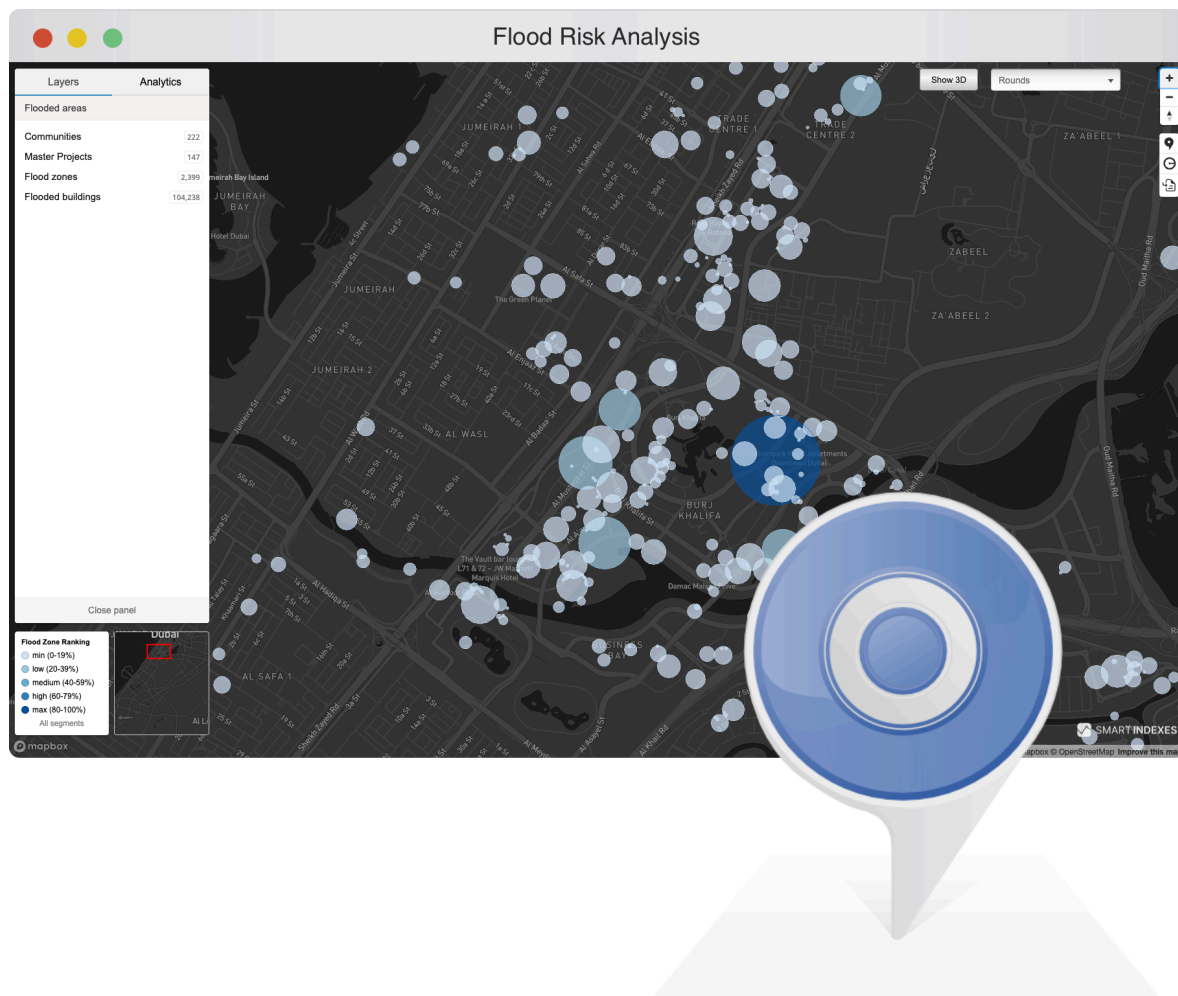




Dubai Flood Risk Analysis

Geo analysis based on meteo data on April 2024

Published at July 21, 2025



Introduction

In early April 2024, Dubai recorded meteorological events in the form of increased rainfall. These meteorological events highlight the importance of considering the risk of flooding of residential, industrial and public areas of districts and master development projects implemented in Dubai.

