Assessment of Salinity Environment near Coastal Line by using Gauze Method

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Abstract: *Myanmar occupies the northwestern part of the Southeast Asia peninsula. It is bounded to the west by India, Bangladesh, the Bay of Bengal and the Andaman Sea and to the east by Chin, Laos and Thailand. Myanmar is located within the Monsoon Belt of Asia; the climate is influenced locally by geographical position and topography. The total area of Myanmar is 676,578 km2 with 1930 km coastal line. This study monitored the deposition rate of chlorides at seven sampling stations scattered around the Letkokkon village, Kyun Chan Kone Division of Yangon Region. The study area is situated on the coastline of Andaman Sea which is the part of the Indian Ocean. Salinity can impact environmental consequences and salinity damage has also occurred to infrastructure. The type and amount of salts captured in the solution from the dry Gauze were determined by ion chromatography. Both on site measurement and chemical analysis were doing every month for the whole season to get seasonal chloride deposition rate. Deposition rate is not only dependent on distance but also other weather and environmental conditions. Even longer distance could be affected more salinity concentration and consequently specify as the salinity environment. The concentration of ABS is closely related to the wind velocity as wind with higher speed may carry more.*

Key Words: *Letkokkon, Chloride Deposition, Salinity, Dry Gauze, Wind Velocity.*

1. INTRODUCTION:

The mechanism of airborne salt (ABS) transportation is the phenomenon of the seawater moisture from splashed sea wave being carried to the land by the wind. The sea salt can significantly influence the quality of air. Sea salt can cause enhanced concentrations of particulate matter and change particle chemical composition, in particular in coastal area. The salt in the moisture becomes the ABS. The ABS is transported along the coastal area and rests on the surface of concrete structure [1] – [3]. Maintenance of deteriorated infrastructures subjected to chloride attack had become a challenging task. It is going to be more serious problem in near future in which budget and resource are decreasing. One of the critical issues is quantification of the airborne chloride amount coming to the structure [4]. The concentration of ABS is closely related to the wind velocity as wind with higher speed may carry more salt to a longer distance. It has been reported that the distribution of ABS is closely related to the wind velocity, distance from the coastal line, and humidity of the region [3]. Letkokkon village is situated on the coastline of Andaman Sea, where the action of sea spray creates an aggressive atmosphere for materials and products used in construction. In coastal area, the atmosphere has a strong presence of marine aerosol that has high levels of chloride ions [5], [6]. Very little research has been conducted to measure and evaluate the quantity of airborne sea salt in Myanmar. The purpose of this study is to establish the spatial distribution of marine salts in the coastal region of Myanmar. An experimental program is conducted to measure the concentration of airborne sea salts in the atmosphere using the dry gauze plate at seven sampling stations and to develop relation between the concentration of airborne sea salts and the distance from the sea. In addition, the environmental conditions do have significant influence on airborne sea salt deposit characteristics and prediction salinity environment near coastal line.

2. EXPERIMENTAL INVESTIGATION:

A method of dry-gauze plate is used to capture the chloride ion concentration in the atmosphere. The chloride concentration is measured by the silver nitrate titration of Standard method.

2.1. Selection of the location

Six exposure sites at different distances (50 m, 295 m, 701m, 1694 m, 2958 m and 11379m) and one more site at on the roof of Technical High School is 800 m from the sea in the Letkokkon Village that is selected location are shown in Fig. 1. Only the exposure site no. 1 is located in the open atmosphere in front of the sea. The remaining four stations are located in the paddy fields. Sample house on the roof of THS is particular condition because the elevation is higher than others and environmental condition is quite different. The distances from the coastline to the north direction is measured by using Google Map software and shown in Figure 1.

