Jurnal Hukum UNISSULA

Volume 41 No. 4, December
P-ISSN: 1412-2723

THE LEGAL POLICIES BASED ECOREGION WASTE HANDLING IN THE BENGAWAN SOLO RIVER

Absori
Universitas Muhammadiyah Surakarta, Indonesia, E-mail: abs154@ums.ac.id
Valisher Sapayev
Mamun University, Uzbekistan, E-mail: sapayev.vali.2017@gmail.com
Endah Pujiastuti
Universitas Semarang, Indonesia, E-mail: endah.pujiastuti@usm.ac.id
Mohammad Indra Bangsawan
Universitas Muhammadiyah Surakarta, Indonesia, E-mail: mibsambi@gmail.com
Trias Hernanda
Universitas Muhammadiyah Kudus, Indonesia, E-mail: triashernanda@umkudus.ac.id

ARTICLE INFO

Keywords:
Autonomy; Ecoregion; Regional; River; Waste

DOI :
10.30659/jh.v41i4.46504

ABSTRACT

The decrease in Bengawan Solo River's water quality threatens the livelihood of the people living around this river, considering that it is one of the sources of their livelihood. There has been large-scale pollution in the upstream area of Bengawan Solo River caused by alcohol waste, carcasses of pig cattle, and wastewater from textile factories that were not processed in the wastewater processing installation. The aim of this research is to analyze how the ecoregion methods can be applied and how it can became solution in managing the Bengawan Solo River to free from the threat of waste pollution.. Methods: This research employed the sociological method, where the authors collected field data from seven districts or regencies. The primary data were sourced from observation and interviews, while the secondary data consisted of regulations, laws, etc. These data were descriptively analyzed to illustrate policies for handling waste. Waste processing issues happen in almost every area in Indonesia. Findings: Even though legal instruments that govern this issue already exist, such an issue cannot be resolved through the regulations of one city or regency. Thus, there is a need for inter-regency regulations. There needs to be a new concept to help protect this river, which is the ecoregion approach.

1. Introduction

Indonesia has a target to resolve energy transition by 2050.[1] This concept has the goal of implementing the sustainability program that has been ratified in the governmental regulation as well as to create a balance between development and environmental protection. The sustainable development concept[2]

1 Wirjawan.,The Paradox of Sustainability - A Critique of the Modern World's Approach to Sustainable Development, *Shorenstein Aparc Working Paper*, March 2024.
2 Rajvikram Madurai Elavarasan,Rishi Pugazhendhi,Muhammad Irfan,Lucian Mihet Popa, Pietro Elia Campana., A Novel Sustainable Development Goal 7 Composite Index as the Paradigm

encourages changes to every country's paradigm. Such a concept has been applied to major rivers, including the Nile River,[3] Euphrates River,[4] Ganges River,[5] and the Amazon River.[6] Even, in Indonesia, sustainable development-based changes have been adopted at the regional level. These changes emphasize the existence of different perspectives on environmental protection.[7]

Indonesia also has term issues,[8] with river and watershed management.[9] The Bengawan Solo River faces various problems, which can directly be categorized with the support of field facts. The first problem is that society uses rivers as trash and waste disposals. Then, rivers act as a source of flood. The habit of people throwing rubbish into rivers can cause the river to experience sedimentation and shallowing so that the capacity of the river decreases drastically and when it rains it will cause flooding in residential areas.

One of the rivers that is impacted by waste pollution in Indonesia is the Bengawan Solo River in Central Java Province, especially in Surakarta City.[10] The Bengawan Solo River has a cultural and historical relationship with Central Java citizens. Unfortunately, according to the Indonesian Ministry of Environment and Forestry, this river is categorized as a damaged and critical river.[11] It is a fact that the issues of river damage and pollution are classical problems in Indonesia.[12] The existing legal bases, such as the Law on

for Energy Sustainability Assessment: A Case Study from Europe. *Applied Energy,* Vol.307, 2022; Also see, Abdul-Halim et al., Knowledge, Attitude and Practice of Environmental Sustainability among Sustainable Science Students in Universiti Malaysia Kelantan. *IOP Conference Series: Earth and Environmental Science,* Vol.842 No.1, 2021.

3 El Bastawesy, Shalaby, and Mohamed., Management of Waste Water Discharge within the Nile Valley of Egypt: The Collapse of Al Ballanah Waste Water's Lake in Aswan in September 2013 *The Egyptian Journal of Remote Sensing and Space Science,* Vol.21, 2016.

4 Mashaan et al., Sustainable Management Strategies of the Water Pollution of the Euphrates River Within Ramadi City West of Iraq. *International Journal of Sustainable Development and Planning,* Vol.19, 2024.

5 Sigdel, Carlton, and Gautam., Resolving the Ganges Pollution Paradox: A Policy-centric Systematic Review. *British Medical Bulletin,* October 2017.

6 de Oliveira et al., Integrated Municipal and Solid Waste Management in the Amazon: Addressing Barriers and Challenges in Using the Delphi Method. *International Journal of Environmental Impacts*, Vol.4 No.1, 2021.

7 Stephen Morton and Squires., Sustainable Development Goals (SDGs), and Their Implementation Systems Approach at Every Level. *British Medical Bulletin*, October 2017"

8 Arpangi, Denny Suwondo, Andri Winjaya Laksana, Chami Yassine., Integrating Australian Employment Law Practice in Support of People with Disabilities in Indonesia, *Khazanah Hukum*, Vol.7 No.2, page. 236-254.

9 Mega Mutiara Sari, Pertiwi Andarani, Suprihanto Notodarmojo, Regil Kentaurus Harryes, Minh Ngoc Nguyen, Kuriko Yokota., Plastic Pollution in the Surface Water in Jakarta, Indonesia. *Marine Pollution Bulletin,* Vol.122, 2022.

10 Yuspin, Fauziyyah, and Budiono., The Impact of Deforestation on Sustainable Development Goals Regulations: An Empirical Studies on Tawangmangu. *International Journal of Sustainable Development and Planning,* Vol.18 No.7, 2023.

11 Handayani., Urgensi Peraturan Daerah Pengelolaan Daerah Aliran Sungai Bengawan Solo Dalam Rangka Penguatan Fungsi Lingkungan Hidup Dan Good Governance. *Jurnal Hukum Ius Quia Iustum,* Vol.20 No.2, 2013.

12 Kamarulzaman et al., Field-Based Assessment of Vegetation Structure and Configuration (VSC) For Thermal Regulation in Tropical Residential Environments. *Architecture Image Studies*, Vol.6 No.3, 2025

Environmental Management, the Law on Forestry, the Law on Water Resources, the Governmental Regulation on Hazardous Waste, and Regulations on Waste in Watersheds have substantial articles that may be used to manage or protect rivers.[13]

The central government has fully delegated the regional authority in environmental protection and management in the waste sector to regional governments, as regulated in Law No. 32 of 2014 on Regional Governments. Unfortunately, law enforcement in the waste sector has not optimally been carried out, including in several cities/regencies that are part of the Bengawan Solo River area. The regional autonomy era encourages the existence of a change in the environmental management paradigm in regional development.[14] Thus, the failure to resolve issues related to waste in every city will lead to the emergence of a question on whether or not the regional autonomy is carried out well and whether or not it supports environmental protection.

