Introduction

Welcome. In this video, we will explore a series of use cases dedicated to urban planning, designed to demonstrate how the integration of Earth Observation data, autonomous systems and advanced digital technologies can support the development and management of urban areas. Cities today face increasing operational and management complexity. In dynamic urban contexts such as Nairobi, rapid urban expansion, population growth and growing pressure on infrastructure make it increasingly difficult to plan and manage the territory effectively.

Urban authorities must continuously monitor changes in land use, the growth of settlements, the condition of infrastructure and the availability of essential services. At the same time, urban planning requires the ability to coordinate multiple sources of information, which are often distributed and not always up to date. Maintaining urban infrastructure is also a key challenge. Roads, bridges, drainage systems, public buildings and transport networks require regular inspection to ensure safety, functionality and resilience. Without adequate tools, the timely detection of critical issues becomes difficult, leading to increased costs and potential risks for the population. These challenges are further amplified by environmental and climatic factors.

Events such as heavy rainfall, flooding and heatwaves directly affect urban livability and require advanced tools for risk analysis and management. To address this complexity, many cities are adopting technological solutions that enable large-scale data collection, continuous monitoring of the territory and more informed and timely decision-making processes. Among these technologies, autonomous robotic systems are gaining increasing relevance in the urban context. Ground-based robotic platforms can operate directly in urban environments to perform close-range inspections, collect visual and environmental data and support infrastructure monitoring activities.

These systems can analyze road conditions, detect structural damage, monitor the status of buildings and critical infrastructure, and collect detailed information in environments that are difficult to access or potentially hazardous for human operators. Alongside robotic systems, satellite data represent a fundamental source of information for urban planning. Through Earth Observation missions of the Copernicus Programme, it is possible to observe the evolution of urban areas on a large scale and analyze key indicators related to territorial development. Satellite imagery enables the monitoring of urban expansion, the identification of land use changes and the analysis of phenomena such as the growth of informal settlements or variations in impermeable surfaces. These data can also support the assessment of ground conditions and hydrogeological risk.

Another key advantage of satellite data is the ability to analyze urban dynamics over time. By combining historical and recent observations, urban planners and decision-makers can better understand how cities evolve and plan more effective and sustainable interventions. While satellites provide a large-scale view, drones enable the acquisition of high-resolution information over specific areas of the city. Aerial surveys support detailed analysis of neighborhoods, infrastructure and construction sites, facilitating planning, monitoring and verification activities. These observations can be repeated over time, making it possible to track the progress of urban projects, assess the impact of interventions and identify emerging critical issues. In some operational scenarios, drones and robotic systems can operate in a complementary way.

For example, an aerial survey may identify areas affected by infrastructure issues or rapid, unplanned development. A ground robotic system can then be deployed to perform detailed inspections and collect additional data at street level. The real effectiveness of these technologies emerges when they are integrated. Satellite observations provide a large-scale perspective, allowing the continuous monitoring of urban dynamics across wide areas. Drones enable the acquisition of high-resolution data at a local scale, supporting detailed analysis of specific zones.

Ground-based robotic systems operate at a micro scale, allowing close-range inspection and direct interaction with the urban environment. By combining these different levels of observation, it becomes possible to obtain a more complete and multi-scale understanding of urban systems, supporting more informed analysis and interpretation of complex urban phenomena.

In this context, the EagleArca platform represents an operational environment where satellite data, drone missions and robotic operations can be integrated and managed in a coordinated way. Through the platform, and through the activities developed within the SDIC laboratory in Nairobi, it becomes possible to monitor urban evolution, analyze infrastructure conditions and support decision-making processes using reliable, up-to-date and easily interpretable data. The use cases presented in this video represent practical and replicable applications designed to support urban planning, improve infrastructure management and contribute to the sustainable development of cities. Let us now explore these use cases and see how these technologies can be applied in practice within the urban context.

Mapping and Monitoring of Urban Growth and Road Infrastructure

The first use case we will explore focuses on mapping and monitoring urban growth and road infrastructure. This use case involves the use of a drone hangar and a drone operating within the EagleArca platform environment.

