



## The Concepts of Planning in Architecture and Environment to Mitigate Tsunami Disaster Case Study: Semawang Beach, Denpasar, Bali

*I Gede Surya Darmawan, I Wayan Wirya Sastrawan and Putu Hartawan*

Architectural Study Program, Universitas Warmadewa, Denpasar-Indonesia

E-mail : wirya.unwar1@gmail.com

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**Abstract**—Bali won the title of “World's Favorite Tourist Destination Destination” at the 2020 PVK Award. This title is inseparable from the many natural and cultural tourist objects that attract local and foreign tourists to visit Bali, one of which is Semawang Beach, Denpasar. The wide, white and shallow coastal area, calm sea conditions, a favorite place to enjoy the sunrise, the many gazebos and tourism accommodations, the location near Ngurah Rai International Airport is the main attraction for tourists. However, according to information from the Head of the National BMKG Prof. Dwikorita Karnawati said that the southern region of East Java and Bali, including Semawang Beach, has the threat of an earthquake accompanied by a tsunami in the future which we cannot predict exactly when it will occur. Based on this, it can be concluded that what is the solution, especially from the engineering side, especially architecture, which creates beaches that are safe for tourists to visit in the form of permeable architectural and environmental models that support tsunami disaster mitigation. Specifically for the first year, the existing model will be evaluated first so that it is hoped that in the second year a permeable design model will be produced. This study uses a descriptive qualitative approach using observation data, surveys, and documents. The research instruments were coastal base maps, total station tools, laser meters, stationery, autocad and 3d sketchup software, cameras and computers. The research which is planned for 9 months in the first year is expected to produce findings of evaluation of existing permeable architectural and environmental models in supporting tsunami disaster mitigation in the Semawang Beach area, Denpasar in terms of evacuation rescue routes, protective areas, safe zones, open spaces, facilities general disaster response, and determinants of disaster response in spatial planning and buildings.

**Keywords:** Permeability; architectural and environmental models; tsunami disaster mitigation; coastal

### 1. Introduction

Bali won the title of "World's Favorite Tourist Destination Destination" at the 2020 PVK Award beating four other nominees, namely: Paris, Barcelona, Venice and London. Previously, it was recorded that Bali had also won an award by beating 25 other world destinations in the Travelers Choice event held by Trip Advisor in August 2020 as "The

Best International Tourism Destination" (Bali D.P., 2020). This predicate is inseparable from the many natural and cultural tourism objects that attract local and foreign tourists to visit Bali, one of which is the charm of the coastal area in Denpasar City, Bali, one of which is Semawang Mertasari Beach which is located in Intaran Village, Sanur, Denpasar. Of the many coastal areas that are widely known by the public, there is Semawang Beach, Sanur, which has a wide coastal area. Favorite places to enjoy the

sunrise, including the best sunrise photo hunting spots, can be found at Semawang Beach. The sea conditions are calm, with white sand and shallow, suitable for children swimming and canoeing activities, many gazebos and complete tourist accommodations both places to stay, eat and surrounding coastal tourism objects, as well as a location close to I Gusti Ngurah Rai international airport (only 15 minutes if reached by car), seaweed and coral reef cultivation, and the local fishing village are the main attractions of Mertasari Beach Sanur (Sugiharta, 2013).

However, behind the tourism potential that attracts tourists to come and travel to the coast of Semawang Beach, Denpasar, it turns out that this beach holds the threat of an earthquake accompanied by a tsunami. Located about 200 kilometers from the confluence of the Australian and Asian plates, known as the megathrust plate, Sanur and Kuta are areas that are potentially the most vulnerable to a tsunami impact (Bali, 2020). Geologists and tsunami experts consider that apart from Sanur beach, the coast of Serangan Island is also at high risk of being affected by a tsunami in the future because of the topography and elevation of the land which is relatively parallel to the sea or only 1-2 meters high which makes the coastal area in Denpasar city vulnerable to being inundated by water. sea (Sutarja, 2015).

The last 2 years of research took place next to Semawang Beach, namely Mertasari Beach, obtained several findings related to permeability in the area including: evaluation of the existing architectural and environmental models, there were several items that were found not to be suitable from a permeable perspective in supporting tsunami disaster mitigation including evacuation rescue routes that still using the main road, the unavailability of safe zones and protective areas from the brunt of the tsunami threat, less than optimal placement of vegetation and unfulfilled public facilities; as well as in optimizing permeable architecture and environment there are several recommendations made, namely making more permeable pathways, planting vegetation along the coast with a 3 meter view-free character, building Tsunami TES in 4 buildings that have a height of 3 floors and above, and planning public facilities such as toilets, helipads, open and closed evacuation rooms and first aid at each Tsunami TEST (I Gede Surya Darmawan, 2021).

