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# TOURISMO Final Conference

**Data-driven solutions for smart crowd flow management.**

Visitor counting with sensors and AI at tourism hotspots.

**9th of June 2026**

**Valletta, Malta**

## VISITOR COUNTING ON A BUSY MALTESE BEACH… OPPORTUNITIES FOR PROTECTED AREAS.

BRIAN RESTALL, MRDDf

# Ramla Tal-Mixquqa, Malta

***'The starting point of all economic analyses for protected and touristic areas is a reliable and accurate estimate of the total annual visitation to the area.' (UNESCO).***

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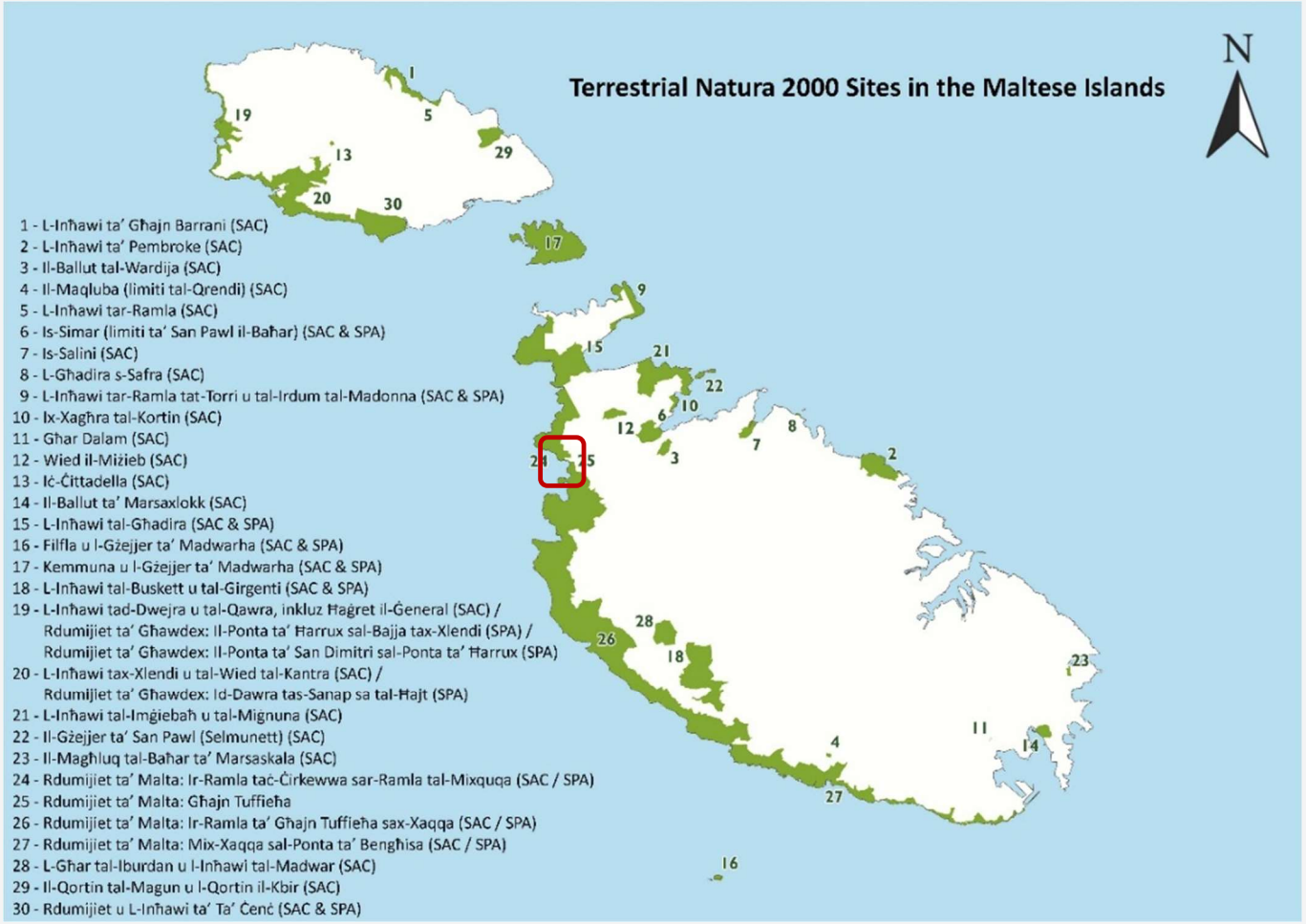
GOVERNMENT OF MALTA | FONDI.eu | NGO | Malta Council for the VOLUNTARY SECTOR

# Natura 2000 site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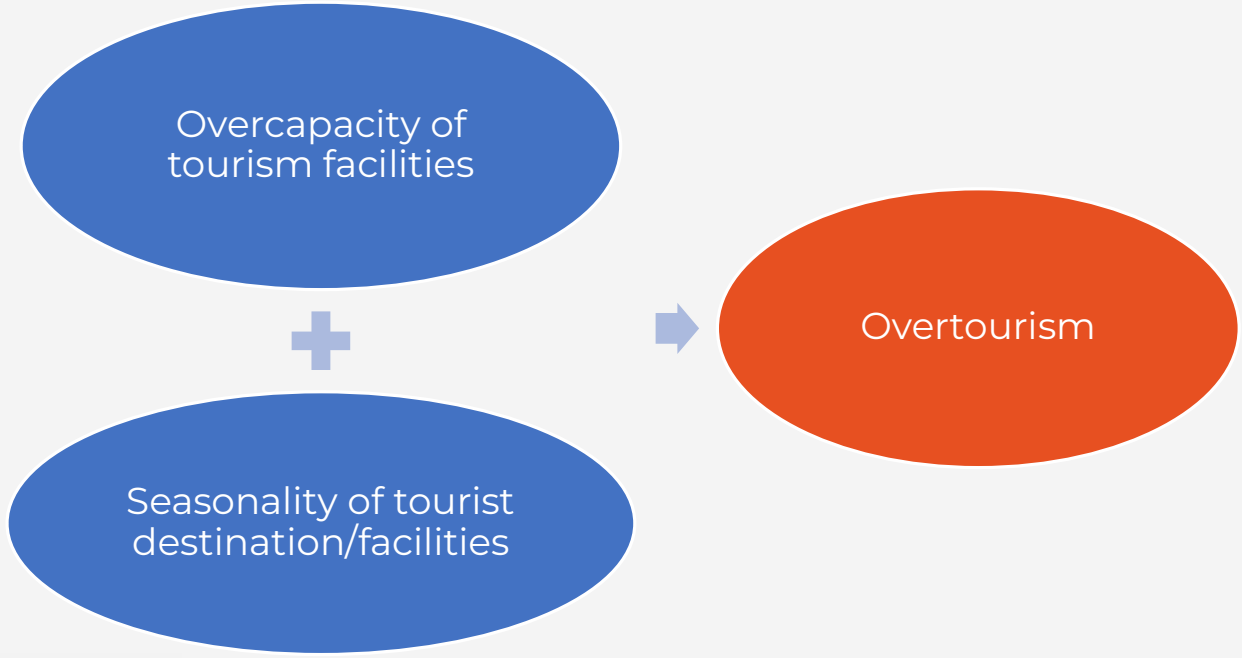
# Mediterranean coastal challenges

MED coastal and maritime natural heritage are **under severe pressure** from the effects of tourism due to:

- Seasonality
- Overcapacity tourism streams
- Excessive construction
- Waste generation
- Resource depletion
- Desertification & erosion
- Biodiversity loss

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# TOURISMO Objectives for Mixquqa

Tourism has negative impacts on the cultural heritage and social relationships, which leads to resistance towards tourism by affected residents, less tourist satisfaction and lower productivity.

