International Journal Publishing
INFLUENCE: International Journal of Science Review
Volume 7, No. 2, 2025
https://influence-journal.com/index.php/influence/index

Transforming Water Hyacinth into a Community Asset: CSR-Based Participatory Innovation in Cengklik Reservoir, Indonesia

Dewangga Cipta M.[1], Siti Fatonah[2], Shoiful Amri[3]
[1,2,3] PT Pertamina Patra Niaga AFT Adi Sumarmo, Indonesia
Email: dewanggaacm@gmail.com

Abstract. The rapid proliferation of water hyacinth (Eichhornia crassipes) in Cengklik Reservoir, Boyolali, has caused acute problems for water quality, the aquatic ecosystem, and local economic activities. Through the CSR initiative Masyarakat Sobokerto Peduli Waduk Cengklik (Sobokerto Community Cares for Cengklik Reservoir), initiated by PT Pertamina Patra Niaga AFT Adi Sumarmo since 2021, this invasive species is no longer seen as a nuisance but is being leveraged as a productive resource. This study employs a Participatory Action Research (PAR) approach to investigate, support, and assess collective management of water hyacinth by converting it into various products among the assisted community group between 2022 and 2025. The findings demonstrate the transformation of water hyacinth into a range of eco-friendly products: (1) liquid and solid organic fertilizers with NPK levels that meet laboratory criteria, (2) biogas via household-scale anaerobic digesters further developed as a renewable electricity source (Lisendo) for public street lighting, (3) organic fish feed with local formulations that strengthen aquaculture group food security, (4) silage as alternative goat feed with fermentative nutrients, and (5) eco-enzymes for improving reservoir water quality. Each year, there has been measurable progress in both technology adoption and the number of engaged groups, indicating expanded community capacity to manage local resources sustainably. These results affirm that integrating CSR, technological innovation, and grassroots participation can convert invasive weeds into strategic ecological, economic, and social assets.

Keywords: *Water Hyacinth, CSR, Renewable Energy, Organic Fertilizer, Fish Feed, Eco-Enzymes, Community Empowerment.*

A. INTRODUCTION

Water hyacinth (Eichhornia crassipes) is widely recognized as one of the most invasive aquatic weeds globally. Its rapid growth, both vegetatively and generatively, enables it to double its biomass within days and extensively cover water surfaces (Dewantara et al., 2021; Marsely et al., 2017; Prasetyo et al., 2021). This condition triggers various ecological issues: a decrease in dissolved oxygen levels, hindrance to sunlight penetration, clogging of irrigation channels, and a decline in fishery productivity. It is not surprising that many reservoirs and lakes in tropical regions experience degradation due to the invasion of this plant (Poernama et al., 2021).

Although often seen as a pest, water hyacinth actually holds significant potential for utilization. Its high lignocellulosic content allows its biomass to be fermented into biogas, while its organic nutrients can be used as both liquid and solid organic fertilizers (Restiamalia, 2020). In aquaculture, water hyacinth can be formulated as an alternative feed for tilapia (Putra, A. N., Ristiani, S., Musfiroh, & Syamsunarno, M. B., 2020), and in livestock farming, it can be processed into quality silage (Bahrun, Ratnanigtyas, N. I., Noorhidayah, R., & Herliana, O., 2020). Recent innovations even direct water hyacinth towards eco-enzyme production as a bioremediation agent for polluted water (Utami & Puteri, 2024). In other words, water hyacinth can be viewed not only as a problem but also as a source of renewable biomass.

