Global Trends in Satellite-Based Emergency Mapping

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Outline

- Introduction
- Satellite-based emergency mapping(SEM)
- Temporal Trends in Emergency response
- Global Spatial Patterns in SEM
- SEM Distributions
- Future Direction
- Conclusion

Overview

- Explore global trends in emergency mapping 2000-2014
- Analyze over 1000 events where monitoring used
- Where was satellite emergency mapping mostly used?
- Where will the field go in the future?

Introduction

- Over the past 15 years, scientists and disaster responders have increasingly used satellite-based Earth observations for global rapid assessment of disaster situations.
- Disaster responders and the humanitarian community increasingly use Earth Observation (EO) satellite systems to assess the impact of and to plan and coordinate emergency response activities after major natural disasters around the world.
- EO satellites provide emergency responders with a situational overview otherwise difficult to obtain during an ongoing disaster event.

Satellite-based emergency mapping (SEM)

- Local, national, and international agencies use satellite-based emergency mapping (SEM) as part of larger resilience strategies to help design, implement, and evaluate disaster risk reduction and recovery programs.
- The ultimate goal of SEM is to improve disaster relief effectiveness and thus to help reduce suffering and fatalities before, during, and after a disaster event occurs.

Major events that influenced SEM community

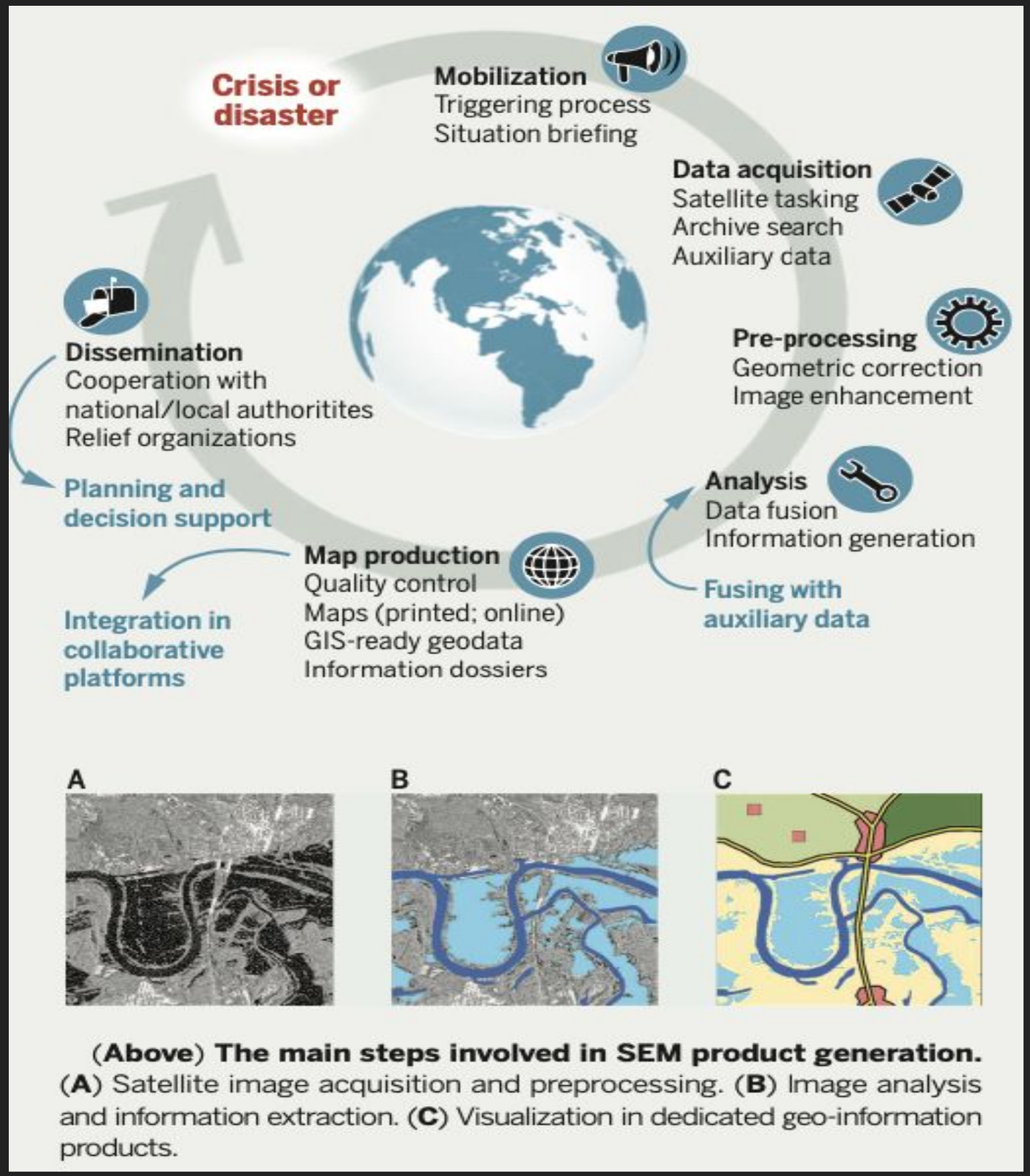
- The Indian Ocean Tsunami in 2004 - During the disaster, satellite mapping played an important role by providing an overview of the situation on the ground and helping people to understand the magnitude of devastation caused by the tsunami.

- The Wenchuan Earthquake in 2008 - During this event, it became clear that satellite imagery alone could not suffice to assess more subtle structural earthquake damage to buildings and infrastructure. As a result, the emergency-mapping community realized the need for airborne sensors and imagery from unmanned airborne vehicles (UAVs) in order to complement satellite-derived products.