**There is an urgent need for a clear study of the tourist flows and available resources, against the capabilities of the study area.**

- To understand and **improve tourist flows** at Mixquqa.
- To prove the applicability of **remote monitoring of tourist flows and behaviour**;
- To **identify local environmental and socio-economic issues affected by tourism flows**;
- To present **the concept of measuring tourist flows to stakeholders**;
- To **serve as a model to other Mediterranean areas**, as a pilot for tourist flow assessments.

**People, vehicle & parking counting**

**Beach monitoring and CCTV**

**Environmental monitoring**

# Data methods

**The Malta pilot integrated both quantitative IoT data and qualitative feedback**

**Quantitative Visual Data**: Five AI-powered CCTV cameras were installed at strategic "funnel points" (entrances and the car park) to count pedestrians and vehicles entering and exiting the site in real-time.

**Wireless Sniffing (Behavioural Data)**: Two Libellium Meshlium sniffers were deployed to detect Wi-Fi and Bluetooth signals.

**Environmental & Qualitative Data**: Imagery was used for monitoring flows and physical changes over time like dune erosion.

**Sentiment Analysis:** Public perception studies via digital satisfaction surveys (accessible via QR codes) and weekly visual inspections by park staff.

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# Limitations…undercounting

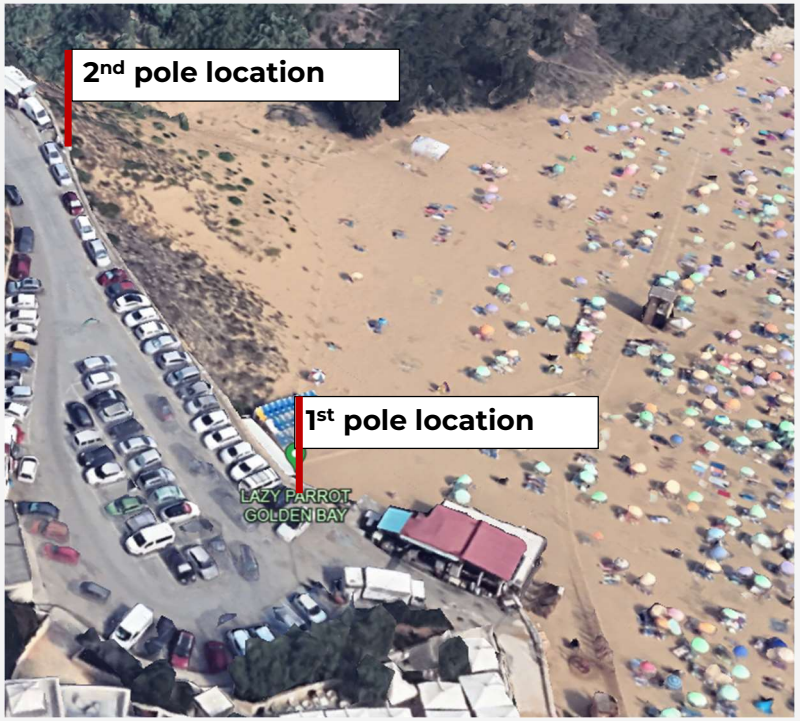
**Beach counts do not include guests staying at the hotel** since they use the private beach. Hotel guests tend to use the hotel entry and exit points within the hotel footprint; hence this traffic cannot be counted at the project monitoring points.

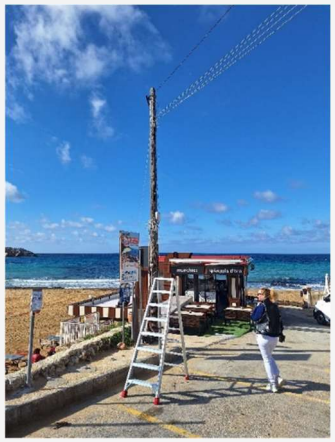
The **private beach covers circa 10/11% of the overall beach space area (770m2 and 7,210 m2. respectively**). It rents out circa 60 to 65 umbrella setups with typically two deckchairs, not only to patrons, but also to booking guests. The average space taken under an umbrella is of circa 10m2.

There are **rare occasions of double counting** when visitors sit right underneath the people counters, either to take a break, remove sand or simply to chat. Similar errors have been noted when loading trucks park illegally impeding the line of view. However, these errors are deemed marginal in relation to the overall daily counts.

# Counting stations

# Equipment





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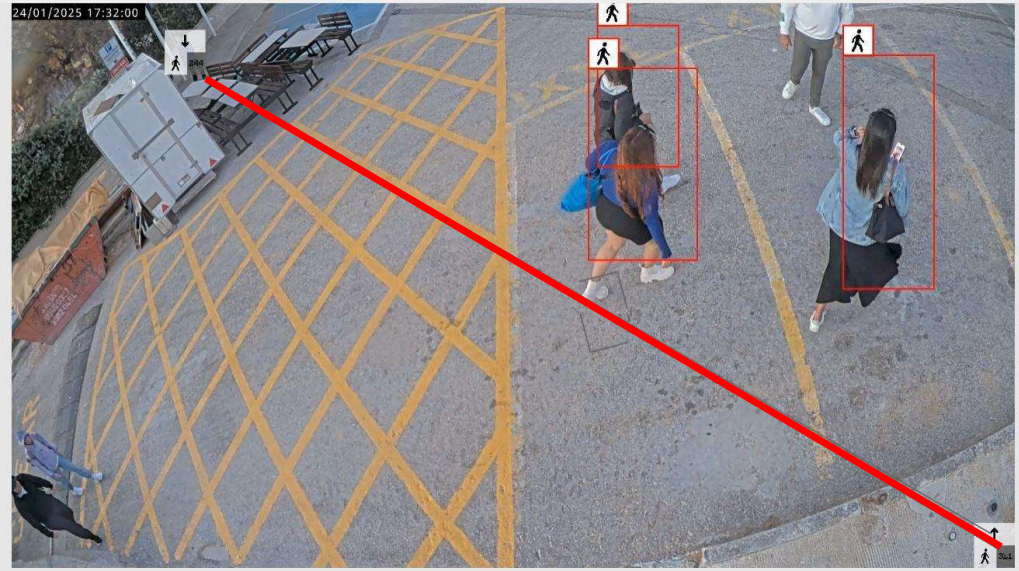
AXIS COMMUNICATIONS

