Proceedings of the

Skills, Knowledge and Innovation Transfer to Nepal Workshop 2014

19th July 2014, Sydney

Dr. Binod Shrestha, Dr. Jagadish Timsina, Dr. Bishnu Devkota
(Editors)

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Preface

The “Skills, Knowledge and Innovation Transfer (SKI) to Nepal” Workshop 2014 was one day national workshop held first time in Australia, and organised by NRNA-NCC Australia SKI Committee. This workshop is also probably the first time organised abroad by the Nepalese diaspora, and provided an opportunity for the scientists, academicians and intellectuals for serious discussion on SKI transfer (or skills transfer) issues and activities by NRNs to Nepal. The workshop brought together NRN scientists, academicians and intellectuals from five states (NSW, Victoria, Queensland, South Australia and Western Australia) and one territory (ACT).

Around 100 participants registered for the workshop which lasted for eight hours, from 9:30 am to 5:30 pm, with two keynote papers and 11 other thematic papers from diverse fields and disciplines presented. In the opening ceremony chaired by Dr. Binod Shrestha, Coordinator NRNA-NCC-SKI Committee and facilitated by Dr. Jagadish Timsina, Adviser to NRNA-NCC Australia and member of the NRNA ICC/NCC SKI Committee, the Honorary Consulate General of NSW Mr. Dipak Khadka, the NRNA-ICC President Mr. Shesh Ghale and the NRNA-NCC President Mr. Mahendra Oli presented their remarks about the workshop. All of them showed their commitment and support for the implementation of a few, high impact type projects selected from this workshop in Nepal.

The workshop participants agreed that it is time to bury the archaic concept of brain drain and turn to assessing the performance of professionals and systems, wherever they are in the world. The technology turns the modes by which scientists/professional around the world can be connected in no time. In this globalized world the physical location of a person may or may not have any relation to the ability to make an impact on the country’s development. The enthusiasms and commitments expressed by the participant NRNs were immense and, if such projects could be implemented they would definitely help transform the wellbeing and life styles of most of the people of Nepal.

The individual paper presenters/authors are thankful for their dedication of time and efforts. The editors are thankful to the Honorary Consulate General of NSW Mr. Dipak Khadka, NRNA-ICC President Mr. Shesh Ghale and NRNA-NCC President Mr. Mahendra Oli for exciting remarks and commitments for the SKI project implementation. We are grateful to all participants, and especially those who attended the workshop from the different states and actively participated to make the workshop successful. We would like to thank NRNA-NCC Vice President Hari Ramjali and Secretary Bharat Pokharel for managing the venue and inviting the NRNA members to attend the workshop, respectively. Similarly, we are indebted to all the journalists including Mr. Rishi Acharya for the publicity of the SKI workshop. Our thanks and gratitude are extended to all volunteers for their help and time to make the event successful. . At last but not least, we would like to thank all the SKI team members for the hard work and team spirit and we expect the same in future too.

Dr. Binod Shrestha
Dr. Jagadish Timsina
Dr. Bishnu Devkota

FOR NEPALI BY NEPALI नेपालीका लागि नेपाली

Non-Resident Nepali Association (NRNA)

गैरआवासीय नेपाली संघ

Ref. N-327/13-15 Date: 7th January, 2015.

Message of Felicitation

I am very pleased to learn that NRNA-NCC Australia is publishing a booklet on Skill, Knowledge and Innovation (SKI).

SKI dissemination and transfer is one of the major contributions that NRNs can make to their motherland and has always been of prime interest to the Association. It is in this context that the Association has created a database for skill registration in its website.

Developing a system and culture of knowledge transfer, introduction of effective mechanisms for the management of interaction between the stakeholders and forming a team of qualified experts in the sphere of knowledge transfer for an effective socio-economic development is what the Association desires.

Innovation through Knowledge Transfer is an initiative to promote and raise the profile of knowledge transfer and innovation through publication opportunities for all those involved in the discipline; and I believe that it will contribute in this aspect.

Hope the publication will also be able to support the commercialization of skills and expertise possessed through higher education and act as a catalyst in transferring knowledge to facilitate innovation.

I thank my colleagues of the NRNA-NCC Australia for your initiative and I wish the very best in all your endeavors.

Wishing the very best,

Shesh Ghale,
President,
International Coordination Council,
Non-Resident Nepali Association

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Message by President, NRNA Australia

As large numbers of academicians, scientists, intellectuals, and skilled people from Nepal are living outside the country, it has been widely realized that their skills, knowledge & innovation (SKI) needs to be utilized for the development of Nepal. By recognizing this fact, NRNA-NCC Australia created a SKI Transfer Committee/Project as one of the 20 committees/projects in 2013. The aim of this committee/project is to identify the individuals and intellectuals and utilize their expertise and skills for transfer of SKI through various projects and works very closely with NRNA-ICC's SKI Committee. As a part of NRNA-NCC's SKI initiatives, NRNA Australia organized a national workshop on 19th July 2014 in which I also participated. The quality of the papers presented and the active and enthusiastic discussions and deliberations made by the participants during the workshop clearly show that many of our scientists, academicians, intellectuals and skilled persons have the innovative ideas, knowledge, skills, experience, and commitment which can be utilized for the widespread development of Nepal.

As an output of the workshop, SKI Committee of NRNA Australia has now published the proceedings of the workshop. I am very much pleased to note the high quality papers and proposals included in the proceedings. NRNA Australia will continue to work with NRNA ICC to work out appropriate mechanisms/platforms which allow us to transfer our skills, knowledge, innovation and experience through the short- and long-term projects that have been identified during the workshop and included in the proceedings.

I would like to sincerely thank the NRNA Australia SKI Committee to successfully organize the workshop and especially thank Dr. Binod Shrestha, Dr. Jagadish Timsina and Dr. Bishnu Devkota who did the painstaking job of reviewing, editing, and compiling the papers for the proceedings.

I wish all the best to all NRNs living in Australia in the New Year 2015 and appeal all to work together for the development of our mother country Nepal.

Mahendra Oli

President, NRNA Australia

Coordinator's Message

It was a great opportunity to organise a workshop among Nepalese scientists, academicians and intellectuals for serious discussion on SKI transfer issues and activities by NRNs to Nepal. We were pleased to welcome NRN scientists, academicians and intellectuals from six different states and territories in this workshop.

It is time to bury the archaic concept of brain drain and turn to assessing the performance of professionals and systems, wherever they are in the world. The technology turns the modes by which scientists/professional around the world can be connected in no time. In this globalized world the physical location of a person may or may not have any relation to the ability to make an impact on the country's development. The responsibilities of a home country will not be fulfilled by only sending remittances even though it constitutes a significant proportion of foreign revenue.

In this scenario, we NRN professionals in Australia have created a common platform to contribute appropriate skills and knowledge learned in abroad to our home country Nepal within NRNA Australia. The scope of SKI has been set to develop a ground up approach and a mechanism that encourages and allows such professionals to make significant contribution. This workshop was organised to meet one of the goals of SKI project.

This workshop was a successful event and we are proud that one of our project/papers by Dr. Jagadish Timsina is being successfully implemented in eastern part of Nepal. We believe such workshop will be continued in future providing a platform to professional/scientists to transfer skills, knowledge, innovation and experience through small and mid-size projects.

I would like to sincerely thank SKI Committee members and NRNA Australia for the team spirit and continuous support for the successful organisation of the workshop. I specially thank to Dr. Jagadish Timsina for his vigorous effort for reviewing and editing papers.

I hope we will receive similar support from professional/scientists, community organisations and all NRNs to make contributions to our motherland.

Dr. Binod Shrestha
Coordinator
SKI Committee, NRNA Australia

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NRNA Knowledge Investment: Skill Knowledge and Innovation (SKI)'s- Review and Recommendation

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Abstract

In the last five years, SKI has gone through many consultative processes and deliberations within NRNA and has signed MoUs (Memorandum of Understanding) with Ministry of Education (MoE) and Nepal Academy of Science and Technology (NAST) for a foundation building work [1-12]. Two major flagship projects launched by NRNA in SKI initiatives during this period have been: 1) Open University of Nepal Initiative (OUNI) which led to an OUN Infrastructure Development Board (OUNIDB) to be formed by Government of Nepal, and more recently, NRNA ICC has formed a separate OUNI Task Force that will closely collaborate with both OUNIDB and the SKI Committee and 2) Nepal Science Foundation Trust (NSFT) that has been registered as a philanthropic organization in Nepal and is funded by SKI Committee and reports to SKI Committee directly. Along with these major initiatives, some other projects have also been underway, such as SKI inventory of Diaspora professionals, Annual SKI Brain Drain Seminar series with Nepal Academy of Science and Technology (NAST)/Biotechnology Society of Nepal (BSN).The paper will present an overview of SKI's activities in past five years and discuss briefly about future plans as well as new team structure, ToR and initiatives.

1. Background

In about a decade since its founding, Non-Resident Nepali Association (NRNA) has emerged as an influential force in the social and economic landscape of Nepal. The credit to this outcome goes to the pioneers and visionaries of NRNA who inspired Diaspora mass to deploy its skills and resources on to the motherland. Today, NRN movement has made its presence felt now in business, philanthropy and several skill and knowledge investment initiatives in Nepal. It is now able to mobilize Nepali Diaspora having diverse interests and competencies. Among this diverse set of participating interests within NRNA, there emerged a group of scientists, researchers and knowledge workers that identified skills, knowledge and innovations as worthy products transferrable from the NRN community to Nepal. The efforts of these people resulted in the formation of Skills, Knowledge and Innovation (SKI) Task Force during the 4th NRNA Global Conference in Kathmandu in December 2009. This was a major paradigm shift in NRNA International Coordination Council's policy commitment and priorities to utilize skills, knowledge, innovations and experiences of Diaspora community for the advancement of Nepal.

Through declarations of its regional and global conferences since 2009, NRNA has emphasised the importance of Diaspora role in knowledge sector. Consequently NRNA is set to invest productive ideas, innovation, skills, and experiences of Diaspora for promoting science and technology capabilities, which are considered important in Nepal's long term prosperity. In forming the SKI Task Force, NRNA pledged to work jointly with the Government of Nepal (GoN) and national stakeholders. In 2014, NRNA ICC (International Coordination Council) made a decision to transform SKI Task Force into a SKI committee of permanent status. A new committee has thus been formed and its ToR (Terms of Reference) is approved by the ICC. The goal of the SKI Committee has been to mobilize NRN's intellectual and physical resources in transferring of Diaspora knowledge, skills, experience and innovation to Nepal through varieties of project initiatives as feasible. The SKI Committee holds its meeting every six months and reports its progress to the ICC on quarterly basis. General information on SKI committee has been made available in the NRN website: **www.nrn.org.np**. The committee envisages ahead working closely with NCC and RCs to help establish regional committees to develop a strong SKI networking at NCC levels.

In the last five years, SKI has gone through many consultative processes and deliberations within NRNA and has signed MoUs (Memorandum of Understanding) with Ministry of Education (MoE) and Nepal

Academy of Science and Technology (NAST) for a foundation building work [1-12]. Two major flagship projects launched by NRNA in SKI initiatives during this period have been: 1) Open University of Nepal Initiative (OUNI) which led to an OUN Infrastructure Development Board (OUNIDB) to be formed by Government of Nepal, and more recently, NRNA ICC has formed a separate OUNI Task Force that will closely collaborate with both OUNIDB and the SKI Committee and 2) Nepal Science Foundation Trust (NSFT) that has been registered as a philanthropic organization in Nepal and is funded by SKI Committee and reports to SKI Committee directly. Along with these major initiatives, some other projects have also been underway, such as SKI inventory of Diaspora professionals, Annual SKI Brain Drain Seminar series with Nepal Academy of Science and Technology (NAST)/Biotechnology Society of Nepal (BSN).

2. SKI Committee Goals for 2014-16

1. Short term (2014-15)

1 Develop skills data bank of NRN professionals
2 Align skills and execute plans on:
-Open University Nepal Initiative (OUNI)
-Nepal Science Foundation (NSF)
3 Gain representation in Nepal's S&T policy and research institutions
4 Continue SKI Conference program activity with NAST/SBN
5 Solicit proposals from Diaspora scientists and technologists, select them for implementation, and set them into implementation mode

2. Long term (2015-16)

1 Identify potential projects for co-investment, particularly in Biotechnology, Agriculture, Health, Energy and Climate Change areas in collaboration with relevant institutions in Nepal
2 Explore and encourage NRNA's regions to take one project each and align them with SKI objectives
3 Establish strong linkages with S&T and Education institutions both public and private, in Nepal and abroad
4 Advise Government on Education and S&T policy matters

The new SKI committee structure within the NRNA and the team members' representation spread around the world are shown in Figure 1 and Figure 2 respectively. The committee members are selected from the NRNA's regions while the task force team will be formed on project basis with required skills. Current members of the SKI Committee are: Navin Vaidya, Hem Raj Sharma, Saroj Ghimire, Rajesh Rana, Pramod Dhakal, Gokul Pokhrel, Drona Rasali, Shree Napit, Jagadish Timlsina, Betman Bhandari, Krishna Giri, Ambika Adhikari, Ishara Mahat, Sunita Chaudhary, Dharma Acharya, Tharka Sen, Suraj Thapa, Ratan Jha (Co-chair), Jeetendra Bothara, S Baniya, Devi Basnet, BK Khanal, S Chettri, Dinesh Gautam, Lok Raj Sharma, Raju Adhikari (Chair).

SKI's primary role is to support the SKI flagship projects, provide policy direction, develop future strategy and represent NRNA ICC in S&T areas. The above outlined initiative will be SKI's strategic priority to meet its objectives. In the new structure, SKI will endeavour to proactively advocate, engage and champion SKI activities at NCC level and involve them in flagship projects. SKI committee structure, fund raising scheme are outlined in Figure 1 and 2 and will be driven on projects basis.

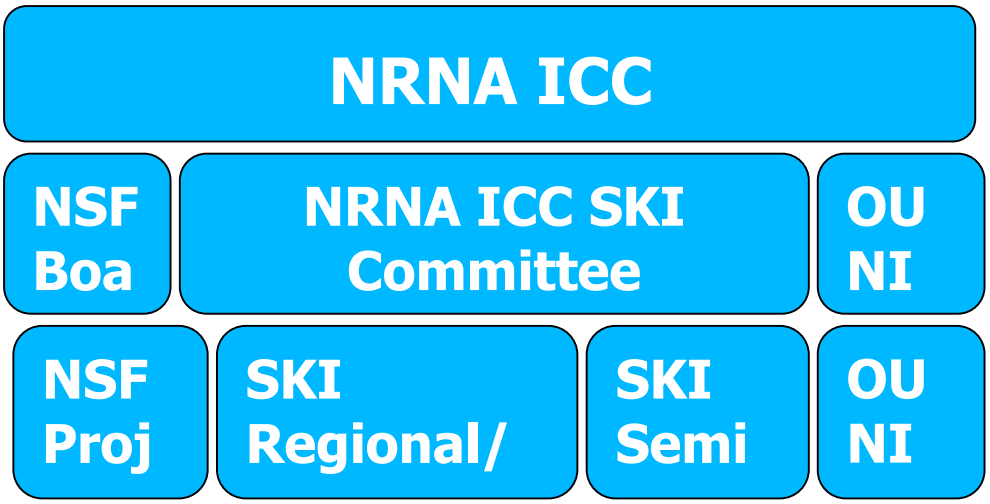

Figure 1. SKI Committee structure and projects

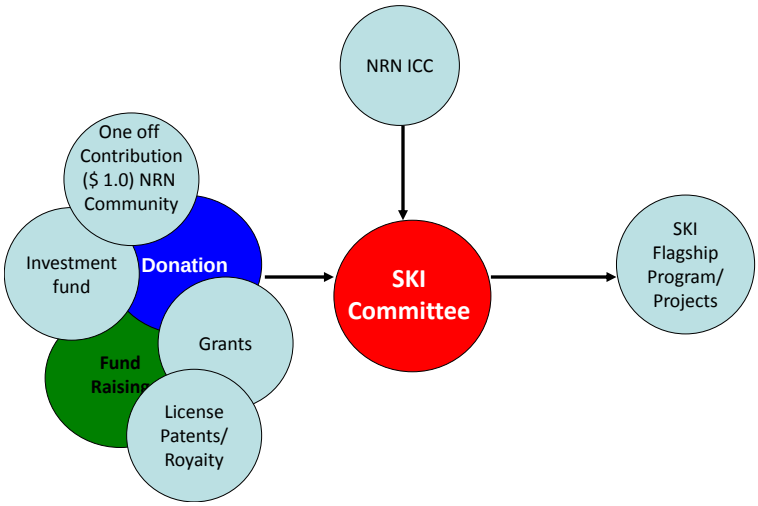

Figure 2. SKI proposed fund raising mechanism

3. The Flagship Project: Open University Nepal Initiative – (OUNI)

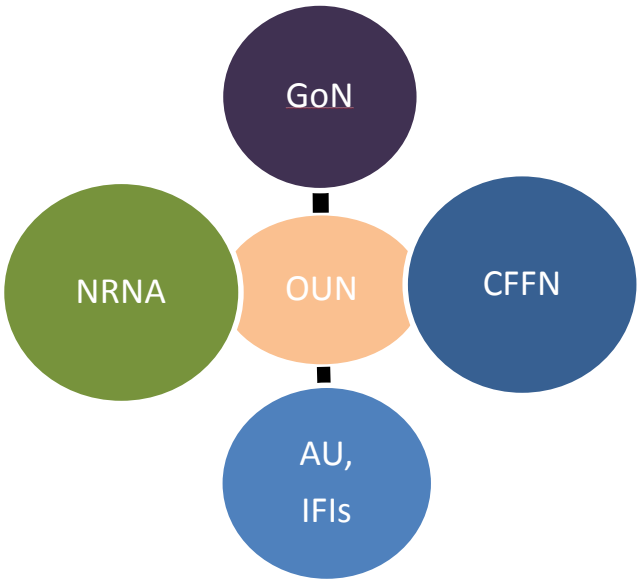

Figure 3. OUNI partners: *OUN – Open University Initiative, AU= Athabasca University, CFFN= Canada Foundation for Nepal, GoN= Government of Nepal, NRNA- Non Resident Nepali Association, IFIs = International Financial Institutions*

3.1 Introduction

Open University Initiative is a NRNA project developed over the last seven years and brought to NRNA community in the last five years. This project was declared as "NRNA Flagship Project" by NRNA Houston Conference 2010. A White Paper on the Open University Initiative was prepared along the way as a compilation of ideas generated through workshops and studies made during this period. The White Paper was submitted by the NRNA Open University Project Champion Pramod Dhakal to the NRNA ICC project evaluation committee formed in 2013. The committee recommended the work of the initiative to be worthy of continuation by the NRNA. Subsequently the Chair of the Open University Initiative Task Force (OUNITF) was appointed. The Chair of the OUNITF presented Terms of Reference to the NRNA ICC President for the approval of the organization and was subsequently endorsed by the ICC.

Consequently, OUNI Task Force was created within the NRNA ICC which carried over the work undertaken by the OUNI Project, the OUNI Steering Committee, and the OUNI Strategic Committee formed before the steering committee. NRNA ICC and NRNA OUITF submitted the White Paper prepared by the Steering Committee to the Ministry of Education, Government of Nepal for official adoption in April 2014 and it has been endorsed as an official document by the Government of Nepal on June 18, 2014. This document was produced by a collective effort of NRNA, CFFN, Athabasca University, and Government of Nepal.

A MoU has been signed between NRNA and the Ministry of Education, Government of Nepal (MoE), in June 10, 2010 which formalized on how the 2010 Resolution and 2012 MoU on OUNI signed by MOE and NRNA would be implemented. This new agreement has already officially been adopted by the OUNIDB on June 18, 2014. On the basis of this agreement, NRNA will take the lead role in the academic program management and operation of the OUNI. Consequently, NRNA and NRNs are positioned to be major players in the making of the Open University of Nepal, which is conceived to be executed as a collaborative initiative of multiple institutions.

Conceived to be executed as a collaborative initiative of multiple institutions, outlined here in this paper are major elements of the project that concern with the NRNA and NRN community.

3.2 Vision, mission, goals and objectives

i) Vision

"Igniting the spirit of learning and harnessing the excellence in every human being for building an intellectual, prosperous, sustainable, and always-learning society"

ii) Mission

Establishing a comprehensive research university of open learning in Nepal with extensive involvement of Nepalese Diaspora community

iii) Goals

1. to take university to people's homes and communities with a robust technological foundation,
2. to remove all barriers to higher learning opportunities including those of income, disadvantageous social circumstances, geography, and readiness by mode of open learning,
3. to meet informational, educational, technical and vocational needs of people by connecting learners with sources of knowledge and skills that may be found anywhere inside or outside the country,
4. to convert the raw knowledge and skills found in the nature, society and culture into formal knowledge by means of distributed knowledge production, co-development and collaboration,
5. to continue educating and training youth that take foreign employment by facilitating lifelong education and learning,
6. to convert brain drain into brain gain by mobilizing Diaspora people in education, research and transfer of knowledge and skills,
7. to offer a learning system that scales to rising enrolments and efficiently adapts to population movement,
8. to bring people residing outside big cities into the mainstream of knowledge economy through education, transfer of skills, and entrepreneurial knowledge,
9. to become the model open university of the 21st century,
10. to democratize education and diversify learning by making it possible to educate all people.

IV) Objectives

1. Establish Nepal's National University of higher learning: a public open university by 2015
2. Mobilize in-country and Diaspora contributors for distributed educational content development and delivery by 2015
3. Secure broadband communication infrastructure in 12 districts in Muktinath-Lumbini corridor for first pilot operation of the university by 2015, and throughout Nepal by 2018
4. Offer at least 3 academic degrees of rural interest, 2 degrees of urban interest, and 1 degrees of workers-abroad interest by 2016
5. Secure technical collaboration and assistance from the best distance learning institutions to establish best practices and best technological solutions by 2016
6. Provide technological foundation, content foundation and bridging programs to school systems for improving primary and secondary education by 2020
7. Become the university with the largest range of program offerings in Nepal by 2025

3.3 Stakeholders, roles and responsibilities

Through agreements of September 20, 2010 and October 07, 2010, NRNA has entered into partnership with the Government of Nepal – Ministry of Education, Athabasca University Canada, and Canada Foundation for Nepal with regards to establishing the national Open University in Nepal. All partners sincerely contributed to the mission and brought the mission to prominence. However, the dissolution

of the first Constituent Assembly before passing necessary law for the establishment of the Open University and formation of the Open University Infrastructure Development Board (OUNIDB) without dissolving the Open University Initiative Steering Committee formed in October 2010 and subsequent transfer of government fund to the OUNIDB led to less than desirable situation arising out of the digression from the main course of the targeted mission. That happened especially because the OUNIDB executives did not uphold the spirits of the past agreements and that of the works of the Diaspora, thereby creating some stress and unforeseen delays in the mission. Nevertheless, the Diaspora initiative persisted until the scenario was changed. Consequently, NRNA was able to re-negotiate with the MoE to uphold the spirits of the past agreements. There was a positive response from the MoE and, as a result, a MoU was signed again in June 10, 2014. This new agreement MoE set the role of NRNA in the initiative by using its power to give directives to the OUNIDB. The board meeting of the OUNIDB has already adopted the MoU for implementation. In another fortunate turn of event in the way forward, the top three political parties represented in the legislature parliament of Nepal have made written commitment to establishing the Open University through their respective election manifestos, and the most parliamentary parties of Nepal have spoken of their support for establishing the OUN, which is also a top priority project of Ministry of Education.

