Thesis Portfolio

Qualitative Study of The Perception of Wildfire Risk

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In Fulfillment of the Requirements for the Degree
Bachelor of Science, School of Engineering

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Sociotechnical Synthesis

Wildfire is an important problem to solve, and a major technology to prevent fires is to detect them and put them out before they become unmanageable. To that end, the technical project undertaken involved creating an internet accessible sensor system to put around homes and outside of towns, along the urban rural boundary known to cause fires. That system can detect fires and transmit that information to centralized servers for firefighters to rapidly respond to fires before they would be spotted with more traditional methods and allow them to respond faster. A fast and reliable fire detection network can save countless lives and prevent millions of dollars in damages.

This technology presumes that human issues around these devices can be managed to make them effective, As the main issues surrounding such devices are the cost and the acceptance of people to use them. The in terms of acceptance of such devices, there is an issue of privacy where sensors will always be collecting data outside of people's homes and in their community. In addition, even though this device is not vision based, other similar devices are and they could always be sending camera data and thus could identify people who inadvertently cause fires. This leaves an ethical aspect of this technology to explore in how people interact with such devices and how they feel about their use.

In the technology, as well, there is an issue in whether or not communities even recognize wildfire as a major problem outside of select areas of the world.

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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Qualitative Study of The Perception of Wildfire Risk

A growing number of people are impacted by wild fires every year, and thus impacted by technology to fight them. The risk of fire has increased exponentially over a twenty-year period, in 2001 only 3.5 million acres were burned, but in 2020 there were 10.5 million acres were burned (NIFC, n.d. a.). Another issue in wildfire prevention is that fires are taking place in an expanded area as compared to just twenty years ago, including fires in the American Great Shield, Midwest and South (fig. 1; fig. 2)(USGS, n.d. a.).

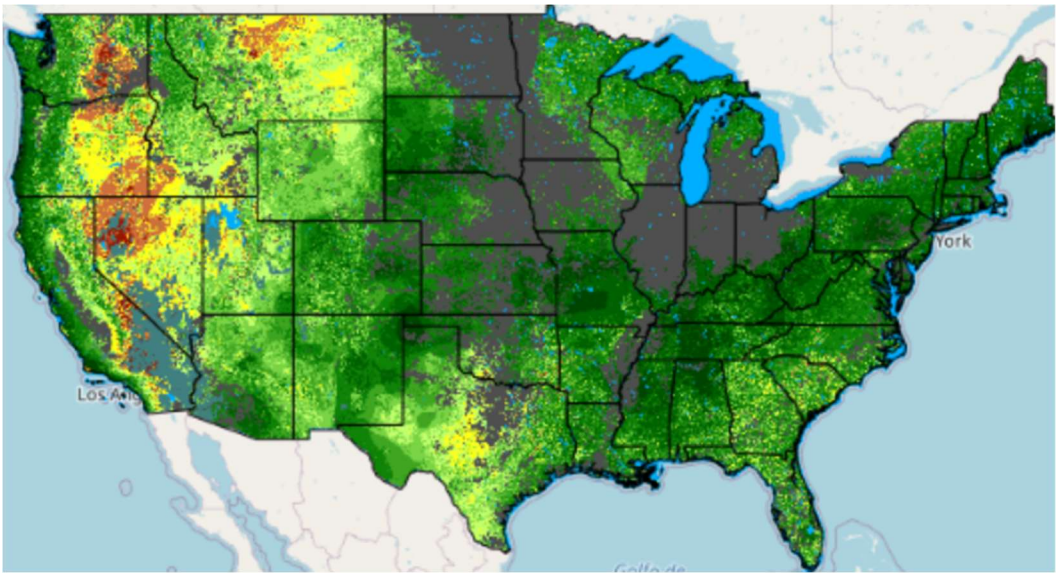

Figure 1 Fire Index Risk as of 2001, Aug 15. (USGS n.d..)

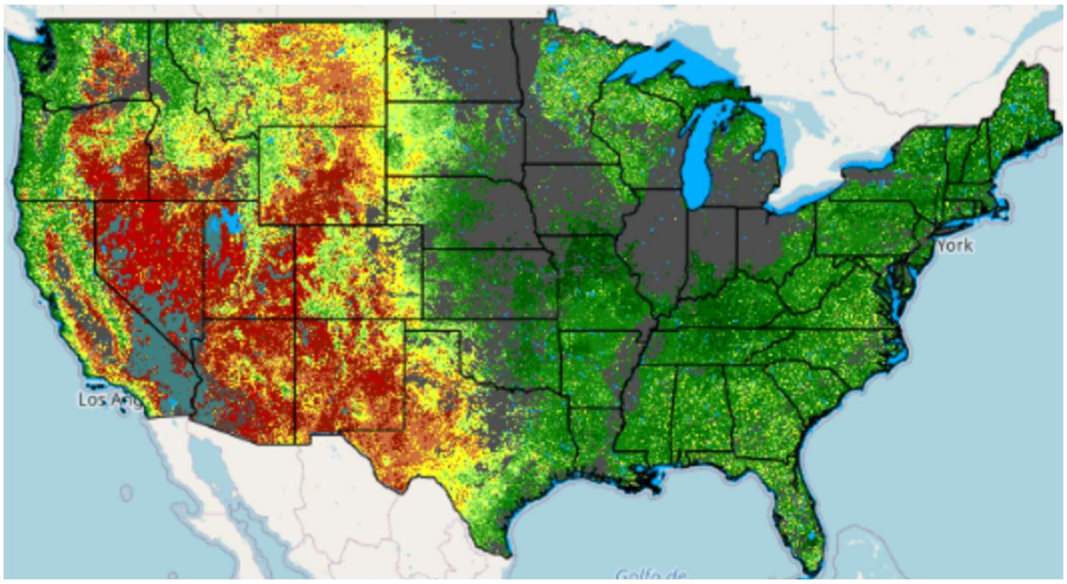

Figure 2 Fire Risk as of 2020, Aug. 15 (USGS, n.d.)

