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土地利用變遷與河川污染之研究(I)

Study of land use change and water quality

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一、 中文摘要

本研究是收集過去 20 年間台灣北部地區除淡水河外其他的主要及次要河川之環保署水質監測資料，利用 Seasonal Kendall Test 來檢查水質變化趨勢，其中分析之水質參數包括：溶氧量、生化需氧量、懸浮固體、氨氮及濁度。並以頭前溪及老街溪流域為研究區分析 1990 年及 1999 年的 SPOT 衛星影像之土地利用覆蓋面積，以了解河川各種水質變化與土地利用之間的關連。分析結果發現以裸露地與溶氧有統計上顯著負相關及濁度有統計上顯著正相關。另外農地也與濁度有統計上顯著正相關，值得注意的是，農地與其他水質參數皆有接近統計上顯著相關。各河川水質變化較明顯一致的趨勢是以在老街溪各測站的氨氮值皆有上升的現象，而頭前溪各測站的氨氮值皆有下降的情形，另外老街溪與頭前溪之濁度皆呈上升情形。南崁溪各測站之水質變化趨勢較無明顯的型態，除大樹大橋及舊路大橋的部分水質參數有明顯下降外，其他測站多為上升的情形。

關鍵詞：土地利用、河川水質、趨勢分析

Abstract

Water quality data, including dissolved oxygen, BOD, suspended particle, ammonia nitrogen and turbidity, were collected from Taiwan EPA river water quality monitoring program during past 20 years. Land use data in both the Tou-Chin Shi watershed and the Lau-Jag Shi watershed were also identified and classified from SPOT images from two different years (1990 and 1999) and their relationship with water qualities were analyzed. The results showed barren and agriculture land use were two major land use categories which affected water quality. The seasonal trends of river water quality parameters were observed in the Lau-Jag Shi and the

Tou-Chin Shi. The trend of turbidity in both rivers were increased. On the other hand, the trend of ammonia nitrogen level was decreased in the Tou-Chin Shi but increased in the Nan-Kan Shi. In addition, there were also some changes in the trends of water qualities of the Nan-Kan Shi.

Keywords: Land use, river water quality, trend analysis

二、緣由與目的

二十一世紀人類面臨最重要的環境議題將是生物多樣性消失、氣候改變、水質源及臭氧層破壞等四大問題(Global Environment Facility, 1998)。相較於其他三個環境議題,水資源問題並未受到相同地重視,投入應有研究人力及經費。水資源問題可分為質與量兩方面來討論,而在水質問題中又以水質惡化及污染的問題最為嚴重。

不同集水區的自然特徵對於河川水質的化學特色會有影響,例如坡度及地質特徵,將影響水中主要化學離子的組成,不同植被及其他生物組成也會對水體中的有機質成分等等。另外,在集水區中不同類別的土地利用對水質更有重要影響,不同土地利用除了可直接於河川中排入不同污染物質影響水質外,也可間接經由對集水區地形、植被等特徵之改變而對水質產生影響。早期研究多集中在地形特徵與水質關係,如集水區的面積、坡度與河川級數對水的濁度、溶氧及溫度的影響。目前在研究水質與土地利用之關係,則多是利用地理資訊系統(GIS)來整合不同的集水區特徵及土地利用特色,再利用統計分析技術來找出其相互關聯性。

許多研究皆觀察到水中營養物質與土地利用間有明顯的關係。Osborne 及 Wiley(1988) 研究在美國中西部集水區,發現水中溶解磷的含量在都市區下游特別是流量較低的時候很高,而水中硝酸鹽則在冬末春初時受農業活動影響升高,在夏秋季節則因都市逕流而升高。Sabater et al. (1990)研究西班牙 Ter 流域之河川的水質之物理化學特性與集水區的特徵,發現水中營養鹽物質與集水區之人類活動、氣候及植被呈高度相關。Perona et al. (1999) 研究西班牙 Alberche 河流的水質變化,也發現水中營養鹽物質與集水區之人類活動有高度相關。Roth et al. (1996)研究在美國 Raisin 流域之河川中的生物指數(Index of Biotic Integrity)與土地利用之關係,發現土地利用是影響此集水區河川生物指數之最主要因子,河川的生物指數與農業土地利用呈負相關,而與森林及濕地土地利用呈正相關。另外,Johnson et al. (1997)分析美國中西

部河川之水質及 Fisher et al (2000)調查美國南方 Upper Oconee 集水區水質狀況，也發現土地利用是影響河川水質的最重要因子。

在考慮水質問題時，土地利用可說是最重要影響的因子(Hunsaker and Levine, 1993)，因此必須要能清楚了解土地利用與水質變化間的關係，特別是在水質的管理上應與土地利用規劃整合，才能有效地經營管理水資源(Allan et al., 1997; Wang 2001)。行政院環保署目前在主要及次要河川都有定期進行水質測工作，不同的測站累積至少 10-20 年的水質資料，但是這些水質資料尚未有效利用分析，或是多集中在淡水河流域。另外，雖然土地利用是最重要的影響水質因子，但是目前台灣並無相關研究及資料，分析在不同特色的集水區其影響水質變化之重要因子為何？因此本研究主要目的是探討水質其隨時間變遷之特性，並以頭前溪及老街溪為研究區分析重要的影響水質變化之土地利用因子。

三、材料與方法

1. 資料蒐集：

(1) 河川水質資料：

將以環保署過去 20 年定期監測各河川水質之資料為主，蒐集水質指數包括溶氧量、生化需氧量、懸浮固體、氨氮、及濁度。本研究蒐集之台北縣及宜蘭縣的河流包括雙溪、磺溪、得子口溪及蘭陽溪，在桃園縣及新竹縣的河流包括南崁溪、老街溪、社子溪及頭前溪(圖一)

(2) 土地利用資料：

利用 1990 年 10 月及 1999 年 7 月在頭前溪及老街溪之法國 SPOT 衛星影像進行分類及比較。

2. 資料分析：

(1) 水質時間變化趨勢分析：

利用 Seasonal Kendall test 分析同一測站之不同水質參數的年度間的變動(Hirsch et al. 1982)。

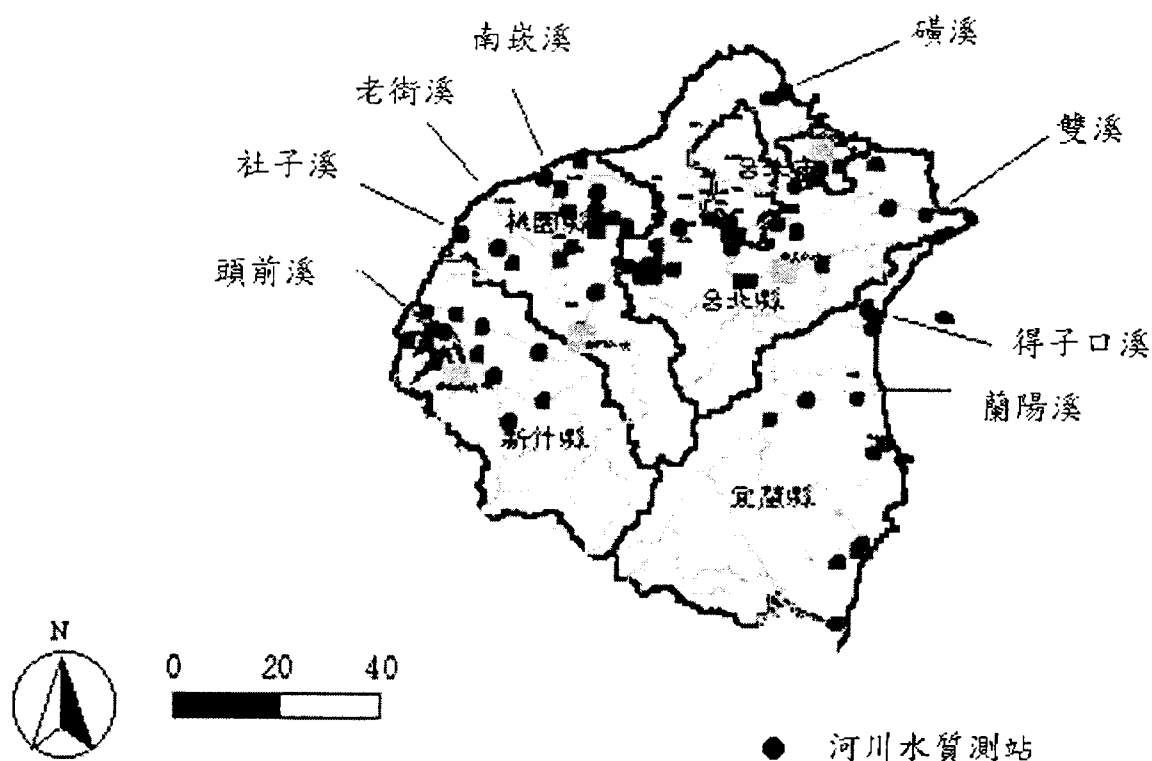
(2) 影像分析

利用法國的 SPOT 衛星影像（解像力 12.5m x 12.5m）進行土地利用監測利用地表覆蓋不同時，其光譜反射值亦隨之改變，計算土地利用面積。首先切出該流域之衛星影像，用 IMAGINE8.4 進行監督性分類（supervised）分出水體、建物、裸露地、農地、林地五種。進

行監督性分類的過程中，以土地利用分區圖加以輔助，隨著種類中不同的次屬性選取訓練區再加以整合，如建物包括交通用地、住宅、工廠，水體(含水池、河川、水道)。每個次屬性起碼 5~10 個訓練區。全部的訓練區總計 70 個以上，再依種類合併。

(3) 土地利用與水質參數關係

依據 1990 及 1999 兩個時間之不同土地利用面積之百分比與 1990 及 1999 年度的年平均水質參數計算其 Pearson 相關係數。



圖一 研究區的河川及水質測站

四、結果與討論

1. 各河川水質變化趨勢

本研究分析之台北縣及宜蘭縣的河流包括雙溪、磺溪、得子口溪及蘭陽溪(圖一)。根據 Hirsch et al (1982) 的 Seasonal Kendall Test 方法檢驗河川水質變化趨勢(表一)。雙溪在 1981 至 2000 年間除了下游貢寮大橋的生化需氧量及溶氧量有顯著降低外，其他水質並無明顯變

化，雖然溶氧量有顯著降低，但是其溶氧量仍高於 8 以上，雙溪水質狀況屬良好。磺溪在 1977 至 2000 年間上游的磺溪大橋及上磺溪橋的生化需氧量及溶氧量有顯著下降外，在磺溪大橋其濁度及上磺溪橋的氨氮值也有顯著下降，與雙溪類似其溶氧量雖有顯著下降，但是其溶氧量仍高於 8 以上，磺溪水質狀況屬良好。蘭陽溪在 1977 至 2000 間其濁度及懸浮固體在部分測站有顯著上升的現象，而氨氮則有下降的狀態。溶氧量在最下游的興蘭大橋有顯著上升的情形，而在蘭陽大橋及上深溝則有顯著下降的現象，在蘭陽溪水質參數中以懸浮固體情形最為惡化，其他之水質參數仍屬稍受污染之狀況。在 1981 至 2000 年間得子口溪下游的復興橋其濁度及溶氧量皆有上升現象，而上游的美慶山莊在 1996 至 2000 年間雖有溶氧量下降而生化需氧量上升的情形，但其水質狀態仍在未或稍受污染的狀態，而下游則已經是受到中度污染。

表一 宜蘭縣及台北縣重要河川(淡水河除外)之水質趨勢變化

河川	測站	資料時間	Seasonal Kendall Test 分析結果				
			溶氧量	生化需氧量	懸浮固體	氨氮	濁度
雙溪	貢寮大橋	1981/04~2000/10	↘	↘	—	—	—
	新寮大橋	1981/04~2000/10	—	—	—	—	—
磺溪	四十號橋	1977/10~2000/10	—	—	—	—	—
	上磺溪橋	1977/10~2000/10	↘	↘	—	↘	—
	磺溪大橋	1977/10~2000/10	↘	↘	—	—	↘
得子口溪	復興橋	1981/03-2000/12	↗	—	—	—	↗
	得子口橋	1981/09~2000/12	—	↘	↘	—	—
	美慶山莊	1996/06~2000/12	↘	↗	—	—	—
蘭陽溪	興蘭大橋	1987/05~2000/11	↗	—	—	—	—
	蘭陽大橋	1977/02~2000/11	↘	—	↗	↘	↗
	崙碑	1977/02~2000/11	—	—	—	↘	↗
	牛鬥橋	1996/02~2000/11	—	—	—	—	—
	上深溝	1977/02~1995/11	↘	↗	↗	—	↗

在桃園縣及新竹縣所分析的河流包括南坎溪、老街溪、社子溪及頭前溪(圖一)。由 Seasonal Kendall Test 檢驗結果(表二)發現，在老街溪各測站的氨氮值皆有上升的現象，而頭前溪各測站的氨氮值皆有下降的情形，不過老街溪與頭前溪之濁度皆呈上升情形。南坎溪各測站之水

質變化趨勢較無明顯的型態，除大檜大橋及舊路大橋之部分水質參數有明顯下降外，其他測站多為上升的情形。在社子溪下游之月眉橋則有生化需氧量、懸浮固體及濁度皆下降的情形。而社子橋則是生化需氧量、懸浮固體及濁度皆有上升的趨勢。

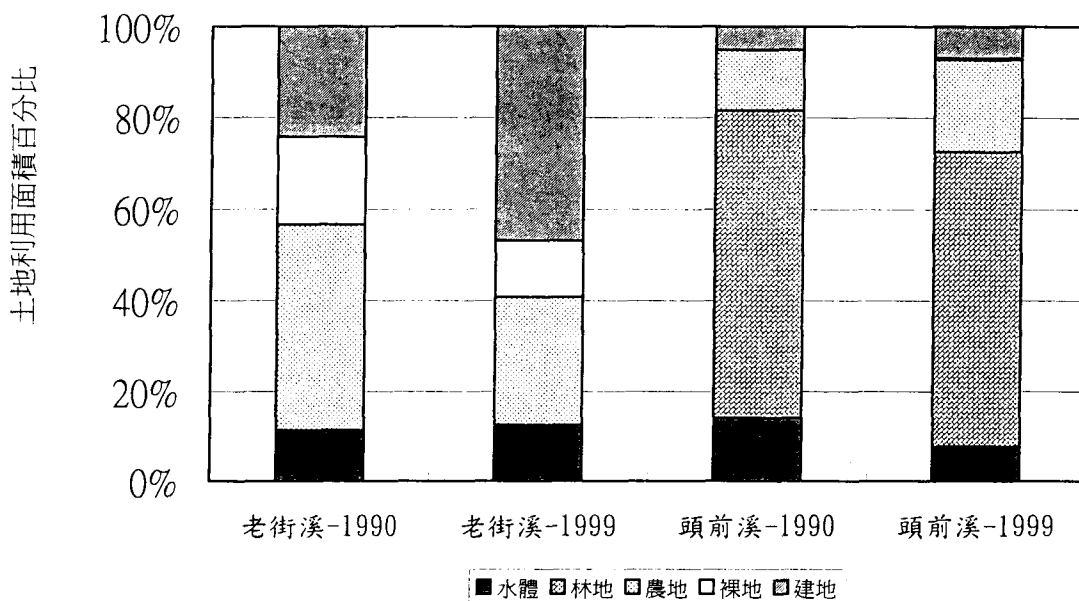
表二 桃園縣及新竹縣重要河川之水質趨勢變化

河川	測站	資料時間	Seasonal Kendall Test 分析結果				
			溶氧量	生化需氧量	懸浮固體	氨氮	濁度
南崁溪	竹圍大橋	1982/05~2000/11	↘	↗	—	↗	↗
	南崁溪橋	1976/01~2000/11	—	—	—	—	↗
	大檜大橋	1976/01~2000/11	↗	↘	↘	↘	—
	龜山橋	1976/01~2000/11	—	—	—	↗	↗
	舊路大橋	1989/03~2000/11	—	—	↘	—	↘
	大埔橋	1996/01~2000/11	↘	—	—	—	—
	宏太橋	1976/03~1997/12	—	↗	↗	—	↗
	星見橋	1976/03~1997/12	↗	↗	—	—	↗
	茄苳溪橋	1976/06~1999/12	—	—	—	↗	↗
老街溪	許厝港一號	1979/02~2000/11	—	—	↘	↗	↗
	中正橋	1976/10~2000/11	↘	↗	↘	↗	↗
	青埔橋	1976/10~2000/11	↘	↗	—	↗	↗
	宋屋	1976/04~2000/11	↗	↘	—	↗	↗
	北勢橋	1988/07~2000/11	—	↘	—	↗	—
	美麗都橋	1988/07~2000/11	—	—	—	↗	↗
	平鎮第一橋	1988/07~1999/11	—	—	—	—	—
社子溪	月眉橋	1976/02~2000/10	↗	↘	↘	—	↘
	老飯店橋	1976/02~2000/10	↗	↘	—	—	—
	社子橋	1976/02~2000/10	↘	↗	↗	—	↗
	笨子港橋	1982/05~2000/09	↘	—	—	—	—
	永寧一號橋	1989/03~2000/10	—	—	—	—	—
頭前溪	溪洲大橋	1984/01~2000/12	—	↘	↗	↘	↗
	頭前溪橋	1976/2~2000/12	↗	↘	—	↘	↗
	中正大橋	1976/02~2000/12	—	↘	↗	↘	↗
	竹林大橋	1977/01~2000/10	—	↘	—	↘	↗
	瑞豐大橋	1983/07~1999/12	—	↘	—	↘	—
	寶山水庫取水口	1987/06~1999/12	—	—	—	↘	—
	竹東大橋	1987/06~1999/12	—	—	—	↘	↗
	內灣吊橋	1981/02~1999/12	—	—	↘	↘	—

2. 土地利用型態與水質因子變化之關係

圖二為 1990 年與 2000 年頭前溪及老街溪流域的不同土地覆蓋面積所佔百分比之變化。老街溪流域最明顯的變化是農地所佔之面積從 45.31% 降到 28.22%，而建地面積則從 24.21% 增加為 46.86%。而頭前溪流域不同土地覆蓋面積之變化不像老街溪非常明顯，主要的改變為水體面積由 14.17% 減為 7.78%，而農地所佔之面積從 13.3% 增加為 20.12%。

受限於資料特性，在進行土地利用型態與水質因子變化之關係分析時，只以計算不同土地覆蓋面積與不同水質參數之相關係數，來探討土地利用型態與水質因子變化之關連。表三為不同土地覆蓋面積與不同水質參數之 Pearson 相關係數結果，其中以裸露地與溶氧有統計上顯著負相關($P=0.033$)及濁度有統計上顯著正相關注($P=0.033$)。另外，農地也與濁度有統計上顯著正相關($P=0.032$)，值得注意地，農地與其他水質參數皆有接近統計上顯著相關，例如其於溶氧量有接近統計上顯著負相關($P=0.103$)，而與生化需氧量、懸浮固體及氨氮則有接近統計上顯著正相關，其 P 值分別為 0.06、0.104 及 0.078。顯示在頭前溪及老街溪流域農地及裸露地為主要影響水質因子。



圖二 在 1990 年與 1999 年頭前溪及老街溪流域不同土地覆蓋面積之變化

表三 不同土地覆蓋面積與不同水質參數之 Pearson 相關係數

r/P value	水體	林地	農地	裸地	建地
溶氧量	-0.344/0.656	0.896/0.104	-0.897/0.103	-0.967/0.033	-0.608/0.392
生化需氧量	0.049/0.951	-0.688/0.312	0.938/0.062	0.870/0.131	0.259/0.741
懸浮固體	-0.411/0.589	-0.527/0.473	0.896/0.104	0.718/0.282	0.109/0.891
氨氮	0.015/0.985	-0.639/0.361	0.922/0.078	0.835/0.165	0.194/0.806
濁度	-0.11/0.89	-0.930/0.07	0.968/0.032	0.967/0.033	0.689/0.311

五、計畫成果自評

本研究利用環保署在北部地區除淡水河外其他的主要及次要河川水質監測資料，做一完成的水質變化趨勢統計分析，可供了解過去河川水質變化之參考。土地利用型態與水質因子變化之探討則是選擇水質參數有較明顯變化的頭前溪及老街溪流域進行分析，其中以農地及裸露地對水質參數影響較大。

