



EARTH
OBSERVATORY
OF SINGAPORE

2015 Annual Report

The Earth Observatory of Singapore

conducts fundamental research on earthquakes, volcanic eruptions, tsunamis and climate change in and around Southeast Asia, toward safer and more sustainable societies.



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A scenic landscape photograph of a village in Sumatra, Indonesia. The foreground is dominated by lush green rice paddies, some of which are flooded with water, reflecting the sky. Several palm trees are scattered throughout the scene. In the middle ground, a cluster of buildings with red-tiled roofs is visible, surrounded by dense tropical vegetation. The background features a range of mountains under a cloudy sky. The text "The Indonesian island of Sumatra is a hot spot for geohazards." is overlaid in white, bold, sans-serif font across the center of the image.

**"The Indonesian
island of Sumatra
is a hot spot
for geohazards."**



Overview

Sitting on the Pacific Ring of Fire, the Indonesian island of Sumatra is a hot spot for geohazards. A large fault known as the Sumatran Fault, which has generated many large historical earthquakes, runs the entire length of the island. The Sunda megathrust located off the island's western coast has produced five great earthquakes in the past decade. Sumatra itself is home to more than 30 volcanoes. Many of Sumatra's 50 million residents live in these at-risk areas.

Scientists from the Earth Observatory of Singapore are studying geohazards in Sumatra and beyond. Understanding the geological processes behind these hazards that threaten Sumatra will save lives and create a safer environment for local communities.

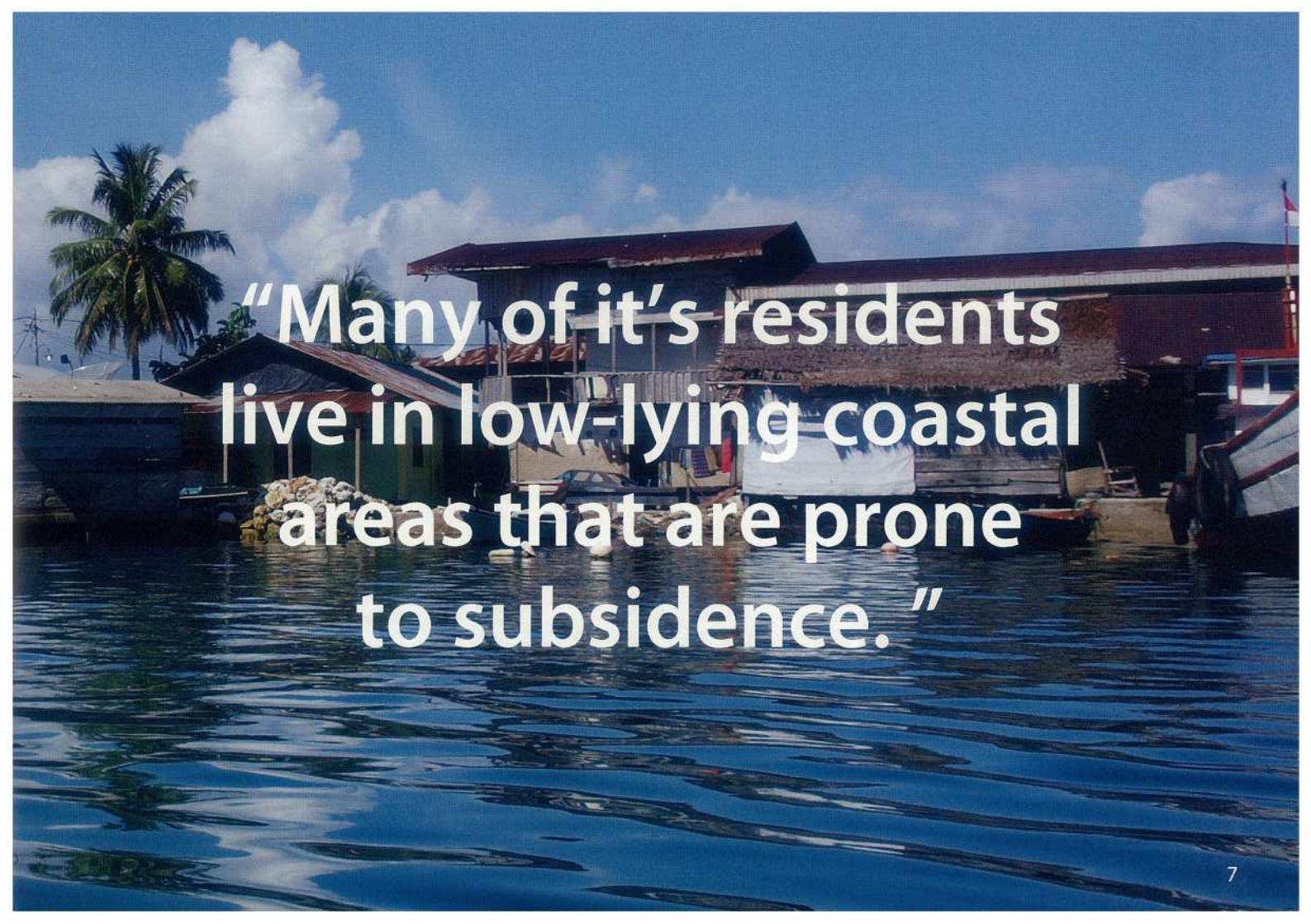
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Climate Research in Sumatra


