Response Geospatial Office: Upgrade for the Remote Sensing Resources Page

Abstract

The Federal Emergency Management Agency (FEMA) recently developed a Remote Sensing Resources webpage to display aerial imagery after disasters. Data on the page was scattered through many sections and prevented users from efficiently retrieving target information. The project goal was to redesign the Remote Sensing Resources page by improving its navigation and content delivery. To accomplish this goal, the team interviewed FEMA employees and partners to identify web page users and establish their needs. Using interview feedback, the team organized page sections, embedded content, and external resources using a content map. The team translated the content map into an HTML visual draft. In addition to the redesign, the team provided FEMA with a list of recommendations to assist in future page maintenance.

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WPI

Making Critical Decisions Using Remote Sensing Technology

The United States Federal Emergency Management Agency (FEMA) has adopted aerial imagery and other remote sensing technologies to gather important disaster information. In recent years, remote sensing has evolved into a key tool for decision-making within FEMA. In modern society, a variety of situations require remote sensing. For example, remote sensing assists with forest fire management. Rangers see a much larger area when forest fires are mapped from space rather than from the ground[1]. In addition, remote sensing data helps in coastal erosion prevention[2]. Specifically, FEMA uses remote sensing during disasters to make effective response and recovery decisions. Remote sensing is critical for FEMA to gather information about the area that is affected by the disaster. In addition, remote sensing helps FEMA gauge the severity of the post-disaster damage[3].

Online data archives and websites contain most of the current remote sensing imagery. In the last decade, FEMA has developed many resources for emergency responders such as lifeline dashboards and incident journals. One example is the FEMA Response Geospatial Office's (RGO) Remote Sensing Hub webpage. The RGO developed the initial page as an archive for remotely sensed data. A surplus of data, however, prevented users from easily locating information. The RGO intended to develop the Remote Sensing Hub page into a centralized place for emergency managers to access the imagery. However, the site needed better structure and navigation tools to embody the RGO's vision. In this project, the team redesigned the remote sensing page to enable users to find information more easily.

The plan to redesign the RGO's Remote Sensing Hub page consisted of four steps: 1) identify the consumers/users of the page; 2) gather a list of consumer requirements/needs; 3) compile guidelines for website redesign through a review of existing high-quality imagery archive websites; and 4) design a draft "mock-up" version of the remote sensing page. The team completed these four objectives in order to improve the RGO's Remote Sensing Hub webpage.

Remote Sensing: Remote Sensing Technologies

Remote sensing is the acquisition of data from a distance[4]. It encompasses a wide range of different data sources and methods of collection. Remote sensing technologies are used to detect various forms of electromagnetic radiation, ranging from radio waves, to microwaves, X-rays and gamma rays. The visible light spectrum (all light that is observable to the human eye) is also a form of electromagnetic radiation. All forms of EM radiation can be recorded with a wide range of different sensors. Recording visible light was the first form of remote sensing to be used, in the form of aerial imagery, captured from a plane, helicopter, drone, or satellite. These images can help organizations like the Federal Emergency Management Agency (FEMA) to create maps of damaged areas after a disaster and make decisions based on analysis of the images. However, aerial imagery is constrained to only being able to capture two dimensional images during relatively clear weather.

In situations where aerial imagery cannot be collected, other sensors must be used. Synthetic Aperture Radar (SAR) sensors can be used when aerial imagery cannot be collected due to cloud cover. While RADAR uses a single radio wave to detect a single target, SAR uses pulses of radio waves to cover an entire target area. Pulses are then echoed back to the SAR antenna, providing information on distance and layout of the ground below. This process can be done through cloud cover, and can produce two dimensional or three dimensional images of the landscape below. SAR also allows collection of data about material on the ground. For example, agencies like FEMA use the data to determine where flooding has occurred.

Light Detection and Ranging (LIDAR) sensors are another way data is gathered remotely. Using a similar method to SAR, LIDAR relies on the use of lasers to gather information on the ground below the sensor. Photons in the form of a pulsed laser measure variable distances to the Earth. These light pulses, in combination with GPS and other on-board systems generate precise, three-dimensional information about the shape of the Earth and its surface characteristics, as seen in Figure 1[5]. These different types of remotely sensed data are analyzed and disseminated for an abundance of uses in the world today.

Remote sensing allows an observer to analyze an object without coming in direct contact with it. Remote sensing is powerful because the remotely sensed data gets collected from a wide variety of resources, such as a satellite or from an airplane. There are two types of remote sensing: active remote sensing and passive remote sensing. Active remote sensing, including SAR and LIDAR, has a beam energy source that comes from the aircraft. However, passive remote sensing, such as photography, detects energy from other objects in the environment that is reflected by the target or energy that is released by the target itself[6].

Uses for Remote Sensing

There are many ways to manage and use remote sensing data. One example is Geographic Information System (GIS) remote sensing. GIS is a system that collects, manages, and displays geospatial data. With GIS remote sensing, the remote sensing technology and GIS join forces to collect, store, and visualize data from any position around the globe. Another use of remote sensing is with agriculture. Specifically, irrigation management and monitoring take place using remote sensing technology. A third use of remote sensing is an assessment of the weather. For instance, doppler radar measures the precipitation severity, precipitation location, wind speed, and wind direction during a major weather event. Remote sensing also focuses on the development of volcanoes. Different kinds of satellites use remote sensing to monitor erupting volcanoes. Remote sensing helps to predict a landslide with the use of Synthetic Aperture Radar (SAR). Remote sensing satellites provide helpful information and imagery for emergency rescue workers to identify the amount of damage after an earthquake.

Companies have specific uses for remote sensing[7]. One company that uses remote sensing is Orbital Insight, a Fortune 500 geospatial analytics company in California. Specifically, Orbital Insight's GO platform uses different types of remote sensing technologies such as satellite imagery and SAR data to answer questions about economic, social, and environmental trends. Stantec, an international professional services company focused on engineering design, also uses remote sensing. Remote sensing analysts at Stantec collaborate with environmental specialists to utilize different remote sensing technologies. These technologies include unmanned aerial systems (UAS), photogrammetry, LIDAR, underwater acoustics, and satellite imagery. The data collected from these technologies is converted to information used in emergency decision-making[8]. FEMA uses remote sensing imagery during disasters to make effective response and recovery decisions. Remote sensing is critical for FEMA to identify the area that is affected by a disaster. In addition, remote sensing helps FEMA gauge the severity of the post-disaster damage[9].

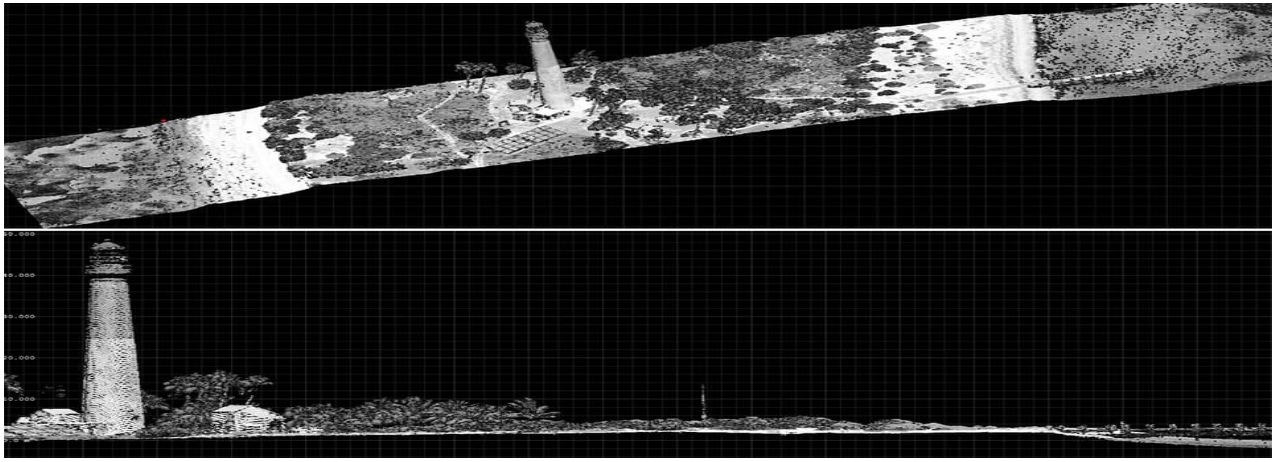


Figure 1. Lidar data collected using NOAA survey aircraft reveals a top down and side view of Loggerhead Key Lighthouse, Dry Tortugas Florida.

