

## Bibliometric Analysis of Drainage System Performance Against Urban Flooding Using Vosviewer

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**Abstract:** Drainage is a channel that serves to drain excess water from one point to another. This journal is in the form of a Bibliometric Analysis of the performance of the drainage system on urban tires. Bibliometric analysis of this study was carried out with the help of VOS Viewer and Publish or Perish software or applications. Publish or Perish helps to collect similar journals around the world that have links to the research under review. Next, bibliometric mapping is performed using VOS viewer software. The results obtained a lot of data such as Research Development by year, influential Authors and Publishers, and others that have a relationship with the research studied. The keywords "System" and "Drainage Capacity" were the densest keywords in this study. 2014 was also the year with the most related research with 79 total published studies.

**Keywords:** Drainage System; Flooding; Rainfall; Channel Capacity; Water.

### INTRODUCTION

Drainage systems have been used in all corners of the world. Because the Drainage System has a very important role, especially in urban areas. Drainage is a channel that serves to drain excess water from one point to another. In Teknik Spiel, in widespread drainage can be interpreted as an action to lessen excess water, which comes from rain, seepage, or extra irrigation water from a place/land (Lubis, 2021). So that drainage serves to prevent waterlogging in an area.

In Indonesia, the Drainage System is still a widespread problem. News of floods is still often heard in various cities and regions. The problem of flooding and inundation in Indonesia has emerged as a country-wide problem that affects all components of humans' lives (Supriyani et al., 2012). Urban drainage systems in general do not function mainly due to high rainfall and rapid urbanization (Yazdanfar & Sharma, 2015). In addition to rainfall and urbanization, public awareness is also an important factor for the drainage system to function properly because accumulated garbage is often the cause of flooding in urban areas.

The drainage system in an area should be able to accommodate normal flow discharge. That is, the capacity of the drainage channel has been designed to accommodate the water discharge that occurs so that flooding does not occur. If the channel capacity decreases for some reason, the normal discharge will not be accommodated. Plus, when there is an increase in flow discharge can be caused by high rainfall or other things that cause flooding. Changes in the use of surrounding land due to housing growth are one of the main triggers of increased drainage discharge (Lubis, 2021).

A good drainage system is able to drain water smoothly so that puddles do not occur. In addition, a good drainage system can prevent flooding, soil erosion, damage to buildings and roads, and so on. Conversely, if the Drainage System is not designed and managed properly, it can cause these disasters. Increasing rainfall intensity due to climate change is one of the factors in the occurrence of flooding in urban areas (Kleidorfer et al., 2014).

The purpose of this study is to find out the latest developments regarding research on the performance of drainage systems globally. The study was made systematically using bibliometric analysis by presenting the review literature. Bibliometric analysis is a study based on the assumption that a researcher must link his research with another research (Mubarrok & Rahmawati, 2020). That way, writing will develop and progress knowledge about the topic discussed. In this study, the analysis was conducted using Publish or Perish and VOS viewer to map topics and collect related research around the world.

A drainage System is one thing that must exist in an urban area. Integrated city water

management is a prime factor in the effectiveness of city drainage systems (Pereira et al., 2023). Therefore, there must be good water management in urban areas so that the drainage system can run well. Also, the drainage system must be carefully designed so that it can operate effectively and handle the risk of flooding in the future.

Manholes are important systems in city drainage structures that join roads and underground drainage networks (Zhang et al., 2024). A manhole is a channel cover or iron plate of sewer cover, which is one of the important components of the drainage system. The function of the manhole is to enter the channel so that control and maintenance can be carried out on the drainage channel. In addition, manholes can also be a component of the beauty of the road layout because they can be designed uniquely and have distinctive characteristics.

Sustainable urban drainage systems represent an opportunity to improve stormwater management that offers a variety of options for runoff control and co-benefits related to social, environmental, and economic aspects (Jiménez Ariza et al., 2019). Non-stop drainage systems regulate rainwater falling in a watershed area by being reminiscent of what occurs obviously and is environmentally pleasant. These systems prevent many problems from floor water runoff by reducing the impact of extra water glide quantity. Sustainable drainage structures maximize benefits and minimize the bad impacts of surface water runoff from evolved regions.

Green infrastructure contributes to advanced city drainage in addition to different social impacts (Locatelli et al., 2020). Green Infrastructure is an effort to prioritize environmental preservation that is integrated with regional development to realize sustainable development. The important thing about implementing green infrastructure is to maintain the continuity of the natural water resource cycle, considering that using clean water, especially in urban environments, has increased along with population growth and urban development.

Rainfall is the quantity of rainwater that falls every certain period. Rainfall data is important for engineering planning, one of which is for drainage systems. To get a precise planning forecast, we need years of rainfall data. The choice of precipitation products can significantly affect performance (Le Coz & Van De Giesen, 2020).

Extreme rainfall of short duration (1 to 3 hours) can cause serious damage to rapidly developing communities (flash floods) (Fowler et al., 2021). So unpredictable rainfall is often the cause of flooding. Rainfall can be influenced by many factors, including elevation or altitude of the place/region, distance from water sources, mountain ranges, and land and water area. Conversely, when there is very little rain, then the dry season will become longer, and drought will hit.