- The Haiti Earthquake in 2010 - During this event many satellite-based emergency maps were produced by many different organizations, which led to an overflow of SEM products. As a result, the International Working Group on Satellite-based Emergency Mapping was established to improve mutual information sharing.

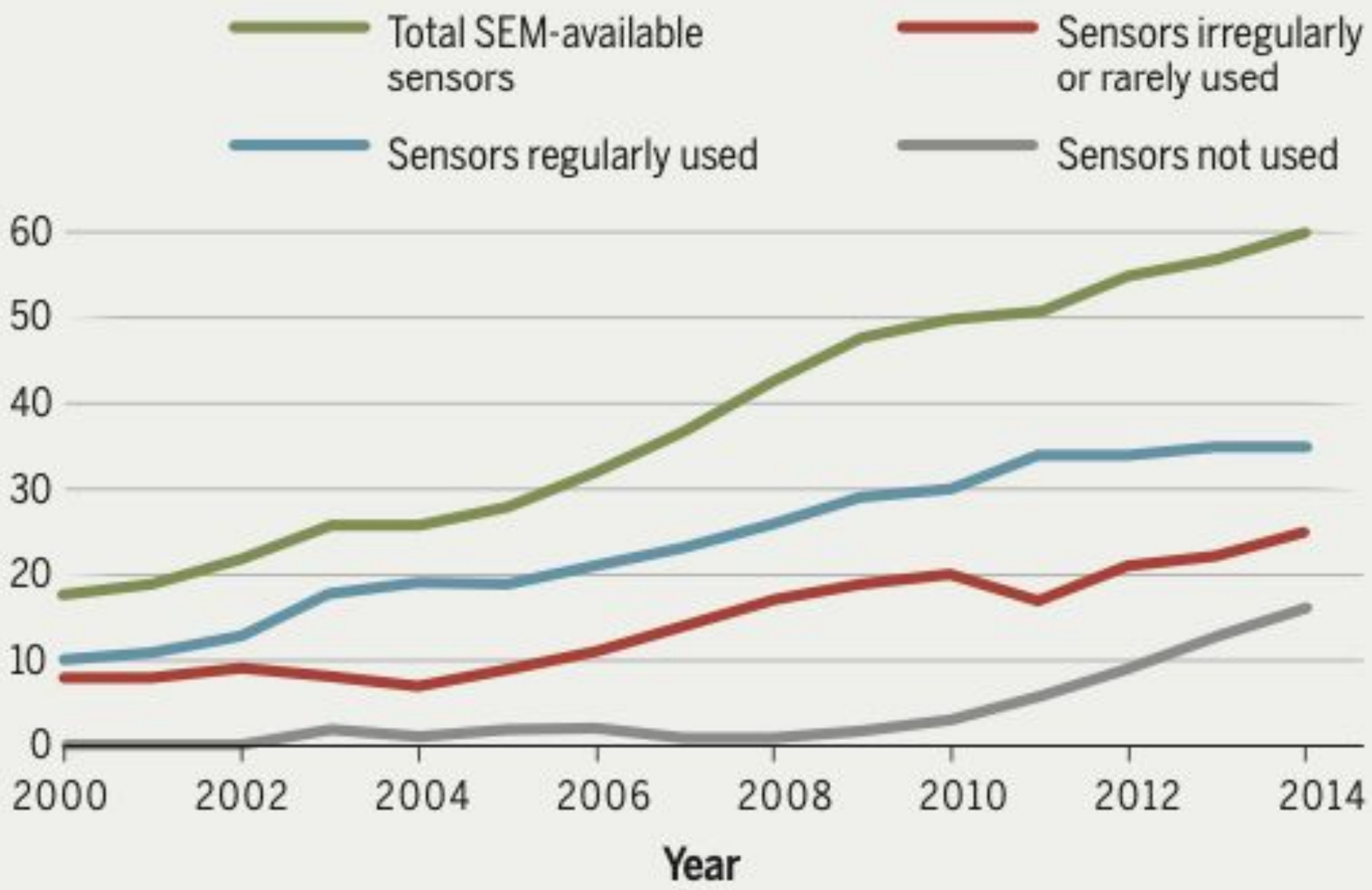
- The Great East Japan Earthquake in 2011 - the Japan Aerospace Exploration Agency enlisted the help of international SEM organizations collecting more than 5000 satellite images for assessment after the earthquake. These images were used to determine the overall extent of the damage and assess local conditions such as the availability of key facilities, allowing for the prioritization of the disaster response activities.