FEMA's Remote Sensing Hub Page

In early 2020, the Response Geospatial Office (RGO) created a website, the Remote Sensing Resource page, to host all the remotely sensed imagery collected by the agency. The page contains multiple sections dedicated to the different forms of imagery and resources available to the public. Currently, the main form of imagery is the post-event maps from recent hurricanes and other natural disasters. Data for each event is displayed as cards with multiple links for the different maps and images. The other resources are links with more information about the technology used in collecting remotely sensed data. Also, the website hosts numerous links to FEMA's imagery suppliers and other supplementary material. The page features educational information based on the latest technologies available. Most of these products are built through the Environmental Systems Research Institute's (Esri) ArcGIS software. Esri is an international supplier of GIS software and a partner of FEMA. The ArcGIS software is used to host the Remote Sensing page and to make Story Maps. Story Maps are interactive pages containing maps, description text, images, and other types of visuals. They are placed in the Remote Sensing page as embedded content.

There are multiple sections on the website dedicated to displaying the technology used to collect data[10]. However, the abundance of data has made the page difficult to navigate. Adding information without carefully meeting the needs of the users caused the navigation to be confusing and inconsistent. Specifically, some hurricane events have disorganized information that keeps the user on the current page. However, other events take the user to a different page.

The amount of data presented on the resource page is expansive and overwhelming to site visitors. As mentioned above, there are numerous links and resources available for a user to browse through. The abundance of links and information on the current page is not intuitive for any of the users. The navigation of the site is muddled, and users are unable to locate what they need quickly and efficiently. This leads to a lack of user engagement on the site, as a user is more likely to use a more organized site[11]. The amount of information present on the site changed the objective of the page. Every section of the website offers a different resource. The unique resources in each section leads to confusion about the page's focus. The overflow of data on the site has reduced efficiency for the user. The goal of this project is to make improvements to the content distribution and site navigation. To accomplish this, the team researched the fundamentals of web design to make improvements to the Remote Sensing page.

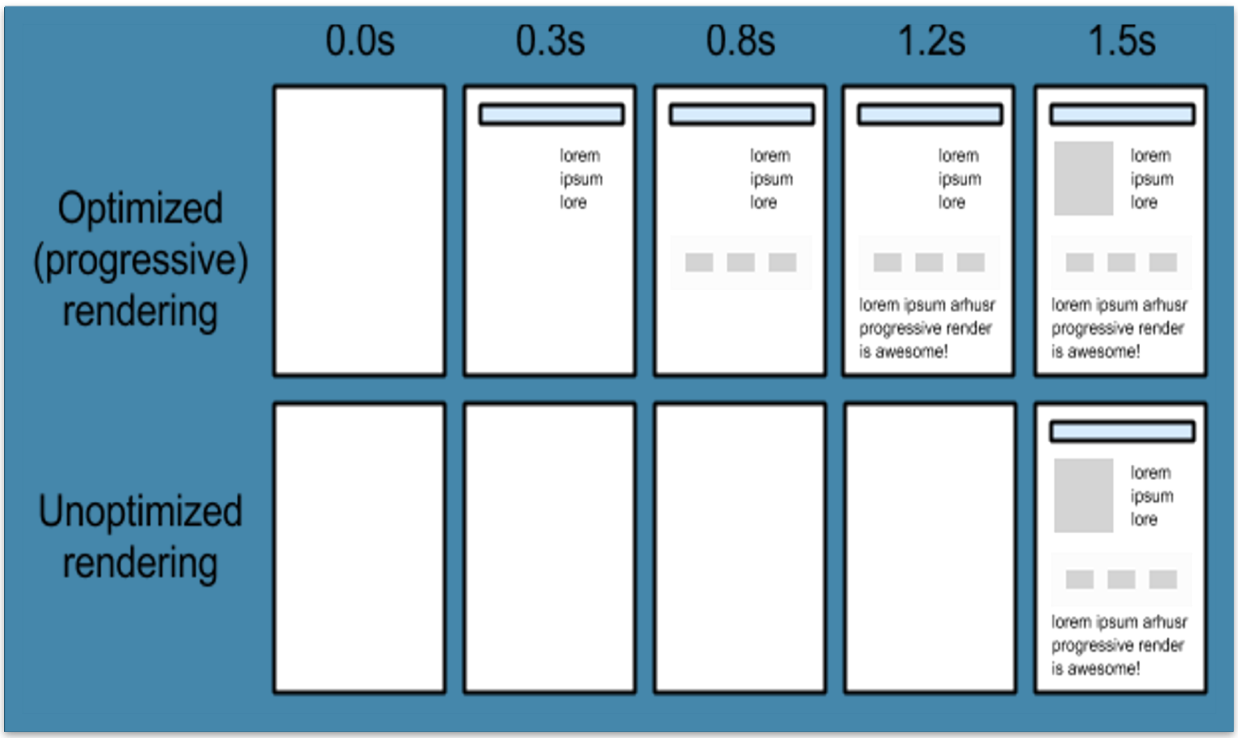


Figure 2: Critical Rendering Path - Optimized rendering vs Unoptimized rendering

Web Design Fundamentals

To make substantial improvements to the website, the team researched the fundamentals of web design. According to Google LLC's web development fundamentals, high-quality websites are fast, integrated, reliable, and engaging[12]. Each of these principles progresses the website towards an efficient and streamlined enjoyable user experience.

Fast websites offer easy navigation and optimized loading. Simple navigation contains clean menus, clear divider names, and convenient links. To ergonomically organize the page, the developer must divide the menus into logical sections with distinct names; this facilitates users' navigation of the website. Within these menus, an evenly distributed network of links helps users navigate to their target destination page. Besides page ergonomics, the website must load quickly and without lag. Good web design principles enforce the critical rendering path method, shown in Figure 2. The figure illustrates the browser's priority for loading elements into the webpage.

The critical rendering path method, or progressive rendering, provides a better user experience. Interactive elements and large images greatly increase the initial loading time when a user first opens a webpage. Progressive rendering significantly improves the browser's loading time. The elements on the site load in stages to reduce the waiting time for the user. Smooth transitions between pages, inconspicuous loading stages, delay reduction, and streamlined navigation are key components of a fast website.

Website integrability is another pillar of web design fundamentals. Compatibility between browser, device, and website is definitively the most important aspect of any website. If the device or browser cannot display the webpage correctly, the contents of the webpage do not matter. A high-quality site supports different aspect ratios for both mobile devices and computers. Furthermore, well-integrated websites must contain themes and palettes to smoothly blend the page content elements into the body of the webpage.

Website reliability consists of maintenance capacity and error containment. Reliability defines the users' perception of the developers. If the site fails to meet the customers' standards for consistent operation, the users will look to an alternate, more reliable website. Websites riddled with bugs and errors discourage users from continuing to use or returning to the site.

Lastly, the websites must engage the user. Elements on the page must contain interactive content and appealing aesthetics. Within the category of interactive content exist subcategories of applets and responsive elements. Specifically, for a page like the Remote Sensing Hub page, the "high-tech" style[13] correctly describes the goal of the developers. Informative graphics, animation, applets, iframes (embedded content), and interactive media flourish and enable the user to better absorb the content displayed on the page.

