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# **vathra.xyz — Crowdsourced Monitoring of Greece’s Geodetic Heritage: Architecture, Empirical Results, and Legal Framework**

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**Repository:** [github.com/ppapadeas/greece-trig-points](https://github.com/ppapadeas/greece-trig-points)

## **Abstract**

Greece’s national trigonometric network comprises 25,258 geodetic survey points established by the Hellenic Military Geographical Service (HMGS/GYS). This paper presents vathra.xyz, an open-source web platform for crowdsourced condition monitoring of these points using Volunteered Geographic Information (VGI) methods. We describe the system architecture (React, PostGIS, Leaflet, browser-based AR compass), report operational results from six months of deployment (52 registered users, 140 condition reports covering 99 unique points across 38 active days), and examine the EU and Greek legal framework governing the re-use of publicly published geodetic data. Among the 99 crowdsourced points, contributors identified 18 DESTROYED or MISSING markers — previously undocumented condition information. To the authors’ knowledge, this represents the first systematic, publicly accessible condition assessment of this network.

**Keywords:** *trigonometric points, geodetic heritage, crowdsourcing, VGI, PostGIS, INSPIRE, open data, citizen science, Greece*

## 1. Introduction

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### 1.1 The Hellenic Trigonometric Network

The Hellenic Military Geographical Service (Γεωγραφική Υπηρεσία Στρατού, GYS/HMGS), established in 1889, built and maintains Greece's national geodetic control network. This network consists of 25,258 trigonometric points of Orders I through IV, monumented across the Greek landscape — from Aegean island peaks to Pindus mountain ridges to Attic hilltops. Each point is a physical marker (typically a concrete pillar with a brass plate, or a bolt drilled into bedrock) whose coordinates have been precisely determined through geodetic surveying. Together, they form the geometric skeleton upon which all Greek cartography, cadastral surveys, and engineering projects are built.

The network's composition by geodetic order reflects its hierarchical structure: 117 Order I points (0.5%) form the primary framework, 429 Order II points (1.7%) densify the network, 3,925 Order III points (15.5%) provide regional control, and 20,745 Order IV points (82.1%) offer local coverage. Points are referenced in the Hellenic Geodetic Reference System 1987 (HGRS87/EGSA87, EPSG:2100) and linked to 1:50,000 map sheets of the national cartographic series.

### 1.2 The Problem: Silent Deterioration

Despite their importance, Greece's trigonometric points receive no systematic condition monitoring. The HMGS does not publish condition data or invite public participation in maintenance — a posture at odds with peer European national mapping agencies (Section 2.2). Meanwhile, the physical markers deteriorate: construction projects destroy them, vegetation obscures them, weathering erodes inscriptions, and rural depopulation means fewer people notice or report damage. Without a continuously updated condition record, there is no basis for prioritising maintenance, measuring deterioration rates, or assessing the operational integrity of the network.

### 1.3 The Solution: Crowdsourced Monitoring

vathra.xyz addresses this gap by creating an open, web-based platform where anyone — hikers, surveyors, geographers, curious citizens — can view the location of all GYS trigonometric points on an interactive map, visit them in the field, and submit condition reports with photographs. Reports classify each point into one of five statuses: OK, DAMAGED, DESTROYED, MISSING, or UNKNOWN. The platform is fully open-source (AGPLv3), bilingual (Greek/English), designed for mobile field use, and periodically archived on Zenodo with a DOI for academic citation.

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## 2. Related Work

### 2.1 Volunteered Geographic Information (VGI)

The concept of citizens as voluntary contributors to geographic databases was formalised by Goodchild (2007) as "Volunteered Geographic Information" (VGI). Subsequent research has examined VGI quality (Haklay, 2010; Goodchild and Li, 2012; Senaratne et al., 2017), contributor motivations (Coleman et al., 2009), and credibility (Flanagin and Metzger, 2008). A recent comprehensive review by Huang et al. (2024) identifies seven key challenges including data quality, sustained engagement, and legal/ethical

navigation.

vathra.xyz operates within the VGI paradigm but adopts a constrained contribution model — selecting from a fixed status enumeration rather than mapping new features. This approach aligns with what Goodchild and Li (2012) characterise as a "crowdsourcing" quality assurance strategy, where the bounded vocabulary reduces the scope for errors while the accumulation of multiple reports enables cross-validation. Similar constrained-vocabulary approaches have proven effective in infrastructure condition monitoring (Kiremidjian et al., 2014) and cultural heritage documentation via platforms like WikiData and Europeana (Oomen and Aroyo, 2011).

