



The business case for
RESILIENCE

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Foreword

In today's uncertain world, resilience has never been more important. The ability to overcome shocks and stresses, to cope with uncertainty and to be prepared for whatever challenges the future brings, applies just as much on a personal level as it does to governments, businesses and other societal institutions. And in a world that is increasingly urban – with buildings and other assets being operated in inter-related and inter-dependent systems that keep the wheels of society turning smoothly – resilience is an essential quality to have.



Piet Dircke

Global Leader, Resilience & Water Management - Arcadis

July 2019

Although resilience is often framed within the context of disaster or distress, at Arcadis we believe that resilience provides an overwhelmingly positive opportunity for the world. By embracing a resilient approach, national, regional and city administrations can improve quality of life for citizens, while business leaders, shareholders and stakeholders can improve not only their bottom lines but also the lives of those in the communities around them.

Throughout our work delivering significant resilience projects around the world, our goal is to help clients reduce the gap between resilience planning and resilience implementation. We help them by exploring the following questions:

- Where and when should we invest in resilience?
- Where can resilience investments add the most value?
- How can we reap both short and long-term benefits?
- How can we move from risk identification to starting actionable projects?

At Arcadis, we believe city officials, business leaders, investors, transportation and utility operators and other asset owners should place resilience at the heart of any planning process.

We are encouraged that so many major organizations and international cities have begun embracing this way of thinking. More and more, public and private sector actors are starting to see resilience as a fundamental part of the social contract, under which all institutions operate. By taking a proactive approach, our clients can improve their performance, help safeguard their assets and society from risks, and help ensure quicker recovery, as and when disruption or disaster strikes.

We are also seeing the social value of resilience rising on the agenda, as it becomes clear that true resilience also includes ensuring fairness and equality for citizens and their communities.

Ultimately, we are excited by the many opportunities that being resilient brings to improve quality of life and we look forward to exploring these opportunities with you.

What is resilience?

There are very few places in the world where resilience isn't a hot topic. Most of us have experienced the effects of some of the major trends, such as global climate change, but being resilient is more than being able to withstand natural disasters and extreme weather events.

An unprecedented number of people will call cities home in the decades ahead, placing cities at the frontlines of the 21st century's greatest challenges. Since the world's first Resilience Strategy was unveiled in New York City in 2015, cities worldwide have undertaken ground-breaking work in areas such as participatory governance, water management, transportation, data and technology, and climate mitigation and adaptation. Now is the time for concrete, collective action. By adopting a resilience framework, cities can create a strong future for all.



Michael Berkowitz
President
100 Resilient Cities

A commonly used definition comes from 100 Resilient Cities (100RC), pioneered by The Rockefeller Foundation, a nonprofit organization, which helps public and private sector actors, as well as citizens, become more resilient. 100RC, of which Arcadis is a platform partner, has played a critical role in supporting cities to change their approach to planning and design, with the potential for improving the lives of billions of people who live in urban centers worldwide. 100RC describes resilience as “the capacity of individuals, communities, institutions, businesses, and systems within a city to survive, adapt and grow no matter what kinds of chronic stresses and acute shocks they experience.” This includes preparing for challenges or disruptions caused by cyber threats, immigration and urbanization, and major shocks to financial systems.

At Arcadis, we believe that resilience is a quality that also encompasses societal resilience. Resilience is as much about better-educated citizens, strong democratic institutions, and economic stability as it is about solid and reliable physical infrastructure.

But this still leaves a crucial challenge for resilience planning:

How to make a business case for investing in resilience solutions?

In this paper, we explore answers to this critically important question and demonstrate how we have helped clients move from strategy to implementation of projects that enhance resilience.

Already, over half of the global population is urban – accounting for around 80% of global GDP – and with such a high concentration of people and wealth, the potential impact of major resilience events is enormous. This is why we have concentrated our attention in this report on cities, industries, utilities and mobility – including the financial and digital systems and activities that support them. A resilient city is better able to deal with shocks and stresses, and a well-educated, healthier and more prepared community is undoubtedly better equipped to deal with whatever the future holds.



Enablers for resilience

We have identified four approaches that underpin our efforts to help clients achieve resilience. These are:



HUMAN-CENTRIC
emphasizing the importance of healthy people and communities for a resilient city.



NATURE-BASED
an ecosystems approach which is at the core of Arcadis' heritage and plays an essential role in resilience.



FINANCIAL
Financial, technical, and value engineering are all tools to help find cost-effective solutions. And financial institutions are concerned about resilience in their work and their own assets.



DIGITAL
namely using data and digital platforms to optimize resilience solutions.



Resilience vs. Risk Management

So how should we explore the resilience opportunity, balancing the fulfillment of our immediate priorities with the need to prepare for the disruptions, stresses and shocks that are more and more common in our world? How should resilience planning be approached? And is this all merely about managing risks?

Risk management is an important part of resilience planning – after all, to be resilient you need to plan for risks of all kinds. But, to explore resilience solely within a risk framework is a missed opportunity. Within traditional risk management, if an event is very likely to occur and the impact significant, you would prioritize actions to address this risk, but potentially de-prioritize actions if the likelihood were lower. Within this framework, it can often be difficult to justify investing in a solution to a challenge that may not happen for a long time – if at all.

We believe good resilience planning goes far beyond a discussion of probabilities. For Arcadis, resilience is a quality that reflects the reality

that society is increasingly interconnected – a system of systems – where quality of life and community engagement are just as important as robust flood prevention systems and dependable transportation networks. Within this more holistic framework, resilience planning provides the opportunity to add value, while also reducing risks.

Where theory meets reality

Intellectually, this feels correct, but the challenge remains that today’s political and commercial environment often encourages city-leadership and business executives to focus on, short and medium-term factors, at the expense of longer-term resilience planning. This state of mind changes once a risk becomes a reality. When that happens, even if the chances of a repeat are low, questions from concerned citizens, investors and stakeholders move the debate into a more robust resilience space: “Why were we not better prepared, and why wasn’t this foreseen?” Good resilience planning is therefore about reframing the conversation around the intrinsic value that can be created.

The financial case

This topic arises in conversations with clients all around the world, particularly as resilience often requires additional resources and more ambitious plans – or a quicker timetable for implementation. This can lead to higher costs, which opens up discussions about the economic returns of resilience-based solutions. Of course, there are asset classes where long-term returns are more usual, such as transport infrastructure and city regeneration projects. Redeveloping a city district, a waterfront, or a major transport hub, for example, involves creating infrastructure assets that need to survive a long time and resilience planning will more naturally play a part. But the question of short, medium and long-term economic returns is an important one.