For further exploration, the team analyzed NASA's disaster report webpage[14]. The RGO hub site developers recommended this site because it follows good web design fundamentals. This team reviewed the NASA disaster website against the Association for Computing Machinery (ACM) Web Design Standards[15].

The RGO envisioned the Remote Sensing Hub page as a centralized place for emergency managers to access imagery and as an educational resource for remote sensing technology. The four pillars of website design fundamentals contributed greatly to the development of the redesigned hub site. The navigation tools and the organization of the site content were restructured based on the customers and the customer needs assessment.

Assessing the Existing Remote Sensing Resources Page

For this project, the team was tasked with creating a new design for the Remote Sensing (RS) Resources page. To determine improvements for a redesigned page, the team assessed the existing RS page. For this assessment the team used criteria based on the principles of good web design discussed in the previous section. Also, the team gathered information about the status of the existing page during their interviews with FEMA employees. According to our sponsor, Katie Picchione, the page was first assembled as a Civil Air Patrol (CAP) 3D imagery repository. This information needed to be made available to both emergency managers and GIS specialists. The Response Geospatial Office included other sections alongside the imagery repository, including partner resources (other than CAP) and information about supporting technology for remote sensing.

FEMA dealt with many disasters since the site's creation which led to an influx of imagery being added to the site. The remote sensing resources page became a conglomeration of all RS data on recent disasters. The sheer amount of data caused a disadvantage for users because important content became hidden on the page. As new material was added, older material was pushed further down the page. The amount of content made it difficult to find important information. The existing RS resources page includes a total of eleven different section headings. Some of these headings are unnecessary, because many of them can be combined. While the page contains essential content like the Potential Product Types and Applications table, it retains an equal amount of unnecessary content like the Crowdsourced Photo Resources. The Potential Product Types and Application table contains information about FEMA Products' uses and applications for different disasters. In contrast, the Crowdsourced Photo Resources belong on a different location within the webpage, such as the contribute tab. With so much excess content, the page cannot effectively display information. Effective web pages have to be concise.

The team mapped out the content on the existing Remote Sensing page (Figure 3). By mapping out the content, the team made a diagram of the current sections of the existing page. In these sections, the team also identified the links and whether they took the user to another page.

"The page should connect customer to product efficiently."

— Chris Vaughn

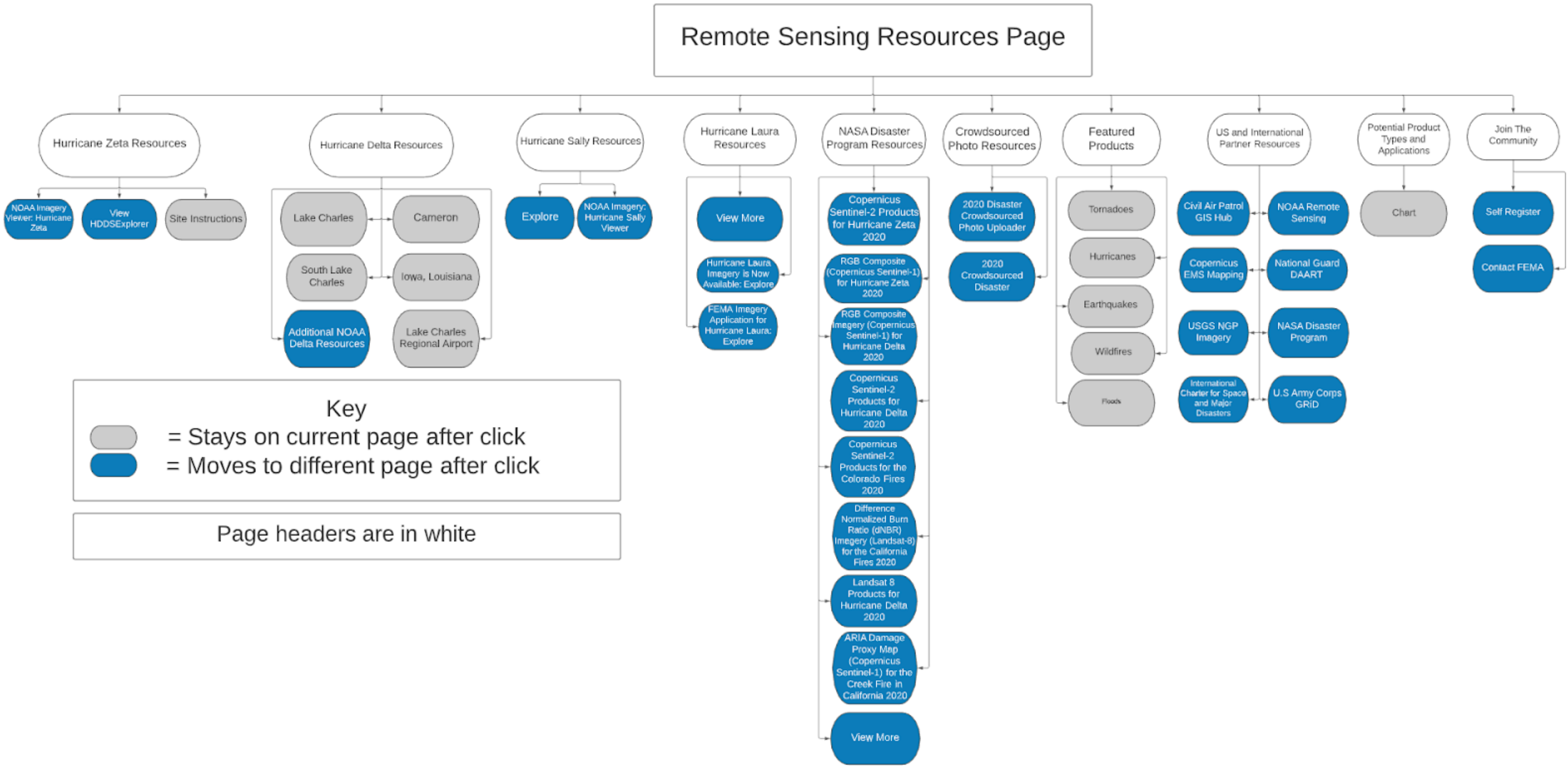


Figure 3: A content map of the existing Remote Sensing Hub page

The “Crowdsourcing Resources”, the “NASA Disaster Program Resources”, and the “Partner Resources” sections could be combined. The sections were combined because they both give background on partner agencies and their contributions to the Remote Sensing Resources page. Another section of the existing Remote Sensing Resources page was the “Featured Products” section. This section displayed different event imagery from a range of disaster types in an extremely intuitive embedded viewer. This section is an example of how clear and concise embedded content benefits page users.

The team determined that using a viewer similar to the one in Figure 4 proves advantageous for the site redesign. It is advantageous because the gallery style selector at the bottom of the Featured Products section gives users control over displayed content. Another useful element on the existing RS Resources page was the “Supporting Technologies” story map. Story Maps are another way that information is effectively and concisely displayed on the site. They are made through applications within the ArcGIS software suite. Story maps show both visual content and text on the same page in an organized and interactive fashion. On the existing RS page, the “Supporting Technologies” story map includes information about 2D and 3D imagery, Synthetic Aperture Radar, LIDAR, and more. The story map includes large pictures but does not leave ample space to display text. For the Remote Sensing Hub site, focusing more on informational text over thumbnail images allowed story maps to be more informative. Overall, the team gained better insight on the functionality of the existing RS page and potential improvements. The team must identify the consumers, identify the consumer needs, apply good web design fundamentals, and redesign the remote sensing page.

Objective 1: Identifying the Consumers

Five FEMA employees and two Environmental Systems Research Institute (Esri) contractors were asked to identify users or potential users of the Remote Sensing page. The team’s main contact from FEMA, Katie Picchione, the six employees, and the contractors as contacts knew who some of the users were, but not all of them. A concrete list of consumers for the remote sensing page was critical towards guiding the team to identify the necessary content for the consumers. Furthermore, the list helped the team create a mock-up design with specific navigation requirements tailored to the consumers.

