STUDI PEMILIHAN LOKASI PEMBANGKIT LISTRIK TENAGA MIKRO HIDRO BERBASIS TEKNOLOGI *GEOGRAPHICAL INFORMATION SYSTEM* DAN *ANALYTIC HIERARCHY PROCESS*

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Diajukan untuk memenuhi syarat untuk memperoleh gelar Sarjana Teknik Elektro
Program Studi Teknik Elektro

Disusun oleh:

Nasywa Imanuddin

E.5051.1800367

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Oleh

Nasywa Imanuddin

Sebuah skripsi yang diajukan untuk memenuhi salah satu syarat memperoleh gelar Sarjana Teknik Elektro pada Program Studi S1 Teknik Elektro

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LEMBAR PENGESAHAN

NASYWA IMANUDDIN

E.5051.1800367

STUDI PEMILIHAN LOKASI PEMBANGKIT LISTRIK TENAGA MIKRO HIDRO BERBASIS TEKNOLOGI *GEOGRAPHICAL INFORMATION SYSTEM* DAN *ANALYTIC HIERARCHY PROCESS*

Disetujui dan disahkan oleh pembimbing:

Dosen Pembimbing I

Prof. Dr. Ade Gaffar Abdullah, M.Si.
NIP. 19721113 1999903 1 001

Dosen Pembimbing II

Dr. Ir. H. Dadang Lukman Hakim, M.T.
NIP. 19610604 198603 1 001

Mengetahui,

Ketua Departemen Pendidikan Teknik Elektro

Dr. Yadi Mulyadi, M.T.
NIP. 19630727 199302 1 001

ABSTRAK

Air merupakan sumber daya alam paling esensial di dunia. Pemanfaatan sumber daya air yang bijak akan membawa manfaat luas dan sebaliknya pemanfaatan sumber daya air yang buruk maka dampak yang ditimbulkan akan sangat luas. Salah satu alternatif pemanfaatan dari sumber daya air adalah energi yang terdapat di dalam alirannya. Pembangkit listrik tenaga mikro-hidro adalah sebagian kecil jawaban untuk pemanfaatan sumber daya air. PLTMH memiliki sumbangsih terhadap penyediaan pasokan energi listrik. Langkah awal dalam riset pengadaan PLTMH adalah penentuan lokasi yang layak dikarenakan lokasi memegang peranan vital dalam keberhasilan dan keberlangsungan PLTMH. Keseimbangan antara daya yang diproduksi dan dampak terhadap lingkungan menjadi perhatian utama. Penelitian ini bertujuan untuk mengembangkan suatu sistem pendukung keputusan dengan basis *Analytic Hierarchy Process* dan teknologi *Geographical Information System* yang diimplementasikan untuk memudahkan dalam menentukan lokasi yang layak berdasarkan kriteria dari para ahli. Dengan melihat potensi aliran sungai di Kabupaten Banjarnegara, terdapat 3 lokasi strategis yang menjadi alternatif dalam penelitian ini dan ditetapkan aliran Sungai Brukah menjadi tempat paling cocok didirikan PLTMH.

Kata Kunci: PLTMH; *Analytic Hierarchy Process*; *Geographical Information System*.

ABSTRACT

Water is the most essential resources in the world. Wisdom in utilization of water resources could bring a wide benefit to the world otherwise if it is not managed wisely, it could be spread bad impact widely. One of most common things used in water resources is hydropower for example Micro-Hydro Power Plant (MHPP). MHPP has contributed to the supply of electricity. First step in research of feasibility study for MHPP is selecting decent location by reason of the location plays a vital role in the success and sustainability of MHPP. Balancing between the power produced and environment impact are the main concern on this study. This research aims to develop a support system in decision making based on Analytic Hierarchy Process and Geographical Information System technology that implemented in order to facilitate the selecting decent location depend on the experts criteria. Considering the hydropower potential in Banjarnegara District, researcher found 3 strategic locations as an alternative for this study and decided Brukah River watershed as the best location for developing MHPP.

Keyword: *MHPP; Analytic Hierarchy Process; Geographical Information System*

DAFTAR ISI

DAFTAR PUSTAKA

Arthur, E., Anyemedu, F. O. K., Gyamfi, C., Asantewaa - Tannor, P., Adjei, K. A., Anornu, G. K., & Odai, S. N. (2020). Potential for small hydropower development in the Lower Pra River Basin, Ghana. *Journal of Hydrology: Regional Studies*, *32*. https://doi.org/10.1016/j.ejrh.2020.100757

Badang, D. A. Q., Sarip, C. F., & Tahud, A. P. (2018). Geographic Information System (GIS) and Multicriteria Decision Making (MCDM) for Optimal Selection of Hydropower Location in Rogongon, Iligan City. *IEEE*.

