PACÍFICO SUR · BCS

Can We Use the Ocean to Heal Our Aquifer?

*What the world is already doing —
and what it could mean for us*

Para Todos

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SERIES: SUSTAINABLE SOLUTIONS · ARTICLE 2

In our first article, we visited a local desalination plant and came away convinced that the technology works — when it's done right. But that article addressed only half the problem. Desalination can provide an alternative source of water so new developments don't keep draining the aquifer. That's important. But it doesn't fix what's already broken.

Our aquifer is losing nearly 3 million cubic meters of water per year. The saltwater boundary has moved 1.6 kilometers inland. Wells that gave clean water a decade ago are going salty. The question we couldn't stop asking after that first visit was: is there a way to actually put water back?

The answer is yes. It's been done for decades. And the results, in some places, are extraordinary.

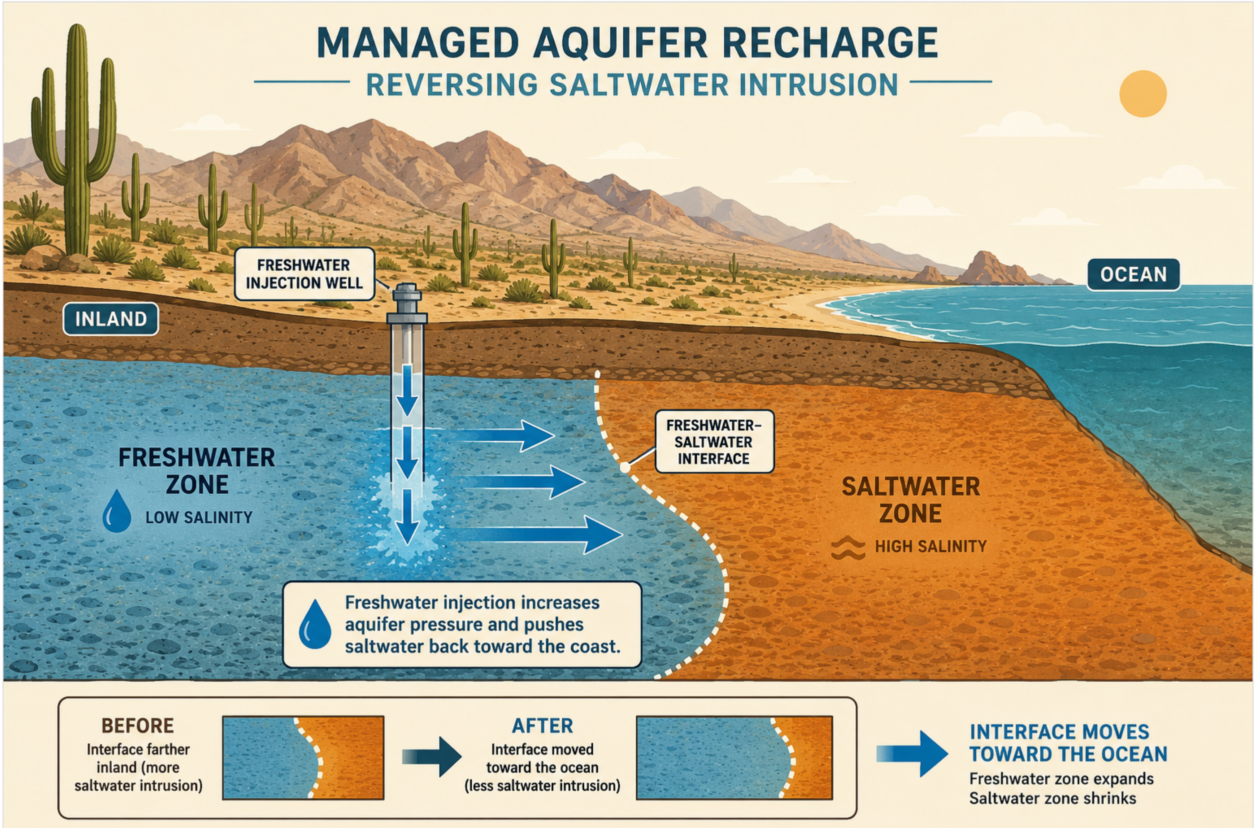
What is managed aquifer recharge?

