Building a Web-based Cancer Atlas for Saudi Arabia

K. Al-Ahmadi[1], A.J. Heppenstall[2], L. See[3] and A. Al-Zahrani[4]

[1]Space Research Institute, King Abdulaziz City for Science and Technology, P.O. Box 231353, Riyadh 11321, Saudi Arabia
Telephone: (+966 1) 4814542
Fax: (+966 1) 4813845
Email: alahmadi@kacst.edu.sa

[2]School of Geography, University of Leeds, Woodhouse Lane, Leeds, LS2 9JT, UK
Telephone: (+44 113) 3433392
Fax: (+44 113) 3433308
Email: a.j.heppenstall@leeds.ac.uk

[3]International Institute for Applied Systems Analysis (IIASA), Schlossplatz 1, A-2361 Laxenburg, Austria
Telephone: (+43 2236) 807423
Fax: (+43 2236) 807599
Email: see@iiasa.ac.at

[4]King Faisal Specialist Hospital and Research Centre, P.O.Box 3354, Riyadh 11211, Saudi Arabia
Telephone: (+966 1) 4647272
Fax: (+966 1) 4414839
E-mail: alisaz@kfshrc.edu.sa

1. Introduction

Cancer is the second most frequent cause of death in developed countries and the fourth in the Eastern Mediterranean Region (EMR). The estimated number of new incidents of cancer each year is expected to rise from 11 million in 2002 to 16 million by 2020, with more than half of these occurring in developing countries. In the EMR, cancer is forecast to rise by a factor of 1.8 times over the next 10 years (WHO, 2005). Saudi Arabia is located in the EMR where more than 45,500 cancer incidences have been registered between 1998 and 2004 (SCR, 2010). These incidences and a range of socio-economic variables have been compiled into a rich spatial-temporal database. GIS and spatial analysis provide opportunities for epidemiologists and cancer researchers to investigate spatial patterns within this dataset and to understand relationships between cancer and other health, socioeconomic and environmental variables (Brewer, 2006). To date, GIS has not been used extensively in Saudi Arabia for this purpose. Interpretation, assimilation and analysis of cancer incidence maps are valuable for identifying low, average and high concentrations of cancer incidence. This can be a preliminary step for research into the causes or aetiology of particular types of cancers and for setting priorities for public health awareness campaigns, educational activities, improving methods of early detection, screening and cancer prevention and control.

The aim of this paper is to describe a new interactive web-based tool aimed at both researchers and the public for analysing cancer data in Saudi Arabia. This statistical and spatial cancer atlas (SSCA) was designed and implemented using a client-server architecture. The atlas uses data from the Saudi Cancer Registry (SCR) at four spatial levels: national, regional, sub-regional and cities. The SSCA contains maps of the spatial distribution of cancer incidence over time and trends in the incidence of different types of cancers at the four spatial scales. It was designed for planning and resource allocation of health care resources and facilities and to highlight areas for further epidemiologic investigations into the causes of cancer. The architecture of the system and the main statistical and spatial features are described in the next section. This is followed by an example of the types of results that can be generated using the atlas. A brief discussion of further research areas is then provided.

2. Design of the SSCA

2.1 Architecture

There are four main components that make up the architecture of the SSCA (fig. 1):

- **The Client:** Flex was used to build the web client for the atlas, where MXML and ActionScript have been used to define the layout, appearance and behaviour of the application. These were then compiled into a single SWF file that makes up the Flex client SSCA application. The ArcGIS Server API for Flex was also used (ESRI, 2010), which allows maps and analysis from ArcGIS Server to be displayed in the client.
- **The Web and Application Server:** responds to client requests, which can involve linking to other application servers, e.g. the database or map server. For the SSCA, ASP.NET was used to build the web application server since it is a powerful tool for creating dynamic and interactive web applications. The cancer database is maintained in a Microsoft SQL Server and the operating system is Windows Server, so the application server interfaces with these other components seamlessly.

- **The Map Server:** fulfills spatial queries, conducts spatial analysis, and generates and delivers maps to the client based upon the users' requests. The output from the map server can be a simple map image in a graphic format or map elements served by ArcGIS Server.
- **The Database Server:** houses the cancer data in a relational database structure stored in Windows SQL Server 2008 (enterprise edition). The Flex client application accesses the database through SQL. For each individual cancer case, 14 variables are recorded including: gender, age, birth date, marital status, region, city, diagnosis date, site, topography, morphology, behaviour and stage of diagnosis.

