

RETHINKING RESILIENCE

**Weathering tomorrow's climate challenges
through a holistic approach**

Net zero and
resilience, united

The test of future-
proofing our cities

What one beach community
reveals about recovery

FROM THE EDITOR



Resilience isn't always called resilience.

'Built to last.' 'Holistic outcomes.' 'Leftward shift.' 'Enhancing societal value.' The popularity of these terms shows that, at last, resilience is becoming woven into our working culture. Across major projects, bolstering the underlying health, security, prosperity, or social wellbeing of a community is becoming increasingly important. And, with climate-related disasters rising by [nearly 35% since the 1990s](#), affecting over 4 billion people worldwide, the imperative of addressing our resilience challenges is timely, to say the least.

Now, at COP28, we're being challenged to do much more than simply demonstrate traditional physical hardening or cyber resilience in our projects. We're being challenged to rethink how we conceive of resilience itself.

Resilience is more than a quality we build into our infrastructure. Nor is it just an additional layer of robustness or redundancy to protect us from threats. Resilience is a fundamental aspect of human communities and the natural, physical, cyber, and social systems that underpin them. And identifying, strengthening, and maintaining resilience – including addressing systemic inequities that leave populations at risk – depends on nothing less than a systematic understanding of society itself.

End-to-end, multidisciplinary, cross-lifecycle, and outcomes-driven, through and through. In this magazine, you'll find features from the forefront of resilience, showing the direct impact that an integrated, systems-thinking approach can have throughout the project lifecycle. From decarbonisation to disaster recovery, wildfires to hurricanes and droughts, AtkinsRéalis is working to embed resilience more deeply at every stage of the lifecycle, from 'Anticipate' and 'Avoid' through 'Withstand' and 'Recover.'

There are no shortcuts – building true resilience to climate change and the range of stressors we face will take decades. And those long-term efforts will inevitably be punctuated by disasters requiring recovery – but that recovery cannot be simply a return to 'normal'. We must build in resilience to future threats that we foresee today. By understanding the deeper fundamentals required to create resilient communities, and endeavouring to strengthen them across different systems, we have a huge opportunity.

Not only to better prepare ourselves for tomorrow's world - but to make that world a stronger, fairer, and more sustainable one, too.

Enjoy the magazine,



Maria Honeycutt
National Director for All-Hazards Resilience
AtkinsRéalis

RESILIENCE ACROSS THE LIFECYCLE:

The articles in this magazine provide perspectives and case studies at every stage of the resilience lifecycle

ANTICIPATE AND AVOID FUTURE STRESSES

Net zero and resilience, by Jonathan Holyoak and Maria Honeycutt

Resilience by design, by Steven Wade

ADAPT AND MITIGATE AGAINST WHAT CANNOT BE AVOIDED

Futureproofing cities, by Matthew Tribe

Adaptation through asset management, by Francis Heil

WITHSTAND AND RECOVER SMARTLY AND EQUITABLY

Towards resilient recovery, by Cathy Clinch

Learning from Hurricane Michael, by Ryan Wiedenman and B. Dina Bautista

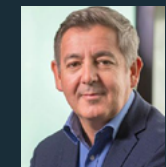
MEET OUR AUTHORS



Maria Honeycutt
National Director for All-Hazards Resilience
AtkinsRéalis



Catherine Clinch
Vice President, Civilian
Sector Manager



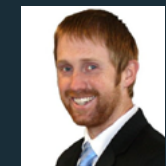
Matthew Tribe
Managing Director for Planning, Design and Engineering



Francis Heil
Associate Director & Team Leader for Climate Change, Resilience & Sustainable Finance



B. Dina Bautista
Senior Engineer for Grants, Resiliency and Master Planning



Ryan Wiedenman
Senior Project Manager for Emergency Management and Natural Disaster



Jonathan Holyoak
Policy and Net Zero Global Programme Director



Steven Wade
Technical Director for Climate Resilience

Neither net zero nor resilience is enough - but together, they can be transformational

Anticipate and avoid



Jonathan Holyoak



Maria Honeycutt

There's a paradox at the heart of net zero and resilience: both are vital, but neither is sufficient. Ignoring net zero and simply adapting our infrastructure and society will lead to runaway temperature rises. But net zero alone, while reducing climate change and its associated disruption, will leave us exposed to suffering undue effects of climate change, which could overwhelm our societies even within the 2°C limit. Now, with the effects of climate change already apparent, the world is converging upon the need for both net zero and resilience.

Yet if we're serious about confronting climate change, we must do more than invest in net zero and resilience. We must approach both in tandem, so that each is informed and enriched by the other. However, this is far from straightforward. Both are inherently complex, involving interconnected systems with myriad feedbacks. Both deal with uncertainty over a long period of time. Both require significant interventions, whether at country, city or corporate level. And while they don't need to be joined up every step of the way, they do need to influence one another. Otherwise, we risk sub-optimal outcomes in both.

For all the uncertainty, it's clear that standing still is not an option. Every type of organisation is being challenged to change. Even without the effects of climate change itself, the ongoing evolution of regulation will challenge our entire sector to improve how we build, operate, and maintain infrastructure over time. Already a blizzard of regulations is engulfing businesses

across the board. A reactive approach leaves organisations at risk of falling behind and of not taking responsibility for their future. The risk of stranded assets, ineligibility for investment and funding, and non-compliance is growing.

The challenges we are facing don't sit within one particular sector, so our solutions must be similarly multifaceted. Cross-sector collaboration is the only way. We're being challenged to hold these conversations immediately, leveraging existing partnerships in new ways, in addition to forming new and unconventional ones and increasing maturity across the board. If the climate is changing, we must change, too.

UNCERTAINTY UNMASKED

Cross-sector collaboration is hard - but in a context of pervasive uncertainty, it becomes enormously difficult. From time frames to severity of impacts to the socio-economic reaction, layers of uncertainty make it hard to prioritise, which hampers decision-making. With so much uncertainty, it's hard to invest with confidence. We must therefore work together to unearth non-traditional ways of anticipating risk and assessing assets, even in the face of uncertainty. Given the urgency of the situation, and the extremely challenging build rates required to build the low-carbon power systems undergirding decarbonisation, converting uncertainty into confidence is crucial.