The concept is simpler than the name suggests. Managed Aquifer Recharge — MAR — means intentionally putting water into an aquifer to replenish it. Instead of just slowing down how fast the aquifer empties, you actively refill it.

There are several ways to do this. You can spread water over large infiltration basins and let it soak through the ground naturally. You can inject it directly through wells. You can capture rainwater that would otherwise run off or evaporate and redirect it underground. The method depends on the geography, the water source, and the aquifer's characteristics.

What they all have in common: they increase the pressure of fresh water in the aquifer. And as we explained in our first article, that pressure is what holds the saltwater back. More pressure means the freshwater-saltwater boundary moves toward the coast. Less pressure — which is what overextraction causes — means saltwater advances inland.

In other words, MAR doesn't just stop the bleeding. It can reverse the damage.



Who is already doing this?

This isn't experimental. It's not a pilot program in a university lab. These are full-scale, operational systems that serve millions of people.

Orange County, California

The most striking example in the world sits just across our border, in Southern California.

Orange County's Groundwater Replenishment System takes treated wastewater that used to be dumped into the Pacific Ocean, purifies it through microfiltration, reverse osmosis, and ultraviolet disinfection, and puts it back into the aquifer. It's the largest system of its kind on the planet — producing 130 million gallons of purified water per day, enough to serve one million people.

The results speak for themselves. Before the system, the aquifer's natural yield was about 100,000 acre-feet per year. With managed recharge, the sustainable yield has more than tripled to 320,000 acre-feet. The aquifer now supplies 85 percent of the region's water needs.

Part of that water is injected into coastal wells that form a physical barrier against saltwater intrusion — the same problem we face here. The rest percolates through basins in Anaheim into the deep aquifer. The system has been operating since 2008, has produced over 445 billion gallons of water, and has won more than 80 international awards.

Israel

Israel faced a crisis similar to ours — a coastal aquifer being depleted by overextraction and threatened by saltwater intrusion. Their response was to build five massive desalination plants along the Mediterranean coast, producing 600 million cubic meters of freshwater per year. But they didn't stop there.

When the desalination plants produce more water than the country needs at a given moment, the surplus is recharged into the coastal aquifer through infiltration ponds. At the Menashe MAR site near the city of Hadera, desalinated seawater has been recharged into the aquifer since 2015. Researchers have tracked the recharged water spreading through the aquifer using isotope analysis, confirming that the water integrates successfully into the groundwater system.

Israel's approach treats the aquifer as a natural underground reservoir — using it for storage when there's surplus and drawing from it during peak demand. The aquifer becomes a partner in the water system rather than a victim of it.

Los Angeles, California

Los Angeles has operated freshwater injection wells as a saltwater intrusion barrier since the early 1950s — over 70 years. Freshwater is injected into a line of coastal wells, creating a pressure wall that prevents ocean saltwater from advancing into the region's drinking water aquifer. It's one of the oldest MAR systems in the world, and it's still running.

