International Congress on Environmental Modelling and Software

5th International Congress on Environmental Modelling and Software - Ottawa, Ontario, Canada - July 2010

Jul 1st, 12:00 AM

A review of user interface conventions in web applications for climate change information

Markus Wrobel

Luis Costa

Tabea Lissner

Marta Moneo Laín

Tobias Weib

See next page for additional authors

Presenter/Author Information
Markus Wrobel, Luis Costa, Tabea Lissner, Marta Moneo Laín, Tobias Weib, and Jürgen Kropp

International Environmental Modelling and Software Society (iEMSs)
2010 International Congress on Environmental Modelling and Software
Modelling for Environment's Sake, Fifth Biennial Meeting, Ottawa, Canada
David A. Swayne, Wanhong Yang, A. A. Voinov, A. Rizzoli, T. Filatova (Eds.)
http://www.iemss.org/iemss2010/index.php?n=Main.Proceedings

A review of user interface conventions in web applications for climate change information

Markus Wrobel[a], Luís Costa[a], Tabea Lissner[a], Marta Moneo Laín[a], Tobias Weiß[a], Jürgen Kropp[a]

[a] Potsdam Institute for Climate Impact Research
[wrobel | costa | lissner | moneo | weiss | kropp] @pik-potsdam.de

Abstract: Web applications are increasingly applied to provide access to the complex field of climate change related information. We review a sample of 32 applications that utilize maps in the context of web enabled access to climate change information in order to examine if the emergence of UI conventions across applications can be observed.

Keywords: HCI, usability, consistency, web, maps, climate change

1. INTRODUCTION AND APPROACH

For the evolving field of climate change impacts and adaptation there is evident need for facilitating access to related knowledge for a broad audience with different levels of expertise and information demands. Web technologies are increasingly being utilized to fulfill this demand, leading to a constantly growing variety of online platforms providing access to climate change related information. However, due to their inherent complexity, all aspects of climate change driven processes can hardly be covered by a single application. Rather, relevant scientific content may well be dispersed across several information platforms, each confronting the user with a proprietary user interface. It is known from Human-Computer Interaction (HCI) that conventions in designing user interfaces (UI) can facilitate the usage of interactive systems. Similarly, UI conventions for accessing climate change information could contribute to facilitated interaction across several information platforms that deal with various aspects of this complex field. A lack of such conventions, on the other hand, would indicate the need for usability improvements. This paper reviews a sample of existing web enabled climate change information applications to investigate if emerging conventions towards consistent user interfaces can be observed. The focus has been laid on applications that utilize maps to aid users in handling the complexity of climate change information.

Complying with conventions in designing web sites can reduce users' learning efforts and increase familiarity [Krug 2006]. In this sense the notion of conventions relates closely to the concept of consistency (for benefits and limits of consistency relating to the usability of user interfaces see, e.g., [Grudin 1989], [Nielsen 1989], [Kellogg 1989], [Chimera and Shneiderman 1993], [Shneiderman 1998], [Pyla et al. 2006]). For the given purpose we investigated whether consistency concerning a set of tasks could be observed across the selected applications. Consistency across applications can be described as external consistency, as opposed to the internal consistency of a system or to its metaphorical consistency to real world features [Grudin 1989]. If the same actions of the user have the same effect independent of the context, we can talk of action-effect consistency; if similar goals or tasks require similar sets of actions, task-action consistency is given [Monk 2000].

We selected a sample (which is not meant to be comprehensive) of 32 web enabled applications that utilize maps to provide access to information in the context of climate change (table 1). Since it is not uncommon that organizations offer more than one application, e.g., to give access to different data or to offer different functionality, we included several applications provided by the same supplier and via the same portal (e.g., IPCC-1..4, IRI-1..4 or CW-1..3). We selected applications presenting one or both of the following aspects:

Table 1. Included applications

#	Acronym	Application / URL
1	AdAt	Adaptation Atlas http://www.adaptationatlas.org/index.cfm
2	ADC-1	ADAM Digital Compendium: Macro-economic-analysis - Direct impacts by sector http://adam-digital-compendium.pik-potsdam.de/macro-economic-analysis/direct-impacts-1/impacts-by-sector/
3	ADC-2	ADAM Digital Compendium II - Maps for drought and heatwave risks to crops http://adam-digital-compendium.pik-potsdam.de/risk-damage-maps/crop-risk-maps/crop-risk-maps-adaptation/
4	AOC	Act on Copenhagen: The impact of a global temperature rise of 4°C http://www.actoncopenhagen.decc.gov.uk/content/en/embeds/flash/4-degrees-large-map-final
5	CCR	Center for Climatic Research: IPCC Results http://ccr.aos.wisc.edu/model/visualization/ipcc/
6	CHM	Global Warming: Early Warning Signs (Climatehotmap) http://www.climatehotmap.org/index.html
7	CW-1	The Climate Wizard http://www.climatewizard.org/
8	CW-2	The Climate Wizard - Future Climate Models http://www.climatewizard.org/tnc/FutureClimateModels.html
9	CW-3	The Climate Wizard - Global Climate Change http://www.climatewizard.org/tnc/ClimateChange.html
10	GLO	Globalis – an interactive world map http://globalis.gvu.unu.edu/
11	IPCC-1	IPCC Data Distribution Centre Visualisation http://www.ipcc-data.org/maps/
12	IPCC-2	Observed fields and GCM anomalies http://www.ipcc-data.org/java/visualisation.html
13	IPCC-3	Observed Regional time Series Anomalies http://www.ipcc-data.org/java/time_series.html
14	IPCC-4	SRES GCM change fields (IPCC 2001) http://www.ipcc-data.org/cgi-bin/ddcvis/gcmcf
15	IRI-1	IRI Indonesia Rainfall Analysis Tool http://iridl.ldeo.columbia.edu/maproom/.Fire/.Regional/.Indonesia/.Dekadal_Rainfall.html
16	IRI-2	IRI World Bank Climate Change Data Portal GHCN Station Temperature & Precipitation Variability Tool http://iridl.ldeo.columbia.edu/maproom/.Global/.World_Bank/.Climate_Variability/
17	IRI-3	IRI Brazil Nordeste Climate Monitoring Map Room http://iridl.ldeo.columbia.edu/maproom/.Regional/.S_America/.NE_Brazil/
18	IRI-4	IRI local monthly climatology of precipitation and temperature http://iridl.ldeo.columbia.edu/maproom/.Global/.Climatologies/Select_a_Point/
19	NASA-CTM	NASA JPL ClimateTimeMachine http://climate.nasa.gov/ClimateTimeMachine/climateTimeMachine.cfm
20	NASA-EO	NASA Earth Observatory http://earthobservatory.nasa.gov/GlobalMaps/
21	NEO	NEO - NASA Earth Observatorions http://neo.sci.gsfc.nasa.gov/Search.html
22	NGeo	National geographic: Global Warming Effects Map http://environment.nationalgeographic.com/global-warming/gw-impacts-interactive/
23	NPR	NPR: Climate connections: a global journey http://www.npr.org/news/specials/climate/interactive/
24	PCIC	PCIC Regional Analysis Tool http://www.pacificclimate.org/tools/select
25	PIK-TE	PIK - Potential Anthropogenic Tipping Elements in the Earth System http://www.pik-potsdam.de/infodesk/tipping-points/index_html?set_language=en
26	ROL	Rising ocean levels http://risingoceanlevels.com/
27	SERV	Servir http://www.servir.net/en/america-latina-caribe
28	UNEP	UNEP Geodata portal http://geodata.grid.unep.ch/results.php
29	WB-1	Worldbank Climate Change Data Portal http://sdwebx.worldbank.org/climateportal/
30	WB-2	Worldbank Climate Change Data Portal - GIS map http://sdwebx.worldbank.org/climateportal/home.cfm?page=gismap
31	WeAD	WeADAPT 3.0 KnowledgeBase browser http://www.weadapt.org/placemarks/#/
32	ZDF	ZDF Folgen des Klimawandels (in German) http://www.zdf.de/ZDFmediathek/#/beitrag/interaktiv/222172/Folgen-des-Klimawandels

(i) Utilization of maps to display the spatial distribution of climate change related variables. Variables might as well relate directly to past, present or future climate (e.g., temperature), to impacts (e.g., crop risk) or to socio-economic information of interest in the context of climate change (e.g., population density). 22 applications in the selected sample utilize maps in this way.

