**Data Collection**

**Survey Design and Structure**

The data used in this study were obtained through an online survey aimed at assessing various aspects of wildland fire management in South Africa. The survey was meticulously designed to capture both qualitative and quantitative information, addressing key areas of wildland fire management practices. The core objective of the survey was to understand the perceptions, experiences, and knowledge of respondents on wildland fire incidents, fire response strategies, recovery initiatives, and readiness efforts. Additionally, the survey sought to gather personal and professional demographic data to contextualize these responses within different societal and occupational groups.

The survey was structured to encompass a range of open-ended and multiple-choice questions, ensuring that the data collected allowed for both statistical analysis and deeper qualitative insights. The inclusion of open-ended questions enabled respondents to provide detailed, narrative responses on specific topics, while the multiple-choice format facilitated more structured and easily comparable data. This mixed-methods approach allowed the survey to capture both the breadth and depth of respondents’ experiences and perceptions related to wildland fire management.

Below is a detailed breakdown of the key areas covered by the survey:

**Review and Analysis**

This section focused on understanding the broader impacts of wildland fires and analyzing specific aspects of fire management strategies in South Africa. Questions in this section aimed to capture respondents' insights on:

* **The negative impacts of wildland fires**: Respondents were asked to identify the three most unwanted effects of wildfires, with responses ranging from loss of life to destruction of biodiversity and economic assets.
* **Positive outcomes**: The survey inquired about the three most desirable effects of prescribed burns or fire management strategies, focusing on ecological benefits such as species diversity or land regeneration.
* **Success factors and areas for improvement**: Respondents provided their views on the most successful aspects of fire management in South Africa and identified areas that need improvement. This included both managerial practices and ecological outcomes.
* **Knowledge sharing**: The survey asked for aspects of fire management in South Africa that could be shared with other African nations, encouraging a comparative analysis of management practices across regions.

**Risk Reduction**

The risk reduction category of the survey explored respondents’ perspectives on the causes and prevention of wildfires. This section aimed to identify:

* **Causes of wildfires**: Respondents were asked to specify the top two causes of human-originated wildfires, with options such as arson, agricultural burns, or negligent use of fire.
* **Preventive measures**: Open-ended questions inquired about measures that can mitigate the risk of wildfires. Respondents shared their thoughts on firebreaks, community awareness programs, and policy measures designed to reduce fire risks.
* **Intentional fires**: The survey sought respondents' opinions on the potential motivations behind intentional fires (ignitors), exploring underlying reasons such as land clearing, cultural practices, or malicious intent.

**Readiness**

This section of the survey evaluated the level of preparedness within communities and organizations to respond to wildland fires. Respondents provided information on:

* **Training programs**: The survey asked about the existence and efficacy of national training programs or certification processes for fire management personnel. Respondents shared their experiences or knowledge about the availability and quality of such programs.
* **Sufficiency of personnel**: Questions were aimed at assessing whether there were enough trained professionals to handle wildland fires in the respondents' communities. This section provided insight into the operational readiness of local fire management agencies.
* **Professional training**: The respondents also discussed whether wildland fire suppression brigades were adequately trained and equipped to handle fires effectively. This involved gauging the overall level of skill and readiness within different regions.

**Response**

The response section of the survey delved into the operational capacity of communities and organizations when dealing with fire incidents. This section captured information on:

* **Incident command systems**: Respondents were asked about the utilization of formal Incident Command Systems (ICS) during fire incidents in their communities. ICS is a standardized, on-scene, all-hazards incident management approach, and its presence was an indicator of organized fire management.
* **Equipment and resources**: The survey sought to understand the types of firefighting equipment and resources available in the community, such as fire trucks, water tenders, helicopters, or personal protective equipment. Respondents indicated whether such resources were government-provided or locally sourced.
* **Operational challenges**: Respondents also identified gaps in equipment, personnel protection, and tactical resources that may hinder the effectiveness of fire response operations in their areas.