## 2.2 International Geodetic Citizen Science

The practice of visiting and documenting geodetic survey markers has international precedent:

TrigpointingUK (trigpointing.uk): A community platform documenting the ~6,500 Ordnance Survey trig pillars across Great Britain. The OS now classifies these as "legacy control data" and actively promotes awareness through its GetOutside initiative.

US National Geodetic Survey Mark Recovery Program: The NGS actively encourages public condition reporting for its 800,000+ survey marks. The complementary GPS on Bench Marks (GPSonBM) programme solicits volunteer GPS observations. The programme has operated for over 40 years, with geocaching.com channelling hobbyists toward benchmark recovery (NGS, 2019).

France's Géodésie de Poche: In 2025, France's IGN launched "Géodésie de Poche" (Pocket Geodesy), a smartphone application for citizen condition reporting of geodetic markers. In its first six months, 2,700 reports were submitted across 10,000+ Android downloads. This government-led initiative is the closest international analogue to vathra.xyz. The scale differential is notable: France has a significantly larger surveyor and hiker community, and Géodésie de Poche addresses France's entire geodetic network with institutional promotion through IGN's established channels, whereas vathra.xyz's addressable community is smaller by language, geography, and the absence of institutional backing.

Switzerland's swisstopo: Since March 2021, swisstopo publishes planimetric (LFP) and height (HFP) control points under Open Government Data principles — no registration required, available via APIs and bulk downloads.

These examples demonstrate that crowdsourced geodetic monitoring is established practice across jurisdictions with military mapping agencies (UK, France, Switzerland). Greece is an outlier in restricting access to data that peer nations freely publish.

## 2.3 Gamification in Citizen Science

The use of game-design elements to sustain engagement in citizen science has been studied extensively (Bowser et al., 2013; Eveleigh et al., 2014). Iacovides et al. (2013) found that leaderboards and achievement systems increase short-term participation but that intrinsic motivation (genuine interest in the subject) is the primary predictor of long-term engagement. vathra.xyz's challenge system (Section 3.7) was designed with this evidence in mind: challenges are tied to meaningful exploration milestones (e.g., covering all Order I points, visiting points across multiple map sheets) rather than arbitrary gamification metrics.

## 2.4 Geodetic Heritage

The Struve Geodetic Arc, inscribed on the UNESCO World Heritage List in 2005 (WHC Ref. 1187, <https://whc.unesco.org/en/list/1187/>), establishes that geodetic survey infrastructure can merit the highest level of cultural heritage protection. This chain of 265 triangulation stations across ten countries, constructed 1816–1855, is protected under both geodetic and cultural heritage legislation. Under Greek Law 3028/2002 on the Protection of Antiquities and Cultural Heritage, structures of historical and scientific significance may qualify for national designation. The GYS network, while younger (post-1889), represents a national scientific effort of comparable scale. Crowdsourced condition data from [vathra.xyz](http://vathra.xyz) could inform future heritage assessments.

