iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 11 **Issue:** VI **Month of publication:** June 2023

DOI: https://doi.org/10.22214/ijraset.2023.54536

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 11 Issue VI Jun 2023- Available at www.ijraset.com

Land Slide Causes and Rehabilation Measures

Sumant Kumar Behera[1], Chitrabhanu Sahoo[2]
[1]M. Tech Schloart, [2]Assistant Professor, Department of Civil Engineering (GIFT), Bhubaneswar

Abstract: The potential for loss of life and destruction of assets through landslides is increasing in many mountainous and hilly areas of Asia. Logging, residential and infrastructure development and other activities continue to expand on slopes highly prone to landslides. Excessive soil water content is the primary cause of slope failure while steep slopes, weak soils or topography that concentrates water are the main factors contributing to landslide risk. Poorly constructed roads and the loss of soil reinforcement and water extraction by tree roots increases the probability of landslides during trigger events such as prolonged heavy rainfall or earthquakes. Climate change predictions suggest that landslide frequency will increase in some areas of Asia as the frequency of extreme storms increases. Drought may also affect some areas resulting in root dieback, pest and disease outbreaks and wildfire - all of which are likely to reduce soil reinforcement provided by trees and increase landslide incidence. Scientific studies confirm the crucial role of trees and forests in preventing shallow landslides, not only by reinforcing and drying soils but also in directly obstructing smaller slides and rock falls. The role of trees and forests in relation to deep-seated landslides is considerably smaller although soil drying by tree roots can still help to avoid excessive soil water pressures. During extreme events, involving heavy rainfall, very weak slopes or seismic activity, forest cover is unlikely to have any effect. Policies encouraging land uses that reduce soil disturbance and retain a high degree of forest cover can, however, reduce landslide risk. Tree planting on susceptible slopes can also reduce risk while natural regeneration and tree planting on failed slopes can help to control the after-effects of landslides such sediment release into rivers. Fast growing trees and shrubs are best suited to this purpose but socio-economic and conservation-related factors should also be considered. Above all, identifying and mapping high landslide risk zones and avoiding activity within these areas is an essential step in reducing the risk to lives and assets posed by landslides.

Keywords: Land slides, topography, risk management and Rehabilitation measures.

I. INTRODUCTION

Much has been written on the impacts of landslides on the total environment, including effects on people, their homes and possessions, farms and livestock, industrial establishments and other structures, and lifelines. However, few authors have discussed the effects of landslides on the natural environment, i.e., on (1) the morphology of the earth's surface, particularly that of mountain and valley systems, both on the continents and beneath the oceans; (2) the forests and grasslands that cover much of the continents, and (3) the native wildlife that exist on the earth's surface and in its rivers, lakes, and seas. This paper deals with these effects. In addition, current approaches used to reduce the impacts of land slide mitigation measures on the natural environment are discussed.

We will use landslide terminology as presented by varnes (1978) and cruden and varnes (1996). As used, the term "landslide" will include all types of gravity-induced mass movements, ranging from rock falls through slides/slumps, avalanches, and flows, and it includes both subaerial and submarine mass movements triggered

II. IMPACTS ON MORPHOLOGY OF THE EARTH'S SURFACE

The surface of the Earth, both on the continents and beneath the oceans is continually modified by internal forces and the forces of gravity; both, particularly the latter, produce landslides. The net morphologic effect of landslides is to reduce slopes to angles at which they possess long-term stability. "The processes involved vary enormously from extremely large rapid movements to extremely slow micro-displacement.

The result is denudation in the source area, frequent erosion along the transport path, and then deposition, the degree of whose permanence varies widely." (Small and Clark, 1982, p. 27). We have made no attempt to quantify the worldwide, or even regional, morphologic significance (i.e., the average rate of downcutting) of landslides, an amount that is extremely difficult to determine for large areas.

However, we do present case histories of some of the world's largest landslides, which provide useful information on the maximum effects of individual or regional landslide events, and which have provided local information on rates of slope recession and cliff retreat.

