科技部補助專題研究計畫成果報告
期末報告

臺灣地區健康資料時空整合平台之建立(第二至第四年)

計 畫 類 別 ： 個別型計畫
計 畫 編 號 ： MOST 103-2119-M-040-001-
執 行 期 間 ： 103年08月01日至104年07月31日
執 行 單 位 ： 中山醫學大學公共衛生學系（所）

計 畫 主 持 人 ： 廖勇柏

計畫參與人員： 碩士級-專任助理人員：徐書儀

處 理 方 式 ：
1.公開資訊：本計畫涉及專利或其他智慧財產權，2年後可公開查詢
2.「本研究」是否已有嚴重損及公共利益之發現：否
3.「本報告」是否建議提供政府單位施政參考：否

中 華 民 國 104 年 10 月 31 日

中 文 摘 要 ： 原計畫書預定為三年期計畫，審查委員都肯定「中華民國癌症死亡率地圖集(1972-2001)及發生率(1995-1998)地圖集」更新的重要性與價值，但對於政府其他資料庫因地理單元不同，空污水質資料是以測量站為單位，不是以鄉鎮為單位，另外政府調查的資料庫也不是包括全部鄉鎮，因此，審查委員認為實用性較低。除此之外，健保資料庫的投保地與居住地又未必相同，如果要花費太多經費購買資料庫，審查委員傾向不予支持，因此只核定一年期之計畫。有鑑於此，本計畫的研究目的為完成「臺灣地區健康資料時空網路整合平台」之建置，並將現有的「中華民國癌症死亡率地圖集(1972-2001)及發生率(1995-1998)地圖集」更新為「中華民國癌症死亡率地圖集(1972-2011)及發生率(1995-2008)地圖集」，並置入至整合平台，測驗其整合平台的實用性。

延續第一年的成果，本計畫將「中華民國癌症死亡率地圖集(1972-2001)」與「中華民國癌症死亡率地圖集(2002-2011)」重新整合，並更新及增加「中華民國癌症發生率(1995-2008)地圖集」。由於「中華民國癌症死亡率地圖集(1972-2001)」是以1976年世界標準人口進行年齡標準化，為了使1972-2001各年代資料能與第一年「台灣地區健康資料時空整合平台(一)」所完成的2002-2011最新死亡資料可互相比較，本計畫統一以2000年世界標準人口來進行年齡標準化，重新計算1972-1981、1982-1991以及 1992-2001年直接年齡標準化死亡率數值，各年代均分析上述三十種癌症，並按男女性分別計算與繪製地圖。同樣的，本計畫也會重新計算與繪製「直接年齡標準化死亡率與全人口死亡率比較圖(P值)」。

原預期完成更新1995-1999、2000-2004、以及2005-2009年的癌症發生率，但考量資料呈現的穩定性，因此本計畫改分析1995-2001、2005-2008、以及1995-2008年的發生率。最後利用上述資料建構出癌症死亡率與發生率的時空電子地圖。

中 文 關 鍵 詞 ： 電子地圖，時空趨勢，癌症死亡率，癌症發生率

英 文 摘 要 ： Objective: This study describes the construction of an easy to use online atlas of cancer mortality (1972-2011) and incidence (1995-2008) in Taiwan.

Methods: Two sets of color maps were made based on “age-adjusted mortality by rate” and “age-adjusted mortality by rank”. AJAX (Asynchronous JavaScript and XML), JSON (JavaScript Object Notation) and SVG (Scaling Vector Graphic) were used to produce the atlas. We constructed the atlas by exploring the spatio-temporal patterns of cancer mortality and incidence in Taiwan over the period 1972-2011 and 1995-2008 respectively.

Results: The constructed online atlas contains information cancer mortality and incidence. The common GIS functions include zoom and pan and identify through to data tables. Users can easily customize the maps to explore the spatio-temporal trends of cancer mortality and incidence using different devices (like PC, mobile phone or pad). This study suggests an easy to use, low-cost and platform

independent for exploring cancer incidence and mortality. This tool is expected to provide as a reference during cancer prevention and risk assessment.
Conclusion: This online atlas is a cheap and fast tool that integrates various cancer maps. Therefore, it can be a more powerful and quicker tool for examining and comparing spatio-temporal patterns of various maps. Furthermore, it can also be an easily useful tool for updating data and assessing risk factors of cancer in Taiwan.

英文關鍵詞：online atlas, spatio-temporal patterns, cancer mortality rate, cancer incidence rate

科技部補助專題研究計畫成果報告

（□期中進度報告/■期末報告）

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計畫編號：MOST 103-2119-M-040 -001
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執行機構及系所：中山醫學大學公共衛生學系（所）

計畫主持人：廖勇柏
計畫參與人員：徐書儀

本計畫除繳交成果報告外，另含下列出國報告，共 ___ 份：
□執行國際合作與移地研究心得報告
□出席國際學術會議心得報告

期末報告處理方式：

1. 公開方式：
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3.「本報告」是否建議提供政府單位施政參考 □否 □是，____（請列舉提供之單位；本部不經審議，依勾選逕予轉送）