Bawan, E. K., & Burami, C. J. (2019). Interkoneksi PLTMH dan Rekonfigurasi Jaringan Terhadap Profil Tegangan dan Rugi Daya Sistem Manokwari. *Jurnal Teknik: Media Pengembangan Ilmu Dan Aplikasi Teknik*, *18*(01), 1–07.

Bayazıt, Y., Bakış, R., & Koç, C. (2017). An investigation of small scale hydropower plants using the geographic information system. *Renewable and Sustainable Energy Reviews*, *67*, 289–294. https://doi.org/10.1016/j.rser.2016.09.062

Bhowmik, C., Dhar, S., & Ray, A. (2019). Comparative Analysis of MCDM Methods for the Evaluation of Optimum Green Energy Sources. *International Journal of Decision Support System Technology*, *11*(4), 1–28. https://doi.org/10.4018/ijdsst.2019100101

Cheruiyot Kipngeny Chelelgo, G. (2016). *Micro Hydro Potential Modelling-Integrating GIS into Energy Alternatives for Climate Change Mitigation*.

Chien, F., Wang, C. N., Nguyen, V. T., Nguyen, V. T., & Chau, K. Y. (2020). An evaluation model of quantitative and qualitative fuzzy multi-criteria decision-making approach for hydroelectric plant location selection. *Energies*, *13*(11). https://doi.org/10.3390/en13112783

Coskun, H. G., Alganci, U., Eris, E., Agiralioglu, N., Cigizoglu, H. K., Yilmaz, L., & Toprak, Z. F. (2010). Remote Sensing and GIS Innovation with Hydrologic Modelling for Hydroelectric Power Plant (HPP) in Poorly Gauged Basins. *Water Resources Management*, *24*(14), 3757–3772. https://doi.org/10.1007/s11269-010-9632-x

Eshra, N. M., Zobaa, A. F., & Abdel Aleem, S. H. E. (2021). Assessment of mini and micro hydropower potential in Egypt: Multi-criteria analysis. *Energy Reports*, *7*, 81–94. https://doi.org/10.1016/j.egyr.2020.11.165

Ghadimi, A. A., Razavi, F., & Mohammadian, B. (2011). Determining optimum location and capacity for micro hydropower plants in Lorestan province in Iran. In *Renewable and Sustainable Energy Reviews* (Vol. 15, Issue 8, pp. 4125–4131). Elsevier Ltd. https://doi.org/10.1016/j.rser.2011.07.003

Ghorbani, N., Makian, H., & Breyer, C. (2019). A GIS-based method to identify potential sites for pumped hydro energy storage - Case of Iran. *Energy*, *169*, 854–867. https://doi.org/10.1016/j.energy.2018.12.073

Hariyanto, S., & Lolyta, D. R. T. (2021). *Indeks Kemahalan Konstruksi Provinsi dan Kabupaten_Kota 2021* (D. S. Takarini, D. M. Ramadita, Munipah, & Y. Adidarma, Eds.). Badan Pusat Statistik.

Hilorme, T., Tkach, K., Dorenskyi, O., Katerna, O., & Durmanov, A. (2019). Decision Making Model of Introducing Energy-Saving Technologies Based on the Analytic hierarchy process. *Journal of Management Information and Decision Sciences*, *22*(4), 489–494.

IMIDAP. (2009). *Pedoman Studi Kelayakan PLTMH* (Vol. 2). Direktorat Jenderal Listrik dan Pemanfaatan Energi Departemen Energi dan Sumber Daya Mineral.

Jafari, M., Fazloula, R., Effati, M., & Jamali, A. (2021). Providing a GIS-based framework for Run-Of-River hydropower site selection: a model based on sustainable development energy approach. *Civil Engineering and Environmental Systems*, *38*(2), 102–126. https://doi.org/10.1080/10286608.2021.1893310

Jeftenić, G., Rašeta, A., Kolaković, S., Panić, M., Kolaković, S., & Mandić, V. (2021). A methodology proposal for selecting the optimal location for small hydropower plants. *Tehnicki Vjesnik*, *28*(5), 1462–1470. https://doi.org/10.17559/TV-20200408160557

Konica, J. A., & Staka, E. (2017). Forecasting of a hydropower plant energy production with Fuzzy logic Case for Albania. In *Journal of Multidisciplinary Engineering Science and Technology (JMEST)* (Vol. 4). www.jmest.orgJMESTN423521827244