## 3. Technical Architecture

### 3.1 System Overview

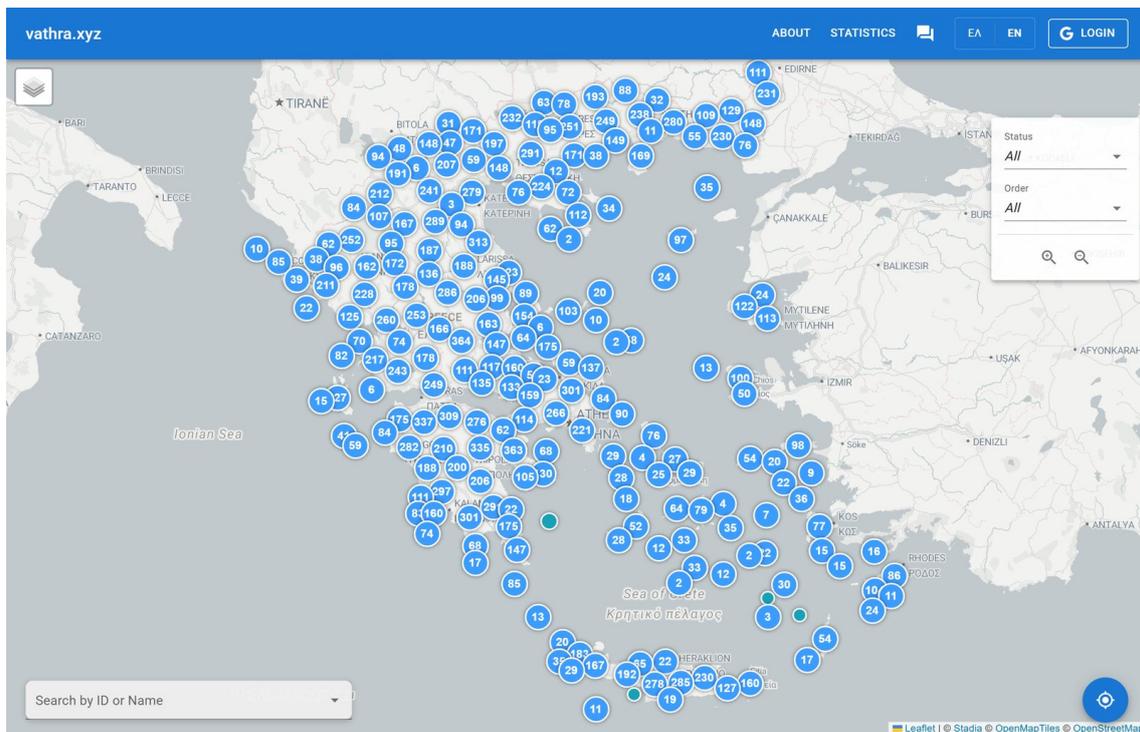


Figure 1. The [vathra.xyz](http://vathra.xyz) map interface showing 25,258 clustered trigonometric points across Greece, with status/order filter controls and search bar.

[vathra.xyz](http://vathra.xyz) is a full-stack web application deployed across three services: Vercel (frontend CDN), Fly.io (backend API, Frankfurt region), and Supabase (managed PostgreSQL 17 with PostGIS 3.4). Image uploads are stored via Cloudflare Workers on S3-compatible storage. Authentication uses Google OAuth2 through Passport.js with sessions stored in PostgreSQL (30-day TTL). The application is a bilingual (Greek/English via [i18next](https://i18next.com/)) Progressive Web App installable on mobile devices.

### 3.2 Data Model

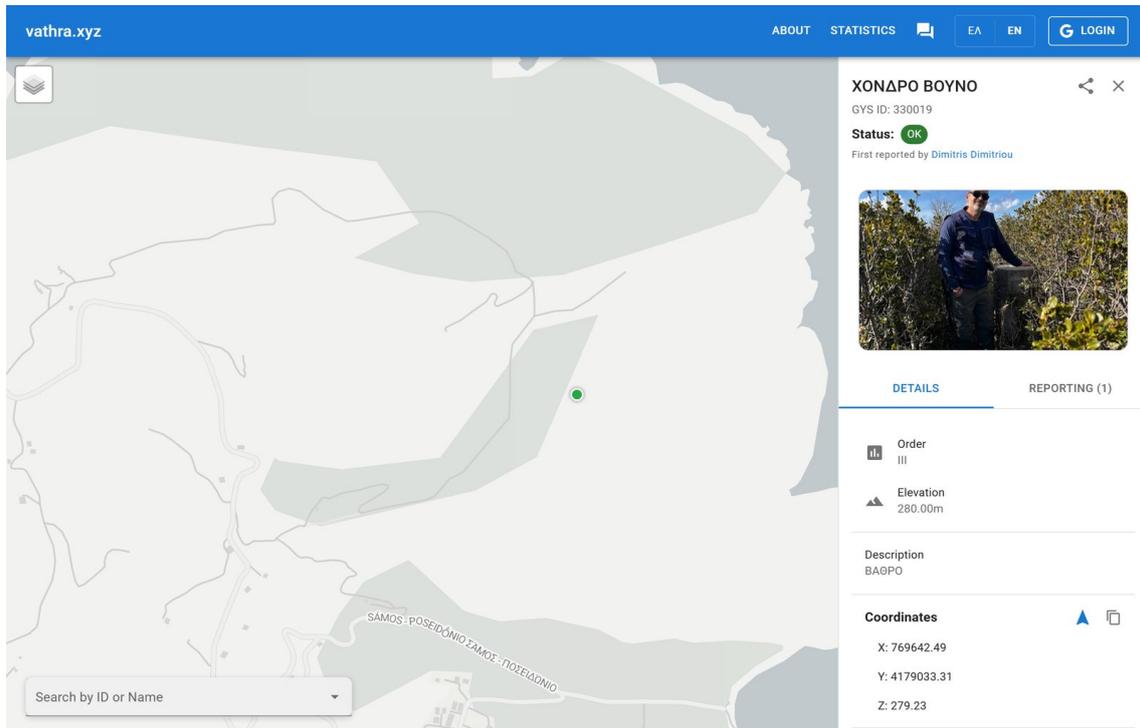


Figure 2. Point detail sidebar for GYS ID 330019 (XONAPO BOYNO), showing OK status badge, contributor photo, geodetic order, elevation, EGSA87 coordinates, and report tab.

