The Blue Marble by the crew of Apollo 17 (1972). Foto Ron Evans

Federica Mallone
Fabio Ranghino

Making Sense of the Most Essential Yet Undervalued Natural Resource

Last September, the mountain hut Quintino Sella, perched at 2,640 meters in the Italian Alps, closed down. It was the third time in 65 years. Twice before it occurred because of early snowfalls in late summer; this year it was due to drought and the resulting cost of hauling water up high. This location suffered from the inherent characteristic of water: it has no substitute. If not available for 3 days, people die. If lacking during irrigation season, food gets lost. If not potable, people get sick. Although our planet appears as a "Blue Marble" from outer space and water covers 71% of its surface, only 0.01% of fresh water is actually accessible and renewable. It is precious and essential.

Yet, society in the developed world generally undervalues it. We feel water is abundant and easily available in terms of quantity and quality, even when it is not. Four billion people, over half of the global population, experience water scarcity at least one month per year and 1.42 billion people live in areas of high water vulnerability. Today's climate change is upsetting the water cycle while unsustainable and polluting consumption patterns are threatening a prevailing false sense of security especially in the developed world.

As we prepare to deal with the long-term consequences of climate change, effective sustainable water management should be at the top of everyone's agenda. As both public and private management of water has shown weaknesses across the world, we debate in this *Ambienta Lens* how investors can contribute to improve water availability and quality by investing along the entire cycle.

The Water Cycle: How Water Brings Life on Earth

The availability of water has shaped human history and will determine its future. Although it covers 71% of the earth's surface, most of it is salty, and often unavailable when and where it is needed. Plus, we can't make more of it: all the Earth's water already exists in different forms (water, ice and vapour).

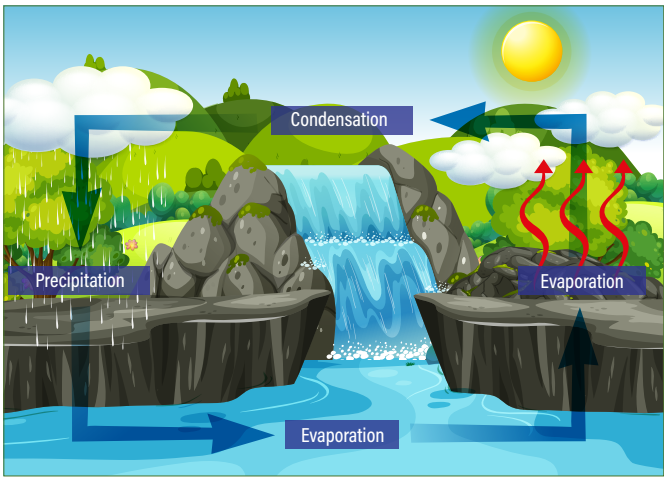
The water cycle is simple: it rains, water cumulates on land and/or in water basins (rivers, lakes, ...), then it evaporates and once up in the atmosphere it condenses and falls again. It thus connects glaciers to rivers and seas, and makes water available to vegetation and to living creatures. Understanding the water cycle helps us grasp major emerging environmental issues and how to address them through sustainable water management.

Fresh water accounts for only 2.5% of global water. Of this, 69% is locked up in glaciers. The rest, which represents the amount of potentially available fresh water, is mostly underground (30%) and a mere 0.3% flows on the surface, in lakes, rivers and streams.

Of the 11 Mn Km3 of ground and surface water, the vast majority (99.96%) is not renewable (it's so deep underground that it can't be replenished during the annual hydrological cycle), or not accessible (it's trapped too far below the surface or missing adequate infrastructure). Only a tiny share is both *renewable and accessible*, forming the Sustainable Water Supply (4,200 Km3), which is equivalent to 0.01% of global fresh water.

Maintaining supply at 0.01% of global fresh water ensures its future availability; withdrawals beyond this threshold upset the natural cycle of regeneration and result in water stress. Obviously, these are global figures. Water is a *local* resource: what is sustainably available in one area is often scarce elsewhere.

The Water Cycle



Climate Change

This scenario would be stable if climate were static. But it isn't. Climate has changed throughout history, turning water-abundant areas into deserts, and viceversa. Recent human activity is profoundly impacting the climate and inevitably affecting fresh water availability. Direct, immediate effects and long-term consequences are evident everywhere.

