COMPREHENDING THE INDIAN OCEAN TSUNAMI

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Shreyas Vernekar
Vivek Kant

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"Hazards are natural, disasters are not" - Terry Canon

The book revisits the 2004 Indian Ocean Tsunami and its aftermath from the viewpoint of resilience and vulnerability. Vulnerability is a multi-faceted concept that lies at the intersection of diversity of risks and their actualization in everyday lived experience. Vulnerability is not the property of people but it is a relational outcome of complex relationships between people and their ecologies in the face of hazards. Understanding disasters such as these from the viewpoint of vulnerability presents real insights into realizing how the disaster is an outcome of multiple interweaving processes at several layers of abstraction. These range from local and global processes related to the social, economic and cultural abilities and coping mechanisms of communities in transition. In this book we emphasize the adaptibility, capacity, vulnerability and resilience in the wake of disasters.

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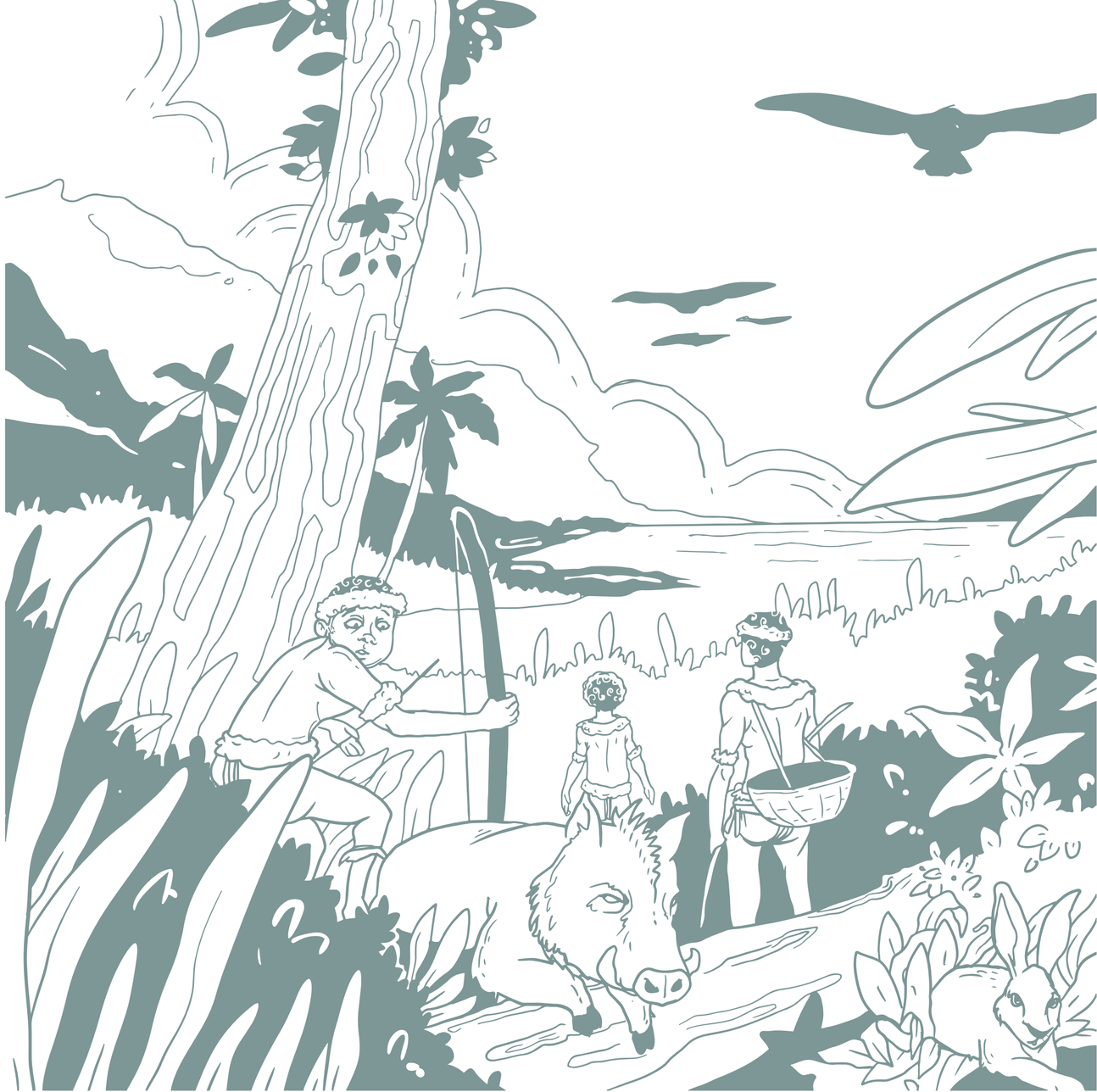


Introduction

Amidst the lush and dense forests of the Andaman and Nicobar islands, a group of Jarawa hunters embarked on a vital mission. Their goal was to secure food for their tribe in their traditional way of life, passed down from generations of skilled and proud warriors. Jarawas are among the many indigenous tribes that call this archipelago their home.

As the hunters made their way through the jungle, the rustling of leaves caught their attention. With stealth and precision, they readied their weapons, ready to take down any unsuspecting prey that crossed their path. The hunters held their breath, waiting for the perfect moment to strike. However, their hopes were quickly dashed as a wild boar burst from the undergrowth and fled the scene. Despite their disappointment, the elders of the tribe were not discouraged. They collected their weapons and set off in search of another opportunity. It was then that they noticed something unsettling. The animals around them ran away from the sea or climbed up into the trees. The elders' hearts raced as they realised that something was amiss. The once peaceful jungle was filled with unease they had never experienced before.

Fate had another unlucky chapter waiting for Jarawas as the seabed rumbled somewhere on the west coast of Sumatra...

On December 26, 2004, the world was forever changed by a massive undersea earthquake that struck off the coast of northern Sumatra in Indonesia. Dubbed the Indian Ocean Tsunami, Boxing Day Tsunami, or the Sumatra-Andaman earthquake, this event was one of the deadliest natural disasters in modern history. With a magnitude ranging from 9.1 to 9.3, the earthquake was caused by a rupture along the fault line between the Burma Plate and the Indian Plate. The seismic waves it generated were felt across several countries in the region, including India, Bangladesh, Myanmar, Sri Lanka, Malaysia, Thailand, and the Maldives. However, it was the resulting tsunami that brought the most destruction. The intensified waves crashed along the coasts of the Indian Ocean with devastating force. The aftermath of the Indian Ocean Tsunami was a scene of utter chaos and heartbreak, with communities hurt and countless lives lost [1].

> "[...] vulnerability seen as an internal risk factor must be related not only to exposure of the material context or to the physical susceptibility of the exposed elements, but also to the social frailties and lack of resilience of the prone communities. This means looking into the capacity to respond to or absorb the impact. Deficient information, communications and knowledge among social actors; the absence of institutional and community organization; weaknesses in emergency preparedness; political instability; and the absence of economic health in a geographic area, all contribute to greater risk. This is why the potential consequences are not only related to the impact of the event but also to the capacity to withstand the impact and their implications in the considered area."
>
> - Omar Cardona [2]

When a disaster strikes, it's not uncommon for certain communities to be hit harder than others. Vulnerability is a social concept and these communities are impacted by various socioeconomic and demographic factors such as poverty, age, race, and education level. Unfortunately, these communities are less likely to recover quickly and may endure long-term consequences due to the disaster. In the aftermath of the devastating tsunami that struck the Andaman and Nicobar islands, the world was left in suspense about the fate of the rare tribes that inhabit the archipelago. With communication systems down and telephones not working, it was impossible to reach the isolated islands and check on the well-being of the Jarawas, Onges, and Sentenalese tribes. The concern for the survival of these six indigenous communities only heightened as news of the catastrophic event spread. Questions loomed about whether these precious cultures, deeply rooted in the island's history, would withstand the force of the killer wave.

While this book tries to bring about the themes of vulnerability and resilience of the inhabitants of the Andaman and Nicobar Islands, other actors such as the Indian Defence personnel also play a major role in the Islands. The Andaman and Nicobar Islands are strategically located at the crossroads of the Malacca Straits and Ten Degree Channel, through which trillions of dollars' worth of trade flows between Southeast and North Asia. These islands play a crucial role in the Indo-Pacific region, being only 237 kilometers from Banda Aceh in Indonesia and overseeing the sea lanes to the Sunda and Lombok Straits, the two primary entry points into the disputed South China Sea. [3]

Historically the islands have remained strategically important in this Indian Ocean region. During India's colonial past these Islands were used as a Jail to imprison the political leaders of country and separate them from mainland India. This cellular jail was known as Kala Pani (Black water) and was used for exiling political prisoners of the British colonial government in India. A number of Independence activist such as Mahatma Gandhi, Jawaharlal Nehru and Vinayak Savarkar, amongst many others who fought for the country. Currently these islands are the stronghold for Indian defence to maintain their strategic position in the Indian Ocean region.

The Indian defense system was dealt a serious blow by the Tsunami, with a significant portion of their defensive capabilities being compromised. The extensive damage to the runway at the Car Nicobar Airforce base has left only 6000 ft of the original 9000 ft intact, and the air traffic control unit was also badly affected. The psychological toll on the 1700 personnel who witnessed the loss of 106 fellow airmen and family members was taxing [3]. The surviving families of all the 250 officers and airmen stationed there were being shifted to Tambaram air force base near Chennai. Post tsunami, the Indian government had declared that the Car Nicobar Airforce base to be a non-family station to reduce loss of lives of families of defense personnels. [4]

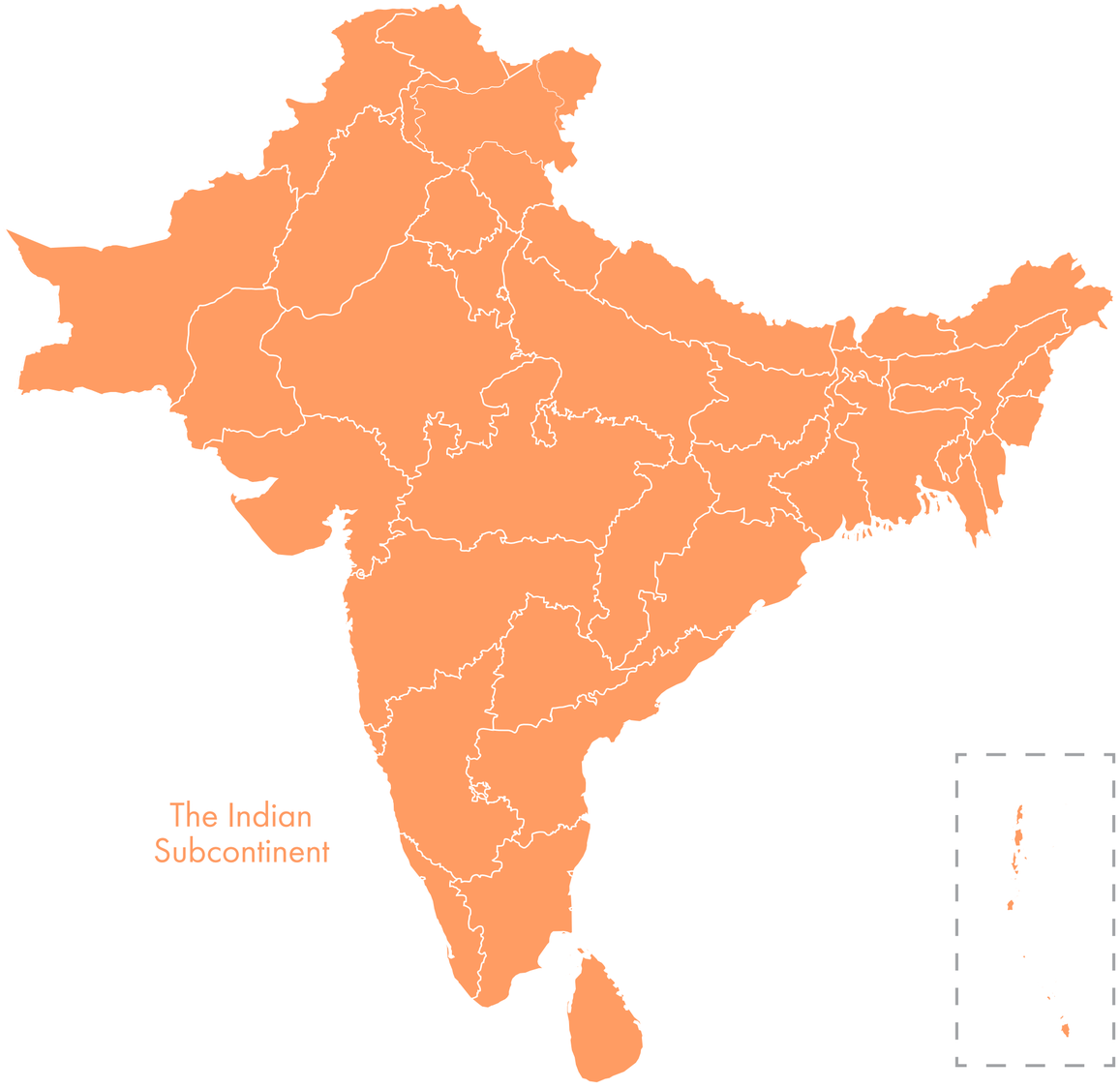
In order to understand the interplay of vulnerability and resilience involved in the 2004 Tsunami the rest of the book is divided into a few chapters which highlight the background and worldview of the island communities. It describes the cause of the tsunami, the challenges of early warning and the aftermath of the disaster. The book analyzes the disaster from an analytical viewpoint of the Pressure and Release (PAR) model. Finally it concludes with a hopeful note of learning from the disaster, enhancing resilience and sustaining livelihoods.

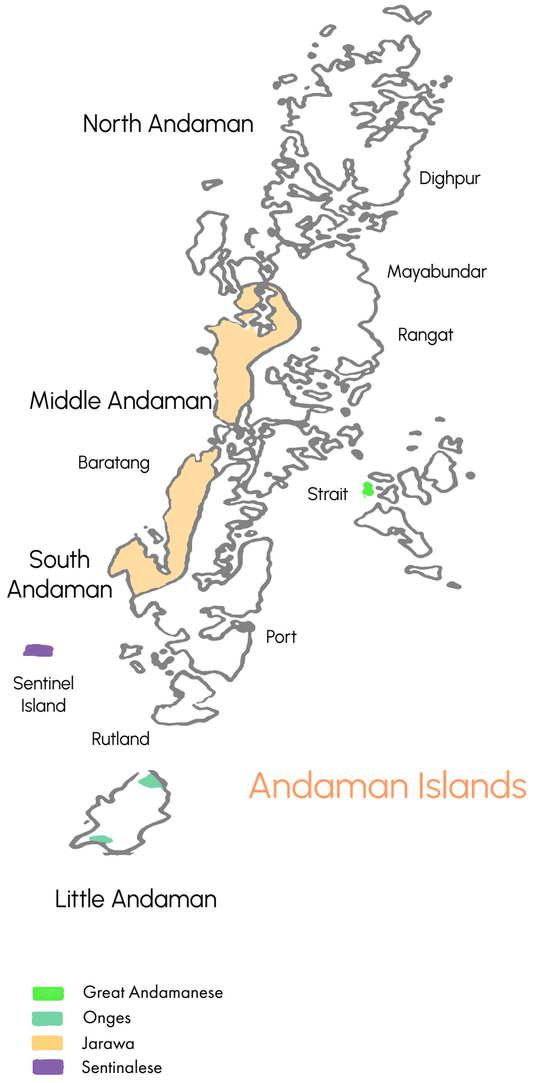
Ways of life of the Tribal communities

"Pygmalion point is the real southern tip of India. You can feel the nation behind you"
—Usha Deshpande, Director of movie "Song of silence", based on aboriginal tribes of Andaman and Nicobar Islands. [3]

PL Purohit (2005, Jan 1) recalls an incident when his friend Officer P Brown in 1955 wanted to take him for a drive around the island in his Jeep. He points towards the trees surrounding the Jarawa houses, "The coconut palms and bananas you see around belong to the community. Naturally, money is of little use to them, and hence there are no thefts either." Much further, we came across a group of Jarawas. P Brown remarked, pointing at one of the Jarawa women, "You know these lasses can walk away with any boy they like. Their children are looked after by the entire community If the girl decides to leave her own mate and move in with someone else. She is free to do so, but her new mate has to pay a penalty of one pig to the village." Six years later, things were shocking when PL Purohit returned to the islands. Simple folk were civilized. The coconuts had to be bought. [..] and there were occasional cases of thefts as well. [5]

The Islands are home to a diverse group of indigenous tribes, each with its unique history and way of life. These tribes include Jarawas from South Andaman and Middle Andaman, Great Andmanese from the Strait Island, Shompens from the Nicobar Island, Onges from the Little Andaman and Sentinalese from North Sentinel Island. The five major tribes of the islands are of immense anthropological importance, and their potential extinction is a cause for great concern among scientists and researchers. In the aftermath of the Tsunami, some have even suggested collecting genetic samples to revive the tribes through cloning, should human cloning ever become legal. "Their loss, if confirmed, would be an immense anthropological disaster." [6]





