A web-enabled Geovisual Analytics tool applied to OECD Regional Data

Mikael Jern[1] , Monica Brezzi[2] and Lars Thygesen[2]

[1]NCVA – National Center for Visual Analytics, ITN, *Linkoping University, Sweden*
[2]OECD, Paris, France

Abstract

Recent advances in web-enabled graphics technologies have the potential to make a dramatic impact on developing highly interactive Geovisual Analytics applications for the Internet. An emerging and challenging application domain is geovisualization of regional (sub-national) statistics. Higher integration driven by institutional processes and economic globalisation is eroding national borders and creating competition along regional lines in the world market. Sound information at sub-national level and benchmarking of regions across countries, therefore, has increased in importance in the policy agenda of many countries. In this paper, we introduce "OECD eXplorer" – an interactive tool for analyzing and communicating gained insights and discoveries about spatial-temporal and multivariate OECD regional data. This database is a potential treasure chest for policy-makers, researchers and citizens to gain a better understanding of a region's structure and performance and to carry out analysis of territorial trends and disparities based on sound information comparable across countries. Many approaches and tools have been developed in spatial-related knowledge discovery but generally they do not scale well with dynamic visualization of larger spatial data on the Internet. In this context, we introduce a web-compliant Geovisual Analytics toolkit that supports a broad collection of functional components for analysis and validation, hypothesis generation, communicating and finally collaborating gained insights and knowledge based on a snapshot mechanism that captures, re-uses and shares task-related explorative events. An important ambition is to develop a generic highly interactive web "eXplorer" platform that can be the foundation for easy customization of similar dynamic web applications using different geographical boundaries and indicators and be publicly available. Given this global dimension, the dream of building a repository "statistical Wiki" of progress indicators, where experts and public users can use these generic tools to compare situations for two or more countries, regions or local communities, could be accomplished.

1. Introduction

We live in a data-rich world where people have become familiar with notions like GDP and sustainable development. There are surveys on the socio-economy progress or economic performance. At the same time, people want to see statistics that capture the quality of their own lives, taking into account a broader perspective beyond the economic one. How then the existing information can be made available in a way to enable decision-makers and citizens to fully explore and make use of it?

This paper reflects a challenging applied research task to stimulate, at global level, an exchange of best practices through collaborative Geovisual Analytics reasoning [TC05]. Tools are introduced that help establish progress initiatives at international and sub-national levels aimed at measuring economic, social and environmental developments and to engage policy makers, statisticians and the public in collaborative activities. Given the global dimension of such a task, the dream of building a repository of progress indicators, where experts and public users can use Geovisual Analytics tools to compare situations for countries, regions or local communities, could be accomplished in close collaboration with our research partner OECD.

While the benefits of Geovisual Analytics tools are many, it remains a challenge to adapt these tools to the Internet and reach a broader user community. Important features include dynamic web-enabled visualization and animation that enables statisticians to explore geospatial demographics data from multiple perspectives [BG03], [Rob04], [JJP*05], [GML06], discover interesting relationships, share their discoveries with colleagues [WH07], [JRÅ*08] and finally communicate selected relevant knowledge to the public. These discoveries often emerge through the diverse backgrounds and experiences of expert domains and are precious in a creative analytics reasoning process.

In this context, we introduce a dynamic web-enabled demonstrator "OECD eXplorer" [OECD08], a customized tool for interactively analyzing, communicating and collaborating gained insights and discoveries including a snapshot mechanism that captures, re-uses and shares findings. We customize tailor-made and task-oriented applications based on layered components thinking. The key feature of OECD eXplorer is its deployment to Internet users for dynamic web. A first version of OECD eXplorer was released in November 2008 at the OECD web-site. An extended version (Figure 1), released March 2009, enhances the possibility to explore trends over time, provides novel functions for presenting stories about the statistics and combines metadata and maps status.

This paper is organized as follows: Section 2 describes the needs for such a tool as seen from the OECD followed by related work in Section 3. The architecture and main components of the GAV Flash framework are described in Section 4, an integrated snapshot mechanism in Section 5 and Adobe Flash-based time animation in Section 6. Section 7 discusses how regional information is presented in OECD eXplorer, drawing examples from the OECD Regional database and recalling the main issues emerged during the evaluation phase of OECD eXplorer and how they have been addressed. The last section concludes and sets out future global project developments.