In terms of property valuation, market models for pricing per square meter based on infrastructure (type, subtype, class, property segment and location) need to be modified to take into account known risks, including the existing risk of flooding in Dubai, so that the valuation has a realistic characteristic with variable risk components.

Disclaimer

This study is of an exclusively introductory nature for the purpose of an independent assessment of the flooding threats to the Emirate of Dubai, UAE, when modeling a multifactorial analysis of the investment attractiveness of real estate in this promising region.

Sources

This study used the following trusted data sources.

- NASA photos
Source:
<https://earthobservatory.nasa.gov/images/152703/deluge-in-the-united-arab-emirates>
- Flooding in the Middle East. April 22, 2024
Source:
https://modis.gsfc.nasa.gov/gallery/individual.php?db_date=2024-04-22

Facts about the image

Satellite: Aqua

Date of receipt: 18.04.2024

Resolution: 1 km (218.3 KB), 500 m (527.6 KB), 250 m (308 KB)

Used ranges: 7,2,1

Image credit: MODIS Land Rapid Response Team, NASA GSFC

- Google Earth Engine
Planetary-scale platform for Earth science data and analysis
Source: <https://earthengine.google.com/>

Flood review

According to NASA, a slowly moving storm system hit the United Arab Emirates and dropped more than a year's worth of rainfall on some cities in April 2024. Heavy rains triggered flash floods in the eastern parts of the country, submerging roads and disrupting the transportation system.

The system first struck Oman on April 14 and continued to hit the UAE for most of the day on April 16. Michael Mann, a climatologist at the University of Pennsylvania, told the Associated Press that three low-pressure systems formed a series of storms slowly moving along the jet stream: a river of air that carries weather systems toward the Persian Gulf. A strong low-pressure system brought several rounds of strong winds and heavy rains to the northern and eastern parts of the country.

Some areas remained flooded on April 19, when Landsat 9 first passed over the region after the storms. The image above (right), taken that day with the OLI-2 (Operational Land Imager 2) satellite, shows flooding in Jebel Ali, a city located 35 kilometers (22 miles) southwest of Dubai. The image uses false colors (bands 6-5-3) to highlight the presence of water, which appears blue. Flooding can be seen in the Jebel Ali industrial zone south of the port and around green resorts and parks south of Palm Jebel Ali.

Parts of Abu Dhabi, the capital of the UAE, were also flooded by storms. The Landsat 9 images above show the city and its surroundings on April 3 (left) and April 19 (right), before and after the storms. On April 19, water can be seen covering Sheikh Zayed Road, the main transportation artery running through Dubai and Abu Dhabi. Areas of flooded land are also visible in Khalifa City and Zayed City, residential areas southeast of downtown Abu Dhabi.

The National Center of Meteorology of the UAE reported that up to 250 millimeters (10 inches) of rainfall fell in the eastern parts of the country in less than 24 hours. The UAE, known for its dry desert climate, receives only about 140–200 millimeters (5.5–8 inches) of rainfall per year.

The visual characteristics of the state of the territories of the Emirate of Dubai before and after the flood are presented in Figure 1.

Fig. 1. NASA images of the territory of the Emirate of Dubai before and after the flood in April 2024.



a. A satellite image from NASA dated April 3, 2024.



b. A satellite image from NASA dated April 19, 2024.

Flood statistics

At Dubai International Airport (northeast of these images), 119 millimeters fell on April 16, which is 1.5 times the usual annual amount of precipitation. Due to the flooding, flights were temporarily suspended at the airport, which is one of the busiest in the world for international travel.

According to news reports, as of April 18, some UAE were working on recovery after the flooding. It is reported that there are still delays at Dubai International Airport.

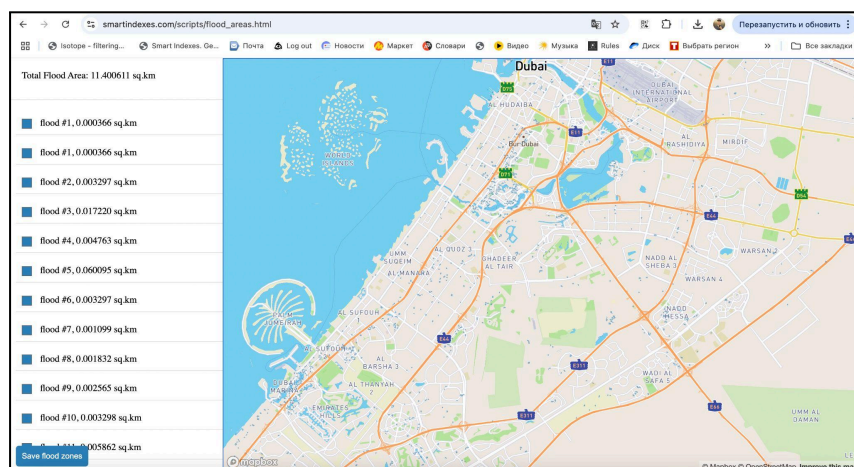
NASA Earth Observatory images taken by Wanmei Liang using Landsat data from the U.S. Geological Survey.

