



International Conference on Industry Sciences and Computer Science Innovation

InfoTick: A Citizen Science Mobile Application for Tick Reporting and Risk Awareness

Emil Gatia^{a, *}, Zoltán Balogh^a, Sepideh Hassankhani Dolatabadi^a, Veronika Taragel'ová Rusnáková^b, Markéta Derdák^b, Alžbeta Šujanová^b, Diana Selyemová^b, Slávka Purgatová^b

^a*Institute of Informatics, Slovak Academy of Sciences, Dubravská cesta 9, Bratislava 84507, Slovakia*

^b*Institute of Zoology, Slovak Academy of Sciences, Dubravská cesta 9, Bratislava 84507, Slovakia*

Abstract

Tick-borne diseases represent an increasing public health concern in Europe, especially in Central and Eastern Europe, where tick-borne encephalitis and Lyme borreliosis pose significant risks. Effective monitoring requires timely, spatially detailed information on tick occurrence, but traditional field surveillance is costly and limited in coverage. This paper presents the concept and current development status of InfoTick, a mobile and web-based citizen-science platform for reporting, storing, visualizing, and reviewing tick observations. The application allows users to submit geolocated tick reports together with contextual metadata and photographs. Reported observations are displayed on an interactive map and can be reviewed through nearby-event lists and management interfaces. The system architecture combines a mobile/web client, dashboard, messaging and authentication middleware, map services, file storage, and a geospatial database. In addition to data collection, the application provides educational content through a SmartHub module. Future work will focus on expert validation, AI-assisted tick identification, dynamic risk maps, and privacy-preserving data analysis.

© 2022 The Authors. Published by ELSEVIER B.V.

This is an open access article under the CC BY-NC-ND license (<https://creativecommons.org/licenses/by-nc-nd/4.0>)

Peer-review under responsibility of the scientific committee of the International Conference on Industry Sciences and Computer Sciences Innovation

Keywords: tick reporting; mobile health application; geospatial surveillance

* Corresponding author.

E-mail address: emil.gatial@savba.sk

1. Introduction

Tick-borne diseases remain a significant public health challenge in Europe, requiring effective surveillance of their spatial and temporal distribution. While expert field sampling is reliable, it is costly, time-consuming, and geographically limited; therefore, citizen science has been proposed as a complementary source of large-scale tick observations [1], [2], [3]. According to the European Centre for Disease Prevention and Control, ticks are common in European woodlands from early spring to late autumn and can transmit pathogens causing diseases such as Lyme borreliosis and tick-borne encephalitis [13]. Recent ECDC maps also show that tick-borne encephalitis hotspots are concentrated mainly in Central, Eastern, and Northern Europe [14], making this issue highly relevant for Slovakia.

These trends motivate digital tools that collect timely, geolocated observations from the public and transform them into useful information for researchers, public-health authorities, and citizens. Although several mobile and web platforms already support tick reporting, they differ in validation methods and only some integrate expert review, AI-assisted identification, risk modelling, and public visualization. In the Slovak and Central European context, there is a need for a localized platform combining citizen-friendly reporting, scientifically validated tick identification, geospatial mapping, and risk communication. This paper presents the current state of research and development of InfoTick, an APVV Slovak national project developing a mobile and web platform that connects citizen observations, AI-supported species recognition, and public-health-oriented tick-risk information.

2. Related work

Mobile and web-based citizen-science systems are increasingly used to complement traditional tick surveillance. Conventional expert field sampling provides reliable data, but it is costly, spatially limited, and difficult to maintain at large scale. Citizen-science approaches can increase the volume and geographic coverage of tick observations, although they also introduce challenges related to sampling bias, user engagement, and data quality [1], [2], [3].