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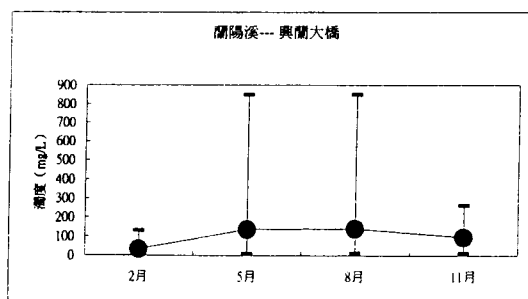
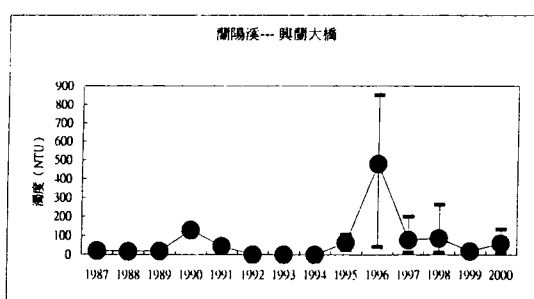
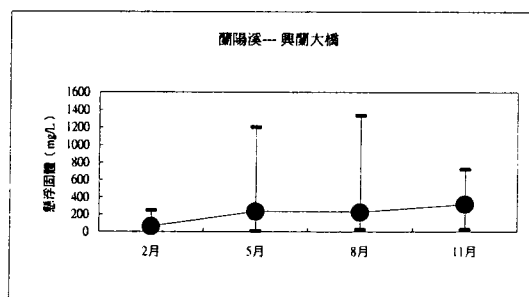
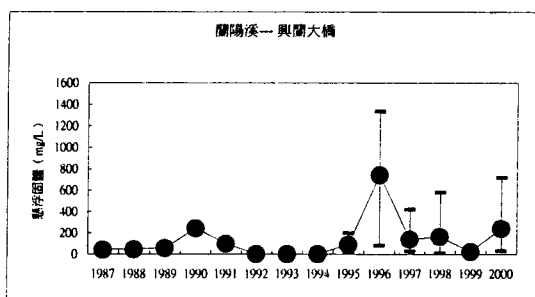
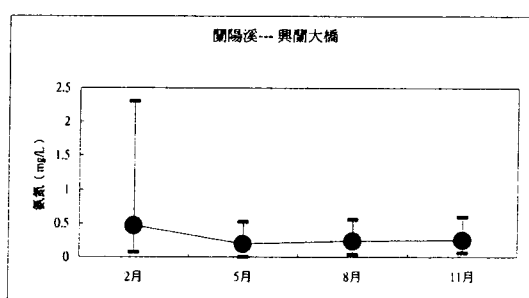
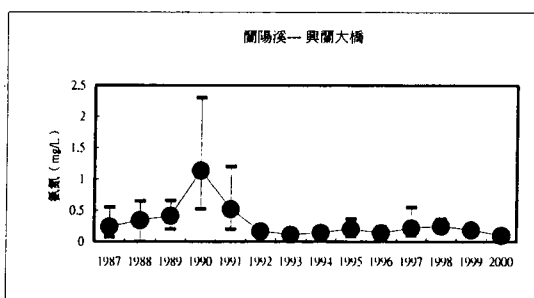
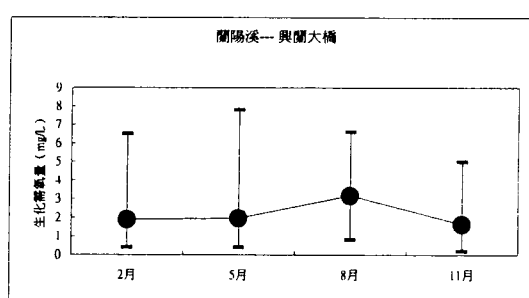
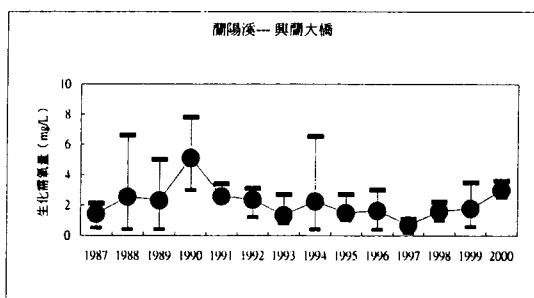
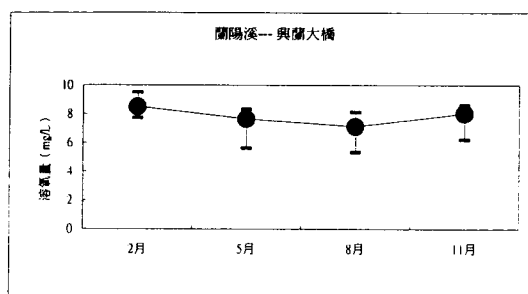
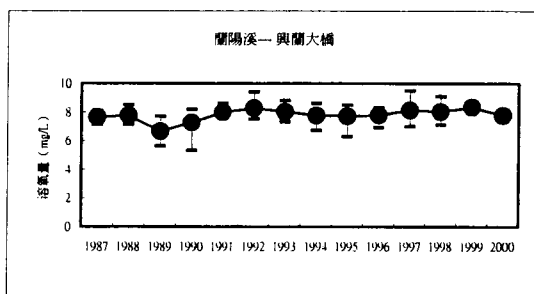
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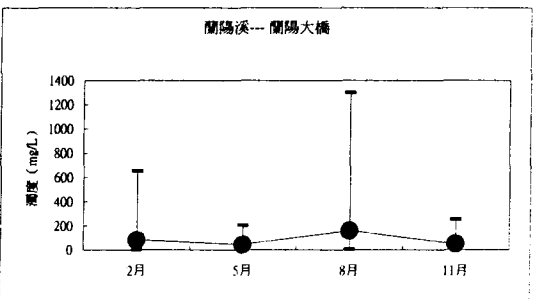
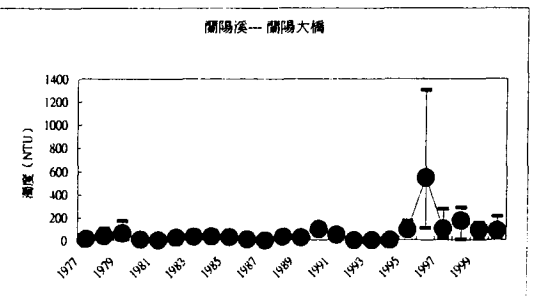
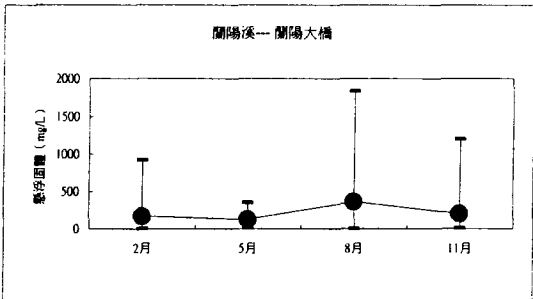
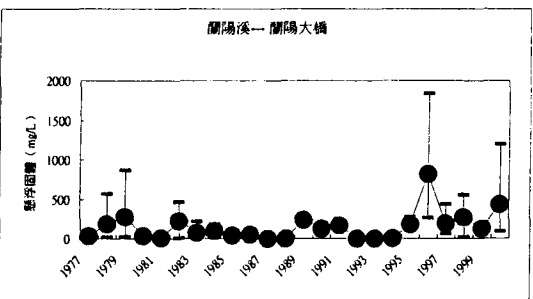
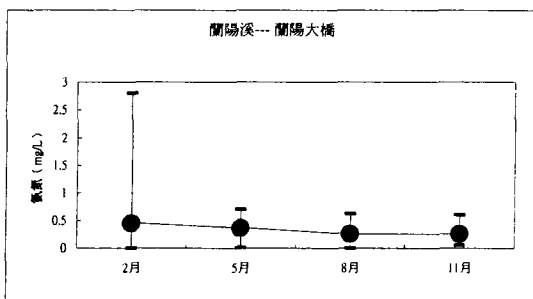
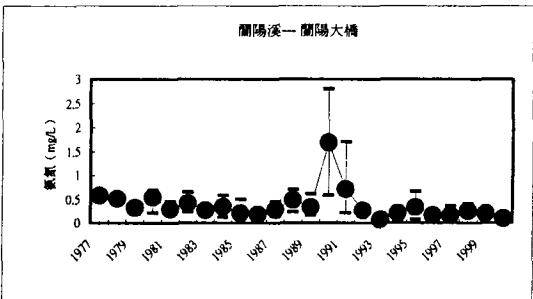
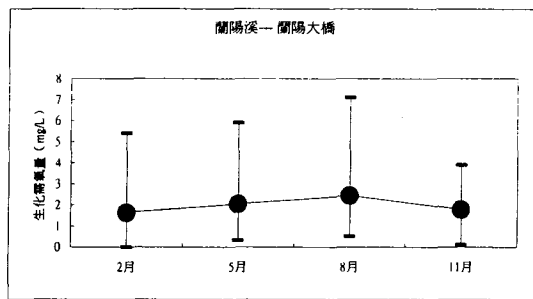
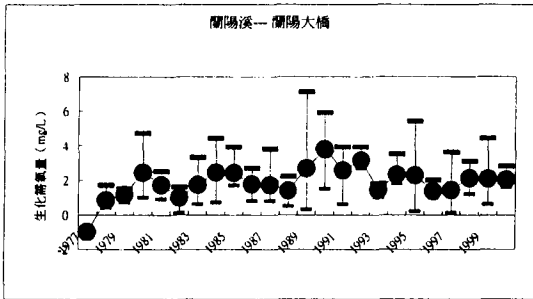
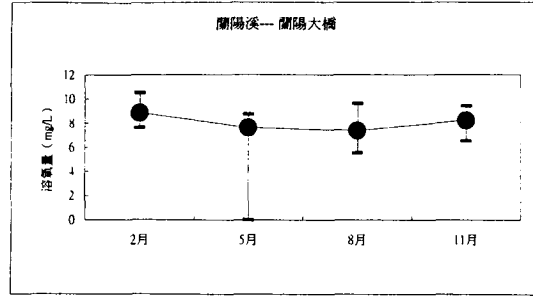
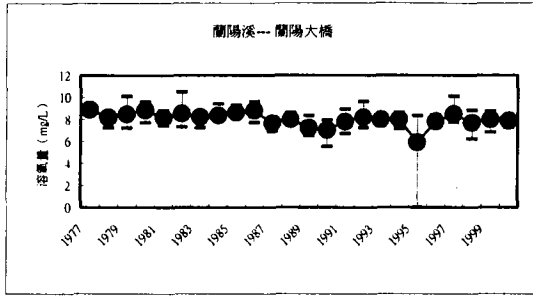
附表一、本研究所蒐集到的環保署河川水質資料

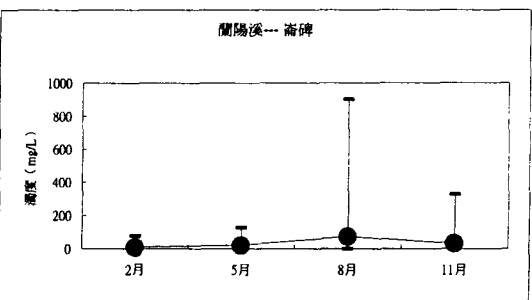
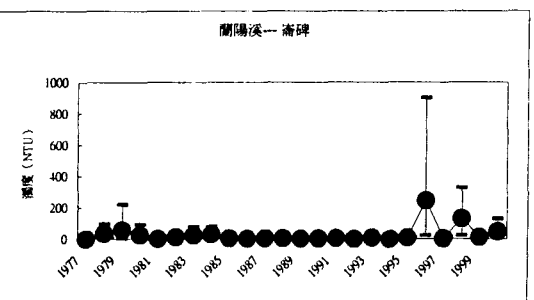
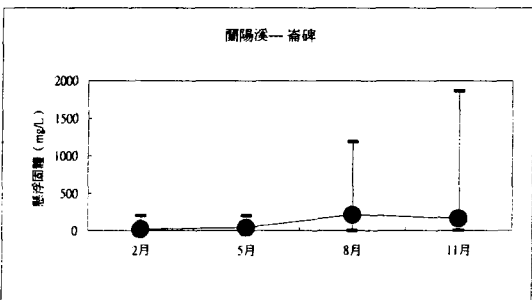
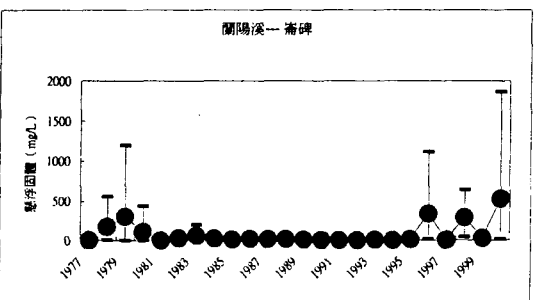
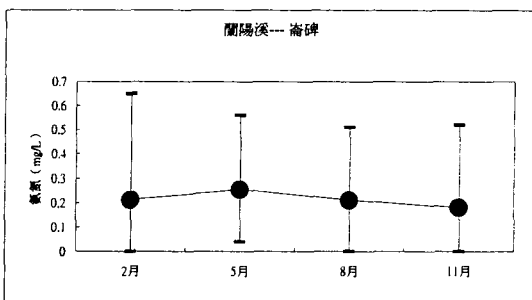
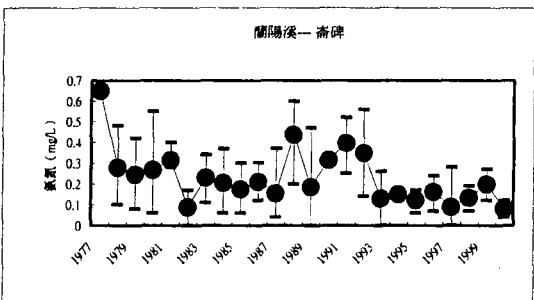
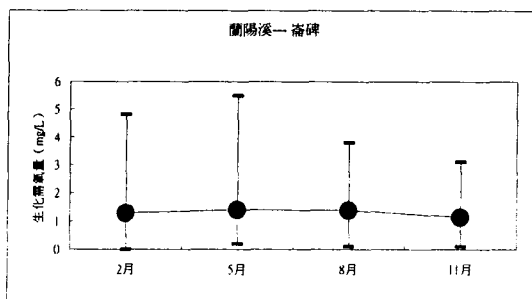
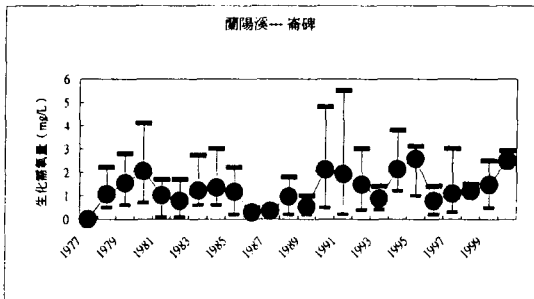
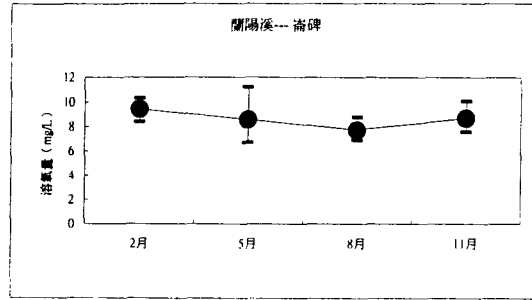
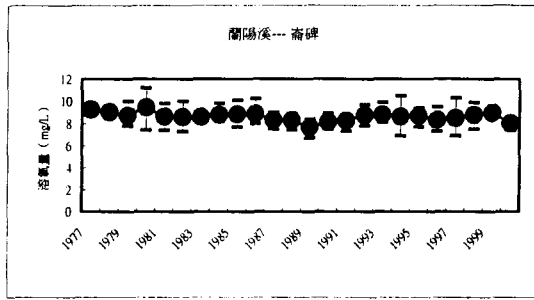
河川	測站	資料分析涵蓋時間	採樣頻率	備註
蘭陽溪	興蘭大橋	1987/05~2000/11	季	
	蘭陽大橋	1977/02~2000/11	季	
	崙碑	1977/02~2000/11	季	
	牛鬥橋	1996/02~2000/11	季	
	上深溝	1977/02~1995/11	季	
得子口溪	復興橋	1981/03~2000/12	季	
	得子口橋	1981/09~2000/12	季	
	美慶山莊	1996/06~2000/12	季	
雙溪	貢寮大橋	1981/04~2000/10	季	
	新寮大橋	1981/04~2000/10	季	
磺溪	四十號橋	1977/10~2000/10	季	
	上磺溪橋	1977/10~2000/10	季	
	磺溪大橋	1977/10~2000/10	季	
南崁溪	竹圍大橋	1982/05~2000/11	隔月	
	南崁溪橋	1976/01~2000/11	隔月	
	大樹大橋	1976/01~2000/11	隔月	
	龜山橋	1976/01~2000/11	隔月	
	舊路大橋	1989/03~2000/11	隔月	
	大埔橋	1996/01~2000/11	隔月	
	宏太橋	1976/03~1997/12	隔月	
	星見橋	1976/03~1997/12	隔月	
	茄苳溪橋	1976/06~1999/12	隔月	
	許厝港一號	1979/02~2000/11	隔月	
老街溪	中正橋	1976/10~2000/11	隔月	
	青埔橋	1976/10~2000/11	隔月	
	宋屋	1976/04~2000/11	隔月	
	北勢橋	1988/07~2000/11	隔月	
	美麗都橋	1988/07~2000/11	隔月	
	平鎮第一橋	1988/07~1999/11	隔月	缺 1993~1995 間資料
社子溪	月眉橋	1976/02~2000/10	隔月	
	老飯店橋	1976/02~2000/10	隔月	
	社子橋	1976/02~2000/10	隔月	
	笨子港橋	1982/05~2000/09	隔月	

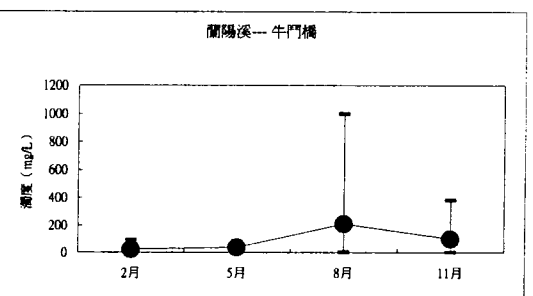
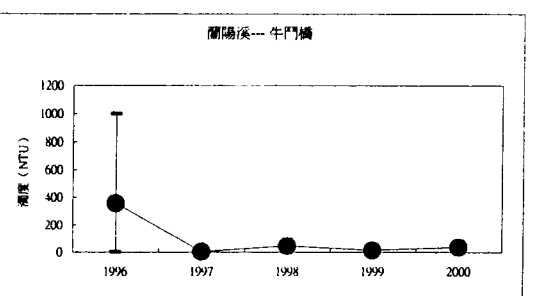
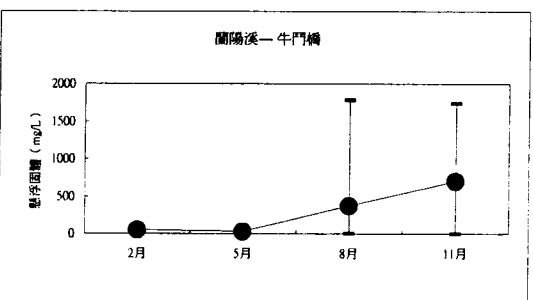
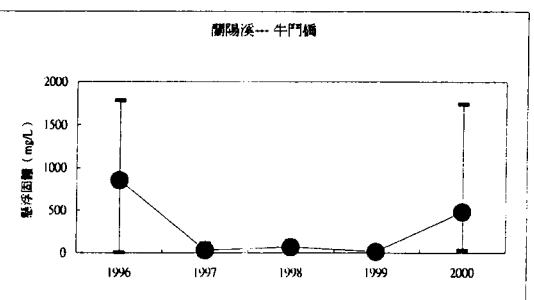
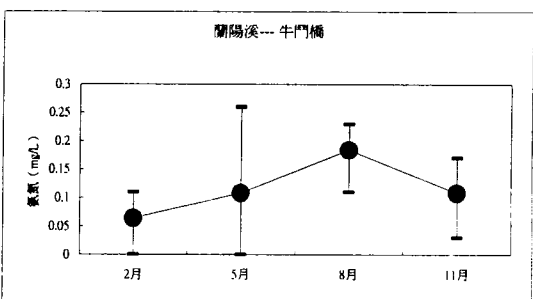
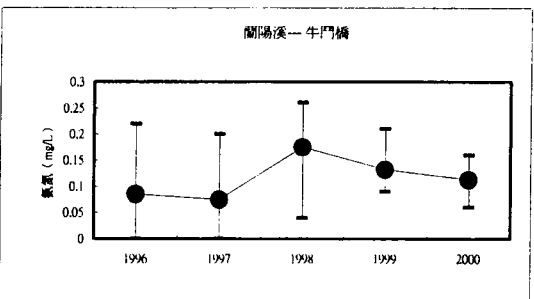
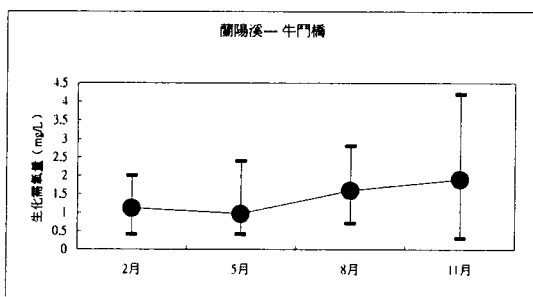
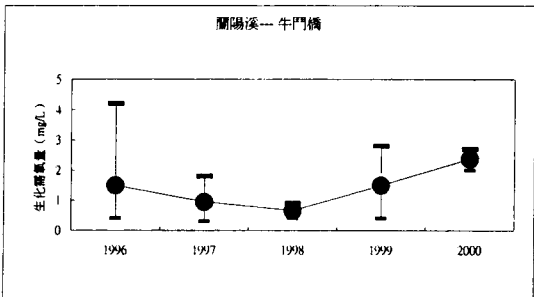
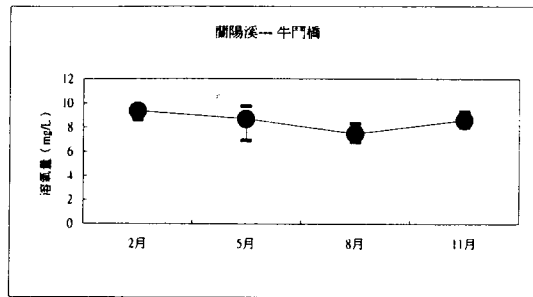
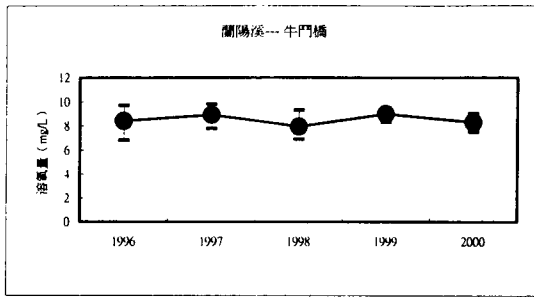
頭前溪	永寧一號橋	1989/03~2000/10	隔月
	溪洲大橋	1984/01~2000/12	月
	頭前溪橋	1976/2~2000/12	月
	中正大橋	1976/02~2000/12	月
	竹林大橋	1977/01~2000/10	月
	瑞豐大橋	1983/07~1999/12	月
	寶山水庫取水口	1987/06~1999/12	月
	竹東大橋	1987/06~1999/12	月
	內灣吊橋	1981/02~1999/12	月

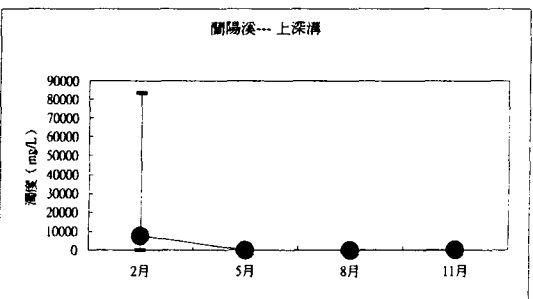
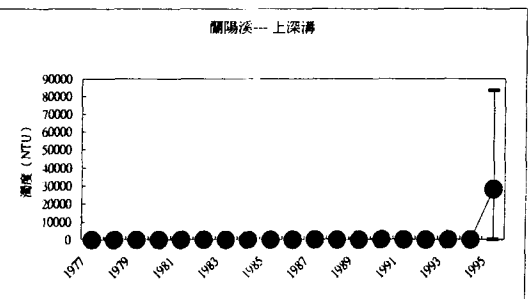
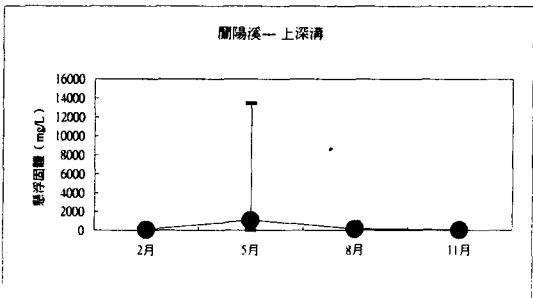
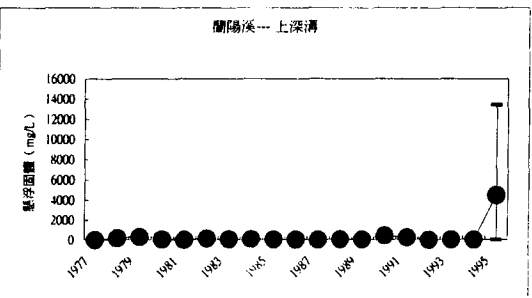
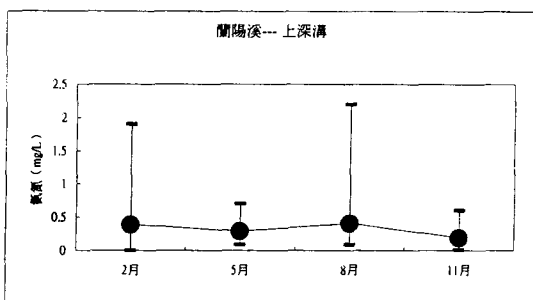
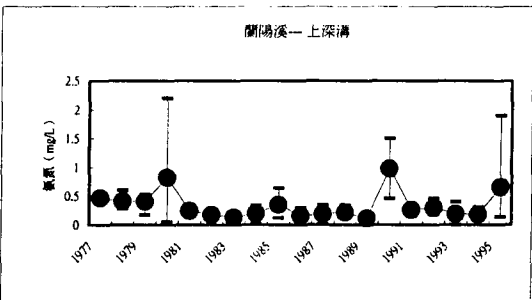
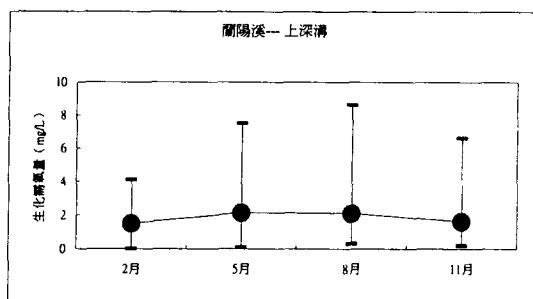
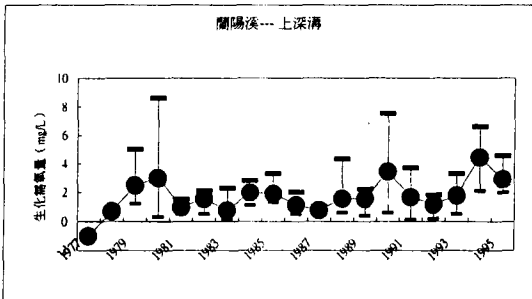
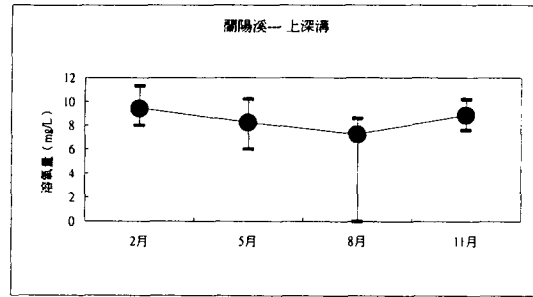
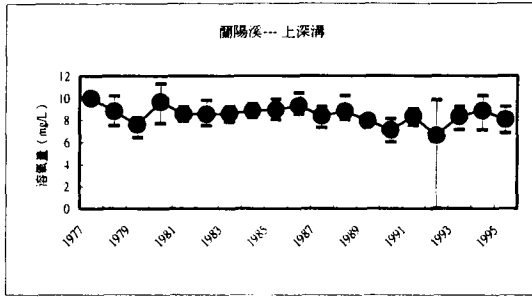
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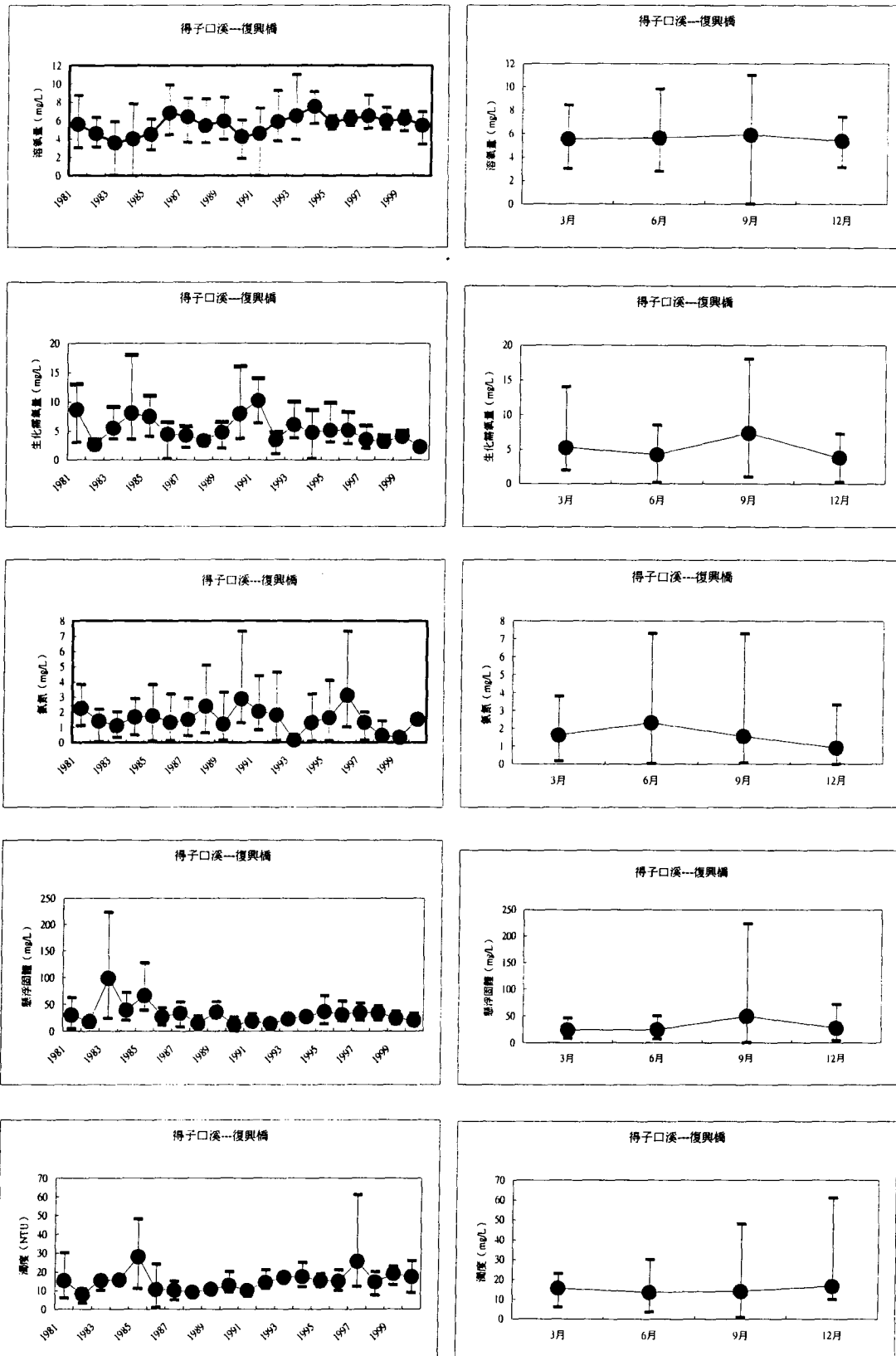