Figure 1: *A snapshot of OECD eXplorer for Adobe Flash and Flex. The visual interface has three coordinated and linked views (choropleth map, scatter plot and parallel coordinate plot (PCP)). The coloured indicator is "Elderly dependency rate", defined as the ratio of the population aged more than 65 years and the amount of people between ages 15-64. Two regions, Madrid and Paris, are highlighted in all views and their two profiles in PCP can be used for comparison including the distribution of the elderly dependency rate across the European regions. The extended PCP component includes statistical analysis functions (histogram and percentile-based filtering) attached to the indicator axes and can be used in the analytical reasoning process. The insights about the elderly dependency rate across OECD regions are here saved together with relevant metadata (see right view).*

2. The OECD user perspective

OECD countries have experienced a growing interest in regional development in recent years [Oreg07]. The performance of regional economies and the effectiveness of regional policy help determine a nation's growth and shape the measure of well-being across countries. For the past years the OECD has been studying regional disparities and development patterns in its member countries in order to evaluate innovative strategies and spread successful policies.

This interest has generated new demand for sound statistical information at the sub-national level on factors that are important to regional competitiveness. The *OECD Regional database* [Odata08] is a unique source of statistical information at sub-national level for all the OECD Countries. It contains yearly time-series for around 40 indicators on demographic, economic, social and labour market for more than 1,700 regions of the OECD countries. OECD has since long felt the need to make regional data much more easily available on the web in an interactive and user-participative way. In particular, to make a

more extensive use of dynamic web-enabled maps which can, more effectively than a graph, convey the four dimensions included in the regional database: statistical indicator, time variable, country value and regional value.
In addition, timely information on the progress of a local community requires crossing different sources of information and new ways to generate and share information for decision-making.

Finally, many analysts and citizens want to create content and express themselves through "user-created knowledge" and a more pro-active, collaborative role in content creation, distribution and shared use. More active users and user-centred innovation could have increasing social impact and importance.

Target groups for such a knowledge-generating collaborative GeoAnalytics tool are quite diverse. A primary target group is policy-makers in charge of regional development policy, who can make use of this tool in their decision process. As well as statisticians and analysts involved in policy analysis and evaluations. Citizens and the media would also be able to get informed and at the same time participate in increasing the knowledge on how life is lived – and can be improved – from region to region..

Because of the different expertise and needs of the target-groups, the tool should be flexible and adaptable to different audiences.

3. Related work

Massive volumes of geospatial statistical data are today generated all over the world but not used as effectively as one would wish for. Too little focus has been given to making GeoAnalytics technologies useful and accessible to statisticians. A common and functional multivariate geovisualization research method, such as the parallel coordinates plot (PCP) used in CommonGIS [AA03], is still unknown to the broad statistics user community. Despite the advances in web graphics technologies, comparatively little research has been focused on more advanced dynamic GeoAnalytics applied to Internet users. The most well-known tool is GeoVISTA Studio [Geo06], an open source Java-based visual programming environment and is commonly used for developing Internet applications within the research community. Rosling [Ros06] has dramatically increased the awareness of geovisualization tools among the world of statisticians by exploring his most efficient Gapminder time-animated bubble plots.

The importance of a capacity to snapshot explorative sessions and then reuse them for presentation and evaluation within the same environment was early demonstrated by MacEachren [MB01] and Jern [J01] in geovisualization and incorporated features to capture and reuse interactions and integrate them into electronic documents. CCMaps [CWM05] presents a conditioned choropleth mapping tool that allows users to save snapshot events and reuse them for presentation purpose. More recent effort was made by Visual Inquiry Toolkit [GCM*06] that allows users to place pertinent clusters into a "pattern-basket" to be reused in the visualization process. [Rob06] describes a method they call "Re-Visualization" and a related tool ReVise that captures and re-uses analysis sessions Keel [Kee06] describes a visual analytics system of computational agents that support the exchange of task-relevant information and incremental discoveries of relationships and knowledge among team members commonly referred to as sense-making. Wohlfart [WH07] describes a storytelling approach combined with interactive volume visualization and an annotated animation.

Many capture and reuse approaches are limited to be used within the same application environment that may well require a software license and are not always easily accessible to team members without installing external software [JJÅ08]. Increased computer security practice for statisticians could limit this possibility. In this context, we introduce a web compliant layered component toolkit facilitating a snapshot mechanism that captures, re-uses and shares active properties for individual functional components. We envision and demonstrate [OECD09] that such an implementation could provide a more open and collaborative GeoAnalytics framework for public use.