The core data model consists of three entities:

**Points (25,258 records):** Each trigonometric point is stored with its GYS identifier, name, location (PostGIS GEOGRAPHY(Point, 4326)), EGSA87 coordinates (X, Y, Z), elevation, geodetic order (I–IV), current status, and map sheet metadata. A GIST spatial index on the location column enables efficient geospatial queries.

**Users (52 registered):** Authenticated via Google OAuth2. User records link to submitted reports for profile pages and leaderboards.

**Reports (140 total):** The crowdsourced contribution unit. Each report references a point and a user, contains a status classification, optional comment ( $\leq 1,000$  characters), and optional photograph URL. Reports carry a moderation flag (is\_reviewed); admin approval syncs the point's canonical status.

### 3.3 Geospatial Query Engine

PostGIS enables several spatial operations:

**Slim map payload:** The list endpoint returns five columns per point (id, gys\_id, status, point\_order, lat, lon) with coordinates extracted via ST\_Y/ST\_X as plain numbers. This was measured to reduce the API response from  $\sim 4.2$  MB (full GeoJSON) to  $\sim 1.2$  MB (slim payload), a 71% reduction before gzip compression, which further reduces the on-wire size to  $\sim 360$  KB.

**Nearest-neighbour search:** The  $\leftrightarrow$  KNN operator, accelerated by the GIST index, powers the "nearest unvisited point" feature with sub-millisecond query times:

```

SELECT id, gys_id, name, status,
       ST_Distance(location, ST_MakePoint($2, $1)::geography) as distance_m
FROM points
WHERE id NOT IN (SELECT DISTINCT point_id FROM reports)
ORDER BY location <-> ST_MakePoint($2, $1)::geography
LIMIT 1;

```

Radius search for the AR compass uses `ST_DWithin` to find points within a configurable radius (1–20 km).

### 3.4 Map Rendering and Performance

The frontend renders 25,258 markers using Leaflet with the MarkerCluster plugin:

- Cluster group persistence: The MarkerClusterGroup is created once in a React `useRef`. Filter changes use `clearLayers()/addLayers()` batch operations, avoiding  $O(n \log n)$  cluster rebuilds.
- Marker differentiation: Colour-coded by status (green=OK, yellow=DAMAGED, red=DESTROYED, grey=MISSING, blue=UNKNOWN) and sized by geodetic order (22px for I, 18px for II, 16px for III/IV).
- Permalink stability: Marker clicks use `window.history.pushState()` instead of React Router's `navigate()` to avoid unmounting the Leaflet map instance.
- Response compression: gzip middleware reduces API response sizes by ~70%.

### 3.5 AR Compass View

The AR compass view (`/compass`) overlays nearby trigonometric points onto the device's camera feed with bearing and distance indicators. It uses three browser APIs without external AR libraries:

- Camera: `getUserMedia({ video: { facingMode: 'environment' } })`
- Compass: `DeviceOrientationEvent` (iOS `webkitCompassHeading`, Android `deviceorientationabsolute` with  $(360 - \alpha) \% 360$ )
- GPS: `navigator.geolocation.watchPosition()` with high-accuracy mode

Compass sensor noise is smoothed via a low-pass angular interpolation filter (coefficient  $\alpha = 0.3$ , empirically tuned to balance responsiveness against jitter on test devices including iPhone 13 and Pixel 7, with  $0^\circ/360^\circ$  wraparound handling). GPS updates are debounced with a 50-metre movement threshold. Points are positioned horizontally based on the angular difference between their bearing and the compass heading, assuming a camera field of view. The current implementation uses a fixed  $60^\circ$  FoV assumption; this is a known limitation, as modern smartphone cameras range from 24mm equivalent ( $\sim 84^\circ$  FoV) to 70mm ( $\sim 34^\circ$  FoV). Future iterations should query the camera's intrinsic parameters via `getCapabilities()` where supported. The feature is mobile-only; desktop browsers display an unsupported-device message.

