भूकम्पीय सुरक्षाका लागि

घुँडा टेकी, गुडुल्की, ओत लागी समात !

Duck, Cover and Hold on

गुडुल्किनु (Duck)	ओत लाग्नु (Cover)	ओतलाई समात्नु (Hold on)
गुँडुल्किनु (Duck) भनेको घुँडा टेकेर घोप्टो परी, गुडुल्किएर हाँसले झैं टाउको लुकाउँदै आफ्नो शरीरको आयतनलाई सकभर सानो बनाउनु हो ।	घोप्टिएर घुँडा टेकी बस्दा टाउको र मेरुदण्ड जोगाउन कुनै टेबल जस्तो बलियो सामग्रीको ओत लागी उभिएर आएका वा खसेका वस्तुहरुबाट बच्नु हो ।	भुईंचालोको बेला ओत दिने वस्तु वा आफु नै हुतिनुबाट जोगिन ओतलाई बलियो गरी समात्नु हो ।

विद्यालयमा "Duck, Cover & Hold on" को अभ्यास गर्ने प्रक्रिया

क. **संकेत** - १ विद्यालयमा तोकिएको व्यक्तिले एक मिनेट सम्म घण्टी बजाउने

ख. **जवाफी कार्य** - कक्षा कोठामा वा अन्य कोठामा भएका सम्पूर्ण शिक्षक तथा विद्यार्थीहरुले संकेत रहँदासम्म गुडुल्किएर बस्ने (चित्र क) ।

ग. **संकेत** - २ पुन: शिक्षकले २ घण्टी बजाउने । त्यसपछि पहिले नै पहिचान गरिएको सुरक्षित स्थान तर्फ नहड्बडाइकन लाईन लगाएर जाने (चित्र ख) ।

घ. **भेला गर्ने** - स्थानान्तरण कार्य समाप्त भएपछि सम्पूर्ण शिक्षक तथा विद्यार्थीहरु सुरक्षित स्थानमा भेला हुने ।

ङ. **गन्ती गर्ने** - विद्यार्थीहरुलाई पूर्वनिर्धारित स्थानमा कक्षागत रुपमा लाईन लगाई गन्ती गर्ने र हाजिरी रुजु गर्ने ।

च. **खोजी** - हाजिरी रुजु गर्दा नभेटिएका विद्यार्थीहरुलाई सम्भावित स्थानहरुमा आफ्नो सुरक्षाको स्याल गर्दै खोजी गर्ने ।

छ. **उद्धार** - सुरक्षित तवरले घाइतेहरुलाई तालिम प्राप्त विद्यार्थी स्वयंसेवीहरुद्वारा उद्धार गरी प्राथमिक उपचार गर्ने (चित्र ग)। सिकिस्त घाइतेहरुलाई छिटो सुरक्षित तवरबाट अस्पताल पुऱ्याउने ।

चित्र क - घुँडा टेकेर घोप्टिई, गुडुल्किएर टाउको जोगाउँदै

चित्र ख - विद्यार्थीहरु सुरक्षित स्थान तर्फ जान विद्यालय भवनबाट बाहिरिँदै

चित्र ग - प्राथमिक उपचार गरिँदै

यही प्रकृयालाई अन्य संस्थाहरुमा समेत प्रयोग गर्न सकिन्छ ।

USAID FROM THE AMERICAN PEOPLE

यो सामग्री अमेरिकी सहायता निकाय USAID को आर्थिक सहयोगमा भूकम्प प्रविधि राष्ट्रिय समाज-नेपाल (NSET) द्वारा सञ्चालित "भुकम्पीय जोखिम व्यवस्थापनमा सार्वजनिक-नीजि साझेदारी प्रवर्द्धन कार्यक्रम (3PERM)" अन्तर्गत प्रकाशित गरिएको हो ।

NSET

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बुलेटिन

नेपाल भौगर्भिक समाज

Volume 30 **April 2013** (वैशाख २०७०)

BULLETIN OF NEPAL GEOLOGICAL SOCIETY

NEPAL GEOLOGICAL SOCIETY
(EST. 1980)
PO Box 231, Kathmandu, Nepal
Email: info@ngs.org.np
Website: http://www.ngs.org.np

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INSTRUCTIONS TO CONTRIBUTORS TO NGS JOURNAL AND BULLETIN

Manuscript

Send a disk file (preferably in MS Word) and three paper copies of the manuscript, printed on one side of the paper, all copy (including references, figure captions, and tables) double-spaced and in 12-point type with a minimum 2.5 cm margin on all four sides (for reviewer and editor marking and comment). Include three neat, legible copies of all figures. Single-spaced manuscripts or those with inadequate margins or unreadable text, illustrations, or tables will be returned to the author without review.

The manuscripts and all the correspondences regarding the Journal of Nepal Geological Society should be addressed to the Chief Editor, Nepal Geological Soceity, PO Box 231, Kathmandu, Nepal (E-mail: publication@ngs.org.np).

The acceptance or rejection of a manuscript is based on appraisal of the paper by two or more reviewers designated by the Editorial Board. Critical review determines the suitability of the paper, originality, and the adequacy and conciseness of the presentation.

The manuscripts are returned to the author with suggestions for revision, condensation, or final polish.

After the manuscript has been accepted, the editors will ask the author to submit it in an electronic format for final processing. Manuscripts are copy edited. Final changes must be made at this time, because no galley proofs are sent to authors.

Illustration

Identify each figure (line drawing or computer graphic) or plate (photograph) with the author's name, and number consecutively, at the bottom, outside the image area. Never use paper clips or tape on illustrations and do not write with pen on the back of figure originals or glossy prints. Where necessary, mark "top." Keep the illustrations separate from the text, and include a double-spaced list of captions. Do not put captions on the figures themselves.

Prepare clean, clear, reproducible illustrations that are drafted at a size not more than twice the publication size. All lettering on illustrations must be drafted or laser printed, not typed or handwritten. Put type, labels, or scales directly on a photograph rather than on a separate overlay. Use graphic scales on illustrations; verbal scales (e.g., "x200") can be made meaningless by reduction of an illustration for printing. Calibrate graphic scales in metric units. Indicate latitude and longitude on maps. Plan all type sizes large enough so that the smallest letters will be at least 1.5 mm tall after reduction to publication size. For review purposes, copies of illustrations must be legible and relatively easy to handle, and any photographs must be direct prints. Do not send original illustrations until asked to do so. Keep at least one copy of all illustrations, as the NGS cannot be responsible for material lost in the mail.

For colour figures, authors must bear all costs, and about $50 per colour figure/plate will be charged.

Style

Authors are responsible for providing manuscripts in which approved geological and other scientific terminology is used correctly and which have no grammar or spelling errors. Authors must check their manuscripts for accuracy and consistency in use of capitalisation, spelling, abbreviations, and dates.

Abstract

The abstract should present information and results in capsule form and should be brief and objective, containing within a 250-word maximum the content and conclusions of the paper. The topic sentence should give the overall scope and should be followed by emphasis on new information. Omit references, criticisms, drawings, and diagrams.

Captions

Make captions precise and explain all symbols and abbreviations used. Type captions in consecutive order, double-spaced. Do not put captions and figures on the same page.

References

All references mentioned in the text, figures, captions, and tables must be listed in the References section. Only references cited in the paper are to be listed. For example:

Auden, J. B., 1934, Traverses in the Himalaya. Rec. Geol. Surv. India, v. 69 (2), pp. 133-167.

Todd, D. K., 1980, *Groundwater Hydrology*. John Wiley & Sons, Singapore, 535 p.

Tokuoka, T. and Yoshida, M., 1984, Some characteristics of Siwalik (Churia) Group in Chitwan Dun, Central Nepal. Jour. Nepal Geol. Soc., v. 4, (Sp. Issue), pp. 26-55.

Reprints

Authors will receive twenty-five copies of reprints free of cost. Additional copies may be ordered for purchase when proofs are returned to the editor.

We highly encourage you to submit online rather than sending from snail mail.

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EDITORIAL

The Bulletin of the Nepal Geological Society brings out activities of the Nepal Geological Society and its members in the preceding year. This is the 30th volume of the Bulletin and contains news about scientific talk prgrammes, scientific articles presented in the talk programmes, report on the last Annual General Body Meeting, news about outstanding achievements by the member of NGS within the last one year, and obituary on the members who have passed away. The bulletin also contains a number of popular articles in the field of geology which are of the public concern. We believe that these information and articles will be of great interest to the geo-scientific community and general public interested in geo-science. A number of books were published by the members of the NGS last year in the field of geo-science. The Bulletin also gives a brief synopsis of the books.

The editorial board would like to extend its sincere thanks to all the authors for contributing their papers to this issue. Those papers have increased the importance of this Bulletin. We would like to express our sincere thanks to the 15th executive committee of the NGS for providing necessary information for the Bulletin. On behalf of the 15th executive committee, the editorial board extends its acknowledgements to various consulting firms and governmental/non-governmental organizations for their technical and financial support to the society.

We hope that the readers will find this volume useful and informative. Comments and suggestions for further improvement of the bulletin are always welcome. We hope to receive your continued support and cooperation in future.

- Editorial Board

CONTENTS

NGS NEWS

The 34rd AGM held

The 34th Annual General Body Meeting (AGM) of the Nepal Geological Society was organized on 21rd Bhadra 2069 (6th September, 2011). In that program President of the 15th executive committee Mr. Uttam Bol Shrestha delivered his speech and highlighted the main functions of his first year tenure. Mr. Sudhir Rajaure (General Secretary) and Mr. Ram Prasad Ghimire (Treasurer) of the 15th executive committee presented annual report and financial report, respectively. Dr. Dibya Ratna Kansakar, converner of the 27th HKT Workshop reported about the progress made in teh preparation of the workshop organization. Coordinator Financial Sub-committee Mr. K. P. Kaphle and coordinaitor of the logistic sub-committee Mr. D. N. Subedi also presented thier report. Similarly, coordinator of the IDDR Mr. S. P. Khan and chief editor Dr. L. P. Paudel presented status of the IDDR preparation and NGS publications. Recommendation committee for the honorary membership proposed names of two scientists for the honorary membership of the society. Finally following agenda were approved by the AGM.

1. Approval of the Annual Report by General Secretary Mr. Sudhir Rajaure
2. Annual Financial Report by Treasurer Mr. Ram Prasad Ghimire.
3. Auditor's report for fiscal year 2068/2069.
4. Honorary membership for two distinguished goescientists Mr. Gopal Singh Thapa and Prof. Dr. Paul Tapponnier.
5. Host a workshop on the issues of mining and mineral based industries in Nepal after the 27th HKT Workshop in appropriate time.
6. Host 7th Nepal Geological Congress in 2014 instead of 2013 because of lack of time after the 27th Himalaya-Karakoram-Tibet (HKT) Workshop going to be held this year in November and one workshop as stated in (5) above.
7. Establish a fund of two lakh and fifty thousand Nepali Rupees in the memory of late Mr. Mitra Rai. The fund will have one lakh and twenty thousand Nepali Rupees collected by his friends and rest one lakh and thirty thousand rupees will be provided by NGS.
8. Install appropriate power back up system in NGS office in the wake of the increasing load shedding and the forthcoming HKT Workshop.

27th HKT Workshop held in Kathmandu

The 27th Himalaya-Karakoram-Tibet (HKT) Workshop has been successfully conducted in Kathmandu, Nepal. It was held during November 28-30, 2012 at The Everest Hotel in Kathmandu, Nepal. This workshop was organized jointly by Nepal Geological Society and the Department of Mines and Geology, Government of Nepal, and was supported by many national and international organizations and institutions including The Academy of Sciences for the Developing World (TWAS), the Tectonic Observatory, California Institute of Technology (CalTech, TO), Earth Observatory Singapore, Nanyang Techinological University and many others. The Workshop was inagurated by Rt. Honorable president of Nepal Dr. Ram Baran Yadav.

The 27th HKT workshop was attended by 312 participants. Among them, 190 participants were the Nepalese geoscientists, engineers, and practitioners. A complete list of the registered participants in the workshop is given in Annex 2. Among the 126 foreign participants, 2 were from Austria, 2 from Bangladesh, 1 from Bhutan, 6 from Canada, 16 from China, 17 from France, 13 from Germany, 23 from India, 3 from Israel, 6 from Italy, 8 from Japan, 6 from Pakistan, 2 from Russia, 3 from Spain, 4 from Switzerland, 8 from United Kingdom and 6 from the United States of America. In addition, 10 participants were accompanied by their spouse or family member. Thus, besides a very large number of Nepalese participants, there were 45 geoscientists from the Himalaya, Karakoram and Tibet regions itself who attended the workshop. For the Organizers, this is a matter of remarkable success and satisfaction.

IDDR Day-2012 observed

In order to observe **the International day for disaster reduction (IDDR) day-2012**, Nepal Geological Society

organized one day workshop in association with Mitra Kunj and Russian Center of science and culture on 12 October, 2012. This program was supported by Kathmandu Metropolitan City (KMC). The workshop was held in the Russian Centre of Science and Culture, Mitra Kunja, Kathmandu, Nepal. The theme of the programme was ***"Step Up Women and Girls- The inVisible Force of Resilience".*** The programme was inaugurated by the Chief Guest, Mr. Keshav Sthapit, Development Commissioner, Kathmandu Valley Development Authority. Altogether seven technical papers were presented in the programme.

Scientific talk programme held

The Scientific committee of the Nepal Geological Society organized two scientific talk programmes to the scientific community of the Nepal Geological Society. Dawn A. Kellett gave talk on " Tectonic evolution of the South Tibetan detachment system, central and eastern Himalaya". Prof. Jörn H. Kruhl, Technical University Munich, Germany gave talk on "Energy for the future: rocks as storage for and source of renewable energy".

34rd ANNUAL GENERAL BODY MEETING OF THE NEPAL GEOLOGICAL SOCIETY

नेपाल भौगर्भिक समाजको ३४ औं साधारण सभा

Speech by Mr. Uttam Bol Shrestha, President of NGS,
delivered to the 34rd Annual General Body Meeting
21rd Bhadra 2068 (6th Sept. 2012)

Respected Honorable Members

Respected Former Presidents

Distinguished Members of Nepal Geological Society,

Ladies and Gentlemen,

It is my great pleasure to welcome you all to this 34th Annual General Body Meeting of our society. On behalf of the 15th Executive Committee and on myself, please I extend my hearty thanks to all of you for coming to this meeting despite your valuable and busy time schedule.

Respected society members, this executive committee is passing out the very first year of its two years tenure. Mr. Sudhir Rajaure, the General Secretary will present you all the programs and progresses made during the period while Mr. Ram Prasad Ghimire, the treasurer will present the income and expenditure account.

Preparation to organize the upcoming International Conference on the Geology of Himalaya Karakoram Tibet Region, "The 27th Himalaya-Karakoram-Tibet Workshop, November 28-30, Kathmandu, Nepal is in process. Until now, we have finished the preregistration and second circular for full registration has already been circulated. I thank the convener of the Workshop Dr. Dibya Ratna Tuladhar for his great continued excellent and experienced efforts in preparation towards the hosting of the Workshop. I am also thankful for necessary guidance and advices from the organizing committee and the advisory board of the workshop. Details on the Workshop will be delivered by the convener.

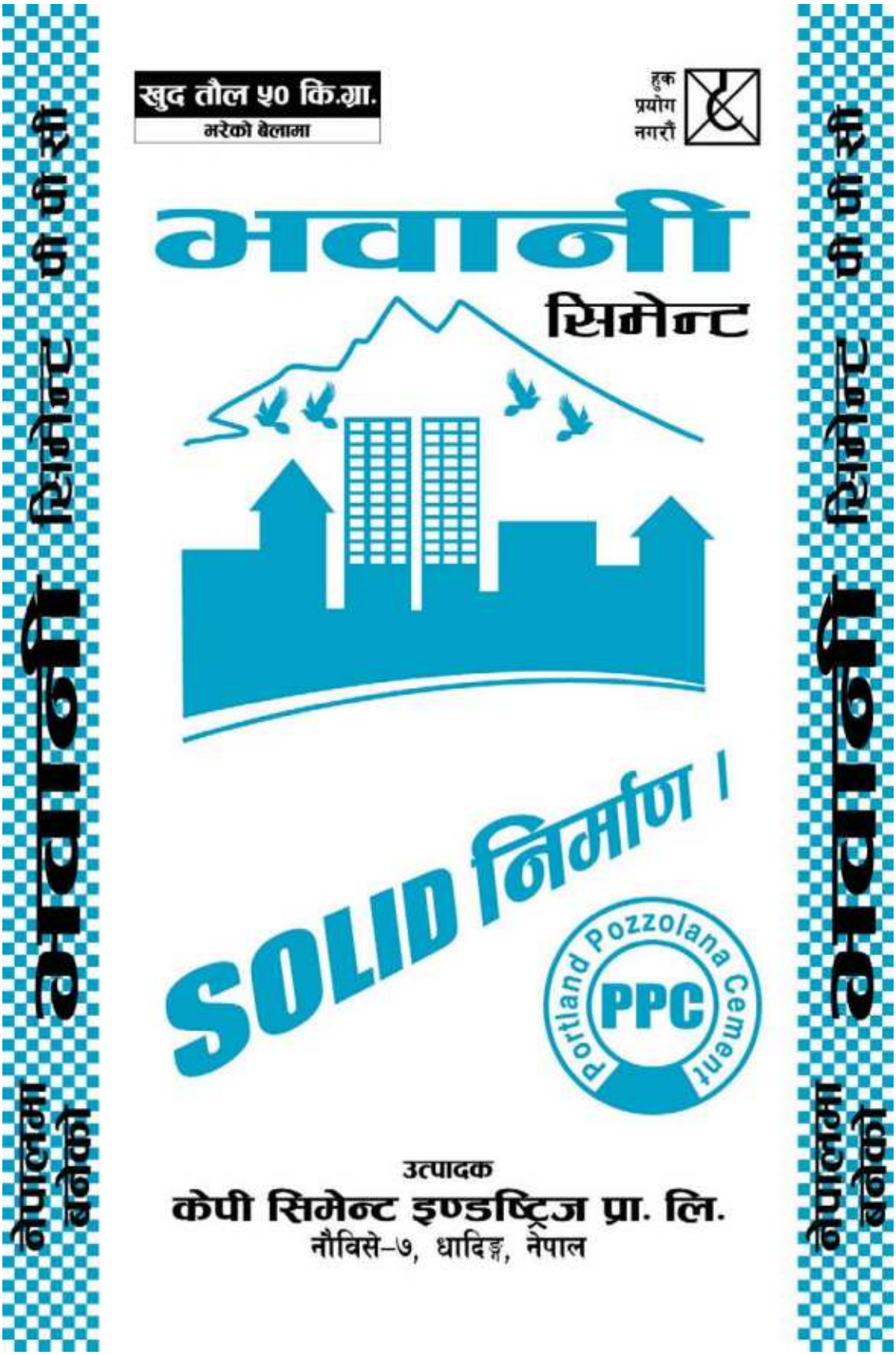
Great efforts of co-convener, Dr. Soma Nath Sapkota, and committee chairman Prof. Dr. Bishal Nath Upreti (Scientific), Mr. Krishna Prasad Kaphle (Financial), Mr. Devi Nath Suibedi (Logistics Support), Dr. Santa Man Rai (Workshop Management) and along with Dr. Khum Narayan Poudyal (Excursion), individual excursion chiefs are highly appreciable. Thanks to all of them. Mr. Kaphle and Mr. Subedi will deliver their present status of progress.

In our regular event, the society is going to observe October-12 as the international day for disaster reduction, IDDR day. Mr. Siddhi Pratap Khan, the coordinator of the IDDR Committee of the society will present you the past activity and present status regarding observing the IDDR in detail.

Dear friends, upon the recommendation of the honorary membership selection committee formed under the coordination of Prof. Dr. Bishal Nth Upreti, we are proposing to award the honorary memberships on your approval at this AGM.

Respected members, beside these efforts, still much works have to be done and I request all members of the society to be active in various activities and help the committees and subcommittees in fulfilling their responsibilities. I request the members, friends to come forward with all kinds of help for better performances of the society. Your constructive criticism, suggestions and advices certainly will help us in fulfilling the laggings what so ever are there in the activities of the society during our tenure.

Dear friends, at last but not least, I take this opportunity to thank various organizations and dignitaries who had supported the society in every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सिमेन्ट
SOLID निर्माण ।
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नौविसे–७, धादिङ्ग, नेपाल
नेपालमा बनेको भवानी सिमेन्ट पी पी सी

steps of its activities either in the form of moral support, financial support or in the form of logistics support. I pay great gratitude to the Director General, Mr. Sarbjit Prasad Mahato, the Department of Mines and Geology for continued support on every aspect of the society. Similarly, my gratitude are to Mr. Shree Ram Maharjan and Mr. Hifjur Rahman, the Deputy Directors for Department for their support at the time of need. Let me also thank all members of the society for their continued support and also chairmen, coordinator and members of various committees for their tireless efforts in society's work.

Once again I heartily welcome you all at this 34th Annual General Body Meeting of this prestigious organizations of all geoscientists, "The Nepal geological Society".

Thank You.

34rd ANNUAL GENERAL BODY MEETING OF THE NEPAL GEOLOGICAL SOCIETY

नेपाल भौगर्भिक समाजको ३४ औं साधारण सभा

Speech by Mr. Sudhir Rajaure, General Secretary of NGS,
delivered to the 34rd Annual General Body Meeting
21rd Bhadra 2068 (6th Sept. 2012)

Respected President of Nepal Geological Society

Respected Honorary Members

Respected Former Presidents

Distinguished NGS Members

Ladies and Gentlemen

It is a great pleasure for me to welcome you all on the occasion of 34th Annual General Body Meeting of the Nepal Geological Society on behalf of the 15th Executive Committee of the Nepal Geological Society and on my own. One year has almost elapsed after we assumed the NGS Executive Committee and took the responsibility of the office of NGS. It is time to assess what were our commitments and what we have achieved in the elapsed period. Similarly it is time to commit for next one year.

Now, let me take this opportunity to highlight some of the activities of NGS in brief.

Observing the IDDR Day

NGS has been responding to the call of the United Nations International Strategy for Disaster Reduction (UNISDR) to undertake various activities in the field of disaster reduction since 1991. Since 2001 NGS has observed International Strategy for Disaster Reduction (ISDR) day in Nepal for ten years. Last year too, NGS organized a one day seminar at the Russian Centre of Science and Culture, Mitra Kunj, Kathmandu on 19th October, 2011 (2nd Kartik, 2068 B.S.) to mark the International Day for Disaster Reduction (IDDR-2011) on the United Nations theme ' Making Children and Young People Partners for Disaster Risk Reduction'. This program was supported by Russian Centre of Science and Culture, Department of Water Induced Disaster Prevention and Kathmandu Metropolitan City.

27th HKT Workshop

It is a great pleasure to all of us and a pride as well to host the 27th Himalaya-Karakoram-Tibet (HKT) Workshop. First Circular and Second Circular of the workshop have already been distributed to potential participants and all NGS members. We have received overwhelming response for participation from Nepal as well as the international sector. The details of the Preparation are presented in the 29th Volume of Bulletin of Nepal Geological Society.

Journal publication

Though we were not involved in the preparation of volume 40, 41 and 42 of the Journal of Nepal Geological Society, we are pleased to announce the publication of these Journals in the last one year.

Nepal Geological Society is now on Facebook

Social Networks are getting popular and popular these days. To comply with the need of the day, NGS has launched its official page on Face book. I hope, in addition to the website and email this Face book page will help to disseminate information among its valuable members. This Face Book Page will help to share activities and information among the members too. All NGS members are requested to join this page by a 'Like'. Additionally you also can post any news you have relevant to Nepal Geological Society and its members.

Collection of personal Information for directory update

Nepal Geological Society has recently taken an initiative to update Members' directory. All NGS members are requested to provide their information as soon as possible. Email, Website as well as Face book are used to disseminate this notice so that goal could be achieved

in a short time. Mr. Surya Prakash Shrestha has happily taken the responsibility to do this job.

Website maintenance

We are trying our best to keep the website updated. Dr. Ranjan Kumar Dahal, coordinator of the Communication and Information Dissemination Committee is looking after the website.

Talk program

Nepal Geological Society organized four talk programs up on the request of:

Dr. Gyanendra Gurung, Chonbuk National University Graduate School, Korea

Dr. Kyle Larson, University of Saskatchewan, Canada

Dr. Pramila Shrestha, Department of Irrigation, Nepal

Dr. Yokito Sugimura, Japan Water Agency (JWA),

The abstracts of the talk programs are presented in the 29th Volume of NGS Bulletin.

New NGS members

The total number of NGS members (Life+General) has reached 658. In our tenure 16 New members have joined the NGS as life member.

Creating job opportunity

Nepal Geological Society has made an attempt to meet concerned authorities of the Government of Nepal in order to explain them the importance of geosciences and the knowledge of geological knowledge in development works in a country like Nepal. However, because of the busy schedule of the authorities, we would meet them after the 'Civil Service Day, 2069' that falls just tomorrow.

Mitra Rai Fund for scholarship

An agreement was made to establish a fund in order to support the genuine students in the field of geology who are in need. Dr. Kamalakant Acharya informed us that the expected amount (120000) is available now. We have the following options:

1. Let them manage this fund

2. NGS accept and manage this fund with the same amount.

3. NGS provide some amount to the fund to make larger.

Land acquisition for NGS Office

As per the assurance of the then Secretary for Ministry of Industry, Mr. Shankar Prasad Koirala to help in approving a small piece of land for this society's building at the premises of DMG, we have forwarded the request letter to DMG. However, in a short time the secretary was transferred and our request has not yet been fulfilled. We are still in continued process for this.

Forthcoming events of NGS

IDDR, 2012: 12 October, 2012

27th HKT Workshop: 28-30 November, 2012

After the 27th HKT Workshop, NGS is planning to hold a seminar to publicize the problems faced by mineral and mining based industries in Nepal. I would like to request for your kind suggestions regarding this seminar.

As we are aware that Nepal Geological Society hosts Nepal Geological Congress in every three year, the Seventh Nepal Geological Congress should be scheduled for by the end of 2013. Therefore, you are requested to approve our proposal for 7th Congress. Kindly suggest us theme for the proposed congress.

Dear members! The above mentioned activities of the present executive committee would have never been materialized without your support and constructive advice, suggestions. We would like to thank you all for your cooperation, support and suggestions, advices in the past and anticipate the same in the coming days too.

Formation of Different Committees of NGS

Formation of Different Committees of HKT

Thank you All

2069 Bhadra 21

(September 6, 2012)

34rd ANNUAL GENERAL BODY MEETING OF THE NEPAL GEOLOGICAL SOCIETY

नेपाल भौगर्भिक समाजको ३४ औं साधारण सभा

Speech by Mr. Ram Prasad Ghimire, Treasurer of NGS,
delivered to the 34rd Annual General Body Meeting
21rd Bhadra 2068 (6th Sept. 2012)

यस सभाका सभापतिज्यू

आदरणिय समाजका पूर्व अध्यक्षज्यूहरु

१५ औं कार्यकारिणी समितिका साथीहरु

साथै उपस्थित हुनुभएका समाजका सदस्य साथीहरु

आज म यहाँ १५ औं कार्यकारिणी समितिले गत आर्थिक वर्ष २०६८।६९ को एक बर्षको कार्यकालमा गरेको आर्थिक आयब्ययको विवरणलाई अधिकार प्राप्त लेखा परिक्षकबाट परिक्षण समेत गराई यस समाजको ३४ औं साधारण सभा समक्ष विगत बर्षहरुमा जस्तैगरी तपाईहरु समक्ष पेश गर्न गइरहेको छु ।

१. गत आर्थिक बर्ष २०६७/६८ साल असार मसान्त सम्म हामीसंग बैंक मौज्दात रु. २९,७७,५३३.८३

२. यस आर्थिक वर्ष ०६८/६९ साल असार समान्त सम्म हामीसँ ग बैंक मौज्दात रु. २८,६४,८६५.०२

बैंक मौज्दात अर्न्तगत

कृषि विकास बैंक (मुदती) मा रु ५५,०००

कृषि विकास बैंक (बचत) मा रु. १७९१५.१९

नविल बैंक (डलर खाता) मा रु. २४,५२१.२२ =२१,७२,५८०.० (1$ = ८८.६० ने.रु)

नविल बैंक (मुद्दती) मा रु. २९,०००

नविल बैंक (कल/चल्ती) मा रु. ४,८७,६२९.०४

नेपाल बैंक लिमिटेड (चल्ती) मा रु. ९,९४९.६८

नेपाल बैंक लिमिटेड (बचत) मा रु. ५८,७३१.९३

३. यस आर्थिक वर्षमा

जम्मा आम्दानी = रु. ६,१८,५७५.१९

जम्मा खर्च = रु. ७,३१,२४४.००

खर्च र आम्दानीको विस्तुत विवरण क्ष्लअयभ बलम भ्हउभलमष्तगचभ ब्अअयगलत मा दिइएको छ ।

४. यसरी हेर्दा आ.व.०६८/६९ मा आम्दानी भन्दा खर्च बढि भएको देखिन्छ । जुन रु. १,१२,६६८.८१ मुख्यत आम्दानी भन्दा बढी खर्च देखिनुमा यस कार्यकारिणीले कार्यभार सम्हाल्ने वित्तकै भुक्तानी दिन बाँ की रहको व्यगचलर्बा साथै बुलेटिनको भुक्तानी रु. ३,७२,१७९.०० दिनु परेकोले भएको देखिन्छ ।

५. यस आर्थिक वर्षमा भएको आम्दानीले माथिको सबैलाई कुर लाई सन्तुलन गरिसकेको हुँ दा यस चालु आ.व. मा समाजलाई आर्थिक दृष्टिले सन्तोषजनक रहने देखिन्छ ।

अन्त्यमा आर्थिक प्रतिवेदनको विवरण सम्बन्धीत कुनै प्रतिक्रिया र सुझावहरु भए सो अपेक्षा राख्दै मेरो प्रस्तुति अन्त्य गदछु ।

धन्यवाद !

राम प्रसाद घिमिरे

कोषाध्यक्ष

१५औं कार्यकारिणी समिति

नेपाल भौगर्भिक समाज


भारकूटी
सिमेन्ट
हामी बनाउँदौं नेपालमाई
O.P.C
अर्डिनरी पोर्टल्याण्ड सिमेन्ट
ट्रेडर्स
भारकूटी सिमेन्ट
भारकूटी सिमेन्ट प्रा. लि.
ISO 9001 & 14001 certified company, Nepal's leading cement producer

34rd ANNUAL GENERAL BODY MEETING OF THE NEPAL GEOLOGICAL SOCIETY

नेपाल भौगर्भिक समाजको ३४ औं साधारण सभा

Auditor's Financial Report (FY 2068/069 B.S.)

Babu Raja Bajracharya
Registered Auditor

20th Bhadra 2069

The Members
Nepal Geologiccal Society
Kathmandu.

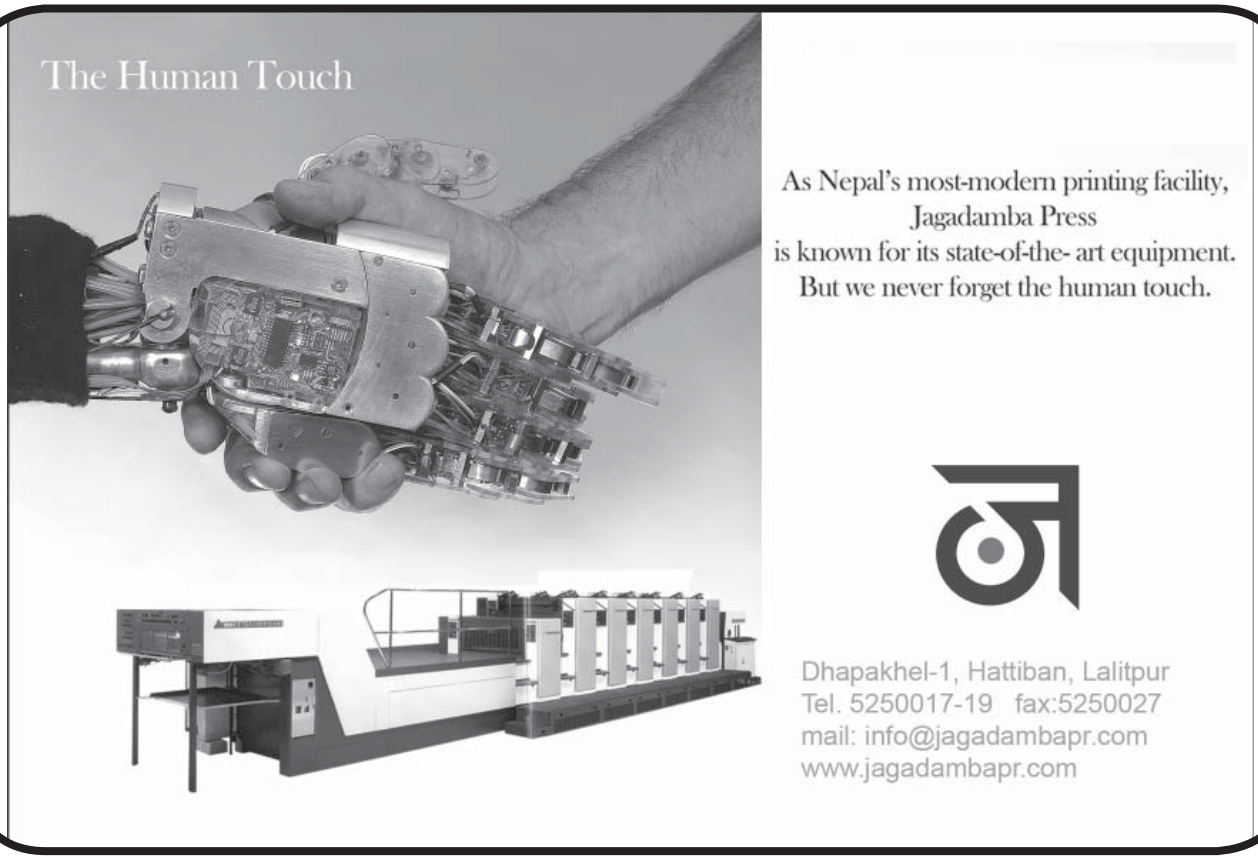
Gentlemen,

I have audited the attached Income and Expenditure Account and Balance Sheet form 1 Shrawan 2068 till the year ended 31 Asar 2069 for the period of Fiscal Year 2068/2069 and report as follows:

1. I have got all the information and explanation which are required for the purpose of Audit.
2. Proper books as required are maintained according to Society's Rule and Regulations.
3. The Attached Income and Expenditure Account and Balance Sheet are drawn properly up in accordance with records which are made available.
4. According to the information given to me the attached Income and Expenditure Account and Balance Sheet prepared from 1 Shrawan 2068 till the year ended 31 Asar 2069 exhibit true and fair view

Babu Raja Bajracharya
Registered Auditor

116 Tinkune marga, Kuleswore, Kathmandu
Phone No: 4282390



34rd ANNUAL GENERAL BODY MEETING OF THE NEPAL GEOLOGICAL SOCIETY

नेपाल भौगर्भिक समाजको ३४ औं साधारण सभा

Auditor's Financial Report (FY 2068/069 B.S.)