Several studies have addressed mobile technologies for tick prevention and reporting. Early work focused on user requirements and end-user profiles for applications supporting citizens in dealing with ticks and tick bites [5], while later evaluations confirmed the usefulness of smartphone-based prevention tools [6]. A representative example is The Tick App, which combines tick reporting, behavioural surveys, tick diaries, educational content, and optional location data collection to study human tick exposure [4]. Follow-up work using The Tick App further showed that smartphone-based community-science submissions can reveal spatial and temporal patterns of tick exposure, while also highlighting challenges related to travel history and image-based tick identification [15]. Photo-based reporting is another important direction. TickSpotters demonstrated that crowdsourced photographs can support expert identification and distribution updates, but also showed that public tick identification is often unreliable, which motivates expert or automated validation [7], [8]. Similarly, recent work on the eTick platform explores deep learning methods to assist in tick identification from crowdsourced images [12]. European systems further show the value of citizen reporting for public-health-oriented monitoring. In Switzerland, data from the Zecke app were used to map tick attachments to humans at high resolution in space and time [10]. In Belgium, citizen-submitted ticks were used to study pathogens in ticks collected from humans [9]. Other platforms, such as TickTrax, combine mobile reporting, web visualization, databases, and exportable reports for analysis [11]. Recent results from the French CiTIQUE programme further demonstrate that citizen-submitted human-biting ticks can support nationwide surveillance of tick species and tick-borne microorganisms, providing a useful European reference model for InfoTick [16].

These works show a clear trend from simple educational applications to integrated platforms that combine mobile reporting, image submission, geospatial visualization, expert review, and analytical services. InfoTick follows this direction, while focusing on a localized Slovak and Central European context and preparing the system for future AI-assisted tick recognition and dynamic risk mapping.

Table 1. Summary of the most related mobile applications and web systems for tick reporting.

Application name	Region	Main contribution	Limitation / lesson for InfoTick
The Tick App	USA	Web/mobile photo submission, public maps	Scaling expert identification motivates AI support.
TickSpotters	USA	Citizen data used for high-resolution risk maps	Shows value of app data for spatial modelling.
eTick	Canada	Bite reporting, contextual data, tick library	Strong model for combining app reporting with biological sample collection.
Zecke	Switzerland	Citizen data used for high-resolution risk maps	Shows value of app data for spatial modelling.
Signalement Tique	France	Bite reporting, contextual data, tick library	Strong model for combining app reporting with biological sample collection.
PragmaTick	Europe	Cross-European reporting, photo upload, researcher review, education	Shows movement toward interoperable European surveillance.
TickTrax	International	Mobile + web platform, live database, visualization, exportable reports	Useful software-engineering comparison for dashboards and data workflows.

3. System component

The InfoTick application is designed as a mobile and web-based citizen-science platform for reporting, storing, validating, and visualizing tick observations. The system enables users to submit tick encounters together with supporting metadata such as location, time, contextual information, and a photograph. These reports can then be inspected through a management interface, enriched by experts, and visualized on a map to support monitoring of tick occurrence and potential risk areas.

As shown in Fig. 1, the proposed architecture comprises three main layers: the front-end GUI, middleware, and backend services. The front-end layer contains two user-facing components. The web/mobile client is intended for citizens and field users who report tick observations, view map-based information, and access relevant guidance. The management dashboard is intended for administrators, researchers, or experts who need to inspect submitted reports, manage data quality, and monitor system activity.

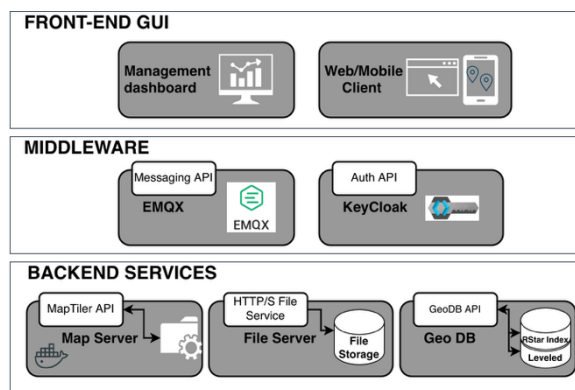


Fig. 1. Block schema of the InfoTick application architecture, showing the front-end GUI, middleware services, and backend services for mapping, file storage, and geospatial data management.

The middleware layer provides communication and access-control services. The EMQX component exposes a messaging API and supports asynchronous communication between the clients and backend services. This is useful for field reporting scenarios where connectivity may be unstable, because reports and notifications can be exchanged through a message-oriented architecture. The KeyCloak component provides the authentication API and manages user

identity, login, and role-based access control. This allows the system to distinguish between ordinary users, experts, researchers, and administrators.

