of ground/atmosphere, presence and absence of snow/cloud cover and phenological alterations and hence may show changes even when none exists[4]. (iii) Images of two different dates of coverage cannot be taken exactly in similar climatic conditions, because of dynamic characteristic of humidity, aerosols and solar radiation, resulting in some inherent errors. (iv) NDVI is also sensitive to anisotropic and satellite sensor effects, which is bound to influence the results.

Although this deviation in results is mainly attributed to the variation in definition, time series, instrument peculiarities, target area factors, differences in the mindset of experts and methodology, the high degree of difference limits the usefulness of the method and suggests that either NDVI is being used in some inappropriate fields or it requires more precautions for useful results. Remote sensing has become a vital tool for front-line research in almost every field, including natural resource management, hazard assessment, geology and mineral exploration, agriculture and forestry, land degradation, oceanography, environmental monitoring and specifically climate change science. Therefore, interdisciplinary science needs to be supervised by subject experts to avoid the mis-registration of imagery, associated errors and unrealistic results.

1. Negi, P. S., *Ecol. Indi.*, 2013, **25**, 85–91.
2. Singh, C. P., Panigrahy, S., Thapliyal, A., Kimothi, M. M., Soni, P. and Parihar, J. S., *Curr. Sci.*, 2012, **102**, 559–562.
3. Negi, P. S., *Int. J. Sus. Dev.*, 2012, **5**, 27–40.
4. Zhang, Y., Xu, M., Adams, J. and Wang, X., *Int. J. Remote Sensing*, 2009, **30**, 1327–1340.

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Megathrust earthquakes and the associated volcanic subsidence

Understanding the relationship between the megathrust earthquakes and volcanoes has been debated by scientists for years and past studies have suggested that large megathrust events can trigger volcanic eruptions, cause ground deformation, thermal anomalies, more earthquakes and hydrothermal changes[1–8]. However, subsidence of volcanic areas was not previously known to occur during such events. Two contributions[9,10] have recently reported this phenomenon, although they have suggested separate mechanisms for the same.

Megathrust faults are similar to the thrust faults; however, their strike length is quite large, e.g. the Sunda megathrust runs south from Bangladesh, curving around the western and southern flanks of Sumatra, Java, Bali and eastern Indonesia to northwestern Australia, stretching over a distance of 5500 km (ref. 11). Similarly, there are examples of megathrusts that run offshore in the Philippines, Taiwan, Japan and southeastern China. The megathrust faults are also found on land and the biggest one traverses from Pakistan through India and Nepal, covering a distance of 2500 km along the southern side of the Himalayan mountain range[11].

Megathrust earthquakes occur once the accumulated strain is ripe to rupture the fault and this generally happens when a locked portion of such a fault experiences continuous stress for centuries or decades via plate motions. Thus, such earthquakes are caused when the friction along the megathrust fault plane is overtaken by stick and slip mechanism. Further, there are some morphological changes which generally occur between earthquakes and particularly, on an overriding plate, that could play a vital role in understanding the fault kinematics. It is observed that between earthquakes an overriding plate generally uplifts and during an earthquake it usually subsides. These changes are measurable and could indicate the potential link between an earthquake and the changes in the total morphology of the affected area. This was the motivation for the research conducted by Takada and Fukushima[9] and Pritchard *et al.*[10]. These studies have reported that subsidence of volcanic areas occurred after the M_w 9.0 Tohoku-Oki of Japan in 2011 and M_w 8.8 Maule earthquake of Chile in 2010, respectively. These critical studies were done using satellite radar interferometric imaging[9,10], which makes it easier to understand and analyse the ground deformations associated with the earthquakes (e.g. during Tohoku-Oki and Maule events). Thus, these two studies suggest a possible interaction between earthquakes and volcanoes and how this could have implications for earthquake and volcanic hazards[12], apart from other associated processes.

1. Hill, D. and Prejean, S., *Treatise Geophys.*, 2007, **4**, 257–291.
2. Donne, D. D. *et al.*, *Geology*, 2010, **38**, 771–774.
3. Manga, M. and Wang, C-Y., *Treatise Geophys.*, 2007, **4**, 293–320.
4. Darwin, C. R., *Trans. J. Geol. Soc. London*, 1840, **5**, 601–631.
5. Linde, A. T. and Sacks, I. S., *Nature*, 1998, **395**, 888–890.
6. Manga, M. and Brodsky, E., *Annu. Rev. Earth Planet. Sci.*, 2006, **34**, 263–291.
7. Walter, T. R. and Amelung, F., *Geology*, 2007, **35**, 539–542.
8. Eggert, S. and Walter, T. R., *Tectonophysics*, 2009, **471**, 14–26.
9. Takada, Y. and Fukushima, Y., *Nature Geosci.*, 2013, **6**, 637–641.
10. Pritchard, M. E. *et al.*, *Nature Geosci.*, 2013, **6**, 632–636.
11. Sieh, K., *J. Earthq. Tsunami*, 2007, **1**, 1–19.
12. Jónsson, S., *Nature Geosci.*, 2013, **6**, 591–592.

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