CHAPTER 3

PRELIMINARY RESULTS

In this chapter, to find the values of the means, standard deviation, standard errors, skew and kurt are not particulary meaningful for the nominal variables (rainfall and salinity) and to compare the mean of variables (rainfall and salinity) between days and stations, the results of the preliminary analysis are presented. These results may be classified as follows.

(a) Histograms and time series plots of rainfall, smoothed rainfall and cube roots of smoothed rainfall.

(b) Histograms and time series plots of salinity.

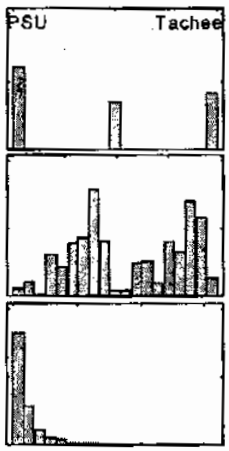
(c) One-way anova analysis and two-way anova analysis of rainfall and seasonally adjusted rainfall.

(d) One-way anova analysis and two-way anova analysis of salinity.

(e) The correlation between salinity and rainfall.

1. Rainfall 1995-1996

Figure 5 presents a summary of the rainfall data used in the analysis. The rainfall is recorded daily at the three locations around the Bay: Prince of Songkla University, Yaring River mouth, and the meteorological station at Laem Tachi (Lighthouse, Laem Tachi, Naval Hydrographic) on the Laem Tachi.



col	variable	size	mean	st dev	SE	skew	kurt	min	max
1	station	553	1.87	0.852	0.036	0.251	1.425	1	3
2	day	553	448.3	208.5	8.864	0.052	1.628	5	786
3	rainfall (mm)	553	25.45	40.86	1.738	3.887	22.02	0.16	319.3

Rainfall 1995-1996

Figure 5: Histograms and Statistics of Rainfall Collected in 1995-1996

From Figure 5 the values of means, standard deviations standard errors, skew and kurt are not particularly meaningful for the nominal variables. Clearly the distribution of rainfall is skewed to the right. Also the days at which rain was recorded show a similar pattern for the two years. The minimum value for rainfall was 0.16 mm and the maximum value for rainfall was 319.3 mm.

Figure 6 shows the rainfall incidence at the three stations.

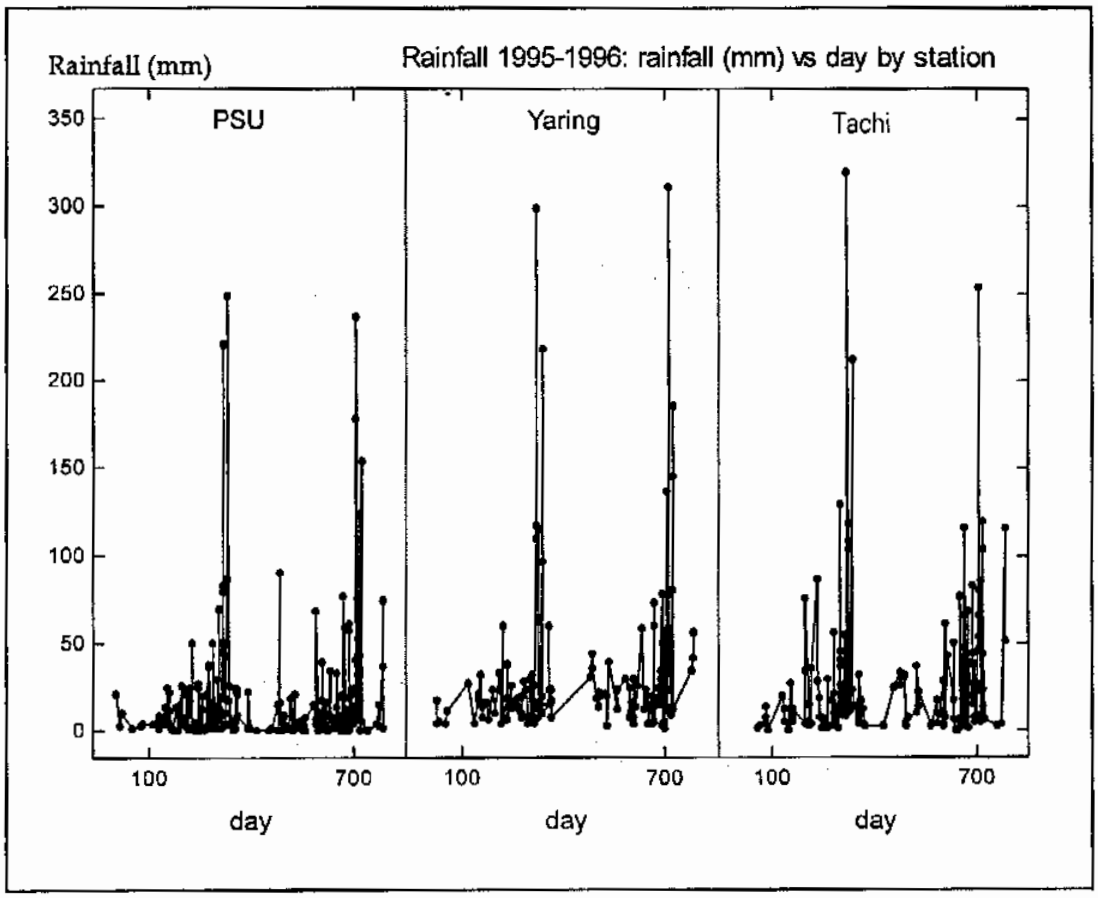
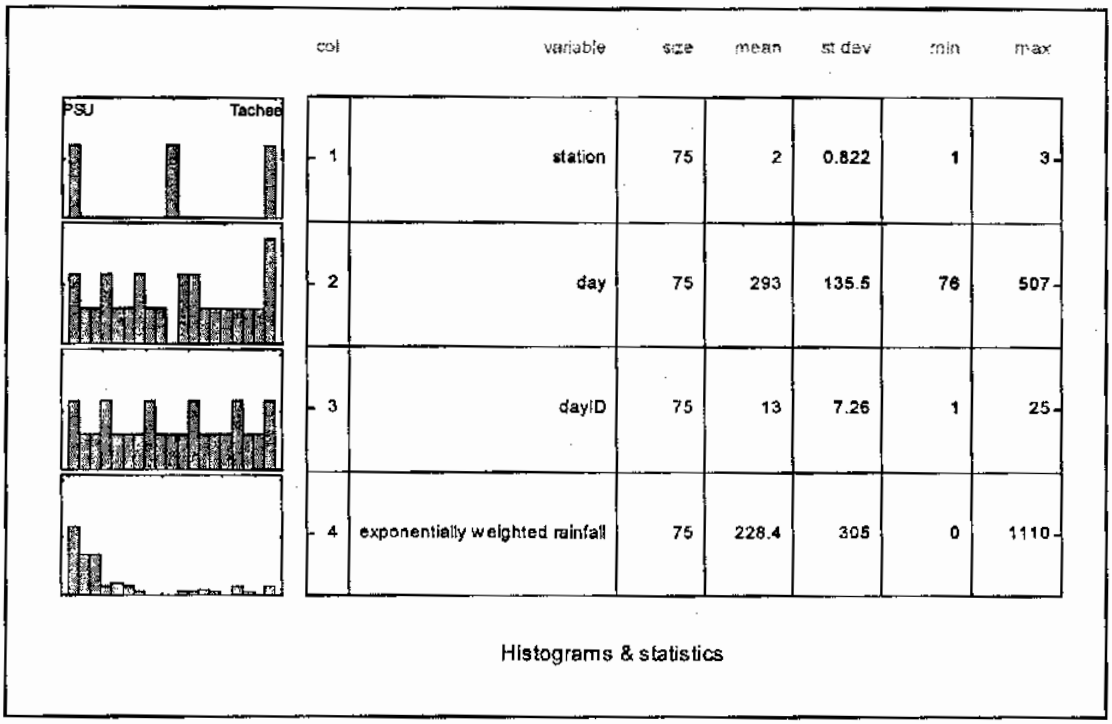


