

CHAPTER 5 - CONCLUSIONS AND RECOMMENDATIONS

This chapter presents the conclusions of the study based on the research objectives and the findings obtained from the machine learning-based mangrove health classification conducted within the Segara Biru Mangrove Area of Interest (AOI), Lontar Village, Serang District, Banten. It summarizes the principal findings related to satellite-derived feature selection, comparative machine learning performance, and the annual classification and health-state dynamics of the mangrove area during the 2020–2025 observation period. The chapter also presents the contributions, limitations, and recommendations for future research.

5.1. Research Conclusions

The conclusions of this study are presented according to the research objectives. The principal findings and corresponding conclusions are summarized in Table 5.1, followed by a detailed discussion of each objective.

Table 5.1 Summary of Research Findings and Conclusions

Research Objective	Summary of Findings	Conclusion
Objective 1	Eight satellite-derived features from Sentinel-2, Sentinel-1, and Landsat 8 were evaluated through feature relevance, combined ranking, redundancy assessment, and comparative feature-scenario experiments. The Full_8 configuration achieved the highest Macro F1 among the evaluated configurations for Random Forest (0.7956), SVM (0.7998), and XGBoost (0.8048).	The Full_8 configuration provided the strongest overall classification performance under the experimental conditions of this study and was therefore retained for final model development.

Research Objective	Summary of Findings	Conclusion
Objective 2 Random Forest, SVM, and XGBoost were compared using the same feature configuration and validation framework. After hyperparameter optimization and class-imbalance evaluation, SMOTE was selected as the balancing method based on the highest Priority Score (0.5169). XGBoost achieved the highest tuned Macro F1 of 0.8048 and was selected as the final model.		The combination of Full_8 features, SMOTE, and tuned XGBoost provided the strongest classification performance among the evaluated modelling configurations.
Objective 3 The contribution of the eight satellite-derived features was evaluated using Permutation Importance and global SHAP analysis. Both methods consistently identified VH as the most influential predictor, although the relative ordering of the remaining features differed between the two interpretation approaches. Permutation Importance ranked VH, NDRE, MNDWI, and NDMI highest, while SHAP ranked VH, MNDWI, NDMI, and LST_Celsius highest.		The results confirm that the satellite-derived features contributed unequally to mangrove health classification. VH provided the most consistent and influential contribution in the final XGBoost model, while the other optical, moisture-related, thermal, and radar-derived features provided complementary predictive information under the conditions of the study.

5.1.1. Objective 1: Effectiveness of Satellite-Derived Features

The first research objective was addressed through the evaluation of the satellite-derived predictor variables and their configurations for distinguishing the Healthy, Stressed, and Dead mangrove classes. The study initially considered eight features comprising NDVI, EVI, NDRE, NDMI, MNDWI, LST_Celsius, VH, and VH/VV Ratio. Their relevance and redundancy were evaluated before conducting comparative feature-scenario experiments.

The results showed that the Full_8 configuration consistently produced the highest Macro F1-score among the evaluated feature configurations for Random Forest, Support Vector Machine, and XGBoost. The corresponding Macro F1-scores were 0.7956, 0.7998, and 0.8048, respectively. This result indicates that retaining the complete set of eight selected features

provided the strongest overall classification performance under the experimental conditions of the study.

The model interpretation analyses further showed that the contribution of the eight features was not uniform. VH was identified as the most influential predictor in both Permutation Importance and global SHAP analysis. Other features, including MNDWI, NDMI, LST_Celsius, VH/VV Ratio, NDRE, NDVI, and EVI, provided additional predictive information. The results therefore indicate that mangrove health classification benefited from the combination of optical, thermal, moisture-related, and SAR-derived information rather than reliance on a single predictor.

Accordingly, the first objective was achieved by establishing a scientifically evaluated Full_8 feature configuration that provided complementary information for the classification of the three mangrove health classes.

5.1.2. Objective 2: Comparative Performance of Machine Learning Models

The second research objective was addressed by comparing Random Forest, Support Vector Machine, and XGBoost under a common classification framework. The models were evaluated before and after hyperparameter optimization, while class-imbalance handling was examined through eight alternative resampling scenarios.

The class-imbalance analysis identified SMOTE as the selected balancing method because it achieved the highest Priority Score of 0.5169, based on the predefined combination of Macro F1 and Dead Recall. SMOTE was subsequently applied to construct a balanced training dataset containing 208 observations for each class, resulting in 624 training observations.

Following hyperparameter optimization, XGBoost achieved the highest Macro F1-score of 0.8048, with an Accuracy of 0.8060, Macro Precision of 0.8093, and Macro Recall of 0.8060 under the Stratified 5-Fold Cross Validation evaluation. XGBoost therefore provided the strongest overall classification performance among the three evaluated algorithms and was selected as the final classification model.

