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BIBLIOMETRIC ANALYSIS OF DRAINAGE CHANNEL CAPACITY USING HEC-RAS METHOD IN FLOOD DISASTER MANAGEMENT

Natasya Aurum Maharani, Andri Irfan Rifai*, Ade Jaya Saputra, Susanty Handayani
Universitas Internasional Batam, Indonesia
*e-mail: natasyaaurum086@gmail.com andriirfan@yahoo.com✉ adejayasaputra@gmail.com
susantyhandayani@gmail.com

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ABSTRACT

Drainage capacity is the ability of a channel to pass a certain amount of water or discharge through the drain. A study entitled Bibliometric Analysis of Drainage Channel Capacity Using Hec-Ras in Flood Disaster Management will map previous interrelated studies and make it easier for the author to conduct research. The method uses bibliometric analysis with the Publish or Perish 8.9 and Vos Viewer 1.6.19 software applications as visualization tools with an output of 2 file types, namely RIS and CSV. From the analysis, it can be found that there are 38 keywords with 3 clusters with the most research peaks in 2022. In addition, the most publishers identified in the IEEE publisher type as many 284, with the dominant type of publication being Journals-article.

INTRODUCTION

Drainage canals have been used on a large scale since Roman times. Drainage comes from drainage, which means draining, drying, and disposing of water. Drainage is a system that overcomes the problem of unnecessary excess water, either flowing above or below the soil surface. This excess water can come from rainwater runoff (excessive rainfall) or residential wastewater. Drainage channels are used to drain flowing rainwater runoff to prevent flooding. The use of the type of drainage channel is reviewed based on the situation and conditions in the field. The kind of drainage used is a natural and artificial drainage (Saidah, et al., Drainase Perkotaan., 2021).

The drainage system is a system that aims to minimize problems due to stormwater surface runoff, reduce water pollution problems, and increase water use value, especially in urban areas. Urban drainage systems are necessary due to the presence of human activity in the natural water cycle activities that occur. There are water extraction activities in the water cycle to meet the needs of human life and the ability of the soil to be impervious to water that diverts rainwater from the natural drainage system. Both types of interaction prove the need for a drainage system to drain water. At the same time, drainage is vulnerable to flooding due to cu. Rain is extreme. Evidence of global warming that causes drastic weather changes (Willems P. , Arnbjerg-Nielsen, Olsson, & Nguyen, 2012).

Today, people worldwide prefer to live in urban rather than rural areas. This proportion is expected to reach 68% by 2050. The impact of urbanization has resulted in the quality and quantity of

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water becoming a problem discussed. Based on the development of research through the title of research Improved hydrological modeling of urban catchments using runoff coefficients, the problem arising from the quantity of water is the reduction of peak time (flashiness), increased peak flow, and runoff volume. For water quality, the main problem is the increased mobilization and transport of contaminants to receiving sources. Understanding and managing the hydrology of highly urbanized watersheds is complicated by the role of drainage networks and their relationship to impermeable areas and waterways. Separate stormwater drainage systems contribute to direct river flow to the watercourse. In contrast, combined stormwater and wastewater drainage systems drain water management work, which, in most cases, is located outside the area (Birkinshaw, O'Donnell, Glenis, & Chris Kilsby, 2021).

Due to changes in land use, the availability of land to collect rainwater is decreasing. This leads to ever-increasing surface runoff. Drainage planning is used to prevent flooding due to excessive runoff water. As an example of applying solutions for using drainage channels in overcoming floods with the ecodrain concept, this ecodrain can collect, filter, and utilize rainwater and wastewater. This can be proven by drainage planning research with the idea of Zero delta runoff, where this planning uses the clump distribution method, Monobe, and FAA methods. Ecodrain using infiltration wells and retention ponds can reduce channel discharge by 58.88% and 46.01%, respectively (Kamila & Sejati, 2023).

