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Reclaiming the Flow: A New Urban Water Vision for Pakistan

Decentralized Solutions for Urban Resilience

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Executive Summary

Pakistan is continuously oscillating between urban flooding and water supply shortages. The declining groundwater levels, coupled with rising population pressures, changing weather patterns, and inefficiencies of centralized piping systems, increase this stress on water resources.

In this brief, we examine decentralized water management systems, specifically rainwater harvesting and greywater reuse, and showcase their viability in enhancing water security. Studies show that these systems are capable of meeting up to 50% of the urban water demand. In the case of Nawabshah, a catchment area of 13,431m² demonstrated a 1,062m³ annual rainwater harvesting potential. These systems help boost climate resilience as well. In Cairo, a greywater treatment plant showed a remarkable reduction of more than 90% in pollutants such as chemical oxygen demand (COD) and biochemical oxygen demand (BOD).

Although promising, the adoption of such systems in Pakistan is unfortunately stagnant. Proven pilots exist but lack scaling. In order to realize true urban water sustainability, we need to start embedding these decentralized systems into our urban planning frameworks. Their successful adoption requires a coherent governance structure with strong regulations, unified building codes, incentives for compliance, and rigorous monitoring.

Introduction

Pakistan's urban sustainability revolves around the issue of water security. The situation has worsened over the decades, with per capita water availability dropping from over 5600m³ since independence to 1000m³ by 2010 (UNDP, 2017). A rising urban population (projected to increase to 52.2% by 2050) has placed additional pressure on water supplies (Maqbool, 2025).

In addition, infrastructure weaknesses also worsen the situation, with Karachi reportedly losing 43% of the supplied water due to leaks and theft (Tabassum, 2020). Even positive effects of traditional and centralized solutions (dams) have been offset by negative social, economic, and environmental impacts (Purvis & Dinar, 2020). Moreover, changing climate and weather patterns also disrupted the supply of fresh water.

Under these conditions, Pakistan is forced to find alternative approaches to help alleviate its water scarcity. Decentralized approaches of rainwater harvesting (RWH) and greywater reuse (GWR) can provide flexible, cost-effective, and scalable solutions (Mancy et al. 2025).

These systems can significantly relieve the pressures on central utilities and provide better climate resilience (Water Care Services, 2025). Such technologies help minimize supply costs by storing and treating water close to where its eventually used (Ecosoftt, 2025).

In this brief, we look into numerous RWH and GWR trial initiatives, piloted by various private, donor, and government bodies. We see whether these systems are feasible and what needs to work for potential large-scale adoption.

We also identify the barriers to the successful broad-scale implementation of these types of systems in the future, and highlight success stories of other countries to better understand what is possible. By accessing both national and international examples we identify key gaps in current water management policies (regulatory aspects, financial aspects, and institutional mechanisms), and recommend different steps to mainstream the future use of decentralized water management systems.

Theoretical Foundations

Decentralized water management systems store and use water close to points of consumption. Due to the nature of such setups, households and institutions become proactive agents in water management (Khan, 2025). As such they help lower cities' reliance on traditional supply (large dams) or treatment systems reducing pressure on municipalities (Water Care Services, 2025).

Rainwater harvesting (RWH) involves collecting rainwater for direct usage or recharge of groundwater through rooftop tanks or infiltration pits. This system reduces risks of urban flooding by reducing runoff: a positive externality (Farreny et al., 2011). A study in Indonesia recorded a 58% runoff reduction within a 7,095m² catchment area (Hardanto et al. 2023). Moreover, rainwater was studied to be of better quality than groundwater (Tabassum, 2025).

Greywater reuse (GWR) works by re-using the slightly treated household water for non-potable purposes (flushing toilets and watering gardens). This approach reduces wastewater volumes and treatment costs. Studies indicate that GWR can supply 30–50% of non-potable urban demand (Eriksson et al., 2002). Being less contaminated than black-water, treated greywater can be used without risking hygiene (Sree, 2021). Further, Xue et al. (2022) noted that on-site greywater treatment can reduce overall energy consumption by over 50%.

Empirical Evidence from Pakistan

At the **urban scale**, Pakistan's water balance is under severe stress. Per-capita availability is already past the scarcity level and further decreasing at an exponential rate (UNDP 2017). Furthermore, Pakistan treats only 1-2% of wastewater before discharge (Parveen et al., 2023). The following table summarizes current water management systems for major cities.

Table 1. Water Management for Major Urban Centers

City	Main water sources	Typical per-capita use (L/person/day)	Reported treatment capacity / treated share	Key notes
Karachi	Indus River & Tankers	~200	Installed 151 MGD; ~55 MGD effectively treated	Large capacity but under-utilization
Lahore	Canal & Groundwater	150–200	Developed a 198 MGD plant but not reported on	Capacity expanding; data on throughput pending
Islamabad / Rawalpindi	Surface & Groundwater	120–180 (est.)	Only small share (<10 %) treated	Limited WWTP operation
Faisalabad	Canal & Groundwater	100–200 (est.)	~7 % historically treated	Primary treatment only
Other urban centers	Mixed	Data limited	Minimal or no treatment	Large data gaps

Sources: Author's compilation based on data from PCRWR (2023); UNDP (2023); WASA Karachi/Lahore 2024 reports; Murtaza et al. (2023).

