Enhancing Geographic Information System Skills through Boundary Mapping Training at Pesantren Rahmatullah, Lempake, Samarinda

Andrew Stefano
Geomatics Technology, State Agricultural Polytechnic of Samarinda, Samarinda, 75131, Indonesia
andrew.itb2001@gmail.com

Sri Endayani *
Forestry, University of 17 August 1945, Samarinda, 75123, Indonesia
nd4.70des@gmail.com
*Corresponding author

Abstract—This program designed to enhance the skills and knowledge of students and teaching staff at Pesantren Rahmatullah (Islamic boarding school) regarding the use of Geographic Information System (GIS) technology in boundary mapping. The initiative was launched recognizing the importance of understanding territorial boundaries in the context of natural resource management, development planning, and disaster mitigation in the surrounding areas. The training includes a series of theoretical sessions and field practices. The first stage involves learning how to gather coordinate points in the field using the Garmin 60 CSX GPS device. The second stage focuses on field data processing and coordinate data correction, covering basic GIS knowledge, introduction to GIS software, and usage of Autodesk Map software and Arc GIS 10.8. The third stage is the scaled printing of processed field data. The duration of the training is one semester, following the curriculum set by the Rahmatullah Islamic boarding school. This training aims to equip participants with the necessary skills to produce accurate and informative boundary maps, which will later serve as tools for decision-making and strategic planning at Rahmatullah Lempake Islamic boarding school in Samarinda. Additionally, this activity also aims to enhance the boarding school's awareness and capacity in utilizing geographic information technology for educational and environmental management purposes.

Keywords—Development Planning, Geospatial Data Retrieval, Geographic Information Systems Training, Regional Boundary Mapping.

I. INTRODUCTION

In the current era of globalization and advances in information technology, the use of Geographic Information Systems (GIS) has become one of the important aspects in various fields, including in regional management and planning (Abkarian et al., 2022; Ashour et al., 2021; Bada et al., 2021). GIS provides a platform that allows users to collect, store, analyze, and display geospatial data for various purposes (Bjørnskov et al., 2021; Boakye et al., 2021; C, 2021). In this context, the ability to create GIS-based boundary maps becomes very relevant, especially for educational institutions such as islamic boarding school that are located in strategic areas and have an important role in local communities (Chen et al., 2021; Fang et al., 2021; Guo et al., 2021). Pesantren Rahmatullah Lempake, located in Samarinda, East Kalimantan, identified the need to integrate GIS technology in their area management and planning. This is seen as a strategic step to strengthen institutional capacity in managing natural resources, infrastructure development planning, as well as mitigation and adaptation to potential disasters.

With this background, Pesantren Rahmatullah Lempake Samarinda initiated training on making GIS based boundary maps for students and teaching staff. This training is designed to provide an in-depth understanding of the basic principles of GIS, GIS software applications, and geospatial data capture and analysis techniques. The main objective is to equip participants with the knowledge and skills necessary to produce accurate and detailed boundary maps. Through this training, it is hoped that participants can utilize GIS as a tool in strategic decision making and effective planning at Pesantren Rahmatullah Lempake Samarinda. Based on the introduction that has been discussed, the results of identifying problems that exist in Public Service activities at the Rahmatullah Lempake islamic boarding school in Samarinda are as follows, One of the main problems identified was the limited knowledge and skills of students and teaching staff of Pesantren Rahmatullah Lempake Samarinda in using the Geographic Information System (GIS). Although the importance of GIS technology in regional management and planning is well recognized, there are still large gaps in the technical understanding and practical application of GIS. This hinders the ability of islamic boarding school to manage accurate geospatial data for boundary mapping, and strategic decision making.

The second problem is limited access to GIS technology and software needed for boundary mapping. Pesantren Rahmatullah Lempake Samarinda faced obstacles in providing hardware (such as computers with

adequate specifications) and GIS software whose licenses were often expensive. This limitation is an obstacle in the effective implementation of GIS learning and practice in the islamic boarding school's environment.

The third problem relates to the low awareness among students and teaching staff about the importance of mapping boundaries and effective natural resource management. Without a sufficient understanding of how boundary mapping can aid in resource planning and management, motivation to learn and apply GIS in this context is limited. This demonstrates the need for increased awareness and understanding of the direct benefits of boundary mapping and GIS in the context of islamic boarding school management and the surrounding environment.

