URBAN WATER BLUEPRINT

Mapping conservation solutions to the global water challenge

Executive Summary

The Nature Conservancy
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In partnership with

C40 CITIES
CLIMATE LEADERSHIP GROUP

IWA
the international water association

EXECUTIVE SUMMARY

More than half of humanity now lives in cities. Large cities alone represent US $21.8 trillion in economic activity, or 48 percent of global GDP [1]. All cities, regardless of size, need a clean, consistent water supply to thrive, so it is little wonder that capital expenditures on water supply are large—US $90 billion per year—and growing. Unfortunately, drinking water sources are increasingly insecure. Cities face twin challenges: water that is both scarce and polluted. Rising demand has been allowed to grow unchecked, competing users upstream do not talk to or trust one another, increasingly unpredictable rainfall patterns have been altered by climate change, and the watersheds where our water comes from have been degraded.

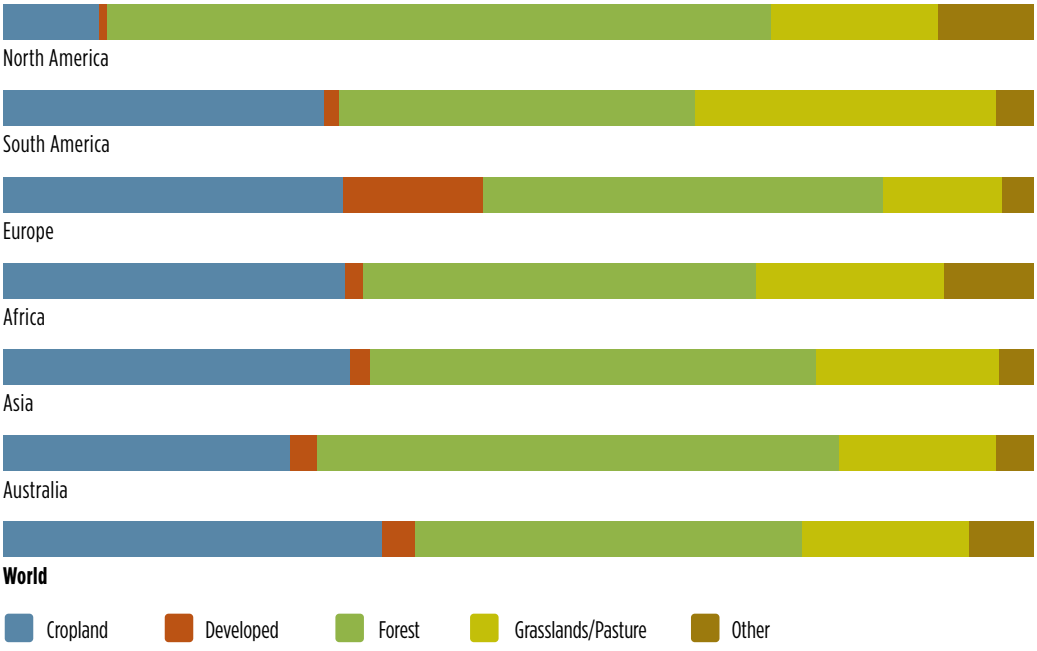
This report is about how investing in nature can help address these challenges. We evaluate one set of solutions to the growing urban water challenge: source watershed conservation. Scientists at The Nature Conservancy (TNC), in partnership with the C40 Cities Climate Leadership Group and International Water Association, present findings on how and where conservation strategies in watersheds can have a material impact on drinking water—drawing on three years of comprehensive, in-depth analysis of the source watersheds that serve over 500 medium and large cities worldwide.

Where our water comes from

Although the 100 largest cities in the world occupy less than 1 percent of our planet's land area, their source watersheds—the rivers, forests and other ecosystems from which they get their water—cover over 12 percent. That's an area of land roughly the size of Russia—1.7 billion hectares—that collects, filters and transports water to nearly a billion people before reaching man-made infrastructure.