In the face of a changing climate, Sumatra is particularly at risk. Many of its residents live in low-lying coastal areas that are prone to subsidence. Emma Hill and her team are analysing data from satellites, GPS stations, and tide-gauges to understand the processes that contribute to subsidence and to help Sumatran residents avoid serious land loss and flooding.

Haze from Sumatra has been plaguing Southeast Asia for decades. In the first study of its kind, Mikinori Kuwata's research group will be monitoring haze in Sumatra to help climate scientists model the haze and quantify its environmental impact.

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A photograph of a coastal area with buildings and boats in the water, illustrating the text about subsidence. The scene shows a body of water in the foreground with ripples. In the middle ground, there are several buildings, some with corrugated metal roofs and others with thatched roofs. A large palm tree is visible on the left. Several boats are docked or floating in the water. The sky is blue with some white clouds. The text is overlaid in the center of the image.

**“Many of it’s residents
live in low-lying coastal
areas that are prone
to subsidence.”**

A scenic view of a tropical landscape. In the foreground, there are lush green plants, including banana trees. In the middle ground, there are several small houses with tiled roofs, some of which are partially obscured by the vegetation. In the background, a large, rugged mountain (volcano) rises against a cloudy sky. The overall atmosphere is serene but carries a sense of potential danger due to the presence of the volcano.

**“Knowing a
volcano’s past
allows volcanologists
to anticipate its future
hazards and save lives.”**



Hazards from Sumatran Volcanoes

Although Sumatra is home to several volcanoes, there have not been many devastating eruptions in recent years. The shapes of many of these volcanoes, however, suggest that they have a rich eruptive history. Caroline Bouvet's volcano petrology group is studying the shape and chemistry of Sumatran volcanoes to reconstruct their histories. Knowing a volcano's past allows volcanologists to anticipate its future hazards and save lives.

Benoit Taisne and his team are monitoring volcanoes using infrasound sensors that locate the imperceptible atmospheric sounds that volcanic eruptions generate over thousands of kilometres away. They built an infrasonic array in Singapore to trace and classify infrasound signals, which can detect volcanic explosions in Sumatra and beyond.