Accordingly, the second objective was achieved through the identification of the most appropriate modelling configuration for the study area, namely the Full_8 feature configuration, SMOTE balancing method, and tuned XGBoost classifier.

5.1.3. Objective 3: Satellite-Derived Feature Contribution and Model Interpretation

The third research objective was addressed by evaluating the contribution of the eight satellite-derived features to the final XGBoost classification model using Permutation Importance and global SHAP analysis. The two methods consistently identified VH as the most influential predictor, although differences were observed in the ordering of the remaining features.

Permutation Importance ranked the features as VH, NDRE, MNDWI, NDMI, VH/VV Ratio, LST_Celsius, NDVI, and EVI, whereas the global SHAP analysis ranked them as VH, MNDWI, NDMI, LST_Celsius, VH/VV Ratio, NDRE, NDVI, and EVI. The consistent position of VH at the highest rank across both methods provides the strongest evidence of its contribution to the final model.

The high contribution of VH can be interpreted in relation to the structural information provided by Sentinel-1 SAR. Unlike optical indices such as NDVI, which primarily represent vegetation greenness, VH provides complementary radar information related to vegetation structure and scattering characteristics. In this study, the combination of VH with optical, moisture-related, thermal, and other radar-derived features provided a more comprehensive predictor space for distinguishing the Healthy, Stressed, and Dead classes.

The difference in the ordering of the remaining features is attributable to the different principles of the two interpretation methods. Permutation Importance measures the effect of disrupting a feature on overall model performance, whereas SHAP measures the contribution of a feature to individual predictions and aggregates these contributions across observations. Therefore, the different rankings do not indicate contradictory findings, but rather provide complementary evidence of how the final XGBoost model used the eight-feature configuration.

Accordingly, the third objective was achieved by demonstrating that the satellite-derived features contributed unequally to mangrove health classification, with VH providing the most consistent contribution and the remaining features contributing complementary vegetation, moisture, thermal, and radar information within the study area.

5.1.4. Overall Conclusion

Overall, this study demonstrates that the integration of multi-source satellite-derived features and machine learning can provide a consistent framework for classifying mangrove health into Healthy, Stressed, and Dead classes within the Segara Biru Mangrove AOI. The empirical evaluation identified the Full_8 feature configuration, SMOTE balancing method, and tuned XGBoost classifier as the final modelling configuration under the experimental conditions of the study.

The feature-importance analysis further demonstrated that the predictor variables contributed unequally to the final model, with VH providing the most consistent contribution across Permutation Importance and SHAP, while optical, moisture-related, thermal, and other radar-derived features provided complementary information. The resulting satellite-based information can serve as supporting information for mangrove monitoring and field verification, while its direct operational application requires further validation and development as discussed in the subsequent sections.

5.2. Research Contributions

This study provides contributions to the academic development of satellite-based mangrove health classification and to the practical use of satellite-derived information for mangrove monitoring within the study area.

5.2.1. Academic Contribution

- a. The study provides an empirical machine learning-based approach for classifying mangrove health into Healthy, Stressed, and Dead classes using satellite-derived features from Sentinel-2, Sentinel-1, and Landsat 8.
- b. The study provides a comparative evaluation of Random Forest, Support Vector Machine, and XGBoost, including feature evaluation, hyperparameter optimization,

and class-imbalance handling, to identify an appropriate classification model for the study area.

- c. The study evaluates the contribution of satellite-derived features through feature relevance and redundancy analysis, feature-configuration experiments, Permutation Importance, and SHAP, providing empirical evidence of the role of individual predictors in the final classification model.
- d. The study applies the final classification model to annual satellite-derived data from 2020 to 2025 and analyses the resulting health-state trajectories and transitions, providing additional information on changes in the model-derived mangrove health classes over the observation period.

5.2.2. Practical Contribution

- a. The study provides supporting information for KTH Segara Biru by presenting satellite-based classifications of mangrove conditions that can serve as initial information before field verification.
- b. The annual classification results can support the prioritisation of locations for field observation and verification, particularly for areas classified as Stressed or Dead.
- c. The satellite-based results can complement existing field-based monitoring conducted by KTH and are not intended to replace direct field assessment.
- d. The developed workflow provides a basis for future development of a more accessible monitoring platform, such as a web-based system for viewing mangrove classification and historical information. Such implementation would require further validation, capacity building, and system development.

5.3. Research Limitations

Several limitations should be considered when interpreting the findings of this study.