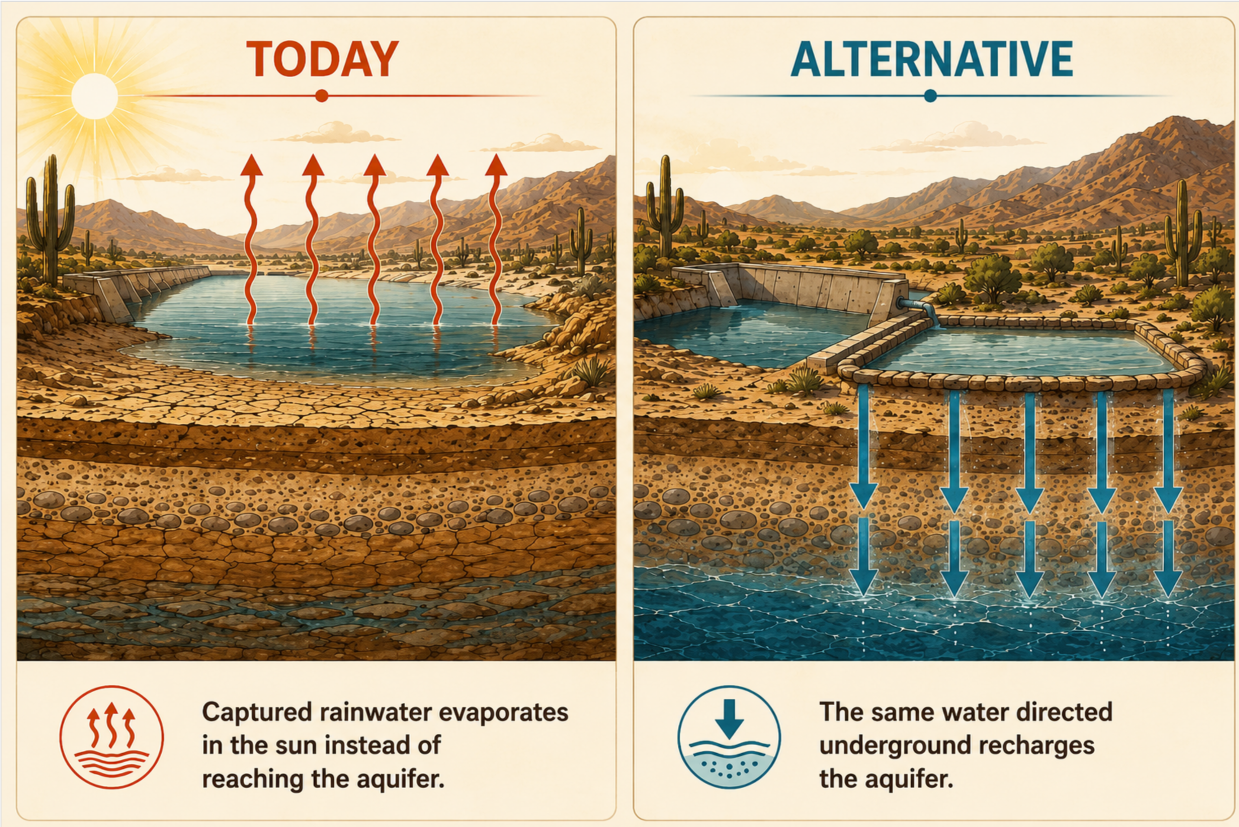
We don't even need desalination for all of it

Here's something that surprised us during our research, and it came from a conversation with a local farmer who knows our water system intimately.

There is a presa — a dam — in our area that captures rainwater, particularly during the rainy season and hurricane-driven storms. But that captured water sits in an open reservoir in the BCS sun. It doesn't soak into the ground. It evaporates.

Think about what that means. We have fresh water — already captured, already sitting right there — being lost to the atmosphere instead of recharging the aquifer it sits above. In a region that averages 160 millimeters of rain per year, every drop that evaporates instead of infiltrating is a drop the aquifer doesn't get back.

Redirecting that captured rainwater underground — through infiltration basins or injection wells — wouldn't require any desalination at all. The water is already fresh. It's already captured. It just needs to go down instead of up.



This is one of the simplest and cheapest forms of managed aquifer recharge, and it's a starting point that doesn't require any of the infrastructure or complexity of a desalination-recharge system. It just requires the decision to do it.

What would this actually involve?

Research on MAR costs across different methods consistently shows that infiltration basins — essentially engineered areas where water soaks into the ground — are the cheapest approach. Levelized costs range from US$0.04 to $0.36 per cubic meter, depending on scale and local conditions. Compare that to the cost of water from a truck at roughly US$7 per cubic meter (140 pesos), and the math is overwhelming.

For our presa specifically, what would be needed is straightforward: earthwork to create permeable infiltration channels or basins adjacent to the existing dam, where captured water is directed to soak into the ground rather than sitting exposed to the sun. The sandy soils in our region are well-suited for infiltration — coarse-grained sand and gravel allow fast recharge, which is exactly what the research identifies as the conditions where infiltration basins perform best.

The estimated cost for a basic infiltration system near an existing presa would be in the range of 500,000 to 2 million pesos — mostly earthwork, channels, and basic monitoring. That's a fraction of the cost of any desalination-based approach. And it could be operational within months, not years.

The limitation is volume — the presa only captures water during rains, and our rains are infrequent. This wouldn't close the 2.9-million-cubic-meter annual deficit on its own. But every cubic meter that goes into the ground instead of evaporating is a cubic meter the aquifer gets back. And in a region where every drop matters, the simplest solution is often the best place to start.

The question is who takes the first step — and that's a question we'll come back to.

