

## Strategy and programmes for geological education in geohazard vulnerable areas in the South-East Asia

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**Abstract:** The risks of geohazards inevitably increase in South East Asia due to the active plate tectonic setting. Thousands of people were the victim of the tsunami that occurred on the 26th December 2004. Other geohazards such as earthquakes, volcanic eruptions, landslides and floods are also a continuous threat to people living in this region. Therefore, it is essential that the development of human resources to support the improvement of geohazard management be urgently implemented to minimize the socio-economical impact of geohazards.

This paper addresses the critical strategy and programmes for development of human resources for geohazard management in vulnerable countries in South East Asia. Such a strategy and programmes highlight the important of formal and informal education programmes for geohazard management. The formal approach emphasises research-based education. This is linked to a network of South East Asia Engineering Education Development Programmes. Establishment of a school-on-the-move to produce specialists for geohazard management is also rigorously discussed in this paper. The programme for informal education is also reviewed with respect to public communication and empowerment towards sustainable life.

**Résumé:** Les risques des geohazards augmentent inévitablement en Asie de l'Est Du sud due à l'arrangement tectonique de plat actif. Les milliers de personnes étaient la victime du tsunami qui s'est produit le 26 décembre 2004. D'autres geohazards tels que des tremblements de terre, des éruptions volcaniques, des éboulements et des inondations sont également une menace continue pour peuple la vie dans cette région. Par conséquent, il est essentiel que le développement des ressources humaines pour soutenir l'amélioration de la gestion de geohazard soit implemented instamment pour réduire au minimum l'impact socio-économique des geohazards.

Cet article adresse la stratégie et les programmes critiques pour le développement des ressources humaines pour la gestion de geohazard dans les pays vulnérables en Asie de l'Est Du sud. Une tels stratégie et programmes accentuent l'important des programmes formels et sans cérémonie d'éducation pour la gestion de geohazard. L'approche formelle souligne l'éducation recherche-basée. Ceci est lié à un réseau des programmes de développement Du sud d'éducation de technologie de l'Asie de l'Est. L'établissement de l'école-sur-le-se déplacent aux spécialistes en produit pour la gestion de geohazard est également rigoureusement discuté en cet article. Le programme pour l'éducation sans cérémonie est également passé en revue en ce qui concerne la communication et l'habilitation publiques vers la vie soutenable.

**Keywords:** geohazard, geological education, disaster reduction, adaptive approach.

## PROBLEM FORMULATION AND RATIONAL

The risk of geohazards inevitably increases in Indonesia due to the dynamic plate tectonic phenomena occurring in this region. Hundreds of thousands of people were the victims of tsunami on 26 December 2004 in Banda Aceh and North Sumatra. Meanwhile, some other geohazards such as earthquakes, volcanic eruptions, landslides and floods also continuously threaten the people living in the Indonesian region. Unfortunately, most of the people living in geohazard vulnerable areas have not yet quite educated about these hazards, thus panicking, trauma, frustrations and being hopeless become more and more evident. Clearly, geohazards can be amongst the biggest obstacles to the sustainable development and social security of an ASEAN country.

It is the right of human beings to live safely in their environment. However, it is also impossible to change the nature of geological phenomena in Indonesia, which actively and continuously result in geohazards. Encouraging communities living in the vulnerable areas **to adapt** to the nature of geology will be rather more feasible, instead of challenging the geological nature itself. Therefore, an **adaptive approach** will be the basic concept introduced, and accordingly public education on geohazards will be urgently required to empower human resources living in geohazard vulnerable areas (Karnawati et al, 2004, 2005a)

## GOAL OF GEOLOGICAL EDUCATION

Regarding the stated problems above, disaster reduction due to geohazard is therefore essential to ensure sustainable development in geohazard vulnerable areas. In this respect, geohazard education at school/university (formal education), as well as for the public (non formal and informal) urgently needs to be further developed with the aim of empowering the communities living in geohazard vulnerable areas. With the appropriate education, the number of geohazard victims can be more and more reduced, and thus the socio-economical loss can be further minimized.