Using the method of digital polarization of images from NASA, presented in the public service Google Earth before and after the flood of April 2024, the following results were obtained for the Emirate of Dubai:

- Urban area of Dubai: 4610 km².
- Total flooded area: 11.4 km².
- Total flooded urban area: 8.8 km².
- A total of 2398 flood zones have been recorded.

Both coastal tourist areas and residential neighborhoods, as well as the DXB airport, were affected.

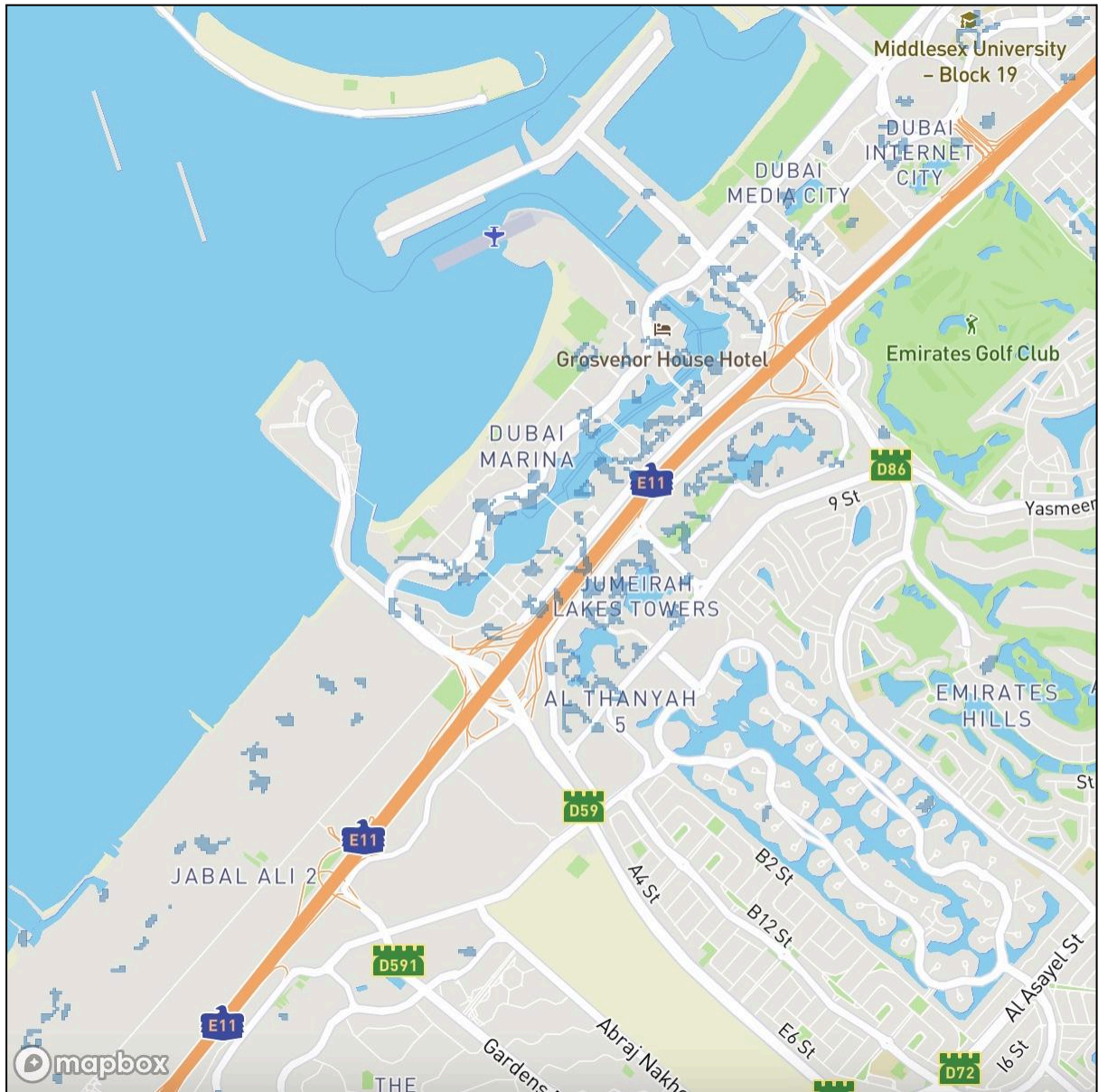
Fig. 2. Visualization of the digitized polygons of the flood zones in Dubai after analyzing NASA images.



