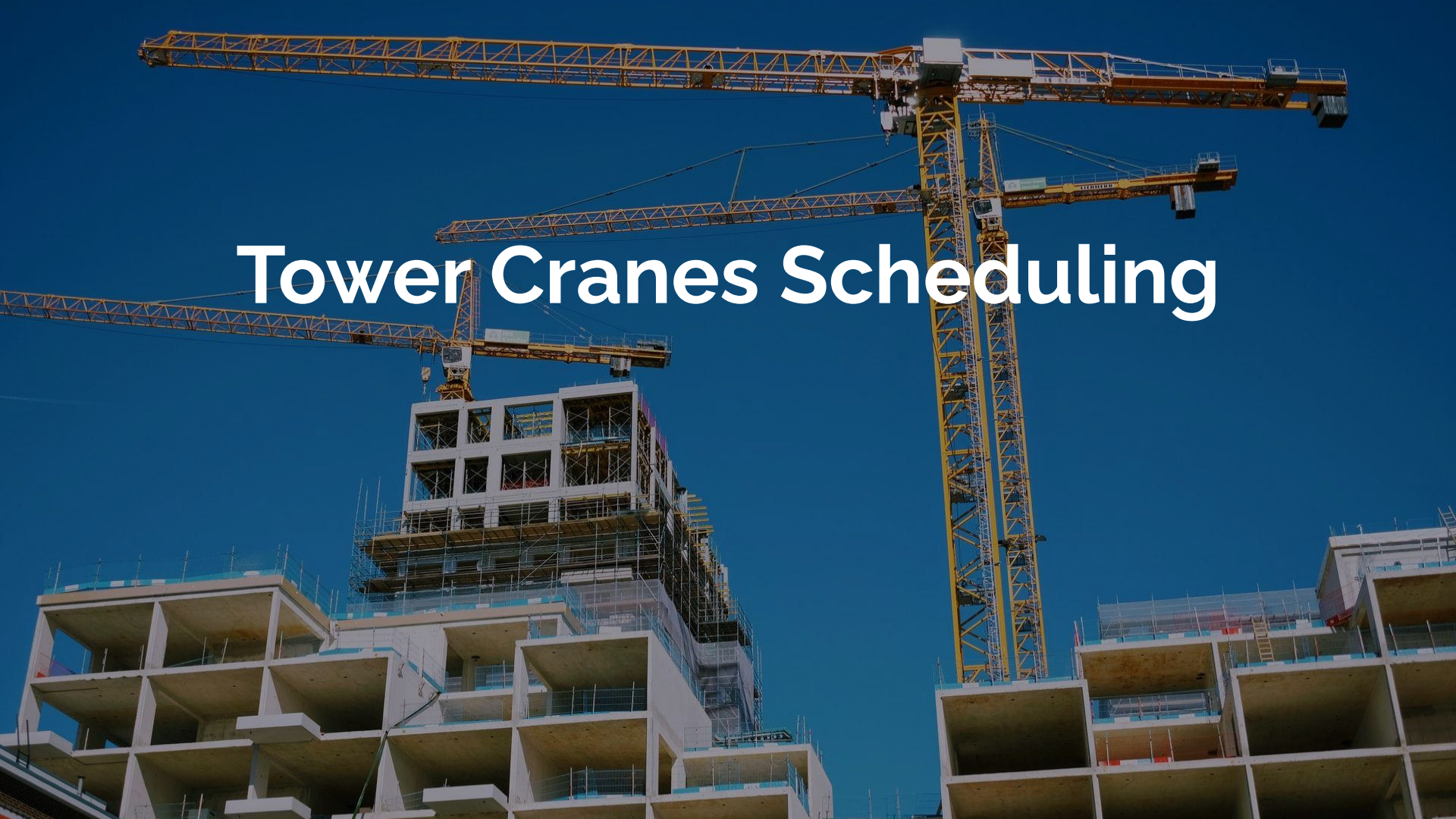

CoEnzyme
Analytics & Decision Optimization
Optimization in construction



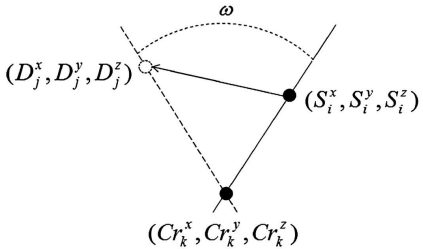
Tower Cranes Scheduling

Tower Cranes Scheduling

Because tower cranes are very expensive resources, their **height**, **capacity**, and **location** need to be carefully chosen to minimize costs and time to move materials on the site.

