

Maretec Responsive (Re)Design

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Abstract - Over the years, the Internet has increasingly assumed an important role in the dissemination of all sorts of information. With the most recent technological development, emerged a whole set of devices with different dimensions, orientations and screen resolutions which allow the access to the Internet from anywhere. For that reason, it has become essential for websites to provide information in a suitable format for every device, in a responsive approach.

The Forecast MARETEC website was inadequate for most of the new devices, with poor presentation of the expected graphic results. The presented information incomprehensible in smaller devices. This work envisioned a redesign of the website in a way that adds responsivity to it.

Capitalizing on recent web tools and frameworks, the implemented solution was based on the type of information already available and on the structure of the previous solution. It created a base interface with a map adaptable to the screen, in which can be displayed map domains, stations, and all the other options, such as widgets or buttons that come up with dialogs or dropdowns. Not only result maps, but also charts are now adjustable according to the screen dimension and orientation.

Despite users being able to check effectively the information available in different devices, user testing has allowed to identify some problems that we present solutions.

Index Terms - MARETEC, responsivity, web development, environmental/meteorological information, maps, charts

INTRODUCTION AND CONTEXTUALIZATION

Over the last few years, the Internet has assumed a leading role in all areas of knowledge as a means of information disseminating. [1] This way, it is possible to have information carried all around the world for several uses, immediately after its production. Internet access is ever more generalized and there is an increasing diversity of content available. These facts facilitate the access to free information, as well as increasing personal knowledge.

Because of the Internet evolution, a lot of information started being available to unskilled users, so it has become imperative that information representation would be simple and understandable. Also, due to last technological developments, we have now an enormous number of devices that are used to access the Internet. These devices have different screen sizes, orientations and resolutions. This has contributed to increase even more the number of users that access the Internet all around the world. However, there is now an additional worry on Web Design: Web Designers need to consider how a website would look on different clients, and not how it would look on a desktop computer alone.

MOTIVATION

MARETEC, a laboratory of Instituto Superior Técnico that studies environmental systems, through a comprehensive approach to water, soil and atmosphere, has a website (Forecast) to present meteorological and environmental information. You can choose a variable to analyze over time, through maps about different geographic areas and charts regarding temporal series of stations in Portugal and Spain. However, this website was conceived considering only the desktop computer. So, trying to get a map or a chart on a mobile device with small dimensions became a truly hard task and, most of times, it was not even possible. The information was presented on a complex and deficient way. Moreover, some functionalities were not obvious even on a desktop computer.

MAIN GOAL

Given the above, the main goal of this work was to develop a solution for Forecast MARETEC that allowed to present the relevant information in a simple and effectively comprehensible way on all devices. So, it was important to consider that the approach to web design should take into consideration, not only the existence of a great variability of screen resolution and screen size of mobile devices (tablets, smartphones), so that the website content would readjust and remodel to different conditions, but also the existence of different types of interaction. To get that, we should take a bunch of new

techniques addressed by the Responsive Web Design (RWD) approach. [2]

Our new solution is called Maretec Responsive (Re)Design, since we wanted to design the Forecast MARETEC website in a different way, using a responsive approach.

RELATED WORK

We have searched for related previous works and examples of services that are already in use to find and analyze pros and cons of each solution. First, we selected two existent solutions – Marpocs and MetOceanView –, considering their functionalities and availability: it was important that solutions had similar functionality principles and common objectives to what we were working on. Second, we analyzed the previous solution for Forecast MARETEC, in terms of structure, data representation, positive aspects and problems.

I. Existent solutions

The analyzed solutions are both online platforms. Marpocs is a platform designed to integrate results of hindcast and forecast operational models, regarding different spatial domains: circulation, meteorology and waves. Its main purpose is to identify and control oil and other harmful chemicals leakages in high seas, over the Atlantic sub-region that includes Morocco, Madeira and the Canarias. The results can be shown either by charts about specific stations or maps. What distinguishes this website is its capability to make simulations about environmental incidents. MetOceanView also integrates and presents information of hindcast and forecast models. We can analyze different variables, over a map interface with tile layers containing the representation. Also, we have the possibility of getting an animation with the sequential presentation of results for different moments.