NEPAL GEOLOGICAL SOCIETY
KATHMANDU
INCOME & EXPENDITURE ACCOUNT
As at 2069/03/31

Particulars	Amount
A. Income	
Membership	70,065.00
Journal Sale	20,050.00
Registration Fee	41,900.00
Donation	25,000.00
Interest Received	30,371.76
Difference in Dollar Account	431,188.43
Total A	**618,575.19**
B. Expenditure	
Advertisement	20,159.00
Audit Fee	11,767.00
Computer and Accessories	53,985.00
Fee & Wages	20,700.00
Office Expenses	33,362.00
Printing	337,179.00
Postage	2,165.00
Seminar & Workshop	179,446.00
Stationary	21,857.00
Telecommunication	15,624.00
Designing Cost	35,000.00
	-
Total B	**731,244.00**
Surplus / Deficit of the Fiscal Year (A-B)	(112,668.81)
Last Year Surplus / Deficit	2,977,533.83
Surplus / Deficit transferred to Balance Sheet	**2,864,865.02**

President General Secretary Treasurer Auditor

34rd ANNUAL GENERAL BODY MEETING OF THE NEPAL GEOLOGICAL SOCIETY

नेपाल भौगर्भिक समाजको ३४ औं साधारण सभा

Auditor's Financial Report (FY 2068/069 B.S.)

NEPAL GEOLOGICAL SOCIETY
KATHMANDU
TRAIL BALANCE
As at 2069/03/31

S.No.	Particulars	Debit	Credit
1	Agriculture Dev. Bank (Fixed Account)	55,000.00	
2	Agriculture Dev. Bank (Saving Account)	17,915.19	
3	Nabil Bank (Dollar Account 24521.22@88.60 / NPR)	2,172,580.09	
4	Nabil Bank (Fixed Account)	29,000.00	
5	Nabil Bank (Call Account)	487,629.04	
6	Nepal Bank (Current Account)	9,949.68	
7	Nepal Bank (Saving Account)	58,731.93	
8	Advance	10,000.00	
9	B/R	6,000.00	
10	Cash in Hand	4,600.00	
11	Tax Payable		3,267.00
12	Last Year Surplus		2,977,533.83
13	Advertisement	20,159.00	
14	Audit Fee	11,767.00	
15	Computer and Accessories	53,985.00	
16	Fee & Wages	20,700.00	
17	Office Expenses	33,362.00	
18	Printing	337,179.00	
19	Postage	2,165.00	
20	Seminar & Workshop	179,446.00	
21	Stationary & Photocopy	21,857.00	
22	Telecommunication	15,624.00	
23	account Receivable	1,200.00	
24	Difference in Dollar Rate		431,188.43
25	Membership		70,065.00
26	Journal Sale		20,050.00
27	Registration Fee		41,900.00
28	Donation		25,000.00
29	Interest Received (NPR)		22,284.35
30	Interest Received (USD 91.28 @ Rs. 88.60/NPR)		8,087.41
31	Advance to Mr. Dinesh Napit	-	-
32	Advance to Dr. Santa Man Rai	-	-
33	Advance to Mr. R.P.Ghimire	11,918.00	
34	TDS Receivable	3,608.09	
35	Designing Cost	35,000.00	
	Total	**3,599,376.02**	**3,599,376.02**

Note: 1 USD =NRs. 88.60 as per Exchange Rate of Nepal Rastra Bank

President General Secretary Treasurer Auditor

NEPAL GEOLOGICAL SOCIETY
15TH EXECUTIVE COMMITTEE AND OTHER COMMITTEES

15th Executive committee

Mr. Uttam Bol Shrestha	President
Dr. Khum Narayan Paudayal	Vice-President
Mr. Sudhir Rajaure	General Secretary
Mr. Kabiraj Paudyal	Joint Secretary
Mr. Ram Prasad Ghimire	Treasurer
Mr. Kumar K. C.	Member
Mr. Sunil Raj Paudel	Member
Mr. Diwakar Khadka	Member
Ms. Suchita Shrestha	Member
Mr. Kushal Nandan Pokharel	Member
Dr. Subodh Dhakal	Member
Mr. Mahesh Pokharel	Member
Mr. Jagadish Nath Shrestha	Immediate Past President

Advisory Board

The advisory board is to provide advices, suggestions and guidelines during the tenure for the betterment of the Society and its members as well as for improvement of the functions and events of the Society. The advisory board comprises of following distinguished personalities.

Mr. Gopal Singh Thapa
Mr. Narendra Bahadur Kayastha
Dr. Ramesh Prasad Bashyal
Mr. Amod Mani Dixit
Prof. Dr. Bishal Nath Upreti
Mr. Pratap Singh Tater
Prof. Dr. Megh Raj Dhital
Prof. Dr. Madhav Prasad Sharma
Mr. Padma Lal Shrestha
Mr. Nirendra Dhoj Maskey
Mr. Vinod Singh Chhetri
Mr. Achyutanand Bhandary
Mr. Krishna Prasad Kaphle
Mr. Ramesh Kumar Aryal
Dr. Ramesh Man Tuladhar
Mr. Jagadish Nath Shrestha
Prof. Dr. Prakash Chandra Adhikary

NGS – ISDR Council

Mr. Siddhi Pratap Khan	Coordinator
Mr. Sagar Kumar Rai	Member
Dr. Rajendra Prasad Bhandari	Member
Dr. Kamala Kant Acharya	Member
Dr. Jaya Kumar Gurung	Member
Mr. Ashish Ratna Shakya	Member
Mr. Surendra Man Shakya	Member

Mr. Sudhir Rajaure (EC)	Member

Editorial Board

The Editorial Board is responsible for publication of journals, bulletins and other publications of the society with its standards and norms. The board comprises of following distinguished personalities.

Dr. Lalu Prasad Paudel	Chief Editor
Prof. Dr. Kazunori Aarita	Editor
Prof. Dr. Erwin Appel	Editor
Mr. Jayandra Man Tamrakar	Editor
Mr. Nir Shakya	Editor
Dr. Rajendra Prasand Bhandary	Editor
Dr. Subodh Dhakal	Editor
Dr. Kamala Kant Acharya	Editor
Dr. Basant Raj Adhikari	Editor
Mr. Kushal Nandan Pokharel (EC)	Editor

Communication and Information Committee

The Communication and Information Committee is responsible for dissemination of all kinds of information, news and notices of society trough its website, and its regular update and maintenance. The committee comprises of following distinguished personalities.

Dr. Ranjan Kumar Dahal	Coordinator
Mr. Dinesh Nepali	Member
Mr. Surya Prakash Manandhar	Member
Ms. Shova Singh	Member
Dr. Prakash Das Ulak	Member
Mr. Sudhir Rajaure (EC)	Member
Mr. Kumar K. C. (EC)	Member

Scientific Committee

The Scientific Committee is responsible for identifying issues to be incorporated in the scientific activities of the society, organizing and conducting scientific talk program, as well as give guidance in preparing yearly work plans of the executive committee. The committee comprises of following distinguished personalities.

Prof. Dr. Vishnu Dangol	Coordinator
Mr. Ramesh Kumar Aryal	Member
Prof. Dr. Megh Raj Dhital	Member
Dr. Rajendra Bahadur Shrestha	Member
Dr. Tara Nidhi Bhattarai	Member
Dr. Naresh Kaji Tamrakar	Member

Mr. Jeevan Lal Shrestha	Member
Mr. Sushil Pradhan	Member
Mr. Upendra Man Singh Pradhan	Member
Mr. Subas Chandra Sunuwar	Member
Mr. Ichha Kumar Shrestha	Member
Mr. Babu Raja Aryal	Member
Dr. Danda Pani Adhikari	Member
Dr. Khum Narayan Paudayal (EC)	Member

Standard Development Committee

The Standard Development Committee is responsible to identify the area that need development of standards of geo-scientific works, accordingly develop norms, standards, and code of ethics as per legal provision and communicate with NGS executive committee. The committee comprises of following distinguished personalities.

Mr. Jagadish Nath Shrestha (EC)	Coordinator
Prof. Dr. Bishal Nath Upreti	Member
Prof. Dr. Vishnu Dangol	Member
Dr. Santa Man Rai	Member
Mr. Bharat Mani Jnawali	Member
Prof. Dr. Ram Bahadur Sah	Member
Mr. Pratap SinghTater	Member
Mr. Hifzur Rahman	Member
Mr. Dharma Raj Khadka	Member
Mr. Achyut Koirala	Member
Mr. Narendra Khattri	Member
Mr. Rupak Kumar Khadka	Member
Mr. Kabiraj Paudyal (EC)	Member

Public Relation and Financial Committee

The Public Relation and Financial Committee is responsible to coordinate with other professional organizations, INGOs; NGOs, and GOs, help to raise funds to conduct different activities of NGS (seminars, symposium/ workshop/talk program/ publication material for public interest etc.), and organize activities to increase interaction and relation between the society, its members and other organizations. The committee comprises of following distinguished personalities.

Mr. Krishna Prasad Kaphle	Coordinator
Prof. Dr. Bishal Nath Upreti	Member
Mr. Pratap Singh Tater	Member
Dr. Dinesh Pathak	Member
Mr. Govinda Sharma Pokharel	Member
Mr. Moti Bahadur Kunwar	Member

Mr. Shankar Giri	Member
Mr. Debi Nath Subedi	Member
Mr. Keshav Kunwar	Member
Mr. Naryan Singh	Member
Mr. Tuk Lal Adhikari	Member
Mr. Ramashis Mandal	Member
Dr. Sandip Shah	Member
Dr. Gyanendra Lal Shrestha	Member
Mr. Shiva Kumar Sharma	Member
Mr. Pradip Kumar Mool	Member
Mr. Jayendra Man Tamrakar	Member
Ms. Suchita Shrestha (EC)	Member
Mr. Ram Prasad Ghimire (EC)	Member

International Relation Committee

The International Relation Committee is responsible to explore different possibilities towards the internationalization of NGS through disseminating information about the NGS, and help NGS to raise fund by coordinating to carry out joint activities with foreign societies and institutions. The committee comprises of following distinguished personalities.

Dr. Suresh Das Shrestha	Coordinator

Prof. Dr. A. K. Sinha	Member (India)
Dr. Pitambar Gautam	Member (Japan)
Dr. Damayanti Gurung	Member (USA)
Mr. Jeevan Bajra Bajracharya	Member (UK)
Mr. Moti Bahadur Kunwar	Member
Dr. Indra Lal Jworchan	Member (India)
Mr. Umesh Shakya	Member (Laos)
Dr. Rajeev Gautam	Member
Dr. Arjun Aryal	Member
Prof. Dr. Jean Philippe Avouac	Member (France/ USA)
Dr. Anne F. Sheehan	Member (USA)
Mr. Diwakar Khadka (EC)	Member

Rules and Regulation Committee

The Rules and Regulation Committee is responsible to review existing rules and regulation of the NGS, suggest for necessary amendments in the rules and regulation and draft rules and regulations if necessary. The committee comprises of following distinguished personalities.

Mr. Achyutananda Bhandary	Coordinator
Mr. Upendra Man Singh Pradhan	Member
Mr. Shanmukesh Chandra Amatya	Member
Mr. Sardesh Raj Sharma	Member
Mr. Gyani Raja Chitrakar	Member
Mr. Dilip Kumar Sadaula	Member
Mr. Narendra Khattri	Member
Dr. Prem Bahadur Thapa	Member
Mr. Mahesh Pokharel (EC)	Member

Land and Building Management Committee

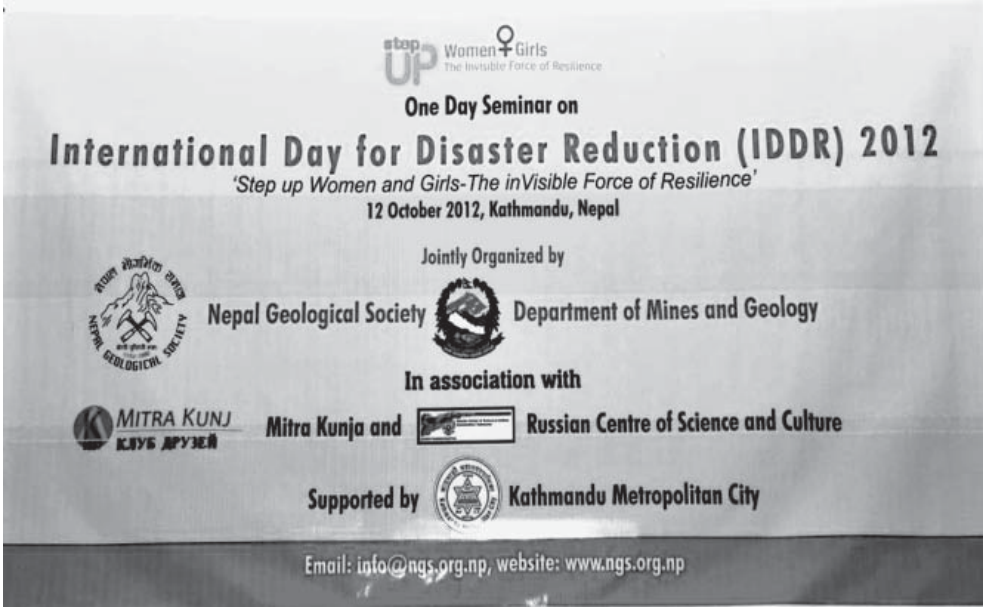
The Land and Building Management Committee is responsible to explore different possibilities towards the construction of NGS building, make necessary approach to concerned organizations for acquiring land for building construction, and locate the areas to purchase land if necessary in order to utilize the money of NGS. The committee comprises of following distinguished personalities.

Mr. Sarbjeet Prasad Mahato	Coordinator
Mr. Shyam Bahadur K. C.	Member
Mr. Ashok Kumar Duvadi	Member
Mr. Jay Raj Ghimire	Member
Mr. Shailendra Bhakta Shrestha	Member
Mr. Khila Nath Dahal	Member
Mr. Sunil Raj Paudel (EC)	Member

INTERNATIONAL DAY FOR DISASTER REDUCTION
IDDR DAY 2012

'Step Up Women and Girls- The inVisible Force of Resilience'

WORKSHOP REPORT



Organized by:

Nepal Geological Society

In association with

Mitra Kunj and Russian Centre of Science and Culture

Supported by: Kathmandu Metropolitan City (KMC)

Kathmandu, Nepal

12 October, 2012

PROGRAMME HIGHLIGHTS OF IDDR DAY-2012

Established in 1980, Nepal Geological Society is a voluntary organization of professional geoscientists from Nepal and many other countries. It was the geoscientists and engineers at Department of Mines & Geology and at Tribhuvan University who took the necessary initiation in establishing this Society, because of the need they felt strongly for a scientific forum in order to cooperate, collaborate and benefit from a global community of scientists, researchers and practitioners who were active in the Himalayan regions. The strength of its memberships at present stands at 650 which comprise a significant number of foreign geoscientists from Asia-Pacific region, Europe, North America and Australia. Among its honorary members are such eminent geoscientists as (Late) Prof. P. Bordet (France), Late (Prof.) A. Gansser (Switzerland), Prof. P. Le Fort (France), Mr. Madhav Raj Pandey (Nepal), Prof. K. S. Valdiya (India) , Prof. K. Kizaki (Japan), Mr. G.S.Thapa (Nepal) and Prof. Dr. Paul Tapponnier (Singapore).

The Society organizes international and national seminars, conferences and workshops regularly. The Nepal Geological Congress is the flagship international conference of the Society that is organized every three year in Nepal. The most recent one was the 6th Nepal Geological Congress held in November 2010. It has hosted in the past, among many others, the 5th Asian Regional Conference on Engineering Geology in 2005, the "International Symposium on Engineering Geology, Hydrology and Natural Disasters with emphasis on Asia" in 1999 and the 9th HKT Workshop in 1994. The Society publishes its own scientific journal, the Journal of Nepal Geological Society, which is being published regularly since 1980 and is in wide circulation all over the world.

Nepal Geological Society (NGS) has been undertaking various activities related to disaster and awareness programs for disaster reduction in response to the United Nations since l991. In response to the call of (UNISDR), NGS organized a one-day seminar on the occasion of international Day for Disaster Reduction (IDDR) 2012 on 12th of October 2012 at Russian Centre of Science and Culture (Mitra Kunj) Kamalpokhari. The theme of the IDDR 2012 was "Step Up Women and Girls- The inVisible Force of Resilience". The main objective of the program was awareness building to all the fact that Girls and Women around the world are on the frontline in making their communities and societies resilient to the impacts of disasters and the effects of the Climate Change. NGS had requested school children, university students, geoscientists and senior officials of ministries and departments of the Government of Nepal to participate in the program. The workshop was participated by two hundred participants. It was organized into two sessions: the first session was inaugural session and the second was technical session. Mr. Keshav Sthapit, Development Commissioner of the Kathmandu Valley Development Authority inaugurated the program. Mr. Sthapit highlighted on the present scenario of unmanaged urbanization in Kathmandu and stressed on the need of initiation from geoscientists for disaster reduction. He also requested the Nepal Geological Society for joint initiation with authority towards the disaster risk management related to urbanization. Mr. Sarbajit Prasad Mahato, Director General of Department of Mines and Geology shed light on the need of planned urbanization and role of geoscientists on it. He also focused on the increased involvement of women geoscientists in disaster reduction activities. Mr. Prakash Paudel, Director General, Department of Water Induced Disaster Prevention, Mr. Ganesh Shah, President of Mitra Kunj and Former Minister, Ms. Anastasia Khokhlova, Deputy Director, Russian Center for Science and Culture, Mr. Kedar Bahadur Adhikari, Acting Mayor and Executive Officer, Kathmandu Metropolitan City also expressed their views. Mr. U. B. Shrestha, President of Nepal Geological Society welcomed the participants and highlighted on the need of organizing such seminars on natural disasters. Finally Mr. Sudhir Rajaure, General Secretary of the society paid vote of thanks.

There were seven technical presentations on natural

disaster and their mitigation. This event was organized jointly by the Nepal Geological Society and Department of Mines and Geology in association with the Russian

GLIMPSE OF THE IDDR 2012 SEMINAR


SSIAN CENTER
of
NCE & CULTURE


SSIAN CENTER
of
NCE & CULTURE

ABSTRACT OF PAPERS PRESENTED IN the IDDR Day-2012

Cause of Seti flood of 5th May 2012: A remote sensing approach

Shreekamal Dwivedi and Yojana Neupane
Department of Water Induced Disaster Prevention, Pulchowk, Lalitpur, Nepal

A catastrophic flash flood has occurred in the Seti River in the morning of May 5 2012 and has killed 72 people and has caused huge damage to the lives and livelihood in Sadikhola and Machhapuchhre VDCs of Kaski district, Western Nepal. The flood occurred in a clear day and no glacial lake of significant size was spotted in the satellite images captured immediately before the disaster. Several professionals and professional organizations have proposed different views and hypotheses regarding the cause of the flood. An attempt has been made here applying remote sensing to find out the cause of the flood which originated form very remote inaccessible area lying in the Western slope of the Annapurna IV peak. Comparative Analysis of the Landsat ETM satellite images of April 2012 and 6th May 2012 which were available online in NASA website revealed that the area of about 32000 square meter of the southern ridge 1.5 kilometer away from the Annapurna IV peak failed in the north western direction. The impact of descending mass of the failed mountain from 6850 meters to 4500 meters almost vertically pulverized the ice, sediment and rock. The pulverized mass formed dark brown cloud which was also captured by the ultralight aircraft of the Nepal Avia Club. The main direction of the failure was towards the North-West. The impact even triggered seismicity (at 9:09.56 a.m. local time) which was recorded all over the 21 stations of National Seismological Centre (Sapkota and Duvadi, 2012). The seismicity was equivalent to 3.8- 4 Richter scale in magnitude. The closest seismic station at Dansing which is 32 km. south west from the area recorded the high signals for 70 minutes which corresponds to the duration of the debris flow. The huge vibration and the heat generated by the impact caused the glaciers located on the slope to fail towards the origin of the Seti River. This whole mass descended further down slope to 3300 meter south western direction from where the Seti River starts. The huge mass of debris along with Ice chunks rushed down the river as a debris flow for 20 kilometres downstream at Kharapani in just 28 minutes (almost 12 meters/second). The photographs captured by the Avia Club Light aircraft before and after the event have also clearly shown the failed ridge.

The suspended sediment sample collected 100 meter downstream of the Irrigation Dam in Pokhara on 5th May was analyzed. Lab analysis of the flood water sample revealed the density of the flow as 1.88 gm/cc. The result of sieve analysis of the dried suspended sediment sample showed that it mostly contains fine sand and silt (Fig, 1. Acid test done in the dried sediments indicated calcareous contents in the flood water. Dark grains showed effervescence when powdered.

Analysis of the satellite based hourly rainfall GSMaP NRT from the period from 20th April -6th May 2012 revealed that there were just 4 occurrences of rainfall which amounted less than 1 mm/hour in the source area of the avalanche. The rainfall > 7mm/hour which occurred in the Kharapani area on 4 May was localized rainfall which did not extend to the avalanche area.

The flooding in Seti River has caused great damage to the life and properties. According to the Ministry of Home Affairs 40 people lost their lives and 32 are still missing (all presumed dead) and 5 are injured. Estimated economic loss is about 82 million rupees including 33 million private properties and remaining 49 million public properties (89 Nrs= 1US$). Devastating flood damaged 7 house and 7 shops. One km blacked topped road 2 km gravel road, 25 electric poles, 4 suspension bridges at different places were damaged by the flood which affected daily operation. Flooding also swept away 12 vehicles including 7 tractors, 7 van, 2 motorbikes and 2 trucks. About 9.5 hectares paddy field has been covered by the sediment. Flood also damaged two water mills and 45 meter drinking water supply lines resulting problem on water supply in Pokhara for several weeks.

After the analysis of the satellite images, suspended sediment analysis, photographs taken by the Ultra Light Aircraft, the eye-witness accounts, satellite based rainfall data and seismic data, we conclude that the flood of 5th May 2012 in the Seti river was caused by the massive avalanche which occurred due to the failure the glaciated area located at 4500 meters

a.m.s.l. on the South-Western slope of the Annanpurna IV peak. The avalanche was triggered by the failure of the ridge at an altitude of 6850 meters and was located 1.5 km. south of the peak which even caused seismic activity equivalent to 3.8- 4 Richter Scale in magnitude. Avalanche triggered high intensity floods, having density >1.88 gm/cc in this event, had similar characteristics to Glacier Lake Outburst Flood (GLOF).

An overview of National Seismological Centre, Department of Mines and Geology

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The National Seismological Centre (NSC) under Department of Mines and Geology (DMG) is the only government organization in Nepal to monitor earthquakes in the territory of Nepal and adjoining region. It was established in 1978 under collaborative project between DMG, Nepal and Laboratoire de Géophysique (LDG), France, presently Department Analyse Surveillance et Environment (DASE), France.

At the moment, this network consists of twenty one short period vertical component, one 3-components long period and one 3-components broadband seismic stations covering the whole country and two independent recording centers. The main purpose of the network is to locate and evaluate local seismic events around the Nepal Himalaya and alert the concerned authorities of the occurrence of all events with magnitude greater than four within the national territory. By the end of September, 2012 the network has recorded total 150,251 earthquakes out of which 50,431 are local and 99,820 are teleseismic. Trend of this local seismicity allows us to refine the seismotectonic model, existing velocity model and basic input parameter for hazard assessment. This network is capable of detecting earthquake with magnitude greater than or equal to 2.0 within Nepal.

Seismic stations allow us to measure the magnitude of an earthquake but we cannot get directly the value of strong ground motion, which is one of the important parameter for developing the attenuation equations and updating the building code. To address this problem, 7 accelerometric stations have been deployed by the end of 2011 in collaboration with DASE from Taplejung to Dadeldhura including one in Department of Mines and Geology premises. With the help of this network we can report the peak ground acceleration (PGA), velocity (PGV) and displacement (PGD).

Earthquake in this region is due to the collision between two continental plates (Indian and Tibetan). Because of this collision, stress is developing between these plates. To monitor the stress development and deformation in this part of Himalaya, twenty nine GPS stations are installed in Nepal in collaboration with California Institute of Technology (Caltech) and DASE. Result from this network will allow us to map the present day situation of stress development during the interseismic period.

Instrumental seismology does not go back beyond seven decades and return period of megaquake might be more than a 500 years. This small time window cannot be extrapoleted for this long period of time. To address this problem NSC in collaboration with Earth Observatory Singapore (EOS), IPGP France and DASE France is conducting research on past surface rupture of great earthquake along the strike of the Main Frontal Thrust (MFT). Pleaoseismological research in the central and eastern Nepal has confirmed the emergent nature of MFT and exposed the surface rupture of 1934 earthquake. Similarly, surface rupture of 1505 earthquake has been exposed in far western Nepal.

Data from NSC network and output of other seismological research are the basic input parameter for updating and developing the building code and to assess the seismic hazard of the country. Earthquake hazard assessment and mitigation is one of the major tasks to cope with the earthquake related disasters. National Seismological Center of DMG has played a significant role in this regard.

Earthquake hazard and its preparedness

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Generally, people are horrified when they listen or read the news of earthquake occurred in any part of the world. The sole reason behind that is significant number of people have been killed in earthquake. It has been depicted in the different figures in the presentation where earthquake is clearly seen as a major among other natural disasters such as flood, storm, volcano etc. For instance, In China, even 450 years ago a single earthquake killed more than 8, 30,000 in 1556 A.D.

From the seismic hazard point of view, Nepal lies in highly vulnerable condition. The 1990 earthquake killed 8519 and destructed large number of structures in eastern and central part of Nepal with more effects in Kathmandu. Until now, there are not effective programs to aware the people on earthquake process, its effects and preparedness and the basic life saving techniques during the disaster therefore, people are horrified when listening about earthquake. In this context, it has been a necessary to aware the people on the fact that earthquake is still unpredictable in terms of the exact time but can easily told the region on which earthquake likely to occur.

There are two methods of describing the size of an earthquake: magnitude and intensity. The magnitude is a quantitative measure of the actual size of the earthquake which indicates the amount of energy released at the source. The magnitude of most earthquakes is measured on Richter scale, after Charles F. Richter (1935). In a unit increase in magnitude (for example from 3 to 4) on this scale 32 times more energy is released. The intensity is a qualitative measure of the actual shaking at a location determined from reported effects of the earthquake on human beings, furniture, building, geological structure etc. An earthquake intensity is most often measured using the Modified Mercalli Intensity (MMI) scale which uses

Roman numerals I (least perceptive) to XII (most severe).

Earthquake itself is not a menace but the resulting effects viz. ground shaking, structural failure, surface faulting, landslide, fire, liquefaction and tsunami are threats to life. There are very simple and effective preparedness techniques to follow before, during and after the earthquake. Unfortunately we have been unsuccessful to disseminate all information and aware the every household about earthquake and life saving techniques.

Women's participation and effectiveness in earthquake risk reduction for IDDR

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Disaster including earthquake has more impact on women than men particularly in a developing country like Nepal. Women are exposed to the risks of earthquake as they have limited access to education, information, skills, trainings, and resources and less decision-making power both within and outside the home. These social physical and economic conditions are often perpetuated by socially constructed roles and responsibilities eventually creating different needs and concerns. This has resulted in a disproportionate percentage of the uneducated population of the world. How the world or a country can be safe if 50% of the population is at risk? This calls for making aware and educating them about the existing risk of earthquake, mitigation measures and preparedness activities which further calls for understanding their different needs and concerns so that they can complement the other initiatives in disaster risk management. Realizing this, various institutions working in this sector have developed strategies, programs and activities to address this pertinent issue. NSET has also worked towards this direction. NSET's Approach for maximizing women participation in DRR/ERR is in one way as an integral part of the various programs and activities such as Safe Home Campaign, SESP- School Management Committee (SMC), Teachers/ Students Training & Orientation, Students 'Club, CBDRM – DMC, RAP, 3PERM, Orientations - Awareness, Trainings - Skill, Program for Enhancement of Emergency Response (PEER- Advanced Training). Also NSET adopts another approach to implement specific programs targeting women such as Housewife's Training- Structural & NSM, Mason's Training and also involvement in grassroots Women's Network. NSET experience has shown that higher women participation in DRR means easier and quicker implementation, quicker and wider Information dissemination and knowledge Sharing, highly resource consciousness and optimum use of resources and also strong potential of low-cost and practical solutions.

Tin Thana landslide: A lesson to us

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A landslide occurred in Tinthana VDC - 5 in the early morning, around 1 AM of Ashwin 1 2069. The land mass, along with one house belonging on the land mass slid about 50 meters down. It was reported in news papers that the house owner was sleeping in the house and felt like an earthquake but realized about the incident two hours later only.

Visual inspection of the site reveals that the slope is not very steep and neither there was considerable toe cutting by the Balkhu Khola in the east. The landslide is a rotational one entierely in clay. Clay layers are exposed on the riverbed of the Balkhu Khola. The landslide blocked the Balkhu Khola for some hours and the nearby area got water logged.

There are many houses built on such slopes in the Kathmandu Valley and more will be constructed in the coming days. This incident has stressed on the need of geological and geotechnical investigation of construction sites in the Kathmandu Valley.

River encroachment status in the Kathmandu Valley, with special reference to the Bagmati River

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River form and fluvial process evolve simultaneously and operate through mutual adjustments towards self-stabilization. Channel stability is the ability of the stream, over time, to transport the flows and sediment of its watershed in such a manner that the dimension, pattern and profile of the river is maintained without aggrading or degrading. Also, rivers are significant geomorphological agent showing diversity in form and behavior and quickly responding to disturbances acting against their system.

The river system of the Kathmandu Valley has high cultural and aesthetical values. The Bagmati River is major river system of the Kathmandu Valley, which originates from eastern hill Nagarkot in Sudal, is seventh order drainage stretches about 51 km and flows over the valley covering 678 km2 of watershed. This river system is suffering from extreme human encroachment. Several anthropogenic activities as channelization, sediment excavation, effluent discharge, dumping waste in and along the river bank, building roads etc. are heading the river towards a narrow and passive channel. Such activities caused environmental degradation as well as cultural erosion of the system. Because of sever human encroachment river morphology is changing abnormally with increasing sinuosity of river but diminishing channel belt width, meander wavelength and radius of curvature. This shows that the river system is being deteriorated with time. But when river achieves its full potential it can cause extreme flood hazard. The present situation of river encroachment is very alarming and this can lead to unrecoverable damage to life and infrastructure. And also there is great risk of health hazard from polluted river flow.

Present scenario of geological and hydro-meteorological hazards, their risk and effects of global warming in Nepal Himalaya

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Different parts of Nepal are frequently suffering from Geological and Hydro-Meteorological hazards like earthquake, landslide, debris flow, flood, glacial lake outburst flood (GLOF), wind storm, hot and cold waves, epidemics, fire etc. and Himalayan region in particular is highly affected by global warming. Because of Global warming climate is changing in almost all parts of the earth especially in the Himalayan regions. As a result glaciers are retreating, snow is melting and a numbers of new glacial lakes are appearing in Nepalese Himalaya. Some of the glacial lakes could burst at any time and might bring the disasters in the downstream by GLOF. In the last 25 years natural disasters had caused tremendous losses of lives (about 865 lives every year), properties and severe damage of infrastructures costing billions of dollars and consequently GDP loss. Hazard when interact

with vulnerability brings the disasters in the affected areas. The frequency of landslides, flood, debris flow, road accidents, airplane crash etc. is increasing due to high rate of population growth, their multiple improper activities and human negligence. Disaster disturbs the normal life and social system, degraded the environment, aggravate the poverty and eco-system in the affected areas. Hazard maps are extremely important in disaster risk management, land use planning, infrastructure development planning, environment protection etc. Applications of information depicted in hazard map help to understand different type of hazards, identify possible risk areas and take suitable precautionary measures against possible disaster well in advance to minimize the loss. However, there is a need of good coordination and combined efforts of the government, local people, NGOs, INGOs as well as bilateral and multilateral agencies to deal with the disaster and save the vulnerable people, infrastructures and protect the natural environment.

Before 1985 Government of Nepal was giving high priority for post disaster rescue, relief operation and rehabilitation but after the bad experience of 1985 Dig Tso GLOF, 1988 earthquake and 1993 and 2007 Flood and Landslide disaster in Nepal and their severe effects causing tremendous loss of lives, properties and damage of infrastructures, it has realized the importance of pre-disaster preparedness and tried to make the people aware of such disasters with the help of Government Departments, NGO, INGOs and other agencies involved in development works in Nepal.

After the declaration of International Decade for Natural Disaster Reduction (IDNDR) by UN during 1991- 2000 and follow up International Strategy for Disaster Reduction (ISDR) and its worldwide awareness program the government of Nepal as well as Nepalese people realized that the effect of disasters can be reduced considerably if they are timely well aware of possible disasters and prepared to face them. Now the government has developed the capabilities in emergency response and logistic support management system up to the district level. It has a plan to extend in the village level. At the same time concerning government departments, some NGOs, INGOs, Red Cross Society, ICIMOD, UN agencies etc. are studying the effect of global warming, climate change, dangerous glacier lakes, and disclosing hydrological and meteorological information, geological maps, hazard maps, engineering and environmental geological maps which are quite helpful for infrastructure development planning, disaster risk management, environment protection in the country. Government of Nepal must continue its exercise to make the development work programs compatible with the disaster management with a view to meet the Millennium Development Goal (MDG).

CONCLUSION OF THE IDDR DAY-2012

Conclusion

Nepal is a mountainous country, which every year suffers from different types of natural as well as human induced disasters. All disasters cannot be predicted; however it is always better to create awareness in public so that the adverse impact of disasters could be minimized.

Participants were interested on the presentations and stressed on the need of creation of awareness regarding different types of disasters. . The role of women and girls after any kind of disaster was highlighted and Awareness of disasters should start from the very beginning school level. Strong need was felt to suggest the concerned agencies to incorporate all kinds of disaster and their possible mitigative measures in curriculum from the very beginning of school education.

Acknowledgements

Nepal Geological Society expresses its sincere thanks to the Mitra Kunj and the Russian Centre of Science and Culture, Kamal Pokhari, Kathmandu, Nepal for providing the workshop hall. Similarly, the Society expresses hearty thanks to Mr. Kedar Bahadur Adhikari, Chief of the Kathmandu Metropolitan City and Department of Water Induced Disaster Prevention (DWIDP) and Department of Irrigation for their respective support to organize the workshop as in the past.