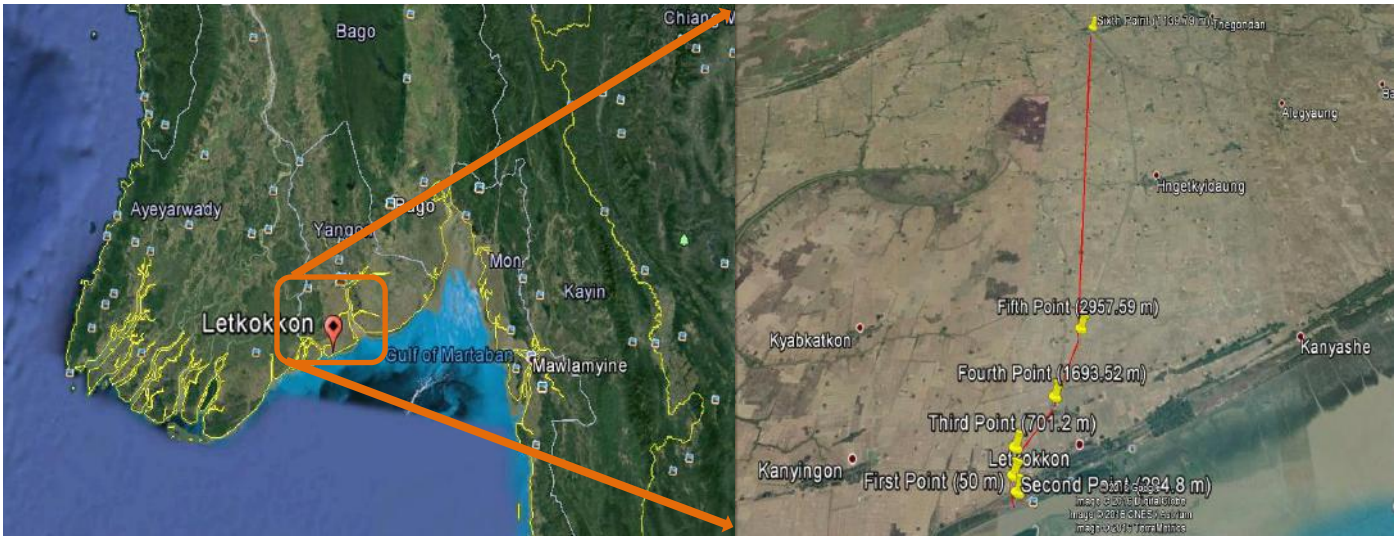

Figure. 1 Location Map and Exposure sites at Different Distances

2.2. Installation of dry gauze sample

In field observation, there have seven exposure sites at different distances (50 m, 295 m, 701m, 800m, 1694 m, 2958 m and 11379m) from the sea in the Letkokkon Village of the Kungyangone township in Myanmar. All sample house is the same level on the ground and one site at distance 800 m is on the roof slab of Technical High School are shown in Figure 3. The chloride concentration attached to the gauze is tested monthly and the deposition rate is calculated. The dry gauze method as specified in JIS Z 2382: 1998 is used as the captured devices [6]. The gauze, used in the hospital, is mounted on the wooden frame. The size of the gauze which is exposed to the atmosphere is 100 mm x 100 mm. The devices are placed at 1 m height above the ground level. They are placed under the sample house, which is oriented to the sea, in order to avoid the washing process due to the effect of rain and snow. Dry gauze in the sample house at different distances are shown in Figure. 2 and different directions of the devices are described in Table 1.