**Recovery**

This category focused on the strategies and support systems available for community and ecosystem recovery after wildland fire events. Key themes included:

* **Community support programs**: Respondents were asked whether there were formal programs in place to assist communities in recovering from the effects of damaging wildfires. This included financial aid, mental health support, and rebuilding efforts.
* **Ecosystem restoration**: The survey examined the availability of restoration guidelines or initiatives aimed at rehabilitating fire-affected ecosystems. Respondents shared their knowledge about biodiversity recovery efforts and whether they adhered to standardized environmental restoration practices.

**Demographic Information**

In addition to the thematic questions about fire management, the survey collected detailed demographic data to enrich the analysis. This information helped profile the respondents and provided context to their responses. The demographic data collected included:

* **Gender and race**: This allowed for an analysis of how experiences and opinions varied across different demographic groups.
* **Geographical location**: Respondents were asked about the province and district in which they primarily resided, providing insight into regional differences in fire management experiences and challenges.
* **Occupation**: Respondents provided details about their professional background, particularly if they worked in fire management, environmental conservation, or related fields.
* **Demography**: The collected demographic data were synthesized into a "Demography" field, which combined race, gender, and location to allow for a quick and comprehensive view of the respondent’s background.

This survey design enabled the collection of rich data across multiple dimensions of wildland fire management. By structuring the questions to cover the key areas of *Review and Analysis*, *Risk Reduction*, *Readiness*, *Response*, and *Recovery*, the survey captured both operational and ecological perspectives on fire management in South Africa. The inclusion of demographic information further allowed for analysis that considered how fire management experiences and challenges varied across different societal groups and regions.

**Approach to data Processing**

**Step 1: Data Collection and Initial Cleaning**

The data collection process was facilitated through an online survey, where respondents from South Africa provided information related to wildland fire management. The survey included both demographic data and open-ended responses addressing various aspects of wildland fire incidents, preparedness, and impacts. Respondents were asked to provide their perspectives on topics ranging from fire management strategies to the ecological impacts of fires in their communities.

Once the survey data was collected, it was exported into a structured format, typically a spreadsheet. The raw dataset included a mix of respondent information, answers to survey questions, and metadata, such as the start and end dates of the responses.

The first step in the processing workflow involved cleaning this raw dataset. This process was necessary to ensure the data was in a usable format, free from irrelevant columns and missing or inconsistent values. Irrelevant columns, such as "IP Address" or optional contact information fields, were removed to focus on the core survey responses. In cases where missing data were encountered, a decision was made to either drop the incomplete entries or fill them with appropriate placeholder values to maintain data integrity.

At this stage, the dataset was saved in its cleaned form, providing a standardized foundation for further processing. The cleaned data included the respondent's demographic information and answers to specific survey questions.

**Step 2: Categorization of Survey Responses**

The second step of the process involved categorizing the responses into predefined categories based on the subject of each question. The survey questions were divided into six primary categories: *Response*, *Readiness*, *Recovery*, *Risk Reduction*, *Review & Analysis*, and *Miscellaneous*. Additionally, there was an *Additional Insight* category for questions that fell outside of the predefined categories.

The categorization process was guided by a keyword-based mapping strategy. Each survey question was analyzed against a predefined set of keywords associated with the different categories. For example, questions involving fire management personnel, equipment, and firefighting tactics were categorized under "Response," while questions related to training programs or preparedness efforts were classified under "Readiness." This mapping required a deep understanding of the survey structure and content.

This step also involved developing an algorithm capable of detecting key phrases within the questions. The algorithm worked by scanning each question, matching it against a list of predefined keywords, and assigning the appropriate category based on the content of the question. This categorization allowed the responses to be organized by theme, making it easier to analyze the data within each respective field.

The output of this step was a newly categorized dataset that included the respondent ID, the category of the question, the question itself, and the corresponding response.

**Step 3: Merging Demographic and Categorized Data**

The third and final step involved integrating the demographic information of each respondent with the categorized survey responses. The demographic information included fields such as race, gender, province, and occupation. The goal was to enrich the categorized data by including these demographic details, allowing for a more comprehensive analysis of the responses.

To achieve this, the cleaned dataset (which contained demographic information) was merged with the categorized dataset (which contained categorized survey responses). This merge was based on the respondent ID, ensuring that each response was linked to the corresponding respondent’s demographic data.