WORKSHOP REPORT

27TH HIMALAYAN-KARAKORAM-TIBET WORKSHOP (HKT), KATHMANDU NEPAL NOVEMBER 28-30, 2012,

An International Confernece of Geology of Himalaya-Karakoram-Tibet Region

ORGANIZED BY NEPAL GEOLOGICAL SOCIETY

WORKSHOP

The 27th Himalaya-Karakoram-Tibet (HKT) workshop has been successfully conducted in Kathmandu, Nepal. It was held during November 28th-30th, 2012 at The Everest Hotel in Kathmandu, Nepal. This workshop was organized jointly by Nepal Geological Society and the Department of Mines & Geology, Government of Nepal, and was supported by many national and international organizations and institutions including

Inaguration of programme of the Workshop at Hotel Everest, Kathmandu, Nepal. Sitting at the front row: Mr. Uttambol Sherestha, President of NGS (right), Rt. Hon. Dr. Ram Baran Yadav, President of Nepal (middle), Mr. Anil Kumar San, minister for industry (left).

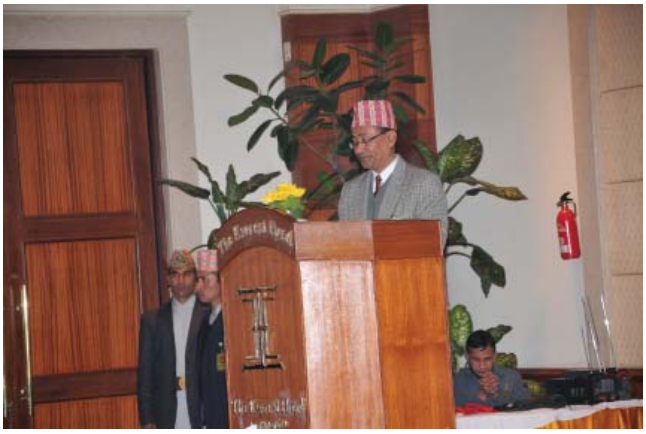
The Academy of Sciences for the Developing World (TWAS), the Tectonic Observatory, California Institute of Technology (CalTech, TO), Earth Observatory Singapore, Nanyang Techinological University and many others.

On 28th November, 2012, the Rt. Honorable President of the Federal Republic of Nepal, Dr. Ram Baran Yadav, inaugurated the workshop. The inauguration program was attended by about 400 which included participants, invited guests and media personnel. In his inaugural speech, the Rt. Honorable President said that proper understanding of the geologic phenomenon operating under our planet Earth is essential for the survival, prosperity and sustainability of not only the mankind, but also the all living beings on Earth. Highlighting the need of geological research for developing mineral resources and hydropower potentials in Nepal, he also expressed the concern over the receding glaciers in the Himalaya, Karakoram and Tibet regions as a result of global warming. He appreciated the active interest of the international geo-scientific community in the geological researches in the regions and expressed his hope that this workshop would benefit the people in this region and in other parts of the world. Dr. Dibya Ratna Kansakar, the Convener of the 27th HKT workshop, gave a glimpse of the size and scope of the workshop, and pointed out the need for more advanced geological research for prosperity, safety and sustainability of the people in the region. He said that "geology is also the 'science of the foundation' for the 'foundation of economic development' because economic sustainability is also a matter of how sustainable the physical infrastructures are and that geological investigations help in avoiding or protecting development infrastructures from geologic hazards. He also opined that geologic "past is the guide to the future" which is instrumental for mankind to equip for facing the consequences of global warming and climate change. Minister for

President of the NGS Mr. Uttambol Shrestha and convener of the workshop Dr. Dibya Ratna Kansakar welcomed the president at Hotel Everest.

Dr. Ram Baran Yadav inagurating the confernece .

Mr. Uttambol Shrestha adressing the inagural session.



Dr. Dibya Ratna Kansakar adressing the inagural session.

Prof. Dr. M. Q. Jan adressing the inagural session.

Prof. Dr. B. N. Upreti adressing the inagural session.

Participants at the technical session.

Industries, Mr. Anil Kumar Jha, said that geological research in Nepal Himalaya has great role to play in the economic development through development of minerals and mining sector in Nepal. He highlighted the contribution of non-metallic and precious minerals sector in the national economy of Nepal. Mr. Uttam Bol Shrestha, President of Nepal Geological Society, welcomed the participants and the guests in the program and Mr. Sarbajit Prasad Mahato, Director General of Department of Mines & Geology, offered the vote of thanks to all the participants, guests and the sponsors of the workshop. During the inaugural program, the Rt. Honorable President of Nepal also handed over the Honorary Membership of Nepal Geological Society to Mr. Gopal Singh Thapa and Prof. Dr. Paul Tapponnier in recognition of their significant contributions in the advancement of geological research in Nepal and understanding of the Himalayan region.

The technical sessions of the workshop followed soon after the inauguration program. The technical sessions were structured into 16 oral presentation sessions and 3 poster sessions (Please refer to Annex 1). The papers were categorized under 5 main themes, namely (i) Regional Geology and Tectonics, (ii) Seismology and Seismo-Tectonics, (iii) Geo-hazards and Engineering Geology, (iv) Climate and Quaternary Geology, and (v) Environmental Geology (Please refer to Annex 1). The first day of the workshop was devoted on the theme of Regional Geology and Tectonics. All the sessions under this theme were dedicated to late Prof. Augusto Gansser, who had died aged 101 years recently. He was a Swiss geologist and adventurer whose explorations had led to new insights about the origins of the Himalaya and other mountain ranges and the sources of petroleum. The 27th HKT workshop session began with a dedication presentation by Prof. Nigel B.W. Harris from Oxford University, who highlighted a number of pioneering concepts that late Prof. Gansser had given to the geologists of the world. He was an honorary member of Nepal Geological Society.

Altogether, 150 scientific papers were presented during the 27th HKT workshop. These papers were selected from over 200 scientific abstracts that were submitted to the Organizers. One Day One, 26 papers were presented in 5 oral presentation sessions and 18 papers were presented in poster session. On Day Two, a total of 55 papers were presented; 35 papers in 4 oral presentation sessions and 20 papers in the poster session. Similarly, 28 papers in 4 oral presentation sessions and 23 papers in poster session were presented on Day Three. There were 28 foreign student participants in the workshop. Similarly, there were a numerous Nepalese students who took part in the workshop.

The 27th HKT workshop was attended by 312 participants. Among them, 190 participants were the Nepalese geoscientists, engineers, and practitioners. A complete list of the registered participants in the workshop is given in Annex 2. Among the 126 foreign participants, 2 were from Austria, 2 from Bangladesh, 1 from Bhutan, 6 from Canada, 16 from China, 17 from France, 13 from Germany, 23 from India, 3 from Israel, 6 from Italy, 8 from Japan, 6 from Pakistan, 2 from Russia, 3 from Spain, 4 from Switzerland, 8 from United Kingdom and 6 from the United States of America. In addition, 10 participants were accompanied by their spouse or family member. Thus, besides a very large number of Nepalese participants, there were 45 geoscientists from the Himalaya, Karakoram and Tibet regions itself who attended the workshop. For the Organizers, this is a matter of remarkable success and satisfaction.

During the workshop on Day 2, Prof. Erwin Appel from Tubingen University, Germany, made a short presentation about the 28th HKT workshop which is going to be hosted by him and his colleagues in Germany. On behalf of his organizing team, Prof. Appel invited all the participants, and through them to all other HKT geoscientists, to Tubingen University in 2013.

The 27th HKT workshop concluded with a valedictory session on 30th November. This program was chaired by the President of Nepal Geological Society, Mr. Uttam Bol Shrestha and co-chaired by Mr. Sarbajit Prasad Mahato, Director General of Department of Mines & Geology. This session began with a workshop report by the convener, Dr. Dibya Ratna Kansakar. He presented the facts and figures about the participation, paper presentations and the participation in the 4 field excursions which were organized as a part of the workshop. Among many sponsors, he highlighted the grant support from the Academy of Sciences for the Developing World (TWAS) which was vital in bringing in the geoscientists from South Asian countries to the workshop. He reported that altogether 24 participants, 2 from Bangladesh, 17 from India and 5 from Pakistan have received financial supports, and that among them, 16 participants received partial travel grant which was received from the TWAS. He thanked all the participants, sponsors, and members of the organizing committee for their support, cooperation and understanding in making the event a grand success. The workshop concluded with the vote of thanks and appreciation by Mr. Sarbajit Mahato and Mr. Uttam Bol Shrestha, who also thanked all the participants, the advisory committee and the organizing committee members and the sponsors of the workshop.

FIELD EXCURSIONS

There was one pre-workshop field excursion and three post-workshop excursions that were organized as a part of the 27th HKT workshop.

Pre-Workshop Excursion No. 5: Quaternary Geology around Kathmandu Valley

This workshop was held on 27th November 2012. It was led by the area subject specialists namely Dr. Ananta Prasad Gajurel, from Tribhuvan University/ NGS, Prof. Harutaka Sakai from Kyoto University, Japan, Dr. Tetsuya Sakai from Shimane University, Japan and Dr. Rie Fujii from Kyoto University, Japan. In this excursion, there were 16 participants among whom 8 were the Master's degree students of Tribhuvan University (List of Participants is given in Annex 3). The travel cost of the 8 Master's degree students of Tribhuvan University was borne by Dr. Dibya Ratna Kansakar, the Convener of the 27th HKT Workshop. All the participants were provided with a field excursion guide book, which was prepared together by the 4 excursion leaders and published with a research grant support from the Government of Japan.

A group photo of the participants of Excursion (No.5) around Kathmandu Valley (left). Participants appreciating the geological record in the Kathmandu Valley sediments (right).

Participants in the Excursion No. 1 with a part of Annapurna Range in the background.

Post-Workshop Excursion No. 1: Kathmandu-Butwal-Pokhara-Tatopani-Jomsom Section

This field excursion was started from Kathmandu on 1st December and ended after returning to Kathmandu on the 6th of December. There were 28 foreign participants in this excursion, which was led by Dr. Santa Man Rai, Dr. Basant Raj Adhikari and Mr. Prakash Das Ulak from Tribhuvan University/NGS and Ms. Delores Robinson from University of Alabama, USA. All the participants were provided with field excursion guide book and relevant latest publications on the geology of the area in advance. Please refer to Annex 4 for the list of participants in this excursion.

Participants in the Field Excursion-3, Kathmandu-Amlekhgunj-Bardibas Section

Some of the Participants of the Excursion No.4

Post-Workshop Excursion No. 3: Kathmandu-Amlekhgunj-Bardibas Section

The Excursion No. 3 began on 1st December and ended on 3rd December 2012. This excursion was led by

Dr. Soma Nath Sapkota from Dept. of Mines & Geology/NGS (also the Co-Convener of the 27th HKT), Dr. Lalu Prasad Poudel from Tribhuvan University/NGS and Prof. Paul Tapponnier currently at Nanyang Technical University, Singapore. Six foreign and 8 Nepalese participants took part in this excursion (Please refer to Annex 5 for the list of participants). An illustrative field guidebook was prepared and distributed to the participants in advance.

Post-Workshop Excursion No. 4: Kathmandu-Galchhi-Malekhu Section (Northwestern Kathmandu Nappe)

This one day field excursion took place on 1st December 2012. This excursion was led by Prof. Bishal Nath Uprety from Tribhuvan University/NGS and Dr. Alex A. Webb from Louisiana State University, USA. In this excursion, 7 foreign participants and 9 Nepalese students participated in this excursion (Please refer to Annex 6).

The Organizers duly acknowledge and appreciate the expert service of all the excursion leaders. Thanks to their expert knowledge, seamless logistic arrangements and excellent interpersonal skills, the organizers had received numerous appreciative notes from the participants.

Recipients of financial support among the participants

Scientists and researchers in developing countries in general find it difficult to attend international conferences, seminars and workshops because of the financial constraints. It is even tougher when such events are held in developed countries because of high cost of living and travel. One of the main reason why Nepal Geological Society took the initiative and subsequently succeeded in convincing the international geoscientists community to host the 27th HKT workshop in Nepal was to narrow down the distance between the conference host country and the geoscientists so that the travel cost is low and living cost is affordable. In spite of these, many find it still hard to manage the fund required for travel, workshop registration and accommodation and food during the conference. Taking into consideration of these difficulties, Nepal Geological Society, being the lead organization, approached a number of national and international institutions requesting them for financial support in order that geoscientists from developing countries could attend the workshop in large number.

The 27th HKT organizers were successful in raising some fund in grants from some institutions and organization, and this fund was utilized in supporting

the developing country participants, particularly the geoscientists from South Asian Countries in this case, by providing funds to pay their travel cost, workshop registration fee and accommodation, as the need was. In total, 23 participants were awarded financial support to participate in this workshop. These recipients were selected from a large number of participants who had requested for financial support. These participants were selected on the basis of their needs, their occupational status, quality of research of paper, and gender. Students, young scientists and women were given preference while awarding the funding support. Among the recipients were three women; one from Pakistan and two from India. According to occupational status, 3 were students, 2 junior scientists, and 3 Government Scientist Officers, and the remaining were university professors and lecturers.

The financial support was provided as per their needs and their capacity to manage fund other sources. However, the Organizers had also provided support to some prominent geoscientists from South Asia whose presence was important and who could add much value to the workshop through their presentation and their contribution in the scientific discussions. Some participants were provided with only the travel cost, while some were given travel and accommodation. A very few participants were provided with a full cost support, i.e. travel, registration fee and accommodation.

Recipients of TWAS travel grant

A total of 15 participants from South Asian Countries have benefitted from a travel grant support which was received by the organizers from The Academy of Sciences for the Developing World (TWAS), Trieste, Italy. They were 11 participants from India, 3 from Pakistan and 1 from Bangladesh. The recipients were selected based on their need as expressed in the request for support, the quality of research work and the geographic representation of the research area, their occupational status and gender representation. Effort was made to encourage as many students and junior scientists as possible while selecting the candidates for travel grant support. Adequate preference was also given to women candidates while offering the travel and/or other financial support to the candidates. Among the recipients, there were 3 students, 1 junior researcher, 7 professors, 1 lecturer, 1 government officer and 1 professional society representatives. There was also one female student.

Evaluation of the 27th HKT Workshop Program

The 27th HKT workshop held in Kathmandu is a great success for several reasons. Firstly, this workshop turned out to a huge gathering of geoscientists from all over the world. A total of 126 international geoscientists, representing 17 different countries from Asia, Europe, and North America participated in it. Besides the foreign scientists, an even larger contingent of Nepalese geoscientists, engineers, practitioners and students, a total of 190 in number, could participate in this workshop. Secondly, it was a gathering of not only the prominent geoscientists but also the young researchers and students from these countries. There was also a good size of women geoscientists in this gathering. Thirdly, there was a good sense of partnership between the Nepalese and foreign geoscientist in the organization of the workshop and the field excursions. The field excursions were designed and conducted jointly by the Nepalese and foreign expert geoscientist and shared their current findings and their knowledge with the participants in the field excursions. Last but not the least, this workshop saw a very significant number of participation from the Asian countries - home of the Himalaya, Karakorum and Tibet Region, the main area of the workshop topic. Instrumental to bringing in such a large number of participants to this workshop has been the generous financial support received from several national and international organizations and institutions. Among them, The Academy of Sciences for the Third World, the Tectonic Observatory at California Institute of Technology (CalTech, TO), Earth Observatory in Singapore at Nanyang Techinological Uniersity have been most noteworthy. Without their grant supports, which were utilized in subsidizing the workshop participation costs and paying their travel accommodation bills, participation of such a large number of geoscientists from India, Pakistan, Bangladesh and Nepal would not have been possible. The Organizers of the 27th HKT workshop acknowledge and appreciate the support received from these and many other institutions.

ABSTRACT OF PAPERS PRESENTED IN SCIENTIFIC TALK PROGRAMME

Energy for the future: rocks as storage for and source of renewable energy

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Based on the hot core and the radioactive decay of elements in the continental crust, the Earth represents an inexhaustible source of energy. In addition, rocks may serve as a suitable storage of heat (or cooling energy). After millennia of use of natural hot-water springs, during the last decades geothermal regions were explored in more detail with respect to their value for a more extensive heat and electricity production. Exemplified by latest developments in the Munich region in Germany, advantages and disadvantages of deep and shallow geothermal energy production, the scientific and technical aspects as well as the energy storage capacities of rocks will be presented and the potential of geothermal energy as a world-wide energy resource will be discussed.

Tectonic evolution of the South Tibetan detachment system, central and eastern Himalaya

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Geological Survey of Canada, Ottawa, Canada

The eastern Himalaya is characterized by a region of granulites and local granulitized eclogites spanning NE Nepal, N Sikkim (India), NW Bhutan and S Tibet that have been buried to and then exhumed from lower crustal depths during the India-Asia collision. The P-T-t history of these rocks can tell us about both the conditions of early burial and crustal thickening, as well as the possible mechanisms for transporting lower crustal material to the surface, during a continental collision.

Timing of prograde garnet growth in these deep-crustal rocks where exposed in the Ama Drime massif, S Tibet was determined by Lu-Hf dating to be Late Eocene, yielding the oldest reported ages for burial of lower Indian crust beneath Tibet from the central-eastern Himalaya. Unlike ultra-high pressure eclogites of the northwest Himalaya, the Ama Drime granulitized eclogites do not appear to be characteristic of rapid burial and exhumation of a cold subducted slab, but more likely the product of crustal thickening during the early stages of continental collision. In that case, they may demonstrate that Indian crust had reached at least ~60 km thickness as early as the Late Eocene.

Spatially, the granulites and granulitized eclogites are proximal to the South Tibetan detachment system, an orogen-parallel normal-sense detachment system that operated during the Miocene, suggesting that it played a role in their exhumation.

PT paths of both the granulites and the granulitized eclogites are characterized by Miocene, large magnitude ($\geq$ 0.5 GPa) near-isothermal decompression during exhumation. Geo- and thermochronological data from footwall rocks in Sikkim, India, combined with complementary data from adjacent regions, show that the South Tibetan detachment system was active in this region between ~24-13 Ma, and footwall rocks cooled rapidly (though diachronously along strike) from ~700 to ~120 ºC in 1-3 myr. While active, the South Tibetan detachment system facilitated exhumation of the granulites from mid-crustal depths, but an additional heat source such as strain heating, advected melt and/or crustal thinning is required to explain the observed isothermal decompression, and a mechanism such as tectonic forcing of an indentor is required to explain transport of the rocks from lower to mid-crustal depths.

ARTICLES

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Rare earth elements, their occurrences and industrial uses

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ABSTRACT

Rare Earth Elements (REEs) are a set of seventeen chemical elements in the periodic table. In fact some of the rare elements like Cerium and Scandium are not rare in the earth crust. They are well dispersed but not often found concentrated as rare earth minerals suitable to exploit as other ore mineral deposits. These elements rarely exist in pure form rather they mix diffusely with other minerals. Mining, extraction, processing and refining of rare earth ore is extremely capital-intensive and a very costly venture. There is a possibility of environmental degradation and health hazard while mining and processing rare earth elements since they are also associated with radioactive minerals like uranium and thorium. In the developing world REEs have multiple uses like in cell phones, laptops, aircrafts, and hundreds of other sophisticated modern equipments. At present China is the world's largest producer of REEs. Other producers are Russia, Australia, USA, India, Malaysia, Brazil, and few European and African countries. The demand of REEs is ever increasing and it is estimated that the world's industries will consume about 185,000tons by 2015 as compared to the expected demand of about 60,000 tons (outside of China) in 2013.

INTRODUCTION

Gadolin, a Finnish scientist was the first person who found Rare Earth Element in 1794. Rare Earth Elements (Rare Earth Metals) are a set of seventeen chemical elements namely Scandium, Yttrium, Lanthanum, Cerium, Praseodymium, Neodymium, Promethium, Samarium, Europium, Gadolinium, Terbium, Dysprosium, Holmium, Erbium, Thulium, Ytterbium and Lutetium in the periodic table. REEs look similar, exhibit similar chemical properties and tend to occur in the same ore deposits but their electric and magnetic properties are quite different. In fact REEs (with some exception e.g. radioactive Promethium) are not rare, rather they exist in substantial amount but scattered in the earth's crust. It is noted that the so called rare earth elements (in combined amount) is nearly 200 times more abundant than gold. Cerium is the 25th most abundant element as the amount of copper in the earth. Because of their geochemical properties these elements are typically dispersed and not often found concentrated as rare earth minerals suitable to exploit or mine as other metallic ore deposits. Among them first such mineral discovered was Gadolinite (a compound of Ce, Y, Fe, Si and few other elements). It was extracted from a mine in the village of Ytterby in Sweden. Similarly the names of most of the rare earth elements are derived from their first identified locations. These 17 elements rarely exist in pure form rather they mix diffusely with other mineral. The extraction, mining and refining and processing of rare earth ore is extremely expensive, ranging from $100 million to $1 billion. Therefore most of the countries leave their own reserves unexploited, even if their demand is rising worldwide.

There are multiple uses of REEs in this developing world. Cell phones, laptops, and hundreds of other equipments and many other items would not have been existed without these important elements. At present China is the world's largest producer of REE. Australia is the world's largest producer of tantalum in the form of tantalum concentrates producing 2.2 Mlb of tantalum pentoxide (Ta_2O_5). China holds 55Mt (48.2%) of the world's economic reserves for rare earth oxides (REO), followed by the Commonwealth of Independent States with 19Mt (16.7%) REO, and the USA with 13Mt (11.4%). Australia's EDR accounts for 1.82% of world's economic reserves with 2.07Mt RE. It is estimated that in 2013 the total demand of REEs will be around 55,000 to 60,000 tons (excluding China) and China will be exporting about 24,000 tons of RE metals. The demand is ever increasing. In 2015 the world's industries are forecasting to consume an estimated 185,000 tons of rare earths elements, 50 percent more than that of 2010.

GEOLOGICAL ENVIRONMENT AND ASSOCIATION WITH OTHER METALLIC MINERALS

The most suitable geological environment for the concentration of Rare Earth Elements is associated with uncommon varieties of Igneous rocks like alkaline rocks, granitic rocks, pegmatite, carbonatite, metamorphosed or migmatized gneiss etc. Regarding the source of rare earth elements there is still debate among the researchers.

However, most of the researchers believe that the primary sources are as mentioned above. Alkaline rocks are rich in Zirconium, Niobium, Strontium, Barite, Lithium and REEs; similarly acidic rocks like granite and pegmatite are rich in Niobium, Yttrium etc. At places Iron Oxide-Cu-Au deposits also consists of REEs. They are also recorded from marine phosphate. These elements are mostly associated with Monazite (Ce,La,Th,Nd,Y)PO_4, Bastnäsite (Ce,La,Y)CO_3F, Zircon, Pitchblende, Cerite, Gadolinite, Xenotim (YPO_4), Samarskite (Y,Er,Ce,Mn,Ca,U,Th,Zr) $(Nb,Ta)_2$ $(O,OH)_6$ and Loparite. However, mineable quantities of REEs are found only in Monazite, Bastnäsite, Loparite and Xenotime.

RARE EARTH ELEMENTS

Rare Earth Elements (Fig 1a and 1b) are heavier than iron and often found scattered in the earth crust. To provide basic knowledge to the readers on the REEs each of them are briefly described below with their important physical and chemical properties as well as their major uses in this developing world.

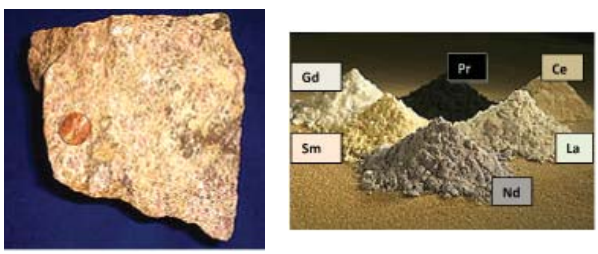

Fig. 1. (a) Rare earth ore, from USA. (b) Rare-earth oxides: Praseodymium (Pr), Cerium (Ce), Lanthanum (La), Neodymium (Nd), Samarium (Sm), and Gadolinium (Gd) (June 4, 2013, Wyoming Geol. Sur.). (Source: Wekipedia.)

Scandium (Sc)

Scandium is a chemical element with symbol "Sc" and atomic number 21. It is a soft metal with a silvery appearance (Fig. 2a). It is a metal in a group known as the transition metals. It has been historically sometimes classified as a rare earth element, together with Yttrium and the Lanthanide. It was discovered in 1879 by spectral analysis of Euxenite and Gadolinite from Scandinavia. There is not very much Scandium found in the earth. Therefore the pure metal is quite expensive. The pure Scandium is very reactive and it can react with other elements like oxygen. It develops a slightly yellowish or pinkish cast when oxidized by air and the metal turns from shiny silver white to gray. It is susceptible to weathering and dissolves slowly in most dilute acids. It does not react with a 1:1 mixture of nitric acid (HNO_3) and hydrofluoric acid (HF), possibly due to the formation of an impermeable passive layer. Scandium is the 50th most common element on earth and 35th most abundant element in the crust.

Scandium is not dangerous because there is not much of it on the earth to harm the people. Its main use is as a component in mercury-vapor lamps (Fig. 2b) to make their light look as much as sun light. Such lamps are mainly used to light stadium, state halls etc. It is also used in certain types of athletic equipment such as aluminum baseball bats, bicycle frames, lacrosse sticks and fuel cells.

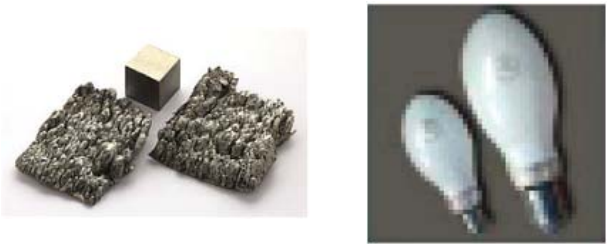

Fig. 2. (a) Scandium metal. (b) Mercury-vapor lamps.

Scandium is recorded in most of the deposits of rare earth and uranium compounds, but it is extracted from these ores in only a few mines worldwide because of its scarcity and the difficulties in the preparation of metallic Scandium. The positive effects of Scandium on aluminium alloys were discovered in 1970s, and its use in such alloys remains its only major application. The global trade of the pure metal on average is around a hundred pounds a year or so.

Yttrium (Y)

Yttrium is an element with symbol "Y" and having atomic number 39 on the periodic table. It looks silvery-white and tends to form crystals (Fig. 3a). It is a silvery metallic-transition metal chemically similar to the lanthanides. It is almost always found combined with the lanthanides in rare earth minerals and is never found in nature as a free element. Its only stable isotope, 89Y is also its naturally occurring isotope.

Carl Axel Arrhenius found a new mineral near Ytterby in Sweden in 1787, and named it ytterbite. Johan Gadolin discovered yttrium's oxide in Arrhenius' sample in 1789,

Fig. 3. (a) Yttrium metal. (b) Yttrium used in TV.

and Anders Gustaf Ekeberg named the new oxide yttria. Elemental Yttrium was first isolated in 1828 by Friedrich Wöhler. Minerals like Gadolinite, Xenotime, Samarskite, Euxenite, Fergusonite, Yttrotantalite, Yttrotungstite, Yttrofluorite, Thalenite, Yttrialite, Zircon contains some amounts of Yttrium.

The most important use of Yttrium is in making phosphors, such as the red ones used in television set to produces color in TV picture tubes (Fig. 3b), cathode ray tube (CRT) displays, and in LEDs. It is also used in the production of electrodes, electrolytes, electronic filters, lasers and superconductors; various medical applications; and as traces in various materials to enhance their properties. It also conducts microwaves and acoustic energy, simulates diamond gemstones, and strengthens ceramics, glass, aluminum alloys and magnesium alloys.

Lanthanum (La)

Lanthanum is a chemical element with the symbol "La" and atomic number 57. It is a silvery white metallic rare earth element (Fig. 4a and 4b) that belongs to group 3 of the periodic table and is the first element of the Lanthanide series. It is soft and can be cut with a knife. It is found in some rare-earth minerals, usually in combination with Cerium and other rare earth elements. Lanthanum is a malleable, ductile and soft metal that oxidizes rapidly when exposed to air. It is produced from the minerals Monazite (Fig. 4c) and Bastnäsite using a complex multistage extraction process. Lanthanum compounds have numerous applications as catalysts, additives in glass, carbon lighting for studio lighting and projection, ignition elements in lighters and torches, electron cathodes, scintillators and others. One of several rare earths used to make carbon arc lamps which the film and TV industry use for studio and projector lights. It is also used in batteries, cigarette-lighter flints and specialized types of glass, like camera lenses. Lanthanum carbonate [$La_2(CO_3)_3$] was approved as a medication against renal failure.

Lanthanum exhibits two oxidation states +3 and +2. LaH_3 is more stable than LaH_2. It burns readily at 150°C to form lanthanum (III) oxide: $4\ La + 3\ O_2 \rightarrow 2\ La_2O_3$. However, when exposed to moist air at room temperature, lanthanum oxide forms a hydrated oxide with a large volume increase. Lanthanum is electropositive and reacts slowly with cold water and quite quickly with hot water to form lanthanum hydroxide: $2\ La\ (s) + 6\ H_2O\ (l) \rightarrow 2\ La(OH)_3\ (aq) + 3\ H_2\uparrow\ (g)$. Lanthanum metal reacts with all the halogens. The reaction is vigorous if conducted above 200°C. Lanthanum dissolves readily in dilute sulfuric acid to form solutions containing the La(III) ions, which exist as $[La(OH_2)_9]_3$+complexes: $2\ La(s) + 3\ H_2SO_4\ (aq) \rightarrow 2\ La_3{+}(aq) + 3\ SO_2{-}\ 4\ (aq) + 3\ H_2\uparrow$ (g). Lanthanum combines with N, C, S, P, Bo, Se, Si and As at elevated temperatures, forming binary compounds. The electron configuration of the colourless La_3+ ion is [Xe] $4f^0$. Lanthanum is most commonly obtained from Monazite and Bastnäsite.

Cerium (Ce)

It is an element with the chemical symbol "Ce" and atomic number of 58. The atomic mass of Cerium is 140.12. It is a member of the Lanthanide series. It is a soft, silvery grey, shiny or lustrous ductile metal (Fig. 5a) which easily oxidizes in air. At room temperature Cerium is a solid. It melts and becomes a liquid at 798°C and boils and becomes a gas at 3424°C. It burns in air to form a compound with one Cerium atom and two Oxygen atoms. It resembles iron in color and luster, but is soft, and both malleable and ductile. Cerium has the third-longest liquid range of any element: (795 to 3443°C). (Only Neptunium and Thorium have longer liquid ranges). It is the most widespread of all REEs/ metals making up about 0.0046% of the Earth's crust by weight. It is more common than Tin and Lead and nearly as common as Zinc. It is found in a number of minerals, the most important being Monazite and Bastnäsite. It is mainly used as catalytic converters and diesel fuels to reduce vehicles' CO emissions and in carbon arc lights, lighter flints, glass polishers and self-cleaning oven. Cerium oxide is an important component of glass polishing powders and phosphors used in screens and fluorescent lamps. It is also used in the

Fig. 4. (a) Lanthanum metal. (b) Lanthanum in a glass tube. (c) Monazite.

Fig. 5. (a) Silver white Cerium metal. (b) Cerium Sulphate.

"flint" (as ferrocerium) of lighters. Minerals like Bastnäsite, Monazite, Allanite, Loparite, , Parisite, Lanthanite Ancylite, Chevkinite, Cerite, Stillwellite, Britholite, Fluocerite and Cerianite contains some amount of Cerium.

Cerium was named after the dwarf planet Ceres. It is the 25th most abundant element in the Earth's crust, (having 68ppm, about as common as copper). Cerium metal tarnishes slowly in air and burns readily at 150°C to form Cerium(IV) oxide: $Ce + O_2 \rightarrow CeO_2$. It is quite electropositive and reacts slowly with cold water and quite quickly with hot water to form cerium hydroxide: $2\ Ce\ (s) + 6\ H_2O\ (l) \rightarrow 2\ Ce(OH)_3\ (aq) + 3H_2\uparrow\ (g)$. Cerium metal reacts with all the halogens: $2\ Ce\ (s) + 3\ F_2\ (g) \rightarrow 2\ CeF_3\ (s)$ [white]. $2\ Ce\ (s) + 3\ Cl_2\ (g) \rightarrow 2\ CeCl_3(s)$ [white]. $2\ Ce\ (s) + 3\ Br_2\ (g) \rightarrow 2\ CeBr_3\ (s)$ [white]. $2\ Ce\ (s) + 3\ I_2\ (g) \rightarrow 2\ CeI_3\ (s)$ [yellow].

Cerium dissolves readily in dilute sulfuric acid to form solutions containing the colorless Ce(III) ions, which exist as a $[Ce(OH_2)_9]_3$+complexes: $2Ce\ (s) + 3H_2SO_4\ (aq) \rightarrow 2Ce_3+\ (aq) + 3SO_2-\ 4\ (aq) + 3H_2(g)$. It is not often used as a metal since it quickly reacts with the air and tarnishes. Its most common use is as the 'flint' in a lighter, because it easily produces a spark when it is struck with another metal. It is sometimes used in alloys because it often makes the alloy more heat resistant. It is also used in special glass, ceramics and self cleaning ovens.

Praseodymium (Pr)

It is a chemical element that has the symbol “Pr” on the periodic table and atomic number 59. It is a soft silvery metal that can be used to make yellow-green salts. It is a malleable and ductile metal in the Lanthanide series and highly reactive to be found in native form and when artificially prepared, it slowly develops a green oxide coating. For the first time it was first separated from other elements in 1885 by the Austrian chemist Carl Auer von Welsbach. In 1841, Swedish chemist Carl Gustav Mosander extracted a rare earth oxide residue and he named it as "didymium" from a residue he called "lantana" in turn separated from cerium salts. In 1885, the Austrian chemist Baron Carl Auer von Welsbach separated didymium into two salts of different colors, which he named Praseodymium and Neodymium (Fig.6a and 6b). Like most of other rare earth elements, Praseodymium most readily forms trivalent Pr(III) ions. These are yellow-green in water solution, and various shades of yellow-green when incorporated into glasses. Praseodymium's industrial uses involve filter yellow light from light sources. Primarily it is used as an alloying agent with magnesium to make high-strength metals that are used in aircraft engines. Also may be used as a signal amplifier in fiber-optic cables, and to create the hard glass of welder's goggles. It is found in Monazite and Bastnäsite, typically comprising about 5% of the lanthanides contained therein. Praseodymium alloyed with nickel ($PrNi_5$) has such a strong magnetocaloric effect that it has allowed scientists to approach within one thousandth of a degree of absolute zero.

Neodymium (Nd)

Neodymium is an element which has the chemical symbol “Nd” and atomic number 60. Some of its properties are recorded as Atomic Weight: 144.242, Melting Point: 1021°C, Boiling Point: 3074°C, Density: 7.01 g/cm^3, Phase at room temperature: Solid, Element classification: Metal, Period Number: 6. Neodymium is most likely known as a magnet. It is mainly used to make powerful neodymium magnets for computer hard disks, wind turbines, hybrid cars,

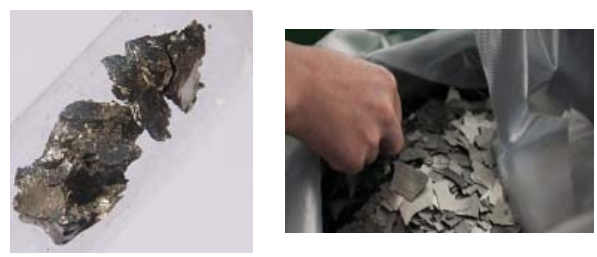

Fig. 6. (a) Praseodymium Metal. (b) Neodymium metal.

ear bud headphones and microphones. It is also used to color glass and to make lighter flints and welder's goggles.