The more ambitious path: Abstraction-Desalination-Recharge

For the coastline specifically — where the saltwater boundary is advancing — there's a more targeted technique. It's called ADR: Abstraction-Desalination-Recharge.

Here's how it works:

Step 1: Extract brackish water near the coast. This is exactly what the desalination plant we visited in our first article already does — pulling water from the saline zone, about 50 meters from the ocean.

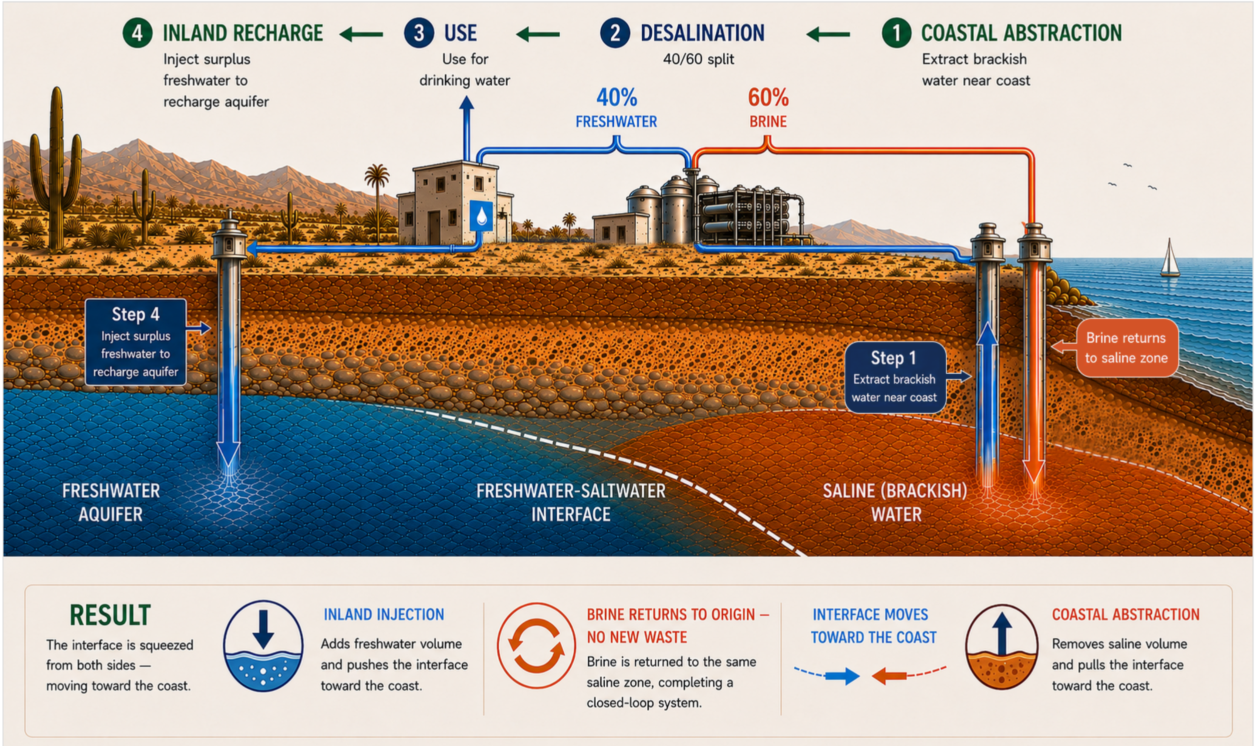
Step 2: Desalinate it. Reverse osmosis removes the salt and produces fresh drinking water. Again, this is already happening.

Step 3: Use what you need. Part of the freshwater serves the property or community's needs.

Step 4: Inject the surplus inland. The extra freshwater gets injected on the inland side of the freshwater-saltwater boundary — not at the coast, but further in, where it adds pressure to the freshwater aquifer and pushes the saltwater back toward the sea.

The beauty of this approach is that step 1 and step 4 work together. Extracting brackish water near the coast removes volume from the saline zone (negative barrier), while injecting freshwater inland adds volume to the freshwater zone (positive barrier). The saltwater boundary gets squeezed from both sides.

Published research describes ADR as an effective and economic method for controlling saltwater intrusion, with lower energy consumption than other approaches because the feed water is brackish rather than full-strength seawater.