The most rapid development of drainage system research is the development of the drainage system in Japan. Japan and Indonesia have the same geographical conditions as Indonesia. This causes Japan and Indonesia to have the same natural disaster. Japan is one of the countries that has an excellent urban drainage system for tackling floods. G-cans are one of Japan's solutions for drainage systems built underground. In addition, one solution that is widely used in urban flood mitigation is underground water reservoirs connected to municipal drainage networks. For example, the underground rainwater retention pond Aquapond was built in Fukuoka city in Kyushu, Japan. The facility was built to prevent drainage overflow by draining water into retention ponds designed to be placed and managed during high rainfall (Ishida, et al., 2003).

The development of the drainage system in Batam City through research on Drainage Channel Analysis of Flood Inundation on the Batam Tengku Sulung road. Batam City is one of the cities in the Riau archipelago with a dense population. Batam is also an industrial city. In addition, Batam is also an area with a high rainfall intensity of 2600 mm/year. The dense population in Batam with high rainfall intensity needs a sound drainage system to avoid flooding in the rainy season (Andriani, Indera, Suciati, & Fauzan, 2021). An adequate channel system is essential to prevent floods during the rainy season. This type of drainage channel in the drainage system on Jalan Tengku Sulung is an open drainage channel (Batam, 2023).

Drainage refers to the capacity of urban areas to channel and manage rainwater well. The drainage channel's capacity is the channel's ability to pass a certain amount of water or discharge through the drain. Drainage capacity is becoming increasingly important as cities grow, infrastructure develops, and land use change (Pongtuluran & Huda,, 2019) s. Flooding and environmental damage can be prevented with a sound drainage system. Therefore, many things must be considered, including efficient water channel design, environmentally friendly materials, and advanced technology to improve supervision and management. One is Sustainable drainage systems (SuDS) technology applied to urban drainage. This can be seen in a study of the SuDS concept in urban drainage using underground pipe systems. Sengkang and sidewalks have a better capacity for controlling flood volume than sewers and infiltration ditches (Scholz, 2014)

The capacity of a drainage channel is influenced by two factors: flow rate and cross-sectional area. A drainage cross-section is an area of track used to drain rainwater or wastewater from one location to another (Ross NF). The depth and intensity of rainwater with a duration of 5 minutes affect the drainage length and the slope (Gallaway B. M., 1971.). Artificial precipitation experiments are used

to determine the intensity of precipitation transverse slope. Surface texture, drainage length, and depth of the water layer correlate. This is based on previous research that attempts to determine the effect of road drainage capacity and geometric characteristics of road facilities on the depth of the water layer. If the drainage system does not have drainage capacity, the depth of the water layer will increase rapidly as rainfall increases (Han, 2021).

The relationship between rainfall and drainage channel capacity greatly affects the water management system in the area. The city's drainage system should float more water if heavy rain falls. This increases the risk of flooding and waterlogging (YUREKLI, 2004). Therefore, the exact capacity of the drainage system can be determined by hydrological and hydraulic conditions. It also affects how hydrologists use rainfall and flood records to predict extreme floods (PRIYANTORO, 2017). Where hydrological conditions are a comparison between flood design analysis and actual flooding, this can be seen in previous studies that stated the equality of rainfall can be seen in hydrological conditions in determining the drainage capacity (Murdhianti, 2021).

According to the development of research on drainage capacity entitled Drainage System Capacity Analysis (Case Study of Drainage Jalan Siliwangi Batam City). Indonesia is the largest archipelago in the world, with 17 thousand islands. Riau Islands is one of the islands that is directly adjacent to Singapore. Batam City is one of the cities in the Riau Islands with an enormous population growth. The need for public facilities increases as the city and its population grow. One is drainage infrastructure that flows rain so that it does not overflow and overflow into the road body or other infrastructure. Based on the analysis results, the planned cross-sectional area size is 1,187 cm X 1,028 cm with a channel discharge, namely Q = 2,064 m3 /s, while the calculation of the scheduled release is Q = 2,064 m3 /s. From the dimensional analysis results, the planned channel in the field needs to meet the plan's capacity so that waterlogging occurs (Winardo & Indrastuti, 2023).