Strategic plans and industrial strategies can generate greater certainty and confidence regarding how and where to invest, but waiting for top-down leadership isn't always viable. Instead, cross-sector bodies can come together in their region to pool their knowledge and speak as one. Regional clusters can help convince national authorities to confront common threats and capitalise on opportunities. Understanding the particular capabilities, needs, and challenges of your region can help to define a manageable path to greater resilience. If you are in a jurisdiction with a strong carbon plan in place, expecting zero carbon power in future, your net zero plans may be clear; but if you don't have that, perhaps you can build your own microgrid or invest in partnership with other businesses to improve local power capabilities. Vertical integration can also help to de-risk investment and improve confidence. For example, [Cement 2 Zero](#) turned a promising low-carbon material into a viable investment, by uniting across the supply chain to break down barriers to adoption and establish a clear route to market. The pattern is clear: partnerships can reduce uncertainty while increasing confidence.

Togetherness and certainty are important, but they must be backed by data. Sophisticated scenario analysis can clarify our choices and enrich decision making. In turn, this can help asset owners to optimise portfolios economically in a changing world, or enable net zero targets to inform decision making. Data can clarify choices and allow organisations to make progress despite the complex technical and

regulatory landscape. Yet these are of limited value if individual organisations pursue them in isolation. Establishing digital architecture enabling collaboration, clarity, and knowledge-sharing can help to eliminate inefficiencies and increase transparency. Common data environments, backed by purposeful data governance and clear standards, foster deep collaboration, especially when embedded into projects from the start. They can ensure that, as we identify the threats, define our options, and develop robust plans for resilience, we do so in unison, and not in siloes.

TOWARDS LASTING RESILIENCE

Across both net zero and resilience, we must learn to focus on outcomes, not threats. Starting with the threats tends towards siloed, linear approaches. But climate change isn't a single threat, and nor is it about simply thwarting rising seas or bad weather. It's a threat multiplier, intensifying individual stressors like intense precipitation, drought, and sea-level rise. At the same time, it's also the concurrent and cascading impacts that climate change is magnifying. For example, persistent drought worsens the incidence and severity of wildland fires, which in turn denude landscapes, increasing the risk of flooding landslides. With such complex and widespread feedback loops, focusing on the threat is difficult, because it's so multifaceted and long-term.

Instead, we should focus on the societal outcomes we want, and evaluate which factors must be safeguarded in order to maintain those outcomes even in the face of a volatile climate. Identifying the fundamentals of a cohesive, robust, and resilient society requires us to gain a deeper understanding of the interdependent systems undergirding society, and the individuals and communities operating within them. So that, in the face of the myriad threats of climate change, we know what we're trying to preserve, and what we need to do so. That's what differentiates an integrated, holistic approach from a narrower one focusing solely on neutralising climate-related threats.

Physical, natural, and digital infrastructure must work together if they're to provide and safeguard critical resources like power, food, and water. Similarly, if we're to develop solutions to the challenges that threaten these systems, we must recognise their interdependence, or else fail to truly protect,

nurture, and prepare them for the future. Failing to take this into account increases the risk that we inadvertently 'bake in' vulnerabilities, even as we make progress. This is especially true of our standards. Leadership in Energy and Environmental Design ([LEED](#)) is the most widespread green building rating system in the world, providing frameworks for virtually all building types. However, although LEED provides rigorous net zero standards, it is [drawing criticism](#) for its apparent failure to consider major flood risk. These certification gaps tend to result from insufficient integration of net zero and resilience, and they could engender a dangerous false confidence in our infrastructure's fitness for the near future. Considering net zero and resilience together can help to avoid such gaps and create more efficient routes to achieving both outcomes.



INTEGRATION FOR TRANSFORMATION

Integration is the hallmark of successful adaptation - and of a resilient society. In order to integrate net zero and resilience, and avoid the risks and inefficiencies incurred by pursuing each individually, we must integrate considerations of decarbonization and broader resource sustainability concerns (water, air quality, and so on) while investing in resilience - such as asset sizing, design, and materials selection. This approach can both strengthen physical assets, while using materials and approaches that also reduce carbon footprint and increase efficiency. For example, windows can be simultaneously wind-resistant and energy efficient, reducing carbon footprint while deepening hazard resilience, too. However, incentivising these choices requires being aware of both needs, and the relationship between them. Otherwise, we risk missing out on optimal solutions, because net zero and resilience were not considered in an integrated, joined up way.

By conceiving of social, natural, and built environments as interdependent matrices, systems thinking helps ensure that we approach these challenges with the whole in mind, rather than becoming preoccupied with discrete problems within the systems themselves. Now, we're realising that our civilization and nature itself are systems of interdependent systems - there's no 'outside' in which to dump so-called 'negative externalities'.

Integration is more challenging, but it's also much more effective. By understanding these principles and shaping our solutions around them, we can exploit vast potential efficiencies and embed resilience at a much deeper level. Collaboration allows us to weave together the different threads that knit communities, from the physical and natural to the social, digital, and cyber. No longer can we simply build a bridge as a discrete piece of infrastructure. Facilitating early-stage dialogues between disciplines, stakeholders, and authorities is therefore vital.

THE RESILIENT RESOLUTION

Resilience and net zero must mature to become inherent in all we do. Like safety, which is not a separate consideration but infused in every aspect of infrastructure, so too must resilience and net zero become fundamental aspects of our culture. No single discipline can be responsible for shaping these responses. And neither is a top-down, owner-operator approach enough; we need to reshape how we plan, conceive of, and relate to our built, natural, and social environments, with resilience and net zero at the heart. We can only achieve this if it penetrates through every type of work; it must be pervasive.

Fortunately, many solutions are already available and underway. From improvements in data gathering, analysis, and sharing,

to rapid and affordable visualisation and scenario modelling technology, the necessary tools are within reach. Coupled with a systems thinking approach and an openness to partnership, these developments can help to overcome uncertainty and enable organisations of all kinds to get started.

Finally, amid all this progress, it's important to recognise that sustainable change is the only kind capable of helping us.

Resilience and net zero are not monolithic, one-off challenges. They're continuous, ongoing, aspirational transformations that will influence society and economy for centuries. The choices before us are difficult, but they're also opportunities to bring about a world that is not only more resilient, but more sustainable, just, and prosperous, too. Ensuring that investments deliver over their lifetime is vital. Long-term, sustainable change is best nurtured in the same way as all successful change: together.

5 STEPS TO GETTING STARTED...

1. Think holistically about the challenge and the outcome

What are the different potential scenarios, and how do they affect different sectors across the lifecycle? Similarly - what outcomes are you looking to achieve, and what do they depend on?

2. Get up to speed on upcoming regulation

It's not just being aware of what's on the horizon. It's understanding its likely impact on different aspects of your project, and preparing the relevant experts accordingly.

3. Organise your data

Integrated data needs integrated organisation. Data standards and Common Data Environments can enable sharing between stakeholders - if they're ready for use in time.