中　華　民　國　104　年　10　月　31　日

概 要 說 明

原計畫書預定為三年期計畫，審查委員都肯定「中華民國癌症死亡率地圖集(1972-2001)及發生率(1995-1998)地圖集」更新的重要性與價值，但對於政府其他資料庫因地理單元不同，空污水質資料是以測量站為單位，不是以鄉鎮為單位，另外政府調查的資料庫也不是包括全部鄉鎮，因此，審查委員認為實用性較低。除此之外，健保資料庫的投保地與居住地又未必相同，如果要花費太多經費購買資料庫，審查委員傾向不予支持，因此只核定一年期之計畫。有鑑於此，本計畫的研究目的為完成「臺灣地區健康資料時空網路整合平台」之建置，並將現有的「中華民國癌症死亡率地圖集(1972-2001)及發生率(1995-1998)地圖集」更新為「中華民國癌症死亡率地圖集(1972-2011)及發生率(1995-2008)地圖集」，並置入至整合平台，測驗其整合平台的實用性。

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結　　果

「臺灣地區健康資料時空網路整合平台」之建置結果，請參閱網址：
http://taiwancancermap.csmu-liawyp.tw/

三立電視台陳雅琳主播專訪本計畫研究成果，並於2015年10月30日開始播出，在Facebook 「陳雅琳 會思考的新聞台！」亦可看到播報內容。

本計畫研究結果已撰寫成論文發表型式(如下頁)，目前狀態為under review。

An online atlas for exploring spatio-temporal patterns of cancer mortality (1972-2011) and incidence (1995-2008) in Taiwan

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Abstract

Objective: This study describes the construction of an easy to use online atlas of cancer mortality (1972-2011) and incidence (1995-2008) in Taiwan.

Methods: Two sets of color maps were made based on “age-adjusted mortality by rate” and “age-adjusted mortality by rank”. AJAX (Asynchronous JavaScript and XML), JSON (JavaScript Object Notation) and SVG (Scaling Vector Graphic) were used to produce the atlas. We constructed the atlas by exploring the spatio-temporal patterns of cancer mortality and incidence in Taiwan over the period 1972-2011 and 1995-2008 respectively.

Results: The constructed online atlas contains information cancer mortality and incidence. The common GIS functions include zoom and pan and identify through to data tables. Users can easily customize the maps to explore the spatio-temporal trends of cancer mortality and incidence using different devices (like PC, mobile phone or pad). This study suggests an easy to use, low-cost and platform independent for exploring cancer incidence and mortality. This tool is expected to provide as a reference during cancer prevention and risk assessment.

Conclusion: This online atlas is a cheap and fast tool that integrates various cancer maps. Therefore, it can be a more powerful and quicker tool for examining and comparing spatio-temporal patterns of various maps. Furthermore, it can also be an easily useful tool for updating data and assessing risk factors of cancer in Taiwan.

Introduction

In many countries, public health mapping and Geographical Information Systems (GIS) are already being used to locate the geographical spread of diseases [1-6]. GIS is a powerful tool that can help epidemiologists in exploring and analyzing cancer data, hence generating ideas and hypotheses at the beginning of a research [7]. Commercial GIS software had been used to construct cancer maps. However, some of the drawbacks include cost, inconvenience, limited platform and data update problems. With improvements in web technology in recent years, the internet has become an important means to obtain information. In this study, we describe the construction and implementation of an easy to use, low-cost and independent, platform for exploring cancer incidence and mortality patterns in Taiwan.

Method and Materials

Cancer mortality data (1972-2011) were collected from the national death databank of the Bureau of Health Promotion, Department of Health, Executive Yuan. Mortality data were divided into four periods (1972-1981, 1982-1991, 1992-2001, 2002-2011). Incidence data (1995-2008) were collected from the Cancer Registry System (CRS), Bureau of Health Promotion, Department of Health, Executive Yuan. The incidence data were divided into two periods (1995-2001, 2002-2009).

Two sets of color maps were made based on the indices “age-standardized mortality/incidence rate (ASR)” and “age-standanj:rdized mortality/incidence rate by rank, (P-value)” for both gender. The ASRs of mortality/incidence were by period, sex, , cancer sites and townships. The ASRs for different townships was stratified by18 age groups (0-4, 5-9, …, 80 to 84, and 85 and over), based on the 2000 World Standard Population. The cancer sites included lip, oral cavity, major salivary glands,

nasopharynx, esophagus, stomach, small intestine, colon, rectum, rectosigmoid junction and anus, liver and intrahepatic bile ducts, gall bladder and extra hepatic bile ducts, pancreas, nasal cavities, middle ear and accessory sinuses, larynx, trachea, bronchus and lung, bone and articular cartilage, connective and other soft tissues, skin(melanoma), skin(non-melanoma), female breast, cervix uteri and uterus, parts unspecified, ovary and other uterine adnexa, prostate, bladder, kidney and other unspecified urinary organs, brain, thyroid gland, non-hodgkin's lymphoma, leukemia and all sites combined.