## CONCEPTUAL BACKGROUND

Geohazards are geological processes that significantly affect or threaten human life and, accordingly, result in socio-economical loss. Geological processes are the natural processes occurring in the earth system as a part of geological cycles. These geological processes are induced by the subduction of oceanic plates, i.e. the Indian oceanic plate and Pacific oceanic plate moving towards the Asian continental plate, and result in the earthquakes, tsunamis, volcanic eruptions and the formation of mountains range which are susceptible to landslides. All of those geological processes are clearly natural and will not be considered as risks if there is no human being affected. Only if there is any socio-economical loss due to those geological processes, will we regard such processes as risks (Karnawati et al., 2004, 2005a)

Serious impacts from geohazards, with thousands of victims, occur because there is no appropriate geohazard management. The appropriate geohazard management should consist of one complete cycle of management as illustrated in Figure 1. These include a prevention/mitigation stage, a preparedness stage, a response stage and a cure or rehabilitation/reconstruction stage. The existing management is mostly focus on responses and rehabilitation stages as well as the cure programmes, and very limited attention is put on the prevention and preparedness stages. This is the reason why the level of readiness of the community to respond to the hazards is very low, and consequently this leads to high numbers of victims and socio-economic loss.

A new paradigm in geohazard management should be introduced by putting more attention on *the prevention and preparedness stages*. Public education is one of most important programmes to support the prevention and preparedness stages in geohazard management. By public education, community awareness can be raised towards the community empowerment. Once the community can be more aware and empowered to adapt to geohazards, they can also be more empowered to prevent substantial socio-economical loss. Furthermore, the number of victims can be reduced; the role of government can only be subsidiary; finally sustainable development in the geohazard vulnerable area can be achieved. Even though, the education will also empower the community to consider and to manage the geological process as RESOURCES instead of as GEOHAZARD.

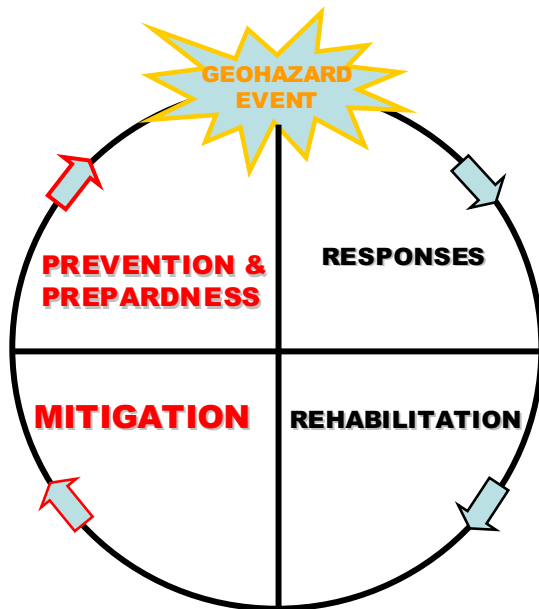


Figure 1. Stages in disaster management.

## ADAPTIVE APPROACH STRATEGY

As had been stated above, the main problem to be tackled is the threat of geohazards, which cause communities living in the vulnerable areas to suffer panic, trauma, frustration and powerlessness. Substantial numbers of geohazard victims are also to be one main problem that should be minimized. In fact, geohazards such as earthquakes, tsunamis, and volcanic eruptions are only the natural geological processes, which repeatedly occur in the earth, following the cycle of plate tectonic phenomena. The goal of geohazard management is to manage the human being not being affected or threatened by the geological processes, or to allow the geological processes to occur without resulting in socio-economic loss.

It is impossible and beyond human capacity to stop the occurrence of all of those natural geological processes. The more feasible effort is to allow people to understand and become aware of the behavior of the geological phenomena and, consequently, they will be able to recognize the characteristics of vulnerable areas and the symptoms that any geological phenomena will occur, as well as will be quite skillful to carry out emergency actions or responses when the hazard occurs. Finally they will be empowered to prevent being the victim of any geohazard. In principal, the community should be encouraged and empowered *to adapt* with their nature which is vulnerable for any geohazard,

instead of to challenge the geological process (Karnawati et al, 2004, 2005a, b). Through this concept, it is believed that the dream living in harmony with nature in geohazard vulnerable environments can be realized.