In addition, this activity also aims to encourage innovation and the use of the latest technology in education in Islamic boarding schools, as well as increased awareness about the importance of geospatial information management in today's digital era. Thus, this training not only contributes to the capacity development of individuals and institutions, but also to the improvement of the quality of education and resource management in the islamic boarding school's environment and surrounding communities.

II. METHODS

Training on Making Regional Boundary Maps Based on Geographic Information Systems (GIS) at Pesantren Rahmatullah Lempake Samarinda (See Figure 1) is designed with a comprehensive approach to overcome identification problems and increase the capacity of students and teaching staff in the use of GIS.

Figure 1. Pesantren Rahmatullah Lempake islamic boarding schoolSamarinda

The methodology of implementing this training includes several main stages as follows (Gurbuz et al., 2021; Halloran et al., 2021; He et al., 2021):

1. Preparation

    Procurement of Devices and Software: Ensuring the availability of hardware (computers with supporting specifications) and GIS software required.

    Training Material Development: Compile training materials that include basic GIS theory, software introduction, and geospatial data capture and analysis techniques.

    Participant Selection: Selecting trainees to ensure they have sufficient motivation and knowledge base to attend the training effectively.

2. Training Implementation

    Theory Session: Hold a theory session covering an introduction to GIS, the importance of boundary mapping, as well as the basics of using GIS software.

Field Practice: Conduct geospatial data collection in the field using GPS or other relevant methods to introduce participants to the data collection process to be used in map making.

Lab Practice: Conduct practical sessions in the computer laboratory where participants are given the opportunity to apply the collected data into GIS software, conduct analysis, and begin the process of making boundary maps.

3. Evaluation and Application

    Training Evaluation: Evaluate the effectiveness of training through skill tests, feedback from participants, and observation of the use of new skills in practice.

    Application Project: Encourage participants to apply skills that have been learned in real projects in islamic boarding school, such as making maps of the boundaries of Pesantren Rahmatullah Lempake Samarinda.

4. Monitoring and Follow-up
Follow-up Session: Hold a follow-up session to review participants' progress in the application of GIS skills.

This methodology is designed to not only provide technical skills in the use of GIS but also to increase awareness and understanding of the importance of this technology in natural resource management and strategic planning in islamic boarding school (Jayakumar et al., 2022; Jiang et al., 2021; Kenpankho et al., 2021). The solution offered in this service activity is training related to how to inventory spatial data from administrative information in the Rahmatullah Lempake islamic boarding school in Samarinda (Liang et al., 2021; Muhammad et al., 2021; Nezhadshahbodaghi & Mosavi, 2021).

Spatial data inventory using GIS-based digital maps (Othman et al., 2021; Rout et al., 2021; Sadeghian et al., 2022). Training activities in making digital maps based on spatial data are carried out in the form of workshops using *Sofware Autodesk MAP* is one of the Geographic Information System (GIS) based software *open source* licensed under the GNU General Public License that can be run on a variety of operating systems (Sha et al., 2021; Shen et al., 2022; Sutton et al., 2021). *Autodesk MAP* Easy to operate by providing common functions and features (Wu & Hifi, 2021; Xu & Liu, 2021; Zeeshan et al., 2021).

Autodesk MAP can be run on *Linux (Ubuntu), Unix, Mac OS, Windows* and *Android*, and supports many vector, raster, and data processing formats and functionalities *database* (B. Zhang et al., 2021; Y. Zhang et al., 2021; Zhao, 2021). The equipment used in this training is a computer / laptop that has been installed *software Autodesk MAP 3.8.* Meanwhile, the data used in making digital maps in this training activity is secondary data.

The implementation of community service is carried out classically by prioritizing the development of basic knowledge about mapping, cartography, and geographic information systems. Skill development is carried out using *Autodesk MAP 3.8 software* is carried out with guided training with training modules that have been prepared. The training participants were students of the Rahmatullah Lempake islamic boarding school in Samarinda. The implementation of GIS based digital map making training at the Rahmatullah Lempake islamic boarding school in Samarinda was carried out offline (face-to-face) at the Computer Laboratory of the Rahmatullah Lempake islamic boarding school in Samarinda.