The ecoregion approach means that to increase the effectiveness in handling waste in the Bengawan Solo River, regional governments in the Bengawan Solo River basin (which includes 8 districts and cities) cooperatively formulate comprehensive policies.[15] So far, each region creates separate policies with different priorities, making these policies lack comprehensiveness. Regarding waste management in the Bengawan Solo River, the regulations are spread across several regulations such as Surakarta City Regional Regulation Number 10 of 2015 concerning Environmental Protection and Management, Wonogiri Regency Regional Regulation (Perda) Number 5 of 2022 concerning the Wonogiri Regency Industrial Development Plan for 2022-2042 and Sukoharjo Regency Regional Regulation (Perda) Number 1 of 2018 concerning the Sukoharjo Regency Spatial Planning for 2011-2031.[16]

From a legal theory perspective, each region has authority over its own region and each region has different priorities.[17] Thus, with an ecoregion-based policy, these governments can align their perspectives and simultaneously apply such policies. There are various principles or methods of river management that can be used to resolve the issue of waste pollution. However, in this research, the authors will utilize the ecoregion approach.[18] The ecoregion approach is defined

13 Rustinsyah, Prasetyo, and Adib., Social Capital for Flood Disaster Management: Case Study of Flooding in a Village of Bengawan Solo Riverbank, Tuban, East Java Province. *International Journal of Disaster Risk Reduction,* Vol.52, 2021.

14 Iksan et al., Fulfilling the Restitution Rights of Crime Victims: The Legal Practice in Indonesia. *Academic Journal of Interdisciplinary Studies,* Vol.12 No.4, 2023.

15 Kamarulzaman et al., Field-Based Assessment of Vegetation Structure and Configuration (VSC) For Thermal Regulation in Tropical Residential Environments. *Architecture Image Studies*, Vol.6 No.3, 2025.

16 Filatova et al., Concepts and Methods of Research on the Visual Image of the City. *Architecture Image Studies,* Vol.5 No.2, 2024.

17 Jiwanti, Ainun, and Sopoyono, Eko., The Urgency of Judge's Legal Reasoning in Deciding on an Environmental Crime Case Based on an Ecocentric Approach (Review of Case Decision No. 640/PID.B/LH/2021/PT PBR). *Jurnal Jurisprudence*, Vol.12 No.2, 2022

18 Absori et al., Environmental Health-Based Post-Coal Mine Policy in East Borneo. *Scientific Foundation SPIROSKI, Skopje, Republic of Macedonia Open Access Macedonian Journal of Medical Sciences*, Vol.9 No.E, 2019

as an approach that emphasizes the integrity of the environmental and natural systems that are based on similarities in climate, land water, as well as flora and fauna.[19]

Some previous articles have discussed the management of rivers and watersheds using the ecoregion approach, such as an article written by Triana[20] entitled "The Ecoregion Approach in the River Water Resource Management Legal System Amid the Regional Autonomy Era", which encourages the adoption of ecoregion-based watershed management as well as the enactment of ecoregion-based regional regulations. This precious research article suggested the adoption of ecoregion-based watershed management, while this current article aims to create an ecoregion-based policy on waste water management in the Bengawan Solo River. The authors' current research is essentially the future research that was directed from Triana's research. Another previous research was written by Çelekli, with the title "Eco-Assessment of Streams of Konya Closed River Basin (Turkey) Using Various Ecoregional Diatom Indices".[21] The conclusion of this previous research explains that the ecoregion method provides great help in analyzing the existence of some species in the watershed area. The novelty of this current research lies in the research area, as Çelekli's research studied the Konya Closed river basin, while this current article studies the Bengawan Solo River basin. Then, Mostafavi wrote a previous research article on this topic entitled, "Habitat and River Riparian Assessment in the Hyrcanian Forest Ecoregion in Iran: Providing Basic Information for the River Management and Rehabilitation".[22] Mostafavi's research focused on the river Riparian rehabilitation based on forest ecoregion policy, while the authors' current research focuses on ecoregion-based policies on waste management. The conclusion of Mostafavi's article explains that the ecoregion method can be used as a measure in the ecosystem revival that is located at the river watershed area.

Then, the aim of this current research is to analyze how the ecoregion method can be applied and how it can become a solution in managing the Bengawan Solo River to free it from the threat of waste pollution. It also aims to analyze the waste management in the Bengawan Solo River area. The future of the Bengawan Solo River must be improved from now on. Therefore, there needs to be further research that emphasizes the protection and sustainability of the Bengawan Solo River.

This research's problems are: how to formulate waste management policies in Bengawan Solo River amid the regional autonomy era, regional governments'

19 Miclat, Ingles, and Dumaup., Planning across Boundaries for the Conservation of the Sulu-Sulawesi Marine Ecoregion. *Ocean and Coastal Management*, Vol.49 No.9–10, 2006.

20 Triana., Pendekatan Ekoregion Dalam Sistem Hukum Pengelolaan Sumber Daya Air Sungai Di Era Otonomi Daerah. *Pandecta Research Law Journal*, Vol.9 No.1, 2014.

21 Çelekli, Lekesiz, and Çetin., Eco-Assessment of Streams of Konya Closed River Basin (Turkey) Using Various Ecoregional Diatom Indices. *Environmental Science and Pollution Research*, Vol.30 No.13, 2023.

22 Mostafavi, Teimori, and Hughes., Habitat and River Riparian Assessment in the Hyrcanian Forest Ecoregion in Iran: Providing Basic Information for the River Management and Rehabilitation. *Environmental Monitoring and Assessment*, Vol.194 No.10, 2022.

challenges in handling waste in the Bengawan Solo River amid the regional autonomy era, and ecoregion-based development of the Bengawan Solo River.

The research gap in this study is that the regions traversed by the Bengawan Solo River do not have a comprehensive, ecoregion-based policy on waste management. Based on the introduction, essentially, the research problems that will be answered in this research are: (1)How is waste managed in the Bengawan Solo river amid the regional autonomy era? (2) What are regional governments' challenges in handling waste in the Bengawan Solo River amid the regional autonomy era? and (3) What is the ecoregion-based development of the Bengawan Solo River like? This is crucial because in essence, each region has separate policies regarding waste management in the Bengawan Solo River basin, reflecting their different priorities. The novelty of this research is that this research attempts to find and formulate ecoregion-based waste management policies in waste management along the Bengawan Solo river basin.

2. Research Methods

This research employed the empirical legal research method.[23] The empirical legal methods is legal research using data which were obtained from observation or interviews. These data were then combined with secondary and tertiary data from literary materials, including laws, reports, journals, etc.[24] This research employed the sociological approach, statue approach, and library approach.[25] In the sociological approach, the authors obtained empiric data for the empirical research.[26] This is combined with statue approach and library approach, where the authors used statutes or positive law and library data, including previous research articles, journals, reports, books, etc..[27] This was qualitative research, [28]which means that the authors analyzed empirical data and the application of regulations in various regions/countries as well as how these regulations were written to find the concept of ecoregion-based waste policies on the Bengawan Solo River, Indonesia.

The data were obtained from seven regencies/cities in two provinces, namely Wonogiri Regency, Sukoharjo Regency, Surakarta City, Sragen Regency, and Karanganyar Regency (Central Java Province) as well as Tuban Regency and Bojonegoro Regency (East Java Province). The data were in the form of

23 Haq et al., Management of National Judicial System Control Based on Local Laws: A Case Study at the Mediation Center in Lombok, Indonesia. *Lex Localis: Journal of Local Self Government*, Vol.19 No.3, 2021.

24 Budiono et al., The Anglo-Saxon System of Common Law and the Development of the Legal System in Indonesia. *WSEAS Transactions on Systems*, Vol.22, 2023.

25 Fahmi et al., Election Crimes and the Architect of Restorative Justice to Achieve Electoral Justice. *Architecture Image Studies*, Vol.6 No.3, 2025.

26 Budiono et al., Pseudo National Security System of Health in Indonesia. *Indian Journal of Public Health Research & Development*, Vol.9 No.10, 2018.

27 Haq et al., Community Mediation-Based Legal Culture in Resolving Social Conflicts of Communities Affected by the COVID-19 Pandemic in West Nusa Tenggara, Indonesia. *Studia Iuridica Lublinensia*, Vol.31 No.2, 2022.