Figure 6: Rainfall at Three Stations Around Pattani Bay in 1995-1996

There is some coherency between the rainfall at the three stations. The rainfall may be analyzed further using the exponentially weighted smoothing method described in Chapter 2 followed by the exponentially weighted accumulation of rainfall at times when salinity is recorded.

Figure 7 shows a summary of the smoothed rainfall data. The value chosen for ρ is 0.99. This value maximises the correlations between the exponentially weighted rainfall and the salinity.

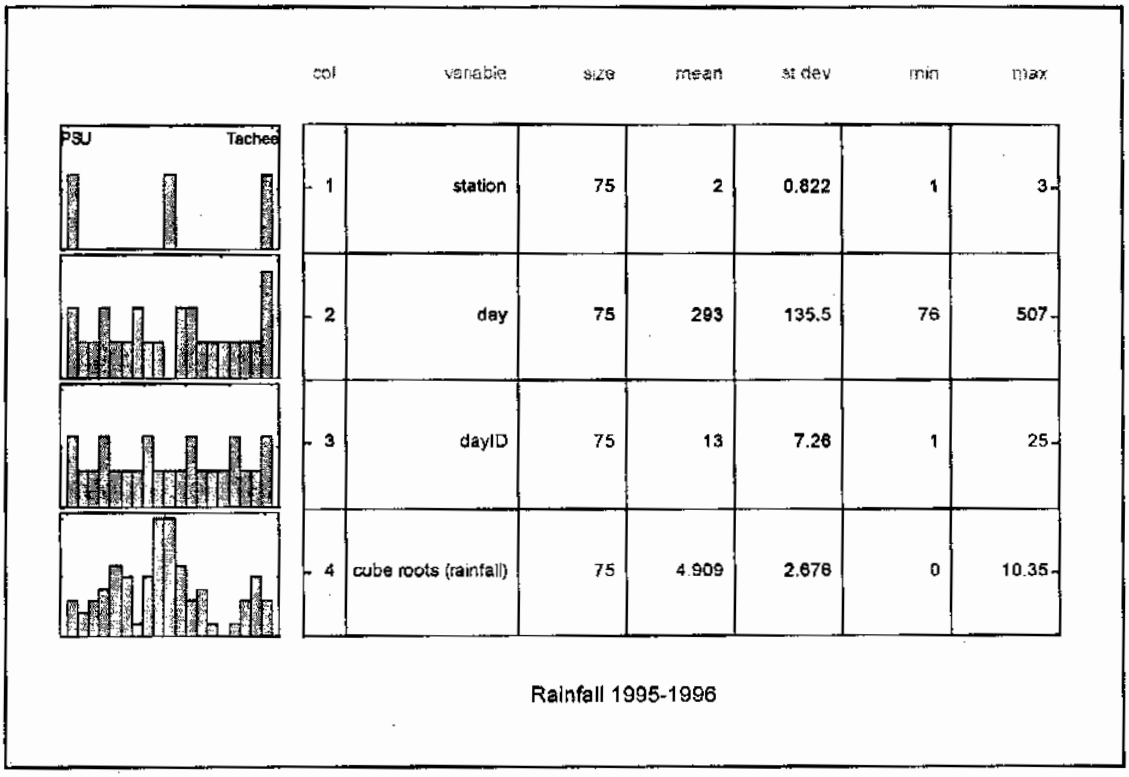


col	variable	size	mean	st dev	min	max
1	station	75	2	0.822	1	3
2	day	75	293	135.5	76	507
3	dayID	75	13	7.26	1	25
4	exponentially weighted rainfall	75	228.4	305	0	1110

Figure 7: Histograms and Statistics of the Smoothed Rainfall

It can be seen that the distribution of the smoothed rainfall is less skewed since the skewness of the coefficient is reduced from 3.887 to 1.687, when compared with the distribution of the raw data. However the distribution of the smoothed rainfall is still skewed to the right, suggesting the need for a transformation by cube root. The dayID (1, 2, 3, ..., 25) is recoded from the day (76, 88, 108, ... , 507).