Source: Smart Indexes / Showcases / [Geoanalytics of Dubai flood risk based on meteorological and precipitation data](#)

The publicly available assessment of the entire area of the Emirate of Dubai is about 4,610 km². The flooded area accounted for 0.25% of the total area of Dubai.

Fig. 3. Enlarged fragment to illustrate flood zones in the Dubai Marina, Al Thanyah areas near the coast of the Persian Gulf.



The total flood area: 11.4 km².

Total flooded urban area: 8.8 km²

This is a relatively small figure, but for investment assessment, it represents a significant risk factor that should be considered in the model for evaluating the investment attractiveness of real estate in Dubai.

As is evident from NASA's images, flood zones cover areas of business districts, residential master projects, and key highways of the city. This factor may negatively impact the long-term assessment of the profitability of real estate under the rental model.

Negative effect of flood event

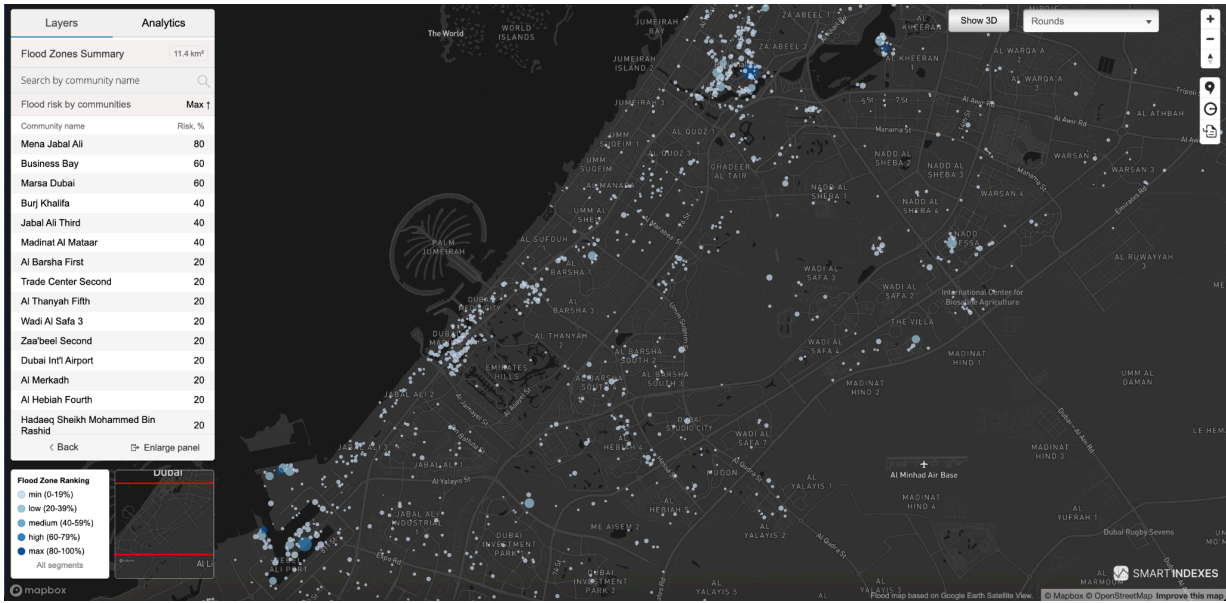
The decline in tourist attractiveness due to safety concerns may also affect capitalization rates in the affected areas. These data highlight the need for a systematic approach to analyzing and accounting for climate risks in long-term urban planning and real estate investment. Furthermore, the consequences of flooding may reduce revenues in the tourism sector, including hotels, restaurants, and entertainment venues, which will impact employment levels and the economic stability of the city. The baseline data from NASA's image analysis could serve as a foundation for developing damage reduction strategies, infrastructure planning, and enhancing the resilience of Dubai's areas to similar events in the future.