While much of the western United States is within an at-risk wildfire area, even the southeast of the United States is projected to have increased wildfires by at most 4% in 2060, as compared to 2016-2020 average yearly fires, which could translate into millions of acres (Prestemon, 2016). This trend in fire severity far outpaces the public, perceived risk of having a wildfire event happen nearby. To quantify how much money these additional wildfires burn acres are costing, the National Interagency Fire Center (NIFC) has quantified a cost of $2.27 billion dollars spent by the forestry service and the Department of the Interior (DOI) in 2020 alone (NIFC, n.d. b.). Nearly 8% of the total proposed budget of DOI for the fiscal year of 2021 is proposed for wildfire risk reduction, such as fuel management, from a total of $12.8 billion; that is before extra money of $310 million that Congress has appropriated for the DOI to use exclusively during fire season (DOI, 2020, p.8). Obviously, given the amount of money spent on just preparedness for wildfires, it is a major issue. Private insurers paid between $7 to $13 billion on wildfire claims in 2020 (Reuters, 2020). Wildfire in the US has changed from a natural disaster, to a predictable one.

This prompts a specific question, how has wildfire changed into this massive a problem? In the United States, concern for wildfire started in 1908, with the Forest Fires Emergency Act which was quickly tested in 1910 when major wildfires across Montana; this led to a major expansion of firefighting resources federally through to the 1930s (NPS, n.d.). In 1935, a policy known as the "10am policy" was implemented by the Forest Service in which it was policy to guarantee every forest fire would be put out by 10am the day after the fire was first spotted (NIFC, 2001). This was led by a mindset that every wildfire is dangerous, and provides no benefit to society. By the 1970s, this attitude started to change about wildfires, as research found that wildfire plays an important role in the ecology of forest systems. One of those roles was shown by Haase (1998) by showing how giant Sequoia's need fire to be able to allow new growths of California's giant Sequoia trees. This has created more need to monitor fires for danger; since some fires prove beneficial and only need to be controlled and contained. This changed official Forest Service wildfire policy from the "10am policy" to a policy known as a let it burn strategy, where when it was appropriate and non-dangerous to people forest areas are allowed to burn and the Forest Service contains it to that area (FHS, n.d.).

This led to issues where some fires became out of control in national parks, such as Yellowstone, because of dry conditions. Because of this issue, in 1989, George Bush ordered the DOI to fight all wildfires directly rather than containing them in certain areas (NPS, n.d.). Into the 2000s fire policy as evolved try to accommodate environmental concerns of preventing all fires by instead of allowing fires in contained areas, the DOI and Forest Service now proscribe fires into certain areas where officials deliberately start fires; this allows environmental renewal, as well as lessening of fuel available for an uncontrolled fire to start (NPS, n.d.). Uncontrolled

fire has become the largest problem for the Forest Service, as it now spends upwards of half of its budget every year to fight and contain wildfire in national parks and federal land (FHS, n.d.).

Wildfire has a complex set of socio-economic and political issues around it in the past two decades since the cost and severity of wildfires and increased dramatically. One of the largest is the issue of people and insurance companies buying private firefighters to protect wealthy clients and neighborhoods. This raises issues of social class as the wealthy can afford insurance policies to protect their homes with private firefighters, while that is not affordable or attainable for most people to protect their homes with. Governments from a local to the federal are struggling to pay for the cost of damages and displacement of refugees. This is also causing critical dilemmas to prevent wildfire which was best seen in California in 2019 when Pacific Gas and Electric (PG&E) turned off power to millions of people to prevent their equipment from starting wildfires across the state which cost upwards of $2 billion (Stanford Institute for The Environment, n.d.).

One of the deadliest fires in US history is the Camp wildfire, which happened in California in 2018. The National Institute of Standards and Technology (NIST) did a major case study in what caused the fire and the issues associated to fight it. They found the major causes of the fire were:

- Fuel Ignition
- Density of vegetation and structures
- Wind and terrain
- Extent of fire front reaching communities

This was found to result in extremely dangerous conditions to both residents and first responders (NIST, 2021, p.6). One main community which was completely destroyed was the town of

Paradise, Ca; in which at least 12,000 structures were destroyed and fatalities of residents was 85 deaths. An interesting issue in the fire was that it was found that the Camp fire resulted in an area where a wildfire occurred in 17 of the past 20 years (NIST, 2021, p. 19). The NIST also found that it wasn't that the town was unprepared. The town was identified as at risk in 2001, and the town had advanced warning systems, their own fire council which would predict fire conditions, and provided extensive training to firefighters to fight wildfire (NIST, 2021, p. 21- 22). Despite being one of the most prepared townships for wildfire in the US, when fire entered the town at 8am, most of the town was unable to evacuate and the town was engulfed within minutes. This marks the severity of wildfire, even when the risk of fire is well known. Another additional risk identified was that weather fluctuated wildly compared to the average precipitations which the area has historically experienced in November, with it being significantly drier than even the previous November, and this climate fluctuation has made fires much worse in times of the year which are normally not fire season (NIST, 2021, p. 15

Wildfires have changed from being a natural disaster into being a complex social-technical issue in which has become a costly and vexing problem both in the present and foreseeable future. Into this landscape emerges the question of how does emerging of fire detection technology, with its own complicated ethical and social issues, effect the complex web of social, economic and political issues around wildfires. This paper looks at the perception of the risk of wildfire across homeowners and comparing that to the known risks of fire. This is an important topic in understanding how fire is perceived considering it is a costly issue and the risk is widespread and growing across the US in future decades.

