

- Adler, R., Huffman, G., Chang, A., Ferraro, R., Xie, P., Janowiak, J., Rudolf, B., Schneider, U., Curtis, S., Bolvin, D., Gruber, A., Susskind, J., Arkin, P., & Nelkin, E. (2003). The Version 2 Global Precipitation Climatology Project (GPCP) Monthly Precipitation Analysis (1979–Present). *Journal of Hydrometeorology*, 4(6), 1147–1167. [https://doi.org/10.1175/1525-7541\(2003\)004<1147:TVGPCP>2.0.CO;2](https://doi.org/10.1175/1525-7541(2003)004<1147:TVGPCP>2.0.CO;2)
- Ahmad, I., Khan, D. A., Almanjahie, I. M., Chikr-Elmezouar, Z., & Laksaci, A. (2019). At-site rainfall frequency analysis using partial duration series and annual maximum series: A case study. *Applied Ecology and Environmental Research*, 17(3), 8351–8364. https://doi.org/10.15666/aeer/1703_83518364
- Andari, R., Nurhamidah, N., Daoed, D., & Marzuki, M. (2024). Validation of TRMM and GPM satellite data using daily precipitation observations. *International Journal on Advanced Science, Engineering and Information Technology*, 14(2), 555–562. <https://doi.org/10.18517/ijaseit.14.2.18980>
- Asdak, C. (2023). *Hidrologi dan pengelolaan daerah aliran sungai (Edisi Revisi)*. Gadjah Mada University Press.
- Becker, A., Finger, P., Meyer-Christoffer, A., Rudolf, B., Schamm, K., Schneider, U., & Ziese, M. (2013). A description of the global land-surface precipitation data products of the Global Precipitation Climatology Centre with sample applications including centennial (trend) analysis from 1901–present. *Earth System Science Data*, 5(1), 71–99. <https://doi.org/10.5194/essd-5-71-2013>
- Bhanage, V., Lee, H. S., Cabrera, J. S., Kubota, T., Pradana, R. P., Fajary, F. R., & Nimiya, H. (2024). Identification of optimal CMIP6 GCMs for future typical meteorological year in major cities of Indonesia using multi-criteria decision analysis. *Frontiers in Environmental Science*, 12. <https://doi.org/10.3389/fenvs.2024.1341807>
- Bharti, V., & Singh, C. (2015). Evaluation of error in TRMM 3B42V7 precipitation estimates over the Himalayan region. *Journal of Geophysical Research: Atmospheres*, 120(24), 12458–12473. <https://doi.org/10.1002/2015JD023779>
- Cheema, M. J. M., & Bastiaanssen, W. G. M. (2012). Local calibration of remotely sensed rainfall from the TRMM satellite for different periods and spatial scales in the Indus Basin. *International Journal of Remote Sensing*, 33(8), 2603–2627. <https://doi.org/10.1080/01431161.2011.617397>
- Chow, V. T. (1951). A General Formula for Hydrologic Frequency Analysis. *Transactions of the American Geophysical Union*, 32, 231-237. <https://doi.org/10.1029/TR032i002p00231>
- Chow, V. T. (1964). *Handbook of applied hydrology*. McGraw-Hill Book Company.
- Chow, V. T., Maidment, D. R., & Mays, L. W. (1988). *Applied hydrology*. McGraw-Hill.
- Ciabatta, L., Brocca, L., Massari, C., Moramarco, T., Puca, S., Rinollo, A., Gabellani, S., & Wagner, W. (2015). Integration of satellite soil moisture and rainfall observations over the Italian

- D'souza, G., Barrett, E. C., & Power, C. H. (1990). Satellite rainfall estimation techniques using visible and infrared imagery. *International Journal of Remote Sensing*, 11(3), 453–469. <https://doi.org/10.1080/02757259009532111>
- Di Tomaso, E., Romano, F., & Cuomo, V. (2009). Rainfall estimation from satellite passive microwave observations in the range 89 GHz to 190 GHz. *Journal of Geophysical Research: Atmospheres*, 114(D19). <https://doi.org/10.1029/2009JD011746>
- Espíndula de Quadros, L., Queiroz, M. D., & Vilas Boas, M. A. (2011). Distribuição de frequência e temporal de chuvas intensas. *Acta Scientiarum. Agronomy*, 33(3), 451–457. <https://doi.org/10.4025/actasciagron.v33i3.6021>
- Fang, J., Yang, W., Luan, Y., Du, J., Lin, A., & Zhao, L. (2019). Evaluation of the TRMM 3B42 and GPM IMERG products for extreme precipitation analysis over China. *Atmospheric Research*, 223, 24–38. <https://doi.org/10.1016/j.atmosres.2019.03.001>
- Faridzad, M., Yang, T., Hsu, K., Xiao, C., & Sorooshian, S. (2018). Rainfall frequency analysis for ungauged regions using remotely sensed precipitation information. *Journal of Hydrology*, 563, 1025–1039. <https://doi.org/10.1016/j.jhydrol.2018.05.071>
- Forster, B. (1985). An examination of some problems and solutions in monitoring urban areas from satellite platforms. *International Journal of Remote Sensing*, 6(1), 139–151. <https://doi.org/10.1080/01431168508948430>
- Gauss, C. F. (1805). *Theoria motus corporum coelestium in sectionibus conicis solem ambientium*. Hamburg: Perthes et Besser.