The most recent situation has been that NRNA has re-negotiated with the government to claim the stake in the leadership of the mission for a fixed number of years and establish the university under its leadership. At the time OUNITF ToR was written the TF Chair had proposed that NRNA should re-negotiate with the government for the following kind of distribution of roles.

3.4 NRNA

1. Negotiates with the Government of Nepal for the renewed commitment to the agreement made in October 2010,
2. Assumes the leadership of the mission for minimum of five to ten years, puts its financial, academic and technical expertise into establishing a world class Open University in Nepal;
3. Develops plans and solicits national and international funding in collaboration with other national and international partners;
4. Establishes a fully functioning and world class Open University in Nepal by 2020;
5. Works with other national and international academic, philanthropic, and development partners to implement OUN plans;
6. Hands over the institution to the people of Nepal through a governing body duly formed as per the law made by the Legislative Parliament of Nepal at the end of its term;

(**Note:** In the subsequent weeks after the presentation of this document to the President of NRNA, one round of negotiation has already been done with the Ministry of Education. We have received unequivocal words from the Ministry that (1) the spirit of the past agreements will be honoured, (2) NRNA contributions will be duly acknowledged, and (3) the bill to the parliament will be tabled with acknowledgment and space for NRNs.)

3.5 Government of Nepal

1. Provides necessary legal outlet to establish OUN as an autonomous public university and to set up a dedicated endowment fund and accounts;
2. Exempts custom duties on equipment and supplies imported for the use of OUN by NRNA, its sister organizations, and partner institutions be they newly purchased or be free of cost transfer of already operating technological equipment, mobile computing devices, data servers and machinery previously used by other international institutions;
3. Permits equal opportunity for Nepalese Diaspora to contribute through their academic, administrative and management roles in the operations of OUN as Nepalese nationals;
4. Allows academics and professional experts to render services to OUN physically or virtually from Nepal and abroad and be financially compensated as per contracts made between OUN and the contributors;

5. Recognizes NRNA as the lead partner organization for establishing OUN and supports NRNA's efforts to mobilize agreed international funding, in-kind support and expertise for the development and operation of OUN.

3.6 Athabasca University, CFFN, and Other potential partners

1. Collaborate in developing plans, seeking funding for the establishment of the Open University;
2. Partner in the implementation of the agreed upon components of the OUN plan;
3. Adapt courses and processes and translate open knowledge and courseware applicable to the OUN;
4. Develop open content, tutor and collaborate in research, program development and program delivery;
5. Collaborate in training of OUN faculty and staff in open education;
6. Take other roles as may be mutually agreed. Task-Force Team

At the time of this writing the proposed negotiation has successfully taken place and some results have already started to show up.

3.7 Initial task force members

Pramod Dhakal, Canada, Chair and chair of the first TF, Drona P. Rasali, Canada, Co-chair and member of the first TF, Ambika P. Adhikari, USA, member of the first TF, Raju Adhikari, Australia, member of first TF and Chair of SKI, Ashok K Shrestha, Australia, Bishal K Sitaula, Norway, Devi B Basnet, Korea, Dharam KC, Saudi Arabia, Dina Bangdel, USA, Gokul Bhandari, Canada
Ishara Parajuli, Thailand, Jeet Joshee, USA, Krishna Chandra Prasad, Netherlands, Krishna Hamal, Australia, Mahabir Pun, Nepal, Ram Giri, Japan
Rana Lama Yonjan, Netherland, Eknath Khatiwada, Zambia

3.8 Task force advisors

1. RNA President, Shesh Ghale
2. Kedar Bhakta Mathema, Ex Vice Chancellor TU,
3. Bidyanath Koirala, Professor TU
4. NRNA Regional Coordinators

3.9 Team expansion and development approach

The tally above is the team dedicated to provide immediate traction in the project. Upon ratification of this TOR by the ICC, the regional coordinators will be asked to communicate with Deputy Regional Coordinators, ICC Members and NCCs to provide one coordinator per country. The country coordinators of the region will then select among themselves the regional coordinators to represent the ICC Task-Force to honour the kind of system NRNA has established for its everyday functioning.

The country coordinator thus selected will take lead role to form NRNA country chapters named OUNI Country Chapter. Subsequently, the member of the Country Chapter will select/elect their own Country Chapter Coordinator. The NRNA ICC Member, NRNA country chapter President, and Regional Coordinator and Deputy Regional Coordinator applicable to that chapter will be advisors to each chapter. From each region two people will be selected to represent the region to the main task force. Once the team is formed in that manner, the Task Force will be reformed at that moment.

3.10 Resources and financial plan

i) Office and Human Resource:

1. OUNTF Office Unit at the NRNA ICC Secretariat or some appropriate place in Nepal, with basic computing and printing facilities.
2. Internet connection in the office and WiMax based Internet facility to take around the pilot area and to OUNI programs to facilitate Diaspora member participation in programs.
3. Four full-time staffers (a, b, c) and one part time staffer (e) reporting to the Task Force Chair with the following responsibilities on a semi-volunteer basis:
    a. Technology and Communication: Develops website, implements mass communication and social media solutions, integrates technology solutions for pilot programs, acquires and assembles Open Source content libraries, installs the technology solutions and delivers training in pilot area.
    b. Administration, Program Development and Outreach: Writes articles, utilizes social media for outreach, sends and receives emails and processes them, organizes workshops, recruits volunteers, interfaces with media, takes minutes, manages volunteer works, manages program development.
    c. Office Assistant: keeps accounts, transcribes conversations presentations, keeps office records, receives and delivers documents, prepares record of programs and proceedings, edits and archives pictures, videos and audio recordings, handles immediate needs of visitors, keeps office open and organized.
    d. Distance and Open Learning Course Coordinator: Works closely with Nepali Diaspora academics around the world under the leadership of TF Co-Chair in designing, adaptation and adoption of the courses for the pilot programs.
    e. Grant Writer: Collect data, interface with experts, write grant applications, submit grant applications and follow-up.

ii) Financial Resources

Minimum Resources:

1. The staff be supported with a small token salary of Rs 10, 000 per month per person (Rs, 40,000 in case of Course coordinator).
2. Internet and phone communication costs incurred on the mission.
3. Office expenses and basic travel expenses of volunteers and staff.
4. Cost of organizing public programs and those with policy makers.
5. Cost of printing and distribution of OUN related publications made by the task force.
6. Cost incurred in pilot open education program.
7. Cost incurred in the initial travel for fund and awareness raising among NRNs.

We estimate that about $20,000 will be needed to demonstrate visible NRNA impact.

Actions Requiring Significant Resources:

1. About $100,000 is required to professionally develop a Semi-Comprehensive Operational Plan of the Open University that will be good enough to solicit funding from international agencies and to position NRNA as the frontier institution to develop the university.
2. Pursue and acquire fund for developing comprehensive operational plan and, through it, develop the fully developed comprehensive operational plan.
3. Write grant applications for achieving component goals and associated activities as required to implement the plan,

4. Acquire land for the OUN, mostly public land; but nearly always there appears a need to also purchase some private land adjoining or enclosed in the public land for enhancing the land use, gaining adequate size for future, and cleanly avoiding any future boundary disputes and access issues ($100,000 - $300,000).
5. Develop pilot programs along with human resource, communication infrastructure and computing infrastructure for their implementation ($50,000).

(Note: Much of this fund will have to be raised among NRNA community, which will be practicable once we gain traction in implementing the 2010 agreement made with the Government of Nepal. As soon as the government eases on its exclusive grip on it and accepts NRNA as an official and lead developer force, it will bring back the excitement there was in Nepal and among NRN communities during 2010-2012.)

3.11 Work breakdown and schedule

1) Immediate term plan (6 months):

1. NRNA delegation negotiates with the government and reclaims the ownership of the initiative on behalf of NRNs such that NRN team will lead the initiative during its establishment phase,
2. Finalize OU White Paper in participation with major stakeholders and advance it along with the Open University Bill to the parliament as a key instrument to educate about the advantages of Diaspora mobilization,
3. Create a 3 member ICC team to oversee OU matters and develop Terms of Reference for forming and running NRN OUNI Country Chapters,
4. Lobby with leaders of major political parties to reclaim NRNA stake,
5. Prepare a document outlining changes required in the proposed bill to ensure full and honourable participation of NRNs in the future of Open University, especially including:

a. Using Diaspora skills, knowledge, and innovation to be one of its stated goals,

b. Participation of NRNs as equals to resident Nepalese in the academic and administrative positions,

c. Freedom to co-develop and co-own programs, materials, resources, research-output and innovations with similar foreign institutions,

d. Upholding the principle of openness in knowledge and information,

e. Open ownership of inventions and innovations with fair and democratic system to reward innovators,

f. Government obligation to ensure affordable access to broadband Internet by all Nepalese learners irrespective of their location and economic standing.

g. System of total openness in continuing, technical and vocational programs and a balance of inclusion and competitive entry in professional and advanced academic programs.

6. NRNA take initiative to create “Parliamentary friends of Open University” to further its claim and expedite the passage of the bill.
7. Establish a NRNA Open Education Project Office as an NRNA arm operating full-time in NRNA office premises or at some suitable location.
8. Launch pilot programs on “use of open content in transformation of schools and college education” and “collaborative knowledge creation”, which will immediately popularize open education as well and NRNA brand among Nepalese people.

2) Near term plan (1 year):

1. Establish OUNI chapters in at least in 6 countries.
2. Clinch NRNA and Diaspora stake in OU governance by putting necessary instruments in Open University Bill.

3. Intensify lobbying for accelerating the passage of OU bill.
4. Select a location for OU Central Campus and establish citizen's group involving resident and Diaspora members.
5. NRNA apply funding application to launch "Diaspora Collaboration in Open Curriculum and Open Content Production" with donor agencies active in Nepal.
6. NRNA call for Diaspora faculties and professionals willing to collaborate with local schools and colleges in content production, tutoring, research and mentoring.
7. NRNA launch a baseline data collection and resource mapping projects integrated with school, college, and local development in one municipality and one village development council.
8. NRNA provide training on screen casting, podcasting, and multimedia content development to 60 students and teachers of six schools and colleges in the pilot area.
9. OUNI launches a series of pilot academic programs in collaboration with Athabasca University and other academic institutions in Nepal and abroad.

3) Short term plan (2 years):

1. Establish OUNI chapters in at least in 20 countries.
2. NRNA launch a Diaspora volunteerism in enhancement of public school education, where NRNA provides the connection between the schools and volunteers and experience sharing platform; the expenses are covered by volunteer themselves.
3. Establish parliament sanctioned entity, Open University, with Diaspora stake in it.
4. Develop "Diaspora Affairs Unit" within Open University dedicated to engaging NRNs in education, research, innovation and collaboration building.
5. Develop one bridge-course on each on Science, Mathematics, and English to cater to students who wish to independently study to qualify for Open University programs at Technical and Vocational Diploma or Bachelor's level.
6. Identify the plans and curriculum for at least five technical and vocational programs that can modernize existing trades and bring in terrain-specific engineering and technology.
7. Collaborate with other stakeholders to develop one broadband wireless corridor with at least 50 schools and colleges to demonstrate the efficiency and effectiveness of the open education programs.
8. Develop one hundred rural-youth podcasters, screen casters, and multimedia content developers dedicated to open education.

4) Near-long-term plan (5 years):

1. Establish OUNI country chapter in 70% countries with NRNA NCCs.
2. Engage 500 Diaspora faculties, scientists and professionals in Open University and open education associated research, innovation and academic collaborations.
3. Engage two dozen Diaspora faculties in "massively open online courses".
4. Develop a comprehensive plan for academic programs for OUN
5. Make Nepal a country where every student has affordable access to broadband wireless connectivity in collaboration with other national and international stakeholders.
6. Make Nepal a country mobile learning, where every student has smart mobile learning device with access to Internet, open content, and open education programs.

3.12 Risks and risk mitigation

Risks:

1. If adequate space for NRNA and NRNs could not be secured in the Open University Initiative through committed negotiation with the government, the synergy, momentum, and enthusiasm required to accomplish the mission may not be created among NRNs.
2. Risk of exclusion, lack of funds, lack of government support, delays in passage of bill in the parliament, loss of quality, and loss of team unity would be risks to the program success.

Mitigation Strategies:

1. Team expansion and country chapter formation will commence only after properly negotiating with the government, and securing written commitment to honour the October 2010 resolution.
2. The task-force will widely disseminate information to NRNs to raise awareness.
3. Regular bimonthly updates will be circulated among NRNs and wider public as were done until the government takeover of May 2012.
4. Interactions will be held in sufficient numbers and the institutional design discussions will be held in Internet based public forums.
5. Inclusion strategies and programs will be developed through public and participatory forums, and will be implemented as per decisions thus made.
6. Mechanisms will be created to make donations to qualify for charitable status (for tax-exemption on income).
7. Avenues to match the donations from other corporate or philanthropic sources will be sought to encourage contributions.
8. Maximum initial mobilization of Diaspora from the region that will have the honour to host the headquarters of the OU will be done in fundraising among Diaspora community.
9. Colleges and buildings will be allowed to be named by donors if they contribute to the majority of expense required to build or establish them.
10. Maximum transparency and openness will be practiced to keep our collective enthusiasm intact.
11. TF team events will be organized along with NRNA programs to maintain team unity.

4.0 Nepal Science Foundation (NSF) Trust-Flagship Project [1-3, 12]

4.1 Background

The concept of the Science Foundation Trust was initiated in 2009. Following several rounds of discussion and meetings [1-3], a formal presentation was made in NRN ICC regional conference in Sydney in 2010 which culminated in the NRN declaration to form the Foundation as a non-profit Trust. Nepal Science Foundation initiative is now on a take-off stage. Open University Initiative and Nepal Science Foundation have made debut as NRN Diaspora's gifts to Nepal. At the initial phase, a MoU was also signed with Nepal Academy of Science and Technology (NAST) in 2011 to promote collaboration between SKI and Nepal in the areas of S&T. In the NRNA global conference 2013, SKI conducted a joint workshop on OUNI and NSF. As the 2013 conference was wrapping up, Nepal Science Foundation formally became a registered legal entity as a Trust incorporated in Nepal under the prevalent laws.

4.2 Nexus with NRN fraternity

The Act of incorporation mentions clearly the role and initiative of NRN fraternity in founding "the Trust for the advancement of knowledge, science and technology, skills and applied researches for the larger benefit of the peoples of Nepal".

While the structure is framed as an autonomous entity with liability among the members, the following points explain further its strong links with the NRN global body:

(a) The incumbent president and founder president of NRN-ICC will be patrons of the Executive Committee and the Governing Council;

(b) The letterhead of the Trust clearly mentions: NRN global initiative for skill, knowledge and innovation (SKI) transfer.

(c) The membership is open to all NRN members.

(d) The present coordination committee is comprised of former or standing members of NRN-ICC body and is given a global character by encouraging regional geographic representation (see the composition of present Committee).

(e) The members, by their academic standing and experience, give high credibility to the newly formed body and NRN-ICC.

(f) NRN policy body plays significant role at the general body meeting of the Trust.

(g) NRNA has room to enhance its role in a befitting manner in the management of the Trust.

4.3 Conceptual framework, scope and limitations

The NSF initiative is envisaged to unfold the ideas and concepts of scholars and professionals of the NRN movement pertaining to the promotion of science, technology and scholarship in Nepal. In this process, emphasis on science has a broader connotation, not only confined to the core science and technology discipline. It is intended to encompass management of resources, economic planning, behavioural changes, better governance standards, and pursuit of options that assure better quality of living for the people.

Currently NSF is operating from a small office with a very limited staff to keep the overhead expenses at the minimum. Even in the future, it is envisioned that NSF will not be an implementing agency but will advance its mission through outsourcing, partnerships and collaboration with specialized agencies and minimise operational costs.

4.4 Policy priorities

a. The core fund is yet to gain its full value through payment of membership fees and transfer of previously committed funds. Some members are said to prefer the transfers to be deposited into a special income generating account providing for the use of interest accruals only to cover program overhead costs. In that case we should be raising some funds to cover basic operation cost of the organization. Members are welcome to put forward their views and suggestions.

b. In light of above mentioned constraints, the listing of programs and activities for this year are few and many of them are intended as partnership projects. All the members are requested to assume and exercise their role as custodians of the Trust and contribute towards its development by ascertaining their sense of belonging and collective ownership.

5. Programs and Activities

During the transitional phase of first year, some programs and activities are proposed but their implementation will be conditioned on availability of resources.

5.1 NSF website

NSF website has now been launched (http://nsft.org/)and will be upgraded and advanced over time. The website will gradually ease the functioning of the organisation, help disseminate information and unfold the prospects of partnerships, program development and linkages. Please visit website for update information or contact us directly.

5.2 Office management system development

This will involve installation of internet devices and communication equipment such as computer, printer, photocopier, etc. The office is located in Bag Bazaar. The present office bearers and members of the Executive Committee are as follows:

Patrons: Mr Upendra Mahato, Mr. Shesh Ghale

Board Members: Dr Raju Adhikari- Chair, Mr Gokul Pokhrel-Coordinator , Mr B.K. Mainali, Dr Pramod Dhakal, Dr Shobhakar Dhakal, Dr Hem Raj Sharma, Mr Mana K.C. Mr Bhagirath Yogi, Dr Ambika Adhikari, Dr Drona Rasali, Dr Benu Adhikari, Mr Rajesh Rana.

5.3 Science education policy development conference

This is the program developed in 2013 but was postponed due to Constituent Assembly elections. The proposal developed last year is ready to be sent to Education Ministry, GoN. Likewise, several other potential stakeholders, national as well as international, will be approached to participate in the program

5.4 Baseline Study on science information dissemination over national media channels

The expansion of media networks (newspapers, journals, radio and television) will be studied in order to ascertain the potential of science information dissemination over national and provincial media networks which have made their presence all over Nepal. (Estimated cost: Rs.25, 000). Proposal outline will be available on demand.

5.5 Exploratory expedition of remote Nepal

NSF intends to sponsor a "Nature trek of science lovers, students and researchers to the most remote mountainous trails of Nepal. The first proposed such route is from Jumla to Hilsa of Humla district bordering Tibet. The program will involve a 10-day trek involving both native and foreign researchers. The newly launched website will be used to reach out to potential clients, supporters and sponsors if we are to undertake this program.

5.6 General body meeting

This meeting is mandatory as per the statute of incorporation and law. It is assumed that NRN anniversary Day falls on 11 October. Hence, the meeting is proposed during the preceding or following week of the event. Exact date will be finalized after consultation with Trust members, NRN-ICC and SKI Committee.

5.7 Awards and commendations

During the GB meeting and Opening function, some awards and commendations are proposed as followed:

a. Publication of a brochure of information about the Trust.

b. Special souvenir and commendation plaque to founder members and certificates to general members, donors and contributors.

c. Some awards (proposed if sponsors are available):

S&T Outstanding Award for Media Excellence: Prizes will be given to a FM radio network, Television channel or newspaper for having rendered exemplary service in the dissemination of S&T information and public awakening, combat superstitions, etc. Some token commendations to outstanding science teachers, researchers of Nepal as may be feasible.

5.8 Note of thanks

NSF acknowledges contributions received from President Shesh Ghale, Founding President Dr. Upendra Mahato, Vice-President Baban Bhatta, Mr. Chandra Yonzon, and NRN Australia for the seed fund amounting to AD 28,000.00. We also thank the ICC for the continuous support.

5.9 NSF membership

One of the major source of revenue for NSF is through membership drive. There are two types of membership i) Ordinary membership $ 250.00 and ii) Life membership $ 1000.00 and we encourage everyone to avail the membership and support NSF activities.

6. Annual SKI Brain Drain Seminar Initiative [1-3]

The seminar project commenced since 2012 as a joint exercise with Nepal Academy of Science and Technology (NAST) and Biotechnology Society of Nepal (BSN). The major objective of the seminar to provide an interactive forum between Nepalese and Diaspora's professional to share their R&D

experience and develop an effective professional networking, highlight and advocate importance of R&D program and forge linkages with policy makers in GoN.

The seminar has met most of its objectives, especially one of networking resident and Diaspora scientists. To-date, five seminars in various discipline of science have been held, which are held every six months. It has grown to an extent that it may be diversified from Biotechnology to other S&T disciplines. Saroj Ghimire (co-ordinator) Devi Basnet and team is currently working on new ToR and a detailed project plan to make SKI seminar aligned to SKI objectives prudently.

The seminar will be an ongoing activities and NSF is considering to promote this forum to a one day international seminar in the future to cover broader areas of S&T.

7. Skill Inventory Project [1-3]

SKI has embarked on this project in 2011 to prepare a comprehensive database of NRN professionals and skills to unite and utilise Diaspora human resources and recycle the brain drain to brain gain for Nepal's development. The main objectives of this project are:

To create a platform for professional networking; support skill transfer back to Nepal for the development of Nepal; create NRN's psychographic and demographic profile; explore opportunities for NRNs in the different corner of the world; and build a "Who is Who" list of people from Nepal living abroad.

A repository to store NRN's academic and professional information has been developed (http://nrna.org.np/ski/) and will work as an online tool to connect NRNs. The database of NRN Diaspora will be made available on request to GoN and professional organisation to connect NRN's skill and knowledge to various development projects in Nepal.

The project commenced in early 2013 with a feasibility study to develop a database program. The data collection had been one of the major challenges so SKI committee and the the team of Lok Raj Sharma, Drona Rasali and Shree Napit is working to improve the current database to make it more interactive to allow sharing skill information with NAST and other professional organisations. SKI inventory process flow is shown in figure 5.

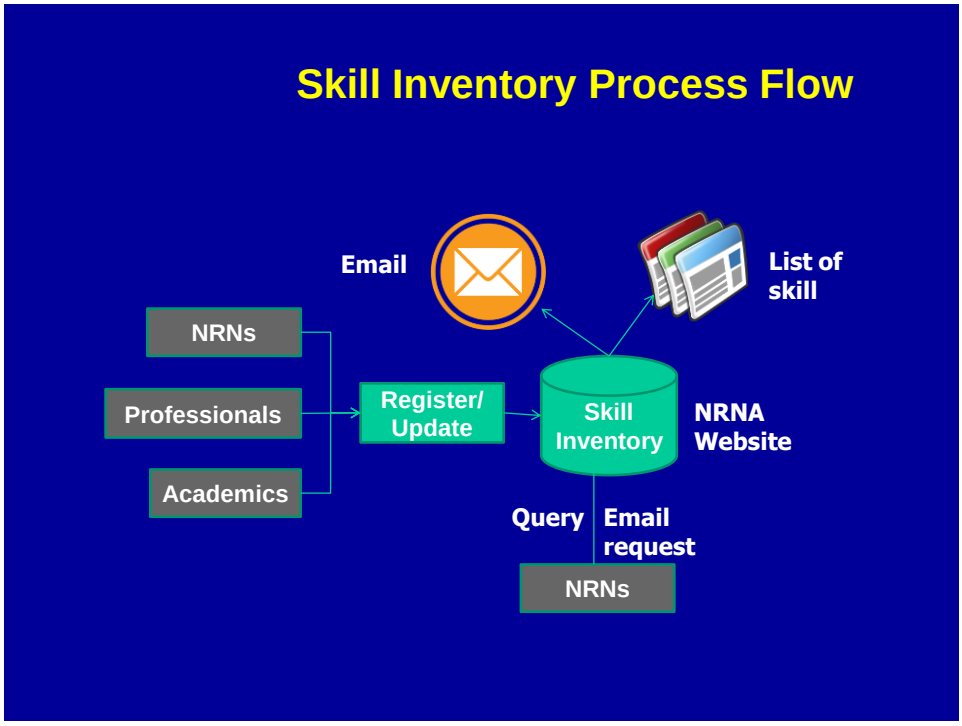

Figure 5: Skill Inventory Process flow

8. Miscellaneous

Beside above projects, a large number of projects at NCC levels are under discussion in areas of biotechnology, health and environment. SKI team at NCC level will work closely with SKI committee to coordinate NCC level projects.