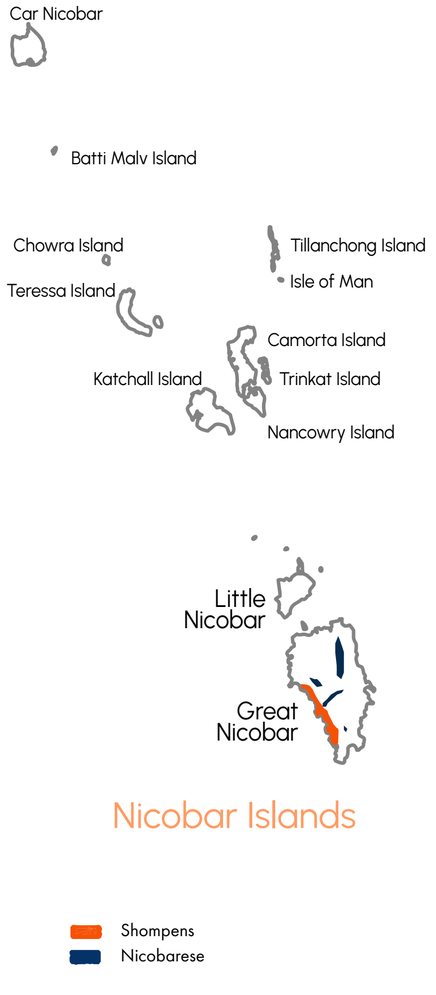


Figure i: Location of aboriginal tribes of the Andaman and Nicobar Islands

Due to their remote existance and secluded lifestyle, the island tribes have acquired a notoriety. As early as 672 AD, the Andaman and Nicobar islands had been referenced in the writings of Tsing, a Chinese traveler who journeyed the Indian seas. He referred to the islands as "Andaban" and depicted its inhabitants as "Cannibals." In 870 AD, two Arab travelers documented their visit to these islands, painting a picture of a cruel and savage people who ate anyone not of their own race. Centuries later, Niccolò de' Conti, an Italian merchant who was involved in creating sea maps, visited the Andamans in 1414-1439 and recorded the chilling tales of the islands' inhabitants tearing strangers apart and devouring them. These frightening legends persisted until 1625, but with the advent of British East India Company's interest in developing the islands, the world finally gained insight into the people of Andaman and their ethnological details. [7]

Among the most prominent of these tribes is the Great Andamanese, once the largest of the tribes but decimated by infectious diseases by British colonists in the 1860s. The Great Andamanese people belong to the Negrito race and are known for their dark complexion and peppercorn hair. Despite their short stature, with an average height for men being 4 feet 9 inches and for women 4 feet 5 inches, the Great Andamanese have well-built bodies. The Nicobarese are a Mongoloid ethnic group, with a complexion ranging from yellowish to reddish brown. They are sturdy and well-built, with the average height for men being 5ft 4in and for women being 5ft. Their Mongoloid features suggest that they may have originated from Burma, Sumatra, or Indo-China. [8]

The Onges, semi-nomadic hunters and gatherers living on Little Andaman, and the Jarawas, a traditionally hostile tribe, who have recently begun interacting with outsiders, on the western coast of middle and south Andaman. The Sentinelese, a fiercely isolated community living on North Sentinel Island, are known for their hostility towards outsiders. Lastly, the Shompens, a semi-nomadic tribe of hunters and fisherfolk scattered across Great Nicobar Island, are considered the only primitive Mongolian tribe in the archipelago. Each of these tribes holds a unique place in the cultural tapestry of the Andaman and Nicobar Islands, and their stories are woven together to create a rich and natural history

Sourav Sanyal recalls his first encounter with the Jarawa tribes. He distinctly remembers his conversation with his driver, "Don't you know that you have to pass through Jarawa reserves? They are very fond of red, they might just tear off your T-shirt", irrespective of the warnings they proceed. After 100 meters, the driver stops, pointing at a group of people; it was a Group of Jarawas in the middle of the road sporting red headgear, armbands and waistbands. It was a group of 6 boys between 6-15 years old. They asked permission to get in the auto, and before permission was given, they were inside it. "Bikkut hai? Paan hai?" asked the Jaarawa boys for biscuits or paan. Avoiding any reply, Sourav asked where they were coming from. The Jarawa boys revealed around ten fish in a homemade basket. They asked, "Macchi pakda, dekho chahiye?"

After dropping them off at the village. They moved ahead, where they had a second encounter with the Jarawas. Around 23 Jarawas with wooden bows and metal arrows. Their arrows were blood-stained. Noticing the tense proceedings, a middle-aged Jarawas says, "Hum suvar mara. Teen suvar"(We killer boars, Three boars) [9]

Amongst these various tribes, the Jarawas were earlier hostile towards any outsider interactions. With the development of the Andaman Trunk Road in the 1970s the Jarawas were rapidly brought into proximity of the outsiders. This has, over the years, changed the dynamics of the tribe and its interaction with the outside world and warrants further attention.

Encounters between mainlanders and the Jarawa community were not uncommon. These interactions often carried a sense of unease and apprehension due to the limited contact and unfamiliarity between the two groups. The Jarawas, who had lived in isolation for thousands of years, were cautious of outsiders, while mainlanders were captivated by the unique culture and way of life of the indigenous tribe.

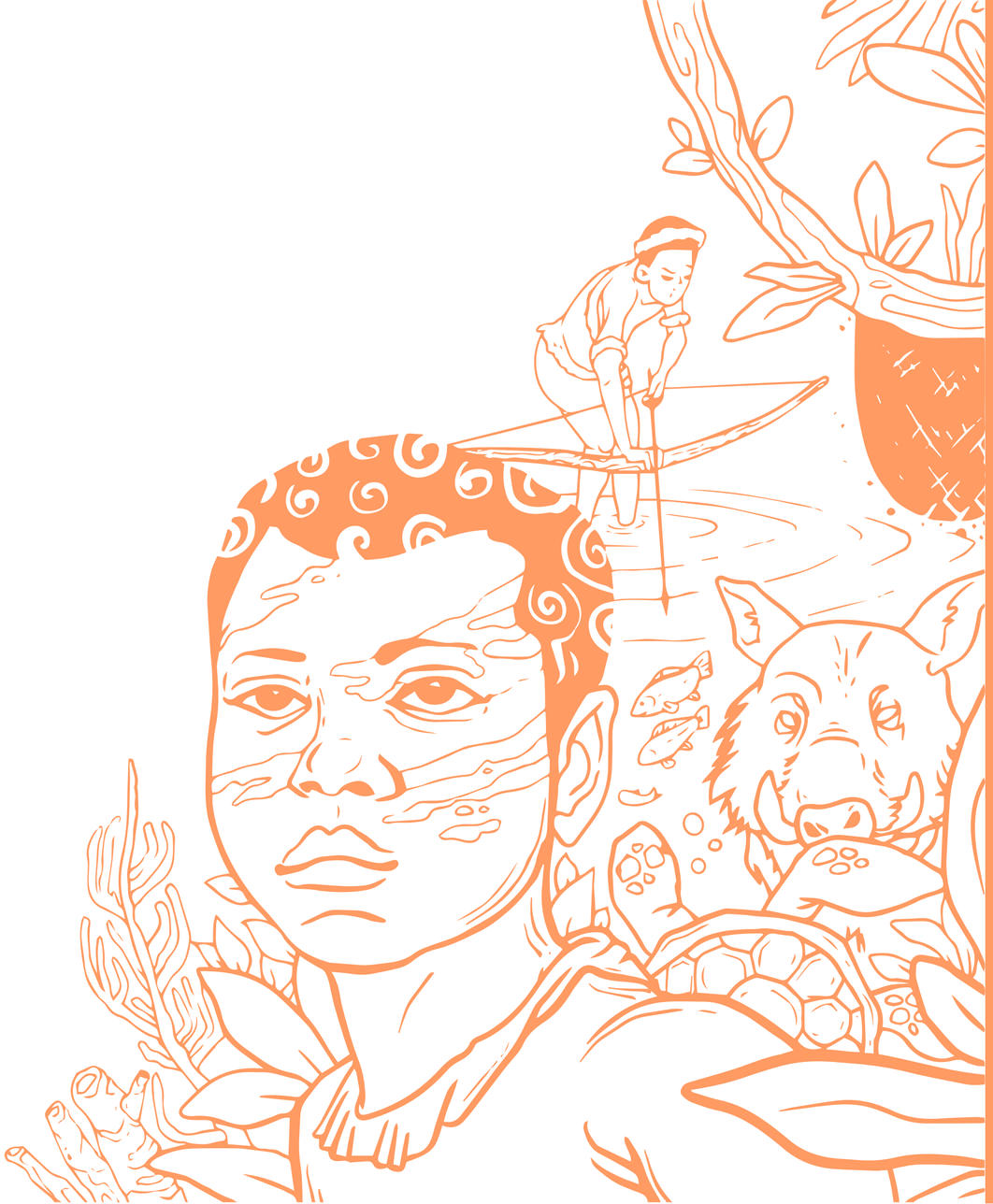
The term Jarawa bears the meaning 'Stranger' or 'unknown person' and they are semi-nomadic food gatherers and hunters still living in stone age situation. Like other Negrito tribes of the Andamans, Jarawas also have short stature, black complexion and curly spring—like hairs. Presently, only about 250–300 individuals of Jarawas exist and they are endogmous people having closely knit society. They inhabit Reserve forests of west coast of middle and south Andamans.

-Shareif and Panda (2017, p.1863) [7]

The Jarawas reside in a large forested area stretching from South Andaman to the Southern part of Middle Andaman, spanning roughly 647 square km. This region has been designated as the "Jarawa Reserve" [7]. They hunt pigs, turtles, and fishes in the coral-fringed reefs using bows and arrows. They target various species, including striped catfish-eel and toothed ponyfish, and gather wild fruits, roots, tubers, and honey. The bows used in these activities are made of chooi wood, which is not found throughout the Jarawa's territory, requiring them to make long journeys to Baratang Island to obtain it.

Both men and women of the tribe participate in the wild honey collection. The process involves climbing tall trees and singing songs of joy while they collect the honey. To keep the bees away, the collectors chew the sap of bee-repellent plants like Ooyekwalin and spray it from their mouths. Once the bees are gone, the nest is cut and placed in a wooden bucket for transport. After consuming honey, it is customary for the Jarawa to bathe. [10] The term "Jarawas" mean "Strangers" or "unknown persons." Like other Negrito tribes of the Andamans, Jarawas also have short stature, black complexion and curly spring—hair. They are a close-knit and endogamous society. [7]

The Jarawas' diet consists primarily of sea animals and wild pigs, with the meat of wild pigs being their favourite food source due to its high levels of protein and fat. While adult males typically go hunting for pigs, the females and children are responsible for fishing, gathering food, and collecting honey. All food collected is considered the property of individual families, but the pigs and other animals caught are shared among the tribe. The females of the tribe typically prepare the food, which can be consumed raw or after being boiled, roasted, or baked.



Worldviews, beliefs and folklores

In the face of crisis and uncertainty, even the most unconventional lifestyles seek solace in the familiar. Such was the case with the islanders, including the indigenous stone-age tribes, who found comfort in their age-old folklore and religious beliefs. To the mainlanders, the tribal way of life may be exotic, but in times of trouble, they too turn to the gods and the stories that have been passed down through generations. A Nicobarese tribal recalls a folklore from his old leaders about frequent tremors. "A giant boar-like animal that was sleeping beneath the islands has been turning in his sleep. It was said to be so large that it could cause the earth to shake and the sea to rise." The Nicobarese had a legendary belief that a giant slumbered beneath their island and its restless tossing and turning caused earthquakes. They feared that if the giant ever fully awoke, it would bring about a disaster that would devastate everything in its path. To pacify the giant, the Nicobarese of old would perform a ritual involving stamping a broom on the ground. Despite their reliance on the bounties of nature, the island's indigenous people did not hesitate to call upon their gods for protection against the treacherous sea.[11]

The Onge also have a unique view of the universe, with Little Andaman at its very heart. Surrounding the island are six celestial layers inhabited by benevolent spirits, and beneath it lies another six layers, home to malevolent ones. These spirits aren't divine beings, but instead lead lives much like our own, with all the joys and struggles of existence. The "onkoboykwe", residing in the first layer above Little Andaman, are considered benevolent spirits, while the "eaka", in the layer below the island, are seen as a source of harm. Beyond the Onge universe lies an endless void, and at its very depths lies Kwatannange, the primordial sea, teeming with turtles.

The Onge believe that all non-Negrito people are the reincarnated spirits of their deceased kin. They collectively refer to them as "inene." According to their beliefs, before the soul of the deceased departs, a miniature human form called "embekete" emerges from the body and swims across the sea to the land of the inene, where it transforms into one of them. Thus, to the Onge, outsiders are seen as their former selves in a previous life. This belief in the existence of two spirits "embekete" and "eaka" within a single individual may have arisen as a way to understand the origin of non-Negritos and incorporate them into their beliefs about the universe. [12]

Among the Onges, the survivors were known to appease the gods by offering intestines of wild boar. Others smear their face with white mud, which they believe will drive away evil spirits. The ancient folklore of the Onges tribe also speaks of a "huge shaking of the ground followed by a high wall of water." Among the Great Andamanese tribe, they are known to invoke a goddess named Bligu, who they believe used to descend from the sky on a giant ladder. They saw the sun and moon as a married couple, with the stars as their children. They didn't have the same beliefs in a supreme being, an afterlife, or morality as many other cultures

The Jarawas however do not have any beliefs or practices related to supernatural powers, the soul, or any other associated concepts such as manaism, demonology, totemism, animatism, etc. Instead, they have a simple ritual of wearing the "whooea," a small bone from a deceased member of their family or band, around their neck or waist using a medium-sized, thick bark thread.It is believed that this practice helps them secure a bountiful food supply through activities like gathering, fishing, and hunting, as well as provides comfort and protection from life's dangers and uncertainties. [13]

The total area of the Andaman and Nicobar islands covers only 8,249 km² out of India's 3.287 million km². Despite its small size relative to the rest of India, the Andaman and Nicobar Islands boast a rich diversity of beliefs, worldviews, and folklore among its residents.

From Quakes to Ferocious Waves

Tsunamis are the result of movement of land plates. The surface of our planet is not a single, uninterrupted expanse of land. Instead, it comprises several large and small plates, each comprising of a massive and irregularly-shaped slab of solid rock. These plates are composed of continental and oceanic lithosphere, slowly moving against one another at an average speed of just a few inches per year. The intense pressure when these plates collide at their boundaries can cause devastating earthquakes and explosive volcanic eruptions.

On 26th December 2004, the ocean was eerily calm at 7:57 am local time, but a cataclysmic event was brewing beneath the surface. The Indian and the Burmese tectonic plates were on a collision course. At 7:58 am, near the west coast of Northern Sumatra, the Indian plate collided with the Burmese plate. The resulting earthquake was massive, with the Indian plate pushing the Burmese plate by 15 meters. The Indian plate, slowly moving at a rate of 5 cm a year, hit and slid beneath the Burma plate. This type of boundary, known as a convergent boundary, results from plate tectonics - the movement of the earth's massive irregularly shaped rock slabs. In this case, an oceanic-oceanic convergence caused the devastating earthquake.

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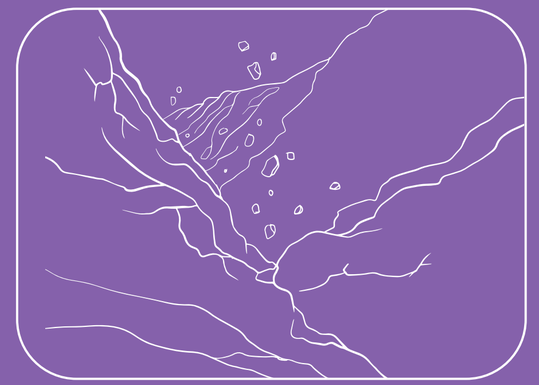


At 7:58 am, near the west coast of Northern Sumatra, the Indian plate collided with the Burmese plate, and the Indian plate was forced beneath the Burmese plate.

The resulting earthquake was massive, with the Indian plate pushing the Burmese plate by 15 meters.