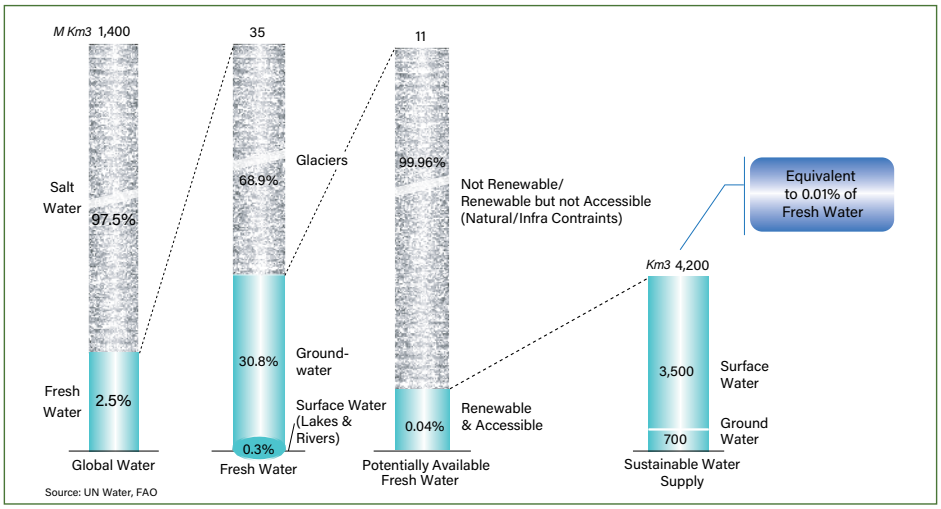
Direct, immediate impacts include:

Droughts have increased 90% in 20 years. As soil gets drier, it absorbs less water and sets in motion a process of desertification. The western basin of the U.S. and the Colorado River have already endured a decade-long drought; Asia, the Middle East and southern Europe have also become hot-spots.

Extreme rainfall causes significant damage to people and the built environment, while not expanding available water supply, since the soil has no time to absorb excess water. The devastation brought by severe precipitation in 2021 in Germany and southern Italy are recent manifestations in Europe alone.

Long-term impacts include depletion of glaciers.

Figure 1: Global Water Sources and Global Sustainable Supply



> "Melting glaciers already pose tremendous geopolitical issues."

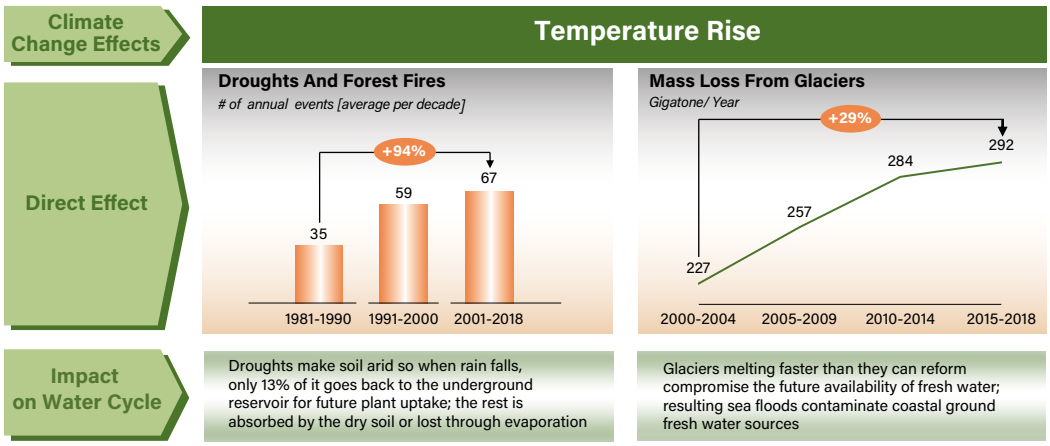
Glaciers, the most accessible inventory of fresh water supply, have been melting faster now than in 300 million years. Even if GHG emissions stopped today, the current temperature increase momentum would cancel 50% of them by 2100.