28 Wardiono., Prophetic: An Epistemological Offer for Legal Studies. *Journal of Law and Justice*, Vol.1 No.1, 2019.

interviews and field observation. Semi-structured interviews were conducted with key stakeholders (environmental officials, staff of River Area Centers, wastewater treatment plant managers, and community representatives), while observations followed a brief checklist at selected sites. These two types of data were then synchronized with some regulations related to waste management and the Bengawan Solo River in each of these regions. Then, the research was supported by normative data from regional laws, regency decisions, reports, research articles, journal articles, etc. Then, the water quality index of the Bengawan Solo River in each of these regions was obtained from the Bengawan Solo River Management Center. The researchers then compared data from the monthly series of Water Quality Index (WQI) for the period of 2024-2025 from these regions. Perbandingan ini merupakan sebuah novelty mengingat data diambil dari tahun yang sama dengan penelitian dari peneliti. Penelitian dari Sulandari et al menunjukkan bahwa WQI Bengawan Solo periode 2024-2025 Bengawan Solo River water quality monitoring analysis stated that the Ammonia content was 13.91%, Chemical Oxygen Demand (COD) 1.84%, BOD 3.31%, Oxygen Demand (DO) 0.28%, Nitrate (pH) 0.21%, Total Dissolved Solid (TDS) 0.23%, Total Suspended Solid (TSS) 3.23%. Based on the analysis results on April 26, 2024, the water quality status of the Bengawan Solo River is categorized as heavily polluted due to the high ammonia pollutant parameter of 13.91%[29]

The data analysis used in this research was related to the method that the authors used, namely qualitative analysis.[30] This analysis was linked to the empirical legal research method, where the authors compared the application of regulations in an area/country and how those regulations are implemented according to the substance of the applicable regulations.[31] Then, this research also portrayed the events that were linked to waste pollution and damage to the Bengawan Solo River watershed. The analysis in this article was a legal policy analysis[32], which carried out coding to show the management of river or environmental areas that were part of the Bengawan Solo River watershed area.

3. Results And Discussion

3.1 The Waste Management in Bengawan Solo River Amid the Regional Autonomy Era

The regional autonomy concept gives regional governments the authority to regulate their own territories.[33] This authority was obtained through the

29 Sulandari etal., Penentuan Status Mutu Air Sungai Bengawan Solo Menggunakan Teknologi Online Monitoring (Onlimo) Pada Stasiun Klhk 60 Jurug Jebres Kota Surakarta, Jawa Tengah.

30 Absori et al., Public Health-Based Policy on Stunting Prevention in Pati Regency, Central Java, Indonesia. *Open Access Macedonian Journal of Medical Science,* Vol.10 No.E, 2022.

31 Imamalieva et al., Legal Difficulties Associated With The Use Of Big Data In Healthcare: Civil Law And Cyberlaw Review. *Medicine Law and Society*, Vol.17 No.1, 2024.

32 Margono et al., The Injustice of Criminal Guidelines in the Act of Corruption Crime. *Jurnal Hukum Unissula*, Vol. 40 No. 2, 2024.

33 Moorthygari et al., Environmental Maintenance and Ecotourism: An Analysis into the Observation of Tourists and Maintenance Agencies in India. *Architecture Image Studies*, Vol.6 No.3, 2025.

concurrent authority, which legitimates the regions in determining the direction of their development.[34] However, the application of this concept in the regions is often hindered by some factors, such as society's culture and weak law enforcement. [35]As quoted by Sidharta, Scholten, a legal scholar from the Netherlands coined the phrase "*Het recht is er, doch het moet gevonden worden*" which means that the law exists but it must be found.[36] Scholten's statement correlates with how waste is currently handled in the Bengawan Solo River.[37]

The factors that are obstacles to regional development also apply to waste management. In the Bengawan Solo River area, waste is a common issue in every city in which this river flows. This problem spreads to seven regencies traversed by the Bengawan Solo River, bringing disasters to citizen and economic business (especially tourism).[38.] As aforementioned in the previous paragraph, the waste pollution in this river area occurred due to the weak legal culture and ineffective law enforcement. The population explosion is also a factor, even though there is Population Administration Law No. 23 of 2006 which only regulates data aspects (registration, documents) but does not provide a limitation mechanism.

As aforementioned in the previous paragraph, the waste pollution in this river area occurred due to the weak legal culture and ineffective law enforcement. The population boom in several cities/regencies around this river also pushed the increase in waste pollution due to society's improper waste disposal practices which lacks consideration over the negative impacts of waste pollution on environmental preservation.

According to Azis, the Bengawan Solo River is a highly polluted river in Indonesia.[39] This finding is supported by a comprehensive study conducted by the Ecooton Institute, which monitored the river's condition along its entire course. It conducted observation of the Bengawan Solo River from the upstream to the downstream.[40]

In line with Azis, Budi from the Environmental Service of Sukoharjo Regency explained that in this regency, one of the causes of the Bengawan Solo River's pollution is textile and alcohol waste that is directly disposed of to the river without utilizing the wastewater processing installation. In Surakarta, the waste pollution in the Bengawan Solo River affects the quality and quantity of the water distributed by the Municipal Waterworksespecially during some months of

34 Budiono et al., Digital Defense Drives Economic Growth in Indonesia and Uzbekistan. *Journal of Sustainable Development and Regulatory Issues*, Vol.3 No.2, 2025.

35 Widayati et al., The Challenges of Using the Omnibus Law Method in Indonesia's Legal System. *Volksgeist: Jurnal Ilmu Hukum Dan Konstitusi*, Vol. 8 No. 2, 2025

36 Sidharta., Kaitan Pemikiran Scholten Dan Dworkin."

37 *Ibid*.

38 Absori et al., Critical Analysis of River Basin Management Regulation in Bengawan Solo for Water Tourism: Local Legislation in 7 Regency. *WSEAS Transactions on Environment and Development*, Vol.19, 2023;.

39 Interview with Abdul Azis, Dari NGO Ecooton, date 21 September 2024

40 Absori et al., Analysis of the Issues on Bengawan Solo River Basin Management Policies. *WSEAS Transactions on Environment and Development*, Vol.19, November 2022, 2023.

the dry season.[41]

In Bojonegoro and Tuban Regencies, East Java Province, there is the issue where waste is directly disposed of in the Bengawan Solo River. The waste that is directly disposed of in this river consists of domestic waste and waste from the local market. According to the Bojonegoro Environmental Service, some members of the society have the habit and mindset that the Bengawan Solo River is a place of waste disposal.[42] They do not think that the water in this river brings benefits to various living creatures.[43] The sustainability of the Bengawan Solo River is part of the mandate stipulated in the 1945 Constitution, Article 28H clause 1 or Article 33 which states that every citizen has the right to live in a good and natural environment. Unfortunately, it is difficult to optimally keep this mandate.

In the regional autonomy system, regional development must orient towards the environment. The legal basis of this is Law No. 23 of 2014 on Regional Governments, Article 262. The substance of this article encourages the existence of a regional development plan that considers the sustainability of the surrounding environment.[44] The environment cannot be sacrificed for mere developmental interests. This is shown by the existence of regional regulations on waste management in every region in which the Bengawan Solo River flows. However, these regulations have not been renewed after the enactment of the Law on Job Creation, as there were changes to environmental permits that were integrated into business permits.[45] One of these is Article 22 of Law No. 6 of 2023, which amends the provisions of Law No. 32 of 2009 concerning Environmental Protection and Management (PPLH). This article changes the term "environmental permit" in the previous law to "environmental approval" (Environmental Feasibility Decision or Statement of Commitment to Environmental Management).