9. Conclusion

As activities in SKI domain are maturing, SKI Committee is expected to motivate the Diaspora to work unitedly on a knowledge investment front to successfully execute flagship projects like Open University Nepal Initiative (OUNI) and Nepal Science Foundation Trust (NSF) along with other projects in national priority areas. The ICC endorsement of SKI flagship projects has provided a long term commitment and NRNA support is critical for its future success and will enable SKI to play a meaningful role in Nepal's overall development.

SKI committee would like to convey sincere thanks to NRNA leaders and teams at both ICC and NCC levels, Government of Nepal and its agencies such as NAST, MoE, MoST&E, National Planning Commission (NPC), Universities, FNCCI for their ongoing support and help.

SKI committee would like to solicit your feedback, suggestions and ideas and our contact email address is.

nrnicc_ski_committee@googlegroups.com

10. References

SKI 1st Quarterly Report, NRN ICC

SKI 2nd Quarterly Report, NRN ICC

Working towards knowledge investment, Nepalnews.com, March, 2011

Open University Update, OUSC, April 2009

A copy of MoU between NRNA and Ministry of Education (MoE)

A copy of MoU between NRNA and Nepal Academy of Science and Technology (NAST)

ICT enabled education solution for Nepal: E library for Rural development, A project report prepared by HeNN and NRN

A Position Paper on Open University of Nepal Initiative "Through the Light of Knowledge©"November 2013

Open University Update, OUSC, April 2009

A copy of MoU between NRNA and Ministry of Education (MoE)

Name of OUNI proponents

Dr Pramod Dhakal, Dr Ambika Adhikari, Dr Drona Rasali, Dr Raju Adhikari

NSFT Reports, July 2013, November 2014, NRN ICC

Skills, Knowledge and Innovation (SKI) Transfer: what is it and how can this be achieved?

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Abstract

The Non-Resident Nepali Association (NRNA) is motivated to work towards transferring skills, knowledge and innovation (SKI) from NRNs to Nepal. This paper analyses feasibility of achieving this in the context of growing globalisation. It argues that currently transfer of new knowledge from NRNs to Nepal is outside the reach of NRNA as the new and useful knowledge and innovation are heavily protected. Consequently, it is not possible for NRNs to do a meaningful transfer of knowledge and innovation. The only component of SKI that can be transferred from NRNs to Nepal is the 'skills'. Therefore the paper recommends that NRNA should focus on skills transfer rather than all three components of the SKI. The paper also provides a roadmap to achieve that.

1. Introduction

Since the past few years, the NRN community scattered across the globe, has shown a great interest in helping their motherland by transferring whatever they can - their skills, knowledge, innovations and investments. As most NRNs have acquired a range of skills and knowledge, some at the cutting edge of their profession, through education, training and work experience, they most likely have the capability to make such transfers. Some of the NRNs have also become successful entrepreneurs and are now willing to invest in Nepal. Furthermore, many in Nepal believe that the NRNs may one day provide much needed innovative ideas, skills, knowledge and financial resources that could help develop the country.

To initiate such transfer of skills, knowledge and innovation (SKI) of NRNs the International Coordination Council (ICC) of the NRNA set up a taskforce in 2009. This taskforce conducted ground work to establish the two flagship projects: the Open University Nepal (OUN) and the Nepal Science Foundation (NSF). Recognizing the importance of this issue, the NRNA-ICC recently formed a permanent SKI committee and developed its terms of reference to manage the transfer of SKI. Recently, a memorandum of understanding was signed by the Nepal Government and NRNA to create frameworks for the establishment of the OUN.

From the various reports and newspaper articles written by the SKI taskforce, we deduce that their emphasis is mainly centered on the OUN and NSF as the vehicles for the SKI transfer. In the past, they had also identified the e-Library project as one of the means to transfer SKI but that appears to have been abandoned. While these initiatives in themselves undoubtedly are praiseworthy, it is still unclear how were they chosen, how can they become the most appropriate vehicles to transfer diverse fields of SKI from a globally scattered community of NRNs and how will these institutions actually implement the transfer. The answers to all of these will depend on how these institutions will evolve and operate; how and what courses will be taught at the OUN; and whether the NSF will be busy in organizing just another talkfest or will do some substantive work and deliver on its objectives. It may not be farfetched if someone claims that OUN and NSF will focus more on 'knowledge' transfer, a bit on skills transfer if some vocational courses were included in the curriculum of the OUN. Whether the transfer of innovation will be covered is not clear yet but as we will argue below the transfer of innovation is not likely to happen in any way in the next 10-20 years when Nepal has to make a leap.

It needs to be recognized here that knowledge transfer without innovation and/or skills transfer would have no real impact. The transfer of knowledge without innovation or skills transfer - has been the key characteristic of Nepalese education system so far. Without higher level skills graduates will be unable

to start private enterprise to employ themselves and create employment for others or be employable by profit-seeking enterprises; they will always rely on the government to create jobs for them.

Innovation comes with business investments and carries high risks. It is therefore more responsive to incentives, rewards and opportunities. Whether innovative NRNs will embrace the OUN and NSF flagship model, therefore, depends on whether these flagships also work on creating investment friendly environment in Nepal. They also need to offer unique opportunity of combining the new knowledge, skills and local resources available in Nepal. Despite good intensions, without proper facilities innovators/investors will go where the best opportunities for profits are.

There seems to be a lack of congruence in the meaning of SKI and what the mechanism of its transfer should be. For example, for many NRNs, knowledge and innovation have come through scientific disciplines and not from the other sectors/disciplines which significantly contribute to income, welfare and standard of living of the people. Due to such misconceptions and lack of understanding resulting from inadequate communications or miscommunications many NRNs with potential for transferring SKI are hesitant to take part in the dialogues and debates on SKI. Given that there is a need to better understand the concept of SKI and the appropriate mechanisms of its transfer, it appears that there is a considerable scope to refocus and adjust the scope of activities the NRNA SKI committee.

Before we start elaborating on the process or mechanism of SKI transfer, we need to understand clearly what the terms skills, knowledge and innovation mean. To make an effective transfer, we need to know exactly what we want (or propose) to transfer before we start transferring. Therefore the purpose of this paper is to (i) broadly describe the SKI concepts in simple terms (ii) explain what does SKI mean, which components of SKI can be transferred and outline its effective transfer mechanism with a road map. Once we are clear on what we want to transfer, how can we transfer it, where and to whom do we transfer it clearly, specific projects can be designed and implemented for effective transfers. An open and serious discussion on the proposals outlined in this paper may help achieve that.

2. What are Skills, Knowledge and Innovations?

Skills

“Skills” means ability to do something well arising from talent, practice, or formal or informal vocational training or experience. Skills enable a person to do a given task more efficiently relative to an unskilled person. Skills reduce wastage of time or material resources or both and thus lower the cost of producing goods and services. Other things remaining the same, better skills make a person more competitive, more productive, which in a fairer society results in higher incomes and a higher standard of living which, in turn, are measures of progress. Higher rewards to higher skills can come from the costs saved and therefore may not impose any burden to the rest of the society. Higher skills add values and create new wealth to share.

For a country to remain competitive and progressive higher skills should always be rewarded. A society that does not reward skills adequately will not provide necessary incentives to people to acquire additional skills. If skills stagnate, the country loses its competitive edge in the globalised market and economic growth stops and may even regress.

Knowledge

Any new understanding is considered as a ‘new invention’ - some patentable, some not. Accumulation of all these ‘inventions’ or ‘discoveries‘ made over time and across the world both in areas of natural sciences or in social sciences or in any other field results in the stock of ‘knowledge’ available for all to use, albeit not always free of charge.

“Knowledge”, therefore, is a familiarity, awareness or systematic understanding of something based on facts, information, or descriptions which is acquired generally through formal (academic) education or training and/or research. As scientists, in areas of agriculture, engineering, medicine, information technology and others, possess a great deal of knowledge on their specific field so do the intellectuals or personnel in the field of, for example sociology, business, education, religion or politics. Most stock of knowledge is stored in text books, whereas the incremental or the frontier knowledge lies with the researchers and in their recent publications. A distinction needs to be made between the stock of

knowledge and the frontier knowledge by which the stock grows.

A country that has access to frontier knowledge can enjoy the early mover's advantage in putting the skills of its workforce at the highest level. It, therefore, will always be able to gain additional competitive advantage in the global market place. Countries which cannot afford to maintain the frontier research capability may, nevertheless, try to benefit from their access to people working at the frontier research if an access to such research outcome can be managed through, for example, by technology transfer or by organizing and attending conferences, seminars and workshops on frontier research. This is perhaps what NRNA wants to do when it is aiming to transfer knowledge to Nepal. We, however, have to be aware of the various barriers, such as IP rights, being put in place and the absorptive capacity of the country.

Innovation

"Innovation" is the act of *creating* something original, new or novel such as applying a new idea or theory or device or product or patent resulting from a study or experimentation. Innovation could apply to any field or anything. For example, a biological or physical scientist could propose a new hypothesis for testing or could develop new techniques, methods or tools for the first time while a successful innovative business person could propose new ideas for rapid spread and reaching to scale of his/her business ideas or products. In agriculture research and extension, innovative ideas could be ways of rapidly transferring new technologies to farmers at scale in both time and space. Further, an academician or an education specialist could introduce online or e-learning or distance education which could be something new, innovative delivery mechanism for schools and universities of Nepal. However, we need to be clear at this point that the proposed method should be using a new technique for the first time. If this new method of delivery has been in use elsewhere and is being introduced in Nepal, then, viewed in a global context, it is the skill of delivering online education that is being transferred to Nepal, NOT the innovation in the delivery of education.

The innovators are the ones who recognize that the new idea is useful to the society. They use new ideas either to create a new product or create more valuable products from the same inputs (or costs) or to reduce the cost of production of the existing products. They can gather relevant stakeholders, explain their vision and organize the necessary production and/or distribution process and support further research to reduce the costs to minimum (re-innovation). At the same time they upgrade the skill level of their workforce. In short, the innovators are the ones who turn new ideas into cash (value). They provide the crucial link between the idea creators (inventors), market and the skilled workforce (skills).

In summary, the value of knowledge lies in its fruitful application in solving human problems by ingenious means. While doing so it also alters the skill sets of the workforce that produces and distributes the goods and services. People will learn a new software, drive or operate a new machine and so on. The art and science of applying a new knowledge (or inventions) into practice is called innovation.

It follows from the meanings and examples of skills, knowledge and innovation given above, that these terms are not only "science based" but also encompass an array of non-scientific activities that have potential to bring dramatic positive changes in income, improve quality of human life and enhance wellbeing. In a nutshell, knowledge points to people engaged in basic research, skills refers to productive workforce from carpenter to a world class scientist - and innovation refers to the entrepreneurs, policy makers and other visionaries who make things happen.

3. Elements of a Transfer and its Mechanism

Elements of transfers

All transfers have the following three distinguishing elements.

- A transfer takes place between two parties: one that gives and the other that receives. In the proposed SKI transfers, the NRN community is the giver and the resident Nepali population is the receiver.

- The object being transferred changes 'custodianship' or creates new owners.

- Transfers are different from exchanges in the sense that transfers are mostly one way and are given free of charge while exchange is a two way process – both parties give and receive objects of almost equal value. In transfers, the party who transfers does not expect anything in return as a compensation for the stuff transferred.

This distinction between transfer and exchanges is sometimes confounded by the presence of an unintended transfer in commercial exchanges. For example, if an overseas company with a superior technology enters into a business deal with a Nepali partner and brings in, say, solar powered ovens to run a bakery. People are employed and trained by this company, which quickly becomes a success. Other people copy it. In a matter of years solar powered bakeries with different names are seen all over the country. Here the technology trickled down from a foreign company to bakeries owned by other Nepali businessmen. This effect was not a part of the business deal between the foreign company and its Nepali partner. This transfer of technology is propagated by the way of commercial competitiveness. This is not the sort of transfer NRNA SKI project is considering to make happen. Our understanding is that NRNA is interested in intentional transfers of the SKI from NRNs to Nepal. Transfers that occur through commercial or business investments are governed by profits, excluding the externalities, and are the issues dealt by other teams.

The supply side: who are the givers of SKI?

NRNs with various skills, knowledge and innovative ability are spread across the globe. Obviously, NRNA, in principle, would rely on all NRNs for the supply of the necessary skills, knowledge and innovations. As the transfer is meant to be free and for the benefits of resident Nepali individuals not all NRNs would be in a position to play the role of a giver. Many NRNs, who are at their prime working age, may not be able to spare more than a few days in a year for such volunteering works, they are time constrained, they may not have acquired enough skills at the cutting edge to be able to teach others what they know; or they may not have attained a comfortable position to share their innovative ideas if they are in the innovation space.

Planning, organizing and executing the real transfer of any component of SKI would involve time, money and other resources. NRNA, therefore, can be advised to identify the section of the NRN population that has something to transfer; that they are willing and interested to make the transfer voluntarily. This section of the NRN population then can be provided with a mechanism to make the transfer.

A number of NRNs are now entering into retiring age. Over time a constant flow of retiree population will be forthcoming. As it is a well known fact that altruism increases with age, this segment of the NRN population can be tapped and utilized to run the transfer program, including the transfer of their own skills, knowledge and innovative ideas. NRNA SKI committee may need to start liaising with this segment of the NRN population and identify the conditions under which some of them may be willing to work/participate on this project. They could be genuine and reliable suppliers of SKI (brain gain) that can help change the country. In our view, retired NRNs constitute the core of the supply side of the transfer. Around this core, other prime age and second generation NRNs may add their value.

The demand side: who are the enthusiastic recipients of SKI in Nepal?

Skill is a relative concept. In a dynamic world, relative skill levels of a person/society keep changing and therefore need constant updating. A progressive society therefore sets up incentive structures for people to actively seek to update their skill levels all the time. In principle, there must be an infinite desire to learn and update all sorts of skills in Nepal. It should not come as a surprise that in advanced economies skills are valued highly.

However, in a society, where rewards are reserved for attributes other than skills, such as caste, kinship and connections, people may lack necessary incentives/motivations/drive to acquire additional skills. In such societies, benefits of higher skills (or human capital) acquired by a person go to enrich someone

else. Similar arguments hold for acquiring additional knowledge or innovative skills.

The question then arises is whether Nepal as a country provide adequate incentives/motivations to people to upgrade their skills, knowledge and innovation or not. A positive answer would indicate the existence of the demand for better skills in Nepal. A negative answer to this question may explain why the SKI level of an average Nepali has been so low by international comparison and that may call for additional steps to remove the factors causing the disincentives.

As all elements of SKI constitute what is known as the 'human capital' the key question can be stated in terms of the real ownership of the human capital in Nepal. It is a question of property rights and its enforcement. Whether the human capital embodied in a person's SKI is owned by the person or not, whether the fruits of human capital belong to its owner or not and whether this property right has been unambiguously enforced in Nepal or not?

Unless people are fully assured that they can reap a fair share of the benefits of their own SKI, we safely assert that, there would not be any party in Nepal who would be enthusiastically looking forward to receive any transfer of SKI from the NRNs. We further claim that current governance framework fails to deliver this guarantee which has been the real, fundamental reason of Nepal's backwardness.

Without any complementary program to establish rule of law in Nepal, where the law would guarantee a fair share of the benefits of SKI to its owner, it is highly likely that the whole exercise of SKI transfer would just be a series of expensive talkfest and dramas. Irrespective of how serious and dedicated NRNs are to transfer their SKI to resident Nepalese, there will not be any serious motivation to receive it and therefore there will not be any meaningful transfer of it.

Matching demand with supply of SKI

A proper matching of demand for SKI with its supply would be a critical element in a successful transfer of SKI from NRNs to Nepal. As mentioned earlier, the supply of SKI is scattered across the globe while demand is also spread out across Nepal. It is quite possible that many NRNs would like to transfer their SKI, which may manifest in many different forms, to their own place of birth or places they lived or worked for a long time before they moved overseas while many others would like to transfer anywhere in the country as long as there is demand for their type of SKI. Similarly, there may be shortage of a particular type of SKI in a particular location, and hence they may not be interested in other types of SKI. For example, apple farmers in Jumla may be looking for expert help in production, processing and marketing of apples; they may not benefit and not interested in the transfer of the service of a world class mining engineer.

4. Skills Transfer or SKI Transfer: What Should be the Focus?

Can we transfer skills? Yes. Can we transfer Knowledge? Yes. Can we transfer Innovation? Conditionally yes, but it depends on the situation. Innovators need to have access to the new ideas. For example, buying of a pizza franchise and helping to set up pizza business in Nepal is not necessarily an innovation. It could surely be a new business, but is not an innovative business. If new business were developed around the patents (or novelty of equivalent status in other fields), possibly held by NRNs, then that may constitute an innovation. If that business were developed by resident Nepali then that would be considered as a transfer of innovation.

Quite a number of NRNs are highly skilled people. Their skills, whether simple or complex, are transferrable under appropriate conditions. These skills embody a lot of knowledge and therefore transfer of these skills would also entail a concurrent transfer of 'old' and 'new' knowledge and in some case it may involve a bit of re-innovation (subsequent cost reducing activity of an innovative business).

Knowledge is transferred through three different ways: by involving in the cutting edge research (transfer of frontier knowledge), by teaching or lecturing (transfer of pure knowledge for its own sake such as religious sermons) and through skill transfers (teaching with real world and useful application).

Transfer of frontier knowledge may occur if collaborative research at the cutting edge – for new inventions - can be organised between Nepal and some leading foreign institution. Given the current state of Nepali institutions, an effective transfer of frontier knowledge can be put on the back burner for the next 10-20 years. This is our reality.

Transfer of knowledge for its own sake can be done, but this is not new. This is what Nepali educational institutions have been doing so far. It may or may not bring change in the skill levels of the Nepali population. Any knowledge that does not impact on the productive skills of people is worthless as far as it is being done in addressing the problem facing the country.

Transfer of knowledge that is done through enhancement of productive skills of the people has the potential to bring the change. It is better done by directly transferring the higher skills NRNs may have to people living in Nepal. Naturally this process will require some knowledge transfer. In this case the knowledge would be custom designed and so packaged to fit the need of the skills that are being transferred.

A successful Innovation links frontier Knowledge with Skills and ultimately, up-skills people involved in the process. It may also bring in new resources. In a globalised economy, which is very competitive, the innovation that matters is the one that applies the frontier knowledge, not the application of old or traditional knowledge. The innovators who apply frontier knowledge, regardless of where they are located, will drive away their competitors across the world. It is just a matter of time. There is, however, some scope to make money by applying old knowledge (re-innovation) in Nepal, but it will not be sustained in the longer run. Innovators may use old knowledge for some time as a stepping stone to move up to the frontier knowledge but would not survive if they remained tied up with the old one for too long. We need to be acutely aware of this fact and note that the flow of the frontier knowledge is severely restricted.

At this point, we assert that, at least currently and in the near future, the NRNA will not be able to transfer the new and frontier knowledge to Nepal even if some NRNs are working at the cutting edge. As a corollary to this we also assert that, at least currently and in the near future, the NRNA cannot transfer the big I of innovation to Nepal as it does not have access to the new knowledge. The only condition under which such a transfer may happen is that if the innovation requires the employment of the resource available only (or mainly) in Nepal (such as Yarsagumba or Ophiocordyceps sinensis). This possibility should be taken as an exception rather than a rule. So the possibility of innovation transfer at the moment is limited to re-innovation (further reduction of costs), provided Nepali labour force and other resources become internationally cost competitive. Nevertheless, the long-term vision and goals of NRNA should be to transfer knowledge and innovations too.

In a nutshell, the only meaningful and effective transfer NRNA can do immediately is that of the Skills. If most of the skilled NRNs, whether working as a professor or a scientist or a plumber, are determined they can transfer their skills to Nepal provided it is wanted in the country. As there may be a big gap between the skill levels of the NRNs and that of a Nepali counterpart, a successful transfer resulting in its application will be a significant leap-frogging.

To make sure that skills of NRNs are wanted in Nepal, we need to make sure that the rules are fair and provide adequate incentives to up-skilling and that they are enforced. To do so NRNA may need to play the role of a strong civil society as well.

We, therefore, propose that the NRNA rename its SKI committee to ‘Skills’ Transfer committee and devote its resources in mapping out and matching the supplies of various skills to their demand in Nepal. By contributing in the up-skilling of the Nepali population NRNs can make a significant contribution in the development of the nation.

5. Road Map for an Effective Skills Transfer

A study needs to be urgently conducted to identify potential users or demanders of SKI in Nepal. For example, is SKI needed in scientific research sector (for example, innovative and cutting-edge research in agriculture, engineering, medicine, information and communication technologies-ICTs, etc.) or is it required in extension and development sector (for example, extension and dissemination of research outputs in various sectors by using spatial and quantitative techniques such as decision support systems and tools)? Is there a demand of skilled construction workers (for example, in roads, transports,

electricity, etc.) or of skilled hospitality trainers or graduates in big hotels and restaurants? Is there a demand of cutting-edge ICT, such as cloud computing, on-line or electronic delivery of education, and spatial and quantitative techniques such as remote sensing and computer modelling? Are skills and innovations required for introduction of new tools and technologies for modernization of the airports, roads and trains services? Are knowledge and innovations required in reduction or elimination of bureaucracy and corruption and for modernization of public sector organizations and institutions? Do we NRNs need to provide special trainings to government officials to modernize the public sector organizations? What sorts of innovations would be required in the education sector? Obviously, on-line or e-learning and distance education are powerful methods of delivery and are already included under OUN Flagship project of NRNA-ICC-SKI Committee. Transfer of SKI by NRNs would be needed in the schools, vocational education and training (VET) centres and in colleges and universities. However, a systematic database would be required identifying districts where there is a greater demand of NRNs as teachers to close the education and learning gap in schools, VET centres, and colleges and universities. Likewise, SKI transfers by NRNs would be needed in health sector such as in hospitals and medical colleges, and database needs to be urgently prepared to identify the demands of NRN health professionals (doctors, nurses, aged-care and child care workers, etc.).

Another aspect of demand side of SKI transfer is the need to educate people to feel the need of SKI transfer by NRNs. Many people in Nepal may not know that there is tremendous SKI with NRNs across the globe and hence they need to be educated. On the other hand, what are the terms and conditions under which NRN-generated SKI would be sought? What are the motivations for NRNs to transfer their SKI? For example, some NRNs, especially semi-retirees or retirees, may transfer their SKIs voluntarily for prestige and honor while the NRNs of their early- or mid-career may expect some remunerations or travel expenses to travel to Nepal and dedicate themselves in transfer of their SKI. Will the Nepal government be ready to recognize or honor the senior and retired NRNs who want voluntarily be involved in transfer process, or the government be ready to provide the energetic, innovative and dedicated NRNs the minimal (or actual) expenses required to travel to Nepal and be involved in transfer process? In addition, some NRNs may generate funds themselves through fund-raising activities or approach donors to support their SKI transfer activities while some may require funds from the Nepal government to implement their activities. This all needs to be worked out in details while preparing the mechanisms and roadmap for transfer of SKI.

