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Visualization of Flood Intensity Level Data and Identification of Priority Flood Affected Areas in Jakarta

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Abstract. Flooding is a major problem in Indonesia, with Jakarta as one of the most affected cities. This study aims to analyze the pattern of flooding events by month and year, the severity of flooding in various administrative areas, sub-districts, and villages, and determine areas that need better water infiltration systems in Jakarta. Data from the National Disaster Management Agency (BNPB) and the Kaggle platform were used to analyze the 2013-2020 period. The research method includes data collection, cleaning, and implementation in Tableau software, visualizations were created to identify patterns, trends, and distribution of flood impacts. Results showed that January and February had the highest frequency of flooding, 480 and 510 events respectively. 2020 recorded 993 flood events, the highest compared to the previous year. North Jakarta was the most affected region with 9,760 evacuation sites, while Central Jakarta had the least, 70 sites. Penjaringan and Pluit sub-districts recorded the most evacuation sites, with 5,270 and 4,650 respectively. North Jakarta and West Jakarta need improved water catchment systems, with inundation durations of 22.47 and 19.51 hours, respectively. Tambora and Tamansari sub-districts showed the longest inundation duration, 45 and 60 hours respectively, while Kedaung Kaliangke and Tambora sub-districts recorded the highest inundation duration of 150 and 100 hours respectively. This research is expected to provide important insights for the government in formulating flood mitigation strategies and improving urban resilience.

Keywords: *Flooding, Jakarta, Flood Occurrence Pattern, Flood Severity, Administrative Region, Water Infiltration System, National Disaster Management Agency (BNPB), Data Visualization, Flood Mitigation, City Resilience.*

1. Introduction

Floods are often a major concern due to their high frequency and widespread impact, as is the case in Indonesia, where the frequency of flood disasters ranks the highest in the world among other types of natural disasters, and ranks third out of 8 major disasters that often occur in Indonesia throughout 2019 (Darwati & Setianingsih, 2021). Floods, as one of the frequent natural disasters in Indonesia, have a significant impact on society, as seen from the visualization of the impact of floods in all Indonesian provinces through the use of business intelligence on the National Disaster Management Agency dataset from January 2008 to January 2023, which shows West Java province as the most affected, with the highest number of damaged houses and public facilities and the most victims. (Triyanto et al., 2023) Every year, Indonesia experiences a rainy season

whose intensity can be a trigger for flooding in various regions, considering that Indonesia is a tropical country traversed by the equator so that the rainy season in Indonesia is very frequent. (Gumilang, 2023)Floods often cause major losses such as damage to homes, loss of goods, damage to physical and social infrastructure, and disruption to the economic and social activities of the community. Flooding is a problem that often occurs in many areas in Indonesia, especially in areas with high population density, such as in urban areas. (Safitri et al., 2022) The increasing trend of urban flooding events in Indonesia during the rainy season is increasingly visible, especially in Jakarta (Gunawan, 2020), as reflected on January 2, 2020, the day after widespread flooding in the Jakarta area, where the mass media gave a special portion to the Jakarta flood news, using the event as a headline (Pinontoan & Wahid, 2020).

Jakarta has a significant level of risk to flood disasters. (Taryana et al., 2022) Given that factors such as topography, extreme weather, and vulnerable infrastructure can exacerbate the impact. (Pinontoan & Wahid, 2020) The economic impact of flooding is also a serious concern, although it has decreased over time. In January 2020, economic losses due to flooding reached IDR 960 billion, although this amount was smaller compared to previous flood events. However, the impact is still significant and affects around 0.025 percent of DKI Jakarta's Gross Regional Domestic Product (GRDP). (Findayani Aprilia, 2019) Floods result in huge economic losses, including damaged homes and submerged goods, cars and motorcycles. Physical and social infrastructure is also damaged, such as school buildings, houses of worship, health centers. (Ginting, 2020) One of the factors causing flooding in the city of Jakarta is because around 40% of Jakarta has a lower elevation than sea level. (Widodo, 2019) Development often takes place in areas that are actually in the floodplain, which should be allowed for limited development appropriate to the characteristics of the area. Despite efforts to improve drainage infrastructure and watershed rehabilitation, flooding still remains a significant threat to the city. Observations of the flooding on January 1, 2020 showed that the main factor causing the flooding was a decrease in the area of water catchment due to widespread residential development in the Ciliwung Watershed, which led to an increase in the surface flow of rainwater. (Roby Dwiputra et al., 2022) Data shows that relatively high rainfall, even daily rainfall reaching 300 mm/day, has caused flooding to spread in various parts of Jakarta. The diverse distribution of rainfall in the Ciliwung and Cisadane watersheds shows that flooding does not only occur in the downstream areas but also in the upstream and middle areas of the watershed. (BPPTPDAS Surakarta, 2020)

Data visualization is the graphical depiction of information or data intended to facilitate understanding, analysis, and communication. The main goal is to convey information clearly and effectively through visual representations. (Wahjoerini et al., 2022) Data visualization can be used to identify areas that require immediate assistance for individuals facing social welfare problems. (Aryanto Lende et al., 2021) As with evacuation or distribution of humanitarian aid, coordination across local government organizations in flood management has a crucial role in achieving

productivity, efficiency, and effectiveness, as observed in research on coordination across local government organizations in flood management. (Septi Dwi Wulandari & Rahmat Salam, 2022) To address this issue, visualization of flood phenomena in Jakarta is important to assist the government in improving the city's resilience to flooding and reducing its negative impacts on society and the environment, as required in flood management that aims to reduce flood losses and secure national road access. (Priambodo & Kamis, 2022) This visualization is not only the basis for setting targets for flood adaptation infrastructure development such as the construction of levees, drainage channels, and floodgates, but it is also the objective of the study to visualize flooding and see the extent of flood inundation areas. (Pratiwi & Santosa, 2021)Increasing the capacity of Jakarta's drainage system, including the development of green infrastructure concepts such as rain gardens, also needs to be considered to slow down the flow of water and increase infiltration, especially given the change in land use from infiltration areas to impermeable areas in DKI Jakarta areas, as observed in Cempaka Putih Sub-district, which is densely populated and still faces flooding or inundation problems. (Sumberdaya et al., n.d.) Thus, visualizing the severity and priority areas affected by flooding in Jakarta will be a useful tool for the government in making strategic decisions to reduce flood risks and improve preparedness in the face of such disasters.