The effect of the Job Creation Law (Omnibus Law) in this case is to provide convenience for businesses, especially in terms of environmental obligations (such as environmental impact analysis), waste management installations, and other obligations, such as environmental rehabilitation. This is so that business investment is prioritized over environmental sustainability. In this case, it has a negative effect on waste management along the Bengawan Solo River basin.
There is weak supervision in waste management in all regions traversed by the Bengawan Solo River. Related laws, such as Article 82C of Law No. 6 of 2023, outline the types of administrative sanctions, including written warnings,

41 Interview with Budi from Environmental Service of Sukoharjo Regency, date 25 October 2022

42 Interview with Susanto Environmental Service of Bojonegoro Regency, date 25 October 2022

43 Hasan and AL-Salam., Green Buildings as a Cornerstone of Green Cities: A Comparative Analytical Study of (Msheireb, Masdar, and NEOM). *Architecture Image Studies*, Vol.6 No.4, 2025.

44 Absori et al., Public Health-Based Policy on Stunting Prevention in Pati Regency, Central Java, Indonesia. Open Access Macedonian Journal of Medical Science. *Open Access Macedonian Journal of Medical Science*, Vol.10 No.E, 2022.

45 Chusniatun., Legal Protection for Child Criminals at the Juvenile Detention Center: Study of Psychiatric Health. *Journal of Global Pharma Technology*, Vol.12 No.8, 2020"

government coercion, administrative fines, suspension of business permits, and/or revocation of business permits. However, the range of administrative sanctions is too broad, leading to repeated violations if oversight is weak due to suboptimal law enforcement.

In conducting waste management, these regions organize education and guidance sessions for business actors, industrial actors, as well as micro, small, and medium enterprise (MSMEs) owners regarding the regulations on waste disposal. This means that there is a limited routine monitoring process for business owners who have the potential to cause pollution. Likewise, there are insufficient strict sanctions for business owners who illegally violate waste disposal regulations.

According to Budi, for instance, in the Kliwon Market area in Surakarta City, there are dozens MSMEs working in the batik handicraft sector that do not have wastewater processing installations. According to Budi, there are some obstacles to hazardous waste management in the Bengawan Solo River area in the Surakarta region.[46] If violators are sanctioned, it will lead to the closing of some MSMEs. Meanwhile, there is a need for a large land area to create a communal wastewater processing installation, which is currently unavailable.

From the legal basis perspective, there is no issue with waste processing amid the regional autonomy era. Issues will arise when law enforcement is not strictly carried out. The culture of low environmental literacy and low environmental friendliness that is already ingrained in local communities also becomes an issue. Sukoharjo Regency has an issue with industrial waste handling that harms the people as Firmanzia et al, due to the waste disposal from PT. RUM which is not according to the standard regulations of environmental quality. Thus, the waste is still red and emits odor. The Bengawan Solo and Gupit rivers have become polluted and emit an unpleasant odor that disrupts residents' daily activities. The river water, normally used for bathing, washing, and drinking, has become unfit for use. Fish living in the river have died or disappeared. Plants planted around the river have wilted or died. Furthermore, this environmental pollution also affects the health of local residents. [47]

This issue becomes worse due to the decreasing regional authority in handling river areas that are categorized into the river basin area, as this authority has been taken over by the provincial government, leading to its slow handling.[48] This aligns with the mandate of Law No. 17 of 2019 concerning Water Resources, which stipulates that the authority to manage natural resources remains based on river basins. This law states that "the duties and authority of the Central Government and/or Regional Governments in managing water

46 Interview with Budi from Environmental Service of Sukoharjo Regency, date 25 October 2022

47 Firmanzia et al., Penegakan Hukum Terhadap Pencemaran Limbah Oleh Pt. Rayon Utama Makmur (Pt. Rum) Dan Dampaknya Terhadap Lingkungan Dan Posisi Hak Asasi Manusia Warga Sukoharjo.

48 Absori et al., Analysis of the Issues on Bengawan Solo River Basin Management Policies. *WSEAS Transactions on Environment and Development*, Vol.19, November 2022, 2023.

resources are based on the existence of river basins." Therefore, provinces have authority over rivers that cross more than one district/city, as divided by river basin. On the other hand, in the regional autonomy system, waste management also becomes an issue of cross-governmental priority. This is because cities and regencies only care about the environmental or natural resource management that are limited to their regional administration, impacting the waste management. This wastewater disposal has caused various negative impacts on the environment and surrounding communities.

In the issue of waste in the Bengawan Solo River area, regional governments often accuse each other of being responsible for such pollution without providing a clear resolution.[49] The Bengawan Solo River is part of the Bengawan Solo River basin area. The authority to handle and take care of the Bengawan Solo River basin area is the responsibility of the Bengawan Solo River Basin Center. Referring to the authority of the Bengawan Solo River Basin Center, the regional authority in managing or handling the issue of waste in the Bengawan Solo River only encompasses the scope of the rivers that flow to the Bengawan Solo area and the land that becomes the source of the issue of the pollution in the Bengawan Solo River area. This status was the result of a division of authority based on Law No. 32 of 2014 on the Regional Government, where river basin areas that encompass two regencies become the responsibility of the provincial government, while river basin areas that encompass two provinces become the responsibility of the central government. The regional autonomy era resulted in some challenges in the handling of waste pollution around the Bengawan Solo River area.

Such challenges may be seen from two perspectives, namely positive and negative. From the positive perspective, every regional government has the authority to handle and process waste in their own administrative areas and they may enact legal regulations according to their needs.[50] Meanwhile, from the negative perspective, the enactment of the Law on Job Creation will also influence how waste is handled in Bengawan Solo River due to changes in absolute responsibility (strict liability) into fault-based liability. This principle governs that there must be an element of evidence in a pollution case. Another negative perspective is that not all regions make changes to their regional regulations to adapt to the new Law on Job Creation. Then, there is also a clash between the law enforcement principle and the economic growth principle in society.[51]

In the regional autonomy era, waste handling should ideally become a mutual responsibility. Every regulation linked to waste management has included community participation. However, at the empirical level, not all societal

49 Budiono et al., Lessons from Indonesian National Healthcare Security (BPJS Kesehatan): HIV/AIDS Patient Medical Data Protection Policies. *Malaysian Journal of Medicine and Health Sciences*, Vol.20 No.9, 2024.

50 Arpangi et al., Integrating Australian Employment Law Practice in Support of People with Disabilities in Indonesia. *Khazanah Hukum*, Vol. 7 No. 2, 2025

51 Sudibyo et al., Municipal Solid Waste Management in Indonesia - A Study about Selection of Proper Solid Waste Reduction Method in D.I. Yogyakarta Province. *Energy Procedia*, Vol.143, 2017.

members understand the regulations related to waste or those linked to environmental protection. This means that the burden of responsibility is not only delegated to heads of services or stakeholders, but there must also be an emphasis on societal participation to prevent waste pollution. This will ease the enforcement of law as well as grow a sense of environmental friendliness, which is the key to the future.[52]

3.2 Regional Governments' Challenges in Handling Waste in the Bengawan Solo River Amid the Regional Autonomy Era

A report has shown that a weakness in the waste management in areas traversed by the Bengawan Solo River is the lack of societal participation in river protection. Apart from industrial waste, the waste that flows into this river are residues of the people's daily activities, becoming a source of this issue. The Environmental Management Service in each region has made efforts to handle waste originating from the people's activities, but the culture that lacks environmental friendliness still becomes a hindrance. This regulatory synchronization is based on an analysis that has been carried out on ten regulations on waste management at the regency and provincial levels. All these ten regulations focused on separated areas without coordinated regulations and policies. The existing regulations in these seven regencies should be protectors of the Bengawan Solo River area, but they are currently ineffective. To conduct this analysis, the authors used the Atlasti software, which carries out coding, to find out the substance of these ten regulations as shown in Table 1 below:

Table 1. Analysis of Ten Regulations on Waste Management Using the Atlasti Software