https://www.axis.com/

# Typical Equipment Costs per Site

| Equipment Breakdown | Qty/Yrs | Unit Price | Estimated Cost (incl. VAT) |
|---|---|---|---|
| Galvanised pole supply and placing (4.5m). | 1 | €450 | € 450 |
| Pole mounted electrical box enclosure. | 1 | €300 | € 300 |
| Earth electrode | 1 | €300 | € 300 |
| Non-Residential meter installation cost (ARMS). | 1 | €300 | € 300 |
| Non-Residential meter deposit costs (ARMS). | 1 | €500 | € 500 |
| Non-Residential Annual Service Charges (120) and electricity costs (ARMS). | 5 | €350 | € 1,750 |
| Internet 5g costs @ €33.24/mnth - €400 yearly for 5 years. | 5 | €400 | € 2,000 |
| Wired People-Counting network camera for beach entrance; 2MP fixed-focal with AI software (flace blur). | 1 | €1,428 | € 1,428 |
| People and Vehicle Traffic Counting Camera for beach road; 2MP fixed-focal with AI software (flace blur). | 1 | €1,292 | € 1,292 |
| Wired camera to serve as a live webcam - including overlay license. | 1 | €1,567 | € 1,567 |
| CCTV camera (4MB bullet) | 0 | €442 | € 0 |
| Solar powered single CCTV Counting module, pole mounted, with 256GB SD card. | 1 | €6,500 | € 6,500 |
| Solar powered double CCTV Counting module, including solar panel, battery, with 256GB SD card. | 0 | €8,000 | € 0 |
| Wireless Bridge + Network components connecting Poles 1 & 2. | 1 | €1,885 | € 1,885 |
| App required for YouTube livestreaming per camera | 1 | €598 | € 598 |
| Axis Camera Station Pro 5-year VMS license per camera | 1 | €110 | € 110 |
| Installation, testing and commissioning. | 1 | €500 | € 500 |
| Installation, configuration and connection to existing data server at MITA. | 1 | €500 | € 500 |
| **Bi-yearly Site Visits (yearly charge)** | 5 | €250 | € 1,250 |
| GDPR and CCTV signage and project signposting + glavanised metal work | 2 | €500 | € 1,000 |
| Pole cleaning attachments for Cleansing Department staff | 3 | €20 | € 60 |
| Environmental and Council permitting (MRDDf). | 1 | €250 | € 250 |
| Coordination and yearly reporting (MRDDf). | 5 | €2,000 | € 10,000 |
| Data stream integration into SNAP4CITY and development of dashboards (DISIT) | 4 | 600 | € 2,400 |
| | | | |
| | | **Sub-Total** | **€ 34,941** |

# Crosspoints and Edge AI vision processing





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https://www.axis.com/

# GDPR Compliance

**In order to minimise our obligations under GDPR legal requirements, we:**

Provided **adequate signage** on site, indicating Data Controller, Purpose, Contacts.

Enabled edge **face blur** on all ai cameras, including drivers.

Only **retain data for a maximum period of seven days**.

Footage is **not linked with law enforcement**.

Server is **password protected** and only three staff members directly involved in the effort have access to the system.


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# Live Webcam Stream



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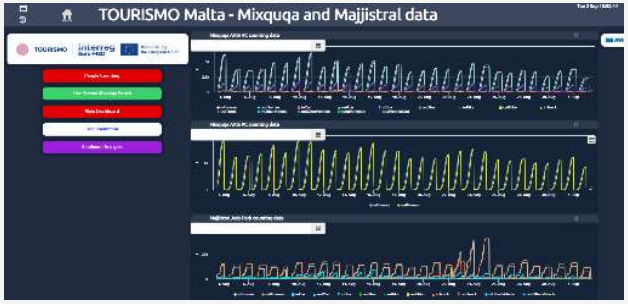
# Open access data dashboards

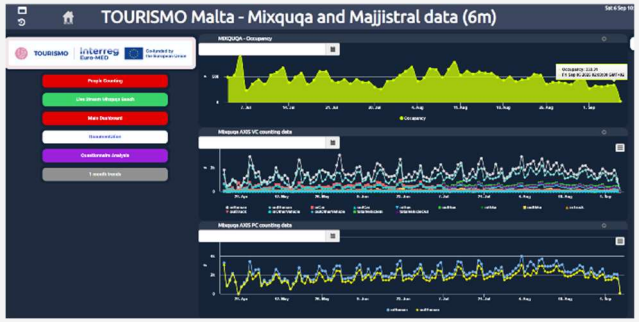
Main Dashboard


Seven dashboards developed.
https://www.snap4city.org/dashboardSmartCity/view/newTheme.php?iddasboard=NDMzNQ==

