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RAINWATER HARVESTING OPPORTUNITIES: WATER RESOURCE SUSTAINABILITY

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Abstract: This study aims to identify the degree of which factors contribute to the rainwater quality and understanding anthropogenic contributions to the atmospheric environment. A total of 1830 rainwater data were collected from rain gauge stations distributed all over the country. Factor analysis were applied to the studied variables to evaluate the physicochemical composition of rainwater samples in Malaysia. The results showed that the extracted four components accounted for 43.45% of the total variance. The source of ionic components was found to be mainly originated from sea salt ions, while biomass burning indicated it was the primary source of anthropogenic activities in the study area. Low heavy metal concentration were detected in the rainwater samples. Generally, the rainwater in the study area was of good rainwater quality and less affected by anthropogenic activities. Some variables were identified to influence the variability of rain, hence affecting the variability of rainwater in the study area, including magnesium, sodium, chloride, ammonium, potassium, nitrate, sulphate, nickel, formate and iron. The variability of these components caused in acidity and conductivity in rainwater samples. This study provides a basis for the rational utilisation of rainwater for peoples' lives, thus maintaining the sustainability of water resources in the environment. Additional research is needed to identify the index of rainwater quality and determine the uses for each index level.

Keywords: Anthropogenic, factor analysis, rainwater harvesting, sea salt, sustainability.

Introduction

Environmental Pollution

The deterioration of environmental quality is severely correlated with human activities. Human's selfishness that only thinks about profit without considering the sustainability of the environment encourages their immoral actions. Inadvertently, the rapid development of the economy in most countries have made a significant impact on the environment (Lee *et al*., 2016). The condition of some environments, such as air quality, water quality, and deforestation, is rather stressed (Latif *et al*., 2012). A great deal of attention has been placed on water pollution. Previous studies have shown that water pollution has become a threat in many countries in recent decades (Su *et al*., 2011). Due to overexploitation of water, especially for domestic use, industrialisation and irrigation, the water quality has deteriorated rapidly (Gazzaz *et al*., 2012). Thus, most countries are facing big challenges in ensuring sustainable water resources. Generally, humans depend on multiple water sources, including riverwater, rainwater, and groundwater, for general purposes. Most countries, including Malaysia, rely on river water as their primary supply for domestic, agriculture, and industrial use (Nasir *et al*., 2012). However, the constant discharge of domestic and industrial waste was affected water quality (Sekar & Randhir, 2007). As the water quality represents a comprehensive index of environmental quality, the impacts of pollutants to the water surface are vital issues, especially in an urban and densely populated areas.

The Need for Rainwater Harvesting as an Alternative Water Supply

Water is the most vital component of all organisms. Thus, preserving water is a mutual responsibility. Water scarcity has been a continuous problem in the arid and semi-arid regions, which have limited water supply (Islam *et al*., 2010). Water scarcity is also a significant problem in rural areas due to polluted water bodies (Gupta, 2011; Molla *et al*., 2015). Previous studies have demonstrated that the problem is becoming critical even in regions with good water supply due to the rapid urbanization (Hashim *et al*., 2013), excessive consumption of water (Zhang *et al*., 2009) and increasing of population (Peeters *et al*., 2020). Therefore, many researchers are studying the new water resources with the aim of greener and more sustainable development that can fulfil water supply needs (Islam *et al*., 2010). Interest in rainwater harvesting is growing steadily, not just in water scarce areas, but also in Malaysia, which has no water supply problem to manage their surface runoff (Sekar & Randhir, 2007).

Since 4500 BC, rainwater harvesting has been practised traditionally in many dry regions in the world (Ayob & Rahmat, 2017). Historically, rainwater has been used in many civilisations as it is a readily available source of water for human activities (Jones & Hunt, 2010). Many studies agree that rainwater harvesting is seen as an alternative water supply to meet demand (Islam *et al*., 2010; Rasyikah Md Khalid, 2018; McFarland *et al*., 2019). The benefits of rainwater harvesting have been recently promoted to solve the water problems not limited to agricultural and domestic needs (Sekar & Randhir, 2007), but also as an alternative to meet the demand for clean water (Nur Syarina Asman *et al*., 2017). By highlighting the theoretical capabilities of ecological modernization that utilize natural water resources (Hashim & Man, 2018), rainwater harvesting is seen as a tool for safe and sustainable green technology (Ayob & Rahmat, 2017). Parallel with that, Malaysia identified rainwater harvesting as an essential initiative to meet increased demand for water (Khalid, 2018). Malaysia has an abundance of rainfall annually, therefore the country has maximum advantage to utilise it. Generally, the quality of rainwater is acceptable for domestic use.