As shown in Figure 5, the team found that the users and the potential users of the page were State and Local Emergency Managers, GIS Specialists, First Responders, and Affected Community Members. Multiple interviewees explained that state and local emergency managers used the page to respond to a disaster in their area. Specifically, state managers were interested in the information on the page because they had to make requests for reimbursement. Local managers use data from the page to assess the damage after a disaster took place. These groups also needed to know what kind of data was on the page so they can best perform their jobs. In addition, these interviewees told the team that if an area is damaged badly enough, emergency managers from the federal government would step in. Several interviewees mentioned that GIS Specialists used the page as a source for remote sensing data to

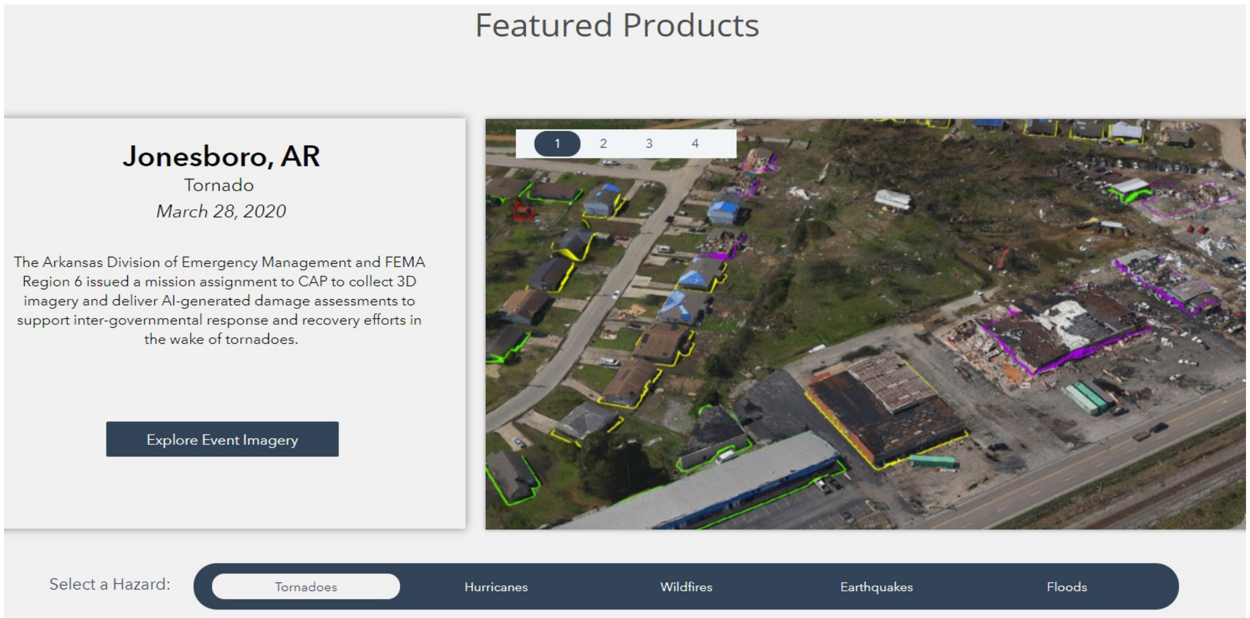


Figure 4. The Featured Products section of the original Remote Sensing Resource page.

assess damage. First responders such as firefighters would use the page to search for damage imagery and remote sensing data. The general public could look at the page to see if their house or a surrounding house was still standing after a disaster.

Objective 2: Identifying the Consumers' Needs

Since little is known about existing or potential users, we asked the interviewees to provide their opinions on the content that users might want to see on the remote sensing hub page. The team analyzed the answers from each of the seven interviewees in order to establish any common themes. Once these themes were established, the team formed an outline to list the identified needs.

A common need was easy access to the information available on the remote sensing pages. Interviewees expressed that organizing the information by event would be helpful on a Remote Sensing Hub page. The web page should follow a consistent format and any new content needs to be added in the same format. The consumers are looking for a clear and concise resource for remotely sensed imagery. By clear and concise, it is important that the consumers have a resource that explains unfamiliar terms and includes an intuitive navigation system. Another way to have a clear and concise resource is to have a defined purpose of what the page includes, which would benefit the users of the page. They would have a clear understanding of the intended use of the page and be able to find the information that they need. There was a clear message in the interviews that consumers need a well-designed web page in order to find all the necessary information.

First Responders need to have access to the imagery on the page as soon as it is available. Firefighters especially will be looking for damage imagery in order to complete search and rescue operations in the hardest hit communities. They will need a well-organized site in order to find specific local information in a timely manner. Emergency managers will be looking for the most recent disaster imagery and will need to find this information quickly and reliably. Originally, the site was intended to allow users to access data immediately following specific disasters; however, there are often delays. Typically, it takes at least two days for information to be available on the current page after data collection. After some events, four weeks pass before information is available on the page.

In addition, the team chose a structure that focuses on the event types because it is important it to be consistent with other FEMA websites. Consistent structures for data organization will help consumers find what they need efficiently, as it is what they already know and expect. A well designed web page would meet the needs of the users with at most two weeks to obtain the information. The general need for all of the consumers is that the information must be

Interviewee	Statement	Determined User
Paul Doherty	"A firefighter might click on explore and go to the NOAA page for imagery"	First Responders
Payten Samuels	"It is useful for users if there is an explanation of what remote sensing is" "Jeff Baranyi is basically a catch all for users of the site"	Affected Community Members GIS Specialists
Jeff Baranyi	"GIS Specialists have interest in available data but there could be a few people not in GIS looking in on the website. People may want to check on their homes, could be potentially be general public looking in for info on their area's disaster"	GIS Specialists Affected Community Members
Chris Vaughn	"People who need this the most will be emergency managers at the local and state level"	State Emergency Managers Local Emergency Managers

Figure 5. Users of the redesigned remote sensing page as identified by interviewees

presented in a way that makes it easier to find. Thus, the team created use cases to test various options for ease of navigation of the newly designed page.

The team created a table with multiple use-cases for each of the five identified user types (Appendix B). The cases were determined from the individual needs of the group of users. Each case describes the actions taken by the users on the page in order to retrieve specific information about a certain event. A better understanding of these cases enabled the team to design the website to meet the needs of the users. The steps for each case were listed in the table next to the expected outcome. In this table, the steps refer to the different areas of the page a user would click on sequentially to get to the specific section containing the desired information. These cases were determined from the initial needs-assessment done by the team after the seven interviews. The team used these hypothetical cases in the process to create the newly-designed navigation scheme and other aspects of the page.

Information About Remote Sensing Technology

During the interviews, the team discovered that important knowledge about GIS technology capability is missing from the page. Without this knowledge, emergency managers cannot take full advantage of the page and find information they seek. The redesigned remote sensing page provides the knowledge that the managers need, including information about GIS, aerial imagery, and the latest technology. The newly designed page will be a resource for managers and GIS specialists who need more information. Providing the knowledge about GIS imagery is one of the main needs that was identified for the emergency managers. Emergency managers will benefit greatly from the content and imagery integrability. Content and imagery cohesion improve greatly through page redesign.

Objective 3: Applying Good Web Page Design Fundamentals

After customer and consumer needs were identified, the team produced a mock-up Remote Sensing Hub page. To create a “good” web page draft for FEMA’s Response Geospatial Office, the team researched effective web page design fundamentals. According to Google LLC’s web development team, a website must be fast, integrable, reliable, and engaging.

The revamped remote sensing page must be fast. To improve the user experience, the team created a logical navigation menu and organized the page around the critical rendering method, as described in the background. The critical rendering method improved the layout of the page. For example, the “active events” section of the redesigned page lists the specific events by its name, location, and type of event. In addition, within each page, key terms are hyperlinked to enhance the user’s understanding of the technical vocabulary. For example, in the “about remote sensing” section, the word “LIDAR” would be hyperlinked to give the user a better understanding of the technology.