ASR and P-value maps were later generated. In order to construct the P-value maps, the mortality/incidence rates were categorized into seven levels using red-green gradients. The mortality/incidence rates for each townships were ranked from highest to lowest. Townships ranked within the top 10 out of all townships in cancer mortality/incidence and for which the rates were significantly higher than the overall average were categorized into Level 1 (red). Townships whose mortality/incidence rates were significantly higher than the overall average but which were not not ranked within the top 10% were categorized into Level 2 (purple). Townships ranked among the top 10 and whose mortality/incidence rates were not significantly higher than the overall average were categorized in Level 3 (orange). Level 4 (green) include townships ranked from 10 and 90% and for which the mortality/incidence rates were not significantly higher than the overall average. Those ranked in the bottom 10 for which their mortality/incidence rates were not significantly lower than the overall average categorized as Level 5 (gray). Townships with mortality/incidence rates significantly lower than the overall average and which were not ranked in the bottom 10 were categorized as Level 6 (yellow). Level 7 (white) represent townships ranked in the bottom 10 that had mortality/incidence rates significantly lower than the overall average. SAS statistical software Version 9.3 was used to analyze the data.

This online atlas was constructed using AJAX (Asynchronous JavaScript and XML)[8], JSON (JavaScript Object Notation)[9], SVG (Scaling Vector Graphic) [10], jQuery[11] and jVectorMap [12] technology .

AJAX, described by Jesse James Garrett in 2005 incorporated a number of technologies for the front-end web development. AJAX is the data transfer technology, i.e. the data information is passed from database to the browser which allows rapid change and exploration of cancer maps by gender or other indices. JSON is a lightweight data-interchange format when compared to XML. When obtaining cancer information through AJAX, JSON can reduce the amount of data transmission. jQuery is a lightweight JavaScript library which can easily control the browser actions such as zoom in, zoom out, pan and query function. jVectorMap is a jQuery plugin that can be used to easily create interactive maps. Unlike the SVG, the GIS shapefile cannot be published on the web.. Therefore, to publish the maps on web, GIS data or shapefile ought to be converted into SVG format. jVectorMap can provide such a function for it uses SVG as the map format. It also has a Python converter for creating maps from the GIS shapefiles. With jVectorMap and SVG, cancer maps can have high resolution and interaction during exploration.

Result

Browse the following link http://taiwancancermap.csmu-liawyp.tw to explore the atlas. Age standardized mortality rate is directly assessed for specific township from 1972-2011 (1972-1981, 1982-1991, 1992-2001, 2002-2011) as shown in Figure 1. Click on the “select cancer” panel or icon (upper left corner) to view cancer type by gender. Select the “Map Index” panel to assess cancer by ASR or P-value (Figure 2

represent the P value). Select the “Map type” panel to view by mortality or incidence (Figures 3 and 4 represent incidence rates from 1995-2008).

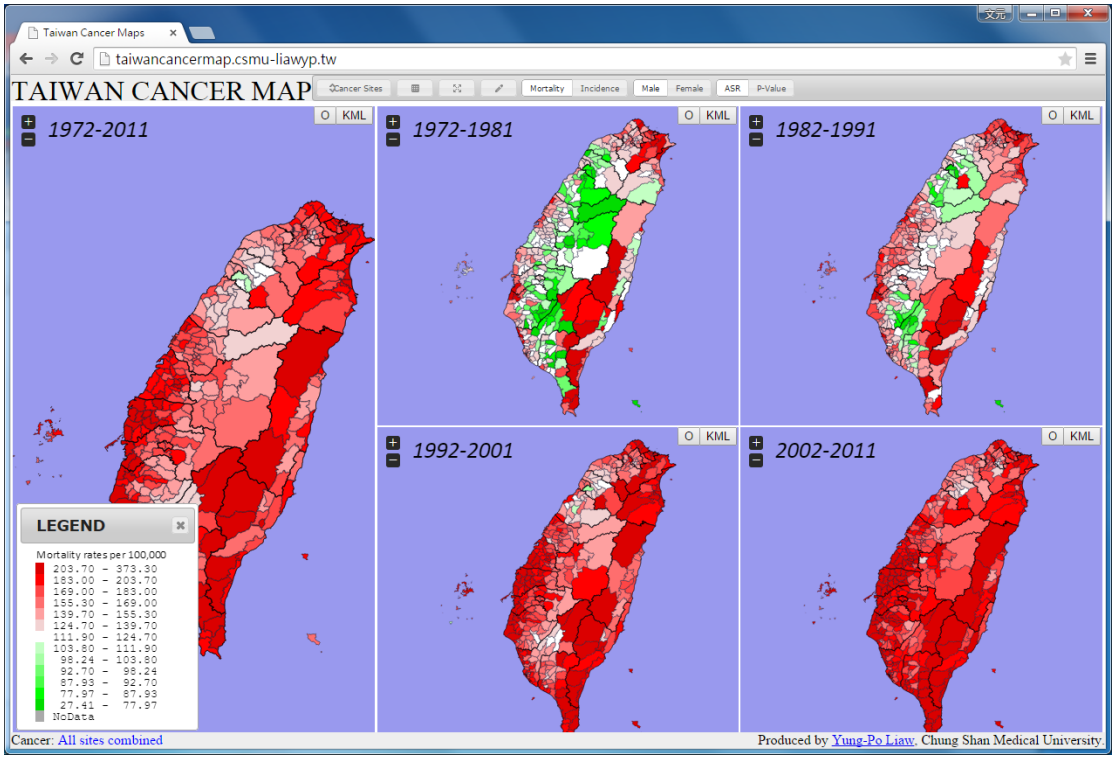

Figure 1 Age-standardized mortality rates for all townships 1972-2011 (per 100,000 persons)