Interestingly, research has found that the quality of rainwater is not due to pollution discharged directly into the rain, but it depended on the quality of the atmosphere (Helmreich & Horn, 2009). Naturally, rainwater is clean, but can be highly contaminated with atmospheric pollutants (Wang *et al*., 2013; Reyneke *et al*., 2017). Previous studies on have reported that the variety of chemical composition of rainwater is due to various pollutants emitted into the atmosphere (Niu *et al*., 2014; Meng *et al*., 2019). In urban areas, anthropogenic sources, such as high pollution density, industrialization, and urbanization, have been identified as the primary cause of atmospheric pollution, (Momin *et al*., 2005). Yet, additional pollutants, including organic matter, faecal deposits from animals and birds, did not do much to affect the quality of rainwater, compared with anthropogenic pollutants (Aladenola & Adeboye, 2010). Therefore, air pollution is highly associated with rainwater quality since all the particles in the atmosphere will dissolve in the rain. In most urban regions, harvested rainwater has several non-potable uses without additional treatment, such as irrigation, toilet flushing (Angrill *et al*., 2012), and vehicle washing (Jones, 2010). Further, these practises can be followed in rural area as well. It is, therefore, necessary to identify the quality of rainwater and provide a reliable assessment of rainwater quality for effective water use management.

In modern research, different statistical techniques, such as multivariate analysis have been used to evaluate and interpret a complex set of data for better understanding of the water characteristics (Zhang *et al*., 2009). Statistical tools, such as factor analysis, have often been used to explore the data, and allow for the identification of possible factors that influence water systems (Al-Mutairi *et al*., 2014). Moreover, factor analysis was applied in many studies, especially in social studies, to establish an index (Li & Weng, 2007; Tesfazghi *et al*., 2010; Fazillah *et al.*, 2018). Studies on rainwater chemistry are essential to evaluate the air quality and anthropogenic emissions to the atmosphere. The rainwater chemistry was analyzed based on the major ion chemistry and its suitability for non-potable purposes. Acting on the knowledge that anthropogenic pollutants affected rainwater quality, the focus of this study is to identify the degree to which such factors influence rainwater quality and understanding anthropogenic contributions to the atmospheric environment. Hence, rainwater harvesting can be used for multiple purposes, primarily for non-potable purposes.

Case Study: Malaysia

Figure 1 shows the area interest for this study is Malaysia, a Southeast Asian country, consist of two regions; the Malay Peninsula, and East Malaysia. Malaysia is situated in the tropics between 1^o and 6^o degrees north of the equator (Suhaila & Jemain, 2007). Hydrometereologically, Malaysia experienced two types of monsoons, i.e., the northeast (November to March) and the southeast (May to September). In between these two monsoons are the inter-monsoon seasons, March to April, and September to October, with average rainfall of about 2400mm (Lan*et al*., 2018).

Materials and Methods

Rainfall Data

In this study, hourly rainfall data were sourced from the Malaysian Meteorological Department for the period 2017 to 2019. The rainfall stations were selected based on the adequacy of data and length of the record. There were 749, 654, and 427 rain gauge stations in 2017, 2018, and 2019 respectively. All of them derived from 18 and 6 districts in Peninsula and East Malaysia, respectively (see Table 1).

Figure 1: Map of Malaysia (Peninsular and East Malaysia)

Table 1: Number of rain gauge stations by districts

District	2017	2018	2019
Alor Setar	26	23	15
Bachok	28	16	11
Batu Embun	21	34	17
Bayan Lepas	35	33	16
Bukit Kledang	34	30	19
Chuping	24	21	14
Kluang	8	4	8
Kota Bharu	28	16	10
Kuala Terengganu	54	25	15
Kuantan	60	24	23
Melaka	12	19	11
Mersing	36	28	14
Muadzam Shah	32	35	29
Petaling Jaya	32	39	36
Seberang Perai	16	14	15
Senai	37	38	21
Sitiawan	37	32	13
Tanah Rata	30	30	28
Bintulu	35	42	30
KK	20	23	9
Kuching	41	37	35
Labuan	52	41	11
Lembah Danum	22	13	12
Tawau	29	37	15
Total	749	654	427

Statistical Methods

Descriptive statistics summarise the rainfall data to explain the general features of the variables, and it is a technique to control and present the data and statistical procedures (Subedi, 2016). It describes and shows the real view of the data, including mean and standard deviation.

