8	66	70%	3.8	87	**58%**
Lack of safety	4	7%	0.5	5	5%	-0.5	9	**6%**
Other*	5	9%	0.6	6	6%	-0.6	11	**7%**
I do not know.	1	2%	-1.0	5	5%	1.0	6	**4%**
Total	**55**	**100%**		**94**	**100%**		**149**	**100%**

N	df	χ^2	V	ω	1- β	p_P	p_F
149	6	22.3	0.39	0.39	0.966	0.0011	0.00063

N'
90

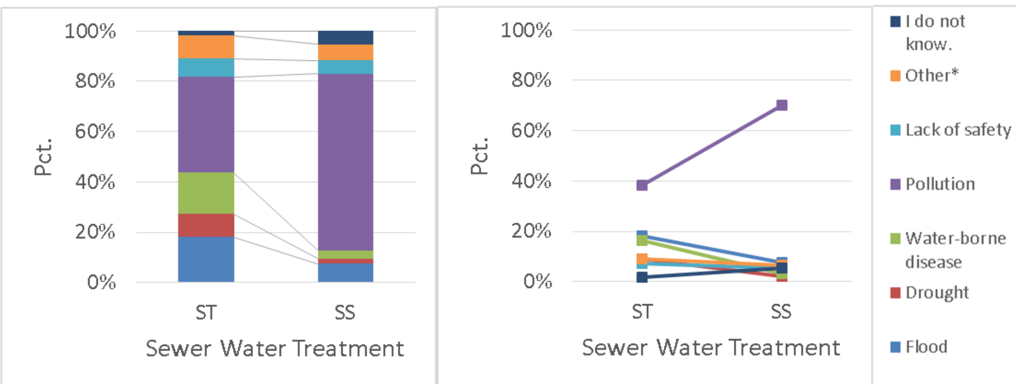


Figure 5.3.2.3-1 Worst Trouble and Sewer Water Treatment (Islam)

The 'Flood' pct. is higher in ST (18%) than in SS (7%); the 'Drought pct. higher in ST (9%) than in SS (2%); the 'Water-borne disease' pct. higher in ST (16%) than in SS (3%); the 'Pollution' higher in SS (70%) than in ST (38%); the 'Lack of safety' pct. higher in ST 'Other*' pct. higher in ST (9%) than in SS (6%); the ‘I do not know.’ higher in SS (5%) than in ST (1%). The ‘Pollution’ and ‘I do not know.’ pcts. are higher in SS while the rest higher in ST.

Whether an answer frequency (freq.) is significantly higher/lower than expected was determined by adjusted standard residual (ASR,z). Viewed from WT side: the ‘Flood’ z value is significantly higher in ST ($z = 2.0 > 1.96$) than in SS ($-2.0 < -1.96$); the ‘Water-borne disease’ higher in ST ($z = 2.9$) than SS ($z = -2.9$); the ‘Pollution’ higher in SS ($z = 3.8$) than in ST ($z = -3.8$); the rest of WTs have no significantly higher/lower z value between ST and SS. Viewed from SWT side, the ST z value is significantly higher in ‘Flood’ and ‘Water-borne disease’ while lower in ‘Pollution’; while SS lower in ‘Flood’ and ‘Water-borne disease’ while higher in ‘Pollution.’ The ST using respondents are possible to suffer flood and water-borne disease than SS users.

The Cramer’s V level ($V = 0.39$) indicates a ‘somewhat weak’ association between WT and SWT. The p-value of Fisher’s exact test (p_F) is significantly low ($p_F = 0.0063 < 0.050$) and the power sufficiently large ($1 - \beta = 0.966 > 0.80$). The sample size sufficiently large ($N = 149 > N' = 90$).

The WT pcts. in ST and SS were radar-charted (**Figure 5.3.2.3-2**). It is visualized that ‘Flood,’ ‘Drought’ and most of all ‘Pollution’ are the main factors.

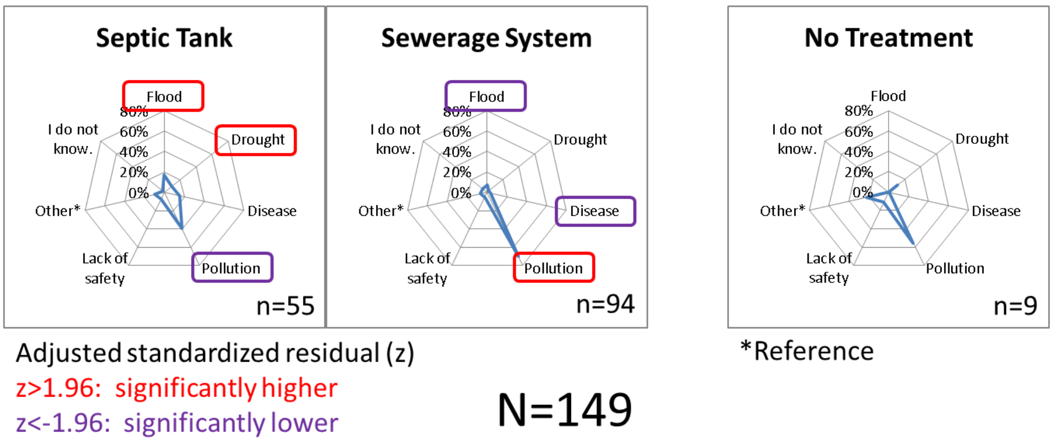


Figure 5.3.2.3-2 Worst Trouble and Sewer Water Treatment (Islam)

5.3.3 Christianity, Buddhism and Hinduism

5.3.3.1 Sampling Site

The statistics of WT-Sampling Site relationship are tabulated (**Table 5.3.3.1-1**) and charted (**Figure 5.3.3.1-1**).

Table 5.3.3.1-1 Worst Trouble and Sampling Site (CBH)

	UM			US(N)			US(S)		
	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.	z
Flood	1	9%	-0.2	1	3%	-1.7	9	18%	1.9
Drought	0	0%	-0.6	1	3%	0.0	1	2%	-0.4
Water-borne disease	1	9%	-2.3	23	66%	3.2	24	49%	1.2
Pollution	1	9%	-1.8	8	23%	-1.5	11	22%	-2.0
Lack of safety	4	36%	4.8	1	3%	-0.7	3	6%	0.3
Other*	4	36%	5.2	1	3%	-0.6	1	2%	-1.0
I do not know.	0	0%	-0.3	0	0%	-0.5	0	0%	-0.6
Total	**11**	**100%**		**35**	**100%**		**49**	**100%**	

	DS			BC+S			**Total**	
	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.
Flood	1	4%	-1.1	7	13%	0.5	19	**11%**
Drought	1	4%	0.4	2	4%	0.4	5	**3%**
Water-borne disease	13	57%	1.5	11	20%	-3.9	72	**42%**
Pollution	6	26%	-0.8	32	59%	4.8	58	**34%**
Lack of safety	1	4%	-0.2	0	0%	-2.1	9	**5%**
Other*	1	4%	-0.1	1	2%	-1.2	8	**5%**
I do not know.	0	0%	-0.4	1	2%	1.5	1	**1%**
Total	**23**	**100%**		**54**	**100%**		**172**	**100%**

N	df	χ^2	V	ω	$1-\beta$	p_P	p_F
172	24	89.1	0.36	0.72	0.99999960	0.0000000020	≤0.0000005

N'
44

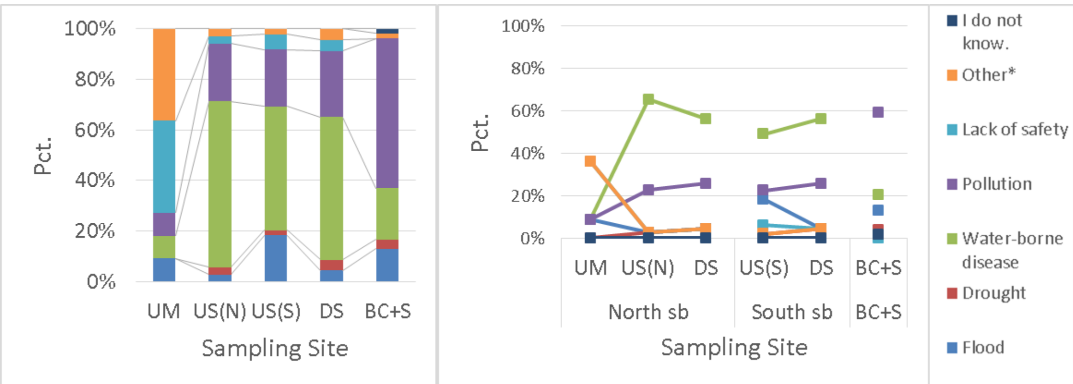


Figure 5.3.3.1-1 Worst Trouble and Sampling Site (CBH)

The ‘Flood’ pct. in the North sb decreases from UM (9%) to US(N) (3%) and then increased to DS (4%); in the South sb decreases from US(S) (18%) to DS (4%). The ‘Drought’ pct. increases flow-wise: in the North sb from UM (0%) via US(N) (3%) to DS (4%); in the South sb from US(S) (2%) to DS (4%). At BC+S it is 4%. The ‘Water-borne disease’ increases from UM (9%) to US(N) (66%) and then decreases to DS (57%); in the South sb increases from US(S) (49%) to DS (57%); at BC+S it is 20%. The ‘Pollution’ pct. increases flow-wise: in the North sb from UM (9%) via US(N) (23%) to DS (26%); in the South sb from US(S) (22%) to DS (26%). At BC+S it is 59%. The ‘Lack of safety’ pct. in the North sb decreases from UM (36%) via US(N) (3%) and then increases to DS (4%); in the South sb decreases from US(S) (6%) to DS (4%); at BC+S it is 0%. The ‘Other*’ pct. in the North sb decreases from UM (36%) to US(N) (3%) and then increases to DS (4%); in the South sb increases from US(S) (2%) to DS (3%); at BC+S it is 2%. The ‘I do not know’ pct. stays unchanged (0%) in SSB; at BC+S it is 2%. It is clear that the main factors are ‘Water-borne disease’ and ‘Pollution,’ although ‘Other*’ and ‘Flood’ may not be negligible.

Whether an answer frequency (freq.) is significantly higher/lower than expected was determined by adjusted standard residual (ASR,z). Viewed from WT side: the ‘Water-borne disease’ z value is significantly higher at US(N) ($z = 3.2 > 1{,}96$); the ‘Pollution’ lower at US(S) ($z = -2.0 < -1.96$) while higher at BC+S ($z = 4.8$); the ‘Lack of safety’ higher at UM while lower at BC+S ($z = -2.1$); the ‘Other*’ higher at UM ($z = 5.2$); the rest of WT have no significantly higher/lower z value throughout the Sampling Sites. Viewed from Sampling Site side: UM is significantly lower in ‘Water-borne disease’ while higher in ‘Lack of safety’ and ‘Other’; US(N) higher in ‘Water-borne disease’; US(S) lower in ‘Pollution’; BC+S higher in ‘Pollution’ while lower in ‘Water-borne disease’ and ‘Lack of safety’; DS has no significantly higher/lower z values throughout the WTs. The significantly higher/lower z values are from the external and peripheral areas, except those of ‘Water-borne disease’ at US(N) and ‘Pollution’ at US(S), and the dendrogram clusters the SSBCA (**Figure 5.3.3.1-3**), which means that the SSBCA’s Sampling Sites have relatively similar trend in Worst Trouble and within the SSBCA ‘Water-borne disease’ in US(S) is particularly characteristic.

The Cramer’s V level ($V = 0.36$) indicates a ‘somewhat weak’ association between WT and Sampling Site. The p-value of Fisher’s exact test (p_F) is significantly low ($p_F \leq 0.0000005 < 0.050$) and the power sufficiently large ($1 - \beta = 0.99999960 > 0.80$). The sample size sufficiently large ($N = 172 > N' = 44$).

The WT rate-based Pearson Correlations of the Sampling Sites by ‘R’ Package ‘qgraph’ (ver. 1.5)[6] and the hierarchical cluster analysis (HCA) dendrogram (Euclidean distance, Ward’s method) by ‘R’ (ver.3.4.3)[3] were shown in (**Figure 5.3.3.1-2**).**Figure 5.3.3.1-2**(**left**) shows that UM is the most characteristic among the five Sampling Sites. **Figure 5.3.3.1-2**(**right**) shows a stairs-like HCA clustering of the Sampling Sites. The closest two (DS and US(N)) can be classified as Suburban North Area (SNA); US(S) in addition to the SNA makes Sg. Selangor Basin Core Area (SSBCA); BC+S and UM are the basin’s external and peripheral and areas (urban and mountain areas), respectively. **Figure 5.3.3.1-3** shows radar charts of WT at the Sampling Sites, visualizing that ‘Pollution,’ ‘Water-borne disease (Disease),’ ‘Lack of Safety’ and ‘Other*’ are the key factors, while ‘Flood’ and ‘Drought’ are not.

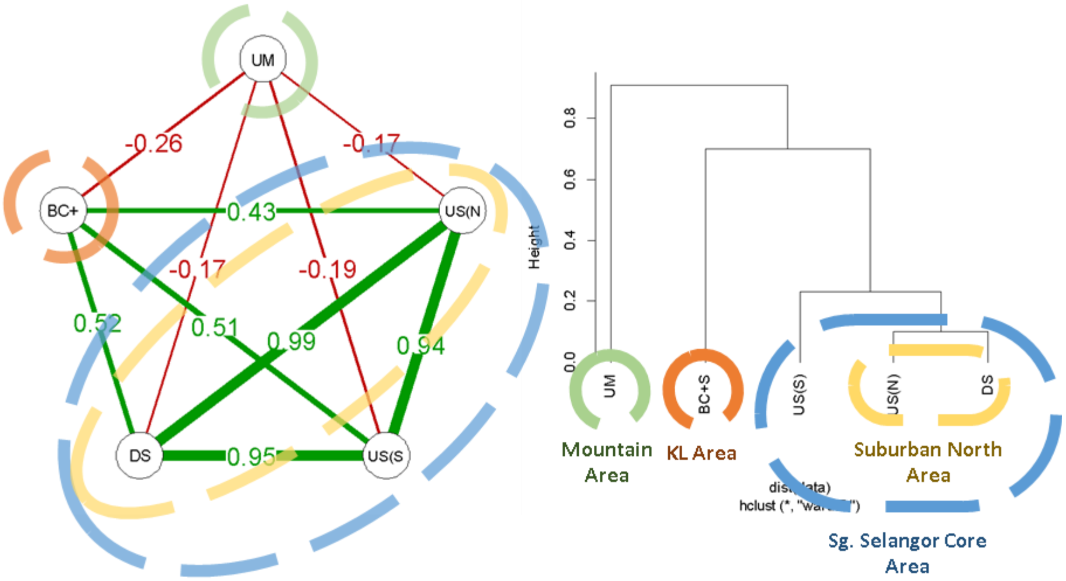
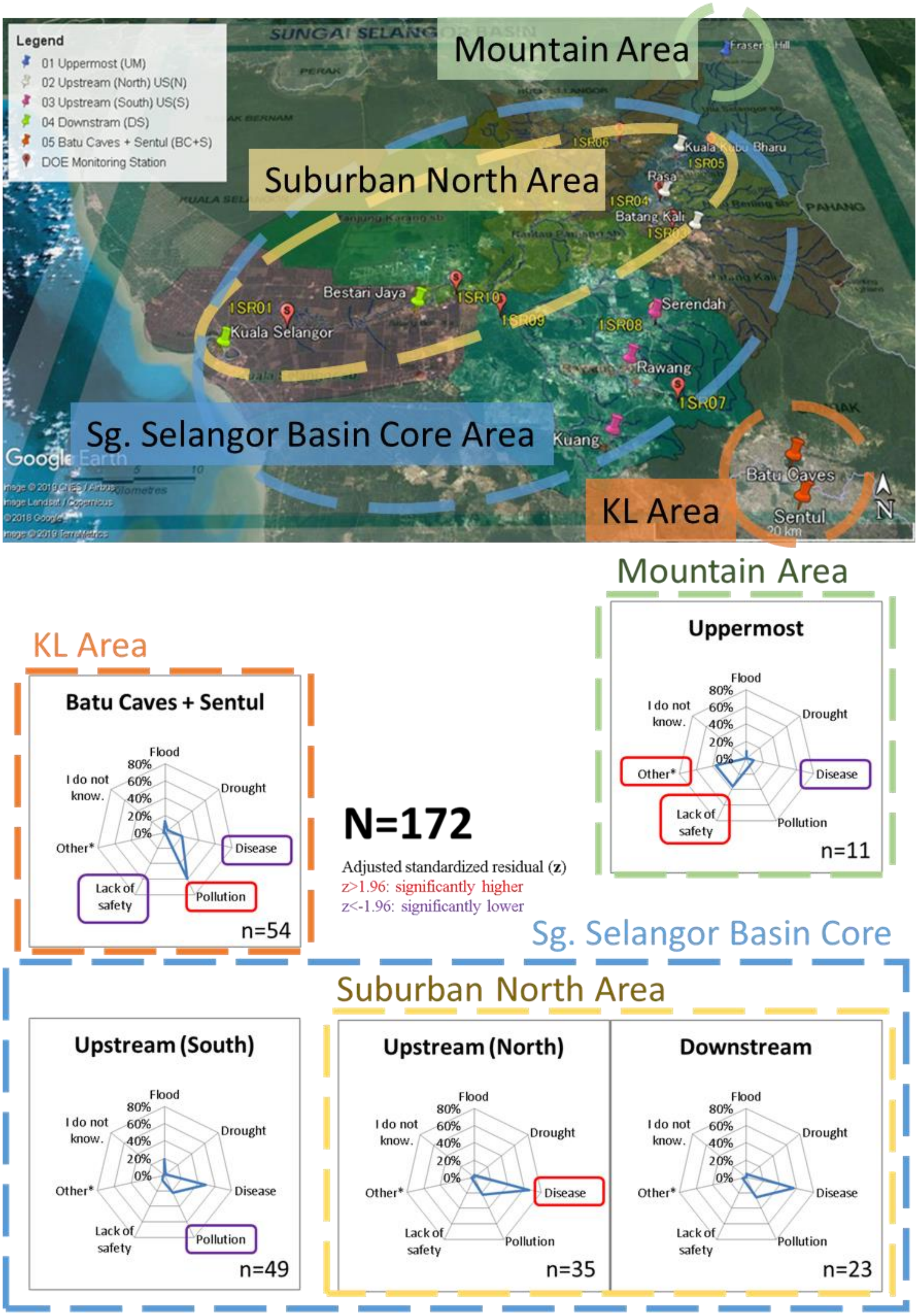


Figure 5.3.3.1-2 Worst Trouble-based Correlation Diagram and HCA Dendrogram of Sampling Site (CBH)



Other* = Other + Multiple answers

Figure 5.3.3.1-3 Map[7] of Clusterings and Rader Charts of Worst Troubles (CBH)

CBH respondents may live closer to the river at each Sampling Site than Muslim respondents, which may make ‘Water-borne disease’ a more prioritized Worst Trouble. CBH respondents are mostly Chinese and Indians, some of whom may live in ‘New Villages’ designed to close to the river.[10] On the other hand, Muslim respondents in towns may live in newly developed residential area that are relatively more equipped with sanitary facilities such as sewerage systems. Even if New Villages are not the case, in Malaysia, same-kind people tend to cluster in a town or a village which as a whole are shared in harmony with other-kinds.[11] If one place’s clustering situation is geographically similar to another, it may reflect as the general perception gap trend.

5.3.3.2 Household Gross Income

The statistics of WT-HGI relationship are tabulated (**Table 5.3.3.2-1**) and charted (**Figure 5.3.3.2-1**).

Table 5.3.3.2-1 Worst Trouble and Household Gross Income (CBH)

	Modest			Middle			Rich			**Total**	
	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.
Flood	3	8%	-0.9	10	11%	-0.2	6	16%	1.1	19	**11%**
Drought	1	3%	-0.2	2	2%	-0.7	2	5%	1.0	5	**3%**
Water-borne disease	18	45%	0.4	48	52%	2.8	6	16%	-3.7	72	**43%**
Pollution	10	25%	-1.2	23	25%	-2.3	22	59%	4.0	55	**33%**
Lack of safety	4	10%	1.5	5	5%	0.1	0	0%	-1.6	9	**5%**
Other*	4	10%	1.8	3	3%	-1.0	1	3%	-0.7	8	**5%**
I do not know.	0	0%	-0.6	1	1%	0.9	0	0%	-0.5	1	**1%**
Total	**40**	**100%**		**92**	**100%**		**37**	**100%**		**169**	**100%**

N	df	χ^2	V	ω	1- β	p_P	p_F
169	12	28.5	0.29	0.41	0.969	0.0047	0.0011

N'
104

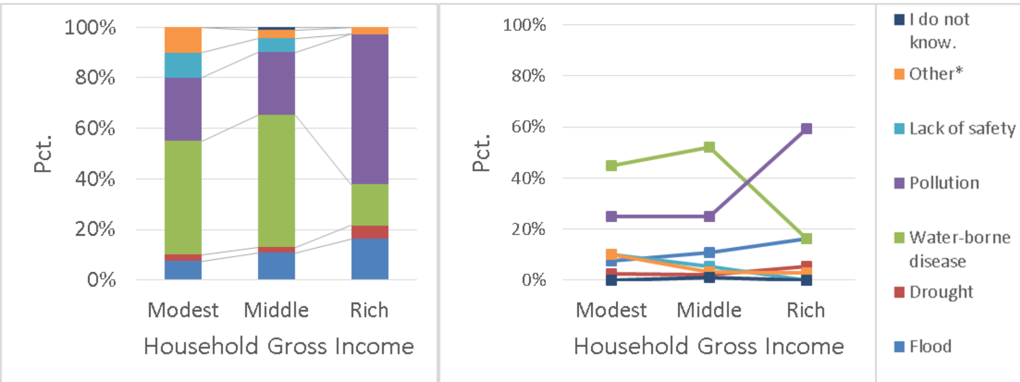


Figure 5.3.3.2-1 Worst Trouble and Household Gross Income (CBH)

The ‘Flood’ pct. increases HGI-wise: from the Modest (8%) via the Middle (11%) to the Rich (16%). The ‘Drought’ pct. decreases from the Modest (3%) to the Middle (2%) and then increases to the Rich (5%). The ‘Water-borne disease’ pct. increases from the Modest (45%) to the Middle (52%) then decreases to the Rich (16%). The 'Pollution' pct. stays unchanged from the Modest (25%) to the Middle (25%) and then increases to the Rich (59%). The 'Lack of safety' pct. decreases HGI-wise: from the Modest (10%) via the Middle (5%) to the Rich (0%). The 'Other*' pct. decreases from the Modest (10%) to the Middle (3%) to the Rich (3%). The 'I do not know.' pct. increases from the Modest (0%) to the Middle (1%) and then decreased to the Rich (1%).

Whether an answer frequency (freq.) is significantly higher/lower than expected was determined by adjusted standard residual (ASR,z). Viewed from WT side: the 'Water-borne disease' z value is significantly higher in the Middle ($z = 2.8 > 1.96$) while lower in the Rich ($z = -3.7 < -1.96$); the 'Pollution' higher in the Rich ($z = 4.0$) while lower in the Middle ($z = -2.3$); the rest of WTs have no significantly higher/lower z value among the HGI groups. Viewed from HGI side: the Middle has a significantly higher z value in 'Water-borne disease' while lower in 'Pollution'; the Rich higher in 'Pollution' while lower in 'Water-borne disease'; the Modest has no significantly higher/lower z value throughout the WTs.

The Cramer's V level ($V = 0.29$) indicates a 'somewhat weak' association between WT and Sampling Site. The p-value of Fisher's exact test (p_F) is significantly low ($p_F \leq 0.0011 < 0.050$) and the power sufficiently large ($1 - \beta = 0.969 > 0.80$). The sample size sufficiently large ($N = 169 > N' = 104$).

The WT rate-based Pearson Correlations of the HGI groups by 'R' Package 'qgraph' (ver. 1.5)[6] and the hierarchical cluster analysis (HCA) dendrogram (Euclidean distance, Ward's method) by 'R' (ver.3.4.3)[3] were shown in **Figure 5.3.3.2-2**. **Figure 5.3.3.2-2** (**left**) shows that the three HGI groups are equally correlated to each other. **Figure 5.3.3.2-2** (**right**) shows the HCA clustering of the HGI groups, clarifying that the Rich is the most characteristic, with a higher 'Pollution' pct. and a lower 'Water-borne disease.' **Figure 5.3.3.2-3** shows radar charts of WT of the HGI groups, visualizing that 'Pollution,' 'Water-borne disease (Disease)' are the key factors.

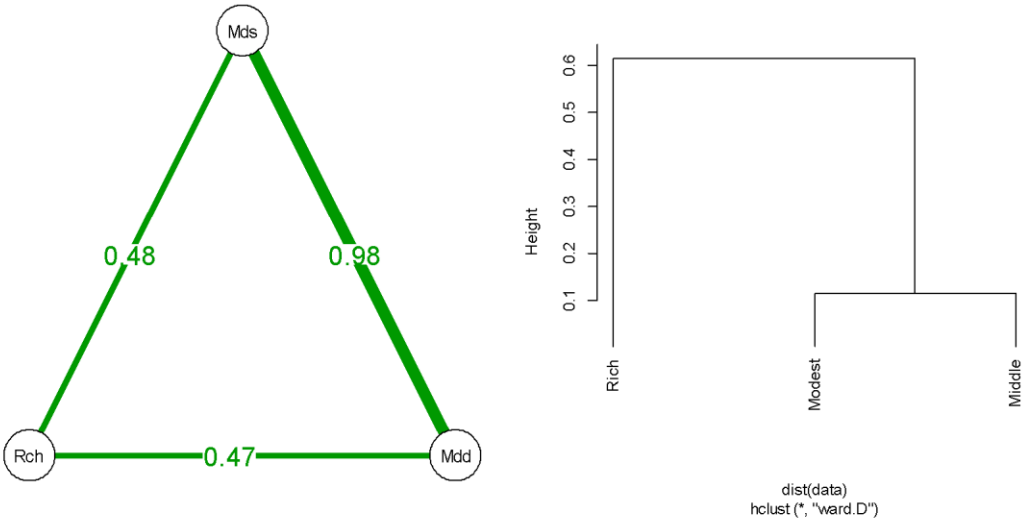


Figure 5.3.3.2-2 Worst Trouble-based Correlation and HCA Dendrogram of HGI (CBH)

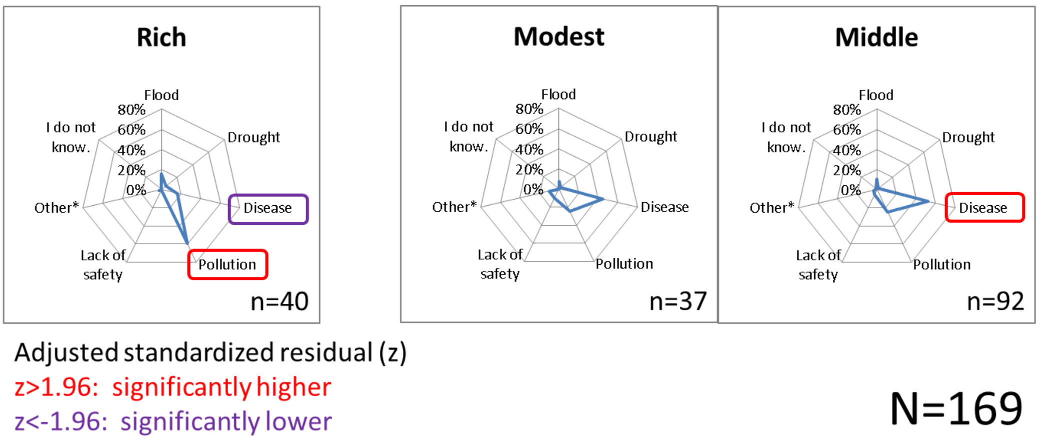


Figure 5.3.3.2-3 Worst Trouble and Household Gross Income (CBH)

The results above indicate that the Rich CBHs have better sanitary condition than the Modest and Middle CBHs.