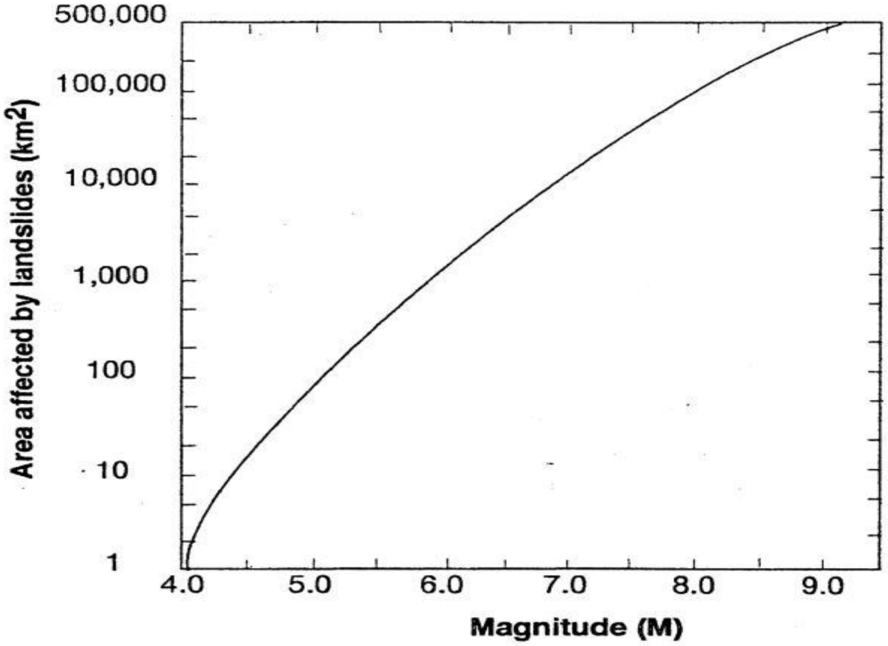


Fig. 1. Area affected by landslides triggered by earthquakes of different magnitudes (after Keefer, 1984)

Fig. 4. Destruction of vegetative cover on the valley walls of the upper San Vicente River, southwestern Colombia, by slides, debris avalanches, and debris flows triggered by the 1994 Paez earthquake.

Fig. 5. Aerial oblique view to the south of the ancestral Mount Shasta, California, debris avalanche (foreground and middle distance). (Photo by D.R. Crandell, U.S. Geological Survey.)

A. Valley Morphology

Both sub aerial and submarine landslides have major long-term effects on valleys (and canyons) in which they occur. While gravitational mass movements tend to lower the surface of the Earth, landslide deposits in mountain valleys often have the opposite effect on the valley bottoms, particularly when the streams are dammed by the landslides.

Effects of Landslide Damming Large landslides often completely block river valleys, impounding lakes. Most landslide “dams” fail by overtopping and breaching due to erosion. However, if they don’t fail, the geologic “short-term” effect on morphology is the impoundment of a lake.

Landslide dams can affect valley morphology in the following ways: • Deposition of lacustrine and deltaic sediments in the lake impounded by the dam, resulting in changes of stream gradient, surface morphology, and surficial geology upstream from the dam. • Formation of avulsively-shifting channels downstream from the dam by the introduction of high sediment loads from erosion of the landslide deposits.

Most landslide dams fail within relatively short periods of time (Schuster and Costa, 1986; Costa and Schuster, 1988). However, many of today's large landslide dams and their impounded lakes have existed for hundreds or even thousands of years. Especially noteworthy are the following: (1) 2,200-yr-old Waikaremoana landslide dam and lake, New Zealand, (2) Simareh (Seimarreh, Saidmarreh) landslide dam in southwest Iran, which about 10,000 yrs ago impounded a huge lake that later filled with sediment to become a lacustrine plain, and (3) 20th century Usoi landslide dam and Lake Sarez, southeastern Tajikistan.

An outstanding example of a landslide-dammed lake that exists as a long-term geologic feature is Lake Waikaremoana on the North Island of New Zealand This 250-mdeep lake with an area of 56 km2 is a remarkable natural feature that owes its survival to the erosion-resistant nature of the Tertiary sandstones and siltstones in the landslide dam (Read et al., 1992; Riley and Read, 1992). The lake has reduced the upstream gradient of the Waikaretaheke River to zero for about 15 km. Because the incoming river carries little sediment, Lake Waikaremoana has not been noticeably reduced in size or volume by sediment deposition.