Factor analysis determines the structure of the underlying dimension of the observable data (Yu *et al.*, 2003). Factor analysis has been widely used in various fields to investigate the spatial and temporal variations with the aim of reducing the dimensionality of data through exploring the complexity and correlation of the variables in the data (Li *et al.*, 2011). The suitability of the data set was first checked by determining the Keser-Meiyen-Olkin (KMO) and Barlett's test values. The factor analysis can be done if the KMO value is greater than 0.5, while the significant level of the Bartlett test is less than 0.1 (Wu *et al.*, 2010). The varimax rotation was then applied to produce the new orthogonal variables known as varifactors (VFs) based on the eigenvalue greater than 1 (Y. Wang *et al.*, 2013). The VFs can be expressed as:

$$z_{ji} = a_{f1} f_{1i} + a_{f2} f_{2i} + a_{f3} f_{3i} + ... + a_{fm} f_{mi} + \mathrm{e\_fi} \quad (1)$$

Where z is the measured value of a variable, f is the factor loading, e is the factor score, m is the residual term accounting for errors or other sources of variation, i is the sample number, j is the variable number, and m is the total number of factors. The interpretation of factor loading after the varimax rotation shows the correlation between variables and factors; thus, it reflects how much the actual variables contribute to that particular component and to what extent each variable has similarities to the others (Li & Weng, 2007; Dominick *et al.*, 2012). Liu *et al.* (2003) classified the factor loadings as 'strong,' 'moderate,' and 'weak,' corresponding to absolute loading values of > 0.75, 0.75 - 0.5, and 0.50 - 0.30, respectively.

Factor analysis was applied in this study to identify the underlying dimensions of rainfall data in Malaysia. Each underlying dimension was referred to as factors, and the elements explain the most variability in the data observed, with factor 1 considered as having the most variance followed by the next factors after that (Li & Weng, 2007).

Results and Discussion

Summary of Rainfall Data

Table 2 provides a summary of the median, mean, variance, and standard deviation of 23 physicochemical properties at 1830 rain gauge stations in Malaysia for three years. The rainfall data were analysed using descriptive statistics. It must be emphasised that the average concentration of some variables, such as chloride and sodium, was high for the three years. The pH value of the rainwater samples was slightly acidic, ranging from 5.00 to 5.15. The mean for conductivity ranges from 1.02 to 1.59 µS/cm. The mean value of heavy metals copper, iron, manganese, mercury, nickel, cadmium, lead and zinc were at a low level of less than 0.1 mg/L. This study assumed that anthropogenic activities that emitted the heavy metals concentrations into the air did not greatly affect the quality of rainwater in this study area. However, the concentration of organic particles in the rainwater was quite high, indicating the acidity of rain was greatly influenced by organic particles. The results show all the parameters for the three years did not significantly change.

Dimensions of Rainfall Data

The suitability of the data to conduct factor analysis were determined via the value of KMO and Barlett's test which are 0.71 and 0.0, respectively. This implies the suitability of the data set for a factor analysis, as well as indicating that the variables are unrelated (Li & Weng, 2007). Theoretically, several parameters may affect the quality of rainwater. Therefore, 23 physicochemical parameters were studied. The results of factor analysis after rotation, scree plot and score plots are shown in Figures 2a and 2b, respectively. The scree plot (Figure 2a) has a pronounced change of slope after the fourth eigenvalue. The scree plot is used to identify the number of VFs in the study area. Four components were retained, which have eigenvalues greater than unity and explain 43.45% of the variance in the original data set.

The factors that originated from the factor analysis were identified as the underlying dimension of the rainwater sample. This study extracted four factors with an eigenvalue higher than 1, then renamed them to indicate the underlying dimensions of the rainwater sample. Therefore, only moderate to strong factor loadings were selected for the VFs interpretation, as can be seen in table 3.

