

Web based applications for climate change related information: a usability test

Markus Wrobel^a, Luís Costa^a

^aPotsdam Institute for Climate Impact Research
[wrobel | costa] @pik-potsdam.de

Abstract: Tailored web based applications can in principle provide valuable contributions to the pressing aim of facilitating access to complex climate change related information. As a consequence, an increasing amount of such applications is being developed. However, due to both the complexity of the information in question and the absence of de facto standards for designing such specific web applications, a remarkable amount of external user interface heterogeneity can be observed. In order to contribute to a systematic usability evaluation in this context, we selected three common user tasks that typically need to be addressed by users of such applications, related to identifying and filtering available content. We then performed a simple, semi-formal usability test to investigate whether alternative available UI approaches for comparable tasks differ with respect to indicators like speed of performance or error rate.

Keywords: usability; web based applications; climate change; adaptation.

1 INTRODUCTION

The need to mitigate and adapt to future climate change is now widely recognized at the political level. More than 100 countries have adopted the mitigation principle of keeping global temperatures below 2°C [Meinshausen et al. 2009]. In parallel, in the past decade adaptation to climate change has become a topic of scientific inquiry in local and international policy and planning [Moser and Ekstrom 2010]. Efficient information exchange can play a crucial role in these processes, and tailor-made web based applications bear the potential to facilitate access to complex climate change related information and to support dissemination of scientific knowledge, e.g. into the sphere of decision makers and practitioners. As a consequence we witness an increasing number of such applications being developed over the recent years. However, due to both the complexity of the information in question and the absence of de facto design standards, a remarkable amount of user interface heterogeneity can be observed across these applications (Wrobel et al. [2010]).

The high relevance of human factors in designing appropriate user interfaces has long been recognised in the field of HCI (e.g., Norman [1988], Shneiderman [1998]), and the advent of the web in the mid 90s of the 20th century led to the identification of additional usability challenges posed by the specifics inherent to web based applications (see e.g. Krug [2006]). A systematic evaluation of web based applications for accessing climate change related information, however, is not straightforward and still lacking. In order to contribute to a systematic evaluation of this field, we have conducted a simple, semi-formal user test to investigate whether alternative user interface (UI) strategies that can be observed in existing applications differ with respect to speed of performance or error rate.

Usability testing can be conducted for different aims and base on different strategies, including tests with 'real users', tests with usability experts only

(heuristic evaluation) [Nielsen and Molich 1990] (for a discussion see e.g. [Jeffries and Desurvire 1992]) or cognitive walkthroughs [Lewis et al. 1990; Wharton et al. 1994]). The appropriate number of test persons to be involved for each strategy should be selected depending on the required rate of usability problems to be detected (e.g. Nielsen and Molich [1990], Nielsen and Landauer [1993]).

The aim of the test we conducted is neither to identify all usability problems in the reviewed applications nor to identify an 'ultimate' UI strategy to implement for a given task. Rather, we were interested in the question whether some of the strategies applied in existing applications appear to be advantageous over others, both with respect to speed of performance and attractiveness to the user. We thus restricted our test to a simple, semi-formal approach by selecting 3 user tasks and a set of 8 existing applications to be tested (4 applications for the first two tasks and 4 different ones for the third task). The test was conducted with 5 test persons; every test person conducted each task with all of the selected applications.

The remainder of this paper is structured as follows. We first give a short overview on results from a questionnaire we ran at 2 workshops related to web based applications for climate change information (sec. 2). We then describe the setup of the test including the three tasks to be performed and the UI strategies and applications selected (sec. 3). The final section (sec. 4) outlines results obtained, discusses the results and concludes the paper.

2 QUESTIONNAIRE RESULTS

To better understand user requirements for web-based application for climate change information a questionnaire was conducted in two workshops. Both workshops were aimed at familiarizing potential users with existing climate change information platforms and at gathering feedback for further improvements. The first workshop was conducted in Mexico City on the 12th October 2011, hosted by the Mexican GIZ¹ delegation, while the second took place in the Durban Climate Change Conference preceding the Conference of Parties 17 (COP17) in December 2011. A total of 46 questionnaires were collected (31 and 15 for the Mexican and South African workshops respectively). The following results were found to be particular relevant for this work.

