



## Tonga Volcano Impacting Weather

**For Prelims:** [Hunga Tonga-Hunga Ha'apai](#), Pinatubo, Krakatoa, Tambora, Samalas, Greenhouse Gases, [El Niño](#), [Paris Agreement](#), IPCC, Cooling credits, Sun dimming.

**For Mains:** [Effect Of Volcano On Global Warming](#), Types of volcano

[Source: TH](#)

### Why in News?

A recent study published in the Journal of Climate revealed that the eruption of the **Hunga Tonga-Hunga Ha'apai Volcano** in January 2022 has had significant implications for global weather patterns.

### Hunga Tonga-Hunga Ha'apai Volcano

- It is an [Undersea Volcanic Eruption](#) consisting of two small uninhabited islands, **Hunga-Ha'apai** and **Hunga-Tonga**.
  - The volcano has **erupted regularly** over the past few decades.
- This is one of the massive explosions the volcano is capable of producing roughly every thousand years.
- One of the reasons for it being highly explosive is the **Fuel-Coolant interaction**.
- The Hunga Tonga eruption's unique characteristic of injecting **massive water vapour** into the stratosphere.
  - Usually, volcanic smoke, which mostly contains **sulphur dioxide**, leads to a **temporary cooling** of the Earth's surface.
    - The sulphur dioxide turns into **sulphate aerosols, which reflect sunlight into space**, causing the surface to cool down until the sulphate settles back on the surface or is washed out by rain.

### What are the Effects of the Hunga-Tonga Volcano on the Climate?

- **Extraordinary Ozone Hole in 2023:**
  - Since, Hunga Tonga is an **underwater volcano**, it produced 100-150 million tonnes of **water vapour** during its eruption, **raising the amount of water in the stratosphere by around 5%**.
    - This water vapour in the stratosphere contributes to the **destruction of the ozone layer and acts as a potent greenhouse gas**.
  - The study found that the **large ozone hole** observed from August to December 2023 was at least partly due to the Tonga eruption.
  - This **ozone hole was almost two years in advance**, as the water vapour from the eruption **had enough time to reach the polar stratosphere over Antarctica**.

- **Wet Summer of 2024 in Australia:**
  - The study predicted a positive phase of the **Southern Annular Mode** during the summer of 2024, leading to a higher chance of a wet summer in Australia.
  - This was **contrary to the expected El Niño conditions**.
- **Regional Weather Disruptions:**
  - The study **predicts colder and wetter than usual winters** for the northern half of **Australia up to around 2029**.
  - **North America may have warmer than usual winters**, while **Scandinavia can have colder than usual winters**.
  - These regional weather patterns are attributed to the Tonga eruption's impact on the way **atmospheric waves** travel, which directly influences local weather conditions.
    - This emphasises the **need for region-specific climate predictions and adaptation strategies**.
- **Minimal Impact on Global Temperatures:**
  - The impact of the eruption on **global mean temperatures was very small, around 0.015°C**.
  - The **incredibly high temperatures observed for about a year** cannot be attributed to the Tonga eruption.

# VOLCANOES

*A volcano is a vent or a fissure in the crust from which lava (molten rock), ash, gases, rock fragments erupt from a magma chamber below the surface*

- **Types: On basis of -**
  - **Periodicity of Eruption:**
    - **Active volcano:** Recently Erupted
    - **Dormant Volcano:** Potential for eruption, no imminent signs
    - **Extinct:** No recent eruptions, low possibility in future
  - **Nature of Eruption:**
    - **Hawaiian:** Calmest types (low gaseous content)
    - **Strombolian:** Formation of large gas bubbles in magma
    - **Vulcanian:** More explosive
    - **Plinian eruptions:** Magma's volatile gases rise via a narrow conduit
    - **Icelandic:** Often build lava plateaus
  - **Shape of Volcanoes:**
    - **Shield volcanoes:** Composed of basaltic lava, low slope
    - **Cone volcanoes (Cinder Cones):** Most abundant
    - **Composite cones (stratovolcanoes):** Formed by layers of diverse materials.
- **Volcanic Features:**
  - **Extrusive :**
    - **Crater:** Cone-shaped vent for magma
    - **Caldera:** Large, crater-like depression
    - **Volcanic Plateaus:** Leveled areas from fissure eruptions
  - **Intrusive:**
    - **Batholiths:** Central core of a volcanic mountain.
    - **Dyke:** Vertical intrusion cutting across country rock bedding.
    - **Sills:** Tabular intrusions along sedimentary bedding.
    - **Laccoliths:** Magma injection along horizontal sedimentary bedding.
  - **Minor:**
    - **Geysers:** Underground water above 100°C, powered by magma, results in powerful eruptions with steam and diluted minerals.
    - **Hot Springs:** Heated water flows quietly along fault zones.
- **Distribution of Volcanoes:**
  - Subduction zones (Circum Pacific Belt)
  - Divergence zones (Mid Atlantic Ridge)
  - Intra-plate oceanic volcanism (Hawaiian chain)
  - Mid-continental belt and volcanoes in Mediterranean region
- **Volcanoes in India:**
  - No volcanoes in Himalayas
  - Barren Island (Only active volcano)
- **Products of Volcanic Eruption:**
  - **Gases:** H, C, O, S, N, CH<sub>4</sub>, NH<sub>3</sub>
  - **Solid:** Pyroclastic materials
  - **Liquid:** Lava