The four factors explain 43.45% of the total variance, with factors 1, 2, 3 and 4 explaining 17.75%, 13.19%, 6.98%, and 5.53% of the total variance, respectively. In this study, the variables with a factor loading value greater than 0.5 were considered in identifying the dimensions.

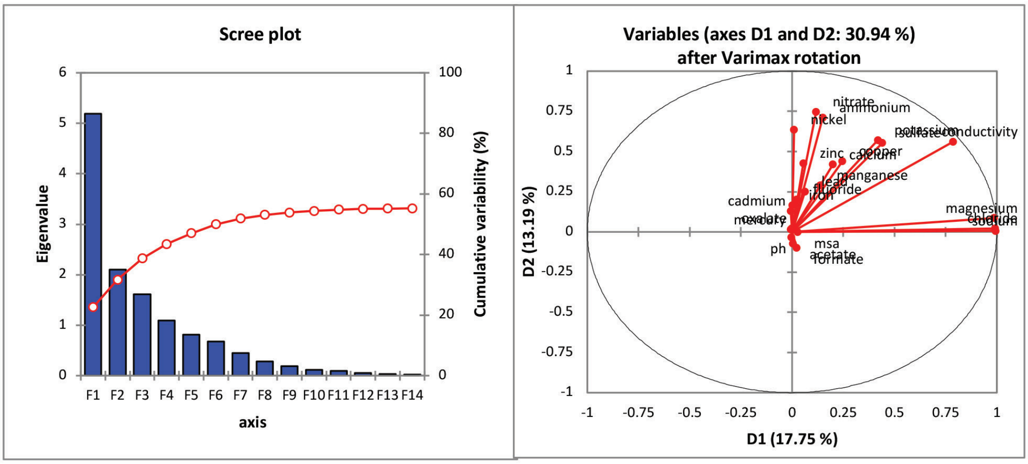

Figure 2: (a) Scree plot of eigenvalue for three years. (b) Factor loading after varimax rotation approaching 1

Table 2: Summary of physicochemical parameters of rainfall data for three years in mg/L except for pH and conductivity

Parameter	2017				2018				2019			
	Median	Mean	Variance	SD	Median	Mean	Variance	SD	Median	Mean	Variance	SD
Ammonium	1.860	10.891	1989.264	44.601	3.795	17.288	2869.637	53.569	0.970	11.947	1469.366	38.332
Calcium	2.570	6.293	390.510	19.761	2.940	6.284	164.300	12.818	3.130	9.598	539.350	23.224
Fluoride	0.100	0.372	1.573	1.254	0.100	0.524	3.229	1.797	0.440	0.679	1.357	1.165
Magnesium	1.040	4.084	354.073	18.817	1.180	3.307	46.438	6.815	1.260	3.388	50.372	7.097
Potassium	1.510	3.780	81.727	9.040	1.885	4.687	114.632	10.707	2.090	3.984	106.788	10.334
Sodium	9.810	35.825	28513.481	168.859	9.960	26.888	2928.961	54.120	10.610	27.477	3318.107	57.603
Nitrate	3.920	9.953	351.231	18.741	8.020	20.294	3489.963	59.076	7.070	15.179	1089.587	33.009
Sulfate	4.350	9.876	493.637	22.218	6.460	10.564	168.143	12.967	6.250	10.293	175.146	13.234
Acetate	0.025	0.247	0.609	0.781	0.025	0.372	5.595	2.365	0.040	0.948	12.361	3.516
Chloride	12.490	43.568	38079.749	195.140	12.480	32.202	3896.244	62.420	14.530	32.656	4034.788	63.520
Formate	0.050	0.158	0.382	0.618	0.050	0.266	2.205	1.485	0.020	0.180	0.388	0.623
MSA	0.015	0.052	0.043	0.208	0.015	0.074	0.088	0.296	0.015	0.082	0.136	0.369
Oxalate	0.035	0.094	0.031	0.176	0.035	0.081	0.020	0.140	0.035	0.114	0.043	0.207
Copper	0.009	0.047	0.039	0.198	0.014	0.041	0.013	0.116	0.013	0.037	0.016	0.126
Iron	0.035	0.093	0.039	0.198	0.035	0.099	0.022	0.148	0.035	0.113	0.038	0.195
Manganese	0.042	0.079	0.013	0.114	0.032	0.075	0.014	0.119	0.066	0.108	0.016	0.127
Mercury	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Nickel	0.015	0.032	0.008	0.088	0.015	0.044	0.030	0.173	0.015	0.028	0.011	0.105
Cadmium	0.001	0.002	0.000	0.011	0.001	0.001	0.000	0.003	0.001	0.001	0.000	0.001
Conductivity	0.880	1.589	11.179	3.344	1.020	1.631	3.769	1.941	1.110	1.583	3.398	1.843
Lead	0.001	0.003	0.000	0.012	0.001	0.004	0.000	0.017	0.001	0.003	0.001	0.031
pH	5.130	5.151	0.294	0.542	5.005	5.055	0.309	0.556	5.070	5.131	0.409	0.640
Zinc	0.107	0.446	1.082	1.040	0.125	0.442	1.934	1.391	0.158	0.329	0.296	0.544

