

CITIES &
PUBLIC SERVICES

FROM DATA TO ACTION:

RETHINKING FLOODING RESILIENCE FOR CITIES AND TERRITORIES

URBAN FLOODING: A MAJOR RISK TO RESILIENT CITIES

KEY FLOODING CHALLENGES FACED BY CITIES AND TERRITORIES

THE URBAN VIRTUAL TWIN: AN ESSENTIAL TOOL TO DESIGN RESILIENCE

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DASSAULT SYSTEMES



URBAN FLOODING: A MAJOR RISK TO RESILIENT CITIES

Flooding is amongst the deadliest natural disasters, striking various regions in the world each year. According to the World Meteorological Organization, **2.5 billion people worldwide are exposed to floods**, which pose a significant risk to lives and livelihoods.

Climate change disruption is ongoing, and consequently, the increase in frequency and intensity of flooding events across the world. Today, **floods account for up to 40% of weather-related disaster occurrences**. According to a report from the United Nations Office for Disaster Risk Reduction (UNDRR), each year, more than USD 300 billion is lost in damage caused by floods.

As cities grow, the extent of soil sealing increases. Cities and territories face different types of flooding events with variations in impact intensity and destruction potential. These risks require anticipation, adequate planning and effective mitigation plans.

Flooding can take various forms. The main ones are:

River Floods

River floods occur when rivers overflow their banks, inundating surrounding areas and damaging critical infrastructure such as bridges, roads or water systems. These events can disrupt transportation networks and local economies for weeks.

Heavy Rain

Flooding from heavy rain is often sudden and unpredictable, overwhelming urban drainage systems and leading to flash floods that threaten lives, damage homes and strain emergency response resources.

Coastal Floods

Coastal floods, driven by high tides, storm surges or rising sea levels, put coastal cities at constant risk, endangering ports, industrial zones and tourism hubs while accelerating shoreline erosion.

With impacts exacerbated by land use change and increased population pressure on flood-prone areas, adequate flood planning and management are becoming crucial for territories.

For planners, city officials and rescue teams, understanding these diverse risks is essential.

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Understanding and Visualizing the Scope and Impact of the Flood

By nature, flooding events as well as their intensity are unpredictable. Therefore, cities need to anticipate risks to evaluate damages in case the event happens. The challenge is to consolidate accurate data on potential water levels, flood duration and progression, infrastructure damage and affected populations to help territories anticipate impacts of flooding episodes before they occur.