Purpose and Benefits

The main objective of this use case is to support urban planning and the efficient management of the territory through continuous mapping and monitoring of urban growth and road infrastructure. Through the EagleArca platform and the integration of drone missions, it is possible to acquire up-to-date, high-resolution data on urban areas, enabling the identification of settlement expansion, the evolution of the road network and land use dynamics. Using the Mission Planner, drones can perform automated flights over urban and peri-urban areas to collect detailed imagery. These observations allow urban planners and public authorities to analyze urban development, identify unplanned expansion, monitor the condition of road infrastructure and assess potential mobility-related issues. This information supports a better understanding of how urban areas evolve over time, facilitating the analysis of settlement expansion, infrastructure development and land use dynamics. By providing objective and georeferenced data, this approach contributes to the study of urban growth processes and supports planning activities related to mobility, land management and infrastructure development.

Image Acquisition Using the Drone

The first step consists of surveying the urban landscape from above using a drone to perform an initial assessment of the area of interest. During this phase, it is possible to identify the boundaries of urban and peri-urban areas, major road infrastructure, built-up zones and areas undergoing expansion, as well as critical elements that may require further monitoring, such as unplanned urbanization, traffic congestion or degraded areas. This type of aerial observation can be carried out through manual drone flights, provided that the operator holds the appropriate certification and operates in compliance with current aviation regulations. However, data acquisition can also be performed through automated missions managed directly within the EagleArca platform. Once the preliminary observation is completed, the drone hangar connected to the platform can be used as the operational base for automated flights. During the mission, the drone captures high-resolution optical and, where necessary, thermal imagery, providing a detailed view of urban morphology, the road network and land-use dynamics. These surveys can be repeated over time to monitor urban growth and changes in infrastructure, enabling the identification of significant variations and supporting comparative analyses for land-use planning and sustainable urban management.

Drone Mission Creation

A new drone mission can then be created by entering the required information, including mission name, mission type, mission unit and flight parameters such as take-off altitude, speed and global altitude. Once the mission is created, it is necessary to define the drone's flight path by placing a set of waypoints on the map and specifying the actions the drone will perform at each point, such as capturing images. These waypoints represent reference points that guide the drone along its flight path across the monitored area.

Definition of Waypoints

Waypoints define the drone's operational path and the altitude it follows during the mission. For each waypoint, it is possible to adjust flight altitude, camera angle and zoom level.

To insert waypoints, the Draw tool available in the platform toolbar can be used. By clicking directly on the map, points can be placed to guide the drone along the desired trajectory.Waypoints are automatically numbered by the system and can be repositioned if needed, allowing the path to be adapted to the specific characteristics of the area.

If the analysis needs to focus on a specific point of interest, such as a key road or a particular zone, a waypoint can be placed near that location. This allows the drone to capture detailed imagery of that specific point during the mission.

Through this process, the urban context can be observed in a structured and repeatable way, enabling the collection of organized visual information on urban growth and road infrastructure over time.

Add Actions to Waypoints

After defining the waypoints, it is possible to configure one or more actions that the drone automatically performs when reaching each point during the mission.

To assign these actions, move the cursor over one of the Action Cards in the left panel of the platform and click the Action button. Through this function, actions such as image acquisition can be assigned to the drone.

All media collected during the mission are automatically stored within the platform and can later be reviewed, analyzed or exported when needed.

Start the Mission

Once the flight path has been defined and the desired actions have been configured, the automated mission can be started.

By clicking the *Start Mission* button, the drone begins its flight following the planned route and automatically executes the actions associated with each waypoint.

Add Specifications to Waypoints

Additional information related to the monitored urban areas can be recorded directly within the EagleArca platform by adding descriptive data fields.

These fields allow the organization of territorial information associated with the observed areas, such as land use, types of infrastructure, road conditions, planned interventions and notes related to critical issues or urban transformation processes.

By storing this information within the platform, it is possible to maintain a structured record of urban evolution over time, supporting the monitoring of territorial development and facilitating future planningand analysis activities.

Satellite and Ground Verification

Satellite data can extend the analysis beyond drone surveys, providing a continuous and large-scale view of land-use changes over time.

These observations support the identification of urban expansion patterns, variations in vegetation cover and changes in surface conditions across wide areas.

At the same time, ground inspections performed with the robot dog allow the verification of specific infrastructure elements, enabling a more detailed assessment of roads, construction sites or degraded areas identified during aerial analysis.

