KEYNOTE ADDRESS

Proof Is Not Enough

Lessons from 25 Years of Scaling Water Innovation in Nepal

Roshan Raj Shrestha, Ph.D

Global Water and Sanitation Center, Asian Institute of Technology/World Toilet Organization

Global FEWture Alliance to Showcase Innovative Wastewater Reuse Technology and Convene International Symposium on Climate Resilience in Nepal, June 29 to 30; KU and University of Maryland-based Global FEWture Alliance (GFA)

OPENING REMARKS

Wastewater Is Not a Problem. It Is a Resource.

We were chasing new water with one hand — and throwing away used water with the other.

⚡

Energy Generation

Electrochemically active microorganisms break down organic matter and transfer electrons to capture electrical energy — directly from wastewater.

🔥

Fuel Production

Microbial Electrochemical Technologies (METs) can produce storable hydrogen or methane — converting wastewater into a clean energy carrier.

🌱

Resource Recovery

Critical nutrients — nitrogen, phosphorus, potassium — recovered for agricultural use. Three resources hiding in every drop: Energy · Nutrients · Water.

GLOBAL CONTEXT

The World Is Finally Catching Up

World Economic Forum Analysis · Rethinking Wastewater: Why the Future of Water Treatment Is About Resource Recovery · Apr 2026

359bn

m^3/year

wastewater generated globally

— yet only half is treated

800,000

GWh

chemical energy in global wastewater

≈ one-fifth of total US annual electricity output

3

resources

hiding inside every drop of wastewater

Energy · Nutrients · Water

Reuse · Restore · Recharge

Parks · Industrial Use · Groundwater Recharge · Lake & River Rejuvenation

"There is no such thing as waste water.

The real waste is failing to reuse it."

— Nandita Kanwar
Director, Hydromo

OPENING REMARKS

Three Blind Spots We Need to Address

Missing from the Climate Agenda

Climate policy focuses on emissions and renewables — but sustainable water reuse barely gets mentioned. Yet it is one of the lowest-cost, lowest-carbon climate adaptations available.

The Pilot Trap

Around the world, proven innovations — rainwater harvesting, constructed wetlands, greywater recycling — are celebrated at conferences and never replicated. We have become very good at starting pilots. Very poor at ending them.

Proof ≠ Scale

Something is broken in the chain between proof and scale. It is not the technology, not the data, not the awareness. The gap is leadership, governance, and systems.

"Wastewater is often viewed as waste — but it is actually a valuable resource providing water, energy, nutrients, and other recoverable materials."

KATHMANDU 2000

The Water Scarcity Paradox

50%

of Kathmandu's water demand went unmet

2.5m

annual groundwater depletion — every year

40 MLD

untreated wastewater into Bagmati River daily

$468M

mega-project to pipe water 27km from Melamchi

Extraction of fossil water

Untreated discharge into Bagmati

People queuing for tanker water

Discharge vs. Reuse — the choice we kept making

CASE STUDY 1 · SYSTEM OVERVIEW

EcoHome — Integrated Water Management (2002)

Home Without City Water Supply · Reuse & Recycle of Waste · Built 2002 · 135 m²

EcoHome — all systems integrated into one building

- 🌧️ Rainwater catchment (2 roof areas)
- 🛢️ Underground water collection tank
- 🌿 Greywater treatment plant (reed bed)
- 🚽 UDD toilet — urine diversion
- ☀️ Solar panel for water heating
- 🪣 Roof tanks for water storage
- ⛏️ Dugwell for groundwater recharge
- 🔵 Biosand filter for drinking water
- 🌻 Garden — fed by urine compost

CASE STUDY 1

EcoHome, Kathmandu — Built 2002

House Without City Water Supply · 135 m² · Family of 4 · No government funding

Aerial view — EcoHome, Dallu, Kathmandu

33 L per person per day (vs. 100–150 urban norm)

47% of clean water saved by greywater recycling

116 m³ rainwater harvested per year

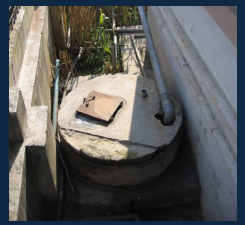
2.4% extra cost over standard construction