In the past, geological education at university level in some ASEAN countries mainly emphasized studying the phenomena, characteristics and behaviour of the Earth to support the exploration and exploitation of geological resources, such as minerals, geo-energy and groundwater. Recently, the subject of environmental geology has been introduced, not only to study the management of geo-resources but also for geohazard management. By considering the urgent need for community empowerment in the geohazard prone regions, much more attention and effort should be undertaken to introduce geohazard education, not only for students at university level, but also for students in primary to high schools, for the community, as well as for decision-makers. Indeed, the university in collaboration with the government agency and some community organizations could play an important role to support geohazard education for all.

## DESIGN OF AN EDUCATION PROGRAMME

### *Formal education*

#### *At university*

Knowledge of geohazard mitigation has been provided for undergraduate programmes in some universities in ASEAN countries, such as in Indonesia, Malaysia, the Philippines, Thailand, Vietnam, Myanmar, Cambodia and Laos. Such knowledge has not yet been provided as a special subject for undergraduate programmes, but it is provided as one topic of discussion, which is integrated in the subjects of Environmental Geology, Soil Mechanics, Geotechnics, Hydrology, Geohydrology, Volcanology and/or Seismology. Discussion on the geohazard topic is focused on factors controlling the hazard occurrence, the mechanisms and processes leading to the hazard and how to predict, mitigate and control such hazards. However, very limited practical exercises and fieldwork are provided for students due to the limited appreciation of the importance of geohazard education. In fact, very limited numbers of students choose geohazard research work for their final thesis. Similar to the undergraduate education, in the postgraduate programme (masters) quite a few universities in Indonesia and some other ASEAN countries provided special courses on Geohazard Management. Moreover, most of the existing geohazard education available is more focused on the enhancement of knowledge but less effort is put in to providing effective learning methods that include sufficient field and laboratory works.

Despite some limitations in conducting geohazard education at the university level, students at university are considered as the strategic target for human resource empowerment in geohazard prone areas. Indeed, the students will be the future analysts and policy-makers for geohazard management in their countries. Thus, they will be important key persons to further trigger the development human resources on geohazard management in the countries. That is why mechanisms and methods of geohazard education in the universities need to be further enhanced through several stages as follows:

- Enhance the learning method in geohazard education;
- Provide more research opportunities in geohazard education;
- Establish an education network in geohazard education;
- Establish the 'school-on-the-move' to support the enhancement of research and education in geohazard management.

Interactive learning methods through student working groups by providing case studies needs to be done to enhance the existing learning methods. A more effective learning process can be stimulated by introducing real case problems supported by fieldwork, working group discussions and seminars. This learning programme should be a medium for the students to learn to apply their knowledge as well their thinking skills critically and creatively to make sound decisions and to solve complex problems concerning geohazards. Even so, the case studies for the final year students to conduct their research works are also important. Support from government agencies is also required through an internship programme to provide facilities and opportunities for students to deal with the real problems in the field and communities. Since problems of geohazard management are complex, so an interdisciplinary approach also needs to be elaborated by inviting the related experts from other disciplines to be the external resources. Obviously, establishment of networks for geohazard education at national and ASEAN levels are crucial to facilitate the effective learning and research programmes in geohazard education. Not only government agencies, but also research institutes or research centres, private companies, non-governmental organizations/agencies, schools and universities are required to be actively participate and collaborate in the network for geohazard education.

Establishment of collaborative research and education in geohazard management by integrating several disciplines such as geology, civil engineering, agriculture and forest science, as well as social science and psychology is important to support the education programme on geohazard management. This collaborative research and education could be facilitated through networks. Recently, ASEAN University Network/the South East ASEAN Engineering Education Network (AUN/SEED-Net) has also established the Field of Geological Engineering Networks consisting of several universities from Member Institution Countries including Cambodia, Indonesia, Laos, Malaysia, Myanmar, the Philippines, Singapore, Thailand and Vietnam as well as from Japan. In this network, education and research on geohazards has been carried out. Due to the leading experience of dealing with geohazard problems, Gadjah Mada

Universities in Indonesia has been assigned as the Host Institution for the network where students from other countries in the network are now conducting the learning and research on geohazards to obtain Master degrees and PhDs (Gadjah Mada University 2005). Academic and research support from Kyushu University, Kyoto University and Hokkaido University are available to guarantee the quality and effectiveness of such research and education programmes.