Figure 8 shows a summary of the cube roots of the smoothed rainfall data.



col	variable	size	mean	st dev	min	max
1	station	75	2	0.822	1	3
2	day	75	293	135.5	76	507
3	dayID	75	13	7.26	1	25
4	cube roots (rainfall)	75	4.909	2.678	0	10.35

Rainfall 1995-1996

Figure 8: Histograms and Statistics of the Cube Roots Smoothed Rainfall

The distribution of cube roots of the smoothed rainfall is now approximately symmetric and the distribution is normal curve.

Figure 9 shows time series plots of the cube root of the smoothed rainfall incidence at the three stations.

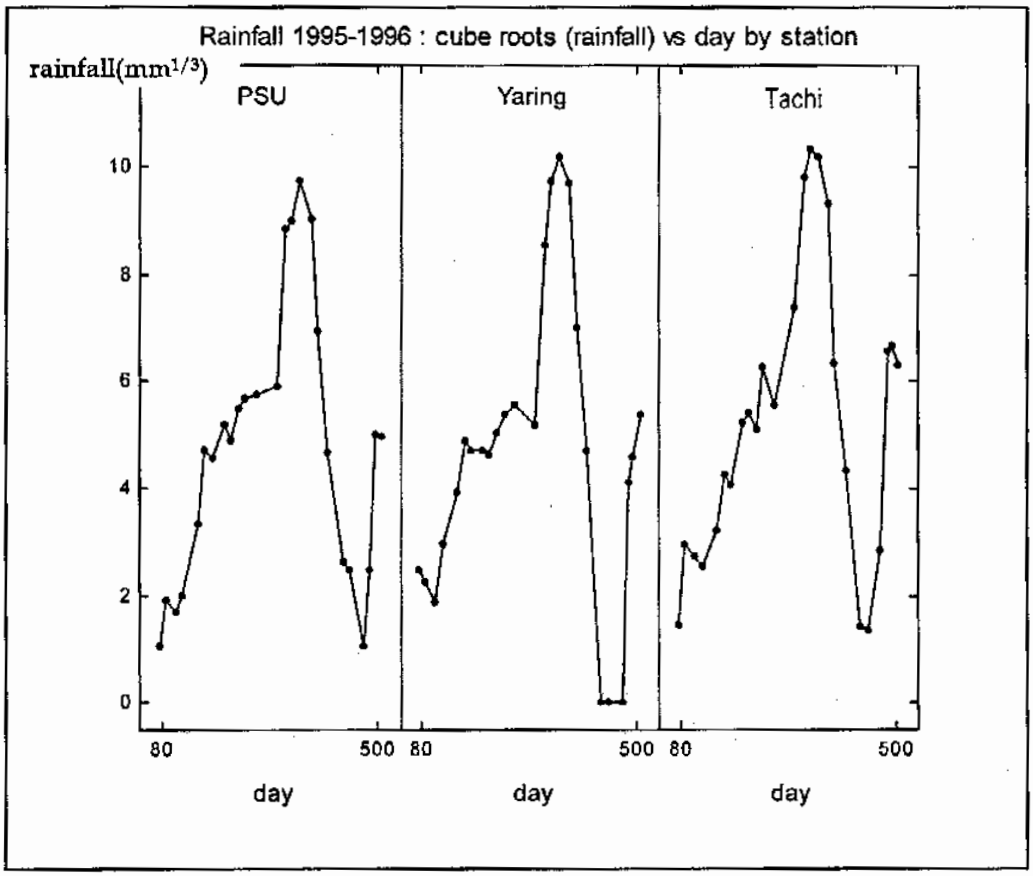
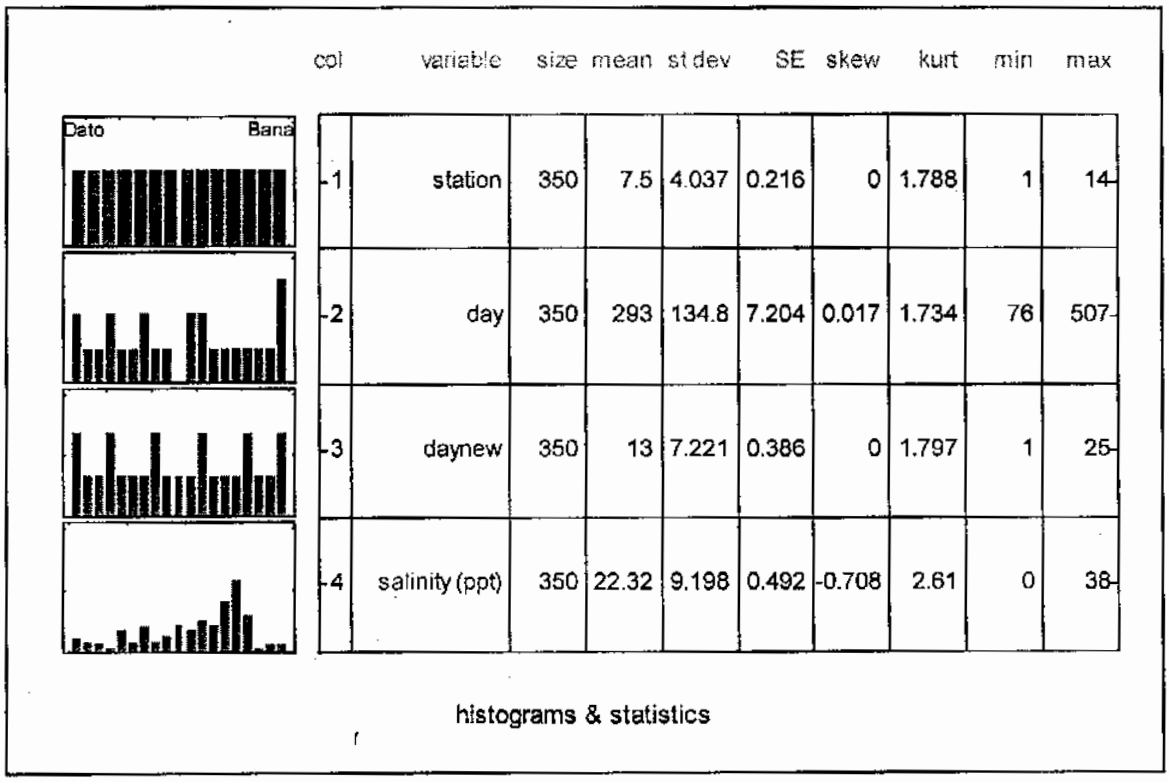