(ii) Utilization of maps to allow user-definable selection of a spatial reference for which additional information can be accessed. The degree of freedom in selecting spatial references can be different, e.g., allowing the selection of grid cells or being based on a set of clickable icons. The sample contains 20 applications that can be attributed to this group.

We first give a rough outline of the sample concerning the climate change related content made available (sec. 2). In the subsequent sections we review the sample with respect to access to information on an application's intended audience and objectives (sec. 3) and give an overview on twelve observed examples for external inconsistency (sec. 4). We conclude with a discussion of the results obtained (sec. 5).

2. CLIMATE CHANGE RELATED CONTENT OF THE SAMPLE

Within the sample two domains can be broadly distinguished concerning the content made available. The first includes applications that provide access to climate variables only, like observed or projected temperature or precipitation data (e.g., IPCC-1..4, CCR). The second domain, which constitutes a slight majority in the sample, comprises applications that - solely or in addition to climate data - provide climate change related information such as on impacts or adaptation options (e.g., ADC-2, WeAD, WB-1, WB-2). A closer look reveals that content is offered in different combinations, including observed climate only (e.g., IRI-1), projected climate only (e.g., IPCC-4), and projected as well as observed climate (e.g., IPCC-1, CW-1). Other combinations include information on climate as well as on impacts (e.g., WB-2), or on impacts as well as on adaptation (e.g., AdAt).

The majority of those applications in the sample that focus on climate data apply 30 year averages (e.g., the baseline period of 1961-1990) to determine the values of climatic variables, as is recommended for climate change science [Carter et al. 2001]. We also found applications that additionally provide 10year (IPCC-2) or 20 year periods (IPCC-1), one example uses a 50 year base line (CW-1), another bases on 20 year periods (CCR). Temporal aggregations made available differ between applications (cf., e.g., CW-1, WB-2, IPCC-1, CCR) and can include annual, monthly and/or seasonal averages. The spatial coverage in the majority of the sample applications is global (e.g., IPCC-1..4, CW-1..3, ZDF, NASA-CTM), however, there are also several examples that restrict the spatial extent (e.g., IRI-1, IRI-3, IRI-4, ADC-1, ADC-2, ROL).

Scenarios are a central concept in projecting future climate change, e.g., by running Global Circulation Models (GCM) [Randall et al. 2007] for a set of SRES emission scenarios [Nakicenovic and Swart 2000]. While some applications in the sample (e.g., IPCC-1, PCIC, CW-1) allow the user to explicitly choose from a variety of IPCC AR4[1] GCM runs for a choice of SRES emissions scenarios, others restrict the user to one SRES scenario (e.g., to A1B in CCR). Other applications provide impact projections for a specific increase in temperature, e.g., a +2°C scenario (ADC-2) or a +4°C scenario (AOC), yet another example from the sample offers the user to choose between five different severity levels of sea level rise (ROL).

3. STATEMENTS ON INTENDED USERS AND USAGE

Gaining rapid access to information on intended audience and objectives can form an important step for first-time users in deciding whether an application deserves further exploration. Keeping this in mind, we examined the sample looking for statements on intended users and objectives. We did not perform an in-depth search but rather tried to identify information within limited

---

[1] The sample also contained examples for access to former IPCC model runs (e.g., IPCC-1).

time, assuming that a typical user might proceed in a similar way. This means that some information might not have been perceived or interpreted as intended by application suppliers. Note also that there is a potential bias due to the fact that the sample includes several applications provided by the same supplier via the same portal. In these cases observed statements typically refer rather to the portal as a whole than to single applications provided there. However, the examination reveals that users can not expect consistent support in identifying intended users and usage across applications. According to observed existence or absence of information regarding target user groups and objectives, three different groups of application were distinguished (table 2).