Research on flooding in Jakarta has great potential to provide important insights into how to better manage disasters and plan cities. By analyzing data from 2013 to 2020, this research reveals the patterns and locations of flooding and the severity of its impacts in different areas. The focus on five administrative regions allows for in-depth comparisons, while determining locations for more efficient water catchment systems shows practical ways to apply the findings. The benefits for local governments include helping to formulate better strategies for dealing with flooding. It also enhances the authors' reputation in natural disaster research, provides important information for government decisions on sustainable urban development, and identifies areas vulnerable to flooding. By identifying the most vulnerable areas, the government can allocate resources more effectively and implement sustainable infrastructure solutions. On an individual level, this research increases understanding of flooding and possible solutions, providing benefits for career development and wider social contributions. As such, this research is not only academically and practically important, but also has a significant social impact by supporting sustainable development efforts and improving the quality of life of Jakarta residents.

2. Literature Review

2.1. Natural Disaster

Natural disasters refer to natural events that have serious consequences for human populations (Sigit, 2019) Since the beginning of the year until December 4, 2017, there were 2,175 disaster events recorded in Indonesia, such as floods, tornadoes, landslides, forest and land fires, floods with landslides, droughts, earthquakes, and volcanic eruptions. According to Sutopo Purwo Nugroho, head of the information data center and public relations of BNPB, disaster events in Indonesia continue to increase from year to year.

Based on the magnitude of the impact of natural disasters on people's lives, the importance of community preparedness must be realized to anticipate their impact. The increasing intensity of disasters is influenced by global and regional environments such as global warming, climate change, and rising temperatures and sea levels, which increase the chances of natural disasters. The impacts of natural disasters, especially weather-driven hydrometeorological disasters such as landslides, droughts, tornadoes, and forest fires, have caused large numbers of deaths, injuries, and displacement and suffering. The resulting damage is also significant, with thousands of homes damaged, health, education and worship facilities damaged. The high incidence of natural disasters should encourage better preparation from individuals, families and communities, to anticipate their impact and minimize losses and casualties. However, the reality is that community preparedness in dealing with the impact of natural disasters is still low, indicating that anticipation of natural disasters is still not optimal. Therefore, appropriate efforts are needed to improve community preparedness and overcome these conditions (Dr. Hj. Sri Rahayu Pudjiastuti, 2019).

2.2. Flood Disaster

According to Hediyanti and Rianti (2021), flooding is a situation where the flow of river water has a discharge that exceeds the norm due to rainfall that occurs in upstream areas or certain areas continuously, thus exceeding the tamping capacity of the existing river channel. Flooding generally refers to a situation where the flow of water in a river has a high volume, or its discharge exceeds normal conditions so that it exceeds the capacity of the river channel and causes inundation in the vicinity. According to Herlina (2019), this phenomenon can be caused by continuous rainfall upstream or in certain areas, so that the river channel is unable to accommodate the water. Flooding can cause physical and material losses and is a natural disaster that often occurs when river water overflows and exceeds its normal limits. One of the main factors causing flooding is when heavy rainfall occurs over a long period of time, causing river water to overflow and exceed its capacity.

2.3. Flood Impacts

Floods can have significant impacts on the affected communities. These impacts include: Material Losses, where flooding can cause huge material losses to the affected communities. Many homes and household furnishings are flooded, causing damage that is costly to repair. Building Damage is also a significant impact, where buildings that are flooded have the potential to suffer damage, such as damaged floors, door frames, and lower walls. In addition, flooding can also cause the surrounding environment to become dirty and muddy due to stagnant water that passes around settlements. This can increase the risk of exposure to diseases in flood-affected communities. Flooding can also disrupt the smooth flow of traffic by inundating roadways, causing disruption of mobility and even damage to vehicles. Lastly, flood water entering clean water sources can cause a

shortage of clean water for communities, increasing the risk of exposure to diseases through the consumption of contaminated water. These impacts are not only materially detrimental but also economically and socially, reducing the quality of life and welfare of the affected communities (Salim & Siswanto, 2021)

2.4. Flood Management in Indonesian Region

According to Government Regulation of the Republic of Indonesia Number 21 of 2008 on the Implementation of Disaster Management, mitigation aims to reduce the risks and impacts caused by disasters to people living in disaster-prone areas. Disaster risk reduction refers to efforts to analyze and reduce the factors that cause disasters through structured and measurable steps. It aims to reduce exposure to hazards, reduce the vulnerability of people and property, manage the environment, and improve preparedness in the face of disaster impacts (Pemda Daerah Istimewa Yogyakarta, 2019). One of the mitigation efforts is to build community preparedness and resilience in the face of flooding.

According to research conducted by Kusuma et al., (2020) in their study entitled "Community Local Wisdom in Tsunami Disaster Mitigation", an analysis was conducted on mitigation efforts against tsunami disasters by considering aspects of local wisdom in Indonesia. They stated that preparation for disasters, especially tsunamis, does not only depend on technology alone, but also pays attention to the social and cultural aspects of society. The research findings show that hereditary knowledge in recognizing the early symptoms of natural disasters can provide communities with an understanding of how disasters occur and the steps to be taken when the signs of disaster appear. Preparedness is carried out by identifying the community's capacity, ability, skills and knowledge related to flood management. However, this effort faces obstacles due to the community's limited knowledge and understanding of the disaster education, training and socialization programs that have been conducted. This can result in a lack of community participation in disaster preparedness and resilience efforts.