A key challenge in this step was ensuring that the demographic fields, such as race, gender, and province, were appropriately aligned with the responses. The solution was to harmonize these fields, ensuring consistent formatting and handling any missing data carefully. In cases where respondents did not provide certain demographic details, placeholder values were used to maintain the structure of the data.

To further enhance the analysis, a new field, "Demography," was created by concatenating the race, gender, and province information into a single field. This allowed for a quick view of the respondent's demographic profile alongside their responses.

The final dataset consisted of the following columns: *Respondent ID*, *Category*, *Question*, *Response*, *Race*, *Gender*, *Province*, *Occupation*, and *Demography*. This structure enabled detailed analysis across multiple dimensions, such as understanding how responses varied by demographic group or region.

The data collection and processing methodology detailed here ensured that the survey responses were meticulously cleaned, categorized, and enriched with demographic information. By following this structured approach, the data was prepared for deeper analysis, making it possible to draw meaningful insights about wildland fire management practices and their impacts across different regions and demographic groups in South Africa.

**3. Analysis Strategy**

The analysis strategy was designed to extract insights from the South Africa Wildland Fire Survey by focusing on the relationships between respondents’ demographic information and their responses across different categories of questions. This section details the methodological approach used for the analysis, focusing on the comparative and correlation-based frameworks applied to the dataset.

**3.1 Approach to Comparative Analysis**

The comparative analysis aims to understand how different demographic groups responded to the survey's various questions. The focus is on identifying patterns and trends across groups such as gender, race, province, and occupation, and how these groups perceive and interact with the topic of wildland fire management.

The comparative analysis begins by filtering the dataset to isolate responses to a particular question. Once the relevant data is extracted, the responses are further grouped based on a selected demographic, allowing for the comparison of answers across different respondent profiles. This helps to highlight the influence of factors such as location or occupation on attitudes toward wildland fire management.

For example, if analyzing responses to the question, “What are the top two causes of human-originated wildfires?” the data would be grouped by the selected demographic (e.g., province). The responses would then be compared across provinces to reveal whether geographic location has a significant impact on perceptions regarding wildfire causes.

The results of these analyses are visually represented using different types of charts, such as bar charts or pie charts, depending on the data structure. The choice of visualization method is driven by the need to present the comparative findings in a clear and interpretable manner. Bar charts are commonly used to show frequency distributions across different demographics, while pie charts are employed to depict the proportional breakdown of responses within each demographic group.

**3.2 Approach to Correlation Analysis**

Correlation analysis, in contrast to comparative analysis, aims to uncover potential relationships between responses to different survey questions. This analysis is valuable for identifying underlying patterns between different aspects of wildland fire management, as perceived by the respondents.

The correlation process starts by selecting two questions that are hypothesized to have some form of interdependency. For instance, responses to a question about the sufficiency of firefighting equipment may be correlated with responses regarding the preparedness of fire brigades. The responses to both questions are merged, allowing for the examination of how often certain responses to one question co-occur with specific responses to another.

Once the data is merged, a contingency table (or crosstab) is constructed to cross-classify the responses to the two questions. The strength of the relationship between the responses is visually represented using heatmaps. Heatmaps are particularly useful for displaying correlations because they allow for the clear visualization of associations between different response categories. Darker colors in the heatmap signify stronger correlations, while lighter colors indicate weaker or no correlations.

The correlation analysis provides insights into how different aspects of wildland fire management are interlinked in the perceptions of the respondents. For example, it can reveal whether respondents who believe that equipment is inadequate are also more likely to view community preparedness as insufficient. This type of analysis offers a more nuanced understanding of the challenges and opportunities in fire management, as seen by the surveyed population.

**3.3 Integration of Demographic Data in Analysis**

A critical aspect of the analysis involves integrating respondents’ demographic data to provide additional context to their answers. The demographic data collected, including race, gender, province, and occupation, was systematically integrated into the analysis to allow for richer interpretations of the results.