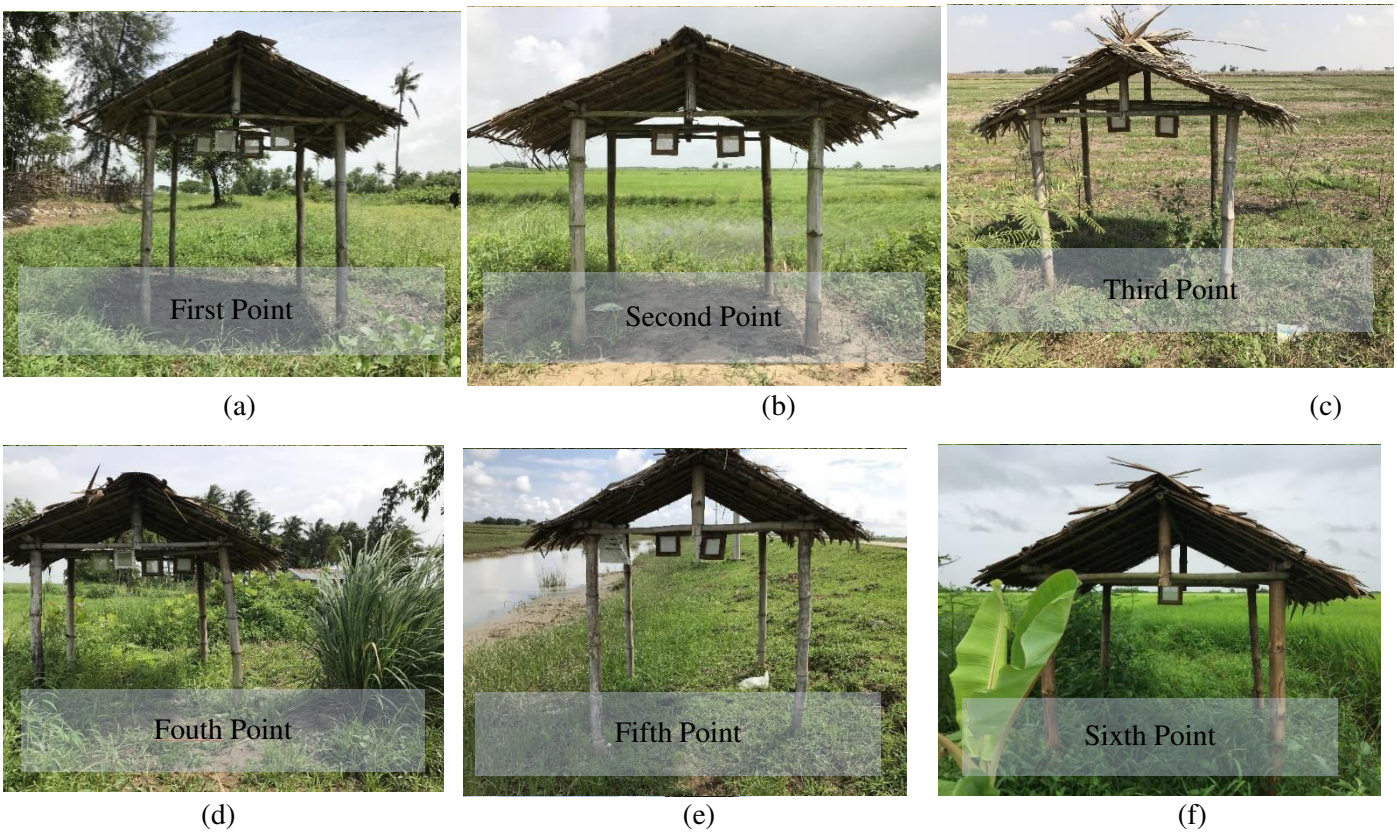

Figure. 2 Installation of Dry Gauzes in the Sample House at Different Distances
(a) 50m, (b) 295 m, (c) 701 m, (d) 1694 m, (e.) 2956 m, (f) 11379 m

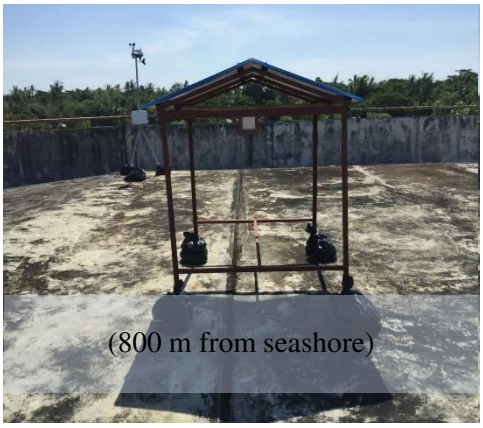

Figure. 3 Dry Gauze in the Sample House on the Roof Slab of Technical High School

TABLE 1. Different direction of airborne sea salt captured devices

Sr. No.	Station No.	Distance from the Sea (m)	Facing Direction
1	L_1	50	163 SSE
2	L_2	295	154 SSE
3	L_3	701	165 SSE
4	L_4	1694	172 S
5	L_5	2958	204 SSW
6	L_6	11379	183 S