2.5. Identification of Priority Areas

The priority scale for identifying areas that require inundation or flooding treatment is determined by comparing the existing conditions with the parameters described in the Minister of Public Works and Housing Regulation No. 12/2014 on the Implementation of Urban Drainage Systems. There are six parameters considered, including the level of inundation or flooding, economic impact, social disruption and public facilities, transportation disruption, loss to residential areas, and loss of property and personal rights (Rahman et al., 2021). Flooding can cause physical and material losses, flooding is a natural disaster caused by high rainfall but not matched by the ability of drainage channels to accommodate the excess runoff. Other research states that river capacity is exceeded due to excess water that stagnates in an area that is usually dry, causing the river's capacity

to be unable to accommodate the excess water. Exceeded soil saturation and high water levels in the river channel are two factors that cause flooding during high rainfall. Flood vulnerability is the degree to which an area is susceptible to flooding. Flat and sloping areas such as flat land, river-flooded land, land around the coast, and areas around rivers that experience erosion are areas that are often affected by flooding. The determination of the priority scale using the Permen PU No. 12/2014 method used in this paper was also used by other studies in determining flood management priorities in South Bogor Sub-district, where the results of their research obtained Cikaret Village as a priority for flood management because it obtained a score value of >200 (Rahman et al., 2021).

2.6. Data Visualization

Visualization is a learning technique that utilizes the sense of sight to gain a better understanding of the concept or material presented in a real way. (Armansyah et al., 2019) Meanwhile, data visualization is an art and science to describe any effort made to help individuals understand the significance of data by placing data in a visual context. Today, the value of data has changed. Data has become a driver of acceleration in business efforts, using data allows organizations to make smarter, near real-time decisions. By using data, organizations can have the ability to spot trends from Big Data stores.

Data visualization can provide a more in-depth view of a report. (Ghivary et al., 2023)This can lead to valuable insights for the institution, as revealed in this analysis of a writer's level of expertise and collaboration with other writers.

2.7. Tableau

Tableau is one of the Business Intelligence (BI) software that allows users to create data visualizations that can improve understanding of the information presented (Angreini & Supratman, 2021) By importing datasets into the platform, Tableau provides direct access to the data warehouse, allowing users to create visualizations that are informative and easy to understand. Additionally, users can extract data from visualizations or connect them directly, which can reduce report generation time by providing intuitive dashboards. The use of Tableau not only increases the efficiency of analytics in various sectors, but can also accelerate the decision-making process in companies or organizations (Sariasih, 2022) The platform comes in various versions, including Tableau Desktop, Server, Online, and Public, which allows users to choose according to their needs and desires. Tableau can combine data from various data sources such as spreadsheets, databases, cloud data, and big data into one program to be used in a dynamic analysis. There are two main variants of Tableau software, namely Tableau Desktop and Tableau Public. Comparison between Tableau Server and Tableau Online (Server Hosted vs Cloud). These two variants are types of Tableau servers that are used to share or distribute data visualizations only to certain divisions or groups within a company, usually by hosting the data locally. The differences between the two include aspects of connection, data storage limitations,

publication process, firewall settings, authentication methods, configuration, accessibility, and so on (Saepuloh, 2020). So, although Tableau Public has limitations in data management, the tool is available for free and is not limited by a trial period.

2.8. Dashboard

A dashboard in Tableau is a visual display that presents important information needed to achieve certain goals. This information is organized and presented on one screen, allowing users to view it quickly (Idah & Pinilih, 2020)With a visual design that takes into account the needs of users, Tableau dashboards help in data analysis and decision-making in various sectors such as business, education, and government. Tableau, as a popular platform for dashboard creation, allows users to create interactive data visualizations with ease. Tableau's main advantage lies in its ability to quickly transform data into meaningful insights. With an intuitive interface, users can combine various data sources and create dynamic visualizations, including bar charts, pie charts, maps, and tables, in one coherent dashboard. Tableau's interactive features allow users to explore data more deeply by filtering, highlighting, and selecting data directly on the dashboard (Marvaro & Sefina Samosir, 2021). This allows users to better understand the patterns and trends contained in the data, making Tableau a very useful tool for organizations in data-driven decision making.

2.9. Previous Research

2.9.1 National Research

Research conducted by Sariasih (2022) in the article "Implementasi Business Intelligence Dashboard dengan Tableau Public untuk Visualisasi Propinsi Rawan Banjir di Indonesia" discusses the importance of using Business Intelligence (BI) in overcoming flood problems in Indonesia. In this context, the study used data from Badan Nasional Penanggulangan Bencana (BNPB) from January 2011 to December 2021 to produce a visualization showing the level of flood prone in each Indonesian province. The main findings of the study show that Central Java Province is the most vulnerable to flooding, with a record of more than 1,300 flood events in a decade, and the peak event occurred in February 2020. Through the use of a BI framework with the Tableau Public application, this research reveals great potential in accelerating the decision-making process related to flood disaster management. By providing clear and structured data visualization, Tableau Public can be an effective tool in helping the government and stakeholders to take appropriate actions in flood disaster mitigation and management efforts in Indonesia. As such, this research provides a strong foundation for applying the use of Tableau Public in the context of flood disaster-related data visualization, which can make a significant contribution to disaster risk management efforts in Indonesia.

