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Management Strategy of Sediment-Related Disasters for Adaptation to Climate Change

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Abstract

To establish a management strategy of sediment-related disasters for adaptation to climate change, it is necessary to 1) understand the specific details and problems about the present status, 2) systematize related technologies by using exact numerical values obtained from physically-based analysis, and 3) ensure the basic guidelines are applied to field elastically. To achieve these successfully, detailed guidelines are required by scientifically considering the utilization and impact of related technology on the field. Here, detailed guidelines should include 1) the development of a basic plan, 2) enhancement of relevant technical instructions, 3) establishment of survey and inspection methods, 4) procedure of erosion control works in urban living sphere, and 5) proactive countermeasures against sediment-related disaster caused by earthquakes.

Key Words: climate change, management strategy, sediment-related disaster, erosion control work, detailed guidelines

Introduction

With the rapid increase in climate change due to global warming, the damage caused by sediment-related disasters is becoming increasingly diverse. In recent times, not only mountainous areas but also residential piedmont areas have been severely damaged due to the increasing frequency of disasters and an enlargement of their scale resulting in landslides, debris flow, and large woody debris. In the aftermath of the earthquake in Gyeongju, Gyeongsangbuk-do on September 12, 2016, which had a magnitude of 5.8, there was unprecedented damage caused by 639 after-shocks (Chun 2017).

However, unlike in developed countries, there is no systematic research undertaken in the field. This is attributed to lack of control towers and adequate research funding. However, the main cause is the lack of mid- to long-term planning and of specific details about the site (Chun 2016).

Therefore, it is necessary to 1) understand change of precipitation pattern by climate change and research trend of those, 2) develop a basic plan, 3) enhance erosion control technical handbook, 4) establish field investigation for erosion control and inspection method, and 5) prepare preemptive responses to social needs as erosion control of urban living sphere and countermeasures against earthquake-induced sediment disaster.

Recent trends

Change in rainfall patterns due to climate change

Among the characteristics of rainfall in the summer season, heavy rains have relatively short duration compared to monsoon front and/or typhoons, and occur intensively in a small region. That is, heavy rains that occur locally and sud-

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denly due to the development of a mesoscale convective system, result in high rainfall intensity during a same duration compared with monsoon front and/or typhoons (Kim et al. 2015). Therefore, "Very strong rain" exceeding 50 mm/h has increased by 30% over the past 30-40 years and is predicted to increase 1.65 times by the end of the 21st century in Korea (Chun and Kim 2015).

Research trend

The recent research trends in the field of erosion control engineering show that there are few studies related to the quantitative evaluation of the prevention function or the effect of erosion control measures. Therefore, it should be prepared engineering bases related to design and construction of erosion control works through research on structural stability, catchment effect of debris-flow, and reduction effect of debris runoff and stream-bed erosion for torrent erosion control measures such as mountainous erosion control measure or check dam. In addition, it is necessary to organize these materials and utilize them as promotional material for effect of erosion control work (Kim et al. 2017).

Future tasks

The scientific erosion control is to identify specific items required for erosion control work, to systematize erosion control technology by using exact values obtained from physically-based analysis, and to apply basic guidelines of erosion control technology to field elastically (Chun 2016).

Development of detailed basic plan for erosion control work

To enhance the practicability of the basic plan for erosion control, it should include specific details applicable to the field. In other words, stream-bed changes which covered in planning stage for erosion control work can be divided into potential sediment (driftwood) yield, design allowable sediment (driftwood) yield, and debris-flow peak discharge at a planned datum point, after which a driftwood and debris-flow control plan can be developed. Hence, it is necessary to organize the systematic procedure such as establishing a disposal plan after setting up a placement plan of debris-flow and driftwood countermeasure facilities.

Revision of erosion control technical handbook

The technical handbook on erosion control revised in 2014 was published 16 years after the first edition was published in 1998. It is truly a technical instruction on erosion control work in Korea that comprises of 432 pages including general information, erosion control of mountain, torrent, coast and urban living sphere, and materials and appendix related to erosion control technology.

However, it does not provide a clear criteria required for plan, survey, design, construction and maintenance of erosion control work to field engineers in form on quantified standard value for each items like erosion control technical criteria in foreign countries. There, it is necessary to compare and analyze contents of various erosion control technical instruction in foreign countries, to identify the contents to be supplemented. And it should be borrowed from foreign criteria and revised them in accordance with the situation in Korea.

Establishment of detailed method of survey and inspection

The success of erosion control work is determined at the survey stage. Therefore, field investigation for erosion control should be performed by dividing the survey of project, plan, design and construction in accordance with survey stage. That is, it carried out to check necessity of erosion control work and investigate the status and field of project plan, to perform investigations for development of basic plan of erosion control and identification of watershed environment in planning survey, and geological, soil, and driftwood surveys in design survey. In construction survey, it should be confirmed foundation bearing capacity at the stage of construction according to design.