2.3 Measuring Chloride by using Titration

The amount of airborne sea salt is measured by exposing the dry-gauze plates at the proposed locations for a duration of one month. After one month of exposure period, the installed devices are removed from each location and they are kept in the plastic bag until the chemical analysis. The chloride that attached to the gauze is measured by the silver nitrate titration at Environmental Laboratory in Yangon Technological University. The concentration of chloride is calculated by the formula of given in "Standard Method"; [9]

$$Cl^- \text{ (in mg/L)} = \frac{(\text{ml } AgNO_3 - \text{blank}) \text{x } 0.5 \text{ x } 1000}{(\text{ml sample})} \qquad (1)$$

2.4. Estimation of the deposition rate of chloride

When the values of chloride concentration are got, the deposition rate of chloride on the dry-gauze can be calculated by using the following formula;

$$R_{(NaCl)} = 0.0412 \text{ x } (C_1 - C_2) \text{ x } \frac{1}{t} \text{ x } 100 \qquad (2)$$

Where,

$R_{(NaCl)}$ = deposition rate of Chloride [NaCl (mg/ m^2 . d)]

C_1 = Concentration of chloride ions in the exposed sample solution (mg/l)

C_2 = Concentration of chloride ions in the unexposed sample solution (mg/l)

t = exposure period (day)

$$0.0412 = \frac{\text{formula weight of NaCl}}{\text{atomic weight of Cl}} \text{ x } \frac{50 \text{ ml}}{1000 \text{ ml}} \text{ x } \frac{100 \text{ cm}^2}{200 \text{ cm}^2}$$