Literature Review

When looking at the scope of this issue, it is useful to look at the overall history of the science of wild fires. The history of firefighting is led by government actors creating technology to detect fire and prevent their spread. That leads into introducing the first and most widespread wildfire detection technology of watchtowers, and it is an active technological field today with research of Bao (2006) to optimize the placement of such towers across a forest. As outlined by NIFC (2001) and the history of fire response, how fires have been managed has changed significantly from all fires must be stopped and contained to recognizing that wild fires do have useful effects on forests and their environment. In wildfire fighting, many different people have stakes in the issue of containing a fire and what areas can be protected or not. That leads to having certain groups left out or not fully considered in the planning and protection from wildfires. Ojerio (2011) shows this problem in vulnerable populations such as Native American peoples for Federal fire protection programs. Specifically, that many minority communities struggle to access federal aid due language barriers as well as the lack of access they have to bureaucratic processes. They point at that Native Americans in particular are the closest to the Wildland-Urban Interface (WUI), which is a term for the area where human populations interface with areas where very few people live and where most wildfires start. This leads to greater risk for Native American communities as they receive less aid from the federal government but that they live closer to areas with higher risk of fires.

Literature specifically along the lines of the research question as applied specifically to fires is sparse; although there is much research into how IOT may impact global disasters, such as from Yu (2018) who looks at how big data and sensor technologies could impact minority communities before and during a disaster management response. What they found was that data gathered in preparing for disasters had several technical issues from a technological sense. The

first issue was that data gathered from fires, such as some qualitative assessments and phone records are not useful to develop models and simulations on the disaster to prepare for it in the future, or in understanding the risk of a similar event in a similar area. They also found that there was bias in the data collected which produced very little data from minority communities impacted from a disaster. This leads to bias in simulation models and Machine Learning algorithms (ML) where the lack of data increases the bias those models have on minority communities. That kind of analysis is useful in understanding the risk historic bias in fire response data which is normally collected in the field. There is also extensive research about IOT and some problems and challenges the technology presents. Bojanova (2015) looks at how the environmental impact of IOT technology and economics of sustainability to produce it. Particularly in a culture of cyber-physical systems where the cost of widespread sensors to collect data cause concerns for the environment and safety as these devices do have semi-toxic materials inside of them. That is one of the ethical issues which participates will be asked about, so research into the actual costs involved is needed. Daj (2016) does a economic analysis of IOT and there direct application to fire systems, which is useful.

Other research reviewed was how McCaffrey looks issues surrounding trust in different communities for if and when they would heed warnings for wildfire evacuations (2017). As well as McCaffrey's paper on peer pressure and how it relates to people's decisions to mitigate fire risk (2011). McCaffrey has done multiple works where she looks at trust in communities to heed wildfire warnings, particularly in understanding how participates view risk of wildfire and how much they trust officials who warn them of disaster. McCaffrey also studied the qualitative views of participants on the risk of wildfire, and found that most people were not aware of any risks when the study was done (2008).

Research along similar lines was done by Champ in *Is Seeing Believing? Perception of Wildfire Risk Over Time* (2016), which discovered that despite common phrase that seeing is believing, she found that the risk perception of wildfire is actually relatively unaffected by seeing a wildfire. In the study, risk perception spiked immediately after a fire event, but quickly decreases over time. Participants who had heightened risk perception were not linked to if they had ever seen a fire, but if people they knew, particularly their neighbors, were concerned about the risk of fire. This shows an interesting idea that the perceived risk of disaster is actually a societal shared perception where concern in one person actually creates concern in others for a particular issue more so than if they had experienced the disaster themselves.

Methodology and STS Framework

To gather data to answer this issue, the methods used was a survey released to general participants. An important part of the study was to make sure that the participants had actual stakes in the risk of wildfire, such as being a homeowner. So, these participants were found in releasing the survey to homeowner groups across Virginia and the east coast of the United States as found on Facebook. They filled out a randomized survey form with questions which asked about how they felt about several related topics to Internet of Things (IoT) devices. That information was collected and automatically turned into anonymous responses.

The questions were created to not bias participants in a strong way to be able to understand their views qualitatively. In that, the exact methods used were to ask systematically about the how people understand the issue of wildfire and different detection technologies around it. Each question was asked for participants to show how strongly they agreed or disagreed with a statement on a scale of one to five. Participants were also asked to give

demographic information to study the breakdown between how different groups feel about wildfires and detection technology.

To understand the results, it would seem that wildfires, and complexities in managing them as a disaster, have become a Large Technological System (LTS). Primarily, the government and the DOI have become system builders, in creating a large system of financial, political, legal, and physical systems in which to manage the issue of wildfires. For example, the DOI has created a framework with the Forest Service where the federal government has physical infrastructure and full-time employees to enact fuel management and monitor fuel levels to understand and control wildfire. In doing so, they rely on a system of political capital in Congress to gain the power and money needed to create these systems. The first issue in the budget for the fiscal year 2021 given by the DOI was fire management to focus Congress on how President Trump's primary mission for the DOI was to cut the number of wildfires through fuel management and proscribed burns (DOI, 2020, p.1 - 8). In this, there is also a reverse salient for this LTS system. The reverse salient or hurdle for the system is that wildfire costs are ballooning and the current system is starting to struggle in managing all of the possible areas that wildfires can start in the US, both in the US but now also in the amount of fire acres being burned in the American South.