Reframing the challenge

At Arcadis, we believe it’s important to encourage cities and industries to think differently about traditional return on investment. Doing so typically lights a path to a compelling business case for resilience. And by going one step further and reframing it within the context of delivering efficiencies – through collaboration – the discussion moves into an even more positive framework, where opportunities to create competitive advantages can be identified. By becoming resilient earlier than a business-as-usual approach, your city can become more competitive against other cities or your business can outpace industry competitors. This means that, as strategic consultants, we can minimize talk of ‘possible future losses’ with clients and keep the conversation within the realm of competitiveness challenges of the here and now.

Social resilience

Resilience extends beyond the boundaries of your premises, your district, your catchment area. It’s a quality that also includes a diverse, well-educated, healthy and well-informed community.

Under this way of thinking, a fortification around physical assets doesn’t deliver adequate resilience, not least because in the event of major flooding or an extreme weather disaster, employee homes may also be underwater, impacting public transport, or the delivery of electricity, clean water, or telecoms services. Resilience is therefore not only a personal responsibility, but also a collective one, which includes resilient citizens. Social resilience can only be reached with an inclusive approach.

Collaborate above all

A social resilience mindset can result in greater collaboration, where mutual benefits can be understood and seized by working in partnership with other organizations and stakeholders. One example is the Rebuild by Design program, launched by US President Barack Obama following Super Storm Sandy in New York. This initiative, shaped as a design competition with strong community and stakeholder involvement, aimed to develop more regional, integrated, fundable, sustainable, and innovative solutions to better protect residents, businesses and infrastructure from future climate events. The results were groundbreaking and highly acclaimed, with the outcomes having the potential to reshape the resiliency landscape. In this way, cities can create the physical infrastructure to protect against the effect of shocks, while helping citizens achieve social resilience.

Resilience - From strategy to implementation

We’re proud of our implementation expertise at Arcadis. We have been working on resilience projects throughout the world and understand the assets, technologies, business rationales and the financial case for embracing resilience. To make the journey towards urban resilience more accessible, we have developed a methodology that we call the resilience pathway, which takes clients through five steps to success.

3

Prioritization

Guiding decision makers on where to invest and how to prioritize, to ensure full commitment from the complete stakeholder community

5

Implementation

Investment solutions from citywide to neighborhood-level need to be prioritized and delivered, along with an asset management and monitoring plan.

This is also a methodology that we use in our Bankable Resilience Tool (BaRT), which helps us identify the benefits of resilience options for a broad range of stakeholders (See chapter 6: Finance and Resilience).

1

Scoping

Identifying the areas of vulnerability. When planning a city program, there must be an integrated approach to connect designers, planners, engineers, developers and financiers to reach a consensus on the issues to focus on.

2

Optioneering

Bringing high-level engineering and financial thinking to find promising, bankable and feasible business models around a development or adaptation solution – all leading to an Investment Opportunity Report. This is where commitment from stakeholders is also critical

4

Deal structuring

Funding and financing strategies need to be identified with an output of projects with an acceptable risk-return profile

Resilience is an evolutionary process – it is never complete. In the same way that humankind had learn how to improve quality of life, while coping with unpredictable disruptions and other perils in nature, so too must we now learn to do the same within our modern cities and communities around the world.

City resilience

With over half of the world's population living in urban locations, city ecosystems work best when economic, ecologic, social and physical infrastructure operate together efficiently and in harmony. But for cities to survive, adapt and grow, they need to be resilient for the benefit of everyone living and working there.

To navigate the challenges they face, cities increasingly will have to invest in adaptation projects that improve their resilience and safeguard communities, businesses, utilities and assets against the impacts of shocks and stresses. They will also need to demonstrate that they understand the wider benefits of promoting societal resilience.

Putting it into practice

In our resilience work, we have learned that there are a number of common issues that can be applied to most cities that need to invest in resilience:

In a resilient city, "the show must go on"

City resilience is all about ensuring that the urban environment remains livable and enjoyable for residents and visitors. This is why in the US, New York City is including the safeguarding of public services as part of its city-wide flood protection. Alongside its most critical public infrastructure, like public transport, tunnels, water and electricity, the city is also making hospitals and other public assets resilient. Additionally, businesses

are being encouraged to invest in protecting their premises and production processes to protect business continuity.

Investing in flood resilience pays off

Proactive approaches to water resilience include not only solid flood protection and drainage systems, but also solutions such as multifunctional flood protection structures, floating water pavilions and attractive water plazas. Investments like these can help cities become water resilient, with a thriving economy and attractive, functional cityscapes.

Multifunctional solutions are essential.

When combined with other urban functions such as parking, transport, recreation and tourism, resilience enhancing measure can increase the value and attractiveness of these investments. By also including nature-based solutions – such as ecosystems-based functions – precious urban space can be protected and can increase the feasibility of such solutions for cities to implement.

Resilience should include an integrated, multilayered approach

All public and private stakeholders within cities should be prepared to interact and share knowledge between themselves and their local communities. Because resilience requires redundancies and the combination of large- and small-scale measures, the alignment of decision makers and community leaders at all levels can help accelerate implementation.

Involve communities and citizens

Communication with all affected parties is an important component of urban resilience. The use of social media and other digital developments can foster community participation, encourage reflexive learning, and can help steer resilience projects towards the most appropriate solutions. Raising awareness among citizens is essential for improving community resilience and increasing preparedness.

CASE STUDIES

Here are some current examples of major city resilience projects Arcadis has underway around the world.



NEW ORLEANS, USA

In response to the carnage caused by Hurricane Katrina in 2005, the U.S. Army Corps of Engineers (USACE) constructed a \$14.5 billion (USD) Hurricane Storm Damage Risk Reduction System that demonstrated its efficacy in August 2012, when Hurricane Isaac struck the Mississippi Delta. This time, New Orleans remained safe, resulting in a 100% return on investment within one year, probably the most successful resilience project in history. Arcadis performed more than 150 task orders, contributing to this success:

- Designing the world's largest storm water drainage pump station at the Gulf Intracoastal Waterway West Closure Complex;
- Planning, project development and program management of Inner Harbor Navigation Canal (IHNC)'s Lake Borgne Barrier, one of the world's largest storm surge barriers, and, also the largest civil works design-build contract ever awarded by the US Army Corps of Engineers;
- Designing the navigable Seabrook Flood Gate Complex, providing flood protection and waterway navigation between Lake Pontchartrain and the IHNC.