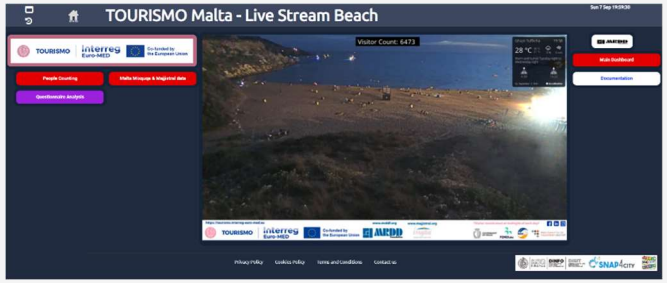
## Mixquqa and Majjistral data




## Monthly trends



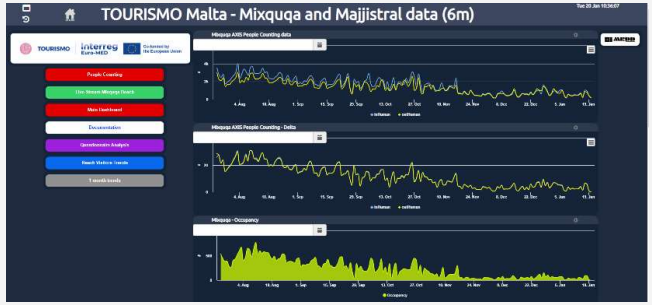

## Live stream




## People Counting


## Beach Visitor Trends


## Six-month trends



# Visitor Flows May 2025 to March 2026

**May 2025 to April 2026**

| Month | Total monthly visitors | Peak visitors in 1 day | Peak beach occupancy | Peak Personal space $m^2$ | Total monthly vehicles | Peak vehicles in 1 day | Mean temp. °C |
|---|---|---|---|---|---|---|---|
| May 2025 | 142,123 | 7,431 | | | 27,010 | 1,551 | 20.6 |
| June | 173,782 | 8,088 | | | 36,783 | 1,891 | 26.2 |
| July | 188,686 | 8,857 | 1,858 | 3.9 | 30,559 | 1,896 | 27.9 |
| August | 213,970 | 9,136 | 2,119 | 3.4 | 40,715 | 1,834 | 27 |
| September | 145,357 | 6,818 | 1,423 | 5.1 | 29,475 | 1,416 | 25.2 |
| October | 121,878 | 6,471 | 1,673 | 4.3 | 20,675 | 1,248 | 20.9 |
| November | 61,037 | 4,126 | 876 | 8.2 | 15,794 | 992 | 17.4 |
| December | 42,450 | 4,126 | 517 | 13.9 | 12,792 | 873 | 14.7 |
| January 2026 | 34,729 | 2,071 | 295 | 24.4 | 13,087 | 676 | 13.8 |
| February | 49,558 | 3,555 | 640 | 11.3 | 15,223 | 1,052 | 14.4 |
| March | 53,437 | 4,101 | 554 | 24.1 | 19,881 | 1,112 | 14.2 |
| April | 120,450 | 7,488 | 1,614 | 4.5 | 24,213 | 1,460 | 17.3 |
| May | 129,170 | 7,633 | 2,054 | 3.5 | 23,274 | 1,417 | 18.9 |
| TOTAL/AVG | 1,476,627 | 6,090 | 1,238 | 10 | 309,481 | 1,334 | 20 |

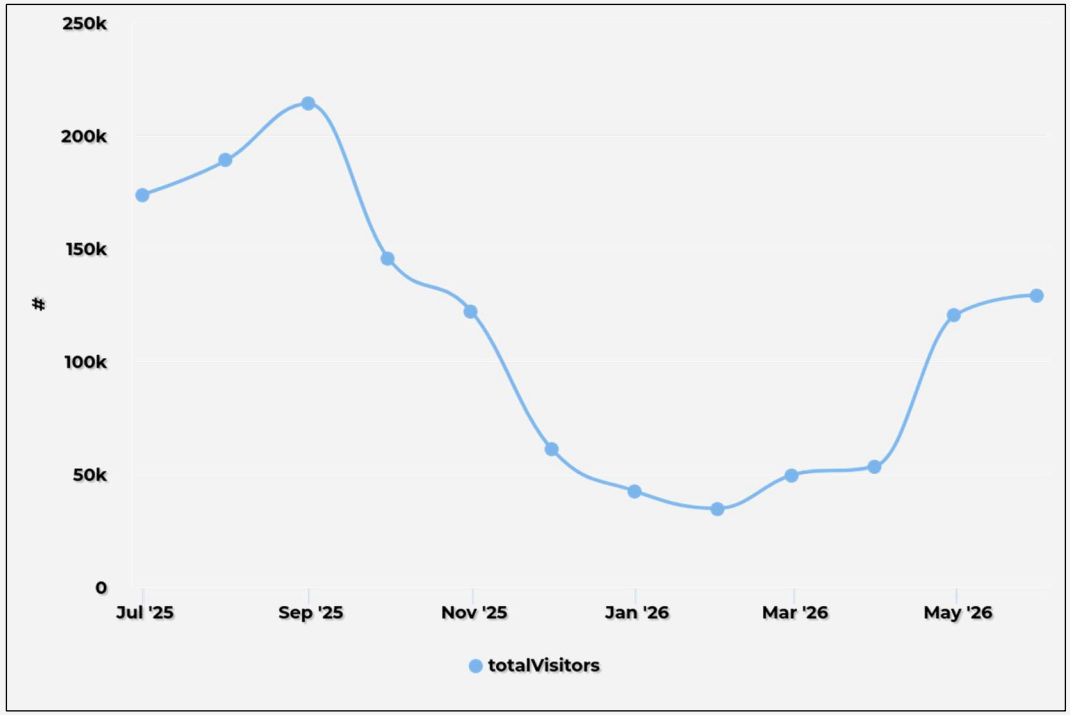
**Assumptions for beach density and personal space:** Available Beach Area = 7,210 m2. EU avg. of personal space/pax = 6.8 m2 (*PAP; 1993.)*

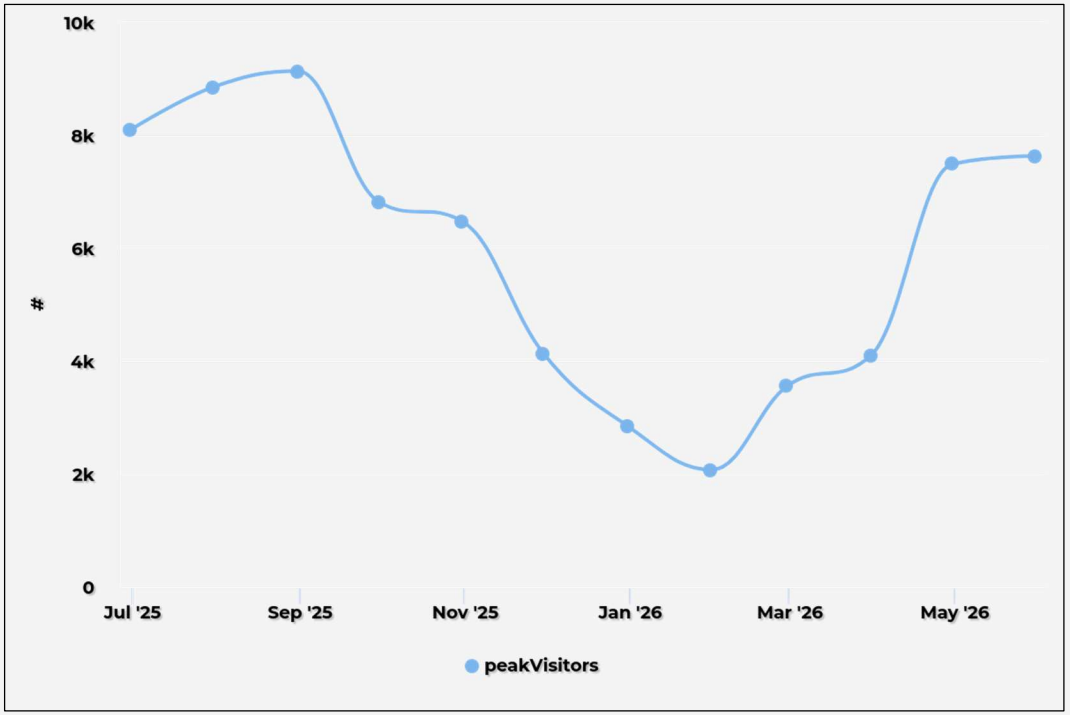
The beach's maximum comfortable capacity is **1,802 people, based on an average of 4m² per person**.