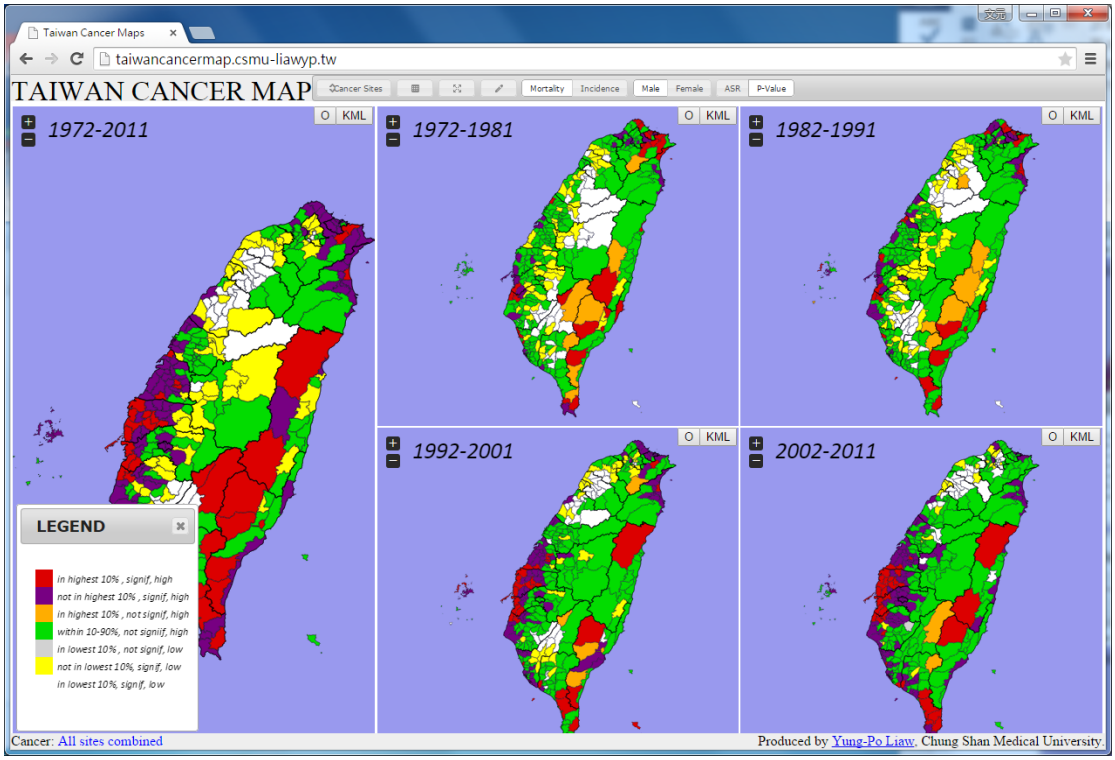

Figure 2　Age-standardized mortality rates by rank, 1972-2011.

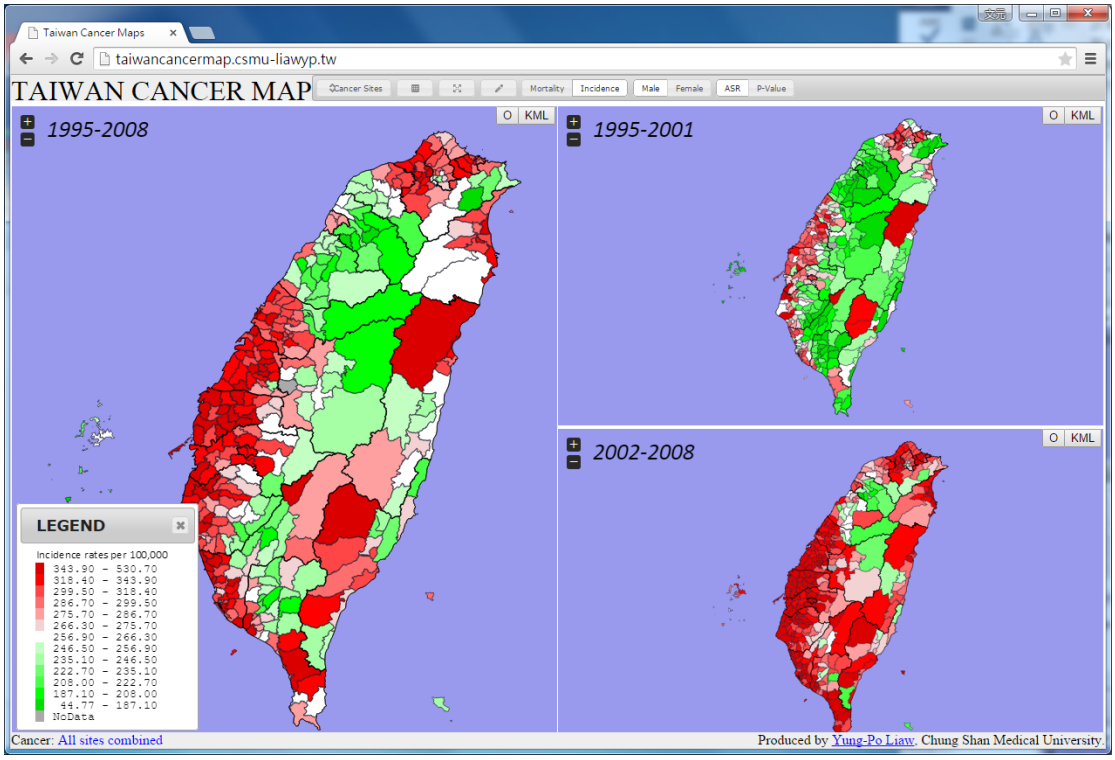

Figure 3 Age-standardized incidence rates for all townships, 1995-2008 (per 100,000 persons)