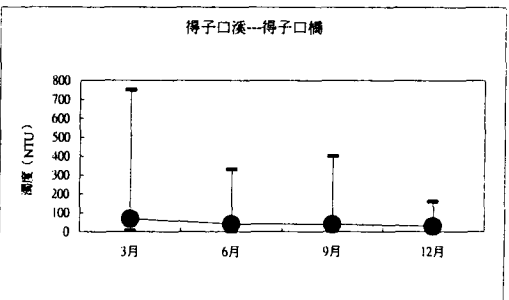
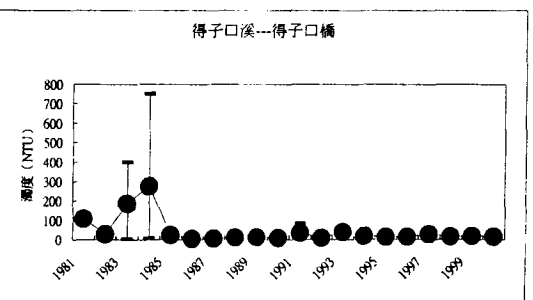
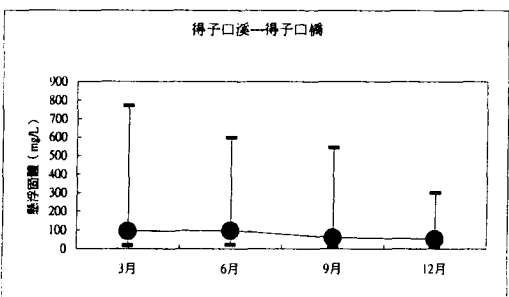
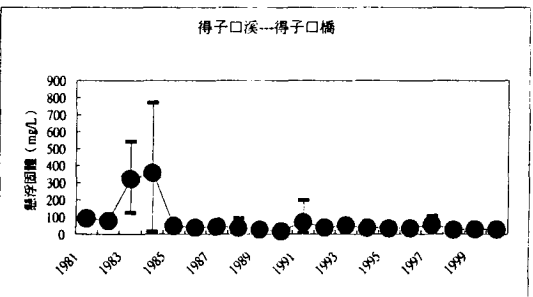
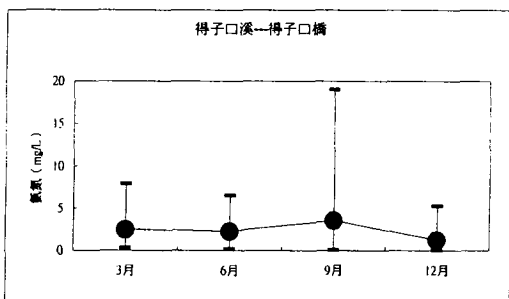
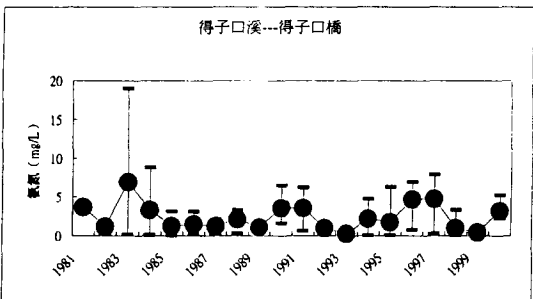
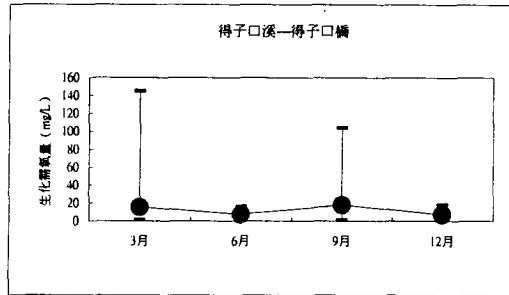
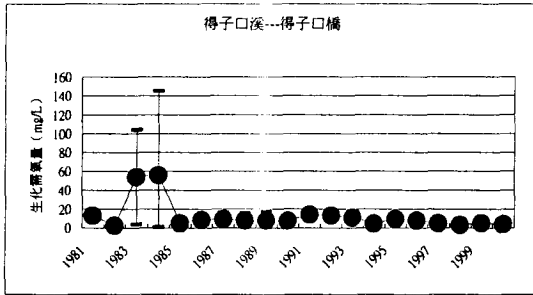
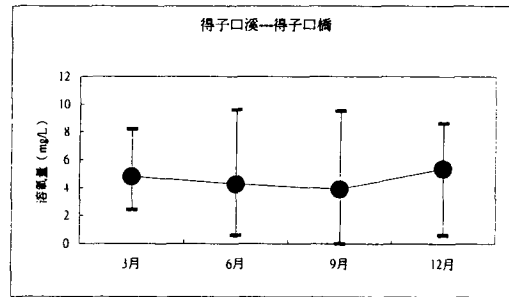
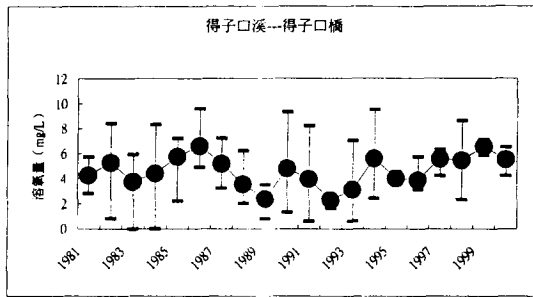


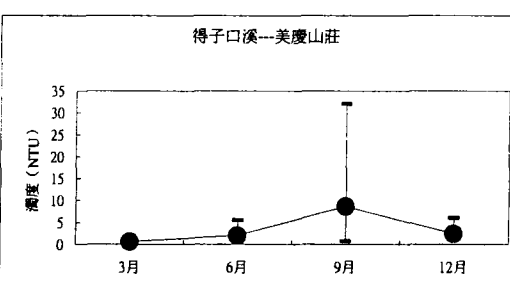
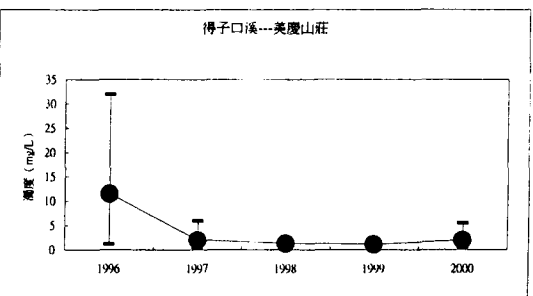
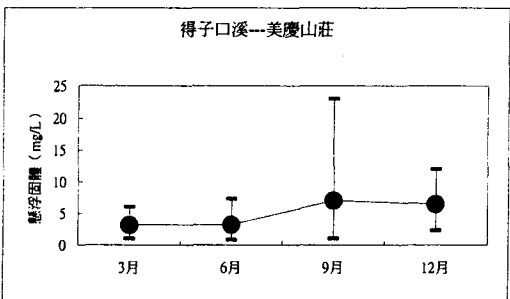
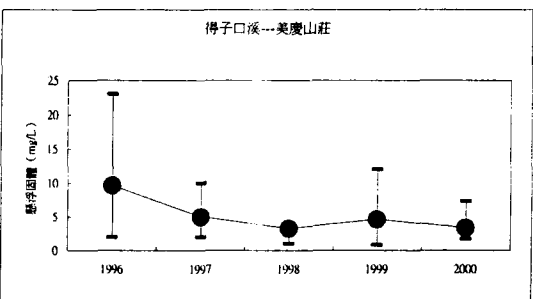
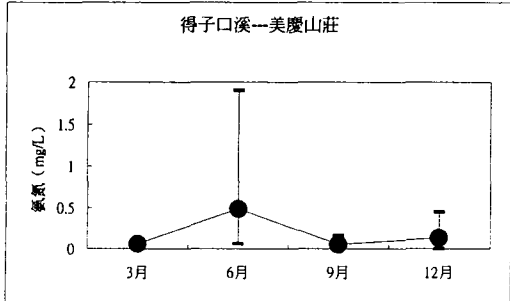
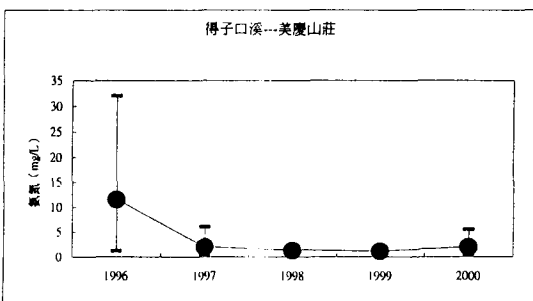
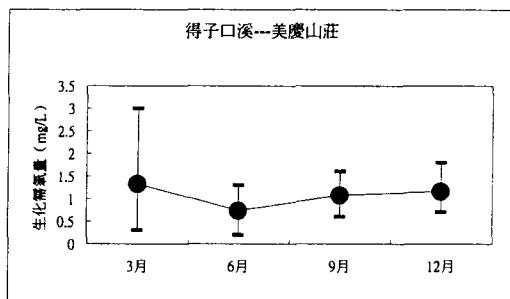
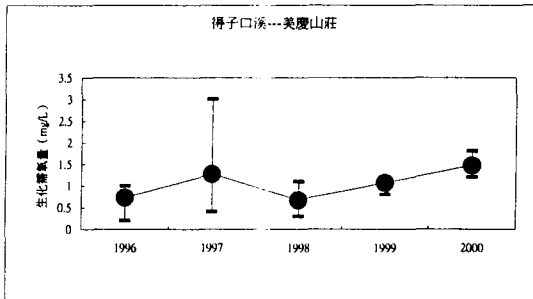
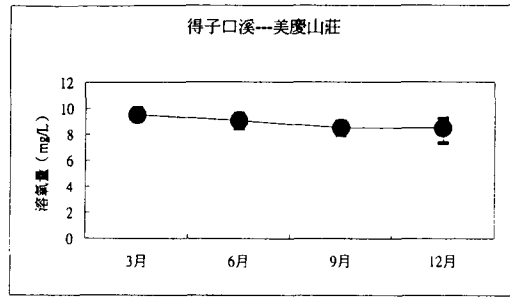
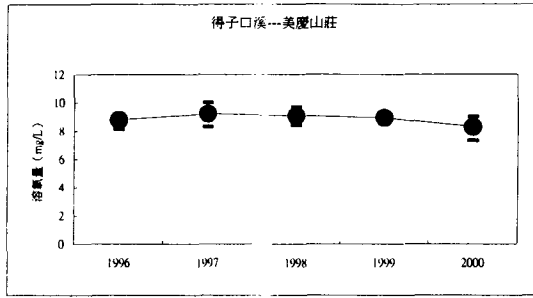




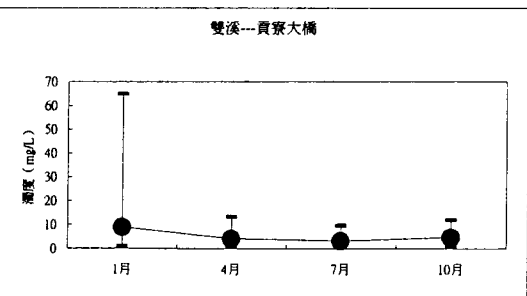
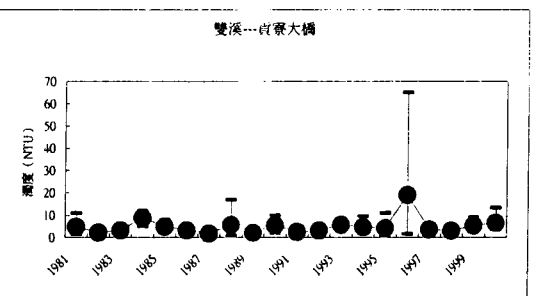
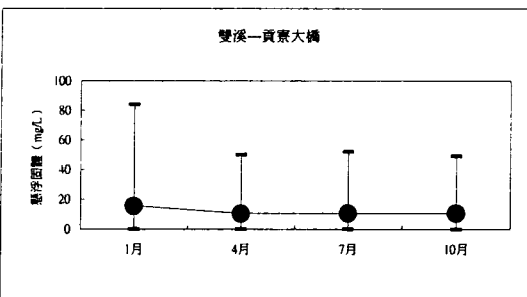
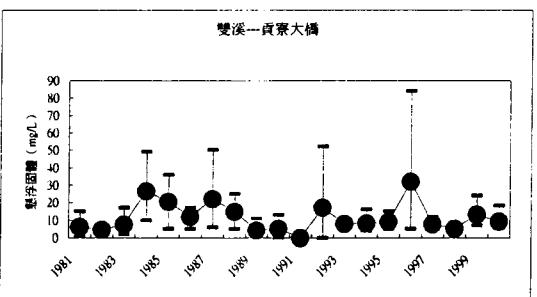
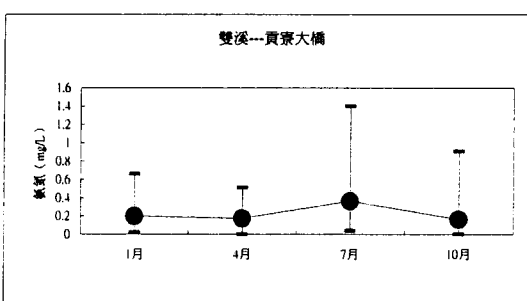
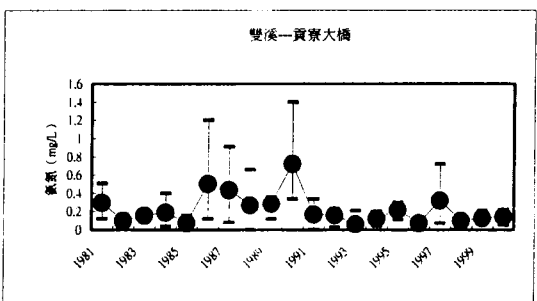
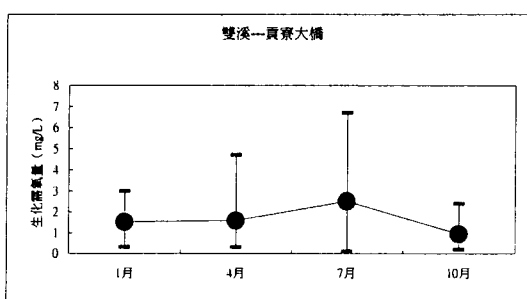
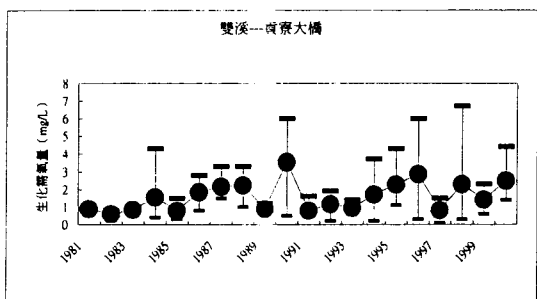
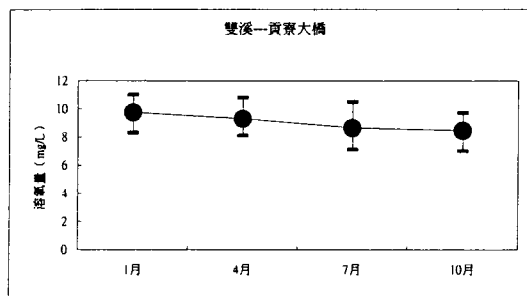
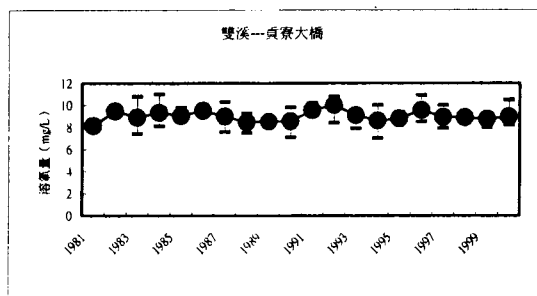
二、得子口溪(左欄是年度變化，右欄為月份間變化。●:平均值，┐: 該年度或該月份在不同年度間所曾經出現之最大值，┘: 該年度或該月份在不同年度間所曾經出現之最小值)

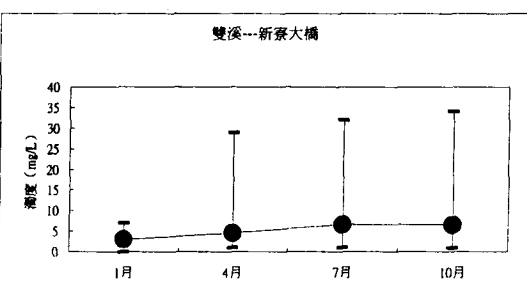
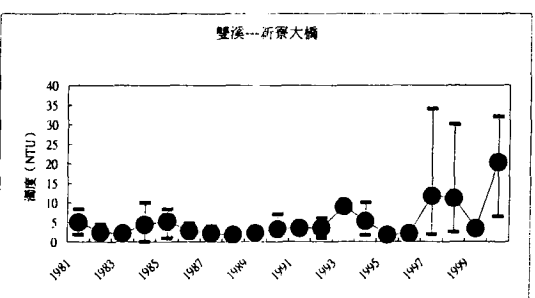
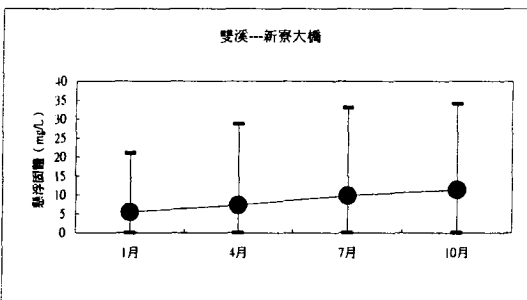
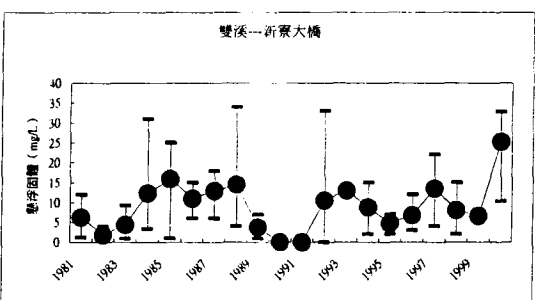
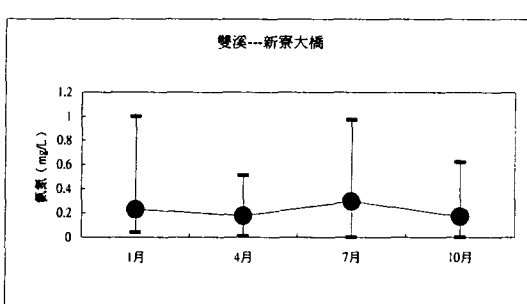
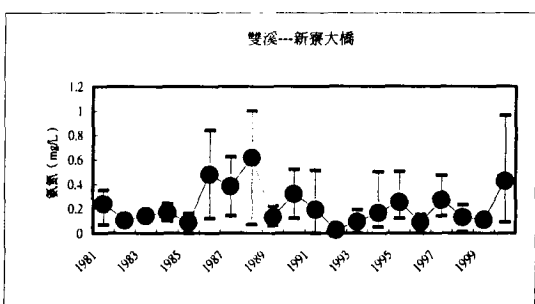
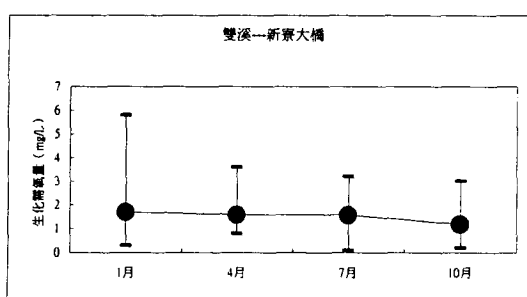
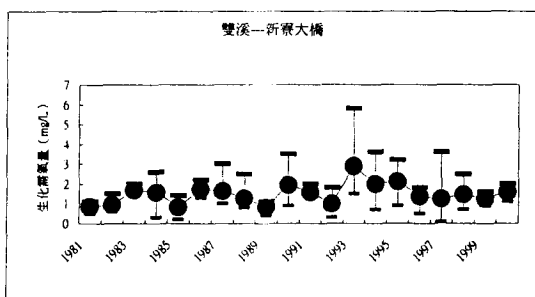
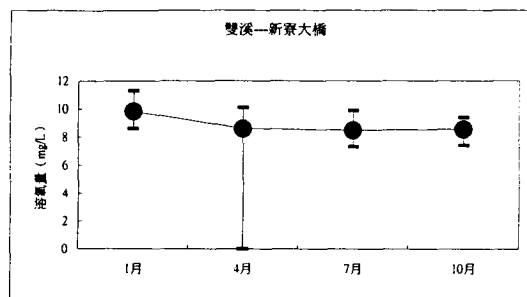
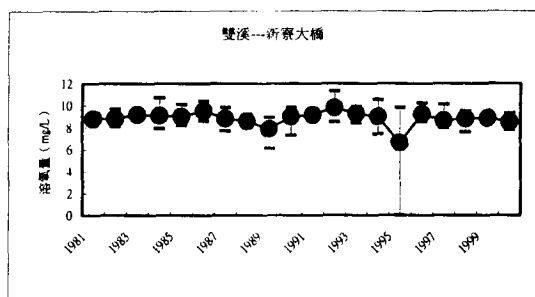