This phenomenon is critical since in the long term it causes a permanent decline of renewable and accessible water supply. Indeed, at first more water from melting glaciers flows into rivers, lakes and ultimately in the sea. Since it can take up to 3,000 years for a drop of salt water in the ocean to evaporate compared to two months for surface fresh water, the local water cycle is significantly impaired and river flow structurally declines as glaciers become smaller and smaller. After a decade or more, most of the water has ended up in the sea, whose level, as we know, rises. Plus, resulting higher sea levels and floods contaminate coastal ground fresh water reservoirs with salt water, further reducing renewable and accessible fresh water supply.

Melting glaciers already pose tremendous geopolitical issues. Thousands of Himalayan glaciers which feed hundreds of millions of people across China, India and Bangladesh are set to stop producing water by 2050. Ethiopia and Egypt compete over the Nile, Turkey and Iraq over the Euphrates, and many other ongoing tensions are examples of this phenomenon.

This is how the water cycle is threatened by climate change, but how is this connected to the global economy?

Figure 2: Climate Change Effects On Water Supply



Source: UN Water

Essential, Yet so Scarce. And Polluted. And Getting Worse

Ancient civilizations always prospered along rivers and in water-rich areas. Over time, we have managed water with little appreciation for how much of it we use and what a lasting impact we have on its availability. But a population of almost 8 billion people and a global economy of nearly $100 Tn forces us to change course. We face two extremely complex issues:

- **Increased water scarcity:** a 10% gap already exists between water withdrawal and sustainable fresh water supply as defined above. Every day, we compromise our future availability of water.
- **Decreasing water quality:** pollutants released into the water threaten water quality everywhere. 80% of municipal wastewater flows back into water bodies untreated, which means that contaminants from industrial and domestic use such as nutrients, metals and pathogens are not removed before wastewater is released into the environment. This alters ecosystems, threatens biodiversity and can permanently impair water usability for human or agriculture use.

These two issues are deeply interconnected. On one hand, scarcity of drinking and irrigation water could be triggered by pollution, which makes water unusable. On the other, a climate change-driven decrease in water source replenishment could create high concentrations of pollutants.

To grasp how and to what extent humans consume and pollute water, let's look at these two issues separately, and then highlight solutions

and related investment opportunities.

Increased Water Scarcity

We already withdraw 10% more water than we should. If the level of sustainable supply remains stable at 4,200 Bn M3 by 2030, the increasing need to withdraw water for domestic, industrial, and agricultural use in a "business as usual" scenario would expand this gap to 40% by 2030. Indeed, water withdrawal is projected to increase by 50% from the current level of 4,600 Bn M3 to 6,900 Bn M3 in 2030, based on population and GDP growth and no water productivity gains.

Today, agriculture accounts for the largest share, about 2/3 of global withdrawal. Industry represents 23% and domestic consumption 13%. Under the current scenario, all segments combined will drive the gap to 40%. Nonetheless, opportunities for efficiency exist in each segment:

- **Agriculture:** water is used for food for ourselves and animal stock. Even certain "healthy diets" have a big water footprint: in California, the annual almond production consumes three times as much water as what is needed to meet the drinking needs of the Los Angeles municipality. Decreasing meat demand and more efficient irrigation technologies can certainly provide considerable efficiency gains in this area.
- **Industrial & Energy:** 75% of water withdrawal for this segment is used to cool down turbines of fossil energy plants. The ongoing net transition towards renewables would allow cutting water use by 50%, according to the International Energy Agency's Sustainable Development scenario.
- **Domestic:** consumption is expected to grow by 12% due to population growth and greater water accessibility. Today, 28% of the global population (2.2 billion people) lacks access to safe drinking water and over 50% (4.2 billion people) does not have access to hygienic services. On the other hand, a U.S. citizen daily consumes 463 liters of water (50% for building heating and A/C), almost twice as much as a European and three times more than anyone else globally. Therefore, significant efficiency gains could be triggered through education and technology.

If mismanaged, people affected by water shortages globally will grow to 5 billion, and even areas which are relatively untouched today, such as southern Europe, will face enduring water crises.