WUHAN, CHINA

The Sponge City program in Wuhan, China, was established in response to the revelation that the number of Chinese cities affected by flooding has more than doubled since 2008. Wuhan is often subject to intense rainfall that overwhelms the urban drainage system, putting its 12 million residents at risk. The name Sponge City refers to the innovative solution of creating green public spaces to absorb storm water, making cities more resilient to the impacts of climate change, while also making them more attractive and livable. Arcadis has supported the Wuhan Water Authority in assessing plans and projects in two pilot districts. Over 300 projects are planned in these two pilot districts, in three years, with the goal of managing 60% of the rainwater. This effort will also serve as an example for how other Chinese cities can become more resilient in the future.

Earthquake Resilience

Resilient cities are also able to cope with earthquakes. Arcadis has worked on several signature earthquake resilience projects over the last years.

In Groningen, the Netherlands, Arcadis is working to address earthquake damage, the result of natural gas exploitation in the area. These quakes impacted thousands of homes, businesses and families. As earthquakes may also have an impact on the stability of the levees in this area, Arcadis developed a plan to accelerate four levee reinforcement projects.

For the Port of San Francisco, Arcadis works as part of a team of consultants on the design and engineering for the iconic 10-year San Francisco Seawall Resiliency Project. Arcadis is leading risk analysis, coastal engineering, and modeling. The major drivers for making significant improvements to the seawall include earthquake protection enhancements and flood

risks caused by climate change. The seawall supports historic piers, wharves, and buildings including the Ferry Building. It underpins the Embarcadero Promenade which welcomes millions of people each year. The seawall also serves as a critical emergency response and recovery area, and it supports multiple municipal transportation systems and utility networks.

Industry resilience

Businesses have many of the same resilience challenges facing cities. In North America alone, over 1900 industrial chemical sites are estimated to be at risk due to extreme weather conditions. Recent superstorms such as Hurricanes Sandy in New York and Harvey in Houston brought industrial production sites to a standstill, leading to billions of dollars in lost revenue. Catastrophic events such as this focus the mind, but the resilience challenges are greater than just dealing with extreme weather.

Businesses are very focused on the short-term risks, such as production processes, short-term pricing and supply chain security. Cyber security is also increasingly important, as is energy independence.

Meanwhile, investments in resilience to protect against major events such as floods or heat stresses are hindered by the uncertainty around whether there will be a return on investment. Despite this reluctance, there are compelling drivers for embracing resilience, including the financial benefit of engaging with insurance companies. Insurers are becoming keener to have conversations with clients about the benefits of taking a more resilient approach, which can be reflected in lower insurance premiums.

Putting it into practice

In our work with major clients around the world, we have identified the following major challenges, which impact on an industrial resilience:

Business continuity

This is perhaps the biggest driver for our industrial clients. If the production lines are closed for an unexpected reason, millions of dollars can be lost each day. Challenges also include storage of raw materials, chemical storage, protection against flooding, environment risks, and pollution.

Supply chain protection and resource scarcity

These two interconnected issues are a close second in terms of the risks keeping CEOs awake at night. Businesses need assurances that their supply chain is resilient – it is only as strong as the weakest link in the chain. Geopolitical issues come in to play here, as does access to raw materials and energy.

Public and market perception

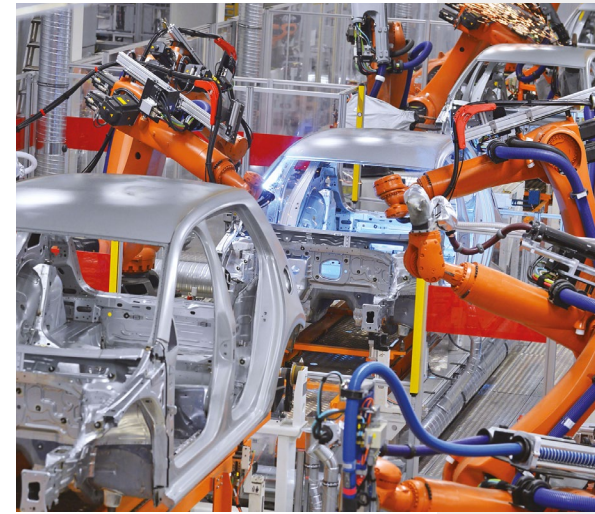
Public perception creates very real resilience challenges. Brand protection is enormously important, affecting shareholders, stakeholders of all kinds, and the community in which businesses operate and within which their employees make their homes. This impacts upon financial resilience, not only in terms of attracting capital but also selling products on the market. Businesses also want to avoid costly litigation, which could follow if, for instance, chemicals or harmful materials were released because of a shock, like a flood or major storm.

Short term needs vs. long term ambitions

Resilience plays an important role in the tension between short term issues of return on investment versus any long-term ambitions to be sustainable, profitable, and grow the business. In the short term, return on investment is a major concern because margins are often low and if fixed costs rise or profits take a hit, then the business will have major resilience issues.

CASE STUDIES

Here are some current examples of major industrial resilience projects Arcadis has underway around the world.



GENERAL MOTORS IN MEXICO

General Motors (GM) runs a production facility within the Guanajuato region of Mexico, an area with considerable water stresses. In line with GM's commitment to reduce water use across its operations by 15% by 2020, the company needed innovative solutions to conserve water at this facility, making it more sustainable and less vulnerable to the chronic stress of water scarcity in the vicinity. Arcadis conducted an audit to understand exactly how water was being used and developed designs for reducing water use. Our solution was based on optimizing and upgrading the on-site wastewater treatment plant, including a micro-bio reactor (MBR) and a three-stage reverse osmosis system. As a result, GM's facility now uses around 900,000 liters (around 238,000 gallons) less water each day – more than 329 million liters (87,000,000 gallons) saved each year. This effort has already enhanced this facility's resilience and improved quality of life for people living nearby, as GM now has a much lower demand for water from the stressed wells in the region



CONFIDENTIAL CHEMICAL CLIENT, THE NETHERLANDS

As a result of heavy rainfall, the basement of one of the largest pharmaceutical factories in the Netherlands was flooded. The rainwater collected at the lowest parts of the site with tens of centimeters of water flowing against the facade. Large quantities of stored medicines were destroyed. The site is situated relatively far away from open water, which hinders quick drainage. There are also several warehouses and loading docks in a recessed bay, which are vulnerable to extreme rainfall. Arcadis measured the ground level of the entire industrial site. Based on this information we executed a stress test, indicating the assets that were at risk. This data informed our design of an upgrade to the sewer system and a groundwater management system that keeps the groundwater level under the basement floor level, which will make this site resilient and able to cope with a once in 25 years rainfall event. The proposed plan will also prevent the spread of any groundwater contamination on the site.