The following steps may provide a road map to the transfer of skills at the conceptual level:

- Develop a current NRN-Skills database with a forward-looking time profile of availability. The database would include the Skills profile and the timing and conditions under which it can be available for the transfer.

- In this endeavor, NRNA-ICC initiated to prepare a database of such NRN personnel since the inception of NRNA-ICC Task Force. However, it seems that the database is incomplete and possibly has become obsolete. Hence, an updated database of NRN-SKI suppliers is urgently needed. Such a database should include various types of skills suppliers currently available or to be available in near or distant future and conditions under which the effective skills suppliers maybe available or forthcoming.

- Establish a Skills Transfer Team in Nepal that
    - liaises with the government departments, NGOs, rural communities and producers/employers and identifies their needs for specific types of skills
    - Match the needs with the NRN-Skills database
    - Negotiate the terms of engagements

- Evaluate whether Nepali legal/constitutional framework provides adequate incentives to people to up-skill themselves. To make sure that this happens NRNA should also play the role of a strong civil society.

- Make sure that NRNs work together with local counterparts and stakeholders and ultimately handover their SKI activities to the locals (the transfer happens).

- Monitor the effectiveness of the transfer and review the program every two years.

6. Conclusions

Skills, knowledge and innovation do not just relate to science and academic area but include all aspects of non-scientific and non-academic activities. Though NRNA's long-term vision and goals should be to the transfer of knowledge and innovations, transfer of new knowledge and innovations from NRNs to Nepal currently and in the near future is outside the capacity of NRNA. The only component of SKI NRNA can effectively and meaningfully transfer from NRNs to Nepal is the 'skills'. Therefore, we recommend that the NRNA SKI committee focus on 'Skills' transfer rather than SKI transfer. A roadmap is also provided for the NRNA to follow.

Transfer, Evaluation and Dissemination of an Innovative Fertilizer Management Tool (Nutrient Expert®) for Increasing Crop Yields and Farmers' Income in Eastern Nepal

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Abstract

There are large gaps between crop yield potential and farmers' yields in Nepal due to use of low-yielding crop varieties; inadequate and inefficient use of water and nutrients, inadequate control of insect pests and diseases, and prevailing socio-economic factors. Of all external inputs required for crop production, nutrients are the most limiting ones, and yield gaps can be closed by efficient nutrient management. Fertilizers are the most important sources of nutrients and are required in large amounts to meet crop demand. In Nepal, nutrients (or fertilizers) recommendations by government bodies and research stations are based on blanket recommendations for a region or district without considering the site-specific soil and weather conditions. This results in under-fertilization in some areas and over-fertilization in others. Moreover, in most cases, there is imbalanced and inadequate use of nutrients which can decrease the nutrient use efficiency (NUE) and profitability and may increase environmental risks associated with loss of unutilized nutrients through emissions or leaching. However, an opportunity exists to enhance yield, profitability and NUE through site-specific nutrient management (SSNM). SSNM captures the spatial and temporal variability in soil fertility and provides an approach to "feeding" crops with all required nutrients based on crop needs.

An innovative, ICT-based decision support systems (DSS) tool such as Nutrient Expert® (NE) for maize, rice and wheat has been developed and evaluated across several farmers' fields in South and SE Asia by International Plant Nutrition Institute (IPNI) and International Maize and Wheat Improvement Centre (CIMMYT). The NE is an easy-to-use, simple computer based DSS or delivery tool that can rapidly provide nutrient recommendations for N, P and K for these crops for individual farmer's fields in presence or absence of soil testing results. Field evaluations of NE across several locations in South Asia, including eastern India, have shown that the location-specific nutrient recommendations by the tool increased yields of maize, rice and wheat and economic benefits of farmers compared with farmers' practices and government blanket recommendations. However, it has not been introduced and evaluated yet in Nepal.

As a case study for SKI Transfer, NRNA Australia will introduce and evaluate the NE for these crops across 200 farmers' fields in two Eastern districts (Jhapa and Morang) bordering West Bengal and Bihar of India in 2014/2015 rabi (winter) season and 2015 kharif (rainy) season through FORWARD (a Chitwan-based NGO but with field staff located in the two districts) and in collaboration with IPNI South Asia. Researchers and extension workers will be provided a short 1-2 day training on NE by IPNI staff before they will be engaged in its evaluation. In the second and third years (2015-2016 and 2016-2017), the tool will be further extended to large number of other fields in those two districts. The knowledge gained from three years of collaborative and innovative work with local farmers and

stakeholders and with IPNI can be utilised for further evaluation and dissemination of the tool to other neighbouring districts of Eastern Nepal. After 3 years of such extensive evaluation and dissemination of NE, we expect efficient use of fertilizers and increased crop yield and income of large number of farmers in Eastern Nepal.

1. Background, Rationale and Relevance

There are large gaps between crop yield potential and farmers' yields. Some of the causes of yield gaps are: use of low-yielding crop varieties; inadequate and inefficient use of water and nutrients; and inadequate control of insect pests and diseases. Of all external inputs required for crop production in Nepal, nutrients are the most limiting factor. In reliable and predictable rainfall environments and under assured irrigation conditions with proper control of pests and diseases, nutrients become the most limiting factor and yield gaps can be closed only by efficient nutrient management.

In Nepal, fertilizer recommendations by government bodies and research stations are based on blanket recommendations for a region or district without considering the site-specific soil and weather conditions. This has resulted in under-fertilization in some areas and over-fertilization in others. In most cases, there is low use of all nutrients while in some cases there is relatively high use of nitrogen (N) and phosphorus (P) and low use of potassium (K), secondary and micro-nutrients. Such imbalanced and inadequate use of nutrients can decrease the nutrient use efficiency (NUE) and profitability and may increase environmental risks associated with loss of unutilized nutrients through emissions or leaching. However, an opportunity exists to enhance yield, profitability and NUE of crops through site-specific nutrient management (SSNM). SSNM captures the spatial and temporal variability in soil fertility in small-holder production systems and provides an approach to "feeding" crops with all required nutrients based on crop needs and thus can improve NUE, crop yield and farmers' income (Dobermann et al., 1996).

An innovative, information and communications technology (ICT)-based decision support systems (DSS) tool such as Nutrient Expert® (NE) for maize, rice and wheat has been developed and evaluated across several farmers' fields in South and SE Asia by International Plant Nutrition Institute (IPNI) and International Maize and Wheat Improvement Centre (CIMMYT) (Pampolino et al., 2012). The NE is an easy-to-use, simple computer based DSS or delivery tool that can rapidly provide nutrient recommendations for N, P and K for above crops for individual farmer's fields in presence or absence of soil testing results. NE has recently received the best innovation award from the Government of Bihar, India, and has been selected as the best ICT solution for improving rural livelihood (IPNI Press Release, 2013). Field evaluations of NE across several locations in South Asia, including eastern India, have shown that the location-specific nutrient recommendations by the tool increased yields of maize, rice and wheat and economic benefits of farmers compared with farmers' fertilizer practices and government's blanket recommendations for states or regions or districts (Sapkota et al., 2014). However, the NE tool has not been introduced and evaluated yet in Nepal.

The short-term objective of the proposed project is to evaluate the NE tool with cereal crops (maize, rice and wheat) comparing three fertilizer management practices in Jhapa and Morang districts in eastern Nepal: (1) Farmers' current fertilizer management practice (FFP), (2) District-based fertilizer recommendation by government, and (3) NE-based fertilizer recommendation. The long-term objectives are to increase farmers' crop yields and farmers' income in eastern Nepal and beyond by adopting site-specific fertilizer recommendations provided by the NE tool.

2. Study Design and Methodology

As a case study for transferring the skills, knowledge, and innovation (SKI) by NRNs living abroad to Nepal, NRNA (Non-resident Nepalese Association)-NCC Australia will introduce and evaluate the NE for rice, wheat and maize initially across 100 farmers' fields in 2 eastern districts (Jhapa and Morang) bordering West Bengal and Bihar of India in 2014/15 rabi (winter) season and 2015 kharif (rainy) season.

Three nutrient management treatments will be evaluated: (1) FFP, (2) District-based fertilizer recommendation by government, and (3) NE-based fertilizer recommendation. Each treatment will be evaluated in 50-100 m^2 area depending on land availability. Thus, considering the need for bunds or

alleyways between 2 plots, each farmer will allocate about 200-400 m^2 land for wheat or maize trials. If a farmer wants to participate in the evaluation of both crop trials, he/she will have to allocate approx. 400-800 m^2 field. In rice season also, each trial will be evaluated in 200-400 m^2 land. As far as possible, rabi crops will be planted just after rice harvest in November, and kharif (main) rice will be transplanted in July. Most commonly-used high yielding varieties of rice, maize and wheat in the districts will be used. Crop, water, fertilizer and pests and weed management will be aimed to be excellent in all fields. Grain yield of each crop will be recorded from 10 m^2 sampling area in each plot/treatment and will be expressed in 14% moisture content for rice and wheat and 15.5% for maize. Straw yield will also be recorded due to its economic value and economic analysis of various treatments will be conducted.

Researchers and extension workers involved in the project will be provided short 1-day training on NE before they will be engaged in its evaluation. In the second and third years (2015-16 and 2016-17), the evaluation trials will be further extended for providing site-specific fertilizer recommendations to 200-300 more fields in each of those two districts. However, it is highly expected that there will be spill-over effects of this tool and so the tool will be used to provide fertilizer recommendations to large number of farmers (say around 2000-3000 farmers) in each district.

An inception workshop of the project will be conducted jointly by FORWARD and NRNA-Australia before the start of the project in October 2014. This workshop will also synchronise with the one-day training by IPNI staff for FORWARD staff and local stakeholders on the use of NE software for wheat and maize trials in 2014-15 (this training will also be conducted before starting rice trials in June 2015). Two one-day workshops will be organised to share the results of field trials with local farmers and stakeholders after completion of each season trial in May 2015 and October 2015 (during first year). Such NE trainings and workshops will be conducted during the second and third years also (details will be provided later on). Representatives from all relevant government (GOs) and non-government organizations (NGOs) such as from NARES, local influential people and farmers, IPNI, and NRNA-Australia will be invited during the inception meeting and ensuing workshops.

3. Partners Involved and Mechanisms of SKI Transfer

FORWARD, Nepal (www.forwardnepal.org): It is a non-profit, service-oriented national NGO established in 1997 to help disadvantaged groups and the rural poor. It is registered at the District Administration Office, Chitwan, and affiliated to the Social Welfare Council, Nepal. Its head office is in Chitwan and project offices in various working districts. The organization aims at reducing poverty of marginalized communities through integrated and sustainable development interventions. It provides forum to researchers, development professionals, rural artisans, private sectors, academia, grass root level organizations and funding agencies committed to change the quality of lives of underprivileged people in Nepal. FORWARD's program activities are focused towards improving food and nutrition security, household incomes and resource conservation to contribute to sustainable livelihoods. It integrates social mobilization, agriculture, livestock, aquaculture, farm forestry, biodiversity conservation, and value chain and market development in a multi-stakeholder approach in partnership with government, non-government organizations and private sectors both at national and local levels. As a cross cutting theme, interventions related to climate change impacts such as drought, floods, submergence, land degradation, losses in agrobiodiversity, shifts in occurrences of pests and diseases and productivity decline have been integrated into several projects implemented by the organizations. It has implemented several interventions relevant to climate change adaptation, has developed training packages and implemented trainings at the district and community levels in different parts of the country. FORWARD implements projects focusing on target groups such as poor households, women, *Dalits, Janajatis*, and children. Over the past 17 years, it has implemented 65 projects in 51districts involving a total of 3, 46,398 direct beneficiaries.

FORWARD Nepal has implemented different projects and activities aimed at improving food security and sustainable livelihoods of smallholder farmers in Jhapa and Morang districts. It has long experience of implementing farmer participatory on-farm trials, selection of farmer preferred variety/technology on cereals, legumes and vegetable crops. In the project "Promotion of rainfed Rabi Cropping (RRC)" implemented between 2001-2007, improved varieties of rice, wheat, maize, pea, buckwheat, chickpea and other crops were intervened among farmers in a multistakeholder approach involving farmer groups, government line agencies and local NGOs/CBOs. This was followed by the implementation of the project "Poverty Reduction through Crops Intensification in Rice Fallow" during 2008-2012 through

DFID UK grant support, wherein improved rice and legume varieties were promoted through distribution of informal research and development (IRDs), capacity building of farmers, initiation of community based seed production (CBSP) programs to enhance access to seeds of improved varieties among farmers, organization of farmers field days (FFDs), interaction workshops, and excursion visits.

FORWARD, with field staff also located in Jhapa and Morang districts, will be the main collaborator in the project but local district- and village-level agriculture development officers under NARES (National Agricultural Research and Extension System) and other stakeholders will also be involved. The study will be conducted in collaboration with IPNI South Asia.

IPNI, Delhi (www.ipni.net): The South Asia Program of IPNI operates with three research scientists managing the program activities in four regions of the program area. It follows the mandate of IPNI, which is "to develop and promote scientific information about the responsible management of plant nutrition for the benefit of the human family". Scientific information on improved nutrient management strategies for crops and cropping systems is generated through research collaboration with the State Agricultural Universities (SAUs) network, NARS of different South Asian countries, as well as in partnership with other international organizations such as CIMMYT and IRRI. Extension and educational efforts to disseminate relevant information to the stakeholders are done in close coordination with the fertilizer industry, extension wings of SAUs and the state governments.

Developing and validating the Nutrient Expert® decision support tool for wheat and maize, in collaboration with national and international partners, was one of the most significant achievements in the last three years. Besides improving crop yield and farm profitability, the tool-based recommendation significantly reduced the GHG emission from farm fields as compared to the existing nutrient management practices (Sapkota et al., 2014). Several NARES partners, State Govts. and other stakeholders are now using these tools while the CGIAR CCAFS Program is using this tool as a scalable technology in the "Climate Smart Villages" project in India. IPNI is now gathering large-scale omission plot data for cotton and soybean to develop the Nutrient Expert® decision support tools for these crops. Besides the above work, IPNI research program across the program area extends to rationalizing fertilizer use in rice-based and groundnut-based cropping systems, estimating temporal changes in nutrient availability under differing management intensity and farmer typology based fertilizer application strategies to improve productivity, profitability and environmental sustenance of fertilizer use. For disseminating improved nutrient management practices, IPNI-South Asia Program produces multi-lingual videos, plant nutrient deficiency books, extension literature and scientific publication to improve awareness of different stakeholder groups.

NRNA-NCC Australia (www.nrn.org.au): NRNA-NCC Australia has recently initiated an "Elderly Housing Project" (called "Pathivara Jestha Nagarik Shradhashram/Bridhhashram" project in Nepali) in collaboration with Biratnagar Municipality in Biratnagar, Morang district. The proponents of that project will visit Biratnagar time to time for monitoring and follow-ups of the project. FORWARD and NRNA-NCC Australia (Dr.Timsina and the proponents of Elderly Housing Project) will coordinate and monitor the NE evaluation trials and will provide technical and logistical advice as and when necessary. Progress of field trials and dissemination of the NE tool will be communicated time to time through farmers' visits and farmers' field days, local newspapers and local FM radios. Such results will also be widely communicated and disseminated by FORWARD, IPNI, and NRNA-Australia through their communication and dissemination means such as their websites, social media such as Facebook and Twitter, newsletters and other publications.

IPNI will provide funds for field evaluation and dissemination of NE tool and will also provide training on NE to field staff and stakeholders. A MoU will be signed between FORWARD, NRNA-NCC Australia and IPNI before start of the implementation of the project. IPNI will transfer funds to FORWARD's account. The budget for the first year (2014-15) approved by IPNI is $13577.00. The budget line items are 2 field staff (one for each district), local travels for field staff and Chitwan-based staff, local travel and accommodation for consultants/experts, expenses for inception workshop and NE training and dissemination workshops, operational costs, and other dissemination related activities such as farmers' field days and farmers' visits, etc. Budget has a provision of 5% overhead cost for FORWARD. Budgets for the second and third years will be prepared after the progress of the first year and upon consultation with IPNI.

FORWARD will be responsible for managing and coordinating the field activities, selecting farmer co-operators, organising workshops, trainings, farmers field visits and field days, disseminating trial results

and reaching more number of farmers for adoption of NE recommendation, and in writing and submitting the reports to IPNI. FORWARD will also assign their senior, experienced staff in supervision and monitoring of trials as and when necessary.

Dr. Amgain will work closely with FORWARD staff and Dr. Timsina. He will assist in providing NE training and on the use of NE tool by field staff and local researchers and extension workers, and in data compilation and report writing.

Dr. Timsina (representing NRNA-NCC Australia and NCC/ICC-SKI Committee) will contribute his expertise and knowledge free-of charge and also bear his international travel expenses (Melbourne-Kathmandu-Melbourne) to visit the field trials in Nepal. He will be responsible for liaising between IPNI and FORWARD in terms of budgets and technical details, providing overall technical supervision and guidance, checking and ensuring activities are carried out as per milestones, and in assisting FORWARD in writing and submitting the reports to IPNI and NRNA-NCC Australia, and the latter to ICC-SKI Committee as per the deadline.

4. Expected Outcomes, Results and Impact

FORWARD will prepare and submit the half-yearly and annual report to IPNI and NRNA-NCC Australia, the latter will then submit to NRNA-ICC-SKI. After 3 years of such extensive evaluation and dissemination of NE with help and support from FORWARD, IPNI, and NRNA-Australia, we expect efficient use of fertilizers and increased crop yield and farmers' income of more than 5000 farmers in these two districts alone resulting in significant economic and community-level impacts. Since NE will recommend the fertilizers as per crop's needs, nutrient (especially N) losses through emissions and leaching will be reduced, resulting in environmental impacts. The knowledge and data gathered from three years of field evaluation and dissemination study will be published in a high-impact scientific journal which will have scientific impact of the project. The experience and knowledge gained from this collaborative and innovative partnership among FORWARD and other agencies/stakeholders in Nepal, NRNA Australia, and IPNI can be used by other GOs and NGOs and the donor communities for further evaluation and dissemination of the tool to other neighbouring districts of eastern Nepal and beyond. The "success story" gained from this study could be a basis for further transfer of such knowledge and innovation by other NRNs also who are spread across the globe. NRNA-ICC-SKI Committee could play a key role in coordinating and transmitting such ideas to NRNA-NCCs of other countries.

5. Challenges, Risks and Opportunities

The project activities will be conducted with farmers who have varying levels of farm size, family size and socio-economic status. The project requires active participation by farmers for its success throughout the implementation period. Farmer participation is expected during all stages of the project: planning, design, implementation and evaluation of NE trials and the dissemination and adoption of NE tool. During the planning and design stage farmers will need to understand about the importance of the trials and the project and should be motivated to participate in field trials. During the implementation stage, farmers need to provide their labour for planting, weeding, fertilizer and irrigation application, and for harvesting and threshing. Of all, fertilizer application at right time and right amount for the three proposed treatments is critical; otherwise, they may not see the benefits of NE tool for achieving increased yield and income. Likewise, if water and weed management are not properly done then the benefits of NE tool may not be obvious. Although farmers will start seeing the benefits from the project after finishing one year (ideally two years) they may not have patience to wait that long as some farmers want to see the benefits immediately. This may pose some social risks and challenges.

Likewise, other local stakeholders involved in the project may also have much higher expectations than what is expected of the project. Such expectations may be in terms of receiving more funds from donors, IPNI, NRNA Australia and FORWARD to expand such activities in other villages and nearby districts.

These are the real and valid challenges posing some risks. The project proponents believe that they can't deal with the natural calamities such as heavy rainfall and flooding, drought and heat, and associated crop damages caused by them. However, if farmers and other stakeholders participate sincerely in implementation and evaluation of field trials, there will be no or minimal risks and will have greater chances for success. Also, since crop yield potential depends on a target yield (called attainable

yield) the fertilizer recommendation by NE may be greater than what the farmers have been currently applying to achieve low yields. Farmers may continue to apply low amounts of fertilizers and obtain low yields as what they have been doing now. However, to achieve higher yields and higher income they will have to change their traditional thinking and either apply full recommendation to achieve highest possible attainable yield and high profit or income, or may apply somewhere between what they have been applying now and what the NE tool recommends to achieve moderate yield and moderate profit or income.

As stated above, once evaluation trials are conducted for 1-2 years, farmers will start seeing benefits of NE tool and will start using fertilizers for three crops as per the recommendations by the tool. During this initial phase of NE evaluation, representatives of some other stakeholders of the project such as extension agencies (GOs and NGOs), seed and fertilizer companies, and some special government initiatives such as Maize Mission or Food Security Initiatives, etc. will also receive NE training by IPNI and they will also visit the NE evaluation trials. It is expected that these agencies will approach NRNA Australia, IPNI and FORWARD for more trainings so that they themselves can disseminate the NE tool to large number of other farmers in their extension and development domains. This phenomenon has happened in Bihar, India, which resulted in large adoption and impact of NE tool in that state last year (IPNI Press Release, 2013). Such innovative work by IPNI together with diverse collaborators resulted in granting of an Innovation Award to IPNI. NRNA Australia, IPNI and FORWARD will be interested in providing such training for extrapolation of project ideas and tools by these agencies themselves to other villages and districts in eastern Nepal and beyond. This way, there will be sustainability and large impacts of the project activities.

NRNA Australia and IPNI expect that there will be enough capacity building of the FORWARD and all related stakeholders during the first three years of the project so that they themselves can train more people in other districts of Nepal. However, since NRNs are spread all over the globe, more NCCs from other countries may also be willing to transfer, evaluate and disseminate the NE and similar other innovative tools in other districts of Nepal. This way there will be some sort of follow-ups for sustainability by NRNs of Australia and other countries.