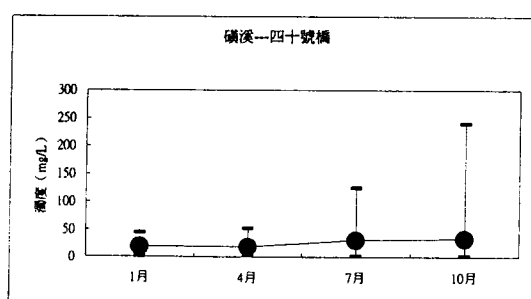
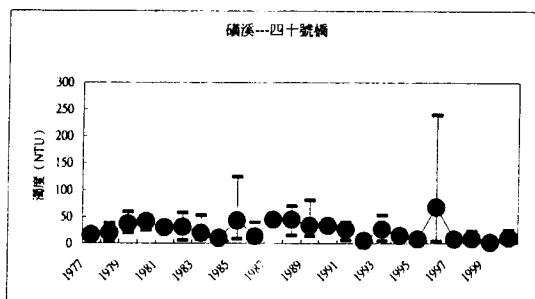
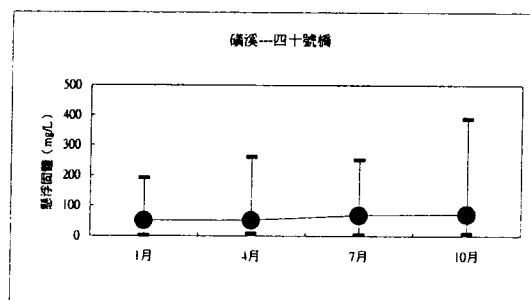
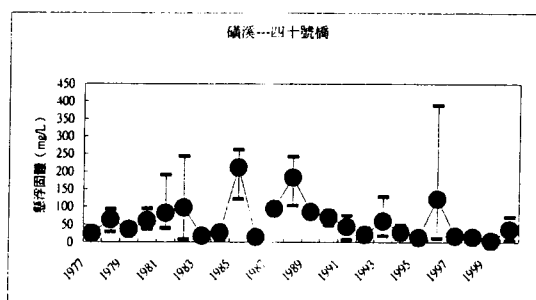
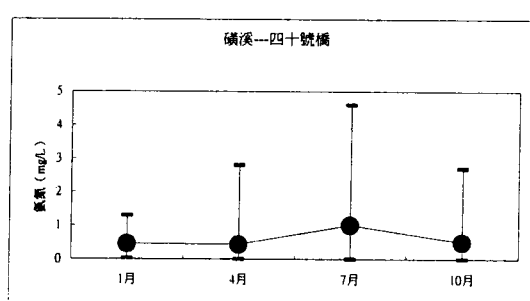
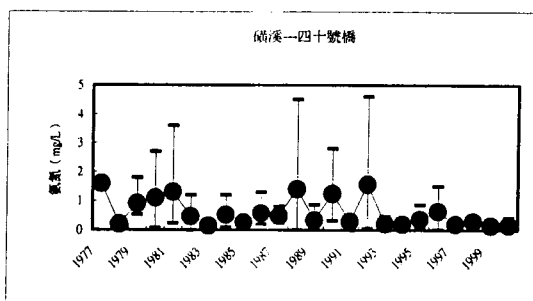
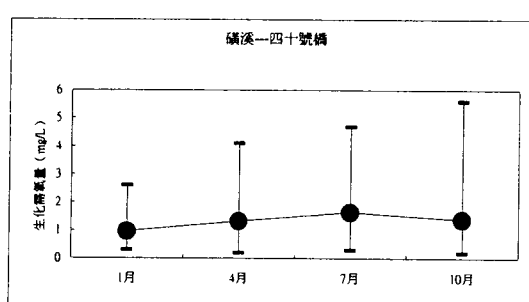
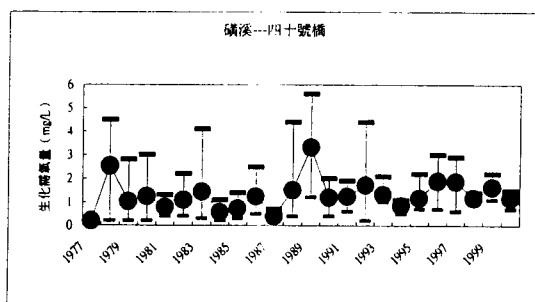
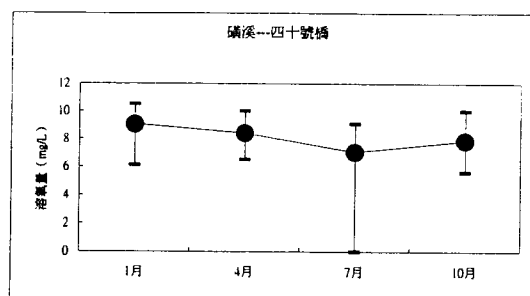
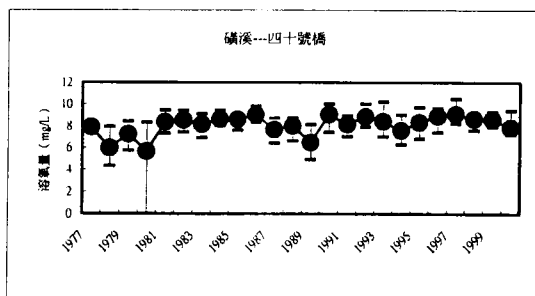


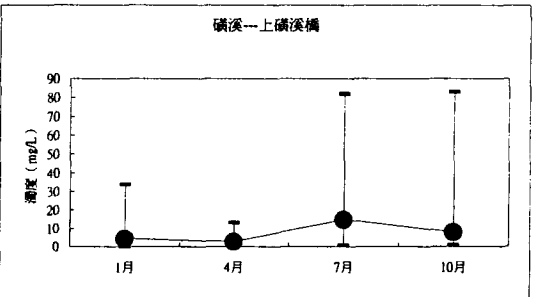
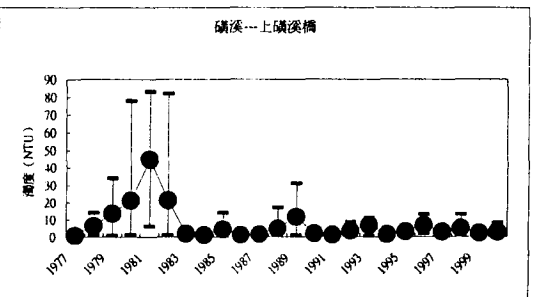
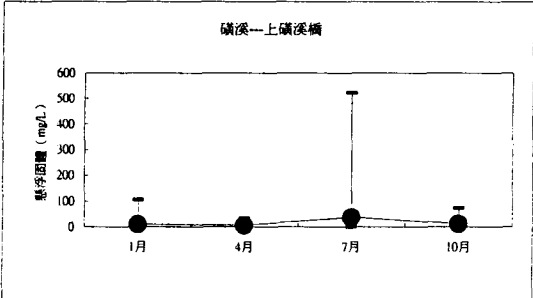
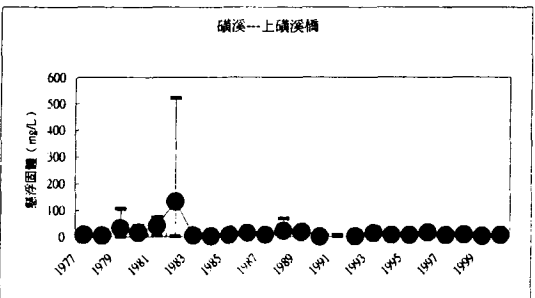
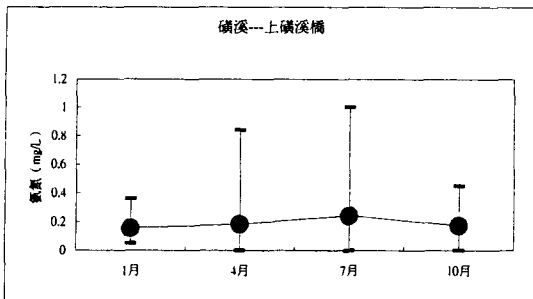
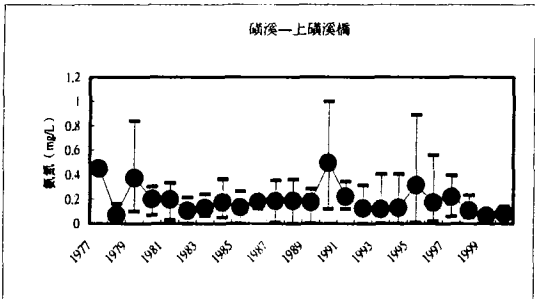
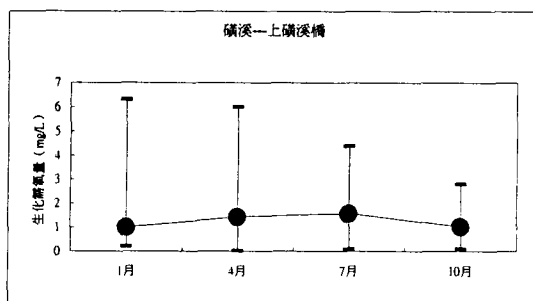
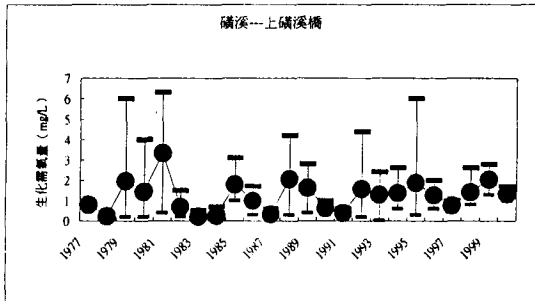
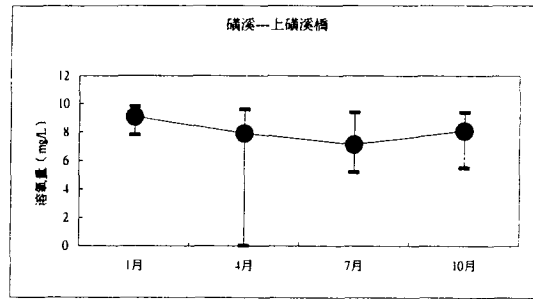
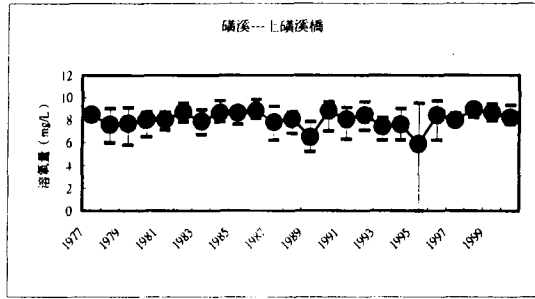
三、雙溪（左欄是年度變化，右欄為月份間變化。●:平均值，┴:該年度或該月份在不同年度間所曾經出現之最大值，┴: 該年度或該月份在不同年度間所曾經出現之最小值）

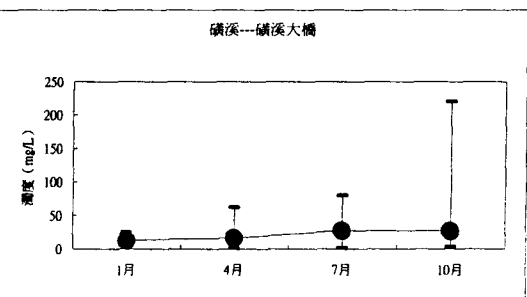
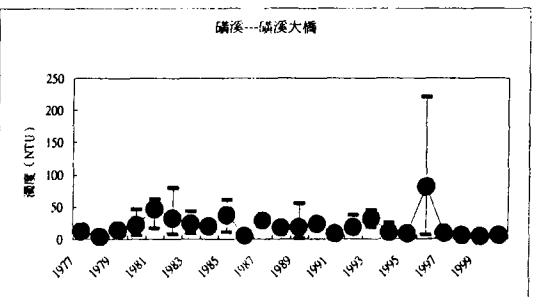
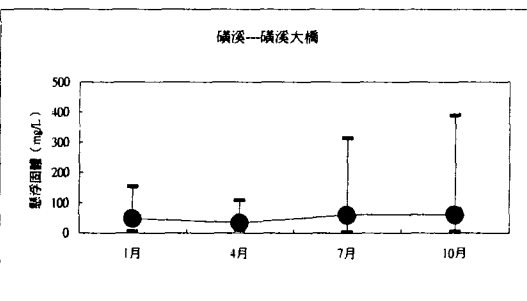
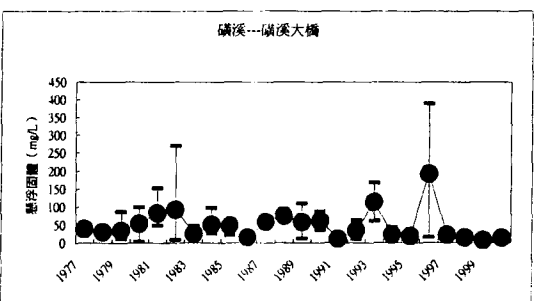
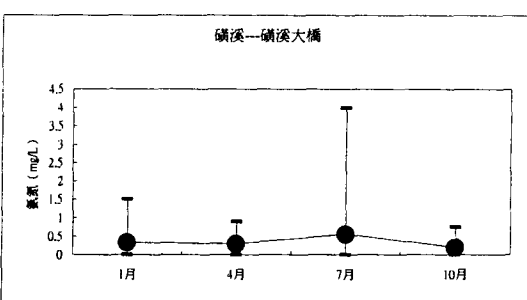
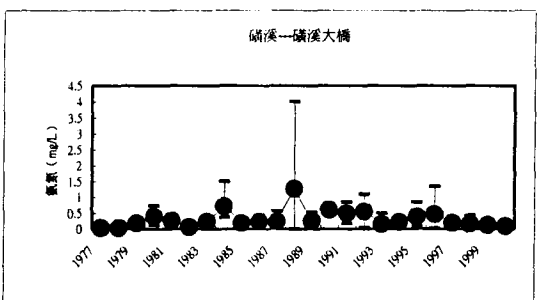
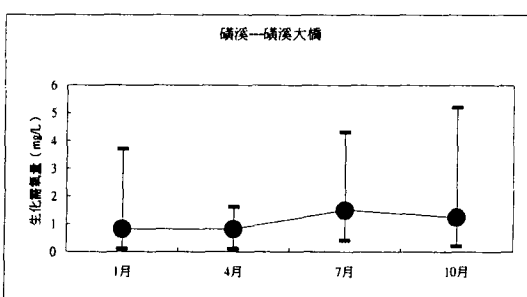
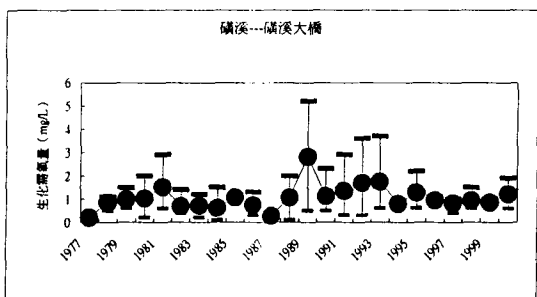
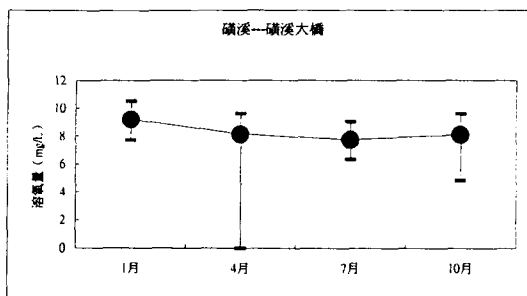
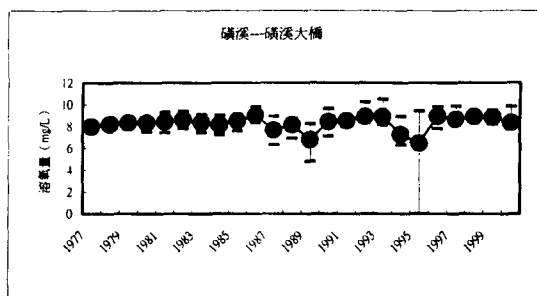




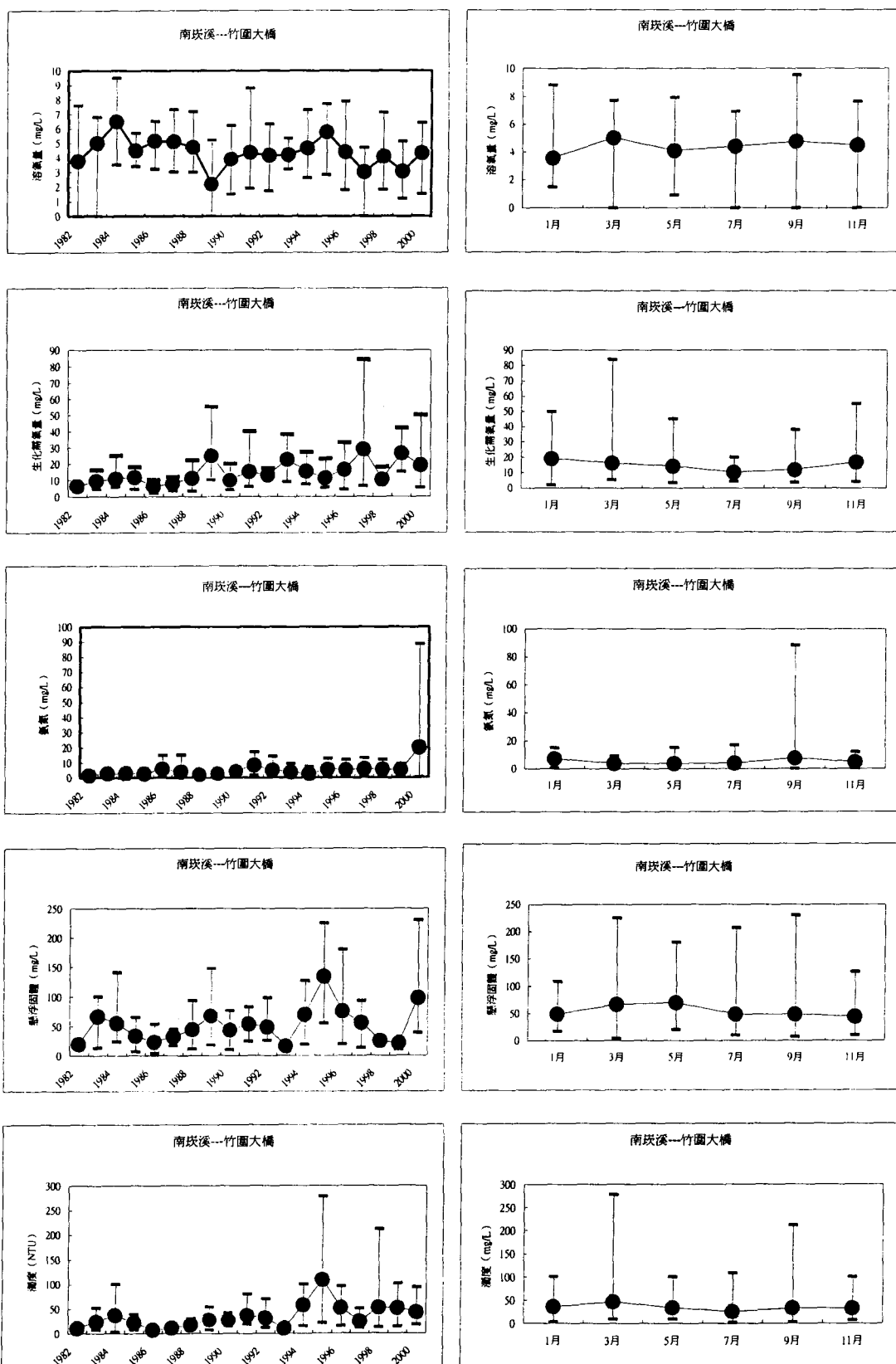
四、磺溪 (左欄是年度變化，右欄為月份間變化。●:平均值，┐:該年度或該月份在不同年度間所曾經出現之最大值，┑: 該年度或該月份在不同年度間所曾經出現之最小值)

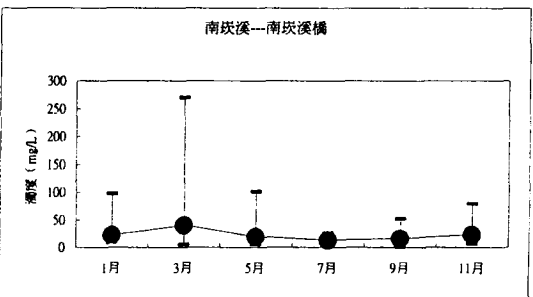
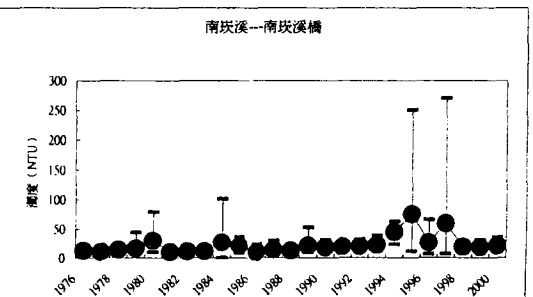
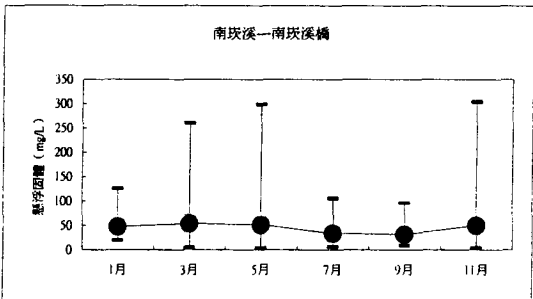
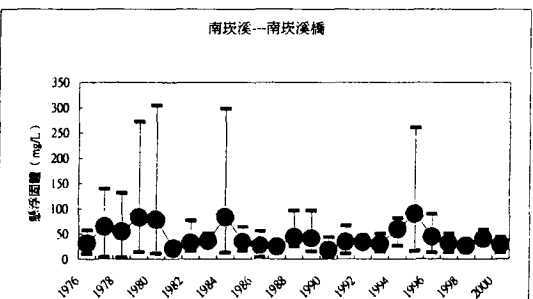
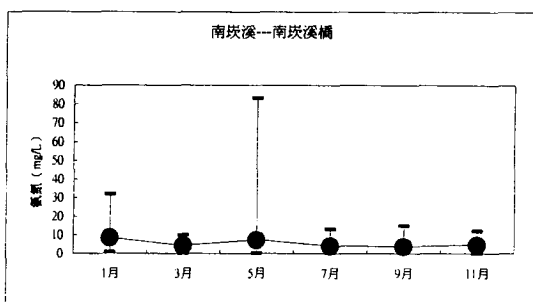
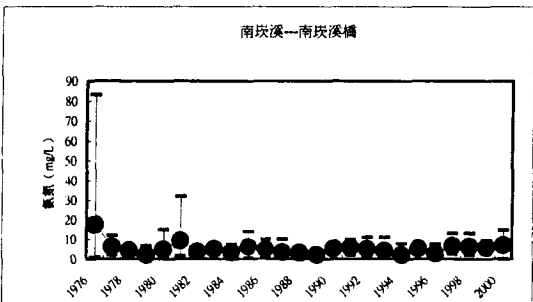
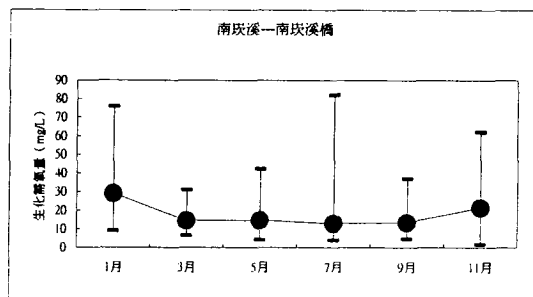
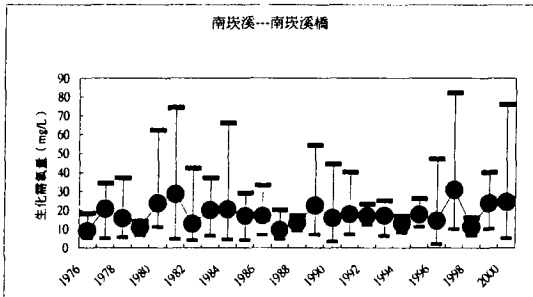
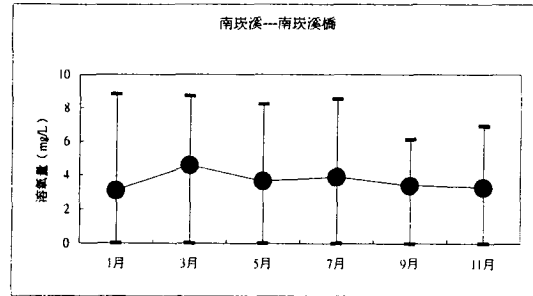
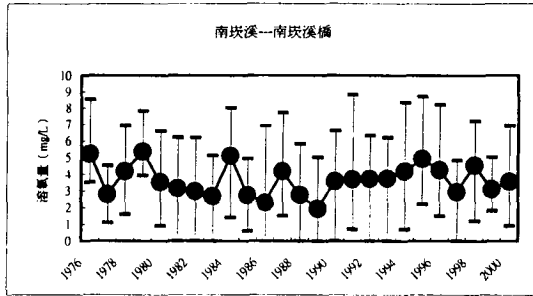