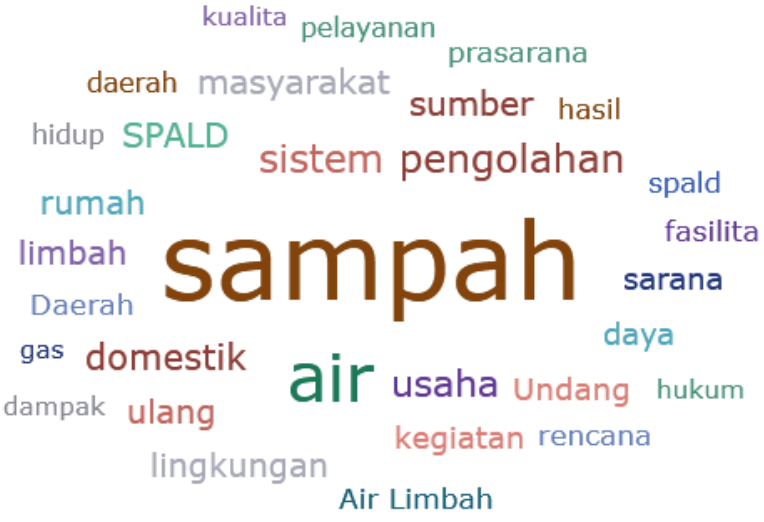
Concept	Noun Phrases	Indonesian Term	Count
Rubbish	Rubbish	*Sampah*	675.00
Management	Management	*Pengelolaan*	396.00
Water	Water	*Air*	362.00
Processing	Processing	*Pengolahan*	152.00
System	System	*Sistem*	146.00
Business	Business	*Usaha*	132.00
Domestic	Domestic	*Domestic*	125.00
Local Government	Local Government	*Pemerintah Daerah*	109.00
Public	Public	*Masyarakat*	106.00
Source	Source	*Sumber*	106.00
SPALD (Domestic Wastewater Management System)	SPALD	SPALD	105.00
House	House	*Rumah*	103.00
Waste	Waste	*Limbah*	102.00
Environment	Environment	*Lingkungan*	102.00
Repeat	Repeat	*Ulang*	102.00
Law	Law	*Undang*	90.00

52 Trias Hernanda, Absori, Aidul Fitriciada Azhari, Kelik Wardiono., Relationship Between Knowledge and Affection for the Environment: A Meta-Analysis. *European Journal of Educational Research*, Vol.11 No.3, 2022.

Activity	Activity	*Kegiatan*	87.00
Means	Means	*Sarana*	83.00
Area	Area	*Daerah*	77.00
Facilities	Facilities	*Fasilitas*	76.00
Wastewater	Wastewater	*Air Limbah*	74.00
Plan	Plan	*Rencana*	72.00
Place	Place	*Tempat*	72.00
Infrastructure	Infrastructure	*Prasarana*	70.00
Law No.	Law No.	*Undang Nomor*	66.00
Results	Results	*Hasil*	65.00
Domestic	Domestic	*Domestic*	58.00
Service	Service	*Pelayanan*	57.00
Collection	Collection	*Pengumpulan*	56.00
Region	Region	*Daerah*	55.00
Provision	Provision	*Ketentuan*	55.00
Life	Life	*Hidup*	54.00
Implementation	Implementation	*Pelaksanaan*	52.00
Waste Management	Waste Management	*Pengelolaan Sampah*	52.00
Organization	Organization	*Penyelenggaraan*	52.00
Law	Law	*Hukum*	50.00
Impact	Impact	*Dampak*	49.00
Gas	Gas	*Gas*	49.00
Quality	Quality	*Kualitas*	49.00
Field	Field	*Bidang*	48.00
Handling	Handling	*Penanganan*	48.00
Permission	Permission	*Izin*	47.00
Maintenance	Maintenance	*Pemeliharaan*	46.00

Then, Figure 1 below shows the arrangement of these words using the Word Cloud scheme. In a Word Cloud, more frequently mentioned terms are shown by their larger sizes compared to less frequently mentioned terms that are shown smaller in size. This Word Cloud shows that the ten regulations lack words on waste and rubbish, meaning that waste and rubbish management is given low priority in the ten regulations.

Figure 1. Word Cloud of Waste-Related Terms from Seven District-Level Local Regulations



(In Indonesian Version)

The table and the word cloud above show that the substance of laws and regulations related to waste in seven regencies flowed by the Bengawan Solo River have many similarities. There are not many identical words, such as waste and rubbish. This means that these regulations do not provide special attention to waste and rubbish management policies for the Bengawan Solo River basin.

The usage of these similar words has the same goal, namely to manage waste in the regency area. However, when referring to these identical words, the authors did not find the term "Bengawan Solo River", meaning that no special regulations on this river that are linked to the regency areas have been enacted. This condition happens because the Ministry of General Affairs and Public Housing as well as the Regulation of the Ministry of Environment prohibits regency-level governments from entering the scope of the Bengawan Solo River area. Several related regulations, such as Minister of Public Works and Public Housing Regulation No. 04 of 2015 concerning River Basin Criteria and Determination, emphasize that river management is based on river basins (not simply district administrative boundaries).

There is a similar pattern in the challenges in managing the Bengawan Solo River from year to year as there are issues related to the government, law-violating industries, and the public that lacks an awareness of environmental friendliness. Even worse, the current regulation does not have the strength to resolve the issue of waste in the Bengawan Solo River. Even, every village already has the Climate Village Program (*Proklim*), which aims to create a balance between humans' daily life patterns and environmental protection. This is to prevent the occurrence of massive climate change as well as annual disasters that some Indonesian cities face.

Azis from the Ecooton non-governmental organization explains that many fish contain microplastic due to waste that is disposed in the Bengawan Solo River, which is dangerous to when consumed by human beings.[53] Apart from that, the decreasing number of endemic fish in the Bengawan Solo River and the abundant suckermouth catfish or common pleco (*Hypostomus plecostomus*) population is proof that this river's environmental area has been damaged.[54]

Samplings research from Aida[55] were carried out in three zones: the upstream zone (I) in Sukoharjo District, Central Java; the middle zone (II) in the Surakarta City, Karanganyar Regency, and Sragen Regency, Central Java; and the downstream zone (III) in Ngawi Regency and Bojonegoro Regency, East Java. Results showed that the waters of Bengawan Solo in zone I were not

53 Interview with Abdul Azis from NGO Ecoton, date 21 September 2024

54 Interview with Sigit from Environmental Service of Sukoharjo Regency, Date 25 October 2024

55 Aida et al., "Distribution of Fish Species in Relation to Water Quality Conditions in Bengawan Solo River, Central Java, Indonesia."

affected by waste. After reaching zone II, there was a heavy pollution effect. In zone III, the water quality has returned to normal levels (recovery). The fish species in zone I were dominated by exotic fish, such as Nila (*Oreochromis niloticus*) and Jambal Sius (*Pangasianodon hypothalamus*). The fish species in zone II was dominated by Sapu sapu (*Pterygoplichthys pardalis*). In zone III were dominated by native fish species, such as Jendil (*Pangasius polyuranodon*), Seren (*Cyclocheilichthys enoplos*), and Bendol (*Barbichthys laevis*). Data show that at downstream zone II, there is decreasing fish due to the waste disposed of in the Bengawan Solo River.

Ironically, the human population living around the Bengawan Solo River has increased. They need clean water but they dispose of waste to the clean water source near their residential area, namely the Bengawan Solo River. In 2018, it has been proven that the water that becomes the source of drinking water for the surrounding society has been polluted with alcohol waste.[56]

Another impact of the waste pollution in Bengawan Solo River was analyzed in Gupit Village, Sukoharjo Regency. Part of the agricultural land which takes water from the Bengawan Solo River tributaries' streams has been polluted, making it difficult to plant rice paddies. The challenge of Bengawan Solo River management is mutual. Thus, there needs to be innovation to raise the awareness of society, the government, and industrial actors to maintain the sustainability of the Bengawan Solo River in the current era for the sake of the future. Normatively, Presidential Regulation No. 37 of 2023 concerning the National Water Resources Policy has synergized water resources management policies, encouraging stakeholder participation at both the national and regional levels. This can serve as a regulatory foundation for innovative awareness campaigns, environmental education, and collaboration between sectors (government, communities, and the private sector).