Unpredictable amounts of rainfall due to climate change can cause reservoirs to overflow or dry out (Ridwan et al., 2021). Climate change is causing shifts in rainfall patterns, which can result in droughts in some areas and flooding in others. This has an impact on water availability, agriculture, and natural ecosystems. Floods, long droughts, landslides, and woodland fires that occur in Indonesia are associated with global weather changes.

The redesign of rainwater control structures is essential in fixing the issues that cause deteriorating flood situations in some important cities (Pereira Souza et al., 2019). Analysis of rainfall data is highly dependent on its distribution patterns (Sharma & Singh, 2010). The rain distribution pattern is a rain distribution pattern where rain records are usually in a time interval. Generally made in units of daily, hour, or minute time.

Because of weather exchange, urban areas have become increasingly at risk of intense storms and flash floods (Lu & Qin, 2020). One of the causes of flooding in big cities is high rainfall. Where the effect is an increase in discharge and volume of water on the ground surface. When stagnant water cannot be absorbed by the soil, it also cannot be drained into drainages and rivers, causing flash floods.

Population density in big cities is also one of the causes of flooding events. Urbanization of the population from villages to cities continues to increase, especially in big cities in Indonesia. Urbanization that occurs is triggered by various good factors such as poverty, low living standards, and limited employment. Urban dwellers must adapt their habitats to the new dynamics resulting from urbanization (Chapa et al., 2020).

Cities face various challenges such as more frequent flooding due to increased land cover (Rosso et al., 2019). Construction that continues to be carried out throughout the day in urban areas is also

the cause of flooding. The reduction of land due to development causes the soil to be unable to absorb rainwater that falls due to climate change. In dealing with this problem, green plants in urban outdoor spaces are usually planted, which is quite effective if designed and applied properly.

The dual city drainage model permits customers to simulate pluvial city flooding by analyzing the interaction among sewer networks (small drainage systems) and inland streams (predominant drainage systems) (Sañudo et al., 2020). Small drainage channels scattered throughout the city must be connected to the main drainage so that the discharge and volume of water on the surface can be drained properly. Solutions to urban flooding can also be overcome by building retention ponds and making infiltration wells which can help to absorb and drain water on the surface.

**MATERIALS AND METHODS**

The method used in this study is a quantitative approach, the use of bibliometric evaluation. Bibliometric evaluation is a quantitative approach to studying bibliographic facts in articles/journals (Effendy et al., 2021). This method is carried out by mapping similar journals from all journals within the international. Bibliometrics is a statistical approach that carries records related to guides used to analyze courses in a particular area (Muhammad et al., 2022). Bibliometric analysis can show the quantity, quality, maturity, and productivity of journals (Natakusumah, 2016).

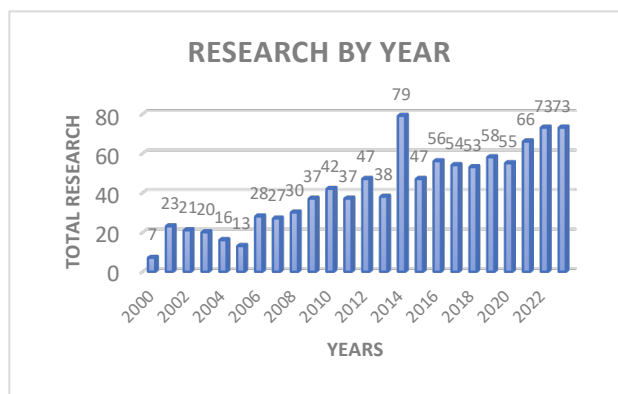
Research is the process of collecting and analyzing data systematically to achieve certain goals (Utami & Karlina, 2022). Bibliometrics is a hard and fast mathematical and statistical strategy used to analyze and measure the quantity and first-class of books, articles, and varieties of e-books (Durieux & Gevenois, 2010). Bibliometric mapping will gain each the clinical community and the public in popular because it could help remodel e-book metadata into maps or visualizations, which are extra plausible to the method so one can advantage beneficial insights, for example visualizing keywords to pick out studies themes or clusters in positive disciplines, mapping the affiliation of authors from a specific journal to pick out the geographical coverage of the magazine, and so forth (Tanudjaja & Kow, 2017).

The bibliometric evaluation of this study was executed with the help of VOS Viewer and Publish or Perish software programs or applications. Publish or Perish is used in accomplishing a literature assessment of the theme below have a look at (Kurniati et al., 2022). Publish or Perish helps to collect similar journals around the world that have links to the research under review. Next, bibliometric mapping is performed using VOS viewer software. With VOS viewer, users can recognize adjacent research clusters, highlight the most influential authors, view collaboration networks between researchers, as well as analyze changes over time (Budianto et al., 2022).