The availability and quality of that water supply, and hence the costs to move and treat it, depend heavily on how land in those source watersheds is used. Presently, the average source watershed is covered by 40 percent forest, 30 percent cropland, and 20 percent grassland and pasture. However, in developing countries, where urban population growth is fastest, source watersheds have a higher percentage of agriculture. The variation across regions is shown in Figure E-1.

Figure E-1. Average land use in source watersheds of the 100 largest cities, by region



Source water area by percentage

Water quality is often degraded by nutrients from excess fertilizer washing into streams and lakes. This problem will grow more severe in coming years, with cropland projected to increase 10 percent by 2030 and fertilizer use by a staggering 58 percent over the same time period. Moreover, water quality is often degraded as forests are converted into cropland or ranchland, which increases sedimentation in water sources. Our analysis reveals that this phenomenon is widespread, with two out of every five source watersheds experiencing significant forest loss over the past decade.

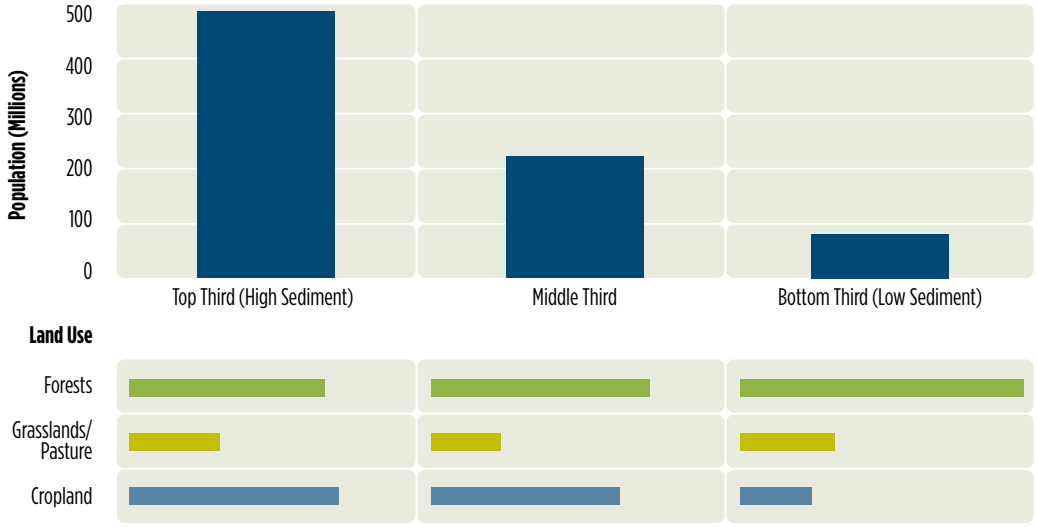
An unsustainable trajectory

With urban demand on the rise, and watersheds and their water quality increasingly degraded, cities are looking farther and farther from their boundaries for water. We estimate that the hundred largest cities in the world currently transfer 3.2 million cubic meters of water a distance of 5,700 kilometers every day in artificial channels. That means roughly 43 percent of water supply is obtained by "interbasin transfer"—moving water from one river basin to another.

Around 500 million people in the 100 largest cities get their water from sources with high sediment levels, while around 380 million people get water from sources with high nutrient levels. Figure E-2 shows how watersheds with more forest cover and less cropland have less sediment, on average.

The Urban Water Blueprint analyzes the state of water in more than 2,000 watersheds and 530 cities worldwide to provide science-based recommendations for natural infrastructure enhancements that can help improve water quality.

Figure E-2. Influence of land use on sediment load



Population in the 100 largest cities that have surface sources with high, medium, or low levels of sediment. The full report also features trends for nutrient pollution.