6. References

Dobermann, A., Cassman, K.G., Peng, S., Tan, P.S., Phung, C.V., Sta. Cruz, P.C., Bajita, J.B., Adviento, M.A A. and Olk, D.C. (1996), *Precision nutrient management in intensive irrigated rice systems,* In: Proceedings of the International Symposium on Maximizing Sustainable Rice Yields through Improved Soil and Environmental Management, 11-17 November, 1996, KhonKhen, Bangkok, Thailand: 133-154

Pampolino, M.F., Witt, C., Pasuquin, J.M., Johnston, A. and Fisher, M.J. (2012), *Comp. Electr. Agric.*, 88,103–110

IPNI Press Release
http://www.ipni.net/ipniweb/portal.nsf/0/9102258F066B5D8F85257C75006744E0/$FILE/AJ-BIF%20II_PR_final_rev.pdf

Sapkota, T.B., Majumdar, K., Jat, M.L., Kumar, A., Bishnoi, D.K., McDonald, A.J. and Pampolino, M. (2014), *Field Crops Res.* 155, 233–244

Opportunities for Recycling of Agricultural Wastes for Manufacturing of High Value Fertilizer for Sustainable Agricultural Industry in Nepal

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Abstract

Subsistence oriented traditional agricultural practices in Nepal largely follow integrated farming systems using conventional approaches for soil fertility management. Conventional methods for soil fertility management rely primarily on use of compost and farmyard manure (FYM) as the main sources of plant nutrients. Recently, a shift from subsistence to semi-commercial production systems required changes in soil fertility management practices, which involved indiscriminate use of inorganic fertilizers, a decreasing trend of FYM and compost availability, and increasing use of poultry manure for crop production. More recent trends of commercial farming include crop intensification, use of high yielding varieties and specialized farming e.g. commercial vegetable and cash crops production. These are nutrient hungry production systems and currently dependent solely on inorganic fertilizers. Extreme nutrient mining by these intensive production systems imposes severe consequences for soil fertility management, including increasing cost of fertilizer, and degradation of chemical, biological and physical properties of soil leading to loss of overall soil fertility and the appearance of severe micro-nutrients deficiencies in a number of crops. A far reaching and sustainable approach includes building integrated soil fertility management together with the utilization of under-utilized sources of plant nutrients such as bio-fertilizer technologies and recycling of organic residues, enhanced composting (such as vermi-composting). Developing fertilizer products (granules, pellets, briquettes) from plant, animal and human wastes, and optimizing the use of these products as alternative fertilizers so that the economic and environmental benefits from these products can be harnessed for sustainable production of crops, without jeopardizing soil fertility and the environment, is a priority goal for sustainable agriculture. This paper describes the scope of the alternative sources of plant nutrient management and their production and scaling-up for a wider adaptation in Nepal.

1. Background, Rationale and Relevance

Nepalese economy is predominantly agriculture based with more than two-thirds of the population engaged in this sector for livelihood. Agriculture contributes 35% to gross domestic product (GDP) (MOAD, 2011). The majority of the farmers are small landholders with an average farm size of < 0.5 ha. Nepalese agriculture is predominantly subsistence oriented and follows mixed farming systems where crops, livestock and agro-forestry are integrated. The share of livestock in GDP is 12 percent. Traditionally, agricultural production systems in Nepal are primarily based on livestock manure as the major source of plant nutrients. This interdependency among crops, livestock and forest resources is still prevalent. Access to chemical fertilizers in the hill and mountain farming communities, especially to the resource-poor farmers, is very limited.

Chemical fertilizer is a critical input for increasing crop yield. Besides supplying crop nutrients, it also enhances the efficiency of other inputs such as irrigation and good quality seeds. Taking into account its importance, fertilizers use has been envisaged as a main driver for rapid economic growth in the 20 year Agriculture Perspective Plan (APP, 1995). The APP has planned to increase the use of major nutrients (NPK) from 31 kg nutrients/ha in the base year (1995) to 131 kg /ha by 2015. Recent surveys and studies show that the current level of fertilizers use in Nepal is in the range from 50 to 60 kg

nutrients/ha (OPM, 2003; ANZDEC 2002), which is less than 50% of the recommended level of fertilizer input by the APP.

The fertilizer option for Nepalese farmers encompasses a number of difficulties such as poor supply, inferior quality, increasing cost and adverse effects on soil fertility. Public sector involvement in fertilizer supply and distribution could not develop a sustainable mechanism for effective supply. Fertilizer has been always a political commodity ever since the establishment of AIC. There has always been instability in fertilizer policy; on and off in subsidies, lack of transparency and irregularity in procurement of fertilizers. Adequate supply and distribution of quality fertilizer at reasonable prices at the right time in all geographical regions have always been a big challenge for the government. There is ever growing frustration among the farmers due to unavailability of adequate quantity of quality fertilizers at reasonable prices during the cropping season.

Although chemical or inorganic fertilizers are considered as a vital input for crop production, there are several disadvantages in using them. The commonly recognized disadvantages of chemical fertilizer use in Nepal are Water pollution, heavy metal contamination, fertilizer dependency, soil acidification, trace mineral depletion, over fertilization, high energy consumption, contribution to climate change, impacts on mycorrhizas and question about long-term sustainability for Nepal as the inorganic fertilizers are not manufactured in the country.

Declining soil fertility is considered as one of the major limitations for increased productivity and food security in Nepal. Current level of dependency on inorganic fertilizers, declining use of organic sources of nutrients (FYM and compost), and limited and imbalanced use of other mineral fertilizers is inadequate to support total nutrient requirement of the country. The conventional sources of plant nutrients alone are not adequate to meet the total nutrients required for sustainable crop production in Nepal. Therefore, additional sources of plant nutrients, especially those currently under-utilized, need to be explored for sustainable crop production systems in Nepal.

There are wide ranges of alternative sources of plant nutrients that can be explored. These are based on microbial products (bio-fertilizers), recycling of organic wastes from plant, animal and human sources (e.g. green biomass, poultry manure biosolids, waste water), and a large number of mineral sources (ore and mine byproducts), which are currently being used in limited scale, but their potentials have not been fully utilized. Although there are certain limitations (technologies, costs, and market) on their wider use in Nepal, the drivers for holistic use of all possible fertilizer options are becoming more and more favored options due to increasing cost of inorganic fertilizers, greater environmental regulation and the need for complete fertilizers maintain long term soil fertility. Alternative fertilizer technologies have been rigorously researched recently and development of alternative commercial products have been routine in crop production in other countries. NRNA Skill, Knowledge and Innovation transfer to Nepal can be pivotal in showcasing the future of alternative fertilizer for Nepal and the future of farming in the country.

Based on the current statistics of Nepal, we present a scenario of how the alternative fertilizer options can provide a sustainable solution for managing soil fertility issues in Nepal. Let us take poultry manure as case in example for the alternative source of nutrients. Based on 2012 poultry statistics in Nepal, there were about 58 million broilers, 6 million layers and 1 million parent birds (Bhattarai, 2011). These birds produce about 0.3 million ton of poultry manure in a year. About 150 g of manure is produced by each bird per day, yielding a total of 1275 tons on a daily basis (yearly 465,375 ton) producing 0.465 million tons in a year of fresh and about 0.3 million tons of dry manure. Fresh poultry manure contains as high as 9% N. However, it is highly volatile during the composting process. If it is assumed that the processed poultry manure contains only 4% N, then the total N from poultry manure will be about 12,000 tons (0.3 million ton x 0.04). This quantity of manure will also contain about 4,000 tons of P and K, and appreciable amounts of micro elements. The new skills, knowledge and innovation in this project are related to converting wide ranges of biological wastes into fertilizer products. The major focus are centered around vermin-composting for conversion of fruits, vegetable and other crop related wastes; and granulation of the poultry and animal manure to make granulated dry fertilizers.

Currently, Nepal has about 2.4 million ha of arable land, of which only about 26% is irrigated (Devkota, 1999). Based on this figure, the N supply from poultry litter alone is sufficient to provide about 5.05 kg N/ha of arable land and about 20.5 kg N /ha of irrigated land. Organic waste production from plant based products in Nepal is estimated to be 2.5 million tons per year (Pokhrel and Virarahghavan, 2005). With the 0.4% N in the organic wastes, the total N from this source will be equivalent to N outputs from the poultry industry. Another major source for plant nutrients can be from bio-solids in Nepal.

With these figures, it is safe to estimate that for each hectare of irrigated land, the N contributions from poultry is about 20.5 kg, from organic waste can be about 20.5 kg, and from bio-solids about 10 kg.

Incorporation of effective legumes can add as much as 50 kg N/ha, and an additional 10 kg/ha can be from the bio-fertilizers. This calculation clearly shows that as much as 111 kg/ha N equivalent can be added into the soil through alternative fertilizer sources, if these options are well integrated into the farming systems in Nepal. This amount brings a substantial quantity of available NPK and soil carbon that not only supports the nutrients demand of the current season crop, but also contributes significantly to build soil carbon and soil fertility that has important bearings on the sustainability of crop production and soil health. Therefore, the alternative fertilizer technologies for Nepal are highly relevant and feasible.

2. Study Design and Methodology

Several other countries around the world have made great achievements in developing alternative fertilizer products, as for example Cuba after cuts in Soviet supplies were brought about by the collapse of the Soviet Bloc in 1989. This involves use of biofertilizers and fertilizers developed from organic wastes (plant wastes, animal waste, and urban sludge). Value adding to various sources of organic and inorganic materials by processing to fertilizers and developing methods for improving the efficiency in their use in crop production cab be economically viable option. Hence, the objective of the project is to develop the potential alternative sources of plant nutrients from micro-organisms (biofertilizers), and biological wastes materials and development of suitable fertilizer products bringing about productive farming outcome and sustainable livelihood in the country.

A preliminary test of concept project (2012-2014) has been funded by AusAID in Nepal for developing alternative fertilizers from the waste streams. In this project CQUniversity Australia in collaboration with TU University in Nepal is undertaking activities by involving wide range of stakeholders. There are 6 key steps in the project for achieving the outcome of developing fertilizer products from wastes:

- Inventory (volume of waste in a year) of vegetable, fruit and poultry waste for major markets in Nepal generated, and waste characterised in order to streamline future strategies for on-site waste management
- Appropriate low-cost vermin composting techniques demonstrated and evaluated and shown to be suitable for Nepal.
- Complete bio-fertilizers in the form of pellettes designed, tested, and developed at the pilot scale from poultry manures and other organic wastes and shown to be useful for production of fruits and vegetable
- Trained manpower for sustainable waste management achieved through hands-on technology modification, dev & verification & engaged multidisciplinary teams setup & working that include policy makers & private enterprises in waste production & management
- Business plan developed for long-term sustainability of biofertilizer through high quality, high value utility, and engagement of marketing and business players around biowaste generated biofertilizers
- Waste producers, researchers, business community and manufacturers networked so that current issues and future challenges of biowaste and bio-fertilizer issues in the country have been advanced and a specialised service provided on the issues

Major activities of the projects are carried out in Chitwon (vermi-composting and granulation of poultry wastes), Pokhara and Kathmandu (vermin-composting). Capacity building (11 post graduate students research), knowledge, skill and technology transfer for developing fertilizer products from waste, and developing sustainable business model for alternative fertilizers are the key theme of the project activities.

3. Partners Involved and Mechanism of Ski Transfer

CQUniversity Australia

Leading project for developing fertilizer from wastes in Nepal

Institute of Agriculture and Animal Science

Role project ordination for Nepal and administration of 11 post graduate research to develop knowledge, skill and technologies for converting waste to alternative fertilizer sources and testing them for crop production with farmers in the field.

Pancharatna Group of Poultry Industries, Chitwon, Nepal

Poultry business collaborator in Nepal participating in establishment of poultry manure granulation plant in Chitown.This industry has installed daily 10 ton capacity poultry manure granulation plant and started producing granulated chicken manure as Bio-mal for Nepal for the first time.

Everest Worm, Chitwon, Nepal

Evert worm Pty Ltd established as first business in Nepal for commercial scale of vermi-compost production from the waste generated from fruits and vegetable wholesale markets in Chitwon.This industry has installed 10 ton capacity vermi-pits for production of worms for distribution, and production of vermi-compost and vermin-liquor for the first time in Nepal and marketed and Everest worm products.

MADE Nepal, Chitwon, Nepal

A community based NGO specialized in agriculture field.This organization has installed 20 ton capacity of vermi-composting pits and started producing commercial quantity of vermin-compost for distribution to growers and also develops this facility as resource centre for the use in training and demonstration of vermin-composting practices for farmers group in Nepal.

4. Expected Outcomes, Results and Impacts

Biofertilizers

Bio-fertilizers are substances produced through biological processes with significant nutrient value that can be used as an effective source of nutrients. These contain living microorganisms which, when applied to soil, seed, or plant surfaces, colonize the rhizosphere or the interior of the plant and promote growth by increasing the availability of nutrients to the host plant (SSSA, 2011). Unlike manures and fertilizers, bio-fertilizers add nutrients to the system through the natural process of atmospheric fixation such as of N or by making nutrients available through the process of mobilization and solubilization such as for phosphorus (P). Some of these species also stimulate plant growth through the synthesis of growth-promoting substances. The microorganisms in bio-fertilizers also restore the natural nutrient cycle and build soil organic matter (OM), that support healthy plant growth and soil health, which are fundamental for sustainable soil fertility. Therefore, bio-fertilizers can contribute significantly towards reducing the use of chemical fertilizers and can play a significant role in Nepal for enriching soil fertility and fulfilling plant nutrient requirements in a sustainable way. There are several types of bio-fertilizers sources including bacteria, fungi and algae. Based on their mode of nutrient synthesis or release in soil or plant, bio-fertilizers can be categorized into different groups, which are summarized in Table 1.

Table 1. Types of bio-fertilizers based on their source and functions

Group	Type of micro-organisms
Nitrogen fixing	Symbiotic e.g. *Rhizobium, Anabaena*
	Free-living e.g. *Azotobacter, Azospirillum*
Phosphorus solubilizing	*Bacillus magaterium* var. *phosphaticum, Bacillus circulans, Pseudomonas striata* *Penicillium sp., Aspergillus awamore*
Phosphorus mobilizing	Arbuscular mycorrhiza e.g. *Glomus* sp., *Scutellospora* sp., *Sclertocystis, Gigaspora* sp.,
	Ectomycorrhiza e.g. *Laccaria* sp., *Pisolithus* sp.

Silicate and zinc solubilizing bio-fertilizers	*Bacillus* sp.
Plant growth promoting bio-fertilizers	*Pseudomonas fluorescens*

Rhizobium sp., the symbiotic N fixing bacteria, is the important group among the micro-organisms used as bio-fertilizers. Rhizobia fix atmospheric N (40 to 250 kg N/ha/yr) symbiotically in the roots nodules of host legume plants (Motghare and Gauraha, 2013). Rhizobia can also be utilized through the growing of leguminous plants as green manure which add N through fixation as well as through the decomposition of the N-rich legume biomass in the soil.

Azolla is a free-floating water fern that fix atmospheric N in association with blue green algae (BGA) (*Anabaena azollae*). The BGA belonging to a general genus, *Nostoc*, *Anabaena*, *Tolypothrix* or *Aulosira* fix atmospheric N and are used as inoculants for upland and low-land paddy rice. *Anabaena* in association with Azolla contributes up to 60 kg N /ha/season and also enriches soils with OM (Stewart *et al*. 2005). Azolla as a bio-fertilizer is commonly used in rice farming systems.

Free-living N fixing bacteria such as *Azotobacter, Azospirillum* and *Clostridium* sp. also fix N in the non-legume crops such as rice, wheat, barley, millet and cotton. These are not as common as Rhizobia but they have a potential of N fixing in the non-legume crops. Azotobacters have been used in cereals (e.g. wheat and barley), cotton, potatoes and vegetables while *Azospirillum* inoculations are recommended mainly for use in sorghum, millets, maize, sugarcane and wheat.

Phosphate-solubilizing bacteria (PSB), such as *Pantoea agglomerans* strain P5 or *Pseudomonas putida* strain P13 can solubilize the insoluble phosphate from organic and inorganic phosphate sources (Erisman et al., 2008). Due to immobilization of phosphate by mineral ions such as Fe^{++}, Fe^{+++}, Al and Ca^{++} or organic acids, the available phosphate ($H_2PO_4^-$) in soil that is absorbed by plants, can be as low as 20% of added P fertilizer.

Bio-fertilizers such as *Rhizobium, Azotobacter, Azospirillum* and BGA have been in use for a long time in Nepal. Rhizobium inoculant is used for legumes. Bio-fertilizer options are low cost, easy to transport, compatible with other alternative fertilizer resources and continuous applicaiotn is not required for a number of species. Bio-fertilizers are eco-friendly and low cost options as these can be used by small and marginal farmers, locally. Rhizobial bio-fertilizer can fix as much as 50-150 kg N/ha/year. It is free from pollution hazards. Some bio-fertilizers, such as BGA can increase rice yields by 10 to 45% and leave about 40 -50 kg/ha N in the soils for subsequent crops (Venkataraman, 1972). In addition, benefits from algalization is about 25 to 30 kg N/ha per cropping season in rice fields. Cyanobacteria secrete growth promoting substances such as IAA, IBA, NAA, amino acids, proteins and vitamins. They contribute to organic matter in soils. Cyanobacteria can grow and multiply under a wide range of pH (6.5-8.5). Hence, they can be used as a potential tool to reclaim saline or alkaline soils because of their ameliorating effect on the physico-chemical properties of soils. Azotobacter and Azospirillum, besides supplying N to soil, secrete antibiotics which act as pesticides. Mycorrhizas increase the longevity of feeder roots and surface area of roots by forming a mantle and spreading mycelia into the soil and in turn enhance the rate of absorption of macro and micro nutrients and water from the soils. Seven types of mycorrhiza have been classified on the basis of types of relationships with the hosts (Marks, 1991). Mycorrhizas also play a key role for selective absorption of immobile (P, Zn and Cu) and mobile (S, Ca, K, Fe, Mn, Cl, and N) elements to the plants (Tinker, 1984). Vesicular Arbuscular mycorrhizal (VAM) fungus reduces the plant response to soil stresses caused by high salt, drought, and toxicity associated with heavy metals, mine spoils and minor element (e.g. Mn) deficiency.

The benefits of bio-fertilizers far outweigh those of inorganic fertilizer. However, there are certain limitations for a wide scale adoption of such technologies in Nepal. The key limitations include (i) unavailability of appropriate inoculum, (ii) preservation and transport of inoculum, (iii) poor technical knowledge of farmers, (iv) cost of production, (v) lack of commercial operation, and (vi) slow effects on crops. These issues should be addressed in order to utilize the potential of bio-fertilizers for developing commercial products available to growers in Nepal.

5. Vermi-composting

Addition of organic manures to the soil improves biodiversity (soil life), long-term soil productivity and also contributes as a repository for CO_2. Organic matter increases the abundance of soil organisms by providing food and nutrients for them. Drivers for organic fertilizer are positive. More recently, use of organic fertilizer is on the rise as consumers and growers are choosing environmental friendly products. Organic fertilizers such as compost and worm castings break down slowly into complex organic structures (humus) which improve the soil by increasing water and nutrient holding capacity. In general, nutrient content in organic fertilizer is low and also much less readily available to plants than with inorganic fertilizers. Hence all organic fertilizers are classified as 'slow-releasing' fertilizers, and therefore, cannot cause fertilizer burn (Zublena *et al*., 1991).

Organic matter and organic fertilizers arise from a wide range of sources. Modern lifestyles produce increasing amount of green or organic wastes in many countries. Khatiwada *et al*. (2013) reported that nearly 2.5 million tons of organic waste (based on the daily per capita production of 0.5 kg solid waste with 53% dry matter by 26 million people) is produced in Nepal, which can be potentially used for sources for organic fertilizer production. Organic wastes are produced more in rural areas is high as these areas produce a large quantity of crop waste. A number of options are available for converting this waste into fertilizer products. The common and affordable methods include composting, vermi-composting, using waste as mulching materials and production of biochar from organic waste streams.

Vermi-compost

Vermi-compost is the manure produced by decomposing organic residues by earthworms. Earthworms have been commercially utilized for large scale recycling of wastes such as household and farming wastes. Various species of earthworms are utilized for composting wastes that produce vermi-casts and vermi-liquor as fertilizer. These products are emerging as potential organic fertilizers in recent years and they are becoming choice fertilizer for many growers. However, about one kg of earthworm is required for complete ingestion of an equal amount of waste per day. Hence a large scale vermi-composting facility is required for the utilization of large quantities of organic waste.

Organic fertilizers developed from these various wastes are bulky and expensive for long distance transport. Hence, decentralized facilities for composting have been advocated as shown in Figure 1 below.

Figure 1: Vemi-composting structures, swag for small scale composting (left), pits for medium scale and benches for large scale composting (right- with the permission of Vermi-crobe International).

Vermi-liquor

Vermi-liquior is extracted liquid from vermi-casts. It is rich in nutrients hence can be utilized as liquid fertilizer both in soil and hydroponics. It has already been used as top dressing fertilizer.

Aerobic composting

Large scale anaerobic digesters are available for the production of high quality compost from organic waste materials. Poor quality compost is a major concern for the composting industry and users of

compost. Modern digester design allows control and precision in composting hence high quality compost can be achieved by the use of such facilities.

Poultry litter and animal waste processing

Organic fertilizers are also generated from naturally occurring organic materials arising from bird and animal industries (e.g. FYM, chicken litter, animal manure, worm castings, compost, seaweed and bone meal) or naturally occurring mineral deposits (e.g. saltpeter). Unprocessed poultry litter and cattle manure often create environmental and disposal problems. However, developing fertilizer products from animal wastes, such as manure and bones through controlled processing into granulated fertilizers or phosphate-rich bone meal has great potential.

The poultry industry in Nepal has seen steady and continuous growth and is consolidating rapidly. The average size of farms is increasing and the industry is well distributed in different Development Regions in Nepal. Our previous estimate showed that poultry manure alone amounts to about 0.3 million tons in Nepal annually. This sum will increase further as the poultry industry expands. The livestock produce more than this amount. FYM is produced in quantity in the countryside; it is the main source of traditional nutrient in Nepal. Recently, there has been a considerable growth in poultry farming in the country. Management of this product has been a big challenge considering the growing poultry industry. The unprocessed application of poultry manure is common in Nepal where nutrient loss through N leaching and volatilization is a major problem. Appropriate composting, drying and granulation of poultry manure not only prevents the manure from nutrient loss, but also creates space and time and reduced transportation cost for the farmers in the hills and mountains.

Poultry manure, whether processed or unprocessed, is still a bulky fertilizer. If granulation facilities can be developed in each region, granules will be available for all regions. This will improve the availability of manure and reduce the transport cost for fertilizer distribution. Extensive field trials will be required to evaluate the effects of the granulated products on crop performance. Recently, a poultry litter granulation plant has been installed in Chitwan, Nepal and the granulated products are available in the trade name of “Biomal” for use by growers. The schematic that underpinned the granulation project is presented in Figure 2.