- Gebremichael, M., Bitew, M., Hirpa, F., & Tesfay, G. N. (2014). Accuracy of satellite rainfall estimates in the Blue Nile Basin: Lowland plain versus highland mountain. *Water Resources Research*, 50(11), 8775–8790. <https://doi.org/10.1002/2013WR014500>
- Gibrat, R. (1931). *Les inégalités économiques*. Paris: Librairie du Recueil Sirey.
- Gumbel, E. J. (1958). *Statistics of Extremes*. Columbia University Press.
- Gumindoga, W., Rientjes, T. H. M., Haile, A. T., Makurira, H., & Reggiani, P. (2017). Performance of bias correction schemes for CMORPH rainfall estimates in the Zambezi River Basin. *Hydrology and Earth System Sciences Discussions*, 1–27. <https://doi.org/10.5194/hess-2017-385>
- Guru, N., & Jha, R. (2022). A framework for the selection of threshold in partial duration series modeling. In *Hydrological Modeling* (pp. 123–140). Springer. https://doi.org/10.1007/978-3-030-81358-1_7
- Gustoro, D., Sujono, J., & Karlina. (2022). Perbandingan Pola Distribusi Hujan Terukur dan Hujan Satelit PERSIANN di DAS Progo. *Jurnal Teknik Pengairan: Journal of Water Resources Engineering*, 13(1), 23–35. <https://doi.org/10.31002/jtp.v13i1.4922>



- Hatmoko, W., Radhika, R., Firmansyah, R., & Fathoni, A. (2018). Ketahanan air irigasi pada wilayah sungai di Indonesia. *Jurnal Ilmiah*, 12(2), 65–76. <https://doi.org/10.31028/ji.v12i2.65-76>
- Hendrawan, V. S. A. (2025). *VRainFreq v1* [Computer software]. Universitas Gadjah Mada. <https://vempi.staff.ugm.ac.id/software/>
- Hong, Y., Hsu, K., Sorooshian, S., & Gao, X. (2004). Precipitation estimation from remotely sensed imagery using an artificial neural network cloud classification system. *Journal of Applied Meteorology*, 43(12), 1834–1853. <https://doi.org/10.1175/JAM2173.1>
- Hossain, F., & Huffman, G. (2008). Investigating error metrics for satellite rainfall data at hydrologically relevant scales. *Journal of Hydrometeorology*, 9(3), 563–575. <https://doi.org/10.1175/2007JHM925.1>
- Huffman, G., Bolvin, D., Braithwaite, D., Hsu, K., Joyce, R., Kidd, C., Nelkin, E., Sorooshian, S., Stocker, E., Tan, J., Wolff, D., & Xie, P. (2020). Integrated Multi-satellite Retrievals for the Global Precipitation Measurement (GPM) Mission (IMERG). In M. Levizzani, C. Kidd, D. Kirschbaum, C. Turk, & K. Nakamura (Eds.), *Satellite Precipitation Measurement* (pp. 343–353). Springer. https://doi.org/10.1007/978-3-030-24568-9_19
- Hunziker, S., Gubler, S., Calle, J., Moreno, I., Andrade, M., Velarde, F., Ticona, L., Carrasco, G., Castellón, Y., Oria, C., Croci-Maspoli, M., Konzelmann, T., Rohrer, M. & Brönnimann, S., 2017. Identifying, attributing, and overcoming common data quality issues of manned station observations. *International Journal of Climatology*, 37(13), pp.4131–4145. <https://doi.org/10.1002/joc.5037>
- Intergovernmental Panel on Climate Change (IPCC). (2021). *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report*. IPCC.