Figure 3: Global Water Gap

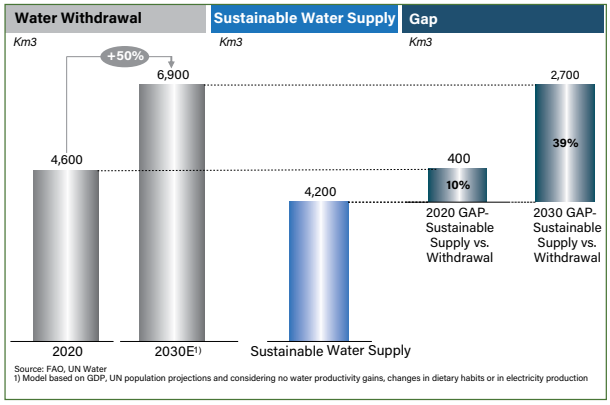


Figure 4: Global Water Withdrawal By Sector

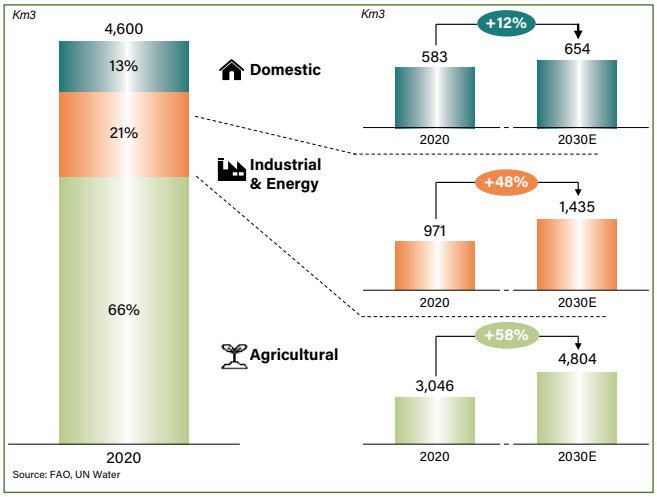
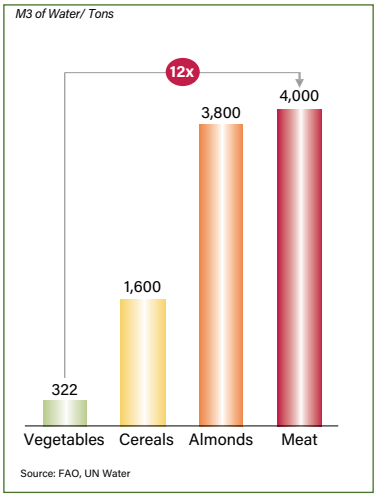


Figure 5: Water Required By Type Of Food Produced



Decreasing Water Quality

Water is polluted by all human activity. 80% of used water flows back into the ecosystem untreated, polluting fresh water sources. Pollutants originate from: organic sources, such as municipal wastewater or livestock; agriculture, which releases mineral residues; industry, which contributes practically every possible chemical compound, from the least to the most hazardous. Given the limited amount of space, we'll comment only on a few of the pollutants and their effects.

Agriculture is a major contributor to water pollution. Nitrogen fertilizers were crucial in producing boom yields in the last 60 years. Not surprisingly, fertilizer use grew 10 times from 12 Mt to 120 Mt in 2020. Unfortunately, up to 20% are washed away by rainfall and are therefore not absorbed by plants; they then accumulate in surface water causing eu-

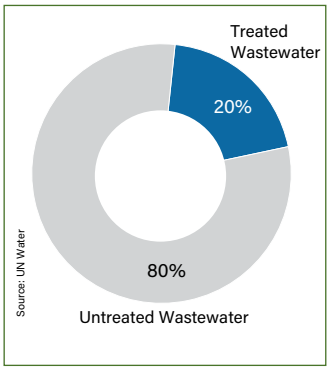
trophication, a dangerous algae bloom that blocks sunlight, depletes oxygen and thus kills sea life. Its manifestation in the Gulf of Mexico is only one recent example; eutrophication affects 54% of lakes in Asia, 53% in Europe, 48% in North America, 41% in South America and 28% in Africa.