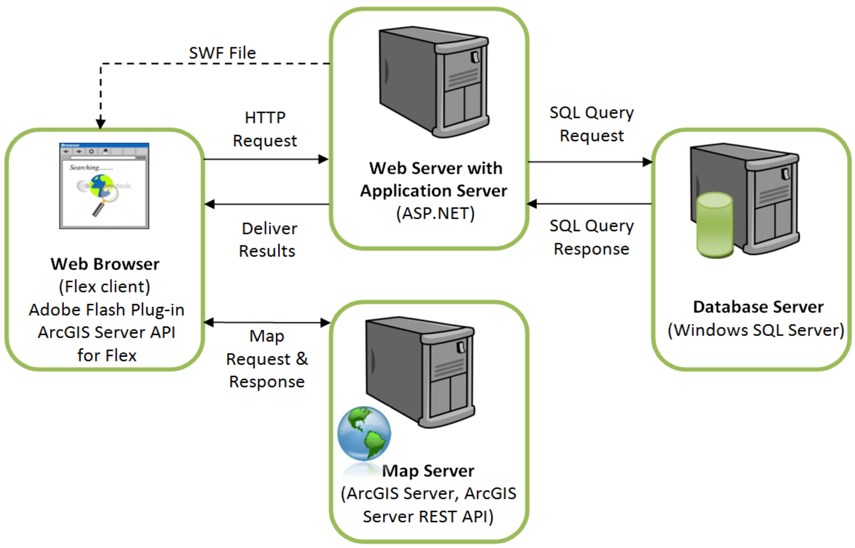

Figure 1. Architecture of the cancer atlas.

A more detailed explanation of the architecture and the database structure is provided in Al-Ahmadi (2010).

2.2 Statistical and Spatial Features of the Atlas

The statistical and spatial functionality is embedded within two different Graphical User Interfaces (GUI). The *statistical analysis interface* is divided into different dynamically-linked panels as shown in fig. 2. The function of the Analysis panel is to allow users to select the spatial level, whether analysis is to be undertaken on all types of cancers or only the ten most common types, and the type of analysis. The type of analysis is standard or advanced where standard consists of 35 pre-defined analyses that allow users to explore the distribution of cancer cases according to different criteria: age group, gender, stage distribution, morphology, time period, etc., as well as animations of population and cancer incidence pyramids over time. Advanced analysis allows the user the option to adjust the parameters of the 35 pre-defined analyses. More details of the types of analyses available are presented in Al-Ahmadi (2010). The *spatial analysis interface* as shown in fig. 3 is similar to the statistical analysis interface except that the results are displayed in map form. However, users can also display figures and tables through the legend panel. Different maps can be generated such as graduated choropleth maps, density maps, symbol maps, pie chart maps and bar chart maps dynamically.

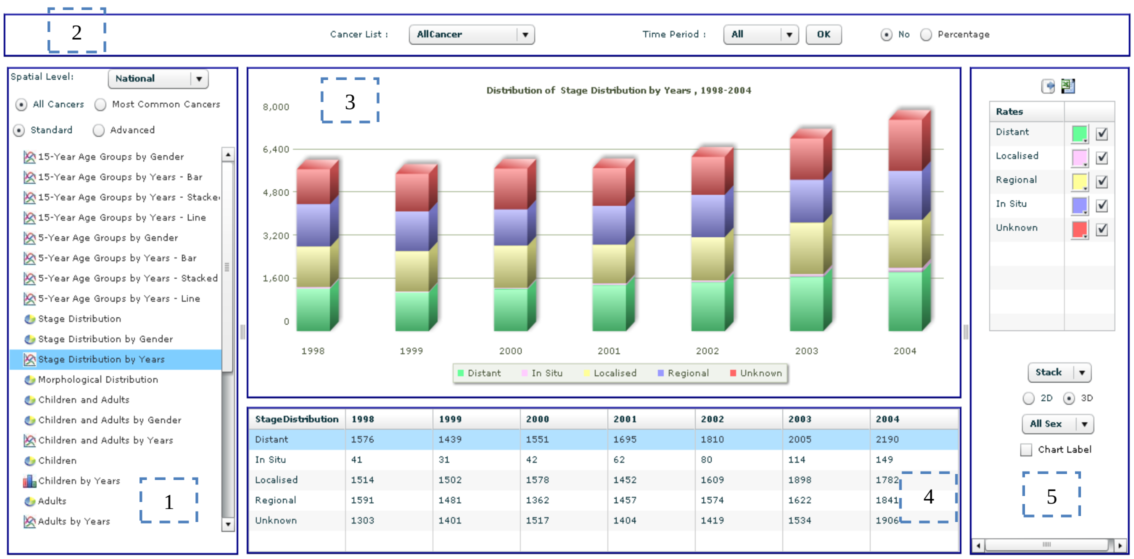

Figure 2: Statistical analysis interface panels for displaying the (1) analysis; (2) cancer type & time period; (3) figures; (4) tables; (5) legend.