4. System implementation

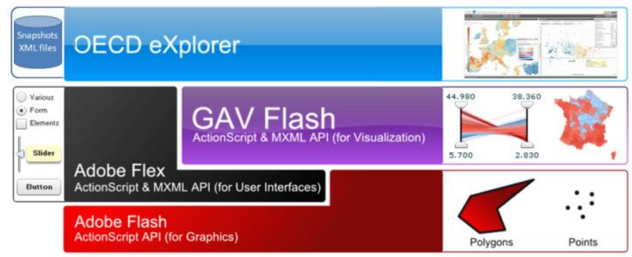

Figure 2: *GAV Flash uses the Adobe Flash API for graphics and integrates with the Adobe Flex Framework.*

First developed for Microsoft's .Net and DirectX [JJ07], our GeoAnalytics Visualization "GAV" methods have now been adapted for the Internet using Adobe's Flash basic graphics and Flex for user interfaces. Programmed in Adobe's object-oriented language ActionScript, GAV Flash (figure 2) facilitates 100% deployment to the Internet through Adobe Flash Player V10 - a requirement from OECD and its associated global statistics community.

GAV Flash includes a collection of common geo-visualization and information visualization components, data analysis algorithms, tools that connect the components to each other and data providers that can load data from various sources. Interactive features that support a spatial analytical reasoning process are exposed such as tooltips, brushing, highlight, visual inquiry, conditioned statistics filter mechanisms (figure 1 and 4) that can discover outliers and methods supporting dynamically linked multiple views.

As GAV Flash is built upon Adobe Flex, a developer has access to all Flex user interface functionalities. By combining buttons, panels and sliders with GAV data providers, managers and visual representations, applications can easily be customized. The open architecture, allows new or existing tools to be incorporated with the already existing components, e.g. statistical analysis tools or visual representations. By separating the data structure from the visual representations, applications are created that work regardless of input, so that data can be supplied from the outside and linked into the system with minimal programming skills (figure 3).

4.1. Layered components architecture

The GAV Flash framework follows a human-centred approach enabling deployment of applications that puts the emphasis on tasks defined by the different expertise and needs of the target-groups. Each *atomic* component according to its nature in the context of object-oriented programming performs a small specific user task in the overall GeoAnalytics process (figure 3). The higher-level *functional* component is constituted by the combination of one or more GAV Flash *atomic* and Adobe Flex's components and typically implements the functionalities of a single view or a view integrated in a multiple-linked views application. For example, the choropleth map view (figure 1) represents a *functional* component assembled from several *atomic* components: map, focus&context view, colour legend, colour choice, Flex GUIs such as pan&zoom, tooltips and required GAV framework managers and data providers (figure 3) . The choropleth map functional component is appropriate in a multiple-linked views application (figure1) but also practical in a standalone mode with all its associated managers. A rich set of component resources with fine grain control allows precise matching to user tasks.

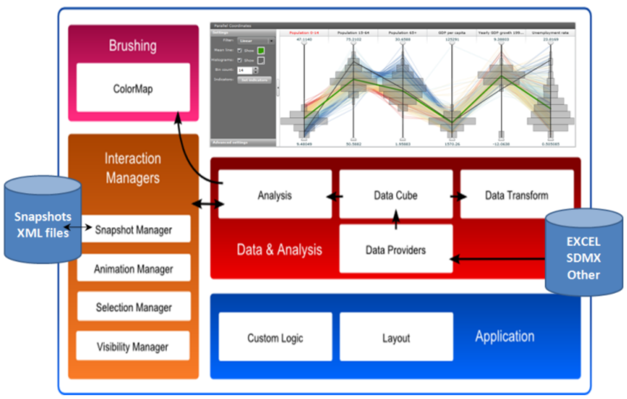

Figure 3: *GAV Flash component architecture. All components rest on different basis such as visualizations, managers or data providers and interact with each other, without knowing the exact nature of the other. A visual component needs a data provider to function, but the source of the data can be different, from a simple Excel sheet to an extensive database. The data runs through the data provider to create a common formatting that all other components can understand.*

All visual components (figure 3) use the same data storage class, *Data Cube*. This class is also used in the analysis to calculate different properties of the indicators, such as percentiles and histograms. Data loading is implemented separately for each data source type. For example, the Excel Reader loads an Excel spreadsheet and creates a data cube containing the data from the spreadsheet and the rest of the framework does not need to know anything about the data source. Data providers can be customized to support many types of sources, Excel is one of the simpler ones, while direct data base connections such as SDMX [SDMX09] are more advanced and often requires more tasks from the user.

In a typical GAV Flash application (figure 1) each visual component is added to a *Selection Manager* and a *Visibility Manager*. The selection manager listens for selection events (such as clicking in the Map) from each component and then forwards these events to all other components. The visibility manager also listens for and forwards events, but here from filters that hide spatial regions based on some criteria. Both the selection manager and the visibility manager store a state (e.g. selected, visible) of each data record.

A minimal GAV Flash application contains a data provider and an interactive visualization component such as the *Choropleth Map (*or *Parallel Coordinates Plot, Scatter Plot* etc*).* An application with a single visualization component does not need any selection or visibility managers since they only deal with interaction between two or more components. The visualizations use a *Data Cube*, supplied by the *Data Provider* to calculate and create its own special view of the data, such as a colour scheme, correlation plot or a histogram.