A good website must be integrable for use on a variety of platforms. The Esri software limits the capabilities of the data catalog which causes it to be unpopular and confusing to use. The organization of the sections on the page and the rearrangement the team suggested led towards a properly integrated page. A properly integrated page makes it easier to navigate and find critical information. Reliability is an essential part of a high-quality page. The sources for data information on the Remote Sensing Hub page are credible organizations such as NASA, USGS, NOAA, and the Civil Air Patrol. To increase the reliability of the elements, the team recommended the use of live-element updates, which prevents the data from becoming obsolete.

Finally, every good website is engaging. To provide an engaging experience to the user, the website features a variety of interactive elements. The team arranged these interactive elements and employed basic graphic design principles to improve the website’s user engagement. The team suggested different immersive subpages to help users understand remote sensing. For example, there could be a subpage that explains more about the different types of imagery, such as satellite imagery and aircraft imagery.

The team utilized the clear fundamentals of web page design to enhance and reorganize the Remote Sensing Hub page. Once researched, the pillars of web design proved to greatly improve the quality of the website, making the website fast, integrable, reliable, and engaging.

The Remote Sensing Page needs to have a navigation scheme that allows the user to efficiently find the information they are looking for. There are some challenges with the navigation design. The navigation on the remote sensing page cannot have a search function because much of the content on the existing page displays data from external sources (non-RGO sources).

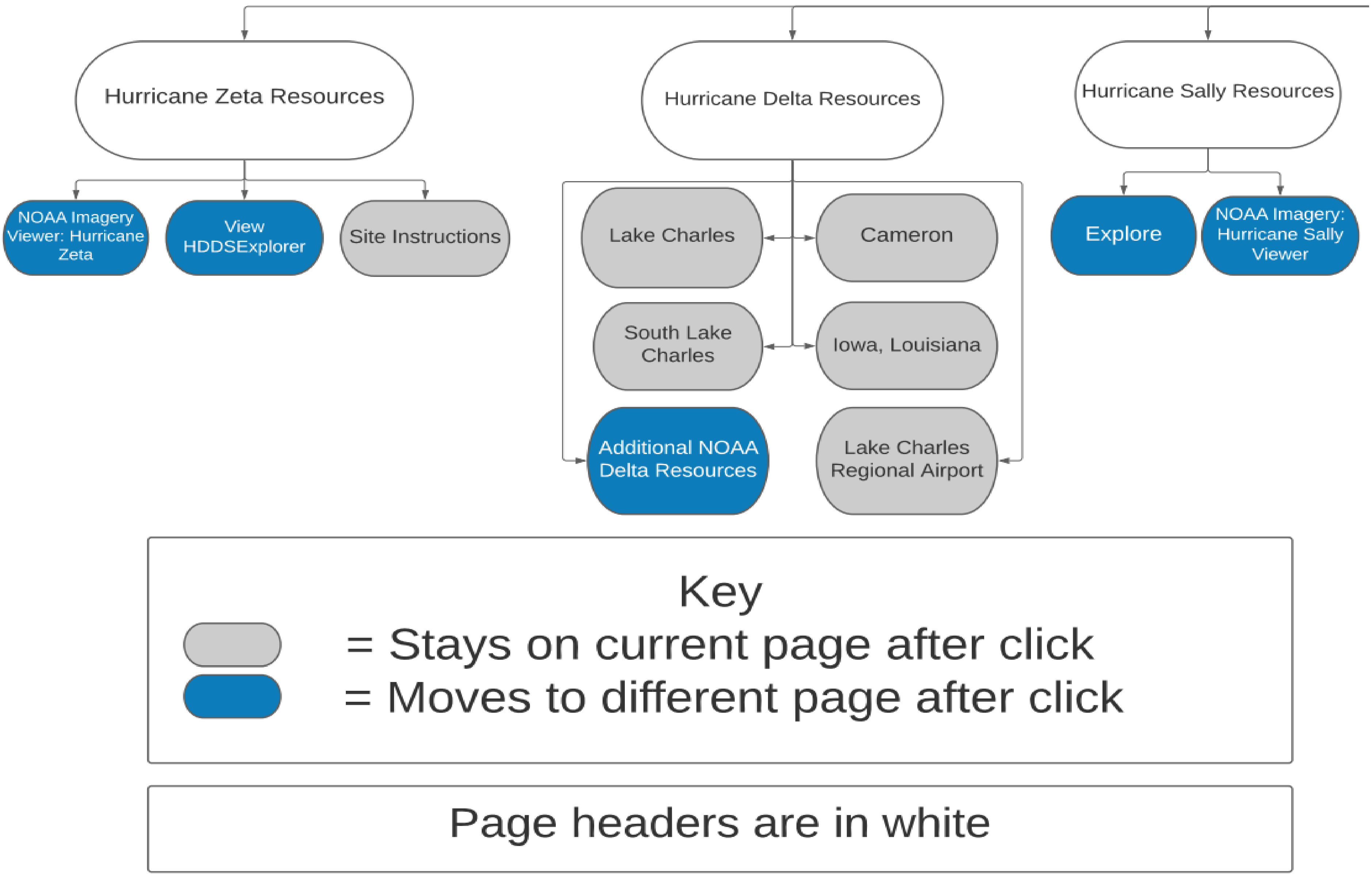


Figure 6: Image that shows part of the content map of the existing page.

Figure 6 shows part of the content mapping for the existing Remote Sensing page. The figure above highlights a key finding the team identified while making the diagram - inconsistent navigation. The bubbles in gray indicate that clicking the link keeps the user on the same page. The bubbles in blue take the user to a different page owned by FEMA after clicking. One of the biggest problems that the users have while navigating the page is trying to find the information they need. The information is more difficult to find when some of the links keep the user on the same page and other links take the user to a different page. The information for the user is not consistent if similar types of events have links that take them either on or off the page. This causes the user to be confused when navigating the page and it prevents them from effectively finding what they are looking for.

To help the team better identify a good navigation scheme, the team also mapped out the NASA Disaster Resources page as a comparison. Katie Picchione and the RGO team at FEMA appreciate the simple layout that exists on the NASA page. After mapping out the NASA page, the team noticed that it had consistent navigation. By consistent navigation, many of the links on the NASA page took the user to a different page.

Figure 7 shows that the navigation is consistent, as these links all take the user to a different page. In comparison with the existing Remote Sensing page, the information here is much easier to find. The user will not have to wonder if some information is on the same page while other information is on a different page. It also allows the page to have a cleaner design. Information will not be cluttered and the links are clearly displayed. The team applied the consistent navigation techniques present in the NASA page to the design of the proposed Remote Sensing page.

Figure 8 shows the Active Events section, the Recent Disaster Resources section, and the key for the redesigned Remote Sensing page for the redesigned Remote Sensing page and aircraft imagery.

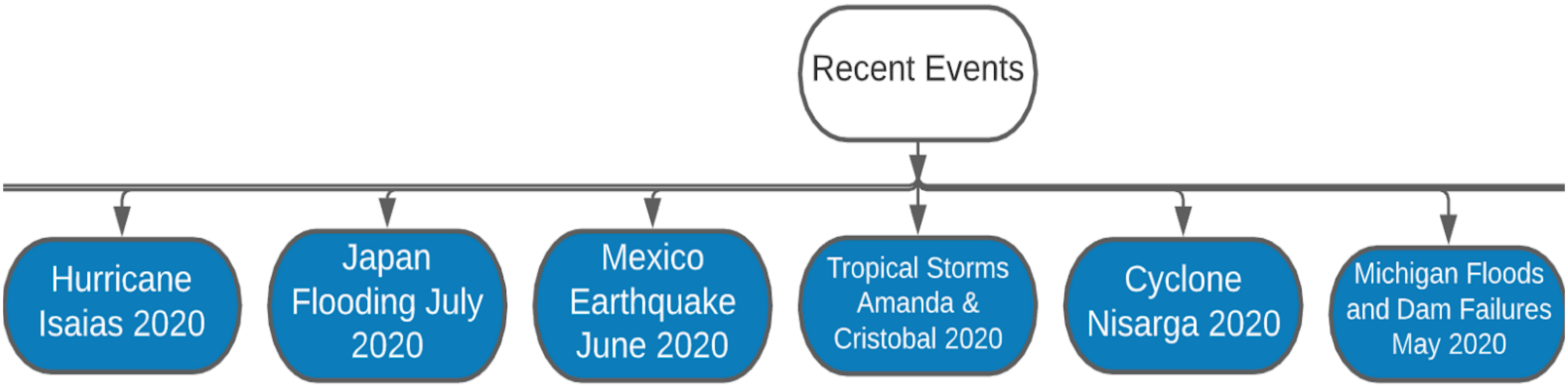


Figure 7. Image of consistent navigation on the content map of the NASA page.