Crane operator schedules and operation times also need to be optimized.

Tower Cranes Scheduling



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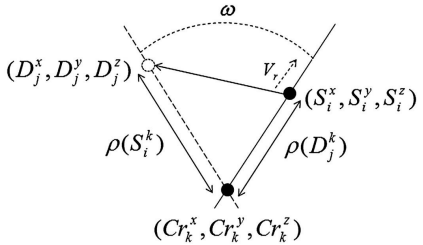

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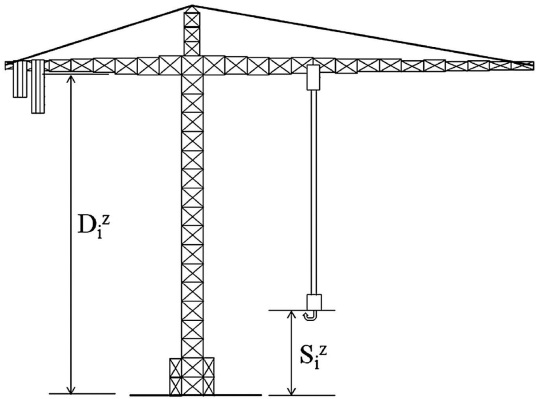
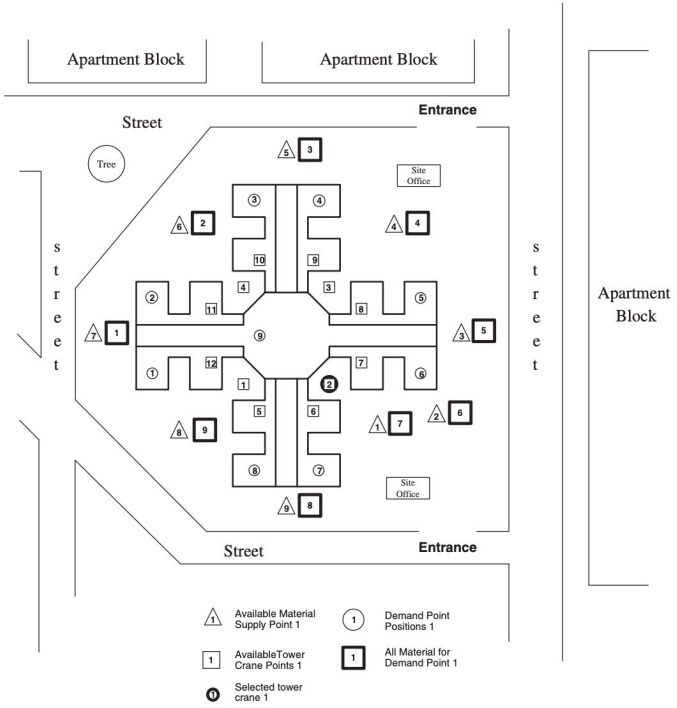


(c)

The location of the crane impacts the **time it takes to move materials** and the **maximum load** the crane can lift. Which indirectly impact the **operation hours** and the **number of operators** required for the crane.

Ultimately driving costs and delays.

Tower Cranes Scheduling



Crane location needs to consider multiple factors like distance between material supply and delivery points, ground conditions, interference with other site equipments, existing site obstacles, places with good visibility and wind.

Tower Cranes Scheduling

Optimization models can help managers make better choices for tower crane types, numbers and locations, as well as optimizer the schedule of their operators.

Concrete Delivery

Concrete Delivery

Concrete delivery is complex and challenging due to the **perishable** nature of the product. It can be affected by weather conditions, has a 30 minutes window before it hardens and can even destroy the barrel.

Concrete - Production challenges

Concrete must be mixed on demand, lasting approximately two hours after water has been added to the mix of dry materials, leaving a reduced and strict time window for its delivery.

In a very dynamic market with **70% of change orders** and very **strict delays**, concrete production need to respond quickly to **changes in the delivery schedule**, while keeping the performance indicators of the plant aligned in terms of energy consumption, stock and maintenance activities.

Concrete - Delivery challenges

Many deliveries of concrete are necessary over **long periods of time** and **multiple sites**. The delivery plan needs to consider the number of vehicles needed, the frequency of deliveries, the distance between multiple customer sites and labor laws.

Truck scheduling and routing needs to avoid **non-full loads** of concrete, because this could result in a=an increased rate of hardening of the concrete.

Concrete - Integrated operations

Synchronized **concrete production** and **truck scheduling and routing** allow operators to better define the number and frequency of concrete-mixer vehicles to deliver concrete from manufacturing plants to multiple construction sites over a working day.