Steps involved in SEM product generation

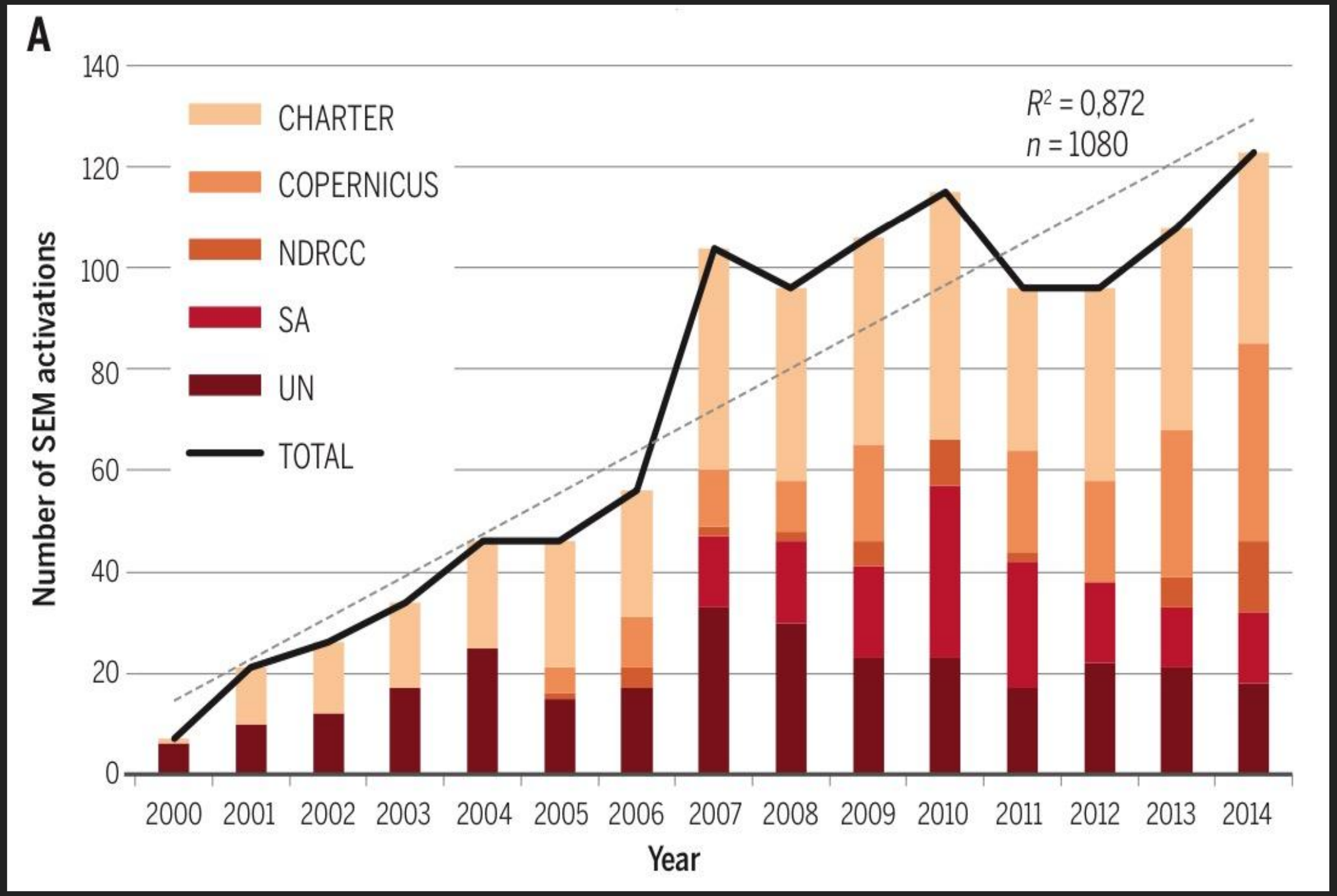


(**Above**) **The main steps involved in SEM product generation.** (**A**) Satellite image acquisition and preprocessing. (**B**) Image analysis and information extraction. (**C**) Visualization in dedicated geo-information products.

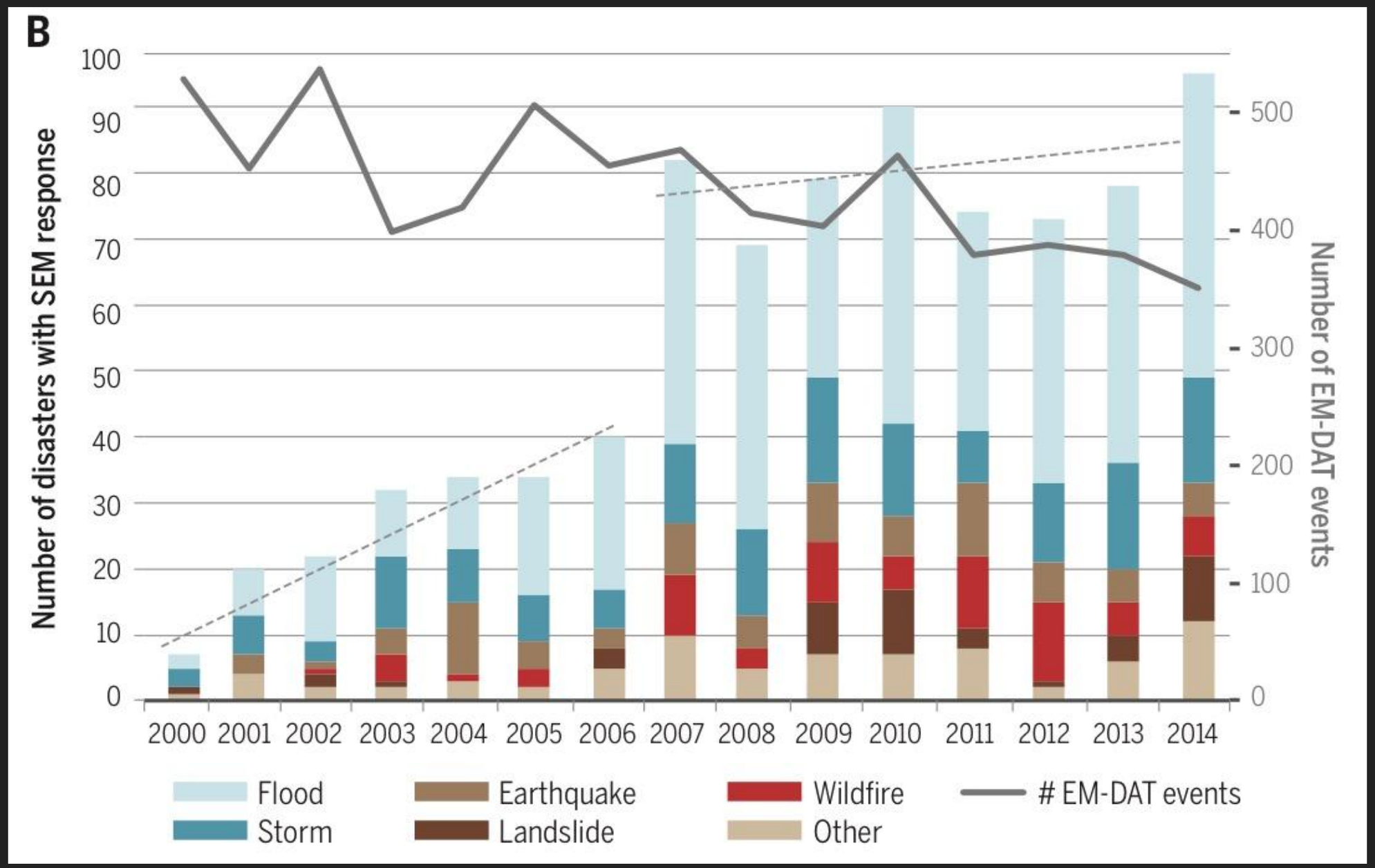
Number of optical and radar satellite sensors (<300 MGSD)



