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E-ATLAS OF HEALTH, PLANNING AND SUSTAINABLE DEVELOPMENT

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ABSTRACT

Through a medical informatics project named 'POLESAT', we aim to begin building a geomatics platform with a new decision-support tool "the e-Atlas of Health" to answer specific Public Health problems in epidemiology, territorial management and healthcare use. Our e-Atlas prototype will improve and provide information to health authorities, healthcare professionals and the general public with new geographical information, geographic knowledge discovery and reflection, analysis and scientific communications at several geometric division levels. Methods: The studied area covers the French Nord - Pas-de-Calais region (4 million inhabitants). The database contains hospital inpatient activity by department for the University Hospital of Lille, France. The specific board frame by specialty was built with medical codification. Results: The prototype is accessible from a secured web server. Maps can be downloaded or saved from the web server in several formats. Thus, the geomatics platform provides quick, easy access to mapping information about territorial supply and demand of hospital care, and displays maps of catchment hospital areas along with additional statistical information and comments. Conclusion: This prototype, usable via Internet or Intranet, allows a background inventory on the state of hospital activity. It has multiple uses and will answer users' problems and needs. So, we aim to offer a global vision of healthcare supply and demand for health management and for health geomarketing uses by professional and patients. e-Atlas will be enlarged to all French public, private hospital inpatient activities and will become our second tool following our previous mathematical modelling process for healthcare management.

KEYWORDS

Atlases, Geographic Information System, Medical Informatics, Access to Information, Decision-Making, Computer-Assisted

1. INTRODUCTION

Health geography is a fairly new discipline in France (Picheral, 1990; Amat-Roze, 2007; Boulos *et al.*, 2001) and often goes unrecognized by health professionals, decision-makers and the general public. At the same time, health professionals have little or no recent information on geolocalisation of supply and demand. They don't have detailed geographical information about the number of hospital stays realized either inside medical establishments or inside healthcare departments. They generally have partial knowledge of supply and demand through their own professional healthcare network, evolving over the professional activity years. How and where is healthcare used? Does information exist about healthcare utilization? Can we get some help to choose and consume healthcare? This issue is all the more relevant given that presently citizen's mobility is rising across the French territory. In fact large distances are covered for professional and individual reasons thanks to improvement of the railways, air and road transportations. It is possible to have several addresses (permanent or not) on the French territory. In consequence, one can consume healthcare in

several geographical areas and for this it is relevant to know how healthcare supply functions in its real-life spaces, family space. The general public takes cognizance of healthcare supply according to its needs and generally with the help of general practitioners and specialist physicians (hospital-based or not). Besides, technology development of information and communication in our society gives to people leverage to become actors of their own health.

The challenge is about: Design and development of decision-making tools applied to health in our geomatics platform for answering fieldwork needs or real needs. Improving communication and diffusion of geographical health information to professionals and the public. Providing the most basic information needed to make an informed choice in terms of qualitative and quantitative geographical hospital activity. In other terms, improving geographical knowledge about healthcare supply and demand with a new geomarketing approach applied to health and check out potential territory of healthcare consumption depending on real life spaces. This challenge through the following complementary aims on the one hand: To start our Polesat project with specific development tools. Here, our first prototype of e-Atlas of health allows describing, analyzing of supply and healthcare demand spreading over our regional territory, or real life spaces of consumption. On the other hand: To demonstrate the potential interest of the prototype and its different ways of use through a marketing campaign. Thereby, we will improve the prototype depending on professional and public feedbacks that we obtain, which should maximize the chances of use by professionals and public. In our region around 12,880 medical doctors are registered in 2008 and the Nord-Pas-de-Calais region represents 4 Million inhabitants.

Overall, we hope for improved communication of geographical information to healthcare facilities, decision-makers, medical professions and the public. In consequence, the geomatics platforms, GIS appear as relevant technologies for a large diffusion of this information through Internet or Intranet.

1.1 Background

The era of medical computing technologies has been improving for several decades. Geomatics platforms, including the following technologies: (SOLAP) Spatial On-line Analytical Processing (McHugh *et al.*, 2008), Map Server Technologies for Internet interactive mapping and (GIS) Geographic Information System platform (APEM, 2007), have increasingly appeared. In Medical informatics, health geomatics applications have gradually developed (Sloane *et al.*, 2005; International Diabetes Federation, 2009). Most of the time, geomatics platforms concern more themes like: environmental sciences, climate, risk areas, industrial risks, fire management, regional economy, urban and rural geography (SIGALE, 1994; APEM, 2007), rather than health themes. Nevertheless, we observe that some research methods have been developed on health geomatics platforms. In fact, the Regional Hospital Agencies in France have built, from a national Diagnosis Related Groups (DRGs) database, a web server known as Parhtage, which is in free access. Thereby, one can request an online map of hospital activities. Unfortunately, detailed analysis and mapping by hospital department is not available from Parhtage (ARH, 2002).

