



OPTIMIZATION OF EVACUATION ROUTES AND TSUNAMI SHELTER LOCATION IN PALABUHANRATU, SUKABUMI DISTRICT

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**CIVIL AND ENVIRONMENTAL ENGINEERING
FACULTY OF AGRICULTURAL ENGINEERING AND TECHNOLOGY
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RINGKASAN

MUHAMMAD NAUFAL ZHAFRAN. Optimalisasi Jalur Evakuasi dan Lokasi Shelter Tsunami di Palabuhanratu, Kabupaten Sukabumi. Dibimbing oleh HERIANSYAH PUTRA dan TRI SUDIBYO.

Palabuhanratu merupakan wilayah dengan risiko tinggi terhadap bencana tsunami akibat keberadaan *seismic gap* di sepanjang zona subduksi Sunda yang berpotensi memicu gempa bumi hingga Mw 9,1 dan gelombang tsunami setinggi 20,2 meter. Tempat evakuasi sementara (TES) yang ada saat ini sebagian besar berupa bukit alami yang terletak di luar zona bahaya, dengan waktu tempuh lebih dari 30 menit sehingga tidak efektif melindungi seluruh populasi terdampak. Penelitian ini bertujuan mengoptimalkan strategi mitigasi tsunami melalui pemetaan indeks bahaya, pemodelan genangan tsunami, penentuan lokasi shelter vertikal baru, serta perancangan jalur evakuasi yang teroptimasi.

Hasil pemetaan menunjukkan bahwa 8,64 km² wilayah pesisir masuk kategori berisiko. Pemodelan genangan untuk skenario tsunami 10 meter memprediksi luas terdampak 3,57 km² dengan 12.553 jiwa terdampak, sedangkan skenario 20 meter memprediksi 6,44 km² dengan 23.574 jiwa terdampak. Analisis keterjangkauan shelter mengungkapkan bahwa TES eksisting hanya dapat dijangkau oleh 26.6% populasi terdampak dalam waktu tempuh 30 menit berjalan kaki. Penambahan shelter vertikal yang direncanakan (gedung bertingkat) mampu meningkatkan cakupan hingga 85.9%, sementara kombinasi TES dengan shelter baru dan jalur evakuasi optimal meningkatkan cakupan menjadi 99%.

Temuan ini menunjukkan bahwa integrasi pemetaan bahaya, pemodelan genangan, penempatan shelter strategis, dan optimasi jalur evakuasi secara signifikan meningkatkan aksesibilitas lokasi aman dan ketangguhan masyarakat terhadap tsunami. Pendekatan ini dapat menjadi model perencanaan mitigasi bencana pesisir yang efektif di wilayah rawan tsunami lainnya di Indonesia.

Kata kunci: Inundasi tsunami, peta bahaya, jalur evakuasi, lokasi evakuasi, keterjangkauan

SUMMARY

MUHAMMAD NAUFAL ZHAFRAN. Optimization of Evacuation Routes and Tsunami Shelter Location in Palabuhanratu, Sukabumi District. Supervised by HERIANSYAH PUTRA, and TRI SUDIBYO.

Palabuhanratu is a region with high vulnerability to tsunami hazards due to the presence of a seismic gap along the Sunda subduction zone, which has the potential to trigger earthquakes of up to Mw 9.1 and tsunami waves reaching 20.2 meters. The existing temporary evacuation sites (TES), mostly natural hills located outside the hazard zone, require travel times of more than 30 minutes, making them ineffective in protecting the entire affected population. This study aims to optimize tsunami mitigation strategies through hazard index mapping, tsunami inundation modelling, identification of new vertical shelter locations, and the design of optimized evacuation routes.

Hazard mapping results indicate that 8.64 km² of the coastal area falls into the risk category. Inundation modelling for a 10-meter tsunami scenario predicts an affected area of 3.57 km² impacting 12,553 residents, while the 20-meter scenario predicts 6.44 km² with 23,574 residents affected. Shelter accessibility analysis shows that the existing TES can only be reached by 26.6% of the affected population within 30 minutes of walking time. The addition of planned vertical shelters (multi-story buildings) could increase coverage to 85.9%, while the combination of TES, new shelters, and optimized evacuation routes could further increase coverage to 99%.

These findings demonstrate that integrating hazard mapping, inundation modelling, strategic shelter placement, and evacuation route optimization can significantly improve access to safe locations and enhance community resilience against tsunamis. This approach may serve as an effective coastal disaster mitigation planning model for other tsunami-prone regions in Indonesia.

Keywords: Tsunami inundation, hazard map, evacuation routes, evacuation sites, reachability



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OPTIMIZATION OF EVACUATION ROUTES AND TSUNAMI SHELTER LOCATION IN PALABUHANRATU, SUKABUMI DISTRICT

MUHAMMAD NAUFAL ZHAFRAN

Thesis
as a requirement for the award of a
Master of Civil and Environmental Engineering
Civil and Environmental Engineering Master Program

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FOREWORD

All praise and gratitude be to Allah SWT for His endless mercy and blessings, through which this undergraduate thesis titled *"Optimization of Evacuation Routes and Shelter Tsunami Shelter Location in Palabuhanratu"* could be completed successfully. This thesis is submitted in partial fulfillment of the requirements for the master degree of engineering at the Department of Civil and Environmental Engineering, Faculty of Agricultural Engineering and Technology, IPB University.

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May this thesis contribute meaningfully to landslide disaster mitigation efforts and further the development of knowledge in the field of civil and environmental engineering.

Bogor, September 2025

Muhammad Naufal Zhafran



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