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## Satellite remote sensing as a tool in disaster management and sustainable development: towards a synergistic approach

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### Abstract

Disasters have become an issue of growing concern throughout the world, whether it is natural hazards or through human factors. The frequency, as well as magnitude, of disasters threatening large population living in diverse environments is increasing in recent years across the world. These disasters also have far-reaching implications on sustainable development through social, economic and environmental impacts. It is highly imperative to develop effective tools for disaster management. Remote sensing systems have been playing a great role in disaster management in such areas as flooding, cyclones, drought, earthquake and tsunami. Satellite remote sensing is largely adopted due to its cost effectiveness, short temporal orbiting and large area of coverage. Remote sensing technologies have been used in disaster management especially during the preparedness/warning and response/monitoring stages. Despite the capabilities of remote sensing technologies in natural and human disaster management, there are still some limitations in its deployment due to the divide between developed and developing countries, data accessibility (especially high resolution imagery) and technological limitations. This paper examines the recent developments in the application of remote sensing in disaster management such as the proliferation of data through unprecedented sources (Google Earth, crowdsourcing, Global Land Cover) and improvement in data resolutions and integration of technologies. It examines how recent developments can help in overcoming the limitations of using remotely sensed data in disaster management. There is a need for more collaborative and interdisciplinary frameworks to fully utilize the capabilities of remote sensing in hazard and disaster management.

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## 1. Introduction

### 1.1. Increasing occurrences of disasters

Disasters have become an issue of growing concern throughout the world, whether it is natural disaster or through human factors. The frequency, as well as magnitude, of disasters threatening large population living in diverse environments (especially in urban areas) is increasing in recent years. For instance, Mara and Vlad (2013) showed that there is an increasing trend of earthquake occurrence and magnitude since the 1990s (Table 1). Also, Van Westen (2002) highlighted an increase in the number and severity of natural disasters between the 1960s and 1990s. Natural disasters, such as flood, drought, landslides and desertification; are sometimes the manifestation of the consequences of human interactions with the environment. The human-environment interactions that have consequences include:

(1) Land degradation that is due to unsustainable land use practices and eventually results in disaster susceptibility of the land. Deforestation and other land cover changes in the upper catchments of the rivers alter the hydrological regime, which result in flash floods causing inundations in the down streams and low-lying areas. Reduction of the vegetation cover in dry lands due to overgrazing may cause dust storms, which may form dunes and may lead to desertification and increase the exposure to drought hazard. These are instances whereby human activities induce or aggravate natural disasters.

(2) Population growth has greatly increased the number of people living in disaster prone areas. Population density has not only increased in existing problem areas, but large groups have also settled in formerly unoccupied dangerous zone (along the rivers flood plain, unstable steep slopes, marginal arid lands and young volcanic eruption areas). According to Hansen (1994) and UNDRO (1991) land degradation and population growth are interrelated therefore, more problems have evolved from uncontrollable settling of squatters and high density urban sprawl.

Table 1. Earthquakes frequency and magnitude (1981-2010). (Source: Mara and Vlad, 2013)

| Magnitude  | Year      |           |           |           |           |           |
|------------|-----------|-----------|-----------|-----------|-----------|-----------|
|            | 1981-1985 | 1986-1990 | 1991-1995 | 1996-2000 | 2001-2005 | 2006-2010 |
| 8.0 to 8.9 | 1         | 2         | 4         | 3         | 5         | 7         |
| 7.0 to 7.9 | 58        | 48        | 70        | 73        | 66        | 73        |
| 6.0 to 6.9 | 502       | 482       | 728       | 660       | 685       | 789       |

Some environmental disasters are best described as sudden emergency situation due to an underestimated creeping hazard in combination with extreme and unusual conditions. Drought, for example, is basically caused by shortage and or misdistribution of rainfall but its greatest impact occurs where desertification has led to the degradation of the land. Similarly, pollution of seawater or river is a creeping process, but the resultant reduction in fisheries may be rapid and disastrous. Assessing and quantifying impacts of disasters is not always easy, the assessor has to consider different dimensions such as loss of human life, capital losses, loss of development impetus and environmental degradation. These dimensions have implications for the social, economic and environmental dimensions of sustainable development. Thus, a sustainable society cannot be achieved without improving the resilience of the society to social, economic and environmental damages from disasters.

### 1.2. Facing the challenges of disaster management

There has been a global awareness of the need to take drastic actions in reducing and mitigating the impacts of disasters through disaster management. Different government and international agencies have made several efforts in combating the challenges posed by natural disasters. The General Assembly of the United Nations in 1987 designated the 1990s as the International Decade for Natural Disaster Reduction (IDNDR) with Secretariat in Geneva, Switzerland. Also, the United Nations Disaster Relief Organization (UNDRO) formed years back, has been traditionally involved in emergency relief measures and recently it has been engaged in disaster prevention and

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