Figure 9: Time Series Plot of the Cube Roots of Smoothed Rainfall Data

In each station we can see that there is a strong seasonal effect with low rainfall in April-August and high rainfall in December-January corresponding to the summer season and the rainy season, respectively.

2. Salinity collected by the Pattani Coastal Aquaculture Station in 1995-1996

Figure 10 shows histograms of the salinity data collected by the Pattani Coastal Aquaculture Station at Yaring in 1995-1996



col	variable	size	mean	st dev	SE	skew	kurt	min	max
1	station	350	7.5	4.037	0.216	0	1.788	1	14
2	day	350	293	134.8	7.204	0.017	1.734	76	507
3	daynew	350	13	7.221	0.386	0	1.797	1	25
4	salinity (ppt)	350	22.32	9.198	0.492	-0.708	2.61	0	38

Figure 10: Histograms and Statistics of Salinity Collected by the Pattani Coastal Aquaculture in 1995-1996

The distribution of salinity is slightly skewed to the left. The minimum value for salinity corresponds to data that were recorded as 0 ppt and the maximum value for salinity corresponds to an observation that was recorded as 38 ppt. The daynew (1, 2, 3, ... ,25) is recoded from the day (76, 88, 108, ..., 507).

Figure 11 shows the salinity incidence over time at the 14 stations.

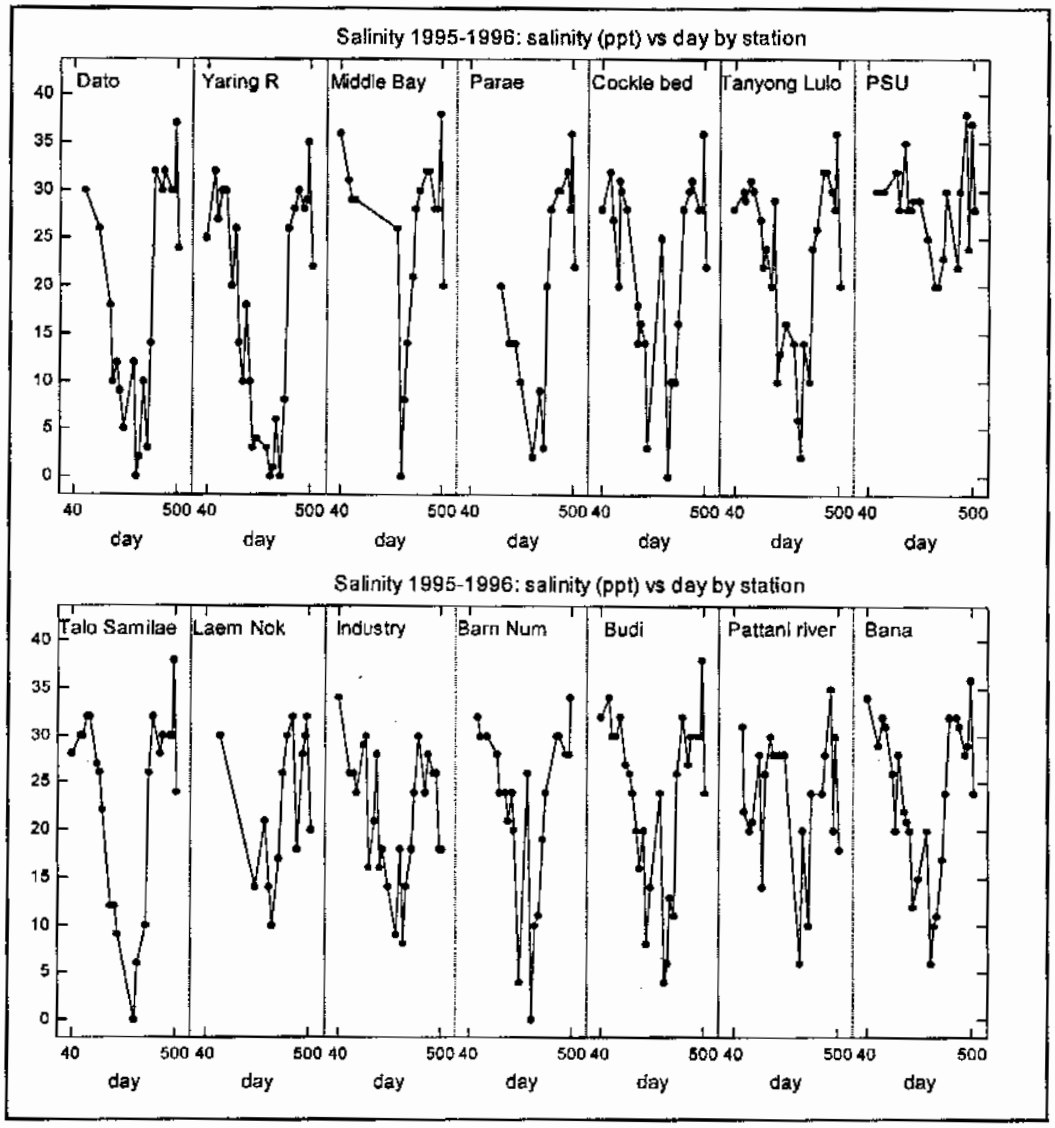


Figure 11: Time series plot of salinity at 14 stations around Pattani Bay in 1995-1996