Table 1. Ranging the communities listed by flood risk from max to min level.

Community name	Plot area, km ²	Number of zones	Flood sq., km ²	Risk, %
Mena Jabal Ali	34.80	126	0.91	80
Marsa Dubai	8.90	93	0.29	60
Business Bay	6.60	103	0.35	60
Madinat Al Mataar	141.80	78	0.48	40
Jabal Ali Third	365.00	70	0.27	40
Burj Khalifa	2.70	61	0.25	40
Dubai Int'l Airport	14.20	36	0.17	20
Jabal Ali First	21.30	34	0.13	20
Al Barsha First	4.00	34	0.13	20
Al Merkadh	10.40	40	0.15	20
Zaa'beel Second	10.80	50	0.16	20
Jabal Ali Industrial Second	32.60	43	0.21	20
Al Safouh Second	4.30	32	0.10	20
Hadaeq Sheikh Mohammed Bin Rashid	36.80	37	0.15	20
Al Hebiah Fourth	9.10	35	0.16	20
Al Thanyah Fifth	9.70	50	0.21	20
Trade Center Second	1.40	39	0.09	20
Wadi Al Safa 3	30.20	31	0.15	20

The full listing of ranging the communities by flood risk, %.

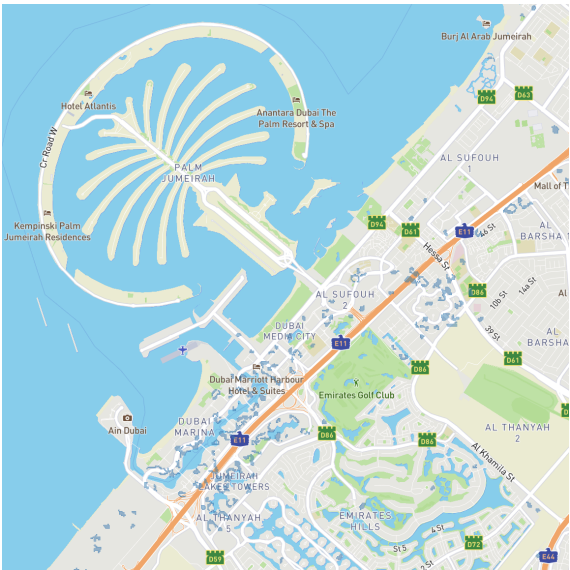
Fig. 4. Showcase of flood risk analysis.



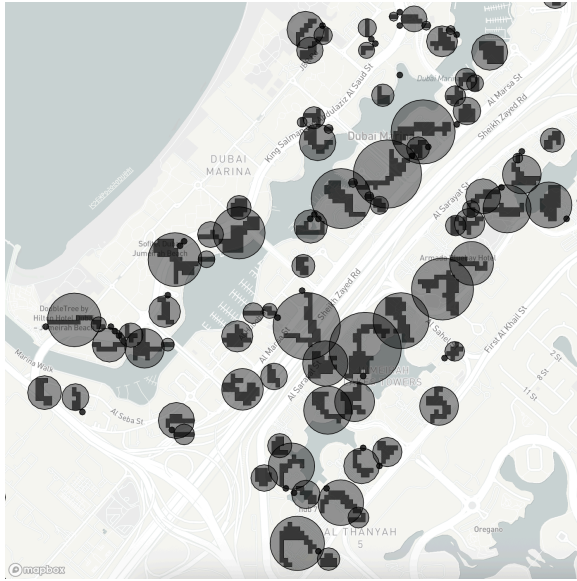
Notices for fig.4:

- Data on the number of flooded areas were obtained empirically using the polarization method of images from NASA satellites before and after the flooding in Dubai in April 2024.
- The original areas of Dubai's communities (borders and square) were obtained from the Open Data Dubai Pulse dataset (community.kml).
- For visualization the showcase used round and complex heatmap segmentation of flood risk on Dubai's map.