III. RESULTS AND DISCUSSION

Training on Making Regional Boundary Maps Based on Geographic Information Systems (GIS) at Pesantren Rahmatullah Lempake Samarinda was successfully carried out with active participation from students and teaching staff of pesantren. Trainees showed significant improvement in their understanding and skills regarding GIS. This includes the ability to operate GIS software, collect geospatial data, and create accurate boundary maps. Production of Regional Boundary Map: One of the concrete results of this training was the creation of a map of the boundaries of the Rahmatullah Lempake Samarinda islamic boarding school. This map not only clearly denotes the boundaries of the area but also includes other important information such as the location of facilities and land use around the islamic boarding school.

There was increased awareness and interest among participants about the importance of GIS in regional management and planning. Trainees also showed interest in applying GIS knowledge and skills in future projects. Limitations and Challenges: Although the training was successful, there were some limitations and challenges faced, such as limited training time and variability in participants' initial level of understanding of the technology. This calls for a more flexible approach and perhaps the provision of additional sessions for participants who need more guidance. Effective Teaching Strategies and Implementation methodologies that combine theory, field practice, and laboratory practice have proven effective in improving participants' understanding and skills. Hands-on experience in data collection and map making reinforces the theoretical concepts taught. Implementation and Long-Term Impact: This training is expected to have a long-term impact on the capacity of Pesantren Rahmatullah Lempake Samarinda in managing its area. The boundary map created will be an important tool in development planning and resource management. In addition, this training also encourages a culture of learning and innovation in the use of new technology in the Islamic Boarding School's environment.

In conclusion, this training succeeded in achieving its goal in increasing capacity and awareness about GIS at Pesantren Rahmatullah Lempake Samarinda. However, to maximize benefits and ensure sustainable implementation of GIS, follow-up efforts in the form of advanced training, technical support, and GIS integration in the daily activities of islamic boarding school are needed. The implementation of this community service activity began with *a Focus Group Discussion* (FGD) between *the Mathematical Soft Computing* Research Group *(RG)* and the Rahmatullah Lempake islamic boarding school in Samarinda which discussed the preparation of training activities for making digital maps based on spatial data with *Autodesk MAP.* Figure 2 to 3 shows, at this FGD, it was agreed on the date and preparation for the implementation of training activities for making digital maps based on spatial data with *Autodesk MAP.*

Figure 2. Students of the Pesantren Rahmatullah Lempakeislamic boarding school Samarinda

(a)   (b)   (c)

Figure 3. Photo documentation of community service, a. theoretical explanation, b. field data collection, c. data processing

This activity begins with the preparation and filling out the participant attendance list. At this stage, each participant who fills in the attendance list gets one training module on making digital maps with *Autodesk MAP.* This digital map making training is also adjusted to cartographic rules. Figure 4 shows, after this training, the students were able to make other digital maps so that they could be useful in the development of science
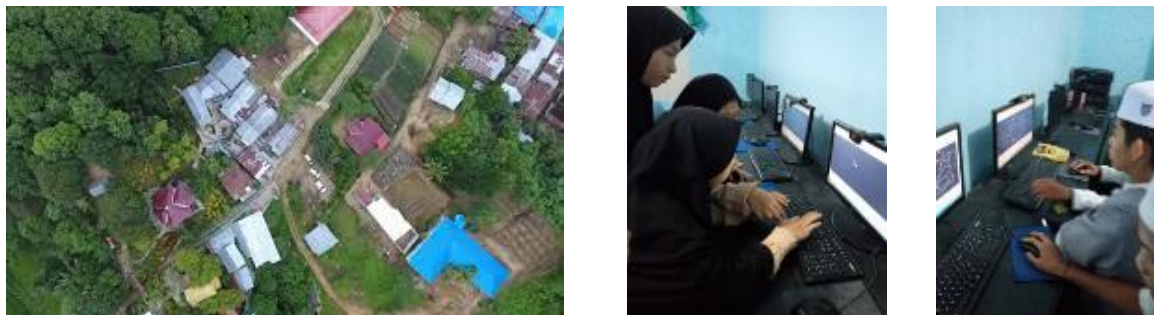

Figure 4. Field Data Processing

After the opening ceremony and remarks continued with the delivery of material by the speakers, which lasted for one hour. The material presented by the resource persons included an introduction *hardware* and *software* GIS is *Autodesk MAP* (see Figure 5); rectification of data; coordinate system; projection and conversion of geographical data; Data model digitization *Vector* points, lines, and *Polygon*; data in GIS; attribute data; spatial data analysis; and the last one is *layouting* and final products (Chen et al., 2021; Fang et al., 2021; Guo et al., 2021)

