

Livable DIAPHRAGM Space

A Tsunami-Related Life History of Survivors in Banda Aceh, Indonesia



AMPHIBIOUS SETTLEMENTS
MAIN MASS
COMMUNITY RESIDENCE
(SOCIAL COHESION)

SECONDARY BUILDING
PUBLIC TOILET
EMERGENCY SHELTER

SECONDARY BUILDING
ENERGY & WATER TREATMENT SHELTER
EMERGENCY SHELTER

AQUACULTURE
FISH HARVESTING
AQUAPONICS SYSTEM

SECONDARY BUILDING
ECONOMIC GENERATORS SYSTEM
FOOD PRODUCING SHELTER
EMERGENCY SHELTER

WATER BREAKER BARRIER SYSTEM
DYNAMIC MOVING STRUCTURE

2021 JACQUES ROUGERIE FOUNDATION AWARDS

Award's category: Grand Prix Award Architecture and Innovation related to the Sea Level Rise

Project's Name

Description

LIVABLE DIAPHRAGM SPACE

Diaphragm House is one innovative prototype of communal living that provides long and short-term shelter for natural disaster

BACKGROUND

Banda Aceh is situated in a complex ocean system due to the conjunctures of three open seas, i.e., the Indian Ocean, Andaman Sea, and Malacca Strait. Almost 14 years have passed since the 2004 Indian Ocean tsunami. According to IPCC and recorded data of TOPEX Poseidon, there is a 7 mm/year of sea-level rise (SLR) rate taking place between 1992 to 2015. Banda Aceh has been predicted that the impact of SLR will be drawn 2.97% produced more frequent coastal floods and disturb the city drainage systems in 2067

EXISTING

Post-Tsunami Sustainable Livablehoods Programme for the Coastal Communities of Banda Aceh



BANDA ACEH



The Banda Aceh survivors interviewed for this tsunami case

Mrs. Saudah; who lost 2 of her 6 children, refused to move from the coastal area. She believes that one day, her daughter and her youngest son will come back home, **ALIVE**; 'If it's our time, wherever we go, we will still be gone'.

"We are the victims. We lack mentality, wealth, family, and siblings; we are **OUT OF BREATH**. In the end, we decided to come back to our **HOMES**, restore them with the memories within, while waiting for **THEM** to come back."

Source : www.bbc.com



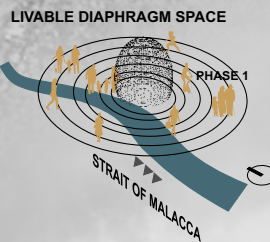
2004 Indian Ocean Earthquake and Tsunami

BANDA ACEH DATA



SITE MEURAXA, ULEE LHEUE PHASE 1

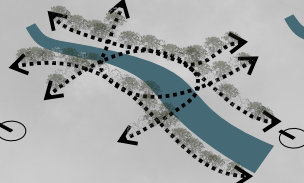
PHASE 2



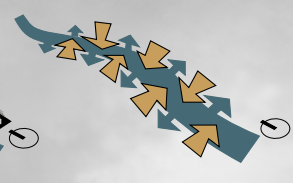
TOLERANT AND INCLUSIVE



RESPONSIBLE, SAFETY AND FUNCTIONAL

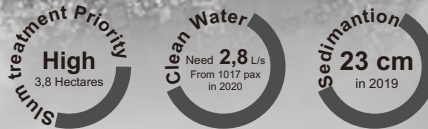


BARRIER MITIGATION, INTEGRATED AND ACTIVE



LIVING SPACE PROGRAMME

EXISTING DATA ULEE LHEUE



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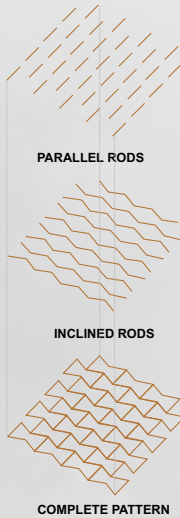
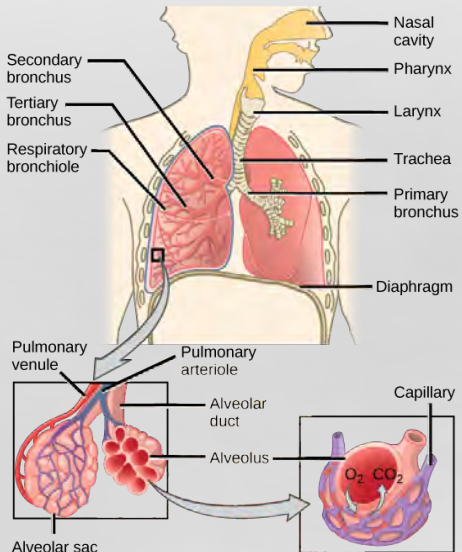
ISSUES & PROBLEMS