This highlights the major issues inside this LTS and how wildfire is more than just a natural disaster. Wildfire prevention as a wide socio-technical system in place to enact it. In looking at this system, this paper seeks to look out how these participants understand the socio-technical system from the point of view of detection systems.

Data Analysis and Collection

In terms of participants, they are diverse in age group, and lean towards much higher female participation overall.

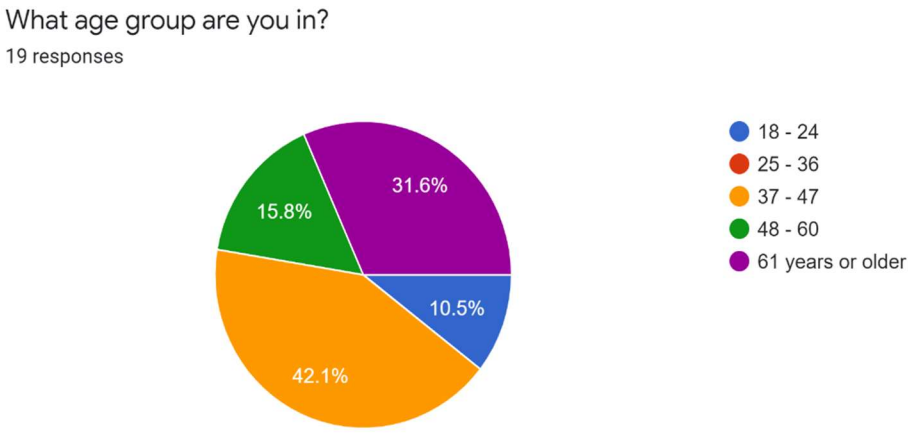

Figure 3 demographic data

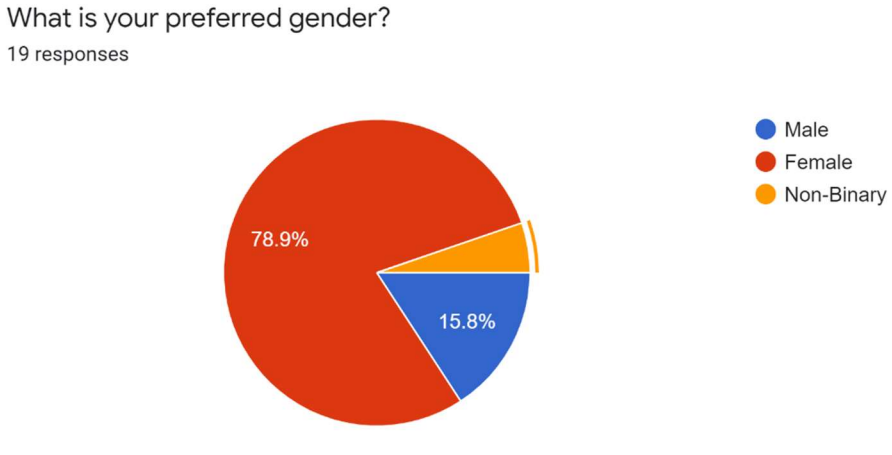

Figure 4 Data of Gender

In their responses, all participants were concerned with simple sensors, such as temperature and humidity in fire detection near their property. Their responses shift dramatically when asked how they would feel if the sensor system included a camera. But those feelings weren't monolithic, as almost all participants said they would dislike devices that had a camera on all the time, but most participants had more positive feelings about a system in which the

camera only saved data when it detected a fire. Overall, participants were ambivalent to how they might feel if their community required to have these sensors around them.

Several questions also looked into how participants felt about economic issues around fire detection sensors, with most participants did not feel like they are struggling economically.

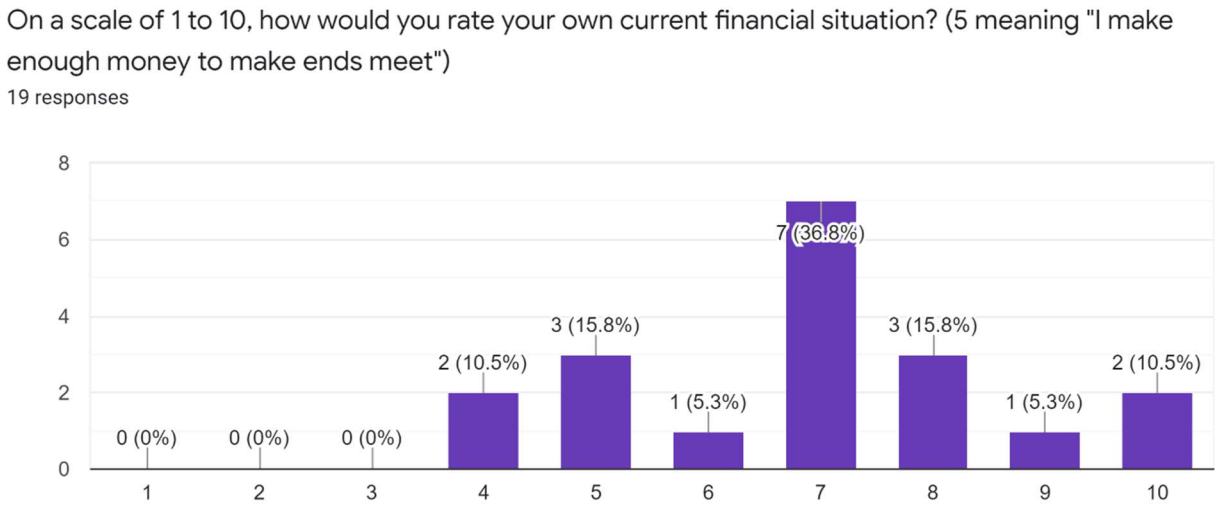

Figure 5 Financial demographic data

The first question asked to participants took common price points for home IoT fire systems on the market and asked which if any, were they willing to pay. The results were mixed in that a majority of participants decided they would not buy a system at any current price point.