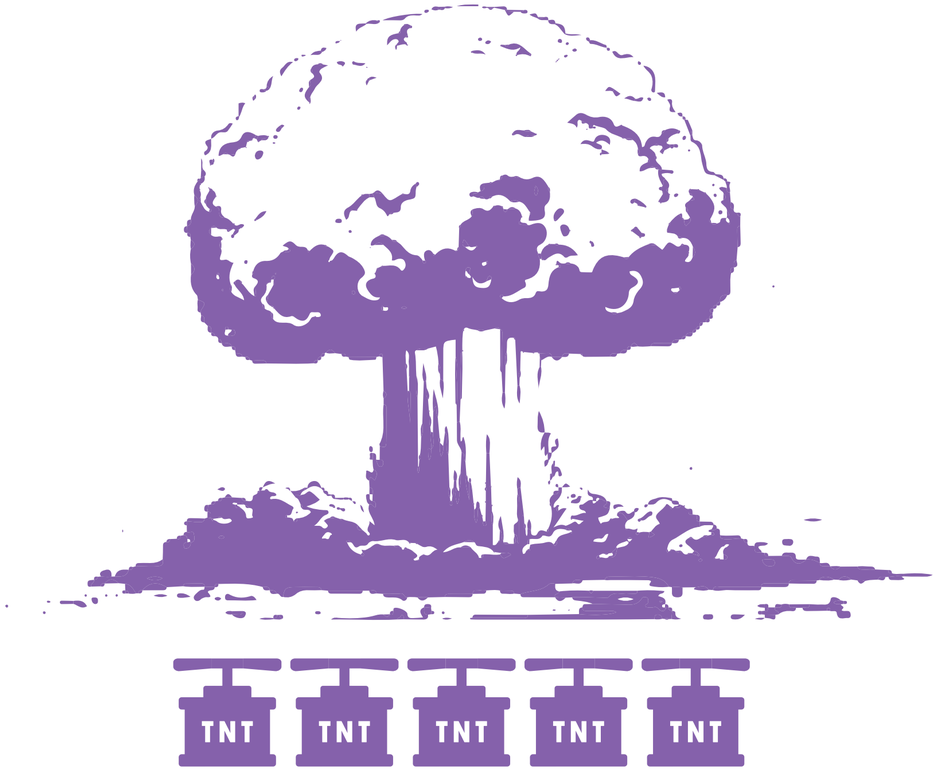
The tsunami reached as far as 2 km inland, submerging the southernmost point of India, the Indira point

The tremors that followed the main quake at the Andaman islands caused the boundary of the Burma plate to shift and fracture by 1000km. This plate, which stretches for an impressive 2000 km in length and varies in width from 700-800 km, was greatly affected by seismic activity. The earthquake occurred just 10 km deep, making it a *shallow quake*, resulting in more destruction. Shallow quakes generally tend to be more damaging than deeper quakes. Seismic waves from deep quakes have to travel farther to the surface; thus, losing energy along the way. As a result deep quakes are not as destructive as shallow earthquakes. Scientists have used the analogy of a bomb just under the city surface to show how much destruction shallow waves can cause. The energy released by this mega-thrust earthquake was equivalent to 5 Megatons of Trinitrotoluene (TNT), twice the cumulative firepower used in World War II, including the two atomic bombs.

The displacement of the Burmese plate acted as a giant piston, deforming the sea and displacing a massive amount of water. Huge waves were formed, and a monstrous tsunami was born, approaching the surface like a malicious scythe. The tsunami's greatest strength was in an east-west direction, moving swiftly and reaching heights of up to 24m before hitting the surface and sometimes up to 30m while moving inland. The tsunami reached as far as 2 km inland, submerging the southernmost point of India, the Indira point. The tsunami struck with devastating force, crumbling structures, taking lives, and injuring countless others.

The region between the Indian and Burma plates is teeming with seismic activity, as evidenced by the two major plate tectonic features on either side of a narrow strip. The Indo-Burma plate margin is a zone of compression, with the Australian plate pushing against the Indian plate in a counterclockwise rotation. This increased activity in the Northeast Indian Ocean results from a release of pent-up energy along the plate boundaries. [14]

The Mega - thrust earthquake occurred along a tectonic subduction zone where the India Plate, an oceanic plate, is being forced beneath the Burma micro-plate, which is a part of the larger Sunda plate. Located along the Equator in the Eastern Hemisphere, the Sunda Plate plays a significant role in supporting Southeast Asia.



5 Megatons of TNT equivalent energy released in the underwater shallow mega-thrust earthquake

Figure ii: Location of 2004 Indian Ocean Tsunami and surrounding tectonic plates

This minor tectonic plate is a bustling hub of seismic activity with complex and dynamic boundaries to the east, south, and west. In contrast, the northern boundary of the Sunda Plate is relatively stable and calm. Nestled in Southeast Asia, the Burma Plate is a tiny tectonic plate that forms part of the greater Eurasian Plate. The Andaman Islands, Nicobar Islands, and northwestern Sumatra are all part of this plate, which serves as an island arc separating the Andaman Sea from the Indian Ocean. The Sunda Plate lies to its east and is separated by a transformative boundary that cuts through the Andaman Sea in a north-south direction. The Australian Plate is a significant tectonic plate that occupies a vast area in the eastern and southern hemispheres. This extensive plate encompasses the entire Australian continent, along with Tasmania, and extends towards parts of New Guinea, New Zealand, and the Indian Ocean basin. The Indian Plate, a relatively small tectonic plate, lies across the equator in the Eastern Hemisphere. It encompasses a vast region of present-day South Asia, including the Indian subcontinent, along with some parts of South China and western Indonesia, as well as a section of the Indian Ocean basin. The plate extends up to, but does not include, Ladakh, Kohistan, and Balochistan.

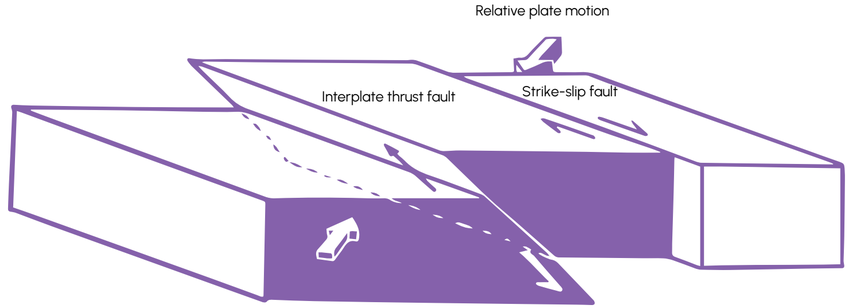


Figure iii: Decoupled: Pure Thrust and Strike-Slip faulting

The interface between the two plates results in a large fault, termed as interplate thrust or mega-thrust. Some of these plates are pushing against each other, and one is sliding underneath the other. This is called subduction. In some places, the direction that one plate is moving relative to the other is not the same as the direction of the subduction. Think of two cars that are crashing into each other, but at an angle. The movement of the two cars has to be accommodated in some way to prevent them from getting stuck. With the plates moving against each other, the movement often happens along a fault line, which is where the rocks on either side of the line move against each other. Normally, when there is movement on a fault line, the rocks on both sides of the line move together. However, in some cases, the rocks on either side of the fault line can move independently of each other. This happens when the rocks on one side of the line are different from the rocks on the other side of the line, and they have different strengths and properties. This is called "decoupled faulting".

The Sumatra subduction zone is an example of the decoupled faulting. The plates move in different directions, and this causes two different types of faults to form. One type of fault is called a thrust fault, which happens where the two plates are pushing against each other. The other type of fault is called a strike-slip fault, which happens where the plates are sliding past each other. The part of the Earth's surface called the Burma plate moved up and down in a way that caused the seafloor to rise up closer to the ocean and sink down closer to the coastline. The line where the seafloor rose up and then went back down towards the coastline is called the "hingeline". This movement caused a tsunami wave to form. The wave split into two parts and moved in opposite directions. One stronger part of the wave traveled far away, across the Bay of Bengal and even to the Atlantic and Pacific Oceans. The other relatively weaker part of the wave traveled in the opposite direction towards nearby islands and countries in the Southeast Asian region such as Indonesia and Thailand, in less than an hour. Due to the geographical location and the origin of the earthquake, the Island countries in the Indian Ocean region were significantly affected by the Tsunami. [15]

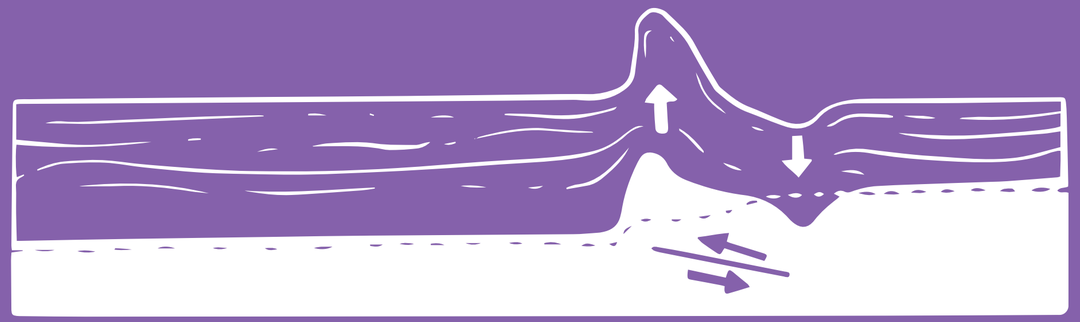


Figure iv: Tsunami generation from an inter-plate thrust fault.

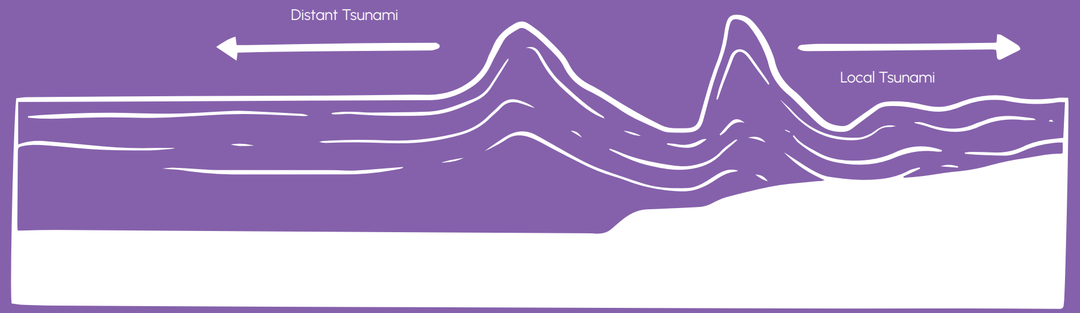


Figure v: Tsunami splitting, soon after generation.

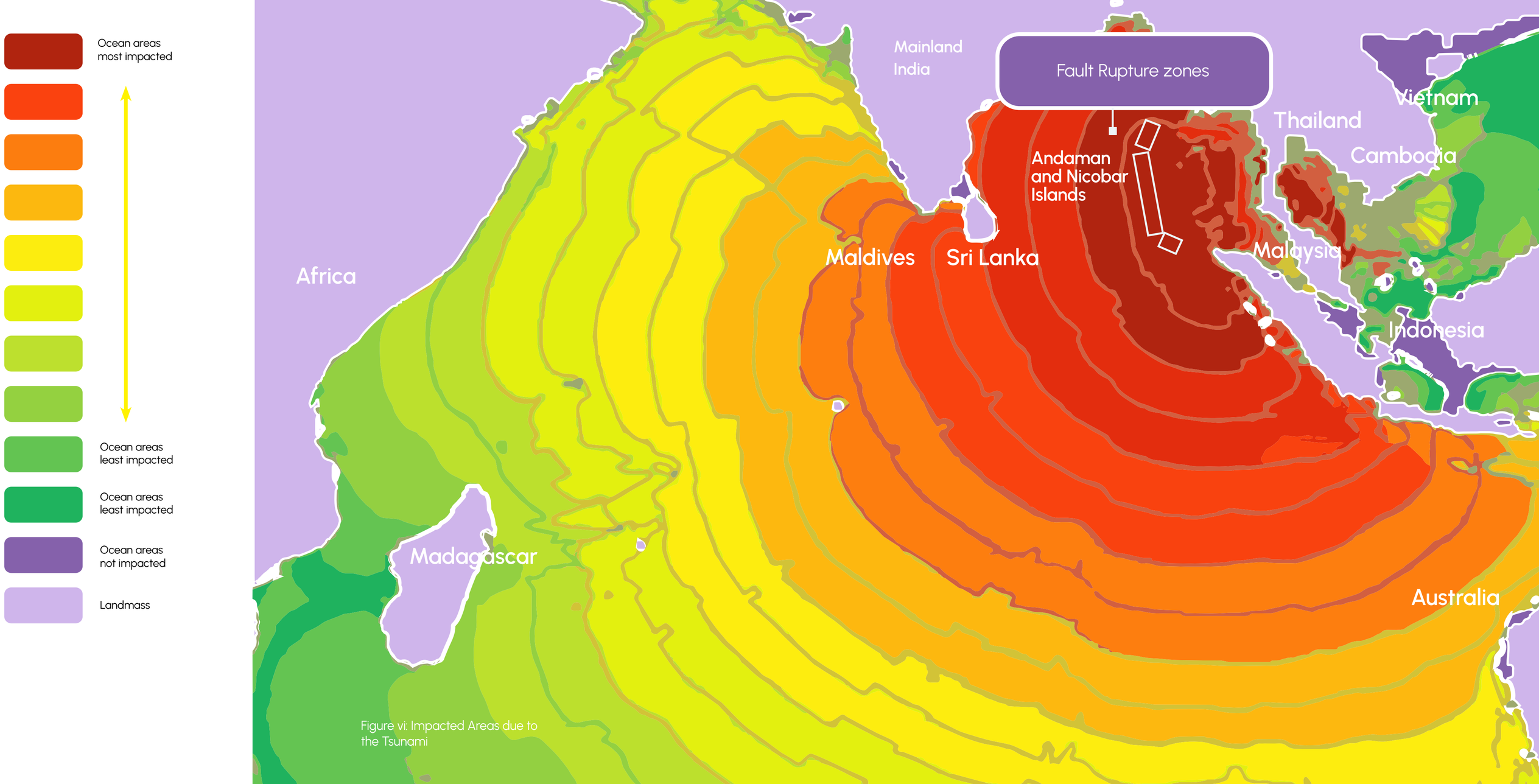


Figure vi: Impacted Areas due to the Tsunami

Adaptability: The Indigenous people

"Thank god we are safe; the hills saved us all"
—Evacuated Man, Great Andamanese Tribe [16]

"They are alive! I can't tell you what a loss it would have been had they too been lapped up by the surging waters"
—Shabnam, Tribal Welfare Officer [16]

"We ran. I dont remember where, but all of us were together on a hill"
—Evacuated child, Great Andamanese Tribe [16]

[..] an old man from the tribe then signalled to all of them to come towards a coconut tree. Around 14 of them climbed up, holding children close to their chests, and stayed there waiting for the sea to recede
— Saurav Sanyal, Reporter [16]

The Great Andamanese, Onges, Shompens, and other tribes heeded the warnings of their ancestral knowledge and sought safety on the high ground. The prehistoric tribes of the archipelago, with their ancient knowledge and deep understanding of the natural world, were able to recognize the signs of the approaching tsunami and take action to save themselves.

As the wave swept through the Andaman and Nicobar Islands, most communication links, travel routes and infrastructure were destroyed, leaving the mainlanders in a state of panic and confusion. The death tolls and numbers of missing people were constantly rising, and there was little to no information about the fate of the indigenous tribes on the islands. However the rescue workers were more positive about the fate of the natives.

> "They can smell the wind. They can gauge the depth of the sea with the sound of their oars. They have a sixth sense that we don't possess."
>
> -Ashish Roy, Environmentalist and Legal Advocate [17]

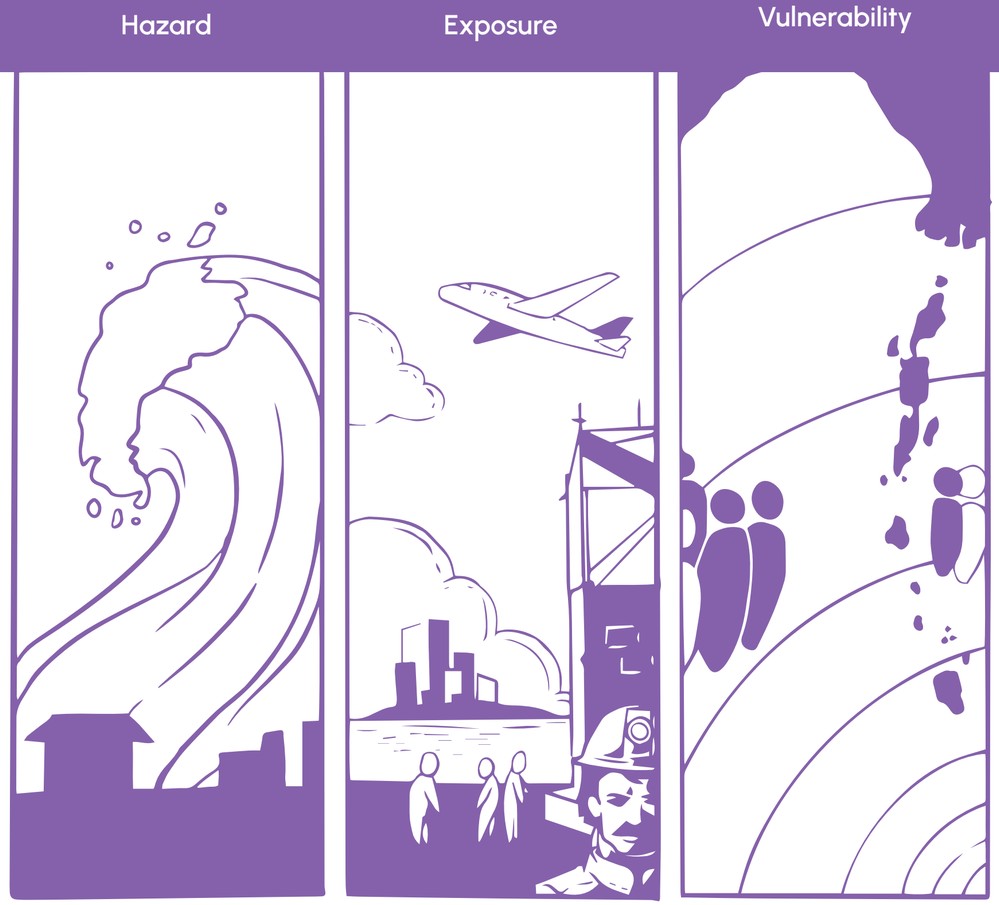
According to government officials and anthropologists, the ancestral knowledge of these tribes have made them more attuned to the subtle shifts in the ecology. Ashish Roy, a passionate environmentalist and legal advocate, spoke about the unique abilities of the five indigenous tribes in regards to wind, sea, and bird movements, Similar stories echoed across the islands as the other tribes of the archipelago.