Interpreting factor loading for each VFs is very important in factor analysis to determine the meaning of VFs. The four factors interpreted to define the dimensions of rainwater in Malaysia are as below:

Sea Salt Ions

Factor 1: Factor 1 revealed the most significant amount of variance at a total of 17.74% to be loaded positively with Mg^+, Na^+, Cl^- and EC. Since it shows high loading of magnesium, sodium, and chloride, this factor was interpreted as sea salt ions. The loading of conductivity in this factor indicates a strong correlation between sea salt ions and conductivity levels. There was a significant correlation between the appearance of the ions and EC, where the presence of ions in rainwater would increase the ability of the water to be a conductor of electricity (Kazi *et al*., 2009). The strong correlation among these ions indicates that it has come from similar sources, likely marine. (Wang *et al*., 2006). This study shows the main cause of decreasing pH levels is sea salt ions. In contrast with the previous research, the acidic rainwater is primarily due to anthropogenic activities (Niu *et al*., 2014). Thus, the higher concentration of ions in the rainwater, the higher the conductivity level.

Inorganic Ions/Heavy Metal

Factor 2: This factor is a combination of inorganic ions and heavy metals with moderate loading for all the variables. Loading of ammonium, nitrate and sulphate in this factor, suggests it is produced by chemical reactions of gaseous precursors (SO_2, $NO_{x,}$ and NH_3) and known as secondary aerosols (Nicolás *et al*., 2009). There was a weak correlation between sulphate with nitrate and ammonium, indicating that coal-burning was not the main activity in the study area (Zhang *et al*., 2011). The results can be linked to the government''s effort to enhance renewable energy consumption in Malaysia (Jayed *et al*., 2011). In 2010, the Malaysian government introduced the National Renewable Energy Policy in an effort to reduce fossil fuel consumption (Shafie *et al*., 2014). A total of six coal-power plants in Kapar in Selangor, Janamanjung in Perak, Tanjung Bin in Johor, Jimah in Negeri Sembilan, Sejingkat in Sarawak, and Silam in Sabah generate electricity (Oh, 2010).

A strong correlation between ammonium (0.69) and nitrate (0.72) suggests that these ions primarily existed as ammonium nitrate (NH_4NO_3), which are believed to be contributed mainly from livestock, fertiliser use and biomass burning (Zhang *et al*., 2007; Abbasi & Abbasi, 2011). However, this factor shows nitrate has the highest loading compared to the others, indicating it originated from multiple sources. This study proposes that another contributor of nitrate to the atmosphere is likely related to the complete combustion of fuel in vehicles. The number of vehicles in Malaysia has multiplied over the past decades, making it a significant contributor to the atmospheric emission of nitrous oxide (N_2O) (Ong *et al*., 2011). Previous study have reported that the transport sector was responsible for mobile pollution sources in Malaysia, up to 68.5% (Bazrbachi *et al*., 2017).