5.3.3.3 Sewer Water Treatment

The statistics of WT-SWT relationship are tabulated (**Table 5.3.3.3-1**) and charted (**Figure 5.3.3.3-1**).

Table 5.3.3.3-1 Worst Trouble and Sewer Water Treatment (CBH)

	Septic Tank			Sewerage System			**Total**	
	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.
Flood	12	11%	0.7	3	7%	-0.7	15	**10%**
Drought	2	2%	-1.0	2	5%	1.0	4	**3%**
Water-borne disease	55	51%	2.4	12	29%	-2.4	67	**45%**
Pollution	28	26%	-2.1	18	44%	2.1	46	**31%**
Lack of safety	4	4%	-1.9	5	12%	1.9	9	**6%**
Other*	6	6%	0.8	1	2%	-0.8	7	**5%**
I do not know.	0	0%	NA	0	0%	NA	0	**0%**
Total	**107**	**100%**		**41**	**100%**		**148**	**100%**

N	df	χ^2	V	ω	1- β	p_P	p_F
148	5	11.8	0.28	0.28	0.75	0.038	0.030

N'
164

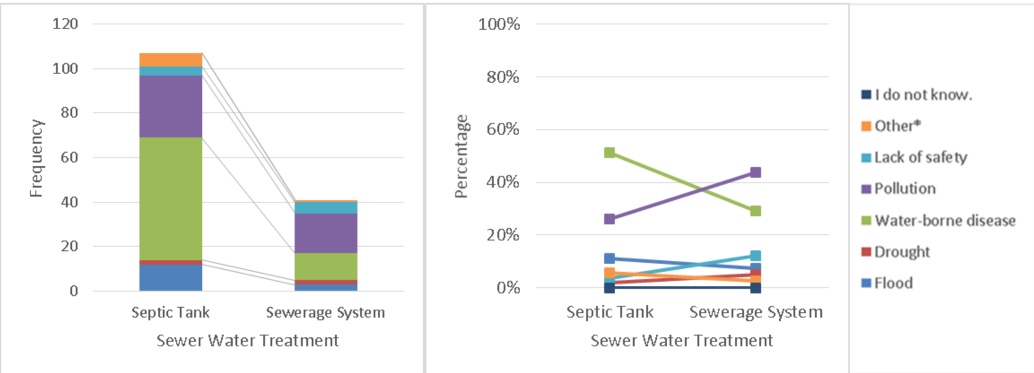


Figure 5.3.3.3-1 Worst Trouble and Sewer Water Treatment (CBH)

The ‘Flood’ pct. is higher in ST (11%) than in SS (7%). The ‘Drought’ pct. is higher in SS (5%) than in ST (2%). The ‘Water-borne disease’ pct. is higher in ST (51%) than in SS (29%). The ‘Pollution’ pct. higher in SS (44%) than ST (26%). The ‘Lack of safety’ is higher in SS (12%) than ST (4%). The ‘Other*’ pct. is higher in ST (6%) than in SS (25). The ‘I do not know.’ is 0% both in ST and in SS. It is clear that ‘Water-borne disease’ and ‘Pollution’ is the key factors between ST and SS.

Whether an answer frequency (freq.) is significantly higher/lower than expected was determined by adjusted standard residual (ASR,z). Viewed from WT side: the ‘Water-borne disease’ z value is significantly higher in ST ($z = 2.4 > 1.96$) than in SS ($z = -2.4 < -1.96$); the ‘Pollution’ higher in SS ($z = 2.1$) than in ST ($z = -2.1$); the rest of the WTs have no significantly higher/lower z value between ST and SS. Viewed from SWT side: ST has a significantly higher z value in ‘Water-borne disease’ while a lower in ‘Pollution’; SS has a higher in ‘Pollution’ while a lower in SS.

The Cramer’s V level ($V = 0.28$) indicates a ‘somewhat weak’ association between WT and SWT.

The p-value of Fisher's exact test (p_F) is significantly low ($p_F \leq 0.030 < 0.050$) while the power insufficiently small ($1 - \beta = 0.75$). The sample size is too small to obtain a significantly small p-value (p_P) with a sufficiently large power ($N = 148 < N' = 164$).

The WT pcts. in ST and SS were radar-charted (**Figure 5.3.3.3-2**). It is visualized that 'Water-borne disease' and most of all 'Pollution' are the main factors.

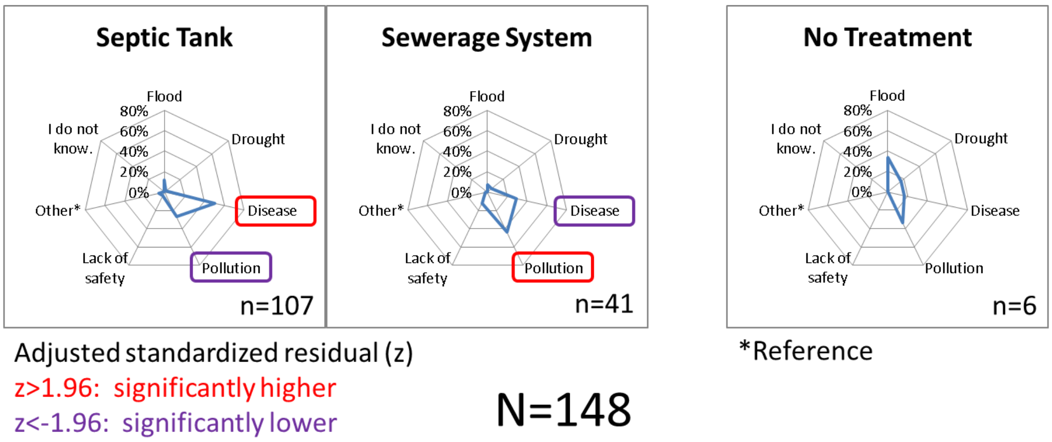


Figure 5.3.3.3-2 Worst Trouble and Sewer Water Treatment (CBH)

5.4 Perception Association with Geographics and Demographics

An extent of a Cramer's V derives from the interaction of the Survey Sheets and the respondents. The Cramer's V value can be interpreted as how strong/weak the interaction. What concretely makes the interaction strong/weak is something behind the value, which could be geographically or culturally observable. In this survey, the ethnic settlement pattern (**Chapter 2**), and Sewer Water Treatment that seems to be related to the settlement pattern, and Islamic water use criteria that appeared in selecting 'Religious taboo' in the WUDF question are supposed to be the main factors.

5.4.1 River Water Drinkability

In order to comprehend how much RWD depends on/associates with Sampling Site, HGI, Religion and SWT, corresponding Cramer's V values were tabulated (**Table 5.4.1-1**) (post-rounded off) , line graphed (**Figure 5.4.1-1**), and network graphed by the Fruchterman-Reingold algorithm using 'R' Package 'igraph' [2] with the edge width being proportional to the corresponding Cramer's V value (**Figure 5.4.1-2**). The left-hand side graph of **Figure 5.4.1-2** shows a possible association network of all the Cramer's V values from **Table 5.4.1-1**, and the right-hand side values equal to or more than 0.25 (pre-rounded off). **Figure 5.4.1-1** visualizes by the bars the orders and behaviors of association levels, and **Figure 5.4.1-2** by the nodes and edges what demographic characteristics are essential to pay attention to in implementing the IRBM of SSB: hubs that are relatively strongly connected to various demographics and thus show up from other levels within the same demographic groups. As a result, Sampling Site is a key to comprehend the basin people's RWD; Sampling Site being 'associated' ($V \geq 0.25$) with Islam, CBH, SS, and Modest. The Sampling Site-Islam and - Cramer's V values are higher than that of Total, meaning that the intra-Religion analyses clarified Sampling Site's impacts on the respondents' RWD. SWT is 'associated' to three Sampling Sites of UM, U(S) and BC+S, indicating that the RWD of respondents sampled at these sites' RWD is characteristic by their SWT. This may be due to urban-rural difference as well as their river water quality difference, because SS is only in relatively urban areas.

Table 5.4.1-1 Cramer's V value of River Water Drinkability (Total)

	Sampling Site					HGI			Religion		SWT		Total
	UM	US(N)	US(S)	DS	BC+S	Modest	Middle	Rich	Islam	CBH	ST	SS	Total
Sampling Site						0.29	0.18	0.21	0.27	0.29	0.24	0.29	0.24
HGI	0.23	0.23	0.16	0.15	0.095				0.23	0.081	0.23	0.18	0.17
Religion	0.31	0.15	0.12	0.13	0.19	0.21	0.15	0.12			0.14	0.065	0.070
SWT	0.27	0.12	0.37	0.027	0.31	0.14	0.19	0.17	0.14	0.10			0.12

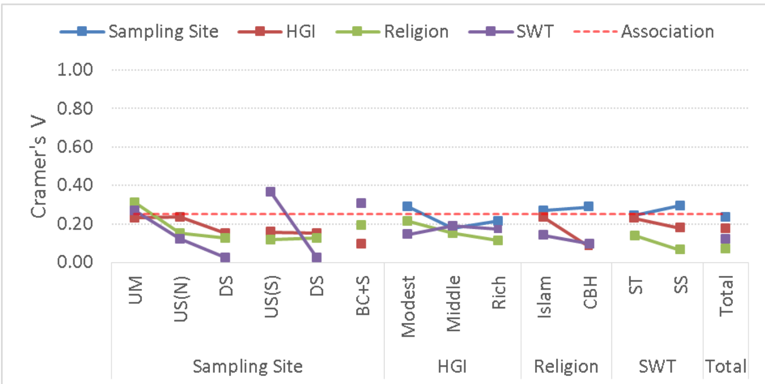


Figure 5.4.1-1 RWD Association with Sampling Site, HGI, Religion and SWT (Total)

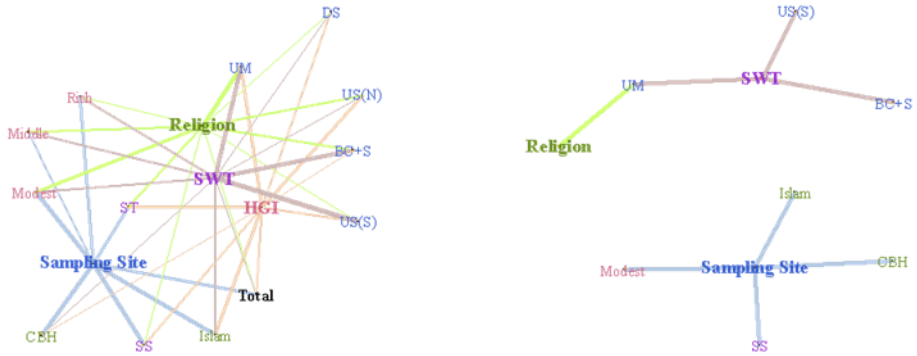


Figure 5.4.1-2 RWD Association Network (Total)

Left: all associations, Right: associations with V≥0.25 only

In Sampling Site, the HGI-RWD Cramer's V value in the North sb stays unchanged from UM (0.23) to US(N) (0.23) and then decreases to DS (0.15); in the south sb decreases from US(S) (0.16) to DS (0.15); at BC+S it is 0.095. The Religion-RWD in the North sb decreases flow-wise from UM (0.31) via US(N) (0.15) to DS (0.13); in the South sb increases from US(S) (0.12) to DS (0.13); at BC+S it is 0.19. The SWT-RWD decreases flow-wise in the North sb from UM (0.27) via US(N) (0.12) to DS (0.027); in the South sb from US(S) (0.37) to DS (0.027); at BC+S it is 0.31. (**Figure 5.4.1-1**)

In HGI, the Sampling Site-RWD Cramer's V value decreases from the Modest (0.29) to the Middle (0.18) and then increases to the Rich (0.21); the Religion-RWD decreases HGI-wise from the Modest (0.21) via the Middle (0.15) to the Rich (0.12); the SWT-RWD increases from the Modest (0.14) to the Middle (0.19) and then decreases to the Rich (0.17). (**Figure 5.4.1-1**)

In Religion, the Sampling Site-RWD Cramer's V value is higher in CBH (0.29) than in Islam (0.27). the HGI-RWD higher in Islam (0.23) than in CBH (0.083); the SWT-RWD higher in Islam (0.14) than in CBH (0.10). (**Figure 5.4.1-1**)

In SWT, the Sampling Site-RWD Cramer's V value is higher in SS (0.24) than in ST (0.29); the HGI-RWD higher in ST (0.23) than SS (0.18); the HGI-RWD higher in ST (0.23) than in SS (0.19); the Religion-RWD higher in ST (0.14) and in SS (0.065). (**Figure 5.4.1-1**)

In Total, the Sampling Site-RWD Cramer's V value is 0.24; the HGI 0.17; the Religion-RWD 0.070; the SWT RWD 0.12. (**Figure 5.4.1-1**)

In conclusion, Sampling Site is a key to comprehend the basin people’s RWD.

5.4.2 Willingness to Pay for River Water Drinkability

In order to comprehend how deeply WTP for RWD (WTP_{RWD}) depends on/associates with Sampling Site, HGI, Religion and SWT, corresponding Cramer’s V values were tabulated (**Table 5.4.2-1**) (post-rounded off), line graphed (**Figure 5.4.2-1**), and network graphed by the Fruchterman-Reingold algorithm using ‘R’ Package ‘igraph’ [2] with the edge width being proportional to the corresponding Cramer’s V value (**Figure 5.4.2-2**). The left-hand side graph of **Figure 5.4.2-2** shows a possible association network of all the Cramer’s V values from **Table 5.4.2-1**, and the right-hand side values equal to or more than 0.25 (pre-rounded off). **Figure 5.4.2-1** visualizes by the bars the orders and behaviors of association levels, and **Figure 5.4.2-2** by the nodes and edges what demographic characteristics are essential to pay attention to in implementing the IRBM of SSB: hubs that are relatively strongly connected to various demographics and thus show up from other levels within the same demographic groups. As a result, SWT and Modest (low income) are keys to comprehend the basin people’s WTP for RWD. The SWT is ‘associated’ ($V \geq 0.25$ before rounded off) with US(S), Rich, Modest and CBH. Modest is ‘associated’ with Sampling Site, Religion and SWT. HGI is ‘associated’ with the two Sampling Sites of UM and DS.

Table 5.4.2-1 Cramer’s V value of WTP for River Water Drinkability (Total)

	Sampling Site					HGI			Religion		SWT		Total
	UM	US(N)	US(S)	DS	BC+S	Modest	Middle	Rich	Islam	CBH	ST	SS	Total
Sampling Site						0.27	0.18	0.20	0.15	0.22	0.21	0.20	0.16
HGI	0.25	0.25	0.22	0.26	0.20				0.16	0.23	0.23	0.22	0.15
Religion	0.14	0.24	0.23	0.13	0.11	0.28	0.15	0.090			0.23	0.16	0.12
SWT	0.14	0.17	0.30	0.14	0.24	0.36	0.18	0.29	0.11	0.34			0.19

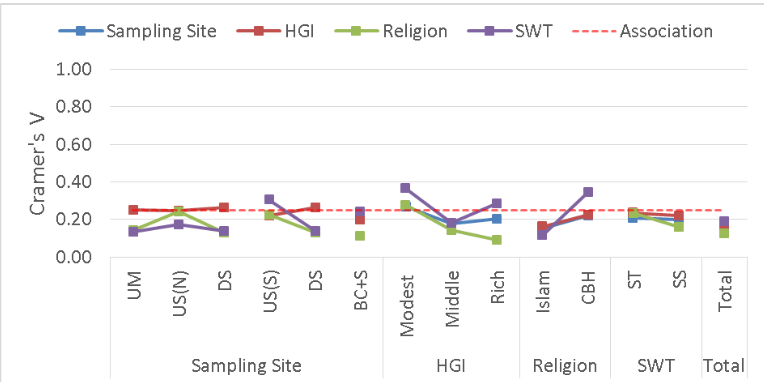


Figure 5.4.2-1 WTP for RWD Association with Sampling Site, HGI, Religion and SWT (Total)

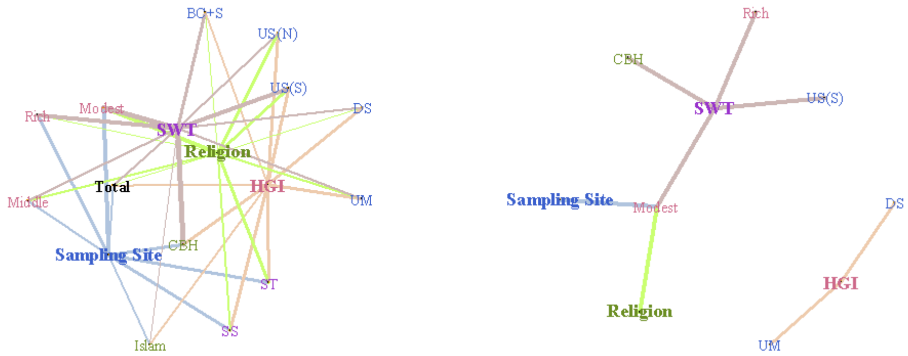


Figure 5.4.2-2 WTP for RWD Association Network (Total)

In Sampling Site, the HGI-WTP_{RWD} Cramer's V value in the North sb stays unchanged from UM (0.25) to US(N) (0.25) and then increases to DS (0.26); in the South sb increases from US(S) (0.22) to DS (0.26); at BC+S it is 0.20. The Religion- WTP_{RWD} in the North sb increases from UM (0.14) to US(N) (0.24) and then decreases to DS (0.13); in the South sb decreases from US(S) (0.23) to DS (0.13); at BC+S it is 0.11. The SWT- WTP_{RWD} increases in the North sb from UM (0.14) to US(N) (0.17) and then decreases to DS (0.14); in the South sb decreases from US(S) (0.30) to DS (0.14); at BC+S it is 0.24.

In HGI, the Sampling Site-WTP_{RWD} Cramer's V value decreases from the Modest (0.27) to the Middle (0.18) and then increases to the Rich (0.20); the Religion- WTP_{RWD} decreases HGI-wise from the Modest (0.28) via the Middle (0.15) to the Rich (0.090); the SWT- WTP_{RWD} deceases from the Modest (0.36) to the Middle (0.18) and then increases to the Rich (0.29).

In Religion, the Sampling Site- WTP_{RWD} Cramer's V value is higher in CBH (0.21) than in Islam (0.20); the HGI-WTP_{RWD} is higher in CBH (0.23) than in Islam (0.16); the SWT- WTP_{RWD} is higher in CBH (0.34) than in Islam (0.11).

In SWT, the Sampling Site-WTP_{RWD} Cramer's V value is higher in ST (0.21) than in SS (0.20); the HGI-WTP_{RWD} is higher in ST (0.23) than in SS (0.22); the SWT-WTP_{RWD} is higher in ST (0.23) than in SS (0.14).

In Total, the Sampling Site-WTP_{RWD} Cramer's V value is 0.16; the HGI-WTP_{RWD} 0.15; the Religion 0.12; the SWT 0.19.

In conclusion, SWT and Modest (low income) are keys to comprehend the basin people’s WTP for RWD.

5.4.3 RWD and WTP for RWD

5.4.3.1 Sampling Site

The Sampling Site-RED and -WTP_{RWD} Cramer’s V values are tabulated (**Table 5.4.3.1-1**) and plotted (**Figure 5.4.3.1-1**). Overall, the RWD Cramer’s V is equal to or higher than the corresponding WTP_{RWD} Cramer’s V.

Table 5.4.3.1-1 Cramer’s V Values of Sampling Site-RWD and -WTP for RWD (Total)

	Sampling Site					HGI			Religion		SWT		Total
	UM	US(N)	US(S)	DS	BC+S	Modest	Middle	Rich	Islam	CBH	ST	SS	Total
RWD						0.29	0.18	0.21	0.27	0.29	0.24	0.29	0.24
WTP for RWD						0.27	0.18	0.20	0.15	0.22	0.21	0.20	0.16

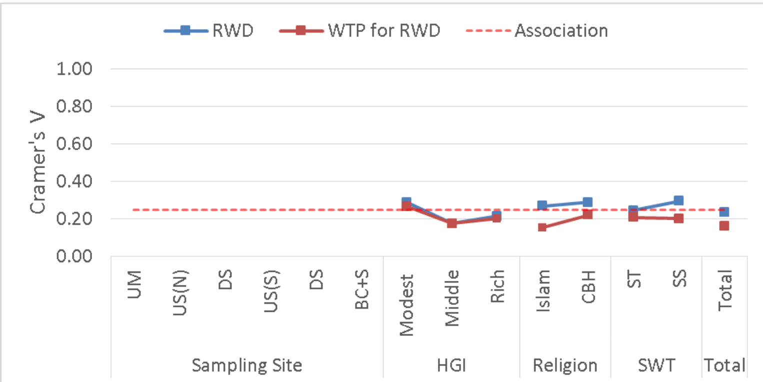


Figure 5.4.3.1-1 Sampling Site-RWD and -WTP for RWD Associations (Total)

The extent of a Cramer’s V derived from the interaction of the Survey Sheet (**Q7** in particular) and the respondent. The Cramer’s V value can be interpreted as how strong/weak the interaction was. If, for example, an WTP_{RWD} Cramer’s V is higher than the corresponding RWD Cramer’s V, it can be interpreted: that the Survey Sheet is more sensitive to money-paying will than to drinkability judgement by the respondent’s conscious or subconscious s water drinking criterion; and/or that the respondent has different criteria respectively for deciding RWD and WTP_{RWD}. We assume that the Survey Sheet is equally sensitive to RWD and to WTP_{RWD}: the difference of the two value derives from different criteria of the respondent.

In HGI, the WTP_{RWD} Cramer’s V is equal to or higher than the corresponding RWD Cramer’s V, being almost overlapping. This implies that each and every the HGI group has a same water drinking criterion for drinkability judgement and money-paying will.

In Religion, the RWD Cramer's V is higher than that of WTP_{RWD}, which implies that each the Religion group has different water drinking criteria respectively for drinkability judgement and money-paying will.

In SWT, the RWD Cramer's V is higher than that of WTP_{RWD} which implies that each the SWT group has different water drinking criteria respectively for drinkability judgement and money-paying will.

In Total, the RWD Cramer's V value is higher than that of WTP_{RWD} which implies that the Total has different water drinking criteria respectively for drinkability judgement and money-paying will.

5.4.3.2 Religion

The Religion-RED and -WTP_{RWD} Cramer's V values are tabulated (**Table 5.4.3.2-1**) and plotted (**Figure 5.4.3.2-1**).

Table 5.4.3.2-1 Cramer's V Values of Religion-RWD and -WTP for RWD (Total)

	Sampling Site					HGI			Religion		SWT		Total
	UM	US(N)	US(S)	DS	BC+S	Modest	Middle	Rich	Islam	CBH	ST	SS	Total
RWD	0.31	0.15	0.12	0.13	0.19	0.21	0.15	0.12			0.14	0.065	0.070
WTP for RWD	0.14	0.24	0.23	0.13	0.11	0.28	0.15	0.090			0.23	0.16	0.12

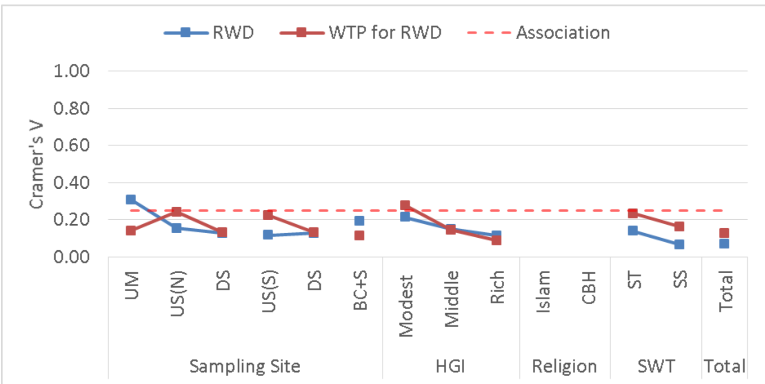


Figure 5.4.3.2-1 Religion-RWD and -WTP for RWD Associations (Total)

In Sampling Site, in the North sb the WTP_{RWD} Cramer's V value than the RWD Cramer's V value at UM; the RWD higher than the WTP_{RWD} at US(S); the RWD and the WTP_{RWD} equal at DS. At UM and BC+S the RWD is more dependent on Religion, and elsewhere the WTP_{RWD} is more. This may imply that the UM respondents have clean river water to be able to emphasize religious aspect of water (*e.g.* source) to drink it (RWD) to be able to less willing to pay extra for river water they are already enjoying. At BC+S the quality of their most likely drinking water, mostly bottled water filtered tap water, is not supposed to very different. And, thus cultural judgement of river water could be emphasized. The BC+S respondents are more willing to pay for RWD than UM respondents, probably because of BC+S's polluted rivers and higher HGI.

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In HGI, the two Cramer's *V* values similarly decreases HGI-wise, crossing at the Middle with the equal value of 0.15. In Modest, the WTP_{RWD} is higher than the RWD; while in the Rich the RWD higher than the $WTP_{RWD.}$ This may imply that the richer, the more similar water-related lifestyle (therefore criteria as well) becomes with water equipment. And, the rich are less restricted to money to pay for extra, which gives the Rich respondents a freedom-of-choice mind.

In SWT, the two Cramer's *V* value are in a parallel in which the WTP_{RWD} Cramer's *V* is higher than the RWD, and those in ST is higher than in SS. This may imply that the SS using respondents, who live in relatively urbanized areas, are more regardless of Religion in RWD judgement and $WTP_{RWD.}$ It could be possible that the both RWD and WTP_{RWD} Religion-regardlessness will decrease to the same extent if the SS users install SS.

5.4.3.3 Household Gross Income

The HGI-RED and - WTP_{RWD} Cramer's *V* values are tabulated (**Table 5.4.3.3-1**) and plotted (**Figure 5.4.3.3-1**). Overall, except in Religion, the WTP_{RWD} Cramer's *V* value is equal to or higher than the corresponding RWD Cramer's *V* value.

Table 5.4.3.3-1 Cramer's *V* Values of HGI-RWD and -WTP for RWD (Total)

	Sampling Site					HGI			Religion		SWT		Total
	UM	US(N)	US(S)	DS	BC+S	Modest	Middle	Rich	Islam	CBH	ST	SS	Total
RWD	0.23	0.23	0.16	0.15	0.095				0.23	0.081	0.23	0.18	0.17
WTP for RWD	0.25	0.25	0.22	0.26	0.20				0.16	0.23	0.23	0.22	0.15

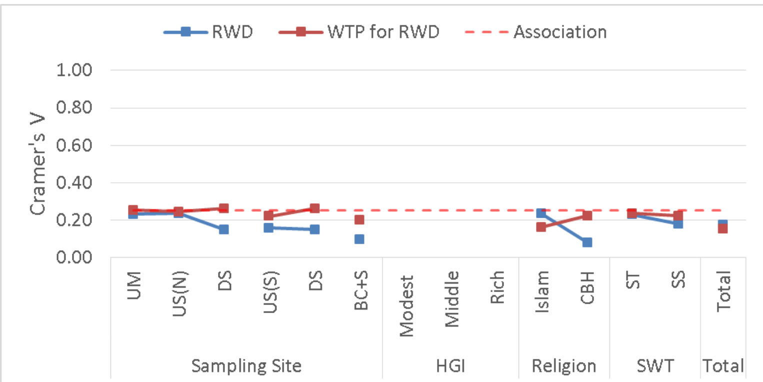

Figure 5.4.3.3-1 HGI-RWD and -WTP for RWD Associations (Total)

In Sampling Site, the RWD Cramer's V value is higher than that of WTP_{RWD} throughout the Sampling Sites, which implies that the RWD and WTP_{RWD} criteria are different at each and every Sampling Site. However, The RWD and WTP_{RWD} Cramer's V values at UM at US(N) are similar and stay unchanged, which implies in each of these Sampling Site, respondents may have a same criterion for water drinkability judgement and money-paying will.