### 3.6 Data Export

Three export formats are available without authentication: CSV (UTF-8 with BOM), KML (OGC 2.2), and GPX (1.1, with status/order/bbox filters). All formats include WGS84 and EGSA87 coordinates.

### 3.7 Community and Engagement Features

To sustain contributor engagement, the platform includes user profiles with report history and mini-maps, a challenges system (achievement badges with progress bars for milestones like "Order I Compleater," "First 100 Club," and "Map Sheet Explorer"), a top-10 leaderboard, a real-time activity feed, a

reports-over-time area chart, a PostGIS-driven "nearest unvisited" banner, and a Discord community server for coordination.

### 3.8 Quality Assurance

Data quality is managed through: constrained vocabulary (5-value status enum), admin moderation with reviewed/unreviewed flagging, rate limiting (20 reports/hour/IP), input validation (1,000-char comment cap, image-only uploads  $\leq 5$  MB), and longitudinal consensus from multiple reports over time. These mechanisms are evaluated empirically in Section 4.3.

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## 4. Operational Results

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### 4.1 Platform Statistics

As of 4 March 2026, after approximately six months of operation (first report: 12 September 2025), the platform has recorded:

Metric	Value
Total trigonometric points in database	25,258
Registered users	52
Total condition reports submitted	140
Unique points with at least one report	99
Network coverage (% of points reported)	0.4%
Distinct active reporting days	38
Mean reports per active day	3.7
Peak reporting day	13 January 2026 (24 reports)
Top contributor report count	58
Contributors with $\geq 3$ reports	10

### 4.2 Network Condition Overview

Of the 25,258 points in the database, 819 (3.2%) currently carry a classified status, while the remaining 24,439 (96.8%) retain the default UNKNOWN status — meaning no condition information is available for them from any source. The 819 classified points include 99 assessed through crowdsourced reports and approximately 720 whose status was pre-populated from historical HMGS data at the time of database seeding. The current network-wide status distribution is:

Status	Points	% of Classified (819)	% of Total Network
OK	790	96.5%	3.1%
DESTROYED	14	1.7%	0.06%
DAMAGED	11	1.3%	0.04%
MISSING	4	0.5%	0.02%
UNKNOWN	24,439	—	96.8%

*Note: The 819 classified points include ~720 whose status was pre-populated from historical HMGS survey data at database seeding, plus 99 assessed through crowdsourced reports on the platform.*

It is important to note that the high proportion of OK status among classified points (96.5%) is expected for two reasons: (1) the pre-populated historical data predominantly records points that were intact at the time of the last official survey, and (2) crowdsourced contributors preferentially visit accessible, well-known points that are more likely to be intact. Points in poor condition — overgrown, in remote locations, or on private land — are less likely to attract visitors. This dual selection bias is inherent to both institutional survey legacy and voluntary monitoring, consistent with findings on spatial coverage bias in VGI (Haklay, 2010; Basiri et al., 2019). The DESTROYED and MISSING findings (18 points) nonetheless represent new condition information that did not previously exist in any public database.

### 4.3 Quality Indicators



*Figure 3. Crowdsourced field photographs of trig points in OK condition. Left: GYS 330019, concrete pillar among vegetation. Right: GYS 330007, pillar with metal observation tripod.  
Photos: Dimitris Dimitriou, CC BY-SA.*

While the dataset is too small for rigorous inter-rater reliability analysis, several quality indicators are observable:

- Admin moderation workflow: All 140 submitted reports are reviewed by a platform administrator before the point's canonical status is updated. The moderation interface displays the submitted status, comment, and photograph alongside the point's current status, allowing the admin to either approve (syncing the new status to the point) or reject (deleting the report and reverting to the previous status). To date, all 140 reports have been reviewed and approved, with zero rejections. This reflects

both the constrained vocabulary that limits erroneous classifications and the self-selecting nature of contributors who visit physical locations before reporting.

- Temporal consistency: Points with multiple reports show stable status over time, suggesting contributor agreement.
- Photograph evidence: Among the 15 most recent reports, 7 (47%) include photographs, providing verifiable visual documentation that enables retrospective quality review. The full-dataset photograph rate is not currently exposed by the platform API; instrumenting this metric is planned for a future release.
- Contribution distribution: The top contributor (58 reports, 41.4%) dominates the dataset, a pattern consistent with the well-documented power-law distribution of VGI contributions (Neis and Zipf, 2012) where a small core of "super-contributors" generates the majority of data. Ten contributors have submitted  $\geq 3$  reports.