Figure 5. Photos of material submission

After the presentation of material by the speakers, this activity continued with the practice of making GIS based digital maps using *Autodesk MAP* which lasted for approximately two hours. Figure 6 shows, The data used in this practice is secondary data
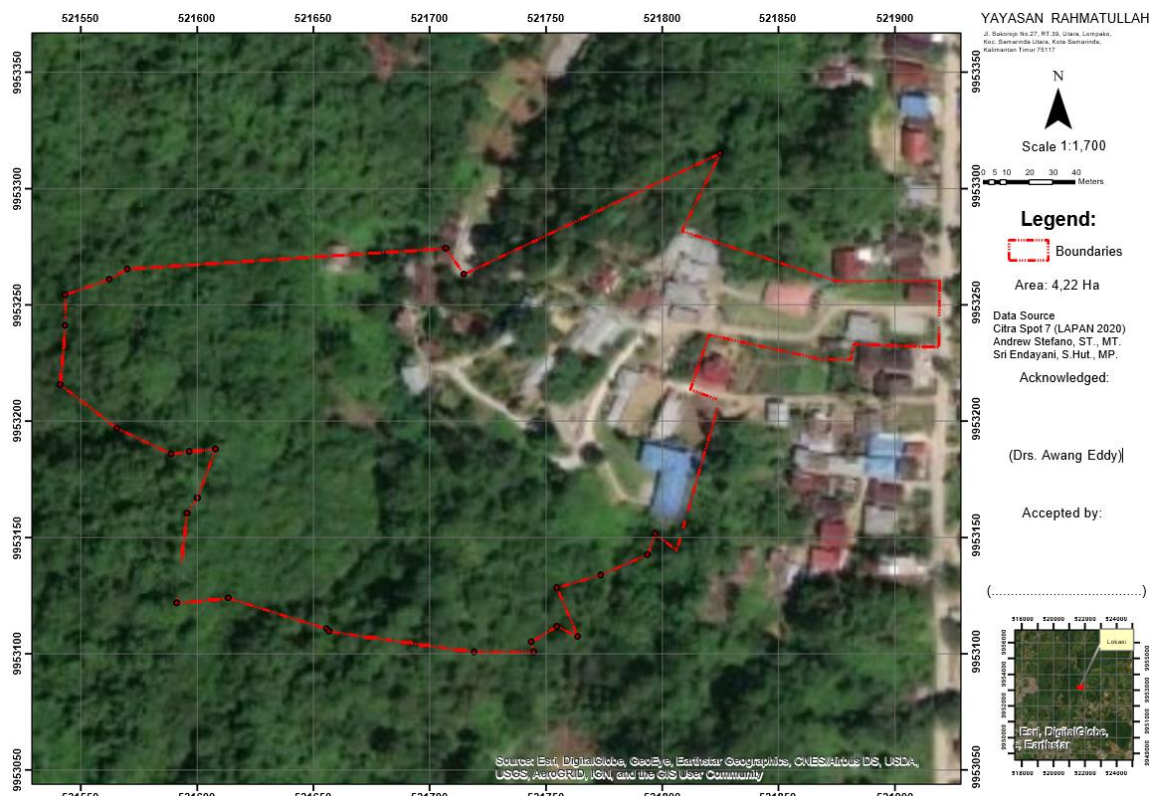

Figure 6. Results of Mentoring the Practice of Making Digital Maps

The integration of Geographic Information System (GIS) technology into daily activities at the Rahmatullah Lempake islamic boarding school can provide various benefits in the management and development of Islamic boarding schools. Here is a description of how GIS can be integrated (Othman et al., 2021; Rout et al., 2021; Sadeghian et al., 2022).:

1. Land and building management, GIS can be used to map all land and buildings in the islamic boarding school environment. Information about the land area, location of buildings, and functions of each building can be integrated into one easily accessible digital map.
2. Natural resource management, Islamic boarding schools that have agricultural land or gardens can use GIS to monitor land conditions, irrigation, and crop yields. Such data can help in making decisions related to land management more efficiently and sustainably.
3. Planning and Development New infrastructure such as dormitories, classrooms, or other facilities can be better planned. Spatial data helps in determining the most suitable location for development based on land conditions and accessibility.
4. Disaster management, GIS, can be used to map disaster-prone areas such as floods or landslides. With this data, islamic boarding school can plan mitigation and evacuation measures in the event of natural disasters, as well as increase awareness and preparedness of islamic boarding school residents.
5. Energy and water management, information regarding energy and water distribution can be incorporated into GIS to ensure efficient use. Islamic boarding schools can monitor water and energy consumption, as well as detect leaks or damage to the distribution system.
6. Management of student and employee data, demographic data of students and employees can be integrated with GIS to map regional origin, distribution, and needs of each individual. This facilitates the administrative and logistical management of islamic boarding school.
7. Monitoring and surveillance, GIS can be used to monitor activities in the islamic boarding school environment through CCTV mapping or other sensors. This helps in maintaining security and order in the islamic boarding school's environment.

