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SABERSIH Innovation: Empowering Riparian Communities in Post-Flood Clean Water Recovery

Inovasi SABERSIH: Pemberdayaan Masyarakat Bantaran Sungai untuk Pemulihan Air Bersih Pascabanjir

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Abstract

Annual flooding along the Martapura River cuts riparian communities in Banjar Regency, South Kalimantan, off from safe water, forcing 73% of Teluk Selong Ulu Village residents to use untreated river water during floods exceeding three days. This programme introduced SABERSIH (Saringan Ember untuk Air Bersih), a multilayer gravity filtration device built from locally sourced materials, applying a Participatory Rural Appraisal approach with 30 residents through problem-based education, hands-on assembly, and follow-up. Evaluation combined a 15-item pre-test/post-test, a skills checklist, laboratory water-quality testing, and a perception survey. Mean knowledge scores rose from 61.3 to 85.7 (39.8%), and 86.7% of participants assembled the device independently. Filtration reduced turbidity by 88.0%, colour by 84.5%, iron by 71.9%, and coliform by 86.7%, though the water still required disinfection before drinking. All participants affirmed its flood-time usefulness, and 90% intended to replicate it at home, confirming SABERSIH's potential to strengthen flood resilience in riparian South Kalimantan.

Keywords*: appropriate technology, clean water, community empowerment*

Abstrak

Banjir tahunan di bantaran Sungai Martapura memutus akses masyarakat riparian di Kabupaten Banjar, Kalimantan Selatan, terhadap air bersih, memaksa 73% warga Desa Teluk Selong Ulu menggunakan air sungai tanpa pengolahan saat banjir berlangsung lebih dari tiga hari. Program ini memperkenalkan SABERSIH (Saringan Ember untuk Air Bersih), alat filtrasi gravitasi bertingkat berbahan lokal, melalui pendekatan Participatory Rural Appraisal dengan 30 warga melalui edukasi berbasis masalah, praktik perakitan, dan pendampingan pasca-pelatihan. Evaluasi menggabungkan pre-test/post-test 15 butir, lembar penilaian keterampilan, uji kualitas air laboratoris, dan survei persepsi. Skor pengetahuan rata-rata meningkat dari 61,3 menjadi 85,7 (39,8%), dan 86,7% peserta mampu merakit alat secara mandiri. Filtrasi menurunkan kekeruhan 88,0%, warna 84,5%, besi 71,9%, dan total coliform 86,7%, meski air hasil filtrasi tetap memerlukan disinfeksi sebelum diminum. Seluruh peserta menyatakan alat ini bermanfaat saat banjir, dan 90% berniat membuatnya sendiri di rumah, menegaskan potensi SABERSIH memperkuat ketahanan masyarakat riparian Kalimantan Selatan terhadap banjir.

Kata kunci*: teknologi tepat guna, air bersih, pemberdayaan masyarakat*

1. INTRODUCTION

Communities living along the banks of the Martapura River in Banjar Regency face a paradox common across riparian lowlands of South Kalimantan: they depend on the river for daily needs, yet are the first to lose access to safe water when the river overflows. Between November and February each year, floodwaters inundate shallow dug wells, river turbidity spikes dramatically, and piped water supplied by the regional water utility (PDAM) fails to reach dispersed households in low-lying neighbourhoods. A preliminary survey conducted by the programme team found that 73% of residents in Teluk Selong Ulu Village had used untreated river

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water during a flood lasting longer than three days — not because they were unaware of the health risks, but because no practical alternative was available.

The water quality of the Martapura River during flood events is a well-documented concern (Zubaidah et al., 2023). Bacterial indicator levels in the river body have consistently exceeded raw water quality standards under Government Regulation No. 22 of 2021 on water quality management and pollution control. During peak flood events, waterborne diarrhoeal illnesses and enteric infections increase substantially, particularly among children under five and the elderly — groups least able to withstand dehydration and infection. Emergency clean water distribution by local government and civil society organisations, while valuable, has historically been reactive: tanker trucks arrive on unpredictable schedules and communities remain dependent on external supply without developing any capacity to treat water themselves (Cairncross, 2006) (Sikder et al., 2020); (World Health Organization, 2022)