Kucukali, S., al Bayatı, O., & Maraş, H. H. (2021). Finding the most suitable existing irrigation dams for small hydropower development in Turkey: A GIS-Fuzzy logic tool. *Renewable Energy*, *172*, 633–650. https://doi.org/10.1016/j.renene.2021.03.049

Kusre, B. C., Baruah, D. C., Bordoloi, P. K., & Patra, S. C. (2010). Assessment of hydropower potential using GIS and hydrological modeling technique in Kopili River basin in Assam (India). *Applied Energy*, *87*(1), 298–309. https://doi.org/10.1016/j.apenergy.2009.07.019

Larentis, D. G., Collischonn, W., Olivera, F., & Tucci, C. E. M. (2010). Gis-based procedures for hydropower potential spotting. *Energy*, *35*(10), 4237–4243. https://doi.org/10.1016/j.energy.2010.07.014

Marhendi, T. (2019). STUDI POTENSI PEMBANGKIT LISTRIK TENAGA MIKRO HIDRO DI SUNGAI BRUKAH (KALI BENING, BANJARNEGARA). *Techno*, *20*(1), 10–16.

Misbah, Z. K., Rizal, M., & Sahril, R. S. M. (2021). Feasibility Study of Micro Hydro Power Plant in Oboi River, Tutuling Village, East Halmahera Regency. *IOP Conference Series: Materials Science and Engineering*, *1125*(1), 012010. https://doi.org/10.1088/1757-899x/1125/1/012010

Moiz, A., Kawasaki, A., Koike, T., & Shrestha, M. (2018). A systematic decision support tool for robust hydropower site selection in poorly gauged basins. *Applied Energy*, *224*, 309–321. https://doi.org/10.1016/j.apenergy.2018.04.070

Moldoveanu, A., & Popescu, D. (2018). Optimized Implementation of Small Hydropower Plants on a River. Case Study. *10th International Conference and Exposition on Electrical and Power Engineering*, 0806–0811.

Muis, M. F., Barkey, R. A., Arsyad, U., & Nursaputra, M. (2020). Analysis of micro-hydro potential based on landuse planning in the Kelara watershed. *IOP Conference Series: Earth and Environmental Science*, *575*(1). https://doi.org/10.1088/1755-1315/575/1/012134

Nasir, B. A. (2014). Design considerations of micro-hydro-electric power plant. *Energy Procedia*, *50*, 19–29. https://doi.org/10.1016/j.egypro.2014.06.003

Odiji, C., Adepoju, M., Ibrahim, I., Adedeji, O., Nnaemeka, I., & Aderoju, O. (2021). Small hydropower dam site suitability modelling in upper Benue river watershed, Nigeria. *Applied Water Science*, *11*(8). https://doi.org/10.1007/s13201-021-01466-6

Palomino Cuya, D. G., Brandimarte, L., Popescu, I., Alterach, J., & Peviani, M. (2013). A GIS-based assessment of maximum potential hydropower production in La Plata basin under global changes. *Renewable Energy*, *50*, 103–114. https://doi.org/10.1016/j.renene.2012.06.019

Pranoto, B., Nur Aini, S., Soekarno, H., Zukhrufiyati, A., al Rasyid, H., & Lestari, S. (2017). POTENSI ENERGI MIKROHIDRO DI DAERAH IRIGASI (STUDI KASUS DI WILAYAH SUNGAI SERAYU OPAK) THE POTENTIAL OF MICROHYDRO IN IRRIGATION AREA (CASE STUDY IN SERAYU OPAK RIVER BASIN). *Jurnal Irigasi*, *12*(2), 77–86.

Prayoga, S. Y. (2019). *STUDI KELAYAKAN PEMBANGKIT LISTRIK TENAGA MIKROHIDRO DI BENDUNG KALISAPI BANJARNEGARA PUBLIKASI ILMIAH*.