Procedure of erosion control works in urban living sphere

As an urban living sphere is mostly formed adjacent to narrow floodplains around river network and alluvial fans, these phenomena lead to cutting the mountain hillslopes and subsequent developing residential land to increase land-use ratio due to the population increase. As a result, houses and so on are concentrated in piedmont area, which are vulnerable to sediment-related disaster. In particular,

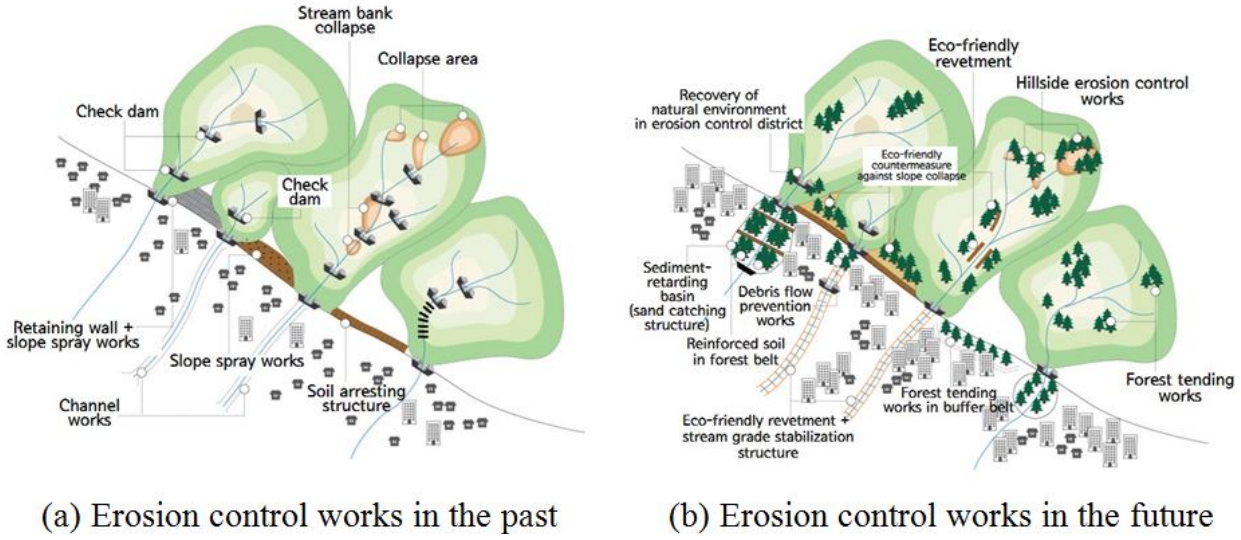

Fig. 1. Conceptual image of environment conserving erosion control works in residential piedmont areas.

houses are concentrated around roads connected to mountainous area, causing damage of massive debris-flow mainly in this area.

Therefore, to avoid only water systems being focused on, it is necessary to establish an erosion control plan focused on restraint and control of sediment in hillside slope, torrent and piedmont area so that the erosion control work is not concentrated on water system. In other words, it should be proceeded hillside erosion control works and forest tending works, prepared control measures for sediment runoff by check dam, and recovered natural environment of check dam construction sites in failure area. In addition, it should establish eco-friendly countermeasure against steep slope collapse, to create buffer forest belt in piedmont area, and to adopt new construction methods such as low-dam series, debris-flow guide bank, and forest belts (Chun et al. 2012).

Establishment of erosion control measures in earthquake-prone area (active faults)

When an earthquake occurs, inertial force is added to mountain, ground water and pore water pressure increases resulting in crack, rockfall, slope failure, landslide and debris-flow, and various types of sediment-related disaster that occur depending on the earthquake intensity. In general, a small crack or liquefaction at a magnitude 5, a small scale collapse or landslide at magnitude 6, and a large scale crack at a magnitude 7 may occur, resulting in extensive landslide or collapse in mountain.

Therefore, erosion control measures are required in earthquake-prone areas. To implement these measures, it is first necessary to identify the problems associated with applying the conventional analysis method for sediment-related disaster to the target area, and then divide it into preliminary and follow-up countermeasures of earthquake. In addition, sediment control plan is develop so that the sediment passing through a planned datum point or sub-datum point during erosion control planning is equal to the design allowable sediment. In other words, Design sediment yield, design sediment discharge and design allowable sediment discharge should be estimated. Based on this, the inflow and outflow of sediment in each watershed or channel section, sedimentation and eroded sediment in each section should be divided according to the watershed or channel section up to a planned datum point, and indicated using a sediment budget map (Chun 2017).

Conclusion

A comprehensive judgment on erosion control works can be made based on experience, but this judgment is made possible by acquiring expertise in various related fields derived from the accumulation of sustained research results. Therefore, the related Industry-University-Institute should be able to secure technical ability of their own responsibility

rather than the institution that specializes in the relevant field. That is, scientific or enhance of erosion control works is an effort to make specialization of erosion control, which should be premised based on calm judgement and formula by numerical analysis. At this time, after 110 years of the use of modern erosion control, we must carefully think about what we have to do once again.

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References

Chun KW and Kim SW. 2015. Eco-friendly countermeasures to control sediment sources in piedmont area of the living sphere. In: The 11th Korea-Japan Sediment Disaster Prevention Technology Conference; Seoul, Korea; November 5, 2015. pp 61-74.

Chun KW. 2012. Review on repair works of greenbelt zone in piedmont area of the living sphere. For Environ 15: 64-71.

Chun KW. 2016. Trend and task of erosion control research. Erosion Control 2: 19-28.

Chun KW. 2017. Sediment-related disasters and countermeasures caused by earthquake. J Disaster Prev 19: 34-43.

Kim SW, Chun KW, Otsuki K, Shinohara Y, Kim MI, Kim MS, Lee DK, Seo JI, Choi BK. 2015. Heavy rain types for triggering shallow landslides in South Korea. J Fac Agric Kyushu Univ 60: 243-249.

Kim SW, Lee DK, Lee CW, and Chun KW. 2017. Research trends in the field of 'Erosion Control' through academic journals. In: Proceeding of the 2017 Symposium of Innovative Mountain Disaster Prevention Center; Chuncheon, Korea; January 13, 2017. pp 217-227.

Korea Forest Service. 2017. Implementation plan for field of landslide prevention in 2017. Korea Forest Service, Daejeon, 390 pp.