4. Set performance metrics tracking resilience and decarbonisation

What's measured is managed - setting clear, evidenced, and widely understood performance metrics can enforce standards across both resilience and decarbonisation.

5. Start with 'no regrets' interventions that tackle both

Some interventions are less controversial than others. Identifying straightforward 'no regrets' interventions impacting resilience and decarbonisation can help to build the confidence you need to get started.

Resilient by design: a systems approach to modelling climate risks, impacts, and adaptation



Anticipate and avoid



Steven Wade

The risks of a changing climate are higher than we assume. Previously we've underestimated how deep, widespread, and significant the changes wrought by climate change will be. Large-scale extreme events are easy to imagine, but it's much harder to discern and anticipate multiple, simultaneous hazards compounding each other year after year. Our infrastructure is struggling with today's events, let alone the intensifying conditions predicted for the near future - much depends on how we model, understand, and adapt for such conditions.

As the effects of climate change manifest, there's a growing acceptance that we must prepare ourselves by identifying vulnerabilities in our social, economic, and built environments. The pace, scale, and complexity of the coming changes mean that we must prioritise, rapidly adapting in the most efficient way possible. Yet traditional approaches to resilience aren't good enough. Standards based on historical climate conditions, or even the use of the previous generation of climate models when science is advancing rapidly, are failing to inform decision-making. Meanwhile, a lack of capacity in climate risk assessment and adaptation planning are hampering progress.

Without improvement, these methods and conditions do not enable resilience. To adapt appropriately, we must embed resilience throughout the project lifecycle. In turn, this requires more systems thinking, through disciplines working together to overcome siloes. We also need to consider climate change and impacts on systems much earlier to ensure project

concepts and designs deliver the necessary transformations. Establishing the risks and potential adaptation and resilience opportunities early on gives projects the best possible chance of identifying and enacting optimal solutions in an efficient way. However, this demands a greater subtlety in our modelling and how we appropriate it for different parts of the project lifecycle.

A SYSTEMS UNDERSTANDING OF RISKS AND IMPACTS

Climate change is extremely complex, with multifaceted long-term impacts. It is both slow and sudden, pervasive and specific, blatant and subtle. Much of our knowledge, and all of our projections, rely upon our modelling systems - and modelling complex systems is notoriously challenging. In addition, we are seeing and will continue to see more multi-hazards and compound events, which are not always well reflected by models. Too much is at stake to content ourselves with over-simplistic models and outdated data; inaccuracies could undermine our efforts to adapt and prepare, leaving whole societies vulnerable to events and impacts more widespread, complex, and extreme than they imagined.

Many technical and statistical approaches still treat the past as stationary and unchanging. Particularly with temperatures, where we've already witnessed a significant upward trend



and seen risks which are beyond the climate projections - for example, the 2022 heatwave in the UK which brought a 40°C day to London and wildfires created the busiest day for the London Fire Brigade since the Second World War. A more accurate assessment demands up-to-date, smarter, more complex statistics or large ensemble climate models, which quickly becomes very complicated (such as those used to deliver Climate Model Attribution studies), discouraging widespread adoption.

Confronting this complexity is daunting. But unless we do so, we cannot optimise our adaptations or develop resilience to it, leaving our societies unduly vulnerable. To confront this vulnerability, we must apply systems thinking across different levels of detail, to empower institutions and businesses alike to understand their vulnerabilities and how best to deploy limited resources to buttress themselves against the worst effects. This integrated,

systems-thinking approach tends to produce more optimal, low regret, solutions, because nature itself is a complex system. An integrated approach (as opposed to narrowly combating specific symptoms of climate change) can also reveal opportunities to generate systems-level improvements across the board, so that we can channel effort and investment towards resilience solutions that have a wide range of benefits.

Improved modelling does more than enhance accuracy. It can be the difference between making sustainable, far-sighted investment, and lacking the confidence to act. Greater visibility of risks strengthens the business case and supports sustainable investment. At AtkinsRéalis, our work with multilateral development banks (MDBs) demonstrates the importance of risk assessment in stimulating appropriate investment. For example, when our clients approach us with ideas to improve a city's

water supply, we make use of AtkinsRéalis' risk assessment tools to analyse their proposals, exploring how greater benefits could be delivered for adaptation, resilience, and benefits across multiple registers of value such as biodiversity gain. By enacting such assessment very early on, prior to feasibility studies, we can establish guidelines and standard frameworks to make sure that these insights meaningfully influence the design and scope of projects. In turn, this can be used to strengthen the business case, often supporting investment in vulnerable communities and developing countries.

TURNING THEORY INTO REAL WORLD OUTCOMES

The business case is just the start. To maintain resilience standards, we must integrate monitoring throughout the project, utilising KPIs, collaborative contract models, and digital tools such as common data environments to ensure transparency on performance, so that theory can be proven in practice. Different kinds of monitoring can help to embed change across the project lifecycle. Broadly, impact modelling identifies the changes required, and adaptation modelling tracks their real-world performance, upholding ongoing learning and accountability.

Impact monitoring is about understanding the thresholds beyond which certain events are triggered, and then collecting evidence to demonstrate what the impact of such



events would actually be. This can enable the development of Adaptation Pathways: tangible, actionable plans detailing how to respond if certain thresholds are triggered. Agreeing in advance the thresholds, impact indicators, and actions to take in the event of breaching the threshold helps to ensure clear, rapid, and well-evidenced responses to potential crises. In turn, this increases confidence and reduces unnecessary damage to society, infrastructure, and the economy. Linking the right responsive actions to the right triggers requires thorough exploration of a whole range of possible scenarios, reduces uncertainty and inefficiency, but it enables a more suitable response in a sensible, efficient, and effective way.

As well as holding people to account, doing due diligence, and upholding good standards in design, these monitoring mechanisms can lead to further refinements that reduce cost and improve efficiency - but only if we measure success and uphold accountability. Adaptation monitoring tracks promises against delivery. At a time when making claims about climate actions and their effectiveness can impact an organisation's reputation, this is vital. This kind of monitoring can help to evaluate how successful major investments are in delivering levels of resilience and reducing amounts of loss, strengthening the case for what actually works in practice. Adaptation should lead to a measurable increase in resilience with real-world data, and not just occur 'on paper' as a form of greenwashing. With better evidence and

learning from past projects, we can then better funnel investment to the projects which are having the greatest impact, refining effective practices and further reducing risk.