Resilient utilities

We depend upon utility companies for some of the most vital services that keep our daily lives functioning smoothly, and their biggest operational concerns are to ensure uninterrupted public services and the continued protection of their assets. Although utility companies are often most comfortable taking a risk-based approach to resilience, we encourage our clients think of resilience as a quality, with impacts which go way beyond the physical boundaries of the utilities' sites or the services they offer. Utility companies need to take appropriate measures to mitigate the risks in asset management programs, but they also need to explore the value-added benefits of becoming a truly resilient.

Putting it into practice

In our work with major clients around the world, we have identified the following major challenges, which impact on a utilities' resilience:

Assessing the risks

One of the tools that we use is a resilient utilities index that Arcadis has tailored to help the UK's water industry. The index helps assess resilience risks, understand the effectiveness of existing resilience controls, and prioritize where and how to invest for more resilience. As an index, it enables comparison and benchmarking within each utility and between different utilities.

Redundant redundancy

The resilience assessment process can often reveal some unexpected outcomes. For example, some organizations will focus on building redundancies into their operations in the belief that redundancy is synonymous with resilience. But that's not the only response to a resilience challenge. And there are instances where a myopic focus on redundancy has compromised resilience, as this led the utility companies to take their eye off maintenance efforts or response and recovery capabilities.

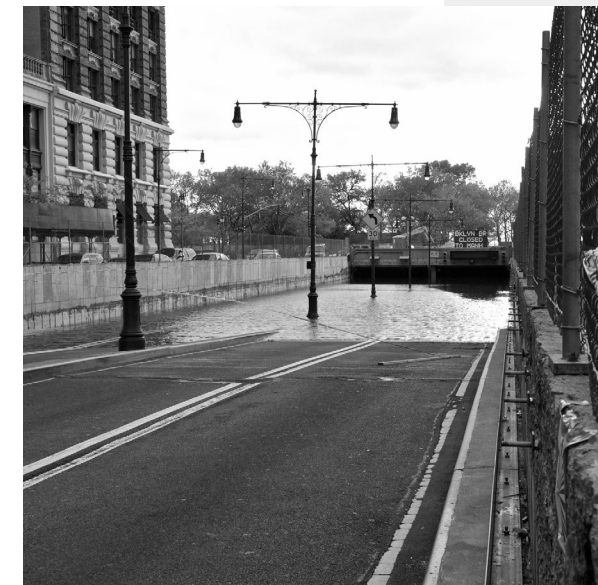
CASE STUDIES

Here are some current examples of major mobility resilience projects Arcadis has underway around the world.



DOHA POTABLE WATER RESILIENCE

The fast-growing city of Doha, the capital of Qatar, faces limited water resources, providing a challenge for its increasing numbers of citizens and tourists. The current water supply system can store only two days' worth of water and any drought has the potential to create a serious water crisis in the city. To increase Doha's resilience and water security, Arcadis is helping in building the first-of-its-kind mega reservoir project. The project will allow Doha to store 15 million cubic meters of potable water, increasing the city's water supply security from two to seven days. The mega reservoirs will be the largest of their kind in the world. With a full week of water security, Doha's citizens and businesses will have a more efficient, secure and resilient supply for the future.



TELECOMMUNICATIONS AFTER SUPERSTORM SANDY

During Superstorm Sandy, a large telecommunications firm saw its major facilities in lower Manhattan, New York, completely flooded, causing a total communications blackout in NYC. Their headquarters had nearly a meter (three feet) of water in the lobby, which took out equipment that served Wall-Street and led to billions of U.S. dollars in economic losses. After the storm, the telecom company engaged Arcadis to survey the damage, assess the recovery efforts and recommend options to increase the company's future resilience against flooding. Working together with our client, we developed both a short and long-term approach for the company's landmark buildings and facilities, to protect the assets from future storms. This work included planning, design, permitting and construction supervision of permanent solutions to meet the company's long-term needs. The solutions included; temporary sandbag techniques, freestanding flood barrier walls, deployable building integrated flood barrier walls, dry side pumping systems, building penetration solutions for louvers, and alternative staircase access.



SÃO PAULO WASTEWATER UTILITY RESILIENCE

In São Paulo, irregular urban settlements and inadequate housing programs lead to untreated sewage being drained into the river and high levels of pollution. The megacity is vulnerable to weather extremes in general, as well as pluvial and riverine flooding and drought. For the São Paulo State Sanitation Company (Sabesp), Arcadis worked on recovering the remaining floodplains of the Tietê River and transforming them into a linear park and recreational area for the urban population. The park also reduced the flood risk in the eastern zone of São Paulo. Arcadis provided management and technical support in the São Paulo Water Loss Reduction Program. Arcadis helped Sabesp deliver infrastructure for improving water quality and access, by connecting additional households to the sewer system and increasing the volume of sewage treated.

Resilient mobility

Mobility plays a critical role in society, facilitating the movement of people, goods and services. For Arcadis, the types of activities included in mobility services include airports, public transport, rail and roads, but a useful way to characterize the sector is to identify those who own mobility assets, and those who operate them. Although the interests of both may differ, owners want to protect the value of their assets, while operators want to ensure uninterrupted public services. Both owners and operators face challenges related to climate change, extreme weather, aging infrastructure, natural and man-made disasters, and cyber threats.