Marpocs website is consistent in terms of design: different pages have the same organization and a similar graphic aspect. There is a median approach to RWD as content adapts to fit mobile screens. However, it did not go further: it there was no effort to find the best way to present the content on smaller mobile devices. On the charts page, it can be complex to achieve the results you want, since charts are not represented on a single representation area: there are one for each variable and it is necessary to scroll to find the representation area you want. On the map page, on a small screen, all items, the display options and the map, which should be the central element of the page, are displayed in a single column. Therefore, the user is forced to scroll down and up to change the options and see the results on the map.

MetOceanView do not have a chart analysis section. In general, RWD is not a primary concern. There is no design consistency between Forecast models page and Hindcast models page, so they look completely different.

On Forecast models page, the content does not adapt to the view, so the elements look small and it is necessary to zoom over them. On Hindcast models page, the contents fit the device, but the different options are always visible on a section that takes up too much space, on smaller devices. Therefore, the map, which is the central element, do not have enough space. In terms of the interface, the analysis is positive, the layers over the maps leads to better visual results and allows a more in-depth analysis.

II. Forecast MARETEC previous solution

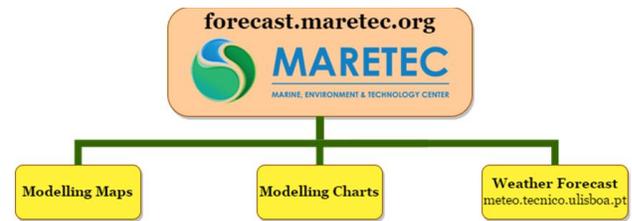


FIGURE 1. STRUCTURE OF FORECAST MARETEC WEBSITE

The basic structure of Forecast MARETEC website is presented on Figure 1. The Home page presents the contacts and the purposes of MARETEC group and three icons. Since there is no navigation bar, the user proceeds by selecting one of those icons that lead to the different pages. With the Modelling Maps page, we can obtain representations on map of images of the results of forecast models and history records, on different territorial areas of one of the spatial domains – Hydrodynamics, Waves or Watersheds –, of a selected variable. Modelling Charts was designed to present charts with the variation of one variable for up to four stations (land or water). Weather Forecast it is a different project, not considered with this approach.

There are lots of variables we can pick to analyze on maps or charts. The vast majority consists of scalars, but velocity variables vectors are also presented. Therefore, in maps, color is used to represents the value according to a scale, but, when velocity is also represented, the colored information is complemented with vector arrows representing direction. In charts, it is not possible to represent any vector information, since we just can have a scalar represented over the time.

Globally, as a positive aspect, the structure of the website was satisfactory, since different services were clearly separated. Also, the home page presents concise information and there's a minimal responsivity principle. Considering the actual results production process, the representation of information (domains and stations) over the map interface was also adequate. The charts interface already provided visually appealing and easily understandable results.

We have identified and analyzed several problems on the previous solution, but the main problem and the focus of the present work was the poor incorporation of the RWD approach. The Modelling Maps did consider the windows dimensions, but, on smaller devices, some items were cut off, since the only adaptation was the change column size according to the window width. On the Modelling Charts page, there was no adaptability and, consequently, the map, the results charts and other options do not fit properly when the screen dimensions are reduced, so that the interaction with the page and the analysis of any result became a difficult task. The Forecast MARETEC website also experienced a lack of design consistency, since the aspect and element organization were different from page to page. Additionally, we found there was an unclear interaction and unnecessary procedure, with some aspects, such as station and domain selection.

III. Summary

The RWD approach it is not just about adjusting contents dimensions. It is necessary to study the roles of the different items, their importance and then which should be the best layout and the best way to make certain types of information to be displayed. Even the solutions that used RWD, did not consider items size variation, visibility and layout, when the space available is limited. The map is a crucial element, in any of the solutions is presented properly on small devices.