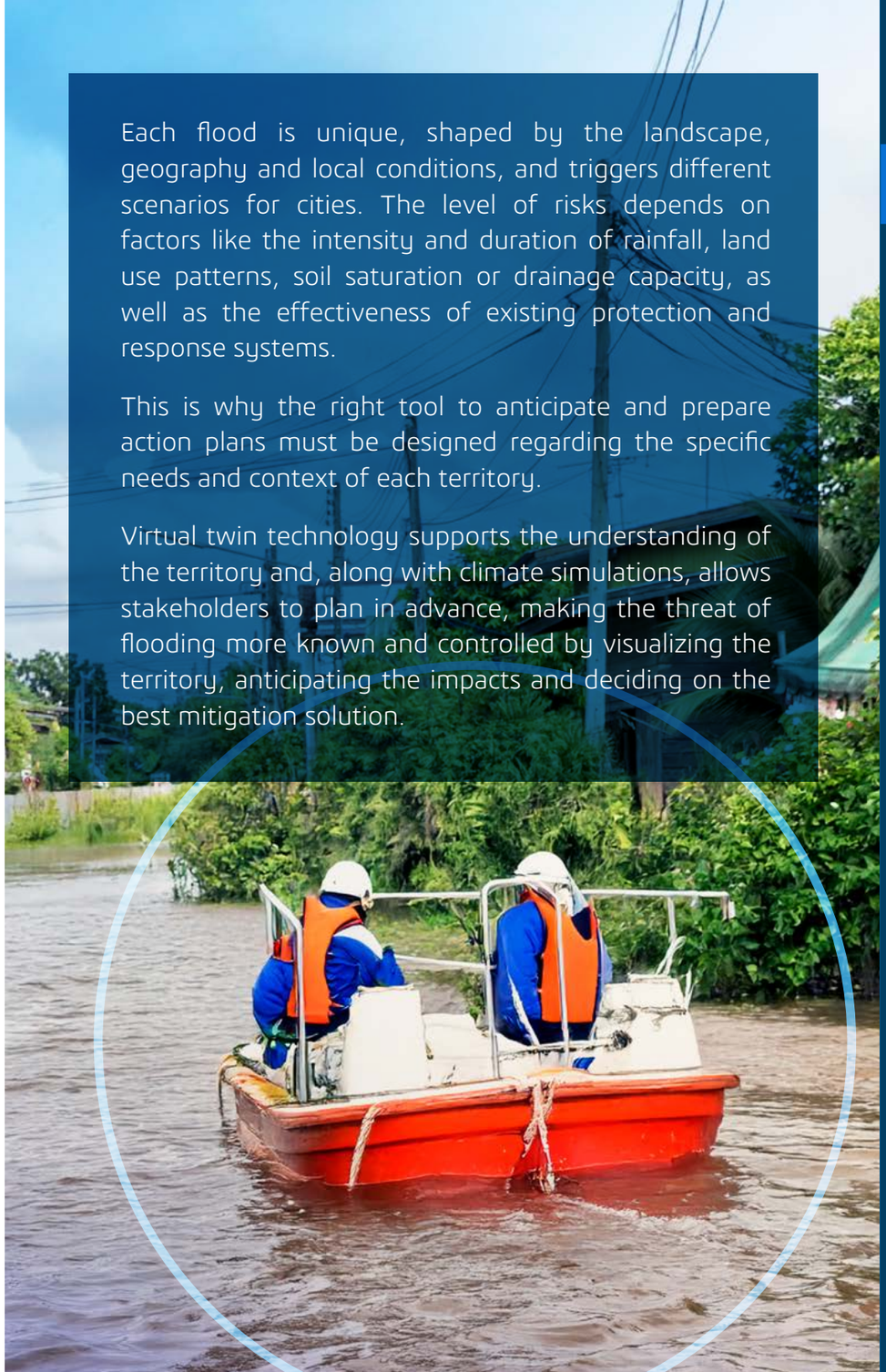
A lack of clarity can degrade planning and emergency response efforts.

Anticipating Mitigation Solutions

Impact analysis is a required knowledge to anticipate and prepare mitigation scenarios. Being able to plan and implement effective flood mitigation strategies is a complex and long-term challenge. Cities and territories must evaluate a wide range of solutions, such as green infrastructure (wetlands, pounds) or engineering projects like permanent walls and barriers. Anticipating which measures will be the most effective requires detailed assessments, modeling and community engagement.

Planning Emergency Plans

Efficient emergency planning is critical to reduce the human toll of flooding, yet it remains a logistical challenge for a lot of territories. Authorities must be able to develop clear evacuation routes as well as hospital access routes, designate safe shelters and ensure that communication channels stay functional. Coordinated planning and regular drills are essential to ensure smooth, efficient evacuation efforts that keep people safe.



Each flood is unique, shaped by the landscape, geography and local conditions, and triggers different scenarios for cities. The level of risks depends on factors like the intensity and duration of rainfall, land use patterns, soil saturation or drainage capacity, as well as the effectiveness of existing protection and response systems.

This is why the right tool to anticipate and prepare action plans must be designed regarding the specific needs and context of each territory.

Virtual twin technology supports the understanding of the territory and, along with climate simulations, allows stakeholders to plan in advance, making the threat of flooding more known and controlled by visualizing the territory, anticipating the impacts and deciding on the best mitigation solution.

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A virtual twin is a dynamic 3D digital replica of a real-world environment, system or asset that integrates data, simulation and visualization into a single unified platform. It consolidates geographic, environmental, social, economic and infrastructure information into a single, reliable source, enabling stakeholders to analyze and understand complex realities. By transforming data into knowledge, it supports science-based decisions that enhance resilience and protect lives.

An urban virtual twin connects multiple layers of the city, such as buildings, infrastructure, transport, natural features and population, with different types of data like geospatial or building information modeling (BIM) data. It allows simulations to be integrated in a city or urban territory context to test and compare scenarios.

In essence, it turns the city into a living, evolving model that helps leaders design safer, more resilient and sustainable places to live.

In the context of flooding, the virtual twin enables authorities to understand local vulnerabilities and critical impacts on population safety, infrastructure damage and economic disruption, helping prioritize interventions where they matter most.

For emergency and rescue planning, it offers situational awareness, showing potential flooded zones in advance, safe routes and evolving conditions with a timeline to support faster, safer preparation and responses.