Globally, geomatics platforms take advantage of technology advances but are more or less easy to use for the layman, and perhaps for some health professionals. In general, geomatics platforms present advantages and disadvantages. They are accessible from free or private Internet connections. Even if prices are decreasing, they could be expensive where they focus on a large set of users. Besides, geomatics platforms can be hampered by bad slow request results, and by slow private Intranet or Internet access. Mapping and charts results could be difficult to analyze if you are not a specialized professional etc.

In our work, we will present an e-Atlas of health, which is included inside the first section of the POLESAT's project. POLESAT is based on the medical information society development and its goals are to develop a geomatics platform for decision-making, which will contain health geographic tools for healthcare planning, disease ecology and healthcare consumption needs. At the moment, POLESAT is not a classical GIS accessible from a map server, which we have just mentioned above. It is an html platform or e-Atlas, placed in a secured web server, displaying previous mapping results. In fact, the geomatics data processing had already been realized in other data system environments before displaying map results through the server. So e-Atlas is an experimental development prototype and not an utilization of a classical GIS and its geomatics technologies within the same environment, which does not allow for obtaining map results on online request. We can see an example of use of e-Atlas, which answers to physician and patients' problematic of healthcare choice. A lady living in Maubeuge, which is located around 88 km East of Lille,

needs a surgical operation. In view of this upcoming intervention, she wishes to be placed close to her children's home (Lille). This would make hospital visits easier for her children and she will not feel isolated during her convalescence. In order to choose the appropriate health center, alone or with her physician, she will refer to our e-Atlas of health. The choice is achieved with the help of the qualitative and quantitative assessment maps. Furthermore, the physician updates his professional knowledge network with geographical and statistical information about activity stays carried out by department.

2. MATERIALS & METHODS

The e-Atlas' geomatics platform has been placed under a protected firewall on a GNU/LINUX secured web server (Free-Software-Foundation., 1985). We used the French Medical Information System (PMSI) anonymised database containing the DRGs of Lille University Hospital for the year 2006 (ATIH, 2009; Fetter *et al.*, 1985), and used the GéoFla database concerning the French administrative divisions 'commune'. We used SAS and Jalbum softwares, html language, and the DRG analysis tool (OAP V 5.2) for data processing and web page setting. An html form and a PHP process for sending remarks from e-Atlas by users were also used. Incident notification is activated by NAGIOS' monitoring tool (Nagios, 2009). From our extranet server, thanks to a web interface, the e-Atlas access is given to researchers and partners, who are placed over the network. The secured access is given by a strong authentication (certificate) (ITU, 2009) and a simple authentication (.htaccess). The Secure Hypertext Transfer Protocol (HTTPS) allows a secured transportation of the requests and responses, and allows for encrypting passwords.

SAS software served in statistical analysis and for automation of the data processing. All databases are called from SAS programs for mapping results by specialty (hospital department). Databases are related to a detailed hospital activity, or hospital stay. Then, it allows for obtaining the detailed map results by disease specialty groups. In the html page, in adding tooltip with a JavaScript function, an interactive mapping appears. We mainly built the web page setting with Jalbum and the DRG analysis tool (OAP V 5.2). Previous statistics and the OAP tool are used to classify the selected disease specialty groups, which are interactively displayed inside a disease group board, and then detailed. Finally, from the disease group code, by a simple click, the linked map can be obtained. Map interpretation is carried out with a summary and statistical tooltip window. Saving and downloading pictures, files from e-Atlas at several output formats are authorized. Thereby, maps can be uploaded in pdf, doc and can be saved in a html file. Reference remarks by medical departments can be sent directly by email from the disease group board. NAGIOS manages incidents in testing access to the web server and to the platform. If NAGIOS is not able to access one or other, then a warning message is sent to the web server and the geomatics platform managers.

3. RESULTS

From a secured web browser the prototype is accessible by both login ID and password. The user arrives on the home page of the Lille University Hospital (year 2006) from which one of the thirty-six following hospital departments can be chosen. An animated map invites users to download a 3-minute video demonstration, which informs on the e-Atlas use and map analysis. After initiating, the user can proceed i.e. to the department sixteen and access hospital activity for 2006 through a directory. From a disease group board, click on the disease group code (called GHM) "24C49Z – oocyte samples: stay under 2 days (*Number of hospital stays*=585 or 10.68%)". Before checking the map, we are specifically informed by the disease group code (GHM) heading on statistics regarding number of stays (585), percentage of stays (10.68%), and hospital activity in comparison to global hospital activity in the department sixteen presented at the board's top. The choropleth mapping also appears displaying a percentage. Disease group (GHM) heading appears in the map's title. For analyzing mapping, the administrative division levels used are the postal PMSI zones (387 polygons). For drawing contour lines, the proximity zone (15 polygons) is used Fig. 1. Map caption presents a classification model based on 5 classes in accordance with "equal number". Moving the mouse over the map zones, a yellow interactive statistical window or a tooltip appears. At the map's bottom, you can read a following comment: "Map_24C49Z: Oocyte Samples, hospital stay < 2 days, represent 585 detailed hospital stay by departement (RUMS) or 10.68% of the global activity in the department sixteen.