Landslide dams may last for several minutes or for several thousand years,

Depending on many factors, including:

1) Volume and rate of water and sediment inflow into the newly formed lake.
2) Size and shape of the dam.
3) Character of the geologic materials comprising the dam.
4) Rates of seepage through the dam.

III. EFFECTS OF LANDSLIDES ON FORESTS AND GRASSLANDS

A. *Forest Destruction*

Widespread stripping of natural forests and jungle cover by mass movements has been noted in many parts of the world, but especially in tropical areas as the result of large-scale, earthquake-induced landslide activity. In September 1935, two shallow earthquakes (M=7.9 and 7.0) in the Torricelli Range, north coast of Papua New Guinea, caused "hillsides to slide away, carrying with them millions of tons of earth and timber, revealing bare rocky ridges completely void of vegetation" (Marshall, 1937). Approximately 130 km2 (8 percent of the region affected) was denuded by the landslides (Simonett, 1967; Garwood et al., 1979). On the south slope of the Torricelli Range, Montgomery and Eve (1935, p. 14) reported: "Soil and sub-soil with their covering of tropical jungle had disappeared from 60% of the slopes, baring the underlying bedrock." In November 1970, a M=7.9 earthquake triggered landslides along the north coast of Papua New Guinea that removed shallow soils and tropical forest vegetation from steep slopes in the Adelbert Range (Pain and Bowler, 1973). Vegetation was stripped from about 25 percent of the slope surfaces in the 240-km2 area that was affected by land sliding. Similarly, in 1976 two shallow earthquakes (M=6.7 and 7.0) struck the sparsely populated, jungle-covered, southeast coast of Panama, causing huge areas of landsliding. Garwood et al. (1979) estimated that the slides removed approximately 54 km2 of jungle cover (12 percent of the affected region of 450 km2).

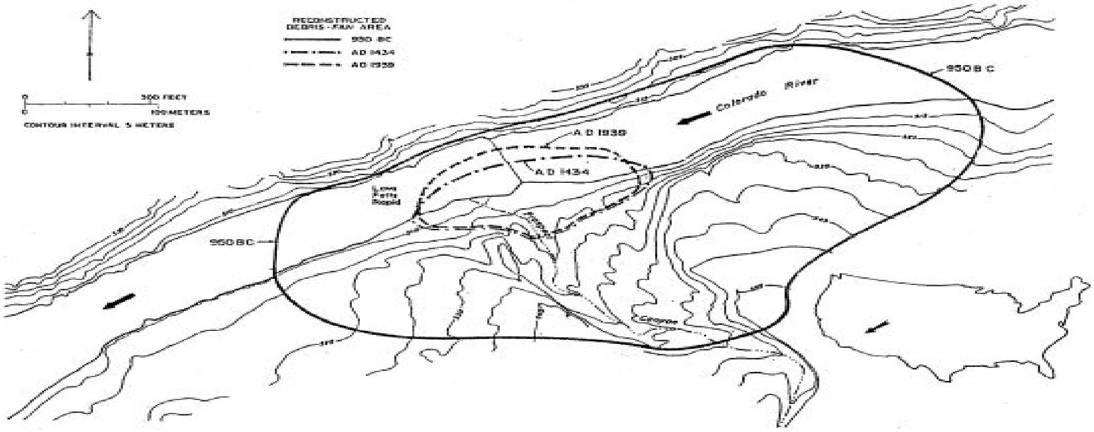


Fig. 6. Debris fans deposited by Holocene debris flows from Prospect Canyon into the Grand Canyon of the Colorado River, Arizona (Webb et al., 1996).