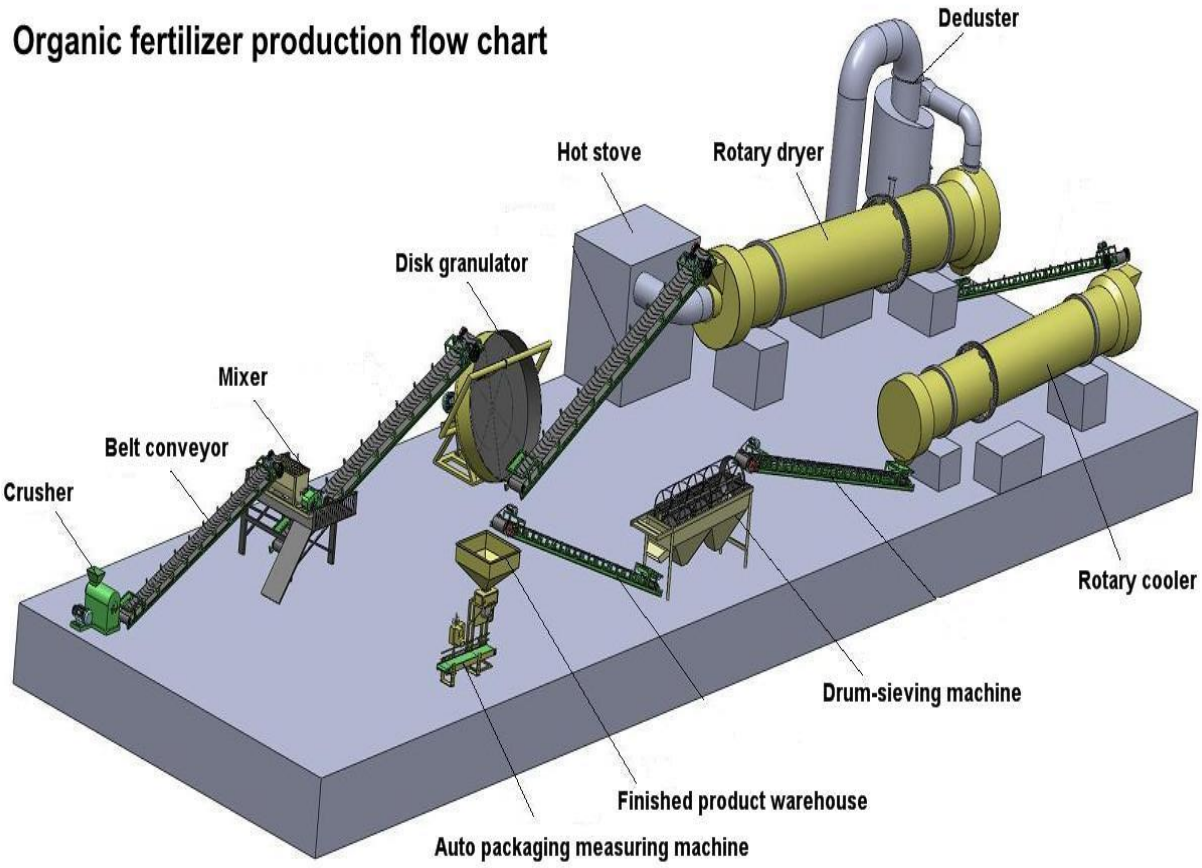

Figure 2: Continuous feed, rotary drum type poultry manure granulation plant (Source: Wang et al., 2006).

6. Challenge, Risk and Opportunities

In spite of numerous limitations of fertilizers use as listed above, Nepalese agriculture in general and food security in particular is largely dependent on fertilizers. Appropriate alternatives need to be developed for sustaining, and enhancing soil productivity, crucial for increasing the productivity and quality of agricultural produce in Nepal. The strategic vision to overcome the over-dependency on inorganic fertilizer should be based on two main themes – (i) improvement in the fertilizer use efficiency and (ii) development of alternative fertilizer products from organic resources. Prospects and methods for developing alternative fertilizer products based on organic resources are required for sustainable fertilizer supply for the Nepal. Opportunities are high as the market for alternative fertilizer products is very high, and the supply of price of chemical fertilizer are becoming increasingly prohibitory. Use of alternative fertilizers can also equally serve the organic production sector in Nepal. The challenges and risk are that organic waste used for fertilizer may contain significant load of pathogen contamination, and this should be completely removed in the fertilizer. Low cost disinfection techniques are available and this can be reasonably adapted for the waste processing process. Other challenge is the cost associated with the bulk handling of voluminous nature of alternative fertilizer, and for overcoming this issues, the production facilities for the alternative fertilizer may well be decentralized in different parts of the country according to the source of waste. The need for electricity supply can be an issue, but the power requirement for vermin-composting is almost nil, and granulation plant for poultry waste is not very high energy consuming operation, and the machine operation may well be staggered when the power is available.

7. Conclusions

The traditional sources of plant nutrients, mainly FYM, compost, and biological waste streams are not sufficient explored for fertilizer product for plant nutrients in Nepal. Therefore, it is necessary to seek other sources of plant nutrients for the sustainable crop production and maintenance of soil fertility in Nepal. Sole use of chemical fertilizer is not a sustainable approach for soil fertility management of Nepalese agriculture as the trend for increasing cost, and long term effect on soil and environment are not favorable. This project has developed capacity, skills and knowledge as well as some products for alternative fertilizer products from waste in Nepal and clearly demonstrated the commercial opportunity for up scaling of the concept for the mass scale production of alternative fertilizers from wastes in Nepal. However, there are several institutional, economical and financing limitations for large scale operation of waste to fertilizer plants in Nepal. It is time that the private sectors and the government develop strategic plans, design business opportunities and promote alternative fertilizer production in the country so as to reduce the dependency on chemical fertilizers. Establishment of industries dedicated for the development of alternative fertilizer products is a need of the day. There are now readily available options for processing of these waste streams to formulate fertilizer products so that the quality, nutrient value and transportability of these materials can be improved for large scale transport, application and adoption by farming communities. Processing techniques that lead to the products such as granules, agglomerates, and briquettes have been suggested. An integrated approach on alternative fertilizer research, development and industry support along with on-farm application trials are suggested to make significant impact of alternative fertilizer technologies for sustainable soil management in Nepal. As the country economy is still dependent on agriculture, and demand for alternative fertilizers are ever increasing, and the investment sector in the country is still not capable of developing country wide large scale industry for waste-to-fertilizer, we suggest NRN to take this as opportunity for partnering with local business and industry to lead the alternative fertilizer industry for Nepal for future farming and sustainable agriculture.

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9. References

ANZDEC, (2002), *Nepal: Agriculture sector performance review (ADB TA No. 3536-NEP)*, Main report prepared for MOAC and Asian Development Bank. ANZDEC Limited, New Zealand

Bhattarai, T.C. (2011), *Nepal - The Poultry Industry,* Meat Trade News Daily, My Republica

Carroll, S., Steven B., and Steven D. (2004), *Ecology for Gardeners*. Cambridge, Timber Press

Devkota, L. N. (1990), *Deciduous fruit production in Nepal.* In Deciduous fruit production in Asia and the Pacific (in Minas K Papudemetrious and Edward M. Herath Ed). FAO. RAP Publication

Jan Erisman, W., Sutton M.A., Galloway, J. Klimont, Z. and Winiwarter, W. (2008), *How a century of ammonia synthesis changed the world*, Nature Geoscience 1 (10), 636

Haussinger, P., Reiner Lohmüller, Allan M. W. (2000), *Ullmann's Encyclopedia of Industrial Chemistry, Volume 18,* Weinheim, Germany, Wiley-VCH Verlag GmbH and Co. KGaA, 18, 249–307

IDL Group, (2006), *APP Implementation Status Report (Vol 1)*: Main Report prepared by NARMA Consultancy Pvt. Ltd. Nepal for the Government of Nepal

IFA, Statistics, Fertilizer Indicators, Details, Raw material reserves, (2002–10)

Khatiwada, N.R., Thapa, A. and Shakya, S.M. (2013), *Biomass Utilisation for Waste Treatment and Biomass Utilisation for Waste Treatment and Energy Production: A Review in the Context of Nepal.* Paper presented in the proceedings of SchEMS, 2013. Current Status and Future Perspective of Waste Biomass Utilization in Nepal. March 7, 2013, Kathmandu, Nepal

Lawrence, F. (2004), *214*, In Kate Barker, Not on the Label. Penguin, 213, ISBN 0-14-101566-7

Lemunier, M., Cédric, F., Sandrine, R., Houot S., Dantigny P., Piveteau P., Guzzo J. (2005), *Long-Term Survival of Pathogenic and Sanitation Indicator Bacteria in Experimental Biowaste Composts*, Applied and Environmental Microbiology 71 (10), 5779–5786

MOAD, (2011), *Ministry of Agriculture Development, Nepal*

Moore, G. (2001), *Soil guide - A handbook for understanding and managing agricultural soils.* Perth, Western Australia, Agriculture Western Australia, 161–207

Mortvedt, J.T. (1996), *Heavy metal contaminants in inorganic and organic fertilizers*, Fertilizer Research 43, 51-61

***Motghare, H.,* and *Gauraha* R. (2006), *Bio-fertilizers - Types & their application*, Krishisewa**

www.krishisewa.com/cms/articles/organic.../115-bio-fertilizers.html .

OPM, (2003), *Nepal Fertilizer Use Study*, A study funded by the UK Department for International Development (DFID), Kathmandu, Oxford Policy Management (OPM) and Ministry of Agriculture and Cooperative (MOAC)

Pandey, S.P. (2013), *Role of Fertilizer in Transforming Agriculture in Nepal*, Agricultural Transformation in Asia, Policy Options for Food and Nutrition Security: September 25-27, 2013, Siem Reap, Cambodia

Pant, D.B. (2013), *Study on the Status and Energy Content of Municipal Solid Waste of Butwal Municipality*, A Dissertation Submitted to Central Dept of Env. Sci., Tribhuwon University for the Partial Fulfilment of the Requirement for the Master's Degree in Env. Sci.

Pokhrel, D. and Virarahghavan, T. (2005), *Municipal solid waste management in Nepal: practices and challenges*, Waste Management, 25**,** 555-562

Stewart, W.M., Dibb, D.W.; Johnston, A.E. and Smyth, T.J. (2005), *The contribution of commercial fertilizer nutrients to food production,* Agronomy Journal**,** 97, 1–6

Tennakoon, N.A., and Hemamala, B.S.D. (2003), *Nutrient content of some locally available organic materials and their potential as alternative sources of nutrients for coconut*, COCOS, 15, 23–30

Venkataraman, G.S. (1972), *Algal Fertilizer and Rice Cultivation*, Today and Tomorrow Printers and Publ., New Delhi

Wang, F.Y., Ge, X.Y., Balliu, N.I.T. and Cameron N.I.T. (2013), *Optimal control and operation of drum granulation processes*, Chemical Engineering Science, 61, 257-267

Zublena, J.P., Baird, J.V. and Lilly J.P. (1991), *Soil Facts - Nutrient Content of Fertilizer and Organic Materials, North Carolina Cooperative Extension Service*. Retrieved 3 January 2013

Can Electronic Procurement and other ICT Tools to Combat Corruption in Public Procurement in Nepal

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Abstract

Information and Communication Technologies (ICTs) have been seen as pioneering tools for the promotion of the better delivery of government programmes and services, enabling the empowerment of citizens through greater access to information, delivery of more efficient government management processes, better transparency and accountability, and the mitigation of corruption risks. Especially the public electronic procurement (e-Pocurement) can improve transparency in the public sector by increasing the coordination, dissemination and administrative capacity of public procurement system. It can facilitate information sharing and social mobilization and ultimately provide digital platforms where citizens can report incidents anonymously. Public e-Procurement systems facilitate the collection of digital footprints and complete audit trail which increase the opportunity to hold individuals accountable and ultimately increase the possibility to detect corrupt practices.

ICT, especially the social media tools, can facilitate the work of civil society organization working towards greater transparency and against corruption by supporting a mix of methods of campaigning on transparency and educating citizens on what corruption is about and their civil rights. While the eradication of corruption using ICT is dependent on several factors including political will and difficult to achieve, it does have a real potential. To this end, NRN Australia as a civil society should actively campaign to demand the transparent public procurement system in Nepal and encourage the adoption and use of public e-Procurement systems for major public procurement.

1. Introduction and Background

Every year, governments spend trillions of dollars on goods and services, information and communication technology, and construction according to their budgeting processes. Public procurement accounts for almost 10 to 15% of Gross Domestic Product (GDP) in developed countries and almost 20% of GDP in developing countries (GTN 2003). Public procurement of goods and services accounts for a considerable proportion of a country's expenditure, and in some developing nations, may be as much as 70% (UNDP 2006). Thus, it is a powerful driver of the development of the country (UNOPS 2012). As Nepal government expenditure are steady at around 19 percent of GDP.

Corruption is chronic disease of the modern world and it is an economic, legal, environmental, and social issue. It corrodes the social structure and trust in government. It damages the economy and

ultimately undermines the legitimacy of the state. Corruption is both a major cause and a result of poverty around the world (Shah 2010). According to Shah (2010) corruption occurs at all level of society, from local and national governments, civil society, judiciary functions, large and small business, military and other services. The corruption effects the poorest the most and whether in rich or poor nations its effect is the same.

Corruption in public procurement process is believed to be rapidly increasing and widespread around the world and is more in developing countries (ADB 2007 ; Iqbal & Seo 2008; Kumar et al. 2007). Poverty and low service salaries can motivate public officials to earn extra income via corruption (Bannon 1999). Other important factors that have driven corruption in public procurement include political instability, lack of transparency and accountability, monitoring and auditing of government works and services, low level of professionalism of the bureaucracy, and a weak separation between the civil society and politics (Del Monte & Papagni 2007; Kolstad & Wiig 2009; Subedi 2006).

Developed and developing countries are making efforts to modernize their procurement system with the use of web-based technologies and have adopted public e-procurement system a great leap toward promoting e-government (Bhatari 2011). Public procurement plays a central role in governance and anti-corruption efforts of its sheer impact on society Compared to manual procurement process, scale of corruption, favouritism and discrimination can be significantly reduced resulting in a more secure, reliable and accountable public procurement process (Prier and McCue, 2006).

In recent years, the Asian countries and Pacific region have increasingly adopted ICT to enhance government services and business transaction. The internet and related ICT technologies have greatly reduced the cost of transaction, reduced the cost per tender, less bureaucracy, standardization of public process and documentation, online reporting, creates clear and more transparency between government and citizens.

Against this background, this paper provides the theoretical overview of corruption in public procurement. Corruption in Public Procurement in Nepal is especially discussed and the role of various ICT-enabled anti-corruption tools, especially, the public e-Procurement has been explained. Based on the definition of corruption, a research model is presented which discusses the various factors of corruption and how public e-Procurement can minimise corruption in public procurement. However, the success of anti-corruption initiative through technology depends on the political and administrative will to overcome resistance for change. Challenges for success of such initiatives are explained in terms of three case examples in India and Nepal. Finally, role of civil society and use of social media (ICT) tools to advocate for transparent procurement system is outlined and recommendations to the Nepal Government and NRN Australia have been made.

2. Public procurement

Public procurement refers to the process whereby public sector organisations acquire goods and services, work and other activities from third parties. Lloyd and McCue (2004, p. 5) defined public procurement as "*buying, purchasing, renting, leasing, or acquiring any supplies, services or construction and also includes all the functions that pertain to obtaining any material, services,*

constructions or construction services including description of requirements, selection and solicitation of sources, preparation and award of contract, and all phases of contract administration". Therefore, public procurement is covers all goods, services, and work of the government. Government spends much of their budget on works, goods, and services and can cover acquisition of items example ranging from stationery, temporary office staff, furniture, in complex and high cost areas such as construction, private finance initiative projects, aircraft carriers or support for major change initiatives. In advance procurement covers also strategy, storage, distribution, contract monitoring, and supplier management of the government.

The main objective of the public procurement is: (a) to provide the public accountability, (b) achieve value for money in all public procurement activities, (c) ensure the open, transparent and complaint processes, (c) procurement efficiency, and more consistency, and (d) promote equality of opportunity for all business. Concerning the fact that the main source of government money obtains from the taxpayers, and civil servants are obliged to use the funds in a rational and cost effective manner, with the maximum guarantee the funds will not be misused (Muk et al. 2012). The public wants all the procurement process should be open and transparent as well as to acquire the right item at the right time, and at the right price. In reality, it should not be open and transparent procurement process. There is a great room for corruption.

3. Corruption in Public Procurement: Theoretical Overview

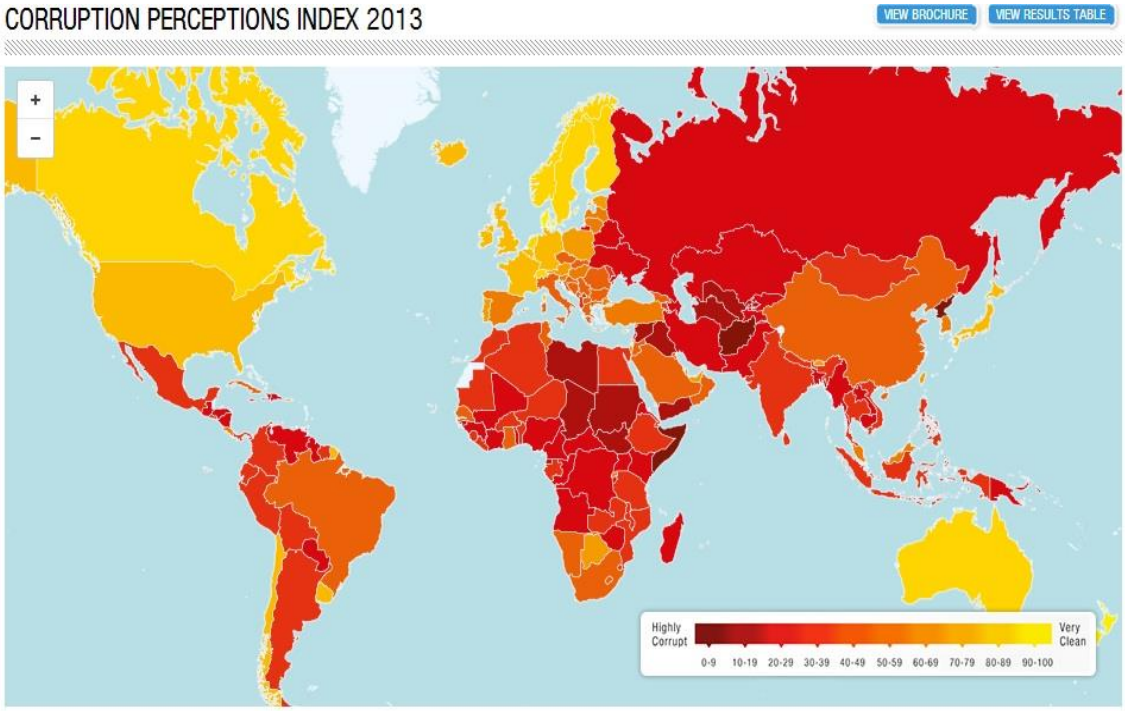
Corruption in public procurement is an international issue that is recognised by many government institutions and international organisations including the World Bank, United Nations (UN), Asian Development Bank (ADB), Organization for Economic Co-operation and Development (OECD), Transparency International (TI). It is a threat to economic and human development in all countries and is believed to be increasing at alarming rates, especially in developing countries. Public procurement processes go through different stages including project planning, product design and documentation, tender process, contract award, and accounting and auditing and each stage has a risk of corruption.

The extended TI definition reads Corruption = (Monopoly+ Discretion-Accountability) / Ethical ambience (TI, 2004). Monopolies and discretion are corruption facilitators, while accountability and an anti-corruption ethical environment in communities are inhibiting factors. There are several ways in which ICT can contribute positively to changes regarding these factors. The obvious, however difficult, ambition then includes to dismantle monopolies, avoid discretion, and increase accountability and the positive ethical ambience.

Corruption in Public Procurement in Nepal

Nepal is ranked as one of the most corrupt countries in South Asia according to Transparency International. The 2013 Corruption Perception Index ranked Nepal at 116 out of 177 countries, which is an improvement compared to recent years. The Commission for the Investigation of Abuse of Authority has investigated high ranking public officials in the country for corruption. Notable cases have included corruption during the purchase of armoured personnel carriers for the Nepalese peacekeeping mission in Darfur, Sudan and the procurement of low-quality transformers by the Nepal Electricity Authority.

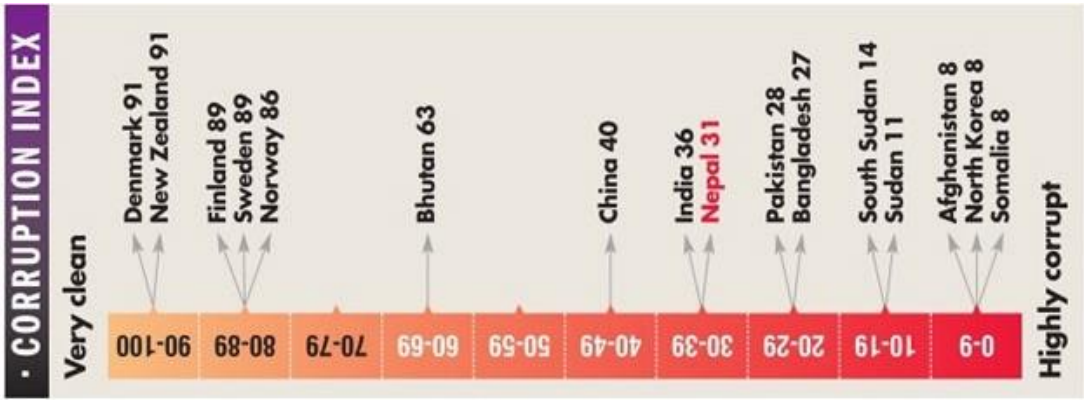
Transparency International (TI) Corruption Perception Index (CPI) ranks countries and territories according to their perceived levels of public sector corruption in a scale from 0 (highly corrupt) to 100 (highly clean). The corruption perception index (CPI) 2013 ranks the 177 countries and territories. Figure 1 shows corruption perceptions index 2013 and results indicate that no country has a perfect score and two-thirds of the countries score below 50 that indicate as most corrupt countries. This information indicates corruption is a serious problem around the world. According to CPI 2013, Denmark and New Zealand are very clean countries with both scoring 91 points each while Somalia, North Korea, and Afghanistan are listed as highly corrupted countries, each of them scoring 8.



(Source: Transparency International (2013))

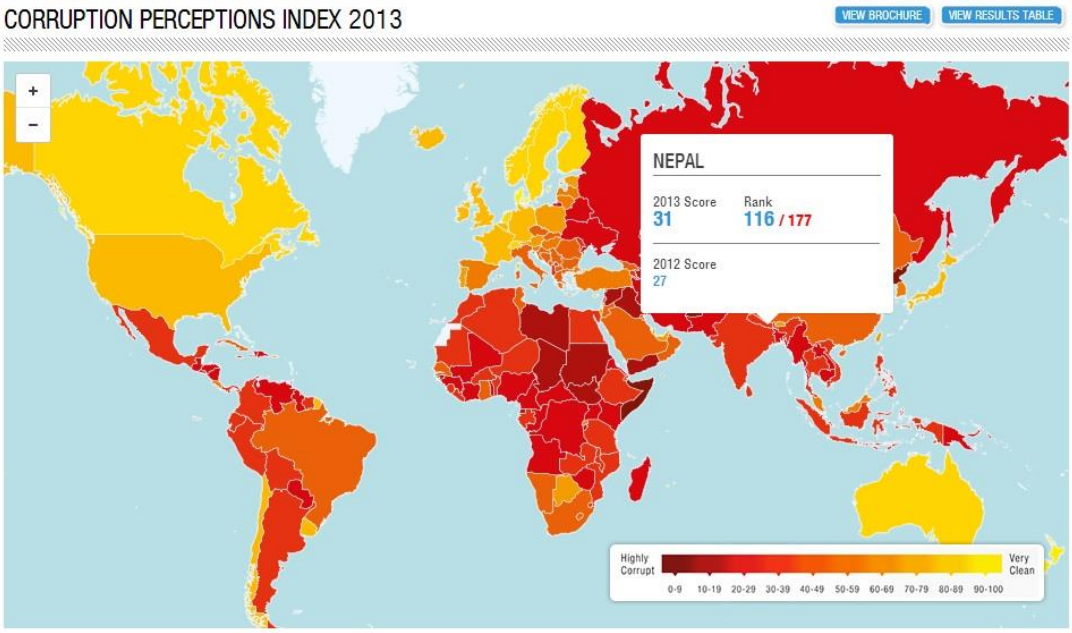
Figure 1. Corruption perceptions index 2013

In South Asia, Afghanistan is the top corrupted country followed by Bangladesh and Pakistan (CPI index 2013). In 2011, Nepal is the second most corrupted country in South Asia. Figure 2.6 shows the CPI 2013 score and rank of Nepal.