CONTEXTUAL ANALYSIS

It was essential to do a pre-analysis associated to an adequate research plan, before we proceeded to the design. Thus, we tried to understand user requirements, since it is critical to the success of interactive systems [3].

I. Users and devices

The users targeted by this solution are all that are interested in meteorological and environmental information. Every common user should be capable to use our solution, but, since most of subjects are not comprehensible to the common user, it is expected that the majority are specialized users acquainted with the theme, such as environmental managers, users that perform activities at sea, and farmers.

This work did not try to address a solution for a specific device, rather it tries to find a way to provide an efficient website on multiple devices. So, it is important to stress that the solution could not be operating system, browser or device dependent.

II. Requirements

From the previous analysis, we tried to understand system functionality and user needs, along with some

knowledge about problem domain, since we needed to be able to specify correct requirements [4].

At a global level, we considered that the website should have a common design for all pages, that included:

- The logotype of MARETEC group must be always visible.
- A navigation bar should be always visible on top.
- The navigation bar should be collapsible on small devices.
- The navigation bar should provide structural navigation.
- There should be a language selector.
- It should be possible to add new languages regardless of the internal structure.
- It should be possible to make persistent the language preferences.

For pages with a map interface, we considered that:

- The map should adapt to different device dimensions.
- It should be possible to select between different map imagery sets.
- It should be possible to add new map imagery sets regardless of the internal structure.
- It should be possible to make map imagery set preferences persistent.
- The information (domains or stations) should show over a map.
- It should be possible to refocus on all the information shown (domains and stations).

For the home page:

- All items should adapt to different device dimensions.
- The navigation icons should be resized and disposed accordingly to different device dimensions.
- The section of the information about purposes and contacts from the original website should be kept.

For the Modelling Maps page:

- All items should adapt to different device dimension.
- It should be possible to temporarily deactivate a domain, without eliminating its information.
- After clicking on a geographic domain, the new page should open immediately with its results.

For the Maps Results Display page:

- Map result images should be displayed occupying the maximum space available on the screen.
- It should be possible to add or modify domain's information regardless of the internal structure.

- There should be a calendar item to pick the time to show.
- It should be always possible to select and modify the variable to be shown.
- The page should provide access to the data catalog.
- Controls to go forward or backward an hour or a day should be available.
- It should be possible to start an animation of the maps results.
- A mechanism to zoom in should be present.

For the Modelling Charts page:

- After clicking a station, it should be immediately selected.
- Selected stations should show with a different color.
- The maximum number of simultaneously selected stations should be 6.
- It should be possible to deselect one single selected station by clicking on it.
- It should be possible to deselect all stations simultaneously.
- It should be possible to access different information (coordinates, domain, model, etc.) for each station.
- There should be two calendar items to pick the start and end dates of the results to show on charts.
- After station selection, it should be possible to choose the variable and generate the chart accordingly.
- Charts representation should adapt to different device characteristics.
- When space is available, the information about data source should be visible alongside the chart otherwise it should be accessible from the chart.

ARCHITECTURE

To describe the solution architecture, we defined the different components and presented the established relationships and interactions with other components or information sources. We kept, as far as possible, the architecture, since it was not our focus and that, considering the intended results, the previous solution structure was acceptable. There was no modification of the external interactions. Nevertheless, we needed to consider and establish new relationships to support some of the new functionalities: obtaining data about available languages, navigation bar elements, several pages elements and some map tiles providers.

Some of the relationships, as request-response flow, are common to many or all pages, but others are page specific. We present the different cases below. In general, data are requested to the Forecast MARETEC server. If this data is not available and needs to be obtained, a

request is made to other servers by Forecast MARETEC. After obtaining this data, it is provided to the client to be presented.

At a global level, the existing data flows between the client and the Forecast MARETEC server is intended to obtain:

- available language data;
- pages items/elements, in different languages;
- navigation bar elements.

For the pages with a map interface (Modelling Maps and Modelling Charts), the existing data flows between the client and the Forecast MARETEC server is intended to obtain data from map tiles providers.