# Annual Trends – Totals Visitors and Vehicles

**July 2025 to May 2026**

**Total yearly visitors = 1,347,457. Peak visitors = 9,136 (August).**

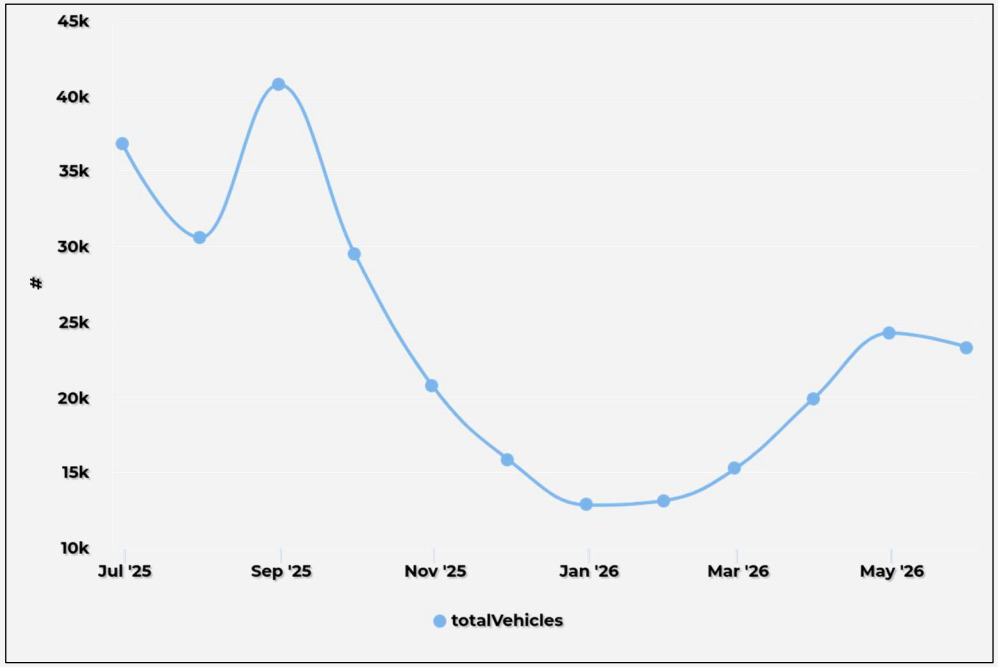


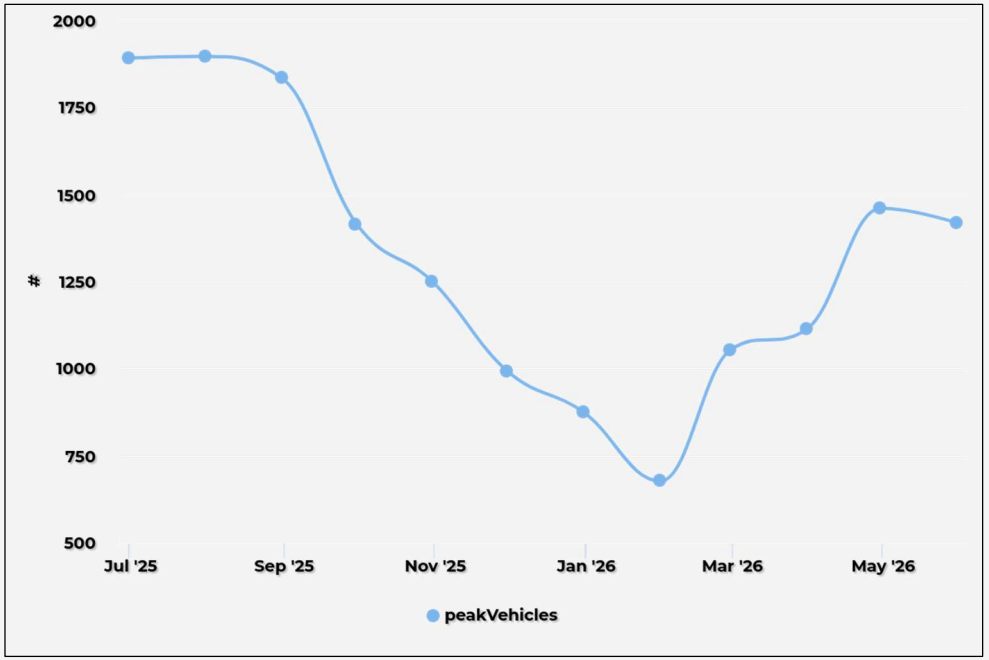



# Annual Trends – Total and Peak Vehicles

**July 2025 to May 2026**

**Total vehicles 309,481; Peak vehicles = 1,896**

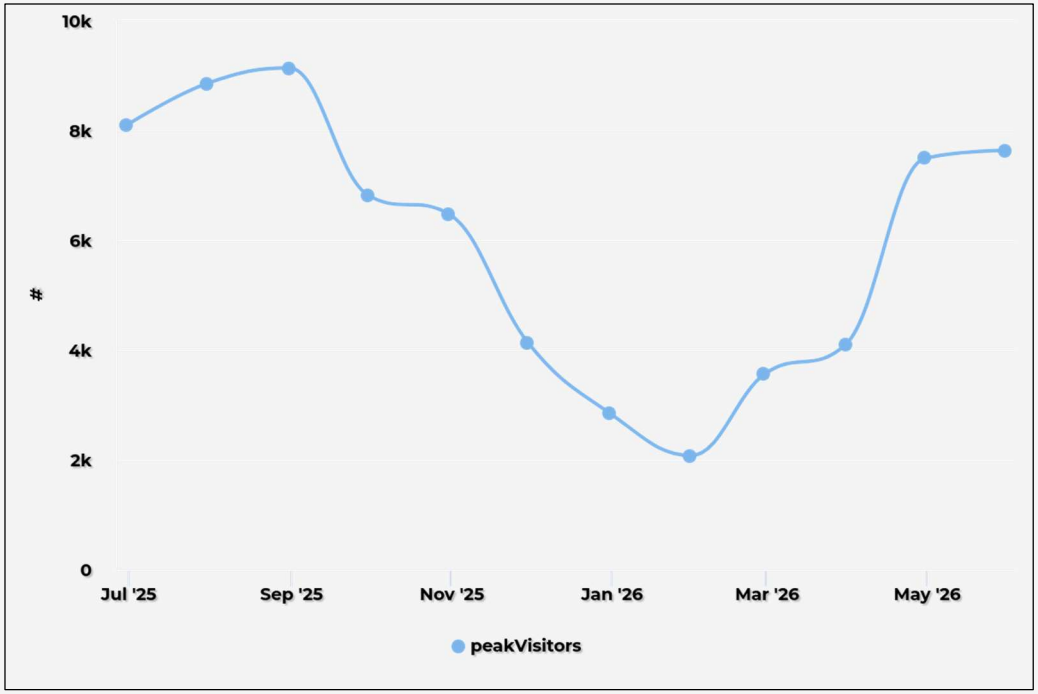


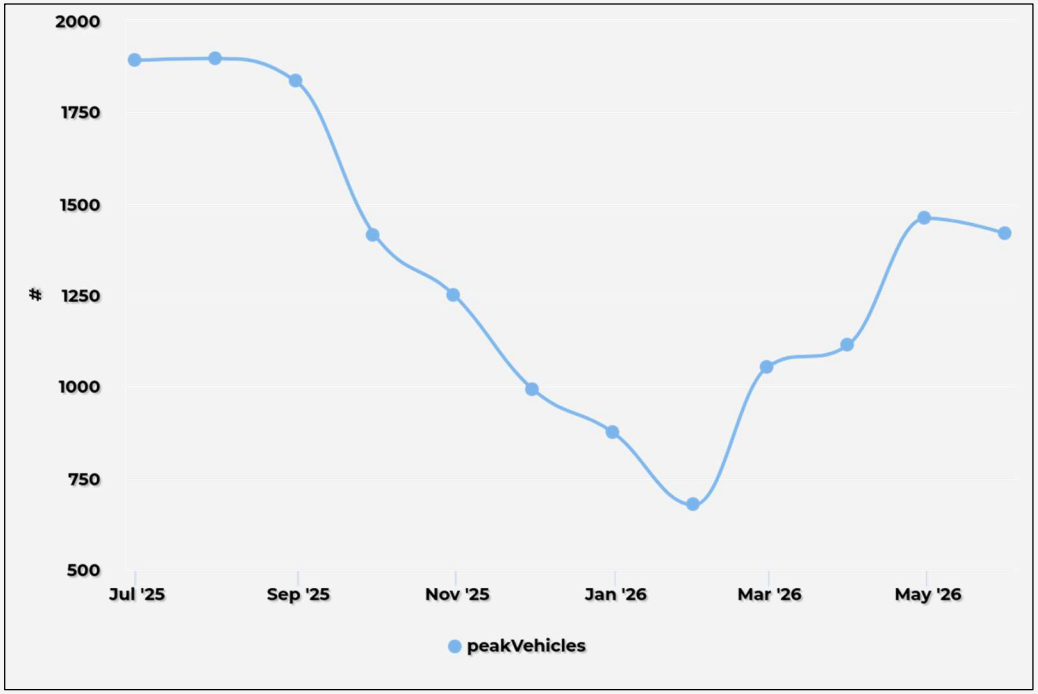



# Annual Trends – Peak Visitors and Traffic

**July 2025 to May 2026**

**Peak visitors = 9,136; Peak vehicles = 1,896 (July)**

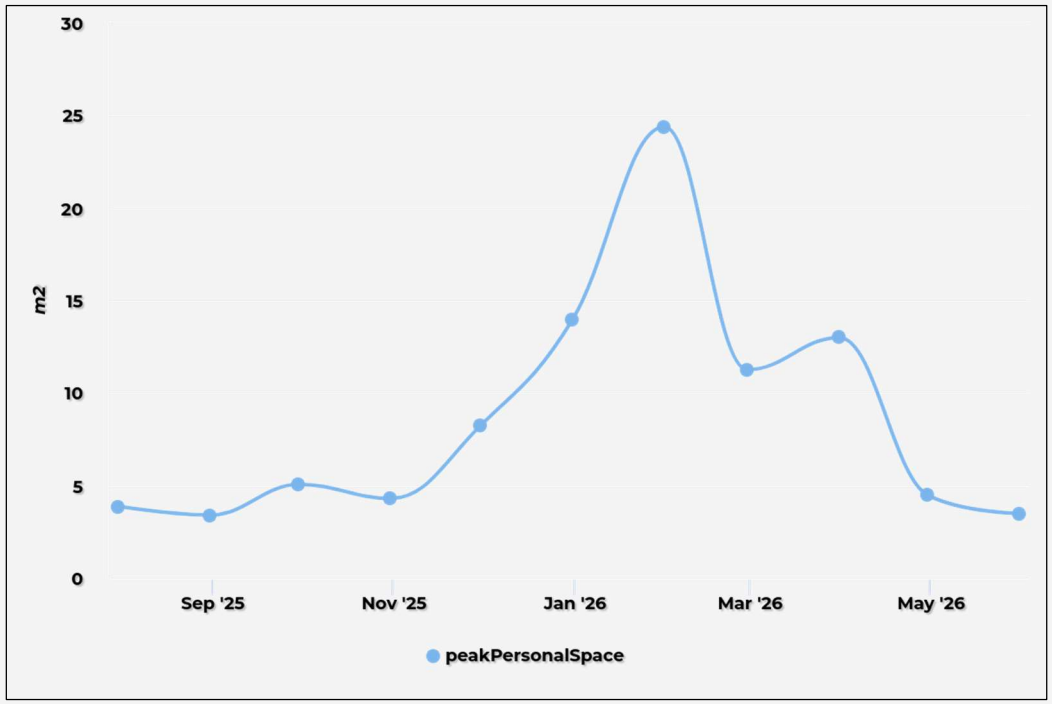


# Annual Trends – Occupancy and Space

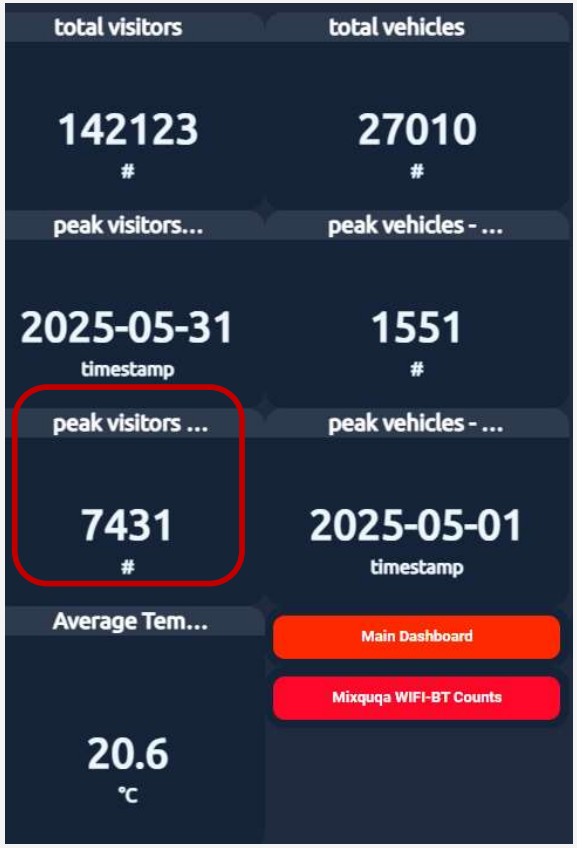
**July 2025 to May 2026**

**Peak occupancy = 2,119; Peak personal space = 3.4m2 (Aug)**

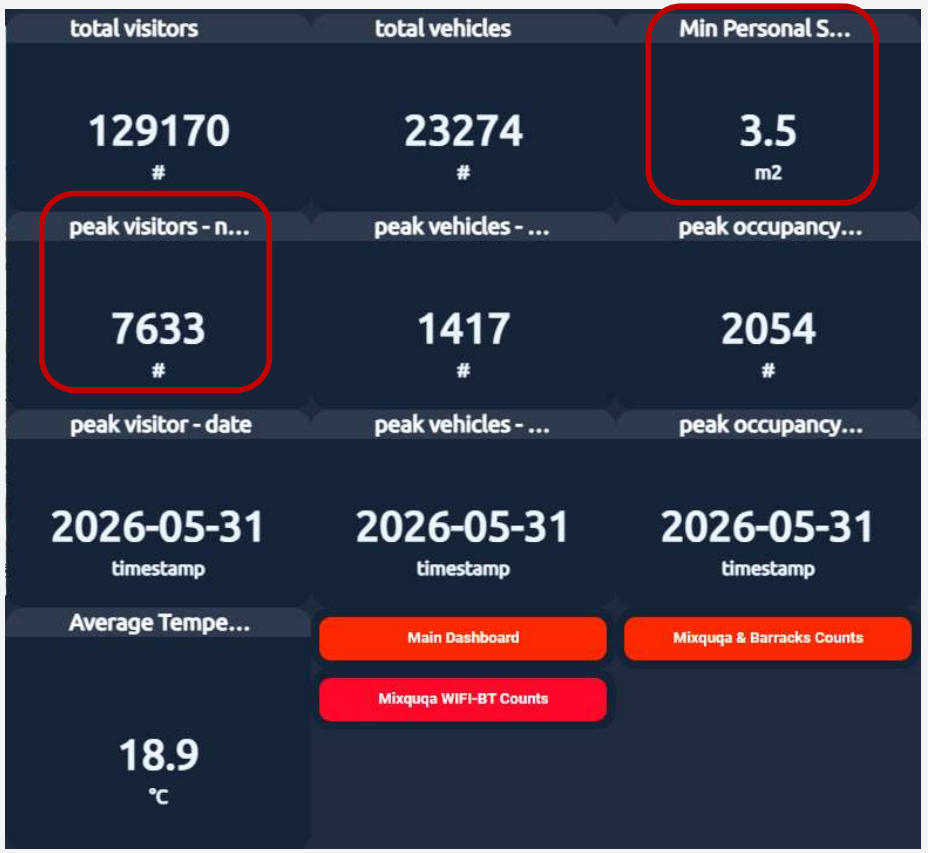



# Annual Trends – May 2025 vs May 2026

May 2025




May 2026



# Data results

**Density and Carrying Capacity: The beach's maximum comfortable capacity is estimated at 1,802 people, based on an average of 4m² per person.** The real-time density analysis revealed that during peak summer months, space shrinks to a highly uncomfortable 3.4 m² per visitor. (Based on a maximum occupancy to-date of 2,119 people on the beach at one point in time, noted in August 2025.