Promethium (Pm)

Promethium belongs to the Cerium Group of Lanthanides and is chemically similar to the neighboring elements. Because of its instability, chemical studies of promethium are incomplete. It does not occur naturally on the Earth. Most Promethium (Fig. 7) is artificially produced via uranium fission, and has between 141 and 156 protons. The longest-living promethium is 145Pm with a half-life of 17.7 years. It is an element with the symbol “Pm” and atomic number 61. All of its isotopes are radioactive; it is one of the two such elements that are followed in the periodic table by elements with stable forms, a distinction shared with technetium. Chemically, Promethium is a Lanthanide, which forms salts when combined with other elements. Promethium shows only one stable oxidation state of +3; however, there might exist few +2 compounds as well.

There are two possible sources for natural Promethium: (a) rare decays of natural Europium-151 (producing Promethium-147), and (b) Uranium (various isotopes). Practical applications exist only for chemical compounds of Promethium-147, which are used in luminous paint, nuclear-powered micro batteries (atomic batteries), with potential

use in portable X-ray devices. Promethium is also used in the illuminated digits of some clocks, its Beta radiation may be used to measure thickness (to make thickness measurement devices). Since natural promethium is exceedingly scarce, the element is typically synthesized by bombarding Uranium-235 (enriched uranium) with thermal neutrons to produce Promethium-147 even though Promethium-145 is the most stable isotope of Promethium.

Samarium (Sm)

Samarium is an element with symbol “Sm” and atomic number 62. It is a rare earth metal having the hardness and density similar to those of zinc. Its boiling point is 1794°C. It is the third most volatile lanthanide after Ytterbium and Europium. This property facilitates separation of Samarium from other minerals. It is a moderately hard silvery metal (Fig. 8) that readily oxidizes in air. Samarium usually assumes the oxidation state +3. Compounds of Samarium(II) are also known, most notably the monoxide (SmO), monochalcogenides (SmS, SmSe and SmTe) as well as samarium(II) iodide. The last compound is a common reducing agent in chemical synthesis. Samarium has no significant biological role but it is slightly toxic.

Samarium was discovered in 1879 by the French chemist, Paul Émile Lecoq de Boisbaudran and named after the mineral Samarskite from which it was isolated. The mineral itself was earlier named after a Russian mine official, Col. Vasili Samarsky-Bykhovets, who thereby became the first person to have a chemical element named after him, albeit indirectly. Samarium is the 40th most abundant element in the Earth's crust and is more common than tin. It occurs with concentration up to 2.8% in several minerals including Cerite, Gadolinite, Samarskite, Monazite and Bastnäsite, the last two being the most common commercial sources of the element. These minerals are mostly found in China, the United States, Brazil, India, Sri Lanka and Australia. So far China is the world leader in Samarium mining and production.

The major commercial application of Samarium is in samarium-cobalt magnets, which have permanent magnetization second only to Neodymium. However, Samarium compounds can withstand significantly higher temperatures above 700°C, without losing their magnetic properties. The radioactive isotope Samarium-153 is the major component of the drug Samarium (153Sm) lexidronam (Quadramet), which kills cancer cells in the treatment of lung cancer, prostate cancer, breast cancer and osteosarcoma. Another isotope, Samarium-149, is a strong neutron absorber and is therefore added to the control rods of nuclear reactors. It is also formed as a decay product during the reactor operation and is one of the important factors considered in the reactor design and operation. Other applications of Samarium include catalysis of chemical reactions, radioactive dating and an X-ray laser. Samarium mixed with cobalt to create a permanent magnet with the highest demagnetization resistance of any known material. Crucial for building "smart" missiles; also used in carbon arc lamps, lighter flints and some types of glass. It is quite electropositive and reacts slowly with cold water and quite quickly with hot water to form samarium hydroxide: $2Sm\ (s) + 6\ H_2O\ (l) \rightarrow 2\ Sm(OH)_3\ (aq) + 3\ H_2\ (g)$. It dissolves readily in dilute sulfuric acid to form solutions containing the yellow to pale green Sm(III) ions, which exist as one of the few lanthanides that exhibit the oxidation state +2. The Sm^{2+} ions are blood-red in solutions.

Fig. 7: Pitchblende the host for Promethium.

Fig. 8: Samarium metal.

Europium (Eu)

Europium is an element with the symbol “Eu” and atomic number 63. It is named after the continent Europe. It is a moderately hard, silvery metal (Fig. 9a) which readily oxidizes in air and water. Being a typical member of the lanthanide series, europium usually assumes the oxidation state +3, but the oxidation state +2 is also common: all europium compounds with oxidation state +2 are slightly reducing. Europium has no significant biological role and is relatively non-toxic compared to other heavy metals. Most applications of europium exploit the phosphorescence of europium compounds.

Europium is used for decades as a red phosphor in TV sets and more recently in computer monitors, fluorescent lamps (Fig. 9b) and some types of lasers but otherwise it has very few commercial applications. Europium is a ductile metal with hardness similar to that of lead. It crystallizes in a body centered cubic lattice. Some properties of Europium are strongly influenced by its half-filled electron shell. Europium is not found in nature as a free element. Many minerals contain europium, with the most important sources being Bastnäsite, Monazite, Xenotime and Loparite. Monazite also contains Thorium and Yttrium.

It has the second lowest melting point and the lowest density of all lanthanides. Europium becomes

a superconductor when it is cooled below 1.8 K and compressed to above 80 GPa. It is the most reactive of all rare earth metals. It rapidly oxidizes in air, so that bulk oxidation of a centimeter-sized sample occurs within several days. Its reactivity with water is comparable to that of calcium, and the reaction is $2\ Eu + 6\ H_2O \rightarrow 2\ Eu(OH)_3 + 3\ H_2$. Because of the high reactivity, samples of solid Europium rarely have the shiny appearance of the fresh metal, even when coated with a protective layer of mineral oil. Europium ignites in air at 150 to 180 °C to form Europium(III) oxide: $4\ Eu + 3$

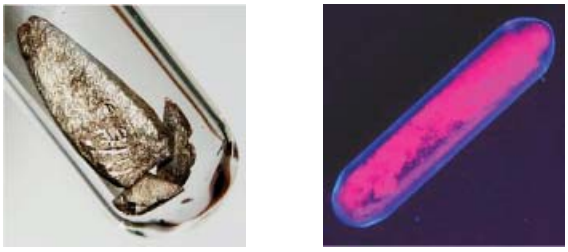

Fig. 9: (a) A sample of Europium in a test tube. (b) Europium fluorescing red.

$O_2 \rightarrow 2\ Eu_2O_3$. It dissolves readily in dilute sulfuric acid to form pale pink solutions of the hydrated Eu(III), which exist as a nonahydrate: $2\ Eu + 3\ H_2SO_4 + 18\ H_2O \rightarrow 2\ [Eu(H_2O)_9]_3 + 3\ SO_2 - 4 + 3\ H_2$.

Gadolinium (Gd)

Gadolinium is also a rare earth element with the chemical symbol "Gd" and the atomic number 64 in the periodic table. It is one of the elements of Lanthanides series. It is silvery white, malleable and ductile (Fig. 10). Its main uses are as chemical compounds in color televisions and nuclear magnetic resonance radio contrast agents. In color cathode ray tube televisions (not flat televisions) some of the pixels are dots Gadolinium compounds. When the electrons from the cathode ray tube hit the pixels and transfer energy to the Gadolinium compounds they give out light as energy. It is used in medical applications such as magnetic resonance imaging (MRI), and industrially to improve the workability of iron, chromium and various other metals. Nuclear magnetic resonance (NMR) imaging is used in medicine where it is named MRI (magnetic resonance imaging). It is used to take picture of inside the body. It makes the images clearer because it makes the difference in the concentration of water in different parts of the body look more contrast in the picture. It is also used in control rods at nuclear power plants.

Thulium (TM)

It is a chemical element that has the symbol "Tm" and

Fig.10:

Fig.11

Fig.12

Fig.10: Gadolinium Metal. Fig.11: Thulium Metal Fig.12: Nuclear power plant.

atomic number 69 in the Periodic table. It is a member of lanthanide series of element. It is the rarest of all naturally occurring rare earth metals (Fig. 11). It has few commercial applications, although it is used in some surgical lasers. After being exposed to radiation in nuclear reactors (Fig. 12), it's also used in portable X-ray technology.

Terbium (Tb)

Terbium is a chemical element that has the symbol "Tb" and atomic number 65. It is used in some solid-state technology, from advanced sonar systems to small electronic sensors, as well as fuel cells designed to operate at high temperatures. It also produces laser light and green phosphors in TV tubes.

Dysprosium (Dy)

Dysprosium is an element with the symbol "Dy" and atomic number 66. It is a rare earth metal found in minerals such as Xenotime, Monazite and Bastnaesite. It has a metallic, bright silver luster and has a very high melting temperature of 1412°C. It can also absorb neutrons. This makes it very suitable to use in some control rods at nuclear power plants (Fig. 12), in certain kinds of lasers, high-intensity lighting, and to raise the coercively of high-powered permanent magnets, such as those found in hybrid vehicle. Its Atomic number: 66, Atomic weight: 162.50, Melting point: 1412°C, Boiling point: 2567°C, Density: 8.55 g/cm^3. It is relatively stable in air at room temperature, but dissolves readily, with the evolution of hydrogen, in mineral acids. The metal is soft enough to be cut with a knife and can be machined without sparking if overheating is avoided. Dysprosium, used in computer hard drives. Present price of Dysprosium metal is $212/Lb.

Holmium (Ho)

Holmium is a chemical element with the symbol "Ho" and atomic number 67. It is a part of the lanthanide series and relatively soft and malleable silvery-white metallic element,

which is stable in dry air at room temperature. It is a rare earth metal found in the minerals monazite and Gadolinite. It has the highest magnetic strength of any known element, making it useful in industrial magnets as well as in some nuclear control rods. It is also used in solid-state lasers and to help color cubic zirconia and certain types of glass.

Erbium (Er)

Erbium is an element with the chemical symbol “Er” and atomic number 68. It is used as a photographic filter and as a signal amplifier (aka "doping agent") in fiber-optic cables. It is also used in some nuclear control rods, metallic alloys, and to color specialized glass and porcelain in sunglasses and cheap jewelry.

Ytterbium (Yb)

Ytterbium is a rare earth element that has chemical symbol “Yb” and the atomic number 70. It is also a part of Lanthanide series. It is soft and has silver color (Fig. 13). Ytterbium is found in minerals like Gadolinite, Monazite and Xenotime. In nature it is found as a mixture of seven stable isotopes. It is mainly used in some steels industries, to make lasers and in some portable X-ray devices. Among its specialty applications, it's used in certain types of lasers, stress gauges for earthquakes, and as a doping agent in fiber-optic cables.

Lutetium (Lu)

Lutetium is a chemical element with chemical symbol “Lu” and atomic number 71. It is silver white in colour (Fig. 14). In chemistry it is placed in a group of metal elements named the transition metals. Lutetium can also be grouped with the lanthanides because it is near to the lanthanides in the Periodic Table. Its physical properties are like that of Lanthanides.

Lutetium is specially used in calculating the age of meteorites or performing positron emission tomography (PET) scans. It has also been used as a catalyst for the

Fig. 13: Ytterbium Metal. Fig. 14: Lutetium Metal

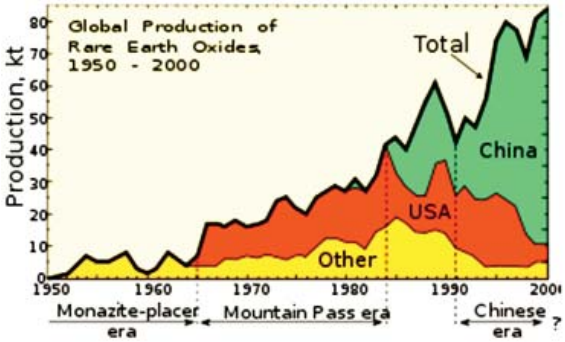

Fig. 15: Global Production of RE oxides (1950-2000). (Source: Wekipedia)

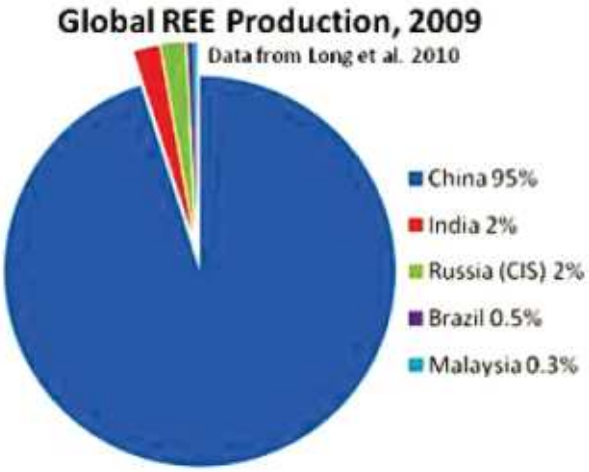

Fig. 16: Global production of REE (USGS 2009) (Source: Website Wikipedia).

process of "cracking" petroleum products at oil refineries and to determine which parts of a drainage basin are eroding.

ORIGIN, DISTRIBUTION AND GLOBAL PRODUCTION

Rare Earth Elements are heavier than iron and they are often found together. They are not usually sold in their pure form, but they are distributed in mixtures of varying purity. They are produced by supernova nucleosynthesis or the s-process in asymptotic giant branch stars. In nature, spontaneous fission of Uranium-238 produces trace amounts of radioactive Promethium, but most Promethium is synthetically produced in nuclear reactors. REEs change through time in small quantities (ppm) so their proportion can be used for geochronology/dating fossil etc.

During fifties most of the world's rare earths were obtained from placer sand deposits in India and Brazil. Later

on South Africa became the world's rare earth source since large veins of rare earth bearing Monazite were discovered there. From 1960s - 1980s, the Mountain Pass rare earth mine in California, USA was the leading producer. By 2012, China had produced over 90% of the world's rare earth supply (Figs. 15 and 16), mostly from Inner Mongolia. All of the world's heavy rare earths (such as Dysprosium) come from Chinese rare earth sources such as the polymetallic Bayan Obo deposit. United States had 13 million metric tons of rare earth elements (USGS 2010). Increasing trend of demand (Fig. 15) has indicated that the developing world may face a shortage of the rare earths in near future.

MAJOR USES AND SUPPLY

Rare Earth Elements/ metals and other critical materials are essential to manufacture high tech electronic equipments, aircraft engine, wind turbines, electric vehicles, fiber optic cable, computer hard disk, hybrid cars, advanced batteries and a host of other products that are essential to energy and national security. They are also used in iPods, GPS navigation systems, plasma televisions, microphones, smart missile, carbon arc lamp, medical equipments (e.g. X-ray unit, MRI etc.), lighter flint etc. RREs and other minerals that are crucial to many technologies and have so far come almost exclusively from China and in small amount from Russia, India, Brazil, Malaysia, USA, Australia and few countries of Europe and Africa. At present China is the global leader in REE mining and supplies.

CONCLUSION AND RECOMMENDATION

Importance of REEs is realized by the developing world and priority is given to explore, mine, extract, process and utilized them for multiple purposes as mentioned above.

Mining, refining and recycling of REEs have serious environmental consequences if not properly managed. A particular hazard is mildly radioactive slurry tailings resulting from the common occurrence of Thorium and Uranium in RRE ores. Additionally, toxic acids are required during the refining process. Improper handling of these substances can result in extensive environmental damage and health hazard.

REEs are not exchange-traded in the same way as that of precious metals (gold and silver) or non-ferrous metals (nickel, tin, copper and aluminium), instead they are sold on the private market, which makes difficult to monitor their price. REEs are not usually sold in their pure form, but instead are distributed in mixtures of varying purity e.g. "Neodymium metal ≥ 99%". Pricing can vary based on the quantity and quality required by the end user's application. The future of rare earths appears to be volatile in the short term, but in the long run it will be stable and growing. Therefore, the Government of Nepal also must give high priority to explore and mine the rare earth elements, precious metals, and polymetal sulphides in the geologically suitable terrains.

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Fossils from Nepal Himalaya: An overview

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ABSTRACT

Field of paleontology is less studied in Nepal Himalaya. Recorded fossil materials of the country are fragmentary and mostly scattered within the different sources. An attempt is made to gather the information on recorded fossils from the Nepal Himalaya. Focus has been given to the names of phylum or genus instead of species. Description has been separated according to the tectonic division of the Nepal Himalaya. Except in the medium to high grade metamorphic rocks of the Higher Himalaya and crystalline rocks of the Lesser Himalayan thrust sheets, the other terrain of Nepal Himalaya is potential for different types of fossil fauna and flora useful for biostratigraphy, paleogeographic reconstruction and paleo-climatic interpretation.

INTRODUCTION

Geological investigations in Nepal started very late in comparison to the studies in other countries of the region. In comparison to other geological field of investigation the depth of systematic research on paleontology is found very less. In the absence of rich paleontological data, the biostratigraphic correlation of the rocks of the region is incomplete to some extent. Nevertheless, there are several scientific papers related to the fossils of the region. The present aim is to gather the information about the fossiliferous areas or zones and type of fossils available in the Nepal Himalaya found by researchers till the date. An attempt is made to synthesize the records of fossils found in the area in this article.

Nepal can be divided into five east-west trending major tectonic zones as: the Terai, the Sub Himalaya, the Lesser Himalaya, the Higher Himalaya and the Tibetan Tethys from south to the north respectively (Gansser 1964; Hagen 1969). The lithostratigraphic succession of major geotectonic zones of Nepal has been well recognized. The Precambrian, Paleozoic, Mesozoic and Cenozoic rocks are developed within these zones. Stratigraphically, the major lithologic units in the Nepal Himalaya consist of the Neogene Siwalik Group, the Proterozoic Lesser Himalayan Sequence, the Proterozoic-Ordovician Greater Himalayan Complex, and the Proterozoic to Eocene Tethyan Himalayan Sequence (Le Fort 1975). The Quaternary sediments are also well studied from the intermountain basins like Kathmandu valley, Thakkhola-Mustang graben, Pokhara valley, Dun valleys (e.g. Dang-Deukhuri) and from the Terai plain. A summary of the records of fossils is described according to the geological time scale in the following headings.

PROTEROZOIC-ORDOVICIAN-HIGHER HIMALAYA

The rocks of this succession are widely distributed within the country. It forms whole part of the Higher Himalaya with 4-10 km thick high grade metamorphic rocks. The late Proterozoic (Riphean-Vendian) age has been considered by its stratigraphic position and few radiometric dating (Bordet et. al. 1972). High grade of metamorphism has completely erased the possibility of the existence of the primitive fossils in these rocks exposed in the Higher Himalaya.

THE PROTEROZOIC (PRECAMBRIAN) LESSER HIMALAYAN

The Proterozoic rocks are also very widely distributed in the Lesser Himalayan Zone. They are developed in two different geological settings: allochthons and autochthons. As allochthons, Proterozoic (Precambrian) rocks are developed within the different crystalline nappes and klippes of Lesser Himalaya. Some of the well-known crystalline nappes and klippes in the Lesser Himalaya of Nepal are the Kathmandu Nappe, Kahun Klippe, Jajarkot Klippe, Karnali Nappe, and Dadeldhura Nappe from central to western Napal (Stöcklin and Bhattarai 1977; Stöcklin 1980; Paudyal and Paudel 2013; Kaphle 1992, 1994; Upreti 1999). There are two broad types of crystalline nappes in the Lesser Himalaya based on different stratigraphy and metamorphic grade (Upreti 1999): (1) Nappes composed of upper amphibolite to granulite facies rocks and (2) Nappes composed of low to medium grade metamorphic rocks with Paleozoic sedimentary cover. The Karnali Nappe with kyanite-sillimanite bearing units (Hayashi et al. 1984) belong to the first category. The Kathmandu Nappe, Jajarkot Nappe, Kahun Klippe and

Dadeldhura Nappe are composed of low to medium grade rocks with Palaeozoic sedimentary cover (Stöcklin 1980; Shrestha 1993; Upreti 1999) where in later two nappes the Paleozoic cover is considered eroded (Paudyal and Paudel 2013).

Fossils in Paleozoic sedimentary cover of the allothons

Paleozoic cover of the Kathmandu Nappe is named as the Phulchauki Group overlying the older rocks of the Bhimphedi Group. The rocks of the Bhimphedi Group do not consist of any fossils. However, the rocks of the Phulchauki Group consist of some traces of worms and marine fossils of echinoderms, brachiopods and trilobites. The rock sequence has been classified into Tistung Formation, Sopyang Formation, Chandragiri Limestone, Chitlang Formation and Godavari Limestone in ascending order. Worm tracks on the bedding planes of mudstones and siltstones of the Tistung Formation have been reported (Stöcklin 1980). Similarly, abundant crinoids and echinoderms are reported from the Chandragiri Limestone. Stöcklin et al. (1977) identified the echinoderm *cystoids caryocrinites* of Upper-Middle Ordovician age. From a lower level, a specimen of *Elliptocinctus barrandae* suggests Middle Cambrian age. These dates suggest a Middle Cambrian to Middle Ordovician age for the formation. The upper part of the Chitlang Formation consists of few layers of hematite beds with rich fauna of trilobites, brachiopods and echinoderms indicating Silurian age. A rich group of *Gometopusdagon*, cephalopod (*Orthoceras*), brachiopod (Lingula species-*Lepatenar homoidalis*, *Tentaculites*), gastropods, echinoderms and crinoids have been identified from this formation (Bordet 1961). A variegated crinoidal limestone with massive dolomitic limestone has been considered as the Godavari Limestone.

The rocks of the Kahun Klippe located in the Tanahun district of central Nepal has been correlated with the rock units of the Bhimphedi Group (Jnawali and Tuladhar 1996; Paudyal and Paudel 2013). There are no reports of fossils in these garnet grade metamorphic rocks.

The rocks of the Jajarkot Nappe located in western Nepal have been divided into three formatios as the Chaurjhari Formation, Thabang Formation and the Jaljala Formation in ascending order (Sharma et.al., 1984). Crinoids have been reported from the limestone beds of the uppermost Jaljala Formation of the Nappe (Fuchs and Frank 1970). Due to the occurrences of crinoids and the lithological similarities, these rocks of Tethyan affinity are correlated with the Cambro-Ordovician Chandragiri Limestone of Pulchauki Group of central Nepal.

There is a very large nappe structure best developed along Karnali and Tila rivers named as the Karnali Nappe. Hayashi et al (1984) have described the geology of this unit in detail. The top most unit of the Nappe is called the Baregaon Formation which consists of calcareous biotite schist with psammitic and pelitic schists and shows typical brick red weathering products more similar to Dhaulagiri Limestone of the Tibetan succession. No fossils are reported so far. But the lithology and its tectonic position suggest the Tethyan affinity of this formation (Fuchs and Frank 1970).

In Dadeldhura area of the far western Nepal, there is a large nappe called the Dadeldhura Nappe. A detail investigation of this crystalline nappe was carried out by Joshi (1978), Bashyal (1981, 1986), Upreti (1984, 1989) and Kaphle et al. (1993). The rocks belonging to this tectonic unit has been designated as the Dadeldhura Group and it is divided into three formations as the Gaira Formation, Saukhark Granite Gneiss and Dadeldhura Phyllite in ascending order. No any fossils are recorded in the rocks developed in this Nappe. Similarly, other nappes developed in the far western Nepal are the Bajhang Nappe (studied by Basyal in 1986) and the Parchauni Klippe located in the north of Baitadi can be considered equivalent to the rocks of the Dadeldhura Nappe in many aspects. No any fossils are recorded in the rocks of these nappes and klippes as in the Dadeldhura Nappe.

Fossis from Proterozoic/Precambrian Lesser Himalayan sequence

The lithostratigraphy of the Proterozoic (Precambrian) autochthonous successions is well developed and studied from the several sections of central and western Nepal. The lithological successions of these Precambrian rocks from different areas are comparable to one another (Sah 2007). The lithostratigraphy of the succession is well worked out by Stöcklin (1980) and has been named as the Nawakot Complex and it has been further divided into the Lower and Upper Nawakot Groups separated by a suspicious unconformity. The Lower Nawakot Group comprises the Kuncha Formation, Fagfog Quartzite, Dandagaon Phyllite, Nourpul Formation and the Dhading Dolomite from bottom to top respectively. Similarly, the Upper Nawakot Group comprises the Benighat Slates, Malekhu Limestones and Robang Formation respectively in stratigraphic up sections. Columnar stromatolites are abundantly found in the rocks of the Dhading Dolomite, an uppermost unit of the Lower Nawakot Group. Some algal mats are also reported from the Malekhu Limestone of the Upper Nawakot Group. Except these algal traces no other fossil are recorded. The rock successions of the Nawakot Complex is comparable to that of the Midland Supergroup (Arita et al. 1973), Kaligandaki Supergroup (Sakai 1985), Sarada and Gwar Khola Groups (Dhital and Kizaki 1987) and Baitadi Group (Sharma 1999). Stocklin (1980) recognized algal structures: *Collenia*, *Conophyton*, *Berocastria*, and *Nubercularites* and

provide the Late Precambrian-Early Paleozoic age. Sakai (1985) has recognized *Kussiella* and *Jurusaria* from the Kaligandaki Supergroup of Palpa-Syanja area, western Nepal. Upreti et al. (1980) have recognized *Conophyton* and from the Kaligandaki section of central west Nepal. The stromatolites are confined to bluish grey, massive to thinly bedded dolomitic succession equivalent to Nawakot Complex of central Nepal. Together with columnar forms, they have also recognized the flat laminated algal mat crinkled and laminated bioherm and large scale vertically stacked domes. They have considered these stromatolites to be of Lower Riphean in age. Basyal (1986) has reported the various forms of Precambrian Stromatolites like *columnaris*, *Baicalia baicalica*, *Conophyton* and others from the Baitadi and Bajhang area of far western Nepal. Dhital and Kizaki (1987) have reported the columnar, dome shaped and spherical stromatolites from the metasedimentary succession of Northern Dang, western Nepal. Upreti (1990) recorded *Conophyton cylindricus* from the carbonate rocks of Dadeldhura-Baitadi road section of far western Nepal. Mahara and Sah (2007) also reported several types of stromatolites from the metasediments of Baitadi area, far western Nepal. They are *Conophyton cylindricus*, *columnaris*, *Baicalia baicalica*, *Kussiella kussiensis*, *Stratifera*, *Irregularia*, algal biscuits and oncolites. *Kussiella kussiensis* was the new species on their studies from far western Nepal.

Fossils from the Paleozoic-Mesozoic autochthonous of Lesser Himalaya

The Paleozoic and Mesozoic succession of autochthon settings of Lesser Himalaya are well studied from Tansen Group (Sakai, 1983), Gondwana Group (Sharma et al. 1984; Kansakar 1991), Barahakshetra Group (Dhital 1992). On lithological features and content of the plant fossils, the considering succession resembles the well-defined rocks of Gondwana. The Paleozoic and Mesozoic succession of Tansen Group have been named as the Sisne Formation and Taltung Formation respectively. The Sisne Formation consists of brayozoan fossils: *Fenestella*, *Polypora* and *Acanthocladia* indicating late Carboniferous to Permian age. The rock succession of Taltung Formation contains upper Gondwana plant fossils: *Ptillophyllum*, *Pterophyllum*, *Cladophlebis* and *Elatocladus* providing Jurassic to Early Cretaceous age for the containing rocks (Kimura et al. 1985). Fossil leaves have been recorded from several localities along the Badahare, Amile and Tinahu rivers. They are embedded in the parallel laminated silty sandstones or carbonaceous silty beds. In other parts of the equivalent successions as mentioned above, such fossils are reported by different authors. Basyal (1980) has reported the occurrence of Lower Gondwana plant fossils (*Schizneura gondwanensis feist*) from the black shale of Takure Khola of Barahakshetra area of south-eastern Nepal. From the Eocene sediments of Surkhet and Dang area Sharma (1990) recorded several microfossils as: *Nummulites atacium Leym., N. globules Leym,. N. obtusus Sow, N. irregularies Desh., Asssilina laxispira de la Harpe, A. daviesi Gill., Globigerina pseudobullordes plumm., Gyrodina girardana Hill., Discorbis sp., Cibicides sp., Asteriagerina, Lenticulina Lamarek 1804, Pleurostromella, Dentalincides, Bolivinopsis, Turrilina, Nodosaria, Valulina*. He also reported several types of pollen and spores and identified as: *Sclerotites, Brandonianus, Teutospora, Ascospora, and Pilzspora*.

Fossils from the Lower Tertiary autothonous stratigraphy of Lesser Himalaya

The lithological successions of lower Tertiary are well studied from Surkhet, Dang, and Tansen area of western Nepal, Lesser Himalaya (Sharma 1977, 1990; Singh 1973; Sakai 1983, 1985; Sharma et al. 1984; Dhital and Kizaki 1987; Sah and Schleich 1990; Matsumaru and Sakai 1989; Kayastha 1992). In each studied sections researchers have recognized three different lithostratigraphic units as formation but are named differently. The upper part of the Tansen Group named as the Amile Formation, Bhainskati Formation and Dumri Formation in ascending order belongs to the Lower Tertiary succession. These rocks are also rich in marine fossils. The Amile Formation consists of bivalves, gastropods and some fragments of vertibrates. Coolified wood fragements are also observed in the Amile Formation. The black shells of Bhainskati Formation is very rich in fossils contents of foraminifera, molluscs, and vertebrates. Within the Eocene Series, two stages have been recognized on the basis of larger foraminifera: Ypressian Stage (Tiwari and Gupta 1976) and Lutetian Stage (Matsumaru and Sakai, 1989). Identified foraminifera fossils are: *Nummulites aff. atacicus, N.cf.mamille, N. beaumonti, N. crimensis, N. leupoldi, N.plamulatus, Assilina spinosa, A. subspinosa, A. laminose, A. papillata, A. dandotica, A. placentula, A. postulosa*. Similarly identified gastropods are: *Limacina cf.pseudopyamaea, Volutilithes sp., Turritela cf. hollandi*. The vertebrates include *Pristichampsinae gn.and sp. Indet*. Identified bivalvs are: *Cordiopsis cf. incrassate, Cordiopsis sp., Euphenax aff. jamaicensis, Septifer cf. denticulatus, Tellina sp., Dimya aff. Deshaysiamna, Botula sp., Corbula c.daltoni, Cardita mutabilis, Flemingo-ostrea cf. flemingi etc*. The Dumri Formation, the youngest unit of the Tansen Group consists of petrified tree trunks only. No any stratigraphic significant fossils are recognized till the date. Sakai (1983) recorded fossil remains of shark teeth and vertebrate bone fragments from the Amile Formation of the Tansen area. He also found left radius, costa and vertebrae of a land mammal, vertebrae, spine and skull of Teleostei

and carapace of Chelonia from the Eocene deposits of the same area. The fossil remains have not been identified upto generic or species level.

Abundant Forminifera (*Nummulites beumonti*), several fossil remains of bivalves, gastropods, and fragments of vertebrates are also recorded from the Tosh area of the northern Dang along with several coal seams from the Sattim and Dubrin Formations and an intervening Eocene Series (Dhital and Kizaki 1987; Paudyal and Sah 2004).

FOSSILS FROM THE TETHYS HIMALAYA OF NEPAL

The Paleozoic and Mesozoic rocks of the Tethys zone are well exposed in the northern parts of the country covering Mt. Everest, Thakkhola area, Dolpo and Mt. Saipal. The lithological successions of Tethyan rocks from different sections are comparable to each other. Complete succession can be observed in the Thakkhola-Muktinath section. All systems except Cambrian with several stages of these erathems have been well recognized by fossils content. A large number of researchers studied the Tethys rocks and containing fossils. All the species of available fossils could not include in this small article due to the limitations of number of pages.

Cambrian System

It includes the rocks of the Dhaulagiri Limestone of the Dolpo area (Fuchs 1977), Larjung Marble, Pi Formation, Annapurana Limestone, lower part of Nilgiri Limestone from the Thakkhola area (Bassoullet et al. 1977), Nilgiri Limestone from Manang area (Fuchs et al; 1988) and Chame Carbonate, Pi-Detrital and Nilgiri Limestone from Nyi-Shang. No fossils are recorded in this system from Nepal Himalaya.

Ordovician System

The upper part of Dhaulagiri Limestone of Dolpo, Nilgiri Limestone and North Face Quartzite of Thakkhola are placed on the Ordovician System based on index fossils. The Dhaulagiri Limestone consists of poorly preserved lumachelles of orchid brachiopods (Bordet et al 1975, low spired gastropods and crinoids stems. The genus of gastropods is identified as *Macluritina or Pleurotomarina* (Fuchs and Frank 1970). Similarly, Bordet at al (1971) recorded small ribbed brachiopods (*Aporthophylla nov sp.*) from the Nilgiri Limestone of Thakkhola area suggesting Lower Ordovician age of the fossils containing rocks. Lin (1979) also recorded several forms of Ordovician brachiopods from the similar limestone beds of Mt. Everest area. The identified species are *Orthambonites cf. rotundiformis, Cooper, Aporthophylla parelegans Lin, A. hipsa Lin, A. intermedia, Xizagastrophica cf. sinensis Rong.* Bordet et al (1971) have identified brachiopods: *Orthambonites sp., Aporthophylla sp., Opekina* ; cephalopods: *Orthoceras* and echinoids: *Glytocystida cheirocrinus or echinocencrinites* indicative of Llanvirian Stage from the North Face Quartzite exposed in Thakkhola area.

Silurian System

The Sombre and Dark Band Formations are placed under this system. Llandoverian graptolites are indentified by Strachen et al (1964) from Thakkhola regions. The other identified species are: *Climacograptus cf. medicus, Orthograptus sp., Dimograptus extenuatus, Monograptus lobiferus, M.aff. tennis, Glyptograptus sp., Diplograptus sp., Rastrites sp.*

Devonian System

The lithological successions of these rocks are well developed in Dolpo, Manang, Thakkhola and Nyi-Shang area. Upper part of Sombre, Dark Band, Muth Quartzite, Tilicho Pass and Bangba Formation are placed under this age based on index Devonian fossils. In Dolpo region, Flugel (1966) reported assemblage of Devonian corals. The identified species are: *Cyathophyllum dianthus, Goldfuss, Acanthophyllum aff concavum (Walter), Stringophyllum isactis (French), Sociophyllum* etc. Fuchs (1977) has recorded a very rich assemblage of brachiopods and determined Givetan age from the Dolpo region. Fuchs and Mostler (1969) have recorded conodonts remains from the equivalent rocks of Dhaulagiri area. Fuchs et al. (1988) have identified Fransnian conodonts from the equivalent carbonate rocks of the system from the Manang area.