For the Modelling Maps page, it is also needed to obtain domains data and, in the Map Results Display page, we needed to obtain not only domains data but also available variables and the map results images that are located on other server.

On the Modelling Charts page, there are other data requests-responses:

- stations data;
- all variables and properties representation information;
- available variables for each station data;
- chart generation and CSV download data.

To provide the two last, Forecast MARETEC needs to obtain data from a data server and format it properly.

TECHNOLOGIES AND TOOLS

The technology is considered a foundation for aesthetic experiences and aesthetics play an important role in supporting the content and the functionality and in appealing to the taste of the target users [5]. To provide a better experience using the new solution, we searched and analyzed the related technology that we would then employ.

Since we wanted to incorporate the RWD approach, granting that the content must adapt to fit different screens, we started by searching the basic techniques to apply responsivity: media queries and screen resolution – CSS rules let apply certain property only if some screen resolution and dimensions conditions are true –, flexible images and media – images or media in a webpage will automatically resize or crop – and fluid grid layouts – specifying percentage-based dimensions to a web page grid allows readjustment according current viewing size. [2] RWD only needs HTML and CSS. There are some frameworks to encapsulate the use of these techniques and other aspects. Two of the most common frameworks are Bootstrap and Foundation. Both frameworks are completely responsive, providing also multiple components (grids, alerts, buttons, menus and navigation bars, dropdowns, modals, or slideshows/carousels) that work on a great variety of screens and devices. Also,

they're both being constantly updated. However, Bootstrap maintains a massive community support and there are more tutorials and more information about it (<https://blog.templatetoaster.com/bootstrap-vs-foundation>).

Technologies like JavaScript became more and more important on web design as they support interactive web pages. A library can be considered a closed functional package that is personalized to provide a solution for a specific problem. A plugin, on a smaller scale, adds a specific feature, extending the functionality of a bigger application or element. Since we needed to support some additional functionality, we used some libraries and plugins that we present below:

- Leaflet (library for map-based websites). It is designed to build web applications based on maps. Besides being one of the most used, it is also light, easy-to-use and its code is easily legible. We can add different imagery set tile layers and display various items (figures, markers, images) with layers. It is also possible to display information under popups and tooltips. The documentation is quite complete and understandable. We also analyzed OpenLayers, but since it is more complex, the previous solution already used Leaflet and the OpenLayers documentation is more difficult to use, we did not use it.
- Tempus Dominus (plugin for date/time selector). It presents a date/time selector widget perfectly integrable with Bootstrap 4. By clicking on a button, a calendar is shown, and we can pick date and time. It is possible to change the date/time format and the default date, and we can define the date/time range. It is easy to implement a widget and the documentation is complete.
- Drift. It is a simple, lightweight, no-dependencies JavaScript "zoom on hover" tool for images. It is possible to zoom over an image making the zoomed area appear in other section or in magnifier-like element over the image.
- Touch-enabled Image Zoom. It is a simple and multiplatform library that provides the enlargement of images. The main functionalities consist on zoom with single and double click/tap, and to zoom in/out with mouse wheel or touch swipe and pinch. The advantage of this library is that lets zoom on an image without affecting any other page contents, even in touch devices.

To develop, verify and test a solution we needed tools that make it possible to incorporate those technologies. Since we designed the new website using only HTML5, JavaScript, CSS3, and some of the mentioned frameworks, there was no need to use any IDE or other specific tools. Thus, the main tool we used was a text editor: we choose Notepad++. To test how our work was

going on, we used several browsers – Google Chrome, Mozilla Firefox, Opera and Safari – on different devices.

SOLUTION

The implementation of the solution could only come after understanding problems and user needs. Before we proceeded, we elaborated some low-fidelity non-functional prototypes based on some of the pre-specified requirements. With this method, we could sketch the first needs, with a paper outline of what later constituted the website. Paper prototyping is also a form of participatory design that allows other intervenients to become part of the design process. [6] That's the way we involved MARETEC group and it was important, since it allowed us to refine requirements and identify further needs.