4.2. Dynamically linked views

Spatial and multivariate data are effectively analysed through the use of multiple-linked and coordinated views [Rob04], [JJP*05]. In order to detect complex patterns it is convenient to view it through a number of different visual representations simultaneously, each of which is best suited to highlight different patterns and features. GAV Flash facilitates an object-oriented architecture with compulsory components (selection manager and visibility manager etc. – see figure 3) and integrated with Adobe Flex layout management provides alternative and different views of the statistical data that can help stimulate the analytical visual thinking process so characteristic for GeoAnalytics reasoning. The views are separated by interactive splitters allowing the user to scale the individual views and allocate more space to the visual representation that is most important. The views are coordinated using a data linking method based on the same data cube model and colouring scheme. Any statistical filtering or highlighting made in one of the linked functional components propagates to all the others via the selection manager.

Visual highlighting is another important feature exemplified through visual representations that use pre-attentive styles like colour, shape and transparency. Figure 1 shows highlighting implemented in the choropleth map, PCP and scatter plot views. A combination of transparency and thick coloured lines is applied in the PCP and hollow marked dots in the scatter plot.

4.3. Parallel Coordinates Plot (PCP) in Adobe Flash

The strength of the PCP has already been demonstrated in many scientific environments [Ins85], [GML06] and [AAF*06] and represents a proven geovisualization technique that enables visual representation of spatial multivariate attribute data and hence a key explorative mechanism in a Geovisual Analytics application. The technique supports a large number of tasks for both analyses of relationships between data items as well as between indicators. Each OECD region is represented by a string passing through the parallel axes. Each axis represents a single indicator in the data cube. A string forms a visual representation of the characteristics of one region. Differences between selected regions can be found by visually comparing the profiles representing them (figure 2). Dynamic range sliders are attached to each axis (figure 4) and the user can dynamically select or combine filter methods thus altering constraints on indicator values shown in the other views.

This PCP is the first known implementation in ActionScript and has been extended with special features that are important to statistical exploration, such as, histograms and filter operations based on percentile statistics [JJ07]. Histograms (figure 7) attached to each axis are used to visualize the distribution of indicator data, splitting the axes into a user defined number of equally high rectangular areas (bins). The width of a rectangle indicates the frequency of regions intersecting that bin, the more regions within an area the wider the rectangle. Dynamic Flash animated histograms have proven helpful by OECD for analysing multivariate temporal indicator data.

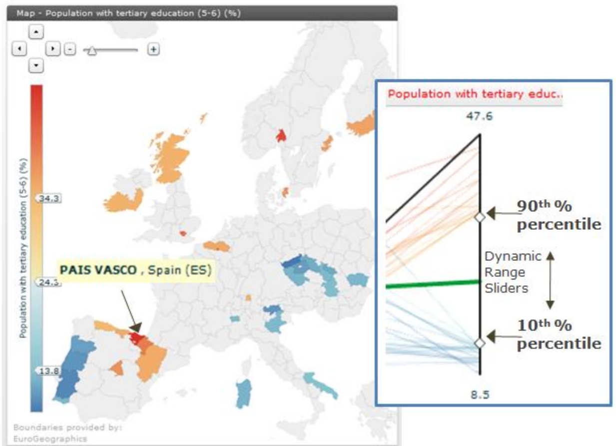

Figure 4: *Statistical filter methods based on percentile calculations are embedded in the PCP attached to an indicator. Only regions with the lowest (below 13,8%) and highest (above 34,3%) percentages of student enrolment in tertiary education are maintained for further exploration. Red regions represent an indicator of a region's future potential and a major factor in determining regional competitiveness in the knowledge based economy. Two regions Oslo and Pais Vasco show exceptional high percentage of students with tertiary education.*

Traditional filter sliders are limited to define a joined range and controlled by the users own judgement. We expand filter operations to also be based on statistical percentiles (figure 4), e.g.: "Find regions with an indicator *population with tertiary (highest) education* below the 10% and above the 90% percentiles. Given a range limited by an upper and a lower percentile value, filter operations can be performed either inside or outside of that area. This method was found useful identifying outliers.

5. Collaborative GeoAnalytics through snapshots

GeoAnalytics has the potential of engaging users in sharing the results of data exploration. Tools that integrate the GeoAnalytics process with collaborative means could streamline the knowledge exchange process of developing a shared understanding with other users.