- Iqbal, J., Su, C., Ahmad, M., Baloch, M. Y. J., Rashid, A., Ullah, Z., Abbas, H., Nigar, A., Ali, A., & Ullah, A. (2023). Hydrogeochemistry and prediction of arsenic contamination in groundwater of Vehari, Pakistan: Comparison of artificial neural network, random forest and logistic regression models. *Environmental Geochemistry and Health*, 46(14). <https://doi.org/10.1007/s10653-023-01838-6>
- Iryani, S. Y., Alia, F., Tauhid, M. A., & Usman, A. P. (2022). Utilization of GPM satellite and PERSIANN satellite data for estimated monthly rainfall in South Sumatera. *UKaRsT*, 6(2), 174–183. <https://doi.org/10.30737/ukarst.v6i2.3482>
- Jain, M. (2020). The benefits and pitfalls of using satellite data for causal inference. *Review of Environmental Economics and Policy*, 14(1), 128–144. <https://doi.org/10.1093/reep/rez023>
- Jarwanti, P., 2021. Validasi data curah hujan satelit TRMM (Tropical Rainfall Measuring Mission) dengan data pos penakar hujan di DAS Grindulu, Kabupaten Pacitan, Jawa Timur. Skripsi, Universitas Brawijaya. <http://repository.ub.ac.id/id/eprint/184291>
- Jenkinson, A. F. (1955). The frequency distribution of the annual maximum (or minimum) values of meteorological elements. *Quarterly Journal of the Royal Meteorological Society*, 81(348), 158–171. <https://doi.org/10.1002/qj.49708134804>
- Kementerian Pekerjaan Umum dan Perumahan Rakyat. (2023). *Data Pos Curah Hujan*. Diakses dari <https://sda.pu.go.id/balai/bbwscitarum/publikasi-aset/aset-pos-curah-hujan>



- Khan, T., Kalimullah, Wang, Y., Salam, M., Alam, F., & Anwar, M. (2021). Analysis of annual maximum rainfall for frequency distribution to determine the best-fitted probability distribution for different sites in Pakistan. *Research Square*. <https://doi.org/10.21203/rs.3.rs-780243/v1>
- Kimani, M., Hoedjes, J. C. B., & Su, Z. (2017). An assessment of satellite-derived rainfall products relative to ground observations over East Africa. *Remote Sensing*, 9(5), 430. <https://doi.org/10.3390/rs9050430>
- King, A. P., & Eckersley, R. (2019). Inferential statistics IV: Choosing a hypothesis test. In *Statistics for Biomedical Engineers and Scientists* (pp. 289–310). Elsevier. <https://doi.org/10.1016/b978-0-08-102939-8.00016-5>
- Kolmogorov, A. N. (1933). Sulla determinazione empirica di una legge di distribuzione. *Giornale dell'Istituto Italiano degli Attuari*, 4, 83–91.
- Kurniyaningrum, E., Faluty, M. D., Mulya, H. D., Andayani, S., Hidayat, D. P. A., Sejati, W., & Sattar, H. (2024). Rainfall correction factor of CHIRPS satellite data against observation data of Ciliwung Watershed (Case study of Kemayoran Meteorological Station). *LIVAS*, 9(2), 149–158. <https://e-journal.trisakti.ac.id/index.php/livas/index>
- Levizzani, V. (2000). Satellite rainfall estimates: A look back and a perspective.
- Li, X. R., & Zhao, Z. (2006). Relative error measures for evaluation of estimation algorithms. *Proceedings of the 9th International Conference on Information Fusion (FUSION)*. IEEE.
- Mardiyah, R., Somayasa, W., Budiman, H., Djafar, M. K., & Sahupala, R. (2022). Uji goodness of fit distribusi gamma terboboti dengan statistik Kolmogorov-Smirnov untuk parameter terestimasi. *Jurnal Matematika, Komputasi dan Statistika (JMKS)*, 2(2), Mei–Agustus. <https://doi.org/10.33772/jmks.v2i2.13>
- McAlister, D. (1879). The Law of the Geometric Mean. *Proceedings of the Royal Society of London*, 29, 367–376.