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The Sumatran Fault

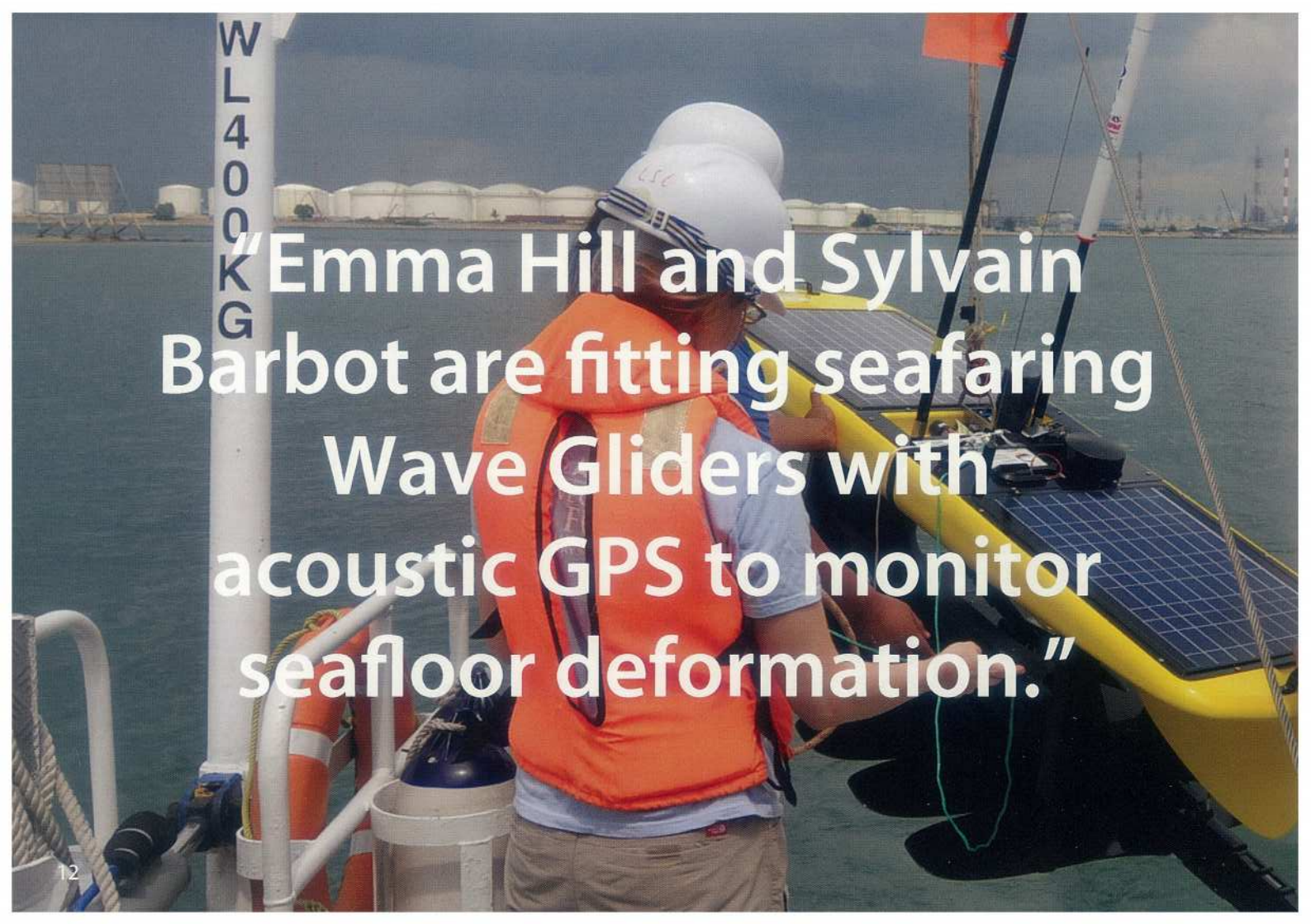
Spanning the entire length of Sumatra, the Sumatran Fault has drawn comparisons to the San Andreas Fault in the United States but the former is much less studied. By learning more about the Sumatran Fault's past and present movement, Observatory researchers will better understand its behaviour and seismic hazard.

Using data from the Sumatra Monitoring (SuMo) network of nearly 100 Global Positioning System sites along the fault, Emma Hill and her team are determining current slip rates for different segments of the fault zone. Using mapping and geological dating techniques, Kerry Sieh's group is estimating the fault's slip rate over tens of thousands of years.