The backend services layer stores and serves the core system data. The Map Server, accessed through the MapTiler API, provides map data for the mobile client and dashboard. The File Server exposes an HTTP/S file service, and stores uploaded images, especially tick photographs submitted with reports. The GeoDB component stores structured geospatial observation records and provides access through the GeoDB API. Its spatial indexing component, represented in the schema by a leveled RStar-tree index, supports efficient location-based queries, such as finding reports near a selected point or visualizing observations within a map area.

A typical workflow begins when a user submits a tick report from the mobile client. The report metadata are stored in the GeoDB, while the attached image is stored in the file server. Messaging services notify the relevant parts of the system, and authorized users can review the report through the management dashboard. After validation, the observation can be used for map visualization, spatial analysis, and public information services.

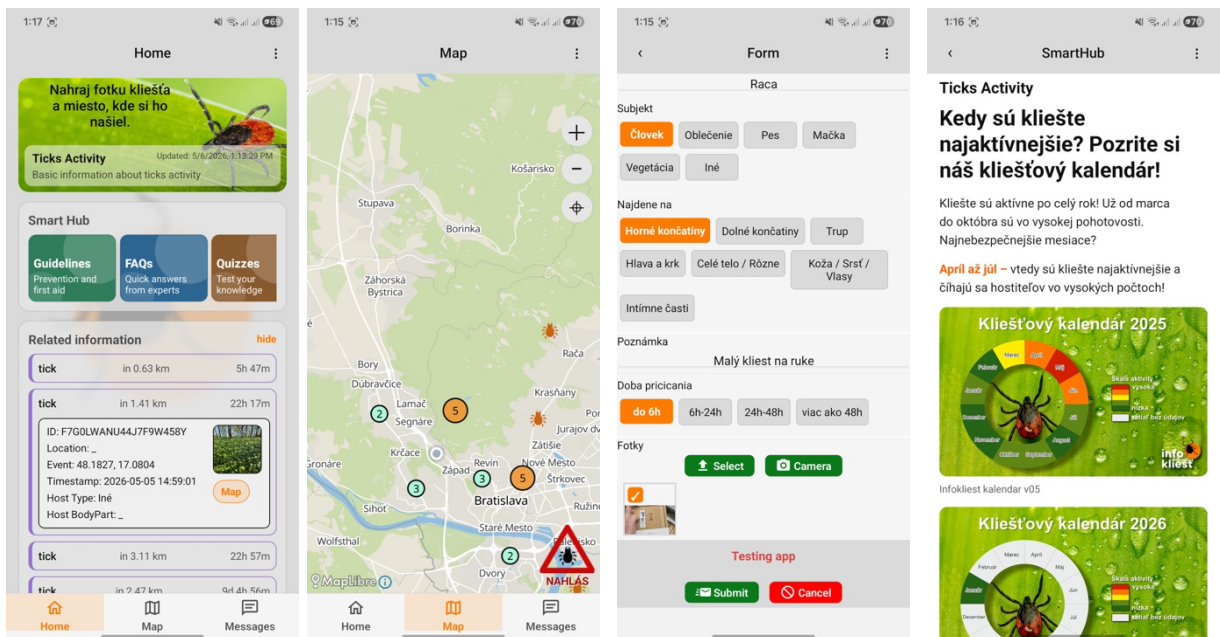


Fig. 2. Main screens of the InfoTick mobile application: (a) tick report form with host, body location, attachment time, note, and photo upload; (b) map view with individual and clustered tick reports and a reporting button; (c) SmartHub with tick activity and prevention content; and (d) home screen with nearby reports and access to reporting and educational modules.

Overall, the block schema in Fig. 1 shows a modular and scalable architecture. By separating the user interface, middleware, and backend services, InfoTick can support public reporting, expert validation, geospatial search, image management, and future extensions, such as automated tick identification or risk map generation.

The screenshots in Fig. 2. illustrate the main interaction flow of the InfoTick mobile client. The application provides a simple reporting workflow that allows users to submit tick observations from the Home screen or directly from the map via the “Report” button. The report form collects structured information about the encounter, including the subject on which the tick was found, the body part or object location, an optional textual note, the estimated duration of attachment, and photographic evidence captured by camera or selected from the gallery. After submission, the observation is stored and made available for spatial visualization and later inspection.