The Key Benefits of Using a Virtual Twin To Mitigate Flooding Impacts:

Sustainable and informed planning	Guides resilient urban development and investment decisions
Simulation and mitigation testing	Enables virtual testing of drainage, barriers or land-use scenarios to find effective solutions
Risk and damage assessment	Quantifies flood losses, helps prioritize protection and reveals impacts on infrastructure, economy, environment and people
Emergency planning	Supports public safety organizations with anticipation of flooding events to plan emergency workforce accordingly
Collaboration and communication	Connects governance, engineering, planning and citizens around one shared understanding
Data-driven understanding	Provides clear insights into flood behavior and exposure zones using real and modeled data
Single source of truth	Unifies all environmental, urban and infrastructure data in one accurate platform

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The service-based approach provides cities and territories with a turnkey urban planning solution that taps into Dassault Systèmes' 40 years of expertise in virtual twin technology.

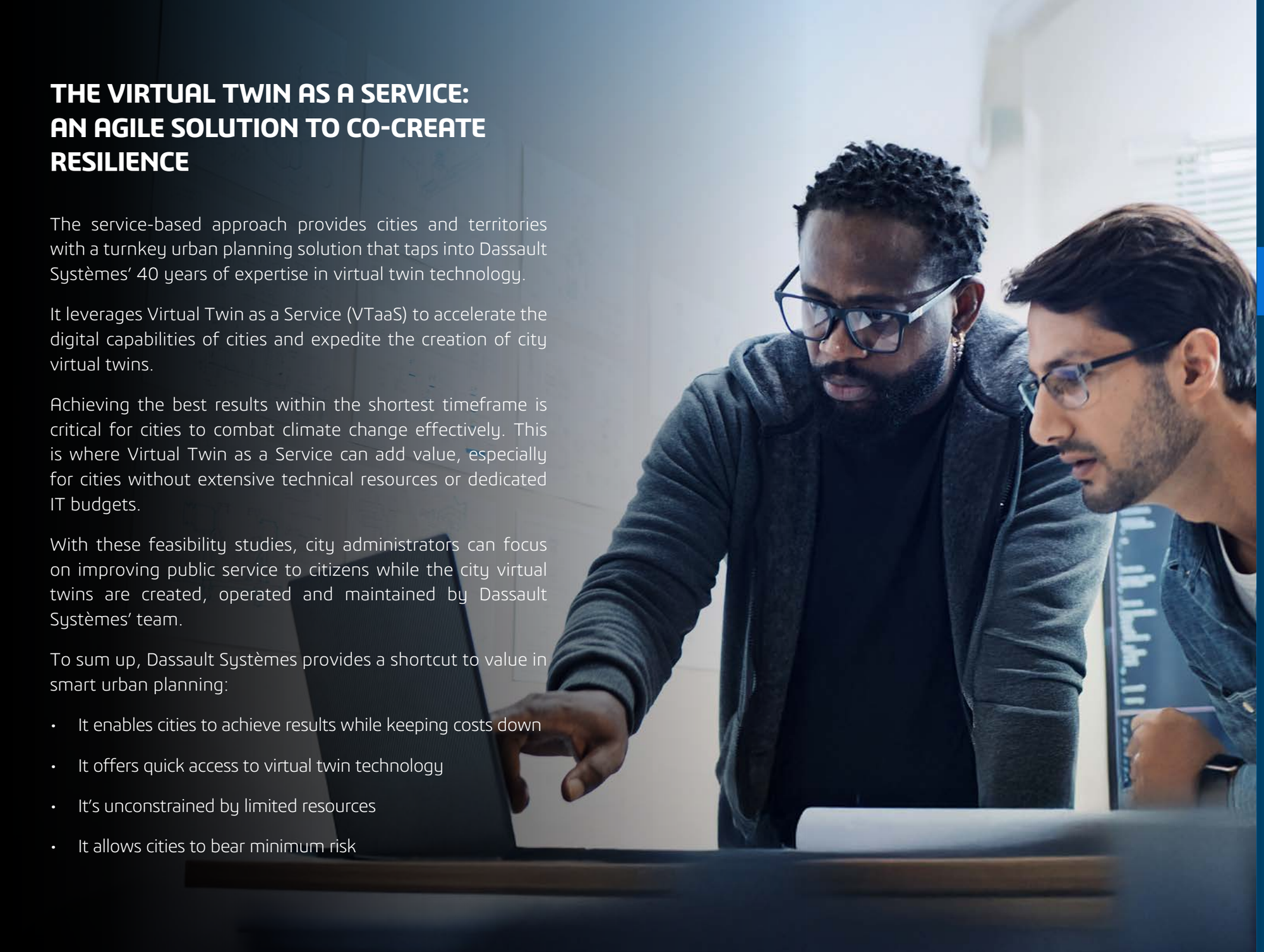
It leverages Virtual Twin as a Service (VTaaS) to accelerate the digital capabilities of cities and expedite the creation of city virtual twins.