Source: Himalayan Times (2013)

Figure 2. Corruption index 2013 very clean to highly corrupt



(Source: Transparency International (2013))

Figure 3. Corruption perceptions index 2013 Nepal

Table 1 illustrates the CPI total score and rank of Nepal in the year 2004 to 2013.

The CPI ratio 2011 ranked Nepal in position 154 out of 183 countries with a corruption score of 2.2. This is deterioration for the poor position in the history. In 2004, the ranking of country score was 2.8 and rank was 90. Similarly, in year 2005 to 2007 corruption ratio was constant 2.5 but in ranking was slightly changed from 117 to 131.

In comparison to 2010, Nepal experienced more corruption in 2011 and the CPI rank of the country is down by 8 points. In the year 2012 and 2013, the corruption ratio is slightly down compared to previous years. The CPI 2013 ranked Nepal at 116th position out of 177 countries with a total score of 31 (figure 3). In 2012, Nepal stood at 154th position with 27 points. In Nepal, there exists official corruption both with executive member of the government and the civil servant that work in bureaucratic positions (Subedi 2006). Some factors that create a favourable environment for corruption include weak professionalisation of the bureaucracy of the country, lack of accountability and transparency in the government work and services, weak separation between civil service and partisan politics, lack of political control and auditing, lack of political stability (Del Monte & Papagni 2007; Kolstad & Wiig 2009; Subedi 2006).

Table 1. Transparency international corruption perception index (CPI) Nepal 2004 to 2013

Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013

S /TC	2.8/10	2.5 /10	2.5/10	2.5/10	2.7/10	2.3/10	2.2/10	2.2/10	27/100	31/100
R /TC	90/146	117/159	121/163	131/180	121/180	143/180	146/178	154/183	139/178	116/177

Note: S= Score, TC= Total Score, R = Rank, TC = Total Country

Corruption in public procurement is a serious problem in Nepal, and due to the use of traditional paper-based procurement systems, there is a potential to avoid rule of law for securing contracts (Bhattarai 2011). There are instances in Nepal where contracts and tenders are awarded because of an abuse of power and political interference. The tendency is that the potential contractors, who use their coercive power, get the contract. In some situations, other contractors are simply not able to submit tender document because of perceived coercive threatening from other influential contractors. In addition, government officers are also involved indirectly and use their official power for their own private benefit. Members of political parties are also involved and manipulated public procurement process for their own ends.

This eventually leads to institutional corruption in public procurement where parties with vested interest have opportunities to 'play' their roles in public procurement for their own benefits. For example, recent case that is an example of public procurement corruption is the Sudan Darfur Scam. In this case, the Special Court (SC) convicted three former police chief and two suppliers for millions of Nepalese Rupees that were embezzled during the purchase of an Armoured Personnel Carrier (APC) for the Nepalese peacekeeping mission in the Darfur region of Sudan (Sharma 2012). Therefore, ICT tools have the potential to assist countries like Nepal to combat the problem presented by systemic corruption.

To overcome the serious problem of public procurement corruption in Nepal and other countries, innovative solutions such as e-procurement can be used to promote good governance, monitor government employees and activities, and enhance the relationship between government employees and citizens. In addition, it reduces human interference and the risk of coercive behaviour, while promoting a free and open market for tenders.

The prevailing procurement system in Nepal is guided by the Public Procurement Act-2007, the only act that outlines the procedures, processes and decision making in the government's procurement process. The act clearly spells out how the procurement process can be made more transparent, fair, competitive, and efficient, while ensuring quality of work and non-discrimination. Violation of this act is seen as a key cause of corruption in public procurement.

Efforts made by the Public Procurement Monitoring Office (PMO) and other government bodies in Nepal highlight the positive role e-procurement can play in reducing corruption. PPMO is the only body responsible for procurement policy formulation, implementation and monitoring of the procurement system in the country. The office installed GEPSON (http://gepson.gov.np) as a single web portal for the procurement processes of all public entities of Nepal. The GEPSON web portal provides easy

access to all tender information and contract awards and is designed to support bidders in submitting their bids online. The Department of Roads was the first organization to introduce public e-procurement in its processes (http://eproc.dor.gov.np/). Other institutions have since followed suit.

4. ICT-Enabled Anti-Corruption Tools

ICT enabled technologies can reduce corruption by promoting good governance, enhancing relationships between government employee and citizens tracking of activities, monitoring and controlling the government employee and reducing potential for corrupt behaviours (Shim & Eom 2008). Controlling for bureaucratic quality, rule of law, anti-favouritism, and competence of government officials, the ICT variables were still statistically significant. Shim & Eom (2008) found that the three ICT variables accounted for 77 % of the total variation of corruption, which means that ICT variables had a substantial effect. In fact, ICT variables were more influential in terms of reducing corruption than traditional anti-corruption factors. The study concludes that ICT enabled technologies is an effective anti-corruption tool for developed and developing countries. As Andersen (2009) concludes - more e-Government is better; the more services online in a country, the less corruption. The effect is considerable.

ICT has a greater positive effect than the traditional anti-corruption factors (e.g. administrative reform without the development of technological support systems, free press) (Shim and Eom, 2009; Andersen, 2009). ICT tools can be broadly categorised into two for the purpose of combating corruption in public procurement: public e-procurement and other ICT tools. Especially e-procurement stands out as a useful tool as it can address at least some of the factors included in the extended definition of corruption.

5. Factors of Corruption and Anti-Corruption Capability of Public e-Procurement

Public electronic procurement has been defined as the use of any Internet-based Inter-organizational Information System, which automates and integrates any part of the procurement process in order to improve efficiency and quality in public procurement, and promote transparency and accountability in the wider public sector (Vaidya 2007). Public e-procurement promotes more efficient government, more transparent and accountable government to business and citizens. The sections below discuss the anti-corruption capabilities of public e-procurement and how they can be associated with each factor of corruption. To restate the extended definition of TI:

$$\text{Corruption} = \frac{\text{(Monopoly + Discretion) – (Accountability)}}{\text{Community/Ethical ambience}}$$

Monopoly

Public e-Procurement provides equal conditions to suppliers so that they can attend to public institutions, regardless of the company size. Besides, the businesses are able to access the site and see, at any time, commercialized items, and the selected companies at their convenience. Suppliers can have access to government bid information at their convenience, increasing the reach of the government to new suppliers. Greater access can lead to further competition between suppliers.

Procurement plans and tender information can be published on the e-procurement platforms and notified to registered suppliers. Online bidding system automatically reduces the cartel, collusion and riggings among the bidders.

Discretion

Public e-procurement can intervene more directly. By automation of processes it is possible to significantly reduce opportunities for corruption by removing human agents at data collection and service delivery points. E-Procurement reduces the discretion of procurement personnel and increases the auditability of various stages in the public procurement process. While the main reason for e-procurement is basically related to efficiency, process automation removes the possibility of the procurement officer acting on his or her personal discretion.

Adoption and use of e-procurement technologies also promote competition by providing alternative delivery channels. E-procurement technologies led to transparency which removes opportunities for discretion. For example, electronic bidding or online bidding is the concept of online marketplace or website allows to buyers to post their requirements in real time bedding events and potential suppliers and service provider can compete to sell their products or services to the buyer. This mechanism reduced the chances of corruption or minimise the errors of human interaction.

E-procurement eliminates the direct human interaction on bidding and other work and services, thus corruption is decreased significantly and internal efficiency increase in government department. It allows the public sector agencies to buy products and services directly from certified suppliers. The order is placed direct to the supplier who is able to configure many price lists, according to commercial regions and clients groups. Public sector agencies may also have better products and services prices using bids placed by certified suppliers. It permits accesses to the notices with invitation to bid, price determination and public tenders conducted by federal and other levels of administration.

Accountability

Accountability refers to the “service guarantee” of a government; the extent to which its actions are accounted for and corrected if not carried out correctly in the first instance. Technically, accountability can be improved fairly easily. Information can be published online, processes and decisions can be traced for audit and analysis, and there can be rules for compensation where accountability is not delivered.

Transparency is an important element that the governments have employed to promote openness and reduce the chance of corruption in procuring goods and services. Lack of transparency creates opportunities for the public officials such as government officers, politicians to abuse their offices for private gain. This indicates to accountability and weak accountability mechanism tends to facilitate

corruption. Where there is lack of transparency and accountability in public goods and services, corruption will flourish. As a result, corrupt bureaucrat realizes that they can take advantage of regulation, so they produce more regulation of such activities and run the risk business by being vague. That's how they could not be noticed by the public or the government.

There are studies showing that the greater the access to information, the lower the corruption levels (DiRienzo et al., 2007). With log analysis tools an control functions provided by e-procurement technologies, both details and aggregates from operations can be monitored to detect anomalies and unexpected performance. E-procurement can centralize data in order to improve audit and analysis. From e-procurement system government can monitor all the works and services easily and efficiently. E-procurement system provides better status monitoring and tracking of application.

Community/ethical ambience

If the public is aware of government rules and procedures they are better able to resist arbitrary treatment. Mobilizing users/community to report cases will make it easier to take corrective action towards individuals and to reorganize systems to avoid loopholes. It increases transparency in works and services and also increases better interaction between supplier and vendors and citizens through online system. It also empowers people to file comments and complaints. Citizens and businesses are better able to question unreasonable rules and procedures. And because detailed transaction data is available, they can also expose errors and wrongful acts.

Based on the corruption factors and the capability of public e-Procurement to address them, the figure below presents the research model.

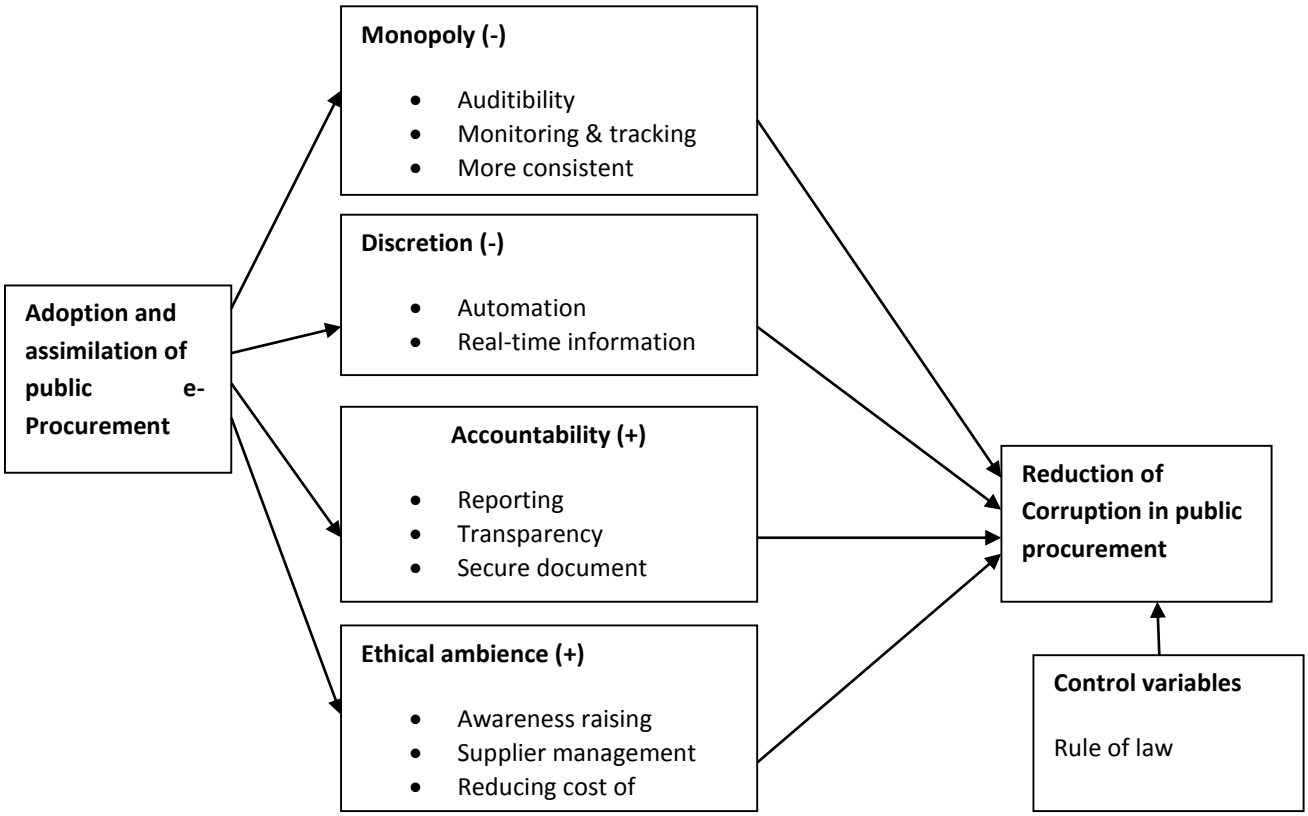


Figure 4: Anti-corruption characteristics of Public e-Procurement: A research model

Other ICT-enabled anti-corruption tools

While public e-Procurement has been regarded as the main anti-corruption technology, there are other ICT tools that can be used during various phases of public procurement, including prevention, detection, analysis, and corrective action. Grönlund (2010) provides some examples of other anti-corruption tools.

The "Pursuit" software from Distiller Software (http://www.distillerysoftware.com/industries/anti_corruption.html) contains tools for intelligence "allowing investigators to capture rich entity and association data and build up a picture of relationships between persons of interest, assets, events and organisations", complaints management and investigation management.

One of the effects of even petty corruption is that civil servants own more expensive property than they can reasonable afford given their official salary, and asset tracking is one way of systematically finding this out. Another way to do this is, of course, by coordinating existing government records of people and properties, if such exist sufficiently. Such software is reportedly used by the Kenya Anti-Corruption Commission (Kenya Anti-Corruption Commission, 2010).

Social Network Analysis (SNA) software is a general tool to analyse communication patterns on the Internet. If this information is coupled to other information, historical as well as present, about specific people, such as their assets or their relation to companies that take part in public procurement processes where corruption may occur, it is possible to trace not just illegal actions but also preparations for such, in particular when combined with the use of linguistic tools.

In Russia, an attempt to fight corruption in government procurement by including automatic checks in the process was announced as "Dmitry Medvedev's Anti-Corruption Software. Reportedly the software detected 190 bids with suspicious distortions in a single week.

Beyond the available commercial software there is also the obvious option for Nepal to invest in in-house development and build proprietary software that contains functionality designed to help fight corruption in ways specifically designed to meet local conditions.

6. Challenges for Success and Some Case Examples

Any government that wishes to use technology to reduce corruption may confront internal resistance and e-Procurement as a tool to promote transparent public procurement can also be expected to meet with self-interested resistance by a wide range of stakeholders. Likewise some civil servants and politicians can be expected to oppose transparency reforms in public procurement that make it easier to evaluate and sanction their performance. Key issues may also include infrastructure and skill conditions for equitable access as well as online privacy, freedom of expression and intellectual property issues.

Department of Roads

Department of Roads (DoR) introduced e-tendering couple of years ago and it has been implementing e-tendering contracts development projects ranging from Rs.150, 000 to Rs 500 million. Last year

DoR saved Rs 3 billion through e-tendering and it solved numerous problems that crop up during the submission of tenders manually (Bhattarai 2011).

Bhoomi

The Bhoomi project was initiated in Karnataka by the Department of Revenue (DoR). The project was designed to facilitate online delivery of land records so that citizens could challenge arbitrary bureaucratic action if they deemed them to be unfair. It was also designed to automate the internal government processes to remove discretion from civil servants (Chawla and Bhatnagar, 2001, in Grönlund, 2010). Some studies have claimed that Bhoomi reduced corruption from 66 % to less than 3 % (Pathank and Prasad, 2006, in Grönlund, 2010).

CARD

The Computer-aided Administration of Registration Department (CARD), is a property registration system implemented in the state of Andhra Pradesh (AP) by the Registration Department (RD). The goal was to increase transparency and efficiency in the land registration process and ultimately reduce corruption. CARD assists officials in the sub-registrar office (SROs) complete the property registration procedure. The registration process consists of four steps; purchasing paper bearing an official stamp, establishing price of the property, determination of the applicable duty, and recording of the details of the transaction (Prakash and De, 2007, in Grönlund, 2010).

Although some portion of the registration process was computerized, the registration process could not be automated because existing laws such as the 1899 Stamp Act and the 1908 Registration Act were not adopted for the effectiveness of the CARD. “Even though the CARD was designed to reduce corruption, the civil servants did not allow its functionality to be integrated because of heavy resistance from the corrupt officials” (Caseley, 2004). The project did not meet the original objective of reducing corruption because the project did not have support from the department head or politicians (Casely, 2004, in Grönlund, 2010).

Role of civil society and use of social media (ICT) tools

ICT creates new approach for openness by providing access to the social media content and interaction that are created through the social interactions of uses via highly accessibly web-based technologies. Berot , Jaeger and Grimes (2010) argued that social media can be used to refer to both the enabling tools and technology and to the content that is generated by them. For example, it include but are not limited to only blogs, wikis, social networking sites (e.g Face book), Twitter and multimedia sharing sites flicker, YouTube. Table 2 shows the six technologies were identified as the most commonly used social media.

Publishing information about reported corruption as well as indicators (such as imbalance between income and property) will deter civil servants from engaging in corruption. Similarly engaging the public by means of pursuing discussions in various online forums promotes ethical attitudes.

Table 2. Types of social media tools

Social media tool type	Description
Crowdsourcing	The act of outsourcing the gathering of information to the public via Internet and/or mobile technology in order to produce collaborative content, to which anyone can contribute. A variant, crowd mapping, geographically places crowdsourced data on a map.
Social Networking	Allows users to connect and engage with friends and contacts through the sharing and discussion of interests, ideas, events, activities and media.
Online Communities	A type of social network maintained via practice of membership rituals by participants with shared interests, often taking the form of chat-rooms or forums.
Blogging	The maintenance of an online space by individuals with regular entries of commentary, descriptions of events, or other material such as graphics or video – allowing for the exchange of ideas between bloggers and visitors.
Circumvention	Communication enabled via mobile phones through voice call, short message service (SMS), multimedia messaging service (MMS) and, increasingly, access to the Internet.

The civil societies could be instrumental in promoting transparent governance, advocating policy change contributing to transparency and accountability in public procurement. To this effect they need improved access to report wrongdoing and protection of whistleblowers and witnesses and use the ICT tools to campaign for anti-corruption initiatives.

7. Recommendations

This section makes some recommendations which the Nepal Government and the NRN Australia (as a civil society) should consider.

Recommendations to Nepal Government

- **Prioritize and promote public e-Procurement as anti-corruption agenda**: Make the implementation of public e-procurement as a priority for e-Government applications in ministerial decisions and budget. Explore incentives for businesses who promote other anti-

corruption technologies. Consider it as key part of the bigger anti-corruption strategy. Encourage the international donor agencies to support this.

- **Develop public e-procurement implementation strategy**: Establish a Steering Committee of executives whose credentials are impeccable to develop public e-procurement implementation strategy. The key element of the strategy should be combating corruption through e-procurement. Review best practices from other developing countries and seek expert advice/consultancy as needed.
- **Use public e-Procurement initiative to drive administrative reforms**: Review and consolidate the existing legislative framework and establish a comprehensive framework governing public procurement. Develop policies to support the implementation of public e-procurement and launch the awareness raising, education/training campaigns among the public, suppliers/businesses and government agencies. Explore incentives for key stakeholders including the suppliers to win their support. Use public e-Procurement initiative to drive administrative reforms.
- **Incorporate the anti-corruption capabilities in the technical design phase**: Identify the key measures of anti-corruption in public procurement and incorporate the anti-corruption capabilities in the technical design phase. Develop the evaluation strategy to measure progress that defines what to measure and how to measure.

Recommendations to NRN Australia

- Re-activate the Civil Society Taskforce (established at the last NRNA conference) to raise anti-corruption awareness campaigns and then to lobby to implement public e-procurement in Nepal.
- Use social media tools to communicate among the civil society members and to act as a watchdog to discourage corruption in public procurement in Nepal.
- Source NRN experts who would be willing to advise the Nepal Government if needed on various issues including public e-procurement strategies, anti-corruption capabilities, other anti-corruption tools and software, and best practices. Communicate these and the recommendations above to the Nepal Government through appropriate avenues.

8. Conclusions

ICT - interventions need to be launched together with real administrative reforms in order to be successful. The realization of ICTs potential is dependent on the surrounding political, social, economical and infrastructural environment.

Combating corruption requires administrative reform; it is not a straightforward ICT matter. Corruption is rooted in the cultural, political, and economic circumstances of those involved. ICT does little to affect these root causes. At the national level, one needs political will, ethical watchdog agencies, proper incentives for honest officials, and effective punishment for corrupt ones (Quah, 1999). The potential of

ICT can, however, only be realized when it is combined with real administrative reforms. In fact, public e-Procurement can drive such reforms.

Nonetheless, as human greed and the culture of corruption are always prevalent in the developing world, the challenges to use public e-procurement and other ICT tools to combat corruption remains. The main problem is in persuading the political leaders that what they are dealing with is public money, not their own, and that they are as responsible for its use as senior government officials are.

The role of civil societies comes here. Demands from the civil societies – for public procurement processes to become more transparent, and for action to be taken on corruption, can create a favorable atmosphere that can help facilitate the rapid and successful implementation of e-Procurement initiatives in Nepal. Needless to say, political return from the public in general due to transparency in public procurement can contribute to enhancing the image of governments.