The review of submitted observations is supported through map-based and list-based views. The Map screen displays individual tick reports and clustered observations, enabling users to inspect tick activity. The Home screen provides a “Related information” section that lists nearby reports, including distance, timestamp, host type, and an image preview. In addition to reporting and review, the SmartHub section provides educational materials, including

prevention guidelines, FAQs, quizzes, and tick activity calendars. These screens show that the mobile client combines citizen reporting, local awareness, map-based visualization, and educational support in a single workflow.

4. Expected contribution

InfoTick contributes a mobile and web-based citizen-science platform for geolocated tick reporting, visualization, and expert review. Users can submit tick observations with metadata and photographs, creating a structured dataset for spatial and temporal monitoring. The platform combines reporting, map visualization, nearby-event review, educational content, and management tools in a modular architecture prepared for future AI-assisted identification, dynamic risk mapping, and integration with environmental or epidemiological data. Through SmartHub feedback, InfoTick supports both scientific data collection and public awareness of tick-borne disease risk.

5. Discussion and future work

The current concept demonstrates how mobile technologies can support citizen-based tick surveillance. The application already covers the main workflow: submitting a tick report, attaching a photograph, storing the observation, displaying it on a map, and providing educational information.

Several challenges remain. Citizen-generated data may contain inaccurate locations, incomplete metadata, or low-quality images. Future work should therefore focus on expert validation, image-quality control, and AI-assisted tick classification. Another important issue is spatial and temporal bias, since reports may be concentrated in populated or recreational areas. Combining citizen reports with field measurements, environmental data, and epidemiological records could improve the interpretation of the collected data. Privacy protection is also essential, because reports may include sensitive location and health-related information.

Future versions should include clear consent, role-based access control, anonymized research exports, and location generalization where appropriate. Planned extensions include automatic tick species recognition, dynamic risk maps, personalized notifications, improved dashboards for researchers, and expanded SmartHub educational content. Overall, InfoTick provides a promising foundation for regional tick monitoring, with future development focused on AI validation and privacy.

Acknowledgements

This publication is the result of the implementation of the following projects: APVV No. APVV-22-0372 INFOTICK (Getting the right info on ticks) and SILVANUS-SK (project No. 09I01-03-V04-00107), funded by the EU NextGenerationEU through the Recovery and Resilience Plan for Slovakia.

References

- [1] R. J. Eisen and C. D. Paddock, "Tick and tickborne pathogen surveillance as a public health tool in the United States," *Journal of Medical Entomology*, vol. 58, no. 4, pp. 1490–1502, 2021, doi: 10.1093/jme/tjaa087.
- [2] L. Eisen and R. J. Eisen, "Benefits and drawbacks of citizen science to complement traditional data gathering approaches for medically important hard ticks (Acari: Ixodidae) in the United States," *Journal of Medical Entomology*, vol. 58, no. 1, pp. 1–9, 2021, doi: 10.1093/jme/tjaa165.
- [3] N. C. Nieto, W. T. Porter, J. C. Wachara, T. J. Lowrey, L. Martin, P. J. Motyka, and D. J. Salkeld, "Using citizen science to describe the prevalence and distribution of tick bite and exposure to tick-borne diseases in the United States," *PLOS ONE*, vol. 13, no. 7, e0199644, 2018, doi: 10.1371/journal.pone.0199644.
- [4] M. P. Fernandez, G. M. Bron, P. A. Kache, S. R. Larson, A. Maus, D. Gustafson Jr., J. I. Tsao, L. C. Bartholomay, S. M. Paskewitz, and M. A. Diuk-Wasser, "Usability and feasibility of a smartphone app to assess human behavioral factors associated with tick exposure (The Tick App): Quantitative and qualitative study," *JMIR mHealth and uHealth*, vol. 7, no. 10, e14769, 2019, doi: 10.2196/14769.
- [5] L. van Velsen, D. J. M. A. Beaujean, J. Wentzel, J. E. van Steenberg, and J. E. W. C. van Gemert-Pijnen, "Developing requirements for a mobile app to support citizens in dealing with ticks and tick bites via end-user profiling," *Health Informatics Journal*, vol. 21, no. 1, pp. 24–35, 2015, doi: 10.1177/1460458213496419.
- [6] L. Antonise-Kamp, D. J. M. A. Beaujean, R. Crutzen, J. E. van Steenberg, and D. Ruwaard, "Prevention of tick bites: An evaluation of a smartphone app," *BMC Infectious Diseases*, vol. 17, article 744, 2017, doi: 10.1186/s12879-017-2836-4.