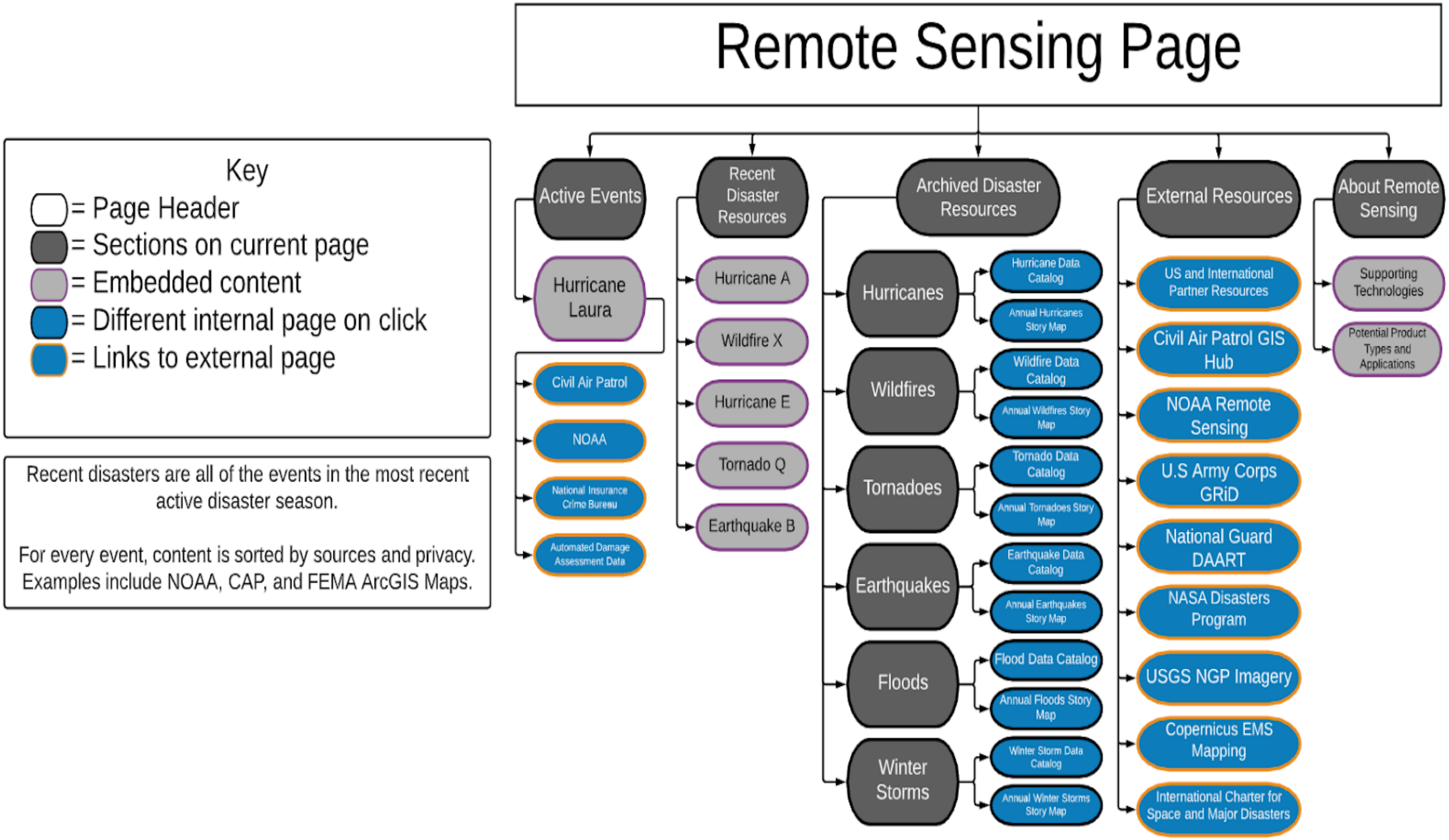
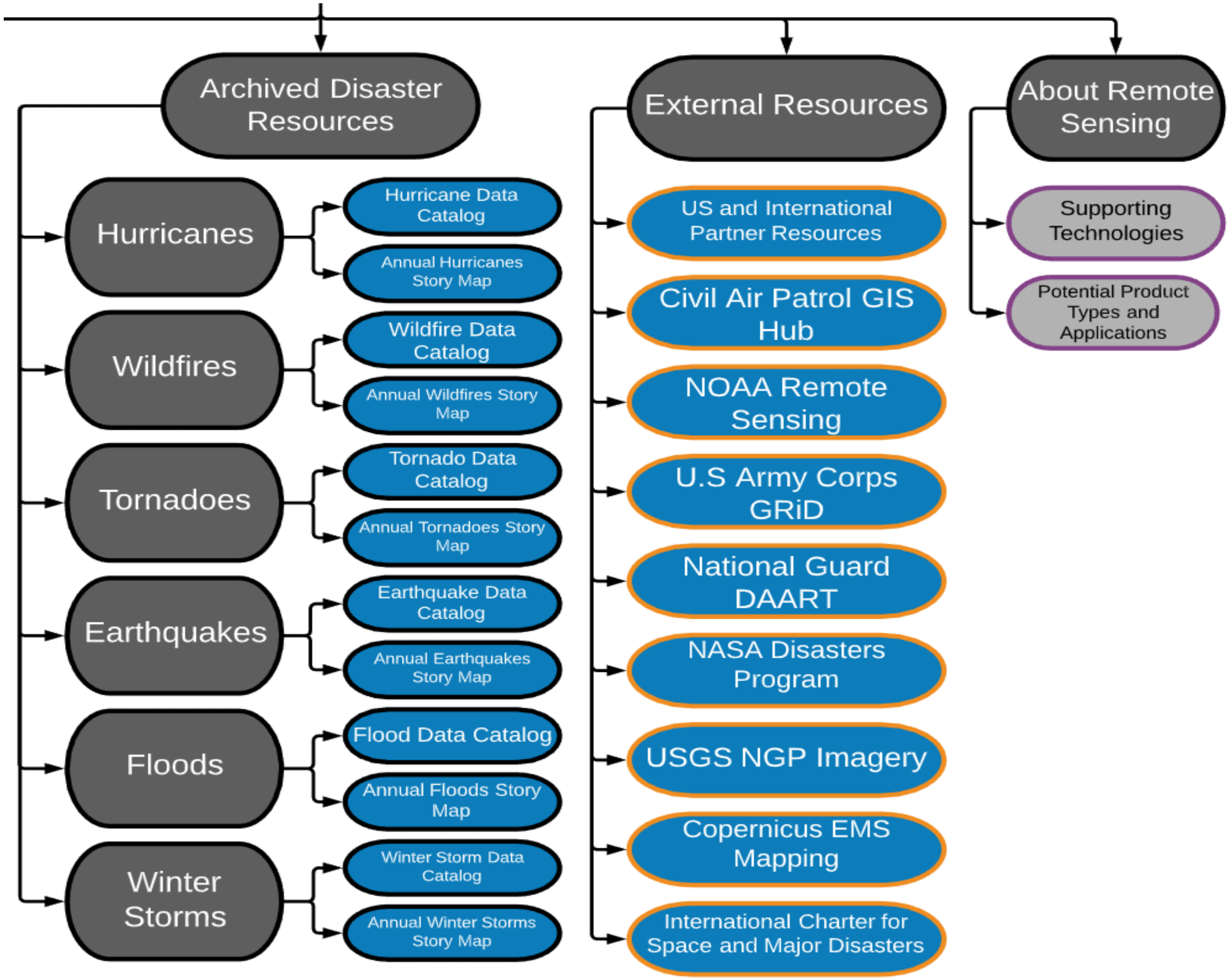


Figure 8.1: Image of redesigned page key and the full content map for the redesigned remote



Figures 8.2: Closer image of the right side of the redesigned page content map.