The GAV Flash toolkit facilitates the architecture (figure 3) to support means of saving, packaging and sharing the history and results of an explorative Geovisual Analytics process in a series of "snapshots". A sharable visualization story can be created by the analyst (author) through a set of linked snapshots. When the button "Capture" in the *Snapshot Manager* (figure 3) is pressed, the state of each GAV Flash functional component (view) in OECD eXplorer is saved together with user-defined annotations (metatext). Before closing the application, the *Snapshot Manager* exports the snapshots into a XML formatted file. Team members can through descriptive text, textual annotations hyperlinked through a snapshot mechanism, and integrated with interactive visualization follow the analyst's way of logical reasoning by loading selected snapshots. At any time a team member, if authorized by the system, can access snapshot files and apply them in OECD eXplorer or any other GAV Flash application assembled from the same component.

This feature has a positive impact on the accessibility of structured information to a larger audience. Users will discuss relevant issues through storytelling based on solid evidence, thus raising awareness and increasing the common knowledge on a certain phenomenon.

5.1. Collaborative activity levels

We envision four possible collaborative activity scenarios:

- OECD domain experts organize and explore task-relevant indicators to be communicated to team members and mixed expertise for comments. This group is responsible for selecting interesting story telling to the public;
- Mixed expertise organizes and explores task-relevant indicators relevant to their expertise; discovers important trends and relationships and communicate these discoveries to OECD team members;
- Same as above but these statisticians now want to share discoveries among team members and converge their individual contributions;
- Public users access OECD eXplorer and a repository of selected interesting stories to be viewed interactively. Public users can also create their own snapshots and share with colleagues or friends;

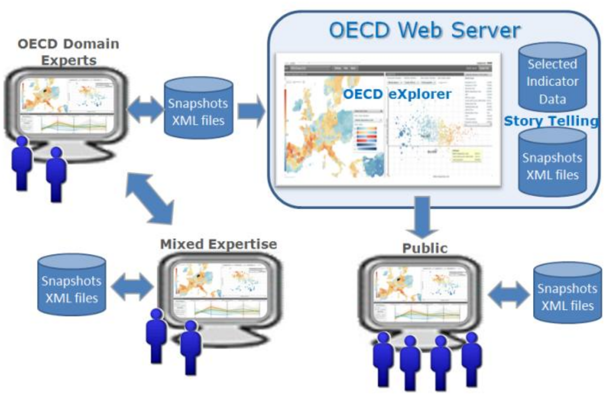

Figure 5: *Recognised snapshots or storytelling can be uploaded.*

6. Applying Flash-based time animation

GAV Flash employs a data model (figure 3 and 6) optimized for handling spatio-temporal and multivariate indicator data sets in a GeoAnalytics context [JJ06]. This conceptual data model can be seen as a data cube with three dimensions: space, time and attributes. The spatial dimension is represented by OECD TL2 or TL3 regions and the indicators are various demographics measurements (GDP growth, elderly dependency rate, etc). Time is the data acquisition period. The general method for finding a value in the cube is by its position (space; time; attribute;).

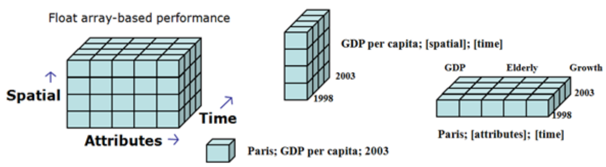

Figure 6: *Data cube model applied in OECD eXplorer.*

Space-time-indicator awareness means that the data cube can be analysed and visualized across all three dimensions simultaneously. OECD eXplorer performs this task by integrating and time-linking three visual representation views: choropleth map, PCP and scatter plot (bubble). The bubble plot is demonstrated to be an effective Flash-based time animation method [Ros06], but integrated and linked with a choropleth map and a multivariate indicator frequency histogram embedded in a PCP, makes it even more useful. The GAV open architecture, handling of large datasets and integrated snapshot mechanism are other important extensions to this emerging animation technique. The spatial cognition for the time-linked views was evaluated by OECD and Statistics Swedish and found to be both intuitive and innovative. Statisticians discovered interesting trends in all three views respectively.