Carboniferous System

Flugel (1966) has recorded Lower Carboniferous corals from the Tilicho Lake of Thakkhola section and Waterhouse (1966) have recorded the Lower Carboniferous brachiopods from the same succession and assigned Tournaisian Age to the fossiliferous beds. Bordet et al (1975) have recorded several brachiopods and assigned Turonian-Namurian Ages for these rocks from the Nyi-Shang area.

Permian System

Flugel (1966) has recorded several index corrals form the Dolpo region (Upper Thinichu Formation) and Waterhouse

(1966) has identified the several index brachiopods of the Permian age from Dolpo and Thakkhola area. Based on Permian brachiopods, he recognized three biozones on brachiopod fossils as *Lamnimargus himalayensis* zone (Punjabian Stage), *Krotovia arcuata* zone (Baisalian-Late Djulfian Stage) and *Echinalosia kalikotei* zone (Dorashamian Stage).

Triassic System

In Thkkhola area, the Triassic deposits have been considered as Thinigaon Formation by Bodenhausen et al. (1971) and he reported *Ophioceras*, *Meekoceras* and *Clypeoceras* ammonites of Scythian Stage. From Dolpo region several types of index ammonites have been reported by Bordet et al. (1971) and assigned the Carnian, Norian and Ladinian Stages of the Triassic system.

Jurassic System

In Thakkhola area, the Jomsom Limestone, Lumachelle Formation and Saligram Formation belong to this system based on the available index fossils of ammonites. The identified species of ammonites found in the Saligram Formation are: *Kranosphinctes indodermanicus, Arisphinctes gr. helenae, Prograyiceras grayi*, and *Epimayaites gr. falcoides*.

Cretaceous System

The Kagbeni Formation exposed in the Thakkhola area belongs to this geological age. The sandstone beds contain plant fossils. The trunks of *Araucariaceae* and stems of *Cycadophytes* have been identified which is assigned as Wealdean Stage (Bordet et al. 1972). Several types of Aptian ammonites are found in the glauconitic sandstones and shale beds of the Kagbeni Formation. The *Partschiceras* species of class cephalopods was recorded by Sah and Sharma (2000) in addition to several already recorded fossils from this unit.

Abundantly found fossils of ammonites in Tethys succession of Nepal Himalaya from Triassic to Cretaceous sediments lure for the invertebrate paleontologist. Actually ammonites are ancient and fossilized form of marine invertebrate animals. They are closely related to Octopuses, Squid and Cuttlefish. Ammonites are considered excellent index fossils because they can be used to trace geological time period on the basis of their special features developed in their bodies. The name of ammonite is considered to be derived from the Greek God with ram's horn called-Ammon and in Nepal, ammonites are called Saligram (a form of Hindu's God Vishnu). In reality, ammonites were sea animals having shells - either straight or coiled. When the Tethys Sea disappeared, they were caught in the shale layers of clay and transformed into fossils. Some of the fossils are large with a diameter up to 2 m.

Spores and pollen fossils have been recognized by several researchers from the Pliocene-Pleistocene sediments of Tetang Formation of Thakkhola area (Yoshida et al. 1984; Adhikari and Paudyal 2012).

FOSSILS FROM SUB-HIMALAYA

In course of detail mapping, researchers have locally classified the Sub-Himalaya (Siwalik) succession into 4-9 mapable units. It is composed of mainly fluvial sediments of Middle Miocene to Early Pleistocene epochs. A very rich assemblage of vertebrate fossils, several mollscan remains (pelecypods and gastropods), many plant imprints, many spore and pollens have been recorded from the Babai, Tui, Tinau, Surai, Rato, Balim and Binai Kholas (streams) of Nepal Sub-Himalaya (West et al. 1978; West and Munthe 1981; Tukuoka et al. 1986; Conroy et al. 1985,; Munthe et al. 1983; Gurung 1998). Identified vertebrate fossils are represented by pieces (*Channiformes sp.*, *Ophiocephalus sp.*), reptiles (testudines, crocodiles, squamata) and mammals (*creodonts, probosscideans, perissodactiles, artiodactiles*, rodents and primates). About 21 species of different vertebrates have been recorded from the Sub-Himalaya in Nepal. Along the Surai Khola section, south of Dang Valley, Corvinus (1988) conducted a detailed study and collected a number of vertebrate and plant fossils. On the basis of vertebrate fossil (*Gompotherium sp.*) the lowest beds in the section has been correlated with the Chinji Formation (Lower Siwaliks). An Upper Siwalik faunal assemblage comparable to the Tarrot and Pinjor faunal zone is also recorded in the massive salt and pepper sandstone facies of the Surai Khola section. Most of the recorded vertebrate fossils are float specimens and they have less stratigraphic value. The first hominoid discovered in Nepal is represented by an upper molar of Sivapithecus. The hominoid specimen is 9.0-9.5 my old and has been identified as *Sivapithecus punjabicus* (Munthe et al. 1983). Seventeen species belonging to 14 genera of gastropod and bivalve have been recognized from the Arung Khola (West et al. 1975; Takayasu 1992). Stegotetrabelodon species of extinct elephant teeth has been recorded from the Patu succession of Rato Khola area, Sub-Himalaya from eastern Nepal (Sah et al. 2000).

The presence of fresh water ostracods has been reported by several researchers from the different parts of the Siwalik succession. In Nepal, Chinese Petroleum Team (CPIT 1973) recognized several species of ostracods from the Siwalik succession of Hetauda-Amlekhganj area of central Nepal. The identified species include: *Hemicypris gibbera, H.*

pisiformis, Cypris subglobosa, Ilycypris bradyi, Cyprinotus tenuis, Cyprinous sp., and Eucypris sp. Twelve fresh water ostracods species are described from the fossiliferous beds of the Siwalik succession of Butwal area (Dahal et al. 2000). Among these *Strandesia indica, herpetocypris repatans, Cypriodopsis disper, Candona morengoensis, Candonopsis kingsleii, Candonopsis sp., Darwinula straubi and Darwinula sp.*, are reported first time from the Siwalik succession of Nepal by them.

Plant fossils comprising 21 species belonging to 19 genera and 13 families of monocotyledons and dicotyledons have been described by Awasthi and Prasad (1990) from the Siwalik sediments of Surai Khola. Fossil materials mainly consisted of leaf impressions and occasionally of fruit and seed remains. The plant fossil assemblage represent mostly tropical evergreen to semi evergreen forms. Several morphotypes of plant leaves have been recognized from the Bhasu Formation of Godavari area of far western Nepal (Sah et al. 2000). Three forms have been identified as: *Bambusa siwalika, Polyalthia palaeosimiarum and Dipterocarpus siwalikus*.

FOSSILS FROM KATHMANDU VALLEY

Kathmandu valley is filled with about 500 m thick successions of the fluvial-deltic to fluvio-lacustrine sediments of Plio-Pleistocene Epochs. Diatoms and very diverse types of vertebrate fossils including fishes, elephants, rhinos, cervids, bovids, suids and crocodiles have been recorded by many researchers (Sharma and Singh 1966; Corvinus and Sharma 1984; Dongol 1985; West et al. 1988; Sah et al. 1991; Corvinus and Nanda 1994). Diatoms, spores and pollens remains have been recorded from the fluvial lacustrine of Thimi Formation, Gokarna Formation and Patan Formation from Kathmandu valley (Igarasi et al. 1988; Sah et al. 1995, 1996; Paudayal 2002, 2005, 2006, 2011a, 2011b). Based on the composition of pinus taxa, the Thimi Formation is divided into seven pollen assemblage zones (Paudayal 2005). Palynological study from Besigaon section of Gokarna Formation revealed 45 species of plant microfossils belonging to 33 families (Paudayal 2011a). The gymnosperm taxa consist of *Abies, Picea, Pinus*, and Tsuga. The major angiosperm taxa are *Quercus, Castanopsis, Betula, Myrica, Alnus, Juglans, Eleagnus* and Oleaceae. Other angiosperms such as Ericaceae,

Sapotaceae, Rutaceae, Euphorbiaceae, Dipsaceae, Caprifoliaceae, and Acanthaceae are present in less amounts. The herbaceous plants like Poaceae, Cyperaceae, Compositace, Caryophyllaceae, Chenopodiaceae, and Polygonaceae are present in high number.

Plenty of aquatic plants *Polygonum, Trapa, Typha, Myriophyllum*, and Nymphoides indicate the lake under eutrophic condition. The eutrophic condition is also evidenced by aquatic pteridophyte *Azolla*, algal remains belonging to *Botryococcus* and *Pediastrum* (Paudyal 2011a). Plant microfossils have also been identified from the dirrerent plant microfossil horizons of the Besigaon section of the Gokarna Formation. From the same section, 66 texa belonging to 38 families are recognized to the genus and species level (Bhandari and Paudayal 2011). The lower part is characterized by the presence of dominance of angiosperms and upper part by gymnosperms. Based on the palynological studies by the researchers, it is suggested that climate had been cooler in the past than the present in the Kathmandu Valley.

The Holocene vegetation history was studied by pollen analysis on the deposits of Lake Rara in west Nepal (Yasuda 2001). He prepared the pollen diagram and showed the four pollen zones. It is the first palynological study of Holocene deposits in Nepal.

CONCLUSIONS

A lot of fossils are recorded from different parts of the Nepal Himalaya by several researchers. Gondwana succession of the Lesser Himalaya, Tethyan sediments, sedimentary rocks of Sub-Himalaya and Plio-Pleistocene sediments of Kathmandu valley are found potential for many types of fossil fauna and flora. However, there is a vast room for the systematic studies of fossils for the establishment of biostratigraphy, paleo-geographical reconstruction and paleo-climate interpretations from Nepal Himalaya.

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Landslide management in Kalimati sub-watershed of Vhalam Khola, Kaski, Nepal

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ABSTRACT

Landslides are chronic problem of Nepal especially in monsoon season. Discontinuities in rock strata, weathering ability of rocks, toe cutting, high intensity rainfall and slope are the major causes of landslide. The aim of this research is to stabilize landslide by bio-engineering measures with 13 check dams and plantation using local resources for community benefit in participatory approach. The plantation of fodder species (*Ficus auriculata*, *Ficus semicordata* and *Bauhinia purpurea*) and cash crops *Thysanolaena maxima*, *Bambusa balcooa* and *Dendrocalamus hookeri* provide livelihood opportunities of local people. The landslide affects 20 households and 307 ropani cultivated land with other physical infrastructures. The active participation of affected community group to control landslide becomes cost effective environmentally sound for long run.

INTRODUCTION

Landslides are the main natural hazards in Nepal and it creates chronic problems in upstream and downstream locations. Many villages in hilly areas of Nepal are situated on or adjacent to unstable slopes and old landslides which have been reactivated from time to time during monsoon season. The Midland areas have been highly susceptible to landslide due to complex interaction of natural and man-made factors (Pradhan 2007). Precambrian to Cambrian Lesser Himalayan meta-sedimentary zone of western Nepal is one of the vulnerable zones among morpho-tectonic units of Nepal due to its rugged mountain topography, complex and fragile nature of the geological formations, active groundwater activities, and soft soil cover, high intensity rainfall in the monsoon season, steep slope and surcharge loads of vegetation (Upreti 2001). This zone has been suffering by landslides doe to the presence of thrusts/faults, folds, bedding, foliation and joints in rock strata (Upreti and Dhital 1996). In addition weathering of rocks in slopes reduces the strength of rock and soil, and chemical alterations in clay are thought to have contributed to triggering of landslides (Zaruba and Mencl 1982). Rainfall in sloppy land is one of the main factors controlling the frequency of landslides that depends upon climatic conditions, topography and geological characteristics of rocks and soils. It increases frequency of landslide during monsoon due to saturation of subsoil (Galay 1987). An increase in natural slope produces a change in the internal stress of the rocks or soil mass, and equilibrium conditions are disturbed by an increase in shear stress (Zaruba and Mencl 1982). Landslides result loss of income, livelihood opportunities, life and property, starvation including displacement of affected families were the major implications of landslide disasters (Achyut 2004).

Vegetation has playing a vital role in slope stability (Howell 1999). Generally, the vegetation cover increases the shear strength of the soil with its root network and protects the slope from landslides. The roots of the trees maintain the stability of slopes through their mechanical and biological effects and help to dry the soil slopes by absorbing some groundwater. However, if the landslide is deeper than the penetration depth of the roots, vegetation cannot stabilize the slope (Newpane 2005). Vegetation fulfills six engineering functions namely armoring, anchoring, supporting, draining, catching and reinforcing. It can modify slope stability by the factors as mechanically reinforcing slopes through plant roots, modifying soil moisture distribution and pore water pressures, adding slope surcharge from the weight of trees, and levering and wedging soil by roots (Gray 1970).

The studied landslide lies in lesser Himalayan meta-sedimentary zone which contains weathered phyllite rock. The landslide was damaged households, public institution and agricultural lands. To control the landslide, bio-engineering techniques was applied by using local resources and local skills to stabilize the vulnerable slope (Howell 2001). The study is aiming to stabilize landslide by using local resources for community benefit in participatory approach. Several studies related to bio-engineering have been adapted in many places of Nepal without considering the livelihood opportunities of affected local people. This study shows due consideration through plantation of fodder species and cash crops for income generation in long run.

MATERIALS AND METHODS

The reconnaissance survey was applied to select landslide with the official records of District soil conservation office (DSCO), Kaski District, Nepal due considering the vulnerability of the slope and their impact on life and properties losses of rural people. The study area lies in the north-eastern part of the Pokhara Valley. The study area lies in sub-watershed of Vhalam Khola in Ryalechour village, Vhalam village development committee (VDC), and ward number 3. The study area is bounded by the latitude 28° 15' 1''N to 28° 15' 3''N and longitude 84° 1' 1''E to 84° 1' 4''E in the topo sheet No. 2884 13A.

The length, breadth, height and failure depth of the landslides were measured for area and volume calculation by using respective instruments to collect technical data. Participatory approach is applied for the stabilization of landslide due involvement of Institute of Forestry, Pokhara campus, DSCO, Kaski District and Kalimati landslide and gulley conservation subcommittee under ward conservation committee of Vhalam VDC especially using bio-engineering method. Primary data related to socio-economy was collected from focused group discussion. Secondary data were collected from official record of DSCO, published and unpublished articles.

RESULT AND DISCUSSION

Nature of landslide

The nature of landslide is complex due to the combination of rotational slide and flow. The major causes of landslide are surface runoff water, deeply weathering of rocks, discontinuities in rock strata i.e. highly jointed and fractured rocks (plane and wedge failure), slope 49° (greater than 45), toe cutting by flooded water, pore water pressure and human activities (canalizing surface runoff water in landslide area).

The deeply weathered, highly jointed and fractured, thin to medium bedded phyllite with infiltrated and percolated water in fine soil develop failure surface at the time of landsliding. The natural slope dipping S75^{o}E/58°SW with three sets of joints S 55°E/85°SW, N 12°E/80°SE and N 55°W/35°NE (Table 1).

The total of 6403.24 m^3 sediment loads was slided in the time of event with the area 1524.58 m^2 over the residential area and cultivated land (Table 2). This sediment in the time of heavy rainfall within joined stream was damaged properties of local people.

Effect of landslide

The Table 3 shows that the landslide damaged 20 households, 307 ropani cultivated land, water supply, irrigation canal, road, school and natural spring due to cutting, rill formation and sediment deposition. It creates several problems in landslide area.

Formation of Affected conservation group (ACG)

A general body meeting of affected people of Ryalechour, Vhalam VDC, ward no 3 was formed ACG under ward conservation committee with different caste groups and women's participation. The seven executive members would lead for the necessary conservation activities and participation of affected households.

Bio-engineering measures

The bio-engineering measures were applied for control of landslide with 13 check dams. The plant species of fodder and cash crops were chosen according to the interest of the affected household members to support their livelihood. The selective plant species Michelia champaca, Boehmeria rugulosa, Litsea monopetala, Ficus auriculata, Ficus semicordata and Bauhinia purpurea were planted for

Table 1: Attitude of natural slope and foliation plane.

S.N.	Attitude	Natural slope	Joint set I (J1)	Joint set II (J2)	Joint set III (J3)
1	Strike	S75^{o}E	S55^{o}E	N12^{o}E	N55^{o}W
2	Dip	58°SW	85°SW	80°SE	35°NE

Table 2: Landslide measurement.

Particulars		Measurement (m)	Total
Length (m)		48.6	48.6
Average Breadth (m)	B1	12.5	31.37
	B2	30.7	
	B3	50.9	
Height (m)		4.2	4.2
Failure depth (m)		4.0	4.0
Area (m^2)			1524.58
Volume (m^3)			6403.24

Table 3: landslide damages.

S.N.	Particulars	Damage (Ropani/No.)	Remarks
1	Affected households	20	Cutting and deposition
2	Khet	300	Sediment deposition
3	Bari	7	Cutting
4	Drinking water supply	1	Affected 15 households
5	Irrigation canal	1	Irrigation stop in 50 ropani khet
6	Road	1	Sediment deposition and rill formation
7	Mahendra sec. school	1	Side cutting
8	Subsidence of spring	1	Due to sediment deposition

fulfilling the engineering functions as support, catch and anchoring in toe and middle part of the landslide (Table 4). Bambusa balcooa and Dendrocalamus hookeri (planted in the side of tributary) , Thysanolaena maxima, Chrysopogon gryllus and Pennisetum clandestinum herbs/grasses species (Table 4) were horizontally planted over the landslide for fulfilling the armoring, catching and reinforcing engineering functions. The involvement of local people was remarkable in plantation (Annex-1) and afterward due to their decisive role in the control of landslide. The environmentally sound bio-engineering method will enhance livelihood opportunities through selling of cash crops like Amriso and livestock farming using fodder.

CONCLUSION

The participatory approach for landslide stabilization due formation of ACG under ward conservation committee becomes more fruitful by using bio-engineering method. The plantation of fodder species and cash crops is cost effective environmentally sound and effective way to remedial measures of landslide control to enhance livelihood opportunities of the local people.

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Table 3: landslide damages.

S. N.	Plant species (trees, fodder trees, bamboos and grasses)		No. of species	Plantation space (m)
	Scientific name	Local name		
1	*Michelia champaca*	White champ	5	5
2	*Boehmeria rugulosa*	Dar githi	10	5
3	*Litsea monopetala*	Kutmiro	15	3
4	*Ficus auriculata*	Nebharo	20	3
5	*Ficus semicordata*	Raikhaniyo	30	3
6	*Bauhinia purpurea*	Tanki	30	3
7	*Bambusa balcooa*	Dhanu bans	10	5
8	*Dendrocalamus hookeri*	Kalo bans	10	5
9	*Thysanolaena maxima*	Amriso	100 strands	1
10	*Chrysopogon gryllus*	Shalimo khar	100 strands	0.5
11	*Pennisetum clandestinum*	Kikiyu grass or thulo dubo	20 strands	0.1

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ANNEX 1:

Some Photographs of Kalimati Landslide and Gully control area of Valam VDC-3, Ryalechour, Kaski District, Nepal.

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Organic facies analysis of the Gokarna Formation, Dhapasi section, Kathmandu Valley, Nepal

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ABSTRACT

The sources and affinities of the sedimentary organic matter are studied in the fluvial-lacustrine deposits of the Kathmandu Basin. Altogether 42 organic rich clay, clay and silty clay samples were collected from the surface exposure belonging to the Gokarna Formation and analysed for organic facies study. The organic facies components such as semi-opaque material, cuticles, fungal spores, fungal hyphae homogeneous AOM, heterogeneous AOM, humic AOM, other plant parts and *Botryococcus* are presented in this paper. The total wood contents are directly related with increase or dominance of total arboreal pollen (AP) throughout the Gokarna Formation however relation of the total organic carbon (TOC) with that of organic facies components couldn't be established. Since the majority of TOC values in the Gokarna Formation ranges between 0.064% to 4% (except for few samples), the potential for any hadrocarbon generation is negligible.

INTRODUCTION

The organic facies (OF) or palynofacies (PF) is the study of bulk organic matter that has been deposited with the sediments in a sedimentary basin. The organic matters usually constitute the lowest proportion of the sediment fraction. It is constituted by organic molecules (under the form of monomers and polymers) deriving directly or indirectly from the organic part of the organisms. Skeletal parts, shells, bones, spines, and teeth are not included (Tissot and Welte 1984; Tyson 1995). Palynofacies are associations of palynological matter (PM) in sediments, considered primarily in terms of the reasons for the association, which is usually geological, but may be connected to the biological origin of the particles. Such non pollen palynomorphs are also called as palynodebris (Traverse 2007). Study of the organic matter in sediments and sedimentary rocks focuses on the interaction between the biosphere and geosphere (Tyson 1995). This requires an understanding of the environmental controls which govern the production of organic matter in the biosphere, the ecological and sedimentological processes which control its deposition and distribution, the biogeochemical, and geomicrobiological factors which influence its preservation and geochemical and physical processes which determine its modification during its incorporation in the geosphere (Filho et al. 2012). Petroleum generation results from the transformation of sedimentary organic matter in the subsurface under the influence of both temperature and geologic time. It is widely accepted that this transformation can be ascribed to the thermal cracking of the kerogen (a solid organic assemblage that is insoluble in organic solvents) which releases micropetroleum (a mixture of liquid and gaseous hydrocarbon-like products that are soluble in organic solvents) into the pore system of the source rock (Tissot and Welte 1984).This paper presents the results of the organic facies analysis from the Late Pleistocene fluvio-lacustrine sediments belonging to the Gokarna Formation in the Kathmandu Basin.

GEOLOGY

The intermontane basin of Kathmandu is filled with fluvial to fluvio-lacustrine sediments ranging in age from Late Pliocene to Holocene. The thickness of basin filled sediments exceeds 600 m. The stratigraphy of these sediments has been described by different authors (Yoshida and Igarashi 1984, Yoshida and Gautam 1988; Sakai et al. 2008 etc.). The oldest deposit is the Lukundol Formation which is distributed widely at the south part of the basin. The Lukundol Formation consists of thick lacustrine sediments overlain by Chapagaon, Boregaon and Pyangaon terrace deposits formed during tilting of the lake towards north due to activation of Main Boundary Thrust (MBT) towards south. This tilting ultimately created a new environment for the sediments being deposited in the northern part mostly under the fluvial dominated environment with occasional lacustrine conditions. These deposits are classified as the Gokarna, Thimi and Patan Formations mostly distributed towards northern and eastern part of the basin (Fig. 1). The age of these three formations is Late Pleistocene to Holocene however the ^{14}C ages obtained by different authors are

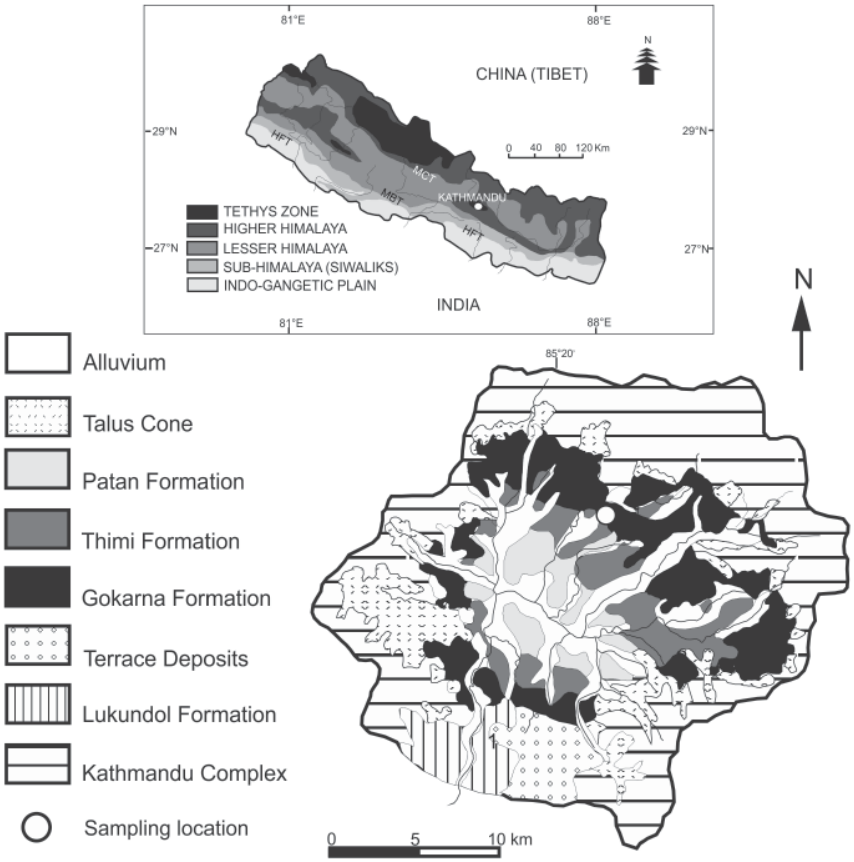

Fig. 1: Location and geological details of the study area.

mostly erratic (see, Yoshida and Igarashi 1984; Paudayal and Ferguson 2004, Paudayal 2005, Paudayal 2006, Paudayal 2011, Sakai et al. 2008; Bhandari et al. 2011a, 2011b).

MATERIAL AND METHODS

Samples for organic facies analysis were taken from a surface exposure near Dhapasi (27°44'50"N and 85°19'45"E) at an altitude of 1358 m (Fig. 1) belonging to the Gokarna Formation from the northern part of the Kathmandu Basin. The thickness of exposure is about 27 m and is composed of alternating layers of clay, silt and fine to coarse sand (Fig. 2). The sand layers are massive, parallel and cross stratified, fine to coarse grained with occasional gravel and pebble layers. The stratigraphy of the Gokarna Formation was documented with its sedimentary structures and the lithological details (Fig. 2). Altogether 42 samples were collected for the organic facies analysis. In order to isolate the organic matter the samples were heated in concentrated Hydrochloric acid (HCl) to remove the carbonate contain it. It is then heated with Hydrofluoric acid to remove the silicates. The organic matter is separated from inorganic fraction using heavy liqhid $ZnBr_2$ (Sp. gr. 2). The suspension obtained after the heavy liquid separation was mixed with glycerin and studied under the NIKON microscope at different magnifications. The relative abundance of the organic facies components has been statistically separated into different organic facies groups. For the characterization of the organic facies groups of the Gokarna Formation various statistical methods have been tested (CONISS of TILIA, Euclidian distance, chi-square and Pearson's correlation of SPSS). The Pearson's correlation was found to be best suited for the classification of organic facies groups when the sedimentological background (sedimentary facies) of the successions was taken into consideration. The total organic carbon (TOC) content was measured to find out the bulk organic input in the sediment from biological remains (Table 1). The total organic carbon (TOC) is the abundance of organic matter in sediment which is usually expressed as the relative dry weight percentage of organic carbon. The TOC analysis was conducted on a Shimazu TOC-5000 solid sampler. A small fraction of the sample was powdered and transferred into ceramic sample holders (max. weight 0.5 g). Subtraction of the automatically measured total and inorganic carbon yielded the TOC in percent (TOC = TC – IC, where TC is the total carbon and IC is the total inorganic carbon present in

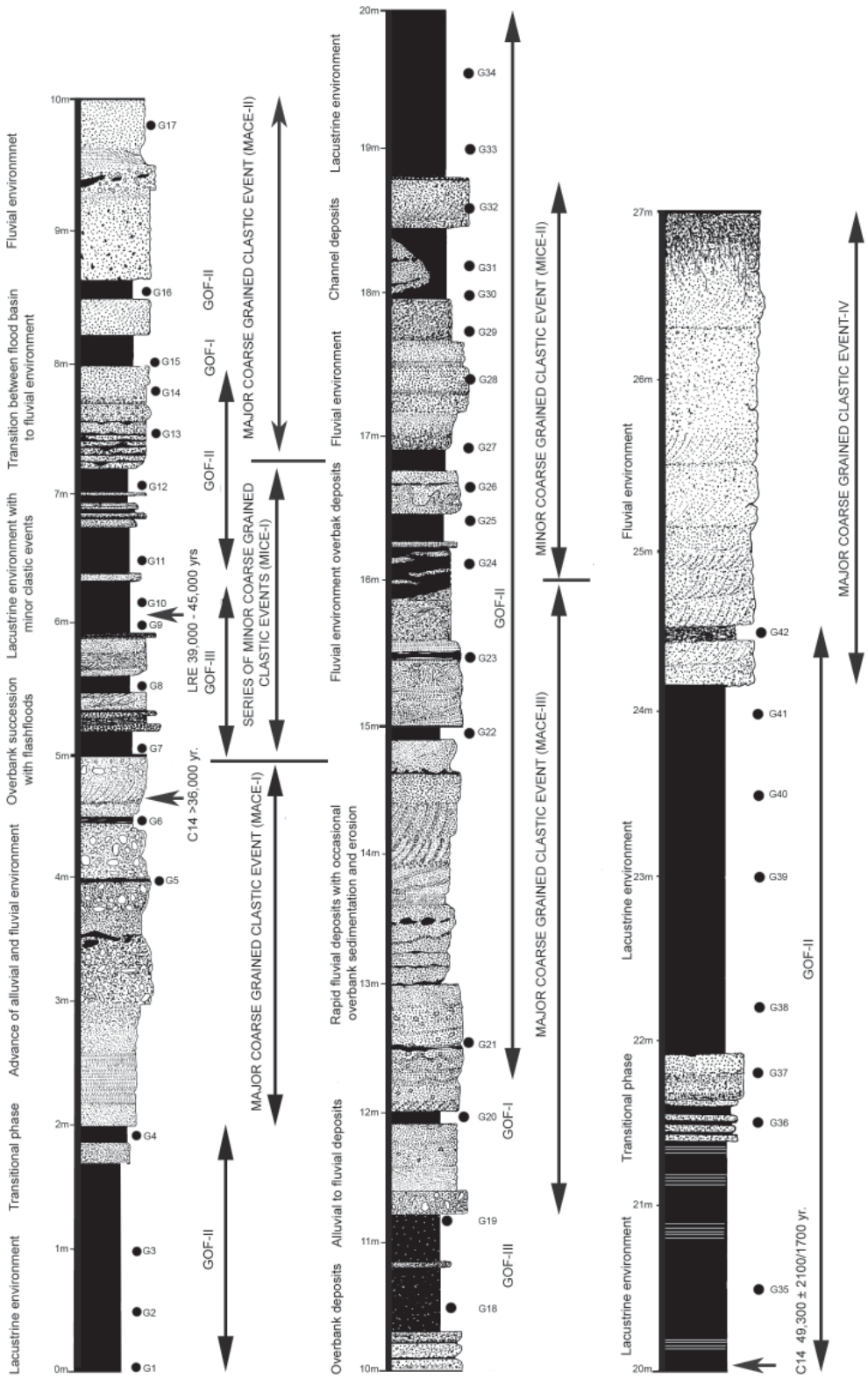

Fig. 2. Lithostratigraphy of the Dhapasi section with chronological and sampling details. The depositional environment and the organic facies group are also indicated at the margin of the column.

the rock). The earlier radiocarbon datings from 4.7 m and 20 m from the bottom of the sequence provided age of >36,000 and 49,300±2100/1700 yr. BP (Paudayal 2006). New age data with the measurement of magnetic remnance at the lower part of the sequence revealed Laschamp Reversal Event (LRE) at about 41 Ka. With the reference of already existed ^{14}C data, the age of Dhapasi section bbelonging to the Gokarna Formation is ca. >45 to 34 Ka (Gautam et al. 2009).

RESULTS

The depositional environment in the Gokarna Formation was either dominated by higher flow regime (alluvial phases) or with lower flow regime (quiescent or lacustrine phases). At least two sub-aerial phases are assumed to have existed during the time of the deposition of the Gokarna Formation. These phases are characterized by strongly oxidized and iron cemented gritty to coarse-grained sand horizons at the top of coarse clastics (2 to 4 cm thick) at 5.2 m and 18.8 m from the bottom of the sequence. It can be speculated that during these phases, the subsidence of the basin was considerably lower than the sediment input, thus resulting in sub-aerial exposures and soil development on the top of the deposited sediments. The sub aerial phases are supported by the organic facies types with numerous rootlets (counted as OPP = Other Plant Parts in samples G7, G8, G10, G20, G32 and G33) in the vicinity of the sub-aerial exposure zones. The coarser clastic phases can be associated with the uplift of the basin shoulder (footwall uplift) which resulted in a high rate of erosion due to an increase of the river gradient. These events were followed by tectonic sleep which in turn allowed the re-establishment of lacustrine environment in the basin. The samples can be crudely divided into two major groups, which are either very rich in total wood (up to 77%) or rich in pollen (up to 55%). Other organic facies components such as semi-opaque material, cuticles, fungal spores, fungal hyphae homogeneous AOM (amourphous organic matter), heterogeneous AOM, humic AOM, kerogen, other plant parts and *Botryococcus* are also present but rarely in significant amounts in the facies groups (Fig. 3). Samples G15 and G19 are assigned to organic facies group GOF-I (with numerous pollen). All other samples belong to group GOF-II (dominated by woody debris), and GOF-III (with many rootlets) respectively. They might define sub group levels (e.g. GOF Ia, sample G7; GOF IIa, G29 etc). The organic facies characteristics of each group are described below.

GOF-I: (Samples G15 and G19). This group is characterized by a high percentage of pollen (51-56%), but very low percentage of total wood fragments (5-10%). Organic debris such as semi-opaque material is present with 10%, whilst fungal spores and mycelia range from 2 to 20%. Among the total pollen content, gymnosperms and Poaceae are presented by <2% and 4-9%, respectively. In contrast angiosperm tree pollen and fern spores have high values (22-40%) and (50-57%) respectively.

GOF-II: (Samples G1, G2, G3, G4, G11, G12, G13, G14, G16, G22, G23, G24, G25, G26, G27, G29, G30, G31, G32, G33, G34, G35, G36, G37, G38, G39, G40, G41 and G42). This group has low to medium pollen contents (1-19%) but mostly very high total wood contents (32-78%) in comparison to organic facies group GOF-I. The percentage of both, semi-opaque material and fungal spores and mycelia vary considerably between 1-28% and 1-19% respectively. The composition of total pollen contents are very variable: gymnosperms are represented by 1-37%, angiosperm tree pollen 1-62%, Poaceae 1-35% and total fern spores 9-80%. GOF-IIa: (Sample G29). This sample is characterized by a relatively high percentage of pollen (31%), a medium wood (37%) and high semi-opaque content (22%). The amount of fungal hyphae (and mycelia) is represented by only 2% of the total organic debris. The total pollen content consists of gymnosperms (4%), angiosperm tree pollen (18%), Poaceae (36%) and fern spores (34%) respectively.

GOF-III: (Samples G7, G8, G10 and G20). These samples are characterized by low to medium pollen (4-22%), low to medium wood (7-26%) and high OPP contents (15-27%). The fungal spores and mycelia attain 10 to 22% of the total organic debris. In the total pollen content, gymnosperms are represented by (2-10%), angiosperm tree pollen (40-55%), Poaceae (3-8%) and fern spores (32-50%) respectively.

The TOC content ranges from a minimum of 0.064% in clastic rich clay to a maximum of 8% in the organic-rich horizons (Table 1). The observed lithological cyclicity usually is reflected in the TOC values. Woody materials significantly contribute to TOC but the clear relationship with any of them couldn't be established.

DISCUSSION AND CONCLUSOINS

The sedimentary succession of the Gokarna Formation is characterized by the rapid changes from low energy lacustrine environments to the high-energy fluvial/alluvial environments. The quiet sedimentation of the lake (clay and silts) was periodically interrupted by either major coarse-grained clastic events (MACE) or a series of minor less coarse-grained clastic events (MICE). The major clastic events were followed by the deposition of fine-grained sediments (e.g. clay and silty clay) indicating a relative tectonic quiescence in the hinterland and consequently in the depositional environment. After a phase of quiescence the following coarse clastic event indicates the next phase of

Table 1: Total organic carbon (TOC) from the Dhapasi section.

Sample	Area	%	Amt. (mg)	Sample	Area	%	Amt. (mg)
G42	2798	1.961	203	G24	2453	1.669	210
G41	5589	3.743	209	G23	3381	2.267	211
G40	2720	1.853	209	G22	7982	5.099	218
G39	3288	2.185	213	G20	2705	1.720	224
G38	3911	2.729	202	G19	0	0.064	203
G37	3270	1.845	251	G16	8485	4.667	253
G36	3735	2.196	240	G15	1570	0.931	246
G35	4665	2.977	220	G13	13119	8.047	226
G34	571	0.451	203	G11	266	0.211	235
G31	3191	1.916	236	G10	2886	1.776	231
G30	3823	2.428	222	G9	1226	0.745	244
G29	976	0.669	220	G8	10014	6.887	202
G27	2269	1.390	234	G7	9590	5.600	238
G26	4719	2.918	227	G2	1198	0.885	201
G25	5495	3.529	218	G1	3034	1.786	241

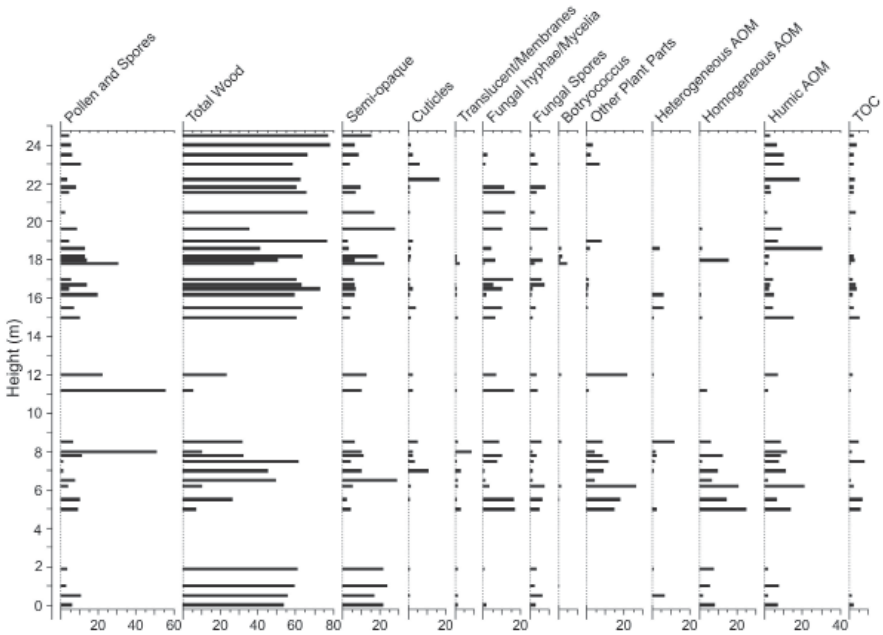

Fig. 3. Percentage diagram showing the OF (PF) components in the Dhapasi section, Gokarna Formation.

tectonic activities. The location and intensity of the successive tectonic activities (footwall uplift, hangingwall down throw) must have varied and therefore the coarse-clastic events do not display many similarities. The MACE are characterized by frequent occurrences of medium to coarse-grained sand, pebbly sands and conglomeratic beds with large tree trunks (or wood fragments), and rip up mud clasts. All these feature the characteristic of the Gokarna Formation (e.g. MACE-I, MACE-II and so on). Sandy layers are often cross-laminated but sometimes they are distorted and display variable de-watering and flow structures indicating high-energy regimes and rapid deposition of the coarse clastic sediments. MICE are characterized by relatively thinly bedded coarse to medium sands, silts and silty clays intercalated with each other. The carbonaceous clay layers were either deposited during phases of quiescence/lacustrine or overbank sedimentation,

such as in flood basins or flood plains. Samples G15 and G19 were taken from the silty clay and sandy clay layers sandwiched between thick coarse-grained sand and pebbly sand beds. These two samples contain exceptionally high percentages of fern spores. Other samples (e.g. G7, G11, G30, G31, etc.) that were taken from or in the vicinity of the coarse-grained clastic layers contain high percentages of wood fragments and abundant fern spores. It is suggested that these assemblages are taphonomically biased: It can be assumed that the physical transport and settling properties of both fern spores and the wood fragments were comparable with those of the smaller sand grains that have been deposited in the winnowing phases at the top of the coarse-grained beds. In this case, the palynomorph assemblages reflect similar depositional/physical processes, but no particular vegetation type. However, it could be argued that the forest floor vegetation was dominated by ferns and this is therefore reflected in such flood assemblages. Observation in comparable modern environment revealed that the enrichment of fern spores in fluvial samples can be explained by fluvial transport and the comparable settling properties of the fern spores originating upstream and fine sand particles (Hofmann and Zetter 2005). Such sudden changes in the sedimentary regime can be particularly enlightening because any differences in the detritus must be related to alteration in the source of the material rather than any longer term changes in the vegetation (Ferguson, 1995). Not surprisingly, the total wood contents are directly related with increase or dominance of total arboreal pollen (AP) throughout the Gokarna Formation. The average organic content of sedimentary rocks is 0.5%. When the organic matter concentration becomes large (4% to 12%), this element is then considered to be potential source rock for hydrocarbon generation (Biju-Duval 2002). The majority of the TOC values in the Gokarna Formation ranges between 0.064% to 4% (except for few samples) the potential for any hadrocarbon generation is negligible.

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Geological hazards in Nepal and triggering effect of climate change

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ABSTRACT

Nepal is exposed to multiple hazards that have tectonic, climatic and geological causes or their combined effect. The dynamics of a collision between Indian and Tibetan lithospheric plates resulted in the formation of numbers of tectonic faults and the highly deformed rocks. Because of the cyclic process of store of energy and its potential of release after certain interval, Nepal is most hazardous country for earthquake and has been experiencing many small and numbers of big scale earthquake time and again. Because of high topographical variation and geological characteristics, together with torrential rain during the monsoon season; Nepal is most hazardous country for the hazards associated with geology like landslides, debris flows and floods. High grade of weathering of rocks in the mountains, intense erosion and bank scouring by the high gradient rivers in the mountains have severe negative impact in the productivity of the land and have enhanced the hazard of flood and debris flows in the Terai zone of Nepal. In addition to this, Nepal is one of the most hazardous countries in the world with respect to climate change because of the high rate of temperature rise. As a result, high rate of glacial melting, formation of glacial lakes and danger of their breaching has intensified the Glacial Lake Outburst Flood (GLOF) hazard. Of all the disasters reported in Nepal, floods and landslides are the most devastating in terms of the number of deaths that occur and the damages they cause.

INTRODUCTION

In technical settings, hazards are described quantitatively by the likely frequency of occurrence of different intensities for different areas, as determined from historical data or scientific analysis. The most challenging hazard in the world is natural hazard, which is a natural process or phenomenon that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage. Alternatively, natural hazards are natural events that threaten lives, property, and other assets. Such hazards generally arise from a variety of geological, meteorological, hydrological, oceanic, biological sources or acting in combination. Geological hazards are the hazards created or controlled or associated with the geological factors. Landslides, floods, earthquake, GLOF and erosion are major geological hazards in Nepal that have been converted to disaster in the past and are still major potential threat. The phenomena associated with the climate change like unpredictable and irregular precipitations as well as increase in global temperature have enhanced the risk of geological hazards.

There is clear difference between a hazard and a disaster. Disaster is defined as a serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources. Not to confuse between natural hazard and natural disaster, it should be clear with the example that the 1934 Nepal-Bihar earthquake was a disaster, whereas earthquakes are a hazard. Therefore to become a natural disaster, hazardous events like earthquake, landslides, floods or others should practically occur and that should affect the people, lives and properties; before that they are just hazards. Not all hazards turn into disasters. If there is no risk to human life and property, even though the area is extremely hazardous, there will be no disaster; e.g., a large-scale landslide in an uninhabited area poses no risk to human life and property although the area may be extremely hazardous. Disaster impacts may include loss of life, injury, disease and other negative effects on human physical, mental and social well-being, together with damage to property, destruction of assets, loss of services, social and economic disruption and environmental degradation.

Climate change refers to the changes in the statistics of temperature, rainfall, atmospheric pressure and other meteorological elements in a given region over considerable periods of time. It has been widely accepted as one of the defining challenges of the 21st century and Nepal is among the most vulnerable countries on earth with regard to

climate change as the rate of temperature rise here is higher than many other countries. The most pronounced effect of climate change in Nepal has been seen in agriculture sector and climate induced disasters. Therefore, climate change and natural disasters has wide relations with each other. For developing countries like Nepal, climate change is not just an environmental phenomenon but also the economic, social and political issues. Nepal is one of the most disaster prone and affected countries in the world. It is ranked as the 4th most vulnerable country form climate change perspective (Maplecroft 2011). The country is exposed to multiple hazards, most prominently floods, landslides, windstorms, hailstorms, earthquakes, forest fires, glacial lake outburst floods (GLOFs) and avalanches. Nepal ranks 11th in the world in terms of vulnerability to earthquakes and 30th in terms of flood risks (UNDP 2004). Reports from Nepal's Ministry of Home Affairs (MoHA) show that over the course of the past 10 years, more than 4000 people have died from climate-induced disasters, which have resulted in accumulated economic losses of US$ 5.34 billon.

MAJOR CAUSES OF NATURAL AND GEOLOGICAL HAZARDS IN NEPAL

The Nepal Himalaya is the outcome of the collision between the southern Indian plate and the northern Tibetan (Eurassian) plate and the collision process is still going on. The dynamics of a collision between such a huge lithospheric plates resulted in the formation of numbers of tectonic faults (Fig. 1) and the highly deformed rocks. Because of the cyclic process of store of energy and its release after certain interval, Nepal is most hazardous country for earthquake and has been experiencing many small and numbers of big scale earthquake time and again. This process is also the reason for the formation of very high elevation difference (climbing from just 60 m to over 8,800 m above sea level) and hence the topographical variation as well as the diversified geological characteristics within very short width of the country. Because of such a topographical variation and geological characteristics, together with torrential rain during the monsoon season, the country frequently experiences landslides, debris flows and floods. High grade of weathering of rocks in the mountains, intense erosion and bank scouring by the high gradient rivers in the mountains have severe negative impact in the productivity of the land and have enhanced the hazard of flood and debris flows in the Terai zone of Nepal. In addition to this, Nepal is one of the most hazardous countries in the world with respect to climate change because of the high rate of temperature rise.

Floods, landslides, and earthquakes of great magnitude are natural hazards, but their impacts are exacerbated by lack of preparedness and absence of measures for mitigating their impacts (Pradhan 2007). They contribute significantly to the total annual loss of life and damage to property in Nepal. Landslides often sweep away whole villages. The mudflows cover terraced land with boulders and debris damaging standing crops rendering the fields useless for agriculture until massive efforts are made to reclaim them. In the foothills and floodplains of the river valleys, floods often deposit coarse sediment over the adjoining floodplain damaging standing crops and converting the land into an infertile land mass. River banks in the northern Lesser Himalaya and Siwaliks

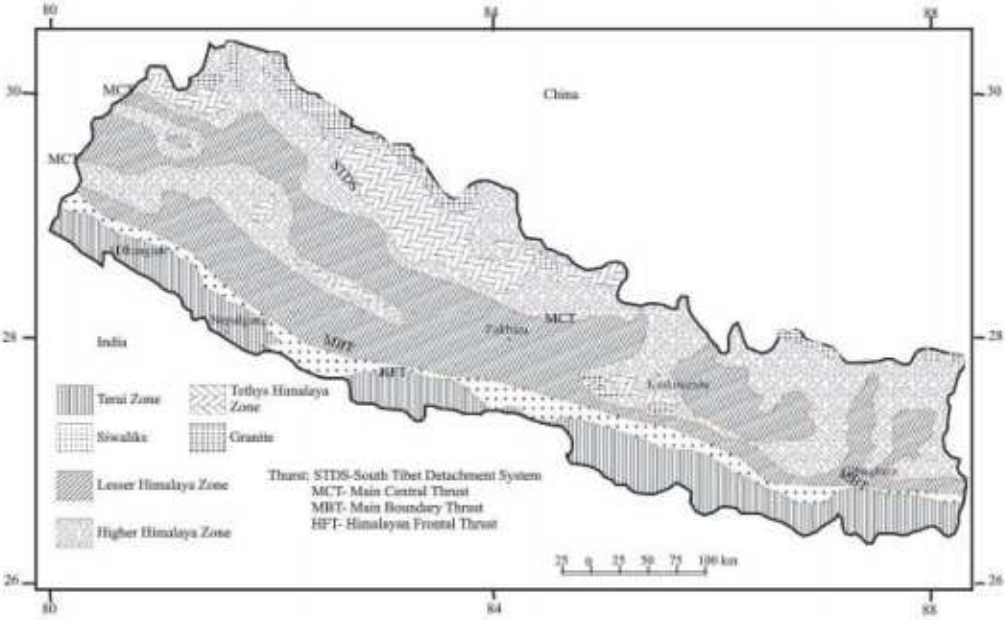

Fig. 1: Generalized geological map of Nepal (redrawn after Dahal 2006).

are subjected to severe bank erosion which in turn provides more sediment for the river to deposit downstream in the Terai. Most river systems along the Nepal-India border have wide floodplains which are frequently inundated, damaging crops and nearby settlements. Damage to life, livelihoods, and infrastructure can be attributed to several factors: landslides, slope failures, debris flow and floods caused by dense precipitation are among them. The structural causes include inadequate design provisions and inadequate use of flood data in designing riverine infrastructure, poor protection measures, and inadequate maintenance of protection infrastructure and hydraulic structures. The nonstructural causes include unregulated economic activities in flood-prone areas, lack of flood-warning systems, and inadequate preparation in disaster management. In Nepal, earthquakes are common because of the presence of major fault lines along the Himalayan mountain range, which are a result of the collision of the Indian tectonic plate with the Eurasian plate. However, unlike floods and landslides, severe earthquakes do not occur annually; still, when they do occur, they cause great losses to the community and to the nation.

Different ecological and physiographical zones of Nepal are at high risk for different hazards. For example Kathmandu is at high risk for earthquake, Terai of Nepal which is highly populated and consists of most productive agriculture land, is at high risk for flood and mountains are at high risk for debris flows, landslides and soil erosion. In summary, the natural and geological hazard in Nepal is controlled by the following major factors:

1. Ongoing mountain building process as a result of the dynamics of the collision between the southern Indian plate and northern Tibetan plate

2. High degree of topographical variation within very short distance

3. Deformed rocks in the mountains, variation in rock types and very weak rocks in the Siwalik of Nepal

4. High rate of deforestation in Siwalik and exposure of the weak fragile rocks for weathering and erosion

5. Heavy torrential rainfall in monsoon

6. High amount of debris in river water, debris-debris collision and sedimentation in the Terai

6. Irregular and unpredictable precipitation pattern

7. High rate of temperature rise in the Himalaya and consequently high rate of glacial melting, formation of glacial lakes and their breaching

8. Lack of awareness, weak institutional arrangements and preparedness for mitigating hazards.

DISASTER RISK AND VULNERABILITY IN NEPAL

Natural disasters are serious events, disrupting the functioning of a community and causing widespread hardship. They contribute significantly to the total annual loss of life and damage to property in Nepal. Geographically, the nature of damage caused by disaster varies according to the geological, physiographical and demographic phenomena. In the high mountains, heavy landslides and mudflows are the main cause of damage. Landslides often sweep away whole villages. The mudflows cover terraced land with boulders and debris damaging standing crops rendering the fields useless for agriculture until massive efforts are made to reclaim them. In the foothills and floodplains of the river valleys, floods often deposit coarse sediment over the adjoining floodplain damaging standing crops and converting the land into an infertile land mass. River banks in such areas are subjected to severe bank erosion and loss of soil, which in turn provides more sediment for the river to deposit downstream. In Nepal, natural disasters take place year after year causing immense damage to public property and loss of human life and livestock.

Because of the topographical variation and geological characteristics, together with torrential rain during the monsoon season, Nepal frequently experiences landslides, debris flows and floods. Numbers of demographic factors such as rapid population growth, improper land use, economic underdevelopment and poverty are other reasons for increasing the frequency and size of the natural disasters in the country. Recently, the impact of global climate change has intensified the disaster risk as the rate of temperature rise in the Himalaya is significantly high compared to the global average. Disaster in Nepal should be analyzed according to the different ecological and geological zones of the country. Since the rock type, metamorphism, and physiography of each zone is unique, each is threatened by different hazards and geology is a key determinant of Nepal's hazardscape. Among the several types of natural disasters, floods including glacial lake outburst flooding (GLOFs), drought, wildfires and earthquakes are the most prominent. There is high rate of glacier melting, formation of glacial lakes and danger of breaching of such lakes in the Higher Himalaya that posed serious threat of glacial lake outburst flood (GLOF) in the downstream. Because of the high gradient of rivers in the higher and lesser Himalaya, as well as because of the presence of the highly deformed rocks, Higher Himalaya and Lesser Himalaya are experiencing high rate of rock weathering, intense erosion and huge landslides. Highly fragile and weak rock containing southern Siwalik zone is highly unstable as the rate of weathering and erosion is very high because of the deforestation and unmanaged drainage

system. The cumulative effect of all these northern zones is transferred to the southernmost Terai of Nepal where there is high rate of sedimentation, flood inundation covering large areas. The fact that Nepal ranks 11th in the world in terms of vulnerability to earthquakes and 30th in terms of flood risks (UNDP 2004) reveals that earthquake and floods are two major disasters in the country. Sometimes, the damage is enormous, as experienced during the earthquakes of 1980 and 1988, floods of July 1993 and August 2006, and landslides of August 2006. Apart from these events, natural calamities have occurred time and again in the past, and the 1934 earthquake was one of the most serious disasters the country has ever faced. Current climate risks such as floods, droughts and landslides are deadly and endemic, while glacial lake outbursts floods pose increasing threats. Most climate projections for the region suggest that rainfall is likely to intensify and that extreme events will become even more frequent.

Of all the disasters reported, floods and landslides are the most devastating in terms of the number of deaths that occur and the damages they cause. Of the total death by any type of natural disaster in 2010, 29.02% were by flood and 24.55% were by landslides (DWIDP 2011). Of the total affected families by any type of disasters in 2010, 71.35% are by flood (DWIDP 2011). If we look at longer time data, 7918 people died, 667347 families affected and estimated Rs. 22248.35 million were lost by the flood, landslide and avalanches during last 28 years between 1983-2010 (DWIDP 2011). The database for 1971-2007 reveals that flood, fire and epidemics are major disasters in terms of number of disaster records whereas epidemic, landslides and floods are major disasters in terms of deaths due to natural disasters (NSET 2007). In both categories, floods and landslides are the main geological and climate induced disasters in Nepal (Fig. 2). If we look at the numbers of people affected by all types of natural disasters, flood is the main disaster affecting 68.3% of the total affected people between 1971 to 2007.

TRIGGERRING EFFECT OF CLIMATE CHANGE ON GEOLOGICAL HAZARDS

Climate Change is considered to be one of the important and serious issues in the present world which is considered to be the result of global temperature rise. This rate is in increasing trend as warming trend over the 50 years from 1956 to 2005 is nearly twice that for the 100 years from 1906 to 2005 (IPCC 2007). A study based on the data from 1975 to 2005 shows that the mean temperature of the country is increasing steadily at the linear rate of 0.04°C/year (Fig. 3, Baidya et. al. 2007). This rate is much higher than the mean global rate (0.017 oC/year for last 25 years). The warming was more pronounced at higher altitudes and in winter.

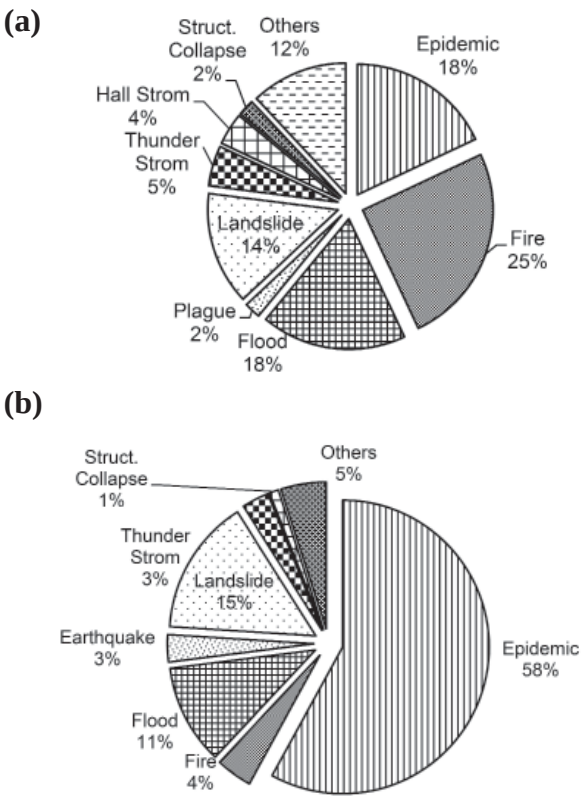

Fig. 2; (a) Number of disaster events, and (b) percentage distribution of deaths by all types of natural disasters (redrawn after NSET 2007).

Despite such serious warming trend and its adverse effect to the environment and livelihod climate change issue is a priority only to the extent that it is reflected in the national development objectives in relation to protection of the environment and sustainable development in Nepal (MoPE 2004). It is necessary to link Climate Change issues to Nepal's long-term development goals-poverty reduction, economic growth and employment, increased self-reliance, promotion of rural development, and preserving the environment.

As a consequence of temperature rise and climate change, the monsoon precipitation pattern is also changing with fewer days of rain and more high-intensity rainfall events. Both trends have resulted in an increase in the magnitude and frequency of water-induced disasters like floods, landslides and debris flow. According to the precipitation trend analysis based upon 80 stations data, hills and mountains of west Nepal and northern belt of eastern Nepal will be having positive trend with a maximum of 1100 mm per decade (MoPE 2004). On analyzing the monthly rainfall data for the period of 30 years from 1976-2005 (166 meteorological stations) throughout Nepal, it is found that most part of the country, including the eastern Terai and Siwaliks, experienced increasing annual trend

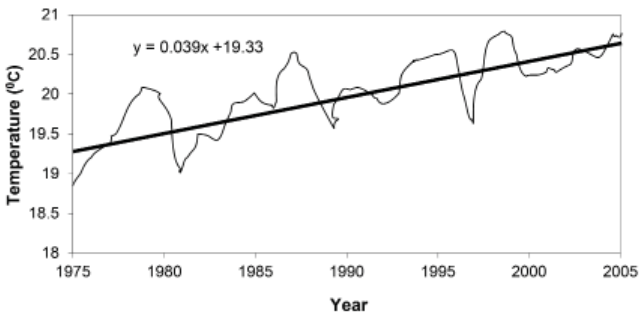

Fig. 3: Annual mean all Nepal temperature trend (redrawn after Baidya et. al. 2007).

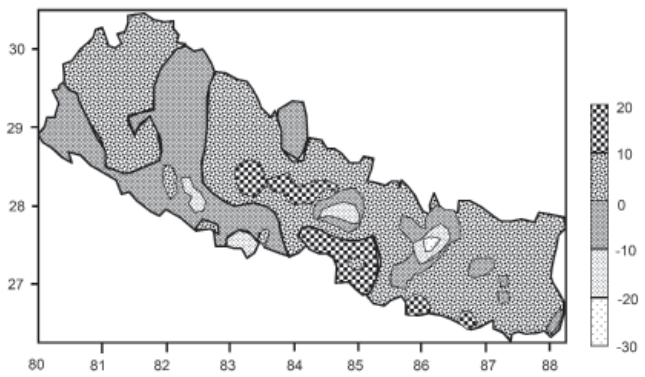

Fig. 4: Annual monsoon rainfall (mm/year) trend (redrawn after Practical Action 2009).

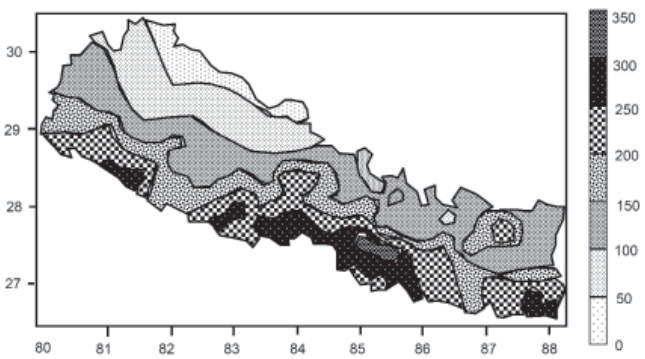

Fig. 5: Extreme rainfall (mm) for 10 years return period (redrawn after Practical Action 2009).

of premonsoon, monsoon, post monsoon and winter precipitation (Practical Action 2009, Fig. 4). The same study carried out frequency analysis of the extreme rainfall event trends for the same duration and reveals that the foothill of the Siwaliks, which is the main source of many rivers in the Terai, received the highest intensive rainfalls for 10, 20, 50 and 100 years of return periods (Fig. 5). Because of the steep topography and high gradient of the rivers in the hills and mountains, increasing trend and unpredictable precipitation are causing increased risk of flood and sedimentation in the Terai. Frequent increase of floods, landslides and soil erosions is a serious concern because mountain settlement areas of Nepal are prone to landslides and Terai is prone to flooding, and hence, likely to be very vulnerable to Climate Change. This vulnerability is particularly exacerbated during extreme weather events.

Climate change has brought irregular and unpredictable precipitation pattern in terms of time, duration and intensity which has shown that Nepal is hazardous for flash flood as well. In addition, glaciers are melting very fast because of the global warming resulting in the formation of glacial lakes and many such lakes are in danger of breaching. It has therefore posed severe threat of glacial lake outburst flood to the downstream population, biodiversity as well as infrastructures. This phenomenon along with unpredictable and intense precipitation for short duration has intensified the risk of landslides. In addition to direct effect, landslides can cause damming of the Mountain Rivers and breaching of such dams can again cause flash floods downstream. Such phenomena have been found in Kaligandaki river valley of Nepal and elsewhere as well (DoG 2005).

High rate of population increase, forest encroachment, deforestation and land degradation in the Siwalik of Nepal has intensified the risk of floods and landslides as the Siwalik consists of weak and fragile mudstone and sandstone types of rocks and are most vulnerable for erosion. As such rocks are further exposed to the surface because of the deforestation in Siwaliks, weathering of rocks and soil erosion are intensified, which ultimately increase that high rate of sediment deposition during flooding in the southern Terai. Further the velocity of flood water and debris is increased by the collision between the discrete debris particles moving together with the flood water. The frequency and magnitude of the extreme events, as well as Nepal's already pronounced seasonal variability, are expected to worsen under climate change. The Intergovernmental Panel on Climate Change's (IPCC) Fourth Assessment Report indicated that Nepal would suffer increased flooding due to changes in hydrology, leading to an increasing loss of life and decrease in crop yields.

The Himalayan snow and ice feeds seven of Asia's great rivers: the Ganga, Indus, Brahmaputra, Salween, Mekong, Yangtze and Huang Ho, which provide water to more than 1.3 billion people (WWF 2005). The rapid melting of these glaciers and snowfields will alter the regional hydrological system significantly as melt water draining from them regulates the hydrology of the Indian subcontinent. Snow melt releases water during the dry season and helps maintain

flows in the rivers during non-monsoon months though it contributes only about 10 per cent of total runoff (Sharma 1977). Climate change, in addition, with temperature rises can accelerate drying of biomasses which in turn will increase the incidences of forest fires across the nation. On the other hand, depletion of water resource triggered by climatic anomalies will continue to exacerbate the water-related diseases such as cholera and diarhoea. These epidemics will occur frequently and lead to more avoidable death without taking measures for mitigation. Nepal's vulnerability to climate-related disasters is likely to be exacerbated by the increase in the intensity and frequency of weather hazards induced by anthropogenic climate change (IPCC 2007) and has already started showing increasing trend of frequency and size of water induced disasters (DoG 2010). As one of the countries in the world sensitive to the effects of climate change, Nepal must act fast and needs support of the international community.

CONCLUSIONS

As a result of topographical variation and geological characteristics, together with torrential rain during the monsoon season, Nepal frequently experiences geological disasters like earthquake, landslides, debris flows and floods. Numbers of demographic factors such as rapid population growth, unsustainable land use, economic underdevelopment, gender inequality and poverty are other reasons for increasing the frequency and size of the natural and geological disasters in the country. Of all the disasters reported, floods and landslides are the most devastating in terms of the number of deaths that occur and the damages they cause. Because of the high rate of glacial melting and temperature rise, there is high rate of glacial lake formation and many of them are in danger of breaching in the higher Himalaya of Nepal. Similarly, topographical variation and geological characteristics, together with torrential rain during the monsoon season, Nepal frequently experiences landslides, debris flows and floods. Numbers of demographic factors such as rapid population growth, unsustainable land use, economic underdevelopment, gender inequality and poverty are other reasons for increasing the frequency and size of the natural disasters in the country. Recently, the impact of global climate change has intensified the climate induced disaster risk as the rate of temperature rise in the Himalaya is significantly high compared to the global average. It has resulted in an increase in the magnitude and frequency of water-induced disasters like floods, landslides and debris flow and therefore climate change has intensified the natural disasters, particularly climate induced disasters, in Nepal.

ACKNOWLEDGEMENTS

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Inorganic solid waste recycling in Kathmandu Metropolis, Nepal

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ABSTRACT

Though country has good number of legal instruments to manage solid wastes in urban centers, managing waste is getting harder day by day because of poor implementation status. With the rapid urbanization and changing lifestyle, the quantity of solid waste to be managed is alarmingly elevating in Kathmandu. The lack of adequate land for safe disposal is forcing to search for other alternative methods for sustainable solid waste management. Recycling of wastes saves the scarce landfill space as well as limited resources, and thus saves the environment. Most of Kathmandu's waste is recyclable (organic as well as inorganic). Recyclable inorganic waste has been increased with the pace of changing lifestyle and urbanization; 29.16% of total waste in 2009 in Kathmandu Metropolis. Recycling of inorganic solid wastes is rampant; mainly by communities and private sectors through scrap dealers. The recyclable materials recovered from the waste are either recycled (paper and plastic) within the

INTRODUCTION

The world's big cities confront the difficult challenge of the environmental management of their urban centers every day. Daily public, commercial and industrial life involves the challenge of properly managing municipal waste to try to promote the reduction of waste production and make better use of recoverable fractions. Such waste is a serious environmental hazard which is causing serious environmental degradation and health risks in many cities and towns of developing countries since it is not managed properly.

Kathmandu does not produce huge amount of waste in comparison to big cities but lack of proper management system is fast giving problems disastrous proportions. Simple solutions such as composting, recycling and private sector participation have been talked about but decision making has been slow and implementation is weak. Attitude of people has also been contributed worsening waste management situation in the country. "Out of sight, out of mind" and "not in my backyard" are the most common responses to the problem. This attitude, coupled with the habit of dumping garbage in areas where no one complains, is doing much damage. Otherwise wastes can be taken as resources.

Prior to 1970, the solid waste in municipal areas of Nepal was locally managed. Almost all the waste was of organic nature. Only little volume was disposed and almost everything were reused, recycled or assimilated into the soil. The organic waste easily biodegradable was either used as animal feed or widely recycled into the compost manure. Traditionally, a composting pit called "Saagaah" was a part of every household (in Kathmandu Valley) setting that was not continued in the modern urban planning context due to lack of in-depth studies and aptitude. Rapid urbanization, change in consumption habit and negligence towards preservation of environmental condition brought new scenario of aggravated problems of solid waste in urban and rural areas (Nyachhyon 2006).

On average, about 70 percent of the household waste generated in Nepalese municipalities consists of organic matter, while about 20 percent consist of recyclable inorganic materials such as paper, plastic and metal, and about 10 percent is inert materials (ENPHO and Water Aid 2008). Referring to table 1, Kathmandu's waste is mainly organic in nature. Paper and plastic are the other two important constituents of the municipal solid waste stream (Alam et al. 2007).

According to table 2 , of the total waste, 63.22% is organic, 10.8% is plastic, 9.02% is paper, 5.42% is glass, 4.5% is construction and demolition waste, 2.3% is textile, 1.2% is rubber and leather, 0.42% is metal and 3.12% is others (SWMS, KMC 2009). These figures indicate that paper, plastic, glass, textile, metal, rubber and leather (recyclable inorganic wastes) make up 29.16% of the total waste. This amount of wastes is recyclable; and if recycled it can contribute to waste minimization for final disposal. Equally, recyclable inorganic waste is in increasing trend except metals since metals are increasingly collected by

Table 1: Waste composition of Kathmandu Metropolis between 1988 and 2003.

Year	1988		1991		1995		2000		2001		2003	
Waste generated	tons/ day	%	tons/ day	%	tons/ day	%	tons/ day	%	tons/ day	%	tons/ day	%
	71.18		86.85		113.37		212.41		213.53		226.79	
Organic	41.15	57.68	52.03	59.93	59.18	52.21	143.37	67.51	149.12	69.84	154.22	67.99
Paper	4.41	6.18	5.92	6.82	6.79	5.99	17.62	8.29	18.14	8.49	18.14	8.00
Plastic	1.42	2.00	2.25	2.59	6.11	5.39	24.22	11.40	19.59	9.17	24.96	11.00
Glass	1.15	1.61	2.77	3.19	4.08	3.60	3.40	1.60	5.34	2.50	4.55	2.01
Rubber/Leather	0.27	0.38	0.68	0.79	2.60	2.30	0.52	0.25	1.40	0.65		
Metal	0.27	0.38	0.44	0.50	5.45	4.81	1.81	0.85	1.97	0.92		
Wood	0.36	0.50		0.00	4.99	4.40	1.29	0.61	1.56	0.73		
Cloths	1.42	2.00	3.29	3.79	9.18	8.10	7.64	3.60	6.44	3.02		
Others	20.88	29.26	19.45	22.41	14.96	13.20	12.52	5.90	9.95	4.66	24.96	11.00

Source: Alam et al. (2007)

Table 2: Waste composition (in %) of KMC between 2006 and 2009.