The risks — because there are real ones

We committed in our first article to doing our homework honestly. That means talking about what can go wrong, not just what can go right.

Arsenic mobilization

This is the most documented risk of managed aquifer recharge, and it's different from what most people would expect.

When you inject oxygenated water — which desalinated water is — into an aquifer that has low oxygen levels, it can trigger a chemical reaction with naturally occurring minerals in the rock. Specifically, if the aquifer contains pyrite (iron sulfide), the oxygen dissolves the pyrite and releases arsenic that was trapped inside it into the groundwater.

This happened in Florida's coastal aquifer — it's the most studied case in the MAR literature. Multiple recharge sites had to be modified or abandoned because of arsenic levels exceeding drinking water standards. A critical review published in *Environmental Science & Technology* identified arsenic mobilization as the most widespread challenge at MAR sites globally.

This is a serious risk and it would be irresponsible to minimize it. But it's also a testable, preventable risk. The mitigation is straightforward:

Before any injection begins, the aquifer's mineralogy must be characterized — specifically testing for pyrite and arsenic-bearing minerals at the proposed injection depth. If they're present, there are engineering solutions: deoxygenating the water before injection, creating buffer zones, or treating recovered water. But you need to know before you start. This is exactly the kind of study an academic partner would design into any pilot.

Abandoned projects

Mexico has its own cautionary history with MAR. Multiple projects in the Mexico City metropolitan area were built, operated briefly, and then abandoned due to what researchers describe as "improper facilities design, inadequate operation, maintenance and monitoring, and unexpectedly high costs."

The technology didn't fail in those cases — the planning did. Projects were started without adequate funding, without monitoring protocols, and without long-term operational commitments. When the money ran out or the political attention moved on, the infrastructure was left to deteriorate.

This isn't an argument against MAR. It's an argument for doing it right — with proper planning, academic oversight, sustained funding, and transparent monitoring. It's the difference between a project and a program.

What happens if the system stops?

This is a question people rightfully ask: if you start recharging the aquifer and then stop — the funding dries up, the equipment breaks, whatever — does it make things worse?

No. If recharge stops, the aquifer simply returns to declining at whatever rate it was declining before. The recharged water doesn't somehow drain out or create a new problem. You lose the benefit, but you don't create new damage. It's not like opening a valve that lets the ocean in. The worst case is returning to the status quo — which, to be clear, is already bad. But the recharge itself doesn't make the status quo worse if it stops.

The regulatory reality

There's one more challenge that isn't technical — it's institutional.

Under Mexican water law, once water enters an aquifer, it becomes part of the general groundwater system. CONAGUA doesn't track "you put in X, so you can take out X." If a private entity recharges 100,000 cubic meters into the aquifer, they don't get bonus extraction rights for doing so. Their extraction is still limited to whatever their concession says.

This creates what economists call a free-rider problem. Everyone who draws from the aquifer benefits from the recharge — the farmers, the town, the hotels — but the entity that paid for the recharge gets nothing extra. So why would anyone spend their own money to recharge an aquifer they can't get credit for?

Mexico does have a legal framework for MAR — NOM-014-CONAGUA-2003 specifically addresses artificial recharge. And there are precedents: projects in Mexico City, Chihuahua, Valle de Toluca, and San Luis Potosí. But the incentive problem remains the core barrier.

This is a policy problem, not a technology problem. And policy problems have policy solutions — tax incentives, reduced permitting costs, priority concession processing for entities that recharge. The question is who creates those incentives.

What this means for us — and where we start

Let's be honest about the math.

Our aquifer deficit is roughly 2.9 million cubic meters per year. No single hotel, farm, or private project can close that gap alone. The scale is community-level — it requires coordinated effort, sustained investment, and the authority to set and enforce standards.

But every journey starts somewhere. Orange County didn't solve their water crisis overnight — they started in 2008 and expanded three times over 15 years. Israel built their system over decades. Los Angeles' injection barriers have been running for 70 years. What all of them had in common was a decision to start — backed by data, guided by science, and sustained by institutions that had the authority and the funding to see it through.

We see two paths that could begin now — one simple, one more ambitious. Both are real.