Research conducted by in the article"Visualisasi Data Lokasi Rawan Bencana Di Provinsi Sumatera Selatan Menggunakan Tableau"discussed strategies to overcome the lack of information about disaster-prone locations in South Sumatra Province through the creation of data visualization using Tableau. They collected data from Badan Nasional Penanggulangan Bencana (BNPB) South Sumatra for the 2018-2020 period and applied a business intelligence (BI) methodology to build a data warehouse, perform ETL processes, and create data models (Angreini & Supratman, 2021). The result is an interactive dashboard that provides access to the public regarding the type of disaster, affected sub-districts, number of victims, and assistance provided. The research found that Musi Rawas Regency is an area frequently affected by disasters, especially floods, with other areas such as OKU, Muratara, and East OKU also vulnerable to floods and flash floods. Through the use of Tableau, this research demonstrated the potential for visualizing data that can assist in understanding and addressing disaster management challenges in the region. This prior research provides additional support for the use of Tableau as an effective tool in visually presenting disaster data, which becomes relevant in the context of disaster mitigation at the regional level.

This research method relies on datasets from Badan Nasional Penanggulangan Bencana (BNPB) from January 1, 2008 to January 31, 2023, using the Tableau Public platform. The results are reports and dashboards that provide data visualizations for the provinces affected by the floods. (Triyanto et al., 2023) Key findings show that West Java Province is the province that suffers the most from the impact of flood disasters, with the worst number of damaged houses and public facilities in February 2021. This research provides a better understanding of the impact of floods in Indonesia through clear and structured data visualization, and provides support for the use of Tableau as a tool to plan and implement more effective mitigation measures in the face of such natural disasters. These findings are consistent with previous research that shows the potential of using Tableau in addressing disaster management challenges in a more effective way.

2.9.2 International Research

In the article “Data Visualization with Tableau” written by Vasundhara (2021)and published in the journal Stochastic Modeling and Applications, discussed the importance of data visualization using Tableau as a tool for understanding and exploring data, focusing on the case of Covid-19 healthcare in India. The research highlights that Tableau can be used to generate interactive visualizations of data, allowing users to conduct in-depth analysis with the various features and customizations provided. The relevance to your research on flood area prioritization is that the use of Tableau is not only useful in a health context, but can also be applied in visualizing natural disaster data such as floods.

By utilizing visualization tools such as Tableau, researchers and practitioners can more easily explore and understand patterns in flood disaster data, which can help in prioritizing areas that require greater care and mitigation. Thus, the study on the use of Tableau in the visualization of Covid-19 data can provide valuable insights for the authors in understanding and addressing challenges related to the prioritization of flood areas.

The study conducted by Subrata et al., (2022)in the article “Implementation of the Tableau Application to Determine Earthquake Prone Areas with Geolocation Features” discussed the importance of data visualization using the Tableau application to determine areas vulnerable to earthquakes. The problem is the need for a tool capable of visualizing earthquake data to provide information that is more accessible to the public, especially in Indonesia. Within the framework of this research, they used Tableau to collect and categorize earthquake data and classify earthquake disasters in each province. The result was the implementation of an application that allows information about earthquake risk to be more easily understood and accessed by the public based on existing facts. The discussion in this study highlighted the importance of using visualization tools such as Tableau in increasing community awareness and preparation for potential earthquake disaster risks in their area. This finding is consistent with the authors' research on using Tableau to understand and address challenges related to flood area prioritization, as the data visualization tool can be used similarly in the context of natural disaster mitigation and management.

In the study entitled “Tableau-Based Data Visualization and Regression Analysis of Landcover and Climatic Trends” authored by Yaswanth et al., (2023)and presented at the World Conference on Communications & Computing 2023, emphasis was placed on the importance of data visualization in analyzing and presenting climate and land cover change, especially in the districts of Rajasthan. The problem encountered is the complexity of climate change-related data that is difficult for stakeholders and policy makers to understand. In the framework of this study, the authors used the Tableau platform to perform interactive data visualization, enabling the identification of trends in climate and land cover over the past 30 years. They used linear regression analysis techniques to establish relationships between variables and predict climate change corresponding to the changing years. The findings of this research are visual data reports that help identify and explain climate and land cover trends with accurate and detailed data representations. The discussion in this study highlights the importance of interactive data visualization in presenting complex information in a more understandable way to stakeholders and policymakers. Relevant to your research on using Tableau for data visualization, these findings suggest that visualization tools such as Tableau can be effectively used to understand and communicate information related to climate and land cover change to different stakeholders, including researchers and policy makers in the field of natural disaster mitigation.

2.9.3 UMN Research

Research by Anwar, Fadjriani (2020) with the title“Penggunaan Tableau Software Sebagai Data Preparation Dan Visualization Di PT. All Data International” in his internship thesis journal at Multimedia Nusantara University discusses the use of Tableau software at PT All Data International. The research attempts to explore the role of Tableau as a data preparation and visualization tool. Anwar looked at the two main products of Tableau, namely Tableau Data Preparation and Tableau Desktop, and noted that a deep understanding and mastery of both products is essential in completing tasks, such as the creation of flow data preparation and dashboard visualization. The results of the research show that an understanding of Tableau is not only beneficial in completing tasks, but also in guiding training and webinars to customers, so that they can use the software effectively. This research provides important insights into the importance of using Tableau in the context of data preparation and visualization, which is relevant in its use in the context of data visualization-related research.