## Undersea Volcano

- The undersea volcanic eruption happens in a volcano which is located **under the ocean surface**. There are an estimated one million undersea volcanoes, and most of them are **located near the tectonic plates**.
- Apart from lava, these **openings also spew out ash**. These deposit on the ocean's floor and lead to the formation of **sea mounds (underwater mountains that are formed on the ocean floor but do not reach the water surface)**.

## Fuel-Coolant Interaction

- If **magma rises into seawater slowly**, even at temperatures of about 1200 degrees Celsius, a **thin film of steam forms between the magma and water**. This provides a **layer of insulation** to allow the **outer surface of the magma to cool**. But this process doesn't work when magma is **blasted out** of the ground full of volcanic gas.
- When **magma enters the water rapidly**, any steam layers are **quickly disrupted, bringing**

hot magma in direct contact with cold water. It is akin to weapons-grade chemical explosions.

- Extremely violent blasts tear the magma apart.

- A **chain reaction begins**, with new magma fragments exposing **fresh hot interior surfaces to water**, and the explosions repeat, **ultimately jetting out volcanic particles and causing blasts with supersonic speeds.**

# Volcano Facts

## The Bad

- **Ash**
  - Causes respiratory problems
  - Triggers **lightning**
- **H<sub>2</sub>O (water vapour)**
  - Largest contributor to **greenhouse gas** effect on earth
- **CO<sub>2</sub> (carbon dioxide)**
  - **Toxic** in large amounts >10%
  - Contributes to **global warming**
- **SO<sub>2</sub> (sulfur dioxide)**
  - Dissolves in water vapour to form damaging **acid rain**
- **H<sub>2</sub>S (hydrogen sulfide)**
  - **Highly toxic** gas that smells like rotten eggs