Ramadhani, R. C., Yerizam, M., & Indrayani, I. (2020). Analysis of Ogan Ilir Regency's Kelakar River Runoff Discharge in Micro Hydro Power Plant (PLMTH) Planning. *Science and Technology Indonesia*, *5*(2), 41. https://doi.org/10.26554/sti.2020.5.2.41-44

Rana, S. C., & Patel, J. N. (2020). Selection of best location for small hydro power project using AHP, WPM and TOPSIS methods. *ISH Journal of Hydraulic Engineering*, *26*(2), 173–178. https://doi.org/10.1080/09715010.2018.1468827

Ratnata, I. W., Saputra, W. S., Somantri, M., Mulyana, E., & Ardhika, A. (2018). Preliminary Study of Micro-hydro Power Plant (MHPP) in the Rural Area. *IOP Conference Series: Materials Science and Engineering*, *384*(1), 1–9. https://doi.org/10.1088/1757-899X/384/1/012067

Rospriandana, N., & Fujii, M. (2017). Assessment of small hydropower potential in the Ciwidey subwatershed, Indonesia: A GIS and hydrological modeling approach. *Hydrological Research Letters*, *11*(1), 6–11. https://doi.org/10.3178/hrl.11.6

RPSDA WS Progo Opak Serang. (2016). Kementerian Pekerjaan Umum dan Perumahan Rakyat Direktorat Jenderal Sumber Daya Air Balai Besar Wilayah Sungai Serayu Opak.

Saaty, T. L. (1990). How to make a decision: The Analytic Hierarchy Process. *European Journal of Operational Research*, *48*(1), 9–26. https://doi.org/https://doi.org/10.1016/0377-2217(90)90057-I

Sammartano, V., Liuzzo, L., & Freni, G. (2019). Identification of potential locations for run-of-river hydropower plants using a GIS-based procedure. *Energies*, *12*(18), 1–20. https://doi.org/10.3390/en12183446

Serpoush, B., Khanian, M., & Shamsai, A. (2017). Hydropower plant site spotting using geographic information system and a MATLAB based algorithm. *Journal of Cleaner Production*, *152*, 7–16. https://doi.org/10.1016/j.jclepro.2017.03.095

Setiarso, M. A., Widiyanto, W., & Purnomo, S. N. (2017). Potensi Tenaga Listrik Dan Penggunaan Turbin Ulir Untuk Pembangkit Skala Kecil Di Saluran Irigasi Banjarcahyana. *Dinamika Rekayasa*, *13*(1), 19. https://doi.org/10.20884/1.dr.2017.13.1.155

Shaktawat, A., & Vadhera, S. (2021). Ranking of hydropower projects based on sustainability criteria in India using multicriteria decision making methods. *Croatian Operational Research Review*, *12*(1), 75–90. https://doi.org/10.17535/crorr.2021.0007

Soulis, K. X., Manolakos, D., Anagnostopoulos, J., & Papantonis, D. (2016). Development of a geo-information system embedding a spatially distributed hydrological model for the preliminary assessment of the hydropower potential of historical hydro sites in poorly gauged areas. *Renewable Energy*, *92*, 222–232. https://doi.org/10.1016/j.renene.2016.02.013

Sutoyo, Muh. N. (n.d.). *Metode Analytic Hierarchy Process (AHP)*.

Taherdoost, H. (2017). Decision Making Using the Analytic Hierarchy Process (AHP); A Step by Step Approach. *International Journal of Economics and Management System*, *2*, 244–246. https://ssrn.com/abstract=3224206http://www.ahooraltd.comhttp://www.hamta.org

Tian, Y., Zhang, F., Yuan, Z., Che, Z., & Zafetti, N. (2020a). Assessment power generation potential of small hydropower plants using GIS software. *Energy Reports*, *6*, 1393–1404. https://doi.org/10.1016/j.egyr.2020.05.023

Tian, Y., Zhang, F., Yuan, Z., Che, Z., & Zafetti, N. (2020b). Assessment power generation potential of small hydropower plants using GIS software. *Energy Reports*, *6*, 1393–1404. https://doi.org/10.1016/j.egyr.2020.05.023

Vassoney, E., Mammoliti Mochet, A., Desiderio, E., Negro, G., Pilloni, M. G., & Comoglio, C. (2021). Comparing Multi-Criteria Decision-Making Methods for the Assessment of Flow Release Scenarios From Small Hydropower Plants in the Alpine Area. *Frontiers in Environmental Science*, *9*. https://doi.org/10.3389/fenvs.2021.635100

Vidhya, S., & Sarvani, L. G. R. (2018). SELECTION OF SUITABLE SITES FOR SMALL HYDROPOWER PLANTS USING GEO-SPATIAL TECHNOLOGY. *International Journal of Pure and Applied Mathematics*, *119*(17), 217–240.

Vrekos, C., Tzimopoulos, C., Evangelides, C., & Arampatzis, G. (2019). Multi-Criteria Decision Making Using Relative Ratio Method for Locating a Small Hydropower Plant in Central Greece. *International Journal of Renewable Energy Sources*, *4*, 32–30. http://www.iaras.org/iaras/journals/ijres