- a. The study area was limited to the Segara Biru Mangrove AOI in Lontar Village, Serang District. The relatively small spatial extent limits the direct generalization of the resulting classification model to other mangrove ecosystems without additional local validation.
- b. The ground-reference dataset was limited in both the number and spatial distribution of observation points. The available field observations were used to establish the Healthy, Stressed, and Dead classes, but they may not fully capture the variation of mangrove conditions across the entire AOI.
- c. The classification relied on eight satellite-derived features from Sentinel-2, Sentinel-1, and Landsat 8. Other environmental factors, including tidal conditions, salinity, topography, and meteorological variables, were not incorporated and may also influence the observed mangrove conditions.
- d. The three mangrove health classes were operationally defined from ground-reference observations within the study context. Therefore, Healthy, Stressed, and Dead should not be interpreted as universal ecological thresholds applicable to other mangrove ecosystems without additional reference data.
- e. The satellite-derived variables were used as predictors or indicators associated with mangrove condition rather than direct measurements of ecological processes. In particular, this study did not directly measure CO₂ emissions, CH₄ emissions, carbon stock, carbon sequestration, or carbon credit potential.
- f. The developed classification workflow has not yet been implemented as a direct operational monitoring system for KTH. The results currently provide supporting information for field monitoring and verification, while practical adoption would require further validation and user capacity building.

5.4. Recommendations for Future Research

Based on the findings and limitations identified in this study, the following recommendations are proposed for future research:

- a. Future studies should expand the number and spatial distribution of ground-reference observations to improve the representation of mangrove conditions and strengthen model validation.
- b. The proposed classification approach should be validated in other mangrove ecosystems with different environmental characteristics before broader application of the model.
- c. Future research may incorporate additional environmental variables, particularly tidal conditions, salinity, topography, and meteorological data, to complement the satellite-derived predictors used in this study.
- d. The observation period may be extended beyond 2020–2025 to provide additional evidence for longer-term changes in mangrove health classification and trajectory patterns.
- e. Future studies may further develop the classification workflow into a more accessible monitoring platform, such as a web-based application that allows users to select a mangrove location and obtain current and historical classification information.
- f. Before such a system is used routinely by KTH, further validation, user-oriented interpretation guidance, and appropriate capacity building should be developed to ensure that satellite-derived results are used correctly as supporting information alongside field monitoring.

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GLOSSARY

Term	Definition
Area of Interest (AOI)	The predefined geographic area within which the satellite-based mangrove health analysis was conducted.
Classification	The process of assigning observations or pixels to predefined mangrove health classes: Healthy, Stressed, or Dead.
Class Imbalance	A condition in which the number of observations differs substantially among the target classes.
Feature Engineering	The process of deriving, transforming, and organizing input variables into a structured feature space suitable for machine learning.
Feature Selection	The process of evaluating and selecting informative predictor variables while considering relevance and redundancy.
Ground Reference Observation	A field observation used as the reference label for supervised machine learning classification.
Healthy	An operational mangrove health class representing relatively favorable vegetation condition based on the field-reference assessment.
Stressed	An operational intermediate mangrove health class representing living vegetation showing observable indications of reduced or altered condition.
Dead	An operational mangrove health class representing vegetation associated with severe deterioration or apparent mortality.
Land Surface Temperature (LST)	A satellite-derived measure representing the thermal condition of the land surface.
Macro F1-score	The arithmetic mean of the F1-scores calculated separately for each target class, giving equal weight to all classes.
Machine Learning	A computational approach that learns patterns from input data to perform prediction or classification tasks.
Mangrove Health	The observed condition of mangrove vegetation represented in this study by the operational classes Healthy, Stressed, and Dead.
Multi-source Satellite Data	Satellite observations obtained from different satellite missions and sensors and integrated to provide complementary information.
NDVI	Normalized Difference Vegetation Index; a spectral index representing vegetation greenness and general canopy condition.
EVI	Enhanced Vegetation Index; a vegetation index providing complementary information on vegetation vigor and canopy response.
NDRE	Normalized Difference Red Edge Index; a spectral index using red-edge and near-infrared information to represent vegetation characteristics.
NDMI	Normalized Difference Moisture Index; a spectral index representing vegetation moisture conditions.