- [7] H. L. Kopsco, R. J. Duhaime, and T. N. Mather, “Assessing public tick identification ability and tick bite riskiness using passive photograph-based crowdsourced tick surveillance,” *Journal of Medical Entomology*, vol. 58, no. 2, pp. 837–846, 2021, doi: 10.1093/jme/tjaa196.
- [8] H. L. Kopsco, R. J. Duhaime, and T. N. Mather, “Crowdsourced tick image-informed updates to U.S. county records of three medically important tick species,” *Journal of Medical Entomology*, vol. 58, no. 6, pp. 2412–2424, 2021, doi: 10.1093/jme/tjab082.
- [9] T. Lernout, N. De Regge, K. Tersago, M. Fonville, V. Suin, and H. Sprong, “Prevalence of pathogens in ticks collected from humans through citizen science in Belgium,” *Parasites & Vectors*, vol. 12, article 550, 2019, doi: 10.1186/s13071-019-3806-z.
- [10] L. Bald, N. Ratnaweera, T. Hengl, P. Laube, J. Grunder, W. Tischhauser, N. Bhandari, and D. Zeuss, “Assessing tick attachments to humans with citizen science data: Spatio-temporal mapping in Switzerland from 2015 to 2021 using spatialMaxent,” *Parasites & Vectors*, vol. 18, article 22, 2025, doi: 10.1186/s13071-024-06636-4.
- [11] D. Oliva, R. Dahan, R. Sultan, J. Lopez, M. Gulia-Nuss, A. B. Nuss, M. B. Teglas, D. Feil-Seifer, and F. C. Harris Jr., “TickTrax: A mobile and web-based application for tick monitoring and analysis,” in *ITNG 2024: 21st International Conference on Information Technology–New Generations*, *Advances in Intelligent Systems and Computing*, vol. 1456, pp. 265–272, Springer, 2024, doi: 10.1007/978-3-031-56599-1_35.
- [12] É. Clabaut, J. Bouffard, and J. Savage, “Combining object detection, super-resolution GANs and transformers to facilitate tick identification workflow from crowdsourced images on the eTick platform,” *Insects*, vol. 16, no. 8, article 813, 2025, doi: 10.3390/insects16080813.
- [13] European Centre for Disease Prevention and Control, “Tick-borne diseases,” ECDC, 2026. Accessed: May 7, 2026.
- [14] European Centre for Disease Prevention and Control, “Tick-borne encephalitis (TBE) in Europe: new maps published,” ECDC, Apr. 15, 2025. Accessed: May 7, 2026.
- [15] P. A. Kache, G. M. Bron, S. Zapata-Ramirez, J. I. Tsao, L. C. Bartholomay, S. M. Paskewitz, M. A. Diuk-Wasser, and M. P. Fernandez, “Evaluating spatial and temporal patterns of tick exposure in the United States using community science data submitted through a smartphone application,” *Ticks and Tick-borne Diseases*, 2023, Article 102163. doi: 10.1016/j.ttbdis.2023.102163.
- [16] J. Durand, T.-M. Bah, I. Lebert, C. Galon, I. Carravieri, S. Massegli, J.-M. Armand, J. Marchand, C. Galley, K. Chalvet-Monfray, M. Vayssier-Taussat, G. Vourc’h, A. Brun-Jacob, S. Moutailler, X. Bailly, and P. Frey-Klett, “Distribution of tick-borne microorganisms in human-biting ticks in France collected through a Citizen-science program,” *Ticks and Tick-borne Diseases*, vol. 17, no. 2, Article 102612, 2026. doi: 10.1016/j.ttbdis.2026.102612.