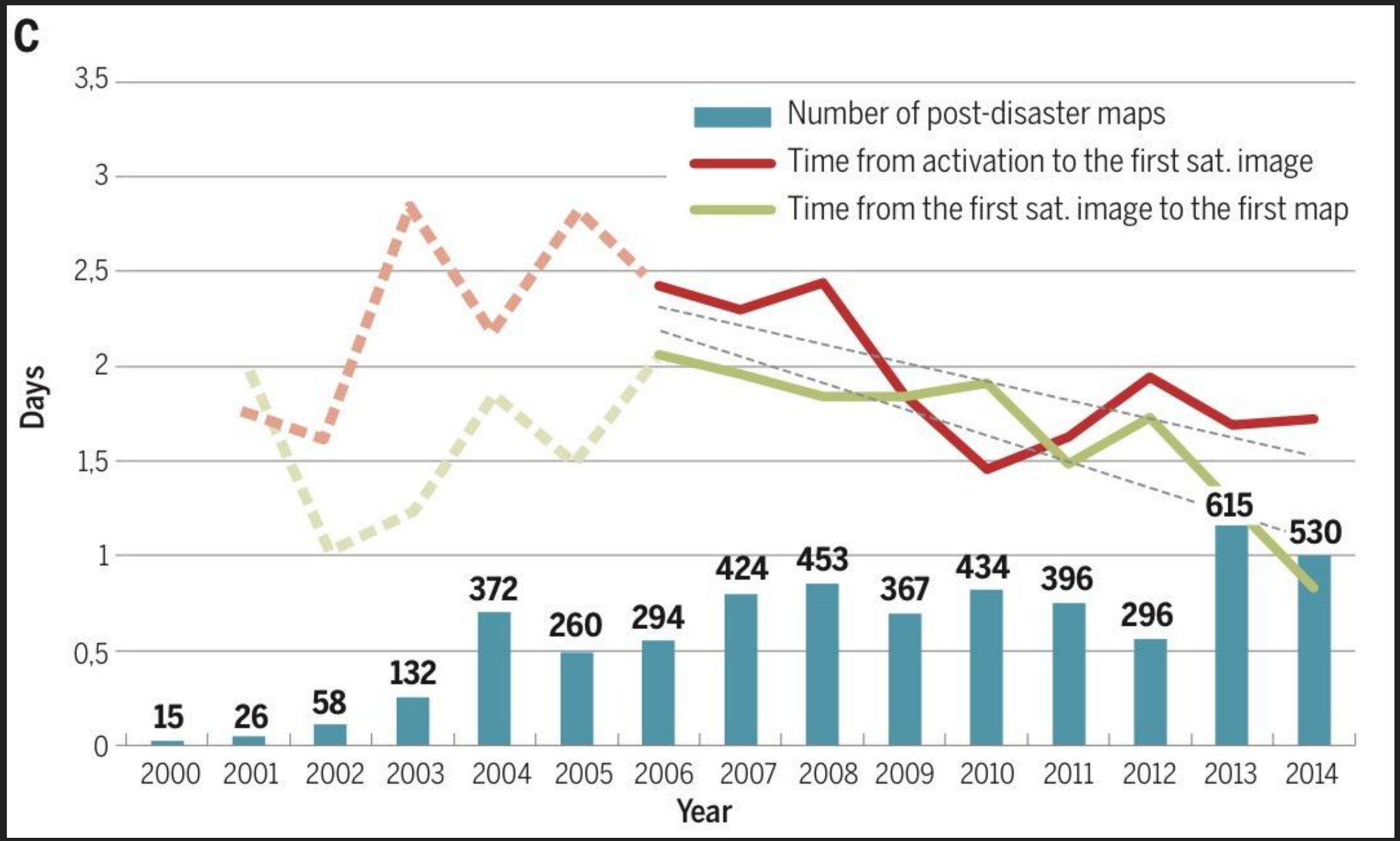
Number of SEM Activations



Differentiation by disaster types over time



Map production volumes and response times



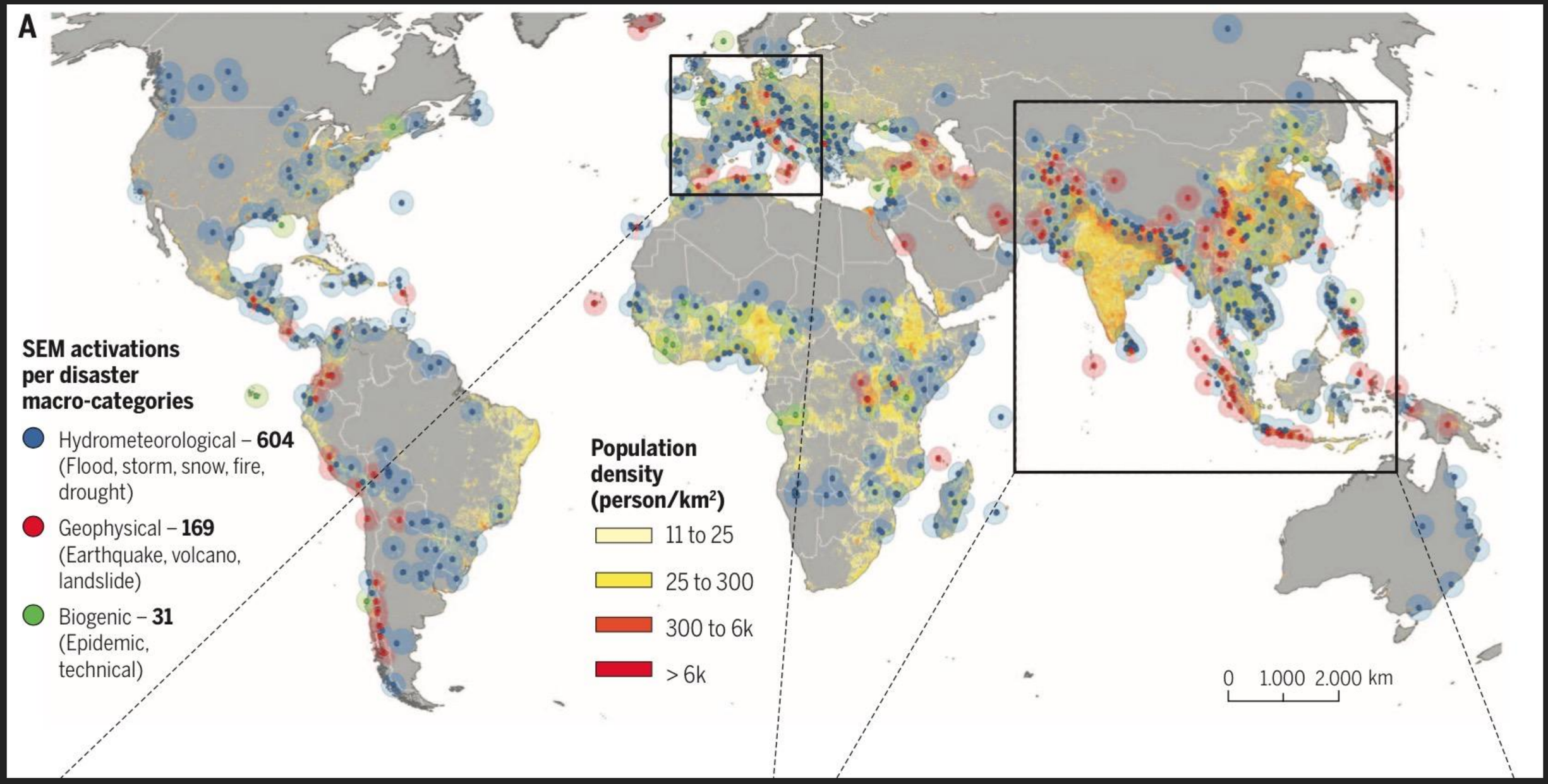
Global Spatial Patterns in SEM

- Large majority (~75%) of SEM activations related to hydrometeorological disasters
  - flood, storm, snow, fire, drought
  - mainly in Americas, Africa, SE and E. Asia, and Europe