In Religion, the RWD Cramer's V value is higher in Islam than in CBH; while the WTP_{RWD} higher in CBH than in Islam, which implies that the RWD and WTP_{RWD} criteria are different in each Religion group.

In SWT, the RWD and WTP_{RWD} Cramer's V values are the same; the WTP_{RWD} is higher than the RWD in SS, which implies that ST using respondents have a same criteria for RWD and WTP_{RWD}, while SS using respondents do not.

In Total, the RWD Cramer's V is higher than that of WTP_{RWD}, which implies that the Total has different water drinking criteria respectively for drinkability judgement and money-paying will.

5.4.3.4 Sewer Water Treatment

The SWT-RWD and -WTP_{RWD} Cramer's V values are tabulated (**Table 5.4.3.4-1**) and plotted (**Figure 5.4.3.4-1**).

Table 5.4.3.4-1 Cramer's V Values of SWT-RWD and -WTP for RWD (Total)

	Sampling Site					HGI			Religion		SWT		Total
	UM	US(N)	US(S)	DS	BC+S	Modest	Middle	Rich	Islam	CBH	ST	SS	Total
RWD	0.27	0.12	0.37	0.027	0.31	0.14	0.19	0.17	0.14	0.10			0.12
WTP for RWD	0.14	0.17	0.30	0.14	0.24	0.36	0.18	0.29	0.11	0.34			0.19

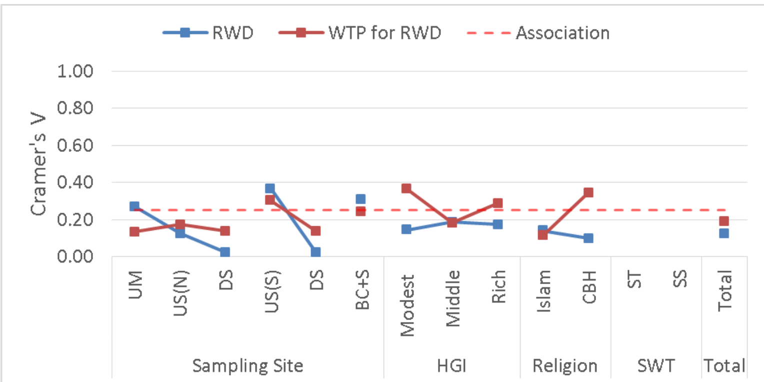

Figure 5.4.3.4-1 SWT-RWD and -WTP for RWD Associations (Total)

In Sampling Site. In the North sb and the South sb, the WTP_{RWD} Cramer's V value is higher than the RWD Cramer's V value at UM and US(S), respectively and at US(N) and DS the RWD Cramer's V value is higher than the WTP_{RWD} Cramer's V value. This may imply that water quality become worse to drink flow-wise and therefore RWD judgement becomes more independent from SWT. In the North sb the WTP_{RWD} Cramer's value is relatively stable from UM to DS, meaning that ST-SS difference affects to a certain similar extent the WTP_{RWD}. At BC+S the RWD Cramer's V value is higher than the WTP_{RWD} Cramer's V value. In the Middle the two Cramer's V is similar. At BC+S the WTP_{RWD} Cramer's V value is higher than the RWD Cramer's V value.

In HGI, the RWD Cramer's V value is relatively stable, meaning that ST-SS difference affects to a certain similar extent the RWD, while the WTP_{RWD} Cramer's V value that draws a V shape from the Modest to the Rich. The Modest and Rich's differences between criteria about river RWD judgement and WTP_{RWD} are considered larger than that of Middle's, though probably for some respective different reasons related to their HGI level.

In Religion, in Islam, the RWD Cramer's V value is higher than that of WTP_{RWD}, while in CBH the order is quite opposite. Compared to Muslim respondents, the difference between criteria about river RWD judgement and WTP_{RWD} is considered larger. It is considered that CBH ST and SS users live in suburban (rural) and urban areas, respectively.

5.4.4 Water Un***ability Factor

In order to understand Sg. Selangor people's water perception characteristics, Water Un***ability Factors (WUXFs) *i.e.*, Water Undrinkability Factor (WUDF), Water Unbathability Factor (WUBF) and Water Religious Acts Unusability Factor (WRAUUF) were questioned in **Q2**, **Q3** and **Q4** in the Survey Sheet. The WUXF-respondents' property Cramer's V values are tabulated in **Table 5.4.4-1**. In **Table 5.4.4-1**, the levels of categorical variables are created from the respondents answers considering mainly similarity and sample size (**Table 5.4.4-2**). As discussed in **5.2.1.1.3** , Religion was clustered into two clusters: Islam and CBH, mainly because Islam was quite characteristic by being more likely to choose non-organoleptic WUDFs ('Religious taboo' and 'Source'), thus 'CBH' group was created (Religion: Islam and CBH). And, since the factors include 'Religious taboo,' Religion-based analyses were done as well.

Table 5.4.4-1 WUXF- property Cramer's V value (Total and Religion)

	WUDF			WUBF			WRAUUF		
	Total	Islam	CBH	Total	Islam	CBH	Total	Islam	CBH
Sampling Site	0.15	0.15	0.24	0.16	0.16	0.30	0.18	0.25	0.26
Gender	0.13	0.23	0.20	0.16	0.22	0.29	0.18	0.24	0.29
Local Authority Area	0.20	0.19	0.26	0.21	0.22	0.29	0.20	0.23	0.24
District	0.20	0.18	0.24	0.21	0.22	0.27	0.21	0.20	0.29
Age	0.29	0.18	0.35	0.18	0.14	0.22	0.26	0.22	0.35
SWT	0.31	0.25	0.15	0.23	0.24	0.20	0.38	0.41	0.24
Religion*	0.28	NA	0.17	0.21	NA	0.14	0.32	NA	0.21
HGI	0.17	0.18	0.18	0.14	0.17	0.22	0.21	0.21	0.27
Env. Body Membership	0.18	0.20	0.16	0.25	0.19	0.35	0.28	0.22	0.29
Education	0.14	0.091	0.24	0.10	0.16	0.18	0.21	0.36	0.31
Ethnic Group	0.33	0.12	0.12	0.25	0.12	0.12	0.37	0.26	0.14
'Water'	0.27	0.18	0.22	0.21	0.19	0.23	0.30	0.22	0.26
'River'	0.26	0.16	0.20	0.19	0.15	0.17	0.32	0.24	0.25

Table 5.4.4-2 Categorical Variables in Table 5.4.4-1

Catecgorical Variable	Question	Levels in Analayis	# ofLevels
Sampling Site		UM:Fraser's Hill, US(N): Kuala Kubu Baru, Batang Kali and Rasa, US(S): Serendah, Rawang, and Kuang, DS: Bestari Jaya and Kuala Selangor, and BC+S: Batu Caves and Sentul	5
Gender	Q17	Male and Female	2
Local Authority Area	Q18	M.D. Kuala Selangor, M.D. Ulu Selangor, M.P. Selayang, D.B. Kuala Lumpur, M.D. Raub, and None of the above	6
District	Q18	Kuala Selangor, Ulu Selangor, Gombak, Kuala Lumpur, Raub, and None of the above	6
Age	Q19	15-24, 25-34, and 35 or more ('15-19' was created by some respondents)	3
SWT	Q20	Septik Tank (Communal and Private) and Sewerage System (Public and Private)	2
Religion*	Q21	Islam, Christianity, Buddhism and Hinduism	4
HGI	Q22	0-2,999, 3,000-4,999, 5,000 or more	3
Env. Body Membership	Q23	Yes and No	2
Education	Q24	Tertiary and Non-tertiary	2
Ethnic Group	Q25	Malays, Chinese and Indians	3
'Water'	Q1	Air, 水, தண்ணீர் , Water	4
'River'	Q5	Sungai , 河, நதி River	4

5.4.4.1 Water Undrinkability Factor

In Total, WUDF is 'somewhat weakly' associated with Age (V =0.29), STW (0.31), Religion* (0.28), Ethnic Group (0.33), 'Water' (0.27) and 'River' (0.26). These properties are inter-related, and at least in this numerical point of view, Ethnic Group can be the foundation of understanding people's water drinking perception, although the Ethnic Group association is not predominant. Thus, for IRBM of Sg. Selangor's drinking water quality, it is recommended that the top five property be considered at the same time. The WUDF's relatively strong association with STW suggests that the WUDF-property association situation can be changed by water engineers as well as politicians.

In Islam, WUDF is 'somewhat weakly' associated with SWT (0.25) only. The following next is Gender (0.23). It is suggested that within Muslims, WUDF is mainly a technical issue.

In CBH, WUDF is 'somewhat weakly' associated with Age (0.35) and Local Authority Area (0.26).

In other words, CBH respondents' WUDF mainly associated with how old they are and where they live and the public services there. It is interesting that the STW association is 'very weak,' (0.15)

5.4.4.2 Water Unbathability Factor

In Total, WUBF is 'somewhat weakly' associated with Environmental Body Membership (Env. Body Membership) (V = 0.25) and Ethnic Group (0.25). Env. Body members may share some information about water as to if it is bathable. Each Ethnic Group may have different bathing culture e.g., the Malays' pre-prayer ablution

In Islam, WUBF is 'very weakly' associated with all the geographics and demographics analyzed. It could be said that Muslim respondents' water bathing practice is similar regardless of the properties. This may be because Muslims share water bathing criteria.

In CBH, WUBF is 'somewhat weakly' associated with Sampling Site (0.30), Gender (0.29), Local Authority Area (0.29), District (0.27) and Env. Body Membership (0.35). It could be said that CBH respondents' bathing water quality is different from a place to another; Env. Body Members share information about water as to if it is bathable; the way and/or frequency of water bathing may be different between Male and Female within CBH. It is interesting that the SWT association is 'very weak.'(0.20)

5.4.4.3 Water Religious Acts Unusability Factor

In Total, WRAUUF is 'somewhat weakly' associated with Age (V = 0.26), SWT (0.38), Religion (0.32), Env. Body Membership (0.28), Ethnic Group (0.37), 'Water' (0.30) and 'River (0.32).' Among them SWT and Ethnic Group are the top two. It is thought that with the combination of water perception difference and water quality, SWT associates with religious water use decision. It is interesting that Ethnic Group has higher association with religious water use than Religion. It may mean that water unusability decision in religion use is statistically, personally, not necessarily doctrinally, ethnic culture-based rather than religion-based.

In Islam, WRAUUF is 'weakly associated' with SWT (0.41), Education (0.36) and Ethnic Group (0.26). Assuming that all Muslims have the same in WRAUUF decision criteria or preference, religion use water quality varies among Sampling Sites and between ST and SS. In that case, it is imaginable that the introduction of advanced SWT system could make river water usable for religious use again, higher education may improve sanitary mind. Ethnicity is still one of the key in WRAUUF in Islam.

In CBH, WRAUUF is 'somewhat weakly' associated with CBH, Sampling Site (0.26), Gender (0.29), District (0.29), Age (0.35), HGI (0.27), Env. Body Membership (0.29), Education (0.31). One may think that the combination of the three religions may cause these relatively high Cramer's V values. However, the Religion*-WRAUUF Cramer's V value (0.21) indicates 'very weak' association (very small practical WRUUF characteristic difference among the three religion). Thus, it is possible that the abovementioned things are supposed to be relatively practically matter within CBH respondents.

5.4.5 Worst Trouble

In order to comprehend how much RWD depends on/associates with Sampling Site, HGI, Religion and SWT, corresponding Cramer's V values were tabulated (**Table 5.4.5-1**) (post-rounded off) and line graphed (**Figure 5.4.5-1**) and network graphed by the Fruchterman-Reingold algorithm using 'R' Package 'igraph' [2] with the edge width being proportional to the corresponding Cramer's V value (**Figure 5.4.5-2**). The left-hand side graph of **Figure 5.4.5-2** shows a possible association network of all the Cramer's V values from **Table 5.4.1-1**, and the right-hand side values equal to or more than 0.25 (pre-rounded off). **Figure 5.4.5-1** visualizes by the bars the orders and behaviors of association levels, and by the nodes and **Figure 5.4.5-2** edges what demographic characteristics are essential to pay attention to in implementing the IRBM of SSB: hubs that are relatively strongly connected to various demographics and thus show up from other levels within the same demographic groups. As a result, Religion and SWT, all the Cramer's V values being at an 'association' level ($V \geq 0.25$ before rounded off), among which Religion-DS(N), -DS, -Middle, SWT-US(N) and –DS being at a 'somewhat strong' association level, are keys to comprehend the basin people's WTP for RWD. The Cramer's V values of 'no association' ($V < 0.25$) level are those of Sampling Site-Rich, Sampling Site-Islam, Sampling Site-Total, HGI-BC+S, HGI-Islam and HGI total. This indicates that Rich, capital area-sampled, Muslim respondents' worst river troubles are relatively homogeneous compared to SSB area-sampled, Modest and Middle, CBH respondents'.

Table 5.4.5-1 Cramer's V value of Worst Trouble (Total)

	Sampling Site					HGI			Religion		SWT		Total
	UM	US(N)	US(S)	DS	BC+S	Modest	Middle	Rich	Islam	CBH	ST	SS	Total
Sampling Site						0.35	0.35	0.18	0.21	0.36	0.30	0.35	0.22
HGI	0.44	0.36	0.38	0.40	0.24				0.20	0.29	0.28	0.26	0.23
Religion	0.33	0.68	0.49	0.56	0.36	0.46	0.51	0.31			0.37	0.44	0.44
SWT	0.44	0.55	0.27	0.53	0.38	0.40	0.43	0.37	0.39	0.28			0.39

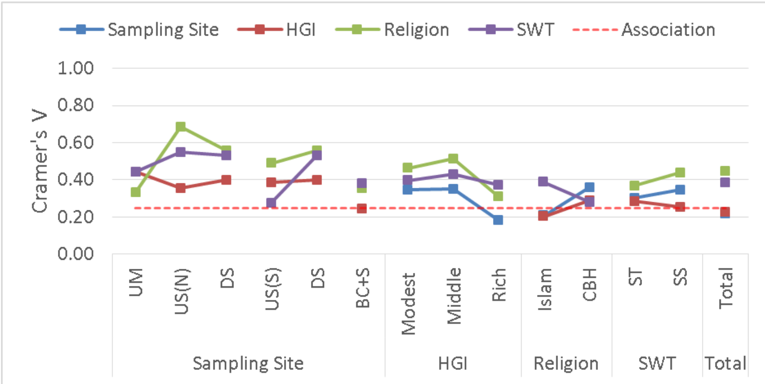

Figure 5.4.5-1 Worst Trouble Association with Sampling Site, HGI, Religion and SWT (Total)

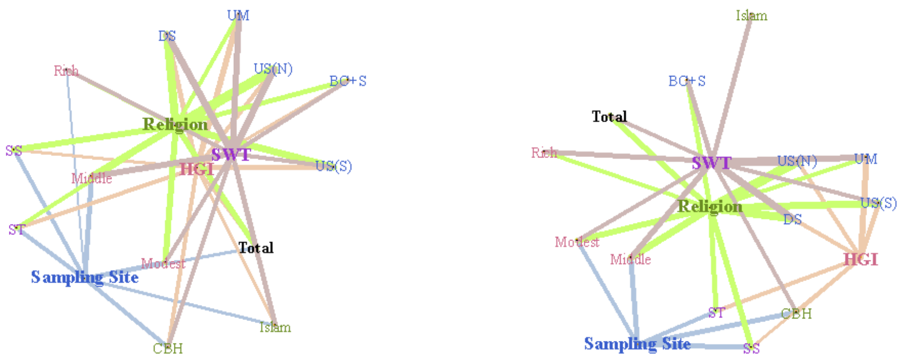

Figure 5.4.5-2 WT Association Network (Total)

In Sampling Site, the HGI-WT Cramer's V value in the North sb decreases fro9m UM (0.44) to US(N) (0.36) than increases to DS (0.40); in the South sb increases from US(S) (0.38) to DS (0.38); at BC+S it is 0.24. The Religion-WT Cramer's V value in the North sb increases from UM (0.33) to US(N) (0.68) and then decreases to DS (0.56); at BC+S it is 0.36. The SWT-WT Cramer's V value in the North sb increases from UM (0.44) to US(N) (0.55) and then decreases to DS (0.53); at BC+S it is 0.38.

In HGI, the Sampling Site-WT Cramer's V value stays unchanged from the Modest to the Middle and then decreases to the Rich (0.18). The Religion-WT Cramer's V value increases from the Modest (0.46) to the Middle (0.51) and then decreases to the Rich (0.31). The SWT-WT Cramer's V value increases from the Modest (0.40) to the Middle (0.43) and then decreases to the Rich (0.37).

In Religion, the Sampling Site-WT Cramer's V value is higher in CBH (0.36) than Islam (0.21). The

HGI-WT Cramer's V value is higher in CBH (0.29) than Islam (0.20). The SWT-WT Cramer's V value is higher in SS (0.29) than ST (0.20).

In SWT, the Sampling Site-WT Cramer's V value is higher in SS (0.35) than ST (0.30). The HGI-WT Cramer's V value is higher in ST (0.28) than SS (0.29). The Religion-WT Cramer's V value is higher in SS (0.44) than ST (0.37).

In Total, the Sampling Site-WT Cramer's V value is 0.22; the HGI-WW 0.23; the Religion-WW 0.44; the SWT-WT 0.39.

In conclusion, WT is a very complicated in SSB, from the points of view of Sampling Site, HGI, Religion, and SWT. Among them, SWT and Religion are the keys to comprehend and solve the river troubles in SSB.

5.5 River Water Cleanness or Usablity Order

Each respondent's answers on his/her nearest river's River Water Drinkability (RWD, **Q7**), River Water Bathability (RWB, **Q8**) and River Water Religious Acts Unusability (RWRAU, **Q9**) are summarized.

5.5.1 Islam

Figure 5.5.1-1 shows respondents' RWB and RWRAU of 'Drinkable (Yes in **Q7**),' 'Undrinkable (No),' and 'Drinkability-uncertain (I do not know.)' waters, respectively.

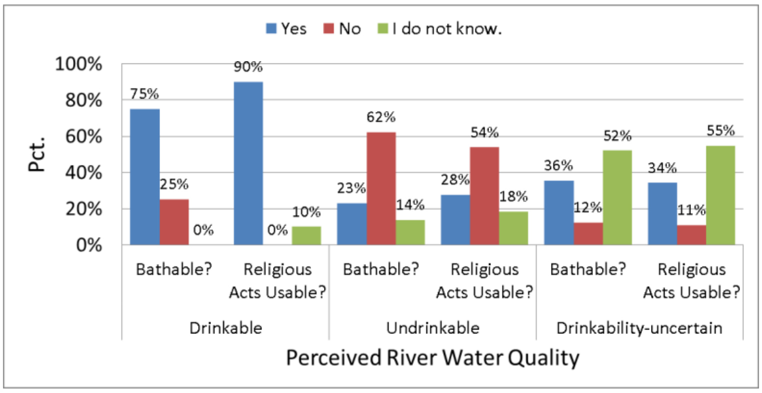

Figure 5.5.1-1 Drinkability-based Bathability and Religious Acts Usability (Islam)

Respondents perceive: drinkable river water bathable (75%) and religious acts usable (90%); undrinkable river water unbathable (62%) and religious acts unusable (54%); and, drinkability-uncertain river water bathability-uncertain (52%) and religious acts usability-uncertain (55%). In some cases, respondents perceive: drinkable river water unbathable (25%); undrinkable river water bathable (23%) or bathability-uncertain (14%), and religious acts usable (28%) or usability-uncertain (18%); and drinkability-uncertain river water bathable (36%) or unbathable (12%) and religious acts usable (34%) or unusable (11%). Overall, respondents perceive ‘bathable’ river water cleaner (more usable) than ‘religious acts usable’ river water.

Figure 5.5.1-2 shows respondents’ RWD and RWRAU of ‘Bathable (Yes in **Q8**),’ ‘Unbathable (No),’ and ‘Bathability-uncertain (I do not know.) ’ waters, respectively.

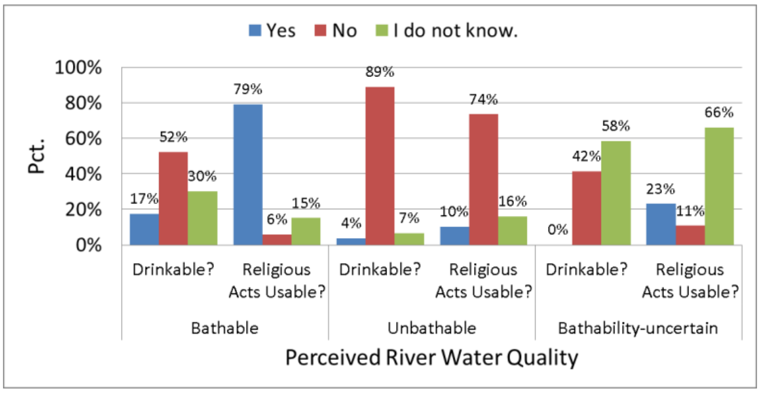

Figure 5.5.1-2 Bathability-based Drinkability and Religious Acts Usability (Islam)

Respondents perceive: bathable river water undrinkable (52%) and religious acts usable (79%); unbathable river water undrinkable (89%) and religious acts unusable (74%); and, bathability-uncertain river water drinkability-uncertain (58%) and religious acts usability-uncertain (66%). In some cases, respondents perceive: bathable river drinkability-uncertain (30%) or drinkable (17%), and religious acts unusability-uncertain (15%); unbathable river water religious acts usability-uncertain (16%) or usable (10%); and bathability-uncertain river water undrinkable (42%) religious acts usable (23%) or unusable (11%). Overall, respondents perceive ‘drinkable’ river water cleaner (more usable) than ‘religious acts usable’ river water.

Figure 5.5.1-3 shows respondents’ RWD and RWD of ‘Religious acts usable (Yes in **Q9**),’ ‘Religious acts unusable (No),’ and ‘Religious acts usability-uncertain (I do not know.) ’ waters, respectively.

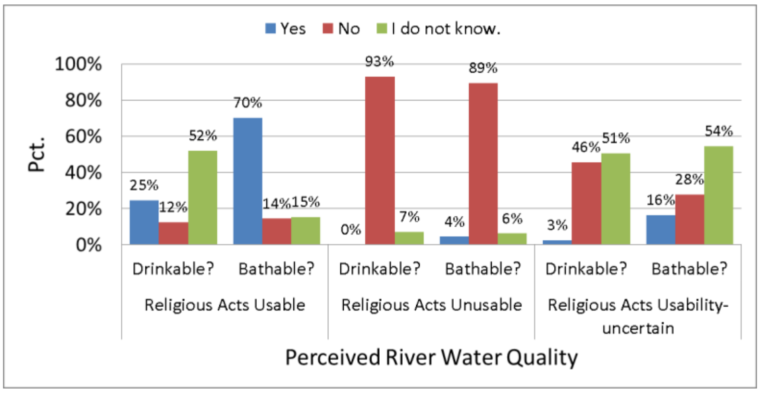

Figure 5.5.1-3 Religious acts usability-based Drinkability and Bathability (Islam)

Respondents perceive: religious acts usable river water drinkalitiy-uncertain (52%) and bathable (70%); religious acts unusable river water undrinkable (93%) and unbathable (89%); and, bathability-uncertain river water drinkability-uncertain (51%) and religious acts usability-uncertain (54%). In some cases, respondents perceive: religious acts usable river water drinkable (25%) or undrinkable (12%); religious acts usability-uncertain river water drinkable (46%), and unbathable (28%) or bathable (16%). Overall, respondents perceive 'drinkable' river water cleaner (more usable) than 'bathable' river water.

In summary, Muslim respondents perceive that 'drinkable' river water is the cleanest (most usable), 'bathable' the second, and 'religious acts usable' the third.

Bathable and religious act usable river waters appear related, because the Survey Sheet has the description '(*e.g.*, pre-prayer ablution)' (**Appendix**) which is mainly washing body parts. This appears inconsistent with the Islamic criteria by Mokhtar *et al.*(2015) that says ablution water is the cleanest [7], but consistent with the 'SmartWUDHU' in a mosque by Suratkon (2015) where drinking water is RO water but ablution water is rain water or water used for roof sprinkling.[12] Mokhtar *et al.*(2015)'s Islamic criteria are based on organoleptics and water source, storage value, flow, *etc.* and the 'SmartWUDHU' is seems consistent with the criteria. Consequently, respondents drinking and bathing water criteria are stricter than the Islamic criteria. This is probably because tap water and bottled water are easily available in today's Selangor and KL, with which people's water quality requirement in terms of hygiene science become stricter. Today, according to WHO, appearance, taste and odor are not considered as directly related to safety, and *vice versa*, although admitting that these aesthetics may indicate some harmful substances and organisms.[13] The Islamic criteria must have been, is and will be practical for ablution in a mosque and survival when and where modern hygiene technology and water market are not available.

5.5.2 Christianity, Buddhism and Hinduism

Figure 5.5.2-1shows respondents' RWB and RWRAU of 'Drinkable (Yes in **Q7**),' 'Undrinkable (No),' and 'Drinkability-uncertain (I do not know.)' waters, respectively.

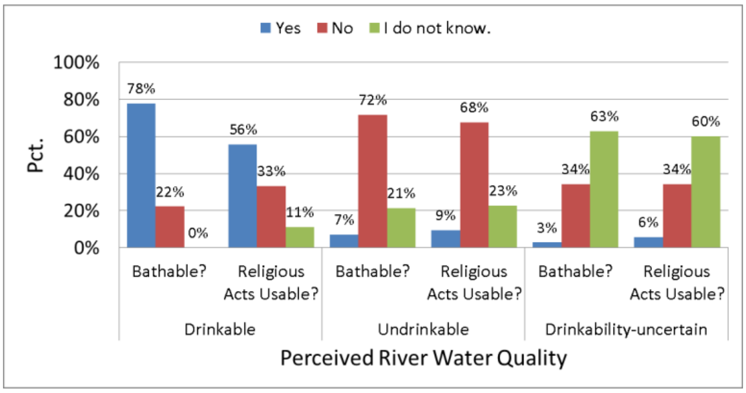

Figure 5.5.2-1 Drinkability-based Bathability and Religious Acts Usability (CBH)

Respondents perceive drinkable river water bathable (78%) and religious acts usable (56%); undrinkable river water unbathable (72%) and religious acts unusable (68%); and, drinkability-uncertain river water bathability-uncertain (63%) and religious acts usability-uncertain (60%). In some cases, respondents perceive: drinkable river water unbathable (22%) and religious acts usable unbathable (33%) or usability-uncertain (11%); undrinkable river water bathability-uncertain (21%), and religious acts usable (23%); and drinkability-uncertain river water unbathable (34%) and religious acts usable (34%). Overall, respondents perceive 'bathable' river water cleaner (more usable) than 'religious acts usable' river water.

Figure 5.5.2-2 shows respondents' RWD and RWRAU of 'Bathable (Yes in **Q8**),' 'Unbathable (No),' and 'Bathability-uncertain (I do not know.) ' waters, respectively.