There are still uncertainties about the future of Bengawan Solo River due to challenges that occur in every era. A just law enforcement and protection pattern is a solution that can provide certainty to the Bengawan Solo River. In this context, there is a need for society's awareness and mindset to develop the sustainability of the Bengawan Solo River. If one only considers the human aspect, the Bengawan Solo River protection will not result in success. So, one must also consider the biodiversity and protection of other living creatures.

Seeing the current situation and condition, there is a possibility of a human population boom in Indonesia, which will require energy sources from nature, such as rivers as a source of clean water. The Bengawan Solo River can provide that solution if all the cities traversed by it utilize and protect the function of this river. Society must protect and bring benefits for the river, as sustainable use certainly requires the condition that the river must be clean. There must be a guarantee of its protection against rubbish and waste. This guarantee is reciprocal, as a clean river can sustainably be used by the population. The people should also be aware that the Bengawan Solo River is one of the

56 Hernanda et al., The Impact of Environmental Regulation Implementation: A Meta-Analysis. *International Journal of Sustainable Development and Planning*, Vol.18 No.10, 2023

sources that may give a solution for citizens of Central Java and East Java Provinces.

3.3 The Ecoregion-Based Development of the Bengawan Solo River

River and justice are two words that have a correlation to the life of human beings and other living creatures. Article 21 of Law No. 17 of 2019 concerning Water Resources states that rivers have social, environmental, and economic functions. This means that river water, as part of water resources, is not viewed merely as a commodity but also as having a social function in meeting the basic needs of the community. Both of these words have their own roles. Rivers have the role of a source of life and protection for human beings and other living creatures, while justice is a source of legal certainty and protection for human beings and other living creatures. However, the creators of justice are human beings who require rivers as the provider of certainty in the future. This applies to the Bengawan Solo River, which has a crucial role in providing life, certainty, and justice. Even so, the Bengawan Solo River also needs justice that human beings must provide to protect them. Therefore, rivers and human beings have a very strong correlation.

The management approach is key to creating a just relationship between human beings and the Bengawan Solo River. The ecoregion approach is an approach that will be applied in this research. Based on research that the authors conducted, it was found that the Bengawan Solo River is categorized as a river with a medium level of risk of pollution and a medium level of land degradation. Without serious actions, this status may change into severe. Ecoregion approach-based river management is one of the methods that can be used to protect and rearrange the special zonation and vulnerability zones that prioritizes the protection of environmental resource quality.

The length of the Bengawan Solo River reaches 548 kilometers, passing through five regencies in two provinces.[57] This makes the ecoregion approach more appropriate to be used in the current era. By integrating it with regional autonomy principles, it will become a new method.[58] Regional autonomy needs a system that is supported by an inter-region integration pattern, as regional autonomy has a negative side, i.e., the existence of sectoral ego. For instance, in cases where there are problems regarding the Bengawan Solo River, rather than working together to resolve them, regional governments tend to accuse each other.[59]

The ecoregion approach has been applied in several developed countries, yielding maximum results. Even, this concept has helped the mapping activity

57 Pebiola, Mulyanti, and Rahmawati., Assessment Of Bengawan Solo River Raw Water Quality Using The Pollution Index. *Analytical: Analytical and Environmental Chemistry*, Vol.10 No.1, 2025

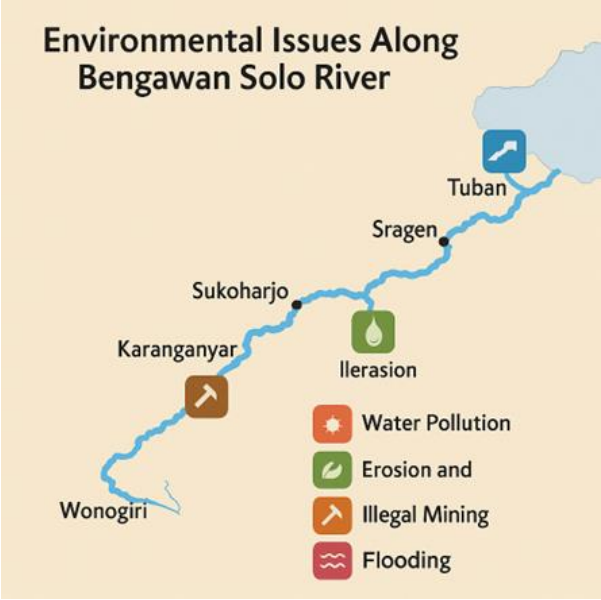
58 Budiono et al., The Ideal Management of Health Insurance for Indonesia According Constitution. *Quality-Access to Success*, Vol.21 No.176, 2020.

59 Kusumastuti et al., Water Quality Monitoring and Evaluation in the Bengawan Solo River Region. *IOP Conference Series: Earth and Environmental Science*, Vol.641 No.1, 2024.

on pollution vulnerability, land criticality, and the extinction of some ecosystems. The ecoregion concept is a concept for formulating integrated policies by several adjacent regions and implementing them jointly in each of these regions. In this case, the ecoregion concept involves each regency within the Bengawan Solo River basin sitting together to discuss Solo's pollution and, after discussion, ratifying an agreement in the form of their respective regional regulations and implementing policies.[60] This needs to be addressed and formulated together because the index shows that the Bengawan Solo River has been polluted.

Due to its condition, the Bengawan Solo River requires special attention. In the previous research, the authors observed that some fish that can be obtained in the Bengawan Solo River area, such as striped snakehead fish (*Channa striata*), three spot gourami fish (*Trichopodus trichopterus*), climbing perch fish (*Anabas testudineus*), and shark catfishes (*Pangasius pangasius*). Unfortunately, these fish are now hard to come by. The authors have also yet to see the concrete handling of mapping on existing species as well as the ones that no longer exist in the Bengawan Solo River area both at the upstream and downstream areas.

Figure 2. An Ecoregion Approach-Based Mapping Concept of Issues Along the Bengawan Solo River



The activity mapping in the ecoregion concept can be used to help handle the Bengawan Solo River area in every regency and province. Even, the mapping results of the ecoregion concept can be carried out with a focus on the source of the main issue, such as pollution in the upstream area. After carrying it out,

60 Itsukushima, Rei, and Yukihiro Shimatani., Study of Segment-Based Ecoregions Using Fish Fauna for Conserving River Environments in Kyushu, Japan. *Ecological Engineering*, Vol.97, 2016; Also see, Edgardo Javier Ignacio Pero, Sergio Miguel Georgieff and Fátima Romero, Guillermo Eduardo Hankel., Physicochemical, or a Combination of All: Which Criteria Are the Best to Define River Types Based on Abiotic Variables and Macroinvertebrates in Neotropical Rivers? *Science of The Total Environment*, Vol.738, 2020

it will continue with the handling of the issues of flood, illegal mining, and detection of extinct or vulnerable ecosystems.[61] Then, the ecoregion concept can also be synchronized with regional policies or regulations. Thus, this concept can be carried out and understood by local stakeholders and communities. It can encourage the existence of local society's participation.