#### 4.4 Contribution Patterns

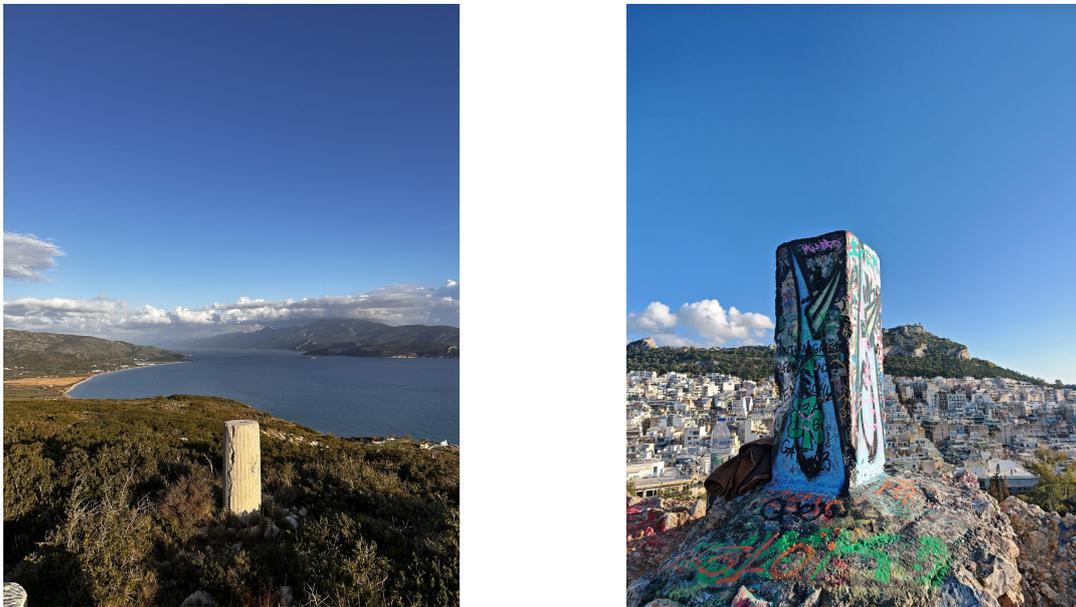


Figure 4. Additional trig point field photographs. Left: GYS 330011, mountain-top pillar with panoramic view. Right: GYS 019057, pillar at a remote location.

Photos: Left — Dimitris Dimitriou; Right — Charalampos Skeparnakos. CC BY-SA.

The temporal distribution of reports shows episodic activity rather than continuous flow. Reports cluster on weekends and holidays, consistent with recreational hiking activity. The launch period (September 2025) saw notably higher density, with 45 reports submitted in the first week — likely reflecting a platform novelty effect amplified by initial promotion in local hiking and surveying communities. Subsequent activity settled to a steady-state rate of approximately 2–5 reports per week. This launch-spike-to-plateau pattern is commonly observed in volunteer platforms (Eveleigh et al., 2014) and does not indicate declining interest but rather a transition from novelty-driven to habit-driven contribution. Geographic coverage is concentrated in accessible mainland areas, with island and remote mountain points underrepresented — a geographic bias common to all VGI projects (Haklay, 2010).

## 4.5 Limitations

The 0.4% coverage rate after six months indicates that fully crowdsourced monitoring of all 25,258 points is a multi-decade undertaking without institutional support. The "nearest unvisited" feature and map-sheet challenges aim to direct contributors toward uncovered areas, but scaling requires either significantly more contributors or partnership with hiking clubs and surveying professionals. The AR compass feature has been deployed but usage analytics are not yet collected; future work should instrument this feature to assess field utility and calibrate the FoV assumption per device.

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## 5. Legal Framework for Open Geodetic Data

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The authors note, by way of disclosure, that informal (non-official) communications from military-affiliated individuals have suggested the platform should be taken down. No formal legal action has been initiated. This section examines the applicable EU and Greek legal framework.

### 5.1 Data Provenance

The trigonometric point locations used by vathra.xyz were obtained from two publicly accessible sources operated by or on behalf of the HMGS: (1) a GeoPackage file containing EGSA87 coordinates, and (2) a public ArcGIS Feature Server endpoint (services3.arcgis.com, layer "ΤΡΙΓΩΝΟΜΕΤΡΙΚΑ\_ΕΛΛΑΔΑΣ") providing point metadata (names, elevations, geodetic orders, map sheet identifiers, and an existence indicator). Neither source carried an explicit licence or terms of use in its metadata. The HMGS also operates a searchable web portal (web.gys.gr) through which individual geodetic control point data can be queried by the public.