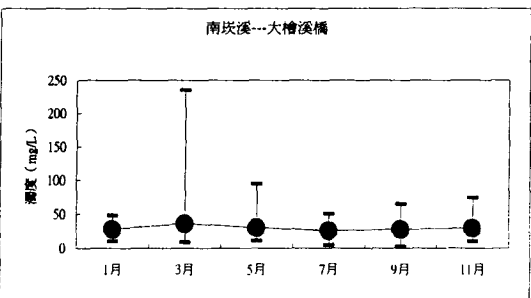
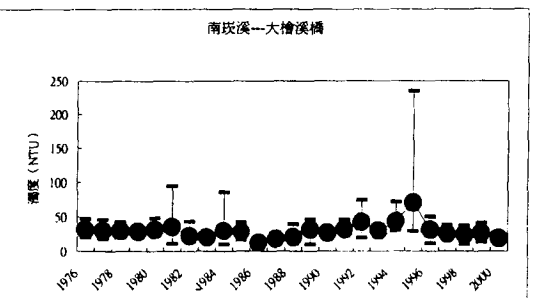
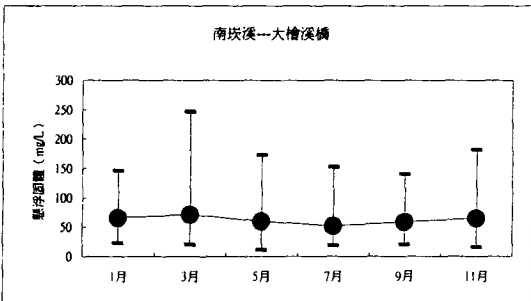
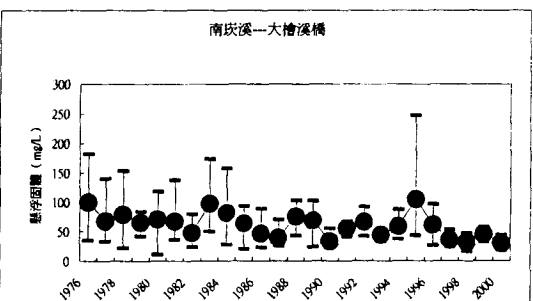
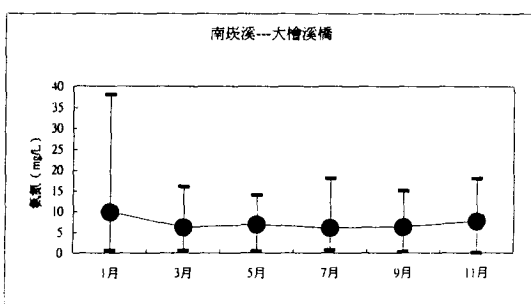
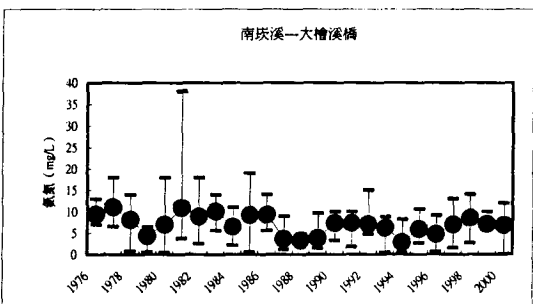
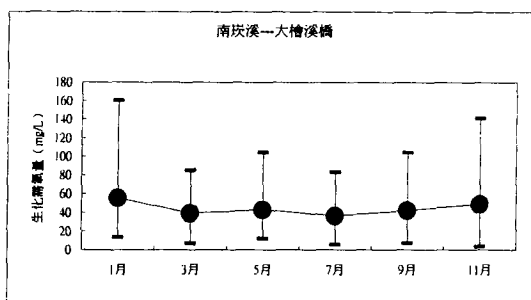
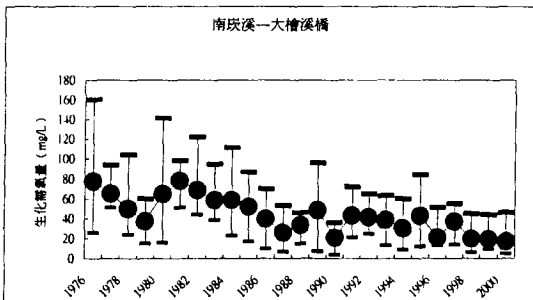
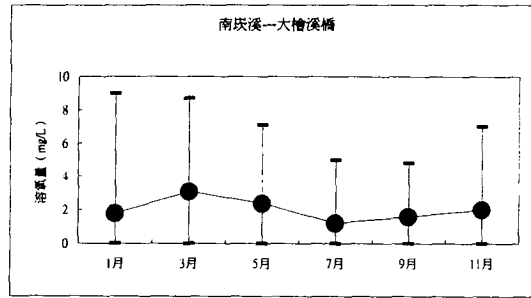
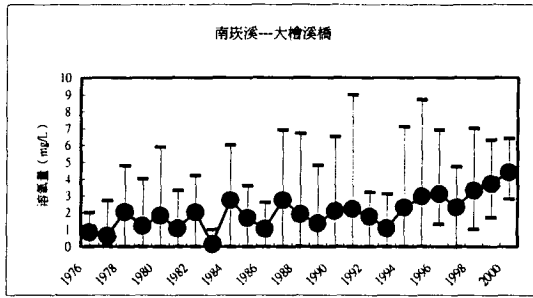


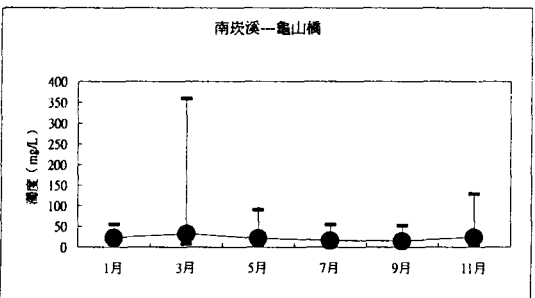
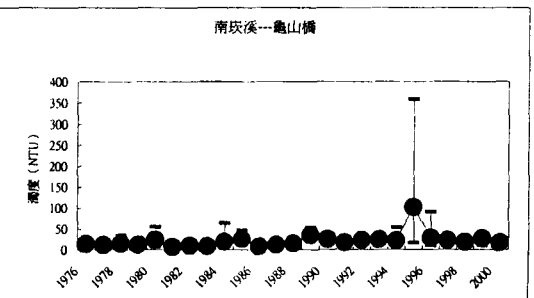
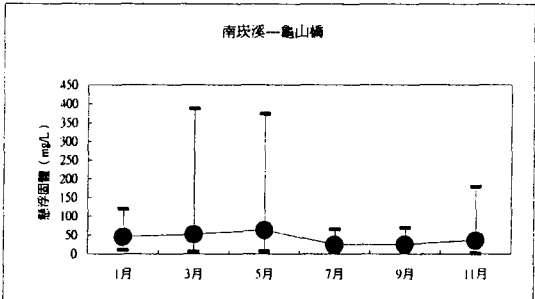
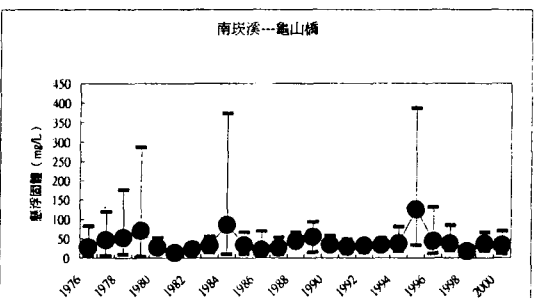
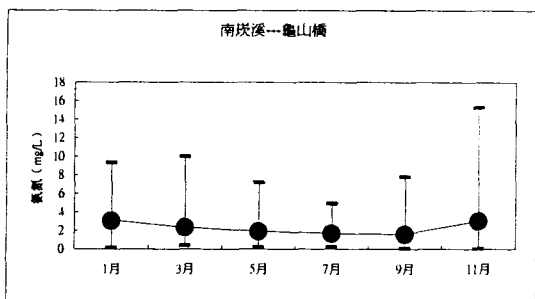
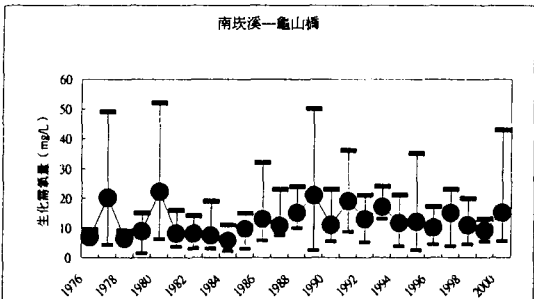
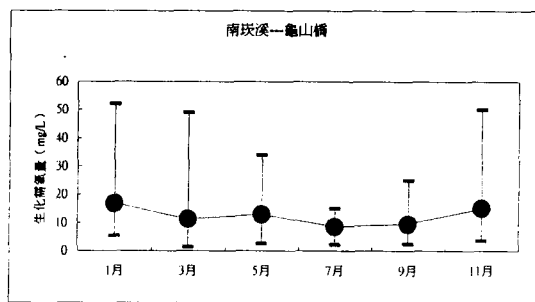
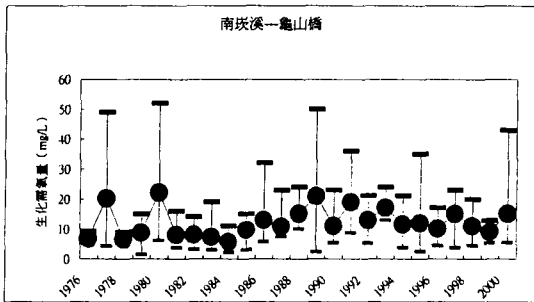
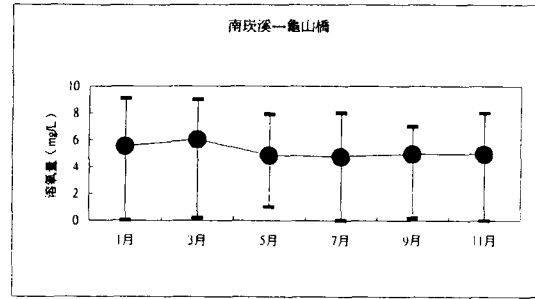
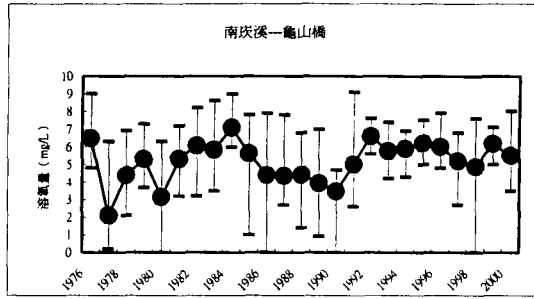


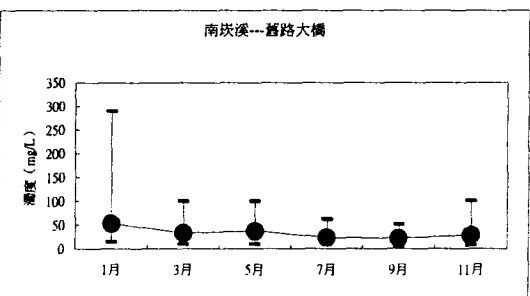
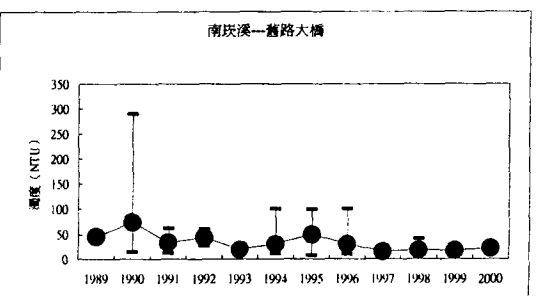
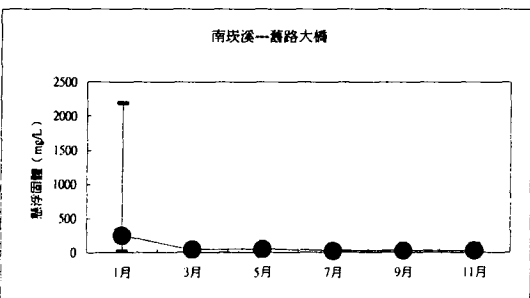
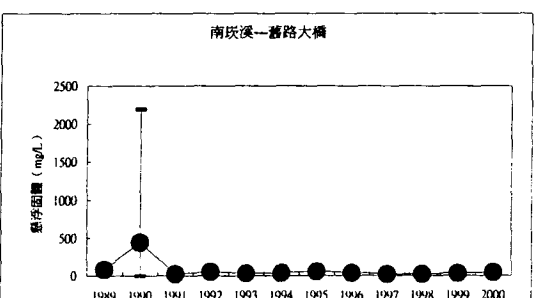
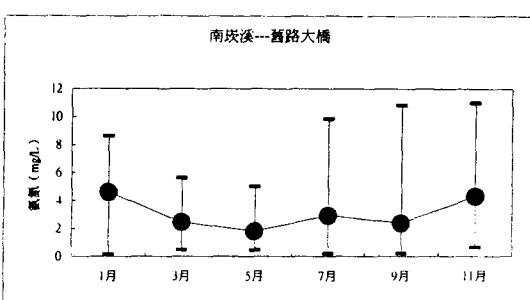
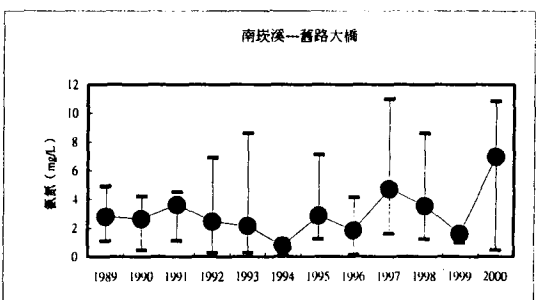
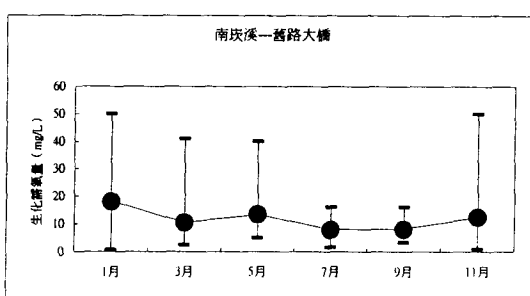
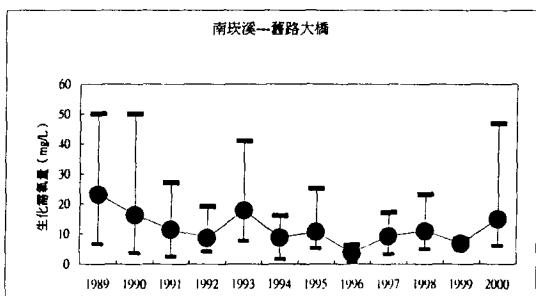
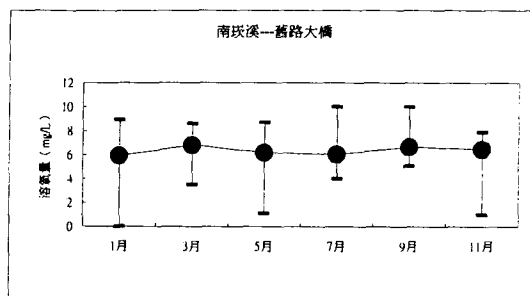
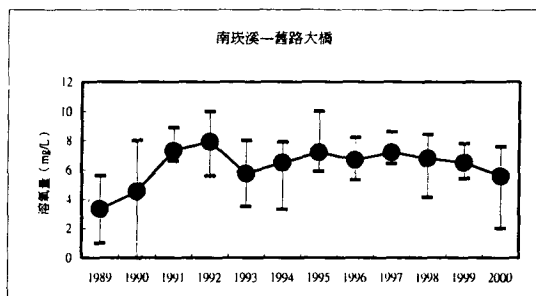
五、南坎溪 (左欄是年度變化，右欄為月份間變化。●:平均值，┐:該年度或該月份在不同年度間所曾經出現之最大值，┘:該年度或該月份在不同年度間所曾經出現之最小值)

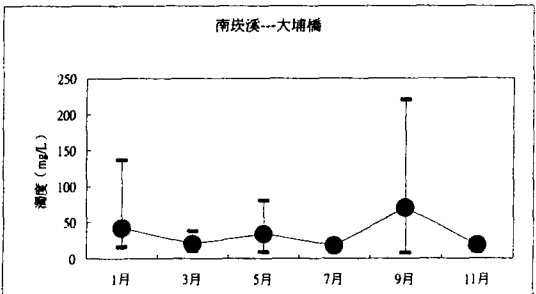
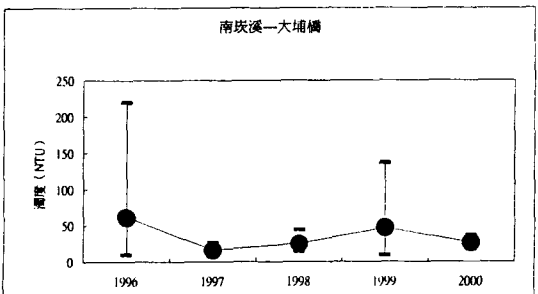
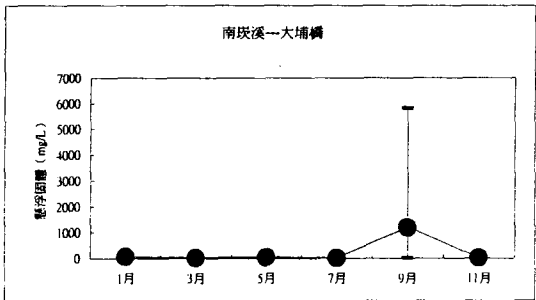
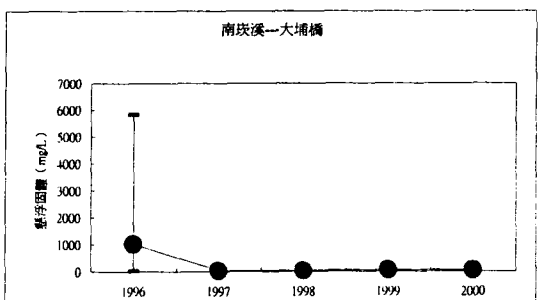
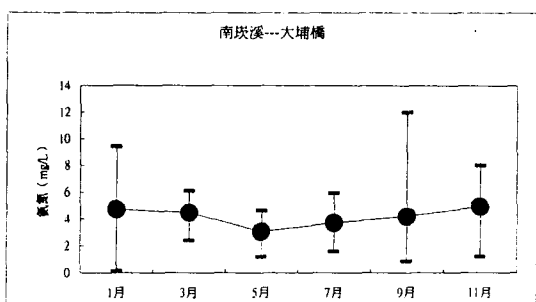
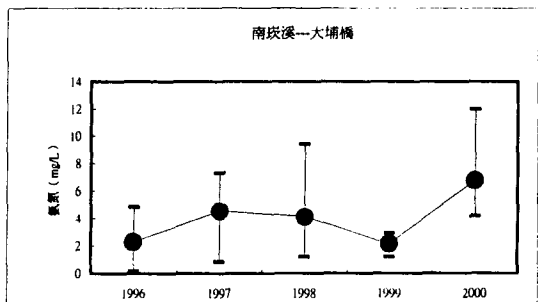
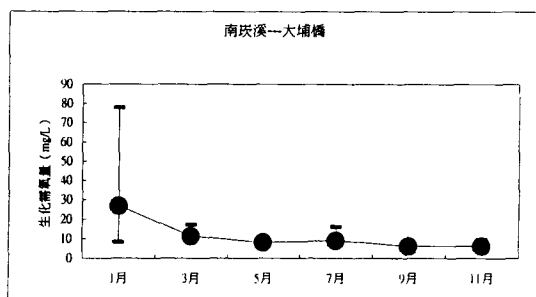
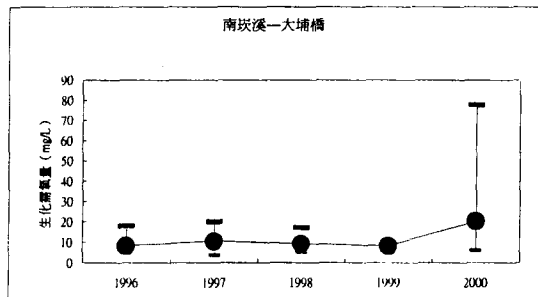
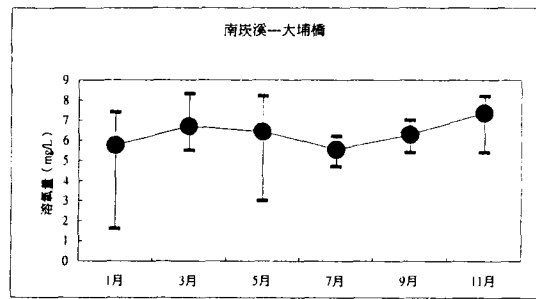
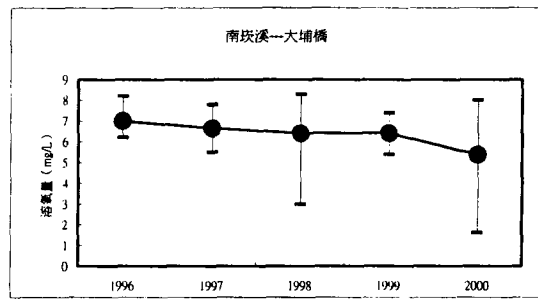


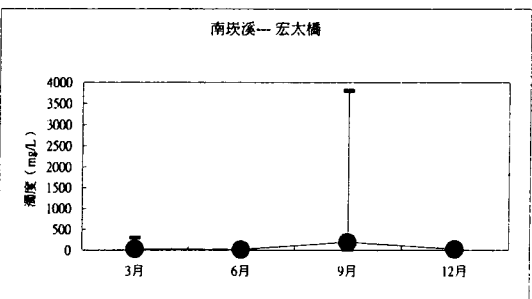
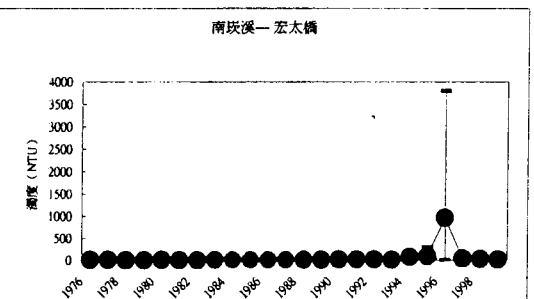
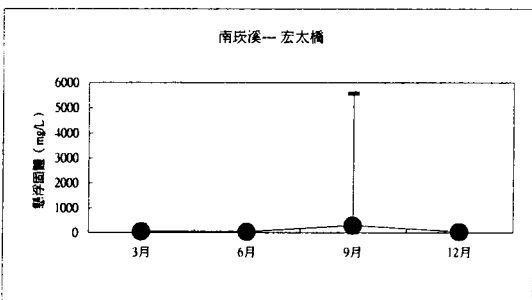
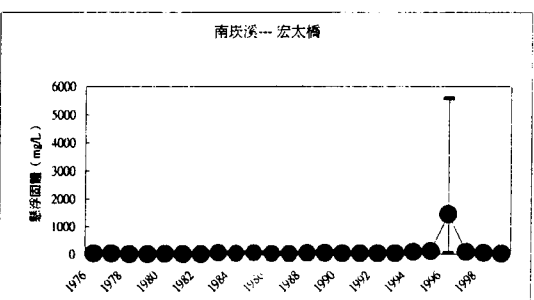
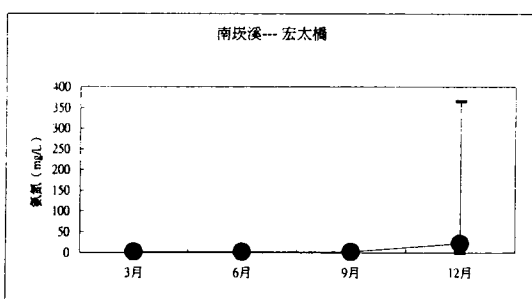
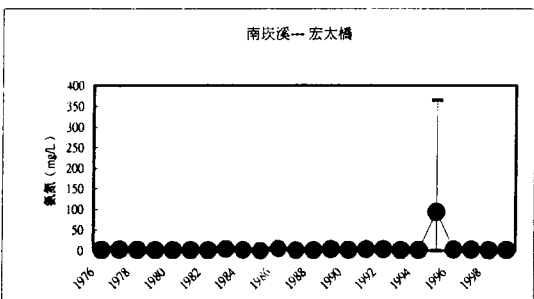
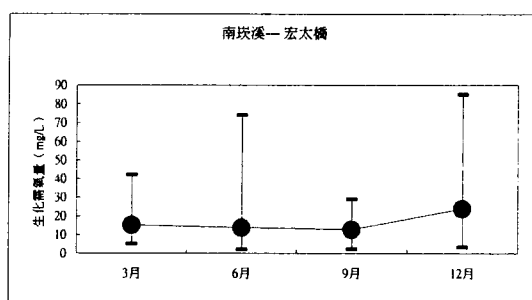
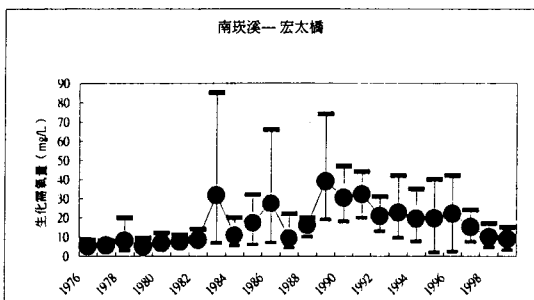
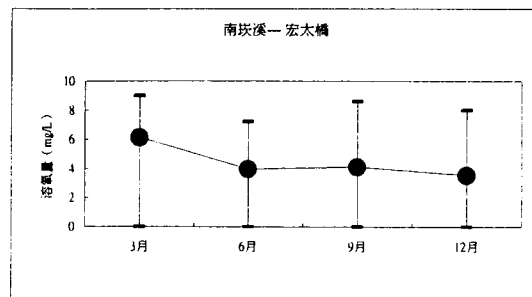
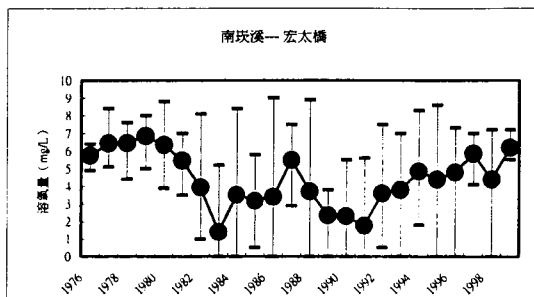