Wealthy cities have the option of importing water, while lower-income cities mostly have to rely on water resources found nearby, as they cannot afford the same level of infrastructure. Our analysis shows that cities with higher GDP per capita supplement their supply with twice as much water from imported sources. By comparison, lower-income cities rely more heavily on local water sources than interbasin transfer.

Cities that can afford to will be tempted to direct future investments toward moving more water ever greater distances to meet demand, but this is not a sustainable long-term solution. It may also not be climate adaptive—even when taking into account interbasin transfers, one in four large cities are already facing water stress today—and it will likely continue to be unaffordable to many cities, especially those in developing countries.

A different approach is possible: using the lands that source our waters more wisely. Investing in nature can change how land use in source watersheds affects water quality—and, over time, possibly water quantity. This report therefore highlights something water managers will already be familiar with: the difference between supply and useful supply. This report also offers something new: a systematic quantification of the global potential for source watershed conservation to help cities secure water for people.

Watersheds as natural infrastructure

To help determine where watershed conservation can help secure water for cities, we estimated the effectiveness of five common conservation strategies: land protection, reforestation, riparian restoration, agricultural best management practices, and forest fuel reduction (Figure E-3). For each strategy, we evaluated how effectively it reduces sedimentation and nutrient pollution in more than 2,000 source watersheds that serve over 500 cities.

Figure E-3. Five conservation strategies to help secure water for cities

	Strategy	Description
	**Forest Protection**	Purchase of easements, land rental, fencing out cattle, and funding for park guards to maintain watershed services
	**Reforestation**	Restoration and planting of native trees, grasses, and shrubs in critical areas to reduce erosion and related sediment transport
	**Agricultural Best Management Practices**	Implementation of cover crops, contour farming to prevent—and wetland and terrace construction to trap—sediment and nutrient runoff
	**Riparian Restoration**	River bank restoration and protection to reduce erosion and improve water quality
	**Forest Fuel Reduction**	Conducting controlled burns and/or mechanical treatment reduce wildfire severity and related sediment and ash pollution

This analysis finds that conservation strategies could measurably improve the quality of water sources serving over 700 million people living in the 100 largest cities. What's more, at least one of the five conservation strategies could achieve a significant reduction in sediment or nutrient pollution in the vast majority of the world's urban source watersheds (Figure E-4).