9. References

ADB, (2007), *(Asian Development Bank) Fighting corruption in Afghanistan a roadmap for strategy and action*, 6 ADB Avenue Mandaluyong City 1550 Metro Manila, Philippines, viewed July 12 2011, <http://www.unodc.org/pdf/afg/anti_corruption_roadmap.pdf>

Bannon, L. (1999), *The fight against corruption : A world bank perspective*, viewed 16 July 2012, <http://www.iadb.org/regions/re2/consultative_group/groups/transparency_workshop6.htm>

Bertot, J.C., Jaeger, P.T. and Grimes, J.M. (2010), *Using ICTs to create a culture of transparency: E-government and social media as openness and anti-corruption tools for societies*, *Government Information Quarterly*, 27(3), 264-71

Bhatari, R. (2011), *Automating public procurement*

Bhattarai, P. (2011), *Curbing procurement corruption', Voices against corruption,* viewed 10 June 2013, <http://voices-against-corruption.ning.com/profiles/blogs/curbing-procurement-corruption>

Del Monte, A. and Papagni, E. (2007), *The determinants of corruption in Italy: Regional panel data analysis*, European Journal of Political Economy, 23 (2), 379-96

GTN, (2003), *Global Trade Negotiations, Centre for International Development at Harvard University*, viewed 3 May 2012, <http://www.cid.harvard.edu/cidtrade/issues/govpro.html>

Iqbal, M. and Seo, J. (2008), *E-governance as an anti corruption tool: Korean cases*, Korean Loacl Information, 11 (2), 51-78

Kolstad, I. and Wiig, A. (2009), *Is transparency the key to reducing corruption in resource-rich countries?*, World Development, 37 (3), 521-32

Kumar, V., Mukerji, B., Butt, I. and Persaud, A. (2007), *Factors for successful e-government adoption: a conceptual framework*, The electronic journal of e-Government, 5 (1), 63–76

Lloyd, R.E. and McCue, C.P. (2004), *What is public procurement? Definitional problems and implications*, paper presented to International Public Procurement Conference Proceedings, Seoul, South Korea

Muk, S., Marovic, J., Popovic, M., Tepavcevic, N. and Sošić, M. (2012), *Corruption and public procurement in Montenegro*, 300 edn, Institute Alternative, Podgorica, Montenegro

n.d., (2013), *Nepal still among the most corrupt countries*, The Hymalayan Times

Shah, A. (2010), Corruption, Global Issues: Social, Political, Economic and Environmental Issues That Affect Us All, viewed 8 May 2011, <http://www.globalissues.org/article/590/corruption>

Sharma, B. (2012), *Sudan scam: 5 convicted, 31 get clean chit*, The Kathmandu Post, 13 February 2012

Shim, D.C. and Eom, T.H. (2008), *E-Government and anti-corruption: Empirical analysis of international data*, International Journal of Public Administration, 31(3), 298-316

Subedi, M.S. (2006), *Corruption in Nepal: An anthropological inquiry*, Dhaulagiri Journal of Sociology and Anthropology, 1, 110-28

TI, (2013), *Corruption Perceptions Index 2013*, Transparency International, 25 March 2013, <http://cpi.transparency.org/cpi2013/results/>

UNDP, (2006), *Capicity development practice note*, viewed 15 July 2011, <http://capacity.undp.org/index.cfm?module-Library&page=Document&DovumentID=5599>

UNOPS, (2012), *Transparency and public procurement*, 2011 Annual Statistical Report on United Nations Procurement, The United Nations Office for Project Services, Copenhagen, Denmark

Vaidya, K. (2007), *Electronic procurement in the Australian public sector: The organizational assimilation process and its impact on public procurement performance*, PhD thesis, University of New England

Solar Paint Technology: Introducing in Nepal as an Alternative Energy Solution

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Abstract

Escaping the world's population from poverty and offsetting the carbon emission to safeguard the earth from irreversible climate change process are the two major issues being experienced and discussed elsewhere today. And, both of these issues are associated with energy use by the world. Working for poverty alleviation by accessing people with convenient means of energy means more emission directed from fossil fuel combustions. Therefore, it is essence of our time to promote new technologies which are non-emitting, reliant on renewable fuel sources, convenient in use and affordable on cost. A recent innovation in University of Newcastle (UoN)'s Priority Research Centre for Organic Electronic (COE) has been able to offer these essentials with a SolarPaint technology while designing a organic photovoltaic (OPV) systems. By transferring this technology in Nepal, the country and the people living in poverty will be benefited in several ways. For example, this technology will be the first choice of 18 million people (3.4 million households) who are not connected with grid supply of electricity. Similarly, this can escape people from irritating load-shedding of 12 hrs a day. It will help every entrepreneurs, especially the small businesses, small users and farmers to sustain and promote their day to day business. Government can feel a relief from subsidizing fossil fuels (diesel and kerosene) and other renewable energy solutions as well. At this context, this paper portrays a proposal to transfer this innovation to Nepal in a stage-gate approach. The first stage suggests to implement a pilot project to demonstrate and understand this technology in detail. A general implementation approach and methods are described in various sections of the paper. And, in the next stage, this paper imagines an investment for commercial scale plant for OPV products. To ease the process of second stage, a business plan shall be prepared in the first stage as proposed in the paper. Implementation of both pilot project and commercial scale plant is a subject of close coordination with kinds of stakeholders. Some of potential stakeholders and ways of coordination are suggested in this paper and other left over stakeholders are to be identified and incorporated during the implementation process. In the context of proved experiment in a sophisticated scientific research environment, author of this paper believes that this is the right time to grab the opportunity for potential investors to take this into Nepal as technology will also be thankful being commercially expanded.

1. Broad Context

Although the science of global climate change is complex, there is a general agreement among most of the climate scientists that greenhouse gas emission (merely the carbon dioxide) during the process of energy conversion from fossil fuels is largely responsible to change energy balance of earth surface due to positive radiative forcing resulting a temperature rise on earth surface (IPCC, 2007) including extreme climate events. This clearly points out the world's conventional energy sources are not suitable for our planet's sustainability. But, we can not imagine a developed or industrialized world compromising on their energy consumption while energy demand is increasing day by day.

On the other corner of the world, people are living with very negligible per capita energy consumption. And, they represent the poor and developing countries largely from South-Asia and Sub-Saharan Africa (For e.g. total per capita primary energy consumption as of US-Energy Information Administration (EIA, 2014) for the year 2010 seems like US-316.94 MBtu, Australia-270.10 MBtu, Europe-138.16 MBtu, China-75.84 MBtu, India 18.68 MBtu, Nepal 3 MBtu, Central African Republic-1.25 MBtu, and World Average-74.38 MBtu. 1Mbtu≈293kWhr). This clearly shows the disparity between developed and developing countries in energy consumption. While thinking responsibly to alleviate poverty from developing countries, accessing people with convenient and affordable energy sources will be appeared as the first pre-requisite. But, because of disappearing fossil fuel sources and their

environmental consequences, it is essential to look upon alternative energy solutions which are clean and inexhaustible and rely on renewable sources.

These two broad and global problems are now overwhelmingly discussed elsewhere and large nos. of experiments are underway dedicated to explore new energy sources, inventing new technologies for efficient energy production, making more efficient devices, capturing or emitting less carbon from fuels combustion and others. We, on earth, are heavily endowed with solar heat and light, which is undoubtedly the best alternative fuel source on hand. But, we have very limited success regarding conversion of sun's energy into usable forms. Some of past experiments are realized very expensive and beyond the affordability of general public without heavy government's subsidy. The case is similar with other renewable energy sources like wind, geothermal, biofuels or tidal energy except hydropower.

In this context, this paper tries to deal with a recent outcome of the University of Newcastle's organic photovoltaic (OPV) research team, which points to '***SolarPaint***' that may be printed onto plastic, integrated into tinted windows and other building materials, making the whole structure itself a source of power. The research has a claim that SolarPaint possesses a potential to generate electricity at a cost per kWhr equivalent to or less than coal and oil, removing the need to subsidise solar energy (UoN COE, n.d.). In fact, this is really an interesting and attractive development of our current need. Thereof, the theme of this paper is to convince the relevant stakeholders for piloting this technology then step forward for commercial project intending to contribute Nepal's energy sector for a sustainable solution.

2. Technology Brief

(This section is adapted from UoN COE Solar Paint Technology Information Document)

Organic PV (OPV) being researched in University of Newcastle is an emerging 3rd generation plastic based PV technology which has overcome the technological and regulatory issues of existing solar cells those are made from mixture of polymer materials dissolved in toxic hazardous organic solvents like chloroform or chlorobenzene. The solar paint technology, which is based upon building OPV devices from water-based polymer nanoparticle dispersion is feasible and has demonstrated successful manufacture of solar cells that are more efficient than current OPV devices.

Solar Paint is a completely printable OPV coating based on semiconducting polymer nanoparticles dispersed in water. Essentially, these tiny particles in suspension are a water-based paint, which can be printed or coated over large areas. Light shining on an organic solar cell produces positive and negative charges that are separated at interfaces between the polymer components in the cell. To address the issues of efficiency and use of volatile materials from existing OPV devices, UoN research team dedicated themselves on:

- Control over the size distribution of the prepared active surface polymer particles at nano-scale
- Holding the nano-particles in an aqueous (i.e. Water based) solution pre-deposition
- Depositing of the nano-particles onto substrate to give a highly consistent active surface

Thus patented Solar Paint process can be summarised in the following diagram:

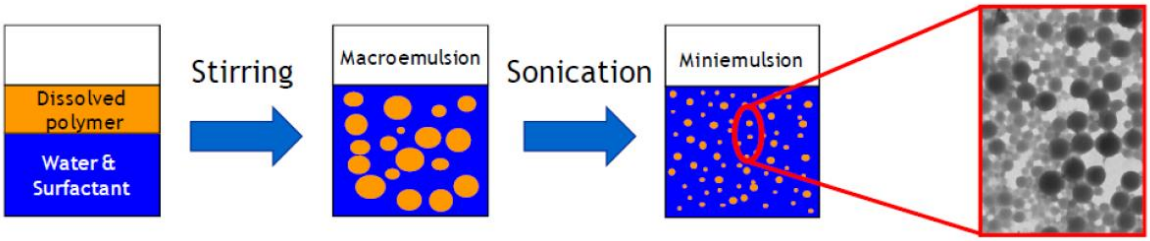

Figure 1. SolarPaint process (Patented)

Using this process to create and accurately distribute nanoparticles enables the creation of a “designer surface”. The designer has control over the maximum distances that charges have to travel before coming to an interface and, hence, effective control over the photovoltaic efficiency of the surface. The Newcastle COE team can “design” the OPV surface offering greater efficiency & consistency than that currently available. Experimentation on standard platforms has indicated that OPV efficiency may be doubled through control of nano-particle size and distribution. Using water as the solvent reduces cost and eliminates environmental issues associated with handling and printing using organic solvents.

OPV technology has the potential to overtake silicon based PV and traditional power generation sources. The key comparison metric for electricity generation is the “levelised cost of electricity” (LCOE), which measures the total lifetime cost divided by the total lifetime energy output for a given energy technology. The LCOE from current power generation in Australia (from conventional coal fired power stations) is $0.10 - $0.11/kWh, whereas that for a domestic PV system utilising silicon photovoltaics is around $0.26 to $0.30kWhr. By comparison, the estimated potential LCOE of SolarPaint™ ranges from $0.31/kWhr (for a 3% efficiency and a 3 year module lifetime) down to $0.11/kWhr for a 6 % efficiency and a 6 year module lifetime. An additional advantage of OPV is its ability to produce electricity from relatively low light sources. This means that OPV can generate power at times of the day and locations that currently silicon PV cannot deliver. This means that OPV can be installed on facades and windows that could be shaded during the day and still produce electricity.

3. Relevance of the Technology in Nepal

3.1 Nepal's energy sector analysis: A socio-economic perspective

It is evident that all of Nepal's current energy related indicators are very devastating. For example, only 60% of total household (among 6 million households resided by 30 million peoples) of the country are not connected with electricity grids (CBS, 2011). Those, who have electricity connection are also suffering from more than 16 hours power-cut every day due to load-shedding even in Kathmandu making it the worst capital city in the world. Whole amount of petroleum is imported from India and distributed with subsidy. Total value of import of petroleum is larger than total export value of all other goods from Nepal, hence is the major cause of overall trade deficit of the country (WTO, 2012). Among the imports, kerosene and diesel are two major components being used by rural households and businesses for lightening and cooking. In contrast to the practices of developed countries, more than 80% of total energy consumption in Nepal is supplied by biomass combustion (particularly the firewood, agricultural residue and animal dung) (NEEP, n.d.). Biomass and Kerosene smoke has been causing a large health problems like asthma and eye irritation including drudgery among women and children. Huge amount of agriculture and animal products get wasted due to lack of energy supply for cold storage or refrigeration (though an exact estimate is yet not available). Most of the small and micro-enterprises have stopped their operation simply due to absence of convenient and affordable fuel sources.

Given the recent political changes in the country, energy sector is receiving utmost priority by the government, who is looking for options to eliminate load-shedding and availing fuel-sources at affordable cost among the rural and isolated areas. But, it seems to take at least next 10 years only to complete major hydropower projects and end the blackouts. Rest of the poor families will have to wait an unpredictable time period to get access with enough and convenient fuel sources at 'as usual business scenario'. On the other side, government of Nepal is offering some subsidy on kinds of renewable energy solution through National Rural and Renewable Energy Programme (NRREP) until 2017 in funding support of some international development partners. Because of limited no. of subsidy targets for a limited period of time, it is apparent that large section of society will still remain unserved. Government's solar system subsidy is available for solar-home systems, institutional solar systems and solar water-pumping systems which are a combined system of Solar PV panel, charge regulator and battery storage with output accessories largely imported from India and Bangladesh. Almost 50% of total cost goes to solar panel. There is no regulatory provision against the potential health and environmental risks arising from those systems.

At this background, Solar Paint Technology can offer a broad range of opportunity to deal with Nepal's energy problem. Basically, this will be useful to every families who are suffering from load-shedding and who are isolated from national electricity grids. Also, the institutions, farmers, small-entrepreneurs, low-income families and every section of society can rely on this technology for their long-term energy demand conveniently and affordably.

3.2 Context of NRN's interest to transferring skills, knowledge & innovation

As explained earlier, Solar Paint is a technological breakthrough to harness solar energy from organic photovoltaic systems. Being a new, innovative and prospective technology, this offers a good investment opportunity for a business potential in Nepal. This is already a technology of need for all 6 million households of Nepal and prospective energy technology to run large business and commuting cars as well. Therefore, this technology address the interest of Non-Resident Nepalese Association of Australia to transfer skills, knowledge and innovations from Australia for the benefit of Nepal.

3.3 Innovativeness of the technology

UoN COE research team is confident that SolarPaint offers the prospect of delivering a low cost sustainable energy source that can be implemented on a global scale. In particular:

1. Solar Paint is planned to be applied via roll-to-roll printing techniques, producing solar modules at a significantly lower unit cost than other competing PV technologies.
2. Solar Paint should be able to utilise any organic electronic materials – thus any improvements in the background science can be immediately implemented as new Solar Paint.
3. The start-up costs associated with installing a Solar Paint printing line are anticipated to be low in comparison to other PV – enabling rapid implementation into the marketplace.
4. The inherently flexible nature of Solar Paint should allow the fabrication of solar modules in a vast array of forms and on previously inaccessible building façades and surfaces.
5. High volume production and low unit cost provides Solar Paint with a potentially unique opportunity to dominate the renewable energy mix in the medium to long term.
6. This technology places a unique offering to the market due to its ability to substantially increase efficiencies of existing OPV material as well as the benefit of producing Solar Paint from water

4. Objectives of the Proposed Intervention

In overall, this intervention is purposed to generate an investment environment in Nepal towards supporting the country's energy sector with alternative technologies for the benefit whole energy consumers in a long run. Immediately and specifically, it is proposed to:

(i) Implement a test with OPV prototype of Solar Paint in Nepal
(ii) Analyze future prospects of the technology in detail in the country
(iii) Prepare a business plan to help potential investors for further expansion

5. Project Design and Methodologies

5.1 Generation of required funding

With an imagination of future initiation from potential investors for business/commercial scale production and distribution of the technology, the proposed project stage shall last for 6 months in relation with the objectives mentioned in section 4. Thereof, test/pilot project shall require a donor support. Non-Resident Nepalese Association (NRNA) Australia may expedite the process of fund generation for this project through NRN-International Coordination Committee by approaching many international governments,

donor organizations and business communities. Obviously, pilot-project will involve large portion of administrative and overhead expenses compared to material components. However, it will be essential to minimize the whole cost by contribution of every organizations involved in the process wherever possible. A tentative cost items are listed in section 6.

5.2 Electro-mechanical deliverables and operating devices

Considering transportation and related cost factors, it is preferable to collect most of accessories in local market. Basically, proposed technology is the substitute of existing PV panels offering low cost and no environmental consequences. Corresponding to the size and capacity of the Solar Paint based PV panel(s), we shall arrange rest of electro-mechanical components like cables, batteries, battery charge controller, and operating devices like light bulbs, TV screens, fans, radio/stereo. Solar panel prototype development and piloting plan shall follow the milestones presented below:

Proposed Development Plan

(1) Initial Prototype – 1% efficiency and 1 year lifetime (available and un-optimised version)

- Approximate Total power per sqm = 20 watts
- Total anticipated energy per sqm for the product life = 7.3 kWh

(2) Initial Optimized Prototype (Sept 2014) – 1% efficiency and 1.5 year lifetime

- Approximate Total power per sqm = 30 watts
- Total anticipated energy per sqm for the product life = 16 kWh

(3) Initial fully-optimized Prototype (Mar 2015) – 1% efficiency and 1.5 year lifetime

- Approximate Total power per sqm = 42 watts
- Total anticipated energy per sqm for the product life = 23 kWh

(4) Initial Commercial Prototype (Dec 2015) – 3% efficiency and 3 year lifetime

- Approximate Total power per sqm = 120 watts per day
- Total anticipated energy per sqm for the product life (3 years) = 130 kilowatts of power

All these prototypes will be produced in UoN's Priority Research Center for Organic Electronics (COE) and ported to piloting center located in Nepal.

5.3 Implementation environment

NRNA Australia will be the lead agency to transfer proposed technology in Nepal in coordination with UoN/COE. Later on, coordination needs to extend with NewCo Pty Ltd-NPL, which holds the intellectual property of the technology. During the pilot project stage, NRNA shall select a team for implementation consisting of overall coordinator, technical expert, and business development expert. Instead, UoN/COE shall designate a researcher to involve/facilitate the process. This team will be responsible to identify related stakeholders in Nepal and abroad and liaise for implementation process. At least, the organizations like Import/Export section of the Customs and Border Protection of Australian Government, Nepal's custom department, Government of Nepal/Ministry of Science and Technology, Alternative Energy Promotion Center (AEPC)-Nepal are to be communicated and contacted during the process. For the safety purpose, insurance should be maintained and Home ministry in Nepal should be informed about the project activities.

An NGO (to be identified later) will be suitable to facilitate the process at local level working in a partnership. And, Federation of Nepalese Chamber of Commerce and Industries (FNCCI) should be contacted for coordination. In particular, FNCCI's involvement will be advantageous to select and host

the pilot project location. They would support by sharing experiences of import, export, tax and regulatory provisions of the government of Nepal. Being an umbrella organization of Nepalese businessman, FNCCI can publicize about the opportunity to attract potential investors within the country.

5.4 Documentation and reporting

Being a foundation for next business scale implementation, the pilot project will have to be considered as an important 'action research' at field-level. This will be an opportunity to document technical feasibility and socio-economic suitability in particular environment of Nepal. Response of the government, policy implications and demand of users shall be assessed through pilot project. Public interest and their responses can be collected through electronic media coverage. Employing this approach, a detail project implementation report will be prepared by the project team to submit NRNA Australia and forward to funding partners and university's research center. Outcome of the pilot project will be disseminated among relevant stakeholders through a meeting in Nepal. In particular, the final project report will incorporate – Technological Description with anticipated adjustments if required, Cost-benefit analysis in future project conditions, Barriers required to focus and address, Public interest and future potential. Project team will design the methods of data collection, analysis and interpretation once they are assigned to undertake the project.

5.5 Preparation of business plan

To support the future business environment on proposed technology in Nepal, a business plan will be drafted in consultation with real and potential investors from Australia, Nepal and abroad. This task will be led by the business development expert from the project implementation team. The business plan will broadly consider the investment portfolio for commercial scale production of SolarPaint film through an industry established in Nepal. The business plan will incorporate the financial analysis (merely the cost benefit and Internal Rate of Return-IRR of the project investment at various discount rates) including a total economic analysis considering immediate benefits by the people and environmental benefits. This will also present a comparison of Levelized cost of electricity (LCOE) from newly researched OPV systems in Nepal with other methods of electricitygeneration. Responsibility of the business development expert include to forecast potential future of OPV technology in the context of government policy and other rival technologies. As estimated now in the research environment, a commercial product (solar-paint panel with 1 sq.m. surface area) will cost AUD 15. This indicates, users will achieve their return within a year given current price of energy. For a preliminary knowledge of potential investors, printer of this technology to make a one sq.m. printed film shall cost 1.5 millions. However, these indicative figures need to be discussed and negotiated with research and technology developers.

5.6 Monitoring and evaluation

Participatory Review and Reflection Process (PRRP) will be the best way for monitoring of anticipated deliverables under this project. During 1.5 years proposed project period, at least 3-events of participatory meeting will be appropriate represented by project team, NRNA-Australia's board representative, UoN/COE representative, donor's representative, government (of Nepal)'s representative, partner NGO's implementation team, FNCCI's representative, media persons, nearby communities and some relevant agencies. This process will guide the project team members to conduct project in right way and portray a right picture of the findings on project report and business plan. Instead, a non-intervening environment should be created for free-observation and feedback process

from every kind of stakeholders including general public, government officials and donor representatives.

6. Analysis of a Budget Required

1. Potential cost items are listed and summed in the table given below.

Table 1. Potential cost items

SN	Cost Item	Estimate for project Period (AU$)	Remarks
1.	OPV panel as specified in Sec. 5.2	700,000	for 3 consecutive and optimized prototypes
2.	All other electromechanical Accessories	2,500	
3.	Transportation	2,500	
4.	Leasing a project site	899	Expect FNCCI contribution
5.	Human Resources		
	• Team Leader	44,000	
	• Technical Expert	41,000	
	• Business Dev. Expert	41,000	
	• UoN Researcher		Expect COE contribution
6.	Flights and Travel	21,400	
7.	Insurance	950	
8.	Office and Stationeries	2,800	
9.	Media coverage & documentation	2,600	
10.	Stakeholders Consultation for Business Plan Preparation	3,900	
11.	PRRP Meetings (monitoring)	6,000	
12.	Outcome dissemination meeting	6,000	
13.	Partner NGO's overhead	7,500	
Total Estimated Sum		**880,549**	

7. Expected Project Outcomes

At an immediate output level, proposed project will create a demo-house utilizing solar power fetched through OPV panels based on Solar Paint technology. But, it is expected to result an investment opportunity for Solar Paint technology in Nepal.

By this, following impacts are desirable:

- Remote and isolated communities of the country who are not much optimistic to be connected with national electricity grids, will be benefitted immediately
- Poor communities who are dependant on wood-sticks or kerosene lamps for lightening due to inability to spend on other clean technologies, will be encouraged to install this technology because of low cost that it can offer
- Small users, farmers and micro-entrepreneurs will be able to fulfill their energy needs at affordable price
- Urban and semi-urban people will be encouraged to set-up OPV solar systems as a back-up source of their energy needs for the time of black-outs. This will ultimately minimize the worst impacts of load-shedding
- This will open up an opportunity to design solar-homes in all areas of the country
- We may be able to turn our imagination of solar (green vehicles) into reality
- It is possible to replace petroleum imports significantly from the abroad thus minimizing trade deficit of the county
- This can create a significant no. of jobs and employment refurbishing the senile energy sector
- This will be helpful to reduce smoke related diseases and set-up gender harmony
- Every OPV systems will help to offset carbon emission which is possible while consuming energy from other traditional fuel sources

These indicators will be described and specified in quantifiable value in the business plan considered by this proposal.

8. Challenges, Risks and Opportunities

Based on the correspondence with business development team of the technology in University of Newcastle, testing of some prototypes with 3% efficiency over 3 year lifetime is yet under process and waiting for funding commitments from relevant agency. However, the COE is optimistic to commence this in near future and help implement pilot project in Nepal at a same time when prototypes are being tested in UoN premises. This indicates a possibility of some delays to commence the pilot project if all milestones mentioned in section 5.2 are not achieved in a due time by the research center when this proposal proceeds towards implementation.

Despite of high cost, low efficiency, inconvenient operation and environmentally unfriendly in nature; there are many technologies in existences in Nepal as alternative energy solutions. In this context, introduction of proposed technology shall realize obstruction from the traders and distributers of such solutions. Therefore, the project and investor team of proposed technology needs to be aware with the rules of fair trade and free market economy for the competency.

But, the situation of energy crisis and attempt of Nepal's government to distributing both renewable energy solutions and petroleum products on subsidy are the opportunities for this technology. Proposed project can alert the government to revise their subsidy policy and switch their priority towards a sustainable solution.

9. