INSPECTING USER INTERFACE QUALITY IN WEB GIS APPLICATIONS

Juliano Schimiguel, M. Cecília C. Baranauskas and Claudia Bauzer Medeiros
Institute of Computing (IC), State University of Campinas (UNICAMP), CP 6176, 13084-971, Campinas, SP, Brazil, {juliano.schimiguel,cecilia,cmbm}@ic.unicamp.br

Abstract: Web GIS applications can be found in many domains. The quality of the interfaces of applications determines not only the usability of such applications, but the possibilities offered to their users. This work investigates aspects of interface quality for Web GIS applications. The approach adopts an inspection evaluation based on ISO 9241. Preliminary results show the effectiveness of such an approach to user interface evaluation as a complement to tests with users.

Key words: user interface; quality; ISO 9241; Web GIS; Geographical Information Systems

1. INTRODUCTION

The evolution in Information Technology (IT), the resources directed to Geographic Information Systems (GIS) and the Internet dissemination in daily life make the creation of “intelligent maps” possible. The term "intelligent map" is frequently used by Web GIS users to denote the possibility of interacting with a GIS and its underlying databases, through a cartographic interface. In this way, a user who is not necessarily familiar with geo-processing can have access to these technological benefits simply by using a standard web browser.

The diversity of Web GIS application users demands investigation in the quality of human-computer interaction. Interface quality involves several factors related to the quality of the interface design process, the quality of

the product and the usage experience that it supports. In this work, we are particularly interested in investigating the quality of the interfaces of Web GIS applications.

Interface evaluation aims to determine if the user's necessities are fulfilled, evaluating the adequacy of the system to a given task or task groups and comparing the system with other products in the market[11]. Usability data can be captured by several approaches: formally by running an evaluation software that receives as input a formal specification of the interface; empirically, by testing the interface with users; informally having expert evaluators inspecting aspects of the interface which would impact in the software usability. Considering the state-of-art in Human Computer-Interaction (HCI), formal methods hardly cope with the complexity of interactive systems on the other hand, empirical methods based on real users are very expensive and time consuming to be applied in every stage of an evolutive development of an interface. Inspection-base methods have been pointed out as an effective method to be combined with user testing.

Human-computer interaction in GIS applications has recently received attention from researchers in the GIS field. Davies and Medyckyj-Scoot[4] formulated some high-level recommendations for the improvement of GIS, based on problems faced by users of GIS software, and the relation between those problems and the context in which the GIS was used. Davies and Medyckyj-Scoot[5] led the evaluation of GIS usability, using interviews, checklists and video recording of users at work with their GIS. The analysis of objective and subjective data showed a strong relationship between the amount of time wasted on errors and problems, and compatibility with the user's conceptual models. The research reported by Pinto and Onsrud[12], in the use and diffusion of GIS, addresses correlations between user characteristics and user satisfaction.

Aime et al.[3] argue that a serious obstacle for the use of GIS is the distance that still remains between the system and the user's culture in geographic information. According to Prado et al.[1], there are usability problems related to interpretation aspects and gaps between user tasks and GIS implementations. GIS interface design still represents a crucial point in the acceptance or rejection of an application[8]. According to these authors, the advances in data modeling need to be reflected at the system interface level, hiding computational representations and allowing the user to concentrate in the geographic data.

Literature has addressed user interface aspects by investigating the use of GIS by prospective users in usability laboratories or in their work situations. In this work we approached the subject by conducting an inspection-based method. The goal of this work is to investigate the use of ISO 9241 standard – *Ergonomic Requirements for Office Work with Visual Display Terminals* (VDTs), to inspect the interface quality of Web GIS applications. Our case

study involves the inspection of three Web GIS applications: Agritempo[6], FUNCEME[7] and SIMEPAR[17]. Our choice was based on a survey of Web GIS applications carried out in previous work[14]. Our contributions are: (i) the proposal of a methodology for interface inspection for Web GIS applications, (ii) the investigation of the ISO 9241 standard as an instrument for interface inspection of Web GIS applications. The paper is organized as follows: Section 2 presents the ISO 9241 standard and quality concepts. Section 3 describes the case study considered; Section 4 presents preliminary analysis of results and Section 5 concludes the work.

2. STANDARDS AND QUALITY

International Organization for Standardization (ISO) is a world wide agency for standard regulation. The work of preparing standards is conducted by technical ISO committees. Several organizations including international, governmental and non-governmental organizations, jointly with ISO, take part in this work.

2.1 Process and Product Quality in Engineering

Software quality is determined by the quality of the process used for its development and by the quality of the final product itself. Thus, the improvement in the software quality is achieved by the improvement in the process of developing it. This concept has guided the elaboration of standards for evaluation and improvement of software development processes. Examples of standards regarding quality of processes are ISO 9000-3, ISO/IEC 12207-1, SEI SW-CMM and SPICE.