Domestic and industrial wastewater can contain a wide variety of pollutants: organic components, pathogens, heavy metals, solvents or toxic sludge. Some could be absorbed back into nature, while others, like chlorine bleaches, can become persistent water pollutants. Some industrial wastewater, such as that by textiles (about 20% of all industrial wastewater), is well-known. But other types are not. Untreated releases from pharmaceutical companies in India are causing a proliferation of antibiotic-resistant bacteria. Even water chlorination, which is crucial for disinfection, if mismanaged, can cause disinfection by-products which are hazardous to health and the environment.

The spectrum of pollutants is infinite and grows as products develop. But since we cannot stop development, we need to manage it. We have a long way to go. So far, we have mostly relied on nature's ability to self-heal. But this is not enough: pollution-control actions and technologies must be widely implemented.

As the world further grows, proper management of water resources to grant long-term access and availability of safe and clean water is and will become increasingly crucial.

Figure 6: Global Wastewater



GOVERNMENTS AND REGULATION: THE ROLE OF REGULATORS AND A WAVE OF INVESTMENTS IN THE EU AND U.S.

The issues highlighted in this *Ambienta Lens* are well-known. Recently, regulators and governments in the EU and U.S. have been trying to tighten the control on water pollution and to promote investments to increase and protect water supply and expand water treatment facilities.

The EU's focus on these issues has been growing but is not new. The Water Framework Directive of 2000 set the goal of attaining 100% of water reservoirs in "good ecological status" by 2015. In 2018, only 40% of water sources respected this standard, so the objective was postponed to 2027. Other new measures were recently introduced. In January 2021, the revised Drinking Water Directive entered into force, creating 48 water pollution parameters to be monitored regularly. In parallel, a 20% reduction in fertilizer use was established by 2030. Plus, investments in water infrastructure became a cornerstone of the Green Deal: € 80 Bn annual investments by 2030 will be required above the current € 45 Bn. Individual country budgets and private capital will step in to meet the goals.

The U.S. Environmental Protection Agency (EPA) in 2021 released preliminary guidelines on upcoming rules regarding PFAS (per- and polyfluoroalkyl substances employed in different processes such as textiles and paints), under the Clean Water Act. The EPA will also set limits for drinking water. For example, the threshold for lead, which usually results from outdated pipes, is 0%. The U.S. network is aged and leaks the equivalent of 3.85 million swimming pools of water yearly. To address these challenges, in November 2021 the U.S. passed a $ 1.2 Tn Infrastructure Bill which contains provisions for $ 82.5 Bn for water investments.

Figure 7: EU Water Investment Gap

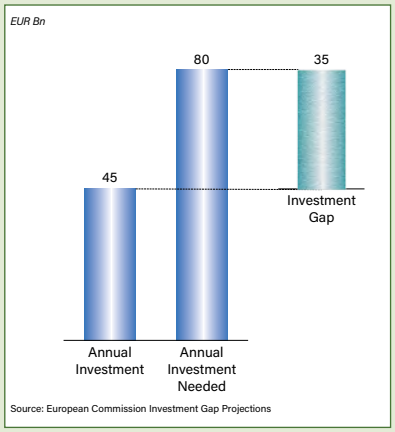
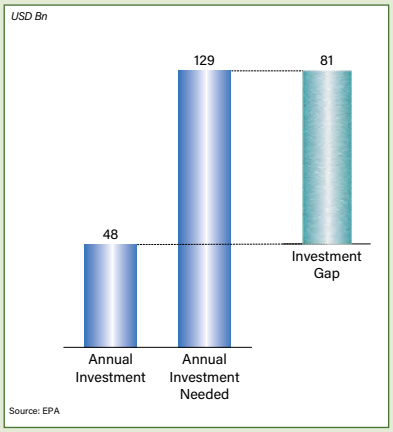


Figure 8: U.S. Water Investment Gap



Unlocking Water Management Investment Opportunities

Managing water is central to making it sustainably available. Areas with severe water scarcity (Israel and rich Gulf countries) are able to thrive through smart irrigation or desalination. On the other hand, the Congo, which receives lots of rain but lacks adequate infrastructure, experiences severe water stress.

> "Managing water is central to making it sustainably available."