Potassium is the essential of biomass burning activities (Kundu & Stone, 2014). Previous studies verified that higher levels of soluble potassium in the ambient air was the result of biomass burning (Shen *et al*., 2009). It was confirmed via the ammonium and potassium ions, load together in this factor (Zhang *et al*., 2007). Currently, biomass burning is one of the significant air pollutions to the ambient air of Malaysia (Dominick *et al*., 2012). While, the emission of nickel into the atmosphere in the study area highly correlated with both natural (vegetation, sea salt, and forest fires) and anthropogenic sources (fossil combustion) (Tian *et al*., 2012). This study found that the existence of inorganic ions and heavy metals in this factor explains its origins from anthropogenic activities; in particular, it was fossil fuel combustion.

Table 3: Factor loading of factor analysis after varimax rotation

Parameters	Factors			
	Sea Salt	**Inorganic Ions/Heavy Metal**	**Organic Acid**	**Heavy Metal**
Ammonium		0.6901		
Calcium				
Fluoride				
Magnesium	0.9844			
Potassium		0.5546		
Sodium	0.9933			
Nitrate		0.7257		
Sulphate		0.5367		
Acetate				
Chloride	0.9886			
Formate			0.6614	
MSA				
Oxalate				
Copper				
Iron				0.5566
Manganese				
Mercury				
Nickel		0.6174		
Cadmium				
Conductivity	0.7852	0.5445		
Lead				
pH				-0.733
Zinc				
Eigenvalue	5.1874	2.1031	1.6137	1.0896
Variability (%)	17.7475	13.1949	6.9803	5.5263
Cumulative %	17.7475	30.9425	37.9228	43.4491

Organic Acid

Factor 3: This factor can be interpreted as organic acid since it loads only formate. Formate is the anion product of formic acid, which can be found in abundance in the atmosphere in gaseous form (Millet *et al*., 2015). The moderate loadings of formate may be from multiple sources, such as photochemical oxidation of precursors from anthropogenic and biogenic origins (Alwe *et al*., 2019), sea spray, traffic and industrial emissions (Mkoma *et al*., 2014), and combustion activities (Kerminen *et al*., 2000). Another cause of formate loading moderately in this factor could be related by the low concentration of formate in marine aerosols (King *et al*., 2019). A study by Hong agreed that the concentration of formate in the continental area was higher than the marine boundary area (Hong *et al*., 2011). This study found that formate had less affect to the acidity of rainwater compared to the sea salt ion.

The higher the score in this factor, the lower rainwater quality.

Heavy Metal

Factor 4: This factor appears to represent moderate positive loading of iron and moderate negative loading of pH. This factor signifies vehicle emission, mainly brake wear, as it constitutes average loadings on iron. Past studies found high concentration of iron initiate in brake wear particles (Furusjö *et al.*, 2007). This result is in line with a previous study by Munim *et al*. (2013), who found that iron was the most abundant heavy metal in road dust derived from vehicle brake pads. A negative correlation between iron and pH level indicates that increasing acidity of rainwater will increase the concentration of water-soluble iron in the air. The acidic reaction by acidic species occurring in the atmosphere may control the solubility of iron (Oakes *et al*., 2012). The evidence that the lower the pH level, the concentration of soluble iron will increase has been obtained through some researches in their studies (Oakes *et al*., 2012; Meskhidze *et al*., 2003; Ingall *et al*., 2018).

Spatial Dispersion of Rain Gauge Stations

The results show that eight rain gauge stations were more dispersed than others in the study area, as shown in Table 4 and Figure 3.

Table 4 shows the factor scores after varimax rotation with the first-factor score: sea salt ions has the highest value in Bachok. Since Bachok is a coastal area adjacent to the South China Sea, it is not surprising that the atmosphere there has a relatively high concentration of elements, like sea salt ions. It is believed that the sea salt ion concentration was high in this area due t abundant seawater droplets (Tahir *et al*., 2013) and marine aerosols (Farren *et al*., 2019). In contrast to the other rain gauge stations, Bayan Lepas and Muadzam Shah had the highest value of second-factor score – inorganic ions/heavy metals – indicating anthropogenic activities had influenced it. Both districts are more densely populated and developed areas compared to Bachok. However, it can be seen in the table that the value of the factor score of Bayan Lepas was higher than Muadzam Shah. It was proven by the dense and developed area of Bayan Lepas, which is a known as an industrial area near the Strait of Malacca, compared to Muadzam Shah (Ismail *et al*., 2017). The highest value was due to the industrial activities contributing to anthropogenic pollutants, such as heavy metals in that area. From the result, the dispersion of the eight rain gauge stations were mostly influenced by sea salt ions and inorganic ions/heavy metals factors.

