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APPLICABILITY AND EVALUATION OF IMERG PRECIPITATION PRODUCT: A SYSTEMATIC REVIEW

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Abstract- The hydro-meteorological communities face major difficulty in accurately estimating precipitation over wider areas. One of the critical and influential factors in water resources management is the accuracy of integrated Multi-Satellite Retrieving for Globed Precipitation Measuring (IMERG) with their calibrated SPP denoted as IMERG Final and uncelebrated SPPs is known as IMERG Early and IMERG Late over different complex or simple topographical area. The purpose of this systematic review study is to conduct for accurate estimation of precipitation by using IMERG SPP. To achieve the aim we use the PRISMA Statement technique for deriving the related articles for detailed review those are published in recent years. From the years 2011 to 2021, the SCOPUS database was chosen to derive research publications written in English with keywords of “IMERG” AND “Precipitation” AND “IMERG Precipitation product”. A total of 28 articles was extracted and after screening the titles and initial abstract thoroughly, only 8 articles were left for additional assessment. It was discovered that the IMERG-Final satellite precipitation product has the lowest likelihood of mistakes and the highest correlation with ground-based measurements and In addition, as compared to IMERG Early and IMERG Late satellite rainfall products, it demonstrated superior and capable accomplishment in estimating heavy precipitation occurrences over both highly complicated and less complicated topography regions. It is therefore recommended to apply the IMERG satellite rainfall product data before the commencement of design and construction of hydraulic structures.

Keywords- IMERG, Precipitation, SCOPUS, satellite precipitation product (SPP), hydraulic structures.

1 Introduction

Precipitation data from weather radar are subjected to major limitations such as errors that are dependent upon range, systemized, and random [1][2]. Data quality (obtained by weather radar) can be affected by surrounding obstruction, such as high-rise buildings, mountains, and other topographical features[1][3][4]. Radar network is expensive to purchase, install, manage and maintenance which severely limits their availability in many countries around the world. In the past, extreme precipitation measurements depend on the rain gauge network, but there are some limitations such that it cannot measure snowfall. Rain gauges have many types of errors such as water can evaporate from gauges due to high temperature. Weather radars have several flaws as well like Due to complicated atmospheric regimes, beam blockage, and variance in reflectivity-rainfall rate connections, the results are less exact.[1][2][5]. Satellite rainfall products are utilized as an alternate source to compensate for the lacking and limitations of ground-based precipitation measurement networks. [5].



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Because rainfall varies widely in time and place, estimating it with ground data such as rain gauges and radars, as well as satellite observations, is difficult. [5].

The objective of this research is to assess the correctness of Integrated Multi-Satellite Retrieving for Globed rainfall measuring (IMERG). IMERG SPPs are at high terrain altitudes, to increase precipitation detection and reduce magnitude mistakes [6]. It has made the quantitative measurement of precipitation by satellite sensors is a significant source[1]. The result illustrated by IMERG SPP have high accuracy and are applicable in the most studied region and could be used in wide fields[4] regarding hydrological and hydro metrological applications of these Satellite products at an international scale.

Consequently, this study conducted a systematic review of published works in the circle of engineering utilizing the PRISMA statement[7] [8], evaluating the function of IMERG SPP in measuring and estimating precipitation, as it is one of the critical factors in the water resources management field to design the hydraulics structures and irrigation systems. After highlighting the positive and efficient results of this SPP. After this study, a future agenda was offered so that the researchers might address the concerns and issues in the future.

2 Significance of the work

The significance of this systematic review is useful for academia in which researchers, scientists get the platform of IMERG satellite precipitation product. This is the more advanced and latest application for measuring and estimating precipitation events. Since the novelty of this study in which the researchers will increase their researches regarding this SPP because the IMERG dataset has freely available on the NASA official website. This technique is more accurate and reliable to analyze and observe the rainfall data because the continuity and quality are more enhanced as compared to other opportunities. This study will also be helpful for the industrial people related to the hydrological department in which hydrologists and engineers use to implement the IMERG precipitation data for designing the hydraulic structures for a long duration and also the chance of disaster is sufficiently reduced.