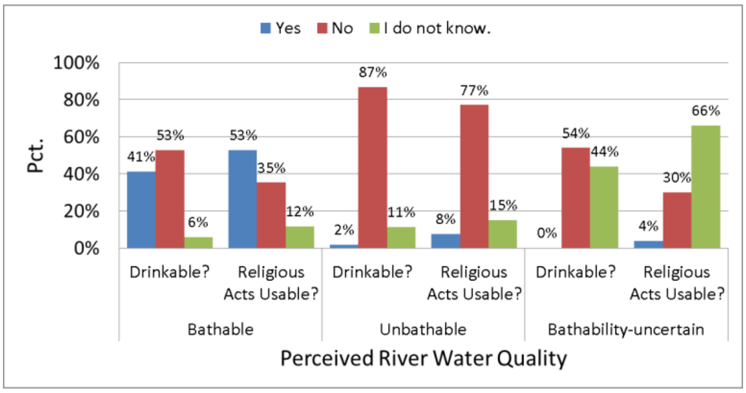

Figure 5.5.2-2 Bathability-based Drinkability and Religious Acts Usability (CBH)

Respondents perceive: bathable river water undrinkable (53%) and religious acts usable (53%); unbathable river water undrinkable (87%) and religious acts unusable (77%); and, bathability-uncertain river water undrinkable (54%) and religious acts usability-uncertain (66%). In some cases, respondents perceive: bathable river water drinkable (41%) and religious acts unusable (35%); unbathable river water drinkability-uncertain (11%) and religious acts usability-uncertain (15%); and bathability-uncertain river water undrinkable (44%) and religious acts usable (30%). Overall, respondents perceive ‘drinkable’ river water cleaner (more usable) than ‘bathable’ river water.

Figure 5.5.2-3 shows respondents’ RWD and RWD of ‘Religious acts usable (Yes in **Q9**),’ ‘Religious acts unusable (No),’ and ‘Religious acts usability-uncertain (I do not know.) ’ waters, respectively.

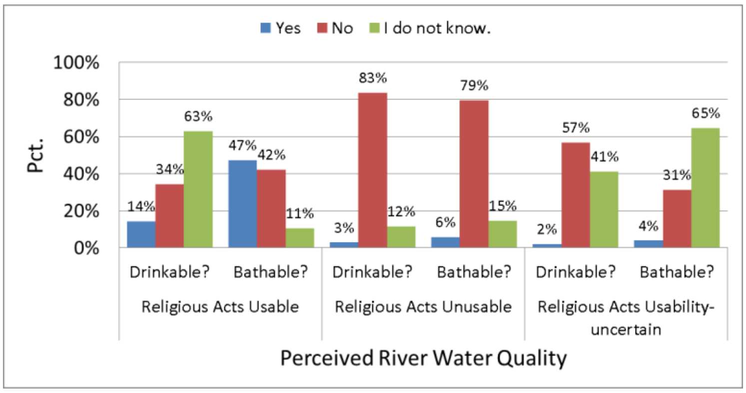

Figure 5.5.2-3 Religious acts usability-based Drinkability and Bathability (CBH)

Respondents perceive: religious acts usable river water drinkability-uncertain (63%); religious acts unusable river water undrinkable (83%) and unbathable (79%); and, religious acts unusability-uncertain river water undrinkable (57%) and bathability-uncertain (65%). In some cases, respondents perceive: religious acts usable river water undrinkable (35%) or drinkable (14%) and bathable (47%) or unbathable (42%); religious acts unusable water drinkable (12%) and bathable (15%); and, religious acts usability-uncertain river water drinkability-uncertain (41%) and unbathable (31%). Overall, respondents perceive ‘drinkable’ river water cleaner (more usable) than ‘religious acts usable’ river water. Overall, respondents perceive ‘drinkable’ river water cleaner (more usable) than ‘bathable’ river water.

In summary, CBH respondents perceive that ‘drinkable’ river water is the cleanest (most usable), ‘bathable’ the second, and ‘religious acts usable’ the third.

Bathable and religious act usable river waters appear less related compared to Muslim respondents. This is probably because CBH respondents’ religious water uses and restrictions are different from

Muslim ones'.

5.6 Discussion

5.6.1 DOE's Water Quality Monitoring

The DOE and Air Selangor (the State-owned water supply and distribution services company) are monitoring Sg. Selangor water quality (13 and 35 stations, respectively),[14] among which we will see nine DOE monitoring stations: 1SR03, 1SR04, 1SR05 and 1SR06 (US(N)); 1SR07 and 1SR08 (US(S)); 1SR09 (US(S)-DS, before merging with the stream from the North sb); and, 1SR10 and 1SR01 (DS) (**Figure 5.6.1-1**). 1SR05 locates at the immediate downstream of Sg. Selangor Dam.

Figure 5.6.1-1 Sampling Sites and DOE Monitoring Stations (Basin Map by LUAS (2010)[14])

As the satellite image (**Figure 5.6.1-1**) shows: UM is in the mountain, US(N) suburban towns; US(S) urbanized area; DS mainly agriculture area; and, BC+S capital area.

5.6.1.1 Water Quality Index

The Water quality index (WQI) is a number which simplifies and represents the water quality. [15,16] The WQI is calculated from various physico- and bio-chemical and bacteriological water quality parameters by various calculating formula, and interpreted in various ways.[15,16] The Malaysia's Department of Environment (DOE) uses the six parameters of dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD), ammoniacal nitrogen (AN), suspended solid (SS), and pH. The DOE's WQI is a linear sum of six sub-indices each of which calculated from one corresponding parameter; and is classified into five usage classes and three pollution classes

(**Table 4.3-1**)[9,14].

Table 5.6.1.1-1 Water Quality Index and Classifications11,16

Usage Classification

Class	Env. Cons.*	Water supply	Drinking	Bathing	Fishery	Livestook	Irrigation
Ⅰ	OK	No treatment needed	OK	OK	Very sensitive spieces	OK	OK
Ⅱa		Conventional treatment		OK	Sensitve species	OK	OK
Ⅱb							
Ⅲ		Extensive treatment			Common, torelant species	OK	OK
Ⅳ							OK
V							

Class	WQI	DO (mg/L)	BOD (mg/L)	COD (mg/L)	AN (mg/L)	pH	TSS (mg/L)	FC**	TC***
Ⅰ	>92.7	>7	<1	<10	<0.1	>7	<25		
Ⅱa	76.5-92.7	5-7	1-3	10-25	0.1-0.3	6.0-7.0	25-50	100	5,000
Ⅱb								400	5,000
Ⅲ	51.9-76.5	3-5	3-6	25-50	0.3-0.9	5.0-6.0	50-150		
Ⅳ	31.4-51.9	1-3	6-12	50-100	0.9-2.7	<5.0	150-300		
V	<31.0	<1	>12	>100	>2.7	<5.0	>300		

*Natural environment conservation.

**Fecal coliform (Counts/100mL; geometric mean)

***Total coliform (Counts/100mL)

WQI = (0.22* SIDO) + (0.19*SIBOD) + (0.16*SICOD) + (0.15*SIAN) + (0.16 * SISS) + (0.12 * SIpH)

where,

DO (%saturation)	SIDO
x ≤8	0
8<x <92	-0.395+0.030x^2-0.0002x^3
x≥92	100

BOD (mg/L)	SIBOD
x ≤5	100.4-4.23x
x>5	108*exp(-0.055x)-0.1x

COD (mg/L)	SICOD
x ≤20	-1.33x+99.1
x>20	103*exp(-0.0157x)-0.04x

AN (mg/L)	SIAN
x ≤0.3	100.5-105x
0.3<x <0.4	94*exp(-0.573x)-5*|x-2|
x ≥0.4	0

SS (mg/L)	SISS
x ≤100	97.5*exp(-0.00676x)+0.05x)
100<x <1,000	71*exp(-0.061x)-0.015x
x≥1,000	0

pH	SIpH
x <5.5	17.2-17.2x+5.02x^2
5.5 ≤x<7	-242+95.5x-6.67x^2
7 ≤x<8.75	-181+82.4x-6.05x^2
x>8.75	536-77.0+2.76x^2

Pollution Classification

	WQI	SIBOD	SIAN	SISS
Clean	81-100	91-100	92-100	76-100
Slightly Polluted	60-80	80-90	71-91	70-75
Polluted	0-59	0-79	0-70	0-69

In order to assess water quality, both objective and subjective approach are essential and complemental to each other. The WQI classifications are objective in terms of following certain criteria, while the respondents' water evaluation is subjective in terms of following their personal sense, value and experience. Some experts may think that an objectively measured and calculated number such as WQI is 'real' and people's subjective water quality is 'estimated' and should be checked the accuracy by objectively measured parameters.[17] This is true except their overvaluing objectivity as accuracy and undervaluing subjectivity as unreality. The objective WQI may be inaccurate. Fulazzaky (2013) criticizes that the Malaysian WQI is unsatisfactory for environmental assessment due to lacking important parameters such as phosphorus.[18] Wai *et al*. (2016) points out that the Malaysian WQI totally ignores heavy metals, which is inconsistent with the holistic environmental policy.[19] Besides, an objective evaluation may be complemented by a certain value system other than science, for example, by religion which is different from person to another (subjective) but may affect the person's practical life (real). Mokhta*r et al.* (2015) compared the DOE's WQI and Water Classification with an Islamic tidiness-dirtiness (*Taharah-Najasah*) standard, and pointed out that ablution water needs to be purer than WQI Class I (directly drinkable, see).[7] Muslims may not drink a glass of water into which one tiniest drop of pig blood fell, no matter how it is sanitarily safe. The Ganges is a sacred river for ablution for Hindus, no matter how it is sanitarily polluted. Besides, ordinary people (t, non-experts, the lay public) may not be careful about scientific and technical drinking water information from experts.[20] Anyway, people drink river water if they think it drinkable, and do not drink it if they think it undrinkable, for survival or for fun. We drink spring water in a mountain with or without objective sanitary data.

SSB is a multi-racial, multi-religious and multi-language society. Religion is one of the most important to form a person's subjective perception and value. Malay Muslims have strengthen their identity as Muslims since the 1970s.[21] On the other hand, Mohamed Mutafa Ishak (2015) views that non-Malays have been getting well accommodated to Malay politics and culture except the Islamic religion.[22] They share the same river basin, but water and river are well-known to be a potential cause of confliction. For preventing social confliction over water and river and managing the river basin to ensure a healthy and cultured life of all people in harmony, it is necessary to distribute water appropriate for the people's use in quantity and quality. For this purpose, in order to have proper knowledge about objective and subjective evaluations of the river, this section will compare the objective WQI classifications and the current research's Survey results, focusing on the DOE monitoring data and the respondents' Sampling Site and Religion difference.

The DOE's monitoring data of WQI were plotted through time, colored according to **Table 5.6.1.1-1**'s usage classified Class I to V (**Figure 5.6.1.1-1**) and pollution classified 'Clean (C),' 'Slightly Polluted (SP)' and 'Polluted (P)' (**Figure 5.6.1.1-2**) . Note that outliers were removed beforehand by the Smirnov-Grubbs test[23] in order to overview general trends within the same scale and compare them with the current Survey results, assuming that people's river and water perceptions are hardly affected by the extreme events. **Figure 5.6.1.1-1** and **Figure 5.6.1.1-2** illustrate that: US(N) and US(S) rivers are usually Class I and II and 'Clean.' and US(N) appears cleaner than US(S); and at DS usually Class

II and III and often ‘Slightly Polluted’ and sometimes ‘Polluted’. It seems like that the US(S) water seems polluted by urban and agriculture activities to reach 1SR09, and mixed and diluted with relatively cleaner water from the North sb and (observed at 1SR10) and then re-polluted to reach 1SR01 mainly by agriculture and sand mining activities. These WQI trends will be compared with the current research’s Survey results. The DOE monitoring data correspond to US(N), US(S) and DS, thus UM and DS+S Survey results are secondary reference here. Abdullah *et al.* (2015) measured water quality parameters in Fraser’s Hill and concluded that the WQI there are mostly in Class II.[24]

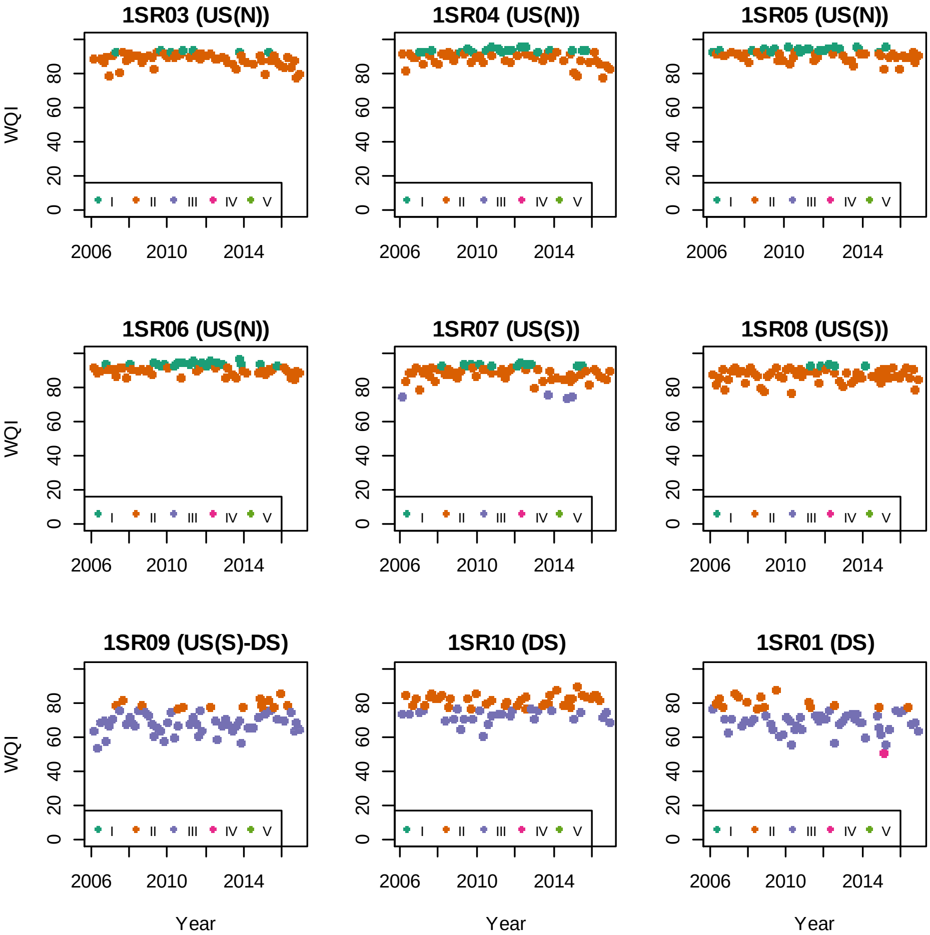

Figure 5.6.1.1-1 DOE-monitored WQI with Usage Classification

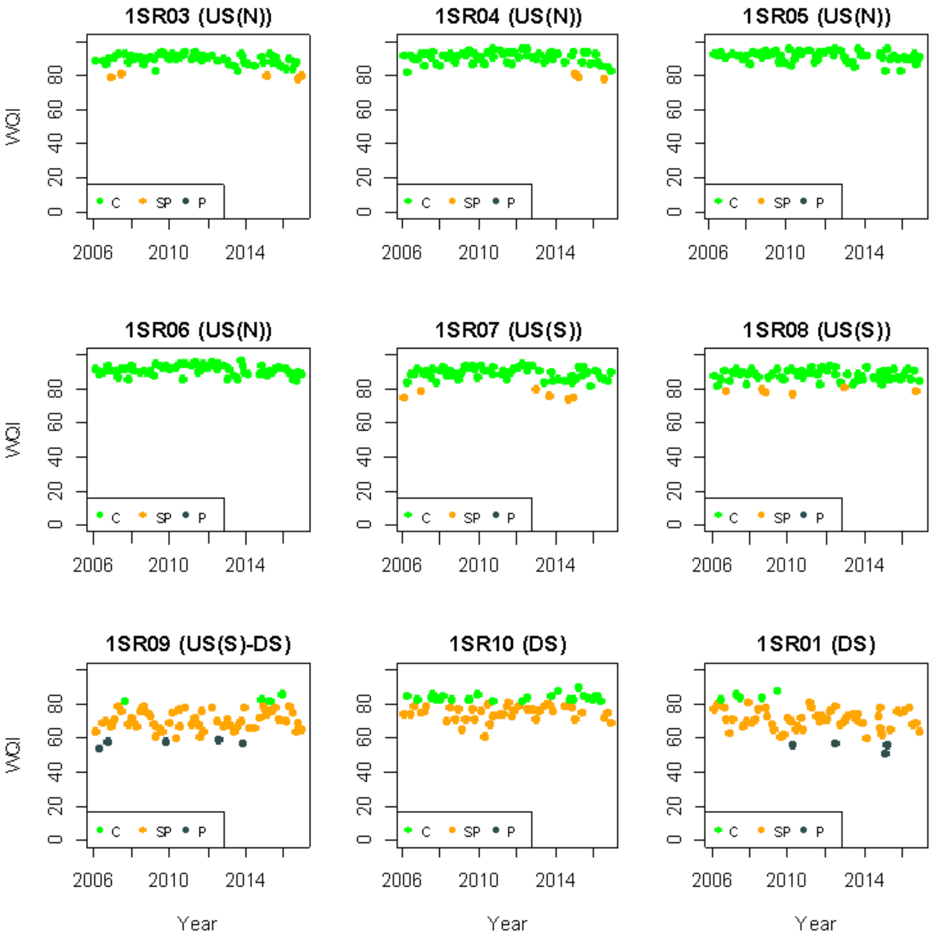

Figure 5.6.1.1-2 DOE-monitored WQI with Pollution Classification

5.6.1.2 RWD and WTP for RWD

Figure 5.6.1.2-1 illustrates respondents' RWD (**Q7**) at Sampling Sites. The areas of the pie charts are proportional to the EWTP for RWD. The RWDs of Muslim and CBH are generally similar at every Sampling Site. At UM river water is more frequently 'drinkable' because UM has clean mountain water. At US(N) and US(S) some respondents answered 'Drinkable (Yes)' while most of them 'Undrikable (No).' This is roughly consistent with the WQI values in there (**Figure 5.6.1.1-1**) that are sometimes Class I while mostly Class II. At DS the 'Drinkable (Yes)' ratios are smaller than US (N) and US(S) (**Figure 5.6.1.2-1**). This basically corresponds to the WQI values at DS that are Class II or inferior (**Figure 5.6.1.1-1**). At BC+S the 'Drinkable (Yes)' ratios are larger than DS, although it is an urban area, probably because some respondents are from places with clean river water such as upper stream.

Figure 5.6.1.2-1 suggests a general trend that a Sampling Site with smaller 'Drinkable (Yes)' pct. or larger 'Undrinkable (No)' pct. has a higher EWTP value. The Sampling Site-based Pearson's correlation coefficients between EWTP and 'Drinkable' pct. are -0.84 (Islam) and -0.92 (CBH); and those between EWTP and 'Undrinkable' pct. 0.74 (Islam) and 0.92 (CBH). The trend more strongly apparent in CBH than in Islam.

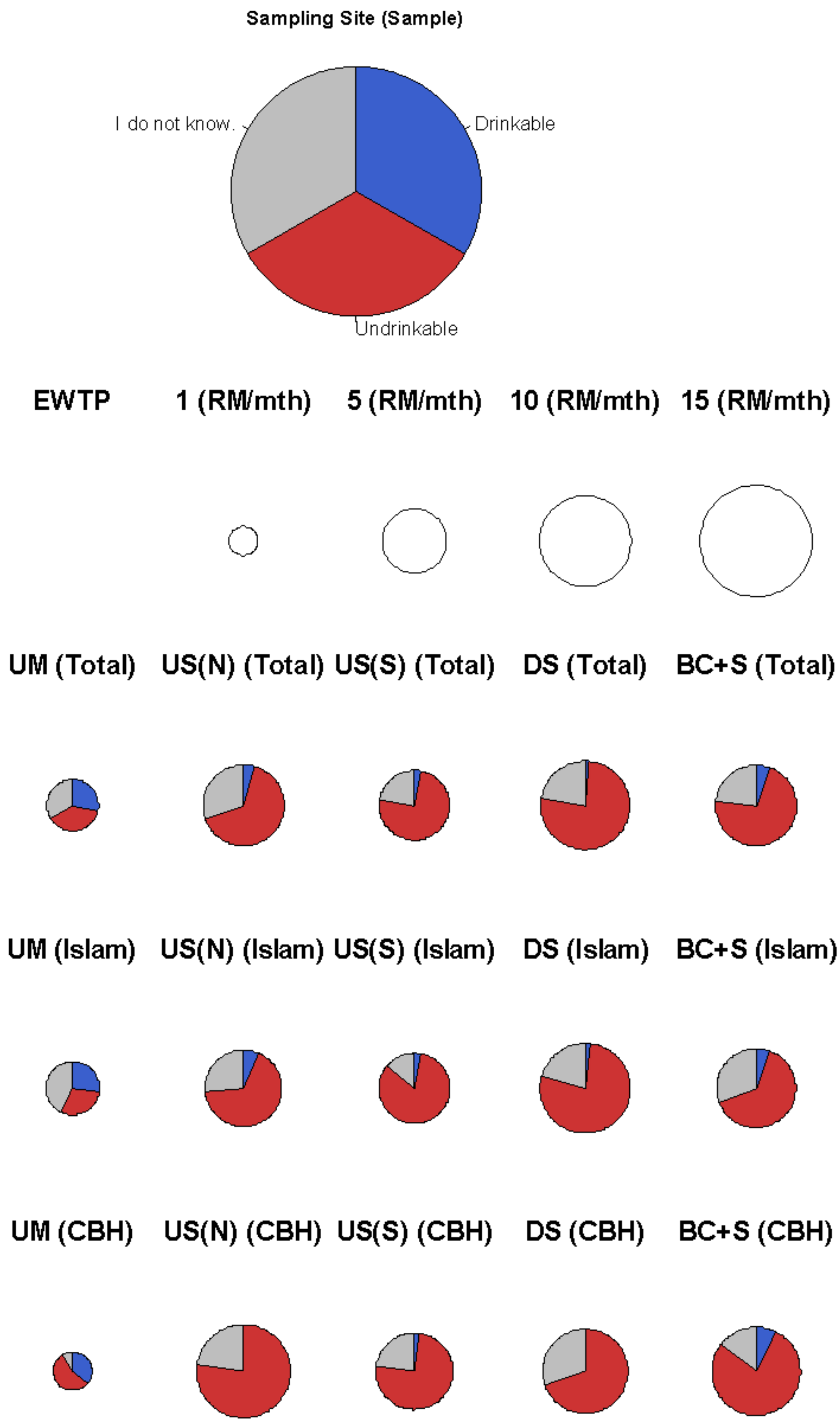

Figure 5.6.1.2-1 River Water Drinkability at Sampling Sites

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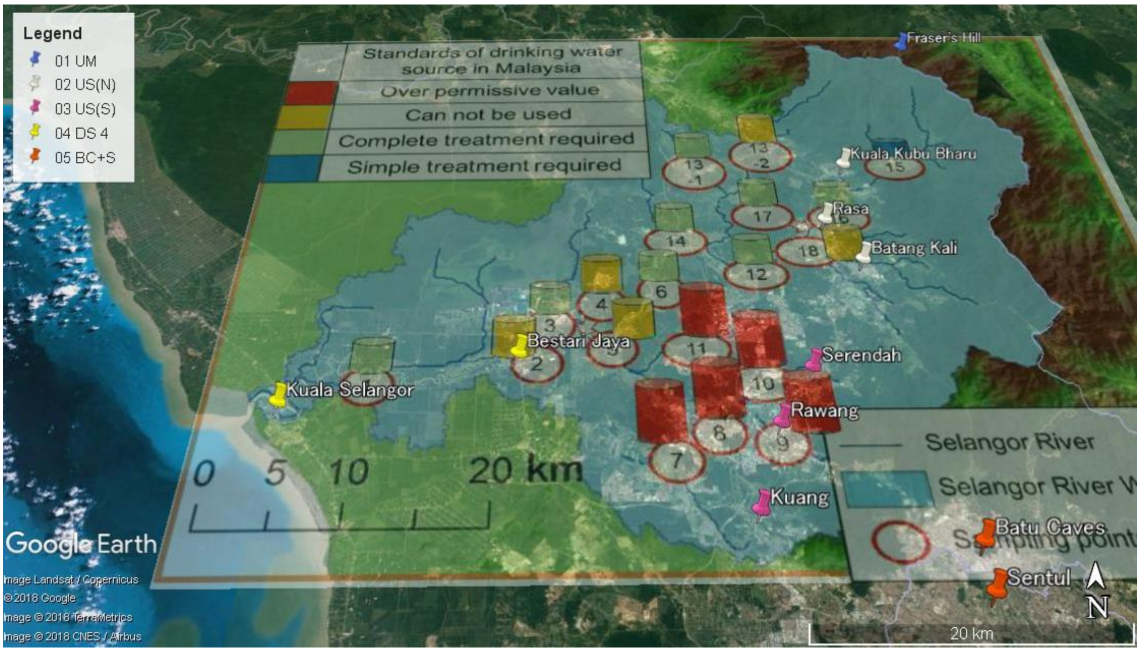

Figure 5.6.1.2-2 *E coli* levels by Shimizu and Kondo (2014)[25]

Figure 5.6.1.2-2 shows SSB's *E coli* levels in November, 2013, with the Malaysian river water quality standard by Shimizu and Kondo (2014).[25] Their water samples are all directly undrinkable, which is consistent with the current study that shows almost only at UM in SSB some people answered their nearest river water directly drinkable (**Figure 5.6.1.2-1**). SSB's rivers are polluted not only with microorganism but also with other things, and microorganisms are invisible by the naked eye. Therefore, *E coli* levels are not directly interlocked with the respondents RWD answers. If the *E coli* levels are associated with human sensible factors such as turbidity and color, the Shimizu and Kondo's and the current study's results are more meaningfully comparable.

The statistics about relationship between RWD and WTP for RWD in Islam is tabulated (**Table 5.6.1.2-1**) and bar-charged (**Figure 5.6.1.2-3**).

Table 5.6.1.2-1 RWD and WTP for RWD (Islam)

	Yes (Drinkable)			No (Undrinkable)			I do not know.			**Total**	
	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.
0	9	45%	1.9	46	24%	-1.5	20	29%	0.4	**75**	**27%**
0.01-9.99	7	35%	1.3	43	22%	-0.6	16	23%	-0.1	**66**	**23%**
10.00-19.99	2	10%	-2.0	59	31%	0.5	23	33%	0.6	**84**	**30%**
20.00 or above	2	10%	-1.2	44	23%	1.7	11	16%	-1.1	**57**	**20%**
Total	**20**	**100%**		**192**	**100%**		**70**	**100%**		**282**	**100%**

N	df	χ^2	V	ω	1- β	p_P	p_F
282	6	9.7	0.13	0.19	0.65	0.14	0.13

N'
377

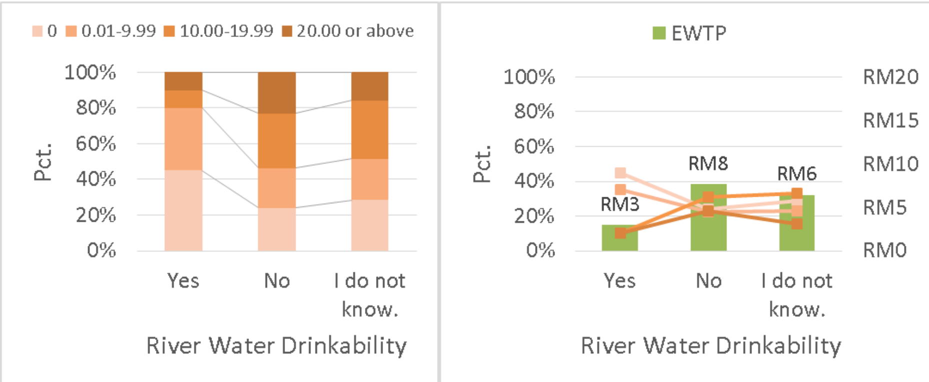

Figure 5.6.1.2-3 RWD and WTP for RWD (Islam)

The ‘0’ pct. is 45% in ‘Yes’; 24% in ‘No’; 27% in ‘I do not know.’ The ‘0.01-9,99’ pct is 35% in ‘Yes’; 22% in ‘No’; 23% in ‘I do not know.’ The ‘10.00-19.99’ pct. is 10% in ‘Yes’; 31% in ‘No’; 33% in ‘I do not know.’ The ‘20.00 or above’ pct. is 10% in ‘Yes’; 23% in ‘No’; 16% in ‘I do not know.’ The ‘0’ and ‘0.01-9,99’ pcts. are higher in ‘Yes’ than in ‘No,’ while the ‘10.00-19.99’ opposite. The ‘I do not know.’ answering respondents are willing to pay for RWD more than ‘No’ respondents and less than ‘Yes’ respondents ($\mathrm{EWTP} = 3, 8$ and $6\ \mathrm{RM/month}$, respectively).