One of the ways in which we're helping mobility clients tackle resilience is by encouraging them to adopt a methodological approach to resilience management, including:

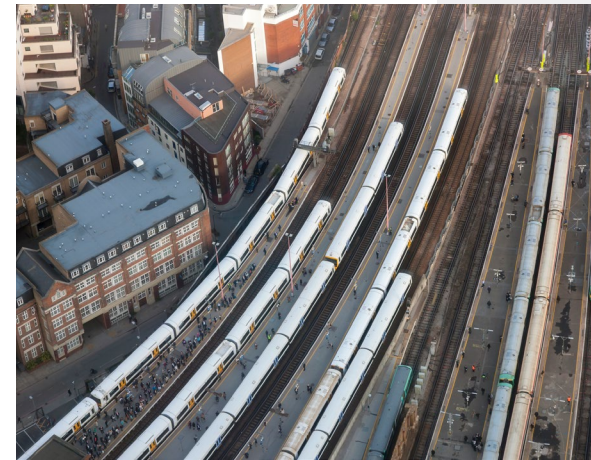
- Maintaining, rehabilitating and recovering existing infrastructure
- Identifying assets susceptible to past and future events and to potential vulnerabilities (determining their exposure and sensitivity);
- Assessing and prioritizing risks according to the level of risk probability (the likelihood of future impacts) and severity (the consequence of the impacts);
- Identifying those assets that are approaching the end of their design life;
- Adapting existing transport infrastructure to the consequences of climate change and the associated increases in extreme weather events;
- Retrofitting or building new resilient transport infrastructure.

Moving beyond immediate risks

Mobility clients understand their day-to-day risks very clearly and are very focused on delivering their services safely. And while the increasing use of digital tools in the management of transport infrastructure is introducing new cyber-terrorism risks, it's also introducing new efficiencies. Resilient mobility is not-only about ensuring service availability during or after a major shock event, it's also about recognizing and enabling the positive impact of a transportation system on a city. At Arcadis, we work across the mobility space to help clients create the right framework and find positive reasons for investing in resilient transport infrastructure.

CASE STUDIES

Here are some current examples of major utilities resilience projects Arcadis has underway around the world.



LONDON BRIDGE STATION REDEVELOPMENT, UK

As part of our work helping to remodel and reconfigure the UK's fourth busiest rail station, London Bridge, Arcadis also contributed to making the site more resilient to terrorism. Working with the feasibility stage security report, which was a classified document, Arcadis produced designs for the areas around the station that were vulnerable to terrorist attacks. Arcadis designed the station to enhance resilience and ensure that if an attack took place, the station would be operational again as soon as possible. Much of the specific work done cannot be revealed for obvious reasons but Arcadis submitted designs for global resilience of structural elements, which were independently reviewed by a specialist blast team, which modeled and analyzed the design and confirmed that it would increase resilience.



TRANSIT ORIENTED DEVELOPMENT, HONOLULU, USA

Arcadis successfully completed an in-depth climate adaptation assessment for Honolulu's most challenged coastal industrial redevelopment zone between the tourist hub of Waikiki Beach and the Port of Honolulu. This was undertaken as part of Arcadis' 100 Resilient Cities membership. The objective for the city was to understand how best to climate-proof and redevelop the under-utilized land around the projected \$1.5bn Transit Oriented Development corridor. Aging infrastructure paired with extensive soil contamination is prompting the city to invest. At the same time the city is targeting 15,000 new housing units around the new railway stations to facilitate its growth ambition. The Arcadis team provided climate data insights, facilitated design charrettes, explored design alternatives and presented a multitude of adaptation strategies that can help transition the area to become more climate resilient.

Finance and resilience

Resilience has a significant impact on the financial sector. Banks, pension funds, insurance companies and investors are concerned about the impact resilience issues will have on their own assets and talk to us about their need to manage risks. Over time, more investments in resilience measures will be made, reducing the impact or probability of hazards, therefore reducing risks.

But the financial sector is also essential for enabling resilience, by holding their investees accountable for environmental, social and governance (ESG) performance, as well as financial performance. Financial services companies have a role to play in encouraging resilient behavior in those who need investment capital and by proactively funding resilience projects.

This is crucial because, wherever we work in the world, we see first-hand that there is a gap between city planners who are looking for funding for resilience projects, and those investors looking for resilience projects they can finance as a socially responsible and sustainable, but also profitable investment opportunity.

The challenge is that resiliency projects don't often meet the specific terms of investment funds – like the expected direct benefits or tangible returns – and it can be hard to show the anticipated monetized values of a resilience project. As a result, we work hard to bring stakeholders together – investors and planners – as early as possible to increase the success rate for financing resilience projects.

Financing resilience

Arcadis has a full range of financial expertise, in-house, and has helped a broad range of clients in the finance field, combining financial engineering with technical engineering to identify the most cost-effective means of adaptation, and value engineering. Examples include successful grant applications for large resilience projects such as the Health & Hospitals Corporation in New York City.

Arcadis has also joined the Task Force on Climate-related Financial Disclosures (TCFD), whose aim is to develop and implement long-term decarbonization strategies, phase out fossil subsidies by 2025, put a price on carbon to help develop business models that keep global temperature rises well-below 2°C, and focus on standards to enable climate-related financial risks and opportunities to be measured.

Overcoming finance barriers

One of our most important roles within the resilience space is to help cities, stakeholders and industries overcome finance barriers. By connecting the financial sector with the urban development sector, we can overcome one of the biggest challenges to resilience projects today: proving that resilience investments can create significant benefits. By doing so, we can frame the discussion around becoming resilient earlier, faster, and with more ambition.

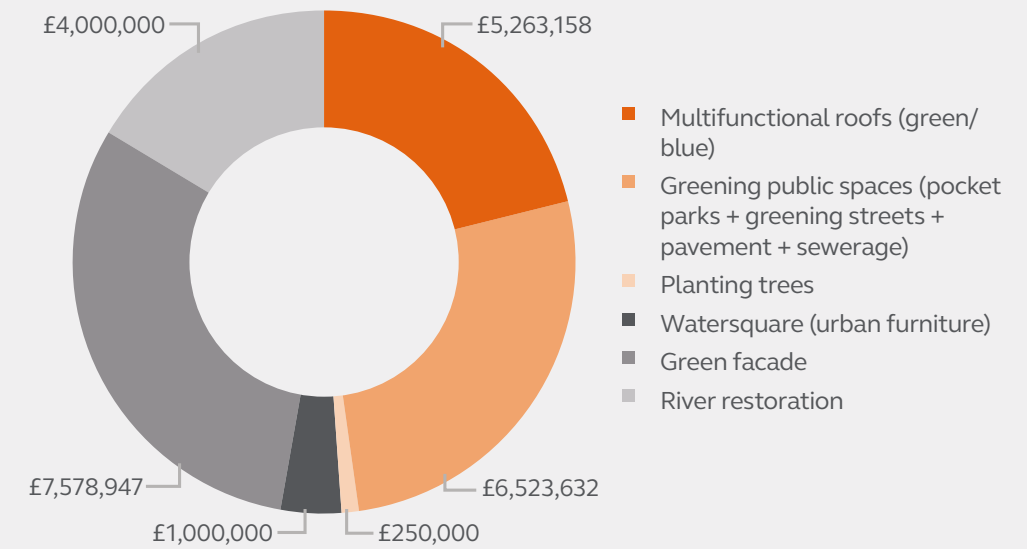
Our clients tell us that, even though they would like to become more resilient and know what they need to do, “we don't know what the benefits are and how to finance it.” Our role is to connect the gaps between those who need funding for their project, and those who are willing to invest. To help, we have developed our methodology Optioneering using our Bankable Resilience Tool (BaRT), which helps clients move from their strategic masterplan to the implementation phase.