Fig. 5. Detailed flood zones on top view to Marsa Dubai.



a. Fragment from pixelized zones in polygons on Dubai's map focused to Marsa Dubai



b. Fragment from map with layers of pixelized and rounded flood zones to checking the position of flood areas and its sizes.



c. Showcase map “Flood Risk Analysis” with colored segmentation by levels according to map’s legend.

Reports of destruction from rainfall in the flood zones of Dubai

In April 2024, Dubai and other regions of the United Arab Emirates (UAE) faced unprecedented rainfall.

As a result of the meteorological events in April, there were serious floods and destruction. According to the National Center of Meteorology of the UAE, these were the heaviest rains in the last 75 years.

Causes of flooding

The floods were caused by a powerful storm system crossing the Arabian Peninsula and moving along the Gulf of Oman. Heavy rains began on April 15 and continued for several days, affecting all seven Emirates of the UAE.

Source: [RBC](#)

Consequences and destruction

According to various sources, the following consequences and destruction of Dubai's infrastructure were recorded:

- **Victims and casualties:** at least four people have died as a result of floods in the UAE.

Source: [Wikipedia](#)

- **Infrastructure:** key roads, including Sheikh Zayed Road, were flooded, causing significant traffic congestion. Traffic was paralyzed and many cars were underwater.

Source: [Current time](#)

- **Airport:** Dubai International Airport (DXB), one of the world's busiest, was temporarily closed due to flooding on its runways. More than 1,200 flights were cancelled or diverted over two days.

Source: [Wikipedia](#)

- **Residential and commercial areas:** both coastal tourist areas and residential areas were flooded. The Dubai Mall suffered pipe bursts, causing interior flooding.

Source: [News of Russia](#)

- **Public places:** several public parks and beaches were closed due to safety concerns.

Source: [News of Russia](#)

Dubai Government Reaction

Representatives of the Government of Dubai:

- urged residents to stay at home and avoid unnecessary travel during periods of heavy rainfall;
- emergency services were deployed to evacuate victims and provide assistance to the population;
- The government has announced the allocation of 2 billion dirhams (about \$544.6 million) to support citizens affected by the floods and rebuild damaged homes.

Source: [Wikipedia](#)

Flood Risk Analysis for Dubai Areas

Dubai's relief is characterized by a differentiated height structure according to the elevation height metric, which determines different levels of flood risk depending on the location of objects relative to sea level.

Smart Indexes analysts have implemented a model for assessing areas, master projects and buildings based on the following criteria:

- the risk of flooding from precipitation (Rain Flood Risk) caused by rain is incorporated, calculated as the ratio of the area of flood-affected areas (Flood Square) to the total area of the project (Master Project Square);
- the risk of flooding from the distance (Distance Flood Risk) from the development project to the coast is considered: the closer the object is to the water, the higher the risk of flooding;
- The Gulf Flood Risk is incorporated, as low-lying areas located close to sea level have a higher risk of flooding.

Based on GPS coordinates of community centroids, the differentiated altitudinal structure of Dubai's relief, according to Google Elevation API, was considered in the analysis.

This method captures the influence of elevation of the elevation height factor to improve the accuracy of risk forecasting. The conclusion about the importance of this parameter is applied in the data model for analyzing the risk of flooding of communities and master projects in Dubai.

Determining the Flood Risk Level

In the developed data assessment model, the flood risk is classified into the following risk levels on a flat scale:

- **Low risk:** from 0% to 19% — low risk, minimal precautions.
- **Medium risk:** from 20% to 39% — average risk, must be taken into account during design.
- **Elevated risk:** from 40% to 59% — increased risk, flood protection must be provided.
- **High risk:** from 60% to 79% — high risk, active protection is required.
- **Max risk:** from 80% to 100% — very high risk, significant protective measures are required.

Top 10 flooded communities

In result of geo analysis for flood Dubai's communities the most flooded areas presented in table 2.