To evaluate the quality of the software product means to verify and consider all requirements, which, in general, express different kinds of needs specified in quantitative or qualitative terms. The goal is to define the characteristics that allow verification of the software.

In this work, we are interested in the evaluation of interfaces of Web GIS applications, not in the process of interface design. As the goal of our work is to investigate aspects of the human-computer interaction, we chose the ISO 9241 standard as the instrument for inspecting the GIS interfaces. The ISO 9241 standard allows a usability inspection of elements related to the interface (verifiable questions), such as: the menu structure, help system, error management, navigation, etc. ABNT[2] classifies ISO 9241 within Software Ergonomics[15].

2.2 ISO 9241

The ISO 9241 international standard was prepared by the ISO/TC 159 technical committee of Ergonomics and SC4 subcommittee in Ergonomics of the Human-Systems Interaction. It consists of 17 parts[10], under the general heading of *Ergonomic Requirements for Office Work with Visual Display Terminals* (VDTs).

There exist already reports on the use of standard ISO 9241 on interface evaluation, but none has been reported on GIS literature. Gediga et al.[9] discussed a software evaluation based on ISO 9241-10, by using a questionnaire denominated IsoMetrics, to collect usability data for summative and formative evaluation. The authors consider it a procedure to categorize and to prioritize weak points that can be used as basic input for usability revisions. Bastien et al.[13] applied the ISO 9241 to detect usability problems in a database application; they considered part 10 (Dialogue Principles) of ISO 9241. Oppermann and Reiterer[16] considered an overview of different evaluation techniques, describing their advantages and disadvantages. They presented ISO 9241 *Evaluator*, an evaluation method for specialists to test 300 items of parts 10 to 17 of the 9241 standard.

3. QUALITY INSPECTION BASED ON ISO 9241: A CASE STUDY

The ISO 9241 standard considers a very large set of issues. Therefore, our work consisted in inspecting the interface of Web GIS applications for a representative part of this standard. We chose applications with emphasis on agricultural systems. The inspection considered the following parts of the standard: Dialogue Principles (part 10), Presentation of Information (part 12), User Guidance (part 13) and Menu Dialogues (part 14). Other parts of ISO 9241 standard were not chosen because they concern physical devices or because they would require user's participation, or else because they do not apply uniformly to all three evaluated Web GIS applications.

The Web GIS applications chosen for the analysis were respectively Agritempo[6], and the systems developed by FUNCEME[7] and by SIMEPAR[17]. FUNCEME and SIMEPAR belong to the "Static Maps Server" application category[14]. These are applications that present images captured by sensors, video-cameras, terrestrial cameras, satellites, and that are available in static files (e.g., jpg, bmp). This category allows a few interactive possibilities, as zoom, pan, query, and visualization of thematic data associated to maps. The other selected application (Agritempo) belongs to the "Map Generator" category, in which, maps are generated from the specifications supplied by

the user via a web browser form. Besides zoom and pan, this application allows querying geographic data associated with the map, or selecting data layers for visualization among other possibilities. These three applications were chosen among several other applications discussed in Schimiguel et al.[14] because of the following reasons:

The "Static Maps Server" category is more frequently found, influencing our choice for two applications of this category. Moreover, the SIMEPAR on presents more emphasis on content elements and FUNCEME on interaction possibilities. Furthermore, an application is from Brazil's southern region (SIMEPAR) and another from Brazil's northern region (FUNCEME); this is important to detect specific characteristics from each context;

The "Map Generator" category allows more interaction possibilities than the "Static Maps Server" category. We chose the Agritempo, developed within the Brazilian Federal Government context.

Tables 1 through 4 follow illustrate the considered parts of ISO 9241 (part 10: Dialogue Principles - Table 1, part 12: Presentation of Information - Table 2, part 13: User Guidance - Table 3 and part 14: Menu Dialogues - Table 4), for the 3 evaluated Web GIS applications. In these tables, the symbol "X" stands for the violation of the respective norm and the letters A, F and S mean Agritempo, FUNCEME and SIMEPAR.

Table 1. ISO 9241-10: Dialogue Principles

Number	Norm Description	A	F	S
10-3.2.1	The dialogue should present the user with only the information related to the task accomplishment	X		
10-3.4.1	The interaction speed does not have to be dictated by the system		X	X
10-3.4.5	Different characteristics and necessities of users require different levels and methods of interaction	X	X	X
10-3.5.3	The application should use vocabulary that is familiar to the user in the task execution	X	X	
10-3.6.2	Errors should be explained to help the user correct them	X		
10-3.7.1	Mechanisms should be provided to allow the dialogue system to be adapted to the user's language, cultural and individual knowledge	X	X	X