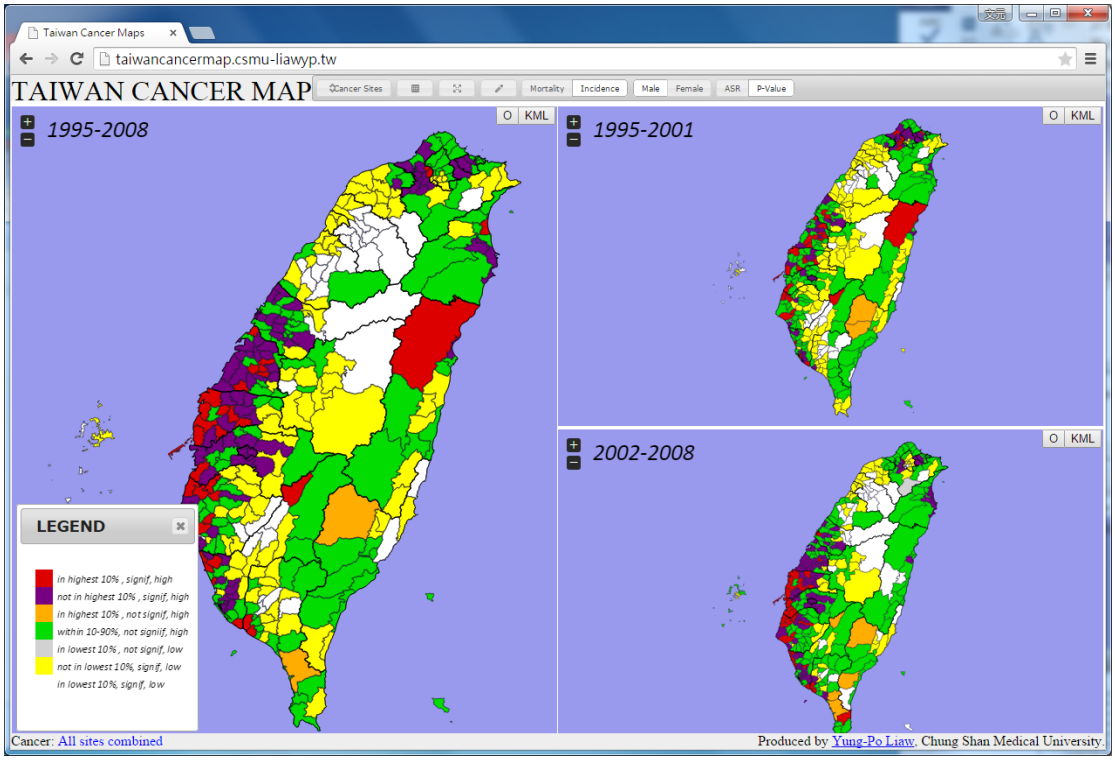

Figure 4 Age-standardized incidence rates by rank, 1995-2008.

Besides mortality/incidence, gender, cancer type and map index, the atlas also provides other basic functions and tooltip to enable exploration of data by township (Figure 5). It also provides legend panel which enables users to adjust or modify map parameters for convenience (Figure 6).

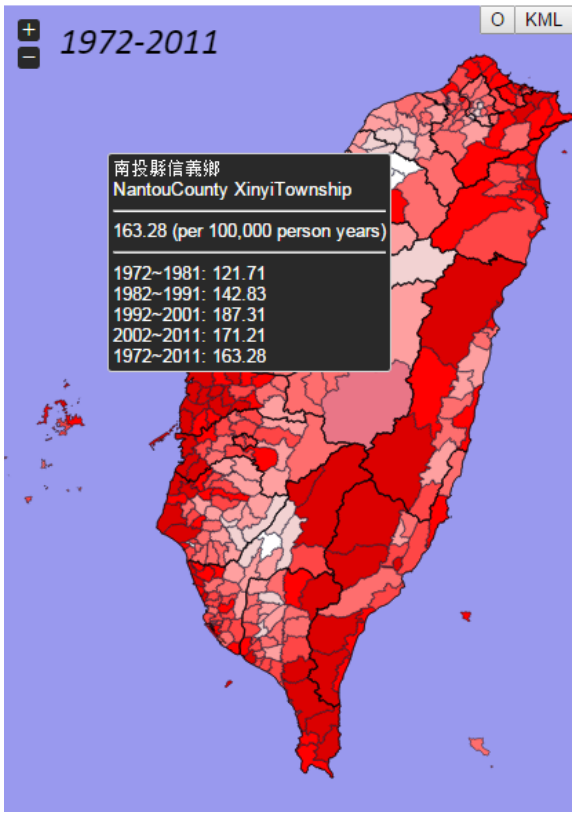

Figure 5 Example of an image map: jQuery tooltip for exploration of data by township