Table. 2. Top 10 flooded communities

Most flooded communities	Flooded area (km ²)
Mena Jabal Ali	0.91
Madinat Al Mataar	0.48
Business Bay	0.35
Marsa Dubai	0.29
Jabal Ali Third	0.27
Burj Khalifa	0.25
Jabal Ali Industrial Second	0.21
Al Thanyah Fifth	0.21
Madinat Dubai Al Melaheyah	0.18
Jabal Ali Industrial Third	0.17

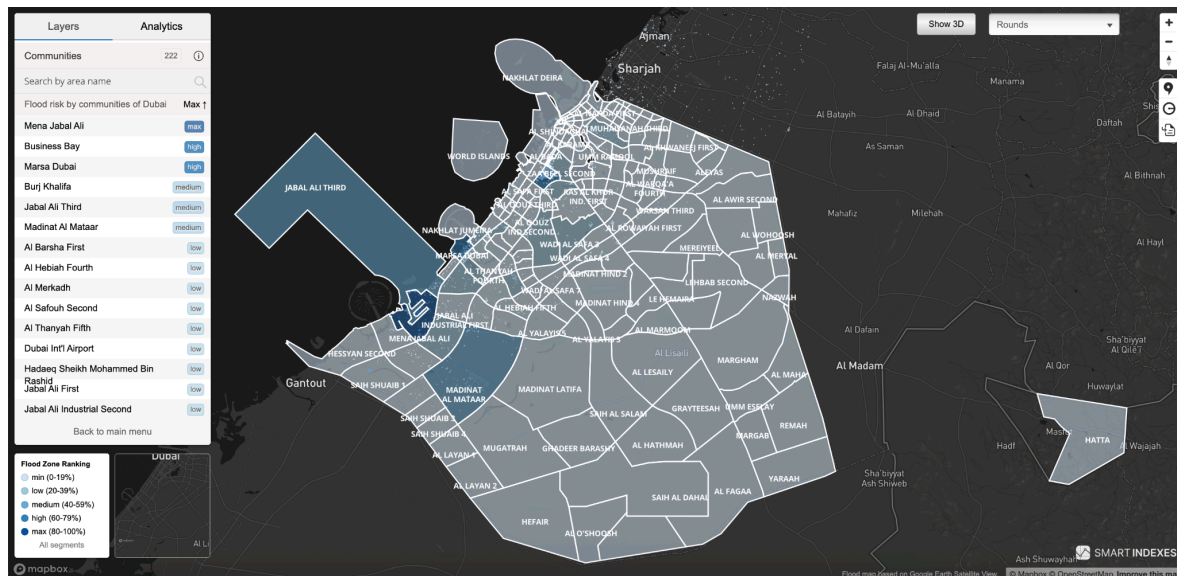
Communities are grouped by flood risk level below.

Flood risk level by communities of Dubai

Next ranging preview in brief the communities by flood risk level segmented by percentage value of total flood risk.

- **Max (80-100%):**
 - Mena Jabal Ali.
- **High (60–79%):**
 - Business Bay,
 - Marsa Dubai.
- **Medium (40–59%):**
 - Burj Khalifa,
 - Jabal Ali Third,
 - Madinat Al Mataar.
- **Low (20–39%):**
 - Al Barsha First,
 - Al Hebiah Fourth,
 - Al Merkadh,
 - Al Safouh Second,
 - Al Thanyah Fifth,
 - Dubai Int'l Airport,
 - Hadaeq Sheikh Mohammed Bin Rashid,
 - Jabal Ali First,
 - Jabal Ali Industrial Second,
 - Trade Center Second,
 - Wadi Al Safa 3,
 - Zaa'beel Second.
- **Min (0–19%)**
 - All other communities (Al Thanyah First, Trade Center First, Al Corniche, e.t.c.) receive a minimum risk level.

Fig.6. Segmentation of communities by flood risk level with color coded filling.



Percentage ratio of flooded zones in fig.7.

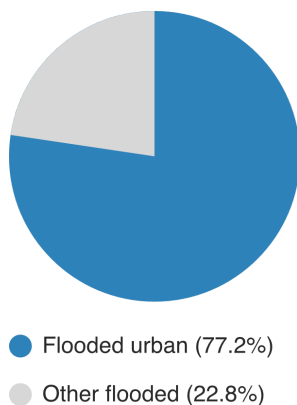


Fig. 7. Flooded urban and other areas of the Emirate of Dubai, UAE.

About 3/4 of the parts were in the flooded area: the urban part of the flooded area of Dubai,

Important clarifications

- Mathematical simplification has been applied to the areas for transparency of risk level calculation.
- For master projects, the risk flooding is detailed and more accurate in terms of input coefficients for calculating the final risk in order to improve accuracy, for investment transactions in comparative analysis of promising real estate objects.
- For buildings: by coordinate inclusion of flood zones on the territory of buildings, so that there is a clear visual representation on the geoanalytics map of the flood risk relative to all buildings in the Emirate of Dubai, UAE.