Table 2. ISO 9241-12: Presentation of Information

Number	Norm Description	A	F	S
12-5.3.4	Appearance of windows should be consistent with the	X		

	application			
12-5.4.2	Density of the shown information: the information density can not be seen by the user as excessively disorderedz	X	X	
12-5.6.1	Groups distinction: groups should be perceptively distinct, according to the spacing and localization		X	
12-5.6.3	Conventions use: information groups should be arranged into common formats, conventions and customs		X	X
12-7.5.1	Colors as auxiliary codification: colors should never be used for codification meaning only		X	X
12-7.5.5	Number of used colors: if codification colors are used, no more than six colors should be used, besides the addition of the black and white colors	X	X	X

Table 3. ISO 9241-13: User Guidance

Number	Norm Description	A	F	S
13-5.3.2	Phrases should be used to enhance the user's perception control		X	
13-7.2.2	No intrusive feedback, it should not distract the user in relation to his task	X	X	X
13-7.2.9	Appropriate time for feedback should be provided	X		X
13-9.2.1	Error prevention should be provided when appropriate	X	X	
13-9.2.3	Users should be informed about the occurrence of potential system failure	X		
13-10-7.1	Context-sensitive help is provided, supplied when the tasks have specific steps or contextual information	X	X	X

Table 4. ISO 9241-14: Menu Dialogues

Number	Norm Description	A	F	S
14-5.1	Options should be arranged inside conventions or natural groups	X	X	X
14-5.1.3	Categories: options should be arranged inside groups from four to eight options per level	X	X	X
14-5.3.5	Use order: if a use order is known, the menu should be arranged in this form	X	X	X
14-6.1.5	Menu Map: representing the menu structure and it should clearly be available when necessary		X	X
14-6.2.4	Navigation to a next level: a simple and consistent meaning should be provided to shift to the next level in the menu structure		X	
14-8.1.7	Headings: the writing should be short	X	X	X

4. PRELIMINARY ANALYSIS OF THE INSPECTION

4.1 Analysis Overview

Table 5 shows the violation of ISO standard, considering all the norms together and parts 10, 12, 13 and 14 separately.

Table 5. Quantification of the Web GIS applications regarding norm violation

Applications	All Norms	Dialogue Principles (10)	Presentation of Information (12)	User Guidance (13)	Menu Dialogues (14)
Agritempo	65.5%	70.6%	52.9%	78.6%	61.1%
FUNCEME	59.5%	61.8%	47.1%	64.3%	72.2%
SIMEPAR	47.6%	47.1%	29.4%	50.0%	66.7%

Analyzing Table 5, we observe that Agritempo is the one with overall lowest conformance to the four norms considered. FUNCEME had a higher violation rate of ISO 9241-14, for Menu Dialogues. Overall, we can see that the difference in Agritempo and FUNCEME is not expressive. One of the factors that can have contributed to Agritempo‘s higher violation rate, is the fact that this application belongs to the "Map Generator" category, while the other two applications belong to the "Static Maps Server" category. The "Map Generator" category[14], by definition, possesses more interaction possibilities than the "Static Maps Server" category, offering margin for a larger norm violation.

Eighty four norms were inspected of which 32 (38.1%) were not obeyed by any of the three evaluated applications. Of the 32 norms, 13 belong to part 10 (40.6%), 3 to part 12 (9.4%), 6 to part 13 (18.8%) and 10 to part 14 (31.3%). This result suggests that the evaluated applications would have potentially more problems in relation to ISO 9241-10 (Dialogue Principles), that involves factors such as task adequateness, controllability, user expectations conformity, customization adequateness, learning adequateness, etc; and, secondly, ISO 9241-14 (Menu Dialogues), which is related to menu organization and dialogue structure.

Seventeen norms were obeyed by all the evaluated applications. Among them, we can point out a norm which recommends that dialogues used for similar tasks should be similar, so that the user can develop common procedures for task resolutions (10-3.5.4). We can also point out a norm that recommends that the dialogue system should allow the user to

choose alternative forms of information presentation, in concordance to the individual's preferences and the complexity of the information to be processed (10-3.7.2). Considering this norm, the evaluated applications allow information visualization in the form of maps, tables, graphics, among others.

4.2 Dialogue Principles – ISO 9241-10

Suitability for the Task and Individualization, Conformity with User Expectations. The dialogue design should take into consideration the task complexity in regard to the user's abilities (10-3.2.4). None of the evaluated applications considers to this norm, since different user profiles are not considered. The application should use familiar vocabulary for the user in task execution (10-3.5.3). The SIMEPAR is the one that seems to have a more adequate vocabulary. Neither of the three applications provides mechanisms to allow the dialogue system to be adapted to the user's language, cultural and specific knowledge (10-3.7.1); the user is not allowed to incorporate his/her own names for objects or to add specific commands (10-3.7.4) and users are not qualified to configure operational parameters of time to match their individual necessities (10-3.7.5).