Research conducted by Sanjaya, Weldiendy (2022) with the title “Implementasi Data Visualisasi Info Media pada PT. Merah Putih Media dengan Menggunakan Aplikasi Tableau” in his internship thesis at Universitas Multimedia Nusantara investigated the implementation of data visualization at PT Merah Putih Media using Tableau application. The research highlighted the importance of data in the context of modern companies and the need to process it so that it is easily understood by clients and superiors, especially in the creation of news articles. PT Merah Putih Media, as an online digital information media company, requires accurate data visualization to support the accuracy of their articles. In this context, datastatistics acts as a tool to process and visualize the required data. The results of the data visualization are sent directly to the supervisor or field supervisor for review, where revisions are made if needed. The findings of this study show that data visualization is an important component in ensuring the accuracy and success of news articles. The discussion on the use of Tableau as a data visualization tool provides insight into how this technology can improve efficiency and effectiveness in processing and presenting data, which is relevant for research related to the use of Tableau in data visualization.

3. Method

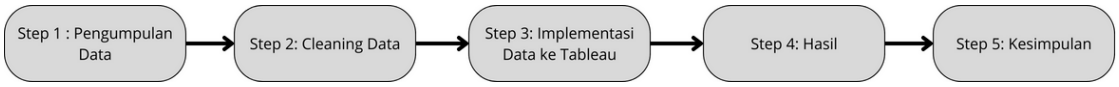

Figure 1. Research stages

This research will go through a series of structured stages to produce a comprehensive understanding of the impact of flooding in the Jakarta area. The first stage, Data Collection,

will involve the acquisition of data from various sources, including datasets from Badan Nasional Penanggulangan Bencana (BNPB) and Kaggle platforms, as well as additional information from the literature study. Next, in the Data Cleaning stage, the collected data will be filtered to remove duplicates, invalid data, or missing values in order to ensure the accuracy and reliability of the data before further analysis is conducted.

After that, the cleaned data will be implemented into Tableau software in the Data Implementation to Tableau stage. In this stage, the data will be visualized using graphs, charts, and maps to understand the patterns, trends, and distribution of flood impacts in the Jakarta area. Furthermore, data analysis is carried out to identify areas that are prioritized in handling flood impacts, and the results will be presented visually in the form of clear graphs and maps. Finally, the Conclusion stage will summarize the main findings from the data analysis and provide recommendations for further actions in handling flood impacts in Jakarta. By conducting this series of stages systematically, it is hoped that this research can make a significant contribution to understanding and addressing flooding problems in the Jakarta area.

4. Results and discussion

In the first phase, the data required for the flood impact analysis in the Jakarta area was collected from various verified sources. The main data came from the dataset Badan Nasional Penanggulangan Bencana (BNPB) which includes information on flooding in Indonesia in 2020. In addition, additional information was also obtained from scientific literature, articles and official documents related to flooding in Indonesia, especially in Jakarta. These sources include previous research, and government reports. Furthermore, the dataset was downloaded from the Kaggle platform with the name of the dataset 'banjir-jakarta' and can be accessed via the link https://www.kaggle.com/datasets/putrafurqan/banjir-jakarta/data. This dataset has 2575 rows and 13 columns covering a variety of information related to flooding in Jakarta, such as administrative city, sub-district, village, year, month, inundation duration, incident date, number of evacuation sites, number of minor injuries, number of serious injuries, water level, and number of deaths.

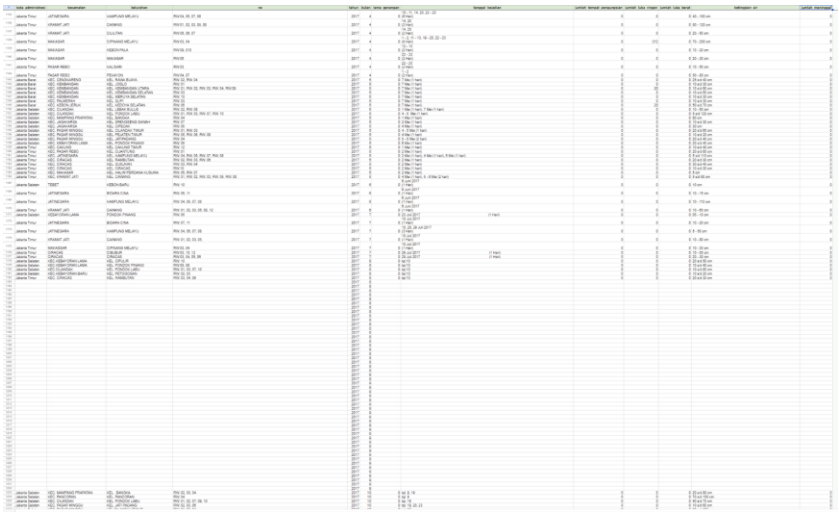

Figure 2. Research Stages

Figure 2 shows the dataset before the data cleaning stage is performed. It can be seen that there are still many null values and mismatched datasets. The data cleaning stage is important to address these issues so that the data can be processed more accurately and reliably. By performing data cleansing, null values can be filled in or removed according to the needs of the analysis, and non-conforming datasets can be adjusted or removed. This will ensure that the data used in the analysis is cleaner, consistent, and relevant, so that the resulting analysis results will be more reliable and useful in decision-making.