This gap between reactive relief and sustainable household capacity is precisely where the SABERSIH programme intervenes. The global literature on household water treatment and safe storage (HWTS) consistently demonstrates that simple, gravity-driven filtration systems using porous and adsorbent media can substantially reduce turbidity and a portion of biological contaminants in turbid water, without requiring any infrastructure, electricity, or specialised skill (Sobsey et al., 2008) (Clasen et al., 2014) (Peter-Varbanets et al., 2009). What makes SABERSIH distinctive as an innovation — rather than simply another water filter — is its design logic: every component is intentionally sourced from Martapura's local market, the construction process requires no tools beyond what a household already possesses, and the technology is explicitly designed to be understood, assembled, and maintained by anyone, including those with limited formal education.

Community empowerment programmes that combine technical skill transfer with locally embedded knowledge and materials have demonstrated sustained adoption rates far exceeding those of externally supplied technology (Luby et al., 2005); (Hutton et al., 2007). By situating SABERSIH within a Participatory Rural Appraisal (PRA) framework, this programme aimed not merely to demonstrate a filter but to activate community agency — enabling residents to become their own first responders in the next flood season and every season thereafter. This paper reports the programme's process, outcomes, and implications for scaling appropriate-technology empowerment models in flood-affected riparian communities of South Kalimantan.

2. METHODS

The programme was implemented in Teluk Selong Ulu Village, West Martapura Sub-district, Banjar Regency, South Kalimantan Province. The site was selected based on its high flood frequency, limited water treatment infrastructure, and an existing institutional relationship between the implementing institution and the village government.

Participants

Thirty community members were recruited through coordination with the village head, using three eligibility criteria: residence in a flood-prone zone, no prior household water treatment training, and willingness to attend all programme sessions. The participant profile included housewives, community health volunteers and working-age adults who typically bear responsibility for securing the family's water supply during floods.

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SABERSIH Design and Materials

Table 1. SABERSIH components, functions, and local sourcing

No	Component	Function	Local Source
1	25-litre plastic bucket	Filtration system housing	Martapura Market
2	Zeolite sand	Fine particle filtration and ion exchange	Building supply store
3	Wood charcoal	Adsorption of organic compounds, colour, and odour	Traditional market
4	Flannel fabric	Coarse suspended-particle filtration	Fabric store
5	Small gravel (2–5 mm)	Filter media support; initial screening layer	Building materials supplier
6	Plastic tap/spigot	Filtered water outlet	Household goods store

Filter media were arranged in descending layers inside the bucket, which was perforated at the base and fitted with a tap on the lower side wall. From bottom to top: 5 cm gravel (structural support); 5 cm flannel fabric (suspended solids); 10 cm crushed wood charcoal (adsorption); and 10 cm zeolite sand (primary filtration). Raw water was poured from above and collected in a separate container after passing through the tap. Production capacity ranged from 15–20 litres per filtering cycle per hour, depending on media compaction.