During this disaster, the Shompens and Holschu tribes had been fortunate enough to avoid any casualties, but the Nicobarese tribe had faced heavy losses [18]. Furthermore, the dense forest cover in some of the islands proved to be a natural shield, significantly reducing the number of casualties. About 400 persons in Car Nicobar, who had retreated to the forests during the disaster returned to their homes. [19] This strengthens the need for natural shields in tsunami or flooding prone areas which reduces the impact of powerful waves and significantly reduces monetary losses and life casualties.

Since 2004, the Indian government has adopted a positive policy towards the Jarawa tribe of the Andaman Islands, with the general principle being that the tribe should control their own future with minimal intervention from the state. The policy formulated in 2004 explicitly stated that no attempts should be made to bring the tribe into the mainstream against their will. However, many voices, have continued to call for the Jarawa to be assimilated, citing their supposed backwardness or primitiveness. [10]

> Objectives related to *the Policy on Jarawa tribe of Andaman Islands*:
>
> (i) To protect the Jarawas from harmful effects of exposure and contact with the outiside world while they are not physically, socially and culturally prepared for such interface;
>
> (ii) To preserve the social organization, mode of subsistence and cultural identity of the Jarawa community;
>
> (iii) To provide medical help to the Jarawas to reduce mortality and morbidity in case of their sudden affliction wilth diseases which their systems are unaccustomed to;
>
> (iv) To conserve the ecology and environment of the Jarawa Reserve Territory and strengthen support
>
> systems in order to enable the Jarawas pursue their traditional modes of subsistence and way of life; and
>
> (v) To sensitize settler communities around the Jarawas habitat and personnel working for the protection and preservation of the Jarawas about the need to preserve this ancient community and to value their unique culture and life styles.
>
> —Excerpt from the *Policy on Jarawa tribe of Andaman Islands, Andaman and Nicobar Gazette*, December 21, 2004 [19]

Despite the government's commitment to protect the Jarawa's privacy and cultural autonomy, tourists have continued to use the Andaman Trunk Road which runs through the Jarawa reserve. The future of the Jarawa tribe remains a contentious issue in India, with conflicting opinions on how best to preserve their cultural heritage and ensure their continued autonomy. [10]



Elements of the Disaster

When does a hazard turns into a disaster? A disaster occurs when several factors contribute to the breakdown of the physical, social, economic and associated systems. Different communities are affected differently by disasters. For example, under-privileged communities that are under-resourced and under-organized bear the brunt of the aftermath in a significant manner. The natives of the Andaman and Nicobar Islands were similarly vulnerable owing to their geographical location, human development and marginalization. Due to several elements coming together to exacerbate the already existing vulnerability, the tsunami of December 26th proved to be horrendous.

Disaster risk is widely recognized as the consequence of the interaction between a *hazard* and the characteristics that make people and places *vulnerable*. In the case of the devastating tsunami that struck, the Hazard was a shallow mega-thrust earthquake with a magnitude of 9.3 on the Richter scale. This catastrophic event generated waves that reached heights of up to 30 meters, making it a rare occurrence that only takes place approximately every 500 to 600 years.

A hazard refers to any potentially dangerous phenomenon, substance, human activity or condition that has the potential to cause severe consequences. Hazards can lead to a wide range of negative outcomes, including loss of life, injury, harm to one's health, destruction of property, loss of livelihoods and services, major social and economic disruption, and damage to the environment. There are many different types of hazards that exist in the world, each with its own unique characteristics and consequences. Natural hazards include earthquakes, landslides, tsunamis, cyclones, extreme temperatures, floods, and droughts. Biological hazards include outbreaks

of diseases, in humans, animals, and plants, as well as pandemics. Technological hazards are caused by events such as the release of chemical or radiological agents, explosions, along with failures in transport and infrastructure systems. Lastly, societal hazards include conflicts, stampedes, acts of terrorism, migration, and humanitarian emergencies.

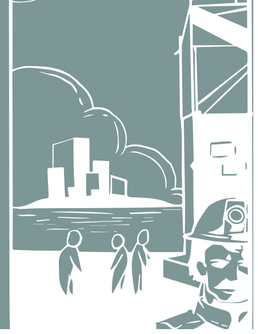
During the devastating tsunami, it was reported that many residents lived in close proximity to the ocean and numerous structures were built in violation of the Coastal Regulation Zone (CRZ) regulations. In several areas, the destruction of mangroves, corals, and other natural barriers left the population exposed and vulnerable to the direct impact of the tsunami waves.

Exposure is a crucial factor in determining the impact of a disaster on a population. When populations are directly or indirectly exposed to a hazard, they are vulnerable to its consequences. Direct exposure refers to the immediate effects of a disaster, such as injury, illness, health problems, evacuation, displacement, as well as economic, social, cultural, and environmental damages. On the other hand, indirect exposure refers to the longer-term consequences that arise from the disruption of infrastructure, economy, social systems, health and psychological well-being.

The idea of *vulnerability* holds a significant importance in managing disasters. The degree of vulnerability can vary greatly depending on a range of contextual elements, including cultural customs, political ideologies, geographical environments, institutional frameworks, historical events, natural processes, and the state of public infrastructure. There are different interpretations of vulnerability, which can be categorized into physical, economic, social, and environmental vulnerability, depending on the type of losses [21]

Experts in disaster studies have repeatedly emphasized that the losses due to disasters can be minimized by the use of *early warning systems*. Despite the existing hazards and vulnerabilities in any given system, early warning systems can provide anticipatory measures for preparedness.

Capacity: Early warning and the cogs in the operations



As the world reeled from the devastating tsunami that struck the Indian Ocean on December 26th, 2004, many were left wondering if there had been any warning signs before the disaster. In the aftermath, it was revealed that a seismic researcher based in Pune, Arun Bapat, had warned of the potential for a catastrophic earthquake as early as August of that year.[22] He had urged the government to establish proper seismic surveillance and earthquake awareness in the region and to undertake a seismic vulnerability assessment. Despite his warnings, little was done to prepare for the disaster that was to come. Mr Bapat's predictions of five minor quakes being potential foreshocks of a more significant seismic event were tragically proven true when the massive earthquake struck, releasing energy equivalent to twice the cumulative firepower used in World War II. [22] The question prevailed: Whether these warnings could have prepared the populace for the disaster? Could the devastation have been prevented if the proper precautions had been taken?

Apart from early warning systems communication during and after disasters also play a major role in recovery. A disaster of such devastating proportions requires a swift and effective communication channel through which the populace at high risk of damage can be promptly warned. Unnecessary communication delays can deter timely reception of warnings. A similar chain of events transpired at least an hour before the Tsunami hit the Tamil Nadu coastline. The first signs of the impending disaster came at 7:30 am when the Chennai unit coordinating logistics for the Car Nicobar base contacted Air Chief S Krishnaswamy with reports of a massive earthquake. As the minutes ticked by, the last message received from the base was that the island was sinking.

Early warning systems are essential to prepare and respond effectively in the short term, corresponding to the first stages of disaster management. Moreover, the implementation of such systems can also contribute to building resilience, as enhancing preparedness strengthens the capacity to recover rapidly, and reduces vulnerability.

-International Labour Organization (ILO) [23]

Effective "end-to-end" and "people-centred" early warning systems may include four interrelated key elements: (1) disaster risk knowledge based on the systematic collection of data and disaster risk assessments; (2) detection, monitoring, analysis and forecasting of the hazards and possible consequences; (3) dissemination and communication, by an official source, of authoritative, timely, accurate and actionable warnings and associated information on likelihood and impact; and (4) preparedness at all levels to respond to the warnings received. These four interrelated components need to be coordinated within and across sectors and multiple levels for the system to work effectively and to include a feedback mechanism for continuous improvement. Failure in one component or a lack of coordination across them could lead to the failure of the whole system.

-United Nations Office for Disaster Risk Reduction (UNDRR) [24]

At 8:15 am, the Air Chief ordered his Assistant Chief of Air Staff to alert the Defence Ministry. It wasn't until 8:32 am that the Indian Meteorological Department (IMD) communicated the situation's urgency to the government and crisis management group. There was a miscommunication at 8:54am. A fax was sent to the residence of the former Science and Technology Minister, Murli Manohar Joshi, rather than his successor, Kapil Sibal. However, regardless of the miscommunication, another fax was sent at 9:14am to the Disaster Control Room in the Ministry of Home Affairs. By 9:17am however wave hits the Chennai coastline. [25]

The journey from warning reception to acting on the warning was tedious and riddled with points of failures(POF), a swift decisive channel could have saved many lives through timely warning. [26]

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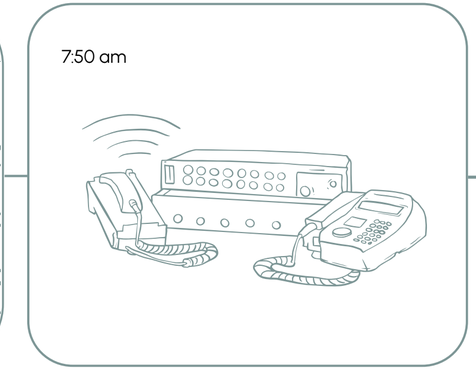

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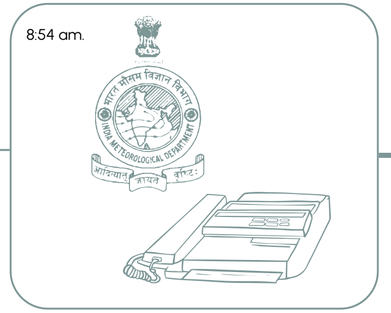

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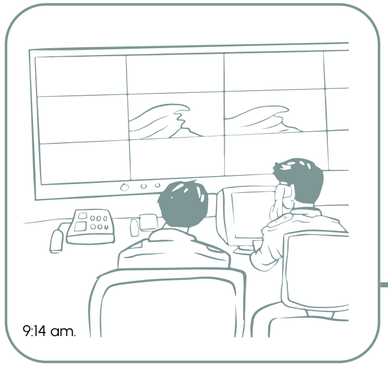


Mr. Murli Manohar
Sc.Technology Minister
19 March 1998 – 21 May 2004

Mr. Kapil Sibbal
Sc.Technology Minister
23 May 2004 – 22 May 2009
(Active during the Tsunami)

As with disasters of huge proportions, relief efforts were quickly put into motion. However, the coordination of aid was far from seamless. Piles of supplies amassed in ports, untouched and unused, while those in need went without. In some relief camps, such as Campbell Bay, there were reports of acute shortages of food and necessities. Organizations like *Médecins Sans Frontières*, or *Doctors Without Borders*, were hindered by lack of access, unable to reach those in need despite their willingness and capability to help. Despite efforts from thirty doctors from *Médecins Sans Frontières* and Voluntary Health Association and six doctors from the state of Kerala to help, they were denied access to the islands due to existing precautious state. The dire situation is compounded by vital water purification tablets not reaching those in need. [27]

The frustration with the bureaucratic red tape had boiled over in some instances, such as when residents tied up the *Tehsildar* (Government Officer) at Hut Bay. In another instance, a relief operation supervisor at Kamorta was criticized by tribals for insensitive comments [28]. These and many more challenges require effective disaster management and post disaster recovery. The repurcussions of the disaster were magnified due to such cases of failure in effective post disaster management. Therefore effective coping with disaster is equally important a concern in the realm of disaster management along with hazards, exposure and vulnerability.

"There are a lot of dead bodies strewed along the beaches. I haven't seen any dead bodies with clothes in it. It will take months before we get to a situation of near normalcy"

—Army doctor visiting the relief camps [29]

"If they thought of us, they would at least provide us with food. They would not have allowed our children to starve. Only god should help us"

—Gabriel Simon, the vice headman of Kakana village of the island [29]

A Class I gazetted officer living at Laxminagar encountered his tale of woe. The Tsunami struck on the 26th destroying everything. For three days no one came to their rescue. The Assistant Commissioner (A. C) assuming since his area was not badly affected that the remainder of the island was safe, apparently sent a radio message that Campbell Bay was fine. No helicopters flew over. The coast guard did not provide relief. In desperation in 29th morning the entire grouo began trekking towards the headquarters, They felt very let down when they heard on the radio that Indian planes and ships had reached Sri Lanka while they were still not rescued. At 10;30 that night they were still on the road looking for the AC.

—Colin Gonsalves, Reporter, 26 Jan 2005 [28]

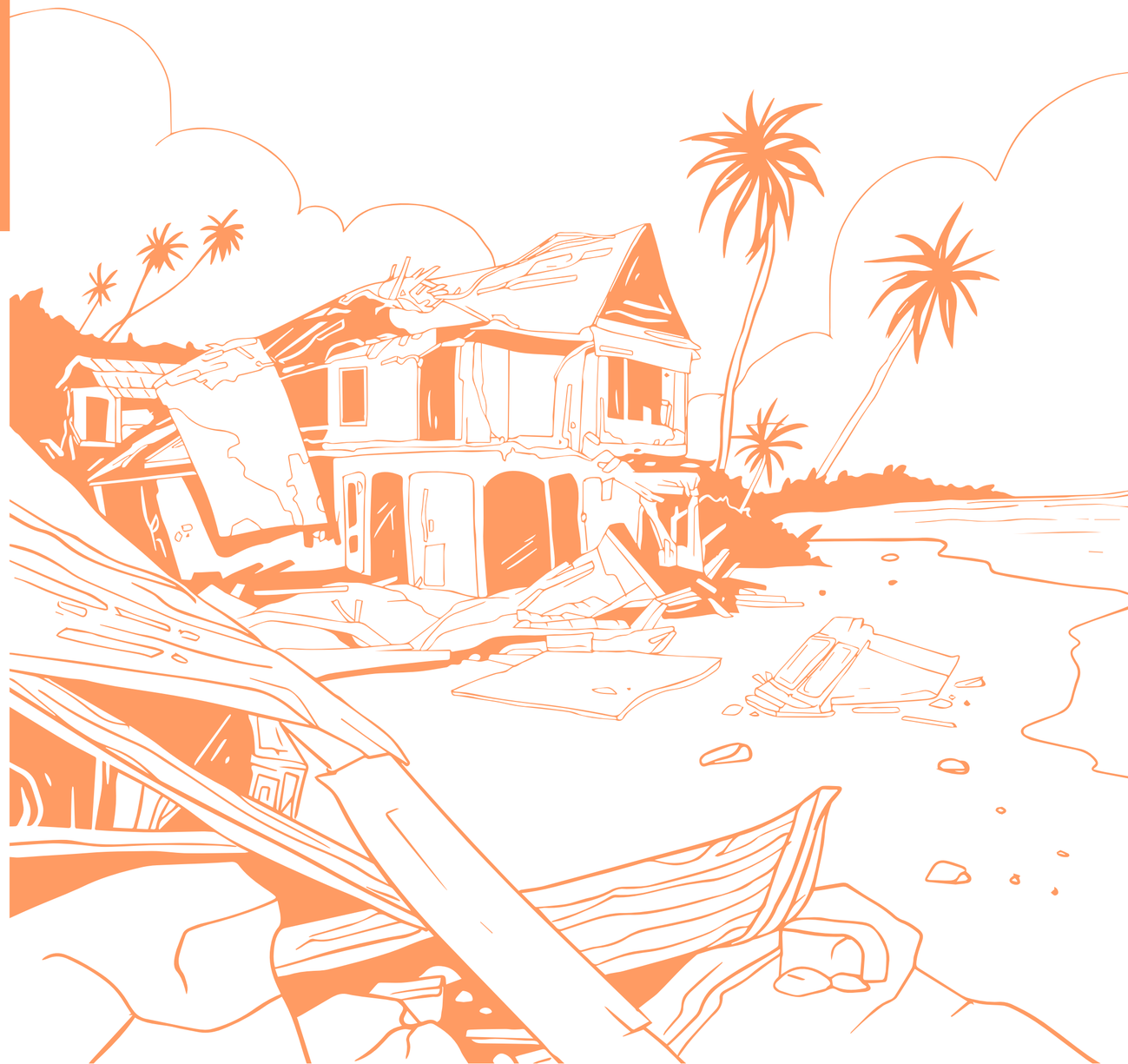
Response and Recovery: Post Devastation Rubble

"The waterfront, a section of Port Blair that sets it apart from Typical Indian cities, was refreshingly different. The city fathers, taking pride in their waterfront, had carved large tree-lined roads with quaint sidewalks along the undulating foreshore. The Andaman Sea lapped gently below the sidewalks and across the harbor like an ornamental apparition hovered the island of Ross" writes Deepak Dalal author of "Andaman Adventures II-Barren Islands"

Immediately after the Tsunami, the situation changed, the Waterfront of Port Blair, which was its crowning glory has been ruined, the Phoenix Bay jetty where you could see boats of all hues and sizes are underwater and Jungli Ghat which was a low-lying market is completely underwater." **[30]**

The stunning Katchal Island was once in the spotlight, attracting visitors to witness the first sunrise of the new millennium. In the wake of the disaster, the idyllic island was making headlines for a different reason. The 2004 Indian Ocean tsunami caused a disturbance, leaving behind a devastating aftermath. Out of the 5000 missing, a staggering 1549 were from Katchal.