Suitability for the Task and Learning. One of the great problems in Web applications is that help systems are unavailable or inefficient. There is a norm that recommends that help information should be task dependent (10-3.2.2). For Web GIS applications, besides not being task dependent, many applications even do not provide access to a help system. Learning strategies should be provided, such as tutorials, learning by examples, among others (10-3.8.2). None of the evaluated applications have considered such factors. Only Agritempo possesses a help system, supplemented by a technical term glossary. However, it is not task dependent. The FUNCEME and SIMEPAR seem to be more adequate as regards task execution, given the scope of these applications, when compared to Agritempo. For example, to visualize weather forecast maps in Agritempo, the application provides a series of forecast maps that can create complexity in task execution. The dialogue should present the user only with information related to the completion of the task (10-3.2.1).

Suitability for the Task and Error Tolerance: In Web GIS applications, web forms are one of the resources frequently found, in which the user can fill out specifications, with the intention of querying maps, tables, graphics, among others. We noticed that in general Web GIS applications do not include default values for data entry fields. This occurred with Agritempo, violating a norm that recommends that when there are default inputs to one given task, it should not be necessary for the user to enter the values (10-

3.2.7). In the case of SIMEPAR, we observed the existence of an important resource: the totality of the form elements is restricted to widgets of the combobox type, i.e., they restrict user data entry, preventing error occurrences. This is the recommendation of a norm that states that the application should assist the user detecting and preventing errors in the input (10-3.6.1). Agritempo and FUNCEME do not obey this norm; therefore if in Agritempo the user enters some invalid information in these fields and the error occurs, the application does not help them correct it (10-3.6.2). Part 17 of ISO 9241 specifically deals with the filling out of forms.

Controllability and Conformity with User Expectations. Users' different characteristics and necessities require different interaction levels and methods (10-3.4.5). The three evaluated applications do not obey this norm. However, we observe that some diversified levels of interaction are offered; for example, sophisticated users have enough resources to fulfill their tasks; for novice users, there are some links (shortcuts) for some application resources, for example, the weather forecast. However, these links provide access to a few functionalities.

Interaction speed is a very important factor and it should not be dictated by the system (10-3.4.1). FUNCEME and SIMEPAR provide the so called dynamic messages, generally used in commercial web sites. These are continuous messages and if the user is not fast enough, (s)he will not be able to read the information that is being shown.

When the user's task in the Web GIS application is interrupted by an energy drop, system failure, for example, users should be able to resume their task from where they stopped (10-3.4.3). This is a resource that many web applications have not implemented yet.

If the reply time deviates from the expected reply time, the user should be informed of that (10-3.5.7). FUNCEME and SIMEPAR do not have resources that demand much processing. However, in the case of SIMEPAR, there are modules whose loading procedure takes time and this is not informed. In Agritempo the visualization of production maps can take a certain time and this is not informed.

4.3 Presentation of Information – ISO 9241-12

Organization of Information (recommendations for windows, areas, input/output area). Windows' design should be consistent through the application as a whole (12-5.3.4). The SIMEPAR is the one that seems to have more consistency regarding its windows. However, it is interesting to point out that the windows of a Web GIS application should allow the visualization of maps, data and graphics; and many times it is necessary to

modify the window standard, to allow a better information visualization (in the case of the applications pertinent to the "Map Generator" category, illustrated by the Agritempo, some regions assume a standard similar to that of available graphical software, allowing direct manipulation of available images). Another norm recommends that their title heading format should be consistent (12-5.3.9). The three evaluated applications maintain the same window heading throughout the application. It would be expected that the headings would vary, depending on the region where the user is at a given moment. The density of the shown information should not be perceived by the user as excessively disordered (12-5.4.2). ISO recommends that, if there is a lot of information, it should be divided into parts, through the use of the scrollbar (12-5.5.2) for example. The three applications obey this norm.