Whether an answer frequency (freq.) is significantly higher/lower than expected was determined by adjusted standard residual (ASR, z). The only significant z value is for the cell of ‘Yes’-’10.00-19.99’($z = -2.0 < 1.96$). The ‘undrinkable’-higher WTP for RWD trend is insignificant in terms of z value.

The Cramer’s V value is 0.13 that means RWD and WTP for RWD are ‘very weakly’ associated in Islam. The p-value of Fisher’s exact test (p_F) is insignificantly large ($p_F = 0.13 > 0.050$) and the power insufficiently small ($1 - \beta = 0.65 < 0.80$). The sample size is too small to obtain a significantly small p-value (p_P) with a sufficiently large power ($N = 282 < N' = 377$). The ‘undrinkable’-higher WTP for RWD trend is statistically unsupported.

Besides, Each HGI group appears to have the ‘No’-pays most tendency (**Figure 5.6.1.2-4**).

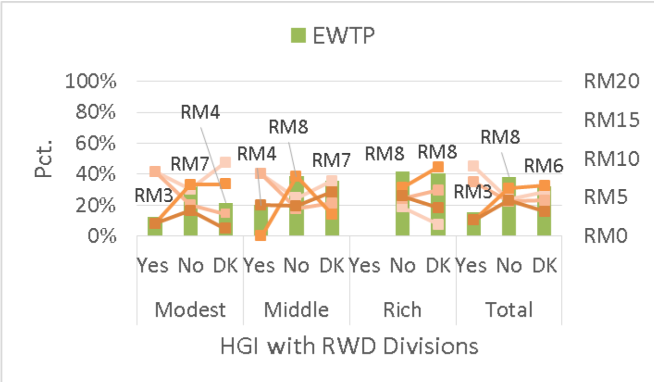

Figure 5.6.1.2-4 RWD, WTP for RWD, and HGI (Islam)

On the other hand, in CBH, the statistics about relationship between RWD and WTP for RWD is tabulated (**Table 5.6.1.2-2**) and bar-charged (**Figure 5.6.1.2-5**)

Table 5.6.1.2-2 RWD and WTP for RWD (CBH)

	Yes (Drinkable)			No (Undrinkable)			I do not know.			**Total**	
RM/month	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.	z	Freq.	Pct.
0	2	22%	0.6	22	17%	0.2	5	14%	-0.5	**29**	**17%**
0.01-9.99	4	44%	2.0	16	13%	-4.7	16	46%	4.0	**36**	**21%**
10.00-19.99	2	22%	-0.8	52	41%	1.3	11	31%	-1.0	**65**	**38%**
20.00 or above	0	0%	-1.6	36	29%	2.9	3	9%	-2.3	**39**	**23%**
Total	**9**	**100%**		**126**	**100%**		**35**	**100%**		**169**	**100%**

N	df	χ^2	V	ω	$1-\beta$	p_P	p_F
169	6	25.5	0.27	0.39	0.983	0.00028	0.00017

N'
90

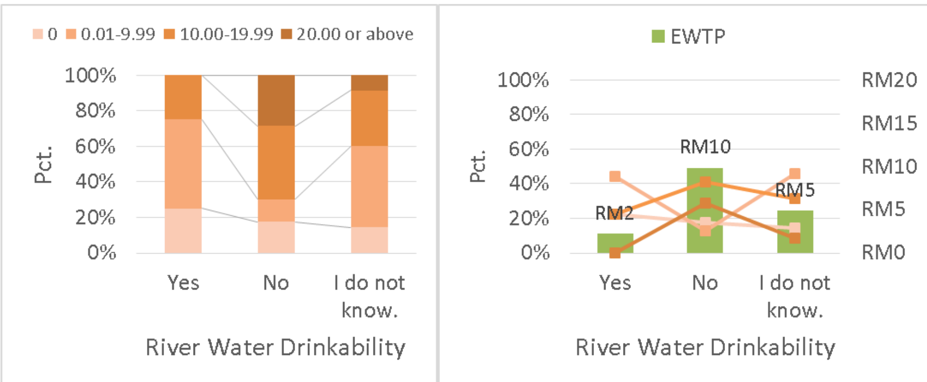

Figure 5.6.1.2-5 RWD and WTP for RWD (CBH)

The ‘0’ pct. is 22% in ‘Yes’; 17%; 17% in ‘No’; 14% in ‘I do not know.’ The ‘0.01-9.99’ pct. is 44% in ‘Yes’; 13% in ‘No’; 46% in ‘I do not know.’ The ‘10.00-19.99’ pct. is 22% in ‘Yes’; 41% in ‘No’; 31% in ‘I do not know.’ The ‘20.00 or above’ pct. is 0% in ‘Yes’; 29% in ‘No’; 9% in ‘I do not know.’

Whether an answer frequency (freq.) is significantly higher/lower than expected was determined by adjusted standard residual (ASR,z). Viewed from WTP for RWD side: the ‘0.01-9.00’ has significantly higher z values in ‘Yes’ ($z = 2{,}0 > 1.96$) and ‘I do not know.’ ($z = 4{,}0$) while significantly lower values in ‘No’ ($z = -4.7$); the ‘20.00 or above’ higher in ‘No’ ($z = 2.9$) while lower in ‘I do not know.’ ($z = -2.3$). The ‘0’ and ‘10.00-19.99’ have no significantly higher/lower z value. Viewed from RWD side: the ‘Yes’ has a significantly higher z value in ‘0.01-9.99’; the ‘No’ lower in ‘0.01-9.99’ while higher in ‘20.00 or above’; the ‘I do not know.’ higher in ‘0.01-9.99’ while lower in ‘20.00 or above’. It can be said that the ‘undrinkable’-higher WTP for RWD trend is significant in terms of z value.

The Cramer’s V value is 0.27 that means RWD and WTP for RWD are ‘somewhat weakly’ associated in CBH. The p-value of Fisher’s exact test (p_F) is insignificantly large ($p_F = 0.00017 < 0.050$) and the power sufficiently large ($1 - \beta = 0.983 > 0.80$). The sample size is sufficiently large to obtain a significantly small p-value (p_P) with a sufficiently large power ($N = 160 > N' = 90$). The ‘undrinkable’-higher WTP for RWD trend is statistically supported with ‘somewhat weak’ association.

Besides, each HGI group appears to have the ‘No’-pays-most tendency (**Figure 5.6.1.2-6**).

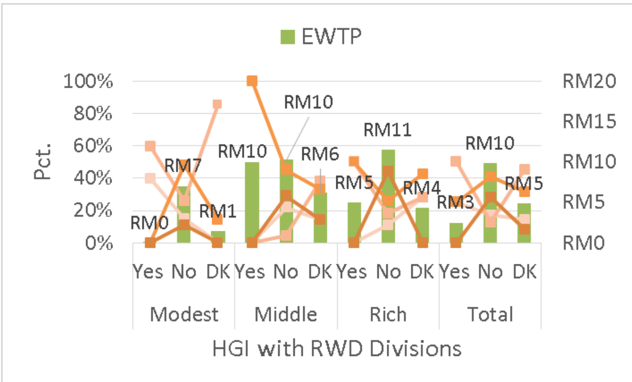

Figure 5.6.1.2-6 RWD, WTP for RWD, and HGI (CBH)

What is common between Islam and CBH in the RWD-WTP for RWD statistics is the EWTP order: ‘Yes (undrinkable)’-‘I do not know.’-‘No (drinkable)’. It is considered that the ‘I do not know.’ is a neutral state and the ‘Yes’ or ‘No’ RWD recognition makes some difference in EWTP. If this is true, Muslim respondents is basically more willing to pay (6 RM/month) for RWD than CBH respondents

(5 RM/month).

The advantage of calculating WTP values is that they are comparable with other related monetary values. **Table 5.6.1.2-3** shows the mean monthly household expenditure (MMHE) for water supply, sewerage collection, refuse collection and mineral water, soft drinks, fruit and vegetable juice, in total, rural and urban Selangor and Kuala Lumpur (KL) in 2016.[26] The 2016 MMHE for water supply is around 40 RM/month; for sewerage collection less than 10 RM/month; for refuse collection less than 1 RM/month; and for mineral water and so on around 20 RM/month. **Figure 5.6.1.2-7** compares the 2016 MMHE and EWTP (Islam and CBH). The EWTP levels are roughly the same as 2016 sewerage collection MMHE levels and clearly less than the 2016 MMHE for mineral water and so on. Recall that the EWTP are calculated from the minimums in the willing -to-pay range items, which does not exceed 20.00 RM/month the mineral water expenditure level. Among all '20.00 or above'-answering respondents (98 persons), 14 described particular amounts: 30 RM/month (4 persons, 29%), 40 RM/month (1, 7% of the 14 descriptions), 50 RM/month (5, 36%), 50.10 RM/month (1, 7%), 100 RM/month (1, 7%), 500 RM/month (1, 7%) and 'Infinity' RM/month (1, 7%). This indicates that some people may value drinkable river water as much as or more than water supply level. However, it is dangerous to assume that they are general, and the minimum estimation of EWTP is the most practical for decision making. And, **Q7** does not clearly ask about 'household' WTP, and thus the respondents may have answered his/her individual WTP for RWD. If this is the case, the EWTP should be interpreted as minimum WTP of the household that the respondent belongs to, which is consistent with the minimum estimation principle.

Table 5.6.1.2-3 Mean Monthly Household Expenditure in Selangor and Kuala Lumpur (2016)[26]

	Selangor			KL
	Total	Rural	Urban	Urban
Water supply	RM38.84	RM37.43	RM38.92	RM51.02
Sewerage collection	RM3.49	RM0.49	RM3.68	RM8.08
Refuse collection	RM0.88	RM0.21	RM0.93	RM0.40
Mineral water, soft drinks, fruit and vegetable juice	RM21.42	RM15.40	RM21.80	RM23.71

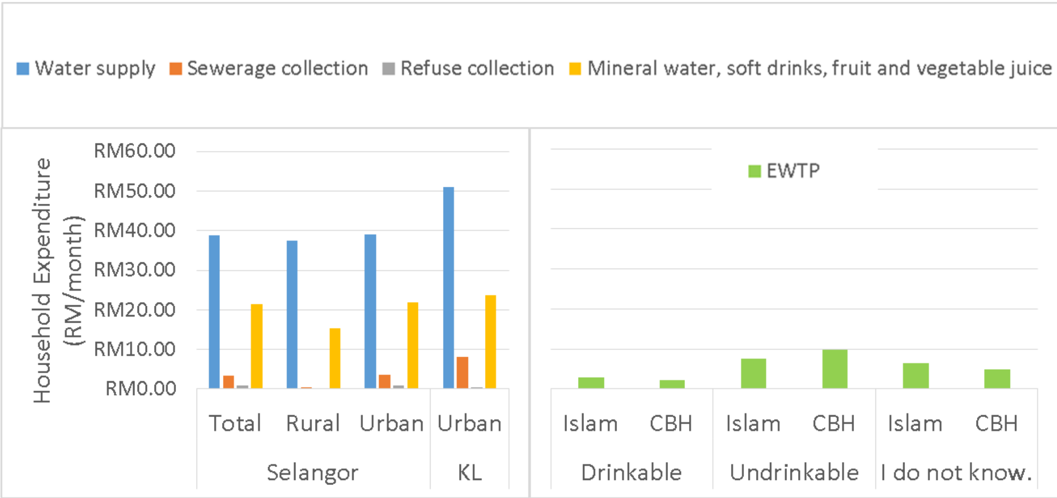

Figure 5.6.1.2-7 MMHE (2016)[26] and EWTP for RWD

In Selangor, water supply tariff by Syarikat Bekalan Air Selangor Sdn. Bhd (SYABAS) is based on how much and where *e.g.* domestic usage, commercial usage, government department, religious places, ship, charitable organizations, condominium/apartments, low cost flats/apartments, army camps/estates/government quarters.[27] The water supply tariff also has various minimum payments from 6.00 RM/month (domestic usage, charitable organizations, and religious places) to 173 RM/month (condominium/apartments). Sewerage tariff on domestic premises by Indah Water Konsortium (IWK) is at a flat rate from 2.00 to 8.00 RM/month according to the treatment (individual septic tank or connected sewerage services) and dwelling house categories (low-cost, estate, new village, village, and government quarters A to I).[28] The sewerage tariff is at the world's lowest level and the face value has been unchanged since in1994[29] (1997[30]). However, at least 13% of bills are unpaid.[31]

The 'real' running cost of water supply and sewerage services are said to be much more expensive than what customers directly pay for the services. F Saad says that the Selangor State provides its full population with water supply subsidy, the amount of which is in average 11.40 RM/month per account.[32] The Malaysian government provides sewerage treatment subsidy, the amount of which Abdul Kadir the MWA President says is in average around 27 RM/month per connection.[32] Lailla Zain at SAYS reports that the IWK sewerage running cost is estimated to be about 20 RM/month per household.[29] 'Green Tariff' that integrates bills of water supply and sewerage services is planned for full cost recovery under the Water Industry Act 2006 (WSIA).[30]

Since the water supply and sewerage tariffs are controlled by the government (the Minister being advised by SPAN), being legitimately agreed by the society including water consumers[33], the consumers are theoretically willing to pay the tariff for the tap water services (TWSs) that purify water and maintain water to/at a drinkable level. On the other hand, the WTP for RWD can be interpreted as the respondents' evaluation of a river's 'Ecosystem Services (ESs)' for RWD that do the same things as the TWSs. As to the service of water purification to a drinkable level, the respondents value TWSs higher than river ESs; as to the service of maintaining already drinkable water, the respondents value the TWSs and the river ESs roughly at the same level. **Figure 5.6.1.2-3** and **Figure 5.6.1.2-5** show the EWTP values of 8 RM/month (Islam) and 10RM/month (CBH) for purifying and maintaining the water to/at a drinkable level; 3 RM/month (Islam) and 2 RM/month (CBH) for maintaining already drinkable river water drinkable; and, 6 RM/month (Islam) and 5 RM/month (CBH) for make/keep drinkability-uncertain river water drinkable. **Figure 5.6.1.2-7** shows that people payed in 2016 much more (around 40 RM/month) for TWSs than the respondents' EWTPs for RWD. This is probably because people have tap water and do not necessarily expect river water as drinking water. On the other hand, Wahid and Hooi (2015) estimates that majority of Malaysians, who have drinkable tap water, are willing to pay up to 5 RM/(2 month) more than their current bill for improving the water quality and services[34]. Since this WTP is not for 'maintaining' but for 'improving' the services, the WTP for maintaining the services is thought to be less than 5 RM/(2 month). This is roughly at the same level as the EWTP for RWD of the respondents with drinkable river water. By the way, Aini *et al.* (2007) reports that their bottled water-buying respondents in 2003, in Seremban, Negeri Sembilan, pay 4.59 RM/day/household (140 RM/month/household)[35], while the 2016 urban Negeri Sembilan MMHE for Mineral water, soft drinks, fruits and vegetable juices is 14.45 RM/month.[26] This magnitude-order difference may be due to their samplings (time, ethnicity, income level, *etc.*), but it tells that water expenditure statistics are by nature more or less rough numbers.

In conclusion, the respondents sampled at a Sampling Site with 'undrinkable' river water tend to have higher EWTP for making the 'undrinkable' river water 'drinkable' in SSB. And respondents with 'undrinkable' river water have higher EWTP than those with 'drinkable' river water, both in Islam and CBH. The association of RWD and WTP for RWD is stronger in CBH than that of Islam. The EWTP is roughly the same as the 2016 sewerage collection MMHE (less than 10 RM/month).

5.6.1.3 Visual WUDFs and Total Suspended Solids

Kadir (2015) describes a 70-year-old lady's memory that in the downstream *mukim* of Pasangan, Kuala Selangor the river water used to be directly drinkable.[36] But, as described earlier, Selangor people in general have tap water and do not need to directly drink river water today. Wai *et al.* (2016) surveyed Sg. Langat and Sg. Klang basins, Selangor, and found there that most people drinking tap water and the few rest ground or well water and nobody river water.[19] The current survey's **Q2** asked about water in general. Consequently, it is highly possible that the respondents' answers were about tap water. The problem here is if and how much the **Q2** answers vary according to the respondents' backgrounds and vary from the WQI from the DOE's river water monitoring data. However, it is still possible that some respondents answered about river water. If so, it is thinkable that SS monitoring values by the DOE affect the respondents' choosing WUDF.

Figure 5.6.1.3-1 and **Figure 5.6.1.3-2** shows the Suspended Solid (SS) values at the DOE monitoring Stations with WQI classifications of Classes I – V and of pollution levels, respectively. Note that outliers were removed beforehand by the Smirnov-Grubbs test[23] in order to overview general trends within the same scale and compare them with the current Survey results, assuming that people's river and water perceptions are hardly affected by the extreme events These **Figures** show: that US(N) and US(S) rivers are clearly less SSed and usually Classes I or II 'Clean,' while DS river water is often turbid and usually Classes II or III and often more polluted than 'Slightly Polluted (SP).' The DS graphs (**bottom**) of the **Figures** illustrate: that 1SR10 water is generally less SSed and less polluted than 1SR09, which implies that the South sb water is more SSed than the North; and that 1R01 (the downmost) is more lower Classed and more often not 'Clean' than 1SR10, although there appears no drastic SS change after 1SR09. This indicates the influence of some parameters other an SS which lower the WQI.

Figure 5.6.1.3-3 illustrates that respondents' WUDF (**Q2**) at Sampling Sites with the visual factors of 'Turbidity' and 'Color' focused on as one continuous concept, considering wording gap between experts and non-experts. Respondents, mostly non-water experts many mean by 'Color' '(yellow) colored' unclearness with suspended solids that is technically termed 'Turbidity' by water experts. Smith *et al.* (1995) assumes their respondents' wordings of 'dirty,' 'muddy,' and 'silty' can be interpreted as 'yellow'-colored.[37] This is also the case in the current research's survey; some respondents asked about the meaning of 'Turbidity' in the survey sheet. **Figure 3-109** clarifies that CBH respondents judge water undrinkable by 'Turbidity' and 'Color' more likely than Muslim respondents do. This is related to that Muslim respondents chose the non-organoleptic items of Religious taboo' and 'Source' more often than CBH respondents did (**5.2.1.2.3**). The 'Turbidity' + 'Color' percentages do not appear to be related to the DOE monitoring SS values among US(N), US(S) and DS. CBH respondents, though less frequently choose the non-organoleptic factors of 'Religious taboo' or 'Source,' the 'Turbidity' + 'Color' percentage is similar among US(N), US(S) and DS. This implies that they do not drink river water there. At UM the respondents tend to worry about something other than 'Turbidity' and 'Color' more than at the other Sampling Sites, this may imply that there is less water-yellowing contamination in the water service and home pipes and tanks in Fraser's Hill compared to other Sampling Sites, or some of the Fraser's Hill respondents drink unpolluted mountain water.

If the **Q7** answers were about river water, it is possible that there is a threshold turbidity and color level above which people do not think of drinking water. The threshold SS level of drinking water is somewhere in UM (less turbid than US(N) in **Figure 5.6.1.3-1** that is, SS<1 mg/L), because a larger ratio of UM respondents have 'drinkable' river water compared to other Sampling Site (**Figure 5.6.1.2-1**). It is possible that the respondents' 'Turbidity' and 'Color' perception is stricter than the WQI Class I-associated Total Suspended Solid (TSS) level of 'less than 25 (mg/L).' [9] Nicolson and Mace (1975) reported that Minnesota campers' perception of recreational lake water pollution was predominantly affected by visual factors.[38] This is also the case of WUDF within the current study's CBH respondents who are hardly affected by non-organoleptic (religious) factors unlike Muslim respondents.

In conclusion, the respondents' drinking water perceptions regarding the visual WUDFs of 'Turbidity' and 'Color' is unrelated to the SS values monitored by DOE near the Sampling Site at US(N), US(S) and DS. They do not imagine river water as drinking water, because they have tap water and bottled water. UM may have a different trend because a larger ratio of respondents have some 'drinkable' river water there.

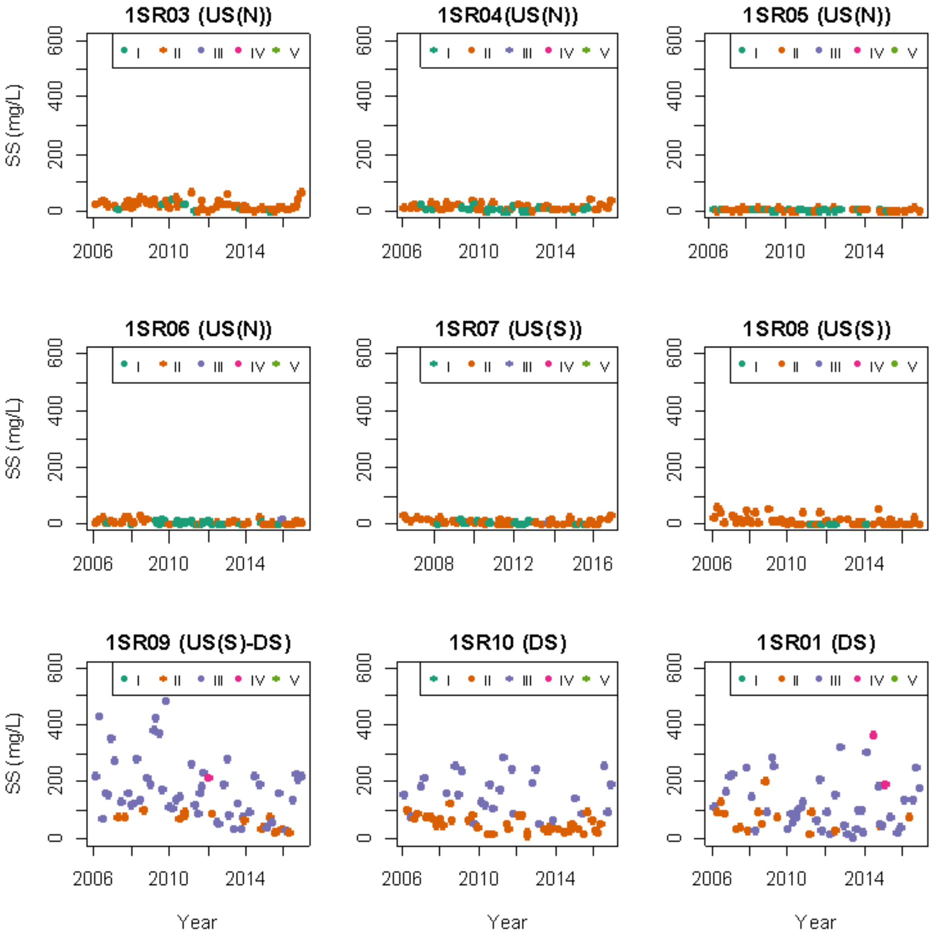

Figure 5.6.1.3-1 Suspended Solid with WQI Usage Classification

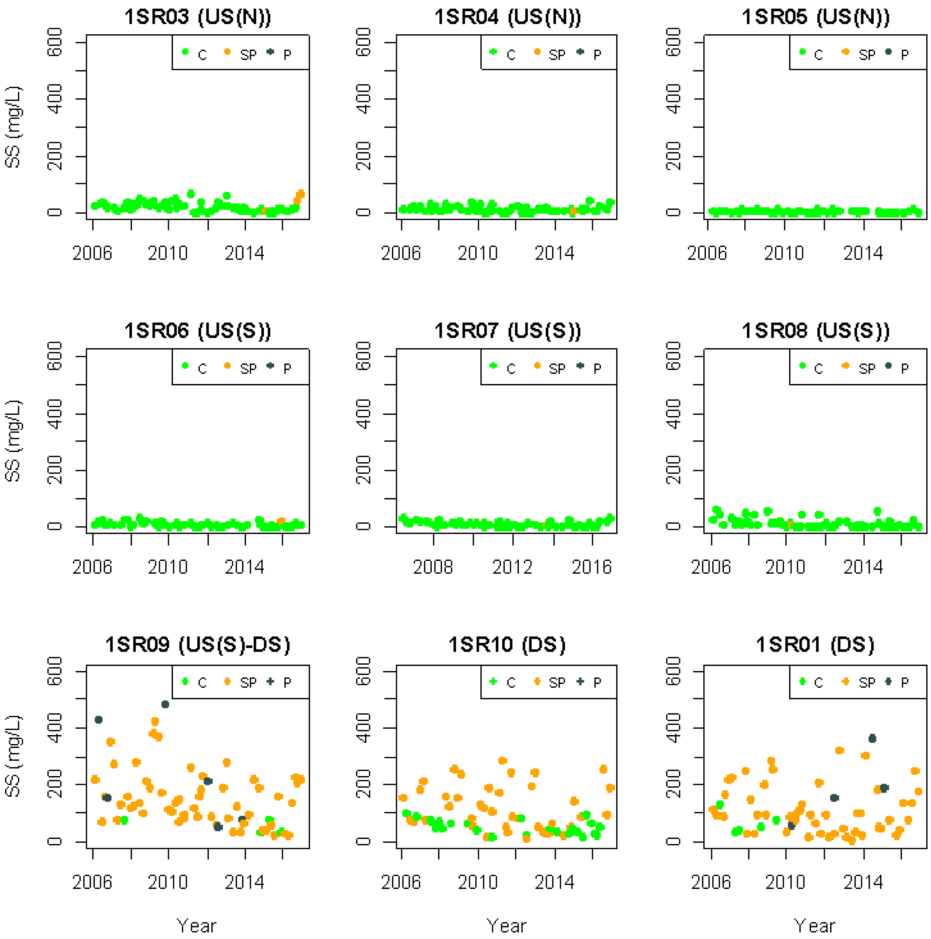

Figure 5.6.1.3-2 Suspended Solid with WQI Pollution Classification

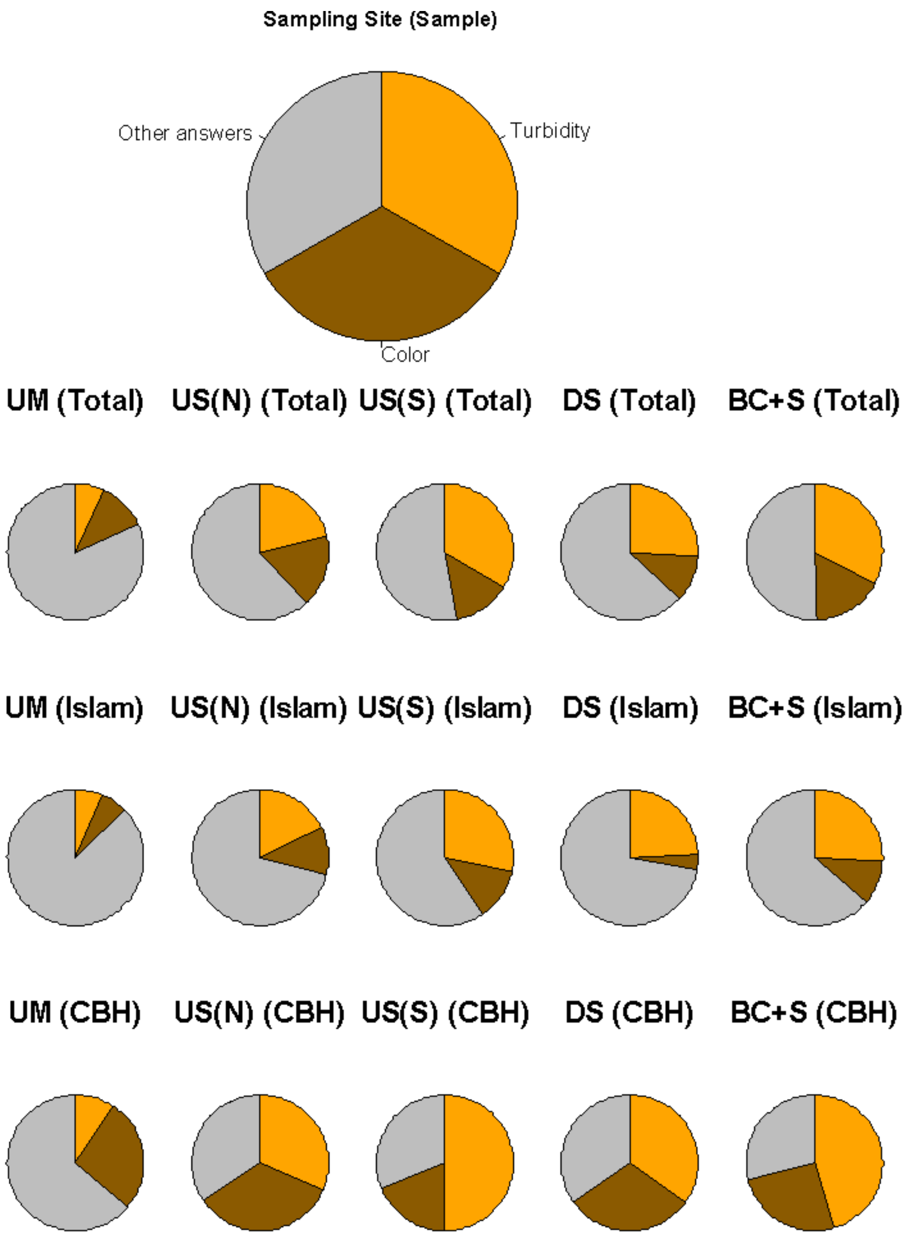

Figure 5.6.1.3-3 WUDF (Turbidity and Color focused on) at Sampling Site

5.6.1.4 Worst Trouble (Water-borne Disease and Pollution)

Figure 5.6.1.4-1 shows the Worst Trouble (**Q11**) focused on 'Water-borne disease' and 'Pollution.' It is clear that at US(N), US(S) and DS, Muslim respondents' WT is 'Pollution,' while CBH respondents' 'Water-borne disease.' This may mean that Muslim respondents do not need to worry about water-borne disease from their nearest river, while CBH respondents need to. Some of CBH respondents may live in 'New Villages' located riverside[10], while Muslim respondents may live relatively farther from the river. Furthermore, the same Sampling Site clustering pattern of Islam (**Figure 5.3.2.1-2)** and

CBH (**Figure 5.3.3.1-2**) indicate that the within-Sampling Site living location pattern commonly exists in each and every Sampling Site characterized by clustering (See also **Figure 5.3.2.1-3** and **Figure 5.3.3.1-3**). At BC+S both Muslim and CBH respondents tend to choose 'Pollution' as WT, which may mean that, although CBH respondents' 'Water-borne disease' percentage is higher than that of Muslim respondents', their sanitary perception gap may be narrower in the capital area compared to SSB area.