The tsunami's impact was particularly severe for the tribal communities in Katchal. Almost all of the tribal chiefs and their heirs were killed, leaving behind the community in turmoil. In addition, the tsunami wreaked havoc on the island's landscape, rendering 112 hectares of land useless due to salinization and destroying 3.54 lakh worth of *supari* trees. The once picturesque island now bears the scars of one of the deadliest natural disasters in modern history.[31]



Few days after the tsunami, hundreds of tourists were anxiously waiting, at Vir Savarkar airport in Port Blair, for a flight out of the Bay of Bengal. The submerged islands of Cowra, Kondul, Trinket, Pillomillow, Little Nicobar, and Bambooka only added to their concerns. The lighthouse at Indira Point, just 93 nautical miles from the tsunami's impact zone, was completely underwater. The once-beacon of safety now served as a stark reminder of the power and destruction of the natural disaster. [32]

The destruction was made worse because existing regulations to protect people had been repeatedly breached. The Coastal Regulation Zone (CRZ) norms of 1991 were meant to regulate human activity within 500 meters of the coast throughout India, with different zones designated for different types of development. The CRZ Zone have divided coastal areas into four zones. According to the norms, Zone 1 constitutes the most sensitive coastal areas with mangroves and corals. Here no development was allowed within 500 meters of the coast. Next, Zone 2 consists of those towns and cities where the buildings were already touching the ocean. Zone 3 included underdeveloped areas and tourist places where development permissions were given on a case-to-case basis in a band up to 200m from the sea. Finally, Zone 4 was the Andaman and Nicobar Islands and the Lakshadweep Islands. However, these rules were often ignored throughout India, leaving communities unprotected and exposed to the sea. In many places, development had encroached on the coast, destroying natural defenses like mangroves and dunes that could have protected communities from the tsunami. [33]

The devastating effects of the disaster have raised questions about the reasons for such widespread ecological and human destruction. Many believe that inaction on Coastal Regulation Zone (CRZ) regulations made the situation even worse [34]. "We got two favorable orders asking the central government to stop aquaculture and implement CRZ. But nothing happened" said Thomas Kocherry, chairperson of National fish workers forum (NFF) The violations of CRZ regulations were evident in several examples, such as the construction of the Essel World theme park in Mumbai, built on a 30-hectare area of lush mangroves, and the Titanium factory, Minerals and Metals in Chavara. Hotels in Kochi and Kovalam in Kerala were also guilty of CRZ violations. [35]

In case of the Tsunami, there have been examples of the mangroves acting as a shield against the devastation caused by waves. These include mangroves in Pichavaram and Muthupet, Tamil Nadu, protected the communities situated there. In contrast, the devastation was more widespread in Alappuzha and Kollam, Kerala, where sand mining and other destructive activities had made the coastline vulnerable. Had the CRZ policies been implemented and followed more strictly, the destruction caused by the tsunami could have been less severe. [35]

At Pichavaram near Chidambaram, the efforts of local organizations to restore mangrove forests have protected coastal communities from the full force of the tsunami [36]. These "bioshields" not only provide protection, but also offer livelihood opportunities to local residents. In the wake of this disaster, scientists explored similar ways to make the area more resilient to future destruction. One potential solution is replicating the coastline belt with a plantation of mangroves, which are known for being a breeding ground for shellfish, small fish, and larvae, and could enhance the fishing industry. This solution was relatively inexpensive and could have been a step towards recovery for the devastated region. [37]

The massive tsunami waves that devastated Southern Asia have taken a devastating toll on the precious coral reefs and mangrove areas along the coast, creating an environmental and economic setback that could take years to recover. In addition, there have been reports of crocodiles attacking local villagers, perhaps because the increased presence of prey has lured them from their traditional habitats. Unfortunately, the tsunami's aftermath has resulted in mammoth levels of salinity that have made the land unsuitable for agriculture. Meanwhile, the coral reefs have become suffocated under layers of mud, and rare turtle nesting sites have been lost to the sea. These issues are compounded by dead fish and other debris clogging the coastlines. On Phuket Island, Thailand, the beaches were piled high with the remains of dead stag horn coral, starfish, gulper eels, sea cucumbers, and sea grasses, making it clear that this was a massive erosion event. [38]

Most of the tribals were semi-nomadic food gatherers. Those who survived were struggling to return to their traditional way of living. This was especially true for those dependent on fishing and hunting for their livelihood.

How does a Bio-shield work?

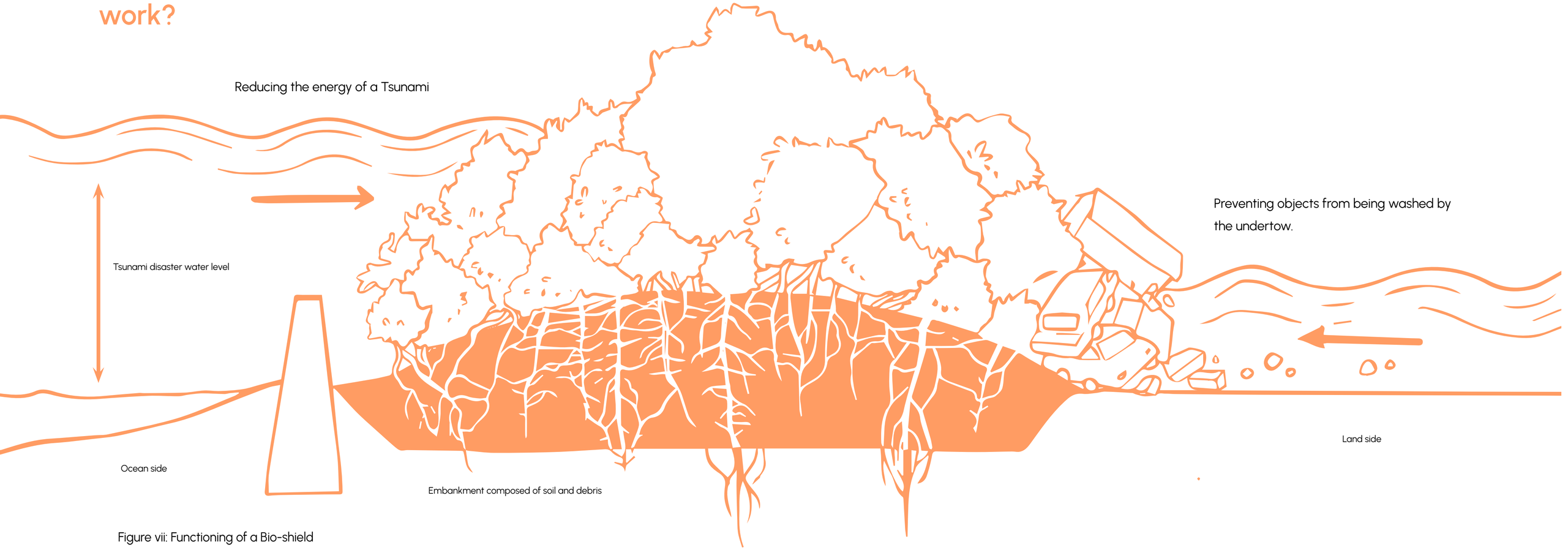


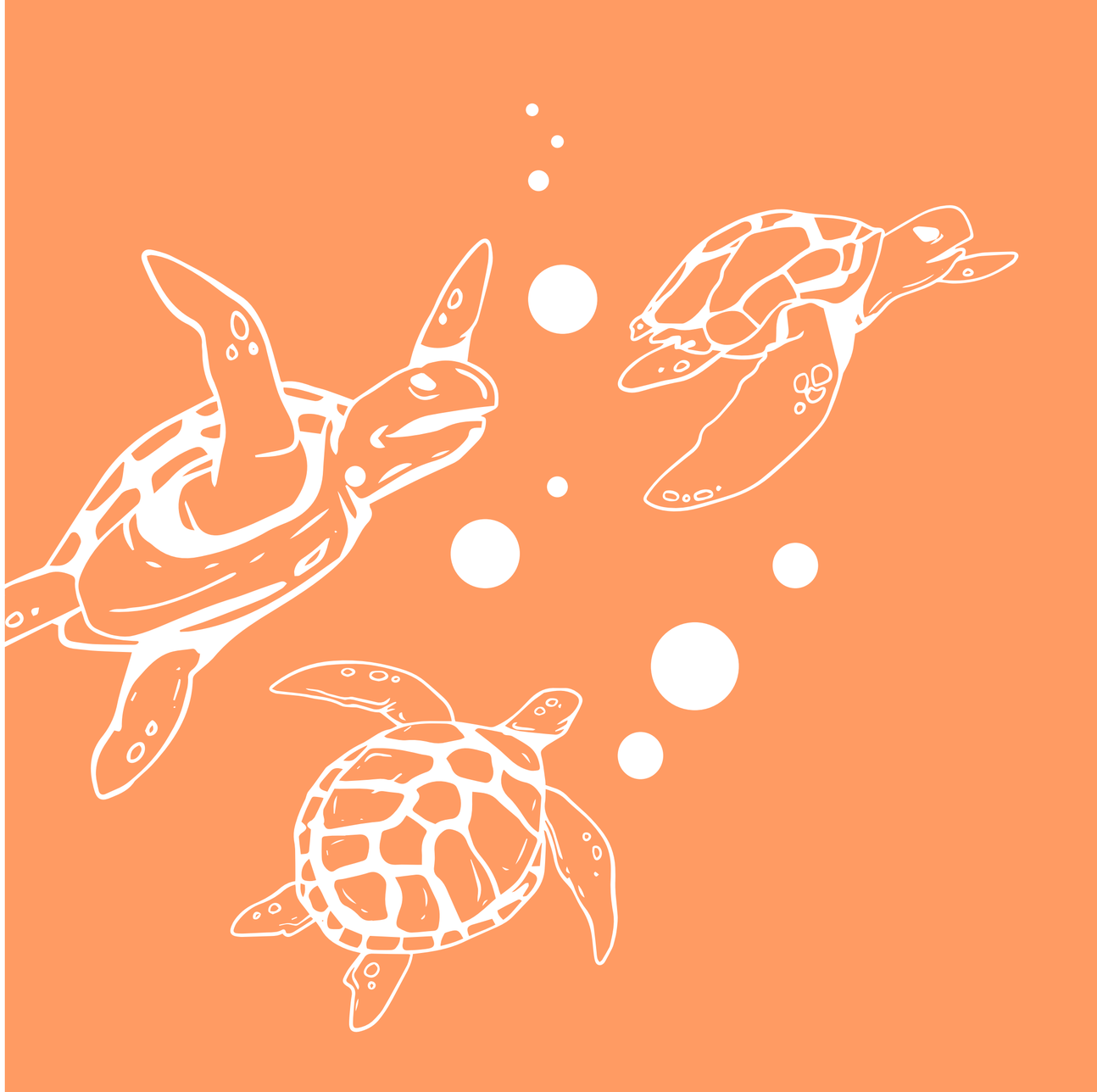
Figure vii: Functioning of a Bio-shield

The destruction of their homes and the loss of their traditional fishing grounds had severely impacted their ability to make a living. The tsunami left a devastating impact on both the coastal and inland areas, affecting over 4,067 hectares of land and damaging over 1.1 lakh houses. The coastal areas bore the brunt of the damage, with around 2,260 hectares affected. [39]

The tsunami's aftermath left deep emotional and physical scars on those who had survived. The constant after-shocks that shook the islands only added to the trauma. Mental health issues were rampant, as many struggled to come to terms with the devastation they had witnessed. Disease and infections were reported among the overcrowded relief camps. Malaria and measles outbreaks were reported, and vector-borne illnesses were common among the survivors. The lack of proper medical care and sanitation facilities weakened the vulnerable communities. [40]

Operation Andamans was a massive military effort was deployed to ensure the safety and recovery of the region. Over 8,000 soldiers from the Army, more than 5,500 naval personnel, and 2,000 Air Force personnel were on the ground, working together with 32 ships, 21 helicopters, 8 aircrafts, and an array of other defense efforts. The operation also included the deployment of 7 IL-76s, 16 AN-32s, two Avros, and 11 helicopters, showcasing the extensive resources being used to restore the region. [41]

The Indian Airforce searched for the perfect location to build administrative and residential quarters. With a new understanding between the Airforce and the local tribal leaders, the Air Force was confident in its mission to provide protection and security to the region. As reconstruction efforts continue, the Air Force station at Car Nicobar was designated as a non-family posting, meaning that the surviving families of the personnel stationed there would be relocated. Air Commodore K.K Vijay Kumar of the ANC stated , "Earlier the tribal chiefs did not allow us. Perhaps now they realize that we are no aliens and are here to protect them" [41]. The post-tsunami rehabilitation brought about many challenges to the forefront which were addressed to bring about a more resilient future for the islands



A downward spiral of increasing vulnerability

Vulnerability of a system plays a major role in determining the extent of damage in the aftermath of disaster. There are various definitions and perspectives of vulnerability, as different groups hold varying views on the concept. This results in a multitude of conceptual frameworks for vulnerability. For example, vulnerability is also defined as a combination of Exposure, Resistance and Resilience. Resistance are the measures taken to prevent, avoid or reduce loss and Resilience is the ability of the system to recover prior state or achieve desired post-disaster state. Vulnerability can be categorized into Physical vulnerability, economic vulnerability, social vulnerability and environmental vulnerability based on the types of losses.[42]

The United Nations Office for Disaster Risk Reduction provides a definition of physical vulnerability in the form of the possibility of physical harm to the environment. It can be measured by factors such as the population density, the remote location of settlements, and the characteristics of critical infrastructure and housing. For instance, while wooden homes may not easily crumble during an earthquake, they are more susceptible to fire damage.[43]

Economic vulnerability refers to susceptibility to external economic shocks based on inherent economic traits. This includes factors such as the level of economic openness, the concentration of exports, and the dependence on critical imports. These are considered structural in nature, making them challenging to change quickly through intentional policy interventions. Social vulnerability refers to the potential harm that disasters can cause to certain groups in society. These groups may include the poor, single-parent households, pregnant

or lactating women, individuals with disabilities, children, and the elderly. [44] This type of vulnerability takes into account factors such as the public's understanding of risk, the ability of these groups to cope with emergencies on their own, and the effectiveness of institutions in place to support them during difficult times. [42]

During the relief operations of the 2004 Tsunami, there were many instances which exhibited the social vulnerability of the inhabitants. Tensions had risen between the indigenous tribes of the Andaman and Nicobar islands and the mainland settlers brought in to aid relief efforts. The tribes, felt that outsiders infringed upon their way of life and resources. They accused the settlers of exploiting them and of corrupting their culture and traditions. Non tribals however had some differing views, "Sometimes, the local tribal people feel that they would have to share their natural resources and land with mainlanders. They have complained of indiscriminate felling of trees, but they would have to get over it" said Shivraj Patil, then Union Home Minister, during his three-day trip to the archipelago during relief operations. [45]

> Vulnerability is the human dimension of disasters and is the result of the range of economic, social, cultural, institutional, political and psychological factors that shape people's lives and the environment that they live in. Vulnerability can be a challenging concept to understand because it tends to mean different things to different people and because it is often described using a variety of terms including 'predisposition', 'fragility', 'weakness', 'deficiency' or 'lack of capacity'. Some definitions of vulnerability have included exposure in addition to susceptibility to harm. However, it is now understood that exposure is separate to the 'susceptibility' element of vulnerability since it is possible to be exposed, whilst at the same time not susceptible to natural hazards. Despite some divergence over the meaning of vulnerability, most experts agree that understanding vulnerability requires more than analysing the direct impacts of a hazard.
>
> — Preventionweb, 2022[46]

> [...] Humans are not equally able to access the resources and opportunities; nor are they equally exposed to the hazards. Whether or not people have enough land to farm, or adequate access to water, or a decent home, are determined by social factors (including economic and political processes). And these same social processes also have a very significant role in determining who is most at risk from hazards: where people live and work, and in what kind of buildings, their level of hazard protection, preparedness, information, wealth and health have nothing to do with nature as such, but are attributes of society. So people's exposure to risk differs according to their class (which affects their income, how they live and where), whether they are male or female, what their ethnicity is, what age group they belong to, whether they are disabled or not, their immigration status, and so forth."
>
> — Wisner, Blaikie, Cannon and Davis, 2003 [47]

Let us consider various dimensions of vulnerability in the aftermath of Tsunami using the case of Ayesha Begum, the chairperson of the Tribal Council of the Nancowry group of islands during the Tsunami response activities. Ayesha Begum's lineage traces back to her great-grandmother, Rani Islon, who was bestowed the title of the tribal queen by the British. This title was passed down through generations and ultimately reached Ayesha Begum. In the context of this disaster, she stated, "The mainlanders are wise and clever. Their presence has influenced our culture and tradition. We want Defense personnel and Government employees to stay, and the business and retired people can leave". This statement clearly demonstrates the existing social dynamics between the mainlanders and the tribal residents of the islands.[48] A tribal elder had said, "We have been living our way for thousands of years, and now outsiders want to change that. We will not stand for it."