The time series plots indicate strong seasonal patterns for salinity. Namely, the lowest salinity occurs during the rainy season (June-January) and the highest in the summer season (February-May). The lowest salinity recordings in the rainy season are at Dato, Yaring, Middle Bay, Cockle Bed, Talo Samilae and Barn Num, which are all close to 0. The highest minimum recorded salinity is at PSU which is about 20 ppt. The lowest salinity in the summer season is at Industry Zone, which is about 30 ppt

and the highest salinity values are at Middle Bay, PSU, Talosamilae and Budi, which are about 38 ppt.

3. One-way and Two-way Anova Analysis of Rainfall

Figure 12 shows one-way anova analysis of the cube roots of the smoothed rainfall data at the three stations. This analysis takes no account of seasonal patterns which compare the mean of rainfall in each station.

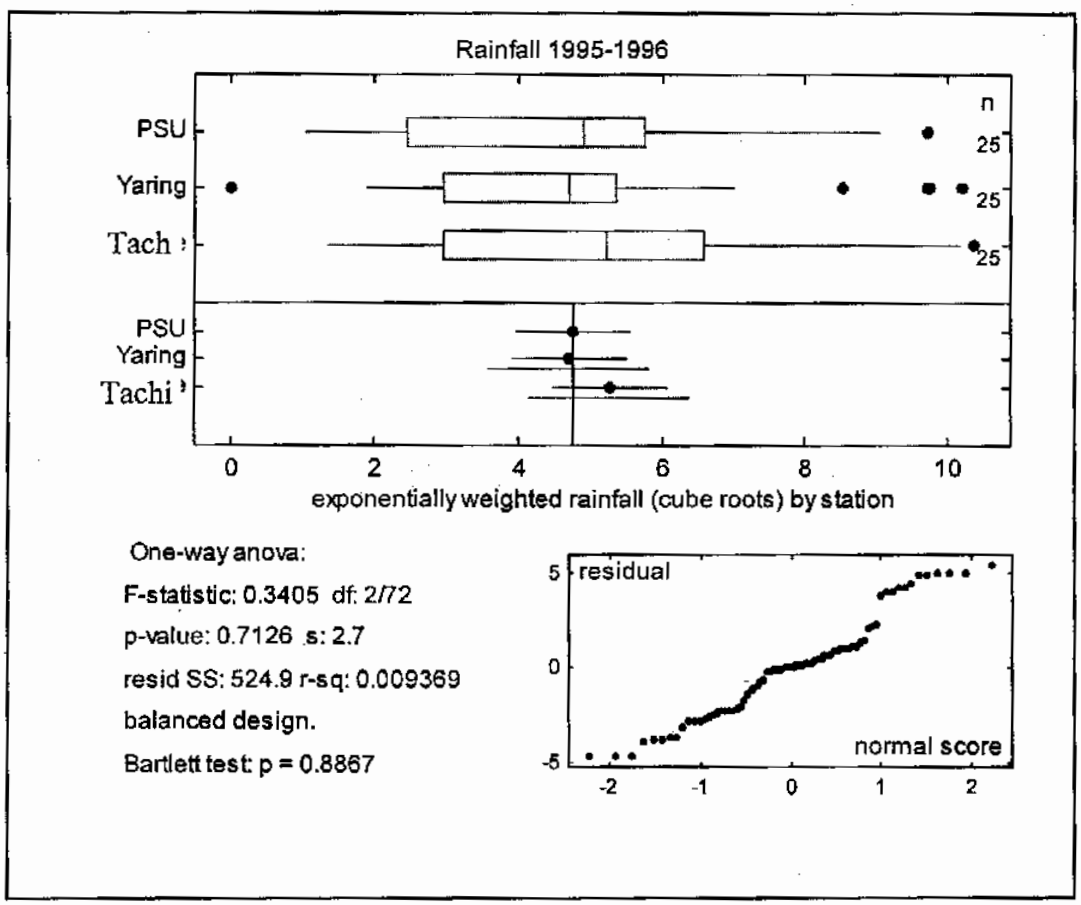


Figure 12: One-way Anova Analysis of Cube Roots of Smoothed Rainfall

Since the normal scores plot shows some nonlinearity, the normality assumption may not be valid. The p-value (0.7126) is greater than 0.05 which implies that there is no for difference in rainfall between the three stations and the goodness-of-fit is very low ($r^2 = 0.009369$)

Figure 13 shows two-way anova analysis of the cube roots of the smoothed rainfall data, now taking account of the seasonal differences.