Achieving the best results within the shortest timeframe is critical for cities to combat climate change effectively. This is where Virtual Twin as a Service can add value, especially for cities without extensive technical resources or dedicated IT budgets.

With these feasibility studies, city administrators can focus on improving public service to citizens while the city virtual twins are created, operated and maintained by Dassault Systèmes' team.

To sum up, Dassault Systèmes provides a shortcut to value in smart urban planning:

- It enables cities to achieve results while keeping costs down
- It offers quick access to virtual twin technology
- It's unconstrained by limited resources
- It allows cities to bear minimum risk



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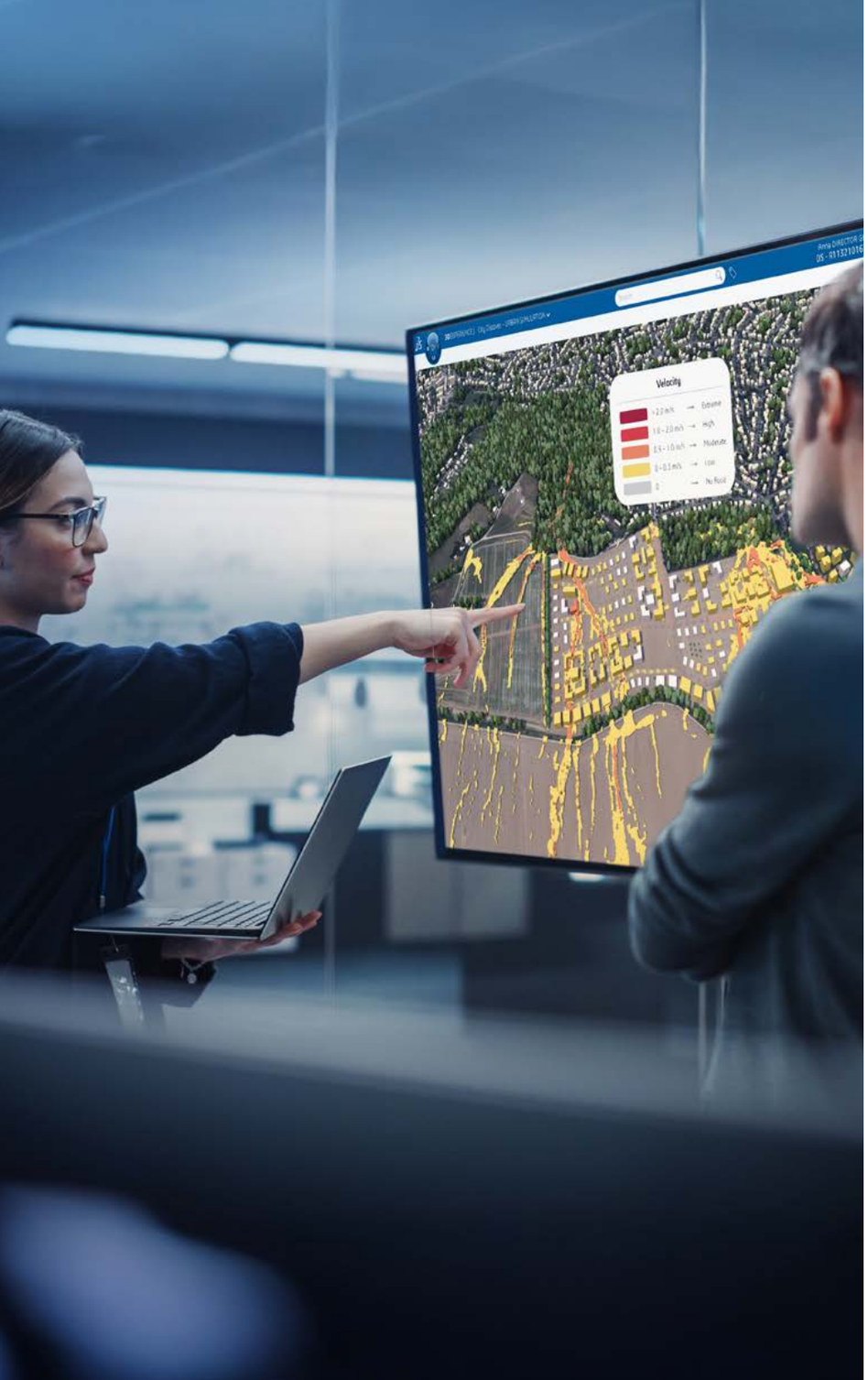
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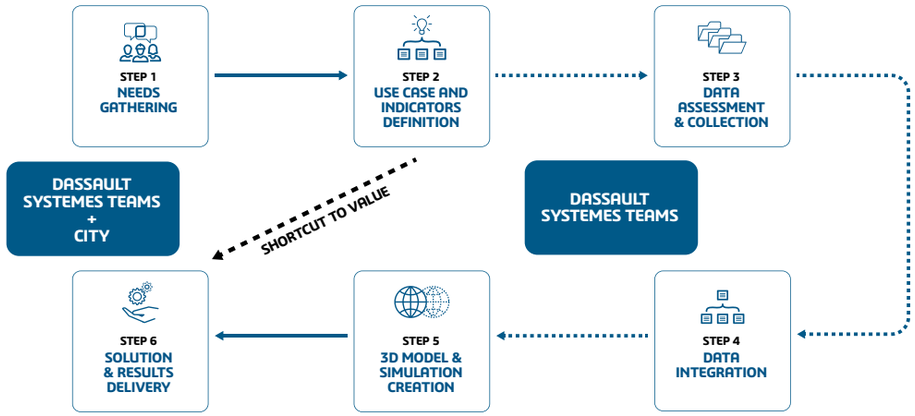
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It All Starts With a Feasibility Study: The Outcomes for Flooding Analysis