Rain is one of the causes of flooding in urban areas. The intensity of heavy rain and its long duration are some of the main factors that cause flooding due to the severe power of rainfall that falls, resulting in runoff. It is controlled by precipitation intensity and permeability during rains, while the amount of sedimentation and soil depth mainly controls the oversaturation mechanism. The intensity of rainfall worldwide varies, depending on geographical location, climate, and seasons in various places. Some places have high rainfall intensity, such as Colombia, estimated at 3240 mm/year. Malaysia 2875 mm/year, Brunei Darussalam 2722 mm/year, and Indonesia 2702 mm/year (Tian, Li, & Sivapalan, 2012).

According to the research study Analysis of Made Lamongan Residential Drainage System Using SWMM (Storm Water Management Model) and HEC-RAS (Hydraulic Engineering Centre-River Analysis System) Models, several things affect the occurrence of urban flooding, such as insufficient residential areas, narrowing of drainage channels caused by permanent closure of drainage channels in front of residents' homes, and unavailability of open green space around residential land. Urban flooding is usually caused by very high rainfall, river overflow, or storm surge, so the land surface cannot absorb much water effectively (Febrianto, Bisri,, & Cahya,, 2023). Urban flooding is also a problem that often haunts cities around the world. Previous studies have also shown an upward trend in the duration, intensity, and frequency of extreme rainfall events that cause more flash floods in urban areas (Saidah, et al., Drainase Perkotaan, 2021). If the intensity of rain increases, the urban drainage system becomes full and causes rainwater to flow slowly into existing channels and cause flooding (Hammond, Chen,, Butler,, & Mark,, 2015) (Bertilsson, et al., 2019).

The intensity of rain is one of the main factors causing flooding in urban areas. Rain intensity is also one of the essential parameters in weather monitoring because it describes the extent to which precipitation falls in a certain period, usually in millimeters per hour. In addition, it is imperative to understand the intensity of rain in irrigation planning, water resource management, and early warning of natural disasters. The intensity of rainfall is becoming a prominent element in the context of climate

change. The drivers of climate change affect the intensity and frequency of rain. As stated in previous studies, the intensity and frequency of rainfall are caused by anthropogenic climate resulting from greenhouse gas emissions (Mamoon, A., & N., 2019).

Climate change is an increasingly troubling global phenomenon. One of the most striking impacts of climate change is the anthropogenic climate. Climate change refers to long-term changes in temperature, rainfall patterns, wind patterns, and other aspects of the Earth's climate system. Climate change today has an extensive root cause of anthropogenic climate change caused by fossil fuel burning, deforestation, and unsustainable land use, resulting in increased greenhouse gas emissions in the atmosphere. Consequently, warmer air may contain more moisture, leading to more frequent and intense rains. Climate change is directly related to social change, and previous studies have discussed that anthropogenic climate change and rainfall are directly related to urban drainage. (Willems, Arnbjerg-Nielsen, Olsson, & Nguyen, 2012) (Willems P. A.-N., 2012)

It is important to investigate changes in rainfall intensity over short time frames due to their significant effect on urban drainage behavior—some research developments on the duration of rainfall intensity in various countries (Deumlich & Gericke,, 2020). In Belgium, research on long-term rainfall did not find short-term rainfall (Adamowski, 2003). Another Canadian study found that 6 out of 8 regional trends lasted 5-10 minutes but were nearly impossible for longer rainfalls. U (Vaes, Willems,P, & Berlamont, 2002) nlike the Danish study, where trends were found for sewer system duration, short-duration rainfall analyses did not show significant trends (Birsan, Molnar, Burlando, & Pfaundler, 2005)..

Flood disaster management in each country is different. Japan faces the risk of flooding due to storms, heavy rain, snow, tsunamis, and floods in the past that have been linked to significant impacts. Japan has geographical conditions in the Nagawa basin, so storms and floods hit Japan. In addition, Japan also has 15 rivers that divide the city of Tokyo. This causes flooding when the city of Tokyo experiences rain and storms. In this case, the Japanese government overcomes flooding by building an underground drainage system called (Fujita & Hamaguchi, 2011). G-cans. G-cans is an underground drainage system built along the direction of an underground river flowing below 50 meters.