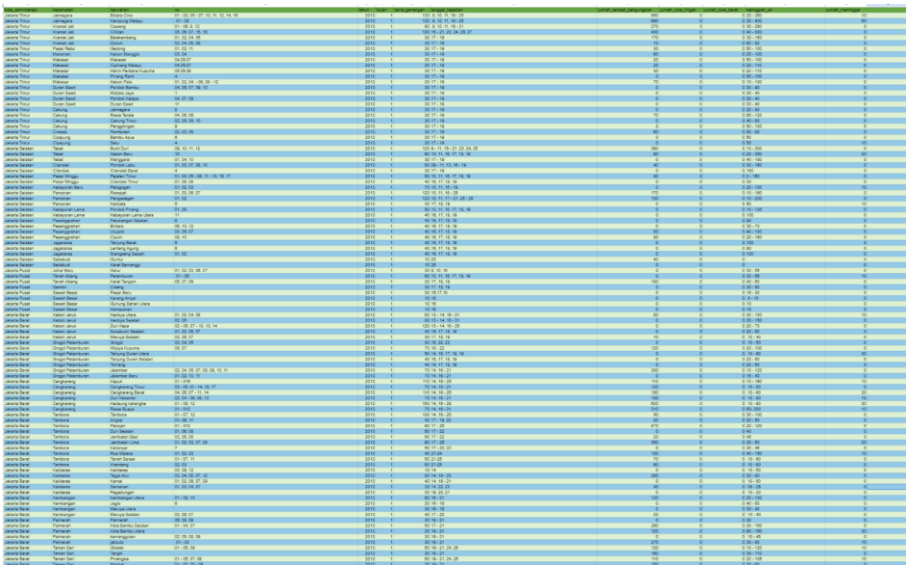

Figure 3. Research Stages

The ETL (Extract, Transform, and Load) stage is an important process in data cleaning that aims to sort, filter, and clean unnecessary or inappropriate data. The image above shows the results of the data cleaning process that has been carried out. After going through the ETL stage, data that initially had null values and inappropriate datasets have been successfully handled. Unused data has been filtered and removed from the dataset, so that only relevant and high-quality data remains. In addition, data transformations may also have been performed, such as the replacement of null values with appropriate values or the removal of unnecessary rows or columns. The result of this stage is a dataset that is cleaner, structured, and ready for further processing in data analysis.

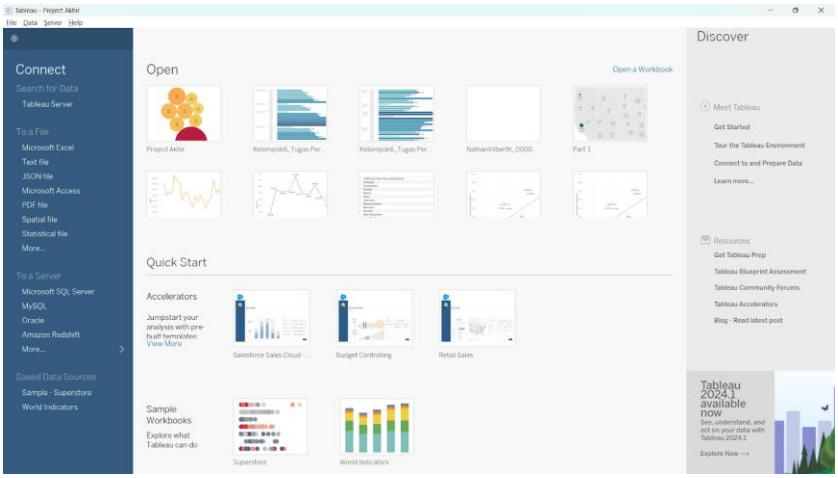

Figure 4. Research Stages

After going through the ETL (Extract, Transform, and Load) stage to clean the data, the next step is to implement the data into Tableau software for further visualization and analysis purposes. The figure above shows the result of this stage, where the cleaned data is imported into Tableau in CSV file format.

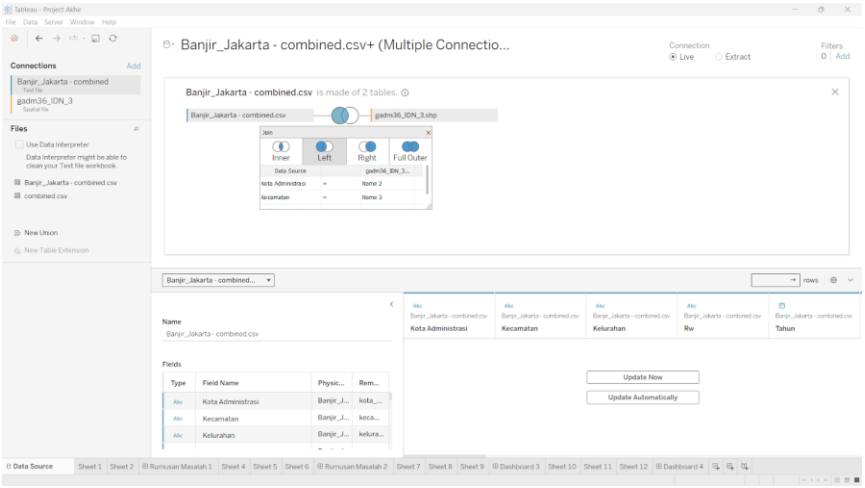

Figure 5. Research Stages

The next step is to merge the data using union left with the GADM dataset in Tableau, specifically to match the administrative city (name_2) and sub-district (name_3) columns, so that the data can be integrated and visualized more accurately.