One question addressed the perceived need for harmonizing the appearance (e.g. wording, controls) of different climate change information platforms. 70% of the answers agreed with the statement that a harmonization would facilitate their information tasks, while 26% answered that they have no problems in using different platforms and therefore harmonizing the appearance would not result in an advantage. The remaining 4% did not use different climate change information applications.

Other questions addressed user preference on having spatial explicit climate related information displayed using static or interactive maps. 70% of the potential users stated to prefer this information presented on interactive maps, while a considerable proportion of participants (28%) revealed no preference for either static or interactive presentation. Only 2% of participants preferred static maps as information visualization strategy. An overwhelming majority (82%) additionally agreed with the statement that interactive maps would make up an attractive and impressive part of climate change information applications, 16% agreed with the statement that would be nice to have features but are not especially important, while 2% of the potential users agreed with the statement that interactive maps would be only "toy" features.

¹ Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)

Finally, users were asked to select statements on possible barriers hindering the use of climate change information platforms. Statements indicating that users find these platforms too time consuming to explore and too complicated to use ranked among the most often selected statements.

3 USER TASKS TO BE PERFORMED AND UI STRATEGIES TESTED

3.1 User tasks

Drawing from this survey we have constructed three plausible tasks that address the use of interactive maps and/or the speed of task completion. For the first two tasks the test users had to select specific content to be displayed on interactive maps. Taking into account that climate change science is characterized by the extensive use of model projections and scenarios, task one asked the test users to display projected values of surface temperature according to a specific scenario, GCM and temporal reference. The second task had the objective of deciding whether particular information on climate change is available within an application or not. The test users had to state whether a map with characteristics similar to those in task one would be available specifically for the month of March. The task was considered as completed when a user stated that such a map either was or was not available. The third task dealt with identifying the total number of entries in existing adaptation information related databases. Our test users were asked to tell the number of entries to be found for Brazil in four different databases.

Our five test users comprised two doctoral students and two post-docs in the field of climate change plus one student assistant, none being a frequent user of the tested or similar applications. Two out of the five test users stated to be familiar with the concept of GCMs and SRES scenarios. The test users were put under considerable time pressure by being told that all tasks are meant to mimic a possible everyday work situation where the answers would be required for an upcoming meeting or telephone conference starting in a few minutes. The time for completion for each task was restricted to 160 seconds.

The tests were conducted during one day with one user at a time, using a standard PC and a Chrome web-browser version 14 running under the operating system Windows XP Professional 2007.

3.2 UI approaches tested

For conducting both task 1 and 2 we selected a set of four web based applications. All four applications allow a user selectable set of variables comprising projected temperature and precipitation data for several GCMs and SRES scenarios to be displayed on an interactive map. All four applications follow a different UI strategy to enable the selection of the required parameters.

Strategy one has been implemented in Nature Conservancy's Climate Wizard² with required controls grouped above the map as well as to the left of the map. A panel on the left hand of the map offers a drop down for selecting aggregations over multiple GCMs (default) as well as single GCMs. Radio buttons on the top of the map allow to select time period, absolute or relative change, and variable; the temporal aggregation (long-term annual, seasonal or monthly averages) is selected using a drop down.

A second strategy has been implemented in the beta version of World Bank Climate Change Knowledge Portal 2.0 section on Global climate data³. The user is

² <http://www.climatewizard.org/>

³ http://sdwebx.worldbank.org/climateportal/index.cfm?page=global_map

presented with a large mouse sensitive map allowing the subsequent selection of regions and a country; alternatively a country can be selected from a drop down on the top right of the map. After a country has been selected, the user is presented with a page showing both a topographical map (left) and a section for time series diagrams (right). To select projected data for the map, the user first needs to select a tab rider labelled 'future' on top of the map section. After this selection both the controls for the diagrams and the map are updated. A menu bar appears above the map offering a set of menu items for the selection of time period, variable, scenario and models for the map. Monthly values for projections appear to be currently not available; the menu item 'map options' shows a disabled entry labelled 'mean monthly' displaying a tooltip 'coming soon' on mouse over.