Optioneering using the Bankable resilience Tool (BaRT)

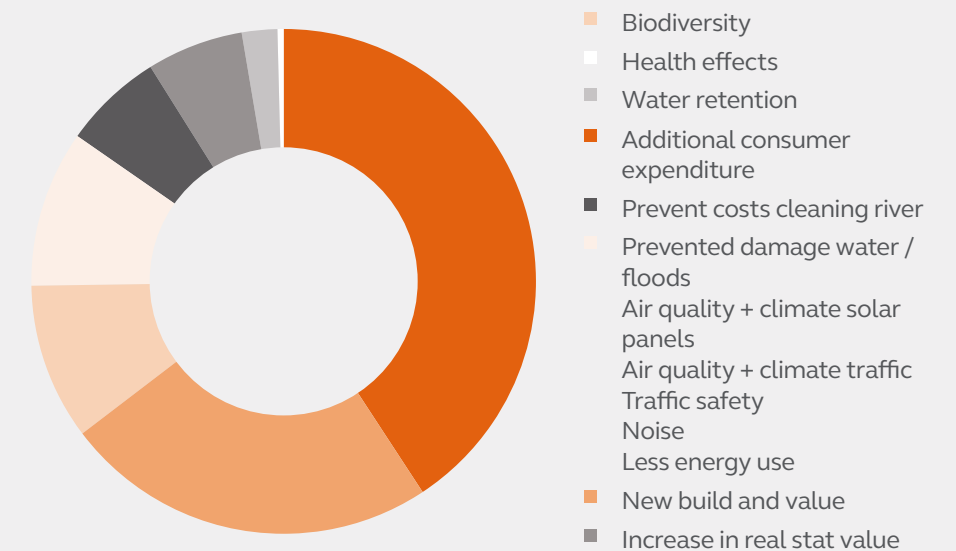
Optioneering is our methodology to combine design, technical engineering and financial engineering. This includes sessions with a full focus on bankable developments. To support these sessions we use our Bankable Resilience Tool. BaRT is a cost-benefit and multi-criteria analysis tool that we use to support cities and developers in evaluating their resilience options when planning an urban (re)development project. We use BaRT to analyze investment opportunities and prove – through financial modeling – that there is a business case for making a resilience investment in a city's transformation. We bring together as many relevant stakeholders as possible – the city council, health sector, developers, major employers – and try to identify together the opportunities that create return on investment. BaRT shows the additional value of resilience measures, highlights opportunities to capture the value of related developments, and outlines possible financial arrangements to deliver resilience. Each stakeholder, BaRT can help in forming coalitions to jointly implement resilience measures.

Often the return on investment will be at least as much, if not bigger, than a business-as-usual approach. And if that's the case, why shouldn't you make it more ambitious, more resilient, and accelerate the transformation?

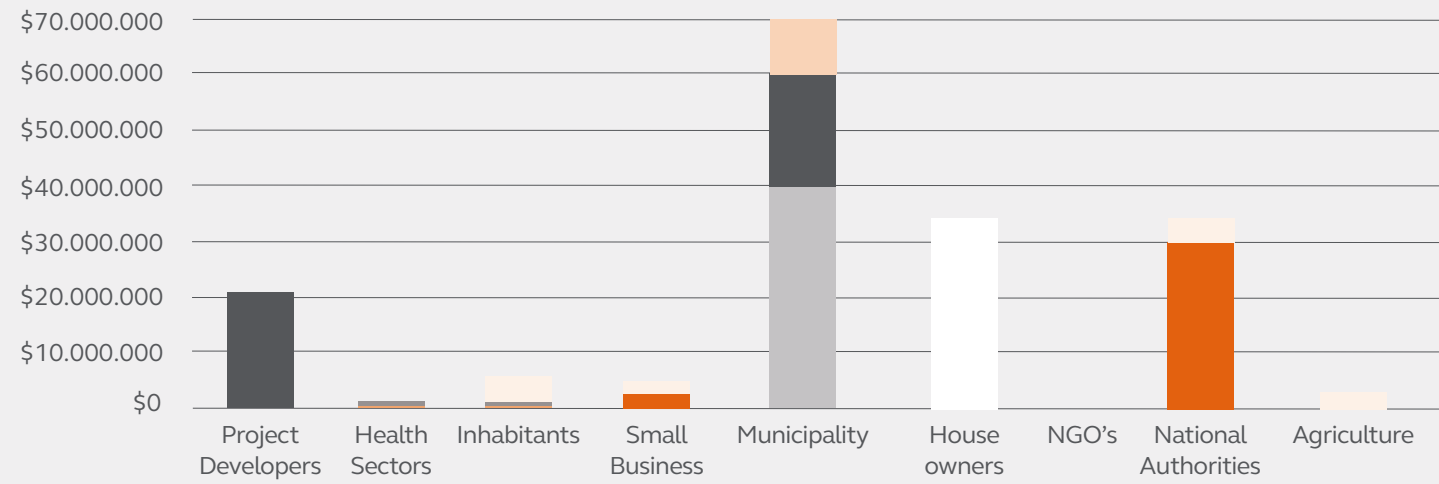
Investment Costs Distributed over measures



An example of how BaRT illustrates the investment cost distribution for each resilience measure