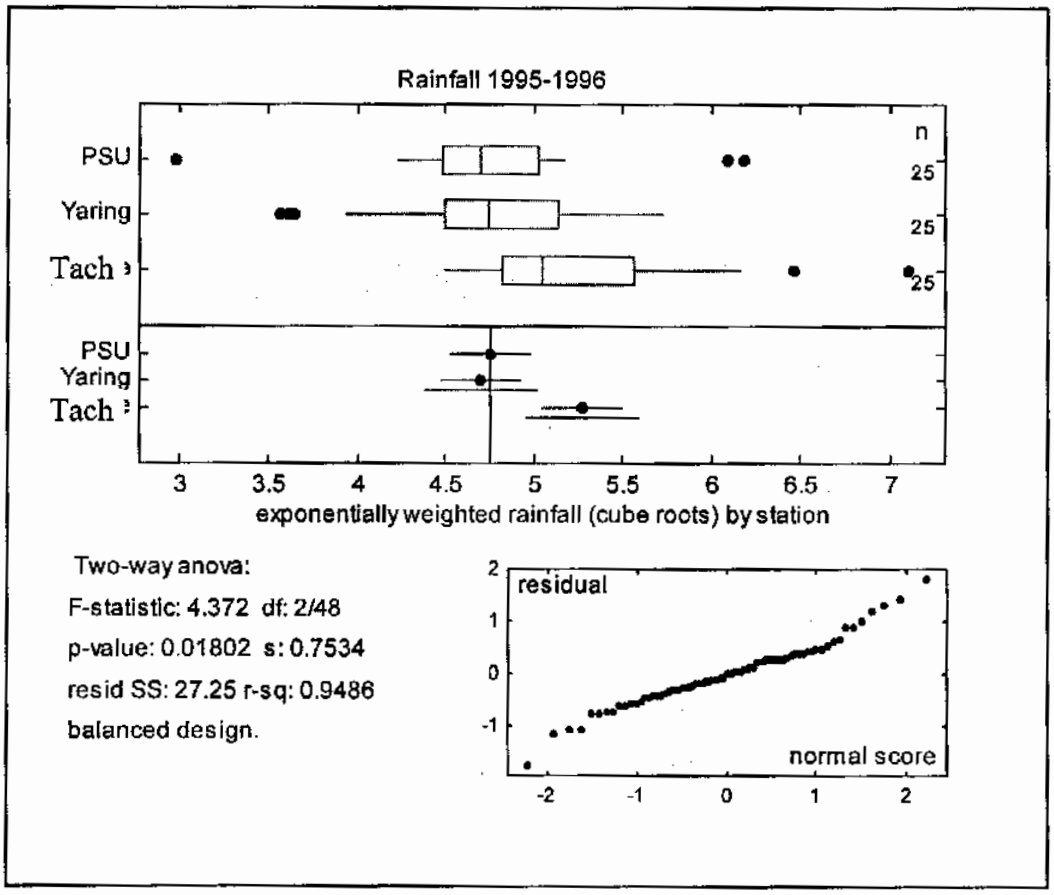


Figure 13: Two-way Anova Analysis of Smoothed Rainfall Collected in 1995-1996

The goodness-of-fit has jumped to 0.9486 compared with the goodness-of-fit on Figure 12. This analysis shows that the normality assumption is reasonable except for a low outlier, which may be omitted. In any case, there is now a difference between amount of rainfall at different stations (*p-value = 0.01802*). After adjusting for the seasonal variation, Laem Tachi has higher rainfall and Yaring has similar rainfall as PSU.

4. One-way and Two-way Anova Analysis of Salinity

Figure 14 shows one-way anova analysis of salinity collected by the Pattani Coastal Aquaculture Station in 1995-1996.