**Personal Space and Comfort levels:** From June to August, the **baseline traffic on the quietest weekdays rarely drops below 1,000 to 1,500 visitors**. The site is subjected to sustained pressure, operating continuously at or above its safe 1,802-person carrying capacity.

**Absolute Capacity Breaches:** August represents the system's breaking point. Daily volumes repeatedly exceed 4,000 visitors, and longer summer dwell times mean concurrent occupancy **surges past its physical limit**.

**Traffic and Infrastructure Strain:** Data showed that on a peak weekend day, **66.6% of visitors (4,952 people out of 9,136 total visitors ) arrived by walking downhill against 1,834 vehicles**.

**Dwell Time Impact: Visitor duration is highly variable**, with many staying for stretches of 5-6 hours. This proved that the beach suffers from "static overcrowding," where spaces do not turn over quickly during peak times.

**Ecological Monitoring:** The AI cameras successfully detected "sand dune breaches" when visitors crossed protective cordons, triggering automated alerts to park rangers for immediate intervention. **Dune breach counts are worrying during peak hours.**

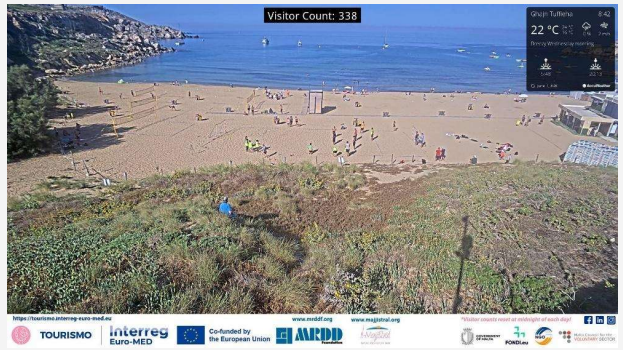
**Visitor Sentiment:** The qualitative surveys confirmed that while tourists appreciate the natural environment, they are **highly critical of the failing built infrastructure**, specifically highlighting poor toilets and a lack of drinking water.

# Qualitative analysis

- Carrying capacity in terms of personal space.