This outlook shows a very poor wastewater treatment infrastructure in Pakistan. This lack of attention is reflected when water prices don't include these costs (Ecosoftt, 2025).

However, these gaps are being realized and concepts of RWH and GWR have moved beyond theory. Multiple government agencies, NGOs, and private actors have piloted a range of decentralized initiatives.

Table 2. Pilot Evidence of Decentralized Water Initiatives in Pakistan

Actor / Region	Key Project / Initiative	Enabling Features / Findings
UN-Habitat & Capital Development Authority (CDA)	$6M project >100 recharge wells and 5,000 RWH systems installed	Demonstrated groundwater recharge and stabilization of water tables
Pakistan Council of Research in Water Resources (PCRWR)	Kachnar Park system recharged ≈ 1.13ML during a 72mm rainfall	Raised groundwater levels by 10m and improved EC from 0.39 to 0.23 dS/m
Urban Unit Punjab & Punjab EPA	1,100 household RWH in Murree; Lahore RWH mandate for 23 building categories	Regulatory compulsion and financial incentives for public uptake
WWF-Pakistan	Two ablution-water reuse systems in Farash Town, ISB	Daily capacity 4m^3; 438m^3 reused by Sept 2023
Water Care Services (WCS)	Bio-treatment systems for pharmaceutical & textile industries	Up to 99.8% BOD reduction (pharma) and 78% COD reduction (textile)
Universities / Research Institutes (QUEST)	GIS-based and campus-scale RWH assessments	1,062m^3 annual RWH potential (13,431m^2 catchment)
Southern Punjab (Micro-catchment Study)	Comparative analysis of catchment designs	V-shaped catchments yielded 713lph runoff and 10,511L harvested

Sources: Author's compilation based on data from UN-Habitat & CDA (2024), Pakistan Council of Research in Water Resources (PCRWR) (2023), Urban Unit Punjab (2023). Government of Punjab EPA (2025), WWF-Pakistan (2023), Water Care Services(WCS) Case Studies (2023), Kumar, V., et al. (2022), Mahmood, K., Qaiser, A., & Farooq, S. (2022).

This evidence indicates that such systems are practical and technically feasible. Efforts such as those by UN-Habitat show positive returns as the CDA report's improved groundwater levels (Khan, 2025). Similarly, small-scale projects (WWF-Pak) also indicate their suitability. Furthermore, private bodies and independent research also strengthen the argument. However, the uptake is still slow due to weak government regulations and lack of incentives. Monitoring gaps further cause hurdles for replication and scaling.

Knowledge Gaps

Among the critical shortcomings, institutional clarity and overlap are most prominent. Pakistan suffers from up to 17 different federal and provincial agencies with overlapping mandates, resulting in up to 42% duplication of projects and efforts (Begum & Ali, 2025). A snapshot of different dimension gaps is as follows.

Table 3. Key Operational Gaps in Scaling RWH and GWR in Pakistan

Dimension	Observed Gaps / Constraints	Illustrative Example
Institutional Clarity	Fragmented responsibilities of WASAs, DAs, EPAs, and PCRWR etc.	-CDA installs recharge wells without PCRWR site data, while WASA handles distribution. -Proper zoning laws for conflicting boundaries such as for CDA and WASA-RWP.
Regulatory Consistency	Weak enforcement and lack of national design standards.	Punjab is the only province that has made RWH mandatory, also limited to Lahore only.
Financing Mechanisms	Absence of credit/subsidy programs; high upfront cost limits adoption.	Donor-funded pilots (e.g., UN-Habitat, PCRWR) while being successful lack incentives for replication.
Monitoring Systems	Infrastructure counted (e.g., tanks, wells) but not outcomes (e.g., recharge volumes, reuse rates).	No standardized city-level dashboards; rarely published data.
Institutional & Public Behavior	Limited use of awareness campaigns to guide user behavior.	Lack of demonstration systems in schools, parks, or public buildings.
Cultural & Social Perceptions	Low awareness in hill towns despite feasibility; Hesitation about purity of GWR	-In Murree and similar regions, adoption is rare -GWR often viewed as impure or "non-halal."

Source: Author's synthesis based on interviews with UN-Habitat and WCS (2025); Institutional mapping from CDA, WASA, and EPA frameworks; and secondary sources including UNDP (2023) and WWF Pakistan (2023).

Next section highlights how countries around the world have tried and succeeded overcoming these challenges of institutional regulation and social adaptability.