Table 2. Grouping according to observed statements on intended users and on objectives

	Users	Objectives	Applications
I	yes	yes	AdAt, IPCC-1..4, PCIC, SERV, WB-1, WB-2
II	no	yes	ADC-1, ADC-2, CCR, CW-1..3, GLO, IRI-1..4, NASA-EO, NEO, WeAD
III	no	no	AOC, CHM, NASA-CTM, NGeo, NPR, PIK-TE, ROL, UNEP, ZDF

Table 3. Assignment of observed terms within group I to user group categories

User group category	Terms (examples)	Applications
policy makers / governments	policy makers governmental organizations national, regional and local governments government national governments	AdAt, WB-1, WB-2 IPCC-1..4 AdAt PCIC SERV
researchers / academia	climate change researchers educators researchers universities	IPCC-1..4 IPCC-1..4 AdAt, PCIC SERV
unassigned	development practitioners project team members general public businesses donors industry private sector NGOs	WB-1, WB-2 WB-1, WB-2 IPCC-1..4 AdAt AdAt PCIC SERV IPCC-1..4, SERV

The first group (I) gathers applications where both information on target users and objectives could be found. E.g., applications from the IPCC Data Distribution Centre (IPCC-1..4) and from the World Bank Climate Change Portal (WB-1, WB-2) have been attributed to this group. The IPCC Data Distribution Centre states to have been "designed primarily for climate change researchers" but also for "educators, governmental and non-governmental organizations, and the general public" (http://www.ipcc-data.org/index.html). Similarly the World Bank Climate Change Portal refers to "policy makers and development practitioners" as main audiences (http://sdwebx.worldbank.org/climateportal/). In addition to information on intended users, statements on the objectives could also be derived. E.g., the stated objective of the IPCC Data Distribution Centre is to "facilitate the timely distribution of a consistent set of up-to-date scenarios of changes in climate and related environmental and socio-economic factors for use in climate impacts assessments" (http://www.ipcc-data.org/ddc_about.html), and the World Bank Climate Change Data Portal aims to provide "quick and readily accessible climate and climate-related data" (http://sdwebx.worldbank.org/climateportal/).

The second group (II) gathers applications where a broad definition on objectives was found but no information on intended users was detected. Examples for this group are applications from the International Research Institute for Climate and Society (IRI-1..4) where to "enhance society's ability to understand, anticipate and manage climate risk in order to improve human welfare" is stated to be the objective (http://portal.iri.columbia.edu/portal/server.pt). Another example is an application provided by the Center for Climatic Research (CCR) which aims at "promoting public understanding of climate-related issues, including global change" (http://ccr.aos.wisc.edu/about/).

Finally, the third group (III) is composed by applications which seem to state neither user groups nor objectives addressed.

Subsequently, we further investigated the first group of applications (the ones that provided information on intended users) for categories of users addressed. We perceived the existence of two major categories of stated users, 'policy makers / governments' and 'researchers / academia' (table 3). In fact, all applications of group I are present in the category 'policy makers / governments' and only two applications (WB-1, WB-2) have not been included also in the category 'researchers / academia'.

Note that these two categories were derived by aggregation and rephrasing of statements. For example, we gathered terms like 'researchers', 'universities' or 'educators' under a common category named 'researchers / academia'. A similar strategy was applied in the case of the category 'policy makers / governments' to subsume terms such as 'policy makers' or 'national, regional and local governments'. There were other intended users mentioned across applications, nevertheless, due to their heterogeneity, we could not formulate a clear category for their inclusion (see category 'unassigned' in table 3). To further elaborate these categories, a larger set of applications should be investigated.