"The alienation of the tribes with the mainlanders is a social faultline that needs to be watched as closely as the tsunami"
—Usha Deshpande, Director of movie "Song of silence", based on aboriginal tribes of Andaman and Nicobar Islands. [49]

"I have been living in Nicobar since 1959. We were brought to Port Blair after the Tsunami but cannot go back because the island was reserved for tribals. We contributed so much to the development of the islands and their people. There was nothing here when we came. Now they want us to leave"
—M.Mani, Non-Tribal resident of Nicobar [45]

Amidst their struggles, the non-tribals were grappling with the belief that the tribals and administration had colluded to push them out. The result was a feeling of abandonment and deep-seated frustration as they desperately cling to their sense of home on the islands. It was a delicate and volatile situation.

The Andamanese tribe rumored to be the first Andaman and Nicobar tribe to come in contact with civilization were around 50 in number. Ruled by a king and a queen, the tribe was in danger of losing its unique identity, with its numbers dwindling and the modern world knocking at its doors. The tribe's youngsters reportedly didn't want to adopt the traditional ways of tribal life. Many of them have studied till about class 8 and they didn't take an interest in what the elders care about. King Jirake, the eldest of the Andamanese tribes getting treated at the hospital, felt uncomfortable in his hospital attire and expressed his wish to go back to the forests, "We want to get back into our leaves, this is not very comfortable". Whereas Princess Tango having studied upto XI standard, a 25 year old mother of two had another reason to long for her home, "Though all 8 Andamanese houses were broken, the television is intact. I have not seen movies for a long time, so I want to go back fast. I adore Bollywood actors, Shahrukh Khan is my favorite". The outsider influence among the generations of Tribal families was prominent.[50]

The Jarawas have started embracing a more modern way of life, accepting new social, economic, and cultural practices. They wear clothing, which they obtain from various sources like tourists and villagers traveling the Andaman Trunk Road, who offer them gifts like food and clothes. This process of transition was rife with difficulties. When they first started wearing clothes, there were initial difficulties, like boys wearing ladies' gowns and vice versa. Previously, the Jarawas did not keep pets as the barking of dogs could give away their location to potential enemies. However, they have started keeping pet dogs, reflecting their changing lifestyle.[7]. The idea that these tribes needed to be "civilized" was twisted, as it ignored the fact that they already possessed a wealth of knowledge and understanding of their environment. They had been living in harmony with nature for tens of thousands of years, and their way of life was deeply intertwined with the natural world. But the arrival of outsiders brought with it a host of new problems.

"The main threat to the Jarawas is an encroachment on their land sparked by building of a road through their forest in 1970". This Andaman Trunk Road allowed an unfortunate intersection of the Jarawas and non tribals. This opened the way for non-tribals to interfere in their lives, which led to inherent distrust regarding non-tribals among the Jarawas. [10]

> "Real threat comes from a complex web of attitudes and a process of colonization of their land. Alien foodstuff has been introduced into their diets, which will have a disastrous long-term impact. They are beginning to get addicted to tobacco and alcohol"
>
> — Pankaj Sekhsaria (2005, February 12) [51]

> "Forced settlements of tribes introduce diseases, destroy the sense of identity and society, robs tribes of their self-sufficiency and leaves them vulnerable to alcoholism and despair"
>
> — Survival International, London based charity group [10]

Post-Tsunami it was imperative for the nation to rebuild and attempt to restore normalcy. One of the most pressing needs was to restore communication channels. Teams worked tirelessly to repair telephone exchanges and satellite communications in the affected areas of the island. Satellite phones were quickly made available to the public for calls,[52] but amidst the chaos and destruction, an unlikely hero emerged: the amateur HAM radio.

"In situations like this, the only thing that works is a radio," says Bharati Prasad, who, when faced with a massive humanitarian crisis with hundreds dying and people becoming completely incommunicado, decided to jump into action. "The phone links had disappeared. So I started using my radio set to connect with people in mainland and give information about people in Port Blair. In fact I was one of the first people to get in touch with a radio chap in Thailand, who told me what was happening there barely minutes after the waves hit Phuket." says Bharti Prasad.

These dedicated amateur radios, often called HAMs, use their equipment and skills to provide a crucial link for emergency responders and affected communities, keeping them connected and informed in their time of need. Unlike commercial systems, HAM radio is not dependent on any network and can operate independently, making it a reliable and invaluable tool in times of crisis. Within a day or two 15 radio operators were coming to the archipelago and were to be dispatched to the remote islands. [53]

> It is not always immediately evident that when an extreme event is called a disaster, both speaker and audience are invoking a particular set of culturally determined principles used to evaluate what is or has taken place. Quite apart from being a physical phenomenon, whether natural or human-induced, the criteria used in classifying a hazard as a disaster are also a form of discourse that implicitly make certain statements about what constitutes threat and normalcy. This lack of awareness is perhaps only more apparent when it comes to discussing people's resilience in the face of such occurrences, and their ability to deal with what has happened utilizing their own physical and psychological assets. These resources are usually referred to as a community's local knowledge and are expressed in terms of its coping practices. As in the case of disasters, though, they also form part of a parallel discursive framework that shares many of the norms and values inherent in that of disasters.
>
> — Greg Bankoff [54]

Fishing industry and Tourism industry were the worst affected. Industry estimates predict losses in the Andaman & Nicobar Islands alone would reach Rs 1,000 crore. In contrast, losses in Tamil Nadu, Pondicherry, Kerala, Karnataka, and Andhra Pradesh were expected to total another Rs 800 crore. Travel agencies faced a wave of cancellations in bookings to the affected islands. Even in the peak tourist season, visitors stayed away, leaving the travel industry grappling with a significant downturn. There was a growing fear that tourists would continue to avoid the islands until next year, as images of the wreckage and destruction continued to circulate. [30]

In order to resume normalcy, the challenge was to continue operations of island infrastructures including the schools. The resumption of classes at Car Nicobar KV had faced challenges, as the status of 4 full-time teachers and 67 students remained uncertain. "The building still stands, the blackboards, benches, chairs and tables are also in place. what's missing is its students and teachers". There's hardly any infrastructural damage, the loss has to be computed in terms of human resources. The Ministry has pledged an advance release of January's salary to KV Teachers and to let KV students from tsunami hit areas to seek admission in any other KV of their choice. [55]

While an outpouring of support had come from the medical community, with many doctors eager to lend a hand in the wake of the disaster. The challenge of finding individuals who were willing to stay and provide long-term care persisted. This could be because of the demanding and often isolated living conditions, as well as the emotional and physical stress that comes with working in a disaster zone. With a constant rotation of medical professionals, maintaining a consistent level of healthcare became difficult. To address this, having a committed and dedicated team of doctors and healthcare professionals on the ground was crucial for delivering effective and continuous medical support. The goal of the relief operations were to ensure that the communities in the islands return to normalcy as soon as possible. In order to understand vulnerability the elements of a disaster needs to be considered more broadly in terms of the dynamics of occurrence. [56]

"Addressing the systemic nature of risks in the context of climate change, which can lead to cascading crises, requires a holistic understanding of the interconnected, complex and non-linear cause–effect relationships within a system, to identify appropriate responses. This is facilitated by reviewing how past disasters have unfolded and how they were handled to inform future planning exercises, shifting from single-hazard to multi-hazard and system perspectives, and identifying measures based on multidisciplinary and inclusive approaches"

— UNDRR, 2022 [26]

"There has to be a broader and a more people-centred preventive approach to disaster risk. Disaster risk reduction practices need to be multi-hazard and multisectoral, inclusive and accessible in order to be efficient and effective. While recognizing their leading, regulatory and coordination role, Governments should engage with relevant stakeholders, including women, children and youth, persons with disabilities, poor people, migrants, indigenous peoples, volunteers, the community of practitioners and older persons in the design and implementation of policies, plans and standards. There is a need for the public and private sectors and civil society organizations, as well as academia and scientific and research institutions, to work more closely together and to create opportunities for collaboration, and for businesses to integrate disaster risk into their management practices."

-Sendai Framework, 2015, P.10 [57]

Comprehending the disaster from an analytical viewpoint

In order to understand the 2004 Tsunami, we refer to an existing model — The Pressure and Release (PAR) model [47,58] is a way to understand how certain societal factors make some people more vulnerable to disasters. In simple terms, *disasters occur when people who are already vulnerable are affected by hazardous events*.

The pressure model determines the progression of vulnerability before advent of any disaster. The three primary layers of vulnerability progression are the disaster's *root causes*, the *dynamic pressures* at play, and the *unsafe conditions* in the area. As the levels rise, so does the vulnerability. A hazard event and high vulnerability gives rise to a disaster situation. Depending on the type of *hazard*, the disaster manifests itself in a variety of ways such as storm surge, flooding, sea level rise, amongst others.

With this brief understanding, let us look at various root causes in the context of the Indian Ocean Tsunami. The community had limited access to resources which help warn people of impending disasters. The Andaman station in Port Blair had an outdated analog seismograph which produced a clipped seismogram during such an event. This was detrimental, as the destructive power of the imminent tsunami needed to be accurately estimated. In order to compute the exact epicenter using contemporary technology of that era, data from three stations in three directions were needed, but with the Andaman station out of operation, it took longer than expected. In times of disaster, communication equipment were difficult to obtain. Existing phone lines were insufficient and prone to failure. It was reported that the electricity and water transport had been badly

Pressure Model

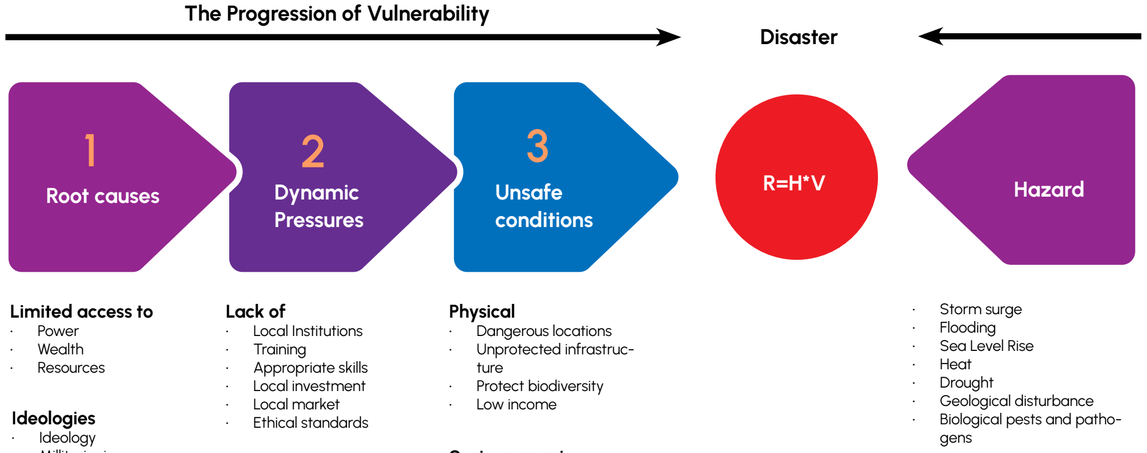
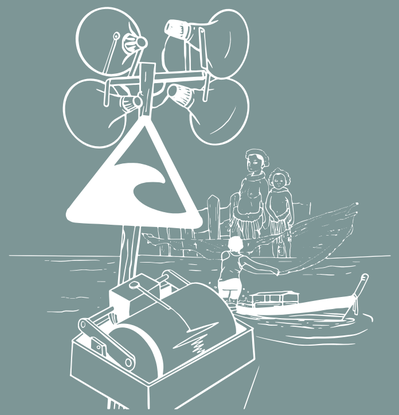


Figure viii: Pressure Model of Progression of Vulnerability

Pressure Model for 2004 Tsunami

Progression of Vulnerability

1
Root Causes

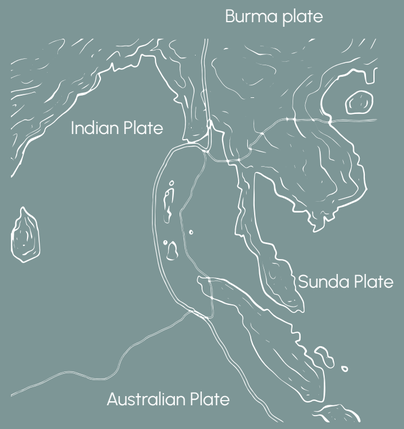


Limited access to appropriate equipments, resources and infrastructure along with dependency on Tourism and fishing industries comprise the root causes for the 2004 Tsunami. The inherent friction between the tribals and non tribals further aggravated this situation

2
Dynamic pressures

Deforestation, land reclamation caused irreversible to the area. Encroachment into Jarawa areas and forcing urbanization let to aggravated relationships. With rapid developments, the ecological impact was huge. These factors contributed to dynamic pressures, building a base for a disaster event.

3
Unsafe conditions



The area between the Indian and Burma plates experiences a lot of earthquakes due to the presence of two significant tectonic plate features on both sides of a small region. The lack of natural wave barriers, such as coral reefs and mangroves, left the area vulnerable.

Disaster

Risk=
Hazard * Vulnerability

Hazard

Shallow mega thrust earthquake, roughly 10km below the sea level released huge amounts of energy subsequently giving rise to humongous waves leading to life loss and infrastructure damage.

Tourism and fishing industries were the economic backbone of the Andaman and Nicobar islands, with these industries heavily dependent on the ocean. This dependence made the economic system vulnerable to Tsunami. Politically, the relationship between the tribals and mainlanders was tense, with the minority population feeling increasingly exploited with disrespect for their culture and the introduction of detrimental alcohol and tobacco abuse habits.

Dynamic pressures constitutes the second level in the pressure model. The communities were not aptly trained on how to act during a calamity. Factors such as rapid urbanization and land reclamation, as well as the development projects near the sea without proper adherence to coastal regulation zone norms, increased the area's vulnerability. Encroachment and deforestation also disrupted the traditional way of life for many tribal communities, making them susceptible to diseases communicable by the non tribals. The communities were not prepared mentally to tackle hardships faced post Tsunami. This lack of mental wellbeing led to reduction in individual productivity during rehabilitation phase.

The third level of vulnerability progression are the unsafe conditions, The Andaman and Nicobar Islands are in a region with high seismic activity and are at risk of earthquakes. The area between the Indian and Burma plates experiences a lot of earthquakes due to the presence of two significant tectonic plate features on both sides of a small region. The Indo-Burma plate boundary is a zone of compression, with the Indian plate being pushed against by the Australian plate in a counterclockwise direction. On the Chennai coast, many people were exposed to the sea waves near the beach when they hit. The lack of natural wave barriers, such as coral reefs and mangroves, left the area vulnerable. Many buildings had been constructed in areas designated as "no development zones", and industries and resorts had illegally tapped into groundwater resources. Fishing communities, whose livelihoods rely heavily on the sea, were particularly vulnerable to the disaster's impact. Indigenous tribes, such as the Shompens, who rely on the ocean for sustenance, were also at risk during the tsunami.