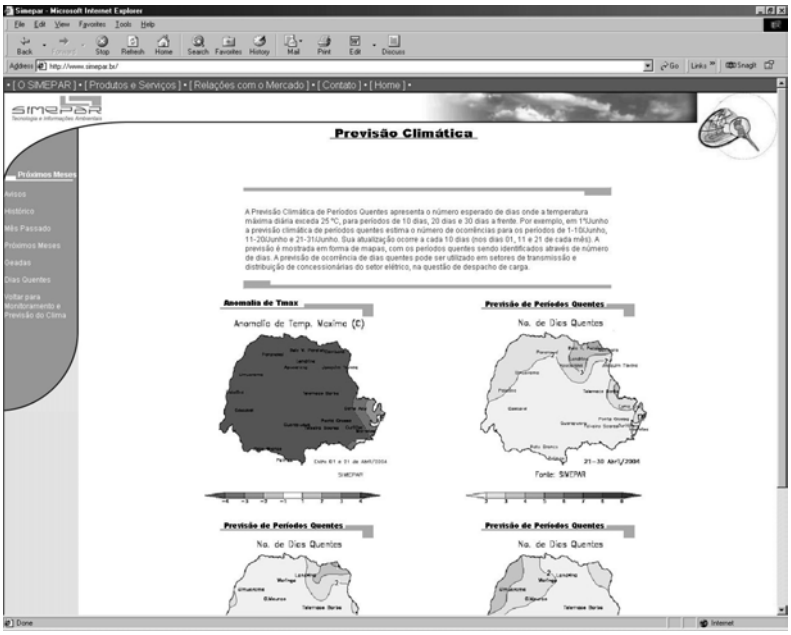
Organization of Information (groups). We have detected that the three evaluated applications organize information by grouping them (12-5.6.1). Conventions should be used, i.e., information groups should be arranged in common formats (12-5.6.3). The Agritempo uses conventions that have already been used in other web sites, as the button bar positioning, the heading bar, regions for news, highlights, etc. A good strategy used by FUNCEME was the availability of "mais" links (“more”), to indicate that there is more information available. In the same application, we notice that many links are not in the standard format, potentially making it difficult to identify them as links. It is necessary to go over a link with the mouse for it to be identified as such. The SIMEPAR uses dots and brackets ([link1]. [link2]) to separate information items making them factors of accessibility.

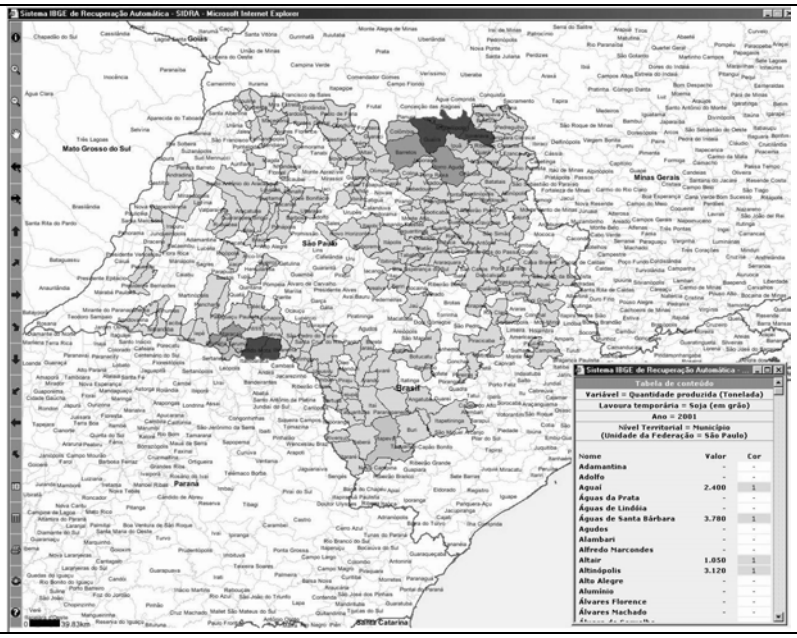
Organization of Information (tables). The "visual scanning" should be facilitated, i.e., some distinct characteristic should be offered to facilitate the visual scanning (12-5.8.4). There is a map of Brazil in the Agritempo home-page to facilitate the access to information about the states. FUNCEME home-page presents Ceará State map, and links for the visualization of satellite images. In the SIMEPAR, there are weather conditions, frost maps and icons which represent the weather in the main cities in the state of Paraná.

Coding Techniques. The number of used colors should not be more than 6, not counting black and white (12-7.5.5). None of the three applications obey this norm; all of them use more than six colors, especially when highlighting information on the map. FUNCEME and SIMEPAR use color in some maps to encode meaning; this does not occur in the Agritempo. Thus, FUNCEME and SIMEPAR do not consider the norm where colors should not be used as the only way of encoding meaning (12-7.5.1). To fulfill the requirements of this norm, these applications would have to add other representations for encoding information, besides the color. All three

applications use background colors that are not saturated, in this case, the white color (12-7.5.10). Table 6 illustrates the violation and agreement on norm 12-7.5.1 for the SIMEPAR and Agritempo respectively.

Table 6. Violation/Agreement examples of norm in which colors should not be used as the only way of encoding meaning (12-7.5.1)

ISO 9241-12: Presentation of Information
Norm 12-7.5.1: colors as auxiliary codification - colors should never be used as the only means of codification
Norm Violation Application: SIMEPAR    Norm Agreement Application: Agritempo