Cost already recovered — saves USD 370/yr

Rainwater Harvesting & Greywater Recycling

RAINWATER HARVESTING

Roof as Rainwater Catchment



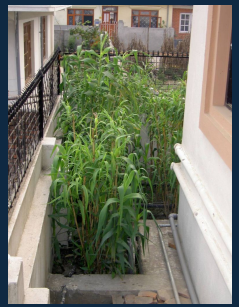
Dugwell for groundwater recharge and sand filter

Underground water collection tank

7–8 months

rain covers full water needs

GREYWATER RECYCLING



Reed bed for greywater treatment — 4.8 m²

Treated water reused — garden flourishes

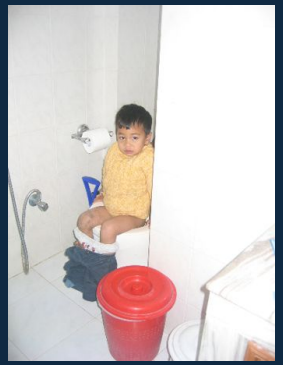
Treated greywater for Flusing toilet and car washing

47%

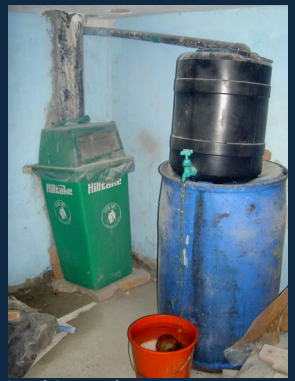
of clean water demand saved

Ecological Sanitation & Garden Produce

🌱 ECOLOGICAL SANITATION (ECOSAN)



UDD toilet — separates at source



Collection bins — basement storage or urine and feces

Excreta converted to soil conditioner

Roof Top Garden where urine and feces applies

🥦 VEGETABLES GROWN WITH ECOSAN COMPOST

Beans & greens

Spinach

Tomato

Radishes harvested

EcoHome as a Living Learning Centre

Open to all — NGOs, schools, media, international delegations · Integrated into academic curriculum

NGO Forum — EcoHome poster

Students learning on-site

Distinguished visitors in the EcoHome garden

12 years of operation · Hundreds of visits · Internationally recognised best practice · Integrated in academic programmes

When the Story Reached the Nation

SURVIVAL PLANS
Architect William McDonough on designing for the future
PAGE 8

FT House & Home

SATURDAY OCTOBER 15 / SUNDAY OCTOBER 16 2005

Eco-properties are coming of age as environmentally sound

Ample water, even when the main runs dry

In Kathmandu, Roshan and Sunita Shrestha run a home that is a model of environmental self-sufficiency Binod Bhattarai pays a visit

To a casual visitor, the home of Roshan and Sunita Shrestha at Dallu in the south-western outskirts of the Nepali capital is just another middle-class residence. The two-and-a-half storey, four-bedroom, white brick-and-mortar building at the foot of Soyambhunath Stupa – a famous Buddhist shrine – is not much different from the roughly 700 houses in the area.

But Shrestha residence has something that most in Kathmandu don't – adequate water supply.

"I have a connection to the mains but there is no supply," Roshan says. "So, we use rainwater for seven months and well-water for the remaining five."

Shrestha, chief technical adviser at the UN Habitat's Water for Asian Cities Programme, became interested in water conservation in the mid 1990s while working on an Italian project that studied water quality. After that ended, he and his co-workers set up the charity Environment and Public Health Organisation (ENPHO) to promote low-cost conservation techniques, and he decided to turn his home into a site for showing how to optimise water use.

"We had ideas for solving water scarcity in the household but did not have a place to demonstrate the technologies," explains Bhushan Tuladhar, general secretary of ENPHO. "Roshan's house has now become a model."

Roughly 116 cubic metres of rain (116,000 litres) falls on the Shresthas' 90 sq metre rooftop each year, and they collect and store it all. It passes through a small, 200-litre tank, which flushes out dust and dirt, and is then deposited in a much larger underground tank, with excess water diverted to a backyard well. This provides about 5,400 litres of water for use each year, or 50 per cent of what the five-person family needs. But, since all the plumbing was planned and installed when the house was built three years ago, nothing shows on the exterior. The pipes converge on a landing covering the storage tank and from there water is diverted to different storages.