Providing geospatial information for learning, GIS can also be a learning aid for students in subjects related to geography, environment, and technology. Integrating GIS into the curriculum, students can learn to use this technology directly. Implementation of GIS technology, the following steps can be taken:

1. Training and Education: Train staff and students in the use of GIS software.
2. Data Collection: Collects spatial data related to land, buildings, resources, and demographic data.
3. Hardware and Software Procurement: Ensure the necessary computer equipment and GIS software are available.
4. Data Integration: Integrates existing data into GIS systems and ensures it is kept up to date.
5. Sustainable Use: Ensure GIS is used sustainably in daily activities and decision-making in islamic boarding school.

The integration of GIS Pondok Pesantren Rahmatullah Lempake can improve the efficiency, safety, and quality of management and education in the islamic boarding school environment. Here are the steps to create tables and graphs to visualize participant upskilling data before and after training (see Tabel 1 a and Figure 7).

Table 1. Data containing participants' skill scores before and after training.

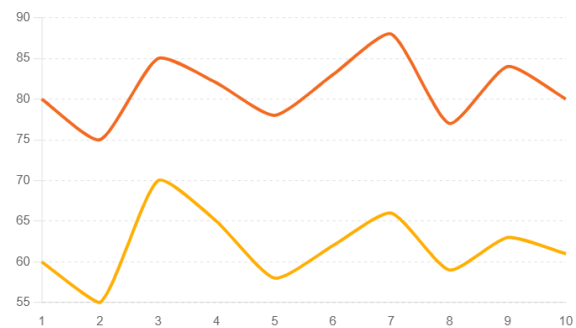| Participants	Before Training	After Training
1	60	80
2	55	75
3	70	85
4	65	82
5	58	78
6	62	83
7	66	88
8	59	77
9	63	84
10	61	80

Figure 7. Training improvement graph

Information Figure 7
Y   Skill Value
X   Participants
——   Before Training
——   After Training

IV. CONCLUSION

Training on Making Regional Boundary Maps Based on Geographic Information Systems (GIS) held at Pesantren Rahmatullah Lempake Samarinda has succeeded in providing students and teaching staff with essential knowledge and skills about the use of GIS. Through a series of theoretical, field, and laboratory hands-on sessions, trainees have acquired the ability to collect geospatial data, operate GIS software, and produce accurate and informative maps of regional boundaries. This activity not only increases the capacity of individuals in using geospatial technology but also instills awareness about the importance of effective mapping and management of areas in the context of development planning and natural resource management.

The resulting boundary map becomes an important tool for islamic boarding school in strategic decision making and future planning. However, there are challenges in the form of limited training time and variability of participants' initial abilities that demand a more adaptive learning approach and the provision of advanced training sessions. To maximize the positive impact of this training, continuous support is needed, both in the form of resources, advanced training, and the integration of GIS technology in the daily activities of islamic boarding school. Overall, this training has laid a strong foundation for GIS utilization at Pesantren Rahmatullah Lempake Samarinda, paving the way for innovation and application of geospatial technology in education and area management. The success of this training confirms the great potential of the integration of geographic information technology in the education and management of religious educational institutions.