Hec-Ras or Hydrologic Engineering Center's River Analysis System is software used to calculate water surface profiles and model river flow through open natural channel s (Lamichhane & Sharma,, 2018). Hec-Ras has a significant role in modeling water flow and assessing the drainage capacity of a region (Razi, Marimin, Ahmad, Adnan, & Rahmat, 2018). This allows engineers and planners to evaluate the effects land-use changes, building structures, or natural conditions can have on changing water flow through sophisticated hydraulics modeling (Santillan J.R., 2013). This was stated in the Hec-ras hydraulic software model research, which proved to be the best method for modeling flood and flood waves and providing fast and accurate data (Gjeshovska, 2021).

Hec-Ras uses the principles of hydrodynamics to simulate water flow in rivers, canals, or other drainage systems. The parameters used in mathematical models by users are topographic and hydrological data, which include land elevation, river length, and hydrological characteristics such as discharge and rain. Hec-Ras used a complex mathematical model to calculate the distribution of water flow, height of the water surface, and flow velocity along a given path. According to the research development of the Hec-Ras model for Manning's roughness: a case study, the main parameters used in Hec-Ras to produce flood-prone areas are River Geometry such as center line, bank line, bank, flow path, and cross-section, Digital elevation model (DEM) with a pixel resolution of 12.5 m x 12.5 m is used. This study produced a flood inundation map showing flood depths and spatially distributed flood-prone areas (Parhi, 2013).

Hec-ras and Hec-GeoRas are two essential software programs in hydrological and hydraulic engineering. Hec-GeoRas is a software application developed by the company's Hydrological Research and Engineering Center (HEC) and Environmental Systems Research Institute (ESRI). Hec-GeoRas supports before and after data processing created by Hec-Ras. Using numerical models, the Hec-ras

app helps simulate water flow in artificial rivers and canals. Hec-Georas software helps before and after the geometric data processing created by Hec-Ras. This can be seen from the research that the Hec-ras and Hec-Georas applications can analyze flash flood maps, estimate the occurrence of future floods, and find out the parameters of rainfall flow water velocity (US Army Corps of Engineers, 2010) (US Army Corps of Engineers, 2010) (US Army Corps of Engineers, 2010) (Gjeshovska, 2021).

This article uses bibliometric methods to provide quantitative analysis results from written publications. This type of analysis is then based on identifying a collection of literature, especially publications in a broad sense in a particular field. The results of this bibliometric method can be used by researchers to understand developments and contributions in the field of science and to identify future research directions. The bibliometric process uses the VosViewer software to visualize and analyze scientific publication data (Olivia, Siregar, Nadirah, Inayatussyfa, & Saragih, 2023). It allows users to visualize citation data, Co-citation, and Co-word analysis in intuitive, easily digestible graphs and charts. The purpose of using the bibliometric method with the help of Vosviewer software in this article is to map previous studies related to research in bibliometric analysis articles of drainage channel capacity using the Vosviewer method in flood disaster management, making it easier for the author to conduct research (Ninglasari & Yayu., 2021).

METHODS

In this study, the method used is quantitative, using one of the statistical techniques to analyze publications, the bibliometric analysis approach. Bibliometric analysis is a relatively comprehensive research method that combines science with mathematics and statistics to investigate knowledge and information quantitatively. Bibliometric research identifies research trends and publication characteristics related to keywords related to the research discussed. Collection of metadata information using keywords. The keywords used were drainage system, capacity, flooding, and Hec-ras (Phoong, 2022) (Zhao, 2018).

Collection of articles and sources related to research using keywords through the help of Publish or Perish software applications. Publish or Perish is a software application that helps collect reference files and metadata such as the number of citations, journal device, author, title, year published, publication, place of publication, and file type. Researchers used publish or perish software version 8.9. Through Publish or Perish, researchers use the Crossef database to collect digital literacy metadata using keywords. The keywords used are drainage system, capacity, flooding, and Hec-race. This metadata stored in Publish or Perish uses CSV and RIS file types. The CSV file type is used to analyze and process data using Ms. Excel. The final shape that will be generated in Ms. Excel is in the form of graphs and tables. The RIS file type can be processed using Vosviewer with the results of the network and map (Maulyda, 2022) (Bukar, 2023).