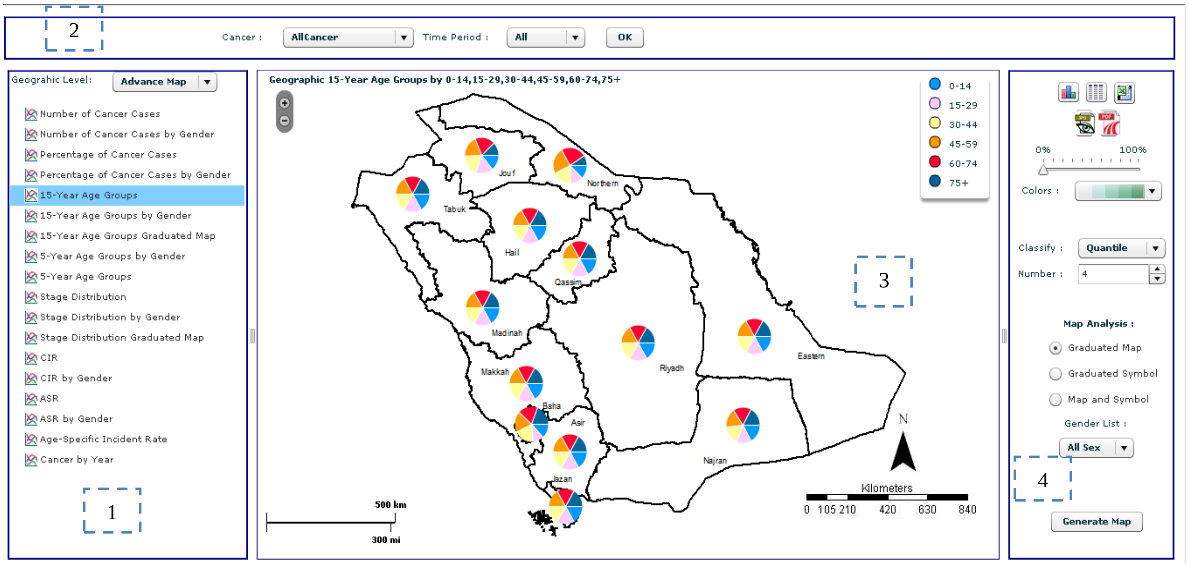

Figure 3: Spatial analysis interface panels for displaying the (1) analysis; (2) cancer type & time period; (3) maps; (4) legend.

3. Further Developments

A web-based interactive Statistical Spatial Cancer Atlas has been developed for Saudi Arabia. The atlas will be used to determine whether observed geographic variation in the cancer incidence rates for the most common cancers such as breast, liver, thyroid, and colorectal cancers are random or statistically significant. Where there are statistically significant clusters, research questions of interest are whether these are temporary or time-persistent, whether they are specific to geographic areas, whether they are consistent across all diagnostic stages and whether they can be attributed to covariates such as age, sex, and urban/rural status. The atlas will be made available to researchers in the spring of 2011 and to the public in late 2011. Based on feedback from the researchers, the application will be improved and new advanced features will be added, e.g. space-time clustering, autocorrelation statistics, logistic regression, etc.

A full demonstration of the Atlas and its capabilities will be given at the conference.

4. Acknowledgements

This research was funded by Grant 29-286 from King Abdulaziz City for Science and Technology (KACST). Cancer data was acquired from Saudi Cancer Registry (SCR). The views stated in this publication are those of the authors and do not necessarily represent the official views of KACST and SCR.

5. References

Al-Ahmadi, K. (2010). Statistical and Spatial Cancer Atlas Web-Based Application. Riyadh, Saudi Arabia.

Brewer, C. (2006). Basic Mapping Principles for Visualizing Cancer Data Using Geographic Information Systems (GIS), American Journal of Preventive Medicine, 30, (2S).

SCR (2010). Saudi Cancer Registry, Saudi Arabia.

WHO (2005). World Health Organization [http://www.who.int/en/]