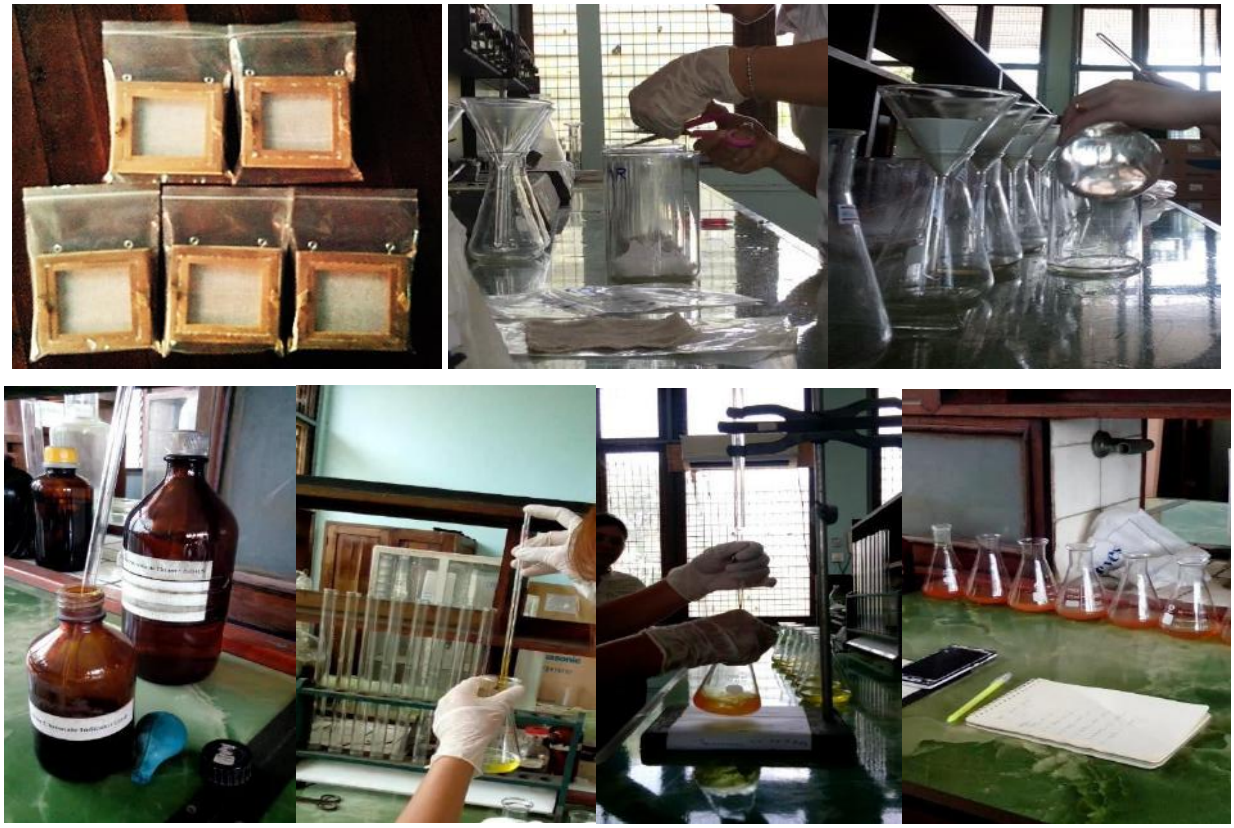

Figure. 4 Titration Process for testing Chloride

3. ANALYSIS OF THE MEASUREMENT RESULTS:

The variations of the results are different at each observation month. To study the causes of these variations, the meteorological data are collected and dry gauze plate are analysed to know how much amount of chloride include in it.

3.1. Collection of the meteorological data

The weather link station Model #6351 which is a kind of Vantage VUE system as shown in Fig. 5 is installed on the roof of Technical High School, Letkokkon Village. From this system, temperature (inside, outside, high and low), humidity (outside and inside), dew point, wind speed, wind direction, wind run, high speed, high direction, wind chill, heat index, barometer, rain rate and rain fall data can be got for every 30 minutes.

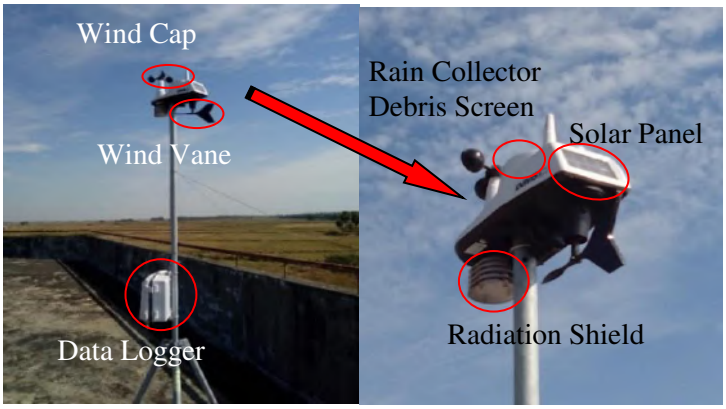

Figure. 5 Anemometer on the Roof Slab of Technical High School

3.2. Chloride deposition at different distance from the sea

Chloride deposition rates for each site were monitored for a period of nineteen months from July, 2016 to January, 2018. Variations of chloride deposition in observation station are closely related to the season. The variation of chloride deposition in each month during the observation period is shown in Table 2.

TABLE 2 DIFFERENT DIRECTION OF AIRBORNE SEA SALT CAPTURED DEVICES

Sr.No	Month	Distance from the Sea						
		50m	295m	701m	1694m	2958m	11379m	800m
1	July (2016)	4.81	6.87	9.06	7.55	18.13	Not start	Not start