4. OBSERVED EXAMPLES FOR EXTERNAL INCONSISTENCY

4.1 Users can not expect a consistent approach to specify content for maps.

The majority of the reviewed applications strive to integrate controls for content selection and the resulting map display into a user interface on a single web page. One example uses a separate web page for the selection of a variable and subsequently directs the user to a different page with the according map application, where temporal references can be selected (UNEP). Another example offers a multi-step wizard to pre-filter content to be displayed (AdAt). It is common for the observed applications to enable content selection based on familiar UI widgets (e.g., drop downs) that give an overview over selectable parameters and avoid syntactic input errors. Yet we could not observe a common approach in attributing subtasks - e.g., variable selection - to specific UI widgets. In the reviewed applications variable selection is offered as well via radio buttons (CW-1), checkboxes (WB-2), drop downs (IPCC-2), or lists (IPCC-1). Similarly, temporal references are specified using different widgets in different applications, e.g., together with selecting a variable using checkboxes (WB-2), together with selecting a variable using radio buttons (AdAt), using a combination of radio buttons and drop downs (e.g., CW-1), based on lists (IPCC-1) or on a set of drop downs (IPCC-2).

4.2 Users can not expect consistent positioning of content selection widgets.

Only two of the observed applications arrange controls for selecting content inside a map, either for the selection of a variable (WB-2) or of a different spatial context (NASA-CTM). It is fairly common to group the controls around the map, but the user should not expect to find controls at the same location across different applications. Basically there are four options for positioning controls around a map: above the map (A), below the map (B), to the left of the map (L) or to the right of the map (R). Within the sample we found various patterns in arranging controls around a map, including A; A+B; A+L; A+L+R; A+L; B+L; B+R; L; R. Similarly, UI widgets for subtasks are provided at different positions. E.g., variable selection is offered as well above the map (CW-1), to the right of the map (AdAt) or below the map (IPCC-1).

4.3 Users can not expect consistent labeling of content selection widgets.

The labeling of widgets applied for content selection was not found to be consistent over the reviewed applications. Observed strategies of attaching labels to widgets used for defining a temporal reference include 'time period' (CW-1), 'time' (IPCC-1), 'period' (IPCC-2), 'time slice' + 'season' (IPCC-4), 'define years' (UNEP), 'time slice' + 'time of year' (PCIC), 'time' + 'season' (CCR), or omitting such a label (GLO). Similarly, examples of strategies of attaching labels to the controls for selecting a variable include 'Climate Data' (WB-2), 'Measurement'

(CW-1), 'Field' (IPCC-1), 'Variable' (IPCC-2), 'Datasets' (NEO), or omitting such a label (IPCC-3).

4.4 Users can not expect a consistent strategy concerning immediate map update.

We could not observe a prevalent approach concerning the update of maps after applying a change in the parameters defining the content to be displayed. While several applications provide direct update (e.g., WB-2, CW-1, NEO, AdAt, IPCC-1, ZDF, AOC, ROL), others require a separate button to be pressed before a change is applied to the map (IPCC-2, IPCC-4, GLO, PCIC). Thus, users have to be aware whether an immediate update in the display is not occurring, e.g., due to a performance related delay, or because an explicit update request is required. The sample contains as well examples that support the user in this respect by providing related feedback (GLO), and others that do not (e.g., IPCC-2).

4.5 Users can not expect consistent access to and positioning of color legends.

Color legends, typically indispensable to interpret visualizations, are in most of the observed applications displayed automatically. However, one application in the sample requires the legend to be activated by the user first (WB-2), and in another it is available only after selecting a different tab rider in the control section (AdAt). A great variety can be found concerning the positioning of color legends. Depending on the application, color legends can be found inside the map, either on the left (WB-1, ROL), on the right (WB-2, ADC-1, ADC-2) or at the bottom (IPCC-2), as well as to the left of the map (ZDF), to the right of the map (CW-2, UNEP, NASA-EO) or below the map (IPCC-1, NEO, IRI-1, AOC).

4.6 Users can not expect consistent access to text depicting current map content.

The applications in the sample do not show a consistent approach on whether and where a short description depicting the content of the currently displayed map is provided. One approach observed is to completely omit additional text; the content of the visualization is then depicted solely by the selection status of the control widgets (IPCC-2, IRI-1, AdAt). One application uses a tabbed approach, allowing to access either the controls for content selection or the color legend; as a result the user can not view both parts of the required information at the same time (AdAt). Another approach found is to provide a subset of the text depicting the content within the color legend, so that required information is distributed over legend and parameter controls (WB-2). Finally, if explanatory text is provided, it is positioned differently in different applications: above the map (IPCC-4, UNEP, PCIC, AOC), below the map (NASA-EO, NEO, GLO, ADC-2), to the left of the map (CW-1, CW-3), as well as to the right of the map (CW-2, ZDF).