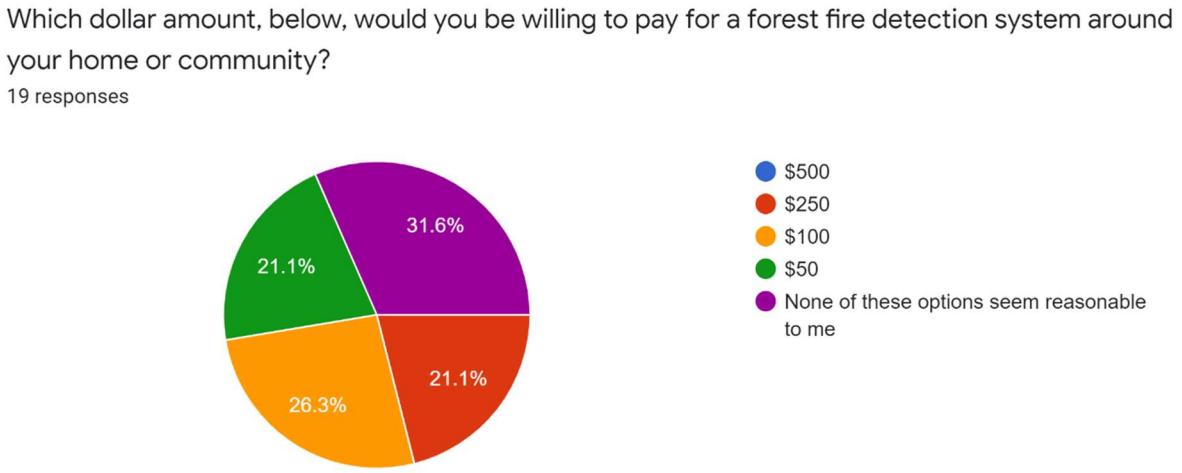

Figure 6 How much are you willing to pay?

The next section of questions asked involved understanding participants background in wildfire, and the most striking result was that most participants are unconcerned about wildfire, even in the future.

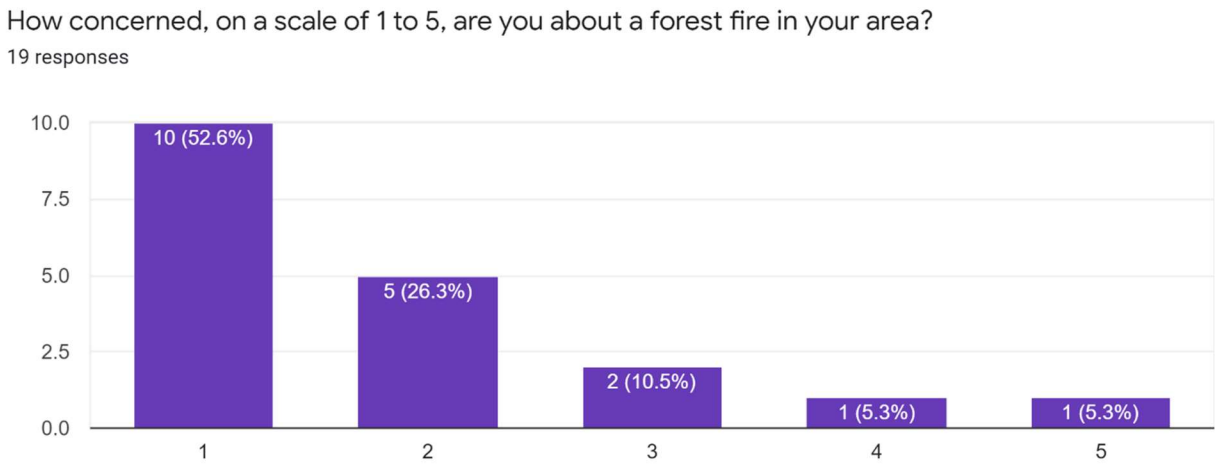

Figure 7 Forest Fire concern in your local area

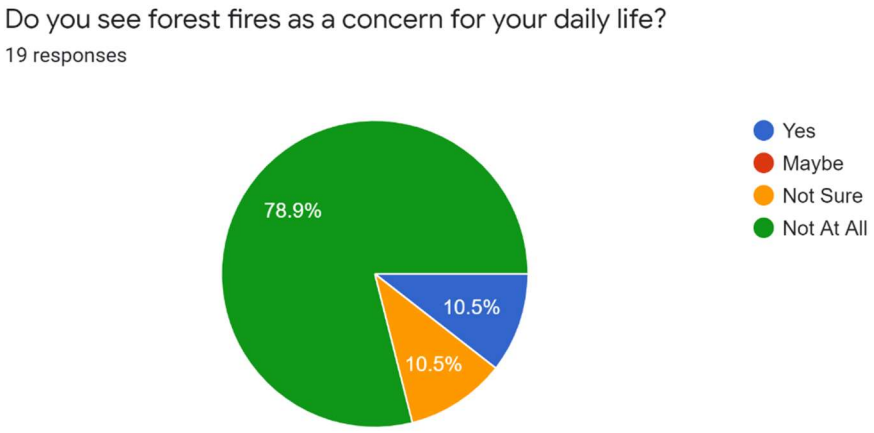

Figure 8 Forest Fire concern overall

Here, a meta-analysis of the data shows that most participants have a positive view of an IoT fire detection device, except for the most invasive systems. As a whole they also agree that it would be the job of a local government or insurance companies, rather than it being a personal responsibility to protect their communities.