Since our solution would not develop from scratch, these first prototypes considered the structure, some functional and representational aspects from the previous solution. In paper prototypes, we presented the first outline of how different items should be presented and adapted.

After some development stages, we obtained the solution that we present below.

At a global level:

- Barrier of separation between content and the internal structure. We chose JSON format to keep externally the information that can be loaded on pages. This way, adding, removing or modifying some items is made by a JSON file modification and not in the code itself.
- Navigation bar. We used navbar component to help us providing a responsive navbar. (Figure 2)

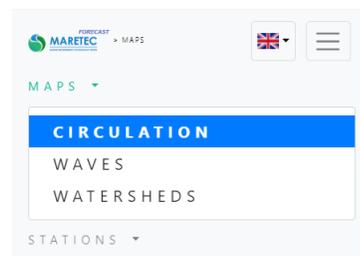


FIGURE 2. NAVIGATION BAR ON A MOBILE DEVICE

- Multilanguage support. We added this functionality providing a selector in the navigation bar. (Figure 3) Selecting a different language triggers an event to proceed with the translation of the different items.



FIGURE 3. LANGUAGE SELECTOR

For pages with a map interface:



FIGURE 4. MODELLING MAPS PAGE ON A MOBILE DEVICE

- The map interface adapts itself to the screen dimensions. (Figure 4)
- Map controls. There are controls to modify the zoom level, to refocus the map to the level where you can see all the information, and to geolocate. (Figure 4)
- Selection between different map imagery sets. There is a button over the map that shows all the imagery sets available and let us to select what we want. (Figure 5) The map automatically changes its look accordingly.

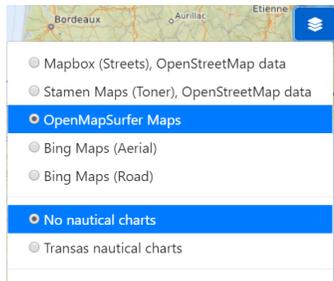


FIGURE 5. MAP IMAGERY SET SELECTION

The home page has a structure similar to the previous one. The elements are the same, but we tried to improve page presentation and layout with new visual elements. The actual home page adapts correctly.



FIGURE 6. HOME PAGE ON A PC, WITH A SMALL WINDOW WIDTH VIEW

On the Modelling Maps page, we represented the domains similarly (Figure 4).

For Map Results Display page:

- The map result images adapt to the screen dimensions. (Figure 7)
- Map result images zoom. To address this, we implemented two functionalities that do not affect any other page contents. It is possible to zoom in/out on images with mouse wheel or touch swipe and pinch. It is also possible to activate a magnifier-like element to zoom on some details (Figure 7).

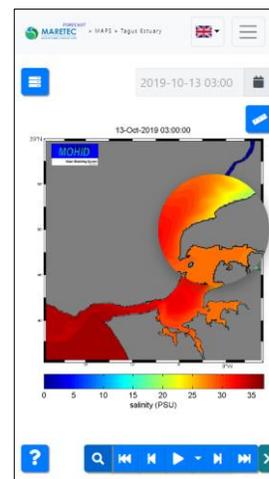


FIGURE 7. MAPS RESULTS DISPLAY PAGE ON A MOBILE DEVICE

- Maps results controls. There are buttons to forward one hour, to backward one hour, to forward one day and to backward one day. It is also possible start an animation of the map results and select the step. (Figure 7, on the bottom right).
- Access to the data catalog is provided by a button on the top left.
- Calendar – date and time picker. We provided this element, in order to select a specific time to show results. (Figure 8)

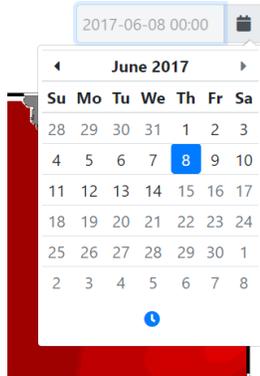


FIGURE 8. DATE AND TIME PICKER

- Variable selection is provided by a button that shows the available variables for current domain (Figure 9). The image updates automatically.