Through simulation and analysis results delivered directly by Dassault Systèmes' teams, cities can:

- Visualize the environment in a 3D model
- Simulate various types of flooding such as river overflow, heavy rain, coastal surge and water runoff
- Evaluate mitigation strategies such as new infrastructure, natural barriers and temporary barriers
- Test the resistance and effectiveness of proposed mitigation measures through realistic scenario simulations
- Collaborate across departments and stakeholders through an integrated platform and customized dashboards, supporting shared understanding and faster decision-making

The process allows cities to comply with local regulations for flooding situations such as mandatory emergency and safety route detection or water management systems.

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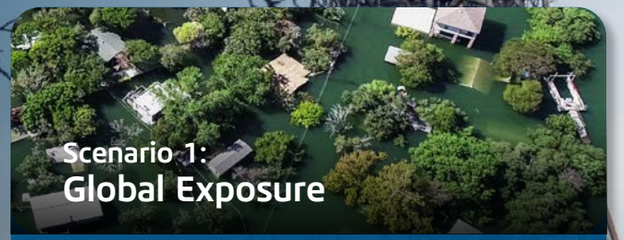
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Our use cases are built on a multi-layer analysis, from the neighborhood to regional level. The examples presented illustrate possible scenarios designed to show how virtual twins can guide evidence-based action. This is a non-exhaustive list of possible scenarios, all of which can be mixed and tailored according to the territory's needs.



Scenario 1: Global Exposure

Extreme rainfall flooding impact on population, property and city infrastructure.

Objectives:

- Visualize the flood evolution development from onset to water recession
- Explore mitigation solutions (temporary barriers)

Examples of data monitored:

- Building heights versus flood water levels
- Flood depth and velocity
- Hourly flood progression
- Disruption risk on transport network

Outcome:
Supported prioritization of protective measures for vulnerable areas and critical infrastructure



Scenario 2: Population Risks and Evacuation

Flooding impact on vulnerable population groups.

Objectives:

- Identify vulnerable population zones exposed to flood
- Quantify human and social impacts to support disaster planning

Examples of data monitored:

- Population exposed (demographic criteria)
- Housing characteristics and displacement estimates
- Accessibility and evacuation capacity

Outcome:
Identified priority neighbourhoods for emergency planning and targeted support

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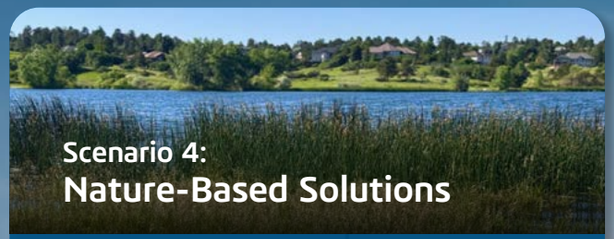
Scenario 3:
Economic Impacts

Flooding impact on key economic sectors such as residential, commercial and transport.