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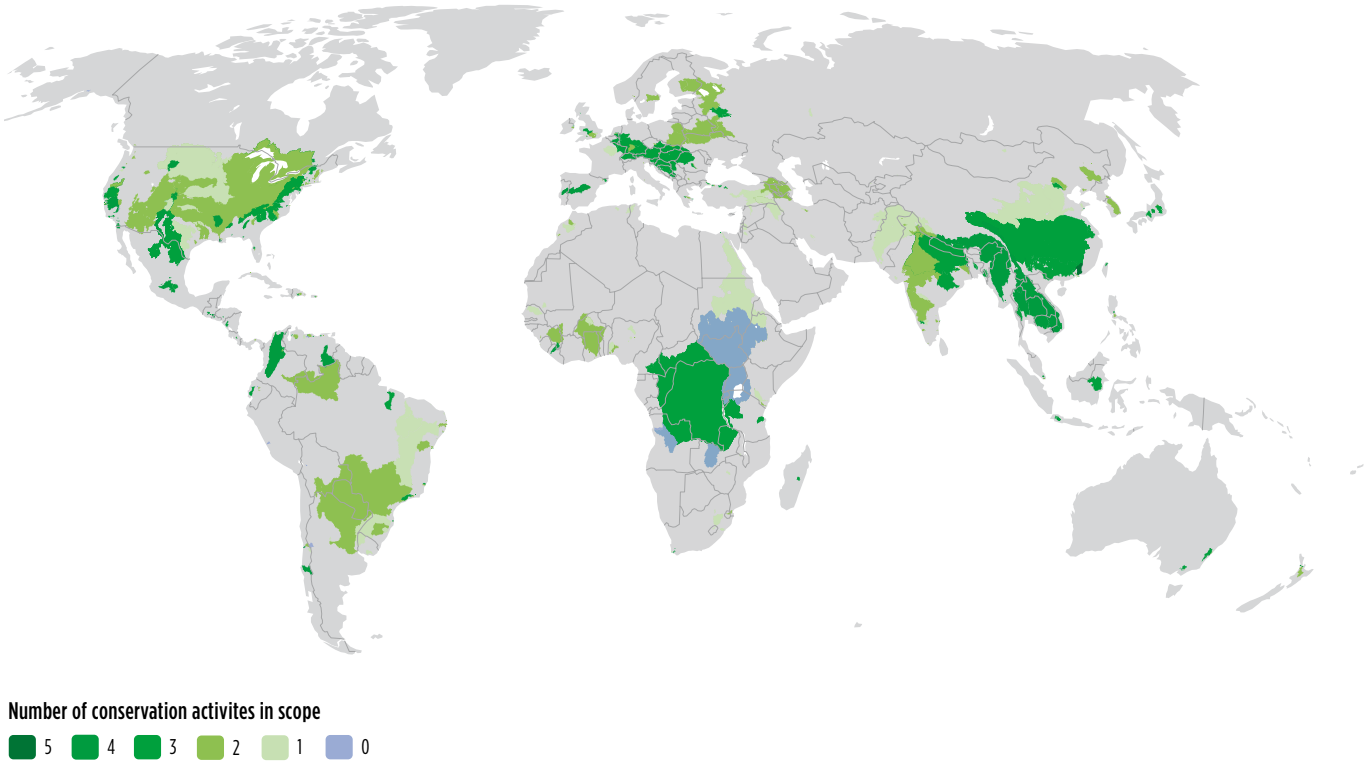
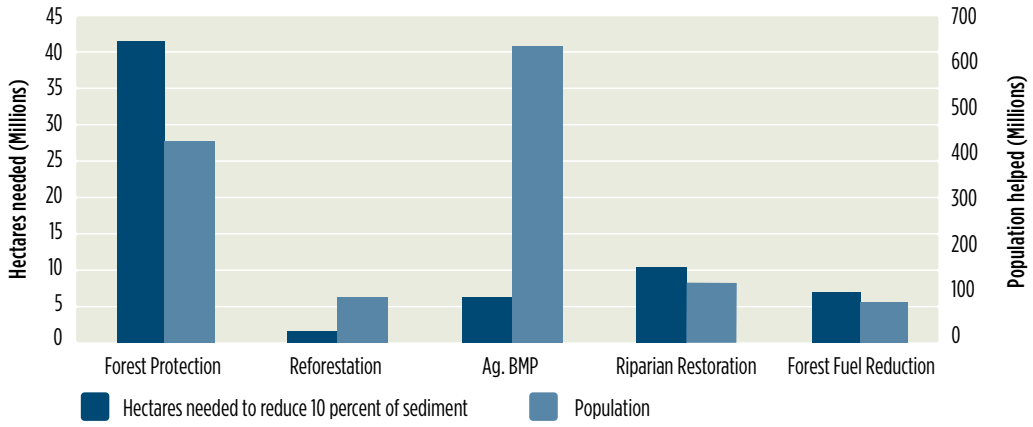
Figure E-4. Number of applicable conservation strategies



Number of conservation strategies that are able to achieve a 10 percent reduction in sediment or nutrient pollution, by urban source watershed.

Water quality benefits can be achieved by targeting conservation on a small fraction of the area in source watersheds. For instance, implementing agricultural best management practices on just 0.2 percent of the area where large cities get their water could reduce sediment pollution by 10 percent. Predictably, the area of conservation it would take to reduce pollution by 10 percent, as well as the number of people whose water supply would improve, varies significantly across the five conservation strategies evaluated in this report (see Figure E-5).