Year	2006	2008	2009
Organic (%)	69	68.72	63.22
Paper (%)	9	9.25	9.02
Plastic (%)	9	12.3	10.8
Glass (%)	3	3.66	5.42
Rubber (%)	1	2.86	1.2
Leather (%)	-		
Textile (%)	-		2.3
Metal (%)	1	0.91	0.42
Construction material (%)	2		4.5
Others (%)	3	2.29	3.12
Sources	CBS, 2008	Luitel, 2008	SWMS, KMC, 2009

scrap dweller (Kawadi).

The current practice of Solid Waste Management is shortly known as "Throw Away" practice with municipalities collecting, transferring and disposing partly into landfill site otherwise in open nature as riverbanks, forests, ponds, and open places (Nyachhyon 2006). Such practice of solid waste disposal causes severe implication on the environment and human health. One method of achieving a better management of solid waste could be recycling of wastes.

In this ground, present study was designed with main aim of exploring status of inorganic solid waste recycling in Kathmandu Metropolitan City, the capital city of Nepal with specific aim of analyzing existing legislations, synthesizing existing formal/informal data and, exploring present practices of inorganic solid waste recycling.

MATERIALS AND METHODS

Study Area

Kathmandu Metropolitan City is located within Kathmandu Valley within 85º20'E to 27º42'N at an altitude of 1,300 meters above sea level; spread over an area of 49.45 km^2 (Fig. 1). Permanently residing population in Kathmandu Metropolis is 975,453 (254,292 households) with male population of 511,841 and female of 463,612 (CBS, 2012). Though socio-political conflict has been addressing somehow still migration from all over the country into capital city is in alarming rate.

Data collection

All policies, plans, acts, regulations and guidelines for solid waste management at national and municipal level were reviewed and analyzed focusing on recycling of such wastes. Available formal/informal records, research reports, articles, dissertations, web pages were reviewed/visited and analyzed as per the objectives.

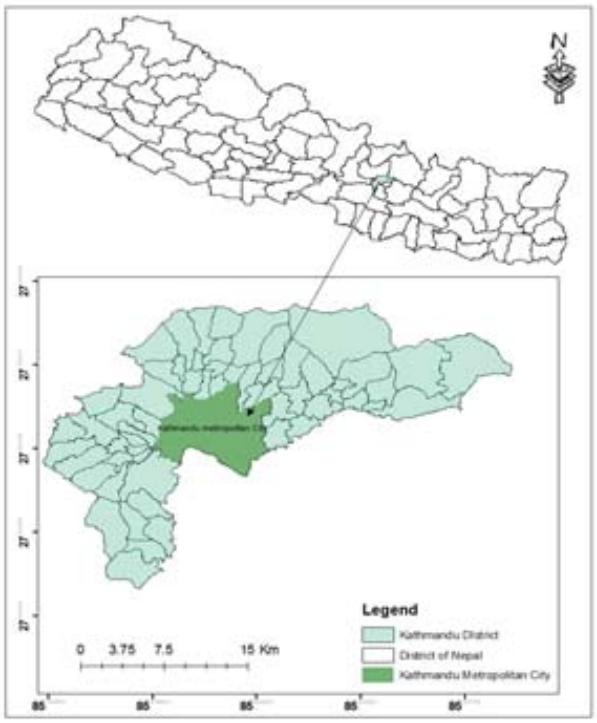

Fig. 1: Location map of Kathmandu Metropolitan City .

RESULTS AND DISCUSSION

Policy initiatives for solid waste management

In Nepal, policy initiatives are good in many sectors. Country has many good legal instruments for solid waste management viz. Solid Waste and Resource Mobilization Act (1987), Local Self Governance Act (1999) and Solid Waste Management Act (2011) (table 3), however implementation is very weak. Solid Waste Management Act promulgated very recently is successfully addressed the gap in previous legislations. Country so very is trying to improve in this sector for the better management of wastes.

Institutional framework for solid waste management

National

Though it is not very functional-National Council for Solid Waste management-a high level policy-making body under the chairmanship of the Minister of Federal Affairs and Local Development is in existence as an umbrella in SWM in National arena. Ministry of Federal Affairs and Local Development (MoFLD) is responsible to support all municipalities of the country in SWM sector (Fig. 2).

Solid-Waste Management Technical Support Centre (SWMTSC) within MoFLD, has been assisting all municipalities in constructing a sanitary landfill and many other SWM related activities, but so far it has not been able to do much because of a lack of financial and human resources. According to the Local Self Governance Act of 1999, municipalities are responsible for SWM within their jurisdictions. The organizational capabilities of municipalities in dealing with waste management, however, vary significantly.

Kathmandu Metropolitan City

The role of Kathmandu Metropolitan City in solid waste management has been increasing with the pace of urbanization. In 1998, KMC took over all SWM responsibilities from the Solid Waste Management and Resource Mobilization Center (SWMRMC) and developed a new SWM strategy that focused on making SWM more effective by involving the local communities and the private sector. The Environment Department (ED) of the KMC is the main agency responsible for managing Kathmandu's waste. The department has a Mechanical Section which is responsible for the maintenance of all vehicles and a Solid-Waste Management Section (SWMS), which is responsible for waste management. The ED has a total staff of 1,259 involved in waste management. Out of these 890 are sweepers (table 4). Each ward has a head sweeper and a supervisor who monitor the sweeping and collection activities. The ward-level staff report to four zonal supervisors who in turn report to the central unit in KMC.

The Community Mobilization Unit (CMU) at the Environmental Department of KMC organizes programs with emphasis on solid waste management with focus on education. They have also designed and produced a compost bin for households.

Recycling of inorganic solid waste in Kathmandu Metropolis

Conventionally the process of recycling in KMC starts with the collection of recyclable wastes from source or segregated recyclable wastes from commingled waste. This scrap waste is sold to kabadi shops, industries in Nepal or India (Fig. 3).

According to a study carried out by Luitel and Khanal (2009), the recyclable materials are currently mainly collected from the waste stream by cycle hawkers. Likewise the market for these recyclable wastes is readily available within the country.

Various efforts are ongoing for recycling solid wastes of Kathmandu Metropolitan City by different government, non-

Table 3: Policy initiatives for solid waste management in Nepal.

S.N.	Initiatives	Year	Addressing solid waste management issue
1	Solid Waste and Resource Mobilization Act	1987	Focused on waste management as a resource
2	The Town Development Act	1988	Provision of empowering the Town Development Committee to regulate, control or prohibits any act or activity that has an adverse effect on public health or the aesthetic of the town, or in any way pollutes the environment but not direct provision for solid waste management
3	Municipality Act	1990	
4	Local Self Governance Act	1999	Recognized the role of local authority to manage waste, provision of fine to the polluters
5	The Nepal Environment Policy and Action Plan	1993	Talks little about wastes
6	National Solid Waste Management Policy	1996	Explains the necessity, priority of solid waste management and defines the responsibility of national and local institutes; also speaks about participatory approach and role of private sector
7	National Waste Management Council	1996	An umbrella organization for policy making on SWM
8	The Environment Protection Act	1997	Bann haphazard disposal of wastes,
9	The Environment Protection Rule	1997	Provision of complain registration and many actions are proposed to control such kind of waste disposal
10	Policy, legislation, and standards Sustainable Development Agenda for Nepal (SDAN)	2003	
11	Tenth Five Year Plan (2002-2007)	2002	Emphasis upon the Public Private Partnership for Solid Waste Management and implementation of Pollution Pay Principle
12	National Health Care Waste Management Guidelines	2002	Provides detail guidelines to manage health care wastes
14	Industrial Development Perspective Plan		Mentions the industrial waste management
15	Medical Waste Management Guidelines	2004	Provisions for management of medical waste that are generated in the course of medical treatment in Kathmandu's hospitals, nursing homes, clinics, pathological labs and drugstores
16	Three year Interim Plan (2007-2010)	2007	Concern of waste management is addressed
17	Solid Waste Management Act	2011	Totally focused on solid waste management issues by putting each and every step as legally binding. It mentions recycling of wastes however doesn't clearly mention inorganic wastes

Source: Compilation of available legal documents

government and private organizations as well. Recycling of wastes either biodegradable or inorganic was not new for people residing in KMC since it was traditionally adapted by communities from historic time. Later KMC initiated involving itself in recycling in partnership with scrap dealers (Tuladhar et. al. 2004). Referring to Rai (2010), KMC has formulated local level solid waste management action plans, established several community recycling centers; Promotion of 3R activities by radio jingling aired on Metro FM (FM radio managed by KMC) and trainings.

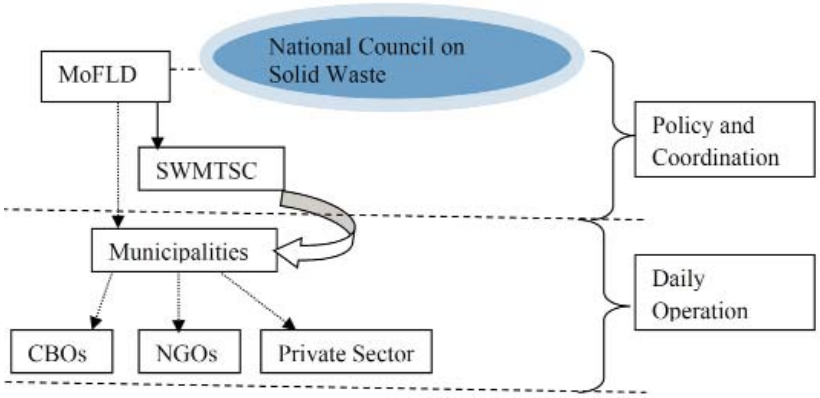

Fig. 2: Institutional framework for solid waste management in Nepal.

Table 4: Institutional strength on solid waste management in Kathmandu Metropolitan City.

S.N.	Unit	Services	Manpower used	
			Manpower	Number
1	Planning	Street sweeping	Department Head	1
2	Private sector participation	Door to door collection	Engineer	4
3	Sewer cleaning	Container services	Officer	2
4	Community mobilization	Street cleanings	Administrative	38
5	Transfer station management	Public toilets	Junior Engineer	5
6	Dumping site management	Dead animal management	Metro police	24
7	Enforcement	Community awareness programs	Mechanics	25
8	Administration	School children programs	Drivers	150
9	Financial management	Medical waste management	Sweepers	890
10	Mechanical Section	Training programs	Others	120
		Transfer-station management		
		Dumping site management		
		Maintenances of vehicles		

Source: SWMS, KMC (2011)

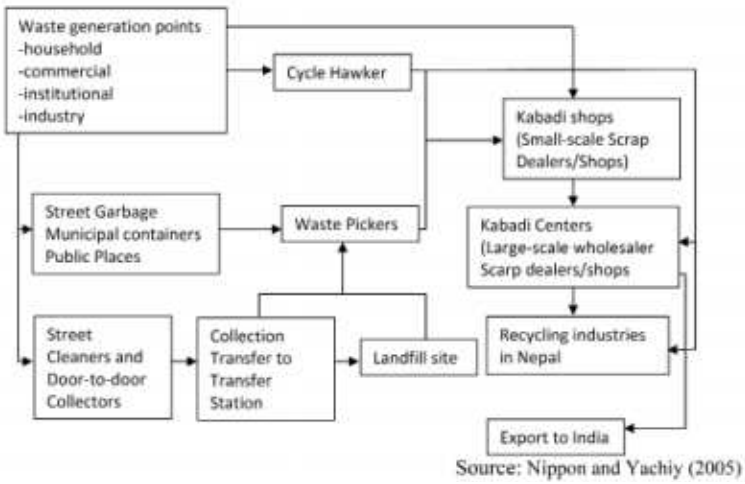

Fig. 3: Scrap waste flow in Kathmandu Metropolitan City.

Several TV programs on household composting and 3Rs activities aired on national TV Public exhibitions. Various NGOs and CBOs have begun working on waste collection and 3R activities mostly at community or Tole levels (Alam et al. 2007; Rai 2010). Private Industries also have been recycled such waste; plain glasses are grinded into pieces and recycled; plastic bottles are shredded into pellets and recycled; recyclable paper are mixed with water and turned into pulp to make paper. Metals are melted and produced to new products (Luitel and Khanal 2009).

CONCLUSION

The Current trend of waste generation in Kathmandu is increasing, in which the waste having high scrap value is growing due to changing lifestyle of the people. In this context, peoples are independently involved in researches related to solid waste generation, disposal and management issues. Peoples in Kathmandu have also been involved in waste reuse and recycling before the urbanization begins. Later national initiatives by policy and laws and institutional setup were begun.

In addition to biodegradable wastes (as compost), metal, glass/ bottles, plastics, and paper are the main items reused/ recycled at community level. Those materials have been collecting by scavengers (people who earn their living by sorting waste in the streets, at the transfer station and dumping/landfill site) and independent collectors. The materials that are sorted out by the scavengers i.e., plastics, paper, glass and metals are sold to private companies that sell it, mostly to India. On the other hand, independent collectors collect metal and plastic from houses and sell them to scrap shops that are either recycling in Nepal or selling to India.

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फोहर संकलनका व्यवस्थित विधीः सहरी नदीको वातावरणीय शुद्दी

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सारांश

काठमाडौंको बागमती नदी तथा यीनका सहायक नदीहरुमा फोहरजन्य तरल पदार्थ (liquid waste or sewage) को निष्कासनका साथै ठोस फोहर पदार्थ नदी किनारमा फाल्नाले नदी प्रदुषण अति बढ्दो छ। यस्ता कुकार्यलाई तत्काल रोकी सुव्यवस्थित फोहर संकलन तथा तह लगाउने कार्य गरेमा सहर तथा नदीको वातावरणमा उन्नती हुन्थ्यो। यहां सुव्यवस्थित फोहर संकलन तथा तह लगाउने कार्य विधीका बारेमा जानकारी दिईएका छन्। नदीनालालाई सफा र सुन्दर पारी प्रदुषणमुक्त बनाउन स्थानिय निकाय तथा काठमाडौंबासीले समन्वयगरी अगाडी बढ्नु आजको आवश्यकता हो।

पृष्ठभूमी

हाल काठमाडौंको बागमती नदीका सहायक नदीहरु मध्ये कूनै पनि नदी फोहर मूक्त छैनन्। बिष्णुमती, मनहरा, नख्खू, मनमती, इत्यादिमा तल्लो धार क्षेत्र बढी फोहर ग्रस्त छन (Tamrakar 2004; Bajracharya and Tamrakar 2007; Maharjan and Tamrakar 2010)। धोबिखोला, टूकूचा खोला, बागमती उपल्लो धार, हनुमन्ते इत्यादि नदीहरु बढी माथिल्लो धार देखी तल्लो धारसम्म प्रदूषित छन्। बढ्दो शहरीकरण तथा जनसंख्या बृद्धि संगै फोहर उत्पादनमा बृद्धि हुनु तथा फोहर तह लगाउने बिधी तथा क्षत्र अस्वभाविक हुनु ले नदी तथा अन्य क्षत्रहरुमा प्रदूषण बृद्धी हुंदै गइरहेको छ। नदी प्रदूषण हुनुको मूल कारण किनार मा खुल्ला रुपमा फालिनु पनि हो। अमात्य (२०१३) का अनुसार देशमा हाल विद्यमान ५८ नगरपालिका मध्ये करिब १९ वटा नगरपालिकाहरुले ठोस फोहर बस्तु खुल्ला नदी किनारमा फाल्दछ। यसरी फालिएका बस्तु बर्गिकृत नभएको हूनाले त्यसमा विद्यमान विभिन्न जैविक तथा अजैविक पदार्थबाट उत्पादन हुने हानिकारक पदार्थबाट नदी प्रदूषित हुनेगर्दछ। विषेशगरी फोहर पदार्थबाट निस्किने झोल पदार्थ जसलाई लाईचेट भनिन्छ पछि नदीको पानीसंग मिसिएर नदी प्रदुषण गदछ। यसरी ठोस पदार्थहरु कुहिएर नष्ट हुने (जैविक पदार्थ) तथा कुहिएर नष्ट नहुने (अजैविक) पदार्थबाट वातावरणलाई अव्यवस्थित, दुर्गन्धीत, बिषालु बनाई जन स्वास्थमा समेत असर पार्दछ। कुहिएर नष्ट नहुने प्लास्टिक तथा रबरबाट शहर का ठाउंठाउंमा वातावरणीय प्रदूषण फैलिरहेको छ। त्यस्तै गरी घरघरबाट निष्कासित फोहरजन्य तरल पदार्थ (liquid waste or sewage) नदीमा सिधै मिसाइनाले नदी अत्याधिक प्रदुषण भएको पाईन्छ। तसर्थ नदीको वातावरणीय स्थितीमा सूधार ल्याउन प्रथमतः नदी किनारमा फोहर पुरिने (dump) कार्य सरोकार वालाले तत्काल रोक लगाउनु पर्दछ। नदी किनारको बैकल्पिक ल्यान्डफिल क्षत्र पहिचान गरिनु पर्दछ। यस बाहेक घरेलु फोहरलाई स्रोतमै बर्गीकरण गरी न्युनीकरण गरी व्यवस्थित रुपमा फोहर संकलन कार्य गर्न सहयोग पुऱ्याउनु पर्दछ। यस कार्यबाट दैनिक उत्पादन हुने ठोस फोहर वस्तुको परिमाणमा तौलमा झन्डै ३०-५० प्रतिशत कमि ल्याउन सकिन्छ। काठमाडौं उपत्यकामा प्रतिदिन झन्डै ११०० टन फोहर उत्पादन हुन्छ। आचार्य (२०१३) को आंकलन अनुसार यी फोहर मध्ये ६७ प्रतिशत जैविक फोहर, ११ प्रतिशत प्लास्टिक, ९ प्रतिशत कागज, ५ प्रतिशत टूटफूट सामान, ४ प्रतिशत कपडा, २ प्रतिशत ग्लास। १ प्रतिशत धातु, १ प्रतिशत अन्य फोहर वस्तु उत्पादन हुने गर्दछ। यी फोहरहरु मध्ये जैविक वस्तु तथा प्लास्टिक बढी समस्याको रुपमा रहेको पाइन्छ। जैविक वस्तुको परिमाण धेरै हुनाले फोहर संकलन कार्य महंगो हुनगएको छभने प्लास्टिक अजैविक र नकुहिने (non-degradable) भएकोले यो पनि समस्याको रुपमा रहेको छ। अन्य वस्तुहरु जस्तै कागज, ग्लास, धातु, कपडा इत्यादि भनेको पुनः चक्रिय तथा पुनःप्रयोगीय वस्तुहरुमा पर्ने भएको हुनाले यिनको उचित रुपमा वर्गीकृत संकलन हुन सकेमा 'फोहरबाट मोहर' भन्ने सिद्धान्तमा प्रभावकारिता ल्याउन सकिन्थ्यो। जैविक पदार्थलाई कम्पोष्टिंग गरी मलको रुपमा प्रयोगमा ल्याउन सकिने हुनाले, यस कार्यबाट जैविक फोहरको परिमाणमा न्युन गर्न सकिन्छ। यसरी हुने फोहर को न्युनीकरण, पुनःप्रयोग र पुनःचक्रिय प्रकृयाबाट फोहरको परिमाणमा कमी आई नदी तथा शहरको वातावरणमा सुधार हुन सक्दछ।

ठोस फोहर पदार्थको वर्गीकरण

ठोस फोहर पदार्थ (क) ज्वलनयुक्त छ/छैन, (ख) पुनःचक्रिय हो/होईन, (ग) पुनःप्रयोगीय छ/छैन इत्यादिका आधारमा चार प्रकारमा विभाजन गर्न सकिन्छ (चित्र नं १)।

(क) ज्वलनयूक्त फोहर (Burnable waste)

(ख) ज्वलन अनुपयुक्त फोहर (Unburnable waste)

(ग) पुनःचक्रिय फोहर बस्तु (Recyclable waste)

(घ) पुनःप्रयोगीय फोहर बस्तु (Reusable waste)

ज्वलनयुक्त फोहर पदार्थ भन्नाले यस्ता फोहरलाई जलाएर नष्ट गर्न सकिन्छ अथवा कुहाएर मल बनाउन सकिन्छ। जस्तै खराब कागजका टूकाटूकी, खेर गएका खाद्यवस्तु, इत्यादी। खेर गएका खाद्यवस्तु मध्ये, सागपात तथा खेर गएका तरकारीलाई कम्पोष्टको कच्चापदार्थका रुपमा प्रयोग गर्न सकिन्छ।

ज्वलन अनुपयुक्त फोहर पदार्थ भन्नाले टूटेफुटेका ग्लास, सेरामिक, चाउचाउ, चकलेट तथा अन्य प्लास्टिकका खोलहरु पर्दछन्। यी पदार्थहरु ज्वलन गरी नष्ट गर्न अनुपयुक्त देखिन्छ। प्लास्टिकको ज्वलनबाट वायु प्रदूषण हुने गर्दछ। ग्लास पदार्थलाई चाहिं पुनःचक्रिय प्रशोधन गरी ग्लासको वस्तु निर्माण गर्न प्रयोग गर्न चाहिं सकिन्छ।

पुनःचक्रिय फोहर वस्तुमा ति विभिन्न वस्तुहरु जसलाई पुनःचक्रिय प्रशोधन गरी विभिन्न नयां वस्तु उत्पादन गर्न सकिन्छ ती पर्दछन् जस्तैः पत्रपत्रिका, कार्डबोर्ड बाकस, काम नलाग्ने लत्ता कपडा, खाली प्लास्टिक तथा धातूका वस्तु, बिग्रेका उपकरण यस्ता फोहर कवाड मार्फत सजिलै तहलगाउन सकिन्छ।

पुनःप्रयोगीय फोहर वस्तु सिधै वा थोरै मर्मत गरी प्रयोग गर्न सकिन्छ। जस्तै खाली बियर शिशी, पुरानो लुगाफाटा फर्निचर तथा घरेलु उपकरणहरु।

घरेलु फोहर उत्पादकले व्यवस्थित फोहर संकलन गर्ने तथा तह लगाउने विधी

फोहर संकलनकार्य बर्गीकृत र व्यवस्थित गर्न सहयोग पुर्‍याउने दायित्व फोहर उत्पादकको हुन्छ। फोहर उत्पादकले सकभर फोहर पदार्थलाई स्रोतमा न्यून गर्ने कोशिश गर्नु पर्दछ र माथी उल्लेखित चार प्रकारका फोहरलाई क्रमशः छुट्टयाउंदै संकलन गर्नु र तह लगाउनु पर्दछ। यसका लागि चित्र नं २ मा देखाईएझैं विधी अपनाउन सकिन्छ। फोहर वस्तु (क)१ र (ख) लाई स्थानिय निकाएका फोहर संकलक मार्फत तह लगाउन सकिन्छ। फोहर वस्तु (क)२ लाई कम्पोष्टिंगमा प्रयोग गर्न सकिने हुनाले सकभर घरैमा व्यवथित गर्न सकिन्छ। अन्यथा (क)१ र (क)२ लाई छुट्टा छुट्टै कागजको बाक्लो बोरामा र ाखी संकलनकर्ता मार्फत नै तह लगाउन सकिन्छ।

फोहर वस्तु (ख) लाई प्लाष्टिकको बाक्लो बोरामा र ाखी संकलनकर्ता मार्फत तह लगाउन सकिन्छ। पुनःचक्रिय फोहर वस्तु (ग) तथा पुनःप्रयोगीय फोहर वस्तु (घ)३ र (घ)४ लाई सिधै कबाड मार्फत उचित मुल्य लिई तह लगाउन सकिन्छ। यस्ता वस्तुलाई राम्ररी पट्टयाएर बांधेर जुटको बोरामा संकलन गर्नु उचित हुन्छ। त्यस्तै पुनःप्रयोगीय फोहर वस्तु (घ)१ र (घ)२ लाई आजकाल खोलिएका सस्तो मुल्यका पसल मार्फत तह लगाउन सकिन्छ। कतिपय पुरानो विधुतीय उपकरण जस्तैः टिभी, फ्रिज, इत्यादि थप मुल्य तिरी नयां संग सट्टा गर्न सकिन्छ।

फोहर वस्तुलाई बर्गीकरण गरी व्यवस्थापन गर्नाले फालिइनु पर्ने वस्तुमा ब्यापक न्यूनिकरण भई फोहर संकलकलाई भार कम हुने मात्र नभई बर्गीकृत फोहरको बिक्रीबाट मुल्य पनि आर्जन गर्न सकिन्छ।

घरेलु फोहरलाई कम्पोष्टिंग गर्ने विधी

बर्गीकृत (क) १ अन्तर्गत पर्ने फोहर वस्तु मध्ये मांशाहारी पदार्थ बाहेकका खेर गएका खाद्य वस्तुलाई छुट्टै संकलन गरी कम्पोष्टिंगमा प्रयोग गर्न सकिन्छ। यस्तो वस्तुमा दुग्ध पदार्थ मिसाइनु हुंदैन। कम्पोष्ट मुलतः डिकम्पोज गरिएको organic matter हो भने कम्पोष्टिंगले यसो गर्ने प्रकृया जनाउंदछ। कम्पोष्टिंगका निमित्त (क) organic matter, (ख) पानी, (ग) अक्सिजन र (घ) बेक्टेरियाको जरुरी पर्दछ। चित्र नं ३ मा देखाईएझैं organic matter लाई ब्राउन अर्गानिक म्याटर (BOM) र ग्रीन अर्गानिक म्याटर (GOM) गरी दुई थरीमा छुट्याउन सकिन्छ। BOM ले कार्बोन तथा GOM ले नाईट्रोजन उपलब्ध गराउंदछ। कम्पोष्टिंग गर्दा यी दुबै लाई उत्तीकै अनुपातमा तहतह (layering) गरी राखिन्छ। तर BOM तथा GOM अन्तर्गतका सबै थरी चाहिन्छ भन्ने हो Og, ती मध्ये कुनै २ वा ३ थरी भए पनि हुन्छ। कम्पोष्टिंग हुन पानी (moisture) र अक्सिजनको पनि आवश्यकता पर्दछन्। बेक्टेरिया तथा अन्य शुक्ष्म जिवाणुले अक्सिजन लिई organic matter लाई क्षयी गरेर (breakdown) कम्पोष्ट बनाउंदछ। गड्यौलालाई पनि डिकम्पोजरको रुपमा प्रयोग गर्न सकिन्छ।

कम्पोष्ट बनाउन निम्नलिखित विधी (चित्र नं ४) अपनाउन

(क) ज्वलनयुक्त फोहर (Burnable waste)

१. खराब कागज
२. खेर गएको खाद्य बस्तु

(ख) ज्वलनअनुपयुक्त फोहर (Unburnable waste)

१. ग्लासका टुक्रा, ग्लासका शिशी
२. प्लाष्टिकका खोल वा टुक्रा
३. सेरामिक

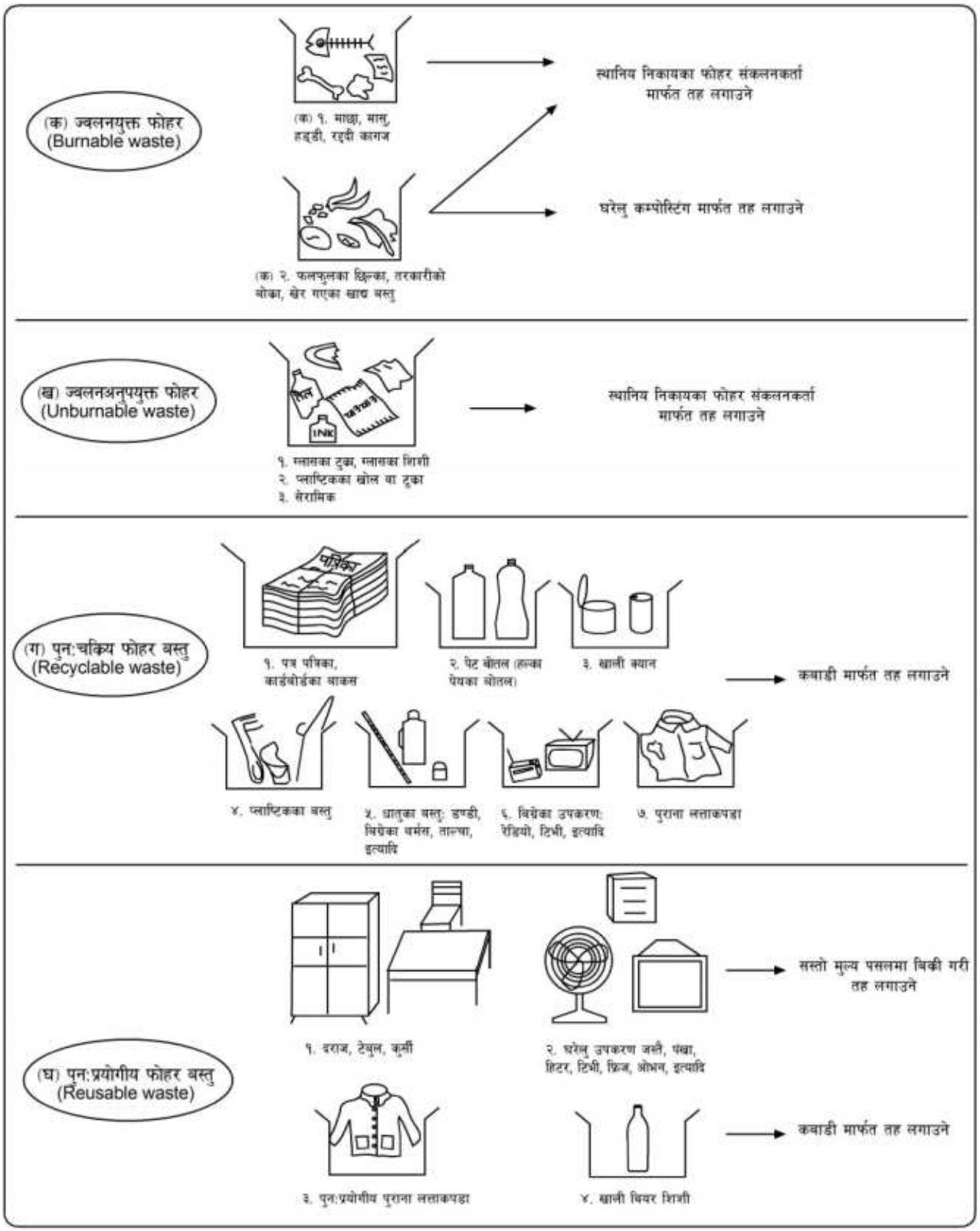
(ग) पुनःचक्रिय फोहर बस्तु (Recyclable waste)

१. पत्र पत्रिका, कार्डबोर्डका बाकस
२. पेट बोतल (हल्का पेयका बोतल)
३. खाली क्यान
४. प्लाष्टिकका बस्तु
५. धातुका बस्तु
६. बिग्रेका उपकरण
७. पुराना लत्ताकपडा

(घ) पुनःप्रयोगीय फोहर बस्तु (Reusable waste)

१. दराज, टेबुल, कुर्सी
२. घरेलु उपकरण जस्तै, पंखा, हिटर, टिभी, फ्रिज, ओभन, इत्यादि
३. पुनःप्रयोगीय पुराना लत्ताकपडा
४. खाली बियर शिशी

चित्र नं १: घरेलु फोहर पदार्थको वर्गीकरण।



चित्र नं २: घरेलु फोहर पदार्थ बर्गीकरणगरी संकलन गर्ने तथा तह लगाउने विधी।

सकिन्छ।

१) सर्वप्रथम कम्पोष्टिंग गर्ने स्थान छनोट गर्नुहोस्। धेरै घाम धेरै छायां नपर्ने, हावा प्रवाह राम्ररी हुने, खुल्ला माटो वा ईंटाको भुईं कम्पोष्टिंगको लागि उपयुक्त हुन्छ।

२) कम्पोष्टिंग गर्न ठुलो डोकोको पिंध काटेर प्वाल बनाउनुहोस्। डोकोलाई घोप्टयाएर राख्नुहोस्।

३) Oganic matter लाई ससानो टुकागरी काट्नुहोस्। चित्र नं ४मा देखाईएझैं दुइ दुइ इन्चको तहमा मिलाएर BOM र GOM लाई एकपछि अर्को गर्दै राख्नुहोस्। सबैभन्दा माथी माटो राखेर छोप्नुहोस्। यसरी मिलाउंदा धेरै कोच्याएर राख्नु हुंदैन। तहतह मिलाएर राख्दा बिचमा नाईट्रोजनयुक्त मल पनि राख्न सकिन्छ। उक्त मलले नाईट्रोजन प्रवाह गरी कम्पोष्टिंग चांडै गराउंदछ। अर्को कुरा डोकोको डुंगुर ओसिलो हुनुपर्दछ।

४) करिब २ हप्ता पछि डोको झिकेर डुंगुरलाई भित्रको बाहिर र बाहिरको भित्र हुनेगरी चलाउनु होस्। यसो गर्दा अक्सिजनको प्रवाह राम्ररी हुन्छ।

५) फेरि डोकोमा डिकम्पोज हुंदैगरेको पदार्थलाई भर्नुहोस्।

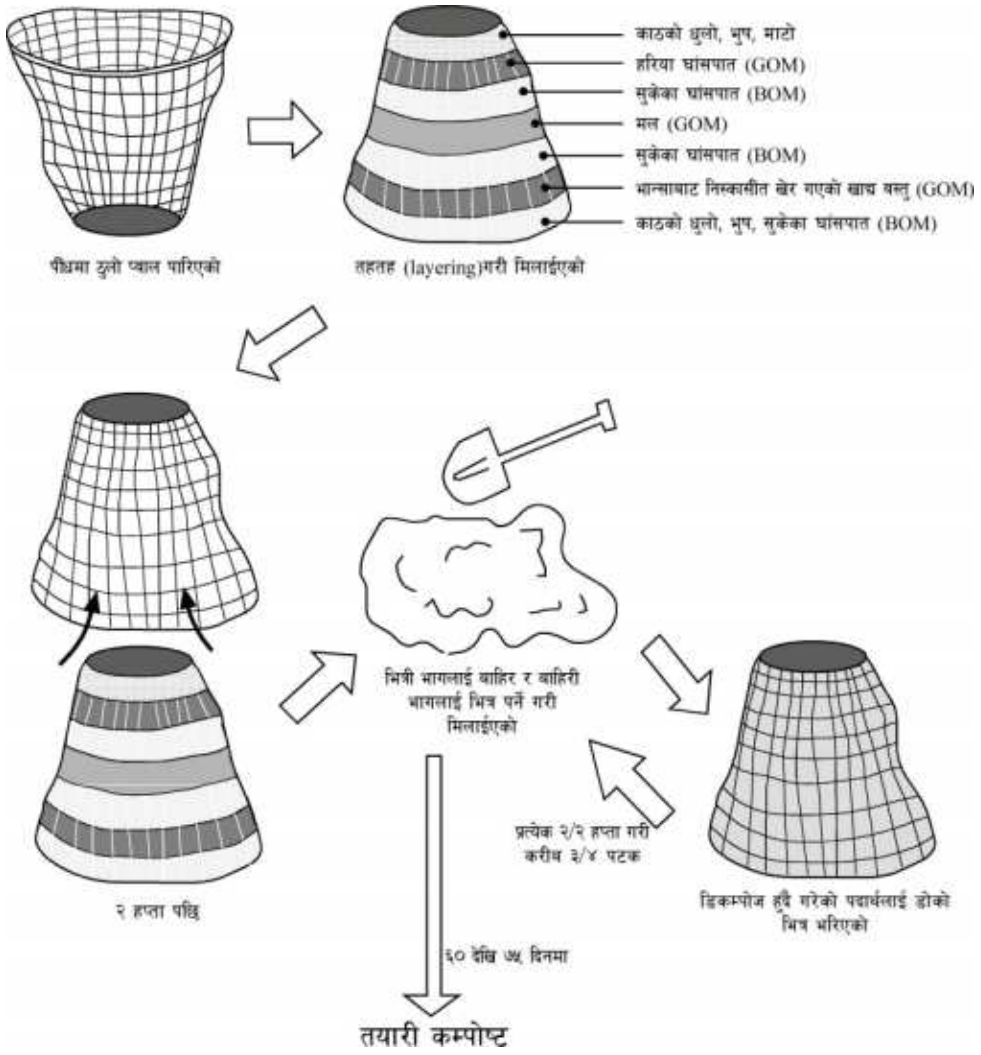
६) फेरि दुइ दुइ हप्तामा अंक ४) मा उल्लेख गरिएझैं चलाउने र यसरी चलाउने बेला धेरै सुख्खा भए पानी छर्कने र धेरै ओसिलो भए BOM अलिकति मिसाउने।