In Indonesia, the water hyacinth problem is particularly prominent in Cengklik Reservoir, Boyolali, Central Java. This reservoir spans 306 hectares and plays a vital role as an irrigation source for more than 3,500 hectares of farmland in Ngemplak and Nogosari Districts

(Yuono, 2013). It also serves as a source of domestic raw water, a fish farming area with floating net cages (KJA), and a natural tourist destination. However, in the past decade, the reservoir has become increasingly pressured due to multi-source pollution. Domestic waste, fertilizer and pesticide residues, culinary waste from dozens of lakeside cafes, and leftover fish feed from the KJA add to the pollution burden (Asmaranto & Suryono, 2017). The process of eutrophication accelerates the growth of water hyacinth, worsens water quality, and reduces the ecosystem's carrying capacity (Rachmawati, 2022). The vulnerability of the reservoir became evident during an upwelling event in March 2024, which triggered the sudden death of approximately 31 tons of ready-to-harvest tilapia, resulting in losses of over IDR 1 billion (Listiyo, 2024). This situation aligns with research in Jatiluhur Reservoir, West Java, where KJA activities contributed significantly to nitrogen and phosphorus waste loads, accelerating eutrophication and water weed outbreaks, including water hyacinth (Anas, Jubaedah, & Sudino, 2017).

Several studies confirm that water hyacinth can be a multi-functional resource. In agriculture, water hyacinth compost has been shown to increase soil nitrogen, phosphorus, and potassium levels, as well as improve crop productivity (Effectiveness of Water Hyacinth Compost, 2018). Hasibuan et al. (2023) also emphasized that processing water hyacinth into organic fertilizer in Lake Toba not only improves soil quality but also provides positive economic impacts for local communities. The use of water hyacinth as liquid fertilizer has been reported to improve agricultural yields (Poernama et al., 2021). Indrianti (2019) added that water hyacinth extract formulated with papaya leaves effectively reduced Bemisia tabaci infestations by 82.34% on chili plants, making it an environmentally friendly plant-based pesticide.

In the field of energy, biogas technology based on water hyacinth has been tested using household-scale biodigesters (Restiamalia, 2020; Agustine et al., 2022). Firmansyah, Wahyudi, and Widodo (2022) found that water hyacinth fermentation can produce bioethanol at a concentration of up to 0.528% under optimal conditions. Meanwhile, Kusman et al. (2024) and Abdillah (2025) demonstrated that water hyacinth can be processed into briquettes as an environmentally friendly alternative fuel, suitable for local communities. Recent research also confirms that utilizing water hyacinth as biomass briquettes can strengthen local energy independence and reduce dependence on fossil fuels (Sofyan et al., 2023). In fact, Prayitno et al. (2020) successfully processed water hyacinth stems into NaCMC, a cellulose derivative with high economic value in the food and pharmaceutical industries.

In the aquaculture and livestock sectors, water hyacinth is also a promising option. Pangaribuan et al. (2020) assisted local communities in processing water hyacinth into fermented feed, producing approximately 50 kg per cycle, thereby reducing feed costs and creating opportunities for home-based businesses. Research by Putra et al. (2020) demonstrated that water hyacinth flour can be added to tilapia feed formulations at a maximum of 10% without compromising growth. For goat farming, water hyacinth can be made into silage and mixed with concentrate (Bahrun et al., 2020).

From an environmental perspective, the use of water hyacinth as a heavy metal adsorbent has also been extensively studied. Nurhilal et al. (2020) demonstrated that activated charcoal derived from water hyacinth has a surface area of 104.32 m^2/g, effectively adsorbing Pb(II). Research by Mahmudah et al. (2023) strengthens the finding that modification with citric acid enhances adsorption effectiveness, even reducing Cr by up to 98%. Sofia et al. (2024) also found that water hyacinth is effective in reducing lead (Pb) levels from landfill leachate, although high concentrations may damage plant morphology. The study by Savira & Fitrihidajati (2024) affirmed that combining water hyacinth with water hyacinth wood can reduce Zn levels by up to 99.2%, proving that collaboration between aquatic plants enhances phytoremediation effectiveness.

Equally important, water hyacinth can serve as a tool for socio-economic empowerment. Arniati et al. (2020) demonstrated that training PKK mothers in processing water hyacinth into woven crafts, marketed digitally, improved their skills and family income. Other recent research highlights the potential of water hyacinth as a raw material for environmentally friendly crafts, aiming to increase rural income (Wulandani, B. R. D., Et Al., 2021). This practice underscores that water hyacinth management is not only a technical issue but also involves social, institutional, and community empowerment aspects.