A third strategy is followed in the Climate Impacts: Global and Regional Adaptation Support Platform *ci:grasp*⁴. The user is presented with a tabbed search panel in front of an interactive map, allowing to select filter criteria for maps (tab 1) as well as for adaptation projects (tab 2). Tab 1 is selected by default. A text field can be used to filter the variable to be displayed; a set of drop downs allows specifying country, time period, temporal aggregation, GCM and scenario. The resulting subset of maps is presented as a list on an additional panel to the right of the filter panel; selecting an item from the list updates the interactive map and collapses the search / result panels. Long-term temporal aggregations of temperature and precipitation projections can be selected both for annual and seasonal averages, but not for single months.

A fourth strategy, implemented in the IPCC Data Distribution Centre's visualization application⁵, distributes the selection of the required parameters over three different panels arranged below and to the right of the map. Two adjacent panels labelled 'dataset' and 'field' are found below the map, a third panel labelled 'domain' is found on the right hand of the map. The selection process starts in the 'dataset' panel. Using a tree like structure the user can first select between observational data and data from the 4th (AR4) or the 3rd assessment report. After AR4 has been selected, the user can select in subsequent steps (i) a scenario, (ii) mean climatologies or mean anomalies for 20 or for 30 years, and (iii) a GCM. After a GCM has been selected, the available variables are shown in the panel 'field'. After a variable has been selected, the map is updated and a drop down appears in the third panel to the right of the map, allowing selecting a different temporal reference. Projections can be selected for long-term monthly aggregations.

For task 3, a different set of existing web based applications was selected, this time related to filtering databases with climate change adaptation related information. Again, all four examples follow four different UI strategies. To avoid confusion with the strategies tested with task 1 and 2, we label the strategies for task 3 with Latin numbers I to IV.

UI strategy I has been implemented in the Adaptation Learning Mechanism (ALM)⁶. The approach combines a mouse sensitive map with a set of filter sections on the right hand side of the map not related to spatial filtering. Above the map a text field offers to 'type a country or region name'. A list below the map / filter section displays the results of the current selection; by default it displays all of the more than 1300 entries of the database. To fulfill our task a user can either enter 'Brazil' in the text field above the map or click on the map to select Brazil. In both cases the map zooms in to Brazil, and the result list below the map is updated accordingly.

⁴ <http://ci:grasp.pik-potsdam.de/worldmap>

⁵ <http://www.ipcc-data.org/maps/>

⁶ <http://www.adaptationlearning.net/explore>

Strategy II is followed for the UNDP Adaptation Portfolio Project Database⁷. The application combines a mouse sensitive map with additional filter controls. On top of the map the user is offered with three adjacent sections, labeled (from left to right) 'region', 'fund' and 'thematic area', each consisting of a set of checkboxes to select values. At the bottom of the 'thematic area' section are additionally two buttons labeled 'search' and 'clear'. Below these three sections is the interactive map, headed with a drop down called 'select a country', a text field saying 'type country name' and a button labeled 'go'. The drop down does initially offer no values for selection, and the entering values into the text field appear to have to effect. To fulfill task 3 the user first needs to select 'Latin America & Caribbean' in the region section and to press the search button on the right hand side. This will update the map highlighting countries for which entries are available, and in addition update the 'select a country' drop down and a result table below the map.

Strategy III is implemented in the Vulnerability & Adaptation Database of the World Resources Institute⁸. The UI strategy followed here organizes sets of 'tags' into several groups, e.g. related to 'regions', 'country', 'impacts' etc. All tags are offered as hyperlinks. To fulfill task 3 the user has to select the hyperlink labeled 'Brazil' in the 'country' section. He then is presented with a page listing the resulting entries.