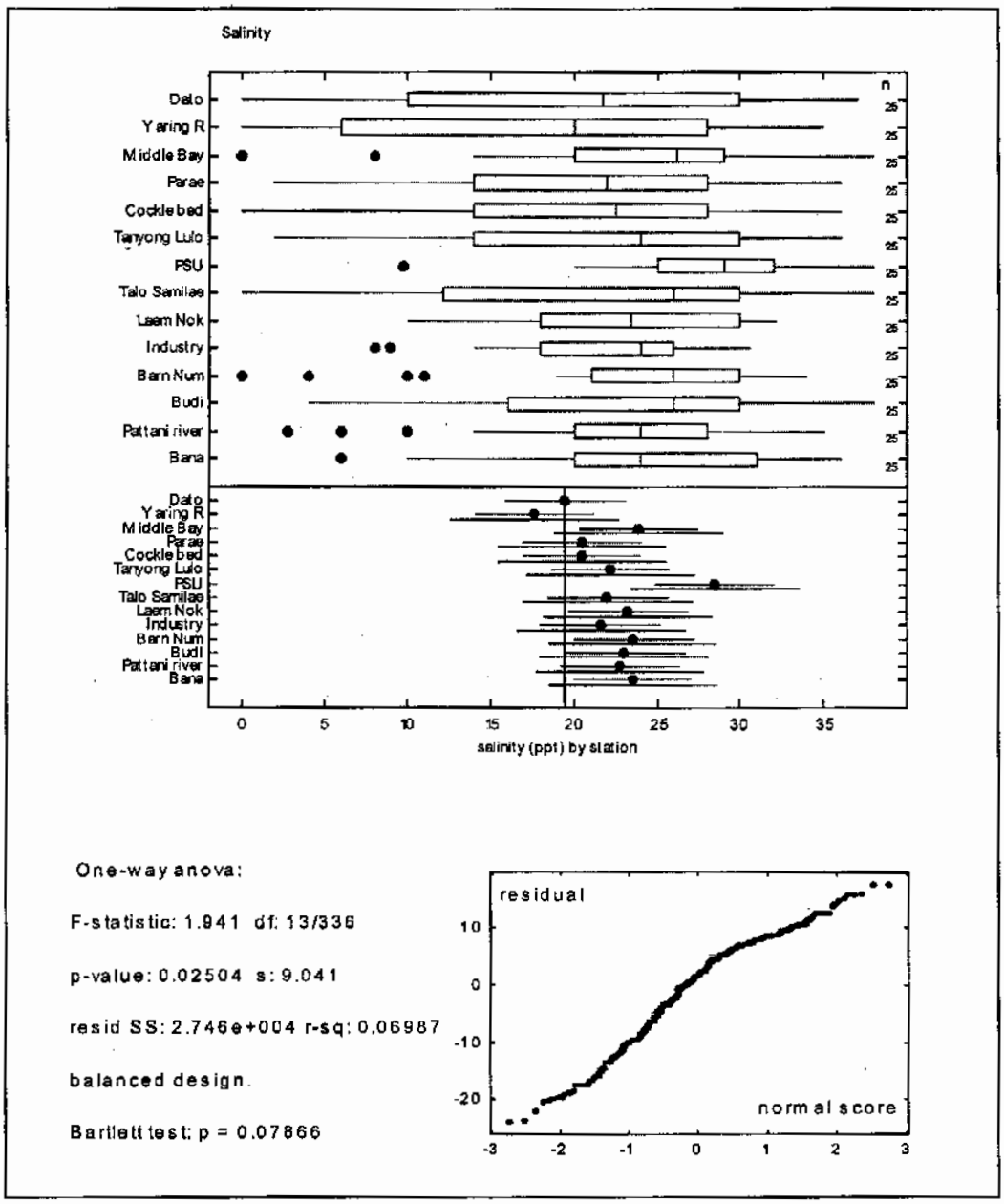


Figure 14: One-way Anova Analysis of Salinity

Figure 14 shows One-way anova analysis of salinity and compare the mean of salinity at each station. The goodness-of-fit is very low ($r^2 = 0.0699$). The normality assumption may not be valid. The p-value is smaller than 0.02 and

many of 95% Confidence Interval (CIs) are separated. The salinity is thus different between stations.

Figure 15 shows two-way anova analysis of salinity collected by the Pattani Coastal Aquaculture Station in 1995-1996, after taking account of seasonal variations.

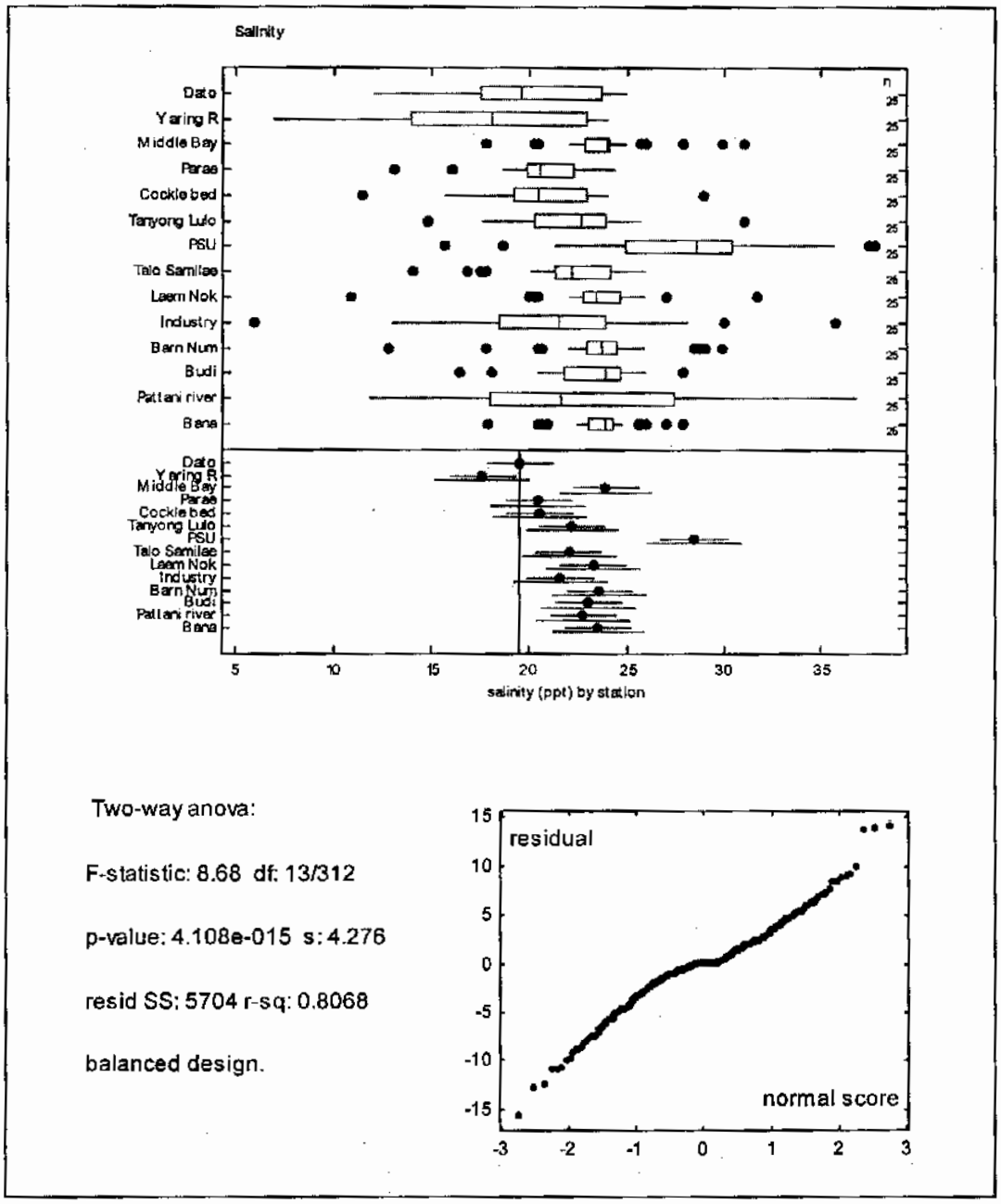


Figure 15: Two-way Anova Analysis of Salinity (Showing Location Difference)

Figure 15 shows two-way anova analysis of salinity and compare the mean of salinity between stations and days (showing location difference) Clearly the normality assumption is violated to some extent. The p-value ($1.108x10^{-15}$) is less than 0.05 and most of 95% CIs are separated. So the salinity is different between stations.

It is also of interest to examine the seasonal differences in salinity, after adjusting for differences in location. Figure 16 shows this result, again based on two-way analysis of varience . The seasonal pattern is very clear, with lower salinity in the rainy season.