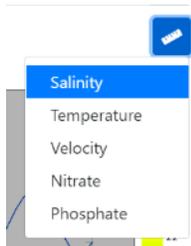


FIGURE 9. VARIABLE SELECTION

On the Modelling Charts page, we represented the stations similarly.

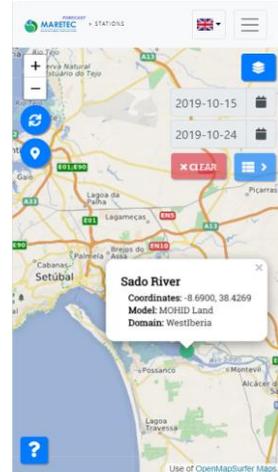


FIGURE 10. MODELLING CHARTS PAGE ON A MOBILE DEVICE

For Modelling Charts page:

- It is possible to access stations different information (Figure 10) by long pressing (touch devices) or right clicking on them.
- With two date pickers (like the one in Figure 8) over the map on the top left, we can pick the start and end dates of the results to show on charts.
- There is a button above the date pickers that deselects all stations.

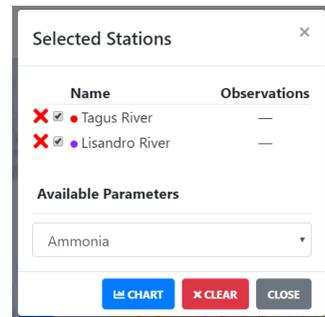


FIGURE 11. SELECTED STATIONS MODAL DIALOG

- The Selected Stations modal dialog is accessed by a button above the date pickers. We can select the variable to analyze on charts, inhibit results or remove any of the selected stations. We can also ask for chart generation, regarding current choices. (Figure 11)
- The chart modal dialog appears after chart data obtaining. Chart adapts correctly. On larger screens, chart data source appears next to the chart. (Figure 12) Although, on smaller screens, the chart occupies the whole area and data source can be accessed by a button that there is on the bottom right.

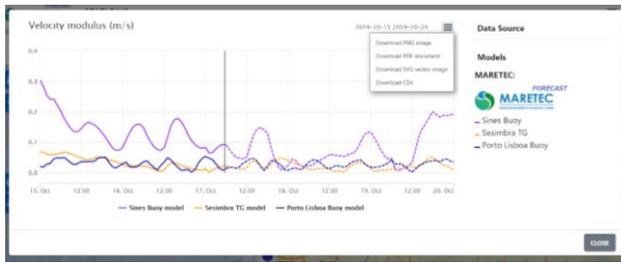


FIGURE 12. CHART AND DATA SOURCE MODAL DIALOG

- Chart and data download. It is possible to download chart in PNG, PDF and SVG formats, with a button on the chart top right. (Figure 12) We can also download the corresponding data in CSV format by providing some information (name, email, organization and purpose of download).

In order to preserve the information about preferred language and map imagery sets, we used cookies. This way, user choices can be presented whenever a user browses the website again.

EVALUATION

We evaluated our solution with usability testing, where users are asked to perform certain tasks on a system/site to measure its ease-of-use, work time, and the user's perception of the experience [7]. This way, we could understand how users would use our interface in a real context. To standardize the procedure and the evaluation methodology, we developed a protocol that was followed every test session. The protocol ensured that all users performed the same tasks, under the same conditions and with access to the same information and previous instructions. The protocol script presented the solution, its purposes and the basics of its structure and functionality, to familiarize users without previous knowledge on the topic.

We used a pre-questionnaire, to obtain the user's profile in terms of demographic information and prior knowledge about Forecast MARETEC. Then, we contextualized the use of the interface by presenting some scenarios. Before the presentation of the tasks to perform, we allowed users to explore the interface for a few minutes.

The nine tasks were divided into two sets. The first with seven tasks was intended to evaluate functionality and interactivity of the website, in global terms. The second with two, in addition to the first, was intended to assess the interface's ease of use, contextualizing responsivity. For each task, we collected time taken to complete the task, number of errors, and a user satisfaction grade. Thereafter, we discussed with the user

the solution, difficulties and experienced problems. The data collected was statistically treated, in order to evaluate the performance of our solution and user satisfaction.