Strategy IV has been implemented for the case study database of the Convention on Biological Diversity⁹. The UI provides a form with four drop downs, allowing to select 'country', 'region', 'adaptation activity', and 'tool type'. A paged list below the form displays the results of the current filtering. Below, a similar form and result list is offered for a second database on 'monitoring tools'. To fulfill task 3 the user needs to select 'Brazil' in the 'country' drop down and to press a 'go'-button.

4 RESULTS AND DISCUSSION

The results obtained for the five users tested for task 1 and task 2 are displayed in Fig.1a and Fig1b, respectively, the results for task 3 are shown in Fig. 1c. After having completed the test both for task 1 and 2, each user was asked to name up to two of the applications he would prefer if he was to conduct more similar tasks. The implementation of strategy 1 got 5 votes, followed by the implementations of strategy 3 and 4 (2 votes each) and the implementation of strategy 2 (1 vote). A similar question for task 3 resulted in 4 votes for the application with strategy IV, followed by the implementations of strategy I and III (1 vote each), while the implementation of strategy II was preferred by none of the test users. In the following, we shortly outline observations and conclusions from our test.

4.1 Users can sometimes fail completing even fairly simple tasks

The selected tasks required not more than selecting either very few parameters (task 1 and 2) or even only one parameter (task 3). However, as can be seen from fig. 1, we observed user failures for all three tasks (8 out of 60 attempts failed to complete the task in the given time, while 2 attempts lead to a wrong result). Two of the failures resulted from non-responsive UI behaviour (cf. 4.3). The other failures occurred because the users were not able to figure out how the application was meant to be used. These observations clearly indicate usability problems with the respective applications that should and could be solved. Of course it needs to be taken into account that we constructed a test situation imposing time pressure on our test persons; a real world user might possibly be motivated to spend a longer time to figure out how to handle an application – but it should not be taken for granted.