The largest negative for such devices and their feasibility comes from the responses in the section of understanding wild fires. The issue is almost all participants do not see such systems as necessary; mainly as most participants do not think that they themselves will experience harm from wildfire soon, or within the next ten years. That is despite the scientific work of Brusentev and others, which shows the south east coast of the United States actually has a higher incidence of wildfire despite having higher average precipitation than the pacific west coast (Brusentev, 2016). This leads to an idea that the perception of such events is underknown in the participant pool and wider population. This is a significant issue in understanding the risks of wildfires, as the general risk of wildfire is higher than public perception of the risk of a fire.

There is also a suggestion in these results that the price of such a pricing model for these devices are too expensive, where the raw devices are sold for a flat price. In exploring different

possible pricing models, other possible models which may be more effective based on participants qualitative feedback is that models such as paying based on a subscription or payment per detected issue, may be a more effective economic model based on different viable economic result models for an IoT system as a payment for data approach (N.C., 2016).

Discussion

In the data collected, a major issue in all of the data is that the participants did not see the same risk of wildfire, as data and experts would suggest is actually there. This is in line with the results of others such as the results of McCaffrey (2008) and Champ (2016). Much like their studies which found in general that qualitative risk assessment by the general public for wildfires is low. In general, the risk assessment of particular properties, especially one's own properties is much lower than the same assessment by a wildfire expert; when rating a different property people tend to rate at closer risk assessments to experts (Meldrum, 2015). This would seem contradictory to increasing media coverage of wildfires, as well as deadly examples such as the Camp fire. But this seems to be in line with psychological studies of how people understand and interpret risk.

Wachinger in *Risk Perception and Natural hazards* (2010), has defined many salient issues when it comes to risk perception in general. Particularly they identified qualitive characteristics which seem to be the main influence on how people understand risk:

- Personal Control
- Institutional Control
- Voluntariness
- Familiarity
- Dread

- Inequitable Distribution (of risks and benefits)
- Artificiality
- Blame

These factors influence how people understand risk, and were identified to shape risk in specific ways, for example that personal control increases risk tolerance, while artificiality of an event amplifies attention and decreases risk tolerance (Wachinger, 2010, p.9). In that lens, participants were less risk averse in how they felt about wildfire because wildfire is typically seen as inside institutional and personal control, as well as being a familiar event where normally there is a person or group to blame when disaster strikes. There is also evidence that people tend to see extreme disasters as events that occur rarely and spread out in time (Wachinger, 2010, p.26). In the view of that, there should be concern over the perception of wildfires since the five of the largest six wildfires even in just California have happened in 2020 (earth.org, 2020). It would seem that many participants seem to view fire under the conceptual bias and semantic image as an event that is a "Stroke of Fate" which includes the ideas and biases that a disaster risk is natural, can be controlled, accessible, and has non-catastrophic consequences (Wachinger, 2010, p.10).

This signals that an important part of the sociotechnical system of wildfire fighting is the social system around fire and that the general population perceives a much lower risk than in actuality, as it could become increasingly difficult to maintain the current LTS system as it is based on the financial and political systems required to maintain it.

Conclusion

Even though the risk of wildfire is increasing, both in terms of human danger and in economic costs, the risk perception of wildfire is not. In 2008, McCaffery found in qualitive

studies that few people were concerned about the risk of wildfire in the US. Now, more than a decade later, and some of the deadliest fires in US history such as the Camp fire, the risk perception of the general population was found to be qualitatively low in this paper. This is despite how both the federal government and private insurances are spending more money than ever before on controlling and paying for the costs of wildfire. As more of the US becomes at risk of wildfire as projected by the NIFC, there will be a major expansion of both the personal risks and the costs of wildfire. In that the general population still does not perceive nearly any risk of wildfire to themselves or their property represents a major issue in the complex socio-technical system of how wildfires are fought in the US.

With such low risk perception found in this paper, there needs to be a paradigm shift in how wildfires and their risks are represented and communicated to the general public. The focus should be in shifting the perception of these disasters as natural disasters, to that these disasters are predictable and the cost of these fires are the result of ignoring the rising risk of wildfire in the United States.