A. Dashboard Visualization Flood Frequency in DKI Jakarta

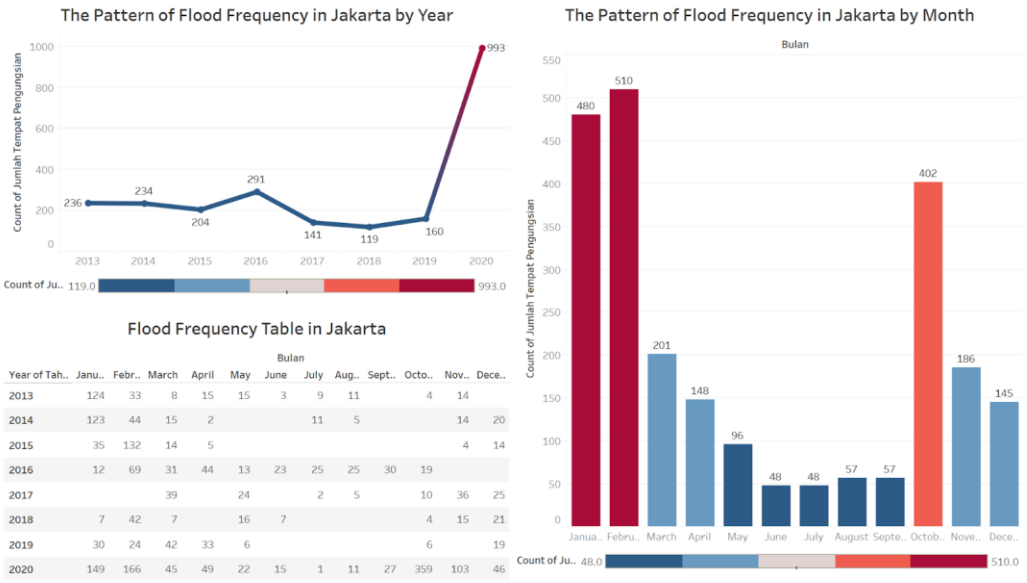

Figure 9. Flood Frequency Dashboard in Jakarta

Figure 9 is a dashboard that displays a visualization of the frequency of flood events in Jakarta by year and month. On the left side, there is a line chart and table that shows the pattern of the frequency of flood events in Jakarta from 2013 to 2020 and also the month. From this visualization, it can be seen that the frequency of flooding fluctuates every year with the highest flood frequency in 2020 with a total of 993 flood events. On the right, there is a bar chart showing the frequency pattern of flood events in Jakarta by month. This visualization shows that floods occur most frequently in January and February with 480 and 510 flood events recorded respectively.

B. Dashboard Visualization Severity of Floods in DKI Jakarta

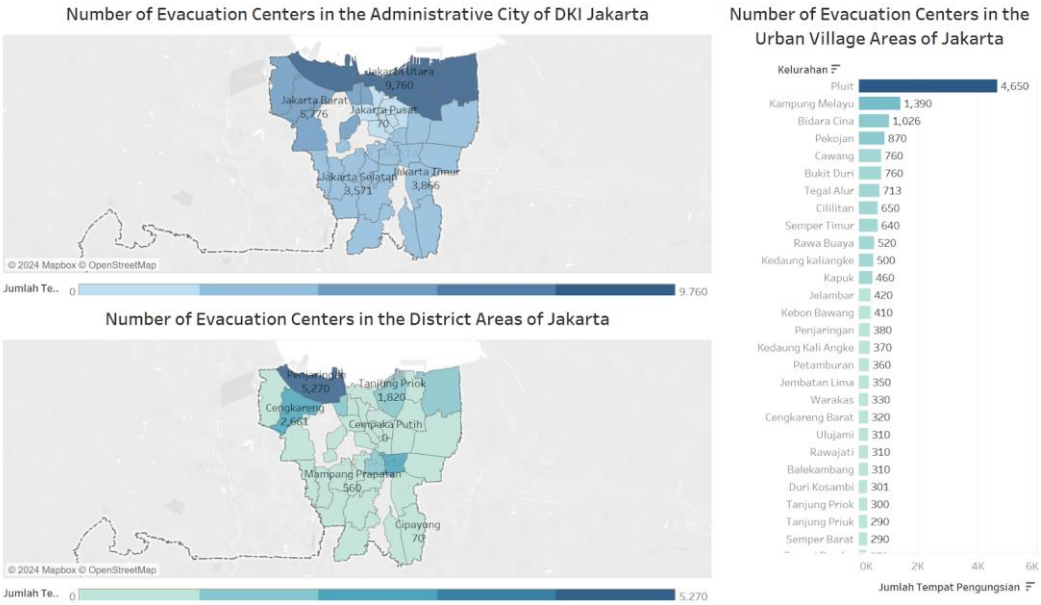

Figure 13. Dashboard Number of Evacuation Sites in DKI Jakarta Region

Figure 13 shows a dashboard consisting of sheet maps of Places of Refuge in Cities and Sub-districts of Jakarta, as well as a bar chart of Places of Refuge in Sub-districts of Jakarta. In the dashboard above, the sheet Maps of Places of Refuge in Cities and Districts of the Jakarta Region is used as a filter so that observers or users can interact by clicking on the Jakarta city area through maps with blue color to filter cities. After the visualization of red maps and bar charts changes based on the filter, the observer or user can click again on the sub-district area in the city through maps with red color to filter the sub-district to change the bar chart results. The dashboard displayed above aims to make it easier for observers to analyze the varying severity of flooding in various administrative regions, sub-districts, and villages in Jakarta.