Figure E-5. Sediment reduction from conservation for five common conservation strategies



The full report also features trends for nutrient pollution.

Our findings suggest that the greatest potential to secure water for cities lies in improving the management of agricultural lands. This is especially true for sediment reduction, where over 600 million city dwellers would see a material improvement in the quality of their water sources if agricultural best management practices were applied in a targeted way to some 6.4 million hectares.

Forest protection would benefit the second greatest number of people, about 430 million. However, to achieve the same impact on water quality as agricultural best management practices, this strategy would require conserving an area of land six times greater, some 41 million hectares. The same trend is true of riparian restoration, suggesting that the additional benefits of forests, from recreation to carbon sequestration, would need to be monetized in order to fund source watershed conservation at a global scale.

Promising opportunities in forest fuel reduction also exist in some regions of the world, including the southwestern United States and Australia. When combined with revenue from timber and avoided damages from forest fires, this conservation strategy holds great promise for wider implementation.

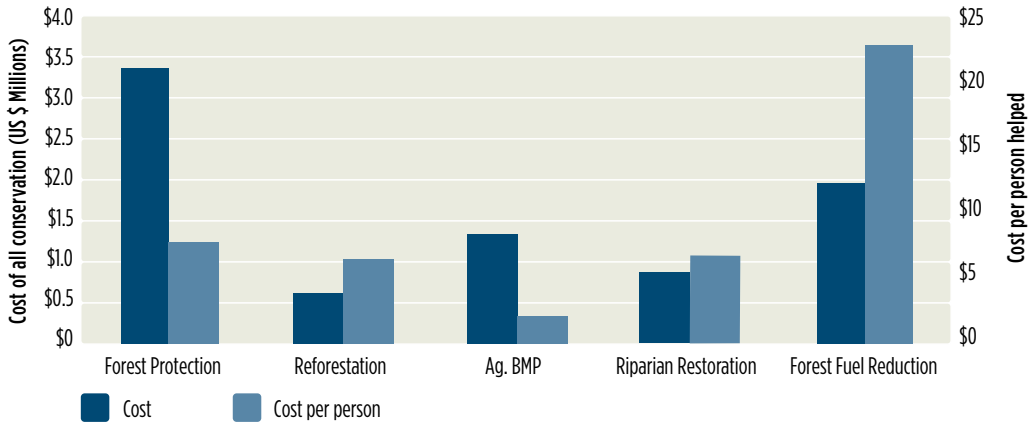
The global market potential for watershed conservation

Not all watershed conservation is equally cost-effective. The amount of land on which conservation activity would have to be conducted to achieve a measurable reduction in a pollutant varies widely among cities. Effectiveness is greatest for small source watersheds, where action on a relatively small number of hectares can significantly change concentrations of pollutants. Estimates of effectiveness for more than 500 cities in our analysis are catalogued in Appendix A of this report and online at nature.org/waterblueprint, which displays more detailed information, including maps of each city's water sources.

The cost for watershed conservation is a function of how many hectares on which the activity must be conducted. For sediment reduction, the market potential across all five activities is US $8.1 billion per year, with the largest costs being forest protection and forest thinning. Figure E-6 shows, however, that the cost per person is lowest for agriculture best management practices.

For nutrient reduction, the market potential across all five activities is US $18.1 billion, with the greatest total costs in agricultural best management practices and reforestation. In this case, however, the cost per person is lowest for forest protection.