The Shresthas also use water from the 10,000-litre well, but only in the dry season and only after pumping it through a bio-sand filter (fabricated in a used paint drum) to remove iron, dust particles and odour and then employing solar purification technique developed in Switzerland. It is usually Shrestha, the resident scientist, or his 13-year-old son Suchit who fill plastic soda bottles and place them in sunlight for six to seven hours, allowing ultraviolet rays to kill microbes.

The last source of supply is wastewater from the kitchen, bathroom and washing, which is collected and treated in a "constructed wetland" set up in the family's 30 sq metre backyard. This consists of a variety of reeds (*Phragmites karka*) planted in sand and gravel, which creates an underground shelter for pollution-digesting microbes that obtain oxygen from the plants and food from the wastewater. The biological processes clean the water, which is then stored separately, and used for gardening or washing the car.

There have been times when neighbours have scolded Shrestha for scrubbing down his vehicle, asking how he can waste water when they don't have enough to drink. "At first many don't believe me when I tell them I do not use water from the mains," he says. "Eventually I end up teaching them to collect rain and recycle wastewater for non-drinking purposes."

His education efforts are not just limited to neighbours, however. Shrestha frequently hosts tours for groups in Nepal and foreign visitors on tours of his home organised for World Water Day in March, Earth Day in April and World Environment Day in June. Inspired by its success, ENPHO and other non-governmental organisations have intensified campaigning for water harvesting and reuse.

But they also remain focused on their home base. Kathmandu, the Nepali capital that was until the late 1960s often compared with the mythical Shangri-la. Now, it is an exploitated, overcrowded urban sprawl of about 1.5m people with an acute shortage of drinking water. Although the city needs around 180m litres per day, its supply is roughly 130m during the wet season and 100m during the dry months. About 40 percent of taps run dry from March through June.

Ironically, Nepal also has hundreds of Himalayan rivers but none of them flow through Kathmandu, located in what geologists call a "high altitude" valley (1,300 metres above sea level). The government has plans to augment supply by spending about $100m to bring 170m litres per day of snowmelt from a nearby snow-fed river. But this project, supported by the Asian Development Bank, has stalled following a controversial end-of-August decision by an anti-graft body that found its contracting faulty.

Rainwater remains a viable option, particularly in Kathmandu, which gets more than 1,400 mm each year, most of it from June through September. But its use is limited.

"It requires additional investment for fittings and storage and not everyone can afford it," Tuladhar says. "But all can benefit if some collect rainwater because they save water that others can use."

Tuladhar himself lives in rented space with his wife Shirjis, so has instead focused on reuse of organic and inorganic waste. The couple has a table that uses old truck tires for a base, curtain rings made of used plastic bottles and pen stands of chipped glasses.

In the corner of his small kitchen, he raises an army of earthworms whose job is to nibble and digest the plant-based household waste. "Composting is aerobic as there is no smell," Tuladhar explains.

But the most interesting conservation tool is another water-conserving device back at Shrestha's house. In the modern bathroom attached to his bedroom, there is a "dry" toilet that has separate outlets for urine and faeces.

The system lets faeces drop two floors vertically into a bin in the basement. A little sawdust or ash is added after use to prevent odours and to facilitate composting. The bin takes about four months to fill up, at which point it's replaced with an empty one. Faeces in the full one takes another six months to convert into soil, which is used in the garden along with compost produced from the kitchen. (The Shresthas grow most edible, fruiting miniature crops and guavas trees and vegetables on a small terrace and garden. "One year we grew 5kg of tomatoes on one plant on the terrace," says Shrestha. "The space is small but the yield is very high.")

Urine is also eventually delivered to the garden. The second chamber in the dry toilet is flushed using a faucet, and the outflow is collected in a separate basement tank. The liquid decomposes for about 15 days after which it is diluted and used to water the Shresthas' plants.

Dry toilets are actually best suited for use in farming villages where there is less of a cultural aversion to handling waste. But Shrestha and his wife both use theirs. "You have to have one to believe it works," he says. "If it was dirty, smelly and unhygienic, Sunita would not have let me have it attached to my bedroom."