Although numerous studies have confirmed the potential of water hyacinth, most remain partial and emphasize only technical aspects, without addressing the holistic integration of ecological, economic, and social factors. In fact, the success of water hyacinth management is highly dependent on the community's ability to adopt, maintain, and develop innovations sustainably. This gap forms the basis for the CSR initiative for community empowerment by PT Pertamina Patra Niaga AFT Adi Sumarmo through the "Masyarakat Sobokerto Peduli Waduk Cengklik" program. This program, launched in 2022, employs a Participatory Action Research (PAR) approach that emphasizes needs assessment, multi-party communication, and group-based implementation. From organic fertilizer (2022) to biogas (2023), innovation in electricity generation from water hyacinth biogas (2024), and fish feed, goat silage, and eco-enzyme (2025), each stage focuses not only on technology but also on empowerment. The Ngudi Tirto Lestari, KJA Sumber Rejeki, and Ngudi Makmur groups serve as concrete examples of how communities can produce fertilizer, process biogas, develop feed, and generate renewable energy "Lisendo" for public street lighting.

Thus, this CSR program not only addresses weed invasion but also opens economic opportunities, strengthens social resilience, and introduces a community-based circular economy model. The novelty of this research lies in the analysis of the transformation of water hyacinth from a weed to a useful resource through a participatory, sustainable, and multi-stakeholder approach. Therefore, this study aims to analyze the role of CSR in the transformation of water hyacinth utilization as a community empowerment strategy based on a circular economy, highlighting the integration of environmental, social, and economic aspects at Cengklik Reservoir.

B. METHOD

This study uses the Participatory Action Research (PAR) approach, a research method that emphasizes the active involvement of the community as the main subject. PAR was chosen because it is not only technically oriented but also emphasizes social change and community empowerment. According to Kemmis, McTaggart, & Nixon (2014), PAR is a collaborative approach that allows for reflective and participatory processes, in which the community is involved in every stage of the research, from problem identification and planning to implementation and evaluation. Thus, PAR is relevant to Corporate Social Responsibility (CSR) programs that aim to create sustainable value from social, economic, and environmental perspectives (Whyte, 1991; Baum, MacDougall, & Smith, 2006).

The research location was situated in Sobokerto Village, Ngemplak District, Boyolali Regency, which is located in the Ring 1 area of PT Pertamina Patra Niaga AFT Adi Sumarmo, specifically around the Cengklik Reservoir. The research subjects included CSR-assisted community groups, namely:

1. Pokmas Ngudi Tirto Lestari: development of water hyacinth utilization into organic fertilizer, biogas, and renewable electricity.

2. Kelompok Jaring Apung Sumber Rejeki: production of organic fish feed and eco-enzymes.
3. Kelompok Tani Ngudi Makmur: development of silage for animal feed.

The application of Participatory Action Research (PAR) in this program was carried out in several stages, with the community actively involved from the very beginning. Each stage was designed to ensure that local residents were not only recipients of the program's benefits but also active participants in identifying problems, planning solutions, implementing activities, and evaluating outcomes. In this way, the research process also became a shared learning journey, enabling the community to strengthen their self-reliance while ensuring the sustainability of the program.

1. Problem Identification (2021)
   The initial stage was carried out through social mapping by the CSR team, in collaboration with the community, to identify the main problems of the Cengklik Reservoir, including pollution and eutrophication. The Focus Group Discussion (FGD) method was used to explore the experiences of the community, particularly farmer groups, cage fish farmers, and tourism operators. Problem identification is fundamental in PAR because it places local experience as a source of knowledge (Kindon, Pain, & Kesby, 2007).
2. Participatory Planning (2022)
   The community and the company developed alternative solutions based on the principles of the circular economy. A collective agreement led to the development of a program utilizing water hyacinth for organic fertilizer, biogas, renewable electricity, fish feed, eco-enzymes, and silage.
3. Implementation (2022-2025)
   a. 2022: Trial production of liquid/solid organic fertilizer and portable biogas on a household scale.
   b. 2023: Water hyacinth management through portable household biogas innovation.
   c. 2024: Development of purified biogas into electricity (Lisendo) and organic fish feed.
   d. 2025: Production of silage animal feed and eco-enzyme innovation for restoring the water quality of the Cengklik Reservoir.