2	August (2016)	9.53	19.83	18.80	17.12	1.16	15.45	
3	September (2016)	3.02	5.36	3.43	2.61	9.20	2.61	
4	October (2016)	2.53	1.59	4.78	4.65	5.32	2.79	1.33
5	November (2016)	4.97	2.98	2.98	3.13	3.41	2.98	5.11
6	December (2016)	5.15	4.64	2.45	12.23	3.73	2.70	4.38
7	January (2017)	7.00	5.08	4.67	13.05	4.94	3.98	8.24
8	February (2017)	9.06	8.51	7.83	32.41	8.10	7.83	10.16
9	March (2017)	14.15	12.22	Loss	28.84	19.09	14.28	20.33
10	April (2017)	17.07	20.16		42.67	22.66	33.11	28.40
11	May (2017)	12.13	4.23		19.23	13.85	11.79	20.49
12	June (2017)	19.91	5.84		19.57	33.07	14.88	31.59
13	July (2017)	10.76	10.53		12.47	22.20	9.5	14.65
14	August (2017)	8.90	15.15		8.77	14.49	7.04	6.11
15	September (2017)	7.30	3.30		3.06	7.53	1.29	2.00
16	October (2017)	5.97	1.96		1.65	6.80	2.16	2.88
17	November (2017)	3.79	3.63		1.81	2.47	3.96	1.98
18	December (2017)	6.99	4.66		1.79	3.92	2.51	7.88
19	January (2018)	4.85	4.39		6.22	5.22	3.51	7.67

4. RESULT AND DISCUSSION:

4.1. Characteristic the distribution of salinity

According to Table 2 and Figure 6, it can be seen that characteristic of chloride distribution in each station is not the same manner because some samples are placed in paddy field, other are in residential area and along road side. Therefore, environmental factors are one of the major influence of salinity distribution. The experimental results show that the variations of chloride deposition in each month not only depend on distance from the sea but also the meteorological parameters and environmental factors like fertilizers, chloride content in the soil and canal water.