⁷ <http://www.undp-adaptation.org/portfolio/>

⁸ <http://projects.wri.org/adaptation-database>

⁹ <http://adaptation.cbd.int/activities.shtml>

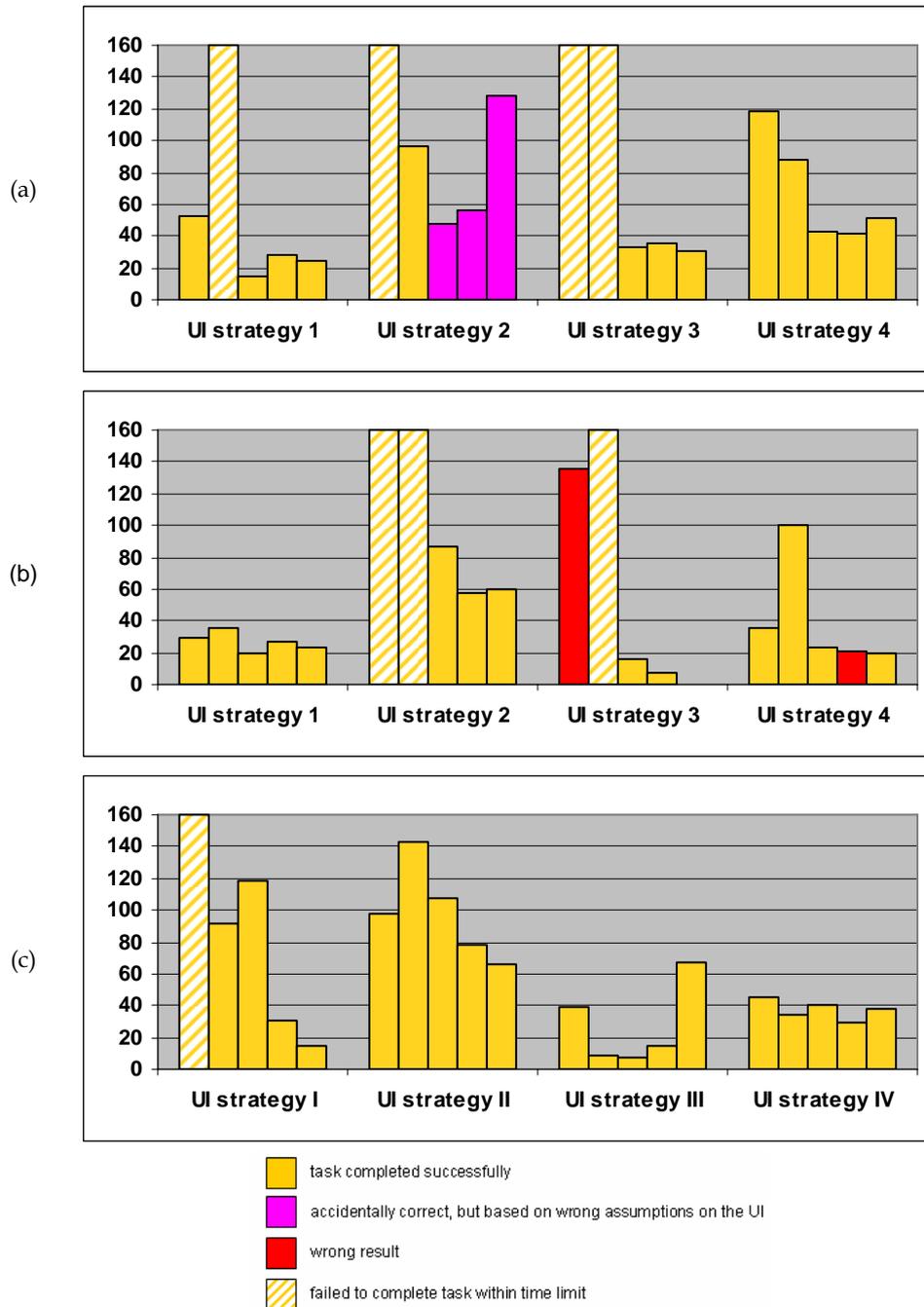


Figure 1. Results for (a) task 1, (b) task 2, and (c) task 3. Columns indicate the time (in seconds) needed to complete a task. Streaked columns indicate that the task was not completed within the time limit. Users are displayed in the same order for each UI strategy and for each task.

4.2 Users sometimes think they did it right but actually are wrong

We observed two types of misconceptions where users assumed they had completed the task successfully but actually had not. The first type (indicated with red columns in Fig. 1) relates to wrong answers on the availability of the requested type of map in task 2. The second type of misconceptions (indicated with magenta columns in Fig. 2) relates to accidentally correct results based on wrong assumptions on the behaviour of the UI: the users erroneously assumed that the content displayed on the map was controlled via drop downs that actually

controlled the content of adjacent diagrams. The result happened to be correct only since the default map parameters accidentally matched the required task. Both types of possible misconceptions lead to errors that are not necessarily detected by the user and should clearly be prevented.

4.3 Responsiveness is important

A third conclusion relates to the observation that the UI's responsiveness plays a critical role for the usability of an application. As stated e.g. by Shneiderman [1998], a well designed user interface should always give the user a locus of control and provide immediate and informative feedback on his actions. The application implementing UI strategy I suffered from poor responsiveness while tested with users 1 to 3. The failure of user 1 with this UI strategy is actually due to non-responsive UI behaviour, and the poor responsiveness of this application is also reflected in the slow task completion of user 2 and 3. The interface happened to respond much faster when the test was conducted with users 4 and 5 and allowed them for a completion that was 2 to 3 times faster. Note also that the application having been rated as most appropriate by the users for task 1 and 2 showed a high overall responsiveness, e.g. for map updates.