The absence of an explicit licence on a publicly accessible government data service does not, under EU and Greek law, imply that re-use is prohibited. The applicable legal framework — examined below — establishes the opposite presumption.

### 5.2 EU Legal Framework

Directive 2007/2/EC (INSPIRE) mandates pan-European spatial data infrastructure. Annex I, Theme 1 (Coordinate Reference Systems) directly covers geodetic markers: the Data Specification states that "spatial referencing is usually referred to selected points of the earth surface. Such points are, e.g., given by geodetic markers, stations performing permanent satellite observations, levelling benchmarks, or tide gauges." Article 13(2) requires that any limitation on public access "shall be interpreted in a restrictive way" with the "public interest served by disclosure" weighed against the restriction interest.

Directive (EU) 2019/1024 (Open Data) applies to all documents held by public sector bodies, with geospatial data identified in Annex I as the first of six "high-value dataset" categories. Article 1(2) excludes documents "excluded from access" on grounds of national security — but this exclusion is inapplicable to data that has been made publicly available through government-operated web services.

Implementing Regulation (EU) 2023/138 establishes the specific list of high-value datasets under Directive 2019/1024. Geospatial data — including geodetic reference systems and coordinate reference frameworks — is explicitly designated as a high-value dataset category, requiring publication under conditions of open, free re-use.

Regulation (EU) 2022/868 (Data Governance Act) establishes a framework for the re-use of protected public sector data, including categories held by public sector bodies with restrictions. The regulation promotes the principle of open access by design and by default.

### 5.3 Greek Law and the Supersession of Law 3882/2010

Informal communications from military-affiliated individuals have cited Law 3882/2010 (the original Greek transposition of INSPIRE Directive 2007/2/EC) as the legal basis for restricting re-use of HMGS geodetic data.

However, Law 3882/2010 has been substantively superseded by more recent legislation:

Law 4727/2020 (Digital Governance — Electronic Communications, Government Gazette 184/A/23-09-2020) transposes Directive (EU) 2019/1024 into Greek law (Articles 59–74), establishing the "open by default" principle for all public sector data. As a later and more specific enactment addressing the same subject matter (public sector data re-use), Law 4727/2020 prevails over conflicting provisions of Law 3882/2010 under the principle of *lex posterior derogat legi priori*.

Law 5188/2025 (Government Gazette 49/A/28-03-2025) implements Regulation (EU) 2022/868 (Data Governance Act) into Greek law, further reinforcing the framework of open access by design and designating the Ministry of Digital Governance as the competent authority for data re-use matters.

The cumulative effect of these instruments is that geospatial data held by Greek public sector bodies — including geodetic control point data — falls squarely within the categories mandated for open, free re-use under both EU and Greek law. The national security exemption in Law 3882/2010 was designed to prevent forced disclosure of classified material; it cannot reasonably apply to data already served through unauthenticated, publicly accessible web endpoints.

### 5.4 Original Data Contribution

vathra.xyz's primary value proposition is the crowdsourced condition reports — original data created by volunteer contributors with no analogue in any HMGS database. The point locations serve as a spatial scaffold for this original data collection. The platform does not reproduce the HMGS database wholesale; it uses publicly accessible point locations as a base layer for community-generated content.

### 5.5 Summary

Legal Instrument	Key Provision	Implication
INSPIRE 2007/2/EC, Annex I	Geodetic markers are mandatory spatial data	Disclosure is the directive's purpose
INSPIRE Art. 13(2)	Restrictions interpreted "restrictively"	High bar for any limitation
Open Data Directive 2019/1024	Geospatial = high-value dataset category	Mandates open, free re-use
Implementing Reg. 2023/138	Specific high-value dataset list including geospatial	Geodetic data explicitly covered
Data Governance Act 2022/868	Open access by design and by default	Re-use framework for public data

Greek Law 4727/2020	"Open by default"; transposes 2019/1024	Supersedes Law 3882/2010
Greek Law 5188/2025	Implements Data Governance Act	Reinforces open data framework

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## 6. Data Governance and FAIR Principles

The dataset adheres to FAIR principles: Findable via Zenodo DOI and DataCite indexing; Accessible via open API, bulk exports (CSV/KML/GPX), and Zenodo downloads without registration; Interoperable using WGS84/EGSA87 coordinate reference systems and OGC-compliant formats; Reusable under CC BY-SA with clear provenance metadata. We note that this is a self-assessed FAIR evaluation; formal assessment using a tool such as F-UJI (Devaraju et al., 2021) is planned for a future version of the dataset.