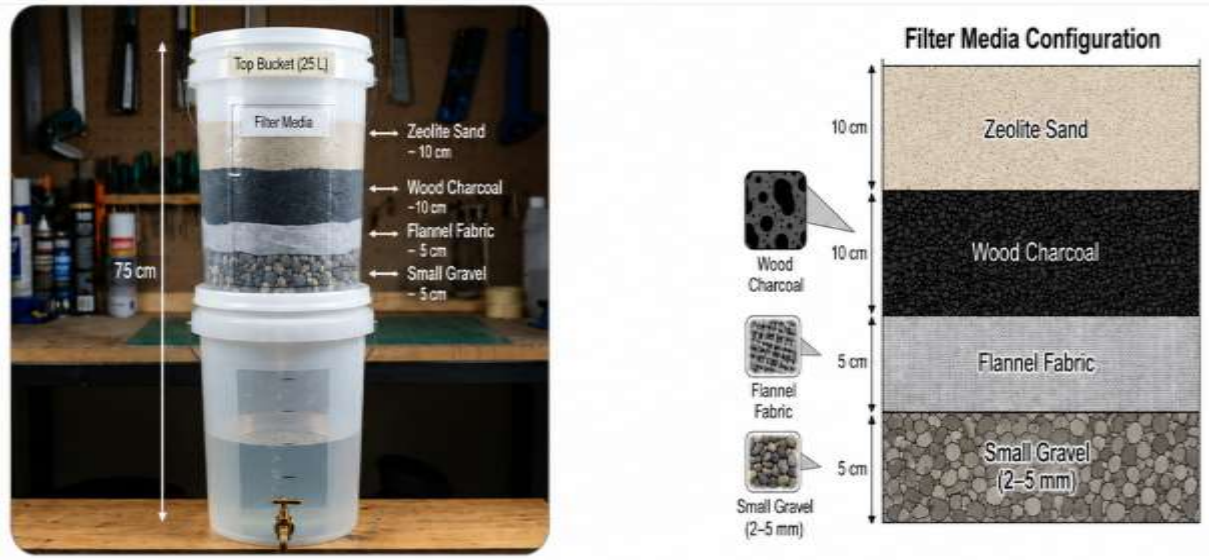

Figure 1. SABERSIH Component

Programme Implementation

The programme unfolded in five sequential stages:

1. Preliminary community survey and participatory problem mapping through focus group discussions.
2. Community education on flood water quality and associated health risks, grounded in local data.

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3. Live demonstration of SABERSIH construction by the facilitation team.
4. Supervised group assembly practice (six groups of five participants each).
5. Field evaluation and filtration trial using collected river water samples, followed by post-training follow-up.

Evaluation Instruments

Knowledge was assessed using a 15-item multiple-choice pre-test and post-test covering water quality principles, filtration mechanics, SABERSIH assembly, and usage procedures (Zimmerman et al., 2008). Assembly skills were rated using an eight-criterion observation checklist, scored independently by two observers. Water quality was assessed through laboratory analysis of river water samples collected before and after filtration. Parameters measured were turbidity (turbidimeter), total dissolved solids (TDS meter), colour (spectrophotometer), iron (Fe) by atomic absorption spectroscopy (AAS), and total coliform by the Most Probable Number (MPN) method. Community perceptions of the technology were captured via a structured post-programme questionnaire.

3. RESULTS AND DISCUSSION

Community Context: Water Conditions During Flooding

Preliminary focus group discussions revealed a picture more complex than raw water quality data alone can capture. In Teluk Selong Ulu, flood events exceeding 50 cm in depth typically last three to four weeks. During this period, virtually all shallow ring wells — the primary water source for most households — become inundated and unusable. PDAM supply lines, while present, do not reach every neighbourhood cluster, and water pressure often drops precisely when demand peaks. Several participants recounted filling cooking pots and bathing from the brown, silt-laden river flowing past their doorstep during the worst floods, not from ignorance of the risk but from absence of choice. That testimony framed the rationale for the entire programme: the intervention space was not a lack of awareness but a lack of accessible alternatives.

Water Quality Outcomes

Table 2. Water quality parameters before and after SABERSIH filtration

Parameter	Unit	Before Filtration	After Filtration	Efficiency (%)
Turbidity	NTU	156.4	18.7	88.0
TDS	mg/L	284	212	25.4
Colour	TCU	245	38	84.5
Iron (Fe)	mg/L	1.21	0.34	71.9
Total Coliform	CFU/100 mL	24,000	3,200	86.7

Turbidity fell from 156.4 to 18.7 NTU — an 88.0% reduction, well within the range of 85–91% reported by Suhirman et al., (2025) for zeolite-and-activated-charcoal multi-media filters treating Kalimantan flood water. The mechanism involves two complementary processes: mechanical straining by the gravel, flannel, and zeolite layers, which intercept suspended particles of varying sizes; and surface adsorption by the wood charcoal layer, which binds organic molecules responsible for colour and odour. The colour parameter declined from 245 to 38 TCU (84.5%), a result that was immediately visible to participants during the live demonstration — without needing to read laboratory numbers, they could see the water clearing in real time. This visual confirmation proved to be a powerful catalyst for technology acceptance, consistent with

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findings on sensory-cue-driven adoption in low-income water intervention studies (Mertens et al., 2023); (Luby et al., 2005)

Iron (Fe) concentration fell 71.9%, from 1.21 to 0.34 mg/L, attributable to zeolite's cation exchange capacity. The post-filtration value of 0.34 mg/L marginally exceeds the 0.3 mg/L maximum established by Ministry of Health Regulation No. 2/2023 for drinking water — a limitation that must be communicated clearly to users. Zeolite's ion exchange efficiency is not linear at higher initial iron concentrations and will diminish without periodic media regeneration (Acheampong et al., 2010).

The most educationally significant finding relates to microbiology. Total coliform decreased by 86.7%, from 24,000 to 3,200 CFU/100 mL (Bain et al., 2014); (Wolf et al., 2022) While this is a substantial reduction, the post-filtration count remains far above the 0 CFU/100 mL standard for drinking water (Ministry of Health Regulation No. 2/2023). During the discussion session, one participant's question crystallised the key risk communication challenge: “So the water still can’t be drunk?” The honest answer — that SABERSIH functions as a pre-treatment step and must be followed by boiling or chlorine tablet disinfection before consumption — became the programme's most repeated safety message. This transparent communication of limitations is consistent with responsible HWTS promotion guidelines (Yahuadong & Promkhambut, 2026); (Sobsey et al., 2008) and, in the view of the facilitation team, actually enhanced rather than undermined trust in the technology.

TDS was reduced by only 25.4%, which is technically expected: mechanical-adsorptive filtration is not designed to remove dissolved ionic species in large quantities. Technologies capable of such removal (reverse osmosis, distillation) are entirely impractical in an emergency flood setting. Clarifying this boundary to participants — that no single household-scale system can address every parameter simultaneously — was itself part of the programme's educational contribution (Peter-Varbanets et al., 2009).

Knowledge Improvement

The pre-test mean of 61.3 reflected a reasonable foundational understanding: most participants already knew that flood water carries health risks. However, technical knowledge — the sequencing of filter media, the rationale for each layer's position — was poorly understood, with fewer than 20% answering those items correctly. Post-training, the mean rose to 85.7, an increase of 24.4 points (39.8%). The greatest gains occurred precisely on items testing media function and maintenance procedure: knowledge that cannot be acquired through verbal explanation alone but emerges through the act of handling materials, layering them, and observing the output. This finding reinforces the evidence that demonstration-practice approaches substantially outperform lecture-only methods for technical skill transfer to audiences with heterogeneous educational backgrounds (Feuerstein, 2006); (Rios, 2024).

Assembly Skills and Group Dynamics

Twenty-six of thirty participants (86.7%) assembled the SABERSIH unit correctly and independently according to all eight observational criteria. The four participants who did not fully meet the standard shared a common difficulty: achieving the correct media compaction thickness by feel. This was not a conceptual failure but a tactile one — a reminder that even apparently simple physical skills require embodied practice. All four participants showed full conceptual understanding on the post-test.

Group dynamics during the assembly session yielded qualitative insights of considerable practical value. In one group composed entirely of housewives, members spontaneously discussed where to source zeolite sand after the programme ended — suggesting that adoption planning was already underway before the session concluded. In another group, a male participant with carpentry experience took the lead and improvised a more secure method of attaching the tap to prevent leakage — a modification not present in the formal instructions but

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grounded in relevant local technical knowledge. These episodes illustrate a principle central to participatory approaches: technology transfer programmes do not merely transmit pre-designed skills; they also activate and surface local knowledge that was previously undocumented (Yahuadong & Promkhambut, 2026) (Wijeratne & De Silva, 2024).

Community Perception and Adoption Potential

Table 3. Community perception of SABERSIH technology (n = 30)

Perception Indicator	Agree (%)
Materials are readily available in local markets	90.0
Construction method is understandable without specialist skills	93.3
Cost is affordable (estimated IDR 80,000–120,000)	86.7
Device is operable by any household member	96.7
Technology is useful during flood conditions	100.0
Willing to build the device at home after training	90.0

The unanimous agreement (100%) that SABERSIH is useful during floods is logically consistent: every participant had personally experienced the hardship of securing water during a flood. More analytically significant is the 90% expressed willingness to replicate the device at home. Suhirman et al., (2025) caution in their study of point-of-use technology acceptability in Kalimantan riparian communities, stated intention does not always translate into sustained practice; longitudinal follow-up is essential to verify actual household adoption. Nevertheless, the quality of that stated intent was noteworthy: during the session itself, participants were already calculating material costs and dividing household responsibilities for post-training construction — behaviours that signal genuine rather than performative commitment.

Cost-effectiveness is a decisive adoption factor in low-income communities. At IDR 80,000–120,000 per unit, one SABERSIH device costs roughly the same as two to three jerricans of purchased water — a recurring expense during every flood season. Viewed as a multi-season investment, the economics are compelling. This contrasts sharply with commercially available filtration units costing upwards of IDR 500,000 and requiring periodic cartridge replacement, conditions that realistically limit uptake among households such as those in Teluk Selong Ulu (Wijeratne & De Silva, 2024) (Suhirman et al., 2025).

Added Value, Field Implementation Challenges, and Development Opportunities

Beyond the technical indicators reported above, the programme generated evidence of behavioural and economic value added rather than a one-off demonstration effect. During the assembly session itself, the housewife-led group began planning where to source zeolite sand after the programme ended, and a participant with carpentry experience modified the tap-attachment method to prevent leakage — both unprompted actions indicating that participants were already internalising SABERSIH as a household practice rather than a passive intervention. Combined with the 90% stated intention to replicate the device at home and its favourable cost position relative to purchased water, these behavioural signals constitute the programme's principal value added, alongside its measurable gains in knowledge and water quality.

Field implementation was not without difficulty. Four of the thirty participants (13.3%) struggled to achieve correct filter-media compaction by feel, an embodied skill that verbal instruction alone could not transfer — a limitation of the demonstration-practice method itself rather than of participant capacity, since all four passed the conceptual post-test. This finding,

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together with the variability of raw river-water quality discussed below, indicates that consistent filtration performance requires more contact time than a single training cycle provides.

Read against Wijeratne and De Silva's (2024) argument that participatory extension outperforms one-way technology transfer precisely because it surfaces tacit local knowledge, and Yahuadong and Promkhambut's (2026) parallel finding in an agricultural-extension setting, these results suggest that SABERSIH's value lies as much in the participatory process as in the device itself. Development opportunities going forward include structured post-training coaching focused specifically on media-compaction technique, formal partnerships with local material suppliers to secure a stable zeolite and charcoal supply chain, and incorporation of SABERSIH into village-level disaster-preparedness planning so that assembly skills are refreshed before, rather than during, the flood season.

Programme Limitations and Next Steps

Several limitations deserve candid acknowledgement. First, skills assessment was conducted only once at programme close; retention of skills and actual household practice remain unconfirmed. Second, water quality testing was performed on a single representative flood-water sample: the Martapura River's actual quality varies with rainfall intensity, discharge volume, and upstream pollution load. Third, post-training monitoring of SABERSIH use at household level was not integrated into the current programme design — an omission that the team intends to address in the next phase through periodic community facilitation visits and a simple resident-led reporting system.

4. CONCLUSION

The SABERSIH empowerment programme in Teluk Selong Ulu demonstrates that appropriate-technology interventions designed around genuine community needs can generate measurable and meaningful outcomes within a single programme cycle. Mean knowledge scores improved by 24.4 points (from 61.3 to 85.7), and 86.7% of participants independently assembled the device. Technically, SABERSIH reduced turbidity by 88.0% and substantially improved other physical and chemical parameters — though it functions as a pre-treatment stage and must be paired with disinfection before the water is safe to drink. Community perception data confirm both the technology's affordability and its perceived usefulness, with 90% of participants expressing intent to replicate it at home.

Beyond its technical performance, the programme illustrates that community empowerment built on local materials, participatory methods, and honest risk communication can activate capacities that exist within the community but have remained dormant. For riparian communities that face annual floods without reliable infrastructure support, SABERSIH represents a model worth replicating and refining. Sustaining the programme's impact will require household-level monitoring, ongoing facilitation, and strengthening of local supply chains for filter media. Future research should examine multi-season adoption rates, the effect of media regeneration cycles on filtration efficiency, and the integration of SABERSIH into community disaster preparedness frameworks across South Kalimantan.

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