- McMillan, H. K., Coxon, G., Sikorska-Senoner, A. E., & Westerberg, I. K. (2022). Impacts of observational uncertainty on analysis and modelling of hydrological processes: Preface. *Hydrological Processes*, 36(2), e14481. <https://doi.org/10.1002/hyp.14481>
- Menne, M. J., Durre, I., Vose, R. S., Gleason, B. E., & Houston, T. G. (2012). An overview of the Global Historical Climatology Network-Daily database. *Journal of Atmospheric and Oceanic Technology*, 29(7), 897–910. <https://doi.org/10.1175/JTECH-D-11-00103.1>
- Noviadi, S. C. (2021). Rainfall modeling based on early predicted and season zone characteristic in the BMKG season zone over Lombok river basin. *IOP Conference Series: Earth and Environmental Science*, 622, 012043. <https://doi.org/10.1088/1755-1315/622/1/012043>
- Nurudin, M., Mara, M. N., & Kusnandar, D. (2014). Ukuran sampel dan distribusi sampling dari beberapa variabel random kontinu. *Buletin Ilmiah Matematika Statistika dan Terapannya (Bimaster)*, 3(1), 1–6.
- Pearson, K. (1895). Contributions to the Mathematical Theory of Evolution. II. Skew Variation in Homogeneous Material. *Philosophical Transactions of the Royal Society of London A*, 186, 343–414.



- Pearson, K. (1900). On the criterion that a given system of deviations from the probable in the case of a correlated system of variables is such that it can be reasonably supposed to have arisen from random sampling. *Philosophical Magazine*, 50(302), 157–175.
- Perdinan, Arini, E. Y., Adi, R. F., Siregar, R., Clatworthy, Y., & Nurhayati, N. D. (2020). Meteorological services for forecast-based early actions in Indonesia. In S. Harijono & B. Soewondo (Eds.), *Climate Risk in Indonesia: Measurement, Management, and Adaptation* (pp. 349–364). Springer. https://doi.org/10.1007/978-3-030-36875-3_18
- Petty, G. W., & Krajewski, W. F. (1996). Satellite estimation of precipitation over land. *Hydrological Sciences Journal*, 41(4), 517–528. <https://doi.org/10.1080/02626669609491519>
- Piche-Larocque, C., Findlay, J., & Faroque, A. (2022). Reflections on learning from observational data. *International Journal of Economics and Finance*, 14(10), 56–66. <https://doi.org/10.5539/ijef.v14n10p56>
- Pipunic, R. C., Ryu, D., Costelloe, J. F., & Su, C.-H. (2015). An evaluation and regional error modeling methodology for near-real-time satellite rainfall data over Australia. *Journal of Geophysical Research: Atmospheres*, 120(19), 9704–9720. <https://doi.org/10.1002/2015JD023512>
- Pombo, S., & Proença de Oliveira, R., 2015. Evaluation of extreme precipitation estimates from TRMM in Angola. *Journal of Hydrology*, 523, 663–679. <https://doi.org/10.1016/j.jhydrol.2015.01.077>
- Pugas, A.F., 2023. The hunt for data: obstacles faced by researchers in the search for accurate information on precipitation in Brazil. *International Journal of Hydrology*, 7(2), pp.61–65. <https://doi.org/10.15406/ijh.2023.07.00344>
- Ramadhan, R., Yusnaini, H., Marzuki, M., Muharsyah, R., Suryanto, W., Sholihun, S., Vonnisa, M., Harmadi, H., Ningsih, A. P., Battaglia, A., Hashiguchi, H., & Tokay, A. (2023). Evaluation of GPM IMERG performance using gauge data over Indonesian Maritime Continent at different time scales. *Remote Sensing*, 15(5), 1222. <https://doi.org/10.3390/rs15051222>
- Romilly, T. G., & Gebremichael, M. (2011). Evaluation of satellite rainfall estimates over Ethiopian river basins. *Hydrology and Earth System Sciences*, 15(5), 1505–1514. <https://doi.org/10.5194/hess-15-1505-2011>
- Rudd, J. D., Roberson, G. T., & Classen, J. J. (2017). Application of satellite, unmanned aircraft system, and ground-based sensor data for precision agriculture: A review. *Applied Engineering in Agriculture*, 33(6), 865–875. <https://doi.org/10.13031/aim.201700272>
- Schneider, U., Becker, A., Finger, P., Meyer-Christoffer, A., Rudolf, B., & Ziese, M. (2016). GPCP Full Data Reanalysis Version 7.0: Monthly land-surface precipitation from rain gauges built on GTS based and historic data. *Deutscher Wetterdienst*. <https://doi.org/10.5065/D6000072>
- Shao, G. (n.d.). Satellite data. In *Wiley StatsRef: Statistics Reference Online*. <https://doi.org/10.1002/9781118445112.stat07755.pub2>
- Shukla, R., Trivedi, M., & Kumar, M. (2012). On the proficient use of GEV distribution: A case study of subtropical monsoon region in India. *arXiv Preprint arXiv:1203.0944*. <https://arxiv.org/abs/1203.0944>



- Silvestro, F., Gabellani, S., Rudari, R., Delogu, F., Laiolo, P., & Boni, G. (2014). Uncertainty reduction and parameter estimation of a distributed hydrological model with ground and remote-sensing data. *Hydrology and Earth System Sciences*, 19(4), 1727–1751. <https://doi.org/10.5194/hess-19-1727-2015>
- Smirnov, N. (1933). Estimate of deviation between empirical distribution functions in two independent samples. *Bulletin Moscow University*, 2, 3–16.