In this study, researchers used the Vosviewer software application to map and analyze journal results collected through the Publish or Perish application. Vosviewer is an open-source directory analysis software that analyzes and provides excellent mapping of network data. In this study, researchers used the Vosviewer software application with version 1.6.19. Map, overlay, and density visualization are three forms of data processing output used to visualize relationships and group keyword-related search topics (Muhammad, 2022).

RESULTS

Publish or Perish

Through the results of metadata withdrawal analysis on the publish or perish software application version 8.9 through crossef with a range of 2000-2023.

Table 1. Citation Metrics

Publication years	**2000-2023**
Citation Years	23 (2000-2023)
Papers	1000

Citations	7370
Cities/years	320.43
Cities/paper	7.37
Cities/author	3452.05
Papers/Author	482.57
Author/Paper	2.37
h-index	42
g-index	70
Hi, norm	25
Hi, annual	1.09
hA-index	13

Source: Result of researcher analysis using Publish or Perish

Development of Research Years

Based on the results of the withdrawal of metadata research on Publish or perish related to research, Bibliometric analysis of drainage channel capacity using the Hec-ras method in flood disaster management. With the keywords Drainage channel, Capacity, Flood, and Hec-race. Based on the results of managing RIS data in Ms. Excel with output in the form of graphs. The development of the research year can be seen in Figure 1. Based on the analysis results in Figure 1 of the research development graph, the most research peaks in 2022 with 96 studies. This proves an increase in research development per year.

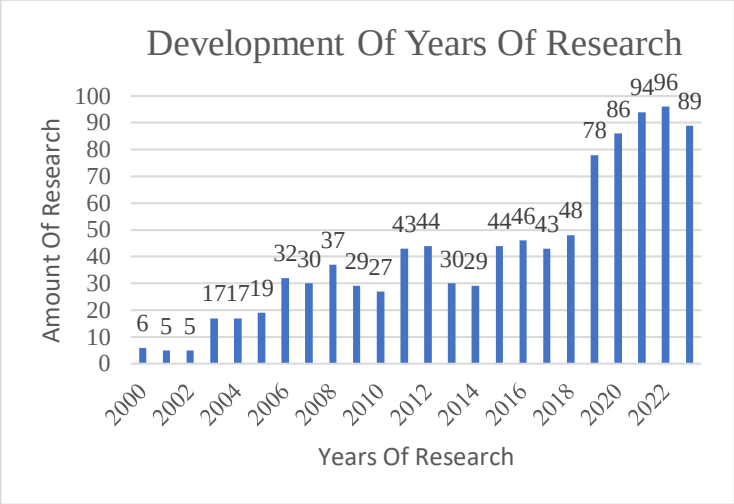

Figure 1. Research Development graph
Source: Results of author's analysis

Keyword development

Based on the results of metadata retrieval on publish or perish, it was analyzed using Vosviewer software version 1.6.19. A visualization and clustering map is obtained, as shown in Figure 2, a map of research-related developments from 2000 to 2023.

From the analysis results, 3 clusters were obtained with 38 keywords related to research. These 38 keywords have been grouped into three sets. In the first cluster shown in green, 17 keywords include assessment, country, depth, digital elevation model, estimation, flash flood, flood inundation mapping, floodplain, geographic information, gis, hec hms, hec-ras model, hydraulic model, hydrodynamic model, parameters, risk, and study area. The second cluster has 16 keywords in red: flood, calculation, capacity, dimension, drainage, drainage channel, drainage system, evaluation, flood

discharge, hec-ras program, height, hydraulic analysis, length, overflow, runoff, year. As for the third cluster, there are five blue keywords: failure, he-ras, hydrologic engineering, reservoir, and river analysis system.