Because Semawang Beach is one of the favorite destinations for tourists and the local community, for this reason, the beach area is expected to become a public space that is friendly to tourists and the community, which can be enjoyed by anyone and not just as if it is enjoyed by hotel tenants and the beach can be seen clearly from the spruce road. For this reason, the authors recommend the permeability model which is implemented in the architecture and environment of the Semawang Beach area. Permeability is designed by making arrangements and designs that are translucent from

various directions, both translucent in sight and translucent in terms of accessibility. Translucent planning in coastal areas will certainly be very useful if the threat of a tsunami occurs because the community can detect signs of a disaster earlier and speed up evacuation to safe zones. In addition, every day, tourists and the public can enjoy the beach as a public open space by utilizing access through hotels, restaurants and local tourist accommodations which are also used as tourist accommodations as public spaces so that the beach can be felt close and can be seen and passed from anywhere.

Based on the background described above, the research problem can be formulated, namely: How is the existing model of permeable existing architecture in supporting tsunami disaster mitigation in the Semawang Beach Area, Denpasar Bali? and existing models of permeable existing environments in supporting tsunami disaster mitigation in the Semawang Beach Area, Denpasar Bali? These two main problems will be answered by the research team in an applied product research scheme for the 2023 fiscal year with the theme of disaster in coastal tourism areas in the world of architecture.

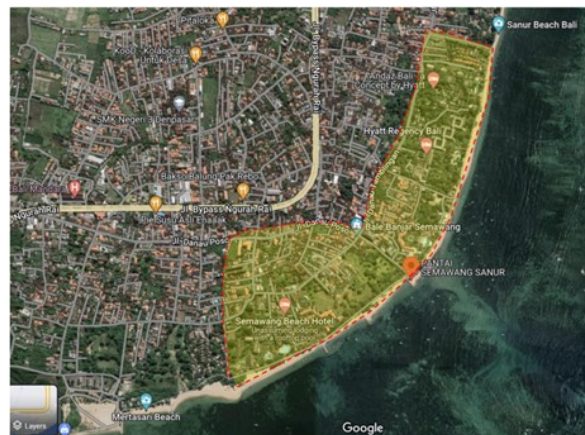


Figure 1. Delineation of Semawang Beach, Denpasar, Bali, 2023  
Source: Researcher Documentation

There are several important concepts in architectural planning in disaster-responsive residential environments, including (Sukawi, 2008):

#### *Evacuation Rescue Route (Escape Route)*

In addition to earthquake-resistant buildings, what is needed in an effort to minimize the impact generated by a disaster is planning an evacuation route for disaster victims. Basically there are 2 types of evacuation route planning, namely evacuation routes in buildings and evacuation routes in residential areas.

#### *Evacuation Routes in Buildings / Buildings*

Planning escape routes for buildings/buildings, especially those with lots of floors, is done by making emergency stairs or lists that can be directly connected to the outside space. Usually emergency stairs are placed on the side of the building or right in the middle which is the core of

the building. This is intended to make access to and from the building easier and safer.

#### Evacuation Routes in Residential/Settlement Environments

When planning a settlement, consideration should be given to the planning system for environmental services/service lines. Because this system is a design for the flow of movement of service vehicles (such as garbage collectors, goods carriers, fire engines including ambulances) from a plot or certain environmental blocks, which are mapped to the hierarchy/class of roads that exist in the planning area. This is important because if one day a disaster occurs, then as much as possible the rescue vehicles can immediately go to the location to provide assistance. Identification of rescue paths in the event of a disaster:

Availability of pedestrian paths to higher areas. Road for evacuation route.

The construction of multi-storey building structures, must pay attention to better evacuation routes (eg emergency stairs outside the building).

Disaster-based spatial planning that has prepared itself with places and evacuation routes if floods or fires or other disasters occur.

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Figure 2. Buffer zone or green belt planning, 2008  
 Source: Sukawi

Apart from that, it is also necessary to have a pedestrian linkage system, so that there are linkages that allow it to penetrate certain buildings or several plots and be utilized for the benefit of public lines. In addition to this integrated connecting route needed in areas with high intensity and various activities, such as in commercial areas of residential neighborhoods or mixed-use areas, it is also intended to provide easy accessibility for pedestrians to save themselves in the event of a disaster. The house/building placement plan on the site must pay attention to:

Land/environmental capacity to accommodate new developments,

Paying attention to settlement patterns

Building Boundary Line (GSB) and Road Owned Area/MAMIJA (ROW).