This integrated approach combines large-scale observation with localized inspection, improving the overall understanding of urban dynamics.

Let us now move to the next use case.

Urban Safety Monitoring and Emergency Management

The second use case we will explore focuses on urban safety monitoring and emergency management. This use case involves the use of a drone hangar, a drone operating within the EagleArca platform environment and a robot dog, supporting the timely detection of critical situations and the coordination of response actions both from the air and at ground level.

Purpose and Benefits

The main objective of this use case is to support urban safety monitoring and the effective management of emergencies through continuous data acquisition and dynamic surveillance of the territory. Through the EagleArca platform and by integrating drone missions and robot dog operations, it is possible to collect up-to-date information both from the air and at ground level, enabling the timely detection of risks, critical events and anomalies in urban areas. Using the Mission Planner, the drone can perform automated flights over urban areas and sensitive infrastructure to acquire images and data useful for assessing safety conditions. At the same time, the robot dog can operate at ground level in complex or hard-to-reach environments, supporting close-range inspections and real-time data collection.

The collected data allow public authorities, security operators and emergency teams to monitor events such as accidents, fires, flooding or hazardous situations, improving response capacity and operational coordination. This approach supports more effective emergency management by enabling the identification of operational priorities, optimizing resource allocation and reducing response times. By providing objective, up-to-date and georeferenced data, the platform supports decision-making processes and offers a more comprehensive and integrated view of urban safety conditions compared to traditional approaches, contributing to enhanced resilience and community protection.

Image Acquisition Using the Drone

The first step consists of acquiring up-to-date information on the urban environment to support emergency management activities. Through the EagleArca platform, drone missions enable both continuous monitoring of urban areas and targeted data acquisition in response to specific events. Regular aerial surveys allow the ongoing observation of the territory, helping to detect early signs of potential risks or anomalies. When a critical situation occurs, data acquisition can be immediately focused on the affected area, supporting a rapid assessment of the event.

During these operations, the drone captures images and data that provide a clear overview of the situation, allowing operators to understand the extent of the event and how it is evolving. When additional detail is required, ground-level inspections can complement aerial observations through the use of the robot dog, enabling close-range analysis in areas that may be difficult to access or potentially hazardous. By combining continuous monitoring with targeted inspections, it becomes possible to obtain a more complete and timely understanding of urban safety conditions.

Drone Mission Creation

As described in the previous use case, a drone mission can be created by entering the required information and defining a flight path through a set of waypoints and their associated actions. In this case, the mission is configured to support both continuous monitoring activities and targeted inspections in response to specific events, focusing on critical urban areas and situations that require immediate assessment.

Ground Inspection with the Robot Dog

Urban area inspection and the assessment of safety conditions can be carried out directly at ground level using the robot dog. Unlike drones, which provide a top-down overview of large portions of the urban environment, the robot operates at street level, enabling close-range and detailed observations of specific areas, infrastructure or emergency scenarios. Equipped with onboard cameras and sensors, the robot can capture images and environmental data useful for documenting critical situations such as structural damage, obstacles affecting mobility, debris or potentially hazardous conditions for public safety. In this way, the robot plays a complementary role to the drone. While aerial surveys provide an overall view and help identify areas of interest, ground-level inspections enable targeted and in-depth analysis directly on site, supporting more accurate verification and assisting response teams during operations.

Robot Dog Mission Creation

The creation of a robot dog mission follows a process similar to that used for drone missions, starting from the definition of the basic mission parameters within the platform. In this case, however, the mission is configured for ground operations, focusing on navigation across the urban environment rather than aerial coverage. The route is planned to allow the robot to safely reach specific locations that require close-range inspection, taking into account obstacles, narrow passages and potentially hazardous conditions. Unlike drones, which operate over wide areas, the robot dog moves at street level and is used to approach precise points of interest, such as areas affected by incidents or damaged infrastructure. This approach enables targeted data collection directly on site, supporting detailed inspections and assisting response teams in managing critical situations more effectively.

Add Actions to Waypoints

As with drone missions, the robot dog follows a path defined by a set of waypoints placed on the map. In this case, these points represent both navigation steps and inspection locations, corresponding to critical areas such as accident sites, damaged infrastructure or high-risk zones. Specific actions can be associated with each waypoint, such as capturing images or collecting visual and environmental data to document site conditions. As in drone missions, the images and data collected during the mission are automatically stored within the platform, where they can be reviewed and analyzed to support emergency management activities and post-event assessments.