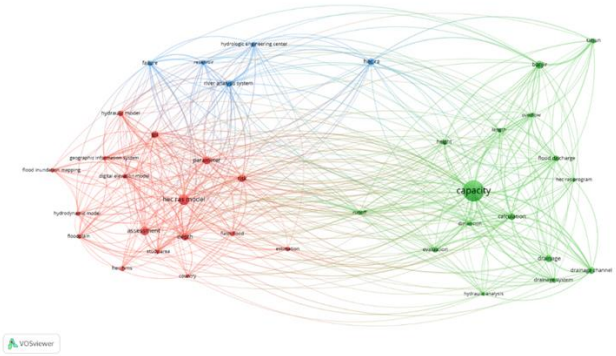

Figure 2. Network Visualization Keyword
Source: Vosviewer research result version 1.6.19

Trend mapping is done after mapping and clustering research has been identified. Furthermore, the study is based on the year the article was published. The data from overlay visualization can be used to assess keyword analysis results related to drainage capacity analysis research carried out between 2000 and 2023. The results can be seen in Figure 3 overlay visualization keyword. Image three overlay visualization keyword is based on metadata analysis imported into Vos Viewer version 1.6.19. In Figure 3, the keyword visualization overlay, the node color shows the year of publication of the article containing keywords related to the research topic. A darker shade of the knot indicates more of the topics covered in the study.

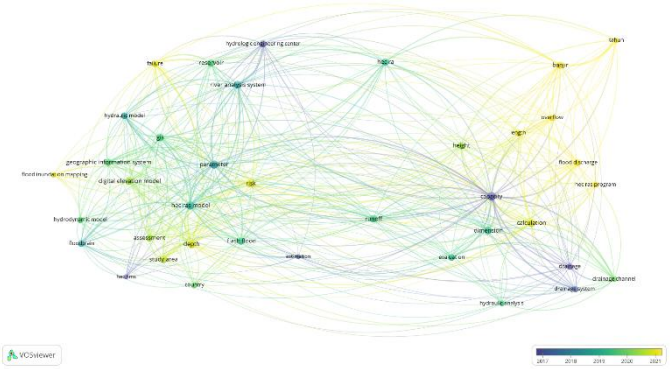

Figure 3. Overlay Visualization Keyword
Source: Vosviewer resercher results version 1.6.19

The density visualization results shown in Figure 4 show the number of node colors close to each other, as shown in the density results shown in Figure 4. The brightest color of the nodes indicates keywords that have been studied in depth in research. This can be seen in Figure 4, which displays density visualization keywords that show all topics related to drainage capacity analysis research using the hec-ras method in flood disaster management.

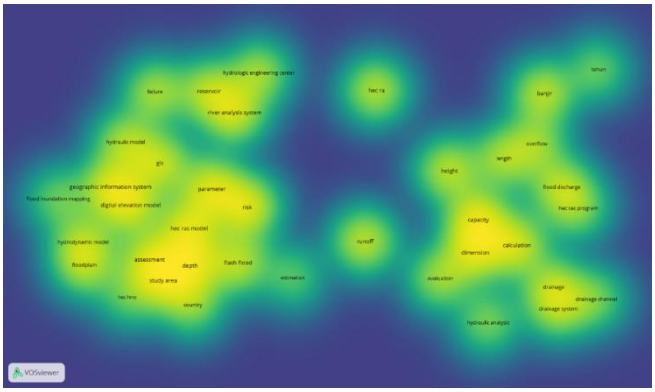

Figure 4. Density Visualization Keyword
Source: Vosviewer researcher version 1.6.19

Author Development

In the results of Vosviewer's analysis, the withdrawal of Publish or Perish metadata ranges from 2000-2023 with the RIS file type, as shown in Figure 5 network visualization. In Figure 5, Network Visualization displays the absence of interconnected paths in the results of the Vos Viewer analysis. This indicates that there is no significant difference in the contribution of the three authors involved in thinking about drainage capacity analysis research. In the author Jensen, Mark R, five documents have four links. Brunner author Garry wrote that there are eight documents with four interlocking links.