On the other hand, according to the WQI-based pollution classification, DS river water is clearly more polluted (often 'Slightly Polluted') than US(N) and US(S) (Often 'Clean') (**Figure 5.6.1.1-2**). At US(N) and US(S) Muslim respondents are sensitive to 'Pollution' from the Pollution Classification viewpoint, or the classification is biased to be 'Clean' at the upstream Sampling Sites from Muslim respondents' view point. The river may be 'polluted' due not only to bad water quality but also to bad river landscape generated by such as debris and litter in the river. Debris existence can be a sensitive threshold of water pollution judgement,[17] including which river and lake water quality perception is highly contextual: depending on such as the person's prior experience and the characteristic of the place.[20] Since the WQI have no parameter of debris or litter, respondents' judgement of 'Pollution' may be stricter than the WQI-based pollution classification.

Figure 5.6.1.2-2 illustrates that at US(S) microorganism pollution levels may be the highest in SSB. The current study's US(S) Muslim respondents' 'Water-borne disease' percentage is the highest (**Figure 5.6.1.4-1**), where they judge their river water undrinkable most (**Figure 5.6.1.2-1**). It is possible that their river water is thought by them disease-causing if directly drunk.

LUAS (2010) lists arsenicosis, cholera, leptospirosis, typhoid, cryiptosporidiosis and giardiasis as water-borne disease.[14] In Malaysia, the reported occurrences of water-borne diseases in 2016 are: cholera (170 frequency), typhoid (181), dysentery (126) and Hepatitis A (85).[39] And, the reported incidence rates of typhoid and food per 100,000 population in 2016 in Selangor are 0.3 and 46.4, respectively.[39]

In conclusion, Muslim respondents are worrying about pollution, while CBH respondents water-borne disease both in the upstream and downstream. There may be a river-related sanitary perception gap between them in SSB. From the WQI-based pollution classification, their rivers are classified 'Clean' in the upstream Sampling Sites, implying that WQI-based 'pollution' is somewhat detached from the respondents' perceptions.

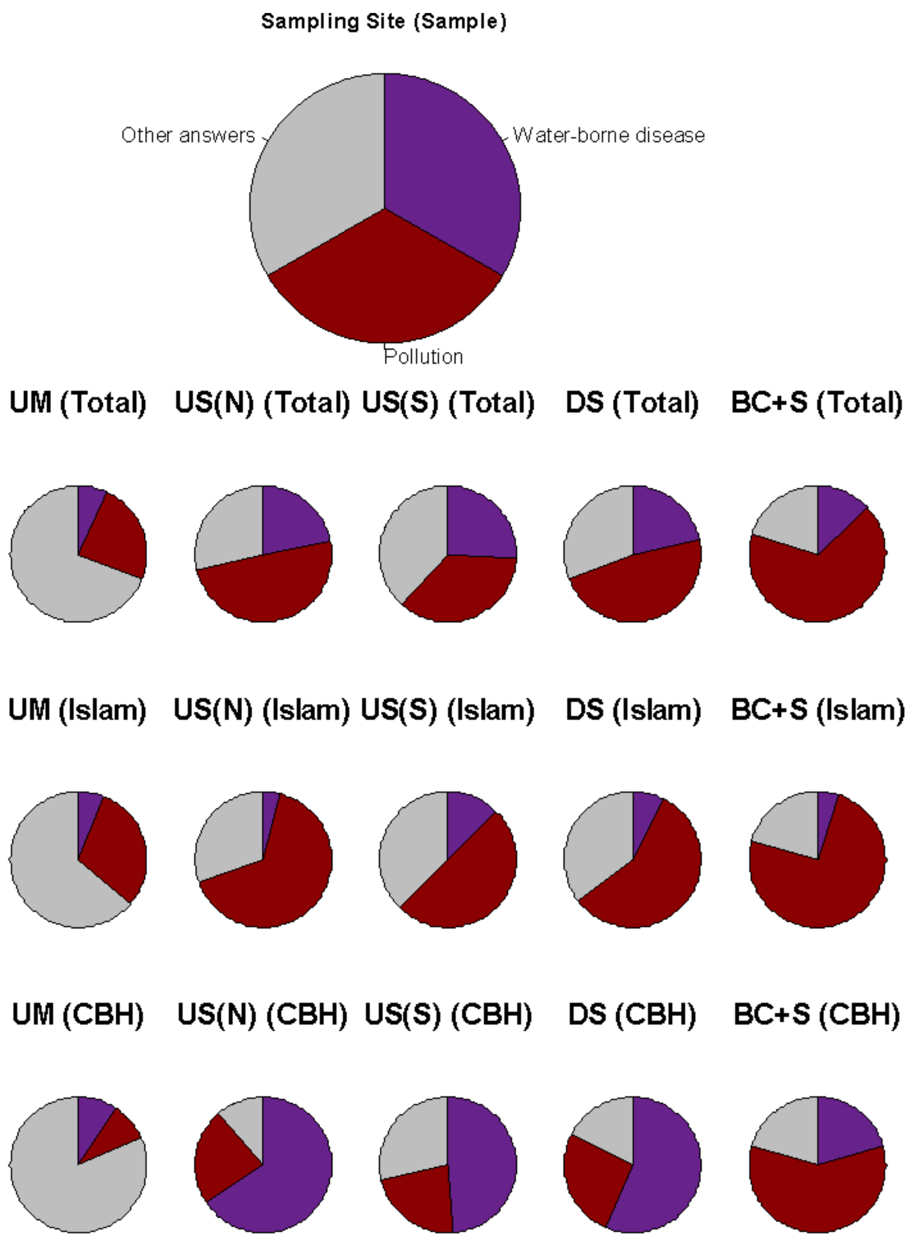

Figure 5.6.1.4-1 Worst Trouble (Water-borne Disease and Pollution) and Sampling Site

5.6.2 Islam and CBH

5.6.2.1 Islam-CBH Similarity

5.6.2.1.1 River Water Drinkability

There is little practical difference in RWD between Islam and CBH. According to Cramer's V values comparisons in **5.4.1** , the Religion-RWD association (Total) is 'very weak' (V = 0.070). 'Somewhat weak' association (V ≥ 0.25) was found in UM respondents (V = 0.31), whose RWD answer ratios were charted in **Figure 5.1.7-1**. However, there seems to be no serious inequality in RWD at UM, because the difference appear to be due mostly to CBH respondents' 'No' and Muslim ones' 'I do not know.'(**Figure 5.6.2.1.1-1**).

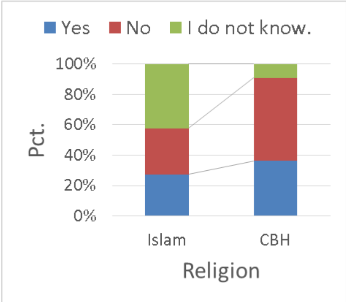

Figure 5.6.2.1.1-1 River Water Drinkability (UM)

Religion-RWD association becomes weaker as HGI increases. In other words, the richer the more regardless of religion RWD is (**5.4.1**) .

Both Muslim and CBH respondents require 'drinkable' river water quality to be the cleanest (most usable) 'bathable' the second and 'religious acts usable' the third (**5.4.4**), which perhaps is the basis of the RWD similarity. The difference in UM (**Figure 5.6.2.1.1-1**) seems to be due to the local ethnic settlement pattern or the sanitary-environment sensitivity of CBH respondents.

5.6.2.1.2 Willingness to Pay for River Water Drinkability

There is little practical difference in WTP for RWD between Islam and CBH. According to Cramer's V values comparisons in **5.4.2** , the Religion-WTP for RWD association (Total) is 'very weak' (V = 0.12). 'Somewhat weak' association (V ≥ 0.25) was found in Modest HGI respondents (V = 0.28), whose RWD for RWD answer ratios were charted in **Figure 5.6.2.1.2-1**. The difference appears to be due to the choice of '0' or 'minimum.' Actually, in front of the author, some respondents chose '0.01-10.00' just because it is minimum. The EWTP is insensitive to the choice of '0' or '0.01-10.00,' because the latter is represented by 0.01, which seems reasonable.

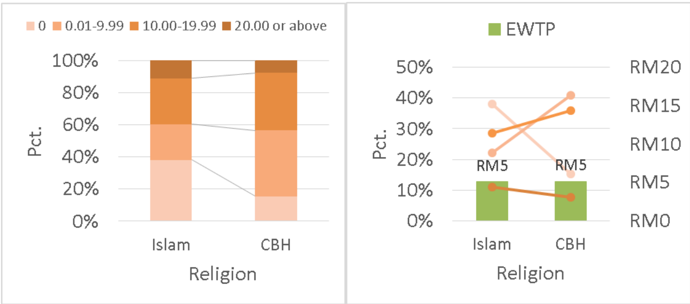

Figure 5.6.2.1.2-1 WTP for RWD (Modest)

Religion-WTP for RWD association becomes weaker as HGI increases. In other words, the richer, the more regardless of religion WTP for RWD becomes (**5.4.2**) (and more willing to pay (**5.6.2.1.2**)).

WTP for RWD is similar in Islam and CBH, although CBH respondents' EWTP (RM 8/month) is slightly higher than Muslim respondents' (RM 7/month) (**5.2.1.2.2**), which seems related to SWT.

The higher HGI is, the more willing to pay for RWD. And, within each HGI group, SWT is related to WTP for RWD: ST using respondents are more willing to pay for RWD than SS using respondents (**5.2.2.2.2** and **5.2.3.2.2**).

The Sampling Site orders regarding EWTP within Islam and CBH respondents are related to their respective Sampling Site orders regarding RWD, although the orders are different from each other. RWD is consistent with WQI-based drinkability. (**5.6.1.2**)

5.6.2.1.3 Water Undrinkability Factor

Respondents' drinking water perceptions regarding the visual WUDFs of 'Turbidity' and 'Color' is unrelated to the SS values monitored by DOE near the Sampling Site at US(N), US(S) and DS. They do not imagine river water as drinking water, because they have tap water and bottled water. UM may have a different trend because a larger ratio of respondents have some 'drinkable' river water there (**5.6.1.3**).

The geological groupings by HCA is the same, although Muslim and CBH respondents' WUDF contents are mutually different (**5.2.2.1.3** and **5.2.3.1.3**) (**Figure 5.6.2.1.3-1**). This indicates that SSB and KL drinking water quality may have a geological pattern.

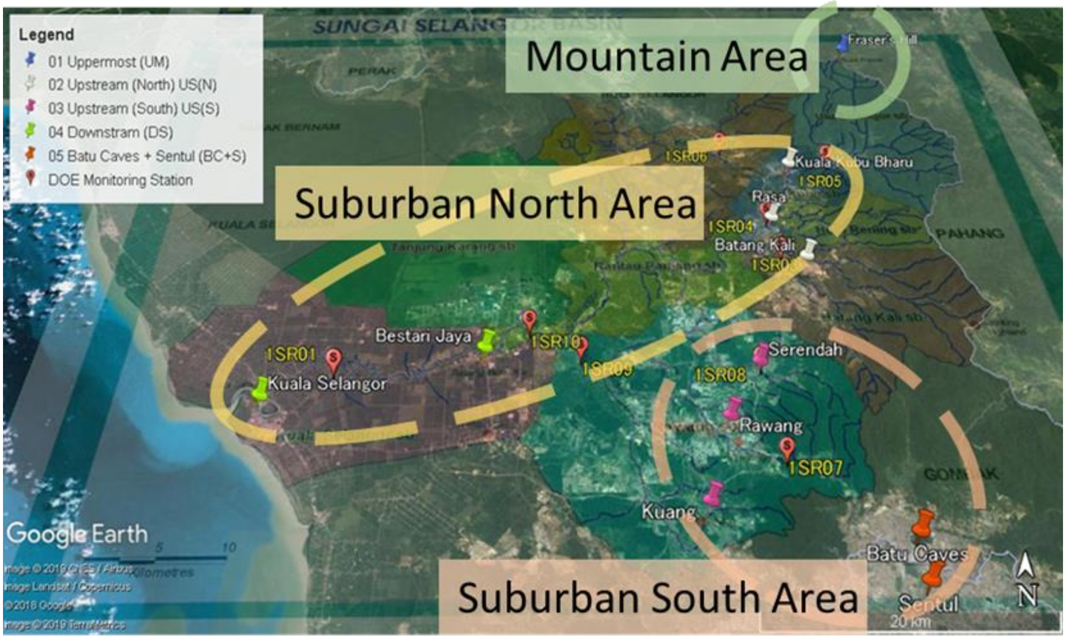

Figure 5.6.2.1.3-1 Geological Grouping by HCA based on WUDF on a SSB Basin Map[40]

5.6.2.1.4 Worst Trouble

The geological groupings by HCA is the same, although Muslim and CBH respondents' WT contents are mutually different (**5.3.2.1** and **5.3.3.1**) (**Figure 5.6.2.1.4-1**). This implies that each town has Islam and CBH areas, whose perceived WT are 'Pollution' and 'Water-borne disease,' respectively. This seems to be related to the sampling result (**5.1.7**) and the local ethnic settlement pattern discussed in **Chapter 2**: Malays are in Kampung and housing developments; Chinese and Indians are in old towns, New Villages, plantations and housing developments.

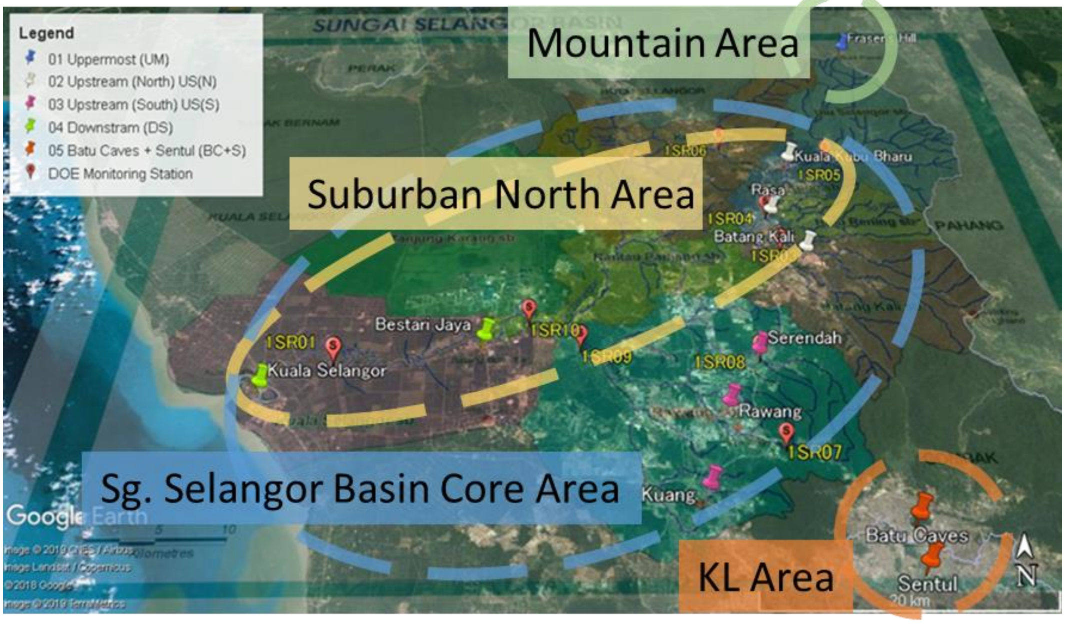

Figure 5.6.2.1.4-1 Geological Grouping by HCA based on Worst Trouble on a SSB Basin Map[40]

5.6.2.2 Islam-CBH Difference

5.6.2.2.1 River Water Drinkability

Muslim and CBH respondents are similar in RWD (V = 0.070), as discussed above (**5.6.2.1.1**).

5.6.2.2.2 Willingness to Pay for River Water Drinkability

Although Muslim and CBH respondents are similar in WTP for RWD with respect to HGI and SWT as discussed above (**5.6.2.1.2**). However, with respect to Sampling Site and SWT, we can obtain another insight: the trend that ST users are more willing to pay for RWD than SS users at each Sampling Site is seen only within CBH respondents (**5.2.2.3.2** and **5.2.3.3.2**). This could be interpreted that CBH respondents are more aware of and interested in their hygiene environment at each Sampling Site more than Muslim respondents. This may be related to the sampling result that 40 % (115/289) of Muslim respondents did not know their houses' SWT, while 9% (15/173) of CBH ones did not: 6% (2/33) of Christian ones, 15% (11/73) of Buddhist ones, 3% (2/64) of Hindu ones (**5.1.5**), and that Muslim respondents' 'I do not know.' is significantly more frequent in the Religion-WT (Total) contingency table (**5.3.1.2**). This seems to be related to the local ethnic settlement pattern **(Chapter 2**).

5.6.2.2.3 Water Undrinkability Factor

As discussed in **5.2.1.2.3** , Muslim respondents' choosing non-organoleptic factor of 'Religious taboo' and 'Source' made the Religion*-WUDF association (V = 0.28). The inter-CBH WUDF Cramer's V value is 0.17 (**5.4.4**). Therefore, Islam is exceptional among Religion*. SWT and Ethnic Group make greater Cramer's V values: V= 0.31 and 0.33, respectively (**5.4.4**). Therefore, the difference is thought to be because of Ethnic Group cultures and hygiene environment rather than Religion*. The Ethnic Group, Religion and SWT appear to be inter-associated probably due to the local ethnic settlement pattern (**5**).

5.6.2.2.4 Worst Trouble

The Religion-WT association (Total) is 'somewhat strong' (V = 0.44). Religion is associated with WT of all Sampling Sites, all HGI groups, and all SWT groups (**5.4.5**). In particular, WT of Middle, US(N) and DS respondents have 'somewhat strong' ($0.5 \leq V < 0.8$) Religion associations (V = 0.51, 0.68 and 0.56, respectively), whose RWD for RWD answer ratios were charted in **Figure 5.6.2.2.4-1**.

The WT differences are mainly due to Muslim respondents' 'Pollution' and CBH respondents' 'Water-borne disease (**5.3.1.2**). This seem to be serious, and further investigation of the perception difference is needed, because it is possible that their hygiene environments are different. The difference is probably caused by the respondents' local ethnic settlement pattern: *Kampungs*, plantations, old towns, New Villages and housing developments. However, since the Religion-WT Cramer's V (0.44) is greater than the SWT-WT Cramer's V (0.39) (**5.4.5**), the WT perception difference could be due mainly to psychological, religious or ethnic perception difference. Or, oppositely, Religion may clear-cut respondents' hygiene environments rather than simple SWT (ST and SS) categorization. The Religion association is particularly apparent in the Middle HGI group, and US(N) and US(S) (**Figure 5.6.2.2.4-1**).

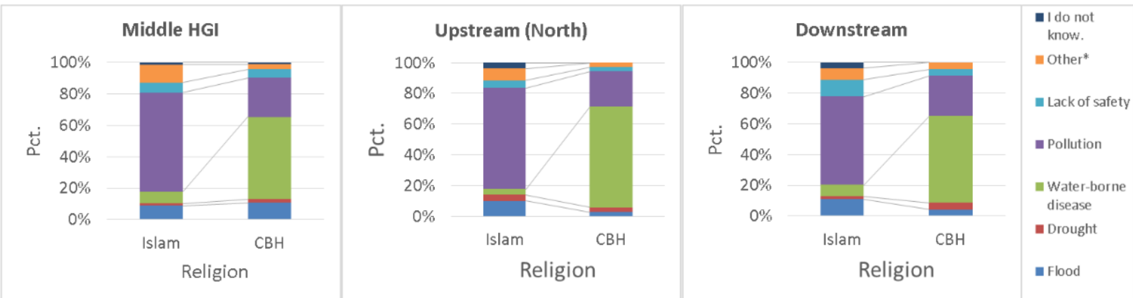

Figure 5.6.2.2.4-1 Worst Trouble with 'somewhat strong' associations

Religion-WT association drops to weakest in Rich respondents. In other words, the Rich's living condition concerning WT is similar regardless of religion (**5.4.5**) (and more willing to pay (**5.6.2.1.2**)).

5.7 Conclusion

There are similar perceptions between the Muslim and CBH (Christian, Buddhist and Hindu) respondents, such as: River Water Drinkability; the river water cleanness or usability order in which ‘drinkable’ water is the cleanest (most usable), ‘bathable’ the second, and ‘religious acts usable’ the third. And, comparing Cramer’s V values, Rich (Household Gross Income (HGI): 5,000 RM/month or more) people have more similar perceptions of River Water Drinkability, Willingness to Pay for River Water Drinkability, and Worst Trouble, regardless of religion than lower HGI groups.

On the other hand, there are different perceptions between Muslims and CBHs. Comparing Water Undrinkability Factors (WUDF), people’s water perceptions depend on religion: Muslims significantly more likely to choose the spiritual factors of ‘Religious taboo’ and ‘Sources’ while CBHs visual factors of ‘Turbidity’ and ‘Color.’ This means that Islamic teachings affect water perceptions. The common Sampling Sites clustering structures of WUDF and Worst Trouble imply that Muslims and CBHs basically share the same water and river in each Sampling Site, but they do not share the same river perceptions. In Worst Trouble and Willingness to Pay for River Water Drinkability, CBHs perceive the sanitary environment more seriously than Muslim respondents. This is consistent with the local ethnic settlement pattern (ESP) discussed in **Chapter 2**. CBHs tend to live closer to the river or stream, or live in less areas with worse sewerage treatment or drainage facilities, *i.e.*, New Villages, old towns and plantations, while Muslim respondents in housing developments with better facilities and *Kampung*s.

References

1. Aini, M. S., Fakhru’l‑Razi, A., Laily, Hj. P. & Jariah, M. Environmental concerns, knowledge and practices gap among Malaysian teachers. *Int. J. Sustain. High. Educ.* **4**, 305–313 (2003).
2. Csárdi, G. *Network Analysis and Visualization*. (2018).
3. R Core Team. *R: A Language and Environment for Statistical Computing*. (R Foundation for Statistical Computing, 2017).
4. Champely, S. *et al. Basic Functions for Power Analysis*. (2018).
5. Afroz, R., Banna, H., Masud, M. M., Akhtar, R. & Yahaya, S. R. Household’s Perception of

Water Pollution and Its Economic Impact on Human Health in Malaysia. *Desalination Water Treat.* 1–9 (2015). doi:10.1080/19443994.2015.1006822

6. Epskamp, S. *et al. Graph Plotting Methods, Psychometric Data Visualization and Graphical Model Estimation*. (2018).
7. Mokhtar, M. I., Abdullah, R. & Baharuddin, A. An Islamic Perspective on Water Quality: A Case of Malaysia. *Water Policy* **17**, 454 (2015).
8. Syed Husin Ali. *The Malays*. (The Other Press, 2008).
9. DID Malaysia. *Sungai Selangor Basin Management Plan, 2007-2012*. (DID Malaysia, 2007).
10. 山田悠未. マレーシア華人新村の成立背景とその概要 : 華人新村研究 その 1. 日本建築学会計画系論文集 **585**, 225–231 (2004).
11. 宇高雄志. マレーシアにおける多民族混住の構図　—生活空間にみる民族共存のダイナミズム. (明石書店, 2009).
12. Suratkon, A. SmartWUDHU': Recycling Ablution Water for Sustainable Living in Malaysia. *J. Sustain. Dev.* **7**, 150 (2014).
13. World Health Organization. *Guidelines for Drinking-water Quality*. (WHO Press, 2011).
14. LUSA. *State of River Report 2008 Sungai Selangor*. (LUAS, 2010).
15. Poonam, T., Tanushree, B. & Sukalyan, C. Water Quality Indices-Important Tools for Water Quality Assessment: A Review. *Int. J. Adv. Chem.* **1**, 15–28 (2013).

16.Lumb, A., Sharma, T. C. & Bibeault, J.-F. A Review of Genesis and Evolution of Water Quality Index (WQI) and Some Future Directions. *Water Qual. Expo. Health* **3**, 11–24 (2011).

17.Moser, G. Water Quality Perception, a Dynamic Evaluation. *J. Environ. Psychol.* **4**, 201–210 (1984).

18.Fulazzaky, M. A. Assessing the Suitability of Stream Water for Five Different Uses and Its Aquatic Environment. *Environ. Monit. Assess.* **185**, 523–535 (2013).

19.Poon, W. C., Herath, G., Sarker, A., Masuda, T. & Kada, R. River and fish pollution in Malaysia: A green ergonomics perspective. *Spec. Issue Hum. Factors Sustain. Future* **57**, 80–93 (2016).

20.Doria, M. de F. Factors Influencing Public Perception of Drinking Water Quality. *Water Policy* **12**, 1 (2010).

21.多和田裕司. マレー・イスラームの人類学. (ナカニシヤ出版, 2005).

22.モハメド・ムスタファ・イスハック. マレーシア国民のゆくえ　多民族社会における国家建設. (公益社団法人日本マレーシア協会, 2015).