SYSTEMS, SUSTAINED

Already, it's clear that the costs of failing to rapidly adapt are very high. Unless we apply a holistic, systems thinking approach to adaptation, we will suffer more failures in response to shocks. Costs will escalate and ripple through major projects. Funding will become harder to obtain. Recovery from setbacks will be more arduous



and uncertain. Integrated approaches can lower these risks while revealing optimal solutions that address multiple challenges at once. If we can benefit adaptation, biodiversity net gain, mobility in one project through taking a systems approach, we reduce costs and deliver more in terms of outcomes.

Such benefits can only be unlocked through holistic and integrated thinking; if we only consider, say, actions to tackle net zero, we risk spending a lot of money without availing ourselves of potential solutions that also improve resilience and biodiversity. As both regulations and measures of value grow more sophisticated, we must be more strategic about decision making and project design.

Systems thinking unlocks efficiency; but monitoring systems help to lock it in. Both impact monitoring and adaptation monitoring are crucial to maintaining standards and momentum. So much change in such a short space of time is bound to increase uncertainty, disruption, and unexpected consequences; without monitoring, these could significantly hamper our efforts, forfeiting key insights and failing to hold projects to account. A holistic, systems-thinking approach, however, makes it easier to consider and embed these evaluative criteria from the very start. That's what it really means to be resilient by design.

Future-proofing our cities: how we can adapt for the coming climate challenges

It's well known that 70% of people will live in cities by 2050. Urbanisation is accelerating, with millions flooding into metropolitan centres around the world. Yet cities are unable to withstand today's climate challenges - let alone tomorrow's. Already, extreme heat, rain, and flooding are pushing cities to breaking point.

What's less well known is that, according to our best estimates, around 80% of the built environment of 2050 has already been built. So not only will cities be responsible for accommodating and protecting even more people, they'll also have to do so with existing infrastructure and all of its associated vulnerabilities. Designed to withstand significantly lower thresholds of heat, water, and storm surge, these vulnerabilities are being exposed by today's volatile weather. Tomorrow promises greater severity and frequency. Yet we are still under-informed about both the current resilience levels of our cities, their weak spots, and the likely weather patterns of the future.

To understand how cities are currently functioning, we must establish their baseline performance, and compare it against tomorrow's demands using scenario modelling. This would allow us to properly test resilience. But existing scenario planning is not accurate enough. China's record-breaking rainfall of 2021 was, according to existing scenario planning, a once in a millennium event, meaning that we are off by a factor of a hundred in terms of our predicted events and capacity in city systems like power, waste, and water. Without baseline data to inform investment,

we cannot retrofit our urban environments to meet the requisite needs, and to design solutions accordingly.

Integration is the answer, and it will fundamentally change how we plan, operate, and conceive of our cities. Yet today's siloed approach means that agencies that run cities - transport, health, education - are too divided. Different parameters and KPIs mean that they stress test their systems and assets independently of each other, making it harder to align in service of a greater togetherness. We must drive a holistic understanding and interdependencies and infrastructure assets of cities to ensure a joined up approach, which alone can yield the deeper resilience we need in the face of the challenges to come. That all depends on how we use innovation to collaborate and drive change.



Matthew Tribe

PICTURE THIS

Scenario modelling must do more than illustrate threats. It must reveal how the interdependent systems synonymous with city life are impacted. Storm Sandy, which inundated New York City in 2012 with an unprecedented quantity of water, reveals how these impacts can cascade. Subways were flooded, cutting off suburban communities. All tunnels entering and exiting Manhattan were flooded, bar one. Power outages forced citizens to use private generators, which led to several deaths through carbon monoxide poisoning. The flooding of a telephone exchange disrupted voice and data communication, exacerbating isolation. Moreover, the social structures designed to support people were exposed as inadequate. And all this in one of the world's richest, most well-organised cities.

From physical infrastructure through to utilities and social networks, cities are fundamentally interconnected. Damage to one area can quickly cascade into others, in unexpected ways. We must better understand how interdependencies align, clearly a gap in understanding those relationships from a holistic point of view; otherwise-solid plans will be undone if they're not properly integrated with their wider context.

That's why we need to run multiple scenarios simultaneously, exploring how initiatives or actions impact on other systems within the city in real time. Extreme weather events are best understood not as a monolithic entity,

but as complex entities with distinct stages requiring different kinds of responses and adaptations. Plans and strategies must understand impact from start to peak to post, tailoring the response accordingly. That's why we need an agile set of responses across this spectrum. Predictive modelling can establish vulnerabilities within infra or communities at each stage, so that we can focus on developing the right response to the right place at the right time.

For example, the true vulnerability of building infrastructure in proximity to sea level rises or flooding events may not be fully understood if our models consider floodwater alone. Hospitals may be built far from rising sea levels or flood-prone areas, but if their power depends on at-risk infrastructure, and their private generators do not last long enough, hospitals might be at much greater risk of collapse in such an event than is assumed. Our cities are systems; the resilience of one system depends on those with which it intersects, visibly or invisibly. Resilient planning evaluates these risks according to different scenarios, ensuring liaison between agencies to manage extreme weather events in tandem through a multi-agency approach. AtkinsRéalis has developed City Simulator, a scenario modelling tool able to assess multiple scenarios simultaneously, supporting an integrated approach.

TWENTIETH CENTURY BLOCKS

The Middle East reveals the unique challenges of adapting cities for the emerging challenges. Whether founded on virgin land or existing metro areas like Riyadh and Dubai, the scale and growth of the Middle East's cities is enormous and is matched by their speed. There's an urgent need to diversify the economy and society from hydrocarbons, but this must be sustainably managed and localised, while taking into account the extremes of the environment. Otherwise, weaknesses may well be exacerbated as cities grow. In the UAE, 90% of food is imported and water depends on desalination. The vulnerabilities are clear, but addressing them requires careful evaluation and integration.

Moreover, many of the region's existing cities grew largely in the late 20th century, when cars were in ascendency and cities were shaped around their use. Dubai's gated and semi-gated communities demonstrate the unintended consequences. Residents all leave their developments at peak times, clogging transport systems. A dearth of community infrastructure encourages atomised individualism, impeding the kind of local grassroots initiative that mitigates impacts of disasters and speeds up recovery.

However, Dubai is learning its lessons very quickly. Dubai is delivering a public transport network through metros and bus systems, supplemented by rideshare and private car hire facilities. Moreover, Dubai is trying to stitch these together as a whole, promoting car-free cycle routes while improving provision of open space and green urban space to reduce heat island effect. The previous inclination for sprawl beyond city limits is being discouraged, in favour of a metropolitan area with distinct boundaries, taking advantage of existing infrastructure rather than more and more building.