Similar sub-tropical forest devastation due to earthquake-induced landslides occurred in the previously mentioned 1987 Reventador and 1994 Paez events in Ecuador and Colombia, respectively. In both cases, the earthquakes occurred after long periods of rainfall, and the saturated residual soils on steep slopes failed as thin slides that rapidly transformed into debris flows. The Reventador landslides (Fig. 17) removed the subtropical jungle from more than 75 percent of the southwestern slopes of Reventador volcano (Nieto et al., 1991; Schuster et al., 1996). Figueroa et al. (1987) estimated that 230 km2 of natural forest were lost in the region. The Paez landslides (Fig. 4) stripped soil and vegetation (mostly second-growth sub-tropical brush and forest) from 250 km2 of steep valley walls (Martinez et al., 1995). In Puerto Rico, landslides are triggered by heavy rainstorms, including hurricanes. In the Luquillo Mountains of Puerto Rico, which are especially hard-hit by landslides, Brokaw (2003) has reported that landslides denude between 0.08% and 1.1% of the forest area per century.

The destruction of temperate forests by landslides has also been studied extensively. In their study of the influence of landslides on forest vegetation in the Valdivian Andes due to the 1960 M=9.2 Chilean earthquake, Veblen and Ashton (1978, p. 165) have noted that: “Catastrophic mass movements associated with seismic activity have affected the Andes of south-central Chile several times in the past 400 years and have profoundly influenced the regional vegetation.” They further noted that more than 250 km2 of temperate forest slopes were denuded in the 1960 event.

Aerial view of the northeast valley wall of the Malo River, northeast Ecuador, showing extreme denudation of slopes due to slips/avalanches/flows triggered by the 1987 Reventador earthquakes.

IV. DESTRUCTION OF MARINE PLANT LIFE

Although less is known about destruction of marine plant life by landslides than that which occurs subaerially, current studies of California’s Big Sur Coast indicate that coastal landslides can harm habitats for marine plants ranging from macroalgae to kelp forests and other varieties of seaweed (Moss Landing Marine Laboratories, 1998; Oliver et al., 1999). In the Monterey Bay National Marine Sanctuary (MBNMS) (Fig. 18), coastal plant life continually is affected by landslides, especially those that are triggered by the effects of California State Highway 1. Disposal of debris from these landslides without harming the habitats of plants and wildlife along this pristeen coastline poses a continual problem to the California Department of Transportation (Caltrans). Although not so well-reported, landslides on other coastlines worldwide undoubtedly have similar harmful effects on marine plant life.

A. Re Vegetation of Forests and Grasslands

Landslides are among the most severe disturbances of the tropical rainforests of Puerto Rico. Revegetation of the forested landslide areas of the tropical, wet Luquillos Mountains of northeastern Puerto Rico has received a greater concentration of study than any other landslide area in the world. The following recent ecological papers having been devoted to this study: Guariguata (1990), Walker and Neris (1993), Walker (1994), Fernandez and Myster (1995), Walker and Boneta (1995), Fetcher et al. (1996), Walker et al. (1996), Myster (1997), Myster and Walker (1997), Myster et al. (1997), Myster and Everham (1999), Brokaw (2003), Walker (2003), and Shiels and Walker (in press). As noted by Walker (2003, p. 1): “Tropical landslides, including those in Puerto Rico, revegetate within a remarkably short time, provided there exists a stable substrate [Fig. 19]. When ample nutrients are also available [landslide] forests recover most characteristics of pre-disturbance forests within 100 yr. Plant succession is governed by slope stability and nutrient availability…Biological processes that lead to succession and stabilization include inputs of seeds by wind, gravity and birds, vegetative expansion of neighboring plants; and the competitive and facilitative interactions of colonizing plants…Attempts to stabilize landslides include physical barriers to slow erosion, plantings to stabilize soil surfaces, fertilization to promote plant growth, and artificial perches to encourage bird dispersal of seeds.” Similarly, in a study of 46 landslides in the Luquillos Mountains, Guariguata (1990, p. 828) noted that post-landslide forest succession “seems to require at least fifty years before regrowth begins to resemble mature-forest basal area.” Other studies of revegetation of landslide areas in tropical forests have been carried out for the following countries/areas: Jamaica (Dalling, 1994); the Caribbean (Walker et al., 1996); Costa Rica (Walker, 1994; Myster, 1997); and Panama (Garwood, 1985).