Build a building with a strong foundation.

Housing/settlement development locations: avoid disaster-prone areas, riverbanks or coastal areas that are prone to tsunamis, do not use flood retention areas for settlements or for other things other than the designation plan, do not build bridges or buildings that block or narrow the troughs river flow.

#### Protective Area

Identification included in the protected area, among others:

Provision of safe zones in residential areas.

Planning of supporting structures (retaining embankments, mangroves, etc.).

Planning of productive buffer zones (ponds, rice fields).

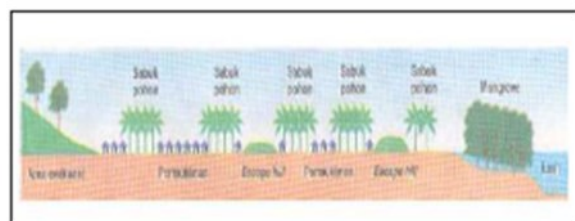


Figure 3. Buffer zone or green belt planning, 2008  
 Source: Sukawi

Planning of layered green lanes to filter debris/garbage in the event of a flood.

Conservation of nature as part of the buffer zone. No deforestation. In residential areas, where it is densely packed with buildings, the rate of infiltration of water into the ground is reduced, with no sufficient catchment area available. If it rains with high rainfall it causes some of the rainwater to become surface water which has the potential to cause flooding.

#### Safe Zone Area

In planning that functions as a settlement, attention must be paid to everything related to the building layout plan and the environment. This is intended so that the arrangement of the residential environment can be more optimal. In addition, with this arrangement, a clear mapping of land use will also be created. One of the things included in the building and environmental planning that needs to be worked out when it comes to disasters is the existence of a disaster safe zone. A safe zone can be an open space in a residential area which in actual function can be a green area such as fields and forests. It can also be in the form of a building for safety/evacuating in the event of a disaster, the real function of which is a building for public facilities.

#### Open Space and Vegetation

There is a boundary between the coastal area and the residential area that can reduce the level of sea water entering during a disaster. One of the boundaries can be hardwoods (mangroves, nipah, waru, coconut). Beaches that are straight and

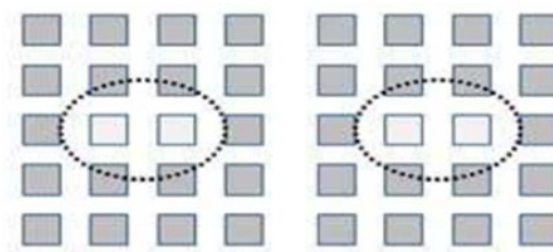
protected by hardwoods are relatively good for settlements. The use of trees to absorb CO<sub>2</sub> and reduce air temperature can reduce the use of air conditioning. Between the beach and the residential area is planted with coastal trees that are strong and have dense leaf volume (for CO<sub>2</sub> absorption).

The development of open spaces and city parks can be maximized which can later be used as urban emergency spaces. The city emergency room is equipped with the need for clean water, KM / WC for defecation, communication tools and warehouses to store food and medicine for several days while waiting for aid to arrive. So that we no longer hear news of refugees starving and not eating for 2 days or more because they have not received assistance.

Realizing a disaster-responsive city can be done by increasing vegetation in the city park which is a habitat for wild animals such as birds and other insects that can also function as an early warning of disasters. We need to learn a lot from the people at the foot of Mount Merapi to foster sensitivity to natural changes marked by the behavior of wild animals.

#### *Public Facilities in Disaster Response Settlements*

In suburban areas, public facilities (shops, schools, community meeting halls) that serve residential areas are grouped close to the houses that need them. So that residents do not need to drive their motorized vehicles to reach it. Meanwhile in big cities, a polycentric (multi-centre) layout of the city can reduce the distance from the suburban area to the main functions (commercial, government centers, etc.) located in the city center. Public facilities are placed at a safe distance and in a central position from housing so they are easy to reach. A number of public facility centers are provided for the housing units it serves.



**Figure 4.** Patterns of Arrangement of Public Facilities in Residential Environments, 2008

Source: Sukawi

## **2. Method**

The research approach used in this study is a descriptive qualitative approach. A descriptive qualitative approach describes phenomena based on the perspective of informants, discovers various realities and develops a holistic understanding of a phenomenon in a particular context (Hilal, 2013). A qualitative approach is generally used to describe inductively, with assumptions based on social reality, variables that are difficult to measure,

complex and interrelated, and the data collected contains an in-depth perspective of the informant (Almalki, 2016). In this case, more data will be obtained through direct observation in the field to see and analyze existing conditions, both potential and problems related to research, as well as existing measurements using a total station tool and an image approach using Google Earth software and drones to map macro positions. building to the surrounding area. The measurement results are transferred to the Auto CAD software and a simple 3d Sketch Up modeling is made and its location relative to the area.

The location of this research takes a location setting in the Semawang Beach area, Denpasar, Bali, starting from Jalan Cemara to Jalan Kusumasari whose territory stretches from the north end to the south. While the locus of this research is on the functions of the existing building and outdoor space that penetrates from the coast to Cemara to the Ngurah Rai Bypass Road in supporting tsunami disaster mitigation. The function of this building can be in the form of a hotel, restaurant, and other commercial functions including its outdoor space/landscape.

Research instruments can be interpreted as the tools needed to collect data. In qualitative research, the main instrument in data collection is the researcher and other people who assist the researcher. In this study, researchers collected data by asking, asking, listening, and taking (Afrizal, 2014). The additional instruments needed by researchers in this study include: delineation maps of the Semawang Beach coastal area, questionnaires that will be distributed to tourists, communities and managers and workers in the area, total station measuring devices and laser meters for detailed mapping of buildings and areas which can be used as a permeable disaster mitigation area, writing tools and drawings, a camera to document the existing conditions in the field, a computer with a minimum specification of a core i7 so that it can use 2D Autocad and 3D Sketchup software to copy measurement results and simulate a complete location picture, and a camera for documentation of survey results.

The data collection method uses 4 techniques, namely observation, in-depth interviews and questionnaires, documents and FGD (Creswell, 2007). However, in research with the context of coastal areas, data collection techniques consist of only 3 types, namely observation, in-depth interviews and questionnaires, as well as documents. The FGD technique was included in the in-depth interview technique so that data was obtained in relation to previous history related to the research object.

## **3. Results and Discussion**

In making the existing permeable architectural and environmental models in support of tsunami disaster mitigation in the Semawang

Beach area, of course, previously there was a need for tsunami disaster data. According to Mr. I Made Kris Adi Astra, S.Sc., M.Sc as BMKG Region III that tsunamis have different speeds, that is if a tsunami has a fast speed it means the sea is at deep depths and if the tsunami speed is slow it means the depth of the sea is at a shallow depth. For the speed of a tsunami in the ocean with deep depths, it has a speed of 943 km/hour, while the speed of a tsunami in shallow seas has a speed of 36 km/hour. The Semawang Beach location is categorized into shallow seas. Even though it is in the shallow category, disaster mitigation efforts from an architectural and environmental standpoint must still be carried out, because the South Bali region, Semawang Beach is no exception, is included in an area that is at high risk of a tsunami disaster, according to Dwikorita Karnawati as head of the National BMKG. Therefore the potential for a tsunami in the Semawang Beach area is low-medium level with a wave height of  $\leq 3.00$  m with an estimated time of reaching land in 30-80 minutes. The following is information on the Tsunami hazard map on the South Coast of Bali.

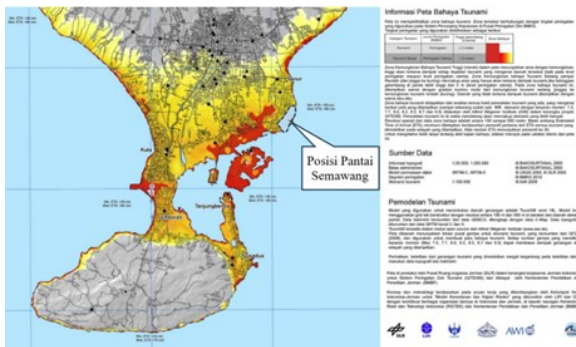


Figure 5. Tsunami Hazard Map in South Bali, 2009  
 Source: AWI

Based on the theories, namely the concept of architectural planning in the tsunami response environment, the concept of spatial planning for coastal cities, and the determinants of disaster response in spatial planning and building layout, then an existing model was created based on these three theories.