COLLABORATION MEANS COMMUNITY

Human wellbeing depends on togetherness, cooperation, and community. Yet cities have grown too atomised, lonely, and individualistic. The breakdown of community networks leave isolation and vulnerability in their wake, factors which exacerbate disasters and hamper recovery. Paris is creating small self-sufficient communities within communities, for greater cohesion, togetherness, and trust. This promotes a higher degree of self-responsibility, creating behaviours that aid recovery.

Security and safety depend on the community, and lives can be saved through vigilance and surveillance just by being better neighbours. 'Soft' interventions based upon behavioural change can yield disproportionate results. Technology, which

often contributes to individualism, does not necessarily have to isolate us; through app-enabled community groups, exchanging information can enhance rather than replace face to face relationships. Empowering citizens to engage in how cities are run and are managed transform people and make them more resilient. Resilience starts and finishes at the local level.

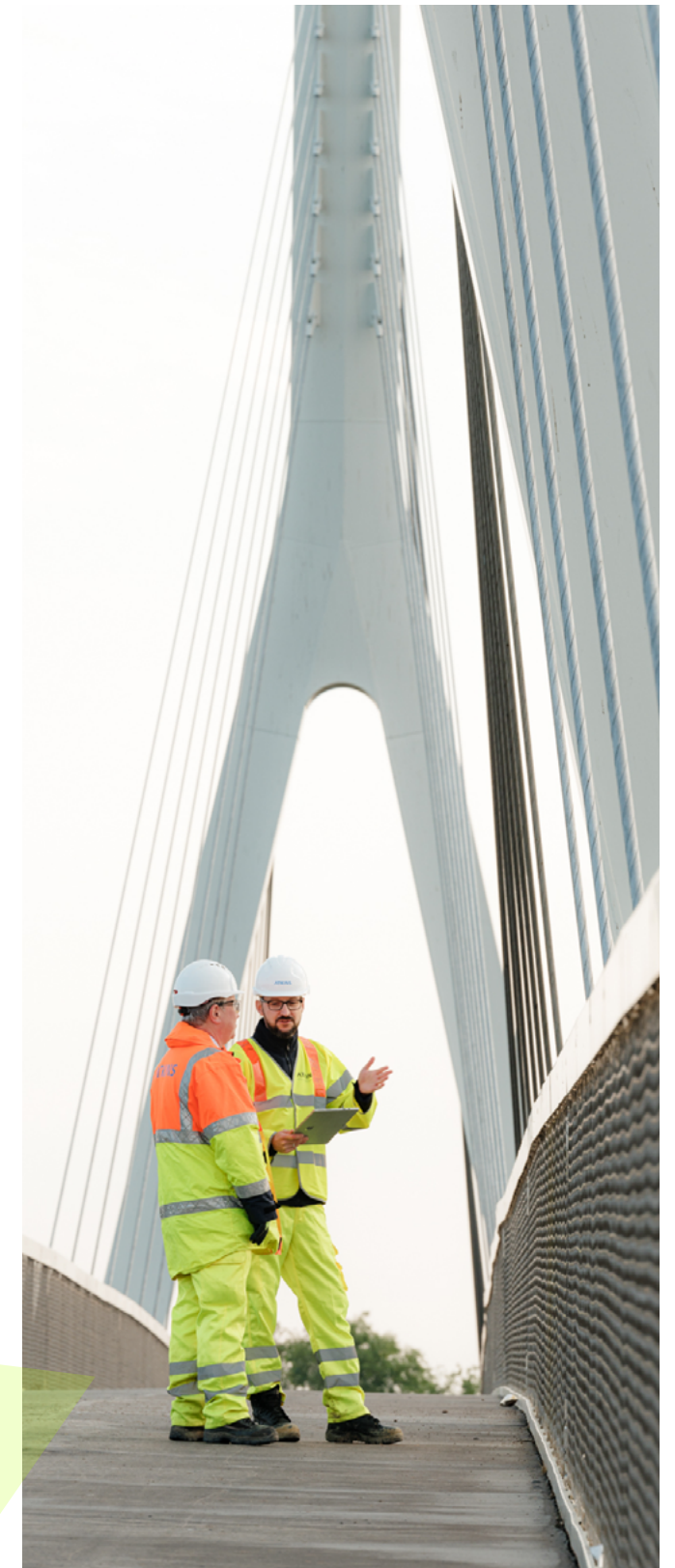
Integration makes cities stronger and more resilient, but integration requires collaboration across disciplines, sectors, and jurisdictions. Collaboration, enabled by data, makes it possible. AtkinsRéalis' breadth of subject matter experts, behavioural scientists, engineers, ecologists, planners, means that we can drive high performance solutions that are truly holistic.

How we collect, analyse, and disseminate data can influence every other aspect. No one firm or discipline can find all the solutions, still less enact them. From virtual reality learning through to engineering, operations, and maintenance, data can enrich understanding and inform decision making, strengthening private and public resilience into our cities to drive better **outcomes**.

CITY LIFELINE

Standing still is not an option. The status quo is not good enough. Were we to continue building and running cities as we have done in the past, the ongoing rise in urbanisation will mean a concomitant rise in loneliness, isolation, and ill-health, will all their impacts for resilience. We have to change our cities, but we must also change how we do so. We simply don't have time to follow traditional methodologies, which are too slow and incomplete. Resilience isn't a discrete factor, but the fundamental factor enabling everything else.

From climate migration to financial investment, political stability to lifestyle, climate change will affect almost every aspect of urban life. Reactive, siloed responses can't deliver real resilience. And with so much already built, neither can we continue with wasteful, sprawling approaches to urban design. Adaptation and maximisation of existing building stock will depend on things like building management systems, high performing facade design, and how to use assets to facilitate community growth. With collaboration powered by innovation, we can transform efficiently - but we must be willing to rethink our cities, from the ground up.



Adaptation and resilience: we can't afford not to, so we need to get moving



Adapt



Francis Heil

Our climate has already changed dramatically. For our citizens, communities, and economies, the risks that accompany the new present and an uncertain future are huge. That's why strategic investments in adaptive resilience, guided by data insights and collaboration are key to cost-effective adaptation. Done effectively, climate resilience offers opportunities to reimagine more sustainable, equitable and resilient ecosystems - if we act fast and collectively.

A growing intensity of flooding, droughts, and extreme weather events: climate change is here. Strengthening resilience to these worsening threats is no longer just wise planning, but an urgent necessity. Resilience used to be secondary to the critical task of tackling carbon emissions. Yet with every year that passes, the costs of inaction are both increasing and increasingly clear. We must adapt to a changing world if we're to avoid devastating impacts to our infrastructure, habitats and economies, right at the same time we need them to perform better than ever to decarbonise. Resilience can no longer be put off.