As the above matter, deposition rate is not only dependent on distance but also other weather and environmental factors. Even longer distance could be affected more salinity concentration than near in some months and consequently specify as the salinity environment. It can be found in Figure 7 that the chloride concentration is highest is April and June. Period of highest chloride concentration is in summer season and the tendency of chloride concentration is steady decrease in rainy season and winter season. So, chloride concentration is strongly related with local wind and atmospheric temperature. The influence of meteorologist parameters to the airborne sea salt distribution was so obvious in analysis of this study. The major factor considered included wind direction and wind speed.

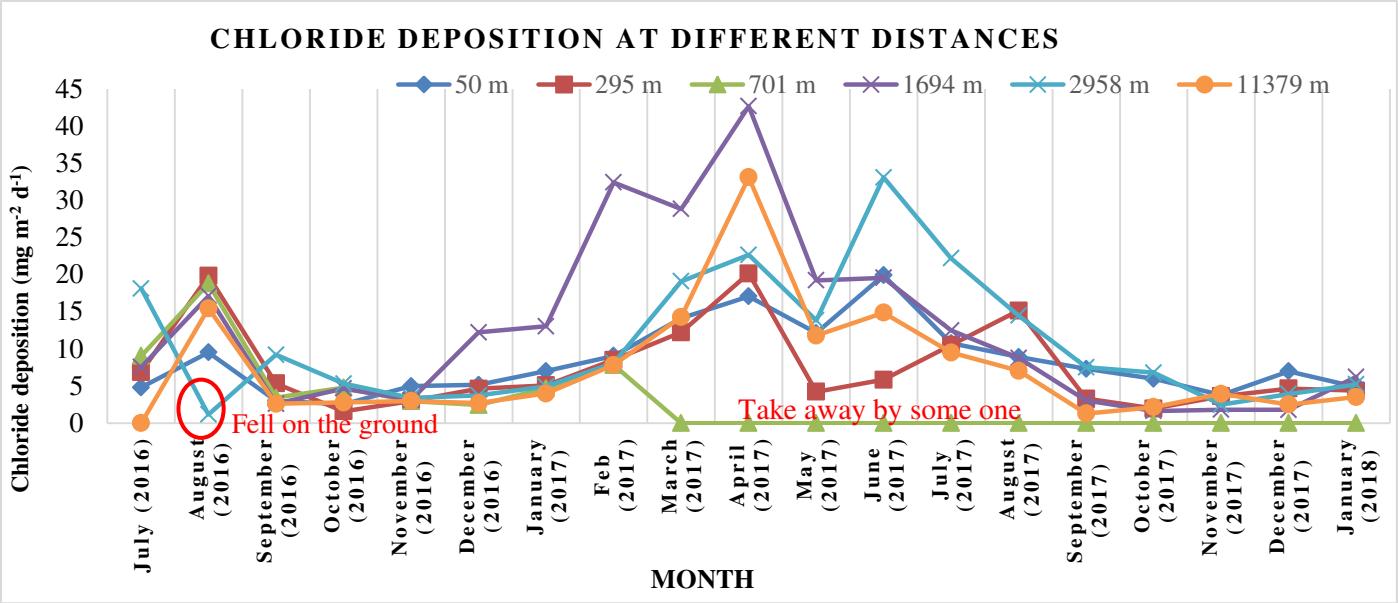

Figure. 6 Chloride Deposition at Different Distance in each Month

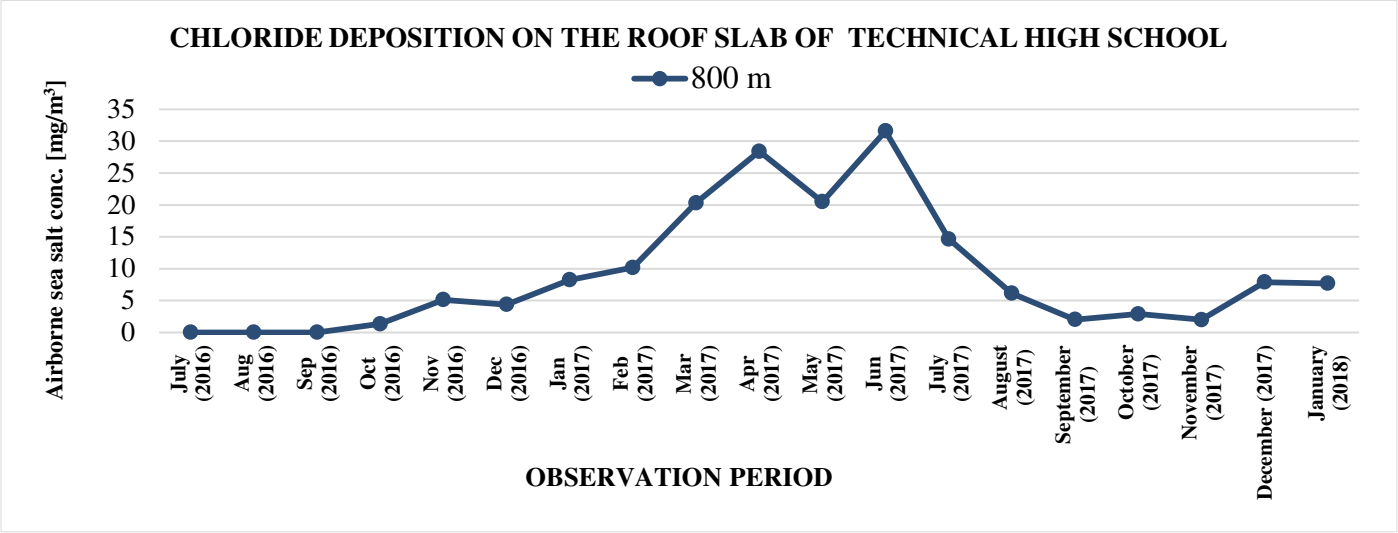

Figure. 7 Chloride Deposition on the Roof Slab of Technical High School

4.2. Wind condition in selected area

In this experiment, only the captured station no. 1 is situated at the free atmosphere area in front of the sea because other stations are in the paddy fields. But station no. 5 is situated beside the motorway and a small canal is located beside it. Therefore, the station no. 1 and 5 can receive more wind than other stations even though there is low wind speed around the station. Based on meteorological data, the magnitude of mean wind speed in that case, in rainy season is about 4.3 ms-1. Mean wind speed in September is about two times higher than both July and August. October is the least in entire rainy season. Furthermore, dominant wind direction for this season is southwest direction. Influenced wind direction in winter is almost north that normal to the coastal line and come from inland. During summer of rising temperatures, the wind is variable with much less steadiness and persistence. The magnitude of wind in both winter and summer are almost same as 2.2 ms-1. The whole Bay of Bengal is almost clam and relax totally insignificant in storm formation. By April, important changes take place in the surface air movements over Myanmar [7]. Along the coastal region the air circulation is characterized by increasing land and sea winds.

As wind may influence not only wind speed but also frequency of wind, consider and draw the wind rose diagram according to getting meteorological data and showing in Figure 8, maximum annual average wind speed is 3.25 ms-1. Furthermore, the most frequent wind direction is from E and SE direction. According to Figure 6 and 7, it is significant that the chloride deposition values do not vary with respect to wind speed flow. For this reason, it can be said that the wind speed flow is not the only factor that influenced on the variation of chloride deposition and there can be another factor.