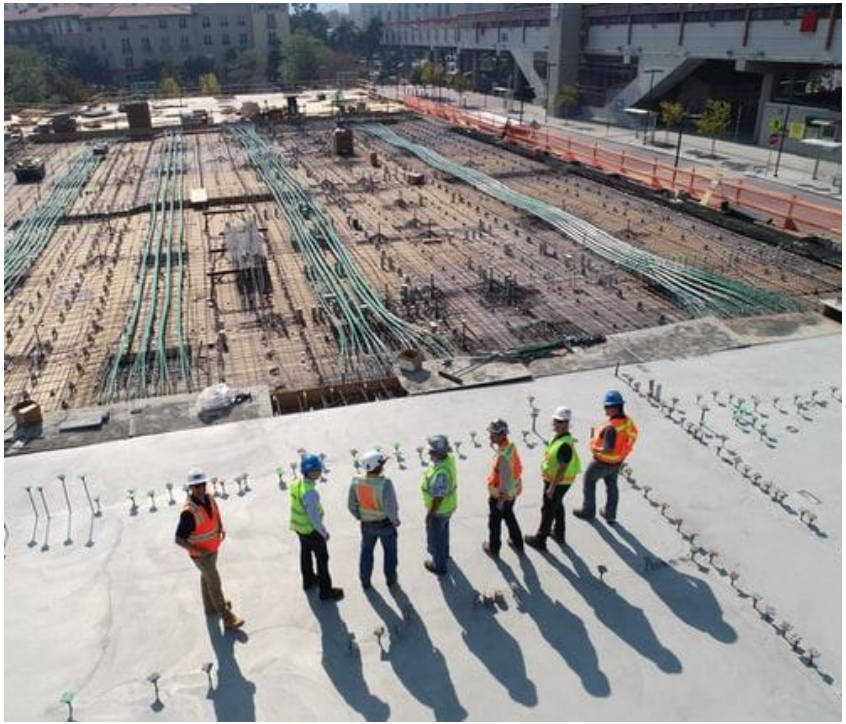
This results in more streamlined operations, less delays and less waste.


Site Layout

Site layout

Disorganized and congested sites can create time delays, cost overruns, and even accidents.

Effective site layout planning, is one of the most important project management tasks. It has a significant impact on all aspects of construction, including safety, productivity, site operations, and ultimately time and cost **[*Binhomaid 2019*]**.



Site layout

Site layout planning determines the **best location for site facilities like workshops, storage areas, or equipment**, needed to execute the project, so that productivity and safety are optimized **[*Binhomaid 2019*]**

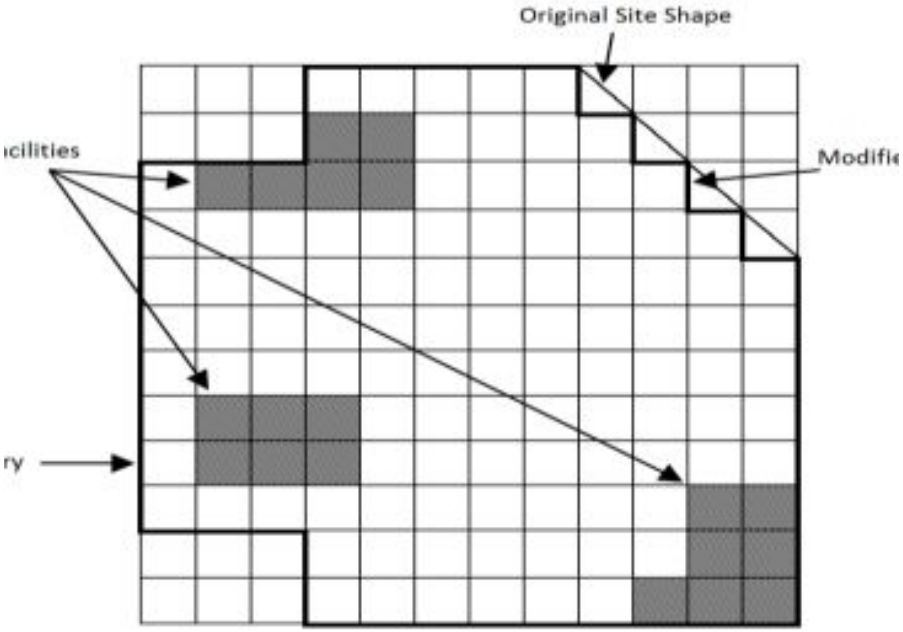
Site layout

Despite its importance, practitioners often ignore site layout planning, believing that it should be performed by site engineers while the project progresses, and the layout is often designed subjectively based on the planner's experience, codes of practice, trial and error, and previous similar projects. **[*Binhomaid 2019*]**

Site layout

Optimization models bring a **quantitative approach to site layout design.**

Managers have a global view of the site with its changes over time, with the ability to view the impact of changes to the layout and evaluate multiple scenarios..