- Environmental permitting.
- Waste management concerns and failures.
- Mechanical sand sifting issues.
- Microplastic, smoking, and marine litter.
- Light pollution.
- Cordoning and breaches in the dunes.
- Concession permitting.
- Sanitation issues.
- Feline predation.
- Invasive Grasses.
- Stormwater management.
- Scaling the counting program to other NATURA 2000 sites.

Enforcement and revision of environmental permit conditions.

Anchoring, shifting, and reinforcing cordoning. Harsher signage.





Most intrusions are related to shading, ball fetching, urinating or changing. Soon for smoking.

Illegal spearfishing and metal detecting.

# Traffic bottlenecks

**No traffic control and free-for-all access road. LESA and Police enforcement absent**

**No pedestrian walkway nor zebra crossings at upper bus drop-off and parking areas.**



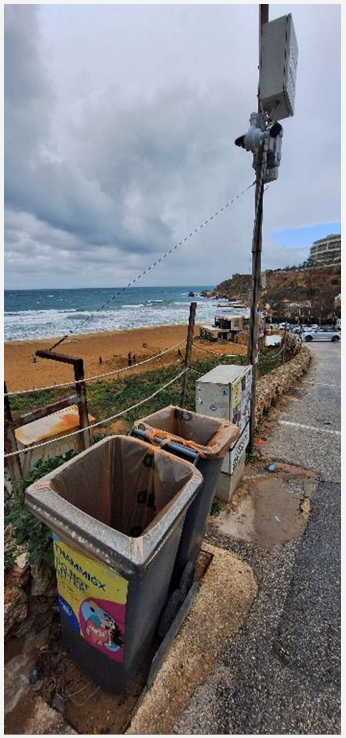
**Highly dangerous to pedestrian traffic**

**Hal Ferh development?**

# Light pollution




# Waste management



No recycling in winter

Inadequate dustbins and open top.

No sifting in winter

# Sentiment analysis


**Most Common Issues:**

- Poor toilet facilities.
- Lack of free drinking water stations.
- Litter (cigarette butts, plastics, seagrass).
- Expensive facilities.
- Limited space and overcrowding.
- Noise from pleasure boats.