However, to meet the scale and pace of this challenge, we must approach resilience intelligently. Building bigger, stronger, and deeper can lock in more carbon emissions and trigger additional expenses. Companies can invest too much, or too soon, or in sub-optimal pathways that the passage of time will render inadequate, insufficient or unsustainable. Instead, we need an adaptive approach, where sustainable investment is strengthened gradually over

time, reinforced by continual monitoring and informed by up-to-date learnings that leads to a long line of low-regret decisions.

Better use of data and greater collaboration hold the key to making that happen. Only data can yield the insights needed to accurately pinpoint shared vulnerabilities, project future threats, and improve the quality of decision-making to execute smart adaptations. And only collaboration at scale will enable the coordination and knowledge sharing sufficient to embed resilience across every sector, at every level. That's a huge challenge, but we're better equipped than ever before to meet it.

SMART APPROACHES TO ADAPTATION

Water companies provide a useful case study for demonstrating the challenges of resilience. In the UK, there simply hasn't been sufficient investment for building long term climate resilience. Now the water utilities face compounding climate risks - from more intense droughts threatening water resources, rainfall overwhelming urban drainage, to changing soil moisture conditions causing ground subsidence that damages buried infrastructure. The interrelated nature of these challenges makes it all more difficult - creaking infrastructure undermines our ability to respond to future challenges, sapping investor confidence, public support, and precious resources.

A change of approach is therefore sorely needed. Greater awareness and better asset management can deliver positive change. But as climate risk proliferates, water companies need adaptive plans and pathways, monitoring and responding to risks, and informing long-term investment that will be acceptable to regulators. Nature-based solutions have to play a major role alongside smart technologies. Real-time sensor networks, climate risk analyses, and scenario modelling can help prioritise the most at-risk assets for enhancement, such as identifying blockages and capacity deficits in wastewater networks. But since available funds are finite, difficult trade-offs around costs and benefits remain.

That's why risk-based prioritisation methods are essential. They must capture the policy landscape, reputational and legal risks, as well as physical climate risk. Through broad and transparent collection of data, climate-proofed value for investment is possible. But without robust climate risk and adaptation assessments, there is a clear danger of stumbling on the difficult course ahead. Like other organisations threatened by a changing climate, water companies need access to sustainable finance, reducing their borrowing costs by meeting sustainability criteria. Integration is now no longer a nice-to-have idea, it's vital.

In 2021, the City of Edinburgh commissioned AtkinsRéalis to guide the city through the development of a climate risk and adaptation assessment. Evaluating both risk and adaptation opportunities depended upon

early-stage input from a range of stakeholders. That's why we facilitated interactive, multidisciplinary workshops spanning infrastructure operators, health and environmental agencies from Edinburgh and Scotland, and public sector organisations. This collaboration allowed us to rapidly gain inputs and insights, and develop consensus across stakeholders of key priorities.

It also enriched our analysis of Edinburgh's climate risk profile based on UK climate projections (UKCP18), the UK Climate Change Risk Assessment (CCRA), and case studies of the impacts and costs of climate hazards across the city. In turn, this informed our climate risk mapping, harnessing public data and GIS to identify risk hotspot locations and infrastructure vulnerabilities across transport, health, and the built and natural environment. Informed with these insights, we produced an adaptation assessment considering progress, highlighting both the barriers to climate adaptation and best practice case studies of successful solutions. Armed with an integrated, informed, and insightful climate risk and adaptation assessment, Edinburgh is equipped to take the next steps with confidence.

COLLABORATION FOR RESILIENCE AND RECOVERY

At the same time, we also need to face up to the tough reality that some things cannot be prevented, and plan accordingly. If cost far outweighs benefit (say, in areas where it is uneconomical to prevent flooding during severe events) we must instead increase the speed of recovery through adaptation instead. Water companies and resilience partnerships work with communities to build resilience, raising awareness and reducing both impacts and costs. These can take the form of better warning systems, strategies at the property-level to reduce damage (such as moving valuable items from ground to upper floors), or plans to best help people get back to normal and get critical infrastructure working again.

Resilience is a team effort. That means data is only as good as its context, so collaboration and sharing between different bodies is crucial - successful recovery depends hugely on how well efforts are coordinated. For example, the Environment Agency (EA) in the UK has

the overall strategic oversight for surface water flood resilience, but Local Authorities actually own a lot of the infrastructure and land. Their asset maintenance, land use, and public awareness raising in turn has a huge impact on surface water flooding. Water companies, meanwhile, own the water and drainage infrastructure. Therefore, these three stakeholders (together with others) must work together to reduce risk of surface water flooding, pooling their resources to invest in projects to improve flooding, and empower people to take action.

Furthermore, collaboration must also extend to the public. Only individuals can close their curtains on the hottest days to reduce heat, or ventilate at night, for example; so people must be properly informed and equipped to take appropriate action. Networks can help to disseminate change. For example, the London Climate Change Partnership (LCCP), led by the Greater London Authority and the EA, is a collective of organisations including infrastructure owners, service providers, and community groups sharing best practice around resilience and advocating for local action on climate change. AtkinsRéalis is proud to be supporting LCCP to make London a more resilient, inclusive, and liveable city.



RESILIENCE IS AN OPPORTUNITY

Anticipate, adapt, monitor; these will be the hallmarks of data-based approaches and partnerships. We need to know when to trigger action, what to anticipate, and how to expedite recovery. We need collaborative adaptation plans, to implement strategies and measures that keep people safe and keep ecosystems secure. Without coordinated efforts, asset owners and operators will continue to struggle to chart the best course through the available multitude of options, risking sub-optimal resilience and recovery plans.

At AtkinsRéalis, we understand this clearly - because we're multidisciplinary through and through. We work across sectors, across the world, bringing together multifaceted approaches to strategy, planning and commercialisation. We've worked with water companies for years to build drought resilience plans, and have helped multilateral development banks establish their own climate risk systems, explore how climate change could affect investment viability, and embed those considerations into systems to support long-term resilience.

Rising to the great climate challenge is filled with daunting threats. But the opportunities are huge too. Climate change isn't just about the climate. Indirect changes to the global economy, markets, regulations, and consumer behaviour will reshape the world. By proactively exploring, anticipating, and preparing for these changes, we can change

the narrative from despair to hope - and embed the resilience that our communities deserve. Building resilience is a chance to imagine more liveable and inclusive cities for everyone, and to restore our connection to nature. For example, we can scarcely imagine being able to swim in the River Thames. But Paris has committed to a swimmable Seine by 2025. For all the changes, for all the challenges, adapting our society can bring untold benefits - if we are proactive, collaborate, and value resilience and natural capital in our investment decisions.