## The Good

### Source of materials

Metals, precious gems, and construction material

### Power Generation

Geothermal and hydroelectric opportunities

### Rich volcanic soils

Yay coffee! The best coffee grows in volcanic soils

92,000

People killed in the deadliest volcano in **Indonesia** in **1815**

20

Volcanoes are **erupting** right **Now**

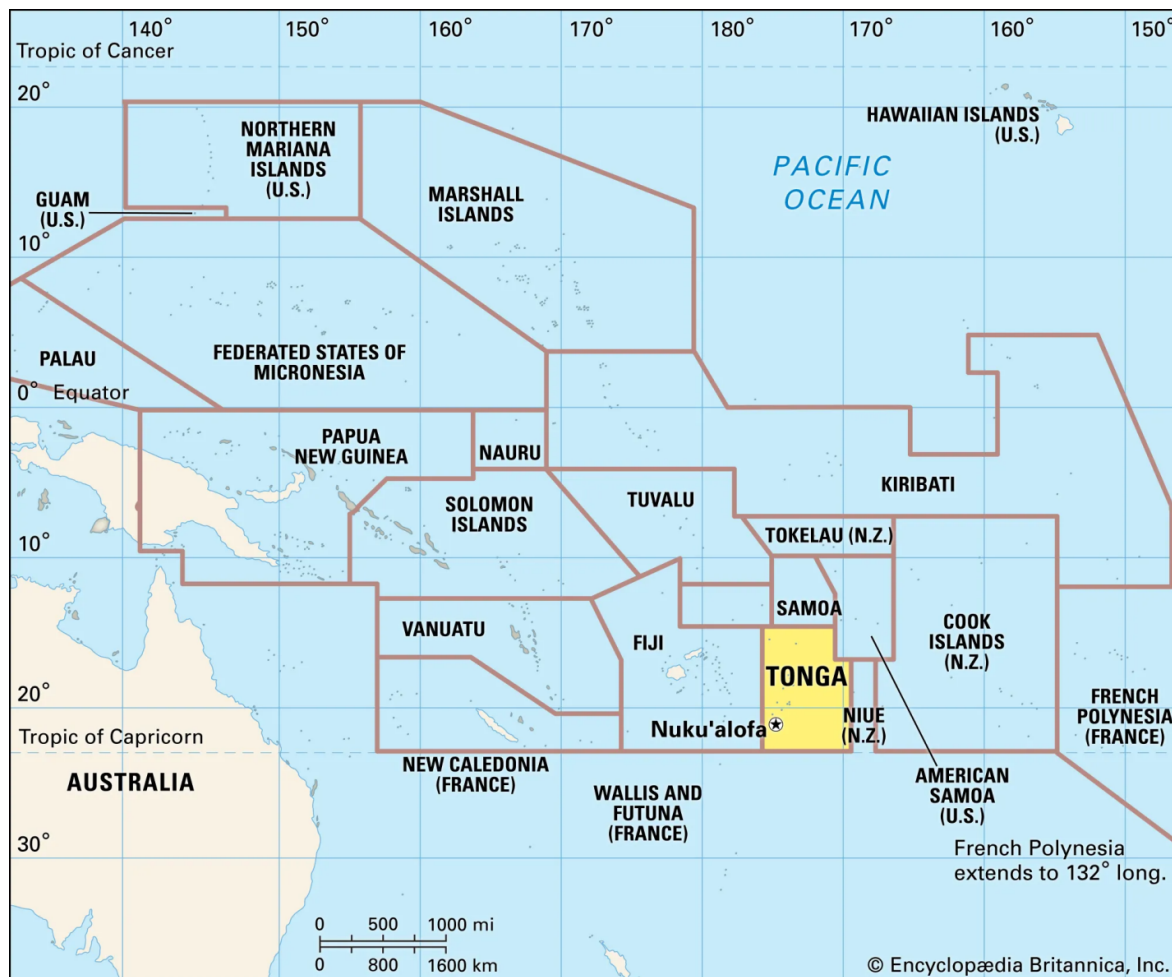
**Supervolcanoes** can plunge the world into an **ice age**

Krakatoa eruption **ruptured** eardrums within **50 KM** radius

**2X** more **ash** by weight erupted from Mt. St Helens (USA) in 1980 than garbage the entire US produces in 1 year

**\$2.2 Billion** worth of electrical energy wasted by Krakatoa volcano in **1883, Indonesia**

- Tonga is an island country in **Polynesia**, part of Oceania, with 171 islands, of which 45 are inhabited.
- The country spans approximately 800 km north-south and is **surrounded by Fiji, Wallis and Futuna, Samoa, New Caledonia, Vanuatu, Niue, and Kermadec**.
- Tonga has a **tropical rainforest climate**. The economy relies heavily on remittances from Tongans living abroad, particularly in Australia, New Zealand, and the United States.
- The **economy focuses on small-scale industries** like handicrafts and agriculture, with efforts to enhance sectors such as tourism and communications.
- The **largest ethnic group in Tonga is Tongan**, followed by a mix of Tongans, Chinese, Fijians, Europeans, and other Pacific Islanders.



### **Drishti Mains Question:**

Discuss the factors leading to volcanic eruptions. Also, suggest mitigation strategies for managing volcanic hazards in India.

## **UPSC Civil Services Examination, Previous Year Question (PYQ)**

### **Prelims**

**Q. Consider the following: (2013)**

1. Electromagnetic radiation

2. Geothermal energy
3. Gravitational force
4. Plate movements
5. Rotation of the earth
6. Revolution of the earth

**Which of the above are responsible for bringing dynamic changes on the surface of the earth?**

- (a) 1, 2, 3 and 4 only
- (b) 1, 3, 5 and 6 only
- (c) 2, 4, 5 and 6 only
- (d) 1, 2, 3, 4, 5 and 6

**Ans: (d)**

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**Mains:**

**Q.** Discuss about the vulnerability of India to earthquake related hazards. Give examples including the salient features of major disasters caused by earthquakes in different parts of India during the last three decades. **(2021)**

**Q.** Why are the world's fold mountain systems located along the margins of continents? Bring out the association between the global distribution of fold mountains and earthquakes and volcanoes. **(2014)**

**Q.** Mention the global occurrence of volcanic eruptions in 2021 and their impact on regional environment. **(2021)**

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