**Conclusions:**

- **Structural deficiencies** (toilets, showers, water stations, cleanliness) strongly impact visitor satisfaction.
- **Overcrowding** is a recognised issue.
- Maltese residents are more willing to return despite the problems, while **international tourists express greater disappointment** and lower likelihood of revisiting.

**Priority improvements suggested:**

**Improved toilet facilities**, installation of **free water stations**, and **enforce regulation of services** and activity to protect the natural environment.

# Solutions found

**Clearing of various accretions and kiosks** at the beach entrance.

**Increased no parking buffer** to provide more space at beach entrance and improved access to emergency services.

**Improved connectivity and signage** to areas in the vicinity like Ghajn Tuffieha and the Majjistral Nature and History Park next door in order to offer options during overcrowded peaks.

**Improved enforcement and cleansing.**

Golden Bay declared a **smoke free beach as of 01st January 2026**.

**Geo-fencing system** will limit Y-plate vehicles from entering the beach road during peak hours and will not be able to park and wait in these designated areas. A designated drop-off point has been indicated.



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# Impact of surging population and tourist nos.

**Capacity Overload:**
Golden Bay's maximum safe occupancy competing for the available 7,210 m² of sand, is roughly **1,802 people based on a 4m2 of personal space per person**. The maximum occupancy to-date was of 2,119 people on the beach at one point in time, indicating that personal space dropped down to **an uncomfortable 3.8 m.2** (August 2025).

**Infrastructure Failure:**
**Basic facilities are already buckling under current loads**. Toilets are almost universally criticised, and the single access route suffers from severe traffic bottlenecks and parking chaos during peak.

**Accelerated Ecological Damage:**
More people implies a **proportional spike in waste**, specifically microplastics and cigarette butts, which are already top visitor complaints. Lack of space will also force desperate beachgoers into protected areas, increasing intrusions past the sand dune cordoning.

**Loss of International Appeal:**
Sentiment data shows a stark divide: while Maltese residents are willing to tolerate the issues and return, **international tourists are highly likely to abandon the beach entirely due to poor conditions**.

**Growth data proves that the predictive alerts and capacity management tools being adopted under TOURISMO are not just innovative upgrades but a necessity to prevent the site from being loved to death.**

# Lessons Learned and Key Barriers

**Lessons learned regarding the intersection of technology, physical infrastructure, and public administration:**

**Real-time crowd monitoring program at a protected NATURA 2000 beach is possible and accurate.**

**Fragmented governance:** The most significant lesson is that having actionable, real-time data is useless without an empowered, unified body to act upon it. Because responsibilities across the beach are fragmented between different agencies (MTA, ERA, Transport Malta, Local Councils), the data often gets trapped in bureaucratic bottlenecks rather than driving preventative interventions.

**The Institutional "Silo Effect“:** Since no overarching coordinating body exists, nobody is looking at the bigger picture. Consequently, this fragmentation breeds a severe lack of proactive enforcement.

**Digital Optimisation Cannot Mask Physical Decay:** The project highlighted a major "Infrastructure Disconnect". While the IoT solution effectively monitored flows, the digital innovation was overshadowed by basic physical failures; tourists heavily criticised the dilapidated toilets and lack of water stations. Digital solutions are viewed as secondary priorities if the foundational physical infrastructure remains broken. The pilot successfully generated highly actionable data regarding traffic bottlenecks, abusive parking, waste and dune intrusions.

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# Lessons Learned and Key barriers...

**Free Access Expectations**:
Sentiment analysis revealed a strong resistance among visitors to paying an entrance fee to control overcrowding.

**Stakeholder disconnect:**
There is a fundamental disconnect between local tolerance and international expectations. Maltese residents indicated a willingness to return despite overcrowding and poor facilities, while international tourists expressed severe disappointment.

**Concession agreement transparency:** The lack of concession agreements with the existing commercial beach operators, and lack of enforcement, at Ir-Ramla tal-Mixquqa exacerbates the chronic overcrowding issues and undermines sustainable management.

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# Data-Driven Policy Solutions

**The Visitor Counting Data at Ramla tal-Mixquqa can help inform policy-making in the following ways:**

**Establishing Safe Carrying Capacities**: The data provides objective proof that the beach regularly exceeds its safe limit of 1,802 people, reaching as few as 3.4 m2 of personal space per visitor in August. This allows policy-makers to **move beyond "static" management toward dynamic, data-led limits** on commercial concessions and visitor arrivals.

**Addressing the Infrastructure Ceiling:** The analysis shows that while **human traffic can surge by 25x**, vehicular capacity is physically capped at roughly 900 vehicles per day. This provides the evidence required for Transport Malta and Local Councils to **implement traffic diversion strategies** before gridlock occurs.

**Bridging Institutional Silos**: By providing a unified dashboard (Snap4City), the project enables the MTA, ERA, and Local Councils to share a single source of numbers, **facilitating coordinated responses to waste management, dune protection, and traffic enforcement**.

**Lack of Pedestrian Safe Passage**: The correlation between the Uphill and Downhill Mixquqa cameras reveals that on peak Sundays, nearly **5.0 pedestrians arrive for every 1 vehicle** attempting to use the same narrow access road. The data captures a high-risk environment where visitors per day are forced to walk alongside heavy vehicle traffic in a confined bottleneck.

**Strategic Nudging and Diversion**: Monitoring of the Majjistral Park confirms its utility as a relief valve during cooler months, **absorbing spikes of 1,500 pedestrians.** Policy-makers can now use this **to target "nudging" campaigns** specifically for the spring and autumn shoulder seasons.

# Solutions elsewhere

**Greece's "Untouchable" Beaches law** bans all commercial exploitation, including sunbeds and umbrellas, on 198 ecologically sensitive Natura 2000 sites, and mandates that **at least 85% of protected beaches remain completely free of such commercial activity**.

**Italy is enforcing the EU's 2006 Bolkestein Directive**, requiring that public beach concessions be subject to transparent, competitive public tenders to eliminate closed monopolies and ensure public assets are managed for the collective good.

The absence of similar, proactive regulation at Golden Bay means the **operational environment remains largely unconstrained**, preventing the necessary structural management required to protect the vulnerable NATURA 2000 site.

**It is recommended that at least 50% is left free of commercial sunbeds.**

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# Key advantages of TOURISMO

- Accurate counting
- Improved flow management
- Real-time monitoring
- Automated detection & alerts
- Better planning
- Monitoring of large and busy areas
- Faster Responses
- Efficient resource allocation

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# Scalability

Other pocket beaches with restricted access.

1. Għajn Tuffieħa (Riviera).
2. Paradise Bay.
3. Wied iz-Zurrieq.
4. Gnejna Bay.
5. Ramla l-Ħamra (Gozo).
6. Hondoq ir-Rummien.
7. Dwejra Bay.
8. Comino, Blue Lagoon.
9. San Blas Bay.
10. Mgarr ix-Xini.

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# Thank You!

**Mellieha Local Council**

**Malta Tourism Authority**

**Heritage Parks Federation**

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# Making the Mediterranean Green Transition happen