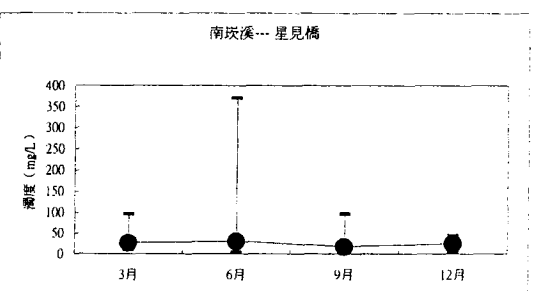
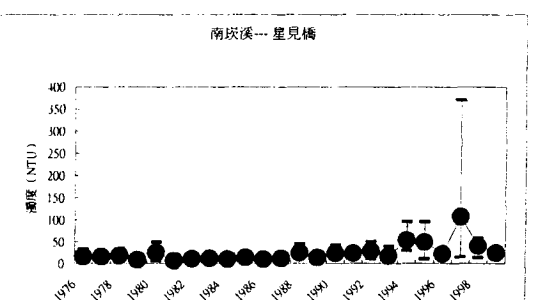
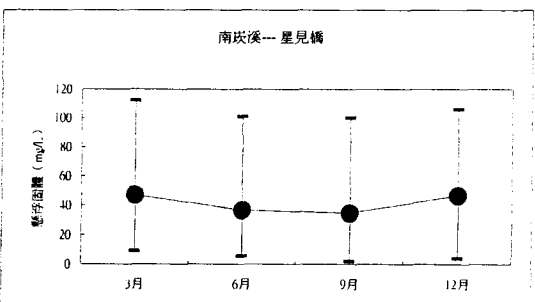
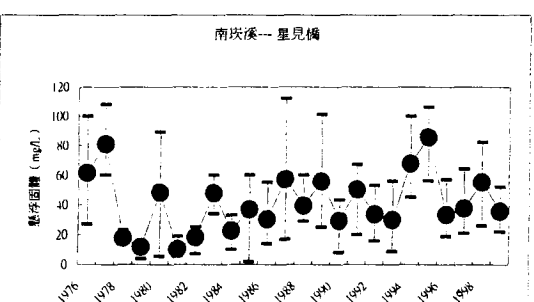
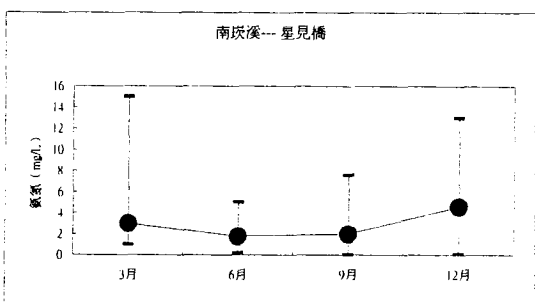
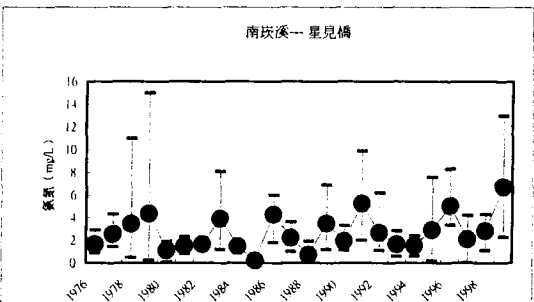
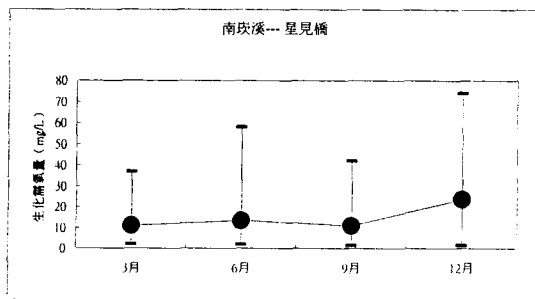
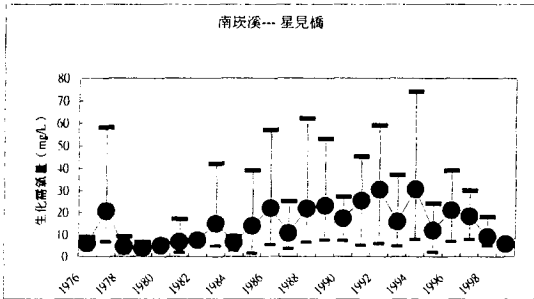
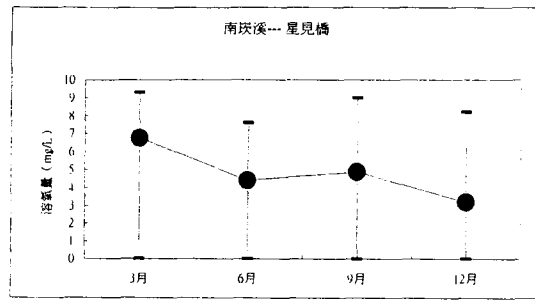
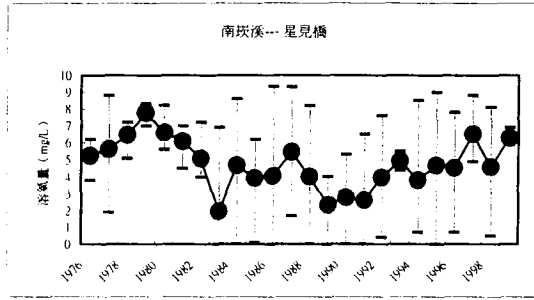


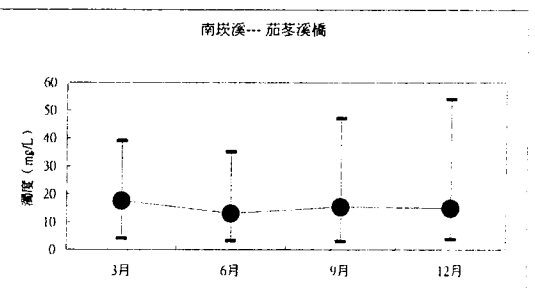
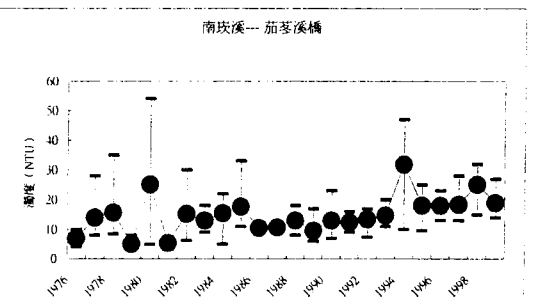
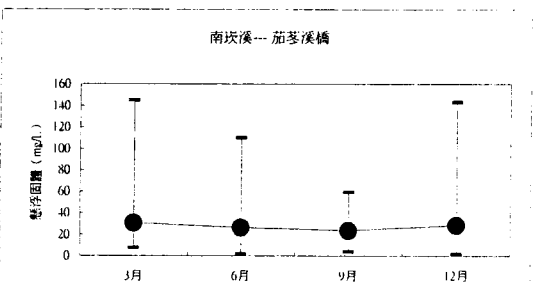
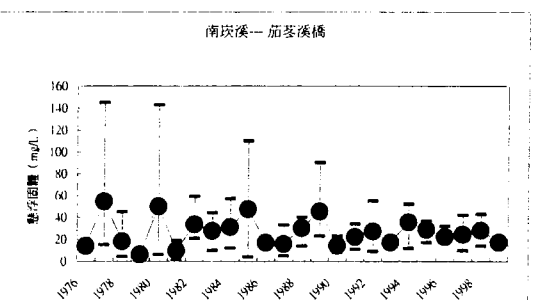
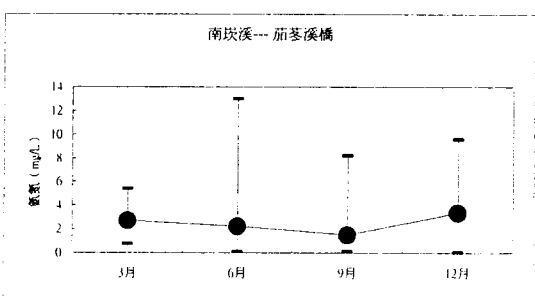
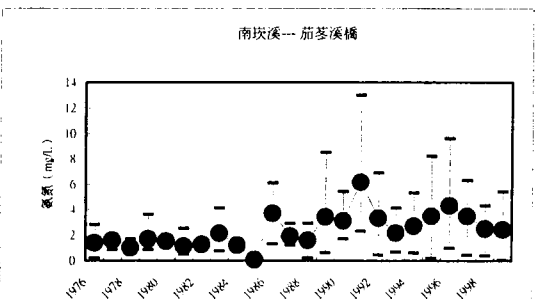
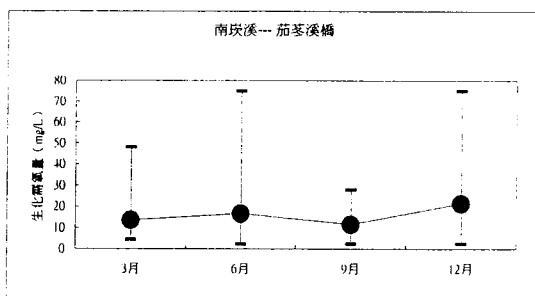
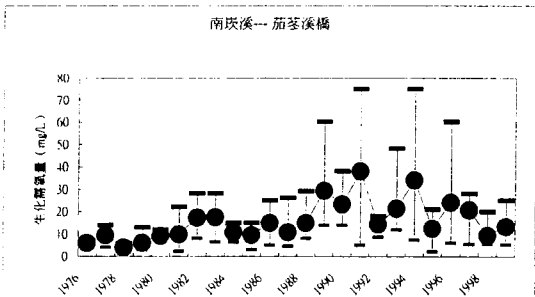
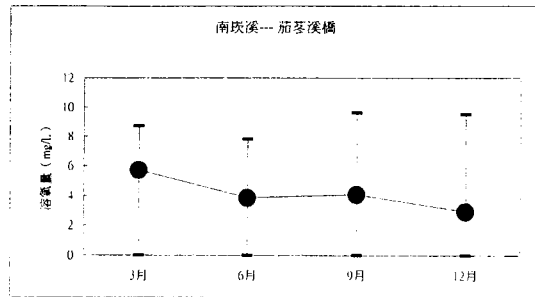
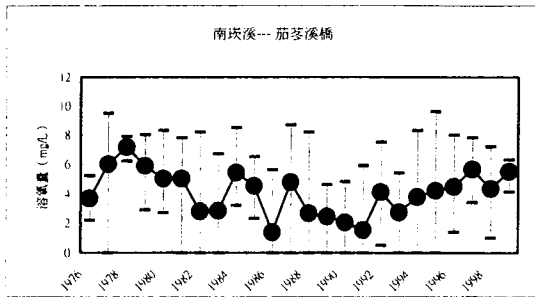




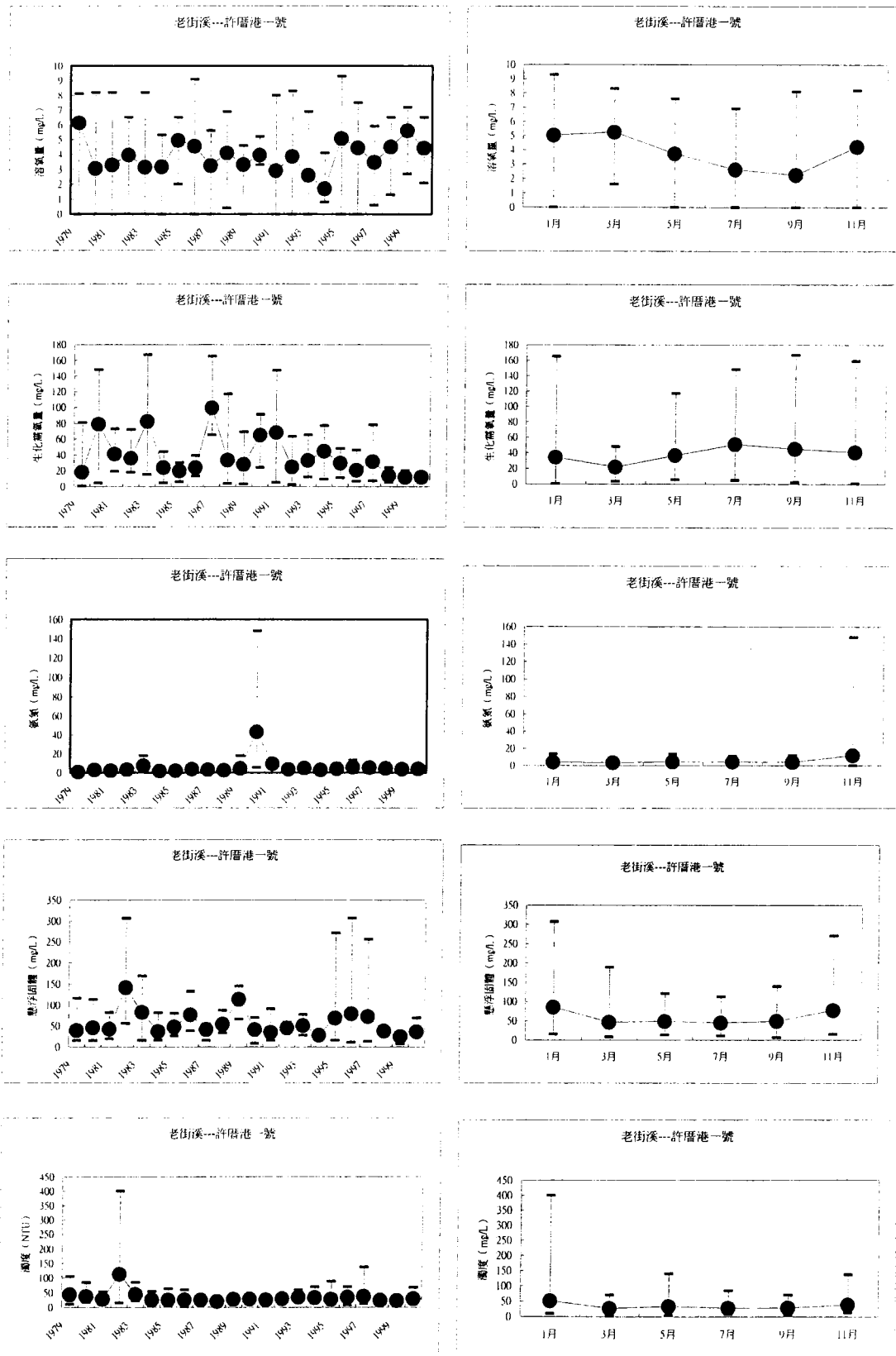


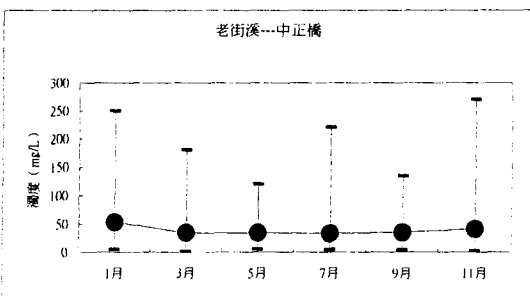
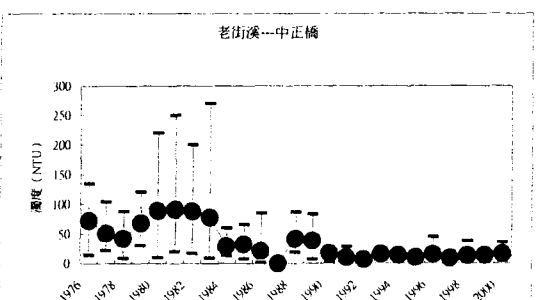
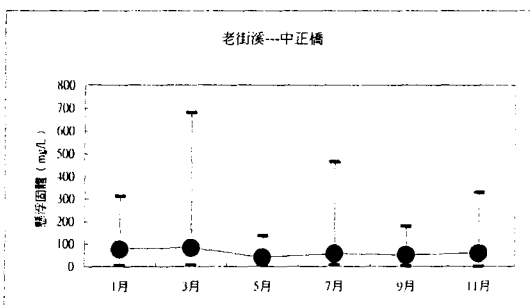
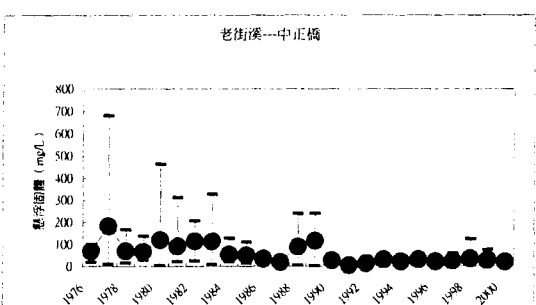
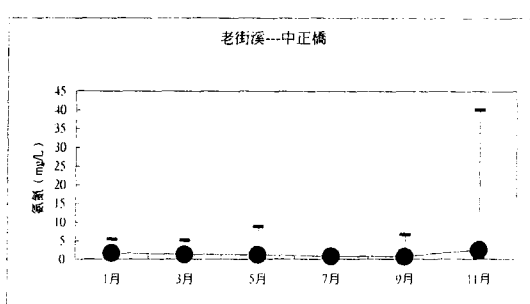
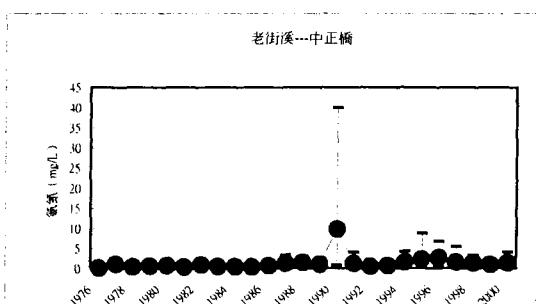
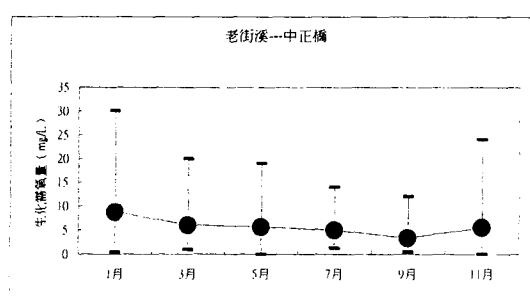
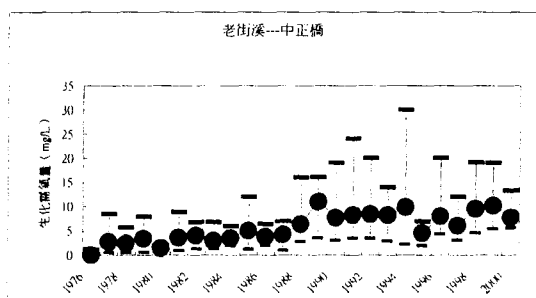
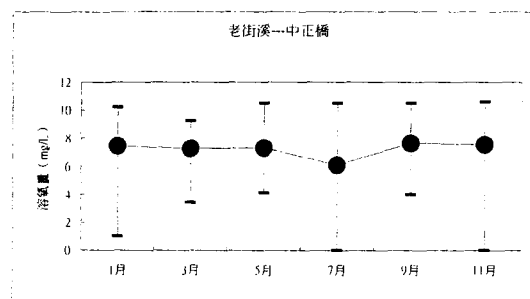
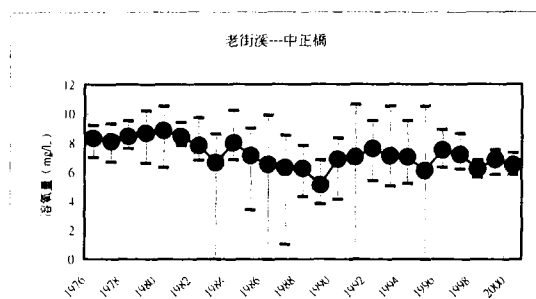