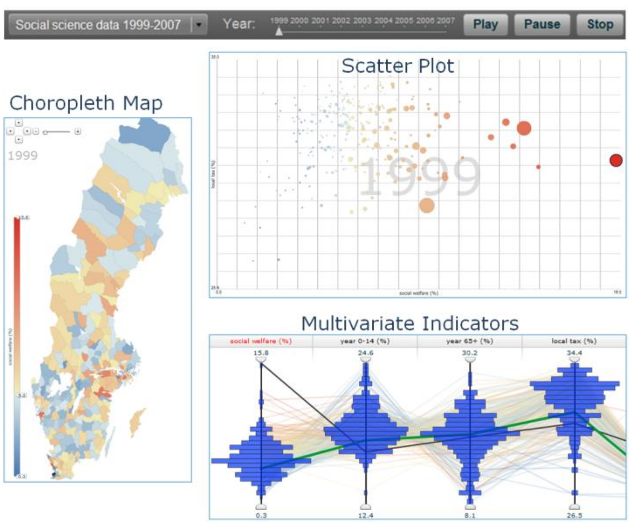

Figure 7: *A pre-release of Time Animation in eXplorer applied to Swedish regions. Three views are dynamic time-linked and animated using Flash animation and interpolation.*

7. OECD eXplorer – The history and the result

When the OECD and Statistics Sweden organised a seminar on innovative methods of generating knowledge from statistical information in Stockholm in May 2008, OECD and NCVA became partners, and it became apparent that the tools developed by NCVA had a lot of potential to meet the wishes of OECD. This started a cooperation that resulted, a few months later, in the launch of OECD eXplorer on the OECD's web site.

NCVA demonstrated ability and will to adapt the tool to the needs expressed by the OECD, and later to the proposals expressed by pilot key users during a two months trial, thus adjusting eXplorer in an ideal way to user needs. The current version of OECD eXplorer [OECD08] has two identical tools to analyze, respectively, statistics on large regions (TL2) and small regions (TL3). This choice was made to avoid complexity and long downloading time of large geometry files. OECD regions are analysed through four separate application scenarios grouping countries in continents and according to the territorial level chosen.

The choropleth map dynamically linked with a PCP and a data grid gives the domain experts facility for simultaneous analysis of the geospatial data profusion. All views are synchronized to the same point and indicator and advance the understanding of spatial cognition for interacting intuitively and effectively with geospatial data.

National economic performance is often compared across countries, and such comparisons are frequently used to highlight countries whose national policies appear to promote growth and development more successfully. However, national averages can hide wide regional differences in economic conditions and performances. The use of the filtering function in OECD eXplorer, through the percentile distribution, helps visualizing which regions within national borders are the main ones responsible of a certain development and to what extent regions across countries are comparable. The use of lines and mean values in the PCP can help identify those regions that outperform their country or the OECD area as a whole and those that lag behind. Finally the scatter plot can highlight correlation among indicators and patterns of association among different types of regions.

7. 1. Evaluation

The OECD eXplorer development followed a user-centric design approach [AA03]. A combination of domain experts from OECD, statistical managers and selected users of OECD statistics outside the organisation have been involved in the various stages of the prototype design and implementation, providing user feedback about usability and utility evaluation. The user-centric design process involved public access to beta versions of the web-based tool, allowing focus group discussions. The overall involvement and reactions have been very positive. Many useful suggestions for improving the functionality were made and have been incorporated in successive implementation iterations.

A number of characteristics of the current version of OECD eXplorer were derived from comments received during the evaluation phase. First, it became clear that there was a need of having help functions and tutorial features for dynamic web-enabled GeoAnalytics tools targeted to audiences whose expertise is not in geo- or information visualization technologies. Second, users asked to keep the entire structure sufficiently simple, while maintaining some functions to analyze data and not only visualize them. In this context, for example, the PCP was considered not to be self-evident to traditional users of statistics, as this is a technique that has not previously been employed in the statistics community and is not described in the methodological literature on statistics, and therefore it was decided to keep it hidden in the start-up phase; at the same time it was regarded as a valuable addition to the statistical toolbox, especially the possibility of dynamically filtering to discover outliers and use profiles to make comparisons between highlighted regions. Finally, the dynamic links between views (context and focus maps, scatter plot, PCP and table grid) were evaluated as very important.

The test phase also revealed limitations that had to be addressed, e.g. resource demands when accessed on the web resulting in too long times for data upload and response. It became clear that not all institutional users had the possibility of having the latest versions of Flash installed on their client pc's, which is an issue that needs to be addressed by the user organisations.