3 Experimental Procedures

The methodology was divided into four stages. A research plan was devised in the first step to define the research database. The PRISMA statement was used to construct selection criteria in the second phase. The quality of the work was appraised in the third phase using an abstract and full-text examination. Data finalized was finished in the fourth phase in preparation for further analysis. The research and methodology flow chart is shown in Figure 1

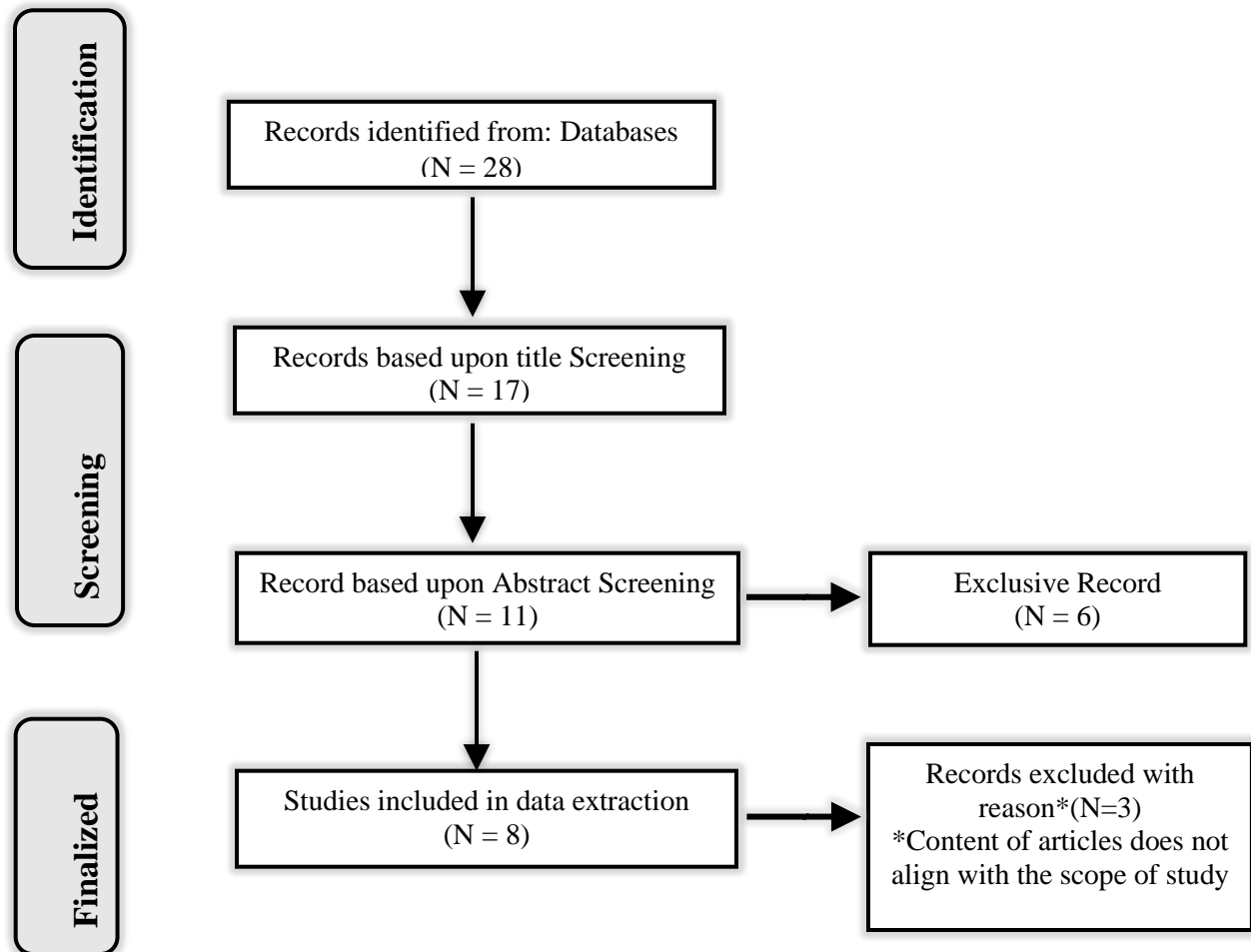


Figure 1: Research and Methodology Flow Chart

4 Research Methodology

4.1 Strategy for Researches.

Only the SCOPUS database was used for this systematic review, hence a strategy was designed to include related material accordingly with the study's scope. "IMERG" AND "Precipitation" AND "IMERG Precipitation product" were the search phrases in this database. The papers were limited by the years 2011 to 2021, with the additional restriction of only selecting research publications that have been published in the language of English.