Figure 5. Network Visualization
Source: Vosviewer researcher result vosviewer 1.6.19

Publisher Development

The results of data processing and CSV file analysis using the help of Ms.Excel software. The number of publishers obtained on the withdrawal of metadata on crossef. With a total of 994 studies obtained by 279 publishers. The author groups the number of publishers related to this research by taking a minimum data limit of 5 published journals and obtaining from the results of analysis and processing of IEEE publisher data as many as 234.

Table 2. Number of Research publishers

Publisher	Number of Study case
Wiley	39
Thomas Telford Publishing	5
Springer Science and Business Media LLC	45
Springer International Publishing	9

Science Publishing Group	6
Research Square Platform LLC	6
MDPI AG	28
IOP Publishing	22
IEEE	234
Elsevier BV	24
EDP Sciences	7
Copernicus GmbH	9
Brawijaya University	13
American Society of Civil Engineers (ASCE)	60

Source: Author's analysis results using MS. Excel apk

Type of Publications

It was based on the data processing and analysis results on Ms. Excel using CSV files on crossef metadata withdrawal. A grouping of file types is obtained, summarized in the data retrieval results on Publish or Perish. Figure 6 shows that the number of file types received by the most research formats found in Publish or Perish is 51.5%.

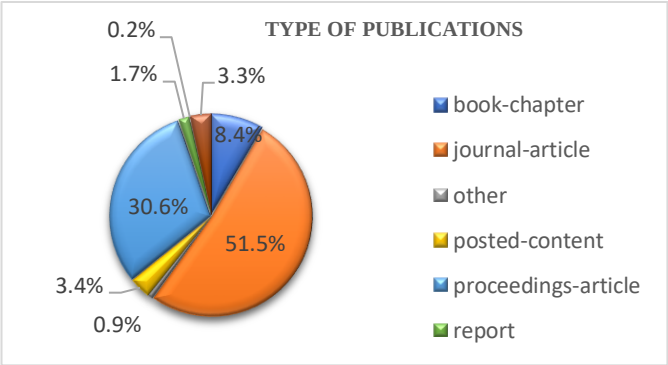

Figure 6. Number of Type of Publications
Source: Results of author's analysis using Ms.Excel apk

Relevance

The results of the analysis of keyword development on Vosviewer, as well as relevant and occurrence values, appear displayed on Vosviewer. The results of data processing can be shown in Figure 7. Based on Figure 7, it can be seen that the keyword Year gets a high occurrence number of 3.58.

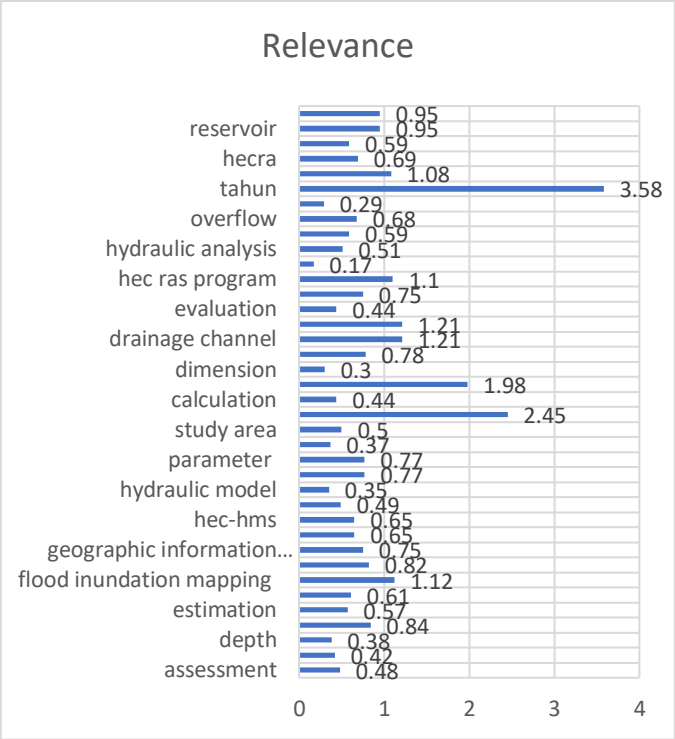

Figure 7. Relevance keyword

Source: author's anaysis results using Ms.Excel apk

Occurrence

Based on analysis and data processing using Vosviewer software version 1.6.19 and Ms.Excel. these results relate to keywords netted using Vosviewer. This keyword returns the occurrence values in Figure 8 below. From the analysis results, it can be seen that Capacity is the most found keyword and is related to research by 284.