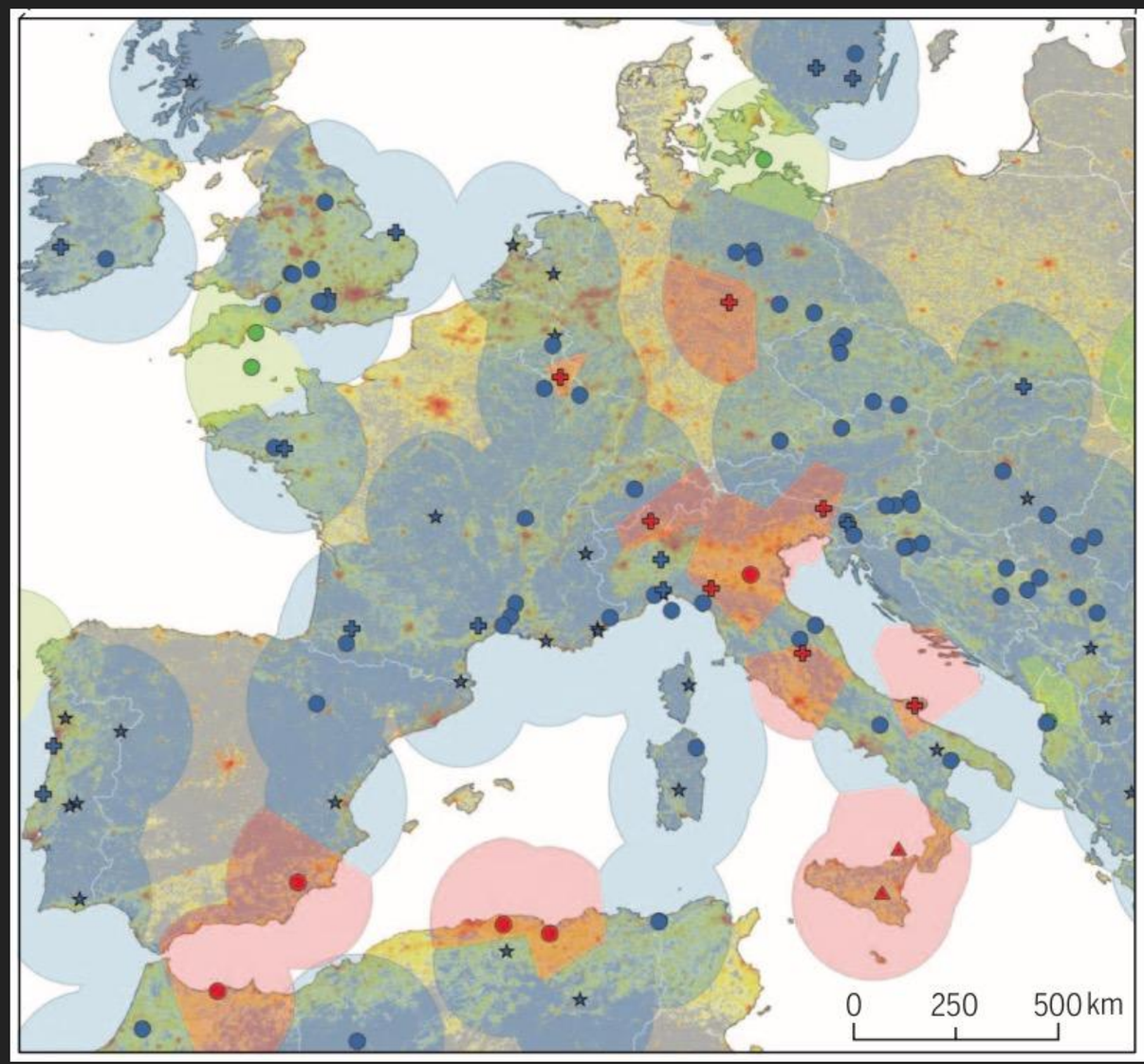
- SEM activations due to geophysical disasters (~21%)
  - earthquake, volcano, landslide
  - Nazca/S. America plate boundary, Eurasian/Indo-Australian plate boundary

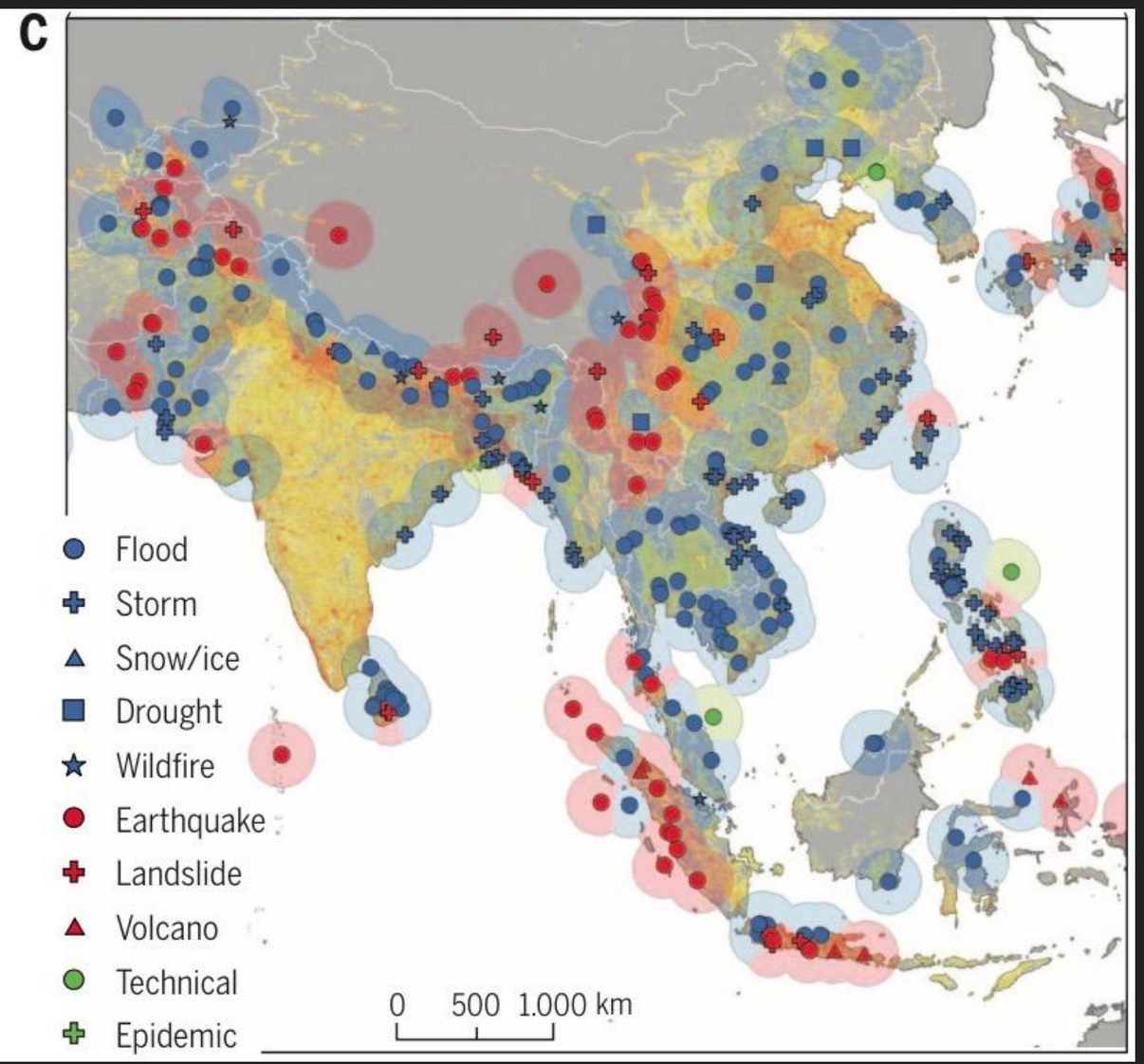
- Mixed clusters of geophysical and hydrometeorological
  - European, Himalayan, N. Andes, C. America, and Caribbean

Global Spatial Patterns in SEM



Global Spatial Patterns in SEM



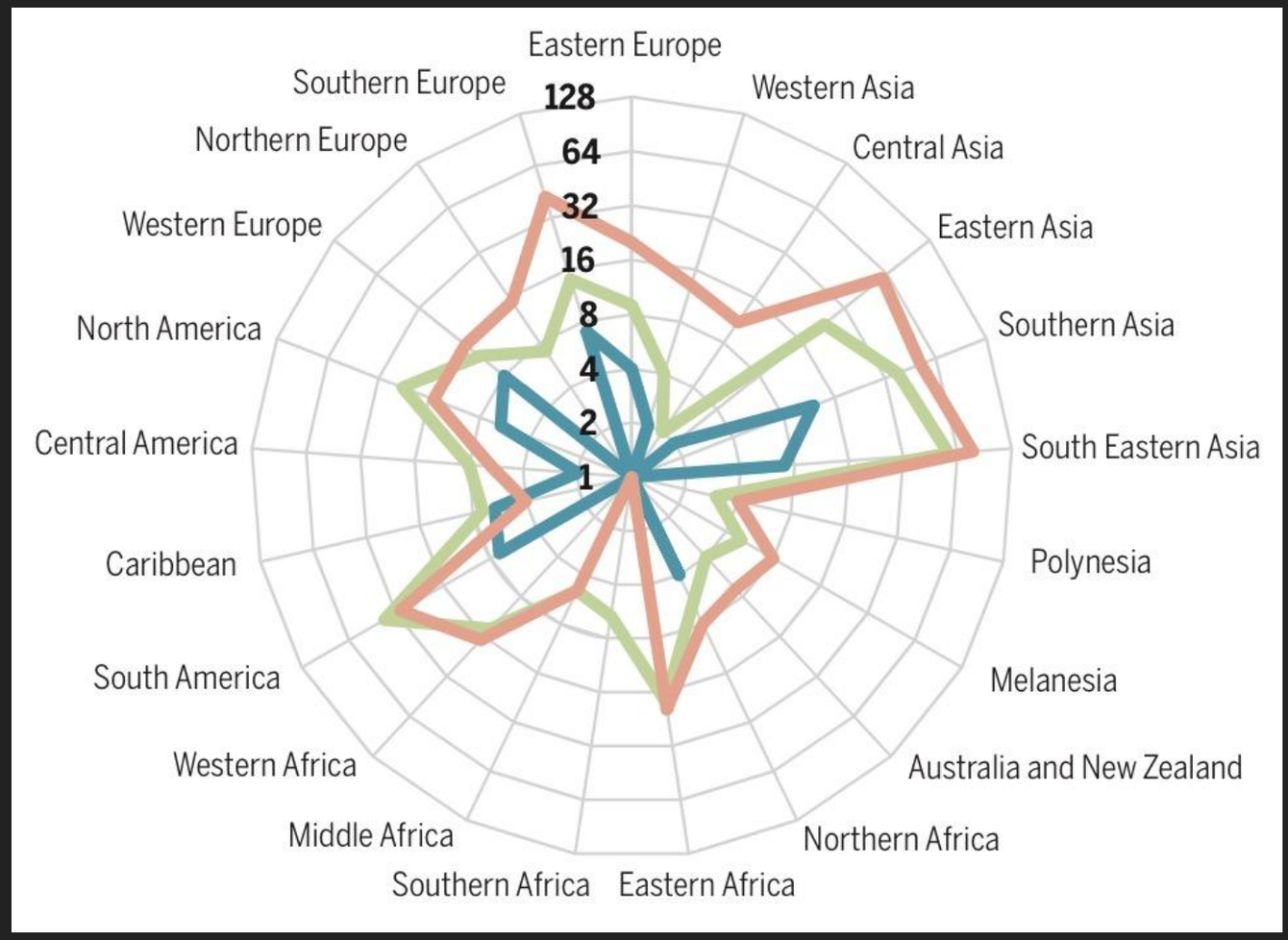


Global Spatial Patterns in SEM

- Generally, the locations of SEM activations resemble the large global natural hazards patterns, with the seismic active zones and the major storm systems
- Spatial correlation between location of the SEM activities and densely populated areas of the world.
  - Human exposure drives the decision to request international SEM
- Outlier: India
  - why? many parts of India don’t have international SEM activations
  - assumption is that there is a large preference for domestic SEM capacities instead of asking for international help