Architects in the UK, agrees: "It's no longer a minority thing or an old hippie thing. This isn't limited to Greenpeace activists. We are seeing a variety of people who are just genuinely interested in finding out how they can live more in tune with the planet."

Today, some small communities of eco warriors in yurts (circular Mongolian tents, for the uninitiated) and

Warm waste disposal

Documentary film — broadcast on Nepal Television

Financial Times House & Home

ECO-FRIENDLY HOME

Panacea To Water Shortage Problem

By Nanuel Nemburg

"Panacea to Water Shortage Problem"

National television. International press. An FT feature.

By every conventional measure of success, EcoHome's story was told widely. And yet mass replication still did not follow.

Publication is not adoption. Visibility is not scale.

CASE STUDY 1

EcoHome: What Happened Next

✅ What Worked

- Became a demonstration site — open to all
- NGOs, schools, media visited on World Water, Earth & Environment Days
- Technology performed flawlessly for 12 years
- Internationally recognised best practice — integrated in academic curriculum
- Rainwater harvesting replicated by many; greywater treatment by a few

❌ What Didn't Follow

- Visitors left inspired — most forgot within months
- UDD toilet attracted almost no public interest
- Unable to train enough technicians for maintenance
- Building engineers did not adopt integrated water design
- No recognition or incentive from city or government
- Couldn't continue once I left the country after 12 years

"We had working technology. We had open doors. We had data. The city kept waiting for Melamchi."

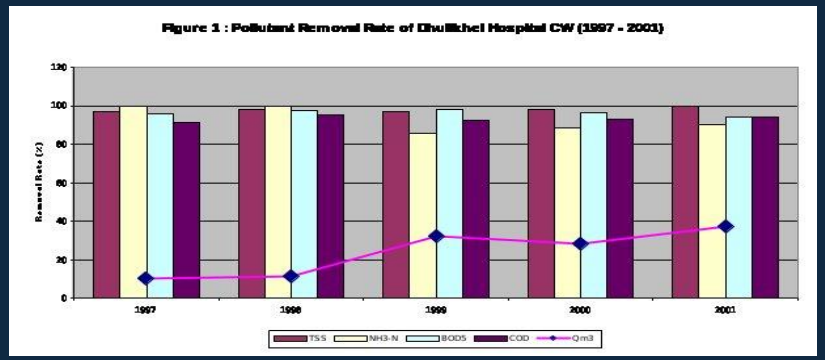
CASE STUDY 2

Dhulikhel hospital wastewater treatment plant (1997)

Nepal's first — gravel, sand, local reeds, no electricity, no chemicals

Same system — reeds fully grown

Pollutant Removal Rate 1997–2001



95%+ pollutant removal
Water → irrigation

CASE STUDY 2

From One Site to Eight — Then the Stall

1997 — First CW at Dhulikhel Hospital (30 beds). 20 m³/day. Met with deep scepticism.

2001+ — Hospital grows to 80 beds. System scales to 40 m³/day. 95%+ removal — consistently.

2003+ — 8 more plants: Sushma Koirala Hospital, Malpi School, Kathmandu University, hydropower office, Pokhara septage & leachate system.

2025 — Around 70 units built; many are non-functional or poor O&M

Treated water into irrigation canal — a hazard became a community resource.

Kathmandu University CW system

Pokhara Fecal Sludge & Leachate Treatment

KEY FINDINGS

System Assessment Findings — Part 1

01 Planning, Design & Implementation

Only 50% of systems had good design; implementation was good in 81.8% of installations. However, the handover process was identified as poor across the board.

02 Operation & Maintenance (O&M)

O&M skill was adequate in only 4.5% of systems, leading to improper daily maintenance. Unskilled management bodies and lack of supervision further compounded the problem.

03 Treatment Performance

Treatment efficiency rated good in only 33.3% of systems. Microbiological removal was significant but insufficient for safe direct reuse of treated water.

Lab Analysis (5 systems in-depth):
BOD removal: 66%–97%
COD removal: 65%–95.4%
TSS removal: 86%–99.8%

KEY FINDINGS

System Assessment Findings — Part 2

04 Factors Governing Performance

Better-performing systems shared: good design to prevent stormwater inflow, skilled O&M personnel, secured financial sources, and effective daily maintenance routines.