Figure E-6. Cost and effectiveness of watershed conservation for sediment reduction



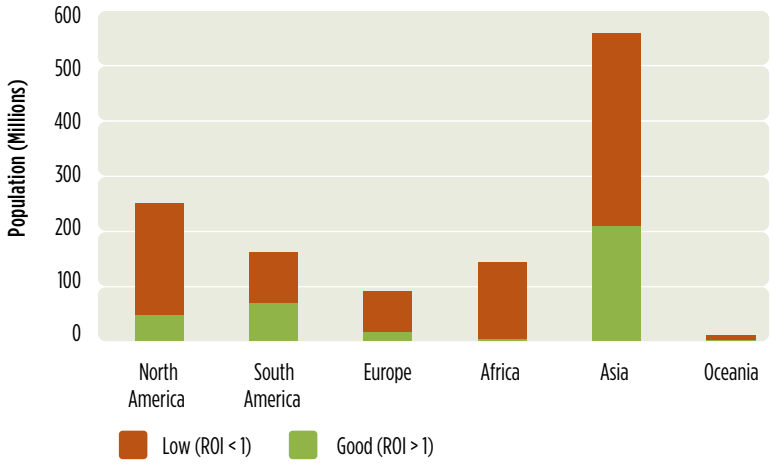
The full report also features trends for nutrient pollution.

The return on investment for water treatment

Using information on reported water treatment plant operations and maintenance (O&M) costs from a sample of cities, we show that reductions in sediment and nutrients lead to significant reductions in treatment plant O&M. A reduction in sediment and nutrients by 10 percent leads to a roughly 5 percent reduction in treatment costs. If all possible conservation strategies were applied, global water savings on treatment plant O&M would be US $890 million per year.

Out of all 534 cities analyzed, one in four would have a positive return on investment for implementing watershed conservation. Of course, the return on investment would vary widely among cities. The geographic distribution of where the return on investment is positive is shown in Figure E-7.

Figure E-7. Potential return on investment for watershed conservation by continent



Potential return on investment for watershed conservation by continent.

Conservation strategies can measurably improve the quality of water sources serving more than 700 million people living in the 100 largest cities.

Source watershed conservation saves money for utilities in other ways as well. For instance, investing in conservation strategies is likely to reduce capital expenditures over time for utilities, as cities can continue using cheaper water treatment technologies rather than upgrading to more complex, expensive technologies. Watershed conservation also creates value to cities beyond water treatment, including recreation, economic development, and biodiversity.

The way forward

This report lays out a basic set of facts about the market potential for conservation to improve the supply of water, in particular its quality. Our findings provide an important basis for comparing engineered and natural solutions and exploring how the two can be integrated to provide a more robust system.

The report also lays out some elements of a scale-up recipe, including developing a reliable track record of delivery, monetizing the value of conservation, and stimulating demand. Combined, these building blocks represent an agenda to drive conservation down a path to scale—an agenda that requires action from a number of stakeholders if we are to truly unlock the potential for conservation in the urban water sector.

Cities are drivers of stewardship for hundreds of miles around them. They shape the landscape, and in doing so end up defining a route of development for both themselves and their neighbors in rural areas. Water managers should extend their definition of water infrastructure to include the entire river systems and watersheds that their cities depend on, and incorporate investment in those watersheds as part of their normal toolkit of securing water for people.

For the one in four cities fortunate enough to have a positive return on investment, watershed conservation can likely be funded in-full by utilities through avoided costs in treatment. Here the challenge should not be securing adequate funds, but deploying these funds on investments outside municipal jurisdiction.

For most cities, it is unlikely to be cost-effective for utilities to pay the entire cost of water conservation. In these cases, cities should consider investing jointly with competing water users in a water fund, a process that establishes a financial mechanism to direct funds toward watershed conservation investments based on impartial science. Alternatively, cities can monetize the extended benefits of watershed conservation. While the multiplicity of benefits increases the chances of mobilizing funds, it also makes establishing a reliable payment model more challenging.

Securing adequate, clean water supply for cities is a global challenge that will require investment in both engineered and natural solutions. Cities that embrace both these approaches will not only meet future water demand; they will reshape our planet's landscape for the better.

nature.org/waterblueprint

1 in 4

One in four cities could see a positive return on investment from investing in watershed conservation

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IWA
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Worldwide Office
4245 North Fairfax Drive, Suite 100
Arlington, VA 22203

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