Term	Definition
MNDWI	Modified Normalized Difference Water Index; a spectral index used to represent surface-water-related conditions.
Permutation Importance	A model interpretation method that evaluates feature contribution by measuring the change in model performance after randomly permuting a feature.
Redundancy	Overlapping or highly correlated information among predictor variables.
Random Forest (RF)	An ensemble machine learning algorithm that combines predictions from multiple decision trees.
Support Vector Machine (SVM)	A supervised machine learning algorithm that determines class boundaries by maximizing the separation margin between classes.
XGBoost	An ensemble gradient-boosting algorithm that sequentially builds decision trees to reduce prediction errors.
SAR	Synthetic Aperture Radar; an active remote sensing technology that provides microwave observations related to surface and vegetation characteristics.
SHAP	SHapley Additive exPlanations; a model interpretation method that quantifies the contribution of individual features to model predictions.
SMOTE	Synthetic Minority Over-sampling Technique; a resampling method that generates synthetic observations for minority classes to address class imbalance.
Stratified 5-Fold Cross Validation	A validation procedure that divides the dataset into five folds while maintaining the class distribution across the folds.
Trajectory	The sequence of annual mangrove health classifications assigned to the same spatial location during the observation period.
Transition Matrix	A matrix showing the number or proportion of pixels that change from one mangrove health class in 2020 to another class in 2025.
VH	Cross-polarized Sentinel-1 SAR backscatter measured using vertical transmission and horizontal reception.
VH/VV Ratio	The relative ratio between VH and VV radar backscatter responses.

APPENDIX

Appendix A: Curriculum Vitae



Tiara Ramayani

28 Years Old | +6281214589098 | tiararamayani000@gmail.com |

<https://www.linkedin.com/in/tiararamayani> | Jakarta, Indonesia

<https://jurnal.iaii.or.id/index.php/RESTI/article/view/552/90>

SUMMARY

Dedicated and adaptable professional with a background in Information Technology, Industrial Management, and business operations, supported by academic qualifications in Informatics Engineering and Information Systems, and currently pursuing a Master's degree in Information Technology.

Experienced in project coordination, stakeholder management, technical documentation, and cross-functional collaboration across IT and operational environments. With experience in IT education, industrial management, and technology industries, I have been involved in supporting technology-driven initiatives, managing operational processes, and delivering solutions aligned with business needs.

Strong in communication, analytical thinking, problem-solving, and maintaining effective collaboration within diverse teams. Passionate about continuous learning and open to opportunities that allow me to contribute to organizational growth, operational excellence, and innovation.

Open to opportunities where I can leverage my multidisciplinary background and experience to contribute to organizational growth, operational excellence, and innovation.

AREA OF EXPERTISE

- Management
- Administration
- Network Engineer
- Presales Consultant
- Multimedia
- IT Infrastructure
- Technical Consultant
- Networking
- Wireless Solution Architect
- Service Business Delivery
- IT Costing Specialist

EDUCATION

Swiss German University | Indonesia | 2024-Now | Master Degree | Master of Information Technology | Now

Universitas Mercu Buana | Indonesia | 2022-2024 | Bachelor's Degree | Informatics Engineering | S.Kom | GPA 3.69/4.00 Politeknik

Negeri Padang | Indonesia | 2015-2018 | Diploma Three | Information Technology | A.Md.T | GPA 3.54/4.00

SKILL, COMPETENCY, AND SOFTWARE

Technical Skills

- Sizing Pricelist Aruba (Iris.apk)
- Networking Fundamentals (VLAN, Trunk, TCP/IP)
- Networking Device (Cisco, Aruba, H3C)
- Microsoft (Ms.Word, Ms.Excel, Ms.Power Point)
- Service Delivery Support
- Requirement Analysis
- Technical Proposal Development
- Bill of Quantity (BoQ) Preparation
- Infrastructure & Network Solutions
- Project Coordination & Documentation
- Technical Costing & Effort Estimation (Mandays)
- etc

Soft Skills

Communication, Stakeholder Management, Teamwork & Collaboration, Problem Solving, Time Management, Adaptability, Analytical Thinking, Negotiation, Attention to Detail

WORK EXPERIENCE

PT. Packet Systems Indonesia | Jakarta Selatan, Indonesia | December 2025 – Present

Business Delivery | IT Costing Specialist

December 2025 – Present

PT. Packet Systems Indonesia is an IT solutions and system integration company providing technology services across networking, infrastructure, security, collaboration, and digital transformation solutions.

Responsible for supporting business delivery activities through technical costing, project analysis, and cross-functional coordination to ensure solution feasibility and alignment with customer requirements.

I work as an IT Costing Specialist within the Business Delivery team, responsible for:

- Prepare technical costing and effort estimation (mandays) for implementation, maintenance, and managed service opportunities.
- Analyze customer requirements and align proposed solutions with project scope, technical requirements, and business objectives.
- Develop and review project documentation including scope definition, assumptions, notes, in-scope, and out-of-scope activities.
- Support the preparation of technical proposals, Bill of Quantity (BoQ), and solution-related documentation for customer opportunities and tenders.
- Collaborate with Account Managers (AM), Solution Architects (AS), and Service Operation (SO) teams to ensure costing accuracy and solution feasibility.
- Review implementation requirements and provide recommendations for infrastructure, networking, security, and system integration solutions.
- Support opportunity and project-related activities to ensure technical and commercial alignment prior to customer submission.
- Coordinate with internal stakeholders to ensure project requirements, deliverables, and proposed solutions meet customer expectations.

PT. Agiva Indonesia | Tangerang Selatan, Indonesia | September 2022 – December 2025

Network Operation Center

Augustus 2025 – December 2025

Agiva Indonesia is an IT Service and Consulting Company focusing to help business to improve its productivity anywhere and on any platform.

Solution Focus: Network Connectivity - Collaboration - Information Security and Control

Headquarters : Bintaro - Tangerang Selatan, Banten

Founded : 2010

Specialties : Technology Consulting, Network Connectivity, Collaboration, Project Management, and System Integration
Platinum Partner of ARUBA

I work as a Network Operation Center, responsible for:

- Monitor and analyze network performance to ensure stability, availability, and security.
- Troubleshoot and resolve network incidents, with escalation when needed.
- Support installation, configuration, and optimization of networking infrastructure.
- Prepare technical and incident documentation for internal and client reporting.
- Collaborate with technical teams to ensure smooth service operations and customer satisfaction.

Network Engineer

October 2024 – Augustus 2025

Agiva Indonesia is an IT Service and Consulting Company focusing to help business to improve its productivity anywhere and on any platform.

Solution Focus: Network Connectivity - Collaboration - Information Security and Control

Headquarters : Bintaro - Tangerang Selatan, Banten

Founded : 2010

Specialties : Technology Consulting, Network Connectivity, Collaboration, Project Management, and System Integration
Platinum Partner of ARUBA

I work as a Network Engineer, responsible for:

- Install and configure infrastructure technology which consists of data center infrastructure, core networking, and wireless networking.
- Prepare installation and/or migration document.
- Provide technical support to customers.
- Troubleshoot technical problems.

Share technical knowledge with Professional Service team.

Technical Consultant

September 2022 – November 2024

Agiva Indonesia is an IT Service and Consulting Company focusing to help business to improve its productivity anywhere and on any platform.

Solution Focus: Network Connectivity - Collaboration - Information Security and Control

Headquarters : Bintaro - Tangerang Selatan, Banten

Founded : 2010

Specialties : Technology Consulting, Network Connectivity, Collaboration, Project Management, and System Integration
Platinum Partner of ARUBA

I work as a Technical Consultant (Pre-Sales Network and Building), responsible for:

- Understanding customer requirements
- Recommending solutions
- Preparing the Bill of Quantity (BoQ)
- Drafting technical proposals

My current focus is on advising clients about the best methods to achieve business goals, solve problems, or streamline their IT systems.

PT. Mulia Taktar Dumai | Dumai, Riau, Indonesia | Mei 2019 – Agustus 2021

Transportation Secretary Director of Cement Padang Industry

The position of *Transportation Secretary Director* at *Cement Padang Industry* likely involves managing and overseeing all transportation aspects within the company, including logistics, product shipments, and coordination of the vehicle fleet. This role includes developing efficient transportation strategies, ensuring regulatory compliance, and collaborating with relevant teams to ensure the smooth distribution of cement to various locations.

PT. Dumai Indah Sejati | Dumai, Riau, Indonesia | Mei 2019 – Agustus 2021

Distributor Administration of Cement Padang Industry

The *Distributor Administration* role at *Cement Padang Industry* focuses on managing and coordinating distributor relationships, overseeing the distribution process, and ensuring accurate documentation and smooth operations for the delivery of cement products to distributors.

Politeknik Negeri Padang | Padang, Indonesia | Oktober 2015 – Oktober 2018

Laboratory Assistant Technology of Information

Handle all tasks related to the laboratory, including repairs, installations, and configurations. The laboratory includes network labs, multimedia labs, installation and software labs, information systems labs, and programming labs.

CERTIFICATES, AWARD, AND ORGANIZATIONS

Certifications

- 2023 – Present | BNSP Network Technician
- 2023 – Present | Junior Network Administrator – LSP Telekomunikasi Digital Indonesia
- 2024 – 2026 | HPE Sales Certified – Aruba Networking Solutions Professional
- 2024 – 2026 | Aruba Product Specialist – Central
- 2024 – 2026 | Huawei Certified Specialist Associate Presales – IP Network
- 2024 – 2026 | Fortinet Certified Associate Cybersecurity
- 2024 – 2025 | H3C Certified Sales Engineer - Generalist
- 2024 – 2025 | IBM Aspera Technical Sales Intermediate
- 2023 – 2024 | IBM Power Infrastructure as a Service Solutions Sales Foundation
- 2023 – 2024 | IBM Power Infrastructure as a Service Solutions Technical Sales Intermediate
- 2023 – 2024 | IBM Power System Virtual Server Technical Sales Intermediate
- 2022 – 2024 | Fortinet Certified Fundamentals Cybersecurity
- 2022 – 2024 | Fortinet Network Security Expert Level 1: Certified Associate
- 2022 – 2024 | Fortinet Network Security Expert Level 2: Certified Associate
- 2022 – 2024 | Fortinet Network Security Expert Level 3: Certified Associate

Awards

- 2018 | Participant in the 31st National Student Science Week (PIMNAS)
- 2018 | Favorite Winner of PKM-KC at the 31st PIMNAS
- 2018 | Presenter at the National Seminar on Information Systems & Technology (SISFOTEK)
- 2018 | Best Paper Award at the National Seminar on Information Systems & Technology (SISFOTEK)
- 2018 | Outstanding Student Award at the 31st Anniversary of Padang State Polytechnic
- 2017 | Cyber Peace Ambassador, BNPT, West Sumatra Region
- 2017 | Participant in KEMRISTEKDIKTI PKM-KC MONEV for “GIBAL – Gelang Anti Begal Sebagai Solusi Pencegahan Dini Kejahatan Begal Berbasis Mikrokontroler”
- 2016 | Participant in KEMRISTEKDIKTI PKM-KC MONEV for “LELINDO – Lelang Indonesia”

Organizations

- 2013 – 2014 | General Secretary of the Student Council (OSIS)
- 2013 – 2014 | Chief of Scouts “Tuanku Nan Rekeh”
- 2015 – 2017 | Member of the Cybertech Student Activity Unit – Multimedia Division
- 2016 – 2017 | Member of the Student Representative Council (MPM) Commission 2
- 2018 – 2020 | Member of Andalas Diving Club (ADC)
- 2025 – Now | Young On Top (YOT)

PROJECT EXPERIENCE

as Technical Consultant

- PT. Combiphar Padalarang
- PT. Jasindo
- Bank Jasa Jakarta
- BTPN dan BTPN Syariah
- British School Jakarta
- Agung Sedayu Grup
- ABDA Insurance / OONA Insurance
- Arya Nobel (ERHA)
- Bank Jatim
- Bank Permata
- BFI
- Bumi Makmur Mandiri Utama (BUMA)
- Gunadarma
- Icon+
- JICT
- Kawasan Berikat Nusantara
- KCIC
- Kharisma Bangsa School
- KINO
- Mowilex
- Pelni
- Prasetya Mulya University
- Sari Roti
- Sinarmas Mining
- SIS
- BRI Danareksa Sekuritas

as Network Engineer

1. PT Arya Nobel
 - Project Implementation Network Infrastructure PT Arya Nobel
 - Switch Replacement HO and DC
2. Siloam Hospital
 - Project Network Refreshment Siloam All Site (National)
 - Migration Aruba Switch (Core Switch, Server Farm, Access Switch)
 - Installation and Configuration Aruba Wireless Controller & Access Point
 - Sizing Design Wireless Access Point
3. BTPN
 - Project Network Data Center

as Network Operation Center

1. PT Pembangunan Deltamas
2. Siloam Hospital Group
3. Sinarmas Land

DOCUMENT ATTACHMENT

SCAN HERE TO SEE THE ATTACHMENT
OR CLICK

https://drive.google.com/file/d/1r64BqP6am-t5rwGcQZnAKabZUDm7YPpP/view?usp=drive_link



Appendix B: Output Data Tables and Figures



Appendix C: Letter Requesting Research Permission and Data Support



Your Gateway to Global Success

Nomor : L/MIT/252 – 1/VII/2026
Perihal : Permohonan Izin Penelitian dan Dukungan Data

Kepada Yth.
1. Kepala Dinas Lingkungan Hidup Kabupaten Serang
2. Ketua Tempat Pelelangan Ikan (TPI) Desa Lontar
3. Ketua Kelompok Tani Hutan (KTH) Mangrove Segara Biru
Di Desa Lontar, Kec. Tirtayasa, Kab. Serang, Banten 42193

Tangerang, 14 Juli 2026

Dengan hormat,

Sehubungan dengan penyusunan Tugas Akhir (Thesis) pada Program Magister Swiss German University, bersama ini kami mengajukan permohonan izin kepada Bapak/Ibu agar mahasiswa kami dapat melaksanakan penelitian di Kawasan Hutan Mangrove Segara Biru, Desa Lontar, Kecamatan Tirtayasa, Kabupaten Serang, Provinsi Banten.