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A topographic map of Sumatra and surrounding regions, including parts of the Malay Peninsula and the island of Java. The map features contour lines indicating elevation, with labels for various locations such as Meulaboh, Sibutu, and Bengkelu. A prominent red line, likely representing a major fault, runs horizontally across the map. The text overlay, in a large blue font, reads: "...the Sumatran Fault has drawn comparisons to the San Andreas Fault in the United States, but is much less studied...".

"...the Sumatran Fault has drawn comparisons to the San Andreas Fault in the United States, but is much less studied..."

A person wearing a white hard hat and an orange life vest is working on a yellow wave glider on the deck of a boat. The wave glider has solar panels and a black float. In the background, there are white storage tanks and industrial structures on a distant shore. A white vertical pole with the text 'WL400KG' is visible on the left.

WL400KG

“Emma Hill and Sylvain Barbot are fitting seafaring Wave Gliders with acoustic GPS to monitor seafloor deformation.”



The Sunda Megathrust

The region along Sumatra's southern coast hosts some of the deadliest earthquakes in the world. Earth Observatory researchers are unlocking the secrets behind these tectonic events.

The Earth Observatory of Singapore, in partnership with the Indonesian Institute of Sciences (LIPI), maintains the Sumatran GPS Array, a 60-station continuous Global Positioning System (GPS) network that monitors tectonic activity processes along the Sumatra subduction zone.

Emma Hill and Sylvain Barbot are fitting seafaring Wave Gliders with acoustic GPS to monitor seafloor deformation. Kerry Sieh's team recently wrapped up a project using corals to measure land-level change, illuminating past earthquake cycles.

Paul Tapponnier and Visiting Professor Satish Singh completed a research cruise along the Mentawai Gap, a section of the subduction zone where a major earthquake has not occurred in the past 200 years. This region is also of interest to Shengji Wei and Sylvain Barbot, who are using seismic and GPS equipment respectively, to monitor the Mentawai Gap.

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The background image is a composite. The top portion shows a grey, overcast sky. The bottom portion shows a dark, muddy ground covered in debris, including what appears to be twisted metal and other unrecognizable fragments. On the right side, there is a vertical strip showing a blue metal structure, possibly a collapsed building or bridge, and more debris below it.

Tsunami Hazards in Sumatra

The 2004 Indian Ocean tsunami devastated coastal regions in Asia, killing an estimated 230,000 people and displacing almost two million people. Observatory researchers are approaching geohazard preparedness from different angles. In his Aftermath of Aid project, Patrick Daly's team spent a decade gathering data on tsunami reconstruction projects and whether those projects reduced risk. Kerry Sieh's group is researching how tsunamis affected Aceh, Indonesia, in the 1300s. To spread geohazard awareness, Isaac Kerlow completed *Ichiro and the Wave*, a documentary film about the tsunami, and released multi-language editions of *Earth Girl 2*, an interactive game about geohazard preparedness.

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A photograph of a blue fishing boat beached on a shore covered in debris and rocks. The boat is tilted and appears damaged. In the background, there is a body of water and a cloudy sky. The text is overlaid in white, bold font.

**"...Patrick Daly's team
spent a decade gathering
data on tsunami
reconstruction projects..."**

A young boy with dark hair and a thoughtful expression is looking towards a vertical wooden post. The post is painted with horizontal bands of red and blue. The background is a blurred outdoor setting with warm, golden light.

Other Research Projects

Sumatra is far from the only region in Asia at risk from natural disasters. Our scientists are working in several countries across Asia on multiple projects, from researching tectonics in Nepal and searching for an impact crater in Laos to studying volcanoes in the Philippines and demystifying climate history in Vietnam.

Publications

The online list contains all authored publications in 2015 by Principal Investigators, Research Fellows, staff members and PhD students at the Earth Observatory—organised by research area.

Research Map

The Earth Observatory's mission takes our scientists all across Asia to study geohazards, from the Mayon Volcano in Philippines and the corals in Vietnam to cave deposits in China and tectonic plate movement in Nepal. The online map shows where our researchers have been in the past year.