Each Zenodo version receives a unique DOI while maintaining a concept DOI that always resolves to the latest release, creating a versioned, citeable, permanently preserved record of geodetic heritage condition over time.

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## 7. Discussion

### 7.1 Comparison with International Programmes

vathra.xyz's six-month results (140 reports, 52 users) are modest compared to France's Géodésie de Poche (2,700 reports, 10,000+ downloads in the same period) and the NGS Mark Recovery Program (40+ years of operation). However, critical differences in context apply: Géodésie de Poche is a government-backed initiative with institutional promotion through IGN's established outreach channels, while vathra.xyz is a single-developer community project without institutional support or public promotion channels. France also has a significantly larger population of active hikers and professional surveyors (the Fédération Française de la Randonnée Pédestre reported approximately 235,000 members for the 2024–2025 season (FFRandonnée, 2025), while the Hellenic Federation of Mountaineering and Climbing (EOOA) comprises 84 affiliated clubs across 38 provinces, with an estimated combined membership of approximately 30,000 (EOOA, 2024)). The per-capita contribution rate, when normalised for community size and promotion effort, may compare more favourably.

### 7.2 Coverage Scaling

At the current rate (~4 reports/day on active days, 38 active days in 6 months), achieving 10% network coverage (~2,500 unique points) would require approximately 5 years without acceleration. Partnership with organised hiking clubs and professional surveying associations could substantially accelerate coverage. As of this writing, preliminary informal contacts have been made with members of the Hellenic Mountaineering and Climbing Federation and the Technical Chamber of Greece, but no formal partnerships have been established. The platform's GPX export with status/order/bbox filters is specifically designed to support organised fieldwork campaigns by these groups; formalising such partnerships is a priority for the next phase of the project.

### 7.3 Implications for Military Mapping Agencies

The tension between military provenance and civilian utility of geodetic data is not unique to Greece. The UK (Ordnance Survey), France (IGN, formerly under military administration), Switzerland (swisstopo), and Spain (IGN) have all transitioned from restricting geodetic data to publishing it as open civic infrastructure. France's IGN — founded in 1940 as a military geographic service successor — now actively crowdsources geodetic condition data. Greece's HMGS is among the last European national mapping agencies to resist this trend.

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## 8. Conclusion

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vathra.xyz provides, to the authors' knowledge, the first systematic, publicly accessible condition assessment of Greece's 25,258 GYS trigonometric points. After six months of operation, 52 contributors have submitted 140 reports covering 99 unique points, identifying 18 DESTROYED or MISSING markers — information that did not previously exist in any public database. While 0.4% coverage is modest, the platform demonstrates both technical feasibility and community interest in geodetic citizen science.

The legal analysis confirms that the project operates within EU and Greek open data law. The underlying geodetic point locations were obtained from publicly accessible government web services, and their re-use is mandated by Directive 2019/1024, Implementing Regulation 2023/138, and Greek Law 4727/2020 — instruments that supersede the older Law 3882/2010 cited by the military mapping agency. The crowdsourced condition reports are original data with no analogue in any official database.

Greece has an opportunity to follow France, Switzerland, the UK, and the United States in treating geodetic citizen science as a complement to official operations. The 25,258 trigonometric points are a national asset whose preservation requires the kind of distributed, continuous monitoring that only community engagement can provide.

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## Appendix A: Platform Availability

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- Web application: <https://vathra.xyz>
- Source code: <https://github.com/ppapadeas/greece-trig-points> (AGPLv3)
- Dataset archive: <https://zenodo.org> (search: vathra.xyz trigonometric)
- Community: <https://discord.gg/Kqn3UEZsGp> (Discord)

## Appendix B: Technology Stack

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Component	Technology	Version
Frontend	React + Vite	19 / 7
UI library	Material-UI (MUI)	7
Map rendering	Leaflet + MarkerCluster	1.9
Charts	Recharts	3
Internationalisation	i18next (el/en)	25
Backend	Express.js on Node.js	5 / 20
Database	PostgreSQL + PostGIS	17 + 3.4
Authentication	Passport.js (Google OAuth2)	0.7
Image storage	Cloudflare Workers + S3	—

Hosting	Vercel (frontend) + Fly.io (API) + Supabase (DB)	—
Testing	Vitest + Testing Library	4
PWA	vite-plugin-pwa	1.2