Table 4: Value of factor scores for BPRI

Observation	**Factor Score 1**	**Factor Score 2**	**Factor Score 3**	**Factor Score 4**	**Rain Gauge Station**
Obs68	**17.6228**	-1.0607	-0.2338	-1.0663	Bachok
Obs70	**19.6358**	-1.9738	-1.4868	1.1065	Bachok
Obs109	**17.6228**	-1.0607	-0.2338	-1.0663	Bachok
Obs111	**19.6358**	-1.9738	-1.4868	1.1065	Bachok
Obs245	0.0738	**11.4413**	-2.3552	2.4564	Bayan Lepas
Obs253	-0.2269	**15.5378**	-2.5758	1.4527	Bayan Lepas
Obs814	2.6756	**9.5629**	-0.0676	4.5962	Muadzam Shah
Obs894	2.6756	**9.5629**	-0.0676	4.5962	Muadzam Shah

*bold value indicates the highest value of factor score in the group

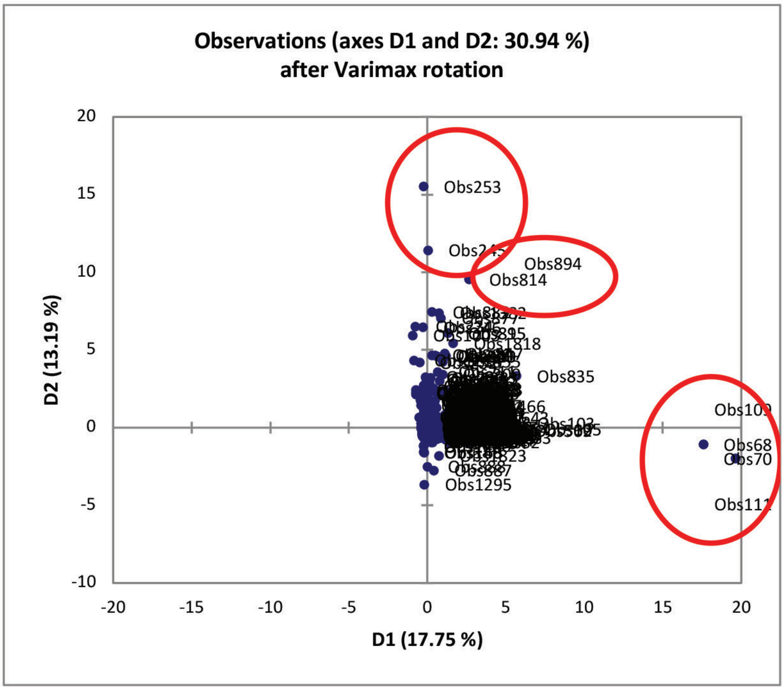

Figure 3: Observation variables

This study identified 12 out of 23 variables denoting that the seal salt; inorganic ions/heavy metals, organic acid, and heavy metal factors are the most significant parameter to identify the quality of rainwater. All 12 significant variables, including magnesium, sodium, chloride, ammonium, potassium, nitrate, sulphate, nickel, formate, iron, conductivity, and pH.

Conclusion

Rainwater harvesting has promise as an alternative water sources. Even though Malaysia has no water shortage problem, rainwater harvesting is viable due to the large volume of rain during the monsoon. Moreover, the deterioration of surface water quality due to in Malaysia due to exposure to pollution, strengthens the case for rainwater harvesting in this country. In an effort to reduce dependency on surface water, rainwater harvesting is a viable way to meet water demand. The collected rainwater could be used for multiple purposes, especially for non-potable uses. This study suggests the rainwater quality in Malaysia is good and does not require any treatment if it is for non-potable purposes. From this study, there is a clear indication that the rainwater in the study area has less contamination from anthropogenic sources. The low pH values are mainly caused by sea salt ions from the marine atmosphere. This result is supported by the location of Malaysia surrounded by the sea. It also indicates that anthropogenic sources mostly originated from biomass burning. Future research should consider the location of each rain gauge station then identify the index of rainwater quality to determine the uses for each index level.

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