According to the researchers, the ecoregion concept will provide great help to regional autonomy. This is because it resolves issues in a certain place, which will bring positive effects to other regions. It also brings the concept of community participation in encouraging regional development in a better direction, freeing the Bengawan Solo River from the issue of waste. This is the primary goal of this research funded by Universitas Muhammadiyah Surakarta through Riset Kompetensi Professor Scheme (with contract 95.47/A.3-III/LRI/IV/2025 fiscal year 2025)"

4. Conclusion

Changes to the paradigm of rivers' benefit for society will also influence changes to rivers' condition. This happens to the Bengawan Solo River, which experiences an unresolved issue of damage. There needs to be a new concept to help protect this river, i.e., the ecoregion concept, which allows a mapping of activities that occur in the Bengawan Solo River area. Indonesia is already familiar with the regional concept, i.e., the regional autonomy concept, which is similar to the ecoregion concept. By offering the ecoregion concept in handling waste in the Bengawan Solo River area, it will help the system in which the regional autonomy system runs. The handling of this river's issue requires an integrated understanding, as the issue of this river encompasses the damages that occur from the upstream to the downstream. Therefore, to free the Bengawan Solo River from waste, one must map the issue from the upstream to the downstream on the types of waste disposed of in this river. Theoretical contribution for this research is that it enriches the environment legal research with the study of an ecoregion-based regulation for Bengawan Solo River basin. The practical implication for this research is the creation of concrete policies or regulations based on ecoregion (from several regional governments), prioritizing the Bengawan Solo River basin waste management to achieve effectiveness. Then, the authors recommend the seven regional governments (city and regency levels) and two provincial governments to create a single effective and efficient policy for the waste management of the Bengawan Solo river basin.

BIBLIOGRAPHY

Journals:

Abdul-Halim, N. S., N. S. Ruslan, N. S.U. Idris, and S. A. Nawawi., Knowledge, Attitude and Practice of Environmental Sustainability among Sustainable

61 Edgardo Javier Ignacio Pero, Sergio Miguel Georgieff and Fátima Romero, Guillermo Eduardo Hankel., Physicochemical, or a Combination of All: Which Criteria Are the Best to Define River Types Based on Abiotic Variables and Macroinvertebrates in Neotropical Rivers? *Science of The Total Environment*, Vol.738, 2020?

Science Students in Universiti Malaysia Kelantan. *IOP Conference Series: Earth and Environmental Science*, Vol.842 No.1, 2021;

Absori, Absori, Hartotok Hartotok, Khudzaifah Dimyati, Heru Santoso Wahito Nugroho, Arief Budiono, and Rizka., Public Health-Based Policy on Stunting Prevention in Pati Regency, Central Java, Indonesia. *Open Access Macedonian Journal of Medical Science*, Vol.10 No.E, 2022;

Absori, Absori, Trias Hernanda, Aidul Fitriciada, Kelik Wardiono, and Arief Budiono., Analysis of the Issues on Bengawan Solo River Basin Management Policies. *WSEAS Transactions on Environment and Development*, Vol.19, November 2022, 2023;

Absori, Absori, Trias Hernanda, Kelik Wardiono, Aidul Fitriciada, and Arief Budiono., Critical Analysis of River Basin Management Regulation in Bengawan Solo for Water Tourism: Local Legislation in 7 Regency. *WSEAS Transactions on Environment and Development*, Vol.19, 2023;

Absori, Aulia Vivi Yulianingrum, Khudzaifah Dimyati, Harun Harun, Arief Budiono, and Hari Sutra Disemadi., Environmental Health-Based Post-Coal Mine Policy in East Borneo. *Scientific Foundation SPIROSKI, Skopje, Republic of Macedonia Open Access Macedonian Journal of Medical Sciences*, Vol.9 No.E, 2019;

Aida, Siti Nurul, Agus Djoko Utomo, Dian Pamularsih Anggraeni, Yoga Candra Ditya, Tuah Nanda M. Wulandari, Muhammad Ali, Christopher Marlowe A. Caipang, and Indra Suharman., Distribution of Fish Species in Relation to Water Quality Conditions in Bengawan Solo River, Central Java, Indonesia. *Pol. J. Environ. Stud.* Vol.31 No.6, 2022;

Arpangi, Andri Winjaya Laksana, and Chami Yassine., Integrating Australian Employment Law Practice in Support of People with Disabilities in Indonesia. *Khazanah Hukum*, Vol. 7 No. 2, 2025;

Bastawesy, Mohammed El, Adel Shalaby, and Ihab Mohamed., Management of Waste Water Discharge within the Nile Valley of Egypt: The Collapse of Al Ballanah Waste Water's Lake in Aswan in September 2013. *The Egyptian Journal of Remote Sensing and Space Science*, Vol.21, 2016;

Budiono, A., G. O. Alba, S. S. Gulyamov, and T. M. A. P. Ogli., Digital Defense Drives Economic Growth in Indonesia and Uzbekistan. *Journal of Sustainable Development and Regulatory Issues*, Vol.3 No.2, 2025;

Budiono, Arief, Absori Absori, Harun, Heru Santoso Wahito Nugroho, Khudzaifah Dimyati, and Kelik Wardiono., The Ideal Management of Health Insurance for Indonesia According Constitution. *Quality-Access to Success*, Vol.21 No.176, 2020;

Budiono, Arief, Absori Absori, Ayesha Hendriana Ngestiningrum, and Heru Santoso Wahito Nugroho., Pseudo National Security System of Health in Indonesia. *Indian Journal of Public Health Research & Development*, Vol.9 No.10, 2018;

Budiono, Arief, A. S. Nurrizky, F. Fairuzzaman, S. S. Gulyamov, A. L. Prakoso,

Wardah Yuspin, A. M. Farid, and T. M. A. P. Ogli., Lessons from Indonesian National Healthcare Security (BPJS Kesehatan): HIV/AIDS Patient Medical Data Protection Policies. *Malaysian Journal of Medicine and Health Sciences*, Vol.20 No.9, 2024;

Budiono, Arief, W. Yuspin, S.S. Nurani, F. Fairuzzaman, S.W.A. Pradnyawan, and S. D. Sari., The Anglo-Saxon System of Common Law and the Development of the Legal System in Indonesia. *WSEAS Transactions on Systems*, Vol.22, 2023;

Çelekli, Abuzer, Ömer Lekesiz, and Tolga Çetin., Eco-Assessment of Streams of Konya Closed River Basin (Turkey) Using Various Ecoregional Diatom Indices. *Environmental Science and Pollution Research*, Vol.30 No.13, 2023;

Chusniatun, C., Legal Protection for Child Criminals at the Juvenile Detention Center: Study of Psychiatric Health. *Journal of Global Pharma Technology*, Vol.12 No.8, 2020;

Edgardo Javier Ignacio Pero, Sergio Miguel Georgieff, María de Lourdes Gultemirian, and Eduardo Domínguez Fátima Romero, Guillermo Eduardo Hankel., Physicochemical, or a Combination of All: Which Criteria Are the Best to Define River Types Based on Abiotic Variables and Macroinvertebrates in Neotropical Rivers? *Science of The Total Environment*, Vol.738, 2020;

Fahmi, Mustafa Ali, Aidul Fitriciada Azhari, Natangsa Surbakti, Arief Budiono, and Zainur Wula., Election Crimes and the Architect of Restorative Justice to Achieve Electoral Justice. *Architecture Image Studies*, Vol.6 No.3, 2025;

Filatova, Tatyana, Meng We, He Feng, Azyk Orozonova, and Aktan Kashymbekov., Concepts and Methods of Research on the Visual Image of the City. *Architecture Image Studies*, Vol.5 No.2, 2024;

Handayani, I Gusti Ayu Ketut Rachmi., Urgensi Peraturan Daerah Pengelolaan Daerah Aliran Sungai Bengawan Solo Dalam Rangka Penguatan Fungsi Lingkungan Hidup Dan Good Governance. *Jurnal Hukum Ius Quia Iustum*, Vol.20 No.2, 2013;

Haq, Hilman Syahrial, Achmadi Achmadi, Arief Budiono, and Sinung Mufti Hangabei., Management of National Judicial System Control Based on Local Laws: A Case Study at the Mediation Center in Lombok, Indonesia. *Lex Localis: Journal of Local Self Government*, Vol.19 No.3, 2021;