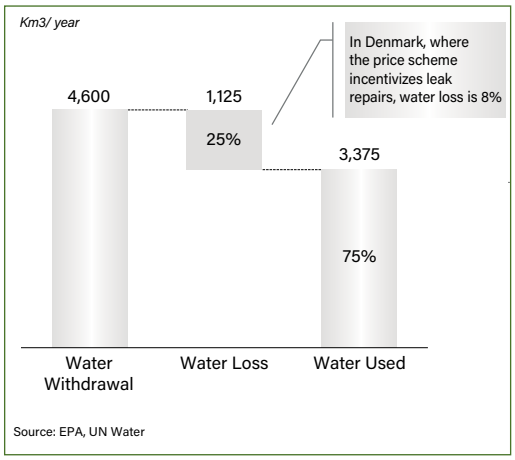
Unfortunately, managing water raises deeply-rooted questions embedded in a society's beliefs, values and ideologies. Is access to fresh water a basic human right that entitles us to have it for free (and paid for by the state) or should it be managed and distributed at a market-driven price (by public or private entities)? Adam Smith debated this question as early as the 18th century: why is water, a life necessity, priced lower than diamonds, a luxury? He concluded that when water abounds, an incremental amount of it is not deemed valuable, and its marginal utility is low. On the contrary, since diamonds are scarce, each additional one is valuable.

When half a billion people worldwide face water shortages, water's marginal utility should sky-rocket. Yet, water is generally not treated as a scarce resource. Especially in developed economies, decades or even centuries of water infrastructure history provide the illusion that water can be taken for granted. Hence, when the price of water is capped by public authorities, it barely covers the Opex of supplying it, and nearly nothing remains for Capex to address network upgrades or maintenance, as Figure 9 shows. A comparison: the Software industry revenue/operating cost ratio is 3.3x.

An average 25% of leaks in water supply networks globally is a prime example of how water is underinvested. But some virtuous examples exist: in Denmark, where the government ruled a Supply Water Tax, which is paid by utilities if leakages exceed 10%, the current level of water loss along the network is 8%. The price of water rose by 50% in 10 years after the tax was implemented in 1992.

Figure 9: Average Operating Cost Coverage Ratio

Figure 10: Global Water Network Loss



Is private water management the best solution? In the 1990's the UK privatized water utilities. Thirty years later, this move has been heavily criticized since limited companies have handed shareholders privileged cash flow rather than investing in the water networks.

Both private and public ownership have shown their limits. The disconnect between the price and the value of water is an unresolved issue that needs to be addressed in order to increase investments, close the water demand gap, provide access to underserved communities and protect water sources from pollution.

The good news is that current environmental and regulatory drivers are already supporting a large and healthy water and wastewater market, valued at about $ 740 Bn in 2021 and growing at a 7% CAGR. Ambienta has believed in the long-term hidden value of the water sector, first by investing in Spig in 2010, in Envirogen Technologies in 2012 and then in Caprari (recently renamed Wateralia), a leading private player in water pump manufacturing, in 2021.

CAPRARI

In February 2021, Ambienta invested in Caprari, an Italian leader in centrifugal pumps. Caprari pumps are used in Agriculture, to extract water from the ground for irrigation purposes, and in Water & Infrastructure, for clean water and wastewater treatment systems.
Pumps play a critical role in improving water resource efficiency and enabling pollution control. New generation pumps enable energy savings and increased water management accuracy. Plus, Caprari pumps used in treatment facilities and sewage systems contribute significantly to wastewater management.
Ambienta's *Environmental Impact Analysis* assessed the overall amount of water treated by Caprari as equivalent to that in 800,000 swimming pools.
We expect that growing awareness of water stress among farmers and the renovated attention to water infrastructure upgrades will drive interest in water investments (+5% CAGR in 2020-2025), which will benefit the growth of Caprari and unlock positive environmental impacts.

Ambienta assesses investment opportunities along the entire water management cycle for different asset classes, according to the most suitable risk-return profile. Indeed, unresolved water pricing mechanisms described above will affect, directly or indirectly, all investment cases.