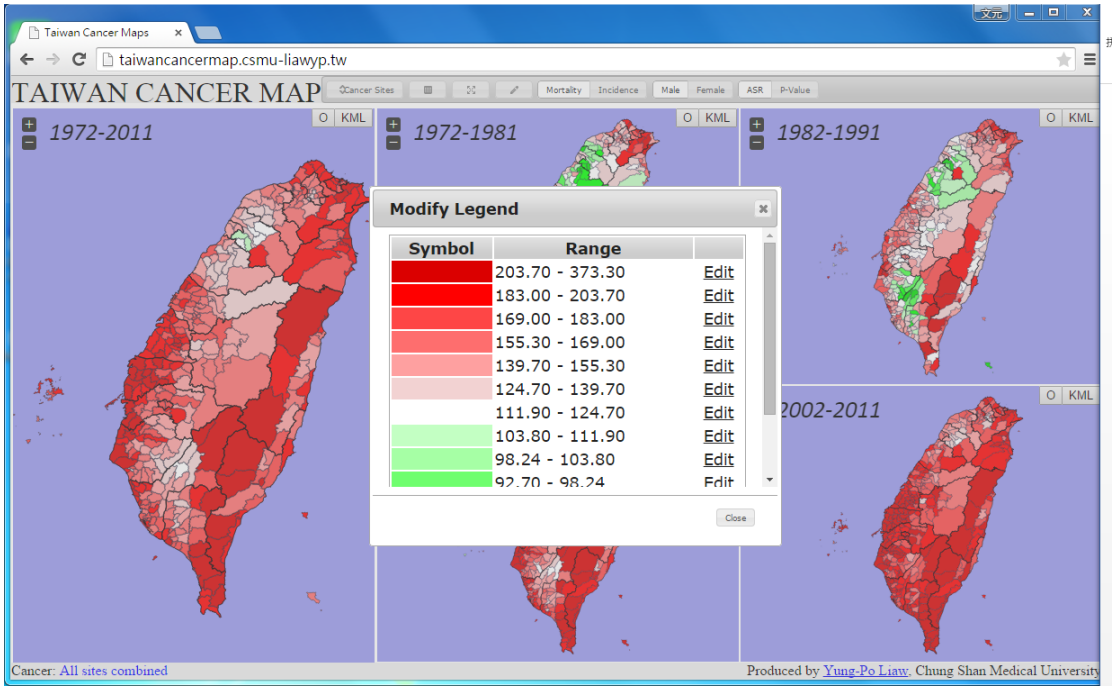

Figure 6 Screenshot of the 'Modify Legend' which enables users to modify data range.

From the map, user can explore the changes of cancer mortality or incidence rate in whole Taiwan. For the perspective of individual townships, the system provide a chart tool that can show the trends in cancer. (Figure 7).

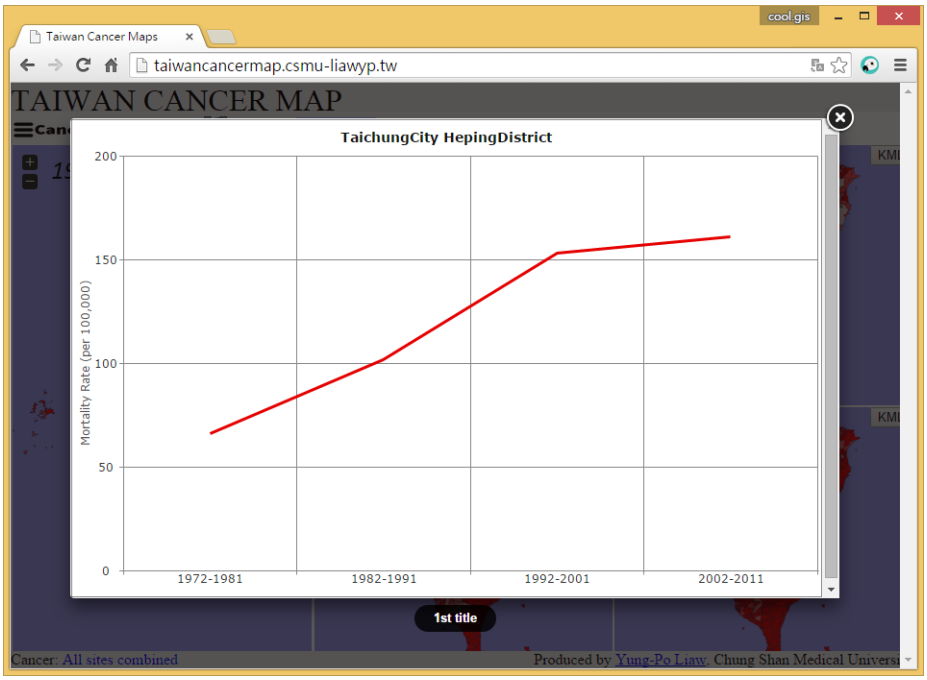

Figure 7 Screenshot of the ‘Chart’ which shown trends in cancer mortality in a township.

Google Earth is an easy use and visualization tools to explore geospatial information. The system provide an export function in which the cancer map can be exported in KML format and overlay to Google Earth (Figure 8).