Release Model

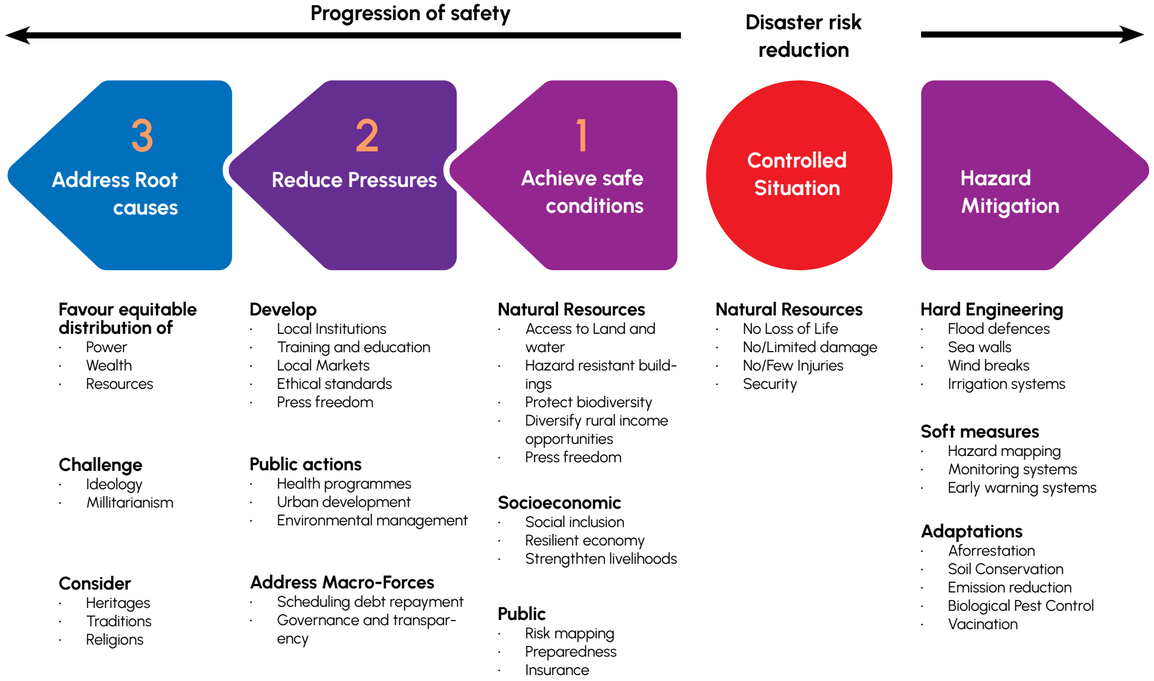


Figure ix: Release Model of Progression of Safety

Release Model for 2004 Tsunami

Progression of Safety

Disaster Risk Reduction

1
Address the Root Causes

Favour equitable distribution of resources were done. several rehabilitation programs were initiated to provide housing for the tribal communities affected. The cabinet approved a relief and rehabilitation package of 821.88 crore specifically for the Andaman and Nicobar Islands. It was ensured that the tribal community were consulted before constructing their house.

2
Reduce pressures

CZR rules were reviewed to ensure compliance in the future after the tsunami. Medical professionals and psychotherapists were deployed to address the mental and physical health concerns of the affected. Ex gratia payments of 50,000 each were granted to the next of kin. Efforts were made to restore schools that had been destroyed by the tsunami with the help of qualified volunteers.

3
Achieve safe conditions

Shelters were set up in consultation with tribal leaders, and subsidies for fishermen were increased to 50%. The package was intended to encourage them to use motorized boats and boost their income. Additionally, 8.6 crore was allocated for the rehabilitation of vulnerable groups such as orphans, widows, disabled individuals, and unmarried girls.

Controlled situation

No Loss of Life
No/Limited Damage
No/Few injuries
Security

The Ministry had planned to create a 'vulnerability line' along the coastline to identify areas that were at risk from various disasters. An expert committee was set up to study the long-term impact of the tsunami on the ocean ecosystem. Efforts were also made to develop an efficient Tsunami Warning System

"Three kinds of people were affected by the tsunami. One, families whose members or breadwinners are dead or seriously injured. Two, people affected mostly by the loss or damage of houses or fishing equipment including boats and three people moved to safety as a cautionary step"

—Thomas Kocherry, chairperson of National fish workers forum (NFF). [35]

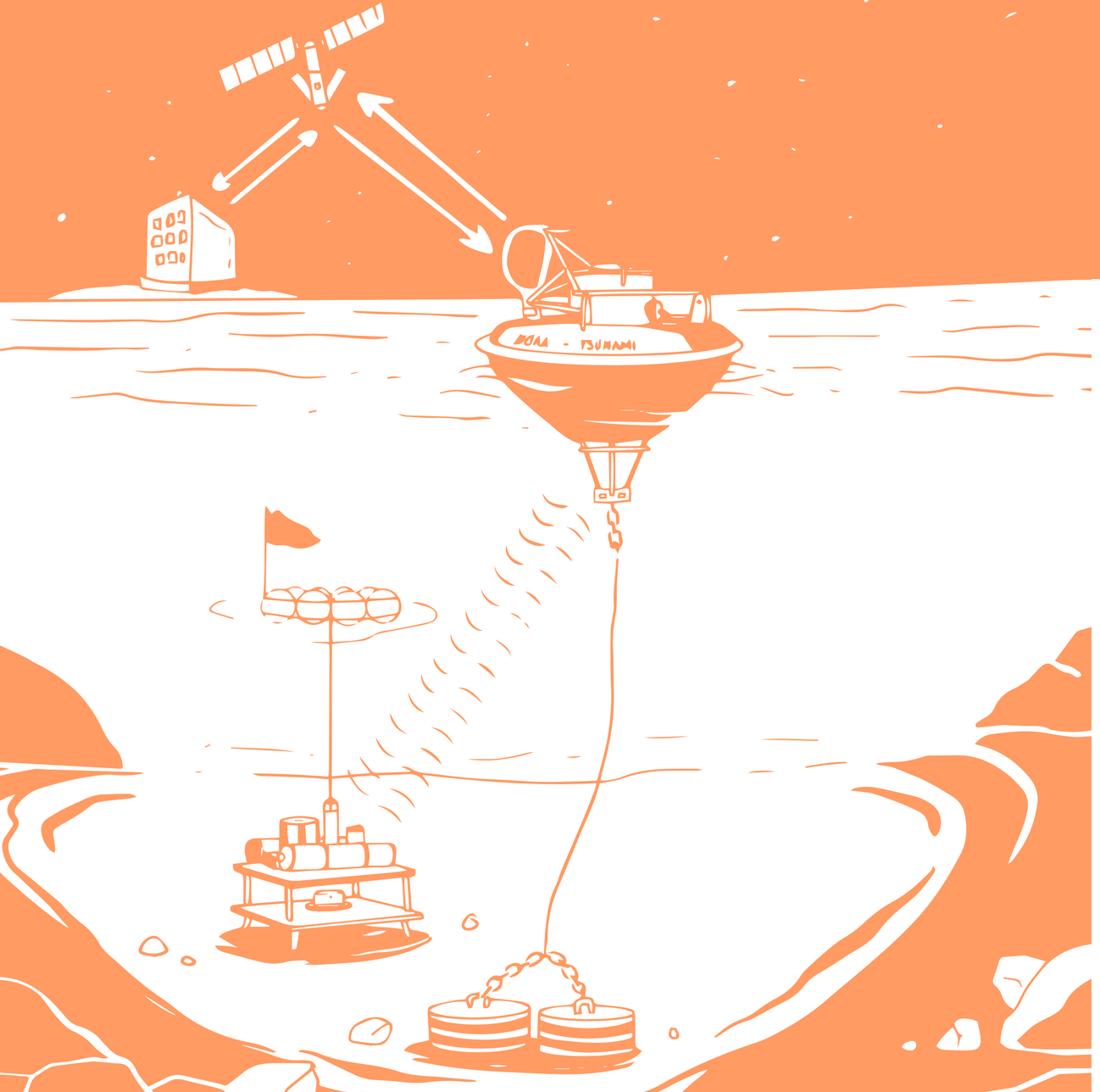
The second component of the PAR (Pressure and Release) Model is the Release Model. This model aims to explain the process of gradually mitigating disaster damage. The Release Model operates in reverse of the Pressure Model, which focuses on reducing risk by addressing root causes, reducing pressures, and achieving safe conditions until a controlled situation is achieved, where there are no fatalities, minimal damage, fewer injuries, and a sense of security. The final stage, hazard mitigation, then begins with the goal of preparing the community for any future disasters.

First stage of the Release model is addressing the root causes of the disaster. Efforts were made to provide housing for tribals impacted by the tsunami through rehabilitation programs. Significant amounts of aid resources were sent to assist those affected by the disaster. Initially, refugees with connections to mainland areas were relocated. The cabinet had approved a relief and rehabilitation package of 821.88 crore for the Andaman and Nicobar Islands.[59]

The second phase included reducing any prevalent pressures on the system. The CRZ rules were sent for reviewed to ensure future compliance. Medical professionals were deployed to address the health concerns of those affected. Psychotherapists were also mobilized to support the mental well-being of survivors. Ex gratia payments of 50,000 each were granted to the next of kin.[59] Efforts were made to restore schools with qualified volunteers as teachers, and facilitate consistent access to doctors. Children in the camp were immunized against measles. DPT and Hepatatis B vaccines were also administered.

The third phase aimed to create a safe environment with access to natural resources like land and water, building structures resistant to hazards, preserving biodiversity, and diversifying rural income. It aimed to build a resilient economy and an inclusive society, and efforts were also made to enhance livelihoods of the affected. Intermediate shelters were prepared with consultation with the tribal captains. It was also decided to raise the subsidy for fishermen from 35% to 50%. Besides helping the Andaman and Nicobar Island administration to start normal functioning, the package for fishermen would act as an incentive to opt for motorized boats and increase their income. Around 8.6 crore had also been allocated for rehabilitation of orphans, widows, disabled and unmarried girls. [59]

The disaster reaches its least destructive stage when the pressures are relieved. This is a controlled situation brought about by disaster management. From this controlled situation the next step is to restore the community to its pre-calamity state. This phase is called Hazard Mitigation. The Ministry had planned creating a 'vulnerability line' along the coastline to demarcate areas that face a threat from a variety of calamities.[60] There were plans to study long term impact of Tsunami on ocean ecosystem through a seven member expert committee. In order to make the communities capable of relaying warning messages easily there were attempts to create an efficient Tsunami Warning System.[61] The PAR model is effective is understanding the 2004 disaster and also presents certain lessons for improvement and in building resilience.



Learning from disasters: enhancing resilience

Our preparedness for future disasters is also based on learnings from past disasters, where the rescue, relief and rehabilitation operations create community knowledge. This knowledge can be used effectively when the next disaster strikes as people involved would have proper understanding of post disaster requirements. For example, the Bhuj earthquake was a major earthquake that struck the western Indian state of Gujarat on January 26, 2001. It had a magnitude of 7.7 on the Richter scale and caused widespread destruction in the city of Bhuj and surrounding areas. The earthquake caused over 20,000 deaths, injured more than 167,000 people, and left hundreds of thousands homeless. The disaster had a significant impact on the local population and infrastructure, causing widespread damage to buildings, roads, and other structures. The earthquake was one of the deadliest in India's history and brought attention to the need for improved disaster preparedness and risk mitigation measures in the country. [62]

The Bhuj earthquake left a lasting impression on the Gujarat government and the armed forces. They were quick to act during the relief operations of 2004 Tsunami, dispatching rescue workers, supplies, and communication equipment to the affected areas. Tents, bamboo sticks, and iron sheets were sent to shelter those left homeless temporarily. A communication team was even sent to Port Blair to set up communication channels, including coordinating with HAM radio operators.

Figure x:
Deep-ocean Assessment and Reporting of Tsunamis

It was stressed that the biggest problem after the tsunami was communication and coordination. An Army official, reflecting on his experience with the Bhuj earthquake, said, "We had aircraft and trucks dumping supplies and running away. We didn't have any training in rescue operations, and we were using rudimentary tools to clear the rubble. It was only later that we learned that specific advanced tools were already available."

The priority after a disaster of this magnitude was relief and rescue. After some time, ideally a month, rehabilitation had to start. Rehabilitation is a long process and generally takes years to establish long-term solutions. Despite the challenges, the collective knowledge and experience of the armed forces and relief agencies made the relief efforts in the tsunami's aftermath more effective.

In order to better understand the extent of damage, Sagar Kanya, an ocean research vessel, in January 2005 set sail on a two-month journey to uncover the true devastation caused by the Tsunami . The mission was to study the changes in the ocean's water columns and the shifting of the Indian plate towards the Burma plate. By understanding the height and energy of the Tsunami, one could better prepare for future natural disasters. Gaining knowledge about geography and plate tectonics is instrumental in informing future policies and decisions to increase the community's resilience against such devastating disasters in future. [63]

An early Tsunami warning system was thought to be necessary. However, there were certain difficulties before such a system could be implemented. In order to ensure a quick reaction to a potentially deadly earthquake, hundreds of computer-aided models had to be created to handle various eventualities. Since sea bottom pressure recorders and other equipment must be placed in many locations for the warning to be timely and accurate, developing a Tsunami warning system should be a cooperative effort among numerous nations. [64] Experts called for a closer examination of the region's volcanic and seismic activity. While cities on India's western coast, such as Mumbai and Goa, were relatively safe from tsunamis due to the absence of active volcanoes in the area, the Java-Sumatra-Andaman belt was not so lucky [65]. In the aftermath of the tsunami, sonar images revealed a ruptured fault stretching 43 to 50 miles, making it difficult for experts to determine how the fault moved as there are no maps of the area before the earthquake [66]. In order to get a better understanding of the changes that have taken place on the Andaman and Nicobar islands after the tsunami, a team of surveyors and ocean experts planned to undertake a massive survey in the Union Territory [67]. Meanwhile in February 2005, a Bangalore-based team was working on a tsunami alert software that utilizes the internet for faster and more efficient communication. The software planned to send SMS, MMS, and email-based alerts and will gather disaster data from existing early warning systems that track changes in land and sea through transducers. Implementing this software was estimated to require a network of government agencies and mobile service providers to collaborate and build virtual private networks between them [68].

In March 2005, the Ministry of Environment explored the idea of creating a "vulnerability line" along the coast to identify areas that are at risk from a variety of natural disasters, including cyclones and tsunamis. A meeting with experts to plan out the details of this project was recently held, and the committee recommended using seven key factors to determine the vulnerability of a given area: elevation, geology, geomorphology, sea level trends, horizontal shoreline displacement, tidal ranges, and wave heights.

Post Tsunami a team of scientists from the CSIR-National Institute of Oceanography had embarked on a research expedition aboard the *RV Sindhu Sankalp* to study the ocean bottom seismometer in Indian waters. Their study, published in Nature's Scientific Reports in 2020, reported having uncovered an astonishing 141 high frequency earthquakes and swarms in the vicinity of three major faults - the Andaman Nicobar fault, the West Andaman Fault, and strands of the Great Sumatra Fault. Swarms refer to a cluster of earthquakes that occur in rapid succession and are a notable geological phenomenon. The findings of this study indicate that while the December 2004 mega-thrust earthquake was the primary trigger for the tsunami in the region, the ongoing active volcanic activity in the area is also contributing to the shifts and seismic activity in the region. This discovery offers a deeper understanding of the complex geological forces at play in the Indian Ocean and highlights the importance of continued monitoring and research to better predict future seismic events [69].

The Indian Ocean was hit by a catastrophic tsunami that caught the world by surprise. Despite being one of the worst natural disasters in recent history, the response mechanisms in place at the time were woefully inadequate. In Indonesia, where the 9.1 magnitude earthquake that triggered the tsunami originated, the warning system was down due to a lightning strike. Thailand managed to send out an alert, but only after the first wave had already struck. In India, the disaster alert was sent to the wrong official.

Ten years after the devastating Indian Ocean tsunami in 2014, the region that spans from Africa to Australia was better equipped to face such disasters. Due to the deployment of a comprehensive network of seismometers, tidal gauges, and ocean buoys, the world was now capable of detecting the undersea tremors that trigger tsunamis. With improved communication networks, alerts could reach governments across the globe, ensuring a quicker response.

In the past, predicting tsunamis was based mostly on the magnitude of an earthquake and the assumption that it would lead to a tsunami and its potential size. Bruce Jaffe, a research oceanographer with the US Geological Survey Pacific Science Center, stated that this method was not very accurate and there was often uncertainty about the size of the tsunami that would follow. [70]

However, with advancements in technology, the scenario had changed. DART buoys, which were non-existent before the 2004 tsunami, had become the first line of defense in the deep ocean. After sensing an earthquake, these buoys were able to detect pressure changes, indicating the presence of a tsunami. In 2014, there were 60 of these buoys mostly located around the Pacific rim and three of them were able to detect the 2011 Japan In March 2018 India was ready with a new Tsunami warning system [70]. The new Tsunami warning system can detect tsunami and send alerts withing 3 minutes of initial tremors and shakes. The National Institute of Ocean Technology's Chief Scientist, Vinith Kumar, announced that the Early Tsunami Warning System located in Rangachang, Andaman and Nicobar Islands, is capable of predicting tsunamis within just three minutes of an earthquake occurring. This system evaluates the impact of earthquake-generated waves and promptly sends alerts, with the risk zones receiving the tsunami alert issued by the Centre in collaboration with Indian National Centre for Ocean Information Services (INCOIS) at Hyderabad. Kumar emphasized the speed and effectiveness of this crucial system in detecting tsunamis and ensuring the safety of those in harm's way.
tsunami. [71]

No matter how many warning systems are in place, it is important for communities to understand what to do when receiving a tsunami warning in order to minimize their vulnerability to these disasters. Since the 2004 Tsunami, communities in the region affected by the 2004 Indian Ocean tsunami have seen major improvements as a result of the $14 billion spent on post-disaster reconstruction. Many towns and villages now have access to earthquake-proof homes, modern roads, and cellphone coverage to receive mobile alerts in the case of an emergency. In areas where traditional alert systems were not sufficient, governments had come up with creative solutions to ensure that everyone is warned of an impending tsunami. For example, in Indonesia, mosque loudspeakers were used to issue alerts, while in Bangladesh, bullhorns were used to warn tourists and fishermen. To make the learning experience more enjoyable, a center in Singapore has even created a tablet game that teaches about tsunamis. [71]

While the technological interventions and early warning systems have improved, the valuable human dimension and its coping with disasters still remains a challenge to contend with in the future. Eighteen years later, in December 2022, the question remains: is India better equipped to handle such a disaster of a cataclysmic scale today?