### Escape Route

On the rescue evacuation route, the average speed of people running is around 5 km/h (children, adults and the elderly). At the Semawang Beach location, there are 6 crowd points and evacuation access to go to a higher place, namely the By Pass Ngurah Rai road, which consists of:



Figure 6. Existing Evacuation Flow Simulation, 2023  
 Source: Researcher Documentation

Crowd Point 1, is on the southernmost side. To stay away from the sea area, people can go via Jalan Sanur Beach Hotel to Jalan Mertasari which takes +2 minutes in running condition. However, in a crowded situation, the time required for evacuation may take 3 times the normal time / 6 minutes from the beach to Jalan Mertasari.



Figure 7. Access Jalan Sanur Beach Hotel, 2023  
 Source: Street View on Google Earth

Crowded Point 2, located on the south side after the crowded point 1. To get away from the sea area, people can go via Jalan Cemara to Jalan Cemara which takes + 2 minutes while running / 3 times the normal time / 6 minutes from the edge the coast to Jalan Cemara in a jostling state.



Figure 8. Cemara Road access  
 Source: Street View on Google Earth

Crowded Point 3, to stay away from the sea area, people can go via Jalan Kusuma Sari to Jalan Danau Poso which takes + 1.3 minutes while

running / 3 times the normal time / 4 minutes from the beach to Jalan Danu Poso and Jalan Danau Tamblingan are in a jostling state.



**Figure 9.** Access Jalan Kusuma Sari  
 Source: Street View on Google Earth

Crowded Point 4, to stay away from the sea area, people can go via Jalan Duyung to Jalan Danau Tamblingan which takes + 1.5 minutes while running / 3 times the normal time / 4.5 minutes from the beach to Jalan Danu Tamblingan was in a state of jostling.



**Figure 10.** Duyung Access  
 Source: Street View on Google Earth

Crowd Point 5, This access is closed so it cannot be used.

Crowded Point 6, to stay away from the sea area, people can take Jalan Duyung to Jalan Danau Tamblingan which takes + 1.3 minutes while running / 3 times the normal time / 4 minutes from the beach to Jalan Danu Tamblingan in a state of jostling.

#### Protected Area

In the Semawang Beach area, there are no buffer zones or green belts in the form of retaining embankments or mangrove forests. On the site there is only open space in the form of empty land that is not used and there are only shrubs. So if a tsunami disaster occurs in the future, of course there are no obstacles that can block and slow down the speed of a tsunami from the sea to the land. The absence of a green belt is due to the fact that almost the entire coastal area of Semawang Beach is an area that has the potential to be used as a beach view for tourists.



**Figure 11.** Protected Areas, 2023  
 Source: Researcher Documentation

#### Safe Zone

For the safe zone area in the Semawang Beach area there is no TES (Temporary Evacuation Site) Tsunami available. And the area is classified as unsafe to protect against the threat of a tsunami disaster because the topography of the area's land is relatively equal to sea level which results in a tsunami, the area will definitely be submerged at least if hit by a tsunami as high as about 3 meters.



**Figure 12.** Section of the Coastal Area to Jalan Danau Tamblingan, 2023  
 Source: Researcher Documentation

#### Open Space and Vegetation

In terms of function, vegetation, namely trees as a shade function and providing O<sub>2</sub> which is needed by humans, is sufficient in terms of quantity and type so that it can provide shade for the area. The types of vegetation found in the area are dominated by Ketapang, Palm and Puduk trees. However, from a tsunami disaster mitigation standpoint, the function and placement of these vegetation is not yet optimal to counteract the threat of a tsunami entering the mainland.



**Figure 13.** Vegetation Laying Zoning in the Semawang Beach Area, 2023

Source: Researcher Documentation

### *Public Facilities in Existing Disaster Response Settlements*

Public facilities in the area are complete, such as public toilets along the coast, schools, places of worship (temples), pharmacies and other public facilities. However, related to tsunami mitigation, there is no plan yet either in the form of a Tsunami TES or an empty land where helicopters land (helipad).

#### 4. Conclusions

Based on the findings presented in the results and discussion chapter, the following conclusions can be drawn:

The existing escape route model, there are 6 accesses away from the mainland which takes about 6-10 minutes from the coast to the road after the coast.

The model of the existing protected area, there is no buffer zone or green belt either in the form of retaining embankments or mangrove forests. On the site there is only open space in the form of empty land that is not used and there are only shrubs.

The existing safe zone model, no Tsunami TES (Temporary Evacuation Site) available. And the area is classified as unsafe to protect against the threat of a tsunami disaster because the topography of the area's land is relatively equal to sea level which results in a tsunami, the area will definitely be submerged at least if hit by a tsunami as high as about 3 meters.