In the Active Events section, the team found that it was best to include embedded content for a single active event. Hurricane Laura was a placeholder as it accurately showed FEMA how the embedded content worked on the page. Within the embedded content, the team learned that links to different external pages were the best resources to include because external pages offer content more detailed than on internal pages. For the Recent Disaster Resources, FEMA envisioned there to be specific events with embedded content. The layout is intuitive and it enables the user to find what they are looking for. .

Archived Disaster Resources contains six types of events: Hurricanes, Wildfires, Tornadoes, Earthquakes, Floods, and Winter Storms. Events that are no longer recent will be moved to Archived. Within each of these events, the team proposes two different internal pages: the Data Catalog and the Annual Story Map. For External Resources, nine different hyperlinks take users to educational resources for the partner resources. For About Remote Sensing, two sections containing embedded content delineate the supporting technologies and potential product types. altogether , this design is a significant improvement from the existing page. With the existing page, only certain hurricane information is provided. This layout with the redesigned page provides information to many more events and resources other than just hurricanes.

Objective 4: Page Redesign Outline

To help present the team's ideas for a redesign of the Remote Sensing Hub page, a Page Improvements Outline was created (Appendix E). It is broken down into three primary sections; Users, Page Navigation, and Recommendations.

The presentation begins with the "Users" section. The users section included the four main users of the redesigned page, as well as important findings from the interviews. Next, the team linked to a diagram that mapped the content on the page as well as the proposed redesigned hub page. The diagram of the existing page displayed its complexity. The diagram of the redesign displayed the new site layout with a focus on easy page navigation. The presentation then segued into presenting the team's ideas for easy site navigation. The five new sections of the redesigned hub page were named and outlined, with graphics included to display the team's ideas. Lastly, recommendations for the RGO moving forward were presented as the final slides of the presentation.

The redesigned page was split into five different sections; "Active Disaster Resources", "Recent Disaster Resources", "Archived Disaster Resources", "External Resources", and "About Remote Sensing."

The Active Disaster Resources section is the first section on the page. The Active Disaster Resources section is meant as a data cache, allowing the RGO to quickly store any links and imagery they have to provide for the disaster they are currently responding to. The data and links will be presented as an Esri story map, so an embedded viewer can be used to explore the imagery directly on the site. Since FEMA is responding to many disasters, often in quick succession, having a location to store data quickly and easily is of the utmost importance. Using the story map format also helps ease page maintenance, making it easier to move data in the Active Disaster Resources to the next section, the Recent Disaster Resources.

The Recent Disaster Resources section is the next section and serves as a quick way to find information about recent disasters. This section will include the story maps of the five most recent disasters to which FEMA has responded and for which there is a collection of remotely sensed data. Story maps created in the Active Disaster Resources section can easily be moved to the Recent Disasters section.

The third section of the page redesign is the Archived Disaster Resources. In this section, all remaining remotely sensed data not included in the active events or recent events will be stored and sorted by year for easy access. The Archived Disaster resources will also contain links to various disaster data catalogs.

The fourth section of the page will be the About Remote Sensing section. In this section, the goal is to provide a place for users who are less familiar with remote sensing to come learn more. There are two main parts of the About Remote Sensing section, a supporting technologies story map and a potential product types and applications chart. The supporting technologies story map will include definitions, and descriptions of unfamiliar Remote Sensing terms to provide as much information as possible, while not being verbose. An image relating to the topic in the story map will accompany the text as seen in figure 9. Within the story map some terms will contain the phrase "(Example)". Terms with examples allow the user to change the image in the viewer to another image or interactive content. The team proposes stronger emphasis on text in the story map over the thumbnails and supporting pictures would benefit the story map. The second part of the About Remote Sensing section is potential product types and applications charts. The potential product types and applications chart gives a brief description of remote sensing products and their potential uses for FEMA. The chart also includes a list of hazards for which certain products would provide useful information. ,

Lastly, the External Resources section contains links to sites hosted by FEMA's Remote Imagery partners. These partners include the National Oceanic and Atmospheric Administration (NOAA), the Civil Air Patrol (CAP), the United States Geological Survey (USGS), and more. These links are tailored more towards technical users as they provide a lot of data without many explanations.

HTML Pseudo-Website

To best visualize the team's ideas from the PowerPoint outline, the team drafted a visual HTML (Hypertext Markup Language) version of the website. The HTML pseudo-site is an exact replica of the existing Remote Sensing Resources page with elements moved and replaced to show the proposed page redesign. The pseudo-site displays the proposed redesign in a visual format for the Response Geospatial Office to understand the team's project recommendations. The HTML Pseudo-site is one of the three deliverables of the project.

The main elements of the pseudo-site revolve around embedded tabs. The tabs use Material Design Lite Bootstrap (MDL Bootstrap), an animation and style stylesheet, to provide a lively and attractive user interface. To facilitate navigation remapping, the pseudo-site's tabs each lead to newly-sectioned page contents. The new content organization, as listed in Objective 4, divides the contents into active, recent, and archived disaster resources. At the top of the page, the "Jump To" menu links to each of these sections; this allows the user to easily navigate to their target section on the page. Figure 10 shows the "Jump To" dropdown menu from both the current site and the pseudo site. Currently, the "Jump To" menu on the Remote Sensing Page is not sticky and remains at the top of the page no matter where the user scrolls. For the redesign page, the team proposes that the new "Jump To" menu always remains at the top of the page as a sticky element.

For the Active, Recent, and Archived Disasters sections, the team implemented Material Design Cards, a feature of MDL Bootstrap. These cards perfectly match the technical and aesthetic requirements of the page. The informative yet minimalist design of the cards clearly displays information and images for the user to access. Each material design content card contains a title, a media slot, a card description, and a referral link spot. For each of the cards on the

Figure 9: Image of the Supporting Technologies Story Map

site, the team chose hyperlinked titles (Figure 11, arrow 3) to redirect the user to the appropriate data resource. The organizational tab structure, as proposed, is shown in Figure 11. Arrow 1 denotes the default navigation tab, the link to display the 2020 Annual Hurricanes Story map. Arrow 2 points to the indented subtab for the 2019 Annual Hurricanes Story Map. For further years, the tabs will be indented to show the categorization. The text in the rectangle below the 2020 Hurricanes header is placeholder text; it has been intentionally made unreadable.

The images chosen for the pseudo-site are placeholders for images the Response Geospatial Office will use. Arrow 4 points to a link to the hurricanes catalog page The embedded content cards (the container for arrows 3 and 4 in figure 11) provide additional content embedding capabilities. For the recent events container, several of the displayed disasters consist of embedded story maps or imagery layers. With the use of embedded content, the website further adheres to the "integrated" aspect of the Fundamentals of Good Web Design.