Conclusion: Sustaining livelihoods

"Andaman ready for tourism" is a headline that appeared in a newspaper on March 23 2005. Three months after the devastating tsunami struck the Andaman and Nicobar Islands. The tourism industry in the islands was heavily affected as many people canceled their travel plans. Relief workers flooded the archipelago to assist with rescue and recovery efforts, temporarily replacing the usual tourist demographic. However, with the resumption of a cruise liner, chartered flight services, and a renewed focus on showcasing the islands' rich cultural heritage, the administration was determined to attract international and domestic tourists again. Efforts were made to relocate those in relief camps to temporary housing and to identify safe sites for resettlement [72].

The Union cabinet approved a massive relief and rehabilitation package worth Rs. 2731 crore for the victims of the 2004 Indian Ocean tsunami in the states of Tamil Nadu, Andhra Pradesh, Kerala, and Pondicherry. The then Prime Minister Manmohan Singh announced that the assistance has been increased to 200 crore from the initial amount of 150 crore, providing a much-needed boost to the efforts to help those affected by the disaster. The funds were used to provide immediate relief materials, such as food, water, and medicine, as well as to construct temporary shelters for those who have lost their homes. The government's commitment to supporting those in need is a beacon of hope in the aftermath of the devastating tsunami. With this financial support, the affected communities can begin to rebuild their lives and find a way forward, even in the face of such overwhelming loss [73].

"The reconstruction effort will have to focus on building tremor proof structures before the onset of monsoon and it would involve tribal people"

— Press Trust of India, 2005 [74]

"Reconstruction has to be an organic process, it is essential to have local participation in the planning and execution of reconstruction work"

— Reported in Times of India Hyderabad, 2004, Dec 30 [75]

"If we were given tools to clear the debris and construction material, we would have built houses in our own way,"

— Ayesha Begum, the chairperson of the Tribal council of Nancowry. [76]

In the process of rebuilding the shelter's design was chosen after discussion with the tribe chiefs. They were prepared for habitation across the islands and built in a traditional manner. On January 3, 2005, when the schools reopened, many capable volunteers volunteered to teach. Additionally, measles vaccines and other vaccinations were given to all youngsters in the recovery process.

It is imperative that steps are taken to preserve and sustain the unique cultures and livelihoods of indigenous tribes. Whether its through safeguarding their territories and ways of life, or by providing support to revive their traditional practices, it is crucial that their existence is recognized and valued in today's rapidly changing world. Through collective efforts and a willingness to listen to their perspectives, we can ensure these cultures' survival for generations to come. The challenges faced by the Jarawa tribe in the Andaman and Nicobar Islands, such as the loss of their traditional way of living and the threat to their unique identity, are just a few examples of the adverse effects of being vulnerable to disasters. It highlights the importance of protecting these marginalized communities and promoting sustainable livelihoods. Policymakers must take proactive measures to ensure that the rights and well-being of these tribes are safeguarded and their cultural heritage is preserved for future generations.

The disaster management system of India has undergone a paradigm shift from relief and rehabilitation to holistic management of disasters. This shift was ushered through the Disaster Management Act 2005, institutionalized with the disaster management authorities at national, state and district levels, guided by the National Policy on Disaster Management 2009, and operationalised through a series of guidelines, plans, procedures, programmes and projects at national, state and local levels.

The cumulative effects of these initiatives are clearly visible in advanced early warning systems, coordinated response to disasters and impending disasters, drastic reduction in disaster mortalities, and general increase in awareness about disasters at all levels. The effects are not so visible in disaster risk assessment at various levels, risk prevention and mitigation, and mainstreaming disaster risk reduction across different sectors of development.

— Ministry of Home Affairs, GOI (2019) [77]

Objectives [of the *National Policy on Disaster Management*]:

- Promoting a culture of prevention, preparedness and resilience at al levels through knowledge, innovation and education.
- Encouraging mitigation measures based on technology, traditional wisdom and environmental sustainability.
- Mainstreaming disaster management into the developmental planning process.
- Establishing institutional and techno-legal frameworks to create an enabling regulatory environment and a compliance regime. Ensuring efficient mechanism for identification, assessment and monitoring of disaster risks.
- Developing contemporary forecasting and early warning systems backed by responsive and failsafe communication with information technology support.
- Promoting a productive partnership with the media to create awareness and contributing towards capacity development.
- Ensuring efficient response and relief with a caring approach towards the needs of the vulnerable sections of the society.

— National Policy on Disaster Management [78]

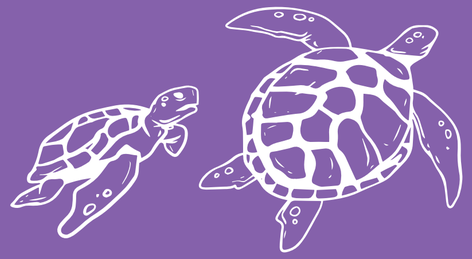
The debate between balancing ecological preservation and development continues to this day, and one of the latest examples is the Rs.72,000-crore project proposed by NITI Aayog in early 2021. The project aims to make major changes in two of the larger islands in the Union Territory's 836 islands - Great Nicobar and Little Andaman. But this is not all, the project also threatens some of the most significant nesting sites for the giant leather-back turtle. The Galathea nesting beach, a 11.44 square kilometer wildlife reserve declared in 1997, has already opened the door for port construction activities, since January 2021. This means that the future of these iconic species and their habitats are at risk. [79]

"The best mitigation plan for these turtles is to have no plan at all. If the project begins then nothing can mitigate the disaster awaiting Galathea Bay and its turtles," writes Pankaj Sekhsaria in *Monumental Folly* published by the environment action group Kalpavriksh. Despite the friction, there is hope that a balance can be struck. Perhaps through careful planning and consideration, we can find a way to push forward with necessary development while also protecting and preserving our ecology. [80]

The 2004 Indian Ocean Tsunami caused widespread devastation and claimed the lives of over 230,000 people across several countries. The death toll was staggering, and the impact on families, communities, and nations was immense. The tsunami affected millions of people and changed the course of countless lives, leaving a lasting impact on the region and beyond. Despite the tragedy and loss, people came together to help each other and to rebuild their communities. The disaster also spurred improvements in early warning systems, disaster response, and preparedness efforts to help prevent future catastrophes.

In December 2022, on the 18th anniversary of the devastating tsunami, the victims were remembered with love and reverence. Tamil Nadu fishermen, along with local residents, gathered in large numbers in the coastal districts of Cuddalore, Thoothukudi, and Kanyakumari to pay tribute to those who lost their lives. The shoreline from Chennai to Kanyakumari was a solemn scene as the mourners took part in a silent procession to the beach. With heads bowed in respect, they poured milk into the sea and scattered flowers, offering a moving and unforgettable tribute to the victims who will always be remembered. The outpouring of love and remembrance was a touching testament to the impact the disaster had on the lives of so many people. [81]

About this Project



The aim of this project was to spread awareness about the tools, models and methods involved in studying disasters. Motivated by a desire to understand the causes and consequences of the tsunami, we embarked on this project with the goal of comprehensively examining the disaster. Our aim was not only to gain a deeper understanding of the physical and geological factors that contributed to the tsunami, but also to explore the human dimensions of the disaster.

We warmly thank Prof. Pankaj Sekhsaria for providing us with a collection of newspaper clippings dated from 27th December 2004 to 31st March 2005. This collection served as the initial basis and helped us to understand the Tsunami and the ongoing underplaying dynamics. It provided us with a much needed window to the past. We spent several months researching the scientific and historical context of the tsunami, analyzing data from a variety of sources, notably the newspaper articles. Learning about the Tribal population of the Andaman and Nicobar Islands was particularly tough, with minimal information available on their lives. However some papers as mentioned in the 'References' section helped us gain a deeper insight into their lives, through which we were able to comprehend the complexities by which the aboriginal tribes of the Andaman and Nicobar Islands have been resilient to many such disasters throughout their existance in the islands.

The process of working on this project has been both challenging and rewarding. We referred the news paper articles and started the analysis by charting different disaster dimensions reported in the newspapers. Eventually certain themes regarding the tsunami induced disaster started emerging. Themes such as the Tribal communities and their existing dynamics, reports of the Tsunami devastation, economical damage dealt, political

of the tsunami and building resilience with technological advancements. We mapped these themes to disaster models - the PAR model (Blaikie et al. 1994) to deepen our understanding of how a vulnerable situation increases pressure on a system, which gives way to a disaster when an appropriate pressure releasing hazard strikes. We charted the disaster and post disaster events on the PAR model where the vulnerabilities were addressed releasing the incremental pressure on the system and eventually lay out plans to build resilience against any such future events.

The next major challenge was communicating the analysis in an effective manner. There were many areas which required appropriate visualization to help readers grasp the concepts spoken about in this book. Various maps had to be included such that the readers have a coherent understanding of the geography which is frequently referred. Illustrations were made to visualize the unique lifestyle of the aboriginal tribals. Infographics and concept visualizations such as the PAR Model and the TNT explosion reference helped facilitate an elemental and systemic understanding of the disaster. Illustration of tribals climbing the coconut tree reflected the knowledge which made the communities resilient in the face of the danger. Throughout the book, there are multiple motifs of tropical leaves and turtles, the focus being on the rich ecological wealth of the Andaman and Nicobar Islands. We decided on a limited color pallete to avoid chaos and saturation with each chapter having a different colour palette than the ones before.

This project required a careful balancing of scientific rigor and human empathy, as well as an ability to navigate the complexities of interdisciplinary research. We have been continually inspired by the resilience and courage of those who have been affected by the tsunami. Ultimately, our hope is that this book will provide readers with am empathetic and nuanced understanding of the December 26, 2004 tsunami, one that is grounded in both scientific analysis and human experience. We hope that it will serve as a tribute to those who lost their lives in the disaster.

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Image References

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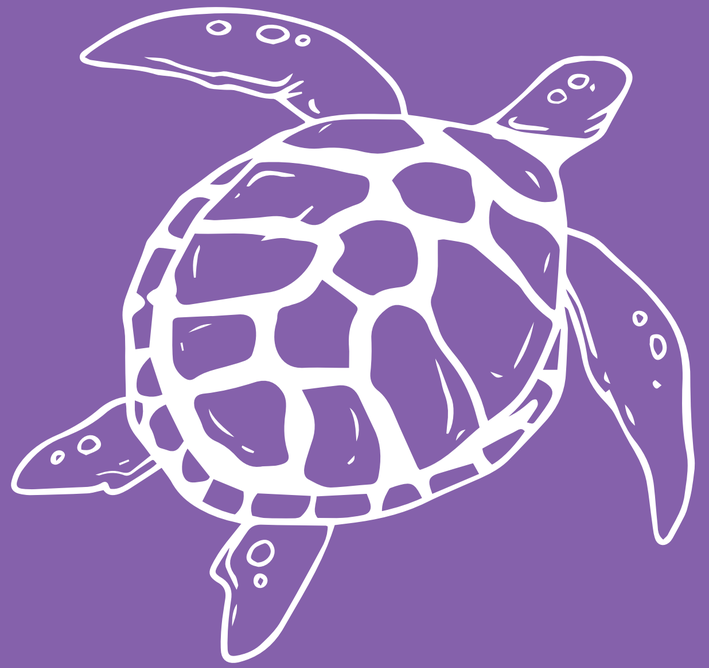
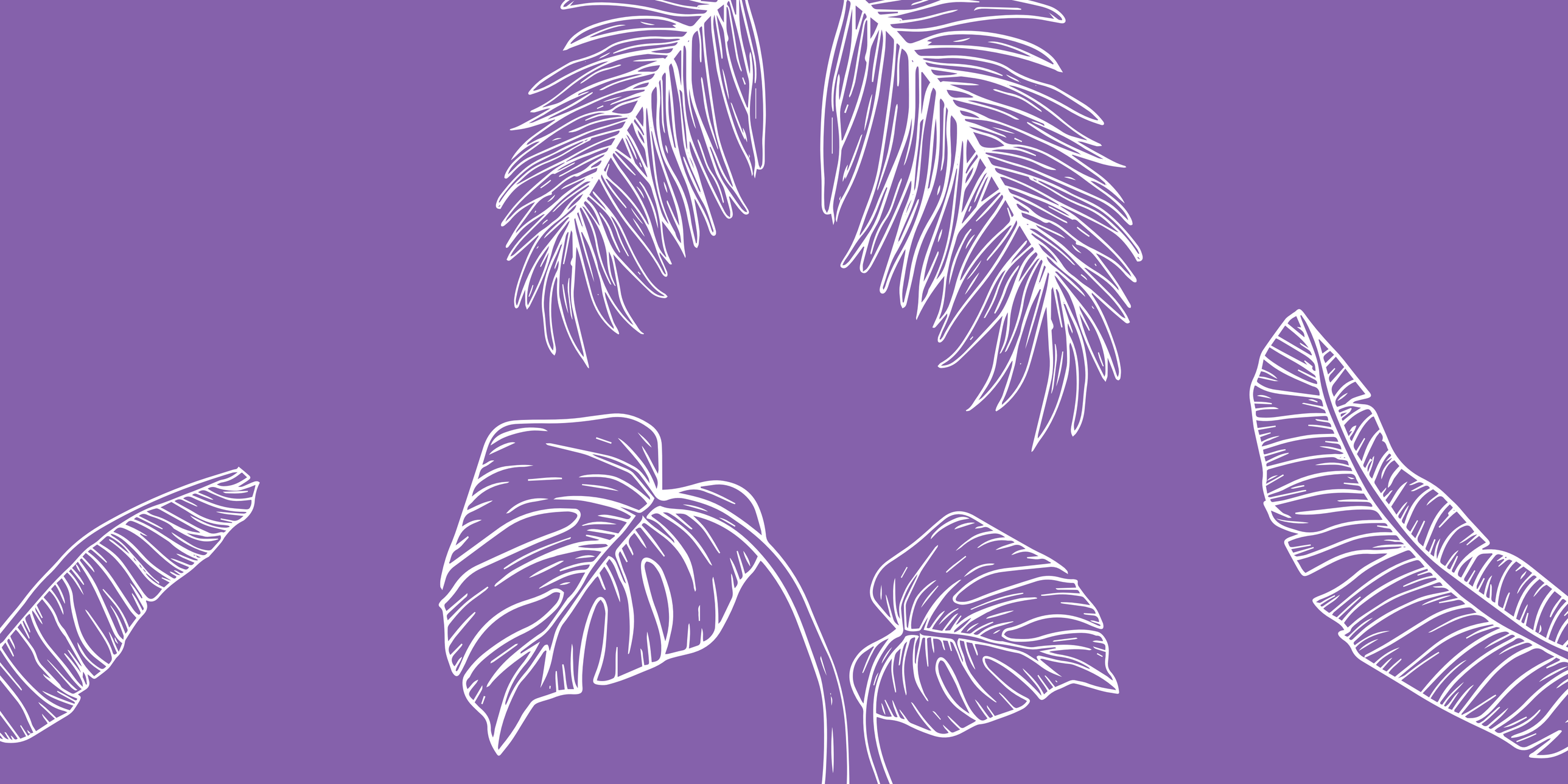
Shreyas Vernekar is currently pursuing his Masters in Communication Design from Industrial Design Centre, IIT Bombay. He has represented IIT Bombay and won as part of the Design team in InterIIT Cult Meet 5.0. He held multiple Design related PORs during his 2 year Masters Programme. He has a three-part soul of a designer, an engineer, and an artist and aims to integrate the skills to create holistic projects.

Vivek Kant, PhD, works at the IDC School of Design, Indian Institute of Technology Bombay (IDC, IITB). He is cross-trained in both systems design engineering and cognitive/behavioral sciences. His research interests are human-centred digitalization, human machine interaction design and human systems integration in complex sociotechnical systems





About this Book

The aim of this project is to spread awareness about the tools, models and methods involved in studying disasters by examining the 2004 Indian Ocean Tsunami. Our aim was not only to gain a deeper understanding of the physical and geological factors that contributed to the tsunami, but also to explore the human dimensions of the disaster. This book will be of help to students, educators and policy-makers in understanding issues related to vulnerability and resilience in disaster management.