Path 1: The presa — start with what we already have

This is the lowest-cost, fastest-to-implement option. Redirect water that's already being captured and lost to evaporation into infiltration basins that recharge the aquifer. Estimated cost: 500,000 to 2 million pesos. Timeline: months, not years. What's needed: a hydrogeological study to confirm soil permeability and identify the best infiltration site near the presa, earthwork to build the channels, and monitoring to measure results. A local university — CSU Todos Santos or UABCS through their new Center for Innovation, Technology and Water (CITA) — could design and monitor a pilot. This is the kind of project that could produce measurable data within a single rainy season.

Path 2: A coastal ADR pilot — test the bigger idea

This is more ambitious but potentially transformative. A small-scale test using existing desalination infrastructure near the coast to extract brackish water, desalinate it, and inject surplus freshwater inland to push the saltwater boundary back. Based on our research, a two-year pilot would require roughly 8 to 14 million pesos — covering a new inland injection well, a pipeline from the desalination plant to the injection site, monitoring wells, an academic partnership for study design and data analysis, and CONAGUA permitting under the existing NOM-014 framework.

Who could make this happen? The desalination plant we visited in our first article already has unused extraction capacity and a functioning system. If the operators were willing to participate, the infrastructure is already in place. Alternatively, any new resort development that builds a desalination plant in the coming years could serve the same role — the technology is the same regardless of who operates it. An academic institution — CSU Todos Santos, which already studied our aquifer, or UABCS through their Center for Innovation, Technology and Water (CITA) — could design the monitoring protocol and validate the results. And the community — through Para Todos — could provide the initiative, the coordination, and the public accountability.

The pilot's value isn't the 15,000 cubic meters of freshwater it would inject. It's the data. Publishable, peer-reviewed proof that aquifer recharge works at this specific location, with this geology, at a measured cost per cubic meter. That data is what justifies the larger community investment that would actually move the needle. Without a pilot, you're asking the community to bet on theory. With one, you're asking them to scale something proven.

Path 3: The community-scale system — what actually moves the needle

Let's be honest: the pilot and the presa are starting points, not solutions. A few resorts contributing 10,000 to 15,000 cubic meters each to recharge would close maybe 2 percent of our 2.9-million-cubic-meter annual deficit. That's valuable proof of concept. It's not enough to reverse the saltwater intrusion.

To meaningfully slow the advance and begin pushing the boundary back, we'd need to close at least 30 percent of the deficit — roughly 870,000 cubic meters per year of freshwater injection. That requires a dedicated community-scale brackish water desalination and recharge plant: a facility whose primary purpose isn't serving a hotel or a resort, but producing freshwater to heal the aquifer.

What would that look like? A plant extracting approximately 2.2 million cubic meters per year from the coastal saline zone, producing around 870,000 cubic meters of freshwater for injection — roughly 6,000 cubic meters per day. That's about 50 times the hotel's current operation.

The estimated cost: 120 to 200 million pesos for the plant, wells, pipelines, injection infrastructure, and monitoring network. Add a solar installation to power it — which cuts operating costs by more than half — and the total capital investment comes to 140 to 240 million pesos. Annual operating costs: 5 to 8 million pesos with solar, or 13 to 15 million without. The difference is almost entirely electricity, which is why our next article on solar energy matters so much for this conversation.

Combine that recharge with conservation measures on the extraction side — mandating treated wastewater reuse, fixing distribution leaks, redirecting presa water underground — and the deficit could shrink to a level where the aquifer stabilizes for the first time in decades.

This is a real infrastructure project. It's the kind of investment that a community makes in its own future. And the question everyone will ask is: can we afford it?

But before we answer that, there's something else we need to address — because if we don't, none of this matters.

Recharge means nothing if extraction isn't controlled

We can build infiltration basins, run ADR pilots, and construct a community-scale recharge plant. But if unmonitored, uncontrolled extraction continues draining the aquifer faster than we can refill it, we're pouring water into a bucket with a hole in the bottom.

This is something our community knows well. Water trucks operate daily, extracting from wells with limited oversight. Agricultural operations draw significant volumes. And the monitoring of who extracts how much, whether they're within their concession limits, and whether illegal extraction is occurring — that monitoring is, by most accounts, inadequate. CONAGUA holds the regulatory authority, but enforcement on the ground has not matched the scale of the problem.

This is not a secondary issue. It's the other half of the equation. Recharge addresses the supply side — putting water back. But if the demand side — how much is being taken out and by whom — isn't addressed with the same seriousness, the math will never balance.