In the course of each test, we've appreciated users' learning. Some users experienced some difficulties on completing some tasks, but some of them said that that fact had to be with lack of experience for being the first time and that they had not yet assimilated some concepts that they did not know. Nevertheless, we considered all the observed problems, since they should be analyzed and addressed in the future, in order to solve them, if necessary:

- It was not clear to several users that on the Modeling Maps page, to select a different spatial domain, the menu needs to be used. However, it was sometimes mentioned that the mistakes were due to the forgetting the need to choose the spatial domain. Alternative: menu dropdown expands when the page is opened or add an item over the map to select domain.
- Access to the data catalog was found to be a feature not well understood by many users, since they did not remember what it refers to because it is intended primarily for the expert user. Alternative: add the designation to button with words.
- There is a minor inconsistency between the menu items on the home page and the menu items on the other pages. On home page there is Modelling Maps and Modelling Charts and on others the reference is Maps and Stations.
- Some users have found that the way to access various station information – using the right mouse button on PCs and long touch on touch devices – are not clear. Although, some users considered that this is possible the best way to present this information, and that learning once is enough for future uses. Alternative: tooltip with information when covering the point over a station.

In general, users felt more comfortable performing stations and charts tasks, so, as future work, it is important to improve the production and representation method of Modelling Maps, as we will see later. The most complex tasks were performed with greater difficulty, but there were users who completed all tasks without a single error.

CONCLUSIONS

With the present work, the main problems initially presented were solved. The conception of this solution started from pre-established objectives; however, it was the different analysis that allowed the identification of the unsolved problems. The study of related solutions allowed us to learn the pros and cons of several solutions. We

observed that RWD was not a priority in many. In order to specify concise requirements about what the system had to accomplish, it was important to understand existing needs. With requirements in mind, we could design and implement the present solution, along with a constant analysis of appropriate technologies.

We tried to keep the structure of the previous solution. This way, users that already used it could be more comfortable with the new one, once they will recognize some navigational, representational and functional aspects that are acceptable, considering actual objectives.

In general, this work fulfilled the main objectives of the proposal: the Forecast MARETEC website was subjected to a redesign that allowed it to become responsive, adapting itself and all elements and results to different views and devices; we add a responsive navigation bar; on pages with a map interface, the map filled now the screen; there are buttons that refer to responsive modal dialogs with different options and dropdowns. With this solution, we also considered other problems: lack of design consistency and unclear interaction aspects.

The evaluation process was relevant to understand if our system was usable. Certain users had some difficulties on completing particular tasks, but some consider that this had to do with non-familiarization with the interface and concepts.

FUTURE WORK

Despite what we observed, this work is not finished. There are relevant aspects to address in the future, since there are possible improvements that can be considered and an integration with work running in parallel to carry out. On the other hand, technology is constantly changing, and new devices and tools will emerge. Some examples of possible future work involving our solution are:

- Since the map results production process mostly generates low resolution images that may not allow a satisfactory analysis and, considering actual possibilities, the implemented zoom tools are not enough to adequate these results, and it is important to develop a solution to be integrated on the current work that allows to represent on a single map interface, the information regarding the analysis of the different variables, in layers generated from raw data.
- Once some of the webpages content information is defined and maintained in JSON format to preserve a barrier of separation between content and the internal structure, it would be interesting to work on an interactive content management application that would let add, remove and modify elements, and dynamically generate JSON responses.

- To obtain charts data, sometimes the server response is incomplete, empty, or slow. We should analyze server-side structure and work and improve it.
- The present work on Forecast MARETEC should be articulated with the remaining MARETEC structure, in order to be extended and address solutions for all websites.
- It is important to incorporate analytics, in order to obtain not only demographic and statistical results but also information about how users interact with the website.
- Lastly, it is important to consider the problems identified by the evaluation process: domain selection option, inconsistency between home page and other page navigation bar items, and how to access information for each station.

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