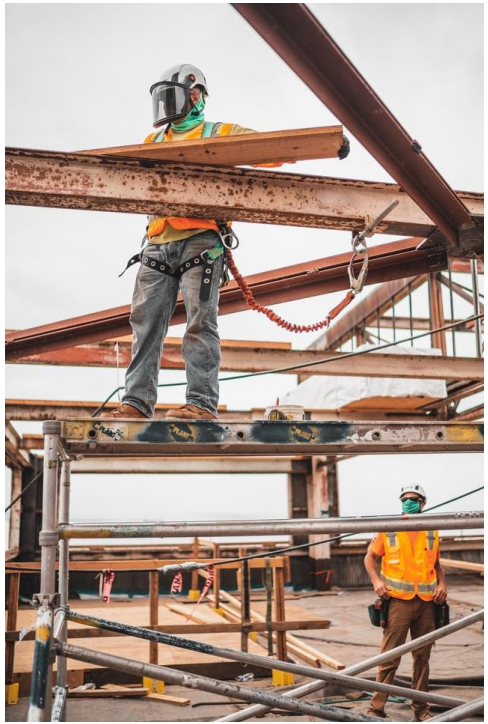



Resource Scheduling

Resource Scheduling

Scheduling all required tasks in a construction project is challenging and time consuming. One has to consider resources such as **machines** and **employees**, **equipment availability**, **capacity limitation of suppliers**, and even **spatial limitations** of the construction site.

Moreover, the schedule is likely to change during the execution of the project, which is why a **robust schedule** that can accommodate some delays is needed.



Resource Scheduling

	Component / Activities	Type / Include
1	**Foundation**	Foundation slab
		Foundation plinth
		Rock filled box timber caisson
		Caisson
		Timber grillage
		Pile
		Backfill
		Erosion protection
		Sheet pile wall
		Rock anchor bolt
2	**Slope and Embankment**	Embankment, embankment end, backfill
		Soil reinforcement and slope protection
3	**Substructure**	Lower front wall
		Bridge seat
		Upper front wall
		Pier
		Footing slab for pier
		Counterfort
		Wing wall
		Supporting wall
4	**Superstructure**	Slab and deck
		Beam
		Truss
		Arch, Vault
		Arch spandrel wall
		Cable system
		Pipe, Culvert
5	**Secondary load-bearing structure**	Secondary load-bearing beam, cross beam
		Secondary load-bearing truss, Wind bracing
		Edge beam

	Component / Activities	Type / Include
6	**Bridge equipment**	Bearing and Hinge
		Expansion joint
		Parapet
		Railing
		Guardrail
		Insulation, water proofing
		Drainage system
		Lightening, Electrical work and Accessories
7	**Surface layers**	Pavement (asphalt etc.)
		Insulation, water proofing
		Epoxy sealing
		Others
8	**Earthworks**	Excavation soil
		Excavation rock
		Soil filling
		Others
9	**Construction**	Scaffolding
		Temporary constructions
		Bridge construction
		Transportation of workers
		Other activities
10	**End of Life Management**	Demolition
		Landscaping
		Waste management (incl. recycling and recovery)

Constructing a bridge, for instance, requires **hundreds of tasks**: foundations, slope and embankment, substructure, superstructure, load-bearing structure, bridge equipment, surface layers, earthworks, assembly, etc.

Each activity has many sub-activities that require coordination of equipment, contractors, machinery, materials, etc.