Objectives:
- Assess overall economic exposure to flood
- Estimate sectoral losses across affected areas

Examples of data monitored:
- Building and asset value exposure and depreciation
- Structural damage estimates
- Households' reconstruction costs
- Transport and logistics disruption

Outcome:
Quantified potential financial losses to justify funding request for resilience investments



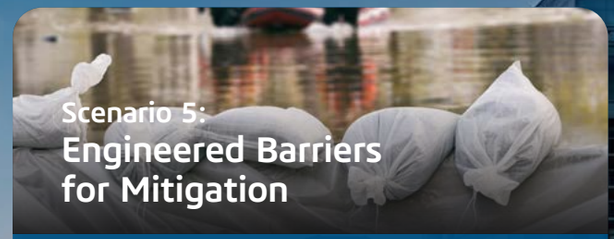
Scenario 4:
Nature-Based Solutions

Flooding management by nature-based Solutions (NbS) such as wetlands, ponds and permeable surfaces.

Objectives:
- Assess NbS effectiveness for flood risk and runoff
- Identify areas to prioritize for implementation

Examples of data monitored:
- Reduction in flood depth and water velocity
- Runoff and peak flow reduction
- Changes in flooded areas under NbS scenarios

Outcome:
Selection and prioritization of NbS projects to integrate in urban development



Scenario 5:
Engineered Barriers for Mitigation

Mitigation flood management using engineered barriers such as levees, floodwalls and temporary barriers.

Objectives:
- Evaluate effectiveness of temporary barriers in reducing inundation depth and extent
- Compare performance under various flood events

Examples of data monitored:
- Reduction in flood depth and duration behind barriers
- Water level and flow velocity with or without barriers

Outcomes:
- Identification of the most effective mitigation with quantified flood reduction and prioritization of strategic locations
- Enabled the selection and prioritization of NbS projects to integrate in urban development

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DEPLOYMENT AND SUPPORT

To deploy the service, the city doesn't require on-premise implementation or expertise.

The project is designed around four components that include:

1. The accuracy of the virtual twin (level of detail)
2. The size of the analyzed area
3. The data and model availability
4. The number of scenarios and iterations

Dassault Systèmes' expert teams will develop and deliver the defined modeled area in a 3D virtual twin and provide analysis results to the city in a collaborative environment in a few weeks or months, depending on the complexity. At the end of the project, if new simulations are needed or the area expanded, the city can scale the project and tailor it to its need.



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Building resilient and sustainable cities in the face of increasing flood risks requires an integrated, data-driven approach centered around collaboration, visibility and strategic planning. The foundation lies in outsourcing the creation of an **urban virtual twin:** A unified, data-rich model that serves as a single source of truth, enabling stakeholders to access consistent and up-to-date information to reduce risks, creating a shortcut to value.

By accessing and exploiting dynamic flood risk assessments and advanced simulations, cities can proactively evaluate vulnerabilities, test mitigation strategies and optimize resource allocation. The use of 3D visualization tools and integrated project planning fosters effective coordination among urban planners, policymakers, elected officials and communities, ensuring mitigation actions are timely and well-executed.

By leveraging comprehensive data analytics, transparent tracking of sustainability and resilience KPIs and robust governance frameworks, cities enhance their capacity to adapt to evolving climate challenges while minimizing environmental impact. Ultimately, this holistic framework empowers urban planners and decision-makers to build safer, more resilient and sustainable cities that protect both people and infrastructure for the long term.