The '*school-on-the-move*' concept is proposed to further develop the existing research and education programmes, especially for postgraduate programmes through the ASEAN network. By means of the '*school-on-the-move*' programme, students can have the opportunity to move from one research institute to another, either in their own country or outside of their country having research training in geohazard education. The idea of this programme is to provide more opportunities for the students to be exposed to the real geohazard problems within the ASEAN regions. So, the student will have quite varied experiences in geohazard management before completing their Masters degree. Their communication skills and capability to adapt to the new environment also can be improved by having the '*school-on-the-move*' programme. Nevertheless, financial consideration remains as an obstacle to this programme. Therefore, cost sharing within the ASEAN countries is required.

### *In school*

ANONIM (2004) reported that basic and simple knowledge on some geohazards such as flooding, landsliding and soil erosion have been introduced as a part of the subject of geography at schools from the primary level in Indonesia, Vietnam, Cambodia, Laos, Malaysia and Thailand. Meanwhile, knowledge of volcanoes and earthquakes also has been introduced in schools in Indonesia and the Philippines. However, it is apparent that such education has not yet successfully improved the students' skill and attitude for geohazard awareness and preparedness. This existing education only emphasizes the knowledge aspects such as what is flooding, landsliding, soil erosion, earthquake and volcanic eruption and why it occurs. More information and practice on how to recognize the symptoms of hazard occurrence and how to prevent the hazard have not yet been provided. Indeed, the contents and syllabus, as well as the method of delivery and learning process for geohazards in schools need to be further evaluated and enhanced.

Practical knowledge about geohazards as well as the necessary actions for preparedness and response should be provided by a simple but attractive method of teaching and learning. The most important aspects that need to be learned by the students are:

- mechanisms of occurrence of geological process that result in geohazard;
- symptoms of geohazards;
- practical knowledge on hazard preparedness and emergency responses.

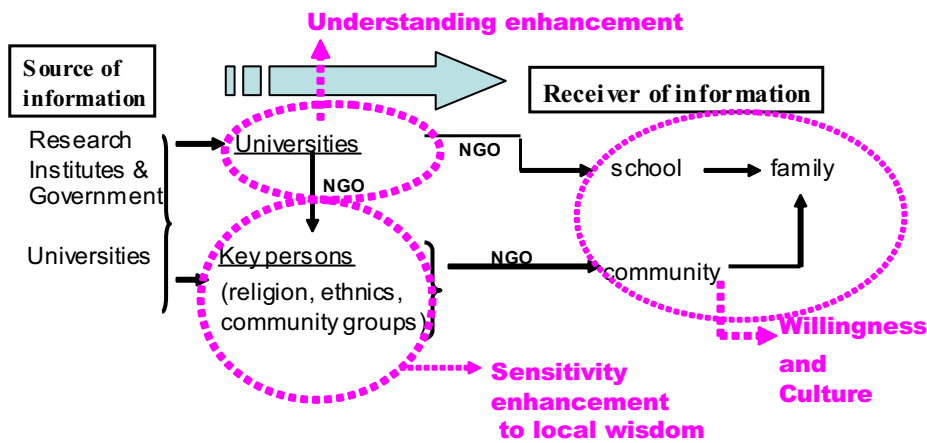
It was also suggested in the National Workshop on Geohazard Education held in Indonesia in August 2005 that a new curriculum is not necessary to provide a special subject on geohazard awareness and preparedness at school. The knowledge of geohazards can be integrated in the syllabus of the existing subjects such as Geography, Natural Sciences, Language or Religion. Practical exercises for emergency responses are also important and should be included in the existing subject of Physical Exercise. Visits to the field and institutions dealing with geohazard management will also be useful to provide students with more visual examples on the real problems of geohazard. In fact, some schools in Indonesia also suggested that a special module on Geohazard Awareness and Preparedness is required, to be provided in the extra-curricula activities.

Some revisions of the Geography textbooks were suggested as well because some inappropriate explanations of some geological terms and processes related to geohazard were found in the Primary and High School books. For instance, there was some misleading information about lava and lahars. Correction of the definition of lava and lahar is crucial because some volcanoes in Indonesia are actively produced lava and lahars. In response to this situation, training for teachers in Geography and Geosciences has been conducted regularly every year during the last five years to improve the teachers' knowledge and skills, as well as to provide the field experience.