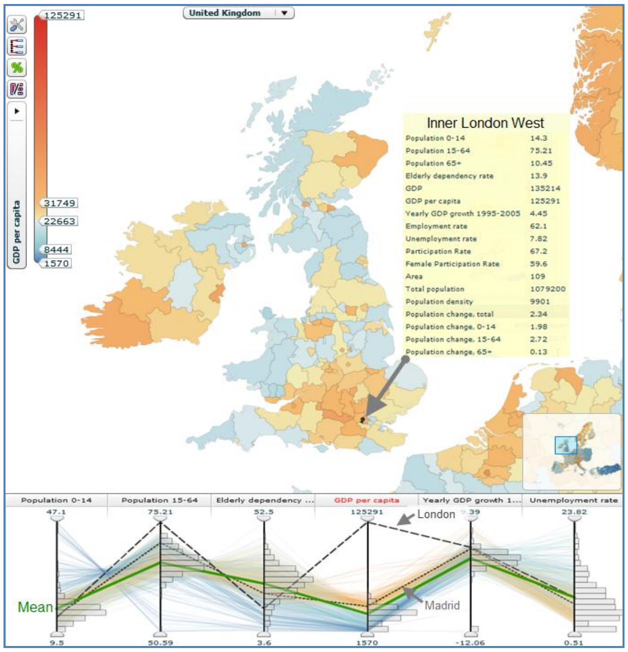

Figure 8: *Customized view based on two linked choropleth map and PCP functional components showing Inner London West as the region with highest GDP per capita in Europe. Madrid and London show similar profiles for the indicators "Yearly GDP growth" and "unemployment rate". Blue colour represents regions below the 50% percentile.*

8. Conclusions and future development

The authors expect that the web-enabled OECD eXplorer [OECD09] will enhance the use and understanding of OECD regional statistics, thus adding to sound, evidence-based policy decisions. At the same time, it will encourage the practical use of advanced GeoAnalytics science technologies because of its easy accessibility on the Internet. It will enable the analyst to take a more active role in the discovery process of exploring regional indicators, for example, to identify those regional areas that outperform other regions of their country or OECD mean values. The tool will increase the interest in and knowledge of regional structures and development patterns among specialist as well as non-specialist users. The patterns of development may differ widely in urban and rural areas and regions may lag behind even when the national economy is performing well. Feed-back from domain experts and statisticians who have started using the tool shows that a sense of analytical reasoning and speed-of-thought interaction is achieved through the ability to dynamically link views in OECD eXplorer and thus see the multi-dimensionality of regional development.

Major achievements that can be summarized:

- Geovisual Analytics framework and layered component architecture developed in the O-O language ActionScript with 100% deployment to Internet users;
- A proof-of-concept application OECD eXplorer developed and evaluated in close collaboration with domain experts from OECD and exposed to global statisticians and public;
- An O-O architecture facilitating the statisticians to explore data and simultaneously save important snapshots of discoveries or create a continuous story of snapshots to be communicated and shared with team or public;
- An ambition to develop a generic "eXplorer" platform that can be the foundation for easy customization of similar dynamic web applications using different geographical boundaries and indicators and be publicly available;

An extended version was launched in March 2009 together with the report OECD Regions at a Glance [Oreg09]. Three key new features were included in the latest OECD eXplorer version:

- An SDMX interface that allows direct import of data to be presented in the tool. This gives seamless access to the entire OECD Regional database on the data warehouse "OECD.Stat" via an SDMX web service, as well as to any other database supporting SDMX. SDMX is the world standard for exchange and sharing of statistical data and metadata, recommended by the UN Statistical Commission as the preferred standard, see *www.sdmx.org*. It is already implemented in information systems in many organisations, and many more are coming. This feature enables users to explore data of their own choice and integrate information coming from different sources. This feature is, therefore, of particular interest to regional policy-makers who will be able to drill-down the information on specific topic and or on their own country, while using a common benchmark based on the OECD regional database. In the evaluation test preceding the release of OECD eXplorer, many decision-makers on regional policy have welcomed this feature.
- Possibility to explore trends over time (yearly time series) for the indicators in the regional database (Section 6);
- Snapshot mechanism (Section 5) for presenting stories about the statistics embedded with interactive visualization and integrated into, for example, a HTML document structure;

As a result of this described project and our ambition to develop a generic eXplorer platform (figure 3), NCVA has been invited as an associated partner to in the OECD Global Project on "Measuring the Progress of Societies". This "Wiki4progress" [Wpr08] project should represent the catalyst of initiatives existing around the world on the measurement of progress, as well as their use for raising awareness amongst stakeholders, informing them through statistical indicators describing economic, social and environmental trends and allowing them to discuss relevant issues through storytelling based on solid evidence. GAV Flash will provide Geovisual Analytics tools that can answer questions like:

- Who is developing initiatives on measuring progress (well-being, quality of life, etc.)?

- What type of classification do these initiatives use?
- Which indicators are being used to measure the different dimensions of progress?
- How is my country/region/community achieving over time and in comparison to other similar territories?

Wiki-Progress should represent **the** place where both experts and public could share their analysis practices on indicators, about the data that underlies our knowledge and hence our action. OECD eXplorer has indicated that Geovisual Analytics could represent a fundamental tool in developing knowledge, thus making better evidence based decisions possible.