In the comparative analysis, demographic information acts as the key factor for segmenting the data. This segmentation allows for comparisons between different groups and helps identify how personal and professional backgrounds influence perspectives on wildland fire management. For example, examining responses from individuals in different occupations, such as firefighters versus foresters, reveals how roles within the fire management ecosystem shape perceptions.

In the correlation analysis, demographic data does not directly affect the calculation of correlations but helps in understanding the broader context of the relationships between different responses. Demographic insights add depth to the findings, offering possible explanations for why certain responses are associated with each other.

**3.4 Response Distribution and Top-N Analysis**

In order to manage large datasets and focus on the most significant findings, the analysis includes a Top-N approach. This involves selecting the top N most frequent responses for analysis, which ensures that the most impactful or commonly held views are prioritized in the analysis. The Top-N responses provide a clearer picture of general sentiment without being overwhelmed by outliers or less common opinions.

For example, in a question where respondents are asked about the most frequent causes of wildfires, only the top 20 responses might be visualized, allowing for more focused insights on the primary drivers of wildfires as perceived by the majority of respondents.

**3.5 Analytical Flexibility and Customization**

The analytical approach is flexible and customizable, allowing for a variety of combinations of questions, demographics, and analysis types. Users can choose to focus on specific survey questions or explore the relationships between multiple questions. The ability to switch between comparative and correlation analysis ensures that a broad range of analytical insights can be uncovered, depending on the research goals.

This flexibility supports the broader aim of the survey analysis, which is to not only understand respondent perceptions but also to derive actionable insights that can inform policy and operational strategies in wildland fire management. The data-driven approach allows stakeholders to identify key areas for improvement, assess the efficacy of existing programs, and prioritize future research and interventions.

**3.6 Using Streamlit for Exploration and Visualization**

To facilitate interactive exploration and visualization of the survey findings, the analysis was implemented in a web-based application using **Streamlit**. Streamlit provides a flexible and user-friendly platform that allows users to dynamically filter and analyze the data by selecting different categories, questions, and demographic attributes through an intuitive sidebar interface. This approach enables stakeholders, researchers, and decision-makers to engage with the data in real time, making it possible to generate insights quickly based on specific interests or concerns.

The app allows users to perform comparative or correlation analyses across various survey questions, providing tailored visualizations such as bar charts, pie charts, heatmaps, and line charts. Users can select the type of analysis they wish to perform, along with the chart type, to best represent the relationships and trends they are interested in exploring. This interactive capability is critical for presenting complex datasets like the South Africa Wildland Fire Survey in an accessible manner, helping users to gain actionable insights without the need for advanced technical expertise.

A detailed step-by-step guide on how to use the Streamlit app for exploring and visualizing the data can be accessed here <https://github.com/desmond-lartey/Wildfire-Assessment/blob/Fires/README.md>. This guide will assist users in fully leveraging the interactive features of the app to perform their own customized analyses.

**Findings and Analysis of Wildland Fire Management in South Africa**

In the survey responses, we found significant insights into the perceptions and experiences surrounding wildland fire management across various regions in South Africa. These findings are organized under the five thematic areas of fire management: **Review and Analysis**, **Risk Reduction**, **Readiness**, **Response**, and **Recovery**. By examining these areas, we observed notable patterns that reflect regional, demographic, and gender-based differences in experiences and perceptions related to wildland fires.

**1. Review and Analysis**

Our findings indicate that 58% of respondents either "somewhat agree" or "strongly agree" that wildland fires have substantial unwanted effects on their communities. This result highlights the widespread recognition of the detrimental impacts associated with these fires. Notably, respondents in the **Western Cape province** expressed heightened concern, with 11 out of 19 participants in this region "strongly agreeing" about the severe negative impacts of wildland fires. This suggests that certain areas in South Africa are particularly vulnerable to the effects of wildland fires, likely due to local environmental conditions or higher fire frequency.

Demographically, we found that **Black respondents** were more likely to express concern about the unwanted effects of wildland fires, with 46% of respondents in this group indicating agreement. This could point to increased exposure to wildland fire impacts or heightened awareness within this demographic. Additionally, **male respondents** were more likely to "strongly agree" about the negative effects of wildland fires compared to females, suggesting that men in the survey may have had more direct encounters or negative experiences with wildfires.