   The implementation process is based on the action research cycle principle: plan, act, observe, reflect (Lewin, 1946; Kemmis et al., 2014).
4. Monitoring and Evaluation
   Monitoring is carried out collaboratively between the company, the community, village officials, and relevant agencies. Evaluation uses qualitative (interviews, field observations) and quantitative (fertilizer laboratory tests, biogas measurements, fish productivity, generator power) approaches. Participatory evaluation is important in PAR to ensure shared learning (Cornwall & Jewkes, 1995).
5. Reflection and Replication
   Reflection is carried out with the community to assess the effectiveness of the program. The results of the reflection are used in the development of new foster groups and the replication of the model to other villages. Collective reflection enables a continuous social learning process (Reason & Bradbury, 2008).

   Through PAR, this CSR program developed gradually and systematically:

1. 2022: proof of concept for water hyacinth utilization.
2. 2023: development of utilization innovations.
3. 2024: product diversification and added value enhancement.
4. 2025: utilization integration (silage, eco-enzymes) and ecosystem restoration.

This methodology shows that CSR is not merely providing assistance, but rather a process of co-creating sustainable solutions with the community. With PAR, each assisted group not only receives technology but also builds mutually reinforcing social, economic, and environmental capacities. The implementation of CSR through community empowerment programs run by PT Pertamina Patra Niaga AFT Adi Sumarmo is a manifestation of the company's social and environmental responsibility, which applies the 5 Pillars of Sustainable Development (SDGs) covering People, Planet, Prosperity, Peace, and Partnership, which form the basis for the company to build positive social, environmental, and economic impacts, maintain good governance, and collaborate for sustainability.

C. RESULTS AND DISCUSSION

1. Dynamics of Water Hyacinth Utilization 2022-2025

The Sobokerto Community Cares for Cengklik Reservoir Program shows gradual progress in water hyacinth utilization over the past year. In 2022, the focus was on organic fertilizer production. In 2023, the development of water hyacinth utilization for portable biogas will be pursued. In 2024, there was diversification of innovations, including organic fish feed and the conversion of biogas into electricity for water hyacinth (Lisendo). In 2025, utilization was expanded through the use of silage for goat feed and the production of eco-enzymes as agents for improving water quality. This annual progress demonstrates that water hyacinth, initially considered a weed, can be transformed into a multifunctional commodity with economic, social, and ecological value.

2. Water Hyacinth Organic Fertilizer

In 2022, the Ngudi Tirto Lestari community group produced solid and liquid organic fertilizers using fermented water hyacinth mixed with molasses, pineapple, and E4 culture for 21 days. Laboratory tests showed that the NPK content met the national standards for liquid organic fertilizers. This finding aligns with the results of research by Asmaranto & Suryono (2017), which demonstrated that water hyacinth-based liquid fertilizer contains 0.18% nitrogen, 0.05% phosphorus, and 0.12% potassium.
From a social perspective, this innovation addresses the complaints of Sobokerto farmers regarding the scarcity of subsidized fertilizer. Ecologically, the use of weeds as fertilizer also reduces the volume of water hyacinth biomass covering the reservoir. Similar research by Poernama et al. (2021) confirms that converting water hyacinth into liquid fertilizer can increase plant growth by up to 35% compared to the control, thus having great potential as a substitute for chemical fertilizers.