From back to normal to build back better: why resilience is vital to recovery



Catherine Clinch

Withstand and Recover

Changing climates and extreme weather are putting infrastructure and societies under greater and greater stress. Severe storms that were previously considered once-in-a-century events are happening much more frequently - sometimes multiple times within a year or two. And our old approach to recovery, focused on getting things back to normal as rapidly as possible, cannot embed the resilience we need to withstand the more frequent and severe events we are witnessing. Standing still is not an option - because as climate impact increases, doing what we've always done means more damage, more suffering, more cost. We must change how we recover.

We need to build back better, but to do so, we need a holistic approach. Fundamental to this change is a shift in mindset. Too often, recovery is simply rebuilding in kind, as it was before. Not only does this tend to be faster and cheaper, it also tends to comply more easily with existing standards and practices. Together with the understandable desire of impacted communities to 'get back to normal' as quickly as possible, these factors combine into a powerful force pulling us towards rebuilding quickly and in kind.

But this doesn't mitigate the impact of current or future events. Almost by definition, rebuilding to prior standards and designs bakes in the very same vulnerability exposed by catastrophic events, as well as ongoing vulnerability to long-term changes such as sea-level rise. Lasting, resilient recovery requires us to re-establish infrastructure in

ways that better prepare us for future events, while maintaining the infrastructure's social and cultural value. This demands treating the event and the recovery not as a one-off, but as continuous learning, drawing insights from past experience and our understanding of what may plausibly happen in the future to design for resilience.

However, our current standards and default ways of working are not designed for this, making it harder to develop bespoke, integrated, and optimal recovery solutions. That's why our whole industry - and beyond - must collaborate to build truly resilient recovery, in service of thriving places with strong communities. By understanding the interconnected physical, natural, social, and cyber systems that undergird civil society, and strengthening those systems rather than infrastructure components alone, we can maximise our investments and build back better. Strategic plans can then be enriched with insights from the full complement of stakeholders, leading to truly resilient recovery programmes. But this requires confronting the complexity of working together across multiple disciplines, schemes, and institutions.

RECOVERY REIMAGINED

Resilience is impossible without confronting the key issue: society is inherently complex, climate change is inherently complex, and therefore so too is recovery.

So our understanding of recovery must change, from linear and straightforward to holistic and multifaceted. Recovery is not simply cleaning up debris and rebuilding roads and pipes. It's revitalising the manifold systems undergirding social and economic life. Understanding how these are affected by disaster events is crucial to prevent equivalent damage in future.

Often overlooked or unexpected elements can contribute disproportionately to the damage - and, once identified, reveal the path to greater resilience. For example, the Colorado wildfires of 2022 were exacerbated by stormwater management systems, which acted as a conveyance for the fires. But it wasn't the system itself - it was the dry foliage which had accumulated within them. Therefore, and perhaps surprisingly, the maintenance regimes of the stormwater management systems have a significant impact on wildfire impact. Without such learnings, few would have predicted that the maintenance of stormwater management systems could play an important part in reducing the damage wrought by wildfires. Taking the time to understand disaster events depends in part on how we conceive, scope, and approach recovery.

BUILDING BACK BETTER

Hurricane Maria wrought enormous damage to Puerto Rico. Extreme rain and saturated soils caused enormous landslides, destroying infrastructure and cutting off access for communities in the rainforest.

AtkinsRéalis worked on Puerto Rico's recovery at El Yunque, a national forest, supporting the construction of resilience to landslides while maintaining the site's beauty. We helped adapt Puerto Rico's attractive but outdated stormwater management infrastructure with solutions designed to embed greater resilience. Applying improved design techniques, these solutions allow transport facilities to handle larger hydraulic capacity in water flowing through, using porous rock rather than concrete so that water can move through without filling it to its breaking point. These adaptations reduce negative impact, lower risk, and allow communities to build back stronger. Still, while there are broader lessons to be learned, there is no single or universally applicable solution. Not only is each community, region, and event unique, but also adaptations are not mutually exclusive - improving resilience in one area may unintentionally weaken another. For example, 91% of housing in Boulder, Colorado, has been built since 1990. Built to newer building codes and standards, new houses tend to be more resilient to rainfall and storms, while also being more energy-efficient - strengthening the region's resilience. Yet local developers and

decision-making authorities allowed housing to expand into undeveloped, vegetated landscapes, increasing the potential for wildland fires to impact the encroaching communities. Failure to address the threat of wildfire in the long-term plans exposed the State and its citizens to greater risk.

That's why we need a broad, holistic view on both routine growth and post-disaster recovery, so that solving one or two aspects of resilience doesn't blind us to ongoing vulnerabilities in a third area. Trade-offs are unavoidable - yet collaboration allows us to chart an optimal course through the myriad possibilities. Facilitating conversations between diverse stakeholders can ensure enriched decisions with the full complement of perspectives necessary to confront such a complex threat.

FROM SURVIVING TO THRIVING

For resilient, long-term recovery, bringing the right stakeholders to the table early on can make all the difference. Yet bringing stakeholders together, building mutual understanding, and defining the long-term plan takes time - and our mechanisms for funding, including disaster funding, tend towards immediate response. And without multidisciplinary collaboration, we cannot embed resilience throughout complex, holistic systems. If each stakeholder is limited to their own silo, with a limited perspective and data set, and unable to define, develop, or contribute to integrated, resilient solutions, our solutions are correspondingly limited, too.

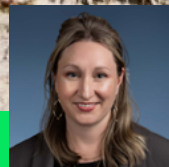
Yet the willpower for change is there. The problem isn't insufficient will, but the capacity to respond to the increasing intensity, frequency and cost of the events, and their subsequent impact on our built and socio-economic infrastructure and natural resources. Expediting process improvements in response to this increased frequency depends on changing our perception of 'recovery', from a one-off cost to an ongoing process of deepening understanding. It's relatively easy to rebuild the road exactly as it was; it's much harder to improve it so that it's more resilient in the face of evolving hazards. And if it's not resilient, it's not true recovery. If we can rally around a shared vision of resilient recovery, if we can come together to challenge and improve standards, then we can transform not just how we rebuild our infrastructure - but our communities, too.