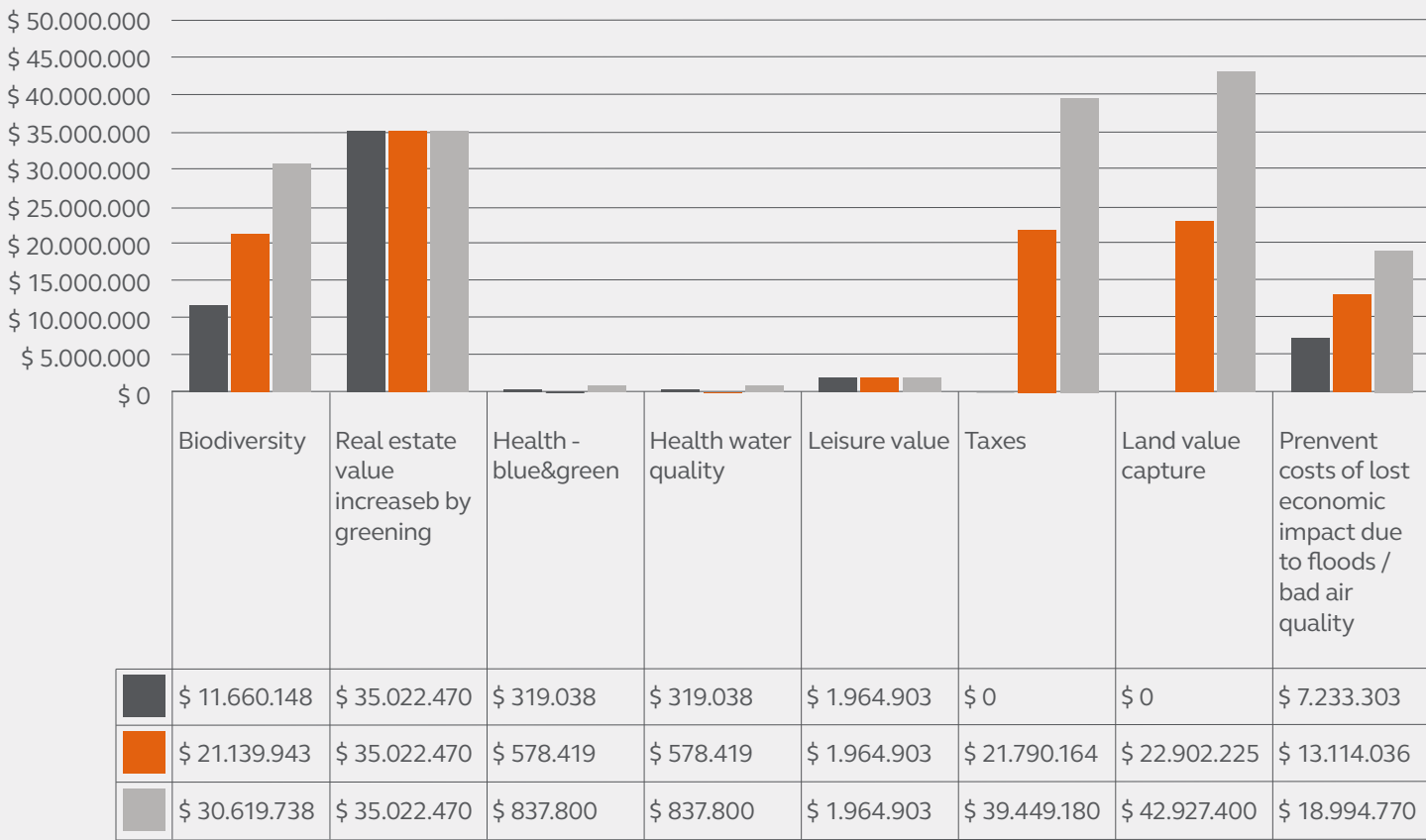


An example of how BaRT measures the benefits of resilience



An example of how BaRT shows the distribution of benefits for each type of stakeholder

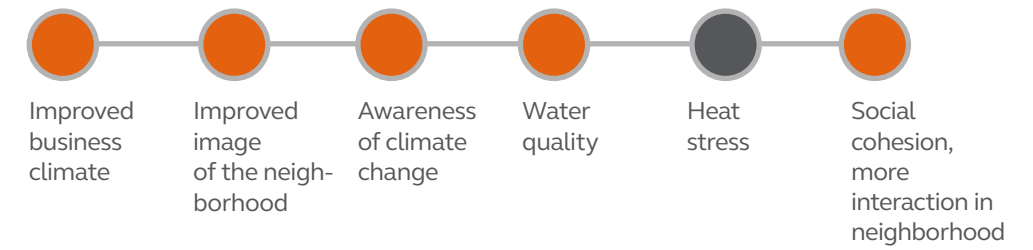
- Leisure value
- Health - orange & gray
- Biodiversity
- Land value capture
- Health water quality
- Taxes
- Prevented costs of lost economic impact due to floods/ bad air quality
- Real estate value increase by blue



- Blue-green scenario
- Low density scenario
- High density scenario

Qualitative Benefits - value add

Benefits



The above presented 'traffic light' model shows the qualitative benefits of the project. The most important benefits will be explained further in the section below

Results MCA

Dimension	Description	Weights	Score of project (1-5)
Institutional		0,25	● 5
Social		0,25	● 5
Environmental		0,25	● 5
Technical		0,25	● 5
Total		1	● 5

Environment & surroundings

- IMPROVED BUSINESS CLIMATE**
The project contributes to a green/innovative profile of the neighbourhood. It improves the business climate.
- IMPROVED IMAGE OF THE NEIGHBOURHOOD**
The project contributes to a green/innovative/safe profile of the neighbourhood. The reputation of the city and districts improved.
- SOCIAL COHESION**
The project strengthens social cohesion because there are additional opportunities to meet.
- AWARENESS CLIMATE**
By making the climate adaptation measures visible in the project, it contributes to awareness of the climate change.

Water

- WATER QUALITY**
By storing (rain) water, less mixed wastewater will end up in the surface water (overflowing). The actual effect depends on the design of the sewage and water system.

Health and nature

- HEAT STRESS**
The project has a cooling effect on the surroundings through evaporation. The effects on energy in the building (albedo and insulation) are nihil.

An example of BaRT's multi-cost analysis output.