७) करिब ६० देखी ९० दिनमा कम्पोष्ट तयार हुन्छ। यसरी तयार भएको कम्पोष्टको रंग खैरो हुन्छ। यसको बास्ना माटोको जस्तो हुन्छ। बिशेषतः शुरुमा राखिएका कच्चा पदार्थ प्रायःजसो डिकम्पोज भई चिन्न सकिने अवस्थामा हुंदैन।

फोहरजन्य तरल पदार्थ (Liquid Waste) को व्यवस्थित निष्कासन

ठोस फोहर पदार्थ (solid waste) जस्तै घरेलु फोहरजन्य तरल पदार्थ (liquid waste)ले पनि नदीलाई त्यत्तिकै प्रदुषित बनाईरहेकोछ। घरेलु फोहरजन्य तरल पदार्थ भन्नाले मलमुत्र देखि भान्सा र चोकबाट बग्ने फोहर पानी बुझिन्छ। हाल काठमाडौंमा घरेलु फोहरजन्य तरल पदार्थ निष्कासन हुने ढल (sewer)को संजाल व्यापक छ। यी ढलहरुबाट मुल ढल हुंदै फोहरजन्य तरल पदार्थ सिधै नदीमा मिसाईएका छन्। विष्णुमती नदीमा मात्र ताम्सीपाखा देखि महादेवटार खण्डमा करीब ११५ वटा ढल तेर्साइएको पाईएको थियो (Tamrakar 2004)। यो संख्या दश बर्ष यता झण्डै दोब्बर पुगेको अनुमान लगाउन सकिन्छ। काठमाडौंका प्रायः सबै नदीहरुमा हरेकमा सय भन्दा बढी ढल नदीमा सिधै मिसाईएका छन्। ती ढलबाट निस्कने घरेलु फोहरजन्य तरल पदार्थ (कभधबनभ)ले नदीको पानीमा एमोनिया, नाईट्रोजन र बेक्टेरियाको मात्रामा बृद्धि गराउंदछ। यस्ता नदीको पानीमा प्रति १०० एमएलमा झण्डै २५००० भन्दा बढी कोलिफर्म बेक्टेरिया (Escherichia Coli) पाईन्छन (Tamrakar 2012)। यस्ता पानी बाट दुर्गन्ध आउने मात्र नभई साधारण प्रयोगका लागि समेत

चित्र नं ३: कम्पोष्टिंग गर्न चाहिने फोहर पदार्थ तथा प्रकृया दर्शाइएको।



चित्र नं ४: कम्पोष्टिंग गर्ने विधी।

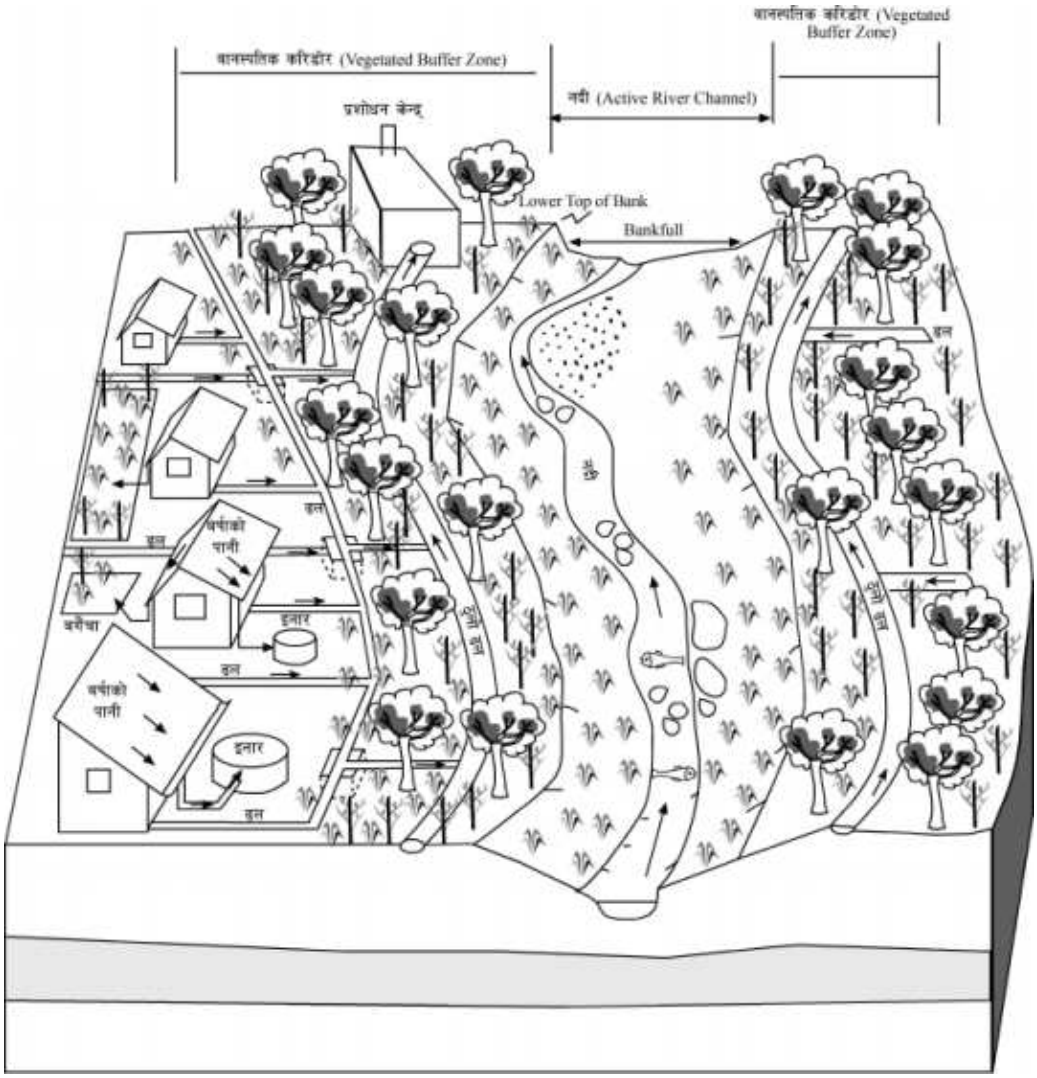
उचित हुंदैन। किनकी यस्तो पानीको सम्पर्क वा इन्फेक्टेड पानी अथवा खाद्य वस्तुको सेवनबाट झाडा बान्ता लाग्ने, एनेमिया हुने, वा किड्नी खराब हुने हुन्छ। अर्को कुरा ढल मिसाईएका नदीको पानीमा नाईट्रोजन अधिक भई एल्गी तथा लेउले अत्याधिक बृद्धीहुने मौका पाउंदछ। यस अवस्थाबाट कालान्तरमा नदीको पानीमा BOD (Biological Oxygen Demand)/COD (Chemical Oxygen Demand) बृद्धी भई DO (Dissolved Oxygen) को मात्रामा ह्रास भई पानीमा निर्भर जीवको विनाश हुन्छ। तसर्थ नदीमा ढल मिसिन नदिन स्थानिय निकाय तथा सरोकारवालाले तत्काल नदीको दुबै किनार वानस्पातिक करिडोर निर्माण गर्दा ठुलो ढलको पाइपलाईन समेत बिछछयाएर हाल बिद्यमान नदीतिर तेर्सिएका ढलहरुलाई जोड्नु पर्दछ (चित्र नं. ५)। यसरी नदी किनारै किनार घरेलु फोहरजन्य तरल पदार्थ संकलन गर्दै विभिन्न ठाउंमा फोहरजन्य तरल पदार्थलाई प्रशोधन गरी निस्केका सफा पानी मात्र नदीमा खन्याउनु पर्दछ। अर्कोतिर प्रत्येक घरधुरीले अआफ्नो घरबाट निस्कासन हुने फोहर पानीलाई वर्गीकरण गरी भान्सा र चर्पीबाट निस्कने पानीमात्र ढलमार्फत निस्कासन गरी अन्य पानी जस्तैः कौशी र छानाबाट बच्ने बर्षातको पानीलाई छुट्टै संकलन गरी प्रयोग गर्न वा भुमीगत जलमा रिचार्ज गर्न सकिन्छ।

सुझाउ

१) नदी नालालाई फोहर फाल्ने, पुर्ने अथवा संकलन गर्ने केन्द्र बनाईनु हुंदैन।

२) नदी क्षेत्रको दायां बायां लगभग ३० ३० मिटर चौडा हरियाली वानस्पातिक कोरिडोर बनाई त्यस छेउबाट नदी किनारै किनार ढल निर्माण गरी घरघरबाट नदीमा मिसाइएका घरेलु फोहरजन्य तरल पदार्थ नदीमा नखसाई प्रशोधन केन्द्र स्थापना गरी प्रशोधन गर्नु पर्दछ।

३) सुव्यवस्थित तथा बर्गीकृत फोहर संकलन तथा तह लगाउने विधी घरघरमा अपनाइनु पर्दछ। यसका निमीत्त व्यवस्थित र बर्गीकृत फोहर संकलन गर्ने तथा तह लगाउने विधीको बारे जनचेतना फैलाउनु पर्दछ।



चित्र नं ५ फोहरजन्य तरल पदार्थको निष्कासन विधी देखाईएको।

४) फोहर संकलकले फोहर संकलन गर्दा ज्वलनयुक्त फोहर तथा ज्वलनअनुपयुक्त फोहर छुट्टा छुट्टै दिनहरुमा तदारुपताकासाथ संकलन गर्नु उचित हुन्छ।

संदर्भ सामग्री

आचार्य, घ. प., २०१३, शहरी फोहर मैला व्यवस्थापन समस्या फोहर मैलालाई फालिने वस्तुको रुपमा हेर्ने दृष्टिकाण नै प्रमुख समस्या हो। वातावरण सन्देश। वातावरण संरक्षण अभियान नेपाल। पृ ९४।

अमात्य, सु., २०१३, उपत्यकाको फोहरबाट उपत्यकालाई चाहिने बिधुत उत्पादन हुनसक्दछ. वातावरण सन्देश। वातावरण संरक्षण अभियान नेपाल, पृ २५-३०।

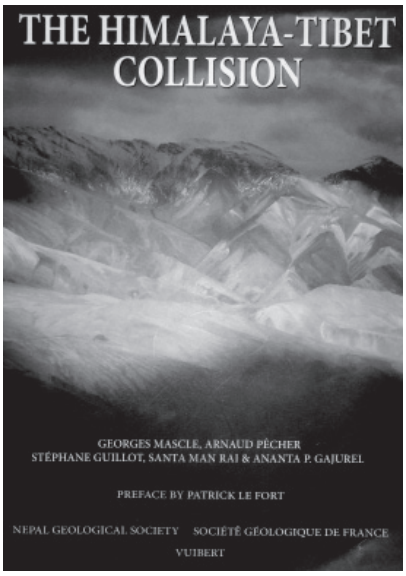
Bajracharya, R. and Tamrakar, N. K., 2008, Environmental status of Manahara River, Kathmandu, Nepal. Bull. Dept. Geol., Tribhuvan University, Nepal, v. 10, pp. 21–32.

Maharjan, B. and Tamrakar, N. K., 2010, Morphohydraulic parameters and existing stability condition of Nakhu River, Southern Kathmandu, Central Nepal. Bull. Dept. Geol., Tribhuvan University, v. 13, pp. 1–12.

Tamrakar, N. K., 2004, Disturbance and instabilities in the Bishnumati River Corridor, Kathmandu Basin, Bulletin of JUSAN, v. 9, no. 16, pp. 7–18.

Tamrakar, N. K., 2012, Deteriorating condition of the Bishnumati River: An assessment of channel stability and disturbances. Lambert Academic Publishing, Germany, 90p.

NEW BOOKS



The Himalaya-Tibet Collision

Authors: George Mascles, Arnaud Pecher, Stephane Guillot, Santa Man Rai and Ananta P. Gajurel

Publisher: Societe Geologique de France and Nepal Geological Society

ISBN: 978-9937-845-2-5551-6

Year of Publication: 2011

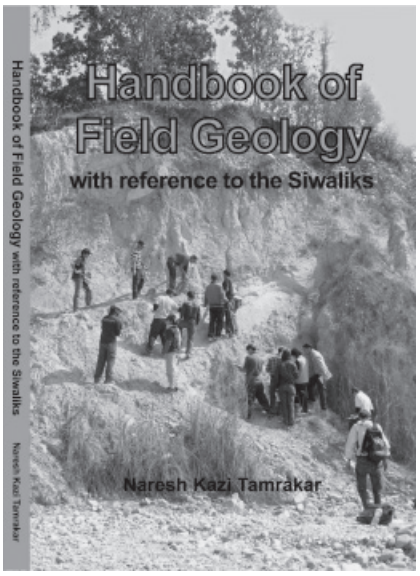
Price: NRs. 300/-

About the book: The Himalaya-Tibet orogenic system is the highest and widest topographic system on earth, resulting from the continuous and still active collision between the two continental landmass of Asia and India.

There are thirteen chapters included in this book. Global situation of the Himalayan range; general pattern of the Himalaya-Tibet; the Indian block, the Himalayan belt; Indus-Tsangpo suture zone; the Asian margin; Tibet and Karakorum; the lateral subductions: Arakan, Makran; metamorphism in the Himalaya; magmatism in the Himalaya-Tibet; the geodynamic evolution; the models of the Himalayan collision and finally global effects of the India-Asia collision; respectively are the major chapters.

The objective of this book is to present a "state-of – the art" about Earth Science knowledge in Himalaya, Karakorum and Tibet. The contents of this book explain the geodynamic history of these regions to the readers.

This book was initially published in French version jointly by Société Géologique de France, Nepal Geological Society and VUIBERT, Paris in 2010.

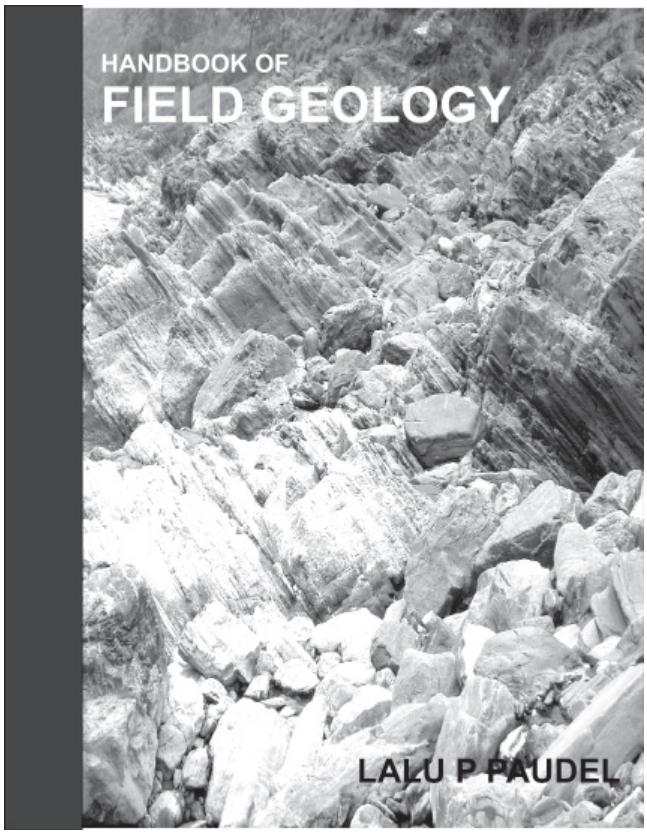


Handbook of Field Geology with reference to the Siwaliks

Title: Author: Naresh Kazi Tamrakar
Publisher: Central Department of Geology
ISBN: 978-9937-524-47-6
No of pages: 162
Year of Publication: 2013
Price NRs. 400/-

About the book: This handbook has been designed to assist students to familiarize with data recording and treating. The techniques of scalar and vectoral data acquisition and treatment have been elucidated more with theoretical background of properties of rocks and their classification. Apart from these, various observations made in the Siwaliks, and the technique of mapping has been provided. This handbook will be of immense use for M. Sc. and B. Sc. studnets of Geology and allied discipline.

The authors of this book are the prominent French geoscientists: Prof. Georges Mascle, Prof. Arnaud Pêcher and Dr. Stêphane Guillot. This book is also included in the syllabus of the graduate students of the university in France. In 2012, Nepal Geological Society, Société Géologique de France, and VUIBERT, Paris published jointly in English version including the Nepalese geoscientists as authors: Prof. Santa Man Rai and Dr. Ananta P. Gajurel.



Handbook of Field Geology

Authors: Lalu P. Paudel

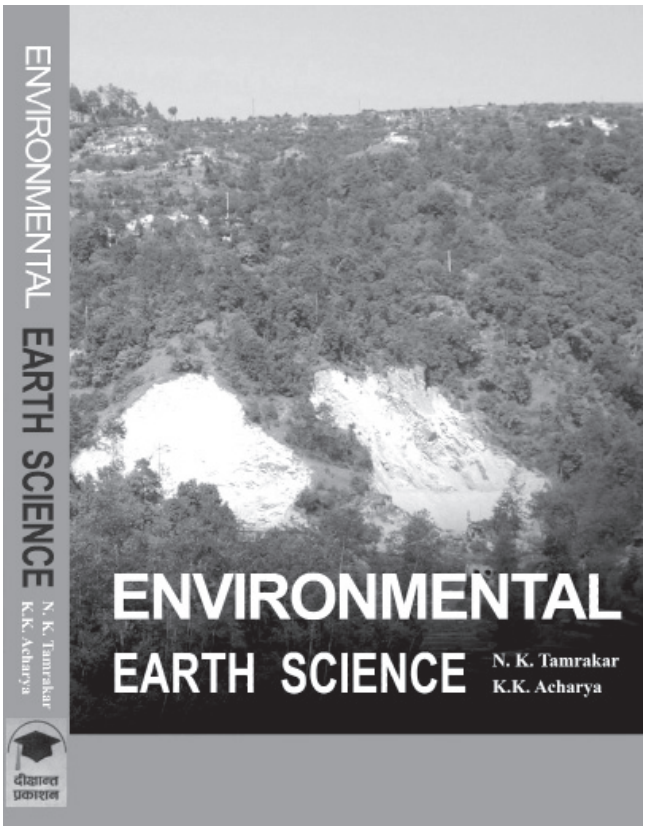
Publisher: Geo-Science Innovations P. Ltd.

ISBN: 978-9937-845-2-5551-6

Year of Publication: 2012

Price: NRs. 250/-

About the book: Geological field work is often exciting, challenging and rewarding occupation. One must have knowledge of every branches of geology, must be physically and psychologically fit, and be social to conduct a field work. It is essential that the student of geology have a strong background in field observation. Present geology curriculum of the Tribhuvan University for M. Sc. and B.Sc. levels includes compulsory field work of several weeks. However, students do not find concise book for the orientation in the field. This is a basic guide book for the undergraduate and graduate students of in the field. This book describes what should one do before going to the field, during the field work and after the field work. The book gives detail account of the field equipments and their use, methods of gathering data in the field, methods of data analysis, presentation and report writing.



Environmental Earth Science

Authors: Naresh Kazi Tamrakar and Kamala Kant Acharya

Publisher: Dikshant Prakashan, Kirtipur, Kathmandu

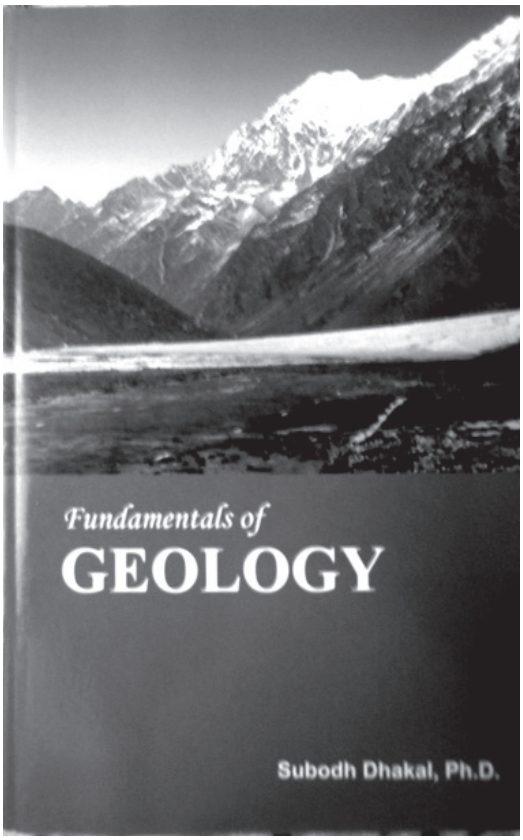
Number of Pages: 398

ISBN: 978-9937-2-5238-6

Year of Publication 2012

Price NRs. 350/-

About the book: This book has been designed to fulfill the course of Environmental Earth Science as part of the Master Degree in Environmental Science. The book includes chapters of geomorphic processes, morpho-tectonic divisions of the Himalayas, rocks, mineral and soils, environment of deposition, geological hazards, bio-engineering and river training works, mineral and water resources, and mountain risk engineering. This book will be helpful to graduate as well as undergraduate students of Environmental Science, and Civil Engineering.



Fundamentals of Geology

Author: Subodh Dhakal
ISBN: 978-9937-2-5516-5
Number of Pages: 167
Year of Publication: 2012
Price: Rs. 325/-

About the book: This book is published in the form of text book of Engineering Geology for the Bachelor's of Civil Engineering of Pokhara University and Purbanchal University; and best reference book for the students of BE Civil of Tribhuvan University. It can be used as a reference book for graduate and undergraduate students of Geology, Civil Engineering, Environmental Science and forestry. This book has been resolved into fourteen theoretical chapters and five appendices that are meant for the practical exercises. The book covers physical geology, crystallography, mineralogy, petrology, structural geology, groundwater, landslides, site investigation methods and geology of Nepal.

OBITUARY

Late Madhav Raj Pandey
(15 June, 1945–)

Madhav Raj Pandey was born in Gyaneshwor, Kathmandu on 15 June, 1945. He was graduated from St. Petersburg Mining Institute, Russia in exploration geophysics in 1969. He recieved training on integrated methods of mineral exploration, seismology, and geological hzards. He was the life member of Nepal Geologial Society and American Geophysical Union. He worked at the Department of Mines and Geology as an exploration geologist and senior divinisonal geologist for several years. He has a major contribution in the establishment of the National Seismological Networks in Nepal. He has published a microseismicity map of Nepal and adjacent regions.

Mr. Pandey was honored by honorary membership of the Nepal Geological Society. He received Science and Technology Award for 2010/2011 for his outstanding contribution in establishing seismological data processing centre, its operation and integration of seismological results with geological and geophysical data for studying earthquake patterns in Nepal.

His contribution to the Himalayan Geology and Nepal Geological Society will always be remembered.

May his soul rest in perfect peace.

RECENT JOURNALS AND BULLETINS OF GEOLOGY

Six issues of various journals and bulletins related to geology have been published by the Nepal Geological Society, Department of Mines and Geology, Central Department of Geology, TU and Department of Geology, Tri-Chandra Campus. They are as follows:

Journal of Nepal Geological Society, Vol. 44, 2012.

Journal of Nepal Geological Society, Vol. 45, (Special Issue), Abstract Volume of 27th HKT Workshop, 2012.

Journal of Nepal Geological Society, Vol. 46, 2013.

Bulletin of Department of Geology, Tribhuvan University, Vol. 14, 2012.

Annual Report of Department of Mines and Geology, Vol. 8, 2013.

NEW MEMBERS OF THE NEPAL GEOLOGICAL SOCIETY

LM	Name	Address	Email
656	Kameshwar Yadav	Siraha, Nepal	yaadkames@gmail.com
657	Naresh Maharjan	Chapagaon-9, Nepal	nrshmhrjn72@gmail.com
658	Lok Bijaya Adhikari	Birendranagar-8, Surkhet, Nepal	lbadhikari@hotmail.com
659	Vijaya Kattel	Amarapuri-6, Nawalparasi, Nepal	vkattel@gmail.com
660	Chintan Timsina	Subhang-2, Panchthar, Nepal	chintan1119@gmail.com
661	Bishow Raj Silwal	Kharanitar-6, Nuwakot, Nepal	bisoow@outlook.com
662	Roshan Koirala	Manakamana-6, Gorkha, Nepal	koiralaroshan@yahoo.com
663	Saunak Bhandari	Chapali-7, Kathmandu, Nepal	saunakbhandari@yahoo.com
664	Deepak Kumar Jha	Balkumari, Lalitpur, Nepal	jhadeepakkumar77@yahoo.com

Happy Vijaya Dashami and Dipawali, 2070

Nepal Geological Society

CONGRATULATIONS

PROMOTION

The Nepal Geological Society extends its heartiest congratulation to the following members of the Nepal Geological Society for their promotion.

Dr. Santa Man Rai

Promoted to the Professor of Geology, Tribhuvan University

Date of Promotion: 2070/01/16.

Dr. Lalu Prasad Paudel

Promoted to the Professor of Geology, Tribhuvan University.Date of Promotion: 2070/01/16.

Dr. Prem Bahadur Thapa

Promoted to the Associate Professor of Geology, Tribhuvan University

Date of Promotion: 2070/01/16.

Dr. Ranjan Kumar Dahal

Promoted to the Associate Professor of Geology, Tribhuvan University

Date of Promotion: 2070/01/16.

Mr. Kushal Nandan Pokharel

Promoted to Senior Divisional Geologist (Class II), Department of Mines and Geology

Date of Promotion:

Mr. Lok Bijay Adhikari

Promoted to Senior Divisional Geologist (Class II), Department of Mines and Geology

Date of Promotion:

Mrs. Suchita Shrestha

Promoted to Senior Divisional Geologist (Class II), Department of Mines and Geology

Date of Promotion:

PHD AWARDS

The Nepal Geological Society extends its heartiest congratulation to the following members of the Nepal Geological Society for obtaining degrees.

Dr. Murari Khatiwada

Institute: University of Oklahoma, USA.

Thesis Title: Integrated Geophysical studies of the Fort Worth Basin Texas, Harney Basin Oregon and Snake River Plain Idaho

Year of Ph.D. Award: 2013

Dr. Sudarshan bhandari

Institute: Tribhuvan University, Nepal.

Thesis Title: Plant Macrofossil from the Quaternary Sediments of the Kathmandu Valley and its Palaeoclimatic Implications

Year of Ph.D. Award: 2012

Dr. Ganesh Tripathi

Institute: Department of Earth and Environmental Sciences, University of Kentucky, Lexington KY, USA

Thesis Title: Spatio-temporal variability in groundwater dischagre and contaminant fluxes along a channelized stream in western Kentucky. Year of Ph.D. Award: 2013

NEW JOB ENTRY AS A GEOLOGIST/ HYDROGEOLOGIST

The Nepal Geological Society extends its heartiest congratulation to the following members of the Nepal Geological Society for their success in getting a permanent job in different government offices.

1. Lelin Raj Dhungel (Hydrogeologist class III)

1. Saunik Bhandari (Geologist class III)

2. Ratna Mani Gupta (Geologist class III)

3. Roshan Koirala (Geologist class III)

4. Biswa Raj Silwal (Geologist class III)

5. Chintan Timsina (Geologist class III)

6.Tara Pokhrel (Geologist class III)

7. Naresh Maharjan (Geologist class III)

8. Pramod Singhkhada (Geologist class III)

LIST OF PUBLISHED JOURNALS OF NEPAL GEOLOGICAL SOCIETY

1. Journal of Nepal Geological Society, Vol. 46, 2013.
2. Journal of Nepal Geological Society, Vol. 45, special issue, abstracts of the 27th HKTW 2012.
3. Journal of Nepal Geological Society, Vol. 44, 2012.
4. Journal of Nepal Geological Society, Vol. 42, 2011.
5. Journal of Nepal Geological Society (Abstract of Sixth Nepal Geological Congress on Geology, Natural Resources, Infrastructures, Climate Change and Natural Disasters, 15-17 November 2010), Vol. 41 (Special issue), November, 2010.
6. Journal of Nepal Geological Society, Vol. 40, June 2009.
7. Journal of Nepal Geological Society, Vol. 39, June 2009.
8. Journal of Nepal Geological Society (Proceedings of International Workshop on Seismology Seismotectonics, and Seismic Hazard in Nepal Himalaya, 28–29 November 2006 and Fifth Nepal Geological Congress on Geology, Environment, and Natural Hazards Mitigation: Key to National Development, 26–27. November 2007), Vol. 38 (Special Issue), December 2008.
9. Journal of Nepal Geological Society, Vol. 37, June 2008.
10. Journal of Nepal Geological Society (Abstracts of Fifth Nepal Geological Congress on Geology, Environment, and Natural Hazards Mitigation: Key to National Development, 26–27 November 2007), Vol. 36 (Special Issue), November 2007.
11. Journal of Nepal Geological Society, Vol. 35, June 2007.
12. Journal of Nepal Geological Society (Proceedings of Fifth Asian Regional Conference on Engineering Geology for Major Infrastructure Development and Natural Hazards Mitigation, 28–30 September 2005), Vol. 34 (Special Issue), December 2006.
13. Journal of Nepal Geological Society, Vol. 33, June 2006
14. Journal of Nepal Geological Society (Abstracts of Fifth Asian Regional Conference on Engineering Geology for Major Infrastructure Development and Natural Hazards Mitigation, 28-30 September 2005), Vol. 32 (Special Issue), September 2005.
15. Journal of Nepal Geological Society, Vol. 31, June 2005.
16. Journal of Nepal Geological Society (Proceedings of Fourth Nepal Geological Congress, 9–15 . April 2004), Vol. 30 (Special Issue), December 2004.
17. Journal of Nepal Geological Society, Vol. 29, June 2004.
18. Journal of Nepal Geological Society, Vol. 28, June 2003.
19. Journal of Nepal Geological Society (Proceedings of Third Nepal Geological Congress, 26-28 September 2001, Kathmandu, Nepal), Vol. 27 (Special Issue), December 2002.
20. Journal of Nepal Geological Society, Vol. 26, June 2002
21. Journal of Nepal Geological Society (Proceedings of Workshop on the Himalayan Uplift and Palaeoclimatic Changes in Central Nepal, 10 November 2000), Vol. 25 (Special Issue), December 2001.
22. Journal of Nepal Geological Society (Abstract Volume of Third Nepal Geological Congress,

26–28 September 2001), Vol. 24 (Special Issue), September 2001.
23. Journal of Nepal Geological Society, Vol. 23, June 2001
24. Journal of Nepal Geological Society (Proceedings of International Symposium on Engineering Geology, Hydrogeology, and Natural Disaster with Emphasis on Asia, 28–30 September 1999, Kathmandu, Nepal), Vol. 22 (Special Issue), December 2000.
25. Journal of Nepal Geological Society, Vol. 21, June 2000
26. Journal of Nepal Geological Society (Abstract Volume of International Symposium on Engineering Geology, Hydrogeology, and Natural Disaster with Emphasis on Asia, 28–30 September 1999, Kathmandu, Nepal), Vol. 20 (Special Issue), 1999.
27. Journal of Nepal Geological Society, Vol. 19, 1999
28. Journal of Nepal Geological Society (Proceedings of Second Nepal Geological Congress, 1995), Vol. 18 (Special Issue), 1998.
29. Journal of Nepal Geological Society, Vol. 17, 1997
30. Journal of Nepal Geological Society (Abstract Volume of Second Nepal Geological Congress), Vol. 16 (Special Issue), 1997.
31. Journal of Nepal Geological Society, Vol. 15, 1997
32. Journal of Nepal Geological Society (Proceedings of First Nepal Geological Congress, 1995), Vol. 14 (Special Issue), 1996.
33. Journal of Nepal Geological Society, Vol. 13, 1996
34. Journal of Nepal Geological Society (Abstract Volume of First Nepal Geological Congress, 1995), Vol. 12 (Special Issue), 1995.
35. Journal of Nepal Geological Society (Proceedings of 9th Himalaya–Karakoram–Tibet Workshop, 1994), Vol. 11 (Special Issue), 1995.
36. Journal of Nepal Geological Society, Vol. 10, 199531. Journal of Nepal Geological Society (Abstracts of 9th Himalaya– Karakoram–Tibet Workshop, 1994), Vol. 10 (Special Issue), 1994.
37 . Journal of Nepal Geological Society, Vol. 9, 1993.
38. Journal of Nepal Geological Society, Vol. 8, 1992.
39. Journal of Nepal Geological Society, Vol. 7, 1991.
40. Journal of Nepal Geological Society, Vol. 7 (Special Issue), 1991.
41. Journal of Nepal Geological Society, Vol. 6, 1989.
42. Journal of Nepal Geological Society, Vol. 5, No. 1, 1988.
43. Journal of Nepal Geological Society, Vol. 4 No. 1 & 2, 1987
44. Journal of Nepal Geological Society, Vol. 4 (Special Issue), 1984*
45. Journal of Nepal Geological Society, Vol. 3, No 1 & 2, 1985
46. Journal of Nepal Geological Society, Vol. 2 No. 2, 1985
47 . Journal of Nepal Geological Society, Vol. 2 (Special Issue), 1982*
48. Journal of Nepal Geological Society, Vol. 2, No. 1, 1981
49. Journals of Nepal Geological Society, Vol. 1, No. 2, 1981*
50. Journal of Nepal Geological Society, Vol. 1, No. 1, 1981*
*Out of prints (only photocopy available upon request.)