4.7 Users can not expect consistent zooming strategies.

Three different strategies towards zooming could be observed within our sample, namely (i) no support of zooming; (ii) zooming functionality by selecting from a set of maps for different spatial subsets, e.g., continents; and (iii) free zooming allowing a user-definable part of the current map to be displayed in greater detail. These strategies are not attributed to specific utilizations of maps. Instead, we found applications without support for zooming to be used as well for displaying the spatial distribution of data values (e.g., IPCC-2), for selecting spatial references to access time series (IPCC-3) or to provide access to additional information via clickable icons (PIK-TE). Similarly, support of free zooming is used as well with maps that display the spatial distribution of data values (IPCC-1, CW-1, CW-2, CW-3, WB-2), with maps used for time series selection (WB-1, IRI-2), and with maps providing clickable icons (CW-1, AOC, SERV, WeAD). Several examples in the sample adhere to strategy (ii) by providing a limited set of maps for predefined spatial subsets (e.g., PCIC, GLO, CHM, NPR, ZDF, NASA-CTM).

4.8 Users can not expect consistent interaction metaphors for free zooming.

Those applications that provide free zooming utilize a variety of interaction metaphors to this end, including scrolling the mouse wheel, dragging a slider, double-clicking a location in the map, or dragging a rubber band to specify a rectangular area on the map. Free text entry in coordinate boxes can be found as alternative or supplement to using a rubber band. In the considered applications, several different combinations of these zooming related interactions have been observed, including (i) double-click (WB-2); (ii) double-click + mouse wheel + slider (CW-1); (iii) double-click + mouse wheel + slider + rubber band + free coordinate entry (IPCC-1); (iv) double-click + rubber band (UNEP); (v) mouse wheel (WeAD); (vi) slider (AOC).

4.9 Users can not expect consistent spatial feedback.

Suited spatial feedback can aid the user in fulfilling tasks like zooming or selecting a spatial reference. Yet only a few of the considered applications provide direct feedback on the latitude (lat) and longitude (lon) coordinates relating to the current position of the mouse cursor over a map (cf. WB-1, WB-2, IPCC-1, CW-1). Even within this small group the coordinates are displayed at different locations: below the bottom right map corner (WB-1), in the bottom right corner of the map (WB-2, IPCC-1) or in the left bottom corner of the map (CW-1). The sequence of the displayed coordinates differs as well and is displayed either (from left to right) as lat / lon (WB-1, WB-2, CW-1) or as lon / lat (IPCC-1). Labels are used to indicate the coordinates in two of these applications (WB-1, CW-1) and omitted in the other two (IPCC-1, WB-2). Only one of the applications in the sample provides direct feedback on the name of the country at the mouse cursor position on the map (ADC-1), while different strategies are followed in displaying country names and country borders on the map. Some applications use semantic zoom to display country names and country borders after a certain zoom level is reached (e.g., WB-1, WB-2, CW-1, CW-2, WeAD). Other display only country borders (IRI-2, ADC-2, NASA-CTM) or only borders between land and sea (e.g., IPCC-1, IPCC-4, NGeo). A last group neither displays borders or country names on the map (cf. IPCC-2, NPR, AOC).

4.10 Users can not expect a consistent approach in accessing time series plots.

Only a subset of the considered applications support access to plots of geo referenced time series. Spatial references taken into account vary between applications and include grid cells (e.g., IPCC-3), stations (IRI-2) or administrative units like countries (GLO, CW-1) or districts (IRI-1). The spatial reference is selected either by clicking on the map to define a location (WB-1, IRI-1..4) or by defining a rectangular area by dragging a rubber band or typing coordinates (IPCC-3). One example displays a time series plot if the user has parameterized the map to show historical data and additionally selects to zoom to a country using a drop down (CW-1).