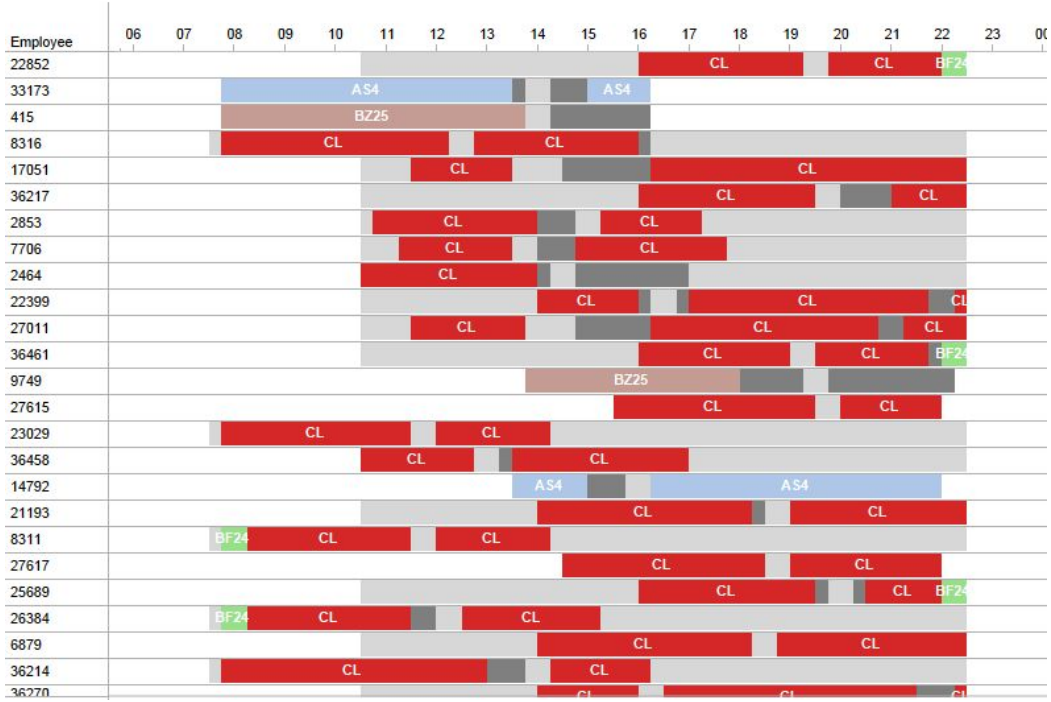
Resource Scheduling

Because of its complexity, a **large number of people are involved** in the planning and daily operations of all these tasks. This makes adjusting the schedule to unexpected situations very difficult and soon teams start **desynchronizing**, creating more **delays** and **cost overruns**.

Resource Scheduling

Scheduling optimization creates schedules that take into account the large variety of tasks and limitations found in construction sites, while being robust to changes and delays, and disrupting as little as possible existing operations.

And they can be modified as many times as needed.




Traffic Rerouting

Traffic Rerouting

Road blocks during construction cause traffic disruption.

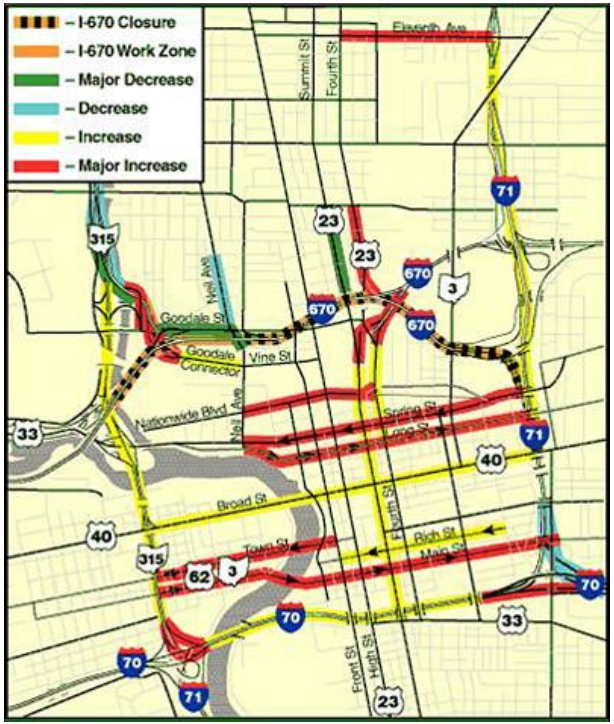
Not managing it properly exposes the company to severe financial losses as well as inconvenience to the public road users.

Traffic Rerouting

Traffic delays at work zones are caused by a **reduced number of lanes** and **lower speed limits**.

Traffic flow rates above the work zone capacity create queues and traffic delays. Below the work zone capacity, vehicles drive at reduced speed reducing the throughput.

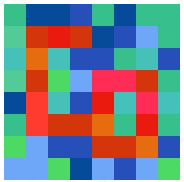
In both cases, traffic is significantly disrupted..



Traffic Rerouting

Modeling deceleration, queues, speed and alternate routes in an optimization solution allows finding the **best rerouting plan** for day and night operations.

Plans can be adjusted for particular conditions (weekends, rain) and presented to authorities for discussion and scenario analysis.



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