4.4 Avoid unfamiliar UI strategies

A last conclusion is that designers of climate change information applications should consider implementing existing UI strategies that already appear to work well for common tasks instead of striving to invent new, proprietary solutions. This conclusion is well in line with recommendations for web usability e.g. from Krug [2006]. In general, our test users worked best with - and appreciated most - responsive interfaces that provided classical, form based controls in clear arrangements. The UI strategies in our sample that required the user to follow a proprietary sequence of interactions resulted in longer time needed to explore and understand the UI and also in a lower user acceptance. Controls that were not easily identified or were only available after specific actions have been performed typically resulted in problems for the users. To avoid confusion, relevant controls should additionally be clearly marked out against other UI elements of the surrounding web site. Our test also showed that applications that work well are not automatically perceived as more attractive: UI strategy III allowed for successful and fast completion of task 3 for all 5 users but was only rated by 1 test user as an appropriate candidate for similar tasks.

4.5 Conclusions and Recommendations

The results of this work confirm our observation that designing appropriate and attractive applications for disseminating climate change information is not straightforward. Even fairly simple tasks as selecting content to be displayed on a map or filtering a database for country specific information result in various different - and not always easy comprehensible - user interfaces. Designers of new applications in this context thus need to take into account that each user is actually different [Shneiderman 1998] and will not necessarily share the same mental model of how an application should be used [Norman 1988]. They should consider identifying and adopting existing UI strategies that appear to already work well for users. Simple and inexpensive user tests as conducted here can help to identify such strategies as well as to reveal existing (and, luckily, solvable) usability issues.

ACKNOWLEDGEMENTS

This work was supported by the FP7 project MEDIATION (Methodology for Effective Decision-Making on Impacts and Adaptation, Project No. 244012) and by the Adaptcosts project, funded under the UFOPLAN 2010; Optionen für Anpassung im internationalen Klimaschutzregime FKZ: 3710 41 141

REFERENCES

- Jeffries, R.; Desurvire, H.: Usability testing vs. heuristic evaluation: was there a contest? ACM SIGCHI Bulletin Volume 24 Issue 4, Oct. 1992
- Krug, S. (2006) Don't make me think. New Riders, 2nd ed.
- Lewis, C.; Polson, P.; Wharton, C.; Rieman, J., Testing a Walkthrough Methodology for Theory-Based Design of Walk-Up-and-Use Interfaces. CHI '90 Proceedings of the SIGCHI conference on Human factors in computing systems: Empowering people
- Meinshausen, M.; Meinshausen, N.; Hare, W.; Raper, S.C.B. Frieler, K.; Knutti, R.; Frame, D.J.; Allen M.R.: Greenhouse-gas emission targets for limiting global warming to 2°C *Nature* 458, 1158-1162 (30 April 2009)
- Moser, S.C.; Ekstrom, J.A.: A framework to diagnose barriers to climate change adaptation, PNAS 2010
- Nielsen, J., Molich, R. (1990). Heuristic evaluation of user interfaces, Proc. ACM CHI'90 Conf. (Seattle, WA, 1-5 April), 249-256.
- Nielsen, J.; Landauer, T.K.: A mathematical model of the finding of usability problems, Proceedings of ACM INTERCHI'93 Conference (Amsterdam, The Netherlands, 24-29 April 1993), pp. 206-213.
- Norman, D.: The psychology of everyday things. Ney York 1988
- Shneiderman, B. (1998) Designing the User Interface: Strategies for Effective Human-Computer-Interaction. Addison-Wesley, Reading, 3rd edition.
- Wharton, C., Rieman, J., Lewis, C., and Polson, P.: The cognitive walkthrough method: A practitioner's guide. In Nielsen, J., and Mack, R. L. (Eds.), Usability Inspection Methods, John Wiley & Sons, New York, 1994, 105-140.
- Wrobel, M.; Costa, L.; Lissner, T.; Moneo Laín, M.; Weiß, T.; Kropp, J.: A review of user interface conventions in web applications for climate change information. *International Environmental Modelling and Software Society (iEMSs) 2010 International Congress on Environmental Modelling and Software*