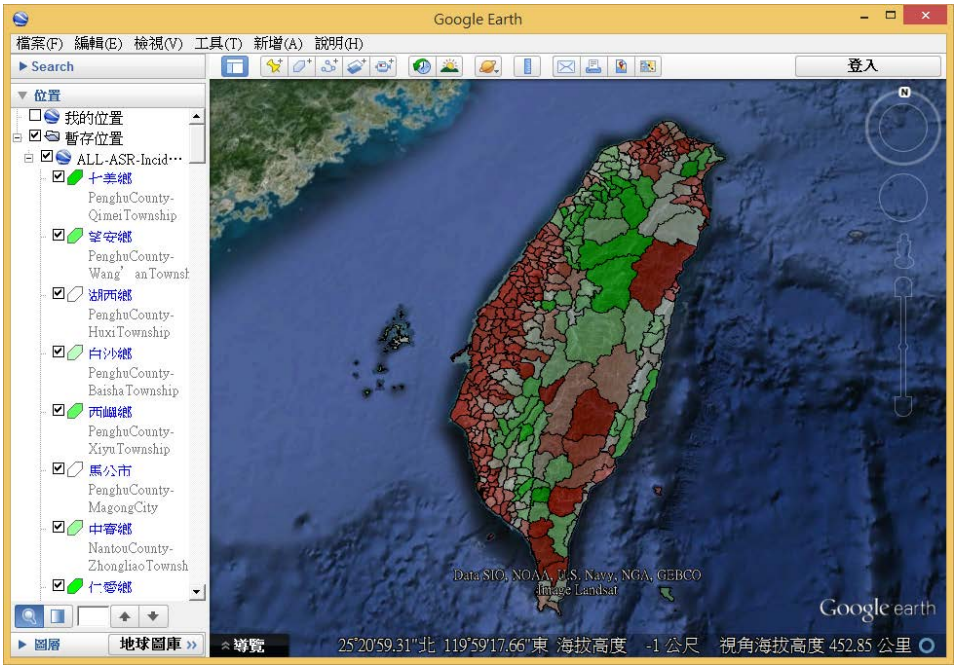

Figure 8 Screenshot of the ‘Google Earth’ which overlay a KML file by township (all cancer mortality)

Discussion

To the best of our knowledge, this is the first online atlas (with spatio-temporal cancer data) with a cross platform. It can be assessed through other devices like PC, mobile phone or pad. The online atlas is an effective, easy to use, updatable and independent platform. The GIS can play an important role in generating hypotheses for many researches. The GIS is a powerful communication tool in public health which allows epidemiologists to investigate spatio-temporal patterns through visualization and analysis [1, 7, 13-15]. However, most commercial GIS softwares are

expensive and complex, hence many researches use GIS technologies free of charge in public health GIS analysis [2, 16-19].

This study showed that the SVG combined with web technologies (AJAX, JSON, JavaScript, jVectoryMap, jQuery) will minimize the amount of network transmission and enhance usage. This study used open-source software such as AJAX, JSON, JavaScript, jQuery, SVG and jVectorMap free of charge, hence reducing development costs.

With the development of the Internet, using the web for data mapping and sharing of public health have become increasingly popular and will be an important and exciting development trend [20], such as the WHO Global Health Observatory theme pages that provide interactive map [21], too. However, WHO interactive map uses Adobe Flash. However, most of the mobile devices can’t support Flash plug-in and this hinders users from exploring the map. Relatively, our system is are platform-independent and can render map on browser without requiring plug-in.

The application of SVG in public health can be traced back to 2005. Boulos and Russell constructed a diagnostic map of sexually transmitted diseases from 1997-2003 in London using SVG [13]. Kamadjeu and Tolentino used SVG technology to develop a database driven web-based GIS system using the EPI (Expanded Program on Immunization) data[16]. However, early use of SVG as seen above, was limited to web technologies.. Each thematic map of cancer required to be pre-generated to SVG file through MapInfo software which was however inconvenient.

In this study AJAX technology was used. The contents of the map are based on

user setting which transfers data from the database server to the browser. By this way, the system has good scalability, flexibility and a reduced maintenance cost. Furthermore, using AJAX technology can reduce network traffic and improve system performance to enhance user experience. In other words, this study used AJAX technology where the SVG model was generated only once before being reused on different thematic cancer maps. When a user selects cancer type, the system will send an AJAX request to the server. When the server receives this request, it will execute database query and will respond to the browser in JSON format. Finally, the system will set the style of SVG element using JavaScript. By this way, it can render a new map by not having to leave the existing page. SVG with JavaScript is used to make maps more interacting and enables the user to explore the spatio-temporal health data.

The system could also provide a function in which the cancer map can be exported in KML format and overlay to Google Earth. With Google Earth and its rich satellite images, users can assess the state of environment by region and this can help to generate research hypotheses. The online atlas can be integrated with that of WHO and can also be linked with Google Earth to generate hypothesis and to better comprehend cancer etiology. This technology can also make use of data from other countries. This will make it easier to compare cancer mortality and incidence patterns globally. Therefore, an easy to use, affordable and independent online atlas is vital especially for those countries with high risk of cancer.