To read more about our projects, and to view the full report, visit
<http://www.earthobservatory.sg/annualreport2015>

Community Engagement Office

This past year, the Community Engagement Office organised outreach events, hosted visitors on-site, and expanded relationships with both the scientific and non-scientific communities. The ultimate goal of the Office is to further the Observatory's mission of creating safer and more sustainable societies in Southeast Asia and beyond.

Main highlights included the outreach events organised in support of the Mentawai Gap—Tsunami Earthquake Risk Assessment (MEGA-TERA) expedition and Joanne Petrina's visual archive of the scientists' field trips. Under the direction of Sabrina Smith, the Community Engagement Office expanded its communication and outreach efforts to connect and engage with a broader audience across the globe.

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Applied Projects Group

The Applied Projects Group connects geoscience researchers with policy experts to address pressing geohazards issues in Southeast Asia. Led by Andreas Schaffer, the group works closely with EOS scientists, leading academics, and geo-risk experts to assess and mitigate risks surrounding climate change, earthquakes, tsunamis, and volcanoes.

2015 was an eventful year for the Applied Projects Group. They successfully secured two externally funded grants to conduct valuable studies in both Singapore and Thailand. The Applied Projects Group has also been appointed to support the implementation of the ASEAN India Project on Enhancing Local Level Climate Change Adaptation in Southeast Asia.

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Technical Office

The Technical Office manages all field instrumentation networks developed by the Earth Observatory of Singapore. Currently active permanent instrumentation networks include GPS, broadband seismic, infrasound, and other geophysical installations. These networks are spread across seven countries throughout Asia.

After the magnitude-7.8 Nepal earthquake occurred in April 2015, the team, led by Paramesh Banerjee, installed six new broadband and strong-motion seismic stations in the area. They also carried out LiDAR surveys in Nepal and Myanmar, set up a 30-station broadband seismic network in Myanmar, installed five infrasound stations in Singapore and continued seismic and telemetry installations at both Gede, Salak, and Mayon, EOS' laboratory volcanoes.

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A photograph of three people in a lush green rice field in Bali, Indonesia. In the foreground, a person wearing a light-colored bucket hat and a backpack with a 'patagonia' bag is looking at a map. Another person in a green shirt is partially visible on the right. The background shows a dense field of rice plants and palm trees under a clear sky.

“...students marked
the end of their first
academic year with an
overseas field trip in
Bali, Indonesia.”



Asian School of the Environment

The Asian School of the Environment is an interdisciplinary school in the Nanyang Technological University College of Science that trains future leaders to face Asia's biggest environmental challenges.

The School offers a rigorous PhD programme in Earth Sciences and an undergraduate degree that facilitates hands-on education. Students have a wide range of research opportunities, including designing wave gliders for recording seafloor movement and reconstructing historical typhoons. The undergraduate students marked the end of their first academic year with an overseas field trip in Bali, Indonesia. The trip enabled the students to learn practical skills and experience what it is like to work in the field.

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Impact

Over the past year, the Earth Observatory of Singapore has expanded its reach and grown its global network. We're connecting with a broader audience from local educators to international agencies, addressing crucial issues in Southeast Asia through events such as workshops and onsite seminars. We've also increased engagement throughout our social channels. Here's how our impact has grown in the past year. Honours include:

Best Student Poster at the 12th Asia Oceania Geosciences Society Meeting

Yudha Djamil

Best Animation at the Williamsburg International Film Festival 2015

SHADOWS

Silver Winner at the Serious Play Conference

Earth Girl 2

FaceBook likes jumped 5X from 478 in April 2015 to 2,549 in March 2016

539,000 visitors to earthobservatory.sg

72 seminars and workshops held on-site

Supporters

Sustainable funding and strong partnerships are vital to our success in understanding geoscience in Southeast Asia and beyond. Thanks to our generous supporters who believe in building safer and more sustainable societies.



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