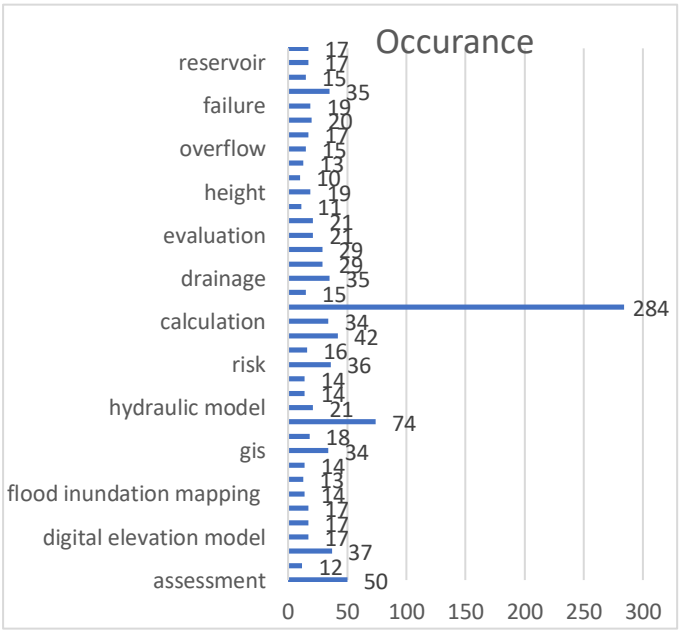

Figure 8. keyword Occurance

Source: Results of author's analysis using Ms.Excel

Country Development

The results of processing Publish or Perish 8.9 data using Ms. Excel by selecting the case study category in each research publication. Data on country groupings based on the number of case studies is obtained. This can be seen in Table 3 on the development of the country. It can be seen that Indonesia is the country with the most research topics and case studies that discuss drainage capacity. As many as 105 case studies can be identified.

Table 3. Country Development

Country	Number of Cases
Afghanistan, Alaska, Albania, Brazil, Chile, Greenland, Kenya, Kazakhstan, Morocco, Egypt, Mexico, Myanmar, Pacific North, Spain, Sudan, Texas, Greece	1
Africa, Algeria, Canada, Iran, Germany, Nakagami, Nigeria, Sri Lanka, Uganda, Turkey	2
Arabic, Australian, Malaysian, Nepalese, Taiwanese	3
Bangladesh, Ethiopia, Pakistan	4
United States	5
Singapore, China	8
South Korea	12
India	20
Indonesian	105

Source: Results of author's analysis using Ms.Excel

CONCLUSION

They are based on data processing results in the study of bibliometric analysis of drainage capacity using the Hec-ras method in tackling floods. In this study, researchers can infer research trends. They are starting with metadata retrieval using Publish or Perish software version 8.9 with a range of 2000-2023 to produce 1000 papers by analyzing metadata results with RIS (Research Information System) file types in Vosviewer 1.6.19 software. Keyword development resulted in 3 clusters with 38 keywords. Three authors are related to the author's story, and there is not much difference in the research network. Researchers also pulled data using CSV file types, resulting in the most dominant publishers in the IEEE format with 234 kinds of publication journals. These researchers can also see the results of the development of the year the research topic is topped in 2022 with the most relevant Capacity keyword. The story of countries related to the number of case studies can be seen in Table 3 of the development of nations, with Indonesia as the country with the highest number of case studies, namely 105 case studies. From all research results, researchers can conclude that the development of research related to drainage capacity research will continue to develop from year to year and will be interconeccted.

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