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Yu, M., Yang, C., & Li, Y. (2018). *Big Data in Natural Disaster Management: A Review. Geosciences*, 8(5), 165. https://doi.org/10.3390/geosciences8050165

STS Prospectus

Introduction Wildfire is an important problem to solve, and a major technology to prevent fires is to detect them and put them out before they become unmanageable. To that end, the technical project undertaken involved creating an internet accessible sensor system to put around homes and outside of towns, along the urban rural boundary known to cause fires. That system can detect fires and transmit that information to centralized servers for firefighters to rapidly respond to fires before they would be spotted with more traditional methods and allow them to respond faster. A fast and reliable fire detection network can save countless lives and prevent millions of dollars in damages. This technology presumes that human issues around these devices can be managed to make them effective, As the main issues surrounding such devices are the cost and the acceptance of people to use them. The in terms of acceptance of such devices, there is an issue of privacy where sensors will always be collecting data outside of people's homes and in their community. In addition, even though this device is not vision based, other similar devices are and they could always be sending camera data and thus could identify people who inadvertently cause fires. This leaves an ethical aspect of this technology to explore in how people interact with such devices and how they feel about their use. Technical topic IoT devices have primarily been used in dense, urban areas and homes because of their reliance on existing wireless network technologies such as Bluetooth, WiFi, ZigBee, all of which rely on devices being located in close proximity to each other, in order to reliably transmit data to the human operator. However, with the emergence of new technologies such as LoRa and ultra low power hardware, it is now possible to use IoT devices in remote, rural areas, and thus gather data from a larger geographical surface area, which enables greater coverage and data acquisition from areas which were previously difficult to monitor. The sensor system design is a distributed IoT

network that can be used to detect and monitor remote fires and other hazardous conditions to aid humans to better respond to these threats and prevent large scale fires and other infrastructure damages. The project is a robust and smart monitoring system for the early detection of forest fires using a vast list of emerging technologies by creating an Internet of Things (IoT) wireless network which utilizes sensors to collect and transmit data to already existing web technologies. These web technologies, which consist of databases and data visualization dashboards, can be used to visualize the data and provide meaningful feedback in a fast and efficient manner. While priority for the device itself is for it to be low power and high efficiency given the challenge of the sensors being geographically distant from each other. The intention is to deploy this system of sensors and data acquisition pipeline in a forested region outside of urban areas, one that is prone to dry weather or extenuating weather conditions with the purpose of aiding in the early detection of forest fires. The inspiration for building such a system came from the spread of California forest fires (which have been cropping up on the news in recent years due to climate change) and how they could have been prevented if there was low cost and low power sensing system in place to help alert and inform human operators about the instance of forest fires. If such a system were both electrically, economically, and commercially viable, it would go a long way in aiding first responders or other related human operators in charge of dealing with disasters involving forest fires, by providing early alerts and improving response time and ultimately, lead to early detection and prevention of any such future events. Each of the sensing nodes, which comprise of an MSP432 microcontroller is interfaced with an air quality sensor, a wireless Wifi module which communicates via I2C, and temperature, humidity and barometric sensor pack which directly attaches to the MSP432 as a pluggable module and communicates via I2C. The device itself will stay in low power mode and will wake up periodically to use the

sensors to detect if there is a fire. Each of the sensing nodes runs firmware that that allows the hardware components listed above to properly acquire data and send it to the MSP432 microcontroller, which then pipelines this data to the Wifi module, in order to ensure that the data is transmitted to the Wifi receiver attached to the Linux server. Multiple sensing nodes will communicate with a Linux server which utilizes a Wifi module to receive data from the sensing nodes and then software takes the data coming in and ensures that the data is properly timestamped and stored in a time-series database software. Then there is a web application running on the Linux server which is integrated with the database that has been acquiring the data from all the sensing nodes, and the web application will be in charge of taking all the data points and creating a visually appealing user interface that lets the human operator monitor all the sensor readings coming from all the geographically scattered sensor nodes. the human operator can then use this platform to detect anomalies (such as temperature spikes, drop in humidity, smoke detected by the air quality sensor) which may suggest the existence of forest fires, and take appropriate action based on the data. Introduction A growing number of people are impacted by wild fires every year, and thus impacted by technology to fight them. This has created many political, social, and economic issues around fighting wild fires. Several political questions currently involving forest fires such as should governments have a role in paying for the damages of forest fires, including the refugees, housing shortages and rebuilding wildfires induce. Wildfires take many resources to fight, including in the aftermath. This creates many economic issues around the fires. The current incentives economically for fighting fires, outside of the government, are insurance company homeowner policies. As claims grow in expense, insurance companies are hiring and paying for private protection of neighborhoods covered by their policies. Social class is also an issue involved in wildfires, as the wealthy can afford

insurance policies to protect their homes with private firefighters, while that is not affordable or attainable for most people to protect their homes with. There are also issues in terms of racial issues in wildfires, as many areas endangered by wildfires have high concentrations of minorities such as immigrants who work as farm workers or native land reservations for example. Into this landscape emerges the question of how does emerging of fire detection technology, with its own complicated ethical and social issues, effect the complex web of social, economic and political issues around wildfires. Fire detection technology consists of several types of systems, the main ones being forest towers, sensor platforms or satellite imaging. IOT detection systems interact with current economic problems by having added cost, as well as involving internet access, which could be complicated for areas without access to WIFI or could be an economic benefit of expanding access to the internet. IOT detection systems also raises ethical concerns to blanket these sensors across an area. Some such proposed systems contain camera and location data, raising questions about privacy as these devices would always be collecting images and data which could include people. An important question would be what kinds of surveillance are possible with IOT fire detection systems, specifically in what kind of data can they generate that may possibly create major privacy concerns. Research Question There are many different questions involving how fire detection technologies effect the wicked problem of wildfires, but in general they can all be phrased as “How does fire detection systems, such as IOT sensor platforms, impact the social, political, economic, and ethical issues in communities impacted by wildfire?”. Breaking this main question into smaller questions lead to answering each of these branches in turn. These smaller questions branch into how different aspects of this problem are affected by the technology. An example of such a branching question is “would having more data and sensors change human behavior around fire culture?” Answering and exploring that