**2. Risk Reduction**

In terms of risk reduction, our analysis revealed that **arson** was identified as a leading cause of human-originated wildfires, mentioned by 17 respondents. This was closely followed by **negligence**, cited by 7 respondents. Interestingly, when asked about intentionally set fires, 41 respondents identified arson as the primary motive, while other significant reasons included **grazing** (16 mentions) and **fuel management** (11 mentions). These findings suggest that while arson remains a major concern, fire management practices related to grazing and fuel management are also contributing factors.

From a gender perspective, we observed that **female respondents** particularly highlighted arson as a significant concern behind intentionally set fires. This could reflect safety concerns or experiences that women associate with these types of fires, indicating gendered differences in perceptions of fire causes.

**3. Readiness**

When evaluating the readiness of personnel to manage wildland fires, our results indicate mixed perceptions. While 29% of respondents "somewhat agree" that there are sufficient personnel to deal with wildland fires, 23% "strongly disagree," highlighting a significant divide in the perceived preparedness. Regional analysis shows that the **Western Cape** once again stands out, with 7 out of 19 respondents "strongly disagreeing" about personnel readiness, pointing to localized concerns in fire management capacity.

Regarding **brigade training**, we found that 42 respondents "somewhat agree" and 33 "strongly agree" that wildland fire suppression brigades are professionally trained and equipped. This positive outlook on brigade readiness was more prevalent among **Black and Coloured respondents**, who were more likely to express confidence in the brigade’s preparedness compared to **White respondents**. This demographic difference suggests varying levels of engagement or exposure to fire response efforts across communities.

**4. Response**

Our findings on the response capabilities to wildfires show that a substantial number of respondents, 36 "strongly agree" and 36 "somewhat agree," believe that a **Formal Incident Command System** is utilized in their communities. This indicates a generally positive perception of the structured mechanisms in place for managing fire incidents. However, we also noted regional disparities, with respondents in the **Western Cape** showing stronger agreement (8 out of 19 "strongly agree") compared to mixed perceptions in **Eastern Cape** and **Gauteng**.

In terms of **equipment provision**, 75 respondents either "strongly agree" or "somewhat agree" that firefighters are adequately equipped. However, 17 respondents expressed concerns about the quality or availability of equipment, suggesting that while most respondents view the equipment as sufficient, there are areas where improvements may be necessary. Gender-based analysis revealed that **female respondents** were slightly more optimistic about the provision of equipment compared to males, possibly indicating different levels of exposure to equipment inadequacies or a more positive perception of firefighting efforts among women.

**5. Recovery**

When it comes to recovery efforts following wildland fires, we found that 42 respondents either "somewhat agree" or "strongly agree" that there are **restoration guidelines** in place for ecosystems affected by wildland fires. However, a substantial proportion of respondents (32) expressed concerns, either "somewhat disagreeing" or "strongly disagreeing," suggesting that recovery programs may not be uniformly effective or adequately communicated.

Regional data suggests disparities in recovery perceptions, particularly in the **Western Cape**, where responses were mixed regarding the presence of support programs and restoration guidelines after damaging wildfires. In terms of gender, **male respondents** were more likely to "strongly disagree" about the effectiveness of recovery programs compared to females. This may indicate that men in the survey have had more direct experiences with post-fire recovery efforts and found them lacking.

**Summary of Key Insights**

Our findings provide a comprehensive understanding of the perceptions surrounding wildland fire management in South Africa. The **Western Cape** stands out as a region of heightened concern, particularly regarding personnel readiness, response effectiveness, and recovery efforts. Additionally, **demographic insights** highlight differences in perceptions between **Black** and **White respondents**, as well as notable **gender-based differences**, particularly in terms of equipment provision and concerns about arson.

In conclusion, while there is a general recognition of the challenges posed by wildland fires, the regional and demographic disparities highlighted in our findings point to the need for targeted fire management strategies that consider the unique vulnerabilities and perceptions across South Africa.