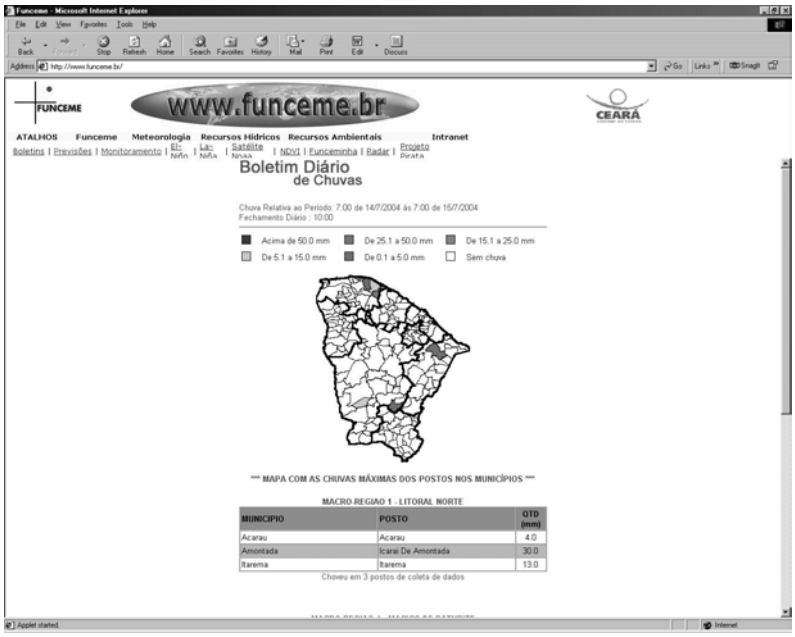


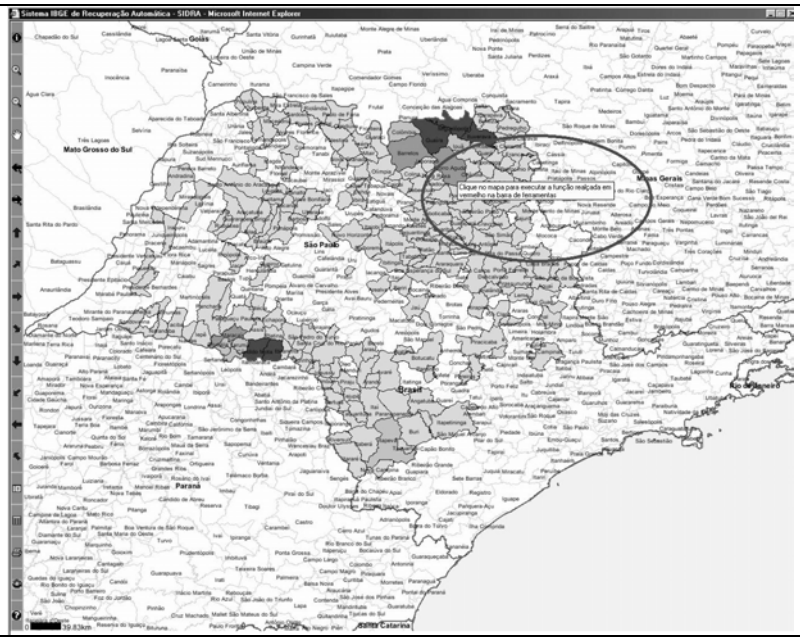
Justification: the climatic forecast maps in the SIMEPAR; the only way that the user has to distinguish Paraná State map regions is through colors. In the Agritempo, the soy production of São Paulo State in 2001 is shown through colors and also the user can visualize descriptive data related to the map (right bottom window).

4.4 User Guidance – ISO 9241-13

Feedback and Phrasing of User Guidance. One of the problems that can happen with Web GIS applications is the fact that the feedback can distract the user during his/her task course; norm 13-7.2.2 recommends that this should be prevented. In FUNCEME, if the user is executing some task and, by mistake slides the mouse over the option bar on top of the screen, the currently visible sub-elements of the menu are replaced by other elements, hampering the users. This example violates a norm which recommends that phrases should be available to enhance the user's control perception (13-5.3.2). In order to have an agreement with this norm, FUNCEME Web GIS application would have to allow the user, while passing the mouse cursor on the map image, to receive specific descriptive information from each one of the locations of the map, through text boxes. When the Agritempo user slides the mouse over production maps, a message is shown (hints), describing how to use the system. Table 7 illustrates norm 13-5.3.2 violation and agreement examples, for FUNCEME and Agritempo respectively.

Table 7. Violation/Agreement examples of norm where phrases should be available to enhance the user's control perception (13-5.3.2)

ISO 9241-13: User Guidance
Norm 13-5.3.2: phrases to enhance the user's control perception
Norm violation Application: FUNCEME    Norm Agreement Application: Agritempo



Justification: the daily rain forecast map of the State of Ceará in the FUNCEME does not offer the user information about the possibility of clicking on the map. In the São Paulo State map for the soy production in 2001, the Agritempo guides the user in the use of the system. The message shown in the pointed out region is: “clique no mapa para executar a função realçada em vermelho na barra de ferramentas”.