Conclusion

This online atlas is a cheap and fast tool that integrates various cancer maps. Therefore, it can be a more powerful and quicker tool for examining and comparing spatio-temporal patterns of various maps

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科技部補助計畫衍生研發成果推廣資料表

日期:2015/10/31

科技部補助計畫	計畫名稱: 臺灣地區健康資料時空整合平台之建立(第二至第四年)
	計畫主持人: 廖勇柏
	計畫編號: 103-2119-M-040-001- 學門領域: 空間資訊整合應用技術

無研發成果推廣資料

103年度專題研究計畫研究成果彙整表

計畫主持人：廖勇柏			計畫編號：103-2119-M-040-001-				
計畫名稱：臺灣地區健康資料時空整合平台之建立(第二至第四年)							
成果項目			量化			單位	備註（質化說明：如數個計畫共同成果、成果列為該期刊之封面故事...等）
			實際已達成數（被接受或已發表）	預期總達成數（含實際已達成數）	本計畫實際貢獻百分比		
國內	論文著作	期刊論文	0	0	100%	篇	
		研究報告/技術報告	0	0	100%		
		研討會論文	1	1	100%		台灣公共衛生學會年會
		專書	0	0	100%	章/本	
	專利	申請中件數	0	0	100%	件	
		已獲得件數	0	0	100%		
	技術移轉	件數	0	0	100%	件	
		權利金	0	0	100%	千元	
	參與計畫人力（本國籍）	碩士生	0	0	100%	人次	
		博士生	0	0	100%		
		博士後研究員	0	0	100%		
		專任助理	0	0	100%		
國外	論文著作	期刊論文	1	0	100%	篇	
		研究報告/技術報告	0	0	100%		
		研討會論文	0	0	100%		
		專書	0	0	100%	章/本	
	專利	申請中件數	0	0	100%	件	
		已獲得件數	0	0	100%		
	技術移轉	件數	0	0	100%	件	
		權利金	0	0	100%	千元	
	參與計畫人力（外國籍）	碩士生	0	0	100%	人次	
		博士生	0	0	100%		
		博士後研究員	0	0	100%		
		專任助理	0	0	100%		
其他成果（無法以量化表達之成果如辦理學術活動、獲得獎項、重要國際合作、研究成果國際影響力及其他協助產業技術發展之具體效益事項等，請以文			「臺灣地區健康資料時空網路整合平台」之建置結果，請參閱網址：http://taiwancancermap.csmu-liawyp.tw/ 三立電視台陳雅琳主播專訪本計畫研究成果，並於2015年10月30日開始播出，在Facebook 「陳雅琳 會思考的新聞台！」亦可看到播報內容。 本計畫研究結果已撰寫成論文發表型式，目前狀態為under review。				

字敘述填列。）	

	成果項目	量化	名稱或內容性質簡述
科教處計畫加填項目	測驗工具(含質性與量性)	0	
	課程/模組	0	
	電腦及網路系統或工具	0	
	教材	0	
	舉辦之活動/競賽	0	
	研討會/工作坊	0	
	電子報、網站	0	
	計畫成果推廣之參與（閱聽）人數	0	

科技部補助專題研究計畫成果報告自評表

請就研究內容與原計畫相符程度、達成預期目標情況、研究成果之學術或應用價值（簡要敘述成果所代表之意義、價值、影響或進一步發展之可能性）、是否適合在學術期刊發表或申請專利、主要發現或其他有關價值等，作一綜合評估。

1. 請就研究內容與原計畫相符程度、達成預期目標情況作一綜合評估
   ■達成目標
   □未達成目標（請說明，以100字為限）
   　□實驗失敗
   　□因故實驗中斷
   　□其他原因
   說明：

2. 研究成果在學術期刊發表或申請專利等情形：
   論文：□已發表 ■未發表之文稿 □撰寫中 □無
   專利：□已獲得 □申請中 ■無
   技轉：□已技轉 □洽談中 ■無
   其他：（以100字為限）
   「臺灣地區健康資料時空網路整合平台」之建置結果，請參閱網址：http://taiwancancermap.csmu-liawyp.tw/

   三立電視台陳雅琳主播專訪本計畫研究成果，並於2015年10月30日開始播出，在Facebook 「陳雅琳 會思考的新聞台！」亦可看到播報內容。

   本計畫研究結果已撰寫成論文發表型式(如下頁)，目前狀態為under review。

3. 請依學術成就、技術創新、社會影響等方面，評估研究成果之學術或應用價值（簡要敘述成果所代表之意義、價值、影響或進一步發展之可能性）（以500字為限）
   台灣四十年癌症地圖的時空趨勢分析，透過三立電視台陳雅琳主播採訪本計畫研究成果，並於2015年10月30日晚上8:30開始播出，在Facebook 「陳雅琳 會思考的新聞台！」亦可看到播報內容。公佈後二十四小時內已超過五千人在facebook上觀看此影片，近期並會密集在三立電視新聞台重播，本研究成果預期將造成全台關注的公共衛生議題。本人在接受採訪時特別要求陳主播，要以正面客觀角度來報導，例如受地下砷井水污染的北門區癌症雖高，但已看出近年來有下降趨勢，顯見政府全面改用自來水的成效，又如子宮頸癌的死亡率早年亦是持續上升，近年來也看到政府子宮頸癌篩檢的效益，子宮頸癌死亡率已逐年下降。另外，桃竹苗地區癌症死亡率相對較低，若能進一步探討其原因，對預防醫學亦將有重大貢獻。然而有些癌症及地區的癌症死亡率持續上升，這些都值得我們必須花更多心力去關注與預防，本研究成果除了顯示及肯定政府的努力有成外，亦將喚醒政府對環境及食安問題的更加重視，期待早日通過公共衛生師立法，讓更多的專業人才一起為全國人民的健康做出貢獻。