Adapun identitas mahasiswa yang akan melaksanakan penelitian adalah sebagai berikut:

Nama : Tiara Ramayani
NIM : 200001086
Jurusan : Master of Information Technology
Konsentrasi : Data Science and Business Informatics (DSBI)
Perguruan Tinggi : Institut Pertanian Bogor (IPB)

Mahasiswa tersebut akan melaksanakan penelitian dalam rangka penyusunan tesis dengan judul:

SPATIO-TEMPORAL CLASSIFICATION OF MANGROVE DEGRADATION TRAJECTORIES USING TIME-SERIES ANALYSIS AND MACHINE LEARNING ON MULTI-TEMPORAL SATELLITE DATA

Kegiatan penelitian meliputi observasi lapangan, dokumentasi, pengambilan titik koordinat (GPS), serta wawancara atau diskusi dengan pengelola kawasan dan pihak terkait apabila diperlukan. Seluruh kegiatan dilakukan untuk kepentingan akademik dalam rangka penyusunan tesis dengan tetap menjaga kelestarian ekosistem mangrove.

Sehubungan dengan hal tersebut, kami memohon bantuan dan kerja sama Bapak/Ibu untuk memberikan izin pelaksanaan penelitian serta dukungan berupa akses data, informasi, dan koordinasi yang diperlukan sesuai dengan kewenangan masing-masing.

Apabila ada hal yang perlu ditanya, mohon untuk tidak ragu mengirimkan email kepada Ibu Tety Academic Operations Officer kami tety.rachmawati@sgu.ac.id.

Demikian surat permohonan ini kami sampaikan. Atas perhatian, bantuan, dan kerja sama yang diberikan, kami mengucapkan terima kasih.

Hormat saya,

Dr. Ir. Eka Budiarto, S.T., M.Sc.
Kepala Program Studi Magister Teknologi Informasi
eka.budiarto@sgu.ac.id

The Prominence Tower, Alam Sutera
Jalan Jalur Sutera Barat No.15, Tangerang 15143 – Indonesia
Telp. : (+62) 21 2977 9596/9597 | Fax : (+62) 21 2977 9598
sgu.ac.id

Tiara Ramayani

Appendix D: Form of Change Thesis Title



Your Gateway to Global Success

Form

Date : 25/07/2026
Name : Tiara Ramayani
Study Program : Data Science Business Informatics
Faculty : Master of Information Technology
Semester : 3

Request to Change Thesis Title

Herewith I request to change my thesis title:

Previous Title:

SPATIO-TEMPORAL CLASSIFICATION OF MANGROVE DEGRADATION TRAJECTORIES USING TIME-SERIES ANALYSIS AND MACHINE LEARNING ON MULTI-TEMPORAL SATELLITE DATA

Proposed New Title:

MACHINE LEARNING CLASSIFICATION OF MANGROVE HEALTH USING SATELLITE DATA IN THE AREA OF INTEREST (AOI) OF SEGARA BIRU MANGROVE, LONTAR VILLAGE, SERANG DISTRICT

I would like to change my thesis title above due to:

Explain your reason:

Adjustment to align with the thesis objectives and the data used in the study.

Remark from advisor:

Requested by:

Tiara Ramayani - 200001086

Approved by:

Dr. Ir. Eka Budiarto, S.T., M.Sc

The Prominence Tower, Alam Sutera
Jalan Jalur Sutera Barat No.15, Tangerang 15143 – Indonesia
Telp : (+62) 21 2977 9596/9597 | Fax : (+62) 21 2977 9598
www.sgu.ac.id

Appendix E: Documentation

	
With the Family of the Head of the Segara Biru Mangrove Farmers Group (KTH), Lontar Village	With the Head of Lontar Village Fish Landing Site (TPI) and Treasurer of the Segara Biru Mangrove Farmers Group (KTH), Lontar Village
	
With the Head of Lontar Village Fish Landing Site (TPI) and Treasurer of the Segara Biru Mangrove Farmers Group (KTH), Lontar Village	With a Member of the Segara Biru Mangrove Farmers Group (KTH) and Mangrove Seedling Expert, Lontar Village



With a Member of the Segara Biru Mangrove Farmers Group (KTH) and Mangrove Seedling Expert, Lontar Village