4.5 Menu Dialogues – ISO 9241-14

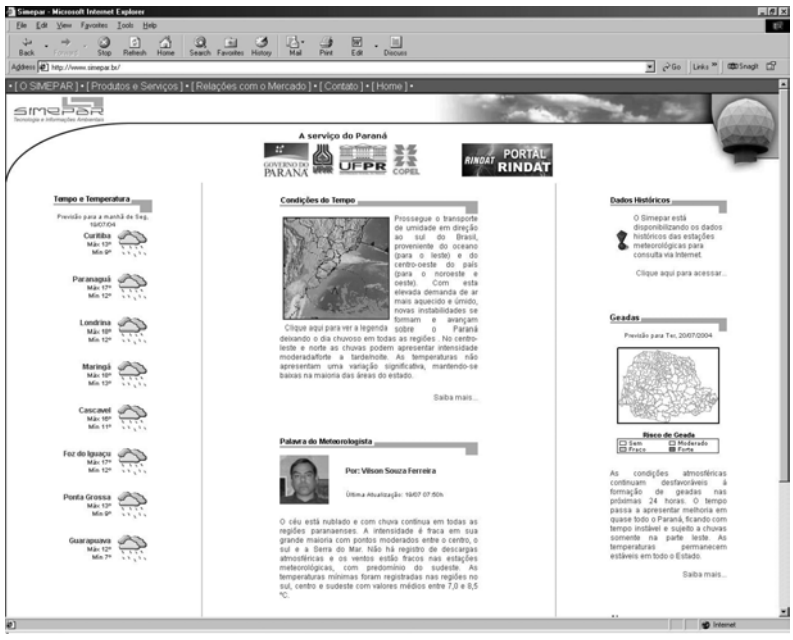
Menu Structure (structuring into levels and menus). The menu options should be arranged according to conventions or grouped (14-5.1). The three applications violated this norm. In Agritempo’s case, there are three menu items called "zoneamento tabela", "zoneamento gráfico" and "zoneamento mapas"; a menu item could be created called "zoneamento", linking the visualization forms through "tabelas", "gráficos" and "mapas". Similar problems occur with FUNCEME and SIMPEPAR. FUNCEME presents two different menus: "solo" (in one) and "humidade do solo" (in another) option. In the case of SIMEPAR, "Temperatura Máxima" and "Temperatura Mínima" menus could be one menu "Temperatura", with the sub-menus "Máxima" and "Mínima".

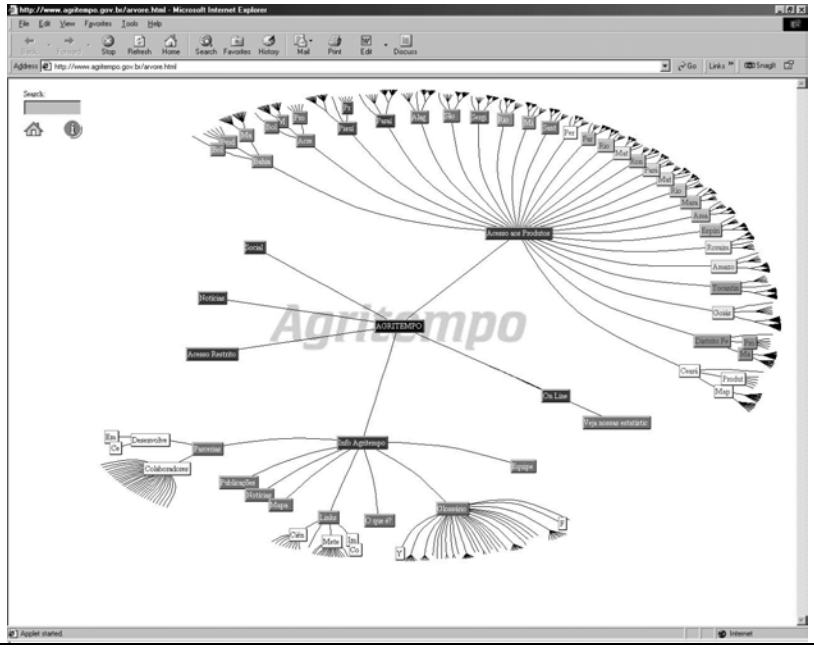
The options inside the menus should be arranged in groups of four to eight options per level (14-5.1.3). None of the applications have obeyed this norm. In Agritempo, we had cases of nine items in a menu and ten in

another; in FUNCEME, we had ten items in a menu. Agritempo also violated this norm by the inferior limit (menus with two and three items).

Menu Structure (sequencing of options within groups) and Menu Navigation. If a task execution order is known, the menu should be arranged in the same order (14-5.3.5). None of the evaluated applications have considered this norm. Few applications in the web consider this norm, exception made for banks and e-commerce web sites. There should be menu maps, to present the menu structure to the user (14-6.1.5). The only application that considers this norm is Agritempo, which provides a menu map on a hyperbolic tree structure. To have FUNCEME and SIMEPAR applications in line with this norm, they should provide a similar function. Table 8 shows violation and agreement examples of norm 14-6.1.5, for SIMEPAR and Agritempo respectively.