question further opens how social behaviors that cause wildfires may change if presented with evidence collected from an IOT device of a human cause to a wildfire. Another question into the social and economic questions of this issue is “would people want to pay the cost of IOT sensor networks even if they show benefit?”. Ethically, the major question to answer is “are most people concerned with potential privacy breaches from such technology?”. In answering these branching questions, a couple key groups stand out, as minority and less economically well-off groups may be impacted differently by such technology, and should be given special attention to. The method proposed to try to answer these questions is to survey and interview people to understand how qualitatively and quantitively how they understand and how they feel about these issues. Overall, this question would look at the overall conscious impact of fire detection systems on how people in terms of their social, economic, and ethical impact. Literature Review When looking at the scope of this issue, it is useful to look at the overall history of the science of wild fires. The history of firefighting is lead by government actors creating technology to detect fire and prevent their spread. The first of these efforts inside the United States is denoted by NIFC (2001) as being termed the “10am policy” of fire suppression, which name comes from the time a fire should be detected from a watch tower and then put out. That leads into introducing the first and most widespread wildfire detection technology of watchtowers, and it is an active technological field today with research of Bao (2006) to optimize the placement of such towers across a forest. As outlined by NIFC (2001) and the history of fire response, how fires have been managed has changed significantly from all fires must be stopped and contained to recognizing that wild fires do have useful effects on forests and their environment. One of those effects was shown by Haase (1998) as how giant Sequoia’s need fire in able to allow new growths of California’s giant Sequoia trees. This has created more need to monitor fires for danger; since

some fires prove beneficial and only need to be controlled and contained. In wildfire fighting, many different people have stakes in the issue of containing a fire and what areas can be protected or not. That leads to having certain groups left out or not fully considered in the planning and protection from wildfires. Ojerio (2011) shows this problem in vulnerable populations such as Native American peoples for Federal fire protection programs. Literature specifically along the lines of the research question as applied specifically to fires is sparse; although there is much research into how IOT may impact global disasters, such as from Yu (2018) who looks at how big data and sensor technologies could impact minority communities before and during a disaster management response. That kind of analysis could be useful here as there is historic bias in fire response. There is also extensive research about IOT and some problems and challenges the technology presents. Bojanova (2015) looks at how the environmental impact of IOT technology and economics of sustainability to produce it. That is one of the ethical issues which participates will be asked about, so research into the actual costs involved is needed. Daj (2016) does a economic analysis of IOT and there direct application to fire systems, which is useful. Other research reviewed was how McCaffrey looks issues surrounding trust in different communities for if and when they would heed warnings for wildfire evacuations (2017). As well as McCaffrey's paper on peer pressure and how it relates to people's decisions to mitigate fire risk (2011). In particular this research is closest to looking at some of the core questions of this research question. McCaffrey's research is going to be used in this research to follow some methods of analyzing how to study social pressure in participants, especially related to disasters such as wildfires. The literature reviewed shows a clear picture of the history of wildfires and responses to wildfires, while also then looking at other research in the field. The other research such as that by McCaffrey, will be used in forming some key

aspects of research to be conducted. STS Framework and Method The major STS framework around this question is ANT theory where a network works with human and inhuman actors to produce the ongoing network of people's responses to wildfires. This theory would provide explanation to look at any kind of translational message of such a IOT sensor system to see if it changes any paradigm around issues of wildfires or not. The main method to explore this question is going to be primary data sources. Primary in collecting survey data and then interviewing a smaller population who took the survey. The survey will ask information in a quantitative way, such questions included will be how much money they would be willing to spend on a sensor system around their home, or how the increase of taxes they would be willing to have for the government to put a system around where they live. A survey would also need to have participants of a certain number and diversity to make it work as a research tool. That means the design of the survey needs to be such that it can be asked to a wide audience both currently impacted by fire and not. Most of the questions therefore are to be designed to look specifically at different scenarios, and questions of technology, and record their responses. The survey would also want to collect some demographic data to better understand and account for minority groups in the results. Also, doing a survey means that there needs to be controls onto biases of the expected responses and questions themselves to prevent any bias from creeping into the results, for example, the survey shouldn't include questions such as "would you feel safer with a fire detection system around your house?" as that question would imply to a reader that they would be safer, which is why the results will focus closer to a quantitative measurement. The interview portion of research will be smaller, depending on the size of survey pool, is expected to be between five to ten interviews. The interviews would focus on some of the questions asked in the survey and try to understand a qualitative response from the participant.

The participant would then be presented with different scenarios that would look at detection technology specifically, but others would look to find out a participant's biases and create metadata around their responses to understand their frame of mind. The main data to try to find out how people feel in different scenarios, with fire detection technology and without it to analyze the effects of implement such technology and societal responses to it. Obviously, that means that the research would need to analyze the notes taken from the interview and then later aggregate them to make sense of the responses in total. Using the survey and interview results in tandem should answer the question raised to analyzed to understand how people interact with such sensor systems. Timeline There will be two weeks to plan and distribute the planned survey and gather data. After that, there will be three weeks to collect and obtain a response. In total, that would be five weeks to collect and receive the data and information back. Given that, there should be another two weeks to analyze and study the data received and write an analysis of it. Conclusion With so many issues already around wild fires themselves, there is significant questions about how new technologies could impact the current framework. To study the impact that those technologies may have, this prospectus would raise qualitative research into how individuals would feel in different scenarios of different fire detection technologies. With enough diverse participants, several thorny ethical and social questions could be looked at and it could be concluded some of the qualitative life impacts of such technology in the groups surveyed.

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