Digital resilience

The reality of resilience in today's world is that digitalization presents both a challenge and a considerable opportunity. The interconnectedness that digital technology brings means that our knowledge of resilience issues has never been greater. We are also better able to measure and prove that a resilience mindset delivers value. However, this interconnectedness also increases the risks associated with not being resilient.

Cyber resilience

For many clients whose resilience focus is on big physical assets, it may come as a surprise that the biggest challenges may be in cyber resiliency. This is what the City of Rotterdam, in the Netherlands, discovered. At an average of more than six meters below sea level, Rotterdam relies on a 24/7 pumping system to keep water out and it turns out that if a cyber-attack occurred or the power supply were interrupted, it would take only 24 hours until the entire city was under water. So cyber security is a bigger resilience risk than storm surges.

Our society is also much more interdependent, and new technologies introduce new vulnerabilities to cyber security issues. Barely a week goes by without stories appearing in the media about public and private sector actors being hacked, or cyber terrorism, whether in the form of hacking major digital systems or attempts to subvert democracy, using digital tools to influence public opinion.

But the opportunity of digital is in the abundance of data that can be mined to provide real insights into resilience issues. And the rise of smart cities creates an environment where resilience can be understood, monitored and proven.

Digital and smart cities for resilience

The Internet of Things (IoT) and real-time analytics are major positive trends. With real-time smart sensor networks, cities can gather the data they need to monitor, test and validate their resilience. But the number of cities that are taking this seriously is still low. New York, in the US, is a city that has made great strides in making data available, but even there the amount of real-time IoT data is small. It is likely to be another three to four years before cities mature in this digital space, but as they take steps forward, it's worth considering some of the major data challenges, because the more we rely on data and digital information, the more we have to account for digital risks.

Challenges for digital resilience

Our clients typically recognize that there is value in data and that it needs mining in a smarter way. But the challenge for most of them is data quality and data availability. As digital resilience rises on city and corporate agendas, this will change. But there is still much to be done. It's all very well sitting on top of a mountain of data, but if that data is poor quality, so too will be the insights.

From a process perspective, one of the biggest risks is data availability and digital collection. Cities must figure out what they need to focus on to understand their resilience, how best to collect that data, and how to make it available to the public. And once they've captured that data, the question is whether they have the right skills on their payrolls to mine it for insights?

At Arcadis, our data analytics community is already helping many clients around the world understand their data and to set up their own digital capabilities in-house, so that their investment in digital resilience is right for the long term. This means helping them to use data and analytics to become smarter around asset usage, as well as the operation and maintenance of assets.

CASE STUDIES

Here are some current examples of major utilities resilience projects Arcadis has underway around the world.



MORE RELIABLE RAIL SERVICE IN THE NETHERLANDS

Solutions for enhancing digital resilience need not always be high-tech. Sometimes, it's simply a matter of using existing data in smarter ways. For ProRail, in the Netherlands, the company that maintains the country's sprawling rail network, we are helping them to predict whether rail switches are about to fail simply by monitoring the fluctuations of electrical current in the rail network switches.



ENHANCING MOBILITY IN LOS ANGELES

By mining mobile phone data, we're helping the Los Angeles Department of Transport think differently about its traffic problem, helping to move towards greater social resilience. By showing where journeys begin and end, we helped create a schedule of where the greatest concentration of people was – and at what times of the day – so that the placement of bike sharing services could be optimized.

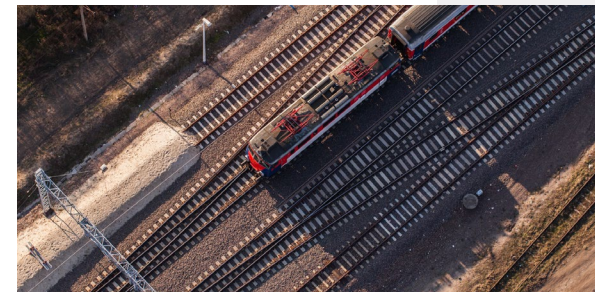


IMAGE RECOGNITION TECH FOR ROAD AND RAIL

We have also developed our own image recognition capabilities to help road, rail and environmental clients identify where assets need to be proactively maintained or fixed. With a GoPro camera and our image recognition algorithms, we can help clients identify cracks or asset deterioration and help asset owners prioritize where they should repave or just invest more.



OPTIMIZING BUILDING MAINTENANCE

We also work with building owners and operators to bring their facilities management data together, visualize it, and then create smart predictive maintenance schedules that are available through digital dashboards. We're doing this for major international financial institutions in the US and UK.

Conclusion

If only it was easy... The issue of resilience is a timely challenge for society, encouraging us all to look hard at what we do on a daily basis and ask ourselves if we can find more resilient ways to do them. It's not difficult to find dramatic and potentially devastating reasons for doing this, given the impact of global climate change is something that all but the most diehard skeptics would admit is real.

Unless change happens, we will continue to experience an increasing number of severe incidents in the world, not only because of climate change but also because of urbanization, technology use (and abuse), shocks to the world's financial system, and the lack of continued investment in resilient infrastructure.

If this all sounds a little challenging, that's because the resilience challenge is real. But there is hope.

By recognizing that resilience is a quality that touches all aspects of society, we can investigate the future together and have the opportunity to protect our assets, our businesses, our families and ourselves in a financially viable and resilient way. The benefits of resilience can be calculated, justified, and factored into the world's investment plans. Resilience can help governments, cities and organizations reduce losses, but also realize significant additional benefits.

For us, as a global company that thrives on providing solutions – on turning strategy into implementation – we are excited to take this resilience journey with our clients. By sharing our global best practices and lessons learned, we can contribute to making the world a more resilient place.

Why now?

The new generation of global citizens demands it of us. Their starting point is very different to that of the previous generations, and especially different to those who are currently leading governments, cities and industries. The younger generations will push us to go beyond risk-based approaches and tap into the myriad benefits of being more resilient.

And for those that embrace resilience early, there will be clear competitive advantages. Here's to a positive and resilient future together.



About Arcadis

Arcadis is the leading global Design & Consultancy firm for natural and built assets. Applying our deep market sector insights and collective design, consultancy, engineering, project and management services we work in partnership with our clients to deliver exceptional and sustainable outcomes throughout the lifecycle of their natural and built assets. We are 27,000 people, active in over 70 countries that generate €3.3 billion in revenues.

We support UN-Habitat with knowledge and expertise to improve the quality of life in rapidly growing cities around the world.

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