Both liquid and solid organic fertilizer innovations have been applied by 32 farmers on 9,750 m² of land and 600 m² of land as demonstration plots for vegetable crops. To date, 225 liters of liquid fertilizer and 1,800 kg of solid fertilizer have been used, resulting in a reduction of 12 tons of water hyacinth in the Cengklik reservoir per year. The water hyacinth liquid fertilizer innovation has reduced water hyacinth by 2.4 tons/year in the Cengklik reservoir. The use of organic water hyacinth fertilizer has increased the frequency of water spinach harvests to nine times per year. The quality of the soil, improved by the application of both solid and liquid organic fertilizers, has significantly enhanced the soil condition. This improvement is evident in the following key metrics: a 48.55% increase in P value, a neutral pH maintained, a 36.96% increase in CEC per 100g, and a 35.54% increase in base content per 100g. Ca and Mg are in the high category at 0.98 Me/100g and 32.91 Me/100g, respectively. However, the nitrogen content in the soil only increased by 0.12%. The application of organic water hyacinth fertilizer increased land productivity by 14,857 bundles of water spinach per year compared to land treated with synthetic chemical fertilizers. As a result, the total CO2 storage from unproductive land to demonstration plots was 0.52 tCO2/ha.

3. Water Hyacinth Biogas

Biogas production began on a household scale (2023) using portable biodigester drums and developed into a 6 m³ capacity planted biodigester in 2024. The raw material formula consists of 50 kg of chopped water hyacinth, 50 kg of cow manure, 100 liters of water, and 1 liter of E4 culture. The fermentation process produces gas with a composition of CH_4 (±60%), CO_2 (30-35%), and traces of H_2S. Daily use indicates that the biogas capacity is sufficient to meet cooking needs equivalent to 1-2 3 kg LPG cylinders per week. When developed in a planted biodigester, biogas production reaches 2 m³/day, equivalent to 1.3 kg of LPG. Research by Restiamalia (2020) and Rahayu (2016) supports these findings, indicating that water hyacinth is capable of producing biogas with a methane content of 55-65%, comparable to other biomass sources such as rice straw or livestock manure.

The economic impact results in a household energy cost savings of around IDR 120,000-150,000 per month. Meanwhile, from an environmental perspective, this technology helps reduce wild methane emissions from the decomposition of weeds in reservoirs. 33 sets of portable biogas digesters for water hyacinth have been constructed by the Ngudi Tirto Lestari community group, capable of reducing water hyacinth by 39.6 tons/year. In one year, the carbon emissions reduced from the water hyacinth biogas innovation amounted to $13,305.47 \times 10^{-3}$ or 13.3 tCO_2/year, equivalent to 68.31 kg of LPG per month.

4. Electricity from Biogas (Lisendo)

The development of biogas into electricity from water hyacinth (Lisendo) was carried out in 2024 using a generator set fueled by purified biogas. The electrical power capacity reaches ±2,000 watts, with energy storage in batteries and distribution to 10 LED streetlights (totaling 1,250 watts). The street lights utilizing Lisendo are installed along the roads in Dukuh Turibang, Sobokerto Village, Ngemplak District, Boyolali Regency.

Analysis shows that this system is capable of operating stably for 6-8 hours every night. This aligns with Subagiyo's (2021) report, which confirms the potential of water hyacinth biomass in supporting renewable energy mixes. The social implications of this innovation are significant: the Turibang Hamlet area now has public street lighting based on local energy, which was previously limited due to frequent disruptions in the PLN electricity supply.

5. Organic Fish Feed

The organic fish feed innovation was developed in 2024 by the Jaring Apung Sumber Rejeki group. The formulation consists of fish meal (40%), maggots (15%), pollard (14%), wheat flour (10%), water hyacinth (10%), tapioca (5%), molasses (5%), and premix (1%). A three-month trial of tilapia cultivation yielded a specific growth rate (SGR) of 2.1% and a survival rate (SR) of 92%, comparable to that achieved with commercial feed.

The results of the analysis show that the use of formulated feed has the potential for significant cost savings compared to commercial feed. Based on calculations, the production cost of the formulated feed is Rp 7,410.40 per kilogram, while the market price of commercial feed reaches Rp 15,000 per kilogram.

In the cultivation simulation, it was assumed that there were 1,000 tilapia fry with an average initial weight of 0.2 kg per fish. After a six-month maintenance period, the average weight of the fish is estimated to reach 1 kg per fish. Thus, the average weight of the fish during maintenance is 0.6 kg per fish, totaling 600 kg for the entire population.