4.11 Users can not expect consistent configuring and display of time series plots.

Some applications in the sample provide plots of predefined time series that apparently can not be further parameterized (e.g., CW-1, IRI-3). Another example provides controls to specify a variable and a temporal reference after a location has been selected by clicking the map. The controls are made available below the map; the parameters have to be entered again after a new location is selected (WB-1). Another application provides controls to configure variable and temporal reference above the map; the user can change these parameters subsequently and press an update button to obtain a new plot, the location selection is preserved (IPCC-3). Yet another application provides controls to select different time series plots for a currently selected location within the popup that is used to display the time series plots (GLO). Finally, different strategies are applied in displaying a currently selected plot. Approaches cover the display of a small enlargeable plot inside the main GUI (CW-1), the use of popups (e.g., WB-1, IPCC-3, GLO), the display of plots below the map on the same web page (IRI-2) or by switching from the web page holding the map to a different web page displaying the time series plots (IRI-3).

4.12 Users can not expect a consistent usage of clickable icons.

12 of the considered applications use maps to provide the spatial context for clickable icons to access geo-referenced information. Depending on the application, this approach is used to give access to information on observed or projected impacts (CW-1, ADC-1, PIK-TE, CHM, AOC), on adaptation projects (WeAD, AdAt), on hazards like volcano alerts, earthquakes or fires (SERV), as well as to climate change related information (short texts or videos) from broadcasting companies (NPR, ZDF). Different types of icons are used in different applications, including small circles filled in different colors (PIK-TE, WeAD, AdAt, ZDF, NGeo), ring shaped icons (AOC) and pictograms (e.g., CW-1, CHM, SERV). In some of the applications a short additional text is displayed beneath the icons (WeAD, NGeo), and some use animated icons (NGeo, ZDF). Different strategies are applied to depict the meaning of the icons, ranging from apparently omitting explanations (CW-1), displaying a legend permanently below the map (PIK-TE) or providing a legend on demand inside the map (SERV), to explanations on a different web page (CHM). Another approach observed is to display the icon symbols on labeled widgets that are used to control the display. Such controls are used for different functionality, e.g., for enabling / disabling the display of all icons (CW-1) or of icons related to a specific theme (AOC), for highlighting icons related to a specific theme (ZDF, NGeo), or for zooming the map to a specific icon's location and displaying the according information (WeAD). All 12 applications provide direct feedback to indicate whether the mouse cursor is over a clickable icon. Again, different strategies can be observed, e.g., the use of tooltips (ADC-1, PIK-TE, ZDF, AdAt), changing the icon color (AOC), or changing the size of icon and related text (WeAD, NGeo). Almost all applications change the cursor symbol if being over a clickable icon; one application directly opens a popup when the cursor is moved over an icon (CW-1). The display of the selected information in a popup is common for most of the considered applications that use clickable icons. Observed exceptions are to trigger a page scroll to a related text section below the map (PIK-TE) or to hide the map and show the selected information instead (ZDF).

5. CONCLUSIONS

Our sample confirmed the impression that accessible climate change related content differs across applications. Additionally it showed that several applications seem to be considerably shy in indicating which users are addressed and which usage is intended. Thus it is likely that users will have to access more than one application in order to fulfill given informational needs. Typically, applications will have to be explored in some depth by the user to decide whether provided content and functionality meet these needs. Yet it showed that users, in order to do so, can not rely on consistency of user interfaces across applications.

Instead, the examination of our sample revealed a remarkably high level of external inconsistency even for fairly simple and common tasks like zooming a map or selecting the content to be displayed. External inconsistencies do not only occur across applications from different suppliers, but also show across different applications provided by the same organization. The observed facets of inconsistency relate on the one hand to action-effect inconsistencies - scrolling the mouse wheel might trigger map zooming in one application and a page scroll in another; double-clicking a map might result in map zooming in some applications, while it may lead to the selection of a location in others. On the other hand, observed external inconsistency can be attributed to task-action inconsistencies, i.e. different applications require the user to perform different actions in order to perform tasks like zooming, selecting content to be displayed on a map, or updating the map display.