05 Financial & Management Aspects

Many systems lacked secured financial sources and consistent management oversight, directly undermining their long-term sustainability.

The evidence is clear: financial security, skilled O&M, and strong governance are the decisive factors between systems that work and systems that fail.

THE HONEST RECKONING

Why Didn't It Scale? — Part 1

01 No One to Call When Things Break

A critical shortage of experienced, hands-on service providers. When a pipe blocked at one of our plants, nobody came for three weeks. A minor issue became a permanent shutdown. We built the car. We forgot to train the mechanics.

02 The Expertise Gap

The people who truly understand these systems are rare — and when large projects get funded, they are precisely the people who cannot get hired. Large projects demand credentials, not field experience. We scale the paperwork while the real knowledge stays small.

03 Motivation That Evaporates

When Kathmandu's water crisis was acute, people were motivated. But the moment immediate pressure drops — the rains come — the long-term solution loses its urgency. Innovation needs sustained motivation. Crisis produces only temporary motivation.

04 No Stick, No Carrot

No meaningful penalty for discharging untreated wastewater. No meaningful incentive for treating it. Without a penalty mechanism, the status quo is always cheaper. Without an incentive mechanism, innovation is always optional.

THE HONEST RECKONING

Why Didn't It Scale? — Part 2

05 People Only Innovate Under Stress

Every visitor to EcoHome left inspired. Most forgot within months. We are wired to solve the problem in front of us — not the one moving toward us. The best time to build a rainwater system is before the drought. We always want to build it during the drought.

06 Short-Sightedness Is a Governance Failure

Short-sightedness is the default human condition. Governance exists precisely to compensate for it. Where water reuse has scaled — Singapore, Israel, Australia — governments mandated it, funded it, and enforced it. Voluntary adoption is not a strategy.

07 No Standards, No Quality Control

A poorly designed system — built by someone who read about the technology but never built one — failed publicly. Decision-makers concluded 'these systems don't work.' Without regulatory standards, every failure becomes an indictment of the entire innovation.

08 The Champion Dependency

Every site that worked had one person who believed in it. When that person left, momentum left with them. We had built systems. We had not built institutions. Individual champions cannot substitute for policy, standards, and sustained investment.

THE REAL BARRIER

It was never the technology.

- 🔧 Missing Service Ecosystem
- 🎓 Expertise Goes to Wrong Places
- ⚖️ No Incentives or Penalties
- 📋 No Standards or Regulation
- 💡 Motivation Tied to Crisis
- 👁️ Short-Term Thinking
- 🧍 Champion Dependency
- 🔁 Pilot Trap Culture

These are not technical problems.
They are leadership and governance problems.

And that is precisely why I am talking to you today.

CONCLUSION

What Leadership Actually Demands

Demonstrate first, advocate second

Build the EcoHome before you write the report. Proof speaks louder than proposals.

Push for standards and regulation

Even when it is unpopular. Standards protect users, protect the technology's reputation, and force the conversation.

Build coalitions, not just systems

Dhulikhel worked because a hospital director believed in it. Find your champions and build institutions around them.

Invest in the service ecosystem

Train the mechanics before the car breaks. Build local capacity for maintenance, repair, and quality control.

Make the invisible visible

Calculate the cost of inaction. Show what untreated wastewater actually costs — in health, rivers, and lost opportunity.

Stay engaged after the ribbon cutting

The hardest work starts after the demo. Be the person who is still there on day 1,000 when nobody is watching.

YOUR ROLE

Find the EcoHome in your field.

The thing that works — but nobody has scaled yet.
That is your leadership opportunity.

1

What proven innovation in your field is stuck at pilot scale?

2

Who is the champion that needs support — or an institution that needs building?

3

What regulation, standard, or incentive is missing — and who needs to hear that from you?

One action this week: Identify one proven local innovation in your field that deserves wider adoption.

My Question?

Water scarcity is not inevitable. The technology exists. The evidence is in.

Climate-resilient water infrastructure is achievable — at household, community, and city scale.

What stands between proof and scale is not technology. It is government will, the right incentives, and a sustainable ecosystem for O&M.

Where governments mandate, fund, and enforce — and skilled people maintain systems long after launch — water resilience stops being a pilot and becomes a norm.

The question is no longer if it works — but whether we choose to make it last.