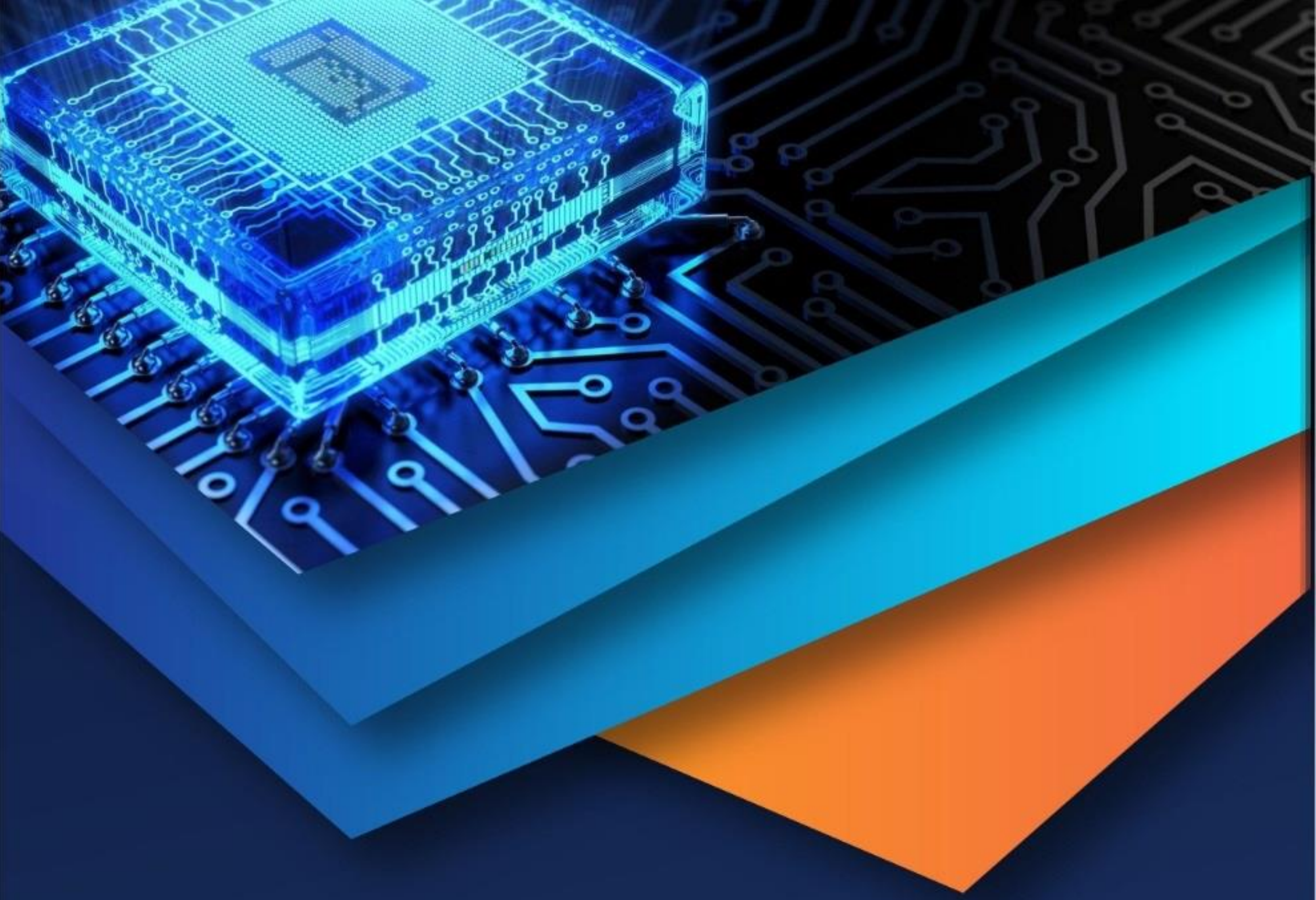
V. CONCLUSIONS

Landslides, and especially large catastrophic landslides, cause significant changes in the Earth’s natural environment. Mountain and valley morphologies are most significantly affected by downslope movement of large landslide masses. Forest, grasslands, and wildlife are often negatively affected by landslides, with forest and fish habitats being most easily damaged or temporarily destroyed. However, because landslides are relatively local events, both flora and fauna can recover with time. In addition, recent ecological studies have shown that, under certain conditions, in the medium-to-long term,, landslides can actually benefit fish and wildlife habitats, either directly or by improving the habitat for organisms that the fish and wildlife rely on for food. Techniques in biotechnical slope stabilization are becoming popular for reducing the environmental impact of slope-protection measures. These so-called “soft” remedial measures not only are environmentally more “friendly” than steel and concrete retaining structures, but they often are more economical and provide better l

