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衛生福利部疾病管制署 102 年委託科技研究計畫

計畫名稱:運用即時氣象資料預測傳染病傳播風險之可行性 研究

# 年度/全程研究報告

執行機構:行政院衛生福利部疾病管制署

計畫主持人:劉宇倫

協同主持人:楊祥麟、郭宏偉

研究人員:袁偉勝、葉鎰維、秦松林、洪偉勝

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\*本研究報告僅供參考,不代表本署意見,如對媒體發布研究成果應 事先徵求本署同意\* 目 錄

頁 碼 封面 目錄 (3) 中文摘要 壹、前言 (5) 貳·材料與方法 (7) 叁、結果 (26) 肆、討論 (52) 伍、結論與建議 (55) 陸、計畫重要研究成果及具體建議 (56) (58) 柒、參考文獻 玖、附錄 (60) 共 (67)頁

#### 中文摘要

研究目的:

為提昇疾管署對於氣候因素相關傳染病流行之預警能力,本研究目的在:

1. 建立與外部單位之即時氣象資料之交換平台及氣象資料庫

建立使用即時氣象資料進行傳染病流行之預測模式
 研究方法:

本研究將與氣象資料研究單位合作,嘗試介接並參與跨政府的氣象相 關資料交換平台,建立署內即時氣象資料庫,並整理過去曾發表之氣候與 傳染病流行之相關文獻,評估可採用之預測模型,連結法定傳染病資料庫, 以建立一使用即時氣象資料進行傳染病傳染風險預測模型,並以GIS 軟體 將預測結果進行視覺化呈現。

#### 主要發現:

本研究成功介接國家災害防救科技中心及大氣研究資料庫的氣象資料,並自行開發資料轉檔程式,透過排程,可以自動及半自動方式進行氣象資料更新,主要測站氣象資料均可回溯自 1990 年。本次研究以成大及中山醫大研究成果的數理模式及推論,進行傳染病傳染風險預測實作,驗證豪雨、大豪雨 70 天後在南部地區可能導致的登革熱流行或是兩個星期後的區域性類鼻疽及鉤端螺旋體感染疫情,中山醫大的數理模式亦可用於南部登革熱疫情起始的推估,但兩個研究的模式及推論結果,無法套用到全國各鄉鎮,亦不能推估疫情規模。

#### 結論及建議事項:

本計畫建置之氣象資料庫可協助疾管署後續有關氣候與傳染病之相關 研究使用,計畫自行開發之氣象資料處理工具程式及資料庫表格綱要亦規

將提供欲建置氣象觀測資料庫的相關單位參考,可望減少研究人員在於氣象資料轉置可能面臨之困難。未來研究氣候相關傳染病傳染風險預測除可 將模式的使用更小的時間單位及鄉鎮自動測站資料以增加精確度外,亦可 將社經因子、疫苗涵蓋率等加入模型以增加推估的正確性。

關鍵詞: <u>氣象資料、雨量、溫度、傳染病、預測</u>

### 壹、 前言

國內有研究指出當週的平均溫度及累計雨量與隔週的病媒蚊布氏指數 具相關性[1]。另,國內有學者分析 2007 年台南市登革熱疫情暴發與氣候因 子之相關研究,發現颱風後的大量降雨會造成7週後登革熱病例數明顯增 加[2]。此外,本署同仁自行研究指出,氣壓、溫度、溼度、及降雨量是建 構病媒蚊密度級數預測模型重要的變項[3]。

成大蘇慧珍教授分析降雨量與傳染病的關係,並將每日降雨量分成 <=130 mm、131-200 mm (豪雨)、201-350 mm (大豪雨)及>350 mm (超大豪雨),發現降雨量多寡與八種傳染病(急性 A 型肝炎、腸病毒重症、 桿菌性痢疾、鉤端螺旋體感染、類鼻疽、恙蟲病、登革熱及日本腦炎)疫 情爆發有相關[4],超大豪雨與桿菌性痢疾疫情爆發及腸病毒流行有高度相 關,而蟲媒傳染病如登革熱與日本腦炎的疫情爆發危險僅與豪雨及大豪雨 有顯著相關。

依據監測資料顯示,2008年台北市5、6月平均雨量較1981-2010年 同期平均雨量高,於同年7、8月間台北市士林區爆發本土登革熱疫情(圖 1);另,依據2012年氣象資料顯示,台南市及高雄市的雨量自4月起較 1981-2010年同期平均雨量高,而台南市及高雄市亦分別於4月及5月出 現本土登革熱疫情(圖2、圖3)。故大量降雨易增加病媒蚊孳生,引發本 土登革熱疫情。



圖 1、台北市平均雨量及本土病例數比較圖



圖 2、台南市平均雨量及本土病例數比較圖



圖 3、高雄市平均雨量及本土病例數比較圖

過去雖然有很多研究在評估氣象因子與傳染病流行,但是少有研究是 使用即時氣象資料來進行傳染病流行風險預測,為提昇疾管署對與氣候因 素相關傳染病流行之預警能力,本研究目的在:

1. 建立與外部單位之即時氣象資料之交換平台及氣象資料庫

2. 建立使用即時氣象資料進行傳染病流行之預測模式

希望經由本研究強化疾管署對與氣候因素相關傳染病流行之預警能力。

貳、 材料與方法

一、 資料來源

(一)國家災害防救科技中心

衛生福利部疾病管制署(Centers for Disease Control, CDC)與國家災 害防救科技中心(National Science and Technology Center for Disaster Reduction, NCDR)於民國 97 年 5 月簽署合作備忘錄,建立跨部會資料與 災、疫情資訊之交換,並由國災中心備妥一電腦伺服器 Ll(Legacy Interface) Server(系統轉介伺服器)[5],透過研考會之政府憑證管理中心(GCA) 加密 機制進行資料傳輸,如圖四所示,以交換全國氣象資料與本署即時疫情監 測及預警系統(RODS)之急診病患通報次級資料及空床資料。由於雙方交 換之資料並無包含個人隱私資料,且透過開放連外 IP 之設定與資安管控, 故在資訊安全上的評估是無慮的。



圖4、資料傳輸架構

(二)大氣研究資料庫

大氟研究資料庫(Data Bank for Atmospheric Research, DBAR)於民 國 86 年之前名為副熱帶氣象資料庫,於民國 79 年開始正式設立於台灣大 學大氣科學系。從設立以來,資料庫負責收集大氣科學界所需之大部分資 料,並免費提供給相關學者使用,主要任務可分為三個部份:(1)收集世界 各國的氣象相關資料,(2)負責設計資料解碼及讀取程式,(3)免費提供資料 及諮詢服務。自民國 100 年 8 月起,由財團法人國家實驗研究院台灣颱風 洪水研究中心負責執行,大氣研究資料庫為國內學術研究界提供更完備的 氣象研究資源,並成為國內使用者互相交流、合作的服務平台。



(三)氣象資料格式說明

1. 氟象测站站台資料

大氣研究資料庫氣象資料之測站來自於中央氣象局的三十個局 屬氣象測站(表 1)之觀測資料,其欄位資料另外還包含經緯度、海拔 高度、測站建立年份等資訊(請參閱附件一),經收集整理後存於資料 庫的測站(Station)資料表,以利後續氣象觀測資料對應之使用。

測站代 碼	測站名稱	測站中文名 稱	地區	縣市	鄉鎮
466880	PANCHIAO	板橋	北區	新北市	板橋區
466900	TAMSUI	淡水	北區	新北市	淡水區
466910	ANBU	鞍部	北區	台北市	北投區
466920	TAIPEI	台北	北區	台北市	中正區
466930	ZHUZIHU	竹子湖	北區	台北市	北投區
466940	KEELUNG	基隆	北區	基隆市	中山區
466950	PENGJIAYU	彭佳嶼	北區	基隆市	中正區
466990	HUALIEN	花蓮	東部	花蓮縣	花蓮市
467060	SU-AO	蘇澳	東部	宜蘭縣	蘇澳鎮
467080	YILAN	宜蘭	東部	宜蘭縣	宜蘭市
467110	KINMEN	金門	外島	金門縣	金城鎮
467300	DONGJIDAO	東吉島	外島	澎湖縣	望安鄉
467350	PENGHU	澎湖	外島	澎湖縣	馬公市
467410	TAINAN	台南	南區	台南市	中西區
467420	YONGKANG	永康	南區	台南市	永康區
467440	KAOHSIUNG	高雄	南區	高雄市	前鎮區
467480	CHIAYI	嘉義	中區	嘉義市	西區
467490	TAICHUNG	台中	中區	台中市	北區
467530	ALISHAN	阿里山	中區	嘉義縣	阿里山 鄉
467540	DAWU	大武	東區	臺東縣	大武鄉
467550	YUSHAN	玉山	中區	南投縣	信義鄉
467571	HSINCHU	新竹	北區	新竹縣	竹北市
467590	HENGCHUN	恆春	南區	屏東縣	恆春鎮
467610	CHENGGON G	成功	東區	台東縣	成功鎮
467620	LANYU	蘭嶼	東區	台東縣	蘭嶼鄉
467650	SUN MOON LAKE	日月潭	中區	南投縣	魚池鄉
467660	TAITUNG	台東	東區	台東縣	台東市
467770	WUQI	梧棲	中區	台中市	梧棲區
467780	CHIKU	七股	南區	臺南市	七股區
467990	MATSU	馬祖	外島	連江縣	南竿鄉

表 1、中央氣象局局屬氣象測站

2. 國家災害防救科技中心氣象資料

由國家災害防救科技中心提供之全國氣象資料包含中央氣象局 局屬測站氣象資料及雷達雨量站整合降水估計資料,其資料的交換 頻率及檔案格式如表 2,國災中心之資料提供端會透過系統自動將全 國氣象資料彙整且提供於 LI Server 上,本署之接收端則定期於 FTP 上接收資料,再進行所需的資料處理並存於自行建置之氣象資料庫。

表 2、全國氣象資料

資料來源單	資料名稱	資料傳送頻	檔案	傳送方式	下載方式
位		率	格式		
國災中心	中央氣象局	1 次/10 min	mdf	提供於 LI	FTP 資料夾
	局署測站氣			Server	
	象資料				

國災中心所提供的每 10 分鐘氣象測站資料,其檔案名稱之格式為 「QPESUMS\_STATION.10M.YYYYMMDDHHMI.mdf」,YYYY 為西元 年,MM 為月,DD 為日,HH 為時,MI 為分,可透過讀取檔案名稱取 得測站資料時間,觀測資料之內容(圖 6)配合主要欄位資料對應表(表 3) 即可取出各項欄位資料,並以測站代碼與測站時間為鍵值,即可作為每 10 分鐘某測站之氣象觀測資料。

📄 QPE:	SUMS_STA	TION.10M.20	1311090800	.mdf 🔀											
1		101 ! (c)	2002 Oki	lahoma Cli	mate Survey	y - all	rights r	eserved	1						
2	19 20	13 11 09 0	8 00 00												
3	STID	STNM	TIME	LAT	LON	ELEV	WDIR	WDSD	TEMP	HUMD	PRES	CITY	CITY_SN	TOWN	TOWN_SN
4	466850	五分山站	1	25.0728	121.7725	757	160.0	9.5	20.2	0.95	931.4	新北市	06	瑞芳區	018
5	466940	基隊	1	25.1348	121.7321	27	150.0	3.7	27.1	0.72	1011.9	基隊市	03	中山區	010
6	466900	淡水	1	25.1656	121.4400	19	310.0	1.7	25.1	0.83	1013.0	新北市	06	淡水區	004
7	466880	板橋	1	24.9993	121.4338	10	70.0	2.2	29.3	0.57	1012.9	新北市	06	板橋區	041
8	466930	竹子湖	2	25.1650	121.5363	607	210.0	0.9	23.1	0.81	947.3	臺北市	01	北投區	006
9	466910	鞍部	1	25.1865	121.5202	826	190.0	4.3	20.7	0.84	923.7	臺北市	01	北投區	006
10	467571	新竹	1	24.8300	121.0061	34	290.0	1.9	25.0	0.79	1011.8	新竹縣	10	竹北市	064
11	467490	臺中	1	24.1475	120.6759	84	210.0	1.2	28.1	0.65	1004.9	臺中市	02	北區	128
12	467770	梧棲	1	24.2587	120.5151	7	260.0	3.6	24.2	0.83	1011.8	臺中市	02	梧棲區	118
13	467350	澎湖	1	23.5672	119.5552	11	10.0	4.1	25.5	0.75	1013.6	澎湖縣	23	馬公市	212
14	467650	日月澤	1	23.8830	120.8999	1015	340.0	1.0	23.0	0.80	905.0	南投縣	13	魚池鄉	164
15	467530	阿里山	2	23.5104	120.8051	2413	90.0	1.3	14.8	0.72	769.9	嘉義縣	17	阿里山鄉	208
1.2	407530	門里田	2	23.5104	120.0051	2413	90.0	1.5	14.0	0.72	/69.9	氟钙称	17	門里田卿	20

## 圖 6、國災中心氣象資料內容

表 3、 國災中心氣象資料主要欄位

欄位名稱	欄位說明	資料對應位置
STID	測站代碼	1-6
WDIR	風向	58-64
WDSD	風速	65-71
TEMP	溫度	72-78
HUMD	濕度	79-85
PRES	氣壓	87-93

3. 大氣研究資料庫氣象資料

大氣研究資料庫提供許多類型之氣象資料的查詢服務,如歐洲展 期天氣預報中心(ECMWF)、測站資料、分析天氣圖、雷達、衛星雲 圖、海象資料,本計畫所需的氣象資料為每日的氣象測站觀測資料, 故選擇測站資料中的「局屬測站逐日」,並勾選正常運作的三十個局 屬測站及輸入欲查詢的日期區間(圖 7),查詢後資料可透過加入暫存 區的方式並於個人檔案管理中下載。

起始時間: 2013/05/01	🛄 結束時	間: 2013/05/31	(格式: yyyy/n	nm/dd 範例:1985/12/02)	
ECMWF 测站資料	分析天氣圖	雷達 衛星雲	圖 海象資料		
資料類型: [氣象局]_局屬測	站逐日  ▼	選擇完成後可進	〔入「資料倉儲」→「	資料暫存區」檢視與	與壓縮檔案
■*466921臺北( ■*467411亭南(	師院)▼466930竹 永康)▼466940其	子湖▼467300東吉 逢 ▼467350澎湖	¦島☑467530阿里山 ☑467540大武	☑467620蘭嶼 ☑467650日月遭	
□*467570新竹	☑466950彭(	畫嶼☑467410臺南	〕 ☑467550玉山	☑467660 <u>臺</u> 東	
☑466880板商 ☑466900淡水	1466990征3 11467060蘇注	庫	2 ■467571新竹 2 ■467590恆春	☑467770梧棲 ☑467780七股	
☑466910鞍部 ☑466920喜北	✓467080宜 ▼467110全日	嶺 ▼467480嘉義 門 ▼467490亭中	៖ <b>☑</b> 467610成功	☑467990馬祖	
民航局站點暨格式說明	用氣象局站點說明	( 局屬站、 自動測	站 、測站地圖 ) 氣	象局測站格式說明	開始查詢

圖 7、大氣研究資料庫資料查詢功能

每日氣象測站的觀測資料為 txt 檔,檔案名稱的格式名為 「CWB\_D\_測站代碼\_YYYYMM.txt」,測站代碼為氣象局局屬測站 之代碼,YYYY為西元年,MM為月份,一個 txt 檔代表一個測站在 某個年月的觀測資料,檔案內則包含該月份下逐日的測站日期,以 測站代碼與測站日期為鍵值,即可作為每日該測站之氣象觀測資 料。雖然在檔案名稱的命名上統一用此格式,但在檔案內之資料格 式,則依據「1897 年至 1950 年」、「1951 年至 2008 年」、「2009 年之後」等三個時間分成三種不同的資料格式,在資料萃取時必須 根據個別格式進行處理,其詳細的資料格式說明可參考中央氣象局 測站資料說明

(http://dbar.ttfri.narl.org.tw/DataDesc/%E4%B8%AD%E5%A4%A E%E6%B0%A3%E8%B1%A1%E5%B1%80%E6%B8%AC%E7% AB%99%E8%B3%87%E6%96%99%E8%AA%AA%E6%98%8E %28update@201112%29.pdf) °

(四) 法定傳染病資料

本研究計畫法傳資料擷取疾管署疫情倉儲之法定傳染病通報系統 資料庫,發病日期自2002年1月1日至2013年10月31日共約12 年份,每名確定病例擷取資料欄位包含「發病時間」、「居住縣市」、「疾 病別」等欄位。 (五) 布氏指數資料

此資料乃取自疾管署內防疫資訊匯集平台,資料來自各縣市衛生局 所病媒蚊調查資料。

二、方法

(一)資料處理與轉入資料庫

為了將國災中心提供之氣象資料與大氣研究資料庫的氣象資料作 為後續研究使用,需將資料作有效且容易利用的儲存,故使用 Microsoft SQL Server 2008 建置一氣象資料庫供資料轉入、存放,除了上一節所 提到的測站站台資料外,另外於資料庫建置三個儲存觀測資料之資料表 (表 4),該氣象資料庫關聯資料模型及資料表綱要如附件二。

資料表名稱	資料來源	說明
QPESUMS_STATIO	NCDR	儲存「每10分鐘」測站氣
N_10M		象觀測資料
QPESUMS_STATIO	NCDR	由每10分鐘氣象觀測資料
N_1D		彙整後的「每日」氣象觀測
		資料
DAILY_STATION_D	大氣研究資料	氣象局局屬測站「每日」氣
ATA	庫	象觀測資料

表 4、氣象資料庫資料表

本研究透過自行開發資料處理工具(表 5),將資料轉入資料庫的部分採 半自動化的方式,透過開發一上傳介面以及自動排程上傳資料的程式上傳 氣象觀測資料,上傳程式採用 Asp.net Windows Form 開發,程式語言為 vb.net,圖 8 為上傳程式之介面。

自動排程程式			Windows Form 上傳介面		
1.	讀取 FTP 上氣象資料	1.	瀏覽並讀取已下載之氣象資		
2.	處理資料格式		料		
3.	由每10分鐘資料彙整逐日資	2.	處理資料格式		
	料	3.	資料上傳至氣象資料庫		
4.	資料上傳至氣象資料庫				
5.	空值资料以國災氣象資料代				
	替之處理				

表 5、 資料處理工具功能

6	Meteor	ology Data Input		
*	氧研究制	翻線 國際由心気象溶料	1	
	TXT		上傳進度:	.7%
	瀏覽	停止上傳		
Г	1	Name	Path	~
	· c	WB_D_466880_201304.txt	E/Brian_DATA/氯象資料/大氣資料庫/download/2013年4月/CWB_D_466880_201304.txt	
	C	WB_D_466900_201304.txt	E:Brian_DATA\氯象資料\大氣資料庫\download\2013年4月\CWB_D_466900_201304.txt	
	C	WB_D_466910_201304.txt	E:Brian_DATA\氯象資料\大氣資料庫\download\2013年4月\CWB_D_466910_201304.txt	
	C	WB_D_466920_201304.txt	E:Brian_DATA\氯象資料\大氣資料庫\download\2013年4月\CWB_D_466920_201304.txt	_
	C	WB_D_466930_201304.txt	E:Brian_DATA\氯象資料\大氣資料庫\download\2013年4月\CWB_D_466930_201304.txt	
	C	WB_D_466940_201304.txt	E:Brian_DATA\氯象資料\大氣資料庫\download\2013年4月\CWB_D_466940_201304.txt	
	C	WB_D_466950_201304.txt	E:Brian_DATA\氯象資料\大氣資料庫\download\2013年4月\CWB_D_466950_201304.txt	
	C	WB_D_466990_201304.txt	E:Brian_DATA\氯象資料\大氣資料庫\download\2013年4月\CWB_D_466990_201304.txt	
	C	WB_D_467060_201304.txt	E:Brian_DATA\氯象資料\大氣資料庫\download\2013年4月\CWB_D_467060_201304.txt	
	C	WB_D_467080_201304.txt	E:Brian_DATA/氯象資料/大氣資料庫Vdownload/2013年4月/CWB_D_467080_201304.txt	
	C	WB_D_467110_201304.txt	E:Brian_DATA/氯象資料/大氣資料庫Vdownload/2013年4月/CWB_D_467110_201304.txt	
	C	WB_D_467300_201304.txt	E:Brian_DATA\氯象資料\大氣資料庫\download\2013年4月\CWB_D_467300_201304.txt	
	C	WB_D_467350_201304.txt	E/Brian_DATA/氯象資料/大氣資料庫Vdownload/2013年4月/CWB_D_467350_201304.txt	
	C	WB_D_467410_201304.txt	E/Brian_DATA/氯象資料/大氣資料庫Vdownload/2013年4月/CWB_D_467410_201304.txt	
	C	WB_D_467420_201304.txt	E/Brian_DATA/氯象資料/大氣資料庫Vdownload/2013年4月/CWB_D_467420_201304.txt	
	C	WB D 467440 201304.txt	E:Brian DATA\氯象資料\大氣資料庫Wownload\2013年4月\CWB D 467440 201304.bt	~
_				

圖 8、氣象資料上傳介面

本研究透過標準作業流程來處理來源端提供之氣象資料(圖 9),經由資 料介接、資料處理並且轉存至本署所建置之氣象資料庫,供後續研究使用。 然而兩種氣象資料在上傳的時機點以及處理方式稍有不同,大氣研究資料 庫的氣象資料會在當月份結束後一個月才在網站上更新,故轉入資料庫的 方式必須採用上傳介面以手動方式上傳所下載的氣象資料,而國災中心的 每10分鐘氣象資料則會在測站時間的十個小時後轉進LI Server,故透過 自動排程的方式存取 FTP 的資料並存進資料庫是較為方便的。另外,也透 過自動排程將國災中心每10分鐘氣象資料彙整為每日氣象資料,供使用者 方便查詢。氣象資料的處理主要為讀取檔案並找出所有相對應的觀測資 料,而少部分觀測資料會有異常的情況出現,在資料中以「-9999」、「-99」、 「-998」、「998」、「999」等數值代表異常資料,本研究以程式處理後轉換 為空值(NULL Value)存入資料表,以減少使用者於判讀資料內容時可能會 造成的誤解。

大氣研究資料庫所提供之資料歷史悠久,觀測項目豐富且資料完整, 故本研究以大氣研究資料庫資料為主要氣象資料,將大氣研究資料庫資料 中出現缺值的部分觀測資料(風向、風速、溫度、濕度、氣壓),以國災中心 的氣象資料作為取代值填入,確保逐日氣象觀測資料的完整性。



(二)統計資料處理

1. 統計分析軟體

本研究使用 SAS EG(Enterprise Guide)來進行資料統計分析及模型建構。SAS 是一個功能龐大的軟體,主要處理的工作為資料處理及統計分析, 故可視為一種統計套裝軟體。SAS 語言可讓使用者依需要撰寫程式去得到 所需的結果。SAS EG 可提供視覺化的操作介面,方便使用者操作應用程 式,可降低統計分析的門檻。 該軟體具有如下列幾個主要功能:

- (1) 可自訂直覺式且視覺化的使用者介面。
- (2) 可更安全存取原始資料,方便資料庫的使用者權限管理。
- (3) 分析資料以流程的方式來編輯,可以降低使用者的門檻。
- (4) 可對相關的程序分門別類為分析、報表、圖表、查詢等功能。
- (5) 可支援自動化排程處理與相關的指令碼產生器。
- (6) 可以支援用程式碼編輯的程式。
- 2. 氣象資料篩選

在本研究中,利用 SAS server 連結前述建置之氣象資料庫,其 資料庫是由 30 個氣象測站所蒐集來之氣候資料,然在進行資料分析 時,為使資料能夠盡可能地表現出某個地區特定的長期氣候型態, 避免整體資料受極端氣候或特殊地形所影響,故在進行統計分析 前,先利用 SAS EG 將海拔高度大於 500 公尺及位於離島之測站資 料剔除,剔除後留下 12 個測站資料,接著再將剔除後的資料依照不 同的時間區間,例如年週或年月,及不同縣市分別計算出某縣市某 時間區間之平均氣象資料以利後續資料串聯使用。

(三)累積降雨量與病例數之關聯-以 GIS 呈現

成大蘇慧珍教授等研究台灣 1994-2008 中,8 種傳染病(A型 肝炎、腸病毒重症、桿菌性痢疾、鉤端螺旋體感染、類鼻疽感染、 恙蟲病、登革熱及日本腦炎) 與降雨量的關係,與每日累積降雨量

小於 130mm 相比,認為豪雨、大豪雨或超大豪雨可能是這 8 種法 定傳染病的流行危險因子, 8 種傳染病在大雨後間隔 7 至 70 天可能 會有疾病流行(如表 6) [4]。Chen 等人亦將 8 種傳染病與豪雨、大豪 雨或超大豪雨的關連,畫出 8 種傳染病的疾病流行風險地圖(如圖 10)。我們以 2013 年截至 9 月 30 日的中央氣象局局屬測站每日累 積降雨量資料與 2013 年截至 11 月 15 日的 8 種傳染病的本土確定 鄉鎮次級統計病例數,以 QGIS 2.0 軟體以地圖呈現,嘗試驗證成 大研究團隊的研究推論。

表 6、8 種法定傳染病在台灣的相對風險 RR 及 95% 信賴區間 [4]

	大雨	一般降雨	豪雨 (Heavy,	大豪雨	超大豪雨
	後疫	(降雨量	降雨量	(Torrential,降	(Extreme,降
	情起	<130	131-200 mm)	雨量 201-350	雨量>350
	始延	mm )		mm)	mm)
	後日				
	數				
A 型	28	1.0	1.1(0.6-2.2)	0.2(0.0-1.5)	1.5(0.2-10.9)
肝炎					
腸病	7	1.0	2.5(1.6-3.8)	1.4(0.7-3.0)	6.0(1.5-23.8)
毒重					
症					
桿菌	7	1.0	0.8(0.5-1.2)	2.9(2.1-3.9)	7.7(5.0-11.8)
性痢					
疾					
鉤端	14	1.0	3.0(0.7-12.1)	8.5(3.1-23.7)	N.A.
螺旋					
體感					
染					
類鼻	14	1.0	10.1(1.3-78.9)	10.0(1.3-78.9)	N.A.
疽					
恙蟲	21	1.0	1.2(0.8-2.0)	1.8(1.1-2.9)	1.8(0.6-5.7)
病					
登革	70	1.0	2.0(1.5-2.5)	2.1(1.6-2.8)	N.A.
熱					
日本	14	1.0	1.5(0.5-4.8)	4.3(1.7-10.4)	N.A.
腦炎					



圖 10、8 種傳染病與豪雨、大豪雨或超大豪雨相關的疾病流行風險地圖[4]

(四)利用氣象因子進行疾病研究之相關文獻整理相關文獻整理

我們以 Pubmed 及 Google Scholar 以「Taiwan」、「Weather」、「Climate」、 「Infectious Disease」、「Dengue」、「Rainfall」、「Temperature」、

「Humidity」、「Model」等中英文關鍵字進行文獻搜尋,並挑選出九篇文獻 以用來評估研究學者模型是否仍適用於台灣傳染病流行的預測,參考 Bai 等人文獻整理方式[14],將文章以研究者及使用語言、研究地區及時間、資 料收集(危險因子及疾病/媒介)、統計方法、主要結果及評論進行分類。 (四)利用氣象因子進行疾病研究之相關文獻整理

研究者及	研究地區及	資米	4收集	放井士计	十西4日	证故
使用語言	時間	危險因子	疾病/媒介	統計力法	土安佑木	計論
Lai et al. 英文[6]	高雄市 2002-2007	每降 骨 骨 骨 骨 骨 骨 骨 骨 骨 骨 骨 骨 骨 骨 骨 骨 骨 骨 骨	每日確診數 每日登革熱發 生率 布氏指數	-Cross-correlation -Duncan's Multiple Range test -Spatial autocorrelation analysis -G5	-確診數在 2002 和 2005 與不同 的氣象因子有不同的落後期相 關,氣象因子包含降雨、溫度及 最小相對濕度。 -溫暖的海面溫度及颱風的天氣 模式會促使登革熱爆發。	<ul> <li>本篇同時考慮了疾病 與傳媒的因子。</li> <li>討論了關於海面溫度 與颱風對於疫情的影響。</li> <li>探討了兩起登革熱的 事件。</li> </ul>
Chen et al. 英文[7]	台北與高雄 2001-2008	每月最小平均 温度 最高温 相對溼度 降雨量	每周登革熱發 生率 布氏指數	-Poisson regression analysis $\ln(Y_t) = \beta_0 + \beta_1 T_{max,t-n} +$ -Spearman correlation	-在台北,登革熱發生率與氣溫成 弱正相關,而高雄地區所有氣象 因于和興發生率皆為喻和欄、β4Rai -斯皮爾曼等級檢定的結果顯 示,在台北地區與最小溫度、平 均溫、最高溫有些微正相關;而 在高雄地區與上述三個因子皆 是負相關。 在高雄地區根據 GEE 的分析結 果,雨量、最低溫度以及相對濕 度皆有3個月的落後,百分比布 氏指數(二級以上)則是1個月的 落後,以上是顯著的登革熱發生 的預測因子。 此研究結論為南部溫暖的溫度 以及上升的濕度會引起蚊類密	-本篇同時考慮了疾病 與傳媒的因子。 n-t使用每時的指標作為It-n 評估。

表 7、利用氣象因子進行疾病研究之相關文獻整理[14]

					度增加,而增加登革熱的案例。	
Shang et al. 英文[8]	南臺灣(台 南、高雄、屏 東) 1998-2007	每日平 最 最 服 定 最 服 定 明 思 二 、 日 照 總 量 、 日 照 總 量 、 日 照 總 量 、 日 照 二 、 日 照 二 、 日 照 二 、 日 照 二 、 日 照 二 、 日 、 昭 二 、 日 、 昭 、 に 、 ( 、 ( 、) 、 ( ) 、 日 、 ( 、) ( 、) ( ) 、 ( ) 、 ( ) ( ) ) 、 ( ) ( )	本土登革熱案 例、境外移入登 革熱案例	-Logistic regression:分 析境外移入數量與本土 病例發生/增加的關係及 本土病例發生/增加與氣 象資料變數之時間延遲 關係。 -Poisson regression:分 析本土登革熱與境外移 入案例之關係;及本土登 革熱病例數與氣象因子 關係。	本土登革熱案件數皆因較乾 燥、較溫暖的天氣而可能引發本 地的疫情 整合氣象資訊的早期警示監測 系統,將是登革疫情尚未成為地 方性流行的地區用以成功防治 疫情	-同時研究境外移入及 本土案例與天氣因子 的關係。 -考慮不同的氣象資料
Hsieh et al. 英文[2]	台灣 2007	颱風、每周溫 度、總降雨量	每周發生率、 Initial reproduction for the multi-wave outbreaks	-Correlation analysis -Multi-phase Richards model	在 2007 年因為連續的颱風帶來 的雨量以及溫度及驟降,造成兩 波的多轉折點疫情爆發 (two-wave outbreaks with multiple turning points)	了解氣象事件在登革 熱疫情爆發扮演的角 色
Wu et al. 英文[9]	台灣 1998-2002	月溫及月雨 量、 都市化程度	月發生率、布氏 指數	-Principle components analysis -Logistic regression -GIS	研究結果發現月均溫高於18度 以及高都市化程度會顯著減少 登革熱感染病例。	同時考慮氣象因子及 社會經濟因素。
Wu et al. 英文[10]	高雄市 1998-2003	月均溫、月最 高溫、月最低 溫相對濕度、 累積雨量	月發生率、病媒 密度	-Cross correlation -Autocorrelation	<ul> <li>-溫度降低及較低的相對濕度會</li> <li>提高登革熱發生率</li> <li>-病媒密度與疾病發生之關係並</li> <li>不明顯</li> </ul>	分析病媒密度與登革 熱發生率的關係,但只 分析單一城市。
Wen et al. 英文[11]	高雄、鳳山 2002		流行期的總週 數(TW)、有病例	-GIS	利用 Frequency、Duration、 Intensity index 三個指標進行登	

· · · · · · · · · · · · · · · · · · ·						
			的總週數		革熱的流行型態劃分,以利同時	
			(EW)、發生率		考量空間與時間的因素,確認具	
			(IR)		有危險的地區。	
Chen et al.	高雄	每周最低温、	產卵率、幼蚊成	Transmission dynamic	與昆蟲相關的因子,皆和溫度呈	
英文[12]	2001-2010	平均温、最高	熟率、成蚊死亡	modeling	現正相關(但幼蚊成熟率與成蚊	
		溫	率、病毒潛伏率		死亡率除外)。	
					另外研究也指出在温度 28 度時	
					是高雄地區登革熱傳染的危險	
					因子。	
Chen et al.	臺灣	病例數	降雨量	Relative risk	發生豪大雨後登革熱約晚70天	
英文[4]	1994-2008			Poisson regression	會發生,可能與埃及斑蚊的成蟲	
					時間、生命週期以及孵化時間有	
					關。先前也有研究指出大越高的	
					雨量,登革熱等蟲媒疾病發生頻	
					率也越高,但在超豪大雨發生	
					後,因為會破壞蚊蟲的棲息地,	
					而降低發生率。	

(五)模型預測

由文獻 Chen 等研究指出[7],發生率與氣象因子間各有延遲期:降雨 量有三個月的延遲期、最低溫度有三個月的延遲期、相對溼度三個月、布 氏級數百分比則是兩個月的延遲期。本研究套入模型之資料欄位如表 8。

表8、模型使用之資料欄位

變數名稱	中文	單位	計算方式
YY_MM	年度_月份编碼		
Year	年度		
Month	月份		
City	研究城市		
Determine	確診數	人	
MYP	年中人口數	人	
Incidence	發生率	1/每十萬人	確診數/年中人口
			數*100000
Avgtemp	月平均温度	度	
Maxtemp	月平均最大溫	度	
	度		
Mintemp	月平均最小溫	度	
	度		
Relative_Humidity	平均相對溼度	%	
Max_Relative_Humidity	平均最大相對	%	
	濕度		
Min_Relative_Humidity	平均最小相對	%	
	濕度		
Precipitation	降雨量	mm	累積總雨量
Blpercent	布氏級數大於2	%	

	之百分比	
Station_No	觀測站編號	

一、 套入模型之資料

(一) 氣象資料

氣象資料來源為本計畫所建構之氣象資料加值資料庫,由資料 庫中選取所需要之分析變數。資料庫中之資料為每日氣象資料,將 每日氣象資料依據變數所需,分別轉換為每月之氣象資料。詳細說 明如下:

- 平均最小溫度(Minimum temp):將該月份之每日最小溫度加總 後取平均即得到該月份之平均最小溫度,單位為度。
- 2. 降雨量(Rain, Precipitation):降雨量為該月份之每日降雨量總
   和,計算出該月份之總降雨量,單位為mm。
- 平均相對溼度(Relative Humidity):將該月份之每日相對溼度加 總後取平均即得到該月份之平均相對濕度,單位為%。

(二)法定傳染病資料

使用署內資料倉儲系統,並篩選下列條件:

1. 疾病名稱:登革熱

- 2. 時間類型:3(發病日)
- 3. 出入境: 0(本土案例)
- 4. 居住縣市:台南市、高雄市、屏東縣。

將篩選後之資料選取確診人數作為計算發生率之用。每月之發生率 是使用每月之確診人數總和除以該年度之年中人口數再換算為每 十萬人之發生率,公式如下:

發生率 = 每月確診人数和÷該年度年中人口数×100000

每年度之人中人口數是以內政部統計處之內政統計年報中之年底 人口數計算:

該年度年中人口数=(去年度年底人口数+該年底人口数)÷2 最後再以兩筆資料計算發生率,即得每月分之發生率。

(三)布氏指數資料

取得至署內防疫資訊匯集平台。每月之布氏級數大於2所佔調查資料之百分比,即為Blpercent之變數資料。若該月份無布氏級數的調查資料,則為缺失值。

二、 統計分析

本研究使用時間延遲的卜瓦松迴歸分析(lagged-time Poisson regression),模型如下:

 $\ln(Y_t) = \beta_0 + \beta_1 \operatorname{Rain}_{t-n} + \beta_2 \operatorname{T}_{min,t-n} + \beta_3 \operatorname{RH}_{t-n} + \beta_4 \operatorname{BI}_{t-n} + e_t$ 

Y<sub>t</sub>為時間 t 時的每十萬人發生率, Rain<sub>t-n</sub>為延遲 n 期之降雨量, T<sub>mim,t-n</sub>為 延遲 n 期之最小溫度, RH<sub>t-n</sub>為延遲 n 期之相對濕度, BI<sub>t-n</sub>為延遲 n 期 之布氏級數百分比。

延遲之期數參考文獻後[7]選用:

變數	延遲(月)
降雨量	3
最小溫度	3
相對溼度	3
布氏級數	1

利用延遲模型對 2002-2012 年之氣象資料與登革熱發生率進行迴歸分析,同時與無延遲模型作比較,並使用延遲模型預測 2013 之登革

評估模型優劣之方法是以 AIC(Akaike information criterion)赤池信息量準則為評估之依據。此評估準則是考慮 AIC 值較小的模型,以此準則可以選出最好的解釋但是包含最少參數的模型。

## 參、 結果

一、 累積降雨量與病例數之關聯(成大研究結論的驗證)

八種傳染病(A型肝炎、腸病毒重症、桿菌性痢疾、鉤端螺旋體 感染、類鼻疽感染、恙蟲病、登革熱及日本腦炎)與曾經於2013年 有出現豪雨、大豪雨或超大豪雨的測站點位分布結果(如圖11至圖 26)

2013年5月11日,台北及新北市因鋒面過境,有大豪雨的災情, 2013年8月21日前後,潭美颱風在中部地區造成多處大豪雨,2013 年8月29日康芮颱風,在台南、高雄曾造成大豪雨的災情,2013 年9月21日天兔颱風在屏東造成大豪雨的災情。

2013年的A型肝炎病例數比過去兩年同期病例數增加,病例數 在台北區(台北、新北、宜蘭)及北區(桃園、新竹、苗栗)較全國 其他地方為多且集中,但並未特別發現有觀測到豪雨或大豪雨後的 28天,造成病例數急速上昇的情形(表6、圖11、圖12)。

成大研究團隊認為,豪雨及超大豪雨後的7日,會有腸病毒重症的疫情,但在2013年,腸病毒重症病例為散發狀態,並未在任何鄉 鎮有群聚的疫情(表6、圖13、圖14)。

成大研究認為大豪雨及超大豪雨後的7日,會有桿菌性痢疾的疫情,也許可解釋2013年於台北區的桿菌性痢疾病例群聚(淡水), 但無法用來解釋其他地區有大豪區及超大豪雨的縣市並未出現桿菌 性痢疾的原因(表6、圖15、圖16)。

恙蟲病的流行仍為地域性,包含花東、山區及離島,部分地區的 流行和大豪雨後21日或許有相關,但離島並未有大豪雨的紀錄,仍 有恙蟲病的流行(表6、圖17、圖18)。

2013年日本腦炎病例為散發性並集中出現在5至7月,未有大 規模流行,與大豪雨的相關程度較低,此外日本腦炎是疫苗可預防疾 病,台灣的高日本腦炎疫苗接種率,也是疫情規模不大的主因(表6、 圖19、圖20)。

2013 年 8 月 29 日康芮颱風,及 9 月 21 日天兔颱風在在台南、高雄、屏東造成大豪雨的災情。學者推論豪雨或是大豪雨後的 70 天 將有登革熱疫情發生,台灣 2013 年的登革熱疫情主要於屏東流行, 屏東於 9 月開始進入疫情高峰,高雄於 10 月進入流行高峰,預期兩 縣市的登革熱疫情將於 11 月達到最高,豪雨及大豪雨後 70 日之於登 革熱流行的推論,可在高雄、屏東及台南等登革熱傳統流行區可以得 到好的驗證(表 6、圖 21、圖 22)。

鉤端螺旋體與淹水的相關性已有多篇研究提及,2013年的台灣 鉤端螺旋體病在9月達到高峰,學者推論大豪雨後的14日可能有鉤 端螺旋體病,康芮及天免颱風帶來的大豪雨災情,或許可解釋部分於 台灣南部出現的散發病例疫情(表6、圖23、圖24)。

2013年的類鼻疽疫情高峰出現在9月,成大學者研究認為,豪 雨或大豪雨後的14天,可能造成類鼻疽疫情,本年8月29日的康 芮颱風在高雄台南造成大豪雨災情,可能是造成9月類鼻疽疫情的解 釋原因,此外,以往認為台灣的類鼻疽多於台南二仁溪流域及高雄沿 海地區,主要是該區域地下60公分的土壤帶有類鼻疽,但今年於中 部烏溪(大肚溪)沿岸的兩鄉鎮,亦發現有零星個案,或許需進一步 調查烏溪流域附近的環境土壤中是否亦有類鼻疽存在(表6、圖25、 圖26)。



圖 11、2013 年本土 A 型肝炎確定病例分布及中央氣象局局屬測站降雨量 關係圖



圖 12、2013 年本土 A 型肝炎確定病例台北區(台北、新北、宜蘭)、北區 (桃園、新竹、苗栗)每月流行曲線圖



圖 13、2013 年本土腸病毒重症確定病例分布及中央氣象局局屬測站降雨量 關係圖



圖 14、2013 年全國本土腸病毒重症確定病例每月流行曲線圖



圖 15、2013 年本土桿菌性痢疾確定病例分布及中央氣象局局屬測站降雨量 關係圖



圖 16、2013 年本土桿菌性痢疾確定病例台北區(台北、新北、宜蘭)、東區(花蓮、台東)每月流行曲線圖



圖 17、2013 年本土恙蟲病確定病例分布及中央氣象局局屬測站降雨量關係



圖 18、2013 年全國本土恙蟲病確定病例每月流行曲線圖



圖 19、2013 年本土日本腦炎確定病例分布及中央氣象局局屬測站降雨量關 係圖



圖 20、2013 年全國本土日本腦炎確定病例每月流行曲線圖





圖 21、2013 年本土登革熱確定病例分布及中央氣象局局屬測站降雨量關係

圖 22、2013 年本土登革熱確定病例屏東及高雄每月流行曲線圖



圖 23、2013 年鉤端螺旋體感染確定病例分布及中央氣象局局屬測站降雨量 關係圖



圖 24、2013 年全國本土鉤端螺旋體確定病例每月流行曲線圖



圖 25、2013 年類鼻疽確定病例分布及中央氣象局局屬測站降雨量關係圖



圖 26、2013 年全國本土類鼻疽確定病例每月流行曲線圖
二、台南市、高雄市、屏東縣 2002 年至 2008 年氣象因子與登革熱發生
 率之分析結果(中山醫大研究結論的驗證)
 (一)月累積雨量(mm)與發生率(1/每十萬人)

由累積雨量的圖表中可清楚看出延遲的情況(圖 27、28、29), 大多的發生率爆發前二至三周前都有發生較多的降雨,此趨勢在三 個縣市中皆可以明顯的發現,然而以降雨量來說,並不是發生大雨 量後都會爆發登革熱,但在有爆發登革熱的前兩、三個月皆有發生 最高的累積雨量,與一般認知多雨後易有登革熱的情形相符,並且 回顧文獻也發現一般遲滯期約是 70 天至三個月不等[7]。



圖 27、2002-2012 台南市月累積雨量與發生率條線圖



圖 28、2002-2012 高雄市月累積雨量與發生率條線圖



圖 29、2002-2012 屏東縣月累積雨量與發生率條線圖

(二)月平均最低溫度(°C)與發生率(1/每十萬人)

最低溫度則是在文獻中認為具有延遲期的氣象因子[7],亦可以 在圖中發現此趨勢(圖 30、31、32),只是較不明顯。



圖 30、2002-2012 台南市月平均最低温度與發生率條線圖



圖 31、2002-2012 高雄市月平均最低温度與發生率條線圖



圖 32、2002-2012 屏東縣月平均最低溫度與發生率條線圖

(三)月平均相對溼度(%)與發生率(%)

較高的相對溼度與登革熱傳播有相關,相對溼度亦被認為是具延遲期 之氣象因子[7],約延遲3至4個月。由台南、高雄及屏東的相對溼度與登 革熱發生率之關聯圖亦可觀察此趨勢(圖 33、34、35)。



圖 33、2002-2012 台南市月平均相對溼度與發生率條線圖



圖 34、2002-2012 高雄市月平均相對溼度與發生率條線圖



圖 35、2002-2012 屏東縣月平均相對溼度與發生率條線圖

(四)布氏級數百分比與發生率(1/每十萬人)

布氏指數為每百調查戶數中的有蚊子幼蟲陽性容器數,可以代表病 媒蚊的密度,為登革熱傳播的重要因子之一,並可由布氏指數轉換為布 氏級數。布氏級數百分比為調查該區在該月份中,布氏級數大於2之百 分比。圖 36、圖 37 及圖 38 可觀察到,疫情發生常在布氏級數百分比 達到高峰之後一到二個月。



圖 36、2002-2012 台南市布氏級數百分比與發生率條線圖



圖 37、2002-2012 高雄市布氏級數百分比與發生率條線圖



圖 38、2002-2012 屏東縣布氏級數百分比與發生率條線圖

三、 模型預測結果

三個縣市之延遲與無延遲模型預測登革熱發生率之比較結果如下: (一)台南市

1. 延遲與無延遲模型之比較

-	Goodnes	_			
	Criterion	延遲模型	無延遲模型	<u> </u>	
	AIC (smaller is better)	509.74	811.02	2	
可由	AIC(Akaike information	on criterior	1)值看出使	用延遲參	數的模
型較	無延遲參數之模型適合	▶• 再由模型	型預測值之	折線圖可	看出預
測結	果之好壞。延遲與無延	遲之折線	圖如圖 39 月	及圖 40,	模型之

參數預估如表9。







圖 40、延遲模型預測結果折線圖

表 9、	模型之參數預估	
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Parameter Estimates									
Parameter	er DF Estimate Standard Error Pr > ChiSq								
Intercept	1	-1.1403	2.1860	0.6019					
Minimum temp(lag3)	1	0.4187	0.0506	<.0001					
Rain(lag3)	1	0.0026	0.0003	<.0001					
BI(lag1)	1	-0.0220	0.0050	<.0001					
Relative Humidity(lag3)	1	-0.1232	0.0236	<.0001					

2. 以 2013 年天氣資料與延遲模型預測登革熱發生率

將 2013 年天氣資料進行發生率的預測,再將預測發生率乘 以 2012 年之年中人口數,即為預測確診數,預測結果如表 10, 折線圖如圖 41,其中預測值與實際值之相關係數為-0.13。

午日	欢於佃數	西训欢办业	預測確診數	預測確診數	
千万	唯砂他数	员则难的数	95%信賴下界	95%信賴上界	
201301	9	2.3	4.1	7.3	
201302	1	0.3	0.8	2.0	
201303	0	0.3	0.7	2.0	
201304	0	0.1	0.3	0.9	
201305	0	0.3	0.7	1.9	
201306	0	1.1	2.2	4.5	
201307	0	2.2	3.8	6.3	
201308	0	17.5	22.6	29.1	
201309	0	57.7	70.5	86.1	
201310	1	45.5	55.5	67.5	

表 10、2013 年台南市登革熱確診數預測結果



圖 41、預測結果折線圖

(二)高雄市

1. 延遲與無延遲模型之比較

Goodness Of Fit								
Criterion	延遲模型	無延遲模型						
AIC (smaller is better)	759.30	1156.80						

延遲與無延遲模型之預測值折線圖如圖 42 及圖 43,由圖可 看出,雖然配適情形不佳,對於實際發生率之大小無法準確預 測,但仍可由資料預測觀察出某些趨勢,模型之參數預估如表 11。







圖 43、延遲模型條線圖

表 11、模型之參數預估

Parameter Estimates										
Parameter	DF	Estimate	Standard Error	Pr > ChiSq						
Intercept	1	-25.2003	2.0087	<.0001						
Rain(lag3)	1	-0.0013	0.0003	<.0001						
Relative Humidity(lag3)	1	0.1984	0.0248	<.0001						
BI(lag1)	1	-0.0085	0.0023	0.0003						
Minimum temp(lag3	1	0.4635	0.0441	<.0001						

2. 以 2013 年之天氣資料與延遲模型預測登革熱發生率

將 2013 年天氣資料進行發生率的預測,再將預測發生率乘以 2012 年之年中人口數,即為預測確診數,預測結果如表 12,折線 圖如圖 44,其中預測值與實際值之相關係數為 0.32。

<b>左日</b>	水公田赴	西测水众业	預測確診數	預測確診數	
平月	唯彭恤政	頂测確診數	95%信賴下界	95%信賴上界	
201301	5	22.4	16.2	31.0	
201302	0	2.8	1.4	5.4	
201303	1	2.9	1.5	5.7	
201304	0	0.8	0.4	1.8	
201305	0	3.4	1.9	6.2	
201306	0	4.2	2.6	7.0	
201307	1	27.1	19.9	36.8	
201308	1	234.2	191.0	287.1	
201309	2	247.7	205.4	298.6	
201310	7	140.0	113.6	172.4	

表 12、2013 年高雄市登革熱確診數預測結果



圖 44、預測結果折線圖

(三)屏東縣

1. 延遲與無延遲模型之比較

Goodness Of Fit									
Criterion	延遲模型	無延遲模型							
AIC (smaller is better)	340.73	393.52							

延遲與無延遲模型之預測值折線圖如圖 45 及圖 46,同高雄 市延遲模型之預測值折線圖,雖配適情形不佳,對實際發生率無 法準確預測,但可由資料預測出一些趨勢,模型之參數預估如表 13。







圖 46、延遲模型條線圖

表	13	•	模型	之	參	數	預	估
v -				-		~ •		

Parameter Estimates										
Parameter	DF	Estimate S	Standard Error P	r > ChiSq						
Intercept	1	-14.1514	2.7340	<.0001						
Minimum temp(lag3)	1	0.8517	0.1277	<.0001						
Rain(lag3)	1	0.0016	0.0004	<.0001						
BI(lag1)	1	-0.0346	0.0073	<.0001						
Relative Humidity(lag3)	1	-0.0919	0.0345	0.0078						

由參數估計結果知最小溫度、降雨量之係數為正,表示此二 變數值越大時,發生率會愈高;而布氏指數、相對溼度的係數為 負,表示變數值越小時,發生率會越大。

2. 以 2013 年之天氣資料與延遲模型預測發生率

將 2013 年天氣資料進行發生率的預測,再將預測發生率乘以 2012 年之年中人口數,即為預測確診數,預測結果如表 14,折線 圖如圖 47,其中預測值與實際值之相關係數為 0.867。

<b>左</b> 日	亦公何世	西川水水业	預測確診數	預測確診數	
平月	唯衫仙奴	預測確診數	95%信賴下界	95%信賴上界	
201301	0	4.0	2.6	6.2	
201302	0	1.2	0.6	2.6	
201303	0	0.2	0.1	0.7	
201304	10	0.1	0.0	0.5	
201305	18	0.4	0.1	1.1	
201306	26	0.4	0.1	0.9	
201307	6	0.5	0.2	1.1	
201308	14	4.7	2.9	7.6	
201309	68	15.9	10.6	23.8	
201310	72	8.7	5.8	13.1	

表 14、2013 年屏東縣登革熱確診數預測結果



圖 47、預測結果折線圖

#### 肆、 討論

本次研究以NCDR 及大氣資料庫的中央氣象局局屬測站氣象資料,用 自行撰寫轉檔及資料清理程式,可以全自動及半自動方式建置並更新疾管 署內使用之氣象資料庫,相關程式將在本次研究結束後,以公開原始碼方 式,提供署外相關研究團隊使用,以避免進行氣象研究時,都要花許多時 間重新再建置及清理研究用的氣象資料庫。氣象資料更新至疫情倉儲,以 提供本署同仁連結其他監測資料庫進行後續分析,但在進行小區域的氣象 資料分析時,因為無全台鄉鎮層級的氣象資料,在比較分析時仍覺不足, 將於近期著手將自動測站(包含全台灣 300 個以上鄉鎮氣象觀測資料)亦 轉入自行開發的氣象資資料庫中。

本研究亦以 SAS EG 為分析工具,並使用資料庫連結方式,能自動進 行氣象資料庫、法定傳染病資料庫、病媒蚊調查資料庫的資料勾稽,讓預 測模型未來能以自動排程方式,自動更新預測結果。

在驗證成大蘇慧珍教授研究有關豪雨、大豪雨、超大豪雨與傳染病病 例數之關聯,使用 2013 年觀察到的八種傳染病(A型肝炎、腸病毒重症、 桿菌性痢疾、鉤端螺旋體感染、類鼻疽感染、恙蟲病、登革熱及日本腦炎) 確定病例資料進行研究結果的驗證,因為尚未建置完成鄉鎮級別的觀測氣 象資料,也未利用 GIS 工具以面化模型取得推估的鄉鎮級別推測氣象資 料,暫時無法以分析統計方式進行相關性分析,故改以直接觀察方式分析 豪雨、大豪雨、超大豪雨出現的時間與法定傳染病於特定區域出現病例的 時間進行比較。

A型肝炎在本年雖在台灣北部看到明顯病例增多並有群聚的情形,但 是並未和豪雨有直接相關,推測原因為台灣北部雖然有大的降雨日,但並 無造成民眾需要直接飲用生水、或是被迫生食、及廁所、衛生下水道被破 壞情形。此外,根據本署的流病調查結果(尚未正式公開調查報告),相關 病例大多有在知名聯鎖壽司餐廳用餐,感染源較可能是在食物處理過程中

遭到汙染的食物。

於腸病毒重症與降雨量之關聯,在本次觀察研究亦未發現有關聯性的 證據,以往腸病毒相關研究已得知腸病毒有季節性流行(春末夏初)及九 月開學的第二波小流行,與氣溫、相對溼度等的關連性較高,腸病毒重症 病例出現,主因還是要有較具侵襲性的病毒株(如 EV71)在環境出現並造 成流行,並考慮其他的社會經濟因素(參見 2013 年本署有關腸病毒病毒株 流行危險因子的研究)。桿菌性痢疾流行和大豪雨的相關,於本研究亦不是 很明顯,在以往桿菌性痢疾的群聚性疫情分析中,危險因子已知為機構場 所的水源遭受污染或是精神病人經由人傳人方式進行細菌傳播。

恙蟲病的流行主要都是在已知的高風險流行區:山區、花東、金馬澎 湖離島,離島在今年未觀測到有豪雨以上的降雨,但是如同過往仍在夏季 有流行疫情,此外,在都會區就鮮少有恙蟲病病例發生(本次研究的 GIS 地圖繪製因為資料來源限制,無法將病例歸因到發生地),恙蟲病與其他蟲 媒傳染病一樣要同時有傳染源(蟲)及適當的氣候因子(溫度、溼度),此 外,雨量過大(如超大豪雨),在以往研究指出,反而是不利蟲媒傳染,我 們觀察到花蓮、台東、澎湖、金門、馬祖雖然沒有大豪雨及超大豪雨的降 雨,但或許是因此而有利恙蟲的繁殖並增加機會造成人類感染。

本土日本腦炎病例數在台灣全面施打日本腦炎疫苗並且有高的疫苗含 蓋率後,每年就僅在夏季有零星的個案及少數的群聚,危險因子主要是住 家附近有水稻田及豬舍鴿舍等,2013年,日本腦炎確定病例分布很廣,亦 無群聚事件,無法驗證日本腦炎在大豪雨後會有疫情出現。

登革熱與豪雨及大豪雨的相關在 2013 年屏東、高雄疫情可以得證,但 因登革熱的主要有效傳播病媒蚊為埃及斑蚊,在台灣北迴歸線以北並沒有 分布,僅管其他地方有豪雨及大豪雨的條件,仍無大規模的登革熱疫情。

鉤端螺旋體為水災後常見傳染病之一,2013年的台灣南部部分鉤端螺旋體病例與康芮及天兔颱風帶來大豪雨後災情有關,在風災過後,有關單位仍需適時提醒民眾有關鉤端螺旋體病的風險。2013年9月的本土類鼻疽

疫情,與康芮颱風在高雄台南造成大豪雨災情,可能有關,此外,類鼻疽 感染除了大豪雨外,尚需在環境中存在有病原體,研究學者認為,類鼻疽 生存在地下 60 公分土壤,特別是高雄沿海及台南二仁溪流域,我們觀察到 中部烏溪沿岸的兩鄉鎮,有零星個案,雖僅1 例病例的發生時序與大豪雨 有關,但仍值得進一步調查烏溪流域附近的環境土壤中是否亦有類鼻疽存 在。

本次模型預測研究使用中山醫學大學團隊所建議較好的氣象因子以及 布氏指數進行回歸模型建構及分析,使用氣象因子包含最小溫度、降雨量、 相對溼度,將每十萬人之發生率作為應變數進行回歸分析及模型預測。由 於登革熱之傳播方式是以帶有登革熱病毒之病媒蚊進行叮咬後傳播,約會 有八至十四天的潛伏期。而觀察埃及斑蚊的成蟲約需九天,而其生活史約 為三十天,因此登革熱的發生可能與過去之氣象資料相關,因此考慮延遲 的因素進模式中。

降雨量、最小溫度、相對溼度變數延遲月數為三個月,布氏指數為延 遲一個月,比較有變數延遲和無變數延遲的模型,不管是台南、高雄或是 屏東,都是有變數延遲模型比較配適。布氏指數可以代表病媒蚊密度,降 雨量、最小溫度、相對溼度則代表病媒蚊生長環境,可以解釋變數的不同 延遲月數。預測模型對疫情的起始推估較為準確,但是對疫情規模的預測 較為失準,本次預測模型預測結果高估了2013年的高雄及台南疫情,但低 估了屏東的本土登革熱疫情,本研究亦使用週為時間單位,套用中山醫學 大學模型,結果與按月的模型相似,相關圖表請參見附錄。

登革熱疫情的發生與規模,除了病媒蚊密度、氣候因子外,尚需考慮 社會經濟因子,如人口密度、老舊社區、族群活動方式等,也需考慮地方 政府及村里對登革熱防治動員,如孳生源清除、噴藥防治,及境外移入病 例與病媒蚊種類分布等影響。

#### 伍、結論與建議

透過本研究計畫建置本署氣象資料庫,其資料內容豐富,可供未來署內 相關研究取得各種氣象因子資料之使用。目前台灣氣象觀測站約共有六百 多個(參考附件三),本研究之氣象資料主要來源是中央氣象局局屬測站的觀 測資料,共有 30 個正在運作之局屬測站分布於台灣本島、澎湖、金門及馬 祖,數量與自動測站比較有明顯落差且涵蓋不密集,局屬測站觀測資料不 適合代表鄉鎮甚至村里等較小行政區域,故本研究主要以縣市進行相關疾 病及氣象觀測指標之分析、探討,若有必要分析更小區域的觀測情形,則 必須取得自動測站之觀測資料作為使用,本研究團隊也正在研究自動測站 的資料格式,將在近期也將進行自動測站的氣象資料轉入氣象資料庫。

本研究以計畫建置之氣象資料庫資料及法定傳染病次級統計資料,試圖 套用國內研究團隊曾發表過之預測模型及推論,用於驗證使用相關氣象因 子於傳染病流行預測的實用性,豪雨、大豪雨可能在南部地區導致 70 天後 的登革熱流行,或是兩個星期後的區域性類鼻疽及鉤端螺旋體感染疫情, 但並無法預測散發病例出現或是預測群聚疫情規模;延遲三個月的降雨 量、最低溫度、相對溼度及延遲一個月布氏指數建構的預測模型,亦可用 於預測登革熱流行起始,同樣亦無法有精確的疫情規模推估。傳染病流行 疫情取決於環境、宿主、及病原三方面因素,氣象因子只能解釋部分環境 因素,宿主本身是否有抗體(包含過去感染情形及疫苗接種率),病原是否 存在於流行地或是本身出現變異,社經因子或是非傳染性疾病及慢性病對 宿主的影響,皆是未來模型需加入考量的參數。

#### 陸、計畫重要研究成果及具體建議

(一)氣象資料庫之建立

雖然目前於傳染病倉儲系統中已建立一氣象資料庫,包含每日 最高溫、最低溫、露點溫度、平均溫度、雨量、氣壓、風力、風向 等資料,但因其資料內容目前只包含 1998 年至 2009 年且未持續更 新,若有相關業務或分析需要使用氣象觀測資料時將無法取得更完 善且長期之資料,因而導致目前該資料的使用及介接比率較低。本 研究計畫成功與國家災害防救科技中心介接每 10 分鐘即時氣象測 站資料,定期取得大氣研究資料庫每月更新之逐日測站觀測資料, 有效處理並建立含有各項觀測資訊的完整氣象資料庫,本研究所建 立之資料庫所跨年度長(1990 年至迄今)以及所提供之項目豐富,局 屬測站雖不如自動測站的觀測點來的密集,但也足以瞭解各縣市在 任一時間之觀測情形,未來可納入自動測站以取得鄉鎮之觀測資 料,並統一規劃將本研究所規劃之資料庫資料轉入傳染病倉儲系統 之資料庫中,進而提升本署在於氣象相關觀測資料之使用。

(二)氣象資料處理工具程式及資料庫表格綱要之分享

國災中心及大氣研究資料庫提供之氣象資料分別以 mdf 及 txt 檔案格式提供,並清楚公告說明其資料內容格式,以利使用者瞭解 資料結構並針對各對應欄取得所需資料,本研究計畫為了更快速且 自動化地上傳氣象資料至氣象資料庫,分別開發自動排程程式及上 傳介面(表五)以利資料處理及儲存,該工具為針對資料提供單位公 告之格式說明進行開發,其資料格式及各欄位可能之錯誤處理均已 完善。本計畫取得之氣象測站資料屬於不具機敏性之開放資料,為 了讓氣象資料能更廣為分享,本計畫開發之程式及資料庫表格綱要 亦規劃提供予欲建置氣象觀測資料庫的相關單位參考,以減少處理 人員在於資料轉置可能面臨之困難。

(三)台灣氣候相關傳染病預測模式實作

國內學術界有多篇有關登革熱及其他氣候相關傳染病的預測 模型研究,本次研究以成大及中山醫大研究成果的數理模式及推 論,進行使用氣象因子於傳染病流行預測的實作,驗證豪雨、大豪 雨70天後在南部地區可能導致的登革熱流行,或是過後2個星期 可能有區域性類鼻疽及鉤端螺旋體感染疫情,中山醫大的數理模式 亦可用於疫情起始的推估,但兩個研究的模式及推論結果,無法套 用到全國各鄉鎮,亦不能推估疫情規模,未來除可將模式的使用的 時間維度調成為以週或是日為單位、氣象資料使用各鄉鎮自動測站 資料以增加精確度外,亦可將社經因子、疫苗含蓋率等加入模型以 增加推估的正確性。

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## 玖、附錄

## 附件一、中央氣象局局屬氣象測站

station_ no	station_na me	ch_sta tion_n ame	region	county	village	north_latitu de	east_longit ude	height_ of_baro meter_a bove_s ea_level	height_ of_ther m_abov e_grou nd	height_ of_rain gauge_ above_ ground	anem _abo ve_gr ound	altitud e	year_of _comm enceme nt	no_of _obs_ per_d ay
466880	PANCHIAO	板橋	北區	新北市	板橋區	24°59' 58"	121°26' 2"	9.7					1972	
466900	TAMSUI	淡水	北區	新北市	淡水區	25°09' 56"	121°26' 24"	20	1.1(1.4)	0.2(0.5)	12.2	19	1942	0
466910	ANBU	鞍部	北區	台北市	北投區	25°11' 11"	121°31' 12"	827.1	1.3(1.8)	0.3(0.5)	7.31	825.8	1937	8
466920	TAIPEI	臺北	北區	台北市	中正區	25°02' 23"	121°30' 24"	6.61	1.21(1.7 )	0.2(0.5)	34.9	5.3	1896	10
466930	ZHUZIHU	竹子湖	北區	台北市	北投區	25°09' 54"	121°32' 11"	607.6	1.4(1.8)	0.2(0.5)	11.03	607.1	1937	8
466940	KEELUNG	基隆	北區	基隆市	中山區	25°08' 05"	121°43' 56"	27.7	1.2(1.8)	0.5(0.5)	34.6	26.7	1946	10
466950	PENGJIAYU	彭佳嶼	北區	基隆市	中正區	25°37' 46"	122°04' 17"	104.6	1.2(1.5)	0.2(0.5)	7.2	101.7	1910	8
466990	HUALIEN	花蓮	東部	花蓮縣	花蓮市	23°58' 37"	121°36' 18"	19.1	1.4(1.5)	0.2(0.4)	12	16	1910	10
467060	SU-AO	蘇澳	東部	宜蘭縣	蘇澳鎮	24°36' 06"	121°51' 52"	25.5	1.3(1.6)	0.5(0.5)	34	24.9	1981	10
467080	YILAN	宜蘭	東部	宜蘭縣	宜蘭市	24°45' 56"	121°44' 53"	8	1.2(1.5)	0.3(0.6)	26	7.2	1935	10
467110	KINMEN	金門	外島	金門縣	金城鎮	24°24' 27"	118°17' 21"	47.88					2004	
467300	DONGJIDA O	東吉島	外島	澎湖縣	望安鄉	23°15' 32"	119°39' 35"	45	1.5(1.5)	0.2(0.4)	9.1	43	1962	5
467350	PENGHU	澎湖	外島	澎湖縣	馬公市	23°34' 02"	119°33' 19"	11.4	1.4(1.5)	0.2(0.5)	14.6	10.7	1896	10
467410	TAINAN	臺南	南區	台南市	中西區	22°59' 36"	120°12' 17"	22.1	1.5(1.5)	(1.5)	53.7	40.8	1897	10
467420	YONGKAN G	永康	南區	台南市	永康區	23°02' 22"	120°13' 43"	9.6	(1.5)	(0.5)	37.6	8.1	1947	0

467440	KAOHSIUN G	高雄	南區	高雄市	前鎮區	22°34' 04"	120°18' 29"	3.1	1.2(1.5)	0.2(0.7)	14	2.3	1931	10
467480	CHIAYI	嘉義	中區	嘉義市	西區	23°29' 52"	120°25' 28"	27.8	1.4(1.6)	0.2(0.5)	14.5	26.9	1968	10
467490	TAICHUNG	臺中	中區	台中市	北區	24°08' 51"	120°40' 33"	85.3	1.4(1.5)	0.2(0.5)	17.2	84.04	1896	10
467530	ALISHAN	阿里山	中區	嘉義縣	阿里山 鄉	23°30' 37"	120°48' 18"	2415.9	1.2(1.4)	0.2(0.5)	15.1	2413.4	1933	8
467540	DAWU	大武	東區	臺東縣	大武鄉	22°21' 27"	120°53' 44"	8.9	1.2(1.5)	0.2(0.7)	12.7	8.1	1939	8
467550	YUSHAN	玉山	中區	南投縣	信義鄉	23°29' 21"	120°57' 06"	3845.7	1.2(1.5)	0.2(0.5)	9.2	3844.8	1943	8
467571	HSINCHU	新竹	北區	新竹縣	竹北市	24°49' 48"	121°00' 22"	28.9	1.1(1.5)	0.3(0.5)	15.6	26.9	1991	10
467590	HENGCHU N	恆春	南區	屏東縣	恆春鎮	22°00' 20"	120°44' 17"	24.1	1.5(1.8)	0.2(0.8)	14.3	22.1	1896	10
467610	CHENGGO NG	成功	東區	台東縣	成功鎮	23°05' 57"	121°21' 55"	37.8	1.4(1.5)	0.2(0.5)	12.8	33.5	1940	8
467620	LANYU	蘭嶼	東區	台東縣	蘭嶼鄉	22°02' 19"	121°33' 02"	325.1	1.5(1.42 )	0.2(0.5)	12.5	324	1941	8
467650	SUN MOON LAKE	日月潭	中區	南投縣	魚池鄉	23°52' 53"	120°54' 29"	1012.2	1.3(1.3)	0.2(0.2)	8	1017.5	1940	8
467660	TAITUNG	臺東	東區	台東縣	台東市	22°45' 15"	121°08' 48"	9.7	1.4(1.5)	0.2(0.9)	11.4	9	1901	10
467770	WUQI	梧棲	中區	台中市	梧棲區	24°15' 31"	120°30' 54"	26.7	1.5(1.7)	0.3(0.4)	33.2	31.73	1976	10
467780	CHIKU	七股	南區	臺南市	七股區	23°08' 52"	120°04' 09"	2.9					2001	
467990	MATSU	馬祖	外島	連江縣	南竿鄉	26°10' 10"	119°55' 23"	97.842					2004	

# 附件二、氣象資料庫關聯資料模型及資料表綱要

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id_precipitation3       scuration1       scuration2       minous_meteor1       minous_meteor2       aporation_in_shelter       aporation_out_shelter       aporation_out_shelter       aporation_out_shelter       aporation_out_shelter       aporation_ditemp_com       xund_temp_Com       xund_temp_30cm       xund_temp_100cm       xund_temp_100cm       xund_temp_30cm       xund_temp_300cm	iid_precipitation3         sscuration1         sscuration2         iminous_meteor1         iminous_meteor2         raporation_in_shelter         raporation_out_shelter         oaporation_Al_type_pan         n_ grass_temp         ound_temp_0cm         ound_temp_10cm         ound_temp_30cm         ound_temp_30cm         ound_temp_20cm         ound_temp_30cm         ound_temp_30cm         ound_temp_00cm         ound_temp_30cm         ound_temp_30cm         ound_temp_300cm         ound_temp_300cm	Idd_precipitation3         sccuration1         sccuration2         iminous_meteor1         iminous_meteor2         aporation_in_shelter         aporation_out_shelter         aporation_div_shelter         aporation_div_shelter         ound_temp_0Cm         ound_temp_10cm         ound_temp_10cm         ound_temp_30cm         ound_temp_200cm         ound_temp_200cm         ound_temp_200cm         ound_temp_300cm         ound_temp_300cm         ound_temp_300cm         ound_temp_300cm	solid_precipitation2			
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scuration2 minous_meteor1 minous_meteor2 aporation_in_shelter aporation_dt_shelter aporation_A_type_pan n_grass_temp ound_temp_0cm ound_temp_0cm ound_temp_10cm ound_temp_30cm ound_temp_30cm ound_temp_20cm ound_temp_20cm ound_temp_20cm ound_temp_20cm	sscuration2 immous_meteor1 immous_meteor2 apporation_out_shelter apporation_out_shelter apporation_out_shelter ound_temp_0cm ound_temp_0cm ound_temp_10cm ound_temp_0cm ound_temp_0cm ound_temp_0cm ound_temp_0cm ound_temp_0cm ound_temp_0cm ound_temp_0cm ound_temp_0cm	sscuration2 immious_meteor1 immious_meteor2 aporation_in_sheter aporation_oLt_sheter aporation_A_type_pan in_grass_temp ound_temp_oCm ound_temp_oCm ound_temp_Jocm ound_temp_Jocm ound_temp_Jocm ound_temp_Jocm ound_temp_Jocm ound_temp_Jocm ound_temp_Jocm ound_temp_Jocm ound_temp_Jocm ound_temp_Jocm ound_temp_Jocm ound_temp_Jocm	obscuration1			
minous_meteor1 minous_meteor2 aporation_in_shelter aporation_out_shelter aporation_A_type_pan n_grass_temp ound_temp_0cm ound_temp_0cm ound_temp_10cm ound_temp_30cm ound_temp_50cm ound_temp_100cm ound_temp_100cm ound_temp_100cm	minous_meteor1 minous_meteor2 aporation_in_shelter /aporation_A_type_pan in_grass_temp ound_temp_0cm ound_temp_0cm ound_temp_10cm ound_temp_30cm ound_temp_30cm ound_temp_30cm ound_temp_30cm ound_temp_0cm	minous_meteor1 minous_meteor2 raporation_in_shelter raporation_Atype_pan in_grass_temp ound_temp_Com ound_temp_Com ound_temp_J0cm ound_temp_J0cm ound_temp_Socm ound_temp_Socm ound_temp_Socm ound_temp_Socm ound_temp_Socm ound_temp_Socm ound_temp_Socm ound_temp_Socm ound_temp_Socm	obscuration2			
minous_meteor2 aporation_in_shetter aporation_out_shetter aporation_A_type_pan rarss_temp bund_temp_form bund_temp_form bund_temp_10cm bund_temp_20cm bund_temp_50cm bund_temp_10cm bund_temp_10cm bund_temp_10cm bund_temp_10cm	minous_meteor2 aporation_in_shelter aporation_Al_type_pan in_grass_temp ound_temp_0cm ound_temp_10cm ound_temp_10cm ound_temp_10cm ound_temp_30cm ound_temp_30cm ound_temp_30cm ound_temp_200cm ound_temp_00cm	minous_meteor2 aporation_in_shelter raporation_d_type_pan in_grass_temp ound_temp_Com ound_temp_Com ound_temp_Jocm ound_temp_Jocm ound_temp_Jocm ound_temp_Jocm ound_temp_Jocm ound_temp_Jocm ound_temp_Docm ound_temp_Docm ound_temp_Docm ound_temp_JoCm	Luminous_meteor1			
aporation_in_shetter aporation_out_shetter aporation_A_type_pan n_grass_temp ound_temp_Corn ound_temp_Corn ound_temp_10cm ound_temp_20cm ound_temp_30cm ound_temp_30cm ound_temp_100cm ound_temp_100cm ound_temp_300cm	raporation_in_shetter aporation_out_shetter aporation_A_type_pan in_grass_temp ound_temp_0cm ound_temp_0cm ound_temp_10cm ound_temp_20cm ound_temp_30cm ound_temp_30cm ound_temp_00cm ound_temp_00cm	raporation_in_shetter aporation_out_shelter aporation_A_type_pan in_grass_temp ound_temp_0cm ound_temp_form ound_temp_10cm ound_temp_20cm ound_temp_30cm ound_temp_00cm ound_temp_100cm ound_temp_00cm ound_temp_300cm ound_temp_300cm	Luminous_meteor2	1		
aporation_out_shetter aporation_A_type_pan grass_temp ound_temp_Com ound_temp_Tocm ound_temp_10Cm ound_temp_30cm ound_temp_50cm ound_temp_50cm ound_temp_100cm ound_temp_200cm	vaporation_out_shelter vaporation_A_type_pan in_grass_temp ound_temp_Corm ound_temp_Corm ound_temp_20ccm ound_temp_20ccm ound_temp_20ccm ound_temp_20ccm ound_temp_20ccm ound_temp_20ccm ound_temp_200cm	vaporation_out_shelter vaporation_A_type_pan in_grass_temp ound_temp_Orm ound_temp_Srm ound_temp_10cm ound_temp_30cm ound_temp_50cm ound_temp_50cm ound_temp_100cm ound_temp_100cm ound_temp_300cm ound_temp_300cm	evaporation_in_shelter			
Appration A_type_pan n_grass_temp und_temp_0cm und_temp_5cm und_temp_10cm und_temp_30cm und_temp_30cm und_temp_100cm und_temp_100cm und_temp_100cm und_temp_300cm	Active_pan in_grass_temp ound_temp_0cm ound_temp_focm ound_temp_10cm ound_temp_20cm ound_temp_30cm ound_temp_30cm ound_temp_100cm ound_temp_200cm ound_temp_200cm	Apportation A_type_pan in_grass_temp ound_temp_0Cm ound_temp_5cm ound_temp_10cm ound_temp_30cm ound_temp_30cm ound_temp_100cm ound_temp_200cm ound_temp_300cm ound_temp_300cm ound_temp_300cm	evaporation out shelter			
. grass.temp pound_temp_0cm pund_temp_5cm pund_temp_10cm pund_temp_20cm pund_temp_20cm pund_temp_10cm pund_temp_100cm pund_temp_200cm pund_temp_200cm	ound_temp_0cm ound_temp_0cm ound_temp_5cm ound_temp_10cm ound_temp_10cm ound_temp_30cm ound_temp_30cm ound_temp_100cm ound_temp_200cm ound_temp_300cm	ound_temp_0cm ound_temp_0cm ound_temp_10cm ound_temp_10cm ound_temp_20cm ound_temp_30cm ound_temp_50cm ound_temp_100cm ound_temp_100cm ound_temp_300cm ound_temp_300cm	evaporation A type nan			
Jund_temp_0cm Jund_temp_10cm Jund_temp_10cm Jund_temp_20cm Jund_temp_30cm Jund_temp_100cm Jund_temp_200cm Jund_temp_200cm	ound_temp_0Cm ound_temp_10cm ound_temp_10cm ound_temp_20cm ound_temp_20cm ound_temp_30cm ound_temp_100cm ound_temp_200cm ound_temp_300cm	ound_temp_0cm ound_temp_form ound_temp_10cm ound_temp_20cm ound_temp_30cm ound_temp_50cm ound_temp_100cm ound_temp_200cm ound_temp_300cm ound_temp_300cm	min grass temp			
Jund_temp_Som Jund_temp_10cm Jund_temp_30cm Jund_temp_30cm Jund_temp_100cm Jund_temp_200cm Jund_temp_300cm	ound_temp_5cm ound_temp_10cm ound_temp_20cm ound_temp_30cm ound_temp_50cm ound_temp_100cm ound_temp_200cm ound_temp_300cm	ound_temp_Scm ound_temp_3Cm ound_temp_30cm ound_temp_30cm ound_temp_50cm ound_temp_100cm ound_temp_300cm ound_temp_300cm	around temp 0cm	-		
Jund_temp_10cm Jund_temp_30cm Jund_temp_50cm Jund_temp_50cm Jund_temp_100cm Jund_temp_200cm	ound_temp_10cm ound_temp_20cm ound_temp_30cm ound_temp_50cm ound_temp_100cm ound_temp_200cm ound_temp_300cm	ound_temp_10cm ound_temp_20cm ound_temp_30cm ound_temp_30cm ound_temp_50cm ound_temp_100cm ound_temp_300cm ound_temp_300cm	ground_temp_0cm	-		
Jund_temp_200m Jund_temp_30cm Jund_temp_50cm Jund_temp_100cm Jund_temp_200cm Jund_temp_300cm	voind_temp_20cm           voind_temp_30cm           voind_temp_50cm           voind_temp_100cm           voind_temp_200cm           voind_temp_300cm           voind_temp_500cm	voind_temp_20cm           ound_temp_30cm           ound_temp_50cm           ound_temp_100cm           ound_temp_200cm           ound_temp_30cm           ound_temp_200cm           ound_temp_300cm           ound_temp_500cm	ground_temp_5CM	-		
Juna_temp_20Cm Jund_temp_30Cm Jund_temp_50Cm Jund_temp_100Cm Jund_temp_300Cm	ouna_temp_2Ucm           ound_temp_30cm           ound_temp_50cm           ound_temp_100cm           ound_temp_300cm           ound_temp_500cm	ound_temp_20cm ound_temp_30cm ound_temp_50cm ound_temp_200cm ound_temp_200cm ound_temp_300cm ound_temp_500cm	ground_temp_10cm	-		
Juna_temp_30cm           pund_temp_50cm           pund_temp_100cm           Jund_temp_300cm	ouna_temp_30cm ound_temp_50cm ound_temp_100cm ound_temp_300cm ound_temp_300cm	ound_temp_50cm ound_temp_50cm ound_temp_100cm ound_temp_200cm ound_temp_300cm ound_temp_500cm	ground_temp_20cm	-		
Jund_temp_S0Cm Jund_temp_100cm Jund_temp_200cm Jund_temp_300cm	ound_temp_50cm ound_temp_100cm ound_temp_200cm ound_temp_300cm	ound_temp_50cm ound_temp_100cm ound_temp_200cm ound_temp_300cm ound_temp_500cm	ground_temp_30cm	-		
pund_temp_100cm pund_temp_200cm pund_temp_300cm	ound_temp_100cm ound_temp_200cm ound_temp_300cm ound_temp_500cm	ound_temp_100cm ound_temp_200cm ound_temp_300cm ound_temp_500cm	ground_temp_50cm	-		
ound_temp_200cm	ound_temp_200cm ound_temp_300cm ound_temp_500cm	ound_temp_200cm ound_temp_300cm ound_temp_500cm	ground_temp_100cm			
pund_temp_300cm	ound_temp_300cm ound_temp_500cm	ound_temp_300cm ound_temp_500cm	ground_temp_200cm			
	round_temp_500cm	ound_temp_500cm	ground_temp_300cm			

Station (資料來源:中央氣象局)

Name	Datatype	ls PK	Comment
station_no	varchar(6)	Yes	測站代碼
station_name	varchar(20)	No	測站英文名稱
ch_station_name	varchar(20)	No	测站中文名稱
region	varchar(20)	No	區域
city	varchar(20)	No	縣市
town	varchar(20)	No	鄉鎮
north_latitude	varchar(20)	No	北緯
east_longitude	varchar(20)	No	東經
height_of_barometer_above_sea_level	varchar(10)	No	氣壓計海拔高度
height_of_therm_above_ground	varchar(10)	No	温度計離地高度
height_of_raingauge_above_ground	varchar(10)	No	雨量計離地高度
anem_above_ground	varchar(10)	No	風速表離地高度
altitude	varchar(10)	No	測站海拔高度
year_of_commencement	varchar(4)	No	設站年份

Daily\_Station\_Data (資料來源:中央氣象局局屬逐日測站資料)

Name	Datatype	ls PK	Comment
station_no	varchar(6)	Yes	測站代碼
year	numeric(4, 0)	Yes	年
month	numeric(2, 0)	Yes	月
day	numeric(2, 0)	Yes	日
date	datetime	Yes	日期時間
avg_atmospheric_pressure	numeric(10, 2)	No	平均測站氣壓
avg_sea_level_pressure	numeric(10, 2)	No	平均海平面氣壓
max_atmospheric_pressure	numeric(10, 2)	No	最高測站氣壓
max_atmospheric_pressure_time	datetime	No	最高測站氣壓時間
min_atmospheric_pressure	numeric(10, 2)	No	最低測站氣壓
min_atmospheric_pressure_time	datetime	No	最低測站氣壓時間
max_sea_level_pressure	numeric(10, 2)	No	最高海平面氣壓
max_sea_level_pressure_time	datetime	No	最高海平面氣壓時間
min_sea_level_pressure	numeric(10, 2)	No	最低海平面氣壓
min_sea_level_pressure_time	datetime	No	最低海平面氣壓時間
avg_temp	numeric(10, 2)	No	平均氣溫
max_temp	numeric(10, 2)	No	最高氣溫
max_temp_time	datetime	No	最高氣溫時間
min_temp	numeric(10, 2)	No	最低氣溫
min_temp_time	datetime	No	最低氣溫時間

avg_dew_point_temp	numeric(10, 2)	No	平均露點溫度
max_dew_point_temp	numeric(10, 2)	No	最高露點溫度
max_dew_point_temp_time	datetime	No	最高露點溫度時間
min_dew_point_temp	numeric(10, 2)	No	最低露點溫度
min_dew_point_temp_time	datetime	No	最低露點溫度時間
avg_wet_bulb_temp	numeric(10, 2)	No	平均濕球溫度
globe_thermometer_temp	numeric(10, 2)	No	黑球温度
daily_range_temperature	numeric(10, 2)	No	氣溫日較差
avg_vapor_pressure	numeric(10, 2)	No	平均水汽壓
max_vapor_pressure	numeric(10, 2)	No	最大水汽壓
max_vapor_pressure_time	datetime	No	最大水汽壓時間
min_vapor_pressure	numeric(10, 2)	No	最小水汽壓
min_vapor_pressure_time	datetime	No	最小水汽壓時間
avg_relative_humidity	numeric(10, 2)	No	平均相對溼度
max_relative_humidity	numeric(10, 2)	No	最大相對溼度
max_relative_humidity_time	datetime	No	最大相對溼度時間
min_relative_humidity	numeric(10, 2)	No	最小相對溼度
min_relative_humidity_time	datetime	No	最小相對溼度時間
avg_wind_speed	numeric(10, 2)	No	平均風風速
avg_wind_direction	numeric(10, 2)	No	平均風風向
avg_wind_run	numeric(10, 2)	No	平均風程
max_avg_wind_speed	numeric(10, 2)	No	最大平均風風速
max_avg_wind_direction	numeric(10, 2)	No	最大平均風風向
max_avg_wind_time	datetime	No	最大平均風發生時間
max_peak_wind_speed	numeric(10, 2)	No	瞬間極大風風速
max_peak_wind_direction	numeric(10, 2)	No	瞬間極大風風向
max_peak_wind_time	datetime	No	瞬間極大風發生時間
accumulated_precipitation	numeric(10, 2)	No	累積降雨量
accumulated_rain_hr	numeric(10, 2)	No	累積降雨時數
max_10min_precipitation	numeric(10, 2)	No	最大10分鐘降雨量
max_10min_precipitation_time	datetime	No	最大10分鐘降雨時間
max_hr_precipitation	numeric(10, 2)	No	最大小時降雨量
max_hr_precipitation_time	datetime	No	最大小時降雨時間
accumulated_sunshine_duration	numeric(10, 2)	No	累積日照時數
rate_of_sunshine	numeric(10, 2)	No	日照率
global_radiation	numeric(10, 2)	No	全天空日射量
hr_max_global_radiation	numeric(10, 2)	No	小時最大全天空日射量
hr_max_global_radiation_time	datetime	No	小時最大全天空日射量發生時間
avg_visibility	numeric $(10, 2)$	No	平均能見度
avg_cloud_cover	numeric(10, 2)	No	平均雲量
snow_depth	numeric(10, 2)	No	雪深

sky_state	numeric(10, 2)	No	天空狀況
ground_state	numeric(10, 2)	No	地面狀況
thunderstorm	numeric(10, 2)	No	雷暴
lquid_precipitation1	numeric(10, 2)	No	液態降水1
lquid_precipitation2	numeric(10, 2)	No	液態降水2
solid_precipitation1	numeric(10, 2)	No	固態降水1
solid_precipitation2	numeric(10, 2)	No	固態降水2
solid_precipitation3	numeric(10, 2)	No	固態降水3
obscuration1	numeric(10, 2)	No	視障 1
obscuration2	numeric(10, 2)	No	視障 2
Luminous_meteor1	numeric(10, 2)	No	光象1
Luminous_meteor2	numeric(10, 2)	No	光象 2
evaporation_in_shelter	numeric(10, 2)	No	20 cm箱內蒸發量
evaporation_out_shelter	numeric(10, 2)	No	20 cm箱外蒸發量
evaporation_A_type_pan	numeric(10, 2)	No	A型蒸發量
min_grass_temp	numeric(10, 2)	No	最低草溫
ground_temp_0cm	numeric(10, 2)	No	地中溫度 O cm
ground_temp_5cm	numeric(10, 2)	No	地中溫度5 cm
ground_temp_10cm	numeric(10, 2)	No	地中溫度 10 cm
ground_temp_20cm	numeric(10, 2)	No	地中溫度 20 cm
ground_temp_30cm	numeric(10, 2)	No	地中溫度 30 cm
ground_temp_50cm	numeric(10, 2)	No	地中溫度 50 cm
ground_temp_100cm	numeric(10, 2)	No	地中溫度 100 cm
ground_temp_200cm	numeric(10, 2)	No	地中溫度 200 cm
ground_temp_300cm	numeric(10, 2)	No	地中溫度 300 cm
ground_temp_500cm	numeric(10, 2)	No	地中溫度 500 cm

# QPESUMS\_STATION\_10M (資料來源:國家災害防救科技中心)

Name	Datatype	ls PK	Comment
station_no	varchar(6)	Yes	測站代碼
station_time	datetime	Yes	時間
avg_wind_direction	numeric(10, 2)	No	風向
avg_wind_speed	numeric(10, 2)	No	風速
avg_temp	numeric(10, 2)	No	溫度
avg_relative_humidity	numeric(10, 2)	No	濕度
avg_atmospheric_pressure	numeric(10, 2)	No	氣壓

QPESUMS\_STATION\_1D (資料來源:國家災害防救科技中心)

Name	Datatype	ls PK	Comment
station_no	varchar(6)	Yes	測站代碼
date	datetime	Yes	日期時間
avg_wind_direction	numeric(10, 2)	No	風向
avg_wind_speed	numeric(10, 2)	No	風速
avg_temp	numeric(10, 2)	No	溫度
avg_relative_humidity	numeric(10, 2)	No	濕度
avg_atmospheric_pressure	numeric(10, 2)	No	氣壓

### 附件三、氣象測站地圖



(網址: <u>https://dbar.ttfri.narl.org.tw/DataDesc/mapcwb\_AB.html</u>)

附件四、模型預測結果—以週為時間進行預測:

將資料以年週為整理之時間單位進行分析。年週對照表採用 SAS 資料 庫中 DW\_WEEKDATE 對照表,2008 年以前為 Excel 計算之年週,2008 年以後為 WHO 之年週對照。其餘參數設定皆依前述之方法,將參數改為 週平均或週累積雨量。

變數名稱	中文	單位	計算方式
YY_WW	年度_週次編碼		
Year	年度		
Week	週次		
City	研究城市		
Determine	確診數	人	
MYP	年中人口數	人	
Incidence	调骚止率	1/每十亩人	確診數/年中人口
meidence	过级工十	114   两八	數*100000
Avgtemp	週平均溫度	度	
Maxtemp	週平均最大溫	臣	
Maxtemp	度	/X	
Minitemperature	週平均最小溫	座	
Minitemperature	度	) <u>X</u>	
RelativeHumidity	平均相對溼度	%	
Max Relative Humidity	平均最大相對	0/	
	濕度	70	
Min Relative Humidity	平均最小相對	0/	
	濕度	/0	
Rain	降雨量	mm	累積總雨量
Blpercents	布氏級數大於2	%	

	之百分比	
Station_No	觀測站編號	

本研究使用和前述相同時間延遲的卜瓦松迴歸分析(lagged-time Poisson regression),模型如下:

 $ln(Y_t) = \beta_0 + \beta_1 Rain_{t-n} + \beta_2 T_{min,t-n} + \beta_3 RH_{t-n} + \beta_4 BI_{t-n} + e_t$ 

Y<sub>t</sub>為時間t時的每十萬人發生率,Rain<sub>t-n</sub>為延遲n期之降雨量,T<sub>mim,t-n</sub>為延遲n期之最小溫度,RH<sub>t-n</sub>為延遲n期之相對濕度,BI<sub>t-n</sub>為延遲n 期之布氏級數百分比。

延遲之期數選用:

變數	延遲(週)
降雨量	12
最小溫度	12
相對溼度	12
布氏級數	4

分析結果:

(一) 台南市

模型估計之參數值:

Parameter Estimates						
Parameter	DF	Estimate	Pr>ChiSq			
Intercept	1	-7.7911	<.0001			
Rain	1	0.0041	<.0001			
RelativeHumidity	1	-0.0445	0.0073			
BIpercents	1	-0.0139	0.0014			
MiniTemperature	1	0.4040	<.0001			



預測發生率與實際發生率之折線圖:

2013年之預測確診個數折線圖(含95% CI 上下界)



(二) 高雄市

模型估計之參數值:

	Parameter Estimates			
Parameter	DF	Estimate	Standard Error	Pr>ChiSq
Intercept	1	-20.3869	1.5559	<.0001
Rain	1	-0.0014	0.0006	0.0293
RelativeHumidity	1	0.1170	0.0159	<.0001
BIpercents	1	-0.0108	0.0022	<.0001
MiniTemperature	1	0.4547	0.0362	<.0001

預測發生率與實際發生率之折線圖:


2013年之預測確診個數折線圖(含95% CI 上下界)



(三) 屏東縣

模型估計之參數值:

	Parameter Estimates			
Parameter	DF	Estimate	Standard Error	Pr>ChiSq
Intercept	1	-13.0584	1.8238	<.0001
Rain	1	0.0020	0.0007	0.0029
RelativeHumidity	1	-0.0186	0.0223	0.4046
BIpercents	1	-0.0306	0.0070	<.0001
MiniTemperature	1	0.5350	0.0749	<.0001

預測發生率與實際發生率之折線圖:





2013年之預測確診個數折線圖(含95% CI 上下界)