### *Informal education*

#### *Approach and mechanism*

Lack of information about geohazard phenomena and symptoms is one of most critical problems leading to the high numbers of geohazard victims. Despite there have been quite a few research outcomes relating to geohazard predictions and zonations, most of the research outcomes and information have not yet reached the community living in the geohazard prone area. Thus, communication and dissemination of the outcomes of geohazard research should be effectively carried out as a part of the informal education program. As illustrated in Figure 2, an effective link between source and receiver of information is crucial to support the effective mechanism of a geohazard education programme. Research institutes and government agencies, as well as the universities, are the prominent sources of information related to geohazard. Meanwhile, the universities, NGOs and some identified key persons have the potential to be a means for transferring and disseminating the information on geohazards to the schools, communities, and families. Indeed, the universities have an important role to enhance understanding of geohazard phenomena to support public awareness and preparedness. However, the key persons from the religious, ethnic and community groups who have the traditional knowledge or wisdom are also important for raising the awareness of the community to recognize symptoms of geohazards. Thus, integrated knowledge based on modern science and traditional wisdom is required to be understood by the communities.



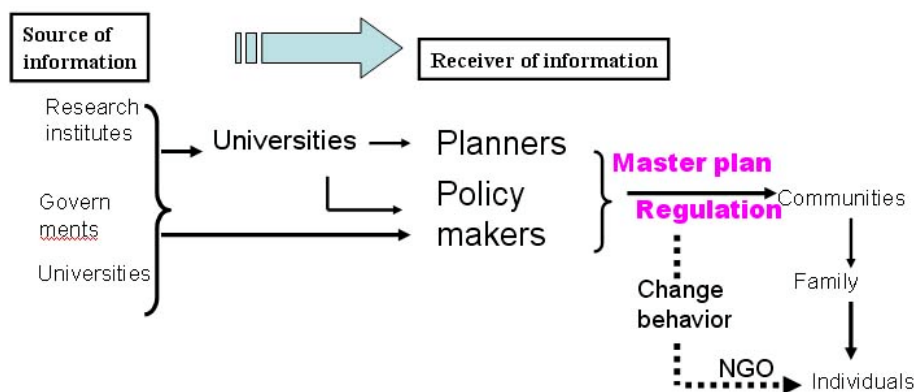
**Figure 2.** Mechanism for geohazard public education with emphasis on the effectiveness of communication.

Transfer of information by the government, research institutes and universities to the planners and policy makers should also be effective to support the development of an appropriate master plan and regulations in geohazard prone areas. Such a master plan and regulations should become the guideline and driving force to build up the attitude and culture of the communities, families and individuals to adapt to the threat from geohazards (Figure 3). Thus, there should be a changing behaviour from challenging to adapting to the forces of nature. Obviously, improvement in community understanding of geohazards, as well as development of an appropriate master plan and regulations, will effectively drive the changing behaviour and the development of an adaptive culture in geohazard prone countries.

### Method of education

More active involvement of geologists in disseminating their research outcomes, especially those related to geohazard management, is also crucial to raise public awareness. The disseminated materials should include information about the mechanisms of the geological processes leading to geohazard occurrence, the symptoms of geohazards, and also practical knowledge on hazard preparedness and emergency responses.

This dissemination should reach the children and the youth at schools, through various mass media, such as leaflets, booklets, popular books (comics, poems, etc), TV, radio, internet (website), or through activities such as the Boy and Girl Scouts and via direct communication with children at schools. With regard to the fact that the cycle of geohazard occurrence can be quite short (only within few years) and also can be long term (for hundred years), development of museums or exhibitions of any geohazard that has been occurred will also be important to transfer and sustain the message of geohazard awareness.



**Figure 3.** Mechanism of geohazard education by improving communication effectiveness

## CONCLUSION

Public education for geohazard awareness and preparedness is important to empower the community living in geohazard vulnerable areas, and to reduce the numbers of victims and loss. An adaptive approach, instead of a challenging approach, is considered to be the most appropriate strategy for such education. Universities have important roles as the resources or providers and also as the means for transferring geohazard information to communities. This education programme should be able to reform the communities' behaviour and to build up the culture for geohazard awareness and preparedness.

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