- Sri Harto, B.R. (2000). *Hidrologi: Teori, Masalah, Penyelesaian*. Yogyakarta: Nafiri Offset.
- Srikanthan, S. (2012). Annual maximum or partial duration series: A review. *Mathematics*. [Corpus ID: 133725421]
- Sutrisno, A. J., Kaswanto, R. L., & Arifin, H. S. (2018). Analisis Prediksi dan Hubungan antara Debit Air dan Curah Hujan di Sungai Ciliwung. *Jurnal Pengelolaan Sumber Daya Alam dan Lingkungan*, 10(1), 25–33.
- Takahashi, Y., Yamashita, K., Sato, M., Miyahara, H., & Hoshino, N. (2011). The use of cloud classification and rainfall radar data to improve geostationary satellite based rainfall estimation.
- Taye, M. A., Simane, B., Zaitchik, B., Setegn, S., & Selassie, Y. (2018). Analysis of the spatial patterns of rainfall across the agro-climatic zones of Jema Watershed in the northwestern highlands of Ethiopia. *Geosciences*, 9(1), 22. <https://doi.org/10.3390/geosciences9010022>
- Trinugroho, M. W., Arif, S. S., Susanto, S., & Nugroho, B. D. A. (2024). Assessing irrigation water demand and pumping operations for rice farming in the Bengawan Solo River, Indonesia. *Sains Tanah: Journal of Soil Science and Agroclimatology*, 21(1), 42–54. <https://doi.org/10.20961/stjssa.v21i1.79343>
- Upadhyaya, S., & Ramsankaran, R. (2014). Review of satellite remote sensing data based rainfall estimation methods.
- Vavrdá, J. (1979). Über die Richtigkeit und Genauigkeit bei der Messung von Netzebenenabständen. *Crystal Research and Technology*, 14(6), 673–679. <https://doi.org/10.1002/crat.19790140621>
- Verma, P., & Ghosh, S. K. (2018). Study of GPM-IMERG rainfall data product for Gangotri Glacier. *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, XLII-5, 383–388. <https://doi.org/10.5194/isprs-archives-XLII-5-383-2018>
- Wati, T., Hadi, T. W., Sopaheluwakan, A., & Hutasoit, L. M. (2022). Statistics of the performance of gridded precipitation datasets in Indonesia. *Advances in Meteorology*, 2022, Article ID 7995761. <https://doi.org/10.1155/2022/7995761>
- Watters, D., Battaglia, A., Mroz, K., & Tridon, F. (2018). Validation of the GPM Version-5 surface rainfall products over Great Britain and Ireland. *Journal of Hydrometeorology*, 19. <https://doi.org/10.1175/JHM-D-18-0051.1>
- Westerhoff, R., White, P., & Rawlinson, Z. (2018). Incorporation of satellite data and uncertainty in a nationwide groundwater recharge model in New Zealand. *Remote Sensing*, 10(1), 58. <https://doi.org/10.3390/rs10010058>
- Williams, S. (2007). Chi-kuadrat test for goodness of fit. In *Encyclopedia of Measurement and Statistics*. <https://doi.org/10.4135/9781412952644.n78>



EVALUASI DATA CURAH HUJAN SATELIT PERSIANN, GPM, DAN CHIRPS UNTUK PERHITUNGAN HUJAN RANCANGAN PADA SKALA DAERAH ALIRAN SUNGAI

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Willmott, C. J., & Matsuura, K. (2005). Advantages of the mean absolute error (MAE) over the root mean square error (RMSE) in assessing average model performance. *Climate Research*, 30(1), 79–82. <https://doi.org/10.3354/cr030079>