- The population growth in Banda Aceh City is 1.84% per year with population density is 4.154 people /Km²
- Most of the living place is located on the coastal area, which is vulnerable to tsunami threat and tidal flood
- Living space Program overlaps, unsustainable, and there is even the possibility of a blank spot if there is no program coordination and synergy
- Lack of understanding of coastal hazards among new residents (migrants)
- Not all coastal areas have disaster protection and evacuation facilities

POTENCIES

- The area with moderately identical geographical characteristics
- Strong social cohesion among the community
- People had known the right procedure of tsunami disaster mitigation, so they are not afraid anymore to live in settlement and housing located in the red zone (prone area)

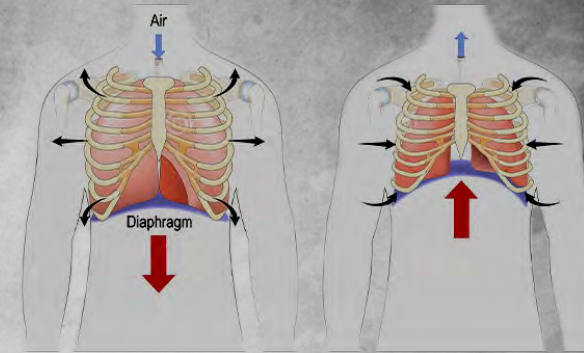
IMPLEMENTATION



CONCEPT LIVABLE DIAPHRAGM SPACE

The purpose of the project is to Reclaimed habitats for native and neighbouring settlements to maintain sustainability in a disaster-prone area. According to the IPCC, 3% mainland of Banda Aceh will be drowned. Located in the coastal area, **The concept of building interpreting biomemetic aspect of the human Diaphragm principles in design projects.** The diaphragm is one of the major respiratory muscles, and its function is vital for proper respiration with flows characterize structures of alveoli. The diaphragm also controls the postural stability, defecation, micturition, and parturition by modulating intra-abdominal pressure. Furthermore, its function is associated with metabolic balance. Biomimetic approach to building design using a diaphragm structural with an auxetic design element that transmits lateral loads to the vertical resisting elements of a structure. This structure is built to respond to various environmental problems of the country. The most common lateral loads to be resisted are those resulting from wind and earthquake actions, but other lateral loads such as lateral earth pressure or hydrostatic pressure can also be resisted by diaphragm action. It guarantees safety, comfort, and durability with climate changes. However, this building can be deployed in other coastal areas with similar environmental characteristics.

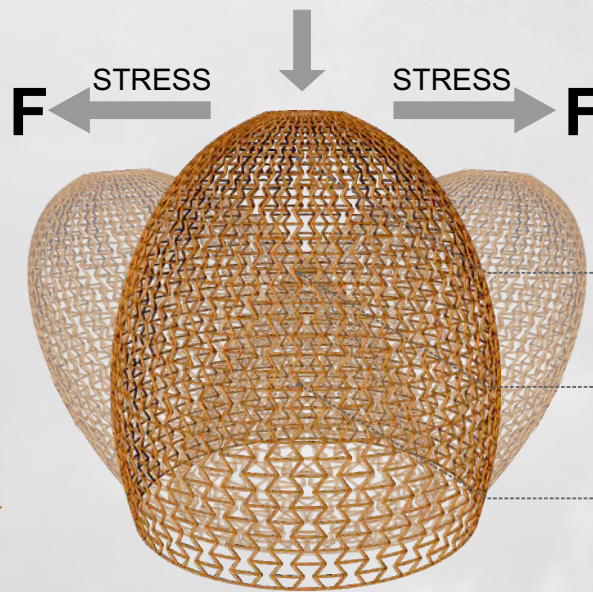
HUMAN DIAPHRAGM PRINCIPLES



BUILDING DESIGN CONCEPT | AUXETIC DESIGN

Auxetics are metamaterial structures with negative Poisson's ratio which enables sensor's flexible diaphragm to be expanded in both longitudinal and transverse directions easily.

INSPIRED BY STRUCTURE OF ALVEOLI

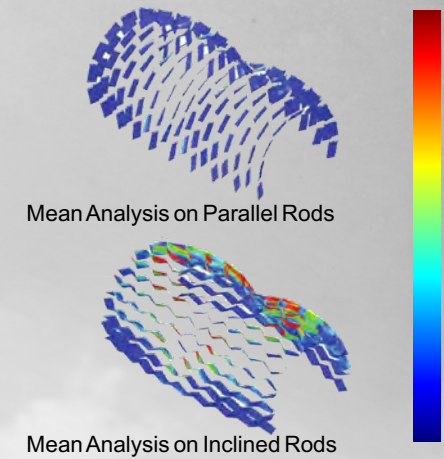
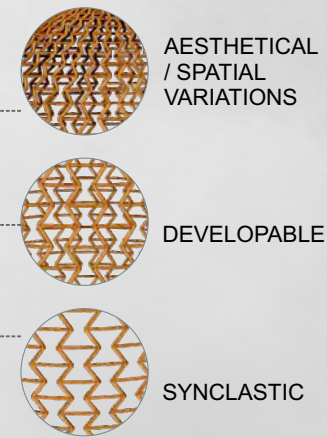


Source : Mirante, Lorenzo. 2015. *Auxetic Structure*.

BENDING-ACTIVE TENSILE HYBRID STRUCTURE



Bending analysis with Kangaroo for Grasshopper



STRATEGY DEVELOPMENT



The development of a new settlement (Diaphragm Housing) in Meuraxa, Banda Aceh City considers the aspect of urban land use which is natural disaster-friendly. Land use plan is determining the structure of the land which comprise various land use plan, the aspects of environmental preservation among other is the physical condition of disaster prone-area, this land-use plan must be in the long term.

PERSPECTIVE



Diaphragm House is one innovative prototype of communal living that provides long and short-term shelter for natural disaster



A local food system is a aquaponic collaborative network that integrates sustainable food production

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DESIGN DATA:

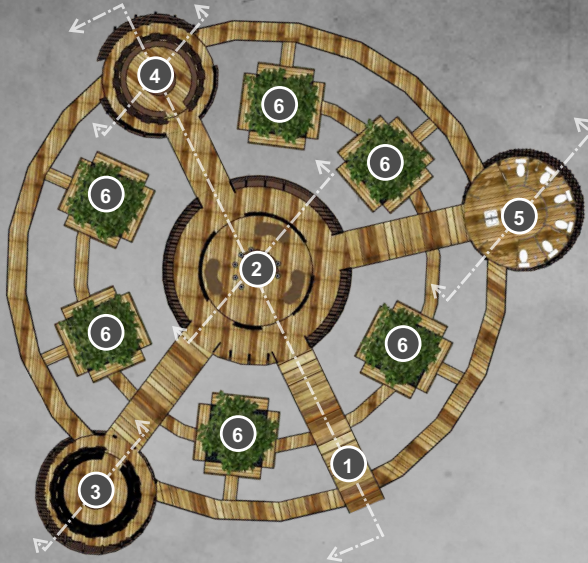
- Site Area 997 m²
- 1 Main Building
- 3 Secondary Building



LIVABLE DIAPHRAGM SPACE

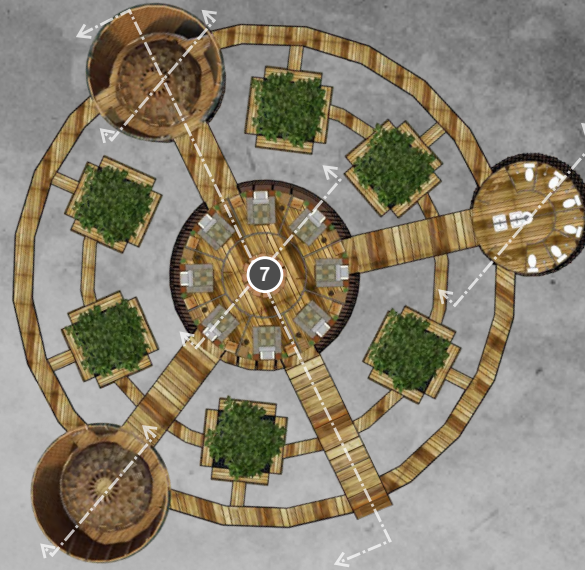
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FLOOR PLAN

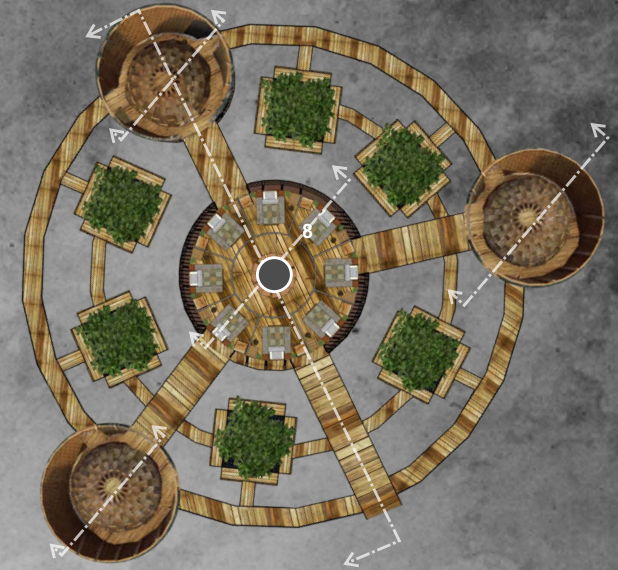


LEGEND

- 1. Main Entrance
- 2. Communal Space
- 3. Food Producing
- 4. Energy & Water Treatment
- 5. Public Toilet
- 6. Fish Harvesting



- ## LEGEND
- 7. Residential Area



- ## LEGEND
- 8. Residential Area



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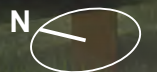
SECTION AND IMPLEMENTATION

Fishes and Plants cultivation are based on Banda Aceh climate and its local commodity

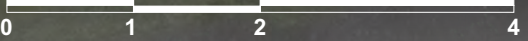
- Hydroponic System
- Aquaponic System



FISH CAGE SECTION



SECTION A



In order to maintain the building structure during the disaster by using materials with high flexibility can decrease the disaster impact. Therefore, the use of wood as the main material is one of the disaster mitigation which can withstand high loads for short period. Besides, it also retains its elasticity and ultimate strength which can be an asset in seismic and high-wind zones, leads to a higher surviving evacuation.

-  Barrel
-  Cocomesh
-  Wood Decking
-  Wood Planks
-  Anti-corrosion Coating Finished Steel
-  Membrane
-  Water
-  Auxetic Structure
-  Steel Pipe Anti Corrosions Coating Finish

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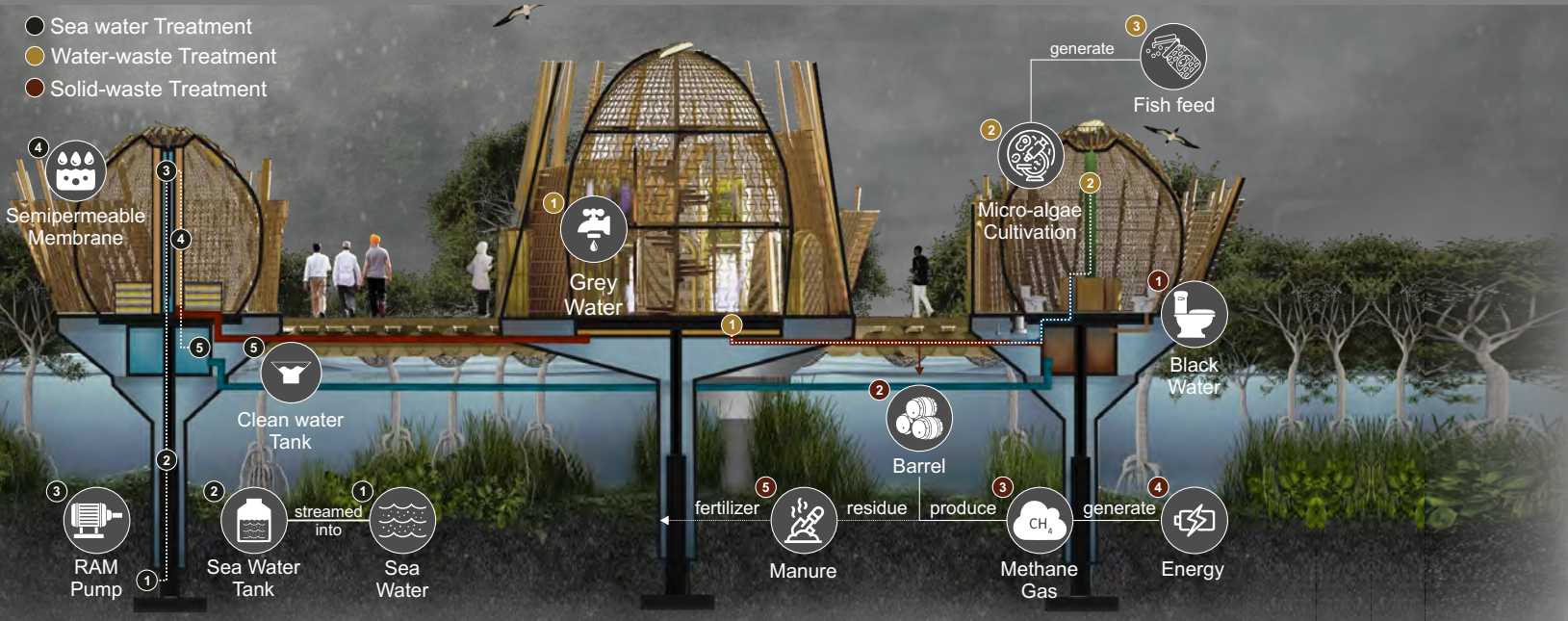
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SECTION AND IMPLEMENTATION

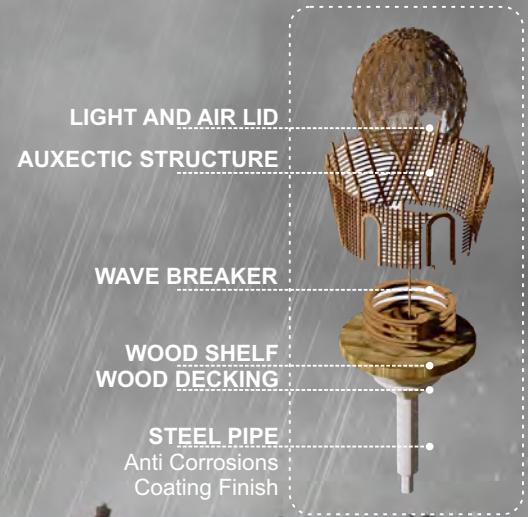
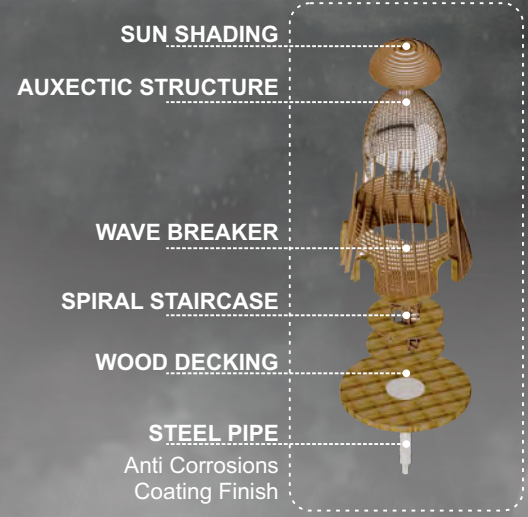
- Sea water Treatment
- Water-waste Treatment
- Solid-waste Treatment



SECTION B



Ecosystem-based adaptation sea level rise with an auxetic design provides a combination of protecting and advancing strategies based on the ecosystem conservation and restoration, such as evacuation-based building and coastal agriculture (wetland purification) to fulfill the human basic need. Accommodation includes a diverse set of biophysical and institutional responses to reduce the vulnerability of coastal residents, human activities, ecosystems, and the built environment.



As a consequence of natural and anthropogenic changes in the climate system, sea-level changes are occurring on temporal and spatial scales that threaten coastal communities. While the occurrence of these incidents cannot be precisely predicted, their impacts are well understood and can be managed effectively through a comprehensive program of hazard mitigation planning. **LIVABLE DIAPHRAGM SPACE** with an auxetic design infrastructure considers protection from identified multi-hazard events, to maintain post-event operability or rapid restoration based on facility functions and requirements.

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