C. Dashboard Visualization Duration of Floods in DKI Jakarta

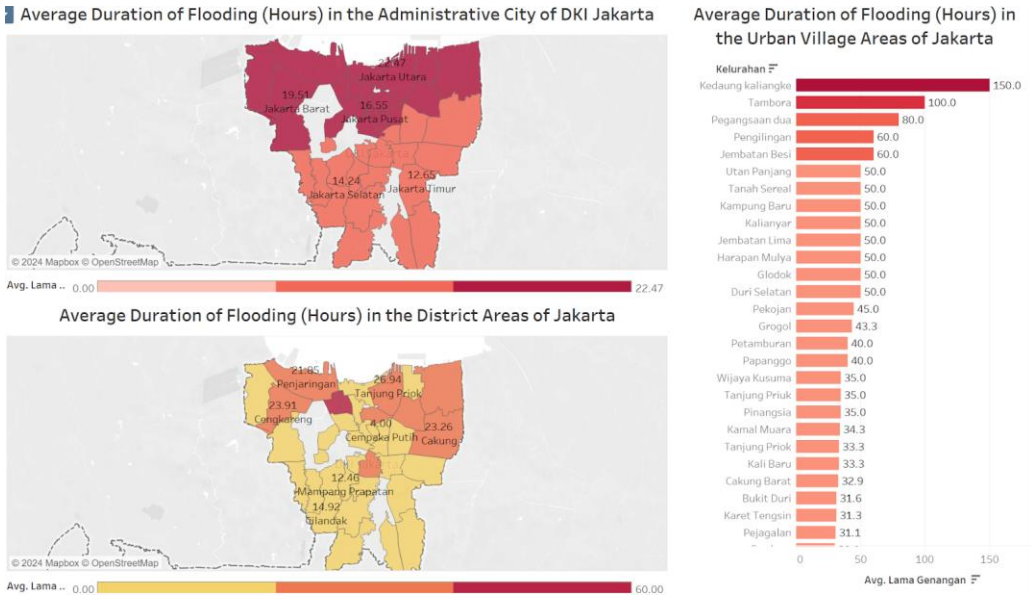

FIgure 17. Dashboard of Flood Inundation Duration in DKI Jakarta Area

Figure 17 is a dashboard that contains the Maps of Inundation Duration in Jakarta City, Maps of Flood Inundation Duration in Jakarta Sub-District, and Bar Chart of Flood Inundation Duration in Jakarta Sub-District. In the dashboard above, the Maps of Flood Inundation in Jakarta City and Maps of Flood Inundation in Jakarta Subdistrict are used as filters so that users or observers can change the output display based on administrative cities and sub-districts in the DKI Jakarta area. This dashboard aims to analyze areas in Jakarta that need a better water infiltration system to overcome flooding by utilizing areas that have a high duration of flood inundation.

D. Dashboard Visualization Impact of Floods in DKI Jakarta

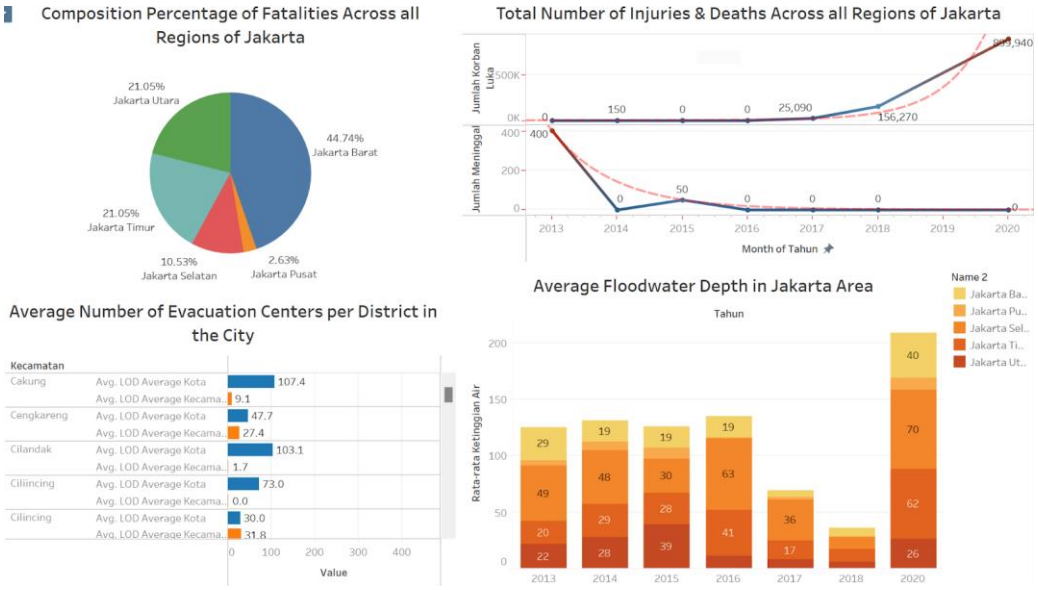

Figure 22. Dashboard of Flood Impact in Jakarta Area

Figure 22 shows a dashboard that displays three different sheets, namely Pie Chart of Percentage of Dead Victims in Jakarta Area, Line Chart of Injured & Dead Victims, and Stacked Bar Chart of Water Level in Jakarta Area. In the dashboard, the pie chart sheet is used as a filter so that observers or users can interact for regional filtering in selecting the administrative city that they want to display in the line chart and stacked bar chart output. The step in forming the dashboard is to enter the three sheets that have been mentioned into the dashboard and click use as filter on the pie chart sheet. This dashboard aims to provide an overview of the impact of floods such as injuries, deaths, and water levels that occur in each city in the DKI Jakarta area based on the year.

5. Conclusion

Flooding in Jakarta shows a clear seasonal pattern, with the highest frequency in January and February each year. January recorded 480 flood events, while February recorded 510. 2020 had the most flood events, with 993, showing a significant increase compared to previous years. The severity of flooding varies across regions. North Jakarta had the highest number of evacuation shelters, 9,760, indicating frequent severe flooding. In contrast, Central Jakarta had the fewest evacuation sites, 70. At the sub-district level, Penjaringan had the most evacuation sites, 5,270. Pluit at the urban village level has the highest number of evacuation sites, 4,650. The areas that need better water catchment systems are North Jakarta and West Jakarta, with 22.47 and 19.51 hours of inundation respectively. Tambora and Tamansari sub-districts have the longest duration of inundation, 45 and 60 hours respectively. At the urban village level, Kedaung Kaliangke and Tambora recorded the longest inundation, 150 and 100 hours respectively. Data visualization is expected to help the government make strategic decisions to reduce risk and improve preparedness. The research on flooding in Jakarta from 2013 to 2020 provides important insights for better disaster management and urban planning, as well as benefits for career development and broader social contributions.

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