The open space and vegetation model, the types of vegetation found in the area are dominated by Ketapang, Palm and Puduk trees. However, from a tsunami disaster mitigation standpoint, the function and placement of these vegetation is not yet optimal to counteract the threat of a tsunami entering the land area.

The model of public facilities in disaster response settlements, related to the mitigation of the tsunami plan, does not yet exist either in the form of TES Tsunami or vacant land where helicopters land (helipad).

#### References

- Afrizal. (2014). *Metode Penelitian Kualitatif*. Jakarta: Rajawali Pers.
- Almalki, S. (2016). Integrating Qualitative and Qualitative Data in Mixed Methods Research-Challenges and Benefits. *Jpurnal of Education and Learning* Vol. 5 No. 3, 288-296.
- Aqli, W. M. (2019). Permeabilitas Kawasan Jalan Mh. Thamrin Terhadap Akses Pejalan kaki Menuju Stasiun MRT Bundaran HI Jakarta. 75-84.
- Bali, D. P. (2020, Desember Selasa, 15). Dinas Pariwisata Provinsi Bali. Retrieved from Bali Government Tourism Office: <https://disparda.baliprov.go.id/bali-raih-predikat-destinasi-wisata-dunia-terfavorit-di-pvk-award-2020/2020/12/>
- Bali, T. (2020, 2 21). Retrieved from <https://bali.tribunnews.com/2020/02/21/dekat-dengan-lempeng-megathust-pesisir-sanur-kuta-rawan-tsunami-bpbd-denpasar-gencarkan-simulasi>
- Bernardo, F. &. (2005). Place Change and Identity Processes. *Medio Ambiente y Comportamiento Humano*, 71-87.
- Breakwell, G. M. (1986). *Coping with Threatened Identities*. London: Methuen.
- Chapman, E. H. (1962). The Image Of The City. *Journal of Aesthetics and Art Criticism*.
- Darmawan, I. G. (2018). Faktor-Faktor Pengaruh Perubahan Penggunaan Lahan Ulayat Akibat Reklamasi di Pulau Serangan. *Undagi*, 6, 37-44.
- Edyanto, C. H. (2011). Analisa Kebijakan Penataan Ruang Untuk Kawasan Rawan Tsunami di Wilayah Pesisir. *Jurnal Teknologi Lingkungan Deputi Bidang Pengembangan Kekayaan Alam*, 10.
- Hasanah, N. (2018, Desember 24). Rentetan Bencana Alam di Indonesia Sepanjang 2018. Retrieved from <https://nasional.okezone.com/read/2018/12/24/337/1995339/rentetan-bencana-alam-di-indonesia-sepanjang-2018>: <https://nasional.okezone.com/read/2018/12/24/337/1995339/rentetan-bencana-alam-di-indonesia-sepanjang-2018>
- Hilal, A. H. (2013). Using NVIVO for Data Analysis in Qualitative Research. *International Interdisciplinary Journal of Education*, 181-186.
- I Gede Surya Darmawan, P. H. (2021). *Integrasi Model Place Identity Tanggap Bencana Tsunami di Kawasan Pantai Mertasari Sanur, Denpasar, Bali*. Denpasar: Lembaga Penelitian Universitas Warmadewa.
- Kompas. (2017, 4 14). Retrieved from <https://travel.kompas.com>: <https://travel.kompas.com/read/2017/04/14/200540027/bali.dinobatkan.sebagai.destinasi.wisata.terbaik.d.i.dunia>
- Lalli, M. (1992). Urban-Related Identity : Theory, Measurement, and Empirical Findings. *Journal of Environmental Psychology*, 285-303.
- R.B. Ruback, J. P. (2008). Evaluations of a Sacred Place : Role and Religious Belief at the Maqh Mela. *Journal of Environmental Psychology*, 397-414.
- Sugiharta, G. (2013). Identifikasi Objek Wisata yang Terdapat di Pantai Sanur. Singaraja: Jurusan Pendidikan Sejarah, Universitas Pendidikan Ganesha.
- Sukawi. (2008). Menuju Kota Tanggap Bencana (Penataan Lingkungan Permukiman Untuk Mengurangi Resiko Bencana. Semarang: Jurusan Arsitektur Fakultas Teknik UNDIP.
- Sutarja, I. N. (2015). Rencana Tempat Evakuasi

Sementara (TES) Pada Kawasan Rawan Bencana  
Tsunami Provinsi Bali. Denpasar: Universitas  
Udayana.