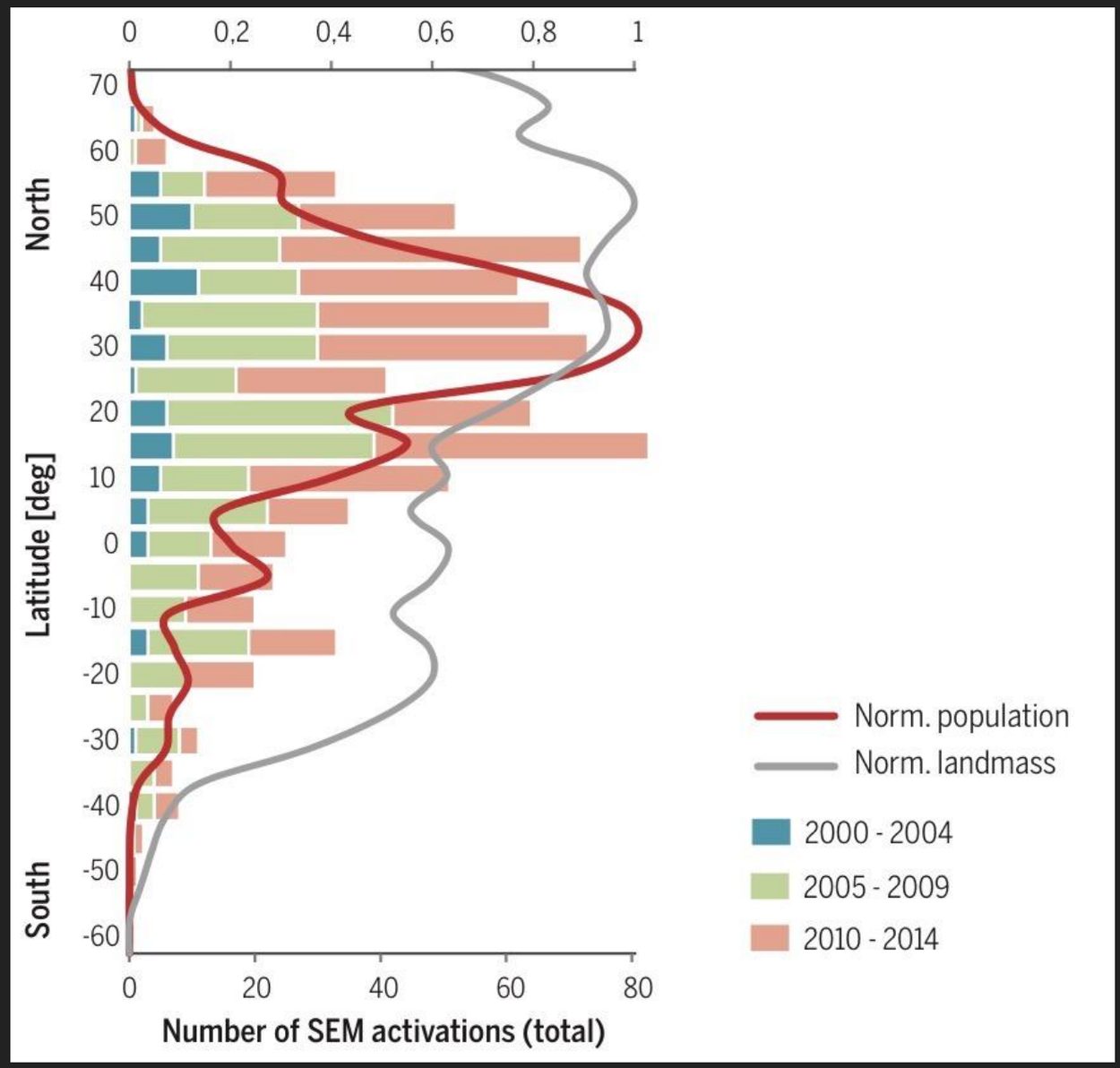
SEM Distributions

- 25% of all international SEM activations covered only 6 countries, 50% covered 21 countries, and 75% covered 50 countries
- Main global focus of SEM activity is Asia
  - more disasters occur in Asia than other continents
- SEM activities rose in almost all regions of the world in the past 5 years
  - exceptions: Caribbean, C. America



Latitudinal Distributions

- North/South distribution matches global population distribution
- Outliers:
  - 15°N & 15-20°S
    - frequent flooding and cyclone storm events
  - 25°N
    - Indian subcontinent, large pop but few intl SEM activations



Recent SEM Direction

- Prediction of slow onset events with vast geographical impact
  - drought/water scarcity
  - health crises
    - 2015 Ebola crisis
      - mapping and planning of health posts
      - locations of oil palm trees (fruit bats)
- Expansion of regular SEM response
  - 2015 Nepal earthquake
    - extensive use of ad hoc satellite imaging, going beyond regular SEM response
      - survey geohazards: landslides and destabilized glacier lakes

Future of SEM

- Very-high-resolution imaging
  - large increase in available data
  - data mining will become very important

- Near real-time observations
  - direct monitoring from space
  - landslides, lava flows, floods

- Fusion with crowd-sourced and social media information
  - online imagery access will greatly increase

Conclusion

- Global SEM activities are evolving
- Scope should be broadened
  - drought
  - extreme temperature events
  - global pandemics and slow onset events
- Challenge
  - satellite tasking, reprogramming, image collection
- Future
  - higher resolution capabilities lead to

Thank You

Questions ?