Table 8. Violation/Agreement examples of norm in there should be menu maps, to present the menu structure to the user (14-6.1.5)

ISO 9241-14: Menu Dialogues
Norm 14-6.1.5: a menu map should clearly represent the menus' system structure and should be available when necessary
Norm Violation Application: SIMEPAR    Norm Agreement: Application: Agritempo



Justification: SIMEPAR does not provide a menu structure map of the web site, while Agritempo provides a hyperbolic tree to represent the menu structure of the web site.

Menu Navigation and Presentation. As favorable factors all evaluated Web GIS applications allow the user to navigate to another part of the web site, without the necessity of returning to the home-page. This is due to the existence of visible dialogue menus. This obeys the norm that recommends that the return to the initial menu should be simple and consistently provided (14-6.2.3). In FUNCEME and SIMEPAR, the initial menus are always visible; in Agritempo, the user only needs to access the home-page. The menu options should be placed in an area that does not overshadow the user's interest area (14-8.1.2). All the applications have considered this norm, since the menus are placed in surrounding regions of the content.

The menus and sub-menus headings should be short (14-8.1.7). None of the applications consider this norm (the ISO does not specify the amount of characters that a menu element should have). None of the applications provide shortcut keys to access menu items; therefore norm 14-8.2.4 is not obeyed. This does not seem to be a characteristic of general applications on the web.

4.6 Discussion

Apparently, the evaluated applications strongly violate norm 9241-10, which deals with dialogue principles. This suggests that these applications have deficiencies in factors related to task execution and controllability. These applications do not consider different user profiles, neither do they support techniques to facilitate learning and appropriate feedback is not provided. Resources that could be available include: task dependent help and learning by showing examples.

Some of the pages of the FUNCEME have high information density, measured by the amount of available information groups (12-5.4.2). The SIMEPAR seems to organize the information through the use of top and left navigation bars.

In some cases, the norms of ISO 9241 do not fit in the Web GIS applications context; for example, norm 10-3.6.5, Dialogue Principles. According to this norm, user needs and characteristics may require that error situations are deferred, leaving the decision to the user as to when to handle it. In Web GIS applications, the error situations should not be postponed because they would have consequences in the following operations necessary for task completion.

Another factor that contributes to the implementation of Web GIS applications is the use of platform standards and conventions. We have noticed that the evaluated applications, try to adopt this practice in some page regions, by using standard icons (help, home-page, e-mail) or already stipulated information grouping (highlights, news), but this is not widely adopted.

Important norms were completely considered by the applications; for example, the possibility of visualizing information with different representations, since GIS applications allow information visualization through maps, graphics, tables formats, etc. Furthermore, application windows that have a similar organization have similar appearance, facilitating the use of the system.

It seems that Web GIS applications interfaces still do not present a convenient menu structure. They presume that all users have a mouse installed; interactions are not possible by using keyboards. The only way of accessing the menus of the evaluated applications with the keyboard is through the Tab key, pressing it successively. If a user wants to access a menu located at the bottom of the screen, he would have to pass through all the elements (menus, images, links) until he gets to his/her destination. Still, using the Tab key, when we go through the menu elements and arrive at its

end, the selection mark (focus) does not return to the first menu item, but it continues to the following interface elements. This is a violation of norms menus in columns (14-7.4.1) and menu in lines (14-7.4.2), that recommend that when navigating through the items of a menu and arriving at the last option, the return to the first option should be allowed and vice-versa.

5. CONCLUSION

This paper inspected the quality of the interface of these Web GIS applications regarding four aspects of ISO 9241 norms. This kind of analysis has shown usefulness and should be adopted by application designers, to help them finding out potential problems in user interaction. Our analysis detected that Agritempo seems to violate a larger amount of norms, when compared to the other two applications. This fact can be explained by the fact that it belongs to the "Map Generator" category[14], which provides more interaction elements, in relation to the "Static Maps Server" category applications.

GIS interface quality studies have mostly discussed results of tests with users. Little has been done in evaluating GIS user interfaces by inspection. Our inspection procedure involved ISO 9241, which is characterized as an important tool for those who would like to search certification for their products. Besides less expensive than tests with users, literature has also shown that results found with inspection approaches could complement results from user testing.

The use of some parts of the standard ISO 9241, for the interface inspection of the Web GIS applications was effective, given the countless captured aspects (positive and negative). However, we have verified that the interface evaluation of web applications in general, needs some additional criteria and rules. We acknowledge the necessity of adapting and extending these norms to consider other relevant aspects in the Web GIS applications such as semantic zoom, pan, animation in maps, query regarding descriptive information related to the maps, etc, and we are now developing research work in this direction.

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