After the storm: how Hurricane Michael reshaped resilience on the Gulf Coast



Ryan Wiedenman



B. Dina Bautista

Withstand and Recover

In 2018, Hurricane Michael became the first Category 5 hurricane to make landfall in the contiguous United States since Andrew in 1992. Yet, in many ways, Hurricane Michael was even more severe than this categorization implies - Category 5 is the most intense in terms of wind speed, but wind force is just one cause of damage from hurricanes. Storm surge is another indicator of intensity, and Michael's storm surge was 14 feet high, inundating normally dry areas under vast amounts of water. Economically, the damage to the United States reached \$25bn.

Preparation can significantly reduce damage. Yet climate change appears to be yielding storms that intensify very rapidly. One of the reasons for Hurricane Michael's catastrophic impact was its unusually rapid intensification. Until just hours before landfall, Michael was only a Category 2 storm, the second lowest on the scale. It escalated to the highest category so quickly that many people were caught unawares, having expected a much milder storm - especially as the region had not experienced a Category 5 storm in recent memory. Building codes that only met the minimum statewide requirements meant that standards were insufficient in parts of the state. If storms will intensify so rapidly, we need deeper, long-term resilience built into codes and regulations.

In one sense, looking at only past events that have impacted the region, Hurricane Michael was a rare event. But the Gulf of Mexico is witnessing an increased frequency of strong hurricane events in recent years.

Since Michael, several severe storms have hit the same region. Suffering intense storms every 5 years, rather than every 20, is exposing inadequacies and vulnerabilities of our usual 'get back to normal, fast' mindset. Communities confronted with concurrent disasters and several ongoing recoveries at once often don't have the staff or resources in place to be in continuous response and recovery mode. This makes it difficult to move on from one storm to the next, especially when the damage is to the same infrastructure.

We must also confront the tension between rapid recovery and resilient recovery. Traditional approaches focus on getting back to normal as quickly as possible - because the longer it takes to get back up and running, the greater the immediate hit to society and the economy. But the need to re-establish a functioning economy and infrastructure services is often at odds with embedding longer-term resilience. Communities must be supported in understanding how and why the storm exposed their weak points, and how best to manage investment so that they're more resilient when the next storm hits. While it's easier and faster to skip redesign and go back to the way it was, this can leave the same vulnerabilities that existed prior to the storm. However, catastrophic storms often leave communities with a determined mentality to never suffer the same devastation again, meaning they're more open to change and improving long-term development. That's a potential silver lining; but only if we build on it.

DISASTER CLASS

Of all the places impacted by Hurricane Michael, few were as badly hit as Mexico Beach. The community of under 2,000 people was completely overwhelmed. Over 14 feet of water inundated the city, leading the United States Geological Survey to classify Michael's surge at Mexico Beach as a 1-in-280 year event. Its vulnerabilities were ruthlessly exposed, leaving the town close to inhospitable. Relying on lift stations to pump its wastewater, Hurricane Michael rendered 25 of its 27 stations inoperable. Similarly, the city's water supply - dependent upon a single pipe, transferring supply from 25 miles from the west - was completely stopped, with the pipe broken in multiple places. Of Mexico Beach's 3 bridges enabling entry and exit, 2 were damaged and one was taken out completely. Like an island, Mexico Beach was cut off from the neighbouring communities and facilities upon which it depended. Over 75% of all citywide structures were damaged and many of those assets were substantially damaged.

As well as the infrastructure, Hurricane Michael exposed the weaknesses of Mexico Beach's response capacity. The police and fire station, so important to the response effort, were inundated by 12 feet of water, and the sheriff's office was swept off its foundation. The city's mandatory evacuation - which was required to save lives - inadvertently stalled immediate recovery, because first responders simply could not get back into the city. One firefighter walked 12 miles with a chainsaw in order to access



the city and contribute to its recovery. Post-storm, the city recognized that a Safe Room for emergency personnel would enable key staff to remain safely within the precinct, and begin recovery efforts immediately afterwards. Similarly, placing the police and fire station further landward of the Gulf of Mexico would help prevent their going offline at the crucial moment.

SMALL BUT STRONG

For communities like Mexico Beach, assistance is vital. With its small population and without experience of a severe storm in living memory, Mexico Beach could not recover on its own. They lacked the staff with the experience of handling the intricacies and sequencing of recovery. AtkinsRéalis were brought in immediately after the storm as disaster recovery specialists, who provided subject matter expertise in managing the relief effort. From getting debris off the streets to establishing the reporting mechanisms to ensure ongoing eligibility for reimbursement from federal agencies, we helped to coordinate the recovery efforts as efficiently as possible.

Our coordinated, integrated approach laid the foundation to build back better than before. Rather than just restoring the water infrastructure, we established a back-up water supply from a neighbouring community in the other direction, with water tightening to prevent corrosion of electrical components in sewers. Observing these weak spots, and understanding how to eliminate or adapt them, is a crucial first step in a resilient recovery.

Beyond infrastructure, communities must develop financial and political resilience, too. For Mexico Beach, this was vital. In the US, communities must clearly demonstrate how the funding is used towards recovery efforts that are aligned with federal policy to rebuild. Otherwise, communities can find that they may be ineligible for reimbursement - a double disaster that could hamper recovery for years. However, even when recovery funds are granted, recipients are required to file documentation to prove the validity of their spending. Moreover, they also have the chance to access second tier funding, but only if they improve resilience. This process of demonstrating greater resilience is demanding, requiring multidisciplinary expertise. But vital funding is at stake, funding which could enable otherwise-unaffordable long-term improvements. We helped Mexico Beach go the extra mile, submitting applications with the required documentation to win additional resilience funding.

FROM REACTIVE TO PROACTIVE

We can no longer afford to play catch-up, struggling to return to normal in the face of more severe and frequent storms is not a viable option. The example of Mexico Beach shows that even the smallest communities can overcome disaster and embed resilience more deeply. Financial constraints or limited resources are not an excuse to bury our heads in the sand. Despite its size, Mexico Beach took on the task of resiliency and now their community is better protected as a result.

Moreover, many interventions can have a big impact without exorbitant investment. Communities across the Gulf, including Mexico Beach, are going beyond just hardening physical infrastructure to shifting policy itself. Changing the ordinances for building permits, from residential to commercial to city infrastructure, is comparatively low in cost - but it can have disproportionately valuable long term effects. As climate change intensifies, the minimum standard within existing codes may no longer be enough to satisfy a community's need to feel safe, especially after a severe storm. Hurricane Michael revealed complacency with standards - Mexico Beach's adherence to minimum standards still left them shockingly exposed.

Ultimately, all communities must ask themselves how protected they are. Is the minimum standard enough? Long-term resilience doesn't happen overnight. But it does start with the willpower to confront complacency, tackle weaknesses, and invest in a resilient future.





Tackling climate risk together

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