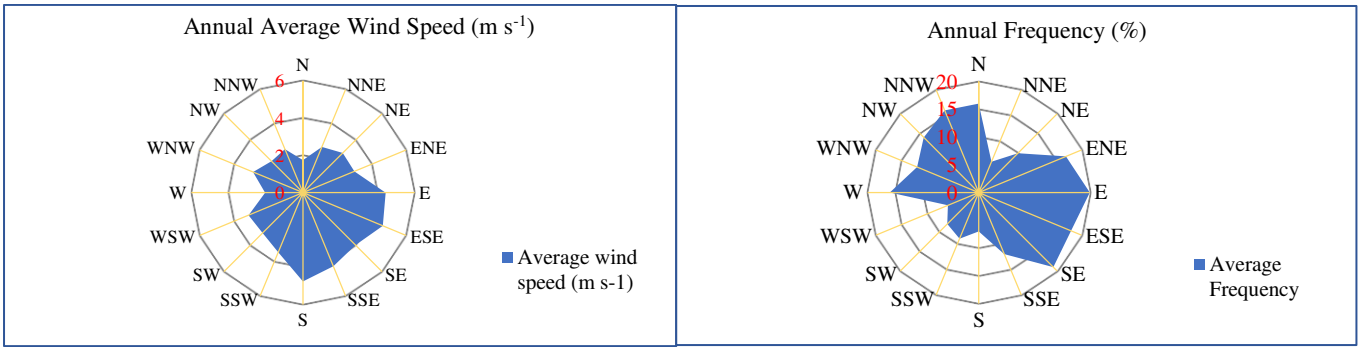

Fig. 7. Wind Rose Diagram with Annual Average Wind Speed and Annual Frequency

5. CONCLUSION:

The result of in-field airborne sea salt measurements that the trends of the distribution of seasonal air born sea salt are almost same for three number of stations (L1, L2 and L3) in every month. But the content of airborne sea salt in (L1) decreases in rainy season because of lacking fertilizer effect on it as it is located in open space. In winter and summer, (L4) 1694 m from the coastal line is seriously high due to environment effects as placing near residential area. Even the control wind is 3.25ms-1, buoyancy dominates and for the cases shown in figure is able to drive a flow out around the upper and lower edge of gauze plate is strong wind that is about 8% more than control wind. On the other hand, backward of the plate, downstream side can be clearly seen there is rare blow of air about 0.15m distance from the plate. The magnitude of wind has about 1.8 ms-1 when the distance reach 0.5m. These flows are qualitatively similar to those obtained for the assisting flow simulations. Based on all analysing results and graphs, it means the further the corresponding airborne sea salt measuring sites to the coastline, the higher the chloride deposition. This is due to the fact that many environmental conditions as above explanation do have significant influence on airborne sea salt deposit characteristics.

REFERENCES:

1. S.A Haque (2006), “Salinity Problems and Crop Production in Coastal Regions of Benglandesh,” Bangladesh Agricultural University Mymensingh, Bangladesh, Pak. J. Bot., 38(50: 1359-1365,.
2. Khandaker M.A. Hossain & Said M.Easa (June 2011), “Spatial Distribution of Marine Salts in Coastal Region Using Wet Candle Sensors,” Vol17Issue3/IJRRAS 7(3).
3. Yu-Sheng Chen, Hui-Jen Chiu, Yi-Wen Chan, Yung-Chang Chang, and Chung-Chia Yang (2012), “Prediction Model of Air-Borne Salt Distribution in the Coastal Region of Northern Thaiwan,” Journal of Marine Science and Technology, Vol.20.
4. Nattakorn Bongochgetsakul, Sachie Kokubo, “Measurement of Airborne Chloride Particle Sizes Distribution for Infrastructures Maintenance,” Kochi University of Technology.
5. S. Houda, N.Zemmouni, R.Athmani, R.Belarbi (2011), “Effect of Urban Morphology on Wind Flow Distribution in Dense Urban area,” Revue des Energies Renouvelables Vol. 14~1.
6. JIS Z 2382. 1998 (E). Determination of Pollution for Evaluation of Corrosivity of Atmosphere. Published by Japanese Standards Association, Japan.
7. Dr. Lai Lai Aung, Mrs. Ei Ei Zin, Ms Pwint Theingi, Ms Naw Elvera, Ms Phyu Phyu Aung, Ms Thu Thu Han, Ms Yamin Oo and Dr. Reidun Gangsto Skaland. “ Myanmar Climate Report,” Department of Meteorology and Hydrology Myanmar, Ministry of Transport and Communications, Norwegian Meteorological Institute, Norway, No. 9/2017, ISSN 2387-4201, Climate, METreport.