Segara Biru Mangrove Nursery, Lontar Village

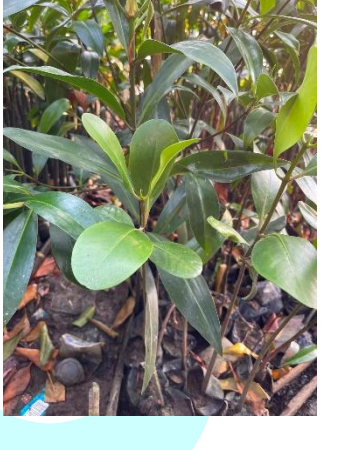


Lontar Village, Serang Regency, Banten

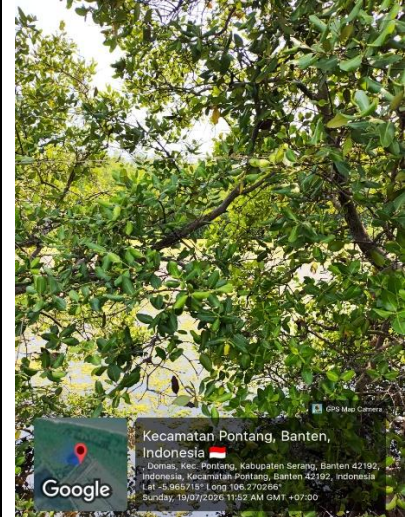
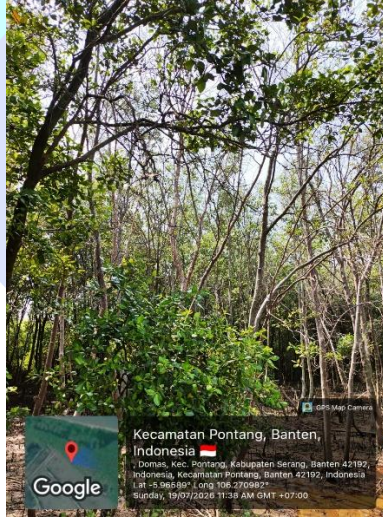
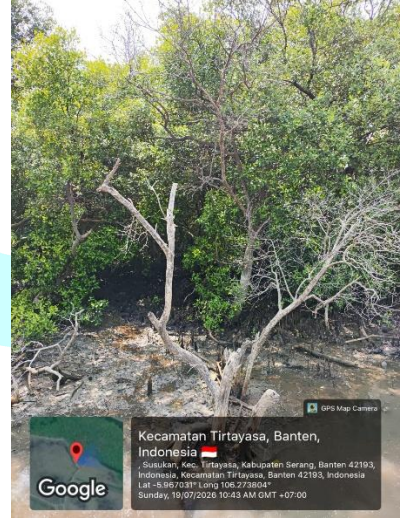


Mangrove Seedling Planting Process

Appendix F: Types of Mangroves

		
Rhizophora apiculata	Excoecaria agallocha	Rhizophora stylosa
		
Rhizophora	Rhizophora mucronata	Bruguiera cylindrica)

Appendix G: Ground Truth

Healthy	Stressed	Dead
 Kecamatan Pontang, Banten, Indonesia Domas, Kec. Pontang, Kabupaten Serang, Banten 42192, Indonesia, Kecamatan Pontang, Banten 42192, Indonesia Lat -5.965715° Long 106.270266° Sunday, 19/07/2026 11:52 AM GMT +07:00	 Tirtayasa, Banten, Indonesia 27p8+ch8, Susukan, Tirtayasa, Banten 42193, Indonesia Lat -5.964602° Long 106.267184° Sunday, 19/07/2026 12:49 PM GMT +07:00	 Kabupaten Serang, Banten, Indonesia Jl. Muayyarah/Kp. Sawah, Tirtayasa, Kabupaten Serang, Banten 15413, Indonesia Lat -5.966492° Long 106.273337° Sunday, 19/07/2026 10:41 AM GMT +07:00 Note: Captured by GPS Map Camera
 Kecamatan Pontang, Banten, Indonesia Domas, Kec. Pontang, Kabupaten Serang, Banten 42192, Indonesia, Kecamatan Pontang, Banten 42192, Indonesia Lat -5.965901° Long 106.270099° Sunday, 19/07/2026 11:54 AM GMT +07:00	 Kecamatan Pontang, Banten, Indonesia Domas, Kec. Pontang, Kabupaten Serang, Banten 42192, Indonesia, Kecamatan Pontang, Banten 42192, Indonesia Lat -5.96589° Long 106.270982° Sunday, 19/07/2026 11:53 AM GMT +07:00	 Kecamatan Tirtayasa, Banten, Indonesia Susukan, Kec. Tirtayasa, Kabupaten Serang, Banten 42193, Indonesia, Kecamatan Tirtayasa, Banten 42193, Indonesia Lat -5.967031° Long 106.273804° Sunday, 19/07/2026 10:43 AM GMT +07:00