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4.2 Selected Criteria.

PRISMA statement was discovered by Liberati et al.[7] was for this systematic review, the selection criteria were employed. The concentration was totally on reviewing the keywords on “IMERG” AND “Precipitation” AND “IMERG Precipitation product” in the circle of water resources management. All articles published before 2011 were omitted from the study period, which ran from 2011 to 2021. These constraints resulted in the creation of 28 papers, which were then evaluated further at an afterward stage.

4.3 Quality Evaluation.

This study truly concentrated on researched-based articles and conferences. The acquired data were double-checked to maintain the reviewing process beneficial for the identified forms in which 6 papers were omitted based on title as our keywords used in gathered data were not matching or including in their titles. After that, all of the abstracts were rigorously read to ensure that the work's quality was sustained. It was found that there is repetition in some papers and the content is not fulfilling the requirements. Therefore, only 11 articles were retained for additional evaluation.

4.4 Extracted Data.

Following the assessment of quality, 8 articles with the following extracted characteristics were chosen:

- Original research publications were chosen, with no consideration given to publish analyzed reports or cased studies.
- The papers chosen were published in English Language and were on the topic of engineering circle.
- The articles that were included for systematic reviewing, published between the years 2011 to 2021.
- There were no country restrictions, and the articles came from all across the world.

5 Results

Explanation of the final included articles, as well as the debate based on those eight pieces of research, are offered in this part.

5.1 Discussion on Results.

The chosen 8 articles were truly concentrated on the measurement of precipitation by using IMERG satellite precipitation product is considered as one of the critical factors. It was revealed that the IMERG precipitation measurement varying with temporal scale, seasonal scale, and complexity of topography in a particular region[1] [4][6][9]. It is a precise measurement of precipitation that plays a vital part in a variety of climate metrological and water structure applications [2] such as predicting floods, hydrological process counterfeit, and managing water reproduction [10]. Using IMERG dataset used to design and maintenance of hydraulic structures to be safe from the natural disaster. IMERG data set comprises of three types which include IMERG Early, IMERG Late, and IMERG Final[1] [3] [9]. IMERG Early and IMERG Late SPPs were used to measure heavy rainfall and IMERG Final was used for the lightest rainfall[2][11]. IMERG Final has the lowest chances of estimation error and high correlation with ground observation[1] and showed better performance as compared to IMERG Early and IMERG Late. Hence IMERG dataset was more powerful and suitable data for application over the regions[4] where insufficient numbers of rain gauges, missing data information, or where gauge network stations were spars or inefficient[2].



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5.2 Summarization of Included Articles.

Figure 2 depicts the overall overview of eight articles collected from every year. Between 2011 and 2021, their researches were a total of 8 published articles, and only 2017, 2020, and 2021 articles are concerned with our topic. In 2020 highest number of researched articles are published in the investigated field.