Haq, Hilman Syahrial, Achmadi, Sinung Mufti Hangabei, and Arief Budiono., Community Mediation-Based Legal Culture in Resolving Social Conflicts of Communities Affected by the COVID-19 Pandemic in West Nusa Tenggara, Indonesia. *Studia Iuridica Lublinensia*, Vol.31 No.2, 2022;

Hasan, Israa, and Nadia A. AL-Salam., Green Buildings as a Cornerstone of Green Cities: A Comparative Analytical Study of (Msheireb, Masdar, and

NEOM). *Architecture Image Studies*, Vol.6 No.4, 2025;

Hernanda, Trias, Absori, Kelik Wardiono, Aidul Fitriciada Azhari, Janu Arlinwibowo, Naili Azizah, and Arief Budiono. The Impact of Environmental Regulation Implementation: A Meta-Analysis. *International Journal of Sustainable Development and Planning*, Vol.18 No.10, 2023;

Iksan, Muchamad, Natangsa Surbakti, Marisa Kurnianingsih, Arief Budiono, Sholahuddin al Fatih, and Tomás Mateo Ramon. Fulfilling the Restitution Rights of Crime Victims: The Legal Practice in Indonesia. *Academic Journal of Interdisciplinary Studies*, Vol.12 No.4, 2023;

Imamalieva, D., E. Inamdjanova, M. A. Turdialiev, and A. Akramov., Legal Difficulties Associated With The Use Of Big Data In Healthcare: Civil Law And Cyberlaw Review. *Medicine Law and Society*, Vol.17 No.1, 2024;

Itsukushima, Rei, and Yukihiro Shimatani., Study of Segment-Based Ecoregions Using Fish Fauna for Conserving River Environments in Kyushu, Japan. *Ecological Engineering*, Vol.97, 2016;

Jiwanti, Ainun, and Eko Soponyono., The Urgency of Judge's Legal Reasoning in Deciding on an Environmental Crime Case Based on an Ecocentric Approach (Review of Case Decision No. 640/PID.B/LH/2021/PT PBR). *Jurnal Jurisprudence*, Vol.12 No.2, 2022;

Kamarulzaman, Noorazlina, Mazran Ismail, Hazril Sherney bin Basher, and Asmat Ismail., Field-Based Assessment of Vegetation Structure and Configuration (VSC) For Thermal Regulation in Tropical Residential Environments. *Architecture Image Studies*, Vol.6 No.3, 2025;

Kusumastuti, Sri Wahyu, Moh Bisri, Solichin, and Tri Budi P., Water Quality Monitoring and Evaluation in the Bengawan Solo River Region. *IOP Conference Series: Earth and Environmental Science*, Vol.641 No.1, 2024;

Margono, Bambang Tri Bawono, Ahmad Hadi Prayitno, Andika Yuli Rimbawan, and Andri Winjaya Laksana. *Jurnal Hukum Unissula*, Vol. 40 No. 2, 2024;

Mashaan, Aws, Subhi Ahmed, Zuhair Mushref, and Sadeq Sulaiman.. Sustainable Management Strategies of the Water Pollution of the Euphrates River Within Ramadi City West of Iraq. *International Journal of Sustainable Development and Planning*, Vol.19, 2024;

Mega Mutiara Sari, Pertiwi Andarani, Suprihanto Notodarmojo, Regil Kentaurus Harryes, Minh Ngoc Nguyen, Kuriko Yokota, Takanobu Inoue., Plastic Pollution in the Surface Water in Jakarta, Indonesia. *Marine Pollution Bulletin*, Vol.122, 2022;

Miclat, Evangeline F.B., Jose A. Ingles, and Jose Noel B. Dumaup., Planning across Boundaries for the Conservation of the Sulu-Sulawesi Marine Ecoregion. *Ocean and Coastal Management*, Vol.49 No.9–10, 2006;

Moorthygari, Sree Lakshmi, Suresh Reddy Jakka, Jayanthi Rajendran, Kavitha Dasari, V. Jeya Santhi, Raju Gandham, and Ravi Kumar Bommisetti., Environmental Maintenance and Ecotourism: An Analysis into the Observation of Tourists and Maintenance Agencies in India. *Architecture Image Studies*, Vol.6 No.3, 2025;

Mostafavi, Hossein, Azad Teimori, and Robert M. Hughes., Habitat and River Riparian Assessment in the Hyrcanian Forest Ecoregion in Iran: Providing Basic Information for the River Management and Rehabilitation. *Environmental Monitoring and Assessment*, Vol.194 No.10, 2022;

Oliveira, B. O. S. de, G. A. de Medeiros, M. X. Paes, and S. D. ManCini., Integrated Municipal and Solid Waste Management in the Amazon: Addressing Barriers and Challenges in Using the Delphi Method. *International Journal of Environmental Impacts*, Vol.4 No.1, 2021;

Pebiola, Intan Ayu, Heri Mulyanti, and Laily Agustina Rahmawati., Assessment Of Bengawan Solo River Raw Water Quality Using The Pollution Index. *Analytical: Analytical and Environmental Chemistry*, Vol.10 No.1, 2025;

Rajvikram Madurai Elavarasan,Rishi Pugazhendhi,Muhammad Irfan,Lucian Mihet Popa, Pietro Elia Campana, Irfan Ahmad Khan., A Novel Sustainable Development Goal 7 Composite Index as the Paradigm for Energy Sustainability Assessment: A Case Study from Europe. *Applied Energy*, Vol.307, 2022;

Rustinsyah, Rustinsyah, Ratna Azis Prasetyo, and Muhammad Adib., Social Capital for Flood Disaster Management: Case Study of Flooding in a Village of Bengawan Solo Riverbank, Tuban, East Java Province. *International Journal of Disaster Risk Reduction*, Vol.52, 2021;

Sidharta., Kaitan Pemikiran Scholten Dan Dworkin., February, 2025;

Sigdel, Rajesh, Gregory Carlton, and Bivek Gautam., Resolving the Ganges Pollution Paradox: A Policy-centric Systematic Review. *River*, Vol.2, 2023;

Stephen Morton, David Pencheon, and and Neil Squires., Sustainable Development Goals (SDGs), and Their Implementation Systems Approach at Every Level. *British Medical Bulletin*, October 2017;

Sudibyo, Hanifrahmawan, Yano Surya Pradana, Arief Budiman, and Wiratni Budhijanto., Municipal Solid Waste Management in Indonesia - A Study about Selection of Proper Solid Waste Reduction Method in D.I. Yogyakarta Province. *Energy Procedia*, Vol.143, 2017;

Triana, Nita., Pendekatan Ekoregion Dalam Sistem Hukum Pengelolaan Sumber Daya Air Sungai Di Era Otonomi Daerah. *Pandecta Research Law Journal*, Vol.9 No.1, 2014;

Trias Hernanda, Absori, Aidul Fitriciada Azhari, Kelik Wardiono, and Janu Arlinwibowa., Relationship Between Knowledge and Affection for the Environment: A Meta-Analysis. *European Journal of Educational*

Research, Vol.11 No.3, 2022;

Wirjawan, Gita., The Paradox of Sustainability - A Critique of the Modern World's Approach to Sustainable Development. *Shorenstein Aparc Working Paper*, March 2024;

Wardiono, Kelik., Prophetic: An Epistemological Offer for Legal Studies. *Journal of Law and Justice*, Vol.1 No.1, 2019;

Widayati, Winanto, Andri Winjaya Laksana, Moh Nurul Huda, and Nur Fareha., The Challenges of Using the Omnibus Law Method in Indonesia's Legal System. *Volksgeist: Jurnal Ilmu Hukum Dan* Konstitusi, Vol. 8 No. 2, 2025;

Yuspin, Wardah, Anis Nur Fauziyyah, and Arief Budiono., The Impact of Deforestation on Sustainable Development Goals Regulations: An Empirical Studies on Tawangmangu. *International Journal of Sustainable Development and Planning,* Vol.18 No.7, 2023.