REFERENCES

Abkarian, H., Tahlyan, D., Mahmassani, H., & Smilowitz, K. (2022). Characterizing visitor engagement behavior at large-scale events : Activity sequence clustering and ranking using GPS tracking data. *Tourism Management*, *88*(August 2021), 104421. https://doi.org/10.1016/j.tourman.2021.104421

Ashour, I., Tokhey, M. El, Mogahed, Y., & Ragheb, A. (2021). Performance of global navigation satellite systems (GNSS) in absence of GPS observations. *Ain Shams Engineering Journal*, *xxxx*. https://doi.org/10.1016/j.asej.2021.09.016

Bada, M., Eddine, D., Lagraa, N., Abdelaziz, C., Imran, M., & Shoaib, M. (2021). A policy-based solution for the detection of colluding GPS-Spoofing attacks in FANETs. *Transportation Research Part A*, *149*(May), 300–318. https://doi.org/10.1016/j.tra.2021.04.022

Bjørnskov, L., Assing, E., & Boch, F. (2021). *Burnout of intrinsically motivated GPs when exposed to external regulation A combined panel data survey and cluster randomized field experiment*. *125*, 459–466. https://doi.org/10.1016/j.healthpol.2021.01.004

Boakye, K. A., Amram, O., Schuna, J. M., Duncan, G. E., & Hystad, P. (2021). Health and Place GPS-based built environment measures associated with adult physical activity. *Health and Place*, *70*(March), 102602. https://doi.org/10.1016/j.healthplace.2021.102602

C, D. A. (2021). *Geodesy and Geodynamics Impact of sampling interval on variance components of epoch-wise residual error in relative GPS positioning : A case study of a 40-km- long baseline*. *12*, 368–380. https://doi.org/10.1016/j.geog.2021.05.001

Chen, Y., Huang, Z., Ai, H., Guo, X., & Luo, F. (2021). The Impact of GIS / GPS Network Information Systems on the Logistics Distribution Cost of Tobacco Enterprises. *Transportation Research Part E*, *149*(July 2020), 102299. https://doi.org/10.1016/j.tre.2021.102299

Fang, J., He, M., Luan, W., & Jiao, J. (2021). Geodesy and Geodynamics Crustal vertical deformation of Amazon Basin derived from GPS and GRACE / GFO data over past two decades. *Geodesy and Geodynamics*, *xxxx*, 0–9. https://doi.org/10.1016/j.geog.2021.09.002

Guo, B., Di, M., Song, F., Li, J., & Shi, S. (2021). Integrated coseismic displacement derived from high-rate GPS and strong-motion seismograph : Application to the 2017 Ms 7 . 0 Jiuzhaigou Earthquake. *Measurement*, *182*(March), 109735. https://doi.org/10.1016/j.measurement.2021.109735

Gurbuz, G., Akgul, V., Gormus, K. S., & Kutoglu, S. H. (2021). Journal of Atmospheric and Solar-Terrestrial Physics Assessment of precipitable water vapor over Turkey using GLONASS and GPS. *Journal of Atmospheric and Solar-Terrestrial Physics*, *222*(January), 105712. https://doi.org/10.1016/j.jastp.2021.105712

Halloran, J. O., Sophie, A., Bj, L., & Gyrd-hansen, D. (2021). *Social Science & Medicine Time to retire ? A register-based study of GPs ' practice style prior to retirement*. *281*(May). https://doi.org/10.1016/j.socscimed.2021.114099

He, X., Zhang, D., Yang, L., Cui, T., Ding, Y., & Zhong, X. (2021). Design and experiment of a GPS-based turn compensation system for improving the seeding uniformity of maize planter. *Computers and Electronics in Agriculture*, *187*(March), 106250. https://doi.org/10.1016/j.compag.2021.106250

Jayakumar, S., Meghwani, A., Chakrabarti, S., Rajawat, K., & Terzija, V. (2022). International Journal of Electrical Power and Energy Systems Spoofing attack on synchrophasor GPS clock : Impact and detection in power system state estimation. *International Journal of Electrical Power and Energy Systems*, *134*(April 2021), 107396. https://doi.org/10.1016/j.ijepes.2021.107396

Jiang, P., Wu, H., & Xin, C. (2021). DeepPOSE : Detecting GPS spoofing attack Jo ur na of. *Digital Communications and Networks*. https://doi.org/10.1016/j.dcan.2021.09.006

Kenpankho, P., Chaichana, A., Trachu, K., & Supnithi, P. (2021). ScienceDirect Real-time GPS receiver bias estimation. *Advances in Space Research*, *xxxx*, 1–8. https://doi.org/10.1016/j.asr.2021.01.032

Liang, H., Zhan, W., & Li, J. (2021). ScienceDirect Vertical surface displacement of mainland China from GPS using the multisurface function method. *Advances in Space Research*, *xxxx*. https://doi.org/10.1016/j.asr.2021.02.024