We don't have all the answers on this yet. But it's important enough that we're going to dedicate a separate article to it: how other communities facing similar challenges have implemented effective water monitoring — what worked, what tools they used, and what our options are if federal oversight alone isn't enough to protect our aquifer. Because any real solution has to address both sides of the ledger.

The bigger question: who has the authority — and can we afford it?

Both paths — the presa and the ADR pilot — run into the same structural question. Who funds this? Who enforces standards? Who creates the incentives for private entities to participate in something that benefits the whole community?

Today, that authority sits in La Paz — over 80 kilometers away, managing a municipality that stretches across a territory far too large to give our region the attention it needs. Our water infrastructure, our development standards, our ability to capture and direct local revenue toward local problems — all of it depends on decisions made by people who aren't living with the consequences.

If our region had its own municipality, the math changes completely.

"140 million pesos? You're dreaming."

Let's address this head-on, because it's the first thing people will say. A community-scale recharge system would cost roughly 140 to 240 million pesos. That sounds like an impossible number. It's not — and here's why.

It's not a one-time payment. Infrastructure projects are built over years. At 20 to 30 million pesos per year over 7 years, the capital investment is fully funded. That's the annual cost we're really talking about — not the total.

A municipality generates its own revenue. For context: Los Cabos — our neighbor — budgeted 7.37 billion pesos in revenue for 2026. La Paz registered 3.1 billion in 2025. A new Pacífico Sur municipality would be smaller, but this region has among the highest property values in BCS, a strong tourism sector, and significant development activity. A conservative estimate puts municipal revenue in the range of 200 to 400 million pesos per year from property taxes, hotel occupancy taxes, development permits, and federal revenue sharing. Directing 10 to 15 percent of that toward water infrastructure — our most urgent problem — would yield 20 to 60 million pesos per year. That covers the annual cost of building the system.

The federal government is already investing in exactly this. Mexico's National Water Plan has committed 122.6 billion pesos to water infrastructure from 2025 to 2030 — including 17 strategic projects. One of them is a desalination plant in Rosarito, Baja California, receiving 12 billion pesos (8 billion federal, 4 billion state). The federal programs PROAGUA, PROSANEAR, and PRODDER provide co-funding for municipal water projects — drinking water, sanitation, drainage, and treatment.

FAIS (the Social Infrastructure Contributions Fund) is another source, and municipalities are required to direct at least 30 percent of it toward basic infrastructure. A new municipality could apply for co-funding that could cover 30 to 50 percent of the capital cost — reducing the local burden to 70 to 170 million pesos over the life of the project.

Developers can contribute, too. Tax incentives — reduced property taxes or development permit fees for projects that include aquifer recharge — don't cost the municipality money; they redirect economic behavior. A new municipality could also establish development fees specifically earmarked for water infrastructure, so that every new project in the region contributes to the solution rather than adding to the problem.

Let's put it in perspective. At the high end — 240 million pesos over 7 years, with 40 percent federal co-funding — the local cost is roughly 144 million pesos, or about 20 million pesos per year. For a municipality generating 200 to 400 million in annual revenue, that's 5 to 10 percent of the budget dedicated to solving the region's most critical problem. Los Cabos spends more than that on street lighting.

Today, all of this revenue — the property taxes, the hotel taxes, the development fees, the federal revenue sharing — leaves our region and goes to La Paz. The money is already being generated here. It's just not being spent here.

The cost of doing nothing

The potential upside of managed aquifer recharge — actually reversing the saltwater intrusion, restoring wells, rebuilding our freshwater reserves — is enormous. But the question isn't just whether the upside is worth pursuing. The question is what happens if we don't.

At current extraction rates, the aquifer continues to lose nearly 3 million cubic meters per year. The saltwater boundary continues to advance. More wells go salty. The cost of water keeps climbing. And by the time the damage is undeniable to everyone, the cost of reversing it will be many times what it would cost to start today.

Every year we wait, the problem gets more expensive to fix. The technology exists. The science is proven. The examples are running. The only thing missing is the decision to begin.

> *This is the second in our series on sustainable solutions. Coming next: how solar energy connects to the economics of water — and why it changes the math on everything we've discussed. After that: how communities around the world have tackled water monitoring when government oversight wasn't enough.*