Metric Total Flood Risk

In the Dubai flood risk analysis, the Total Flood Risk formulates the overall risk by combining the risks obtained for rainfall, distance to the coast and altitude, taking into account their weighting factors.

In principle, the flood risk assessment model developed by Smart Indexes analysts is an adapted model of mathematical and physical modeling of the impact of threats from precipitation (in the form of rain) and from the Persian Gulf (in the form of storm waves). The model is designed for automated data analysis and scaling across all emirates of the UAE, as well as other agglomerations in the Middle East.

In the long term, the results of the study will help to assess the effectiveness of the measures taken to improve the infrastructure of the Emirate of Dubai in a before and after format (in case of a repeat of the scenario of heavy one-time rainfall in this region).

Unlike the study “[Modeling and Analysis of Floods in Dubai Using HEC-HMS Model and Remote Sensing Using GIS](#)” (authors: Ihsanullah R. Khan, Sami I. Elmahdy, Rabi Rustum, Qasim Khan, Mohamed M. Mohamed), the Smart Indexes data model has a simpler structure but uses key geographic data:

- height above the Persian Gulf,
- areas of flooded zones and communities,
- elevation height of community and master project centroids,
- euclidean distance from the community centroid to the nearest point on the coastline.

These empirical metrics allow for a balanced assessment of threats from precipitation and the Gulf for geo-objects in Dubai and other metropolitan areas.

The main advantage of the Smart Indexes model is its efficiency: the analysis requires only a few days, which is achieved through the prompt collection of satellite data, their vectorization and processing within the framework of the developed model. Unlike traditional approaches, this method significantly reduces the analysis time and is adapted to work with streaming data.

Dubai Flood Risk Research Finds

Based on the results of the study, the following conclusions were formulated:

1. Climate change increases flood risk

- The April 2024 floods highlighted the need to **incorporate** extreme weather events such as heavy rainfall and flooding into account in urban and investment planning, including the Master Plan 2040.
- From the engineering interpretation point of view, the solution to the problem of drainage systems for the removal of heavy rainfall comes down to increasing the capacity of drainage pipes and pumping stations. This requires additional engineering surveys and increasing the capacity of existing systems, which will be an important step to prevent short-term transport collapses and minimize economic losses in flood risk zones.

2. Flood risk impacts property

- Areas of business communities, residential projects and key highways are in flood zones, which may reduce the long-term profitability of real estate, which negatively affects the investment attractiveness of certain areas of Dubai.
- Reduced tourist appeal due to safety concerns could reduce rental income and impact capitalization rates in flooded areas.

3. Economic consequences

The April 2024 floods resulted in:

- Delays at DXB International Airport, which has had a detrimental effect on the tourism industry.
- The temporary closure of a number of hotels, shopping malls and entertainment venues, which has reduced employment levels and the sustainability of the city's economy.

4. The need for a systematic risk analysis

- Developers and investors should adopt climate risk management tools, such as flood zone analysis using satellite data (NASA, Google Earth).
- The results of the study of flooded areas in Dubai became the basis for geoanalytics in order to determine the optimal choice of real estate for a given user (client of a developer or real estate agency) for living or renting and earning money on a rental business model.

This analytical solution is integrated into the Smart Indexes GeoAnalytics product.

- Incorporating elevation data based on the Google Elevation API, based on GPS coordinates of community centroids, allows us to take into account the influence of relief on flood zones. This enhances the precision of flood risk modeling in the GeoAnalytics platform.
- Long-term planning of urban infrastructure must account for possible damage caused by weather conditions.

5. Risk Management Recommendations

- Developing strategies to increase the resilience of areas: improving drainage infrastructure, creating protective barriers in areas with a high risk of flooding.
- Integrating climate risks into property valuation to create more realistic pricing models.
- It is possible to integrate the results of flood risk analysis into financial models with the Sortino coefficient and others.

6. Social and financial response of the government

- The rapid response to the crisis (evacuation, assistance to victims) and the allocation of significant funds (2 billion dirhams) demonstrate the readiness of the authorities to cope with emergencies. However, strategic planning is required to prevent similar disasters in the future.

The findings highlight the importance of incorporating climate risks into the analysis of real estate, tourism, and infrastructure markets, and to integrate disaster data into long-term urban development strategies.