23.トライフィールズ. R スミルノフ・グラブス検定を繰り返し用いて外れ値を除去する方法 | トライフィールズ. トライフィールズ データサイエンス – 統計解析・機械学習 Available at: https://www.trifields.jp/how-to-remove-outliers-using-smirnov‐grubbs-test-in-r-2114. (Accessed: 12th June 2018)

24.Abdullah, M. P., Khalik, W. M. A. W. M. & Idris, M. I. Water Quality of the Raub-Fraser's Hill

Corridor. *Proceeding SESKORFRA* 104–108 (2015).

25. Shimizu, Y. & Kondo, T. Evaluation of Microorganism Pollution in Selangor River Watershed, Malaysia 2013 - 2014. *Newsletter* **4**, (2014).

26. Department of Statistics, Malaysia. *Household Expenditure Survey Report 2016*. (Department of Statistics, Malaysia, 2017).

27. SYABAS. Water Tariff. *Syarikat Bekalan Air Selangor Sdn. Bhd.* (2018). Available at: https://www.syabas.com.my/consumer/water-bill-water-tariff. (Accessed: 26th July 2018)

28. IWK. Sewerage Charges : Domestic. *Indah Water* (2018). Available at: https://www.iwk.com.my/customer/domestic. (Accessed: 24th July 2018)

29. Zain, L. Malaysia's Sewerage Tariff Is One of the Lowest in the World. *SAYS.com* (2018). Available at: http://says.com/my/news/indah-water-tariff-one-of-the-lowest-in-the-world. (Accessed: 27th July 2018)

30. Datuk Ir. Abdul Kadir Mohd Din. Charges for Sewerage Services. (2013).

31. Indah Water Konsortium. What's The Hardest Thing About Treating Our Sewers? We Spoke To 3 Guys Who Do It Everyday. *SAYS.com* (2017). Available at: http://says.com/my/lifestyle/who-cleans-our-sewage-system-and-how-do-they-do-it. (Accessed: 27th July 2018)

32. F Saad. Real Cost of Water. *Focus Malaysia* (2018). Available at: http://www.focusmalaysia.my/Mainstream/real-cost-of-water. (Accessed: 26th July 2018)

33. Malaysia. Suruhanjaya Perkhidmatan Air Negara Act 2006. Available at: http://www.commonlii.org/my/legis/consol_act/spana2006322/. (Accessed: 4th July 2018)

34. Wahid, N. A. & Hooi, C. K. Factors Determining Household Consumer's Willingness to Pay for Water Consumption in Malaysia. *Asian Soc. Sci.* **11**, 26–32 (2014).

35. Aini, M. S., Fakhrul-Razi, A., Mumtazah, O. & Chen, J. C. M. Malaysian Households' Drinking Water Practices: A Case Study. *Int. J. Sustain. Dev. World Ecol.* **14**, 503–510 (2007).

36. Kadir, S. N. A., Nasaruddin, A., Musa, M. N., Ong, B. & Mohamad, Z. F. *Pasangan; Pulse of a Riverine Community*. (UM Sustainablity Science Research Cluster and JSPS Asian Core Program, 2015).

37. Smith, D. G., Croker, G. F. & McFarlane, K. Human Perception of Water Appearance; 2. Colour judgment, and the influence of perceptual set on perceived water suitability for use. *N. Z. J. Mar. Freshw. Res.* **29**, 29–43 (1995).

38. Nicolson J. A. & Mace A. C. Water Quality Perception by Users: Can It Supplement Objective Water Quality Measures?1. *JAWRA J. Am. Water Resour. Assoc.* **11**, 1197–1207 (1975).

39. Department of Statistics, Malaysia. *Compendium of Environment Statistics, Malaysia 2017*. (Department of Statistics, Malaysia, 2017).

40. LUAS. IRBM Approach in Water Quality Management **-** Case Study in Sungai Selangor River Basin. (2008).

6. Conclusions

This Chapter describes the final conclusions and proposals for the IRBM of SSB of this research.

6.1 Brief Summaries of Previous Chapters

For the Integrated River Basin Management (IRBM) of Sg. Selangor Basin (SSB), it is necessary for the people to communicate with each other. However, it is not simple, because SSB is a prime example of multi-religion, multi-culture society of Malaysia, although the IRBM administration is with Islamic values. The Federation's and Selangor State's constitutional religion is Islam, and other religions, such as Buddhism, Hinduism and Christianity (CBH), are free to practice in peace and harmony with Islam. In this situation, for people's sustainable coexistence in peace and harmony, various people's water and river perceptions have to be considered. Therefore, as well as more objective water quality measurement and Water Quality Index, more subjective water and river perceptions should be investigated. **(Chapter 1)**

History of the administration and ethnic settlement pattern (ESP) was discussed. Pre-colonial Selangor Sultanate a river is a basis of ruling. The British changed the river-centered Sultanate to a land-centered State of Federation, where molded were the complex, authoritarian and top-down, Federation-centralized administration with colonial bureaucrats' actual power by Sultan's authority. Increasing immigrants settled in downstream agriculture areas (mainly the Indonesian Malays), in mining and rubber towns (mainly the Chinese and the Indians) and plantations (mainly the Indians), while the native Malays stayed in *Kampung*s. This formed the basin-wide ESP. In the Emergency, the New Village Plan moved squatters (mostly the Chinese) to New Villages. After Independence, this ESP was modified by the New Economic Policy (NEP) the Malays started to be urbanized and live in housing developments where various ethnic groups lived mixed but forming loose uni-ethnic neighborhoods. This formed the local ESP **(Chapter 2)**.

The proceeding studies on subjective water and river perceptions was reviewed. Combination of the scopes of engineering and psychology, risk perceptions, and ethnohydrology viewpoints was found to be suitable for investigating the people in the multi-religious, multi-cultural SSB. The hypothesis to be checked is that people's water and river perceptions are associated with cultures, *i.e.* geographics and demographics, religion in particular. **(Chapter 3)**.

In order to check the hypothesis that subjective water and river perceptions are associated with geographics and demographics: religion, income level, hygiene environment (sewer water treatment) and so on, the "Questionnaire Survey on People's Perceptions of Rivers and Water (QS)" was conducted. **(Chapter 4)**

The hypothesis was demonstrated. Muslims are more spiritual than CBH, while CBHs are more visual. CBHs perceive sanitary environment more seriously than Muslims, which is thought to be backgrounded by the local ESP. On the other hand, there are similarities between Muslims and CBHs: River Water Drinkability; the river water cleanness or usability order in which 'drinkable' water is the cleanest (most usable), 'bathable' the second, and 'religious acts usable' the third. Rich (Household Gross Income: 5,000 RM/month or more) people have more similar perceptions of River Water Drinkability, Willingness to Pay for River Water Drinkability, and Worst Trouble, regardless of religion compared to lower Household Gross Income groups. **(Chapter 5)**

6.2 Suggestions for the IRBM of SSB

This dissertation is purely academic, some suggestions may be useful for the IRBM of SSB and for the people's peaceful and harmonious coexistence there.

Subjective water and river perceptions should be considered for decision making in the IRBM as well as objective, scientific measurements, to make communication between policy makers and lay people smoother. For now, the DOE's Water Quality Index considers only biochemical measurements for policy making purpose, whose river water classification, however, could be detached from people's subjective river water use judgement. People may focus on spiritual and visual factors, such as religious restriction and turbidity and color, depending on religions. People may care about trash, garbage and debris in and along rivers, too.

And, it is recommended that the IRBM of SSB consider various people's perceptions and opinions, because people may have different perceptions and values on water and river on the basis of religions or residential conditions, even though the administration is with Islamic values. For example, risk and Ecosystem Services may perceived differently according to religions and sanitary environments.

The administration in Malaysia is too complex for ordinary people to comprehend, and they do not need to. JKKKs (and their likes) seem to be the most familiar public bodies to contact people. However, JKKKs' burdens should be minimized, because their money and staffs may be limited. Therefore, it is recommended to promote and backup local environmental groups with river experts such as Inspirasi Kawa to be another potential communication hubs.

It is well known that balancing of economic growth and people's sustainable coexistence in peace and harmony has been one of the most essential challenges in Malaysia, and environmental problems may not be the first priority. For now, it is recommended to focus the river water quality goal on water-borne disease prevention. There is little demand of directly drinkable river water for now. In its stead, the IRBM policy makers should prioritize the improvement of sanitary environments of old residential areas such as old towns, New Villages and living quarters of plantations, by *e.g.*, installation of better septic tanks or upgrading or cleaning drainages. Here there is a potential opportunity of river improvement and people's communication and cooperation.

Those who are rich, with 'undrinkable' river water, or using septic tank may be more willing to invest for the sanitary environment improvement projects. If drainage status and sewerage treatment are improved in the upstream, the river will be cleaner with less pathogens or trashes, thereby downstream people will be beneficiaries, too. If there is basin-wide communication among those who are willing to pay and beneficiaries, a stable flow of money and working force may occur, with which both economy and the environment will improve. This can contribute to people's co-working for the IRBM. It may be nice to start with picking up trashes from upstream drainages by volunteers with their lunch provided by the beneficiaries.

Appendices

-Acronyms
-Questionnaire Survey Sheets

Malay

Chinese (Mandarin)

English

Acronyms

AN	Ammonical Nitrogen
ASR	Adjusted Standadized Residual
BC+S	Batu Caves and Sentul
BOD	Biochemical Oxygen Demand
CBH	Christianity (Christian), Buddhism (Buddhist) and Hinduism (Hindu)
COD	Chemical Oxygen Demand
DID	Department of Irrigation and Drainage
DO	Dissolved Oxygen
DOE	Department of Environment
DS	Downstream
EGR	Ethnic Group Ratio
ESP	Ethnic Settlement Pattern
EWTP	Expected Willingness to Pay
EXCO	Excecutive Committee
FMS	Federated Malay States
GIS	Geographic Information System
GmD	Gombak District
HCA	Hierarchical Cluster Analysis
HGI	Household Gross Income
HS	Hulu Selangor
HSD	Hulu Selangor District
IKIM	Institute of Islamic Understanding Malaysia
IRBM	Integrated River Basin Management
IWK	*Indah Water Konsortitum Bhd* (a national sewarage company)
JKKK	*Jabatankuasa Keselamatan dan Kemauan Kampung* (= Village Development and Security Committee)
KL	Kuala Lumpur
KS	Kuala Selangor
KSD	Kuala Selangor District
LA	Local Authority
LDO	Land and District Office
LUAS	*Lembaga Urus Air Selangor* (=Selangor Water Management Authority)
MA	Mountain Area
MB	*Menteri Besar* (=Chief Minister)
MDHS	*Majlis Daerah Hulu Selangor* (=Hulu Selangor District Council)
MDKS	*Majlis Daerah Kuala Selangor* (=Kuala Selangor District Council)
MDR	*Majlis Daerah Raub* (= Raub District Council)
MMHE	Mean Monthly Household Expenditure
MPS	Majlis Perbandaran Selayang (=Selayang Municipal Council)
NEP	New Economic Policy
NWQI	National Water Quality Index

NWSC	National Water Service Commission (=SPAN)
PC	Principal Component
PCA	Principal Component Analysis
QS	Questionnaire Survey
RM	Ringgit Malaysia
RWB	River Water Bathability
RWD	River Water Drinkability
RWRAU	River Water Religious Acts Usability
sb	sub-basin
Sg.	*Sungai* (=River)
SNA	Suburban North Area
SPAN	*Suruhanjaya perhkidamatan Air Selangor* (= NWSC)
SS	Suspended Solid (in water quality contexts)
SS	Sewerage System (in household sewer water treatement comparison contexts) See also Septic Tank (ST).
SSB	*Sungai Selangor* Basin
SSB-LA	Sg. Selangor Basin-related Local Authority
SSB-M	*Sungai Selangor* Basin-related *Mukim*
SSB-T	*Sungai Selangor* Basin-related Township
ST	Septic Tank. See also SS (Sewarage System).
SWMA	Selangor Water Management Authority (=LUAS)
SWT	Sewer Water Treatment
SYABAS	Syarikat Bekalan Air Selangor Sdn. Bhd (a water distribution company)
UM	Uppermost
US(N)	Upstream (North)
US(S)	Upstream (South)
USA	Urban South Area
WHO	World Health Organization
WQI	Water Quality Index
WRAUUF	Water Religious Acts Unusability Factor
WTP	Willingness to Pay
WUBF	Water Unbathability Factor
WUDF	Water Undrinkability Factor
WUXF	Water Un***ability Factor
WWF-Malaysia	World Wide Fund for Nature-Malaysia

Soal Selidik

Persepsi Orang Awam terhadap Sungai dan Air

Soal selidik ini bertujuan untuk memahami nilai masyarakat tentang sungai dan air bagi penambahbaikan secara menyeluruh dalam menguruskan legeh Sg. Selangor.

Air merupakan salah satu daripada keperluan asas dalam kehidupan manusia, dan legeh Sg. Selangor menyalurkan sebanyak 60% daripada air yang digunakan di negeri Selangor dan Kuala Lumpur.

Nilai berubah daripada seseorang ke seseorang, namun mereka berkongsi air yang sama. Demi memelihara persekitaran sungai dan menggunakan sumber air secara lestari, adalah penting untuk memahami nilai masyarakat terhadap sungai dan air.

Jikalau anda bersetuju dengan tujuan soal selidik ini dan juga Dasar Privasi di bawah, sila berikan pendapat anda tentang sungai dan air. Terdapat **26 soalan (8 muka surat)**, dan dijangka akan mengambil masa selama **15 minit** untuk menjawabnya.

Terima kasih!

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Dasar Privasi

Soal selidik ini untuk tujuan akademik sahaja. Jawapan anda adalah tanpa nama. Jawapan akan di proses menggunakan statistik dan tidak akan di dedahkan dengan apa jua cara pengenalpastian individu. Dokumen ini akan disimpan untuk penyelidikan akan datang, tetapi ia adalah sulit dan tidak akan di berikan kepada pihak ketiga yang tidak berkaitan.

*Terdapat **<u>26 soalan</u>** (**6 muka surat**). Sila jawab setiap soalan **<u>menggunakan gerak hati anda</u>**:*

❖ **Q1- Q4** adalah berkenaan **<u>persepsi anda tentang air</u>**.

Q1. 'Air' **<u>paling mungkin</u>** dipanggil ____☑____ dalam bahasa pertuturan keluarga anda. (Sila pilih **<u>satu sahaja</u>**.)

☐Air ☐水 ☐ தண்ணீர் ☐Water ☐Lain-lain ________________

Q2. Anda menilai air sebagai **<u>tidak boleh diminum</u>** melalui ____☑____.
(Sila pilih **<u>satu sahaja</u>**.)

☐Rasa ☐Bau ☐Kekeruhan ☐Warna ☐Bekas ☐Sumber

☐Benda hidup ☐Larangan agama ☐Lain-lain _______________

Q3. Anda menilai air sebagai **<u>tidak boleh digunakan untuk mandi</u>** melalui ___☑___.
(Sila pilih **<u>satu sahaja</u>**.)

☐Rasa ☐Bau ☐Kekeruhan ☐Warna ☐Bekas ☐Sumber

☐Benda hidup ☐Larangan agama ☐Lain-lain_______________

Q4. Anda menilai air sebagai **<u>tidak boleh digunakan untuk perbuatan agam</u>**a (contoh: mengambil wudhuk) melalui _____☑_____. (Sila pilih **<u>satu jawapan yang terdekat sahaja)</u>**

☐Rasa ☐Bau ☐Kekeruhan ☐Warna ☐Bekas ☐Sumber

☐Benda hidup ☐Larangan agama ☐Lain-lain_______________

❖ **Q5-Q16** adalah berkenaan **<u>persepsi anda tentang sungai.</u>**

Q5. ‘Sungai’ **<u>paling</u> mungkin** di panggil ___☑___dalam bahasa pertuturan keluarga anda.

(Sila pilih **<u>satu sahaja</u>**.)

☐Sungai ☐河 ☐ நதி ☐River ☐Lain-lain _______________

Q6. Sungai yang terdekat dengan tempat tinggal anda ialah Sg. ___☑___.

☐Sg. ____________________ ☐Saya tidak tahu nama sungai tersebut.

Q7. Air sungai yang terdekat **<u>boleh diminum terus</u>**.

(Sila pilih **<u>satu sahaja</u>**.)

☐Ya ☐Tidak ☐ Saya tidak tahu.

Anda sanggup membayar lebih sebanyak **RM___☑___/sebulan** jikalau air sungai yang terdekat masih boleh/berubah menjadi **<u>diminum terus</u>**.

☐0 ☐0.01- 9.99 ☐10.00-19.99 ☐20.00 atau lebih(RM__________/sebulan)

Q8. Air sungai yang terdekat **<u>boleh digunakan untuk mandi</u>**.

(Sila pilih **<u>satu sahaja</u>**.)

☐Ya ☐Tidak ☐ Saya tidak tahu.

Anda sanggup membayar lebih sebanyak **RM___☑___/sebulan** jikalau air sungai yang terdekat boleh digunakan/di ubah **<u>untuk mandi.</u>**

☐0 ☐0.01- 9.99 ☐10.00-19.99 ☐20.00 atau lebih(RM__________/sebulan)

Q9. Air sungai yang terdekat **<u>boleh digunakan terus untuk perbuatan agama</u>** (contoh: mengambil wudhuk).

(Sila pilih **<u>satu sahaja</u>**.)

☐Ya ☐Tidak ☐ Saya tidak tahu.

Anda sanggup membayar lebih sebanyak **RM___☑___/sebulan** jikalau air sungai yang terdekat boleh digunakan/di ubah **<u>terus untuk perbuatan agama.</u>**

(Sila pilih **<u>satu sahaja</u>**.)

☐0 ☐0.01- 9.99 ☐10.00-19.99 ☐20.00 atau lebih(RM__________/sebulan)

Q10. Sungai yang terdekat **paling memberi manfaat** kepada penduduk di ___☑___.

(Sila pilih **satu sahaja**.)

☐Tempat saya ☐Hulu sungai ☐Hilir sungai

☐Tebing sungai yang bertentangan ☐Kuala Lumpur dan persekitrannya

☐Lain-lain ____________ ☐Saya tidak tahu.

Q11. Masalah yang paling buruk tentang sungai yang terdekat adalah ___☑___ ?

(Sila pilih **satu sahaja**.)

☐Banjir ☐Kemarau ☐Penyakit bawaan air ☐Pencemaran

☐Kekurangan keselamatan ☐Lain-lain _______________ ☐Saya tidak tahu.

Q12. Air sungai yang terdekat adalah **bebas daripada banjir**.

(Sila pilih **satu sahaja**.)

☐Ya ☐Tidak ☐ Saya tidak tahu.

Anda sanggup membayar lebih sebanyak **RM___☑___/sebulan** jikalau air sungai yang terdekat kekal/menjadi **bebas daripada banjir.** (Sila pilih **satu sahaja**.)

☐0 ☐0.01- 9.99 ☐10.00-19.99 ☐20.00 atau lebih(RM___________/sebulan)

Q13. Air sungai yang terdekat adalah **bebas daripada kemarau**.

(Sila pilih **satu sahaja**.)

☐Ya ☐Tidak ☐ Saya tidak tahu.

Anda sanggup membayar lebih sebanyak **RM___☑___/sebulan** jikalau air sungai yang terdekat kekal/menjadi **bebas daripada kemarau.** (Sila pilih **satu sahaja**.)

☐0 ☐0.01- 9.99 ☐10.00-19.99 ☐20.00 atau lebih(RM___________/sebulan)

Q14. Air sungai yang terdekat adalah **bebas daripada penyakit bawaan air**.

(Sila pilih **satu sahaja**.)

☐Ya ☐Tidak ☐ Saya tidak tahu.

Anda sanggup membayar lebih sebanyak **RM___☑___/sebulan** jikalau air sungai yang terdekat kekal/menjadi **bebas daripada penyakit bawaan air.**

(Sila pilih **satu sahaja**.)

☐0 ☐0.01- 9.99 ☐10.00-19.99 ☐20.00 atau lebih(RM___________/sebulan)

Q15. Sungai yang terdekat nampaknya **paling membahayakan** penduduk di ___☑___.

(Sila pilih **satu sahaja**.)

☐Tempat saya ☐Hulu sungai ☐Hilir sungai

☐Tebing sungai yang bertentangan ☐Kuala Lumpur dan persekitrannya

☐Lain-lain _____________ ☐Saya tidak tahu.

Q16. ___☑___ adalah **perkara yang paling penting** dalam menguruskan legeh sungai yang terdekat.

(Sila pilih **satu sahaja**.)

☐Ekonomi ☐Politik ☐Pentadbiran ☐Pembangunan ☐Undang-undang

☐Alam Sekitar ☐Sains/Kejuruteraan ☐Agama ☐Tradisi

☐Kehidupan manusia ☐Lain-lain _____

❖ **Q17-Q26** adalah berkenaan dengan **diri anda**.

Q17. Jantina anda ialah ___☑___.

☐Lelaki ☐Perempuan

☐*Saya tidak mahu menjawab.*

Q18. Pihak berkuasa tempatan di kawasan dan **mukim** anda adalah ___☑___ dan ___☑___ (Sila pilih daripada jawapan di bawah).

Local Authority Area			
M.D. Kuala Selangor	**M.D. Ulu Selangor**	**M.P. Selayang**	**D.B. Kuala Lumpur**
☐ Asam Jawa	☐ Batang Kali	☐ Batu Arang	☐ Batu Caves
☐ Bandar Puncak Alam	☐ Bukit Beruntung	☐ Batu Caves	☐ Jinjang
☐ Bandar Saujana Utama	☐ Bukit Fraser	☐ Gombak Setia/Taman Perwira	☐ Kampong Sungai Penchala
☐ Bestari Jaya (Batang Berjuntai)	☐ Kalumpang	☐ Kampong Baru Rawang	☐ Kampong Batu
☐ Bukit Rotan	☐ Kampong Ulu Yam Baharu	☐ Kuang	☐ Kampong Kepong
☐ Ijok	☐ Kerling	☐ Mimaland	☐ Kuala Lumpur
☐ Jeram	☐ Kuala Kubu Baru	☐ Pengkalan Kundang	☐ Salak Selatan
☐ Kampong Kuantan	☐ Rasa	☐ Rawang	☐ Sungai Besi
☐ Kuala Selangor	☐ Serendah	☐ Selayang Baru	☐ *I do not know.*
☐ Kuala Sungai Buluh	☐ Ulu Bernam	☐ Taman Greenwood/Taman Gombak	
☐ Pasir Penambang	☐ Ulu Kalu	☐ Remainder of M.P.	
☐ Sungai Sembilang	☐ Ulu Sungai Choh	☐ *I do not know.*	
☐ Tanjong Karang	☐ Ulu Yam Lama		
☐ Remainder of M.D.	☐ Remainder of M.D.		**M.D. Raub, Pahang**
☐ *I do not know.*	☐ *I do not know.*		☐ Bukit Fraser
Mukim			
Kuala Selangor	**Ulu Selangor**	**Gombak**	**Kuala Lumpur**
☐ Api-api	☐ Ampang Pechah	☐ Batu	☐ Ampang
☐ Bestari Jaya (Batang Berjuntai)	☐ Batang Kali	☐ Rawang	☐ Bandar Kuala Lumpur
☐ Ijok	☐ Buloh Telor	☐ Setapak	☐ Batu
☐ Jeram	☐ Kalumpang	☐ Ulu Kelang	☐ Cheras
☐ Kuala Selangor	☐ Kerling	☐ *I do not know.*	☐ Kuala Lumpur
☐ Pasangan	☐ Kuala Kalumpang		☐ Petaling
☐ Tanjong Karang	☐ Peretak		☐ Setapak
☐ Ujong Permatang	☐ Rasa		☐ Ulu Kelang
☐ Ulu Tinggi	☐ Serendah		☐ *I do not know.*
☐ *I do not know.*	☐ Sungai Gumut		
	☐ Sungai Tinggi		
	☐ Ulu Bernam		
	☐ Ulu Yam		**Raub, Pahang**
	☐ *I do not know.*		☐ Teras

☐Tiada di atas.

☐*Saya tidak tahu.*

☐*Saya tidak mahu menjawab.*

Q19. Umur anda ialah ___☑___.

☐20-24 ☐25-29 ☐30-34 ☐35-39 ☐40-44 ☐45-49

☐50-54 ☐55-59 ☐60-64 ☐65-69 ☐70-74 ☐75 atau lebih

☐*Saya tidak mahu menjawab.*

Q20. **<u>Air pembetung</u>** dari rumah anda di rawat oleh ___☑___.

☐Tangki septik awam ☐Tangki septik swasta

☐Sistem pembetungan awam ☐Sistem pembetungan swasta

☐Tidak di rawat ☐Lain-lain__________

☐*Saya tidak tahu.* ☐ *Saya tidak mahu menjawab.*

Q21. Agama anda ialah ___☑___.

☐Islam ☐Kristian ☐Buddha ☐Hindu

☐Confucianisme, Taoisme atau agama tradisional Cina

☐Tiada agama ☐Lain-lain__________ ☐ *Saya tidak mahu menjawab.*

Q22. **<u>Nilai pendapatan kasar isi rumah</u>** anda adalah sebanyak **RM___☑___/sebulan**.

☐0-2,999 ☐3,000-4,999 ☐5,000-6,999 ☐7,000-9,999 ☐10,000 atau lebih

☐*Saya tidak tahu.* ☐*Saya tidak mahu menjawab.*

Q23. Anda merupakan ahli organisasi, institusi, kumpulan atau persatuan alam sekitar.

☐Ya ☐Tidak

☐*Saya tidak mahu menjawab.*

Q24. Anda mempunyai kelulusan ___☑___.

☐Pra-sekolah rendah ☐Sekolah rendah ☐Menengah rendah

☐Menengah tinggi ☐Pra-universiti

☐Sijil program dalam perdagangan spesifik dan kemahiran teknikal

☐Universiti (peringkat sijil/diploma)

☐Universiti (ijazah/diploma lanjutan dan seterusnya)

☐Tidak pernah ke sekolah. ☐Tidak diketahui.

☐ *Saya tidak mahu menjawab.*

Q25. Kumpulan etnik anda ialah ___☑___.

☐Melayu ☐Bumiputera lain ☐Cina ☐Indian

☐Kumpulan etnik lain (Warganegara Malaysia) __________.

☐Bukan Warganegara Malaysia (Negara __________)

☐*Saya tidak tahu.* ☐*Saya tidak mahu menjawab.*

Q26. Sila beri **ungkapan/kata-kata** kegemaran anda yang berkaitan dengan air/sungai dan maksudnya. (**<u>Tidak kira dalam bahasa apa</u>**).

❖ *Jikalau anda masih ada masa dan telah menjawab soalan* **Q25** *di mana kumpulan etnik anda ialah* **Melayu, Cina, Bumiputera lain atau India**, *sila jawab* **Q.25'** ***<u>di muka surat belakang</u>***.

❖ *Soal selidik tamat. Sila pastikan bahawa anda telah menjawab semua soalan. Terima kasih kerana sudi meluangkan masa dan atas kerjasama yang diberikan.*

Jikalau anda ingin memberi pendapat tentang sungai atau air, ataupun mengenai soal selidik ini, sila tulis di ruangan ini.

Soalan Tambahan

❖ Sila pilih dan jawab hanya **<u>satu soalan yang bersesuaian</u>** daripada soalan-soalan yang berikut.

Q25'-1. <u>Anda ialah Melayu</u>, dan anda ialah ☑________.

☐Melayu di Selangor ☐ Melayu di Semenanjung__________.

☐Aceh ☐Banjar ☐Batak ☐Batu Bahra ☐Boyan

☐Bugis ☐Jawa ☐Kampar ☐Kerinchi ☐Mandailing

☐Minangkabau ☐Pekan ☐Rawa ☐Sunda

☐Lain-lain__________

☐*Saya tidak tahu.* ☐*Saya tidak mahu menjawab*.