The feed is calculated at 2% of the biomass weight per day, so the daily feed requirement is 12 kg. When multiplied by the rearing duration of 180 days (six months), the total feed requirement reaches 2,160 kg.

If this feed requirement is met with industrial feed, the total cost required reaches IDR 32,400,000. Conversely, if formulated feed is used at a price of IDR 7,410 per kilogram, the cost required is only IDR 16,005,600. This means a potential saving of IDR 16,395,000 over a six-month maintenance cycle.

6. Water Hyacinth Silage

In 2025, the Ngudi Makmur group produced water hyacinth silage as feed for goats. The process involved chopping, fermentation in closed drums, and storage for 21-30 days. Proximate analysis revealed a crude protein content of 12-14% and a crude fiber content of 18-20%, which is sufficient to meet the nutritional requirements of small ruminants.

Field trials have shown that goats fed water hyacinth silage are able to maintain a daily weight of 70-90 g/head, which is comparable to the results obtained with traditional forage. Water hyacinth can be processed into ruminant feed with fairly good nutritional value, although it still requires additional mineral supplementation to meet the needs of ruminants.

7. Eco-Enzymes

The latest innovation in 2025 is the production of water hyacinth-based eco-enzymes. Fermentation is carried out with sugar and other organic materials for ± 90 days. The liquid product is then applied directly to the Cengklik Reservoir to improve water quality. Initial test results indicate a 15% reduction in BOD and a corresponding increase in dissolved oxygen to 1.2 mg/L within two weeks.

The application of water hyacinth-based eco-enzymes aligns with the concept of bioremediation, as demonstrated in Yuono's (2013) research, where aquatic plant biomass can bind heavy metals while enhancing the quality of the aquatic ecosystem.

8. General Implications

Overall, the utilization of water hyacinth has resulted in three main achievements:

a. Economy - the community has gained new income from the utilization of water hyacinth as organic fertilizer, organic fish feed, and silage. These products also have an economic impact through operational savings in agricultural, livestock, and fishery activities carried out by the community, especially those who are members of the program's assisted groups.
b. Environment - weed biomass is reduced, water quality improves, and carbon emissions are suppressed through biogas. The use of water hyacinth for ecoenzymes in the Cengklik Reservoir also has an impact on improving water quality.
c. Social - group capacity increases, cross-stakeholder cooperation is fostered, and community-based innovations emerge, also having implications for kinship and mutual cooperation.

This research proves that a CSR approach based on Participatory Action Research (PAR) can produce simple, applicable, effective, and sustainable technological solutions.

D. CONCLUSION

The Sobokerto Community Cares for Cengklik Reservoir program, implemented through the CSR of PT Pertamina Patra Niaga AFT Adi Sumarmo, shows that water hyacinth weeds, especially those found in the Cengklik Reservoir, are not only a source of environmental problems but can also be transformed into a strategic resource that is beneficial economically, socially, and ecologically.

From 2022 to 2025, innovation development will progress steadily, starting with the production of organic fertilizer, biogas, renewable electricity (Lisendo), organic fish feed, silage for livestock feed, and eco-enzymes for water bioremediation. Each innovation makes a tangible contribution: (1) increasing community income and economic independence; (2) improving the environmental quality of Cengklik Reservoir through the reduction of weeds, waste, and emissions, as well as reducing the amount of water hyacinth in Cengklik Reservoir; (3) raising collective awareness in joint efforts to preserve Cengklik Reservoir; (4) educating the community and increasing their capacity and skills in managing water hyacinth through the creation of various useful product innovations; and (5) strengthening social capacity through the active participation of assisted groups in all stages of the program. Thus, this program serves as an example of an integrative model based on Participatory Action Research that links environmental conservation with the strengthening of the local economy. These findings have important implications for the development of CSR in Indonesian waters and other developing countries: the utilization of aquatic weeds through a multi-product approach has the potential to become a transition strategy towards sustainable development at the community level.

REFERENCES

Abdillah, A. (2025). Pengolahan eceng gondok menjadi briket bahan bakar ramah lingkungan di Surabaya. *Jurnal Energi Terbarukan, 12*(1), 45-53.

Agustine, D., Amyranti, M., & Indriani, I. (2022). Pemanfaatan eceng gondok untuk produksi biogas skala rumah tangga. *Jurnal Teknologi Lingkungan, 10*(1), 15-24.

Anas, M. A., Jubaedah, D., & Sudino, T. (2017). Kualitas air dan beban limbah keramba jaring apung di Waduk Jatiluhur. *Jurnal Akuakultur Indonesia, 16*(2), 133-144.

Arniati, A., Basir, M., & Nuryanti, N. (2020). Pemberdayaan ibu-ibu PKK dalam pemanfaatan eceng gondok menjadi produk kerajinan. *Jurnal Abdimas Bina Bangsa, 1*(1), 59-66.

Asmaranto, A., & Suryono, T. (2017). Pengaruh limbah domestik dan KJA terhadap kualitas air Waduk Cengklik. *Jurnal Ilmu Lingkungan, 15*(2), 145-153.

Bahrun, B., Ratnanigtyas, N. I., Noorhidayah, R., & Herliana, O. (2020). Pemanfaatan eceng gondok sebagai silase pakan ruminansia. *Jurnal Peternakan Tropika, 8*(1), 22-30.

Baum, F., MacDougall, C., & Smith, D. (2006). Participatory action research. *Journal of Epidemiology & Community Health, 60*(10), 854-857. https://doi.org/10.1136/jech.2005.039978

Cornwall, A., & Jewkes, R. (1995). What is participatory research? *Social Science & Medicine*, 41(12), 1667-1676. https://doi.org/10.1016/0277-9536(95)00127-S

Dewantara, A., Lestari, N., & Syamsuddin, H. (2021). Dampak pertumbuhan eceng gondok terhadap ekosistem perairan. *Jurnal Biologi Tropis, 21*(3), 201-210.

Effectiveness of Water Hyacinth Compost. (2018). Effectiveness of water hyacinth compost on soil fertility improvement. *International Journal of Agricultural Sustainability, 16*(2), 165-174.

Firmansyah, A., Wahyudi, T., & Widodo, S. (2022). Potensi bioetanol dari eceng gondok melalui fermentasi. *Jurnal Energi Biomassa, 4*(1), 12-20.

Hasibuan, R., Siregar, A., & Sinaga, F. (2023). Pemanfaatan eceng gondok sebagai pupuk organik di sekitar Danau Toba. *Jurnal Pertanian Berkelanjutan, 9*(2), 101-112.

Indrianti, R. (2019). Efektivitas ekstrak eceng gondok dan daun pepaya sebagai pestisida nabati pada tanaman cabai. *Jurnal Proteksi Tanaman, 7*(1), 34-42.

Kemmis, S., McTaggart, R., & Nixon, R. (2014). *The action research planner: Doing critical participatory action research*. Springer. https://doi.org/10.1007/978-981-4560-67-2

Kindon, S., Pain, R., & Kesby, M. (2007). *Participatory action research approaches and methods: Connecting people, participation and place*. Routledge.

Kusman, K., Faruk, M., & Sibua, R. (2024). Pemanfaatan eceng gondok sebagai bahan bakar briket di Danau Galela. Jurnal Teknologi Energi, 11(2), 55-63.

Lewin, K. (1946). Action research and minority problems. *Journal of Social Issues*, 2(4), 34-46. https://doi.org/10.1111/j.1540-4560.1946.tb02295.x

Listiyo, R. (2024). *Detik-Detik 31 Ton Ikan Nila di Waduk Cengklik Mati dan Rugikan Petani Hampir Rp 1 Miliar*. Retrieved from: https://radarsolo.jawapos.com/boyolali/844431918/detik-detik-31-ton-ikan-nila-di-waduk-cengklik-mati-dan-rugikan-petani-hampir-rp-1-miliar?utm_source=chatgpt.com

Mahmudah, R., Nabilah, R., & Ahdiyati, T. (2023). Adsorpsi ion Cr(VI) menggunakan eceng gondok termodifikasi asam sitrat. *Jurnal Kimia Lingkungan, 14*(1), 12-20.

Marsely, M., Pranoto, A., & Sari, R. (2017). Pertumbuhan dan dampak eceng gondok di ekosistem tropis. *Jurnal Limnologi Indonesia, 3*(2), 88-96.

Nurhilal, S., Yuliani, D., & Hakim, R. (2020). Karakterisasi arang aktif eceng gondok untuk penyerapan logam berat Pb(II). *Jurnal Sains Lingkungan, 12*(1), 25-33.

Pangaribuan, F., Situmorang, P., & Sihombing, A. (2020). Pemanfaatan eceng gondok fermentasi sebagai pakan ternak skala rumah tangga. *Jurnal Pengabdian Kepada Masyarakat, 4*(1), 55-62.

Poernama, H., Santoso, A., & Wicaksono, B. (2021). Invasi eceng gondok di perairan tropis: dampak dan solusi. *Jurnal Ekologi Perairan, 5*(2), 66-75.

Prasetyo, R., Lestari, Y., & Gunawan, H. (2021). Reproduksi eceng gondok dan pengaruhnya terhadap kualitas perairan. *Jurnal Bioteknologi Perairan, 6*(2), 133-141.

Prayitno, H., Hadi, S., & Firyanto, Y. (2020). Pemanfaatan batang eceng gondok menjadi NaCMC. *Jurnal Teknologi Kimia, 8*(1), 17-26.

Rachmawati, N. (2022). Proses eutrofikasi dan dampaknya pada perairan tawar. *Jurnal Lingkungan Hidup, 10*(1), 45-54.

Reason, P., & Bradbury, H. (2008). *The SAGE handbook of action research: Participative inquiry and practice* (2nd ed.). SAGE Publications Ltd.

Restiamalia, R. (2020). Pemanfaatan eceng gondok sebagai bahan baku biogas. Jurnal Teknologi Lingkungan, 8(2), 121-130.

Savira, W., & Fitrihidajati, H. (2024). Efektivitas eceng gondok dan kayu apu dalam menurunkan kadar Zn. LenteraBio, 13(1), 20-26.

Sofia, A., Andayani, A., & Putri, S. (2024). Efektivitas eceng gondok dalam fitoremediasi air lindi TPA Terjun Marelan. Jurnal Lingkungan Tropis, 12(2), 77-86.

Sofyan, E. T., Gumelar, F. A., Yuniarti, A., Joy, B., & Wicaksono, F. Y. (2023). Effectiveness of water hyacinth compost and N, P, K, S fertilizer on S-available, S uptake, protein content, and yield of shallot in Inceptisols from Jatinangor. *Jurnal Kultivasi, 22*(1), 16-25. https://doi.org/10.24198/kultivasi.v22i1.44704

Subagiyo, A. (2021). Dinamika pemanfaatan sempadan waduk: Studi kasus Waduk Cengklik. *Jurnal Wilayah dan Lingkungan*, 9(3), 201-215

Utami, L. B., & Puteri, T. I. C. (2024). Pemanfaatan eco-enzym berbasis eceng gondok untuk perbaikan kualitas air. Jurnal Ecoteknologi, 9(1), 22-30.

Whyte, W. F. (1991). *Participatory action research*. SAGE Publications.

Wulandani, B. R. D., Ulpiana, M. D., Apriliany, I. G. A. M., Pratiwi, N., & Naomi, R. L. (2021). Pemanfaatan tanaman eceng gondok menjadi produk bernilai ekonomis berbasis zero waste di Kelurahan Semayan. *Jurnal Pengabdian Magister Pendidikan IPA, 3*(2), 127-135. https://doi.org/10.29303/jpmpi.v3i2.1057

Yuono, A. (2013). Pemanfaatan Waduk Cengklik sebagai sumber air irigasi. *Jurnal Teknik Sipil Indonesia, 7*(1), 34-42.