8. Acknowledgements

This applied research case study was carried out by NCVA in close collaboration with OECD who supplied data and comprehensive evaluation of the application. The research is in part supported by funding from the "Visualization Program" coordinated by the Swedish Knowledge Foundation. The authors thank colleagues Tobias Åström, Markus Johnsson and Jonathan Nyberg at the National Center for Visual Analytics (NCVA) at ITN, Linkoping University. The authors wish to thank Delegates of the OECD Working Party on Territorial Indicators for valuable feedback on previous versions of the OECD eXplorer.

9. References

[AAV03] Andrienko.V, Andrienko.N, and Voss.H, GIS for Everyone: the CommonGIS project and beyond, Peterson M. (ed.), *Maps and the Internet,* Elsevier Science, 2003, pp. 131-146

[AA05] Andrienko G, and Andrienko N,: Visual Exploration of Spatial Distribution of Temporal Behaviors, In *Proceedings of IEEE IV2005*.

[AAF*06] Andrienko, G, Andrienko, N., Fischer.R., Mues.V, Schuck, A. : The parallel coordinate plot in action: design and use for geographic visualization. International Journal of Geographical Information Science, 20(10), 2006.

[And06] Andrienko G. et al.: Reactions to geovisualization: an experience from a European project, Int. Journal of Geographical Information Science, 2006.

[BG03] Brodbeck D, and Girardin L.: Design study: using multiple coordinated views to analyze geo-referenced high-dimensional datasets. In Proceedings of The Coordinated and Multiple Views in Exploratory Visualization, pages 104–111. IEEE Computer Society, July 2003.

[Geo06] Geovista studio. http://www.geovistastudio.psu.edu.

[CWM05] Carr D., White D, and MacEachren A.M.,: Conditioned choropleth maps and hypothesis generation. In *Annals of the Assoc of Am. Geographers,* vol 95, no. 1, 2005.

[GCM*06] Guo, D., Chen, J., MacEachren A.M., Liao, K.: A visualization system for space-time and multivariate patterns, IEEE Visualization and Computer Graphics, Vol 12, No 6, 2006.

[Ins85]Inselberg, A. 1985.: The plane with parallel coordinates, The Visual Computer 1(2), pp 69-92, 1985.

[J01] Jern M.: Smart Documents for Web-Enabled Collaboration, Published in "*Digital Content Creation*", Vince J. A. and R. A. Earnshaw (Eds) Springer Verlag, June 2001.

[JJP*05] Jern, Johansson, Pettersson, Feldt**:** "Tailor-made Exploratory Visualization for Statistics Sweden", *CMV 2005*, London, July 2005, published by IEEE Computer Society.

[JJ06] Jern M., Franzén J.: "*GeoAnalytics – Exploring spatio-temporal and multivariate data*", Reviewed proceedings, IV 2006, London, published by IEEE Computer Society.

[JJ07] Johansson S., Jern M.: GeoAnalytics Visual Inquiry and Filtering Tools in Parallel Coordinates Plot, Seattle, ACM GIS 2007.

[JRÅ*08] Jern M., Rogstadius J., Åström T., and Ynnerman A: "Visual Analytics presentation tools applied in HTML Documents", Reviewed proceedings, IV08, London, July 2008, published by IEEE Computer Society.

[Kee06] Keel P.: Collaborative Visual Analytics: Inferring from the Spatial Organisation and Collaborative use of information, VAST 2006, pp.137-144, IEEE.

[[MB01] MacEachren A.M., Brewer I., et al.: Geovisualization to mediate collaborative work: Tools to support different-place knowledge construction and decision-making. In *20th International cartographic conference*, Beijing, China. 2001

[OECD09] *http://www.oecd.org/GOV/regionaldevelopment*

[Odata08] OECD Regional database *http://www.stats.oecd.org/WBOS*

[Oreg07] OECD Regions at a glance: 2007 edition

[Oreg09] OECD Regions at a glance: 2009 edition

[Rob04] Roberts, J. C.: Exploratory Visualization with Multiple Linked Views, *Exploring Geovisualization*, J. Dykes, A.M. MacEachren, M.-J. Kraak (Editors) 2004.

[Rob06] Robinson A.: Re-Visualization: Interactive Visualization of the Progress of Visual Analysis, workshop proceedings, VASDS. 2006.

[Ros06] Roslin, L.Gapminder.2006. http://www.gapminder.org/world/

[SDMX09] www.sdmx.org

[TC05] Thomas, J & Cook, K. 2005. Illuminating the Path: The Research and Development Agenda for Visual Analytics, *http://nvac.pnl.gov/*

[WH07] Wohlfart, M., Hauser, H.: Story Telling for Presentation in Volume Visualization, EuroVis2007.

[Wpr08]Wikiprogress: *http://www.oecd.org/pages/0,3417,en_40033426_40033828_1_1_1_1_1,00.html*