Start the Mission

Once the route and the associated actions have been defined, the robot dog mission can be started. The robot autonomously follows the planned path, reaches the predefined waypoints and executes the configured actions, collecting images and data from the inspected areas. As with drone missions, the collected data is made available within the platform, where it can be analyzed to assess the conditions of the inspected locations and support emergency management activities.

Satellite Support for Risk Assessment

In addition to real-time operations with drones and robot dogs, satellite data provide valuable environmental context to support the interpretation of critical events and risk scenarios. For instance, Sentinel-2 can be used to detect surface variations such as water accumulation or changes in land cover, while Sentinel-5P provides information on air quality and pollutant concentration. These data help to better understand the environmental conditions in which an event occurs, supporting the identification of contributing factors and improving both preparedness and post-event analysis.

Let us now move on to the final use case.

Environmental Monitoring and Urban Quality

The final use case focuses on environmental monitoring and the assessment of urban quality. This scenario involves the use of a drone hangar and a drone integrated within the EagleArca platform, combined with satellite data from Sentinel-2 and Sentinel-5P. Through periodic drone-based photogrammetric surveys and the integration of satellite observations, it is possible to monitor changes in land cover, vegetation conditions and air quality in urban areas. This approach enables the analysis of how urbanization impacts the environment, including effects on land cover, vegetation conditions, air quality and microclimate. By combining periodic drone surveys with satellite observations, it becomes possible to monitor environmental dynamics over time and identify trends that may affect urban livability.

Purpose and Benefits

The main objective of this use case is to support environmental monitoring and improve urban quality through the continuous analysis of environmental conditions in urban areas. Through the EagleArca platform, drone missions are combined with satellite data to provide up-to-date and high-resolution information on the territory. This enables the monitoring of changes in land cover, vegetation conditions and air quality over time, allowing the observation of phenomena such as urban vegetation variation, surface transformation and pollution trends in urban areas.

Drone-based surveys can be performed periodically to collect detailed local data, while satellite observations provide a broader and more continuous view of environmental dynamics. The integration of these data sources allows observations at different scales, supporting a more complete understanding of how urbanization impacts the environment. These insights enable public authorities, planners and decision-makers to identify critical areas and define targeted interventions, contributing to more sustainable urban planning and improved quality of life in cities.

Satellite and Ground Observations

In the context of environmental monitoring and urban quality, satellite data available within the EagleArca platform play a key role in complementing drone-based observations. By accessing data from Sentinel-2 and Sentinel-5P, it is possible to obtain a continuous and large-scale view of the urban environment. These datasets enable the monitoring of parameters such as land cover, vegetation conditions, surface changes and air quality, supporting the analysis of environmental dynamics over time. When combined with drone-acquired data, satellite observations provide a multi-scale perspective, linking broad territorial analysis with detailed local inspection. Ground-based inspections can further support this process by enabling the verification of specific locations, improving the reliability of the overall analysis.

Ground-Level Validation and Inspection

While satellite and drone data provide a comprehensive overview of environmental conditions, ground-based inspections allow a more detailed verification of specific locations. Robot dogs can be deployed to collect close-range data in targeted areas, enabling the assessment of localized phenomena such as vegetation stress, surface degradation or the presence of pollutants. This validation step helps confirm the interpretation of aerial and satellite observations, improving the reliability of environmental analysis and supporting more accurate intervention planning.

Conclusion

The presented use cases show how the integration of Earth observation data, digital platforms and robotic systems can support the evolution of urban planning processes. The combined use of drones, robot dogs and satellite data enables a more complete, up-to-date and multi-scale understanding of the urban environment. These technologies allow public authorities and planners to monitor urban growth, assess infrastructure conditions, manage emergencies and analyze environmental dynamics more effectively.

The availability of objective and georeferenced data supports more informed decision-making, enabling targeted and timely interventions. At the same time, this integrated approach improves operational efficiency, reducing the time and costs of monitoring activities while increasing the safety of field operations. Overall, these use cases highlight the role of advanced digital technologies in supporting more sustainable and resilient urban environments. See you in the next video!