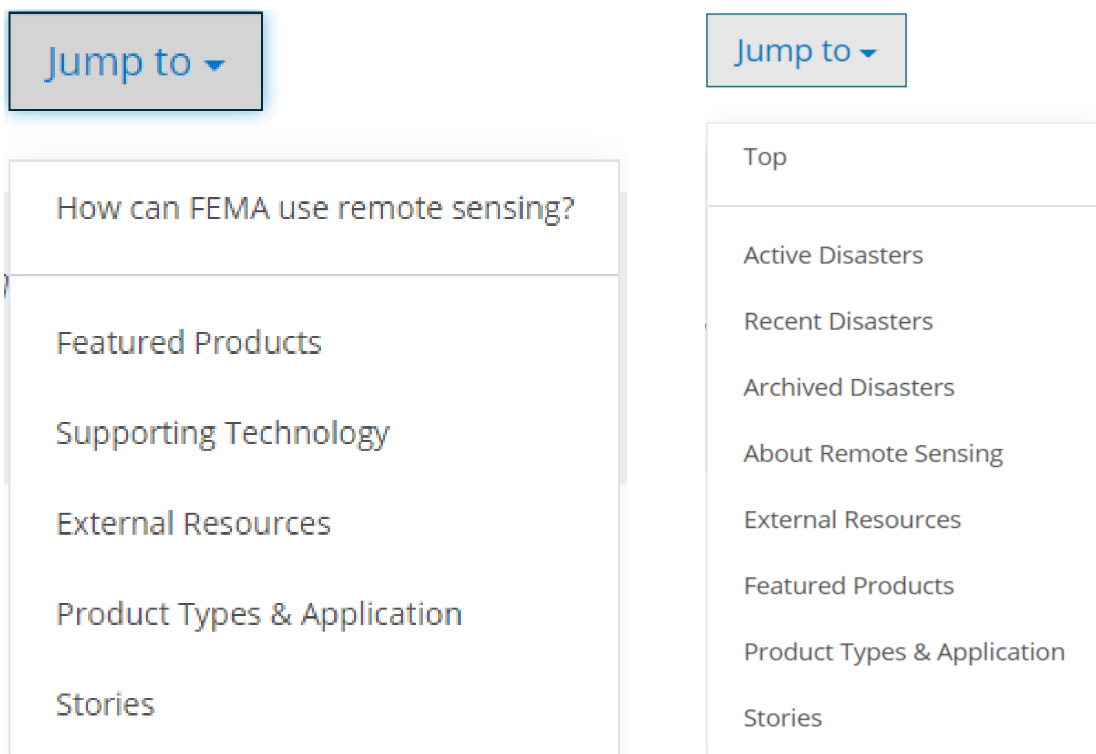


Figure 10: On the left is an example of the "Jump To" menu from the current site and on the right is the proposed "Jump To" menu on the Pseudo site

Maintaining the Site after Redesign

The last step to provide an effective and impactful page redesign was to provide a workflow for post-project maintenance of the new page. The redesigned page was designed to provide the most relevant information in the most accessible way possible. The top of the new page will feature an "Active Events" section. The Active Events section will include the most recent event to which FEMA is responding. This is not to be confused with the "Recent Disaster Resources" section, which includes the five most recent events that are not active. The Active Events section will only include one event. The team determined that FEMA staff prefers one section with the current active event to which they are responding, as long as the data from the event is easy to move to the Recent Disaster Resources section.

In addition to the Active Events section, there will be a section for "Recent Disaster Resources." This section will require regular updates, as new events are occurring all the time. The goal of this section is to include the five most recent events as embedded content. For example, one recent event would show embedded content from Hurricane Zeta. Another example would show the most recent wildfire in California, and a third might have a tornado in Arkansas. Events that are no longer recent should be moved to the Archived Disaster Resources section. It is important that FEMA keeps both the Active Events and the Recent Disaster Resources sections updated. This will allow the page to be easy-to-maintain over time. When a page is easy to maintain, it is easier for the users to find the information they need.

Figure 11: Pseudo-Site Design for Archived Disasters Section; arrows point to year tab, year subtab, an story map link

Product	Description	Potential FEMA Uses	Hazards Supported				
			Flood	Hurricane	Tornado	Earthquake	Wildfires
Flood Extent	Use image classification on Synthetic Aperture Radar (SAR) or multispectral imagery to identify water and delineate extent of flood zone.	• Modeled flood depth grid validation • Damage estimation	✔	✔			
Feature Identification: Debris	Use change detection based on reflectance (multispectral) or backscatter/amplitude/ coherence (SAR) to identify areas where structures and buildings have been damaged, destroyed, or washed away.	• Damage estimation • Debris estimation • Debris volume estimation • Debris removal planning	✔	✔	✔	✔	✔
Debris Volume Estimation	Estimate the volume of debris from post-event elevation data (e.g. LIDAR, stereo-imagery).	• Debris volume estimation • Debris removal planning	✔	✔	✔	✔	✔

Figure 12: The Potential Product Type and Application Chart

Conclusion

The team was tasked with redesigning FEMA's Remote Sensing Resources page. To determine how to best redesign the page, the team completed a series of interviews and extensive research. The interviews provided information on potential users, users' needs, and areas of the existing page that required changes. The team's research gave insight into good web design as well as how other effective pages have strong navigation techniques. In seven weeks, the team produced an HTML draft version of the redesigned page, a content map of the redesigned page, a page-improvement outline made with PowerPoint, and additional supplementary materials. FEMA will be able to utilize the work the team completed for years to come.

Recommendations

While the redesigned Remote Sensing Resources page proposes many changes on the original page, it can still be improved even further. This section includes recommendations for FEMA's RGO on how to best maintain and improve the web page.

To properly maintain the site, **the RGO should designate at least one person who is responsible for keeping the Remote Sensing Resources page up to date.** With the page changing all the time based on whatever recent disaster has occurred, it is important to have someone constantly updating the page, so it does not fall out of date. On the original site, data would pile up and the original content of the page was pushed to the very bottom. Within the redesign, the team included two sections requiring regular updates; the Active Event Resources section and the Recent Disaster Resources section. For the Active Event Resources, any remote sensing data or links that are gathered during the most recent major event can be put into this section. This will allow data to be uploaded quickly and allows the section to be used as a staging area for moving content into the Recent Disaster Resources. Once a new major disaster occurs, links and data from the preceding event must be moved into the Recent Disaster Section. This will also give the opportunity for the page manager to sort and organize any links and data that were not organized previously. The Recent Disaster Resources section will also need to be updated for each new disaster as well as each new disaster season. Disasters that are no longer "recent" can be moved to the archive disaster resources

While the scope of the project was to redesign the Remote Sensing Hub page, the team discovered some things that could help get information onto the redesigned page faster and easier. **The RGO could create a universal naming system for data in the data catalog as well as providing proper tags.** As it stands currently, the data catalog has a lot of data to offer, but anyone unfamiliar with how it is set up could easily be overwhelmed. While currently it could be confusing to some users, specifically affected community members, including things such as clear and standardized naming could help users better understand what they are looking at. In the redesign the team included a link to the data catalog for each disaster in the "Archived Disaster Resources" section. In its current state, the data catalog is not the strongest resource for all user groups but formatting internal data within the catalog will help transform it into a better source for remote sensing resources in the future.

Another important point to consider from the interviews is the amount of time it takes for information to be made available on the page. Currently, it takes a minimum of two days for information to be added to the page. However, it can take up to four weeks to get critical information uploaded to the site. By the time four weeks goes by, the event could become insignificant. **There needs to be a clear maximum time frame for information to be added to the page. It should not take longer than two weeks for information to become available on the page.** Setting up a clear time frame for when information needs to be uploaded improves the user experience when searching for critical information. The information will still be relevant to the user and it can help allocate more resources to areas that are the most impacted. Without a clear maximum two week time frame, the data is less likely to be utilized to efficiently respond to disasters. Unfortunately, users have no control over when the information can first become available making the two week minimum a little more difficult. In addition, it is important to use satellite imagery whenever possible. The team learned from interviews that the data from satellite imagery is the quickest to be made available to the site because it has the shortest supply chain. Using satellite imagery allows the information on the site to be updated more quickly.

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