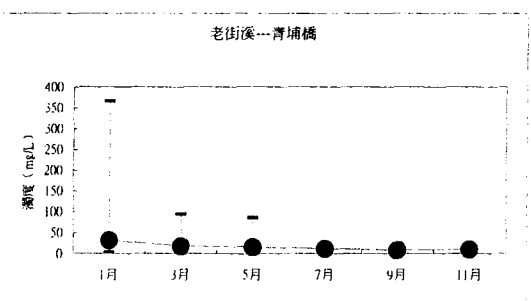
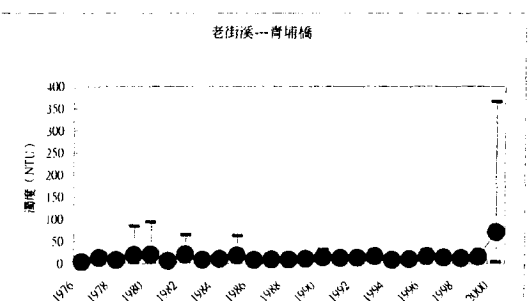
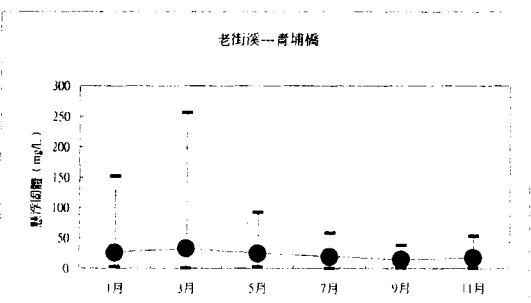
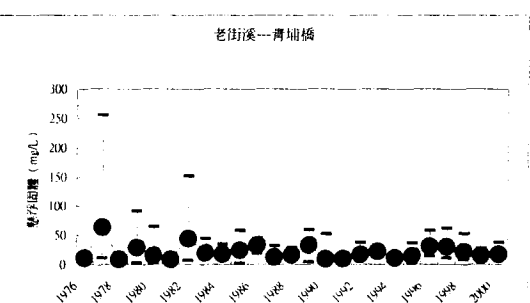
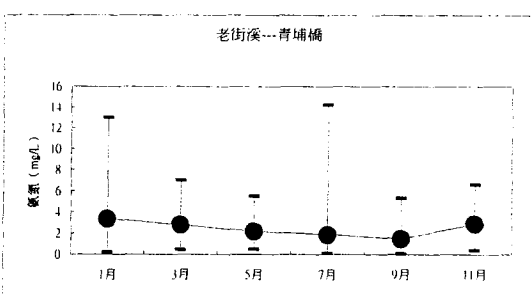
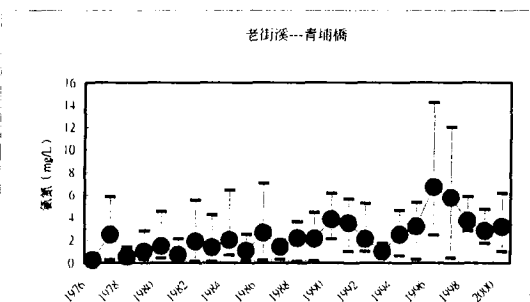
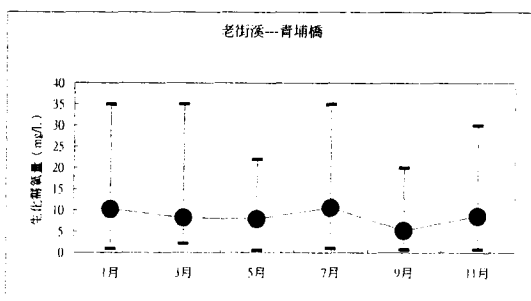
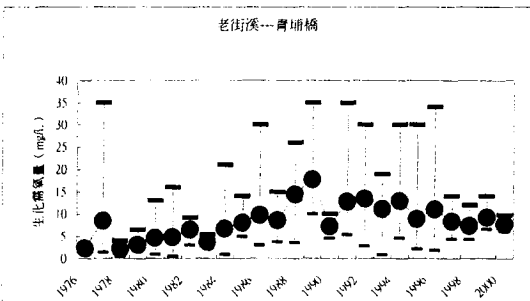
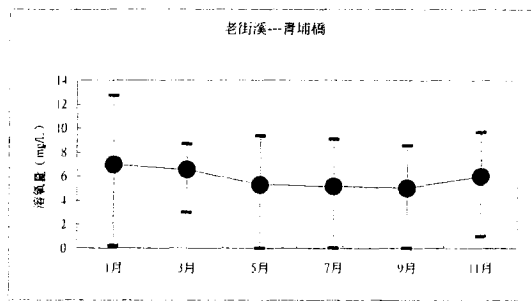
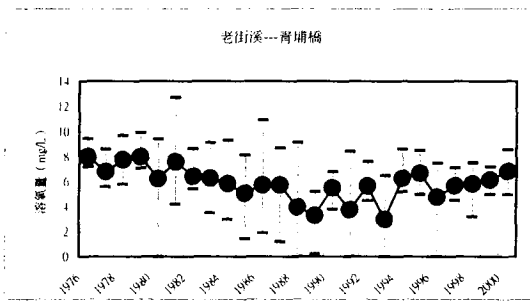


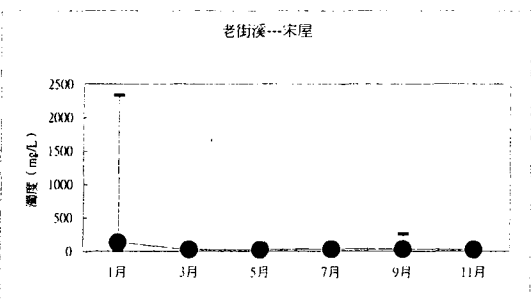
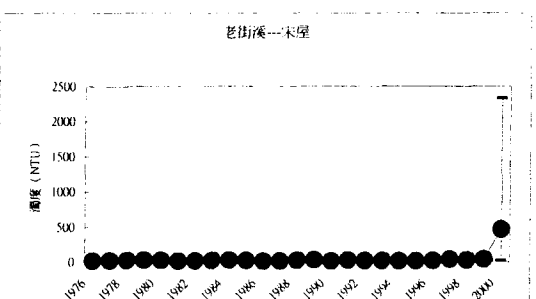
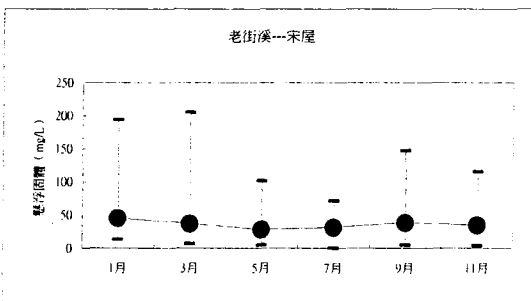
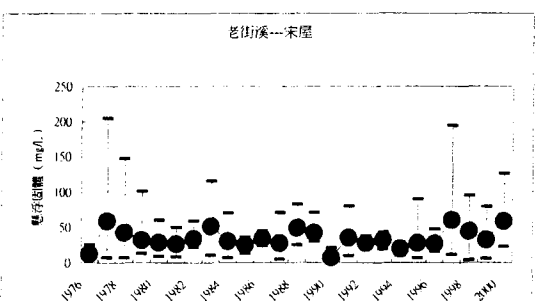
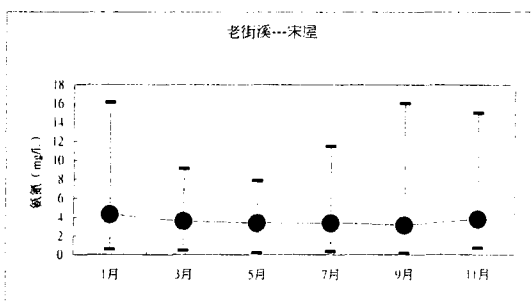
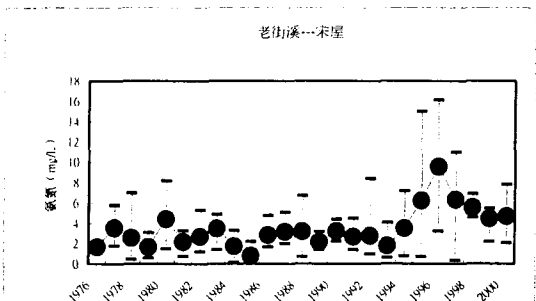
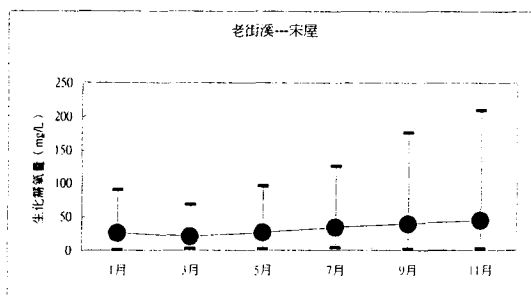
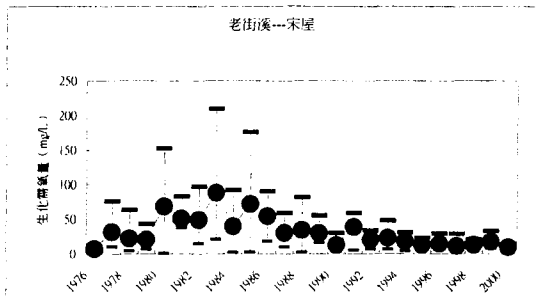
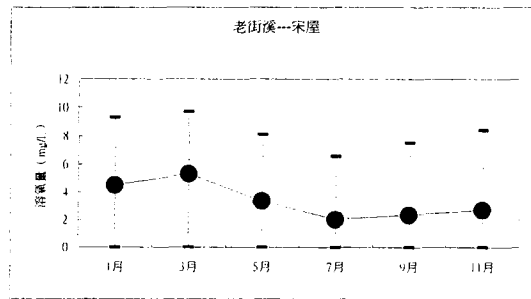
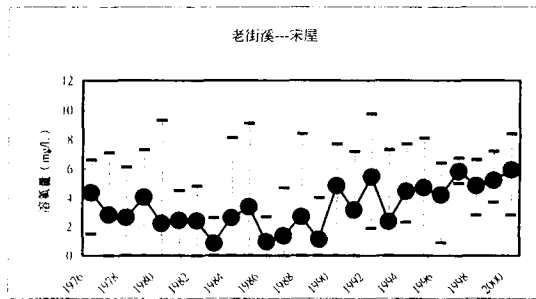


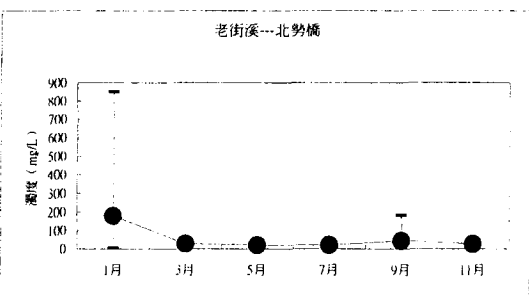
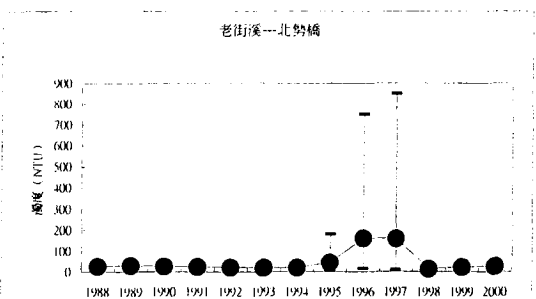
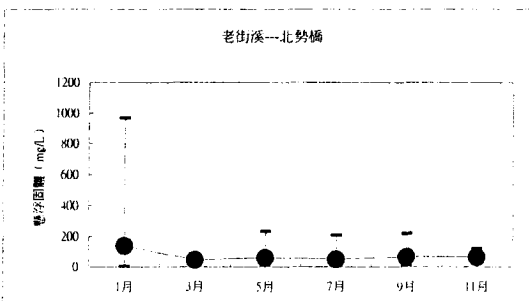
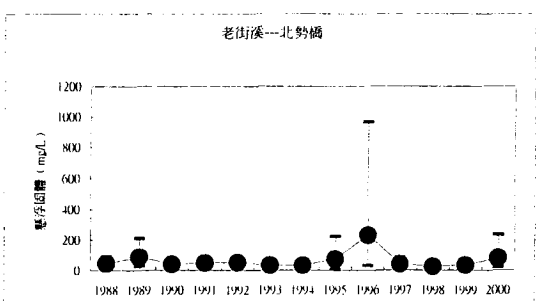
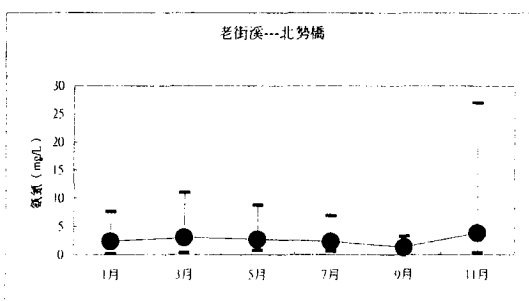
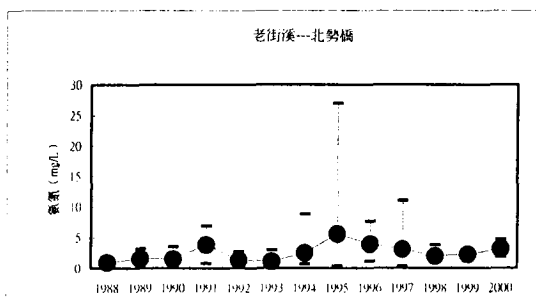
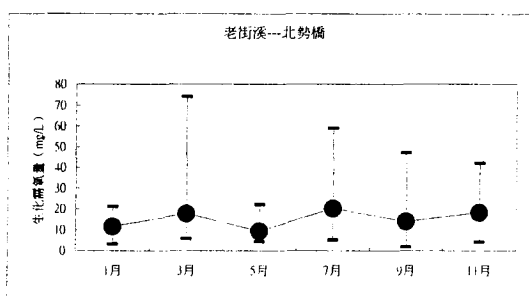
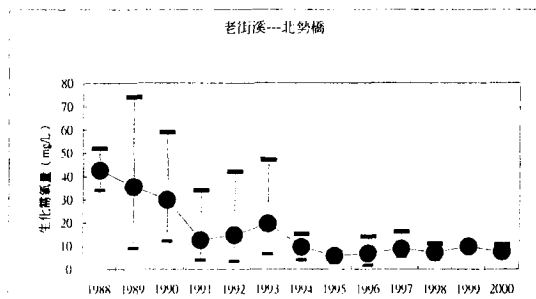
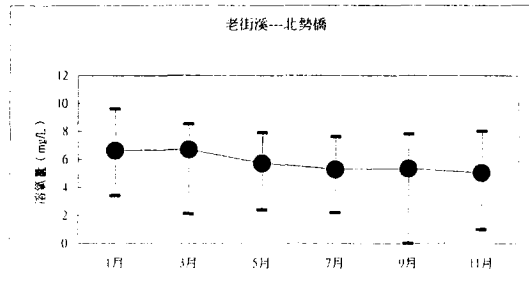
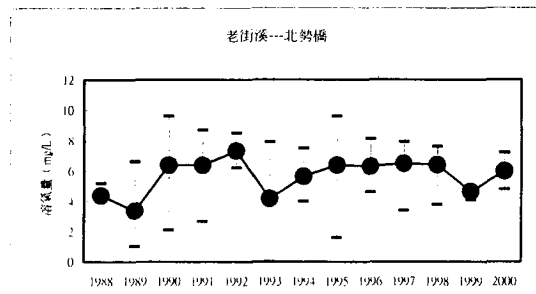
六、老街溪 (左欄是年度變化，右欄為月份間變化。●:平均值， $\top$: 該年度或該月份在不同年度間所曾經出現之最大值， $\perp$: 該年度或該月份在不同年度間所曾經出現之最小值)

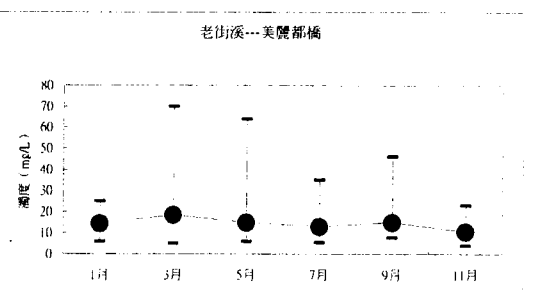
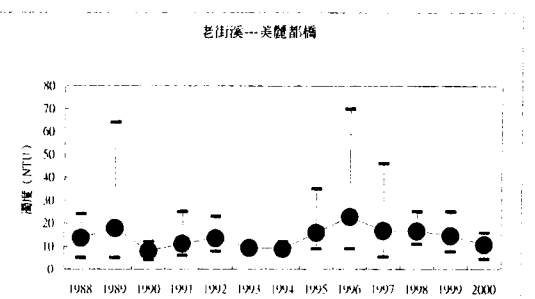
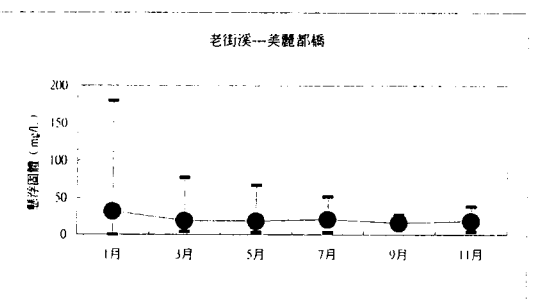
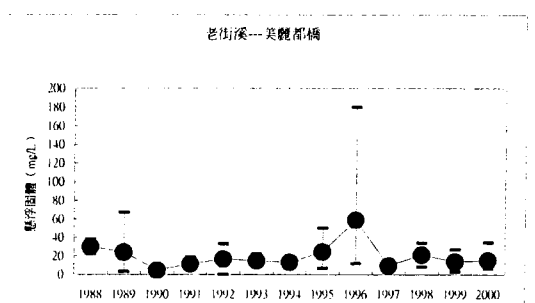
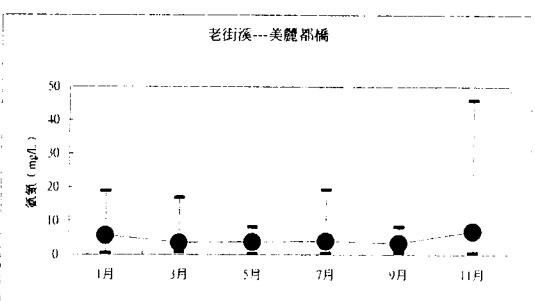
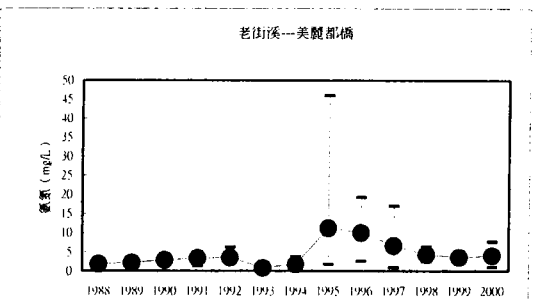
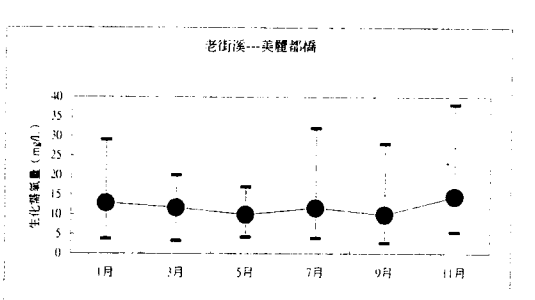
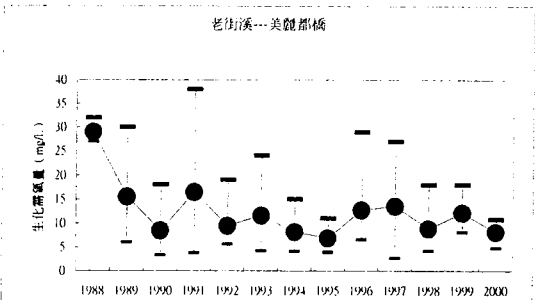
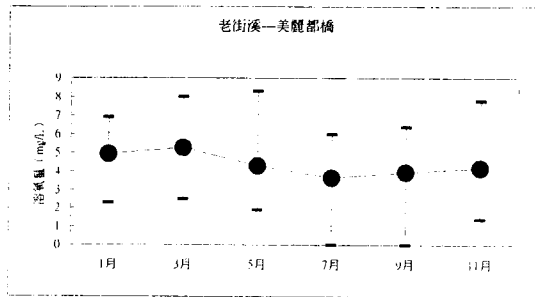
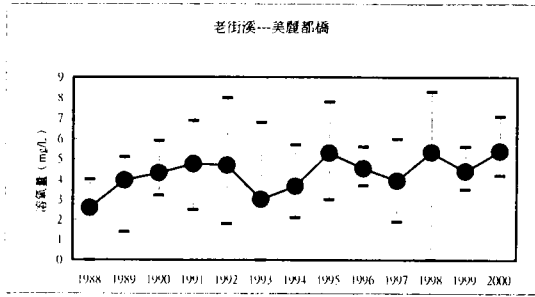


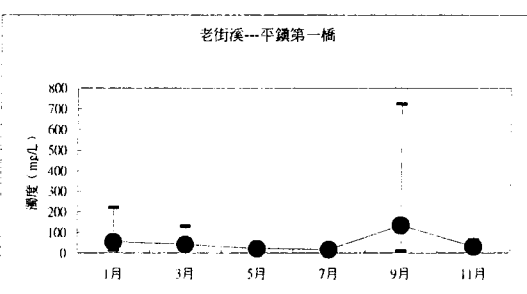
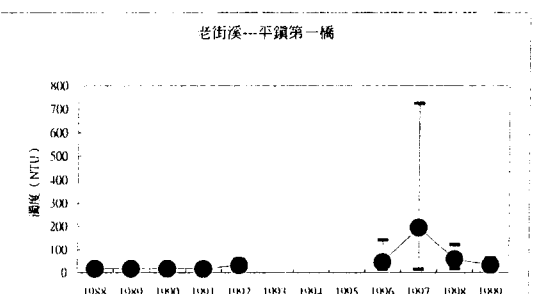
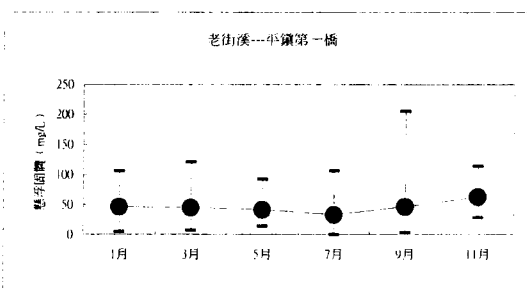
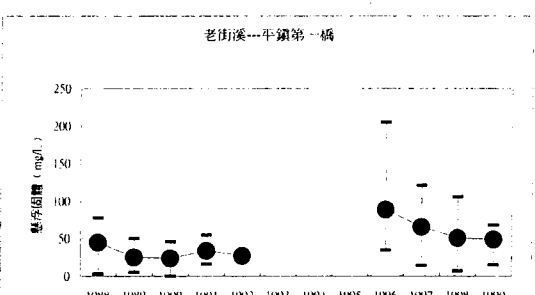
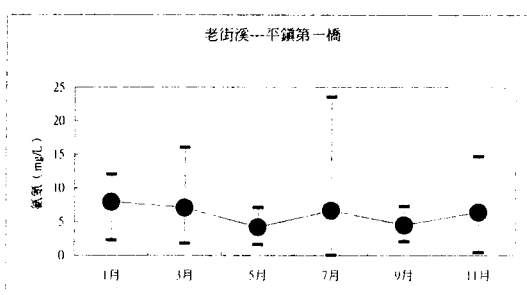
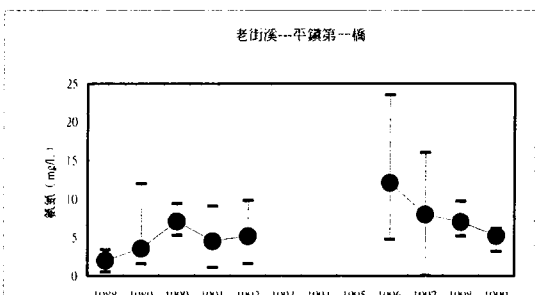
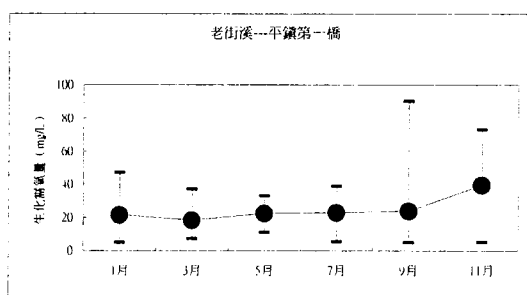
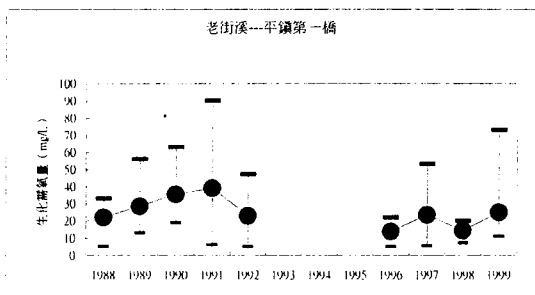
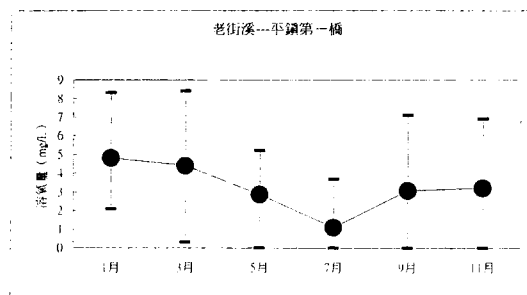
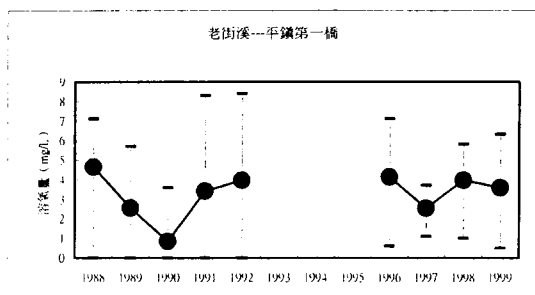