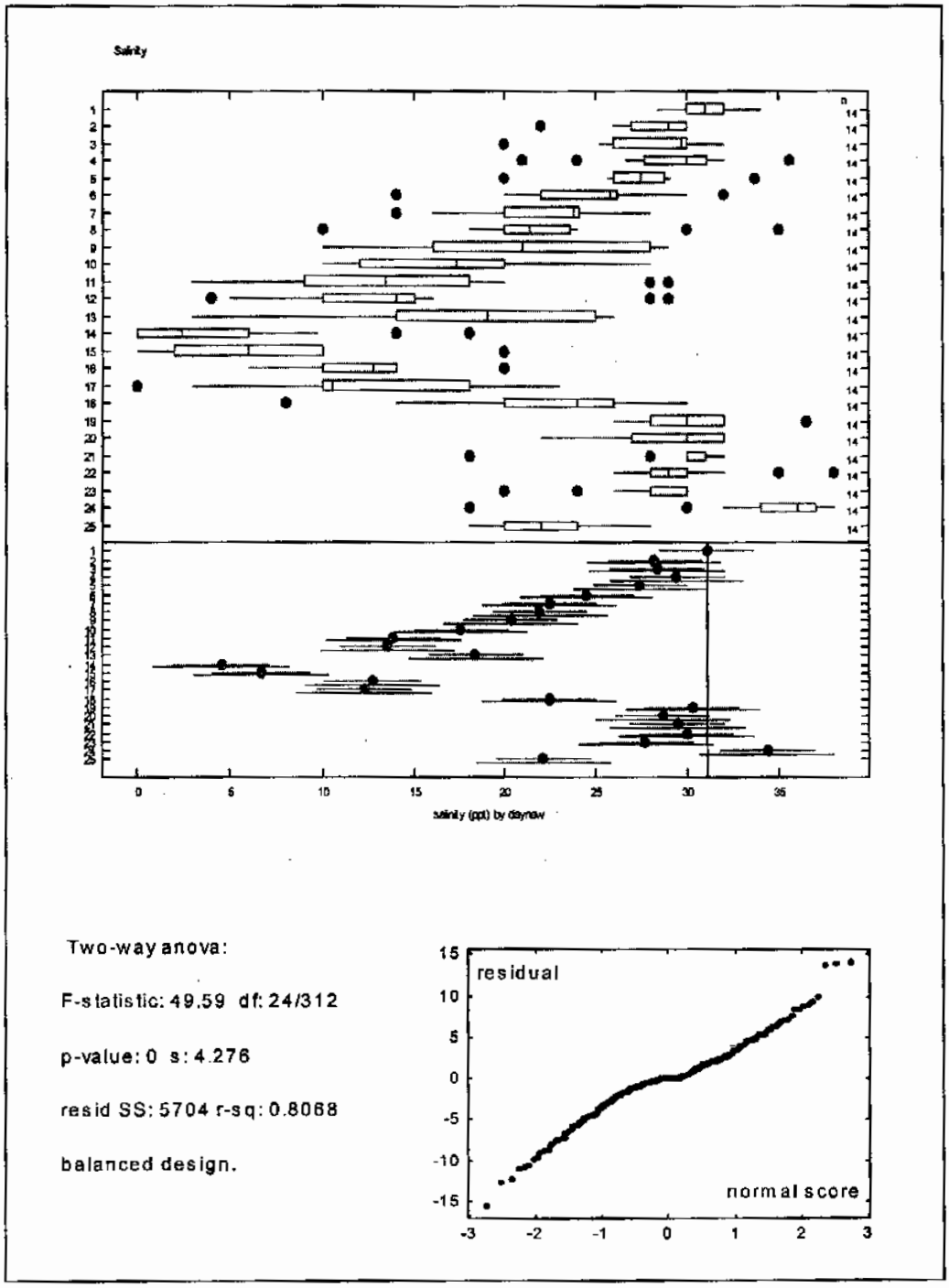


Figure 16: Two-way Anova Analysis of Salinity (Seasonal Difference)

5. The Correlation between Salinity and Rainfall

In Table 3, the correlation coefficients (and p-values) are shown for the associations between the cube roots of smoothed rainfall at each rainfall station and the salinity at each location in the Bay.

Table 3: The Correlation between each Salinity Station and each Rainfall Station

Salinity station	Rainfall station					
	PSU		Yaring		Tachi	
	r	*p*	r	*p*	r	*p*
Dato	-0.8078	0.0000	-0.7730	0.0001	-0.7266	0.0003
Yaring	-0.8394	0.0000	-0.7753	0.0001	-0.7455	0.0002
Middle Bay	-0.7233	0.0004	-0.6988	0.0006	-0.7072	0.0005
Parae	-0.8476	0.0000	-0.8251	0.0000	-0.7719	0.0001
Cockle bed	-0.8020	0.0000	-0.7670	0.0001	-0.7336	0.0003
Tanyong Lulo	-0.8142	0.0000	-0.7927	0.0001	-0.7730	0.0001
PSU	-0.5919	0.0044	-0.5399	0.0097	-0.6026	0.0037
Talo Samilae	-0.7731	0.0001	-0.7089	0.0005	-0.7029	0.0006
Laem Nok	-0.7608	0.0002	-0.6617	0.0013	-0.6780	0.0009
Industry Estate	-0.6774	0.0010	-0.6086	0.0033	-0.7023	0.0006
Barn Num	-0.7441	0.0002	-0.6988	0.0006	-0.7040	0.0006
Budi	-0.7852	0.0001	-0.7187	0.0004	-0.7159	0.0004
Pattani River	-0.5761	0.0056	-0.6098	0.0032	-0.6285	0.0024
Bana	-0.8099	0.0000	-0.7666	0.0001	-0.7653	0.0001

In Table 3 we see that all of the salinity values are negatively associated with the rainfall. The highest negative correlation is between PSU rainfall and Parae salinity (-0.8586) and the smallest correlation is between Yaring rainfall and PSU salinity (-0.5399) and the p-value shows that every correlation coeffiicient is significant.