International Perspectives

Many countries that had faced water crises before have overcome them by expanding their national frameworks to include decentralized water management systems. The success of these systems lies in their adaptive governance, fiscal incentives, and institutional clarity.

Table 4. International Models of Decentralized Urban Water Management: Lessons for Pakistan

Country	Key Program / Intervention	Enabling Factors	Lessons for Pakistan
India	*Jal Shakti Abhiyan* (2019-present): Mandatory RWH & 2,000 water bodies restored.	Federal–state coordination, and a national monitoring dashboard.	PEPA's RWH regulation expansion model.
	Costs reduced of ≈75% by locally built RWH systems.	Cost-effective domestic technology development and manufacturing support.	To provide RWH R&D incentives to reduce costs.
Singapore	Unified authority (*PUB)* for water supply model allows ≈50% of water to be reused.	Unified Institutional, R&D incentives (50% cashback), water-efficiency reporting.	Consolidated governance and monitoring of current fragmented institutes.
	Industrial water recycling plants treat 2,000-2,500m³/day.	Industry-government cooperation and facilitation.	Highlights importance of industrial reuse and cooperation.
Japan	4.2% reimbursement program for waste and recycled water tank installation in *Fukuoka*	Municipal-level incentive schemes.	Inform Pakistan's green-credit programs.
Egypt	*Greywater treatment plant:* >90% reduction in TSS, COD, BOD, and oil/grease	Technological innovation, compliance with national reuse standards.	Technical reference for safe GWR in institutional or industrial setups.
China	Studies show lower flexibility of centralized systems due to high fixed costs (70–80%).	Economic efficiency and design adaptability.	Reinforces the impact of decentralized urban water systems.

Source: Author's compilation based on data from Government of India (2022), Sarkar, D. (2023), Patel, M. et al. (2023), FAO (2020), PUB (2023), Tortajada, C., & Bindal, I. (2020), OECD (2015), Abdel-Shafy, H. et al. (2024), Lam, M. et al. (2022), Lanchipa-Ale, T. et al. (2024), Domènech, L., & Saurí, D. (2011), and Schramm, E., & Felmeden, J. (2012).

Implications for Practice and Policy

These examples showcase the importance of coordination, targeted financing, and accountability for ensuring urban water resilience. The following steps can help translate pilots into mainstream practice.

Horizon	Priority Action	Focus
Short-term (1–2 years)	Under the Ministry of Climate Change and Environmental Coordination, establish a *National Task Force on Urban Water Storage & Reuse*.	Establishing a national entity to reduce coordination disparity and duplication of efforts by aligning of roles, monitoring, and reporting across agencies.
	Design and implement awareness campaigns on RWH and GWR, focused around high rise buildings and newly developing societies.	Promote behavioral change and citizen engagement by public awareness and campaigns for urban planning.
Medium-term (3–5 years)	Implement uniform building codes through-out provinces make RWH/GWR mandatory, establish monitoring and regulating framework.	Develop national standards and implement universal building codes. Ensure regulatory integration and compliance consistency.
	Develop capacity-building programs on decentralized systems for researchers, policy-makers, local engineers, developers, and urban planners.	Institutional learning and skill enhancement. Certify water quality, run community education programs and engage religious scholars.
Long-term (5+ years)	Design fiscal incentives (*Green Credit Program)* and penalties for non-compliance, and develop a *National Data Dashboard* on water volumes.	Make systems affordable, increase transparency and accountability.
	Reform the building codes and national climate policy by embedding these decentralized water systems within urban planning frameworks,	Policy integration and maintenance in areas of urban planning and climate.

Source: Authors' estimation through extrapolation based on HIES datasets (2015-16 and 2018-19).

Conclusion

Water security, if left unchecked poses a great threat to Pakistan's national security and stability. The exponential decrease in groundwater levels indicate that if this trend continues we might cross the absolute water scarcity threshold level (500m³ per capita). In addition, changing climate, outdated infrastructure, and urban sprawl all erode water availability.

The urgency of this situation is being realized and efforts are being made. Innovative decentralized approaches of rainwater harvesting and greywater reuse have been employed and tested throughout the country. Findings from these pilots indicate movement in the right direction, with global cases reinforcing the narrative.

Such systems seem to shrink the demand-supply gap while providing scalable, reliable, and cost-effective solutions to urban water shortages. They also increase resilience against climate variability and reduce demand pressures on central utilities.

However, to fully realize their potential, the policy approach will require a set of clearly sequenced interventions, instead of broad commitments. We can begin by establishing a nationally mandated coordination mechanism (through the Ministry of Climate Change) to align institutional roles for monitoring and maintenance of existing pilot programs. In addition, uniform building codes across all provinces should require rainwater harvesting and greywater reuse systems for the approval of their layout plans (LOPs) and no objection certificates (NOCs). Finally, green financing instruments, compliance linked incentives, and a national water data system could support improved affordability, accountability, and sustained adoption of interventions over the long term.

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