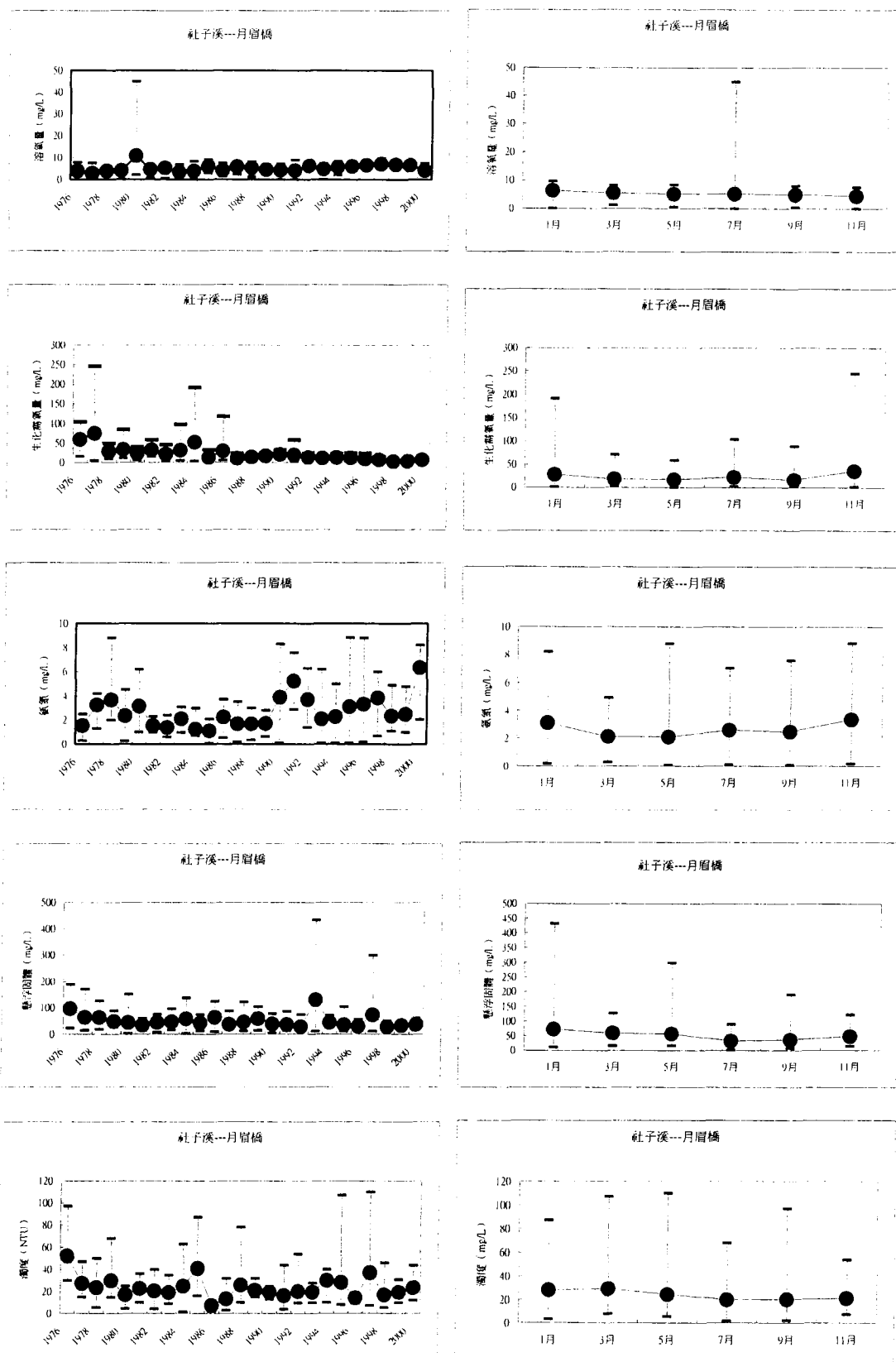


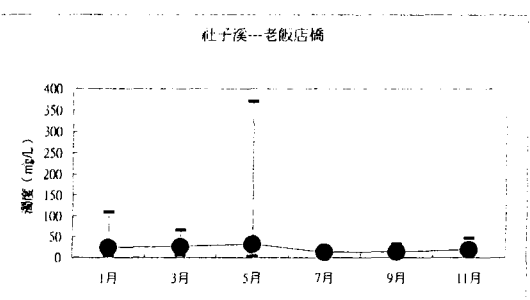
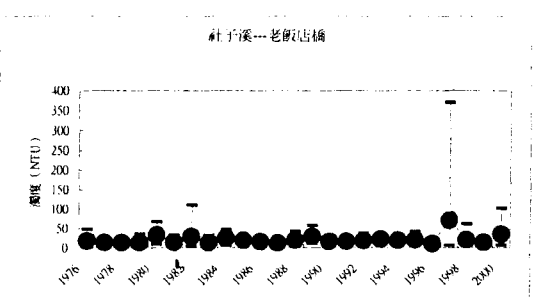
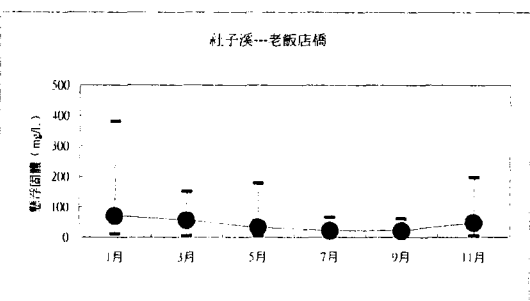
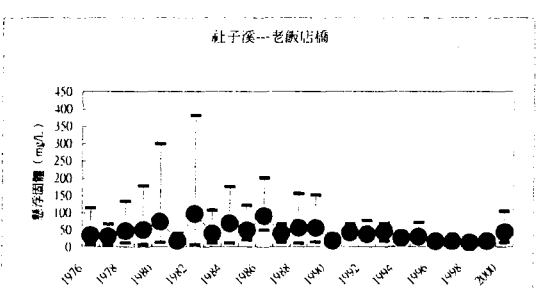
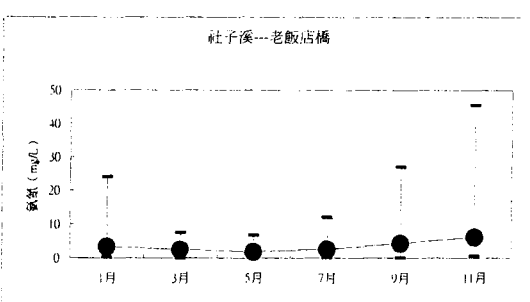
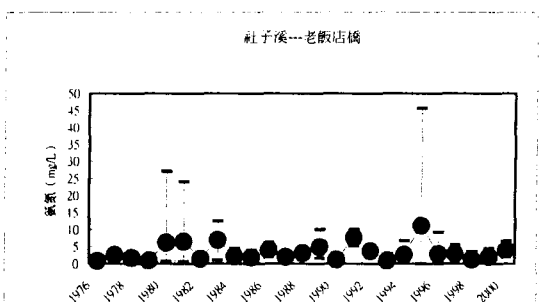
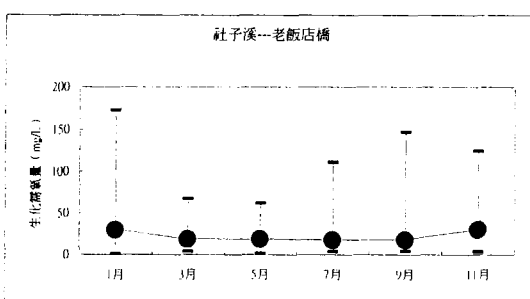
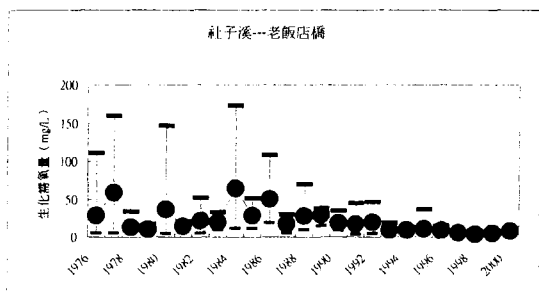
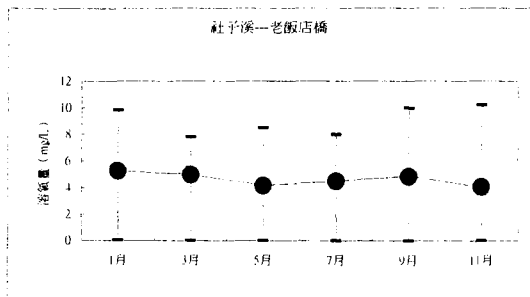
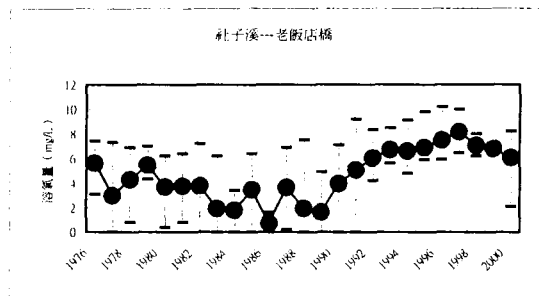


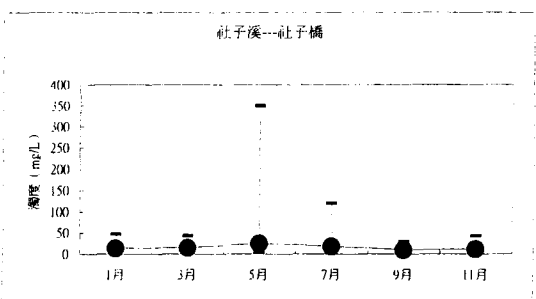
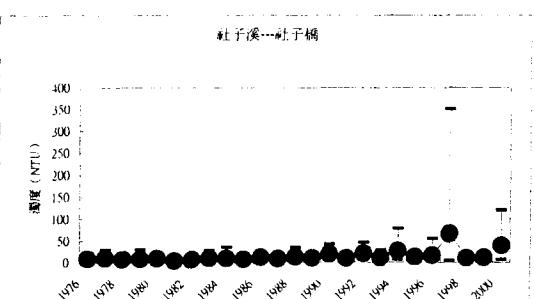
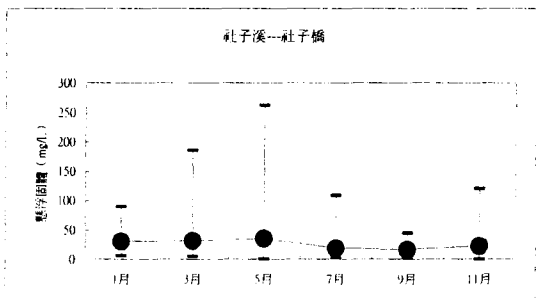
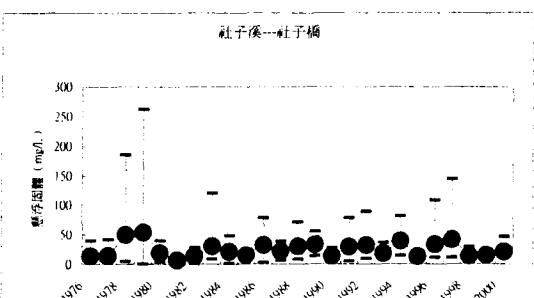
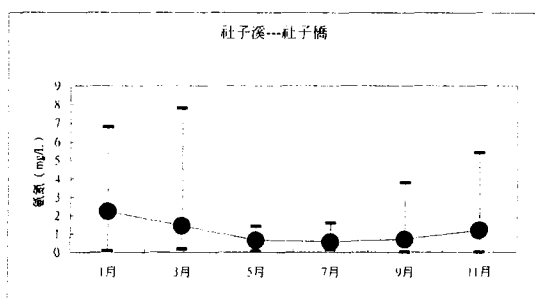
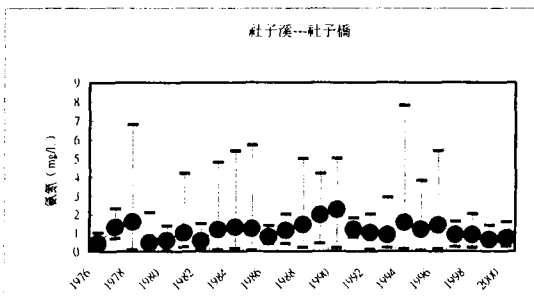
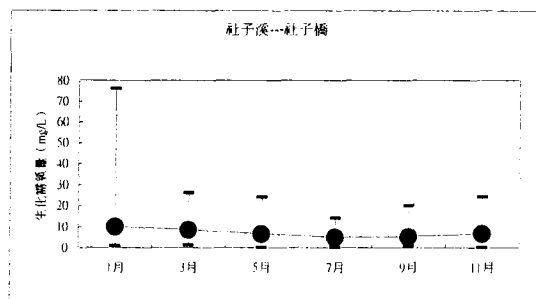
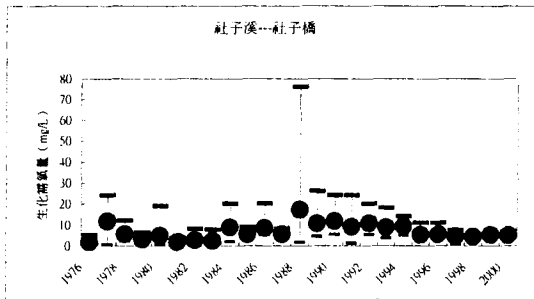
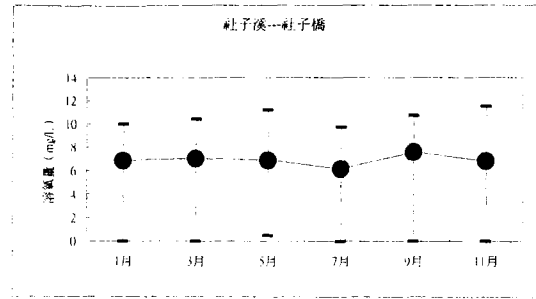
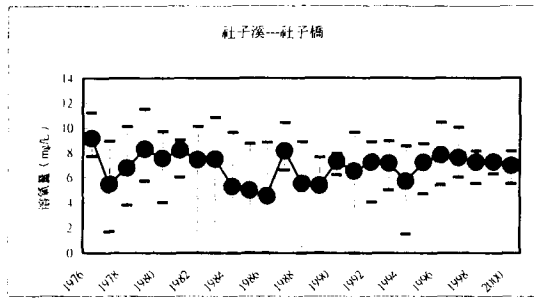


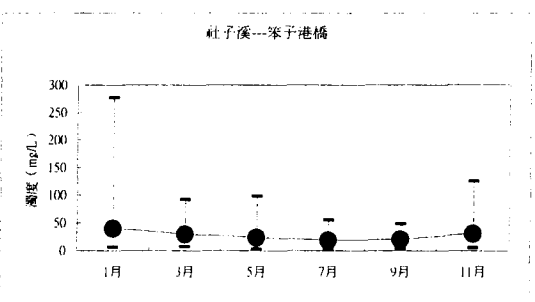
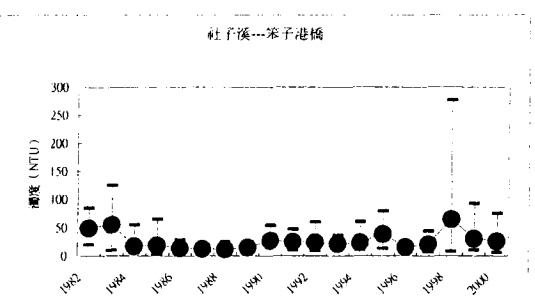
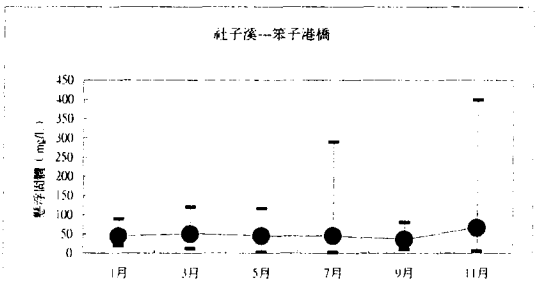
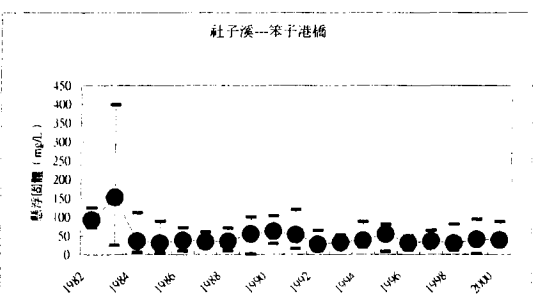
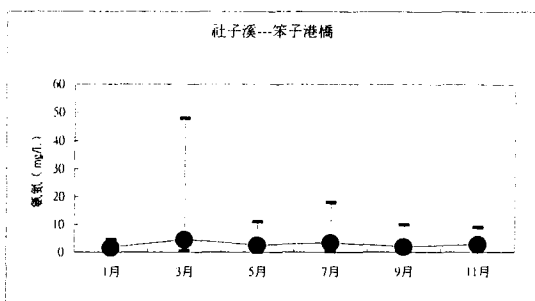
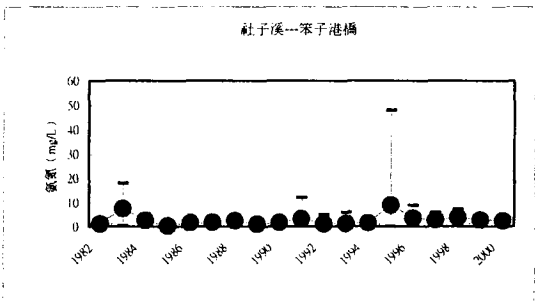
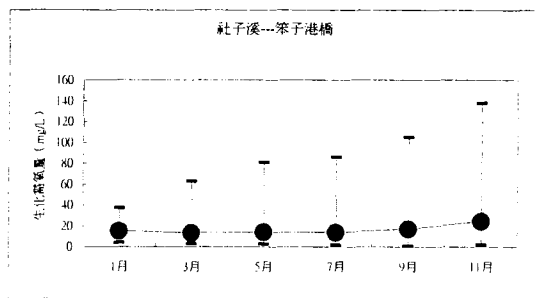
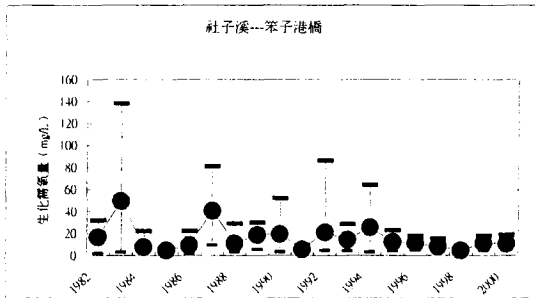
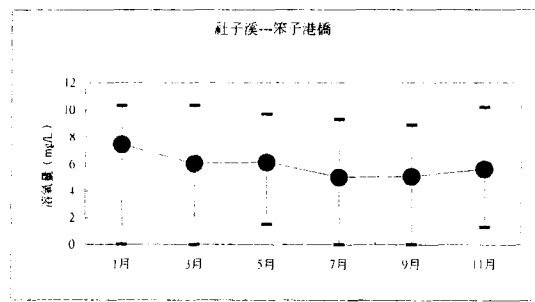
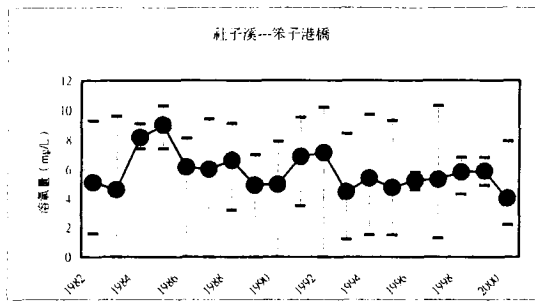


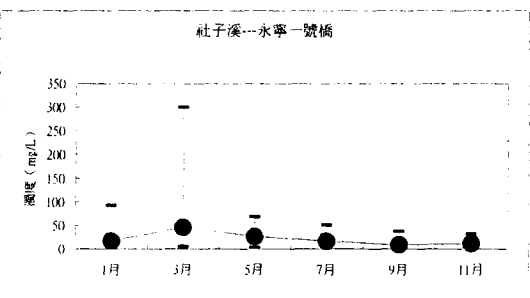
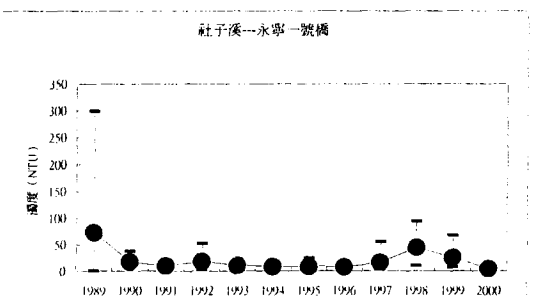
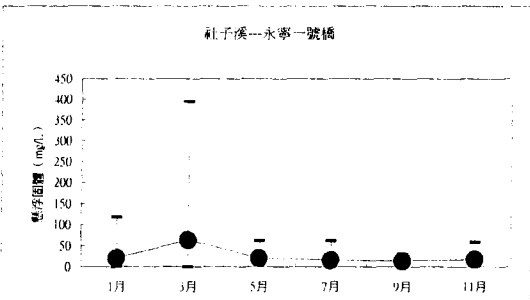
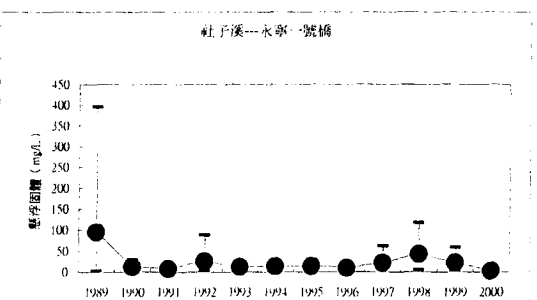
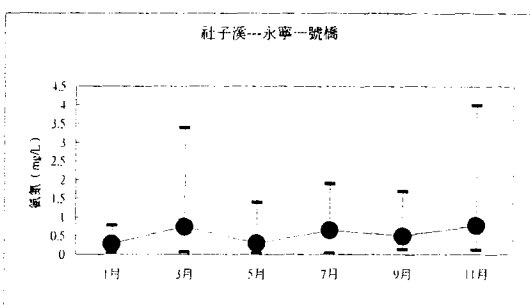
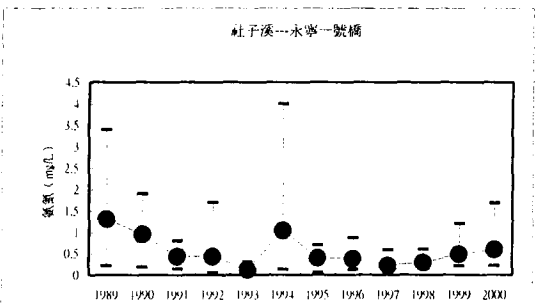
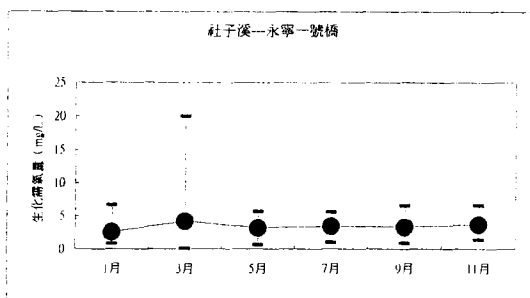
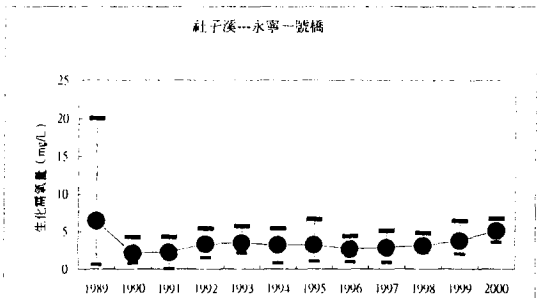
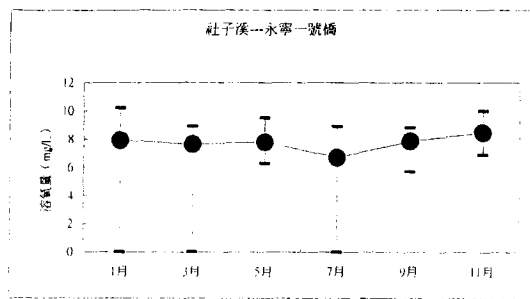
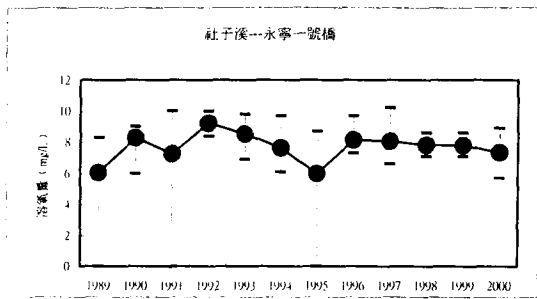
七、社子溪 (左欄是年度變化，右欄為月份間變化。●:平均值，┐:該年度或該月份在不同年度間所曾經出現之最大值，┑:該年度或該月份在不同年度間所曾經出現之最小值)











八、頭前溪（左欄是年度變化，右欄為月份間變化。●:平均值，┐: 該年度或該月份在不同年度間所曾經出現之最大值，┑: 該年度或該月份在不同年度間所曾經出現之最小值）