REFERENCES

[1] Almár, I (2002).Some Difficulties with the Standardization of Definition.Acta Astronautica.50,2,135-38 Google Scholar
[2] Almár, I (2005).Terminology: A Bridge between Space and Society., Paper read at the First IAA International Conference on the Impact of Space on Society17–19 MarchBudapest Google Scholar
[3] Barlow, NG, Bradley, TL (1990).Catalog of Large Martian Impact Craters.Icarus.87,156-79 Google Scholar
[4] Barlow, NG, Boyce, JM, Costard, FM, Craddock, RA,and others. (2000).Standardizing the nomenclature of Martian impact crater ejecta morphologies.J. Geophys. Res.105-, E11 26, 73326738 Google Scholar
[5] Buchroithner, M (1999a).Mars Map: The First of the Series of Multilingual Relief Maps of Terrestrial Planets and Their Moons., Proceedings of the 19th ICA/ACI Conference, August 1999, Ottawa, Canada1-3[CD version]: Google Scholar
[6] Buchroithner, MF, Shingareva, KB, Krasnopevtseva, BV (2002a).Venus Map (1:45,000,000).Dresden:Institute for Cartography, Dresden University of Technology Google Scholar
[7] Buchroithner, MF, Shingareva, KB, Krasnopevtseva, BV (2002b).Luna Map (1:12,800,000).Dresden:Institute for Cartography, Dresden University of Technology Google Scholar
[8] Buchroithner, MF, Shingareva, KB, Krasnopevtseva, BV (2005).Mercury (1:18,000,000).Dresden:Institute for Cartography, Dresden University of Technology Google Scholar
[9] Buchroithner, MF, Shingareva, KB, Krasnopevtseva, BV (1999b).Mars Map (1:25,000,000).Dresden:Institute for Cartography, Dresden University of Technology Google Scholar
[10] Bugaevsky, LM, Shingareva, KB, Krasnopevtseva, BV,and others. (1992).Atlas of Terrestrial Planets and Their Moons.Moscow:MIIGAiK[Russian] Google Scholar
[11] Dezso, L, Kálmán, B (1979).On the Interpretation and Orthography of Astronomical Terms.Csillagászati évkönyv [Astronomical Yearbook] 1979.248-54[Hungarian] Google Scholar
[12] EID—Earth Impact Database (2003).Available at http://www.unb.ca/passc/ImpactDatabase/ Google Scholar
[13] Hargitai, H, Kereszturi, Á (2002).Suggestions for the Initiation of a Standardized Hungarian-Language Planetary Science Terminology.Geodézia és Kartográfia 2002.9[Hungarian] Google Scholar
[14] Hargitai, H, Schenk, P (2004).Io Mountain Online Database.Available at http://planetologia.elte.hu/io/ Google Scholar

[15] Hargitai, HI, Rükl, A, Gabzdyl, P, Roša, D, Kundera, T, Marjanac, T, Ozimkowsky, W, Peneva, E, Bandrova, T, Oreshina, LS, Baeva, LY, Krasnopevtseva, B V, Shingareva, KB (2001–2004).Maps of Mars, Venus, Mercury, Moon, Central European Edition.Budapest:Nyir-Karta-Topograf Publishing Google Scholar
[16] Herrick, RVenus Crater Database.N.d. Available at http://www.lpi.usra.edu/research/vc/vchome.html Google Scholar
[17] ICA Multilingual Glossary (2001).Available at http://www.nasm.si.edu/ceps/ica/glossary.htm Google Scholar



10.22214/IJRASET

INDEX
COPERNICUS
45.98

IMPACT FACTOR:
7.129

TOGETHER WE REACH THE GOAL
IMPACT FACTOR:
7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY