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SMUS

SMUS Science Communication Project

# ECoast

## Ec(*h*)otones Co-creation: Bridging Natural and Built Environment in North Coast of Java, Indonesia

Universitas Diponegoro

2025

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# INTRODUCTION

## Background

Building upon the term ecotone as a transitional zone in between two adjacent ecological systems, SMUS introduced "ec(*h*)otone" that echoes the concept of ecotone as a lens in identifying wicked urban problems. As the intersection of the distinct settings and communities in ecotone areas exhibit rich biodiversity and productive environment, these interactions also pose the buffer area to be sensitive to environmental dynamics, since a minor shift can influence its compositions. This project brings out the notion of ec(h)otone to understand the transitional zone and the intertwining problems inside, with a particular focus on the urban to rural ecotones. Deng, et al. (2024) states that urban-suburban-rural zones demonstrate distinctive transitional characteristics in human-nature interactions, while also reflecting high levels of functional diversity and landscape heterogeneity[1]. Extending this concept, exploring ec(h)otone within urban-rural transitional zones can help foster more integrated approach in spatial planning, further fostering sustainable development.

The Northern Coast of Java Island, Indonesia exemplifies the ecotone area where terrestrial and marine environments converge. Furthermore, this project is taking a particular focus on Semarang City and Demak Regency, two neighboring regions that present the transition from urban to rural areas. The meeting points of these characteristics create a complexity, and small shifts such as land use changes, shoreline changes, or sea level rise can rapidly lead to the stage where wicked urban problems emerge and interact. Such problems significantly influence ecotones over time, causing environmental degradation and disruption to communities' livelihood.

Addressing this concern, SMUS Science Communication Project aims to increase engagement on ec(*h*)otones through innovative audio and visual methods. This project is designed to visualize the shifting dynamics and adaptation measures to wicked urban problems in Semarang-Demak coastal ecotone areas by employing temporal storytelling using digital interactive platforms, to further support urban planning and policy development that enables decision-makers to effectively plan for and safeguard coastal ecotone areas. Specifically, the project will produce four outputs, namely Ecotone Time Map, an interactive digital map, a feature storytelling video, and a virtual reality media (VR), in which all these will be presented using interactive installation through an exhibition event. The information will be portrayed through a dynamic visual timeline, audio components, and written information. Throughout the production, various stakeholders will also be involved through the co-creation process to bridge interdisciplinary perspectives to further support Sustainable Development Goals (SDGs), particularly SDG 11 concerning Sustainable Cities and Communities.

[1] Deng, W., Jiang, Z., Zhang, S., Ren, P., Zhang, H., & Wang, Z. (2024). Dynamic Identification and Evolution of Urban-suburban-rural Transition Zones Based on the Blender of Natural and Humanistic Factors: A Case Study of Chengdu, China. Chinese Geographical Science, 34(5), 791-809.

## Objectives

To increase the engagement of ec(*h*)otones to exhibit the temporal transformation in coastal ecotone areas of Semarang and Demak, Central Java, Indonesia, and its interconnection with wicked urban problems through a digital interactive platform as a reflective learning media for audiences.

## Scope of Area and Content

The creation of the science communication project comprises the Northern Coastal Area of Java Island, Indonesia, particularly in Semarang and Demak. Semarang and Demak are two adjacent regions, where Semarang presents the urban fabrics and Demak displays the rural landscape. The focused area includes eight coastal sub-districts in Semarang and seven villages in Demak, as depicted in figure 1. These areas are bounded by the watershed boundaries to provide a clearer and more consistent range of ecological processes, which further enable a better examination of the links between human activities and the environmental changes.

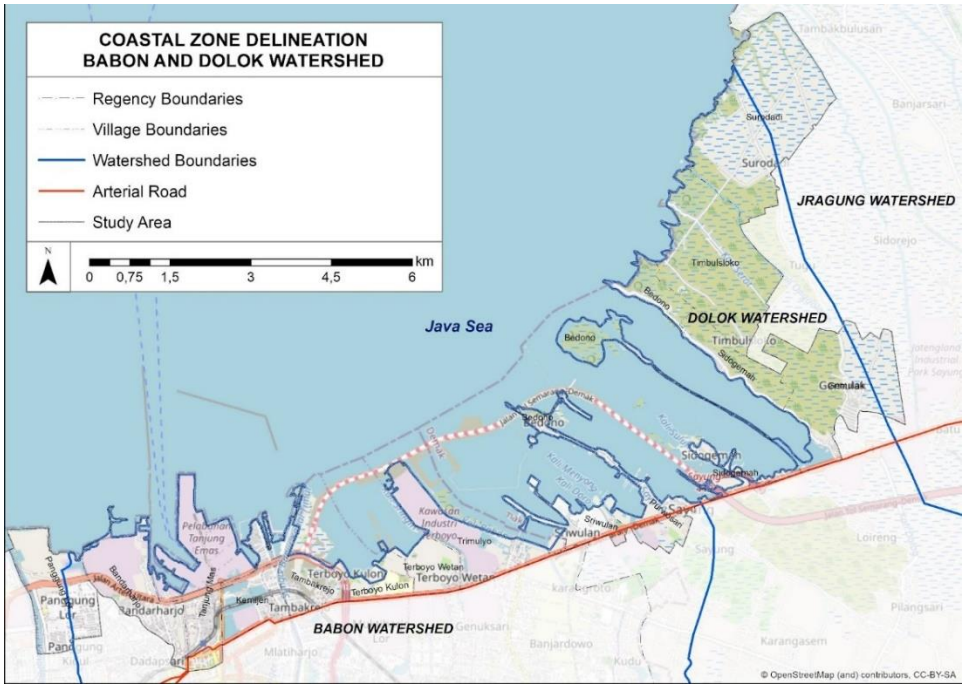


**Figure 1.** Map of Delineation Area for the SMUS Science Communication Project

The selection of these areas aims to showcase these features:

The **contrasting features between coastal urban and rural life**

Diverse settings to explore the **coexistence of different social and ecological systems**

The **urban-rural interactions**

# ACTIVITIES

## Data Preparation

Data preparation, as the initial activity, involves data collection through desk studies from previous research, statistical data, and official government documents. The collected data are maintained in a data inventory, encompassing information from the 1990s to the current 2020s. The data are categorized into various sections, addressing both physical and socioeconomic changes to offer a comprehensive understanding of the dynamics of the coastal ecotone in Semarang-Demak.

## Field Surveys

Surveys for the data collection are conducted two times. The first survey was carried out for broad observations across all zones within the entire study area to obtain a general understanding of its characteristics. This stage provided an initial picture of the landscape conditions, ecological features, and socio-environmental dynamics that later guided the selection of focus areas to be explored in the outputs. Building on the preliminary observations, the field survey was then directed at specific sites within the study area, namely Tambaklorok in the Semarang urban coastal area and Timbulsloko in the Demak rural coastal area. These locations were chosen based on their relevance to the project objectives, representing ec(h)otones that highlight both the dynamics in the transitional zones and its interconnection with wicked urban problems.

**Figure 2.** Field Surveys in Tambaklorok (top) and Timbulsloko (bottom)

## Co-Creation Workshop

Co-Creation Workshop is designed to be a platform to involve relevant stakeholders and local community to provide firsthand insights on the characteristics of ecotones, physical and socio-economic changes, climate change impacts, and ongoing adaptation strategies. Throughout this project, the team has conducted two workshops. Each workshop is conducted with a different set of stakeholders to obtain complementary insights from two sides of the coin, from government and community. The first workshop focused on discussing the key points in addressing wicked urban problems in the ec(h)otone area, involving both Semarang and Demak government stakeholder representatives. In addition, the second workshop focused on exploring the transformation from the local community in Timbulsloko who experienced ec(h)otone temporal changes firsthand.

**Figure 3.** Co-creation Workshops

## Exhibition

The exhibition event is designed to showcase key products from the science communication project, aimed to convey the knowledge generated through the exploration of ec(h)otone in coastal Semarang and Demak. The event brings together invited discussants from diverse disciplinary backgrounds to critically examine ec(h)otone and its relevance to development policies and spatial planning frameworks, while also curated and open to public. The exhibition also offers an interactive space to encourage audiences to learn through game-based activities. The exhibition serves as a space for reflection and dialogue to enable collective learning to further foster shared commitment toward more sustainable coastal ec(h)otone areas.

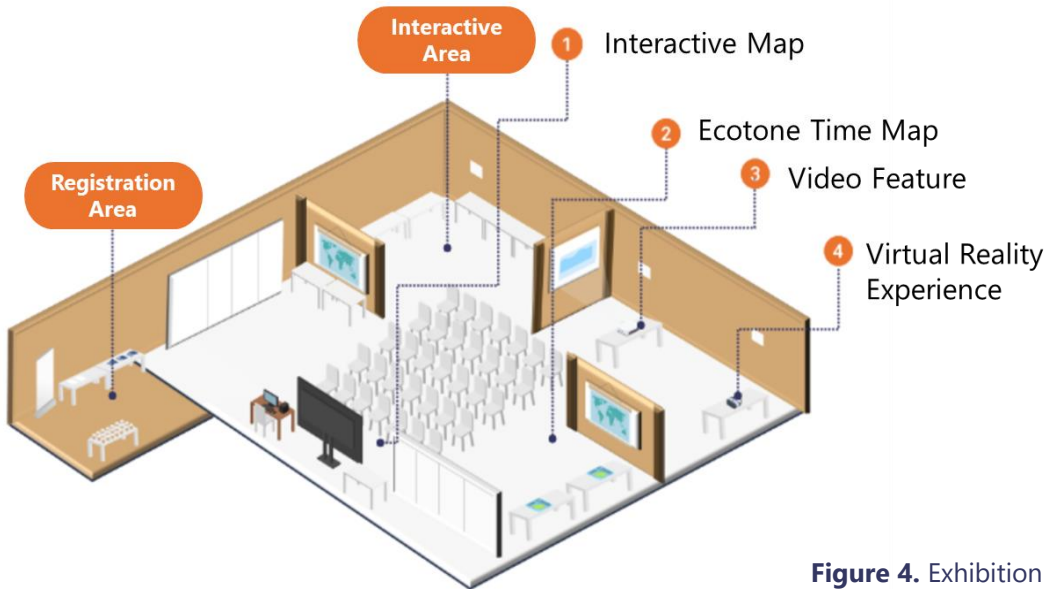


**Figure 4.** Exhibition Event

In addition to achieving its primary objectives, this activity also received media coverage, which contributed to the wider dissemination of its ideas, outcomes, and relevance. The media exposure helped raise public awareness of the issues addressed in the activity and extended its impact beyond the immediate participants, reaching broader audiences across different sectors.

## Media Outreach


**UNDIP dan Technische Universität Berlin Luncurkan Produk SMUS Science Communication Project**
***Universitas Diponegoro*** | https://undip.ac.id/post/54016/undip-dan-technische-universitat-berlin-luncurkan-produk-smus-science-communication-project.html


**Interkoneksi Wilayah Pesisir Jateng PWK Undip dan TU Berlin Jalankan Program SMUS**
***Suara Merdeka*** | https://www.suaramerdeka.com/pendidikan/0416395160/interkoneksi-wilayah-pesisir-jateng-pwk-undip-dan-tu-berlin-jalankan-program-smus


**Undip dan TU Berlin Jalankan Program SMUS**
***Suara Merdeka***


**Undip Rekomendasikan Integrasi Darat dan Pesisir Semarang-Demak**
***RRI*** | https://rri.co.id/semarang/iptek/2032685/undip-rekomendasikan-integrasi-darat-dan-pesisir-semarang-demak


**Undip Rekomendasikan Integrasi Darat dan Pesisir Semarang-Demak**
***Antara Jateng*** | https://jateng.antaranews.com/berita/612634/undip-gandeng-tu-berlin-untuk-mencari-solusi-atasi-persoalan-kawasan-pesisir

# PROFILE OF SEMARANG-DEMAK EC(H)OTONE AREA

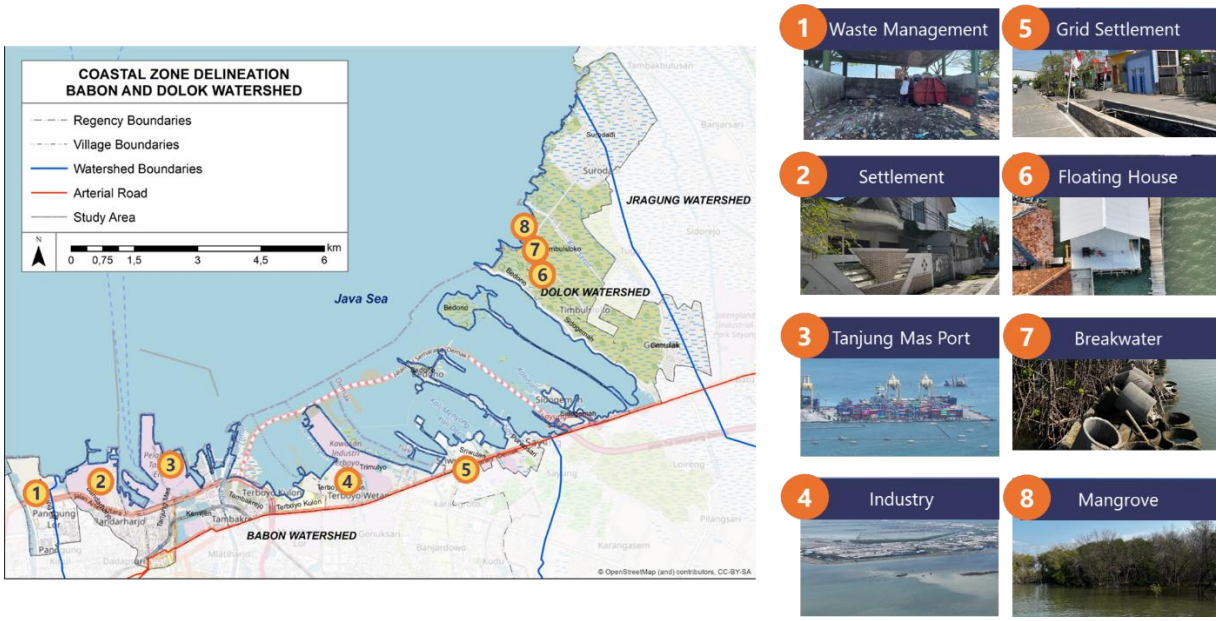


**Figure 5.** Maps of Physical Characteristics in Semarang-Demak Ec(h)otone Area

## Physical Characteristics

In the ec(h)otone study area, Semarang City as urban area and Demak Regency that presents both peri-urban and rural areas. Semarang coastal area is characterized by its dense settlements and massive industrial activities, with critical infrastructures for economic activities such as ports. Moving aside to Demak, the physical form gradually changes from developed industrial zones to a rural landscape where houses, fishponds, and mangroves coexist.

Over the past 20 years, significant land cover changes occur where regions that were previously open land, now transformed into built-up areas, primarily consisting of settlements and industrial zones. Another notable example is the development of Semarang-Demak toll road that contributes to land cover changes, particularly in Terboyo Kulon, Terboyo Wetan, Trimulyo, Sriwulan, Purwosari, and Bedono Villages, that lay as the neighboring villages of Semarang and Demak. Significant land loss also occurred, particularly in coastal Demak where several hamlets are submerged.

## Socio-Economic Characteristics

The socio-economic situation of Semarang and Demak remains similar. Residents in the Semarang coastal ec(h)otones were usually employed as trade and services or industry workers. However, a substantial proportion of the population continues to rely heavily on the fisheries sector, especially those who reside in Tambak Lorok, Tanjung Mas, Semarang. They usually work as fishermen, employees in fish-processing industries, or entrepreneurs operating small to medium-sized enterprises linked to fisheries and marine-based activities.

Most coastal ec(h)otones residents in Demak also depend on the fishery sector. As the disasters keep on occurring, incomes from the fishery have become uncertain. Their fishponds have been submerged and lost to the sea. Therefore, people in Demak coastal ec(h)otones, especially the youths, started to work in the industrial sector, as the peri-urban area of Demak that lies adjacent to Semarang also experienced significant industrial development.

## Wicked Urban Problems

Ec(h)otones underscore the concept where transitional zones that own rich biodiversity have complex interactions that may lead to interconnected problems, or commonly referred as wicked urban problems. Such problems significantly influence and alter the characteristics of ecotones over time.

The complex problems in coastal ec(h)otone has caused various impacts in environment, physical, and socio-economic aspects.

# THE PRODUCTS OF SMUS SCIENCE COMMUNICATION PROJECT

The SMUS Science Communication Project produces 3 key outputs, namely the ecotone time map, feature video, and virtual reality video. These products were displayed through an exhibition event, held on Wednesday, December 10, 2025 at the Department of Urban and Regional Planning, Faculty of Engineering, Universitas Diponegoro.

## Ecotone Time Map

The ecotone time map comprises a digital map and a 2-dimensional printed map that provides information on how the coastal ec(h)otones of Semarang and Demak have changed over time through the dynamic interactions between natural processes and human activities, revealing spatial-temporal transformation in land use, coastlines, and socio-environmental settings in the span of 25 years. Generally, the time map presents an overview of the ec(h)otone through horizontal and vertical lenses, followed by more detailed information displayed through interactive pop-ups.

The digital time map can be navigated using touchscreen devices, enabling audiences to explore the content interactively. The map allows users to view the horizontal and vertical transects of the ec(h)otones, supporting a more holistic understanding of the area. By selecting the "horizontal transect" or "vertical transect" options, users can examine spatial changes, environmental conditions, and socioeconomic dynamics across different scales and over time.

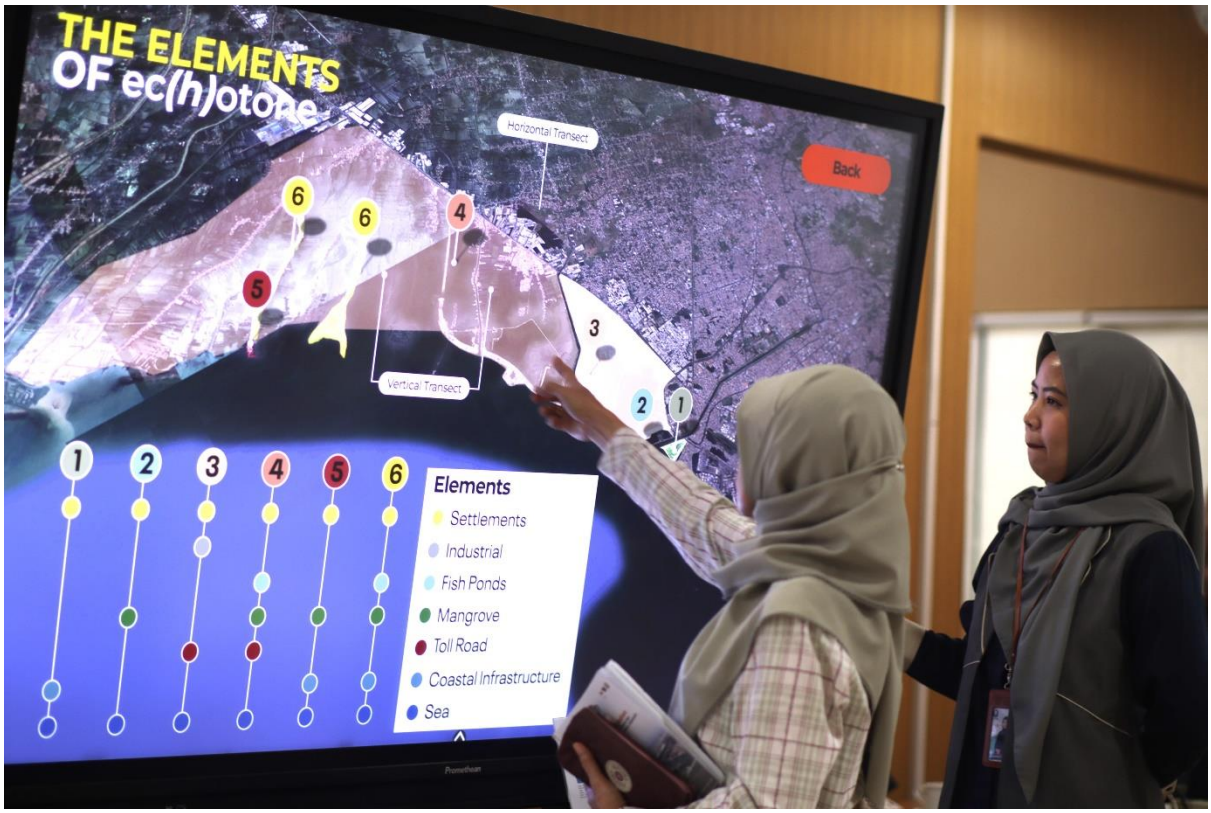


**Figure 6.** Digital Interactive Ecotone Time Map

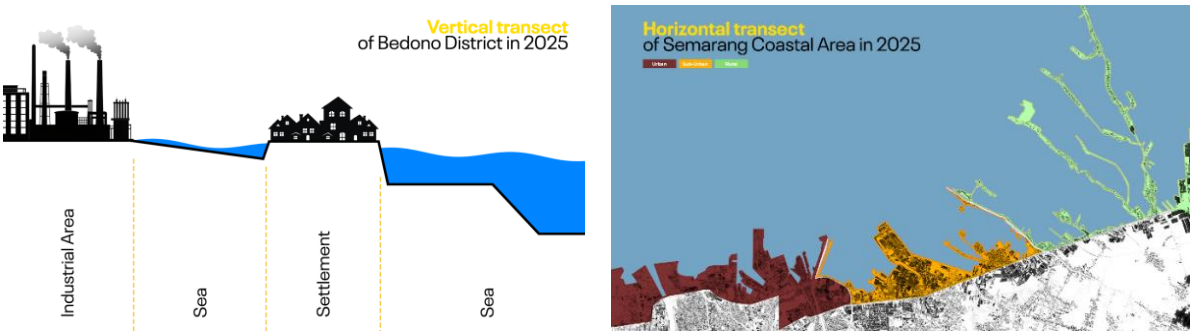


**Figure 7.** Horizontal and Vertical Transects of Ec(h)otones

### Horizontal Ec(h)otones

The horizontal transect presents the Semarang-Demak coastal ec(h)otone from west to east, illustrating the spatial transition from urban to rural areas.

### Vertical Ec(h)otones

The vertical transect highlights the changes across landscapes, from inland plains to coastal and marine environments.

## Pop-up Information

Based on the 8 urban villages in Semarang City and 7 villages in Demak Regency, we choose the main 6 spots to focus on building interactive map. There are 3 qualifications used to justify them, which are the availability of the time series data, the significant change on the spatial and livelihood aspects in the areas, and the representation of urban and rural characteristics.

As coastal issues have contributed in shaping the ecotone area of the study locations, each spot on the interactive map is also equipped with information on the elements that factor in shaping the area. There are 7 defining elements whose presence could be found across all the spots, which are settlements, sea area, mangrove, toll-road, fishponds, industrial area, and coastal infrastructure (this includes both hard and hybrid engineering structure). Figure 8 shows how these elements are presented.

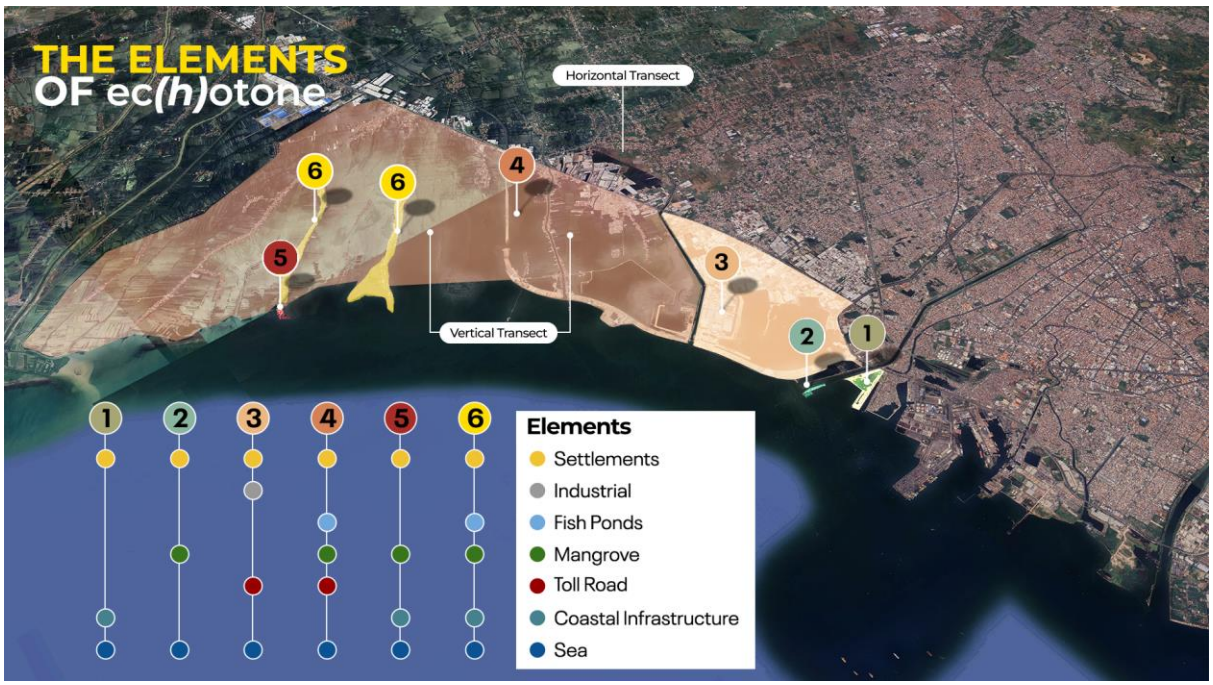


**Figure 8.** The Elements of ec(h)otone

The printed map also displayed time series images of the study area to illustrate the dynamic spatial changes of the coastline in study locations over the course of 25 years. It also presents how land use shifts along the way. Figure 14 is the example of different states shown at the coastline and land use in the study locations. It can be seen how the coastline has moved further towards the land while green areas are significantly infiltrated by more built areas, especially in Demak Regency.


**Figure 9.** Printed Ecotone Time Map of Coastline Changes

## Feature Video

Feature video is designed as a reflective learning tool to help audiences comprehend socio-ecological transition occurring in the Semarang-Demak coastal ec(h)otones and its intersections with wicked urban problems. The video is structured into six main sections:


**Figure 10.** The Display of Feature Video

1. Opening segment, introducing the concept of ec(h)otones to the audiences, as well as the definition of ecotone that may not be widely recognized outside ecological disciplines. This section presents as the fundamental sequence of the video in explaining how the term ec(h)otone evolves and providing the introduction of Semarang-Demak coastal ec(h)otones to ensure the audience comprehends the concept and the urgency conveyed by the media.


**Figure 11.** Feature Opening Segment

2. Semarang-Demak Ec(h)otones: Wicked Urban Problems, Impacts, and Adaptation, that specifically explores the dynamics and its interconnection with wicked urban problems. Rapid urbanization driven by Semarang's role as an economic hub has intensified pressures on land, water, and housing, leading to land conversion, environmental degradation, infrastructure damage, and livelihood shifts. These actions significantly affect the Demak coastal area. While climate change and sea level rise affect coastal ec(h)otones in general, the dynamics and impacts in Semarang and Demak differ due to their distinct regional characteristics and vulnerabilities. Facing these various problems, adaptation becomes one of the residents' ways to survive.

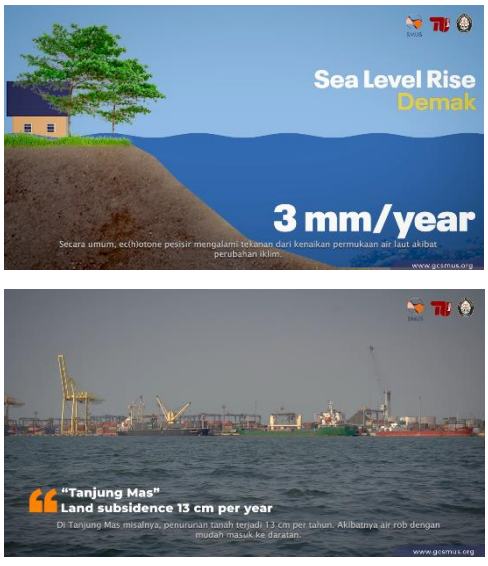


**Figure 12.** Wicked Urban Problems in Semarang-Demak Ec(h)otone

3. Closing segment, where the video concludes with a reflective message emphasizing the importance of ec(h)otones as a concept that needs to be taken into account to gain a holistic understanding of the complex issues in the transition zone, further requires collaboration between various stakeholders and multidisciplinary approach to enable systemic solutions to foster Sustainable Development Goal 11 that aims to create more resilient and sustainable cities and communities.


**Figure 13.** Feature Closing Segment

## Virtual Reality (VR) Video

The virtual reality (VR) videos serve as an immersive medium that allows the audience to directly experience the ambients of the study sites. The VR experience is delivered using a VR headset and a headphone to enable the users to perceive spatial realities and everyday life in these areas as if they were physically present. We chose three representative points for the VR, one in urban area namely Tambaklorok (Semarang), one in peri-urban area namely Sriwulan (Demak), and one in rural area namely Timbulsloko (Demak) to convey the contrasting atmospheres across the three different settings, giving the users an experience of sensing the ec(h)otones from urban to rural.

**Figure 14.** Virtual Reality (VR) Experience

# CLOSING

This study highlights ec(h)otones to identify the dynamic and fragile spaces where environmental change and urban development intersect. Through the ecotone time map and immersive VR experience, the research demonstrates how sea level rise, land subsidence, reclamation, and socio-economic transformation collectively reshape coastal landscapes and everyday life across urban, peri-urban, and rural contexts. The key takeaway is that coastal challenges cannot be understood in isolation; they are interconnected processes that demand integrated, place-based responses.

Looking ahead, this work is expected to serve as a shared platform for knowledge exchange among researchers, policymakers, practitioners, and local communities. The visualization tools developed in this project can support more informed decision-making, foster empathy toward affected communities, and encourage participatory approaches in coastal planning and adaptation. Ultimately, it is hoped that this research will contribute to more resilient, inclusive, and sustainable coastal strategies that respect both ecological processes and human livelihoods over time.

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