Q25'-2. <u>Anda ialah Bumiputera lain</u>, dan anda ialah ☑________.

☐Negrito ☐Senoi ☐Melayu Asli ☐Sabah ☐Sarawak

☐ Lain-lain __________

☐ *Saya tidak tahu.* ☐ *Saya tidak mahu menjawab*.

Q25'-3. <u>Anda ialah Cina</u>, dan anda ialah ☑________.

☐Hainanese ☐Henghua ☐Hokchia ☐Hokchiu ☐Hokkien

☐Cantonis ☐Hakka ☐Kwongsai ☐Teochew

☐Lain-lain__________

☐ *Saya tidak tahu.* ☐ *Saya tidak mahu menjawab*.

Q25'-4. <u>Anda ialah India</u>, dan anda ialah ☑________.

☐India Muslim/Malabari ☐Malayali ☐Punjabi ☐Sikh

☐Sinhala ☐Tamil India ☐Tamil Sri Lanka ☐Telugu

☐Lain-lain__________

☐ *Saya tidak tahu.* ☐ *Saya tidak mahu menjawab.*

Terima kasih!

关于人们对于河流及水的认知的调查问卷

本调查的目的在于了解人们对于河流以及水的价值观，以便对雪兰莪河流域进行妥善的综合管理。

水是人类生活所需的最重要的组成部分之一。雪兰莪河流域供给了雪兰莪州以及吉隆坡 60% 的用水。

价值观因人而异，但人们享用同样的水。 为了以可持续的方式使用水资源和保护河流环境，有必要了解人们对河流和水的价值。

如果您同意本调查的目的及下面的**隐私政策**，请告诉我们您对河流和水的意见。本调查问卷共有 **26 个问题（共 6 页），大概**需要用时 **15 分钟**。

感谢您的配合！

Siti Nurmaya Binti Musa 博士*[1]

清水芳久 博士 (教授)*[2], 清水大吾(Ph.D 学生)*[2]

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电子邮件: selangor.watershed@gmail.com

隐私政策

本调查仅用于学术目的。您的回答将是匿名的。您的回答将被进行统计处理，绝不会被以任何有可能被特定身份的方式公布。此调查问卷将被保留以便将来的研究，但是这将是保密的，而且绝不会被转移给任何不适当的第三方。

*接下来有**<u>26 个问题</u>**（共 6 页）。请**<u>凭直觉</u>**回答每一个问题：*

❖ **问 1-问 4 将询问您对水的感知。**

问 1. "水"在您的家庭中使用语言里**<u>主要被称为</u>** ☑。

（请**<u>只选择一项</u>**）

☐Air ☐水 ☐ေရ ☐Water ☐其他______________

问 2. 您判断水**<u>不能饮用</u>**的最有可能的原因是因为它的 ☑。

（请**<u>只选择一项</u>**）

☐味道 ☐气味 ☐浑浊度 ☐颜色 ☐容器 ☐来源

☐生物 ☐宗教禁忌 ☐其他_____________

问 3. 您判断水**<u>不可用于洗浴</u>**的最有可能的原因是因为它的 ☑。

（请**<u>只选择一项</u>**）

☐味道 ☐气味 ☐浑浊度 ☐颜色 ☐容器 ☐来源

☐生物 ☐宗教禁忌 ☐其他_____________

问 4. 您判断水**<u>不能用于宗教行为（例如预祷澡）</u>**最有可能的原因是因为它的 ☑。

（请**<u>只选择最接近的一项</u>**）

☐味道 ☐气味 ☐浑浊度 ☐颜色 ☐容器 ☐来源

☐生物 ☐宗教禁忌 ☐其他_____________

<u>接下来的问题在右侧</u>

❖ **问 5-问 16** 将询问您关于**<u>您对河流的看法</u>。**

问 5. "河" 在您的家庭中使用语言里<u>**主要被称为**</u> ___☑___。
（请<u>**只选择一项**</u>）
☐Sungai ☐河 ☐ நதி ☐River ☐其他_______________

问 6. 距离我现在住处最近的河是 Sg.___☑___。
☐Sg. ____________________ ☐我不知道河流的名字

问 7. 您最近的河水<u>**可以直接饮用**</u>。（请<u>**只选择一项**</u>）
☐是 ☐否 ☐我不知道
如果距您最近的河水处于或是变成<u>**可以直接饮用**</u>的状态, 您愿意支付额外的 **RM**___☑___/月。（请<u>**只选择一项**</u>）
☐0 ☐0.01- 9.99 ☐10.00-19.99 ☐20.00 或以上（RM ______ /月）

问 8. 您最近的河水<u>**可以直接用来洗浴**</u>。（请<u>**只选择一项**</u>）
☐是 ☐否 ☐我不知道
如果距您最近的河水处于或是变成<u>**可以直接用来洗浴**</u>的状态，您愿意支付额外的 **RM**___☑___/月。（请<u>**只选择一项**</u>）
☐0 ☐0.01- 9.99 ☐10.00-19.99 ☐20.00 或以上（RM ______ /月）

问 9. 您最近的河水<u>**可直接用于宗教活动**</u>**（例如预祷澡）。**（请<u>**只选择一项**</u>）
☐是 ☐否 ☐我不知道
如果距您最近的河水处于或是变成<u>**可直接用于宗教活动**</u>的状态，您愿意支付额的 **RM**___☑___/月。（请<u>**只选择一项**</u>）
☐0 ☐0.01-9.99 ☐10.00-19.99 ☐20.00 或以上（RM ______ /月）

问 10.距您最近的河流对于处于___☑___的人<u>**最有利**</u>。
（请<u>**只选择一项**</u>）
☐您的地点 ☐上游 ☐下游 ☐对岸 ☐吉隆坡及附近
☐其他 _______________ ☐我不知道这个问题的答案

*<u>**接下来的问题在背面**</u>*

问 11.距您最近的河流带来的<u>**最大麻烦**</u>是 ☑ 。（请<u>**只选择一项**</u>）

☐洪水 ☐干旱 ☐介水传染病 ☐污染 ☐缺乏安全

☐其他_______________ ☐我不知道这个问题的答案

问 12.您最近的河流<u>**完全没有洪水**</u>**。**（请<u>**只选择一项**</u>）

☐是 ☐否 ☐我不知道

如果距您最近的河流处于或是变成<u>**完全没有洪水**</u>的状态，您愿意支付额外的 **RM ☑ /**月。（请<u>**只选择一项**</u>）

☐0 ☐0.01-9.99 ☐10.00-19.99 ☐20.00 或以上（RM ______ /月）

问 13.您最近的河流<u>**完全没有枯水**</u>**。**（请<u>**只选择一项**</u>）

☐是 ☐否 ☐我不知道

如果距您最近的河流处于或是变成<u>**完全没有枯水**</u>的状态，您愿意支付额 **RM ☑ /**月。（请<u>**只选择一项**</u>）

☐0 ☐0.01-9.99 ☐10.00-19.99 ☐20.00 或以上（RM ______ /月）

问 14.您最近的河流<u>**完全没有介水传染病**</u>**。**（请<u>**只选择一项**</u>）

☐是 ☐否 ☐我不知道

如果距您最近的河流处于或是变成<u>**完全没有介水传染病**</u>的状态，您愿意支付额外 **RM ☑ /**月。（请<u>**只选择一项**</u>）

☐0 ☐0.01-9.99 ☐10.00-19.99 ☐20.00 或以上（RM ______ /月）

问 15.最近的河对于 ☑ 的人<u>**危害最大**</u>。

（请<u>**只选择一项**</u>）

☐您的地点 ☐上游 ☐下游 ☐对岸 ☐吉隆坡及附近

☐其他 _______________ ☐我不知道这个问题的答案

问 16. 您认为 ☑ 是管理最近的流域之<u>**最重要的核心**</u>**。**

（请<u>**只选择一项**</u>）

☐经济 ☐政治 ☐行政管理 ☐发展 ☐法律

☐自然 ☐科学/工程 ☐宗教 ☐传统 ☐人的生活

☐其他____________

<u>接下来的问题在右侧</u>

❖ **问 17-问 26** 是关于<u>**您自身**</u>的问题。

问 17.您的性别是 ___☑___。

☐男性　☐女性　☐我不想回答

问 18.您的<u>**地方行政区**</u>和<u>**巫金**</u>分别是 ___☑___ 和 ___☑___。

（请从下面选择）

地方行政区

M.D. Kuala Selangor	**M.D. Ulu Selangor**	**M.P. Selayang**	**D.B. Kuala Lumpur**
☐ Asam Jawa	☐ Batang Kali	☐ Batu Arang	☐ Batu Caves
☐ Bandar Puncak Alam	☐ Bukit Beruntung	☐ Batu Caves	☐ Jinjang
☐ Bandar Saujana Utama	☐ Bukit Fraser	☐ Gombak Setia/Taman Perwira	☐ Kampong Sungai Penchala
☐ Bestari Jaya (Batang Berjuntai)	☐ Kalumpang	☐ Kampong Baru Rawang	☐ Kampong Batu
☐ Bukit Rotan	☐ Kampong Ulu Yam Baharu	☐ Kuang	☐ Kampong Kepong
☐ Ijok	☐ Kerling	☐ Mimaland	☐ Kuala Lumpur
☐ Jeram	☐ Kuala Kubu Baru	☐ Pengkalan Kundang	☐ Salak Selatan
☐ Kampong Kuantan	☐ Rasa	☐ Rawang	☐ Sungai Besi
☐ Kuala Selangor	☐ Serendah	☐ Selayang Baru	☐ *我不知道*
☐ Kuala Sungai Buluh	☐ Ulu Bernam	☐ Taman Greenwood/Taman Gombak	
☐ Pasir Penambang	☐ Ulu Kalu	☐ Remainder of M.P.	
☐ Sungai Sembilang	☐ Ulu Sungai Choh	☐ *我不知道*	
☐ Tanjong Karang	☐ Ulu Yam Lama		
☐ Remainder of M.D.	☐ Remainder of M.D.		**M.D. Raub, Pahang**
☐ *我不知道*	☐ *我不知道*		☐ Bukit Fraser

巫金

Kuala Selangor	**Ulu Selangor**	**Gombak**	**Kuala Lumpur**
☐ Api-api	☐ Ampang Pechah	☐ Batu	☐ Ampang
☐ Bestari Jaya (Batang Berjuntai)	☐ Batang Kali	☐ Rawang	☐ Bandar Kuala Lumpur
☐ Ijok	☐ Buloh Telor	☐ Setapak	☐ Batu
☐ Jeram	☐ Kalumpang	☐ Ulu Kelang	☐ Cheras
☐ Kuala Selangor	☐ Kerling	☐ *我不知道*	☐ Kuala Lumpur
☐ Pasangan	☐ Kuala Kalumpang		☐ Petaling
☐ Tanjong Karang	☐ Peretak		☐ Setapak
☐ Ujong Permatang	☐ Rasa		☐ Ulu Kelang
☐ Ulu Tinggi	☐ Serendah		☐ *我不知道*
☐ *我不知道*	☐ Sungai Gumut		
	☐ Sungai Tinggi		
	☐ Ulu Bernam		
	☐ Ulu Yam		**Raub, Pahang**
	☐ *我不知道*		☐ Teras

☐我的地方行政区和巫金不在上述之内

☐我不知道

☐我不想回答

<u>接下来的问题在背面</u>

问 **19.**您的年龄是 **__☑__**。

☐20-24　☐25-29　☐30-34　☐35-39　☐40-44　☐45-49

☐50-54　☐55-59　☐60-64　☐65-69　☐70 -74　☐75 及以上

☐我不想回答

问 **20.**您的住宅排放出的<u>下水道水</u>由 **__☑__**处理。

☐公用化粪池　☐私用化粪池

☐公共污水系统 ☐私人污水系统

☐无处理　☐其他__________

☐我不知道　☐我不想回答

问 **21.**您的宗教是 **__☑__**。

☐伊斯兰教　☐基督教　☐佛教　☐印度教

☐儒教，道教和中国传统宗教　☐无宗教　☐其他__________

☐我不想回答

问 **22.**您的<u>家庭总收入</u>约为 **RM__☑__/**月。

☐0-2,999　☐3,000-4,999　☐5,000-6,999　☐7,000-9,999　☐10,000 或更多

☐我不知道　☐我不想回答

问 **23.**您是环境组织，机构，团体或俱乐部的成员吗？

☐是　☐否　☐我不想回答

问 **24.**您的学历是 **__☑__**。

☐学前　☐小学　☐中学　☐高中

☐大学预科　☐技校

☐大学（证书水平/文凭水平）

☐大学（学位/高级文凭及以上）

☐从未上过学校　☐未知

☐我不想回答

<u>接下来的问题在右侧</u>

问 25.您的族群是 **__☑__。**

☐马来人 ☐其他原住民 ☐华人 ☐印度人

☐其他族群（马来西亚公民）__________。

☐非马来西亚公民（国籍__________）

☐我不知道 ☐我不想回答

问 26.请写出您最喜欢的水/河的**<u>谚语或句子</u>，**

以及其意义。（**<u>任何语言皆可</u>**）

❖ *如果您仍有时间，并且您在***问 25** *的回答是***马来人，华人，其他原住民或者是印度人**，*请您继续回答**<u>背面的</u>***问 25'**。*

❖ *本调查问卷到此结束。请检查您是否回答了全部问题。*
十分感谢您的耐心配合。

如果您有任何关于河流和水的想说的话，抑或是关于本调查问卷的意见与建议，请在此处自由留言。

附加问题

❖ 请您回答下面问题(**单选**)。

问 25'-1.您是马来裔，你是 ☑ **。**

☐雪兰莪马来人 ☐其他半岛马来人___________

☐亚齐人 ☐班家人 ☐巴塔克人 ☐峇都哈拉人 ☐巴韦安人

☐布吉人 ☐爪哇人 ☐金宝人 ☐葛林芝人 ☐曼特宁人

☐米南佳保人 ☐北干人 ☐拉哇人 ☐巽他人

☐其他___________

☐我不知道 ☐我不想回答

问 25'-2.您是其他原住民，您是 ☑ **。**

☐尼格利陀人 ☐色诺人 ☐马来亚原住民 ☐沙巴人 ☐砂拉越人

☐其他___________

☐我不知道 ☐我不想回答

问 25'-3.您是华人，你是 ☑ 。

☐海南人 ☐莆仙/兴化人 ☐福清人 ☐福州人

☐福建/闽南人 ☐广东人 ☐客家人 ☐广西人 ☐潮州人

☐其他___________

☐我不知道 ☐我不想回答

问 25'-4.您是印度人，你是 ☑ 。

☐印度穆斯林/马拉巴里人 ☐马拉雅拉姆人 ☐旁遮普人 ☐锡克人

☐僧伽罗人 ☐泰米尔印度人 ☐泰米尔斯里兰卡人 ☐泰卢固人

☐其他___________

☐我不知道 ☐我不想回答

感谢您的回答！

Questionnaire Survey

on People's Perceptions of Rivers and Water

This survey aims to figure out people's values of rivers and water for proper overall management of the Sg. Selangor watershed.

Water is one of the most essential things for human life, and the Sg. Selangor watershed supplies about 60% of the water used in Selangor State and Kuala Lumpur.

While values vary from person to person, people share the same water. To preserve the river environment and use the water resource in a sustainable way, it is necessary to understand the people's values of rivers and water.

If you agree with this survey's purpose and the **Privacy Policy** below, please kindly tell us your opinion on rivers and water. There are **26 questions** (**6 pages)**, which will take **about 15 minutes** to answer.

Thank you very much!

Dr. Siti Nurmaya Binti Musa[*1]

Dr. Yoshihisa SHIMIZU (Prof.)[*2], Daigo SHIMIZU (Ph.D Student)[*2]

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Privacy Policy

This survey is for academic purposes only. You answers will be anonymous. Answers will be statistically processed and will never be published in any individually-identifiable way. This sheet will be preserved for future research, but it will be confidential and will never be transferred to any inappropriate third party.

*There are **<u>26 questions</u>** (**6 pages**). Please answer each question **<u>with just your intuition</u>**:*

❖ **Q1- Q4** will ask you about your **<u>perception of water</u>**.

Q1. 'Water' is **<u>most likely</u>** called ___☑___ in your family-spoken language.
(Please select **<u>only one</u>**.)
☐Air ☐水 ☐ தண்ணீர் ☐Water ☐Other _______________

Q2. You judge water **<u>undrinkable</u>** most likely by its ___☑___.
(Please select **<u>only one</u>**.)
☐Taste ☐Odor ☐Turbidity ☐Color ☐Container ☐Source
☐Living things ☐Religious taboo ☐Other______________

Q3. You judge water **<u>unbathable</u>** most likely by its ___☑___.
(Please select **<u>only one</u>**.)
☐Taste ☐Odor ☐Turbidity ☐Color ☐Container ☐Source
☐Living things ☐Religious taboo ☐Other______________

Q4. You judge water **<u>unusable for religious acts</u>** (*e.g.* pre-prayer ablution)
most likely by its ___☑___. (Please select **<u>only one closest</u>**.)
☐Taste ☐Odor ☐Turbidity ☐Color ☐Container ☐Source
☐Living things ☐Religious taboo ☐Other______________

<u>Questions continue to the right-hand page</u>.

❖ **Q5-Q16** will ask you about your **perception about rivers**.

Q5. A ‘river’ is **most likely** called ___☑___ in your family-spoken language.
(Please select **only one**.)
☐Sungai ☐河 ☐ நதி ☐River ☐Other _______________

Q6. The nearest river from your current house is Sg. ___☑___.
☐Sg. ____________________ ☐I do not know the name.

Q7. The nearest river water is **directly drinkable**. (Please select **only one**.)
☐Yes ☐No ☐ I do not know.
You are willing to pay extra **RM___☑___/month** if the nearest river water stays/becomes **directly drinkable**.
☐0 ☐0.01- 9.99 ☐10.00-19.99 ☐20.00 or above (RM__________/month)

Q8. The nearest river water is **directly bathable**. (Please select **only one**.)
☐Yes ☐No ☐ I do not know.
You are willing to pay extra **RM___☑___/month** if the nearest river water stays/becomes **directly bathable**. (Please select **only one**.)
☐0 ☐0.01- 9.99 ☐10.00-19.99 ☐20.00 or above (RM__________/month)

Q9. The nearest river water is **directly usable for religious acts** (e.g. pre-prayer ablution). (Please select **only one**.)
☐Yes ☐No ☐ I do not know.
You are willing to pay extra **RM___☑___/month** if the nearest river water stays/becomes **directly usable for religious acts**. (Please select **only one**.)
☐0 ☐0.01- 9.99 ☐10.00-19.99 ☐20.00 or above (RM__________/month)

Q10. The nearest river seems **most benefical** to the people at ___☑___.
(Please select **only one**.)
☐Your place ☐The upstream ☐The downstream ☐The opposite river bank
☐Kuala Lumpur and its surroundings ☐Other ___________ ☐I do not know.

Questions continue to the back page.

Q11. **<u>The worst trouble</u>** about the nearest river is ___☑___? (Please select **<u>only one</u>**.)

☐Flood ☐Drought ☐Water-borne disease ☐Pollution ☐Lack of safety

☐Other ______________ ☐I do not know.

Q12. The nearest river water is **<u>perfectly floodless</u>**. (Please select **<u>only one</u>**.)

☐Yes ☐No ☐ I do not know.

You are willing to pay extra **RM___☑___/month** if the nearest river water stays/becomes **<u>perfectly floodless</u>**. (Please select **<u>only one</u>**.)

☐0 ☐0.01- 9.99 ☐10.00-19.99 ☐20.00 or above (RM__________/month)

Q13. The nearest river water is **<u>perfectly droughtless</u>**. (Please select **<u>only one</u>**.)

☐Yes ☐No ☐ I do not know.

You are willing to pay extra **RM___☑___/month** if the nearest river water stays/becomes **<u>perfectly droughtless</u>**. (Please select **<u>only one</u>**.)

☐0 ☐0.01- 9.99 ☐10.00-19.99 ☐20.00 or above (RM__________/month)

Q14. The nearest river water is **<u>perfectly free of water-borne disease</u>**. (Please select **<u>only one</u>**.)

☐Yes ☐No ☐ I do not know.

You are willing to pay extra **RM___☑___/month** if the nearest river water stays/becomes **<u>perfectly free of water-borne disease</u>**. (Please select **<u>only one</u>**.)

☐0 ☐0.01- 9.99 ☐10.00-19.99 ☐20.00 or above (RM__________/month)

Q15. The nearest river seems **<u>most harmful</u>** to the people at ___☑___. (Please select **<u>only one</u>**.)

☐Your place ☐The upstream ☐The downstream ☐The opposite river bank

☐Kuala Lumpur and its surroundings ☐Other ____________☐I do not know.

Q16. ___☑___ is **<u>the most important core</u>** in managing the nearest river's whole watershed. (Please select **<u>only one</u>**.)

☐Economy ☐Politics ☐Administration ☐Development ☐Law ☐Nature

☐Science/Engineering ☐Religion ☐Tradition ☐Human life ☐Other _____

<u>Questions continue to the right-hand page</u>.

❖ **Q17-Q26** will ask you about **yourself**.

Q17. Your gender is ____☑____.

☐Male ☐Female

☐*I do not want to answer.*

Q18. Your **Local Authority area** and ***mukim*** are ____☑____and ____☑____, respectively. (Please select from below.)

Local Authority Area			
M.D. Kuala Selangor	**M.D. Ulu Selangor**	**M.P. Selayang**	**D.B. Kuala Lumpur**
☐ Asam Jawa	☐ Batang Kali	☐ Batu Arang	☐ Batu Caves
☐ Bandar Puncak Alam	☐ Bukit Beruntung	☐ Batu Caves	☐ Jinjang
☐ Bandar Saujana Utama	☐ Bukit Fraser	☐ Gombak Setia/Taman Perwira	☐ Kampong Sungai Penchala
☐ Bestari Jaya (Batang Berjuntai)	☐ Kalumpang	☐ Kampong Baru Rawang	☐ Kampong Batu
☐ Bukit Rotan	☐ Kampong Ulu Yam Baharu	☐ Kuang	☐ Kampong Kepong
☐ Ijok	☐ Kerling	☐ Mimaland	☐ Kuala Lumpur
☐ Jeram	☐ Kuala Kubu Baru	☐ Pengkalan Kundang	☐ Salak Selatan
☐ Kampong Kuantan	☐ Rasa	☐ Rawang	☐ Sungai Besi
☐ Kuala Selangor	☐ Serendah	☐ Selayang Baru	☐ *I do not know.*
☐ Kuala Sungai Buluh	☐ Ulu Bernam	☐ Taman Greenwood/Taman Gombak	
☐ Pasir Penambang	☐ Ulu Kalu	☐ Remainder of M.P.	
☐ Sungai Sembilang	☐ Ulu Sungai Choh	☐ *I do not know.*	
☐ Tanjong Karang	☐ Ulu Yam Lama		
☐ Remainder of M.D.	☐ Remainder of M.D.		**M.D. Raub, Pahang**
☐ *I do not know.*	☐ *I do not know.*		☐ Bukit Fraser

Mukim			
Kuala Selangor	**Ulu Selangor**	**Gombak**	**Kuala Lumpur**
☐ Api-api	☐ Ampang Pechah	☐ Batu	☐ Ampang
☐ Bestari Jaya (Batang Berjuntai)	☐ Batang Kali	☐ Rawang	☐ Bandar Kuala Lumpur
☐ Ijok	☐ Buloh Telor	☐ Setapak	☐ Batu
☐ Jeram	☐ Kalumpang	☐ Ulu Kelang	☐ Cheras
☐ Kuala Selangor	☐ Kerling	☐ *I do not know.*	☐ Kuala Lumpur
☐ Pasangan	☐ Kuala Kalumpang		☐ Petaling
☐ Tanjong Karang	☐ Peretak		☐ Setapak
☐ Ujong Permatang	☐ Rasa		☐ Ulu Kelang
☐ Ulu Tinggi	☐ Serendah		☐ *I do not know.*
☐ *I do not know.*	☐ Sungai Gumut		
	☐ Sungai Tinggi		
	☐ Ulu Bernam		
	☐ Ulu Yam		**Raub, Pahang**
	☐ *I do not know.*		☐ Teras

☐None of the above

☐*I do not know.*

☐*I do not want to answer.*

Questions continue to the back page.

Q19. Your age is ___☑___.

☐20-24 ☐25-29 ☐30-34 ☐35-39 ☐40-44 ☐45-49

☐50-54 ☐55-59 ☐60-64 ☐65-69 ☐70-74 ☐75 or more

☐*I do not want to answer.*

Q20. Your house's **sewer water** is treated by ___☑___.

☐Communal septic tank ☐Private septic tank

☐Public sewerage system ☐Private sewerage system

☐No treatment ☐Other__________

☐*I do not know.* ☐*I do not want to answer.*

Q21. Your religion is ___☑___.

☐Islam ☐Christianity ☐Buddhism ☐Hinduism

☐Confucianism, Taoism or traditional Chinese religion

☐No religion ☐Other__________

☐*I do not want to answer.*

Q22. Your **household gross income** is about **RM**___☑___**/month**.

☐0-2,999 ☐3,000-4,999 ☐5,000-6,999 ☐7,000-9,999 ☐10,000 or more

☐*I do not know.* ☐*I do not want to answer.*

Q23. You are a member of an environmental organization, institution, group or club.

☐Yes ☐No

☐*I do not want to answer.*

Q24. You graduated from ___☑___.

☐Pre-primary ☐Primary school ☐Lower secondary ☐Upper secondary

☐Pre-university ☐Certificate programs in specific trades and technical skill

☐Tertiary (certificate/diploma level)

☐Tertiary (degree/advanced diploma and above)

☐Never attended school ☐Unknown

☐*I do not want to answer.*

Questions continue to the right-hand page.

Q25. Your ethnic group is ___☑___.

☐Malays ☐Other Bumiputera ☐Chinese ☐Indians

☐Other ethnic group (Malaysian citizen) __________.

☐Non-Malaysian citizen (Country __________)

☐*I do not know.* ☐*I do not want to answer.*

Q26. Please give your favorite water/river-related **proverbs and sayings** and their meanings. (**Any language will do**).

❖ *If you still have time and you answered to* **Q25** *that your ethnic group was* **Malays, Chinese, Other Bumiputera or Indians,** *please kindly answer* **Q.25'** ***in the back page****.*

❖ *This is the end of the survey. Please kindly check if you have answered all the questions.*
Thank you very much for your time and kind cooperation.

If you have anything you would like to say about rivers or water, or any comments on this questionnaire, please freely write them here.

Extra Question

❖ Please choose and answer **only one appropriate** question from the following questions**.**

Q25’-1. You are Malay, and you are ☑ ________.

☐Selangor Malay ☐Other Peninsular Malay__________.

☐Achenese ☐Banjarese ☐Batak ☐Batu Bahra ☐Boyanese

☐Bugis ☐Javanese ☐Kampar ☐Kerinchi ☐Mandailing

☐Minankabau ☐Pekan ☐Rawa ☐Sundanese

☐Other__________

☐*I do not know*. ☐*I do not want to answer*.

Q25’-2. You are Other Bumiputera, and you are ☑ ________.

☐Negrito ☐Senoi ☐Melayu Asli ☐Sabah ☐Sarawak

☐Other__________

☐*I do not know*. ☐*I do not want to answer*.

Q25’-3. You are Chinese, and you are ☑ ________.

☐Hainanese ☐Henghua ☐Hokchia ☐Hokchiu ☐Hokkein

☐Cantonese ☐Hakka ☐Kwongsai ☐Teochew

☐Other__________

☐*I do not know*. ☐*I do not want to answer*.

Q25’-4. You are Indian, and you are ☑ ________.

☐India Muslim/Malabari ☐Malayali ☐Punjabi ☐Sikh

☐Sinhala ☐Tamil India ☐Tamil Sri Lanka ☐Telugu

☐Other__________

☐*I do not know*. ☐*I do not want to answer*.

Thank you very much!