Hospital stay activity (RUM) is realized at the Lille University Hospital and is related to patients, who come from 47.29% of the regional territory (in accordance with postal division zones)”, that summarizes a quantitative attraction with number and percentage of hospital stays. The user can also see a qualitative attraction in terms of proximity, medium, large or recourse attraction basin regarding the numbers of attracted postal zones: here it is 47.29%. Other features, like: statistical distribution shape, overrun boundaries, scientific knowledge of faced issues, are also crucial in the appreciation of attraction types. Users from this e-Atlas can benefit from multiple practices and decision-making information as regards their problematic related to healthcare management, and consumption needs. Information is about healthcare supply, needs, healthcare activity and place, catchment’s area, attraction basin, space-move-time behavior, healthcare choice, sanitation planning, (predictive and prospective ways), knew knowledge participation, spatial mental map, map memorization, sanitation geomarketing.

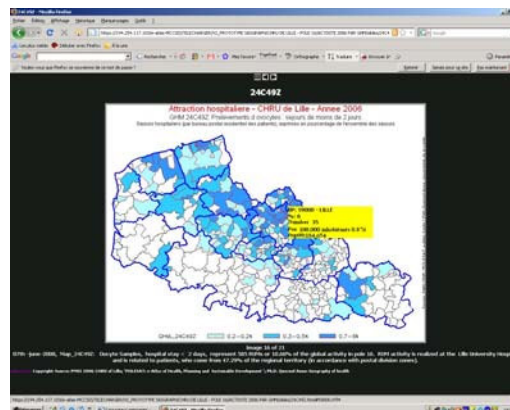


Figure 1. Interactive choropleth mapping of the oocyte samples: a statistical window appears when moving the mouse over the map zones

4. DISCUSSION-CONCLUSION

What is novel here? Our e-Atlas allows doing a detailed background inventory by department on the state of hospital activity (supply and demand) in comparison to Parhitage web server's Regional Hospital Agencies. Its main function is to provide new geographical knowledge discovery and reflection for users. It has multiple uses and will answer users' needs. We have given a patient-physician example of use. We hope to spark off new needs in terms of geomarketing way and life area practices.

The choice of the development prototype: About database for confidentiality reasons (for instance, we have not official authorization to process the detailed regional database by department) and to avoid competition at the expense of the Lille University Hospital, we have hidden the department headings. The distribution of results can be shown by department only for a medical establishment applicant. In consequence, the database utilization is only for one medical establishment (University Hospital) for one year through our current prototype. Feedback could be given in order to obtain a political support to constitute and submit our regional research project to the CNIL (*French administrative authority whose mission is to ensure that data privacy law is applied to the collection, storage, and use of personal data*).

Advantages/disadvantages: To obtain an optimal solution with a minimal cost, we decided to begin this prototype with developing this e-Atlas outside a commercial GIS: therefore we can't make online requests at the moment. Our prototype provides quick, easy access to mapping information about territorial supply and demand of hospital care (consumption needs), and displays maps of catchment hospital areas by department along with additional statistical information and a comment for medical establishment applicant.

Marketing campaign: Observation and assessment phases can begin inside our Lille University Hospital and our region. We aim at attracting the interest of potential users and assessing their numbers during our marketing campaign, period of prototype evaluation, and during scientific communications (Quesnel - Barbet A, 2009) in the making since May 2008. We received a first feedback from our Public Health team about risk

of misinterpretation when looking at the map. In response, we have integrated a tooltip giving additional statistics by zone during the mapping analysis. Then, in version 2 in October 2008, we offered secured Internet connections to medical professionals, Public Platform of geographic information of our region and to a family association, who are interested in doing e-Atlas' assessment.

Future access and updating: A first link toward our secured web server is expected from the Lille University Hospital's Intranet. In the third version of e-Atlas, we will add standardized mapping for epidemiological goals; and also add other health and administrative division levels. We will improve displaying of tooltip, update and fill in the tooltip windows. We are hoping get more feedback in the near future in order to improve the e-Atlas prototype depending on physician activity fieldwork, and to obtain political support and funding if there is a desire to develop a geomatics platform including detailed distribution by department and with online requests. Then, inside our platform, we will integrate our first tool: the modelling process for planning, which will allow decision-making and territorial management for health managers (Quesnel - Barbet A, 2007). Specifically, at the end of the first section of the POLESAT's project, our geomatics platform will include two tools: the e-Atlas of health and a planning modelling process.

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