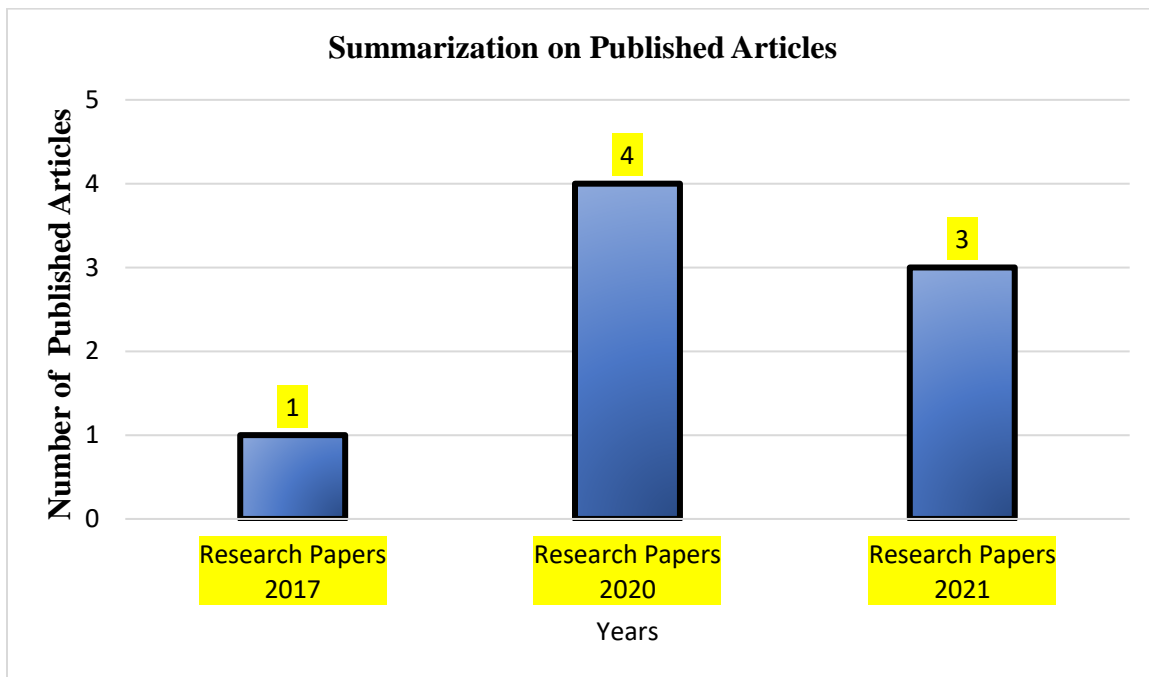


Figure 2: Summarization of Published Articles



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5.3 Summarization of authors cited and journals.

The names of journals and authors, as well as their citations, have been discussed in this particular section. The following is a summary of Table 1. It is clear from Table 1 that the published articles received the most citations in 1) Remote Sensing in 2017, 2) Atmospheric Research in 2021 3) Remote Sensing in 2020 and 4) International Journal of Remote Sensing in 2020 and 5) Water (Switzerland) in 2020. Some journals, on the other hand, have few or no citations as mentioned in table 1.

Table 1- Summarization of authors, cited and journals

Sr. No	Journal Name	Author References	Year of publication	Citation received on the papers
1	Remote Sensing	Mahmoud M.T., Mohammed S.A., Hamouda M.A., Dal Maso M., Mohamed M.M. [1]	2021	0
2	Remote Sensing	Zhou C., Gao W., Hu J., Du L., Du L. [3]	2021	0
3	Atmospheric Research	Ma Q., Li Y., Feng H., Yu Q., Zou Y., Liu F., Pulatov B. [4]	2021	7
4	Atmospheric Research	Yang M., Liu G., Chen T., Chen Y., Xia C.[11]	2020	3
5	Water (Switzerland)	Saouabe T., El Khalki E.M., Saidi M.E.M., Najmi A., Hadri A., Rachidi S., Jadoud M., Trambly Y. [10]	2020	2
6	International Journal of Remote Sensing	Gan F., Gao Y., Xiao L., Qin L., Huang Y., Zhang H. [9]	2020	3
7	Remote Sensing	Maghsood F.F., Hashemi H., Hosseini S.H., Berndtsson R. [2]	2020	6
8	Remote Sensing	Mayor Y.G., Tereshchenko I., Fonseca-Hernández M., Pantoja D.A., Montes J.M.[6]	2017	24
	Total Citation			45



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6 Conclusion

Following conclusions can be drawn from the conducted study:

- All the three IMERG SPPs can measure the precipitation but the third product IMERG-Final SPP has the lowest chances of errors and it is reliable for all the globe. Therefore we recommend this precipitation product as the continuity and quality are enhanced as compared to any other satellite precipitation product.
- the IMERG data set is a great source of opportunity to understand the precipitation events occurring onto the different complex topographic regions and used to design and construct hydraulic structures to sustain in future as compared to ground-based data.

The aforementioned result is favorable, indicating that it should be investigated further. In the next step we will use the application of Web sciences, the science of direct, and also from google scholar to the detailed systematic review on IMERG satellite precipitation product for estimating the precipitation.

7 Future Agenda

IMERG is the best SPP to complement substitute ground precipitation measurement and is more accessible for mountainous and oceanic areas as well as plain areas. This research contributes to a deeper knowledge of IMERG products' global implementation and paves the way for future research into hydrological and hydro metrological applications. Therefore the precipitation data obtained from this satellite should be considered before the commencement of the construction and maintenance of any hydraulic structure to save from natural disasters.

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