Muhammad, S., Ibrahim, E., Kholil, M., & Anggara, O. (2021). Geodesy and Geodynamics Source of the 2019 M w 6 . 9 Banten Intraslab earthquake modelled with GPS data inversion. *Geodesy and*

Geodynamics, *12*(4), 308–314. https://doi.org/10.1016/j.geog.2021.06.001

Nezhadshahbodaghi, M., & Mosavi, M. R. (2021). A loosely-coupled EMD-denoised stereo VO / INS / GPS integration system in GNSS-denied environments. *Measurement*, *183*(April), 109895. https://doi.org/10.1016/j.measurement.2021.109895

Othman, S. E., Salama, G. M., & Hamed, H. F. A. (2021). Jo ur na l P re of. *HELIYON*, e08330. https://doi.org/10.1016/j.heliyon.2021.e08330

Rout, A., Nitoslawski, S., Ladle, A., & Galpern, P. (2021). Computers , Environment and Urban Systems Using smartphone-GPS data to understand pedestrian-scale behavior in urban settings : A review of themes and approaches. *Computers, Environment and Urban Systems*, *90*(February), 101705. https://doi.org/10.1016/j.compenvurbsys.2021.1017 05

Sadeghian, P., Zhao, X., Golshan, A., & Håkansson, J. (2022). A stepwise methodology for transport mode detection in GPS tracking data. *Travel Behaviour and Society*, *26*(December 2020), 159–167. https://doi.org/10.1016/j.tbs.2021.10.004

Sha, A. Z., Aris, W. A. W., Sadiah, S., & Musa, T. A. (2021). Reliability of Seismic Signal Analysis for Earthquake Epicenter Location Estimation Using 1 Hz GPS Kinematic Solution. *Measurement*, *182*(April), 109669. https://doi.org/10.1016/j.measurement.2021.109669

Shen, C., Xiong, Y., Zhao, D., Wang, C., Cao, H., Song, X., Tang, J., & Liu, J. (2022). Multi-rate strong tracking square-root cubature Kalman filter for MEMS-INS / GPS / polarization compass integrated navigation system. *Mechanical Systems and Signal Processing*, *163*(February 2020), 108146. https://doi.org/10.1016/j.ymssp.2021.108146

Sutton, L., Jose, K., Betzold, A., Hansen, E., Laslett, L., Makin, J., Winzenberg, T., Balogun, S., & Aitken, D. (2021). Osteoarthritis and Cartilage Open Understanding the management of osteoarthritis : A qualitative study of GPs and orthopaedic surgeons in Tasmania , Australia. *Osteoarthritis and Cartilage Open*, *3*(4), 100218. https://doi.org/10.1016/j.ocarto.2021.100218

Wu, L., & Hifi, M. (2021). Knowledge-Based Systems Data-driven robust optimization for the itinerary planning via large-scale GPS data. *Knowledge-Based Systems*, *231*, 107437. https://doi.org/10.1016/j.knosys.2021.107437

Xu, J., & Liu, Z. (2021). International Journal of Applied Earth Observations and Geoinformation Radiance-based retrieval of total water vapor content from sentinel-3A OLCI NIR channels using ground-based GPS measurements. *International Journal of Applied Earth Observation and Geoinformation*, *104*, 102586. https://doi.org/10.1016/j.jag.2021.102586

Zeeshan, M., Chu, H., & Burbey, T. J. (2021). Spatio-temporal estimation of monthly groundwater levels from GPS-based land deformation. *Environmental Modelling and Software*, *143*(1), 105123. https://doi.org/10.1016/j.envsoft.2021.105123

Zhang, B., Niu, J., Li, W., Shen, Y., & Wu, T. (2021). ScienceDirect A single station ionospheric empirical model using GPS-TEC observations based on nonlinear least square estimation method. *Advances in Space Research*, *xxxx*. https://doi.org/10.1016/j.asr.2021.07.017

Zhang, Y., Xu, C., Fang, J., & Guo, Z. (2021). Geodesy and Geodynamics Focal mechanism inversion of the 2018 M W 7 . 1 Anchorage earthquake based on high-rate GPS observation. *Geodesy and Geodynamics*, *xxxx*. https://doi.org/10.1016/j.geog.2021.09.004

Zhao, X. (2021). *ScienceDirect Review and evaluation of methods in transport mode detection based on GPS tracking data*. *8*. https://doi.org/10.1016/j.jtte.2021.04.004