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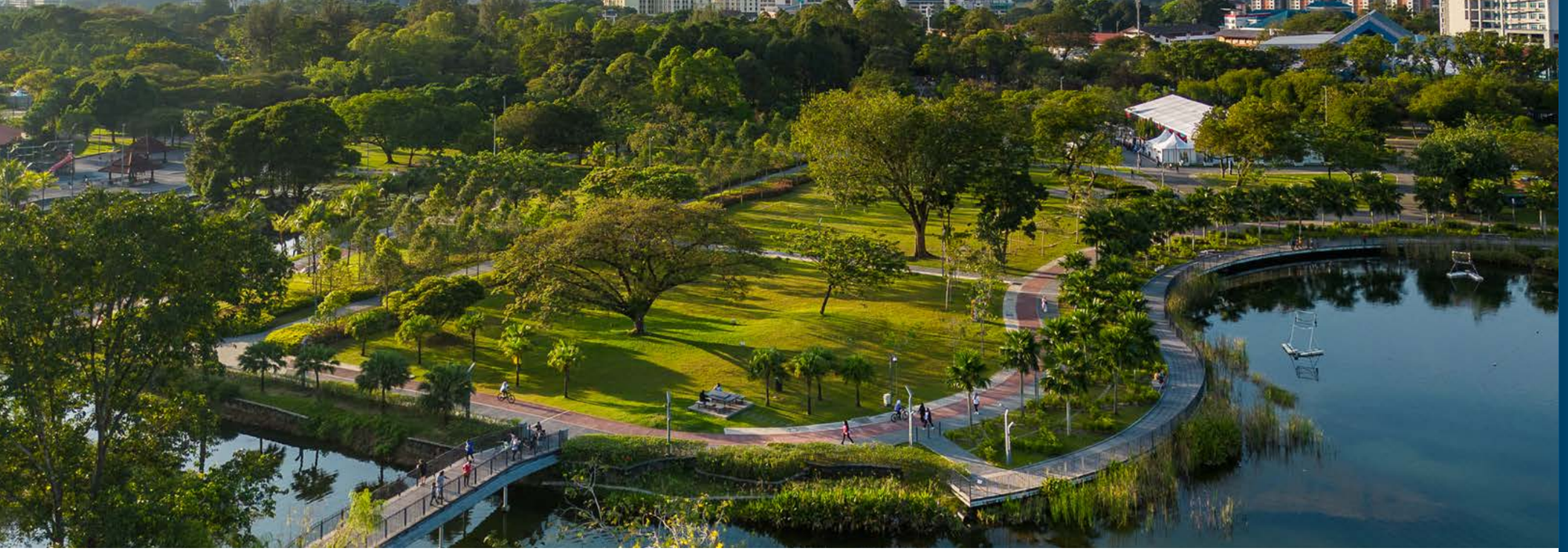
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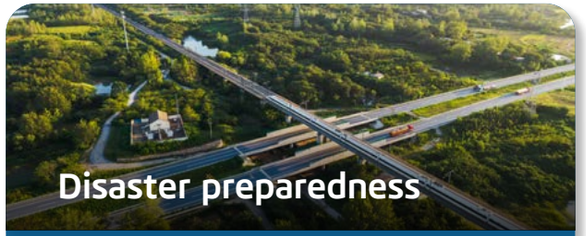
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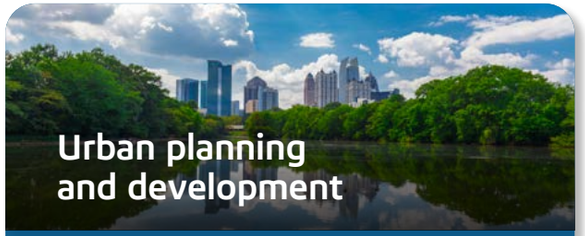
OTHER PATHWAYS TOWARD RESILIENT CITIES AND TERRITORIES

Supporting resilient cities and territorial authorities through public sector expertise requires adapting to all types of challenges. This is why Dassault Systèmes supports cities and territories on more topics with other packaged feasibility studies:



Disaster preparedness

- Extreme heat and heat island simulations
- Mitigation plan



Urban planning and development

- Urban generative design AI tools



Mobility pollution

- Air and noise simulations
- Mitigation plan

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CONTINUING THE CONVERSATION

Dassault Systèmes is keen to continue the discussion with stakeholders across the cities and public services value chain to understand how these vital environments can continue their transformation for the benefit of all citizens. We welcome the views of policymakers in local and national governments, professionals within the industry and the wider urban design community within planning, architecture and cities engineering. Collaborative knowledge-sharing and real-world simulation have the potential to drive many innovations and changes.

The goal is a system of operational excellence which will continue to ensure that cities and territories around the world remain competitive in focusing on the sustainability of businesses, people, products and the environment.

Join this resilient transformation and have your say.

For more information, contact us here.



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Virtual Worlds for Real Life

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