Given the observed level of external inconsistency between applications we have to conclude a clear lack of conventions in the design of user interfaces to access information in the context of climate change. Although it was not the aim of this paper to examine the degree of how much this lack actually adds, e.g., to the workload and learning efforts of a user, we nevertheless would clearly judge the observed degree of user interface heterogeneity as being far from ideal. It is likely to induce annoying and tedious little errors when trying to fulfill common tasks using different applications, and to limit transfer of training. As a consequence users are forced to invest time on understanding and dealing with interaction specifics of applications, as well as on discovering whether a functionality is supported or not; instead this time could be better spent on exploring content and on satisfying actual information needs.

The observed lack in external consistency might be regarded as natural consequence of “local optimization” [Grudin 1989], resulting from autonomous development of applications by a variety of organizations. Content heterogeneity, which was not evaluated within this paper, is likely to add further and potentially more severe dimensions of inconsistency, e.g., relating to differences or redundancies in thematic aspects covered, as well as in levels of detail, structure, concepts, wording etc. Current developments like the decision to work towards a common framework for Climate Services (http://www.wmo.int/pages/mediacentre/press_releases/pr_861_en.html) might provide a useful step forward in this respect.

It remains an open question to what extend the observed level of external inconsistency actually influences, e.g., user performance, rate of errors and satisfaction. To this end further research will have to examine, e.g., who is actually using specific applications in the context of climate change information, what high level aims users are addressing, which combinations of applications are likely to be used intermittently, as well as the frequency of use of applications to distinguish between the need for ease of learning and for ease of use. Not least, given the central role of maps in this context, it should be explored to what extent the still evolving field of research concerning HCI and GIS (see, e.g., [Haklay and Zafiri 2008]) can contribute. User interfaces constitute one important dimension in the overall goal of improving access to information on climate change, and we should constantly take care that usability issues do not get into the way of the users addressed.

REFERENCES

Chimera, R., Shneiderman B. (1993) User interface consistency: an evaluation of original and revised interfaces for a videodisk library. In: Shneiderman B. (ed.). Sparks of Innovation in Human-Computer Interaction, Ablex Publ., Norwood, NJ, 1993

Grudin, J. (1989) The Case Against User Interface Consistency. Communications of the ACM, Vol. 32, No. 10, 1164-1173

Carter, T.R., La Rovere et al. (2001) Developing and Applying Scenarios. In IPCC, 2001: Climate Change 2001: Impacts, Adaptation, and Vulnerability. CUP, Cambridge, UK.

Haklay M., Zafiri A. (2008) Usability Engineering for GIS: Learning from a Screenshot. The Cartographic Journal Vol. 45 No. 2 pp. 87–97 Use and Users Special Issue, 2008

Kellogg, W. (1989) The Dimensions of Consistency. In: Nielsen, J. (ed.). Coordinating User Interfaces for Consistency, Academic Press, San Diego, 1989

Krug, S. (2006) Don’t make me think. New Riders, 2nd ed.

Monk, A. (2000) Noddy's guide to consistency. Interfaces, No. 45 Winter 2000, 4-7

Nakicenovic, N., Swart, R. (eds.) (2000) Emission Scenarios. Special Report. Cambridge, Cambridge University Press, 2000

Nielsen, J. (1989) Executive Summary: Coordinating User Interfaces for Consistency. In: Nielsen, J. (ed.). Coordinating User Interfaces for Consistency, Academic Press, San Diego, 1989

Pyla, P.S., Tungare, M., Pérez-Quinones M. (2006) Multiple user interfaces: Why consistency is not everything, and seamless task migration is key. Proceedings of the CHI 2006 Workshop on The Many Faces of Consistency in Cross-Platform Design

Randall, D.A., Wood R.A. et al. (2007) Climate Models and Their Evaluation. Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the IPCC, Cambridge, Cambridge University Press, 2007

Shneiderman, B. (1998) Designing the User Interface: Strategies for Effective Human-Computer-Interaction. Addison-Wesley, Reading, 3rd edition.