Summary of Key Findings

Supply – Alternative Ways To Supply Water

Desalination projects have gained traction since the cost of desalinated water has come down by 50% over the past 30 years. As a result, global desalinated capacity has increased from 20 m3/day in 2000 to 95 million m3/day in 2020 (+17% CAGR). Of the two existing types of desalination processes, thermal and reverse osmosis, the latter is the less energy-intensive and thus more attractive and sustainable. Even if plant construction businesses are too volatile for some investors, plant components, such as membranes, which need to be replaced every 1-2 years, provide a less bumpy investment case.

Treatment and reuse of water could also contribute to protect fresh water supply. Large industrial players in water-intense sectors, such as textiles, attracted by cost-saving opportunities and the possibility to claim a reduced environmental impact, have already implemented wastewater reuse. But opportunities are ample, given that in Europe only 2% of treated water is reused. Domestic water reuse is marginal but solutions are gaining ground and are becoming increasingly integrated into new projects. Even start-ups like the Dutch Hydraloop, founded in 2016, are tackling the issue: it commercializes a system for decentralized water recycling that allows to reuse water by 85%.

Increased water reuse will require managing greater volumes of sludge, a residue of wastewater treatment which is rich in nutrients and substances. Today in Italy about 56% of sludge ends up in landfills. Alpha Laval, a Swedish listed player,

offers a full range of equipment for filtration and sludge treatment which uses solid liquid separation technologies. These help to maximize sludge reuse, mostly in the form of fertilizers or biofuels.

Distribution – Increasing Efficiency Along Water Networks

A faster pace of water network renovation will be driven by increased awareness of water scarcity risks, network leakages and the larger availability of government funds. Opportunities exist both on the public and private side. Water utility players will play a critical role and are closely monitored by Ambienta, especially in view of the benefits inherent in the Sustainable Infrastructure Income Fund, one of Ambienta X's new funds. U.S. utilities in particular, due to a more straightforward risk-return profile and investment case, will benefit from the new $ 82.5 Bn U.S. Water Infrastructure Fund (see Box on Governments & Regulation).

Network renovation will also favour equipment manufacturers (pipes, pumps, valves), especially those which have extended their offering into digital solutions that allow for remote control and network monitoring. For instance, leakage detection, critical to cut the 25% water loss along pipelines, can be performed through different

technologies that equipment manufacturers have started to provide to utilities. In June 2021, Mueller, a leading U.S. listed player supplying valves for water infrastructure, bought into i2o water, a UK provider of Data Analytics systems, to identify leaks thanks to data input from flow sensors. Suez, a French listed player currently under acquisition from Veolia, has started to offer advanced satellite leakage detection services through its water management division.

Consumption – Monitoring Quality And Quantity
Water meters will be critical to drive point-of-use efficiency across segments. The replacement of old meters (AMR- Automatic Meter Reading) with those based on new technologies driven by continuous data flows enabled by IoT connectivity (AMI- Advanced Meter Infrastructure) will yield a +22% market CAGR for the next years. U.S. listed player Badger Meter is a leader in the space and its 50x PE valuation fully reflects that. As meters hardware technology is mature and does not provide a solid entry barrier, public and private players that show a more advanced offering of software and data analytics will have a higher competitive advantage.

Stricter regulation and consumer awareness regarding drinking water safety drives growth opportunities for players active in household drinking water filtration. Pentair, a U.S. listed player, offers water filtration and disinfection systems for industrial and domestic applications, showing attractive margins and reasonable valuations. In the private space, market fragmentation in providers of tap water filters may still offer consolidation opportunities, even if product entry barriers are not rock-solid.

Conclusion

We cannot replace water in our life. We are made of water. Solving water scarcity and water quality issues on a global scale is a pre-requisite for all sustainable and peaceful global development. We all should strive to solve it. At Ambienta, we are committed to contributing to this goal through our investment approach and by increasingly addressing these issues.

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ABOUT AMBIENTA *Ambienta is a European environmental sustainability investor across private and public markets. Operating out of Milan, London, Paris and Munich, Ambienta manages over €1.5 billion in assets with a focus on investing in private and public companies driven by environmental megatrends and whose products or services improve Resource Efficiency or Pollution Control. In private equity Ambienta has completed 45 investments to date and in public equity markets, Ambienta has pioneered the world's first absolute return fund entirely focused on environmental sustainability.* ***www.ambientasgr.com***