**RESULTS AND DISCUSSION**

**Research Development by Year**

A graph of the research by year from 2000 to 2023 can be seen in (Figure 1) below. Data is obtained from the Publish or Perish application which is then processed Using Ms. Excel so that data in the form of graphs is obtained.

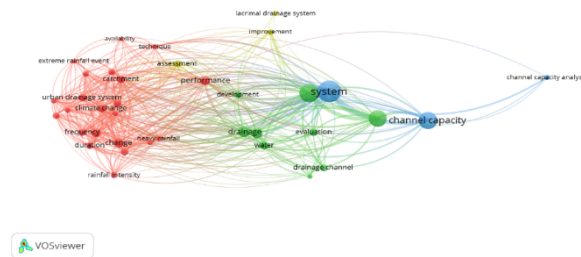


**Figure 1. Research by year chart**

The graph (Figure 1) is data from 1000 studies related to keywords inputted from 2000 to 2023. It can be seen that 2014 was the year with the highest related research with 79 studies. While 2000 was the year with the lowest related research with only 7 studies published.

**Related Keyword Development**

An image of the Keyword Linkage in research can be seen in (Figure 2) below. The image is obtained from the VOS viewer application whereas previously the database has been obtained from the Publish or Perish application.

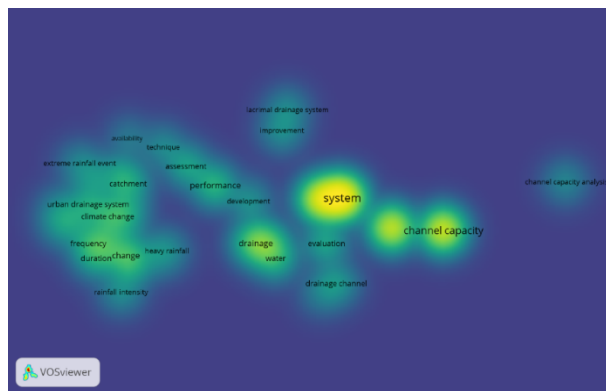


**Figure 2. Keywords Trends**

It can be seen in (Figure 2) that the most dominant keywords are System and Channel Capacity with the largest network and clear colors. Then followed by other keywords that are also related to the research studied.

**Keywords Density**

Another result of using the VOS viewer application is the keyword density image below (Figure 3). By inputting some keywords into the Publish or Perish application then obtained an image which is a visualization of keyword density from related research by the VOS viewer application.



**Figure 3. Density visualization based on keywords**

In (Figure 3) displays the density between keywords related to the research studied. Deep color indicates keyword density which means it has a very strong connection with the research topic. There are also many other keywords that have different levels of density from each other.

**Influential Authors**

–Data also obtained from the Publish or Perish application is the name of the author of the related study. The following (Table 1) describes 10 authors who influenced the research reviewed in the period 2000 to 2023.

Table 1. Influential authors by similar research		
No	Authors	Total Similar Research
1	Mohammad Javed Ali	11

2	E.C Penning-Rowsell	5
3	D.J Parker	5
4	D.M Harding	5
5	Dalin Zhang	4
6	Toshikazu Hori	4
7	Mitoshi Fujimoto	4
8	David A. Chin	4
9	Vartika Bhandari	4
10	Nitin H. Vaidya	4

(Table 1) Mohammad Javed Ali was ranked first with 11 related studies. Followed by E.C. Penning-Rowsell, D.J. Parker, and D.M. Harding with 5 related studies. And many more researchers discuss topics related to this research.

### Influential Publishers

Furthermore, the data that is also generated by the Publish or Perish application is data that publishes related research. Below are the top 5 publishers who have published their research.

**Table 2. Influential publisher by similar research**

NO	Publisher (Country)	Total Similar Research
1	IEEE(US)	226
2	Wiley (US)	69
3	Copernicud GmbH (Germany)	66
4	Springer (Germany)	47
5	Elsavier BV (Netherlands)	43

IEEE Publisher from the United States is the publisher with the most related research with 226 studies that have been published in the period 2000 to 2023. Followed by Wiley from the United States with 69 studies, Copernicus GmbH from Germany with 66 related studies, and others. In addition, there are still many publishers from various countries who have published research that has a major influence on scientific studies to date.

### CONCLUSION

This study describes a Bibliometric Analysis of drainage system performance against urban flooding. Bibliometric analysis is carried out with quantitative research assisted by VOS viewer and Publish or Perish applications or software. This analysis obtained 3 main keywords discussed in the review literature, namely Drainage System, Rainfall, and Flooding. Then bibliometric analysis is carried out by inputting keywords into the Publish or Perish application with a period of 2000 to 2023. The results obtained a lot of data such as Research Development by year, influential Authors and Publishers, and others that have a relationship with the research studied. The database obtained from the Publish or Perish application is then processed using the VOS viewer application to obtain the relationship and density between keywords in the research studied. The keywords "System" and "Drainage Capacity" were the densest keywords in this study. 2014 was also the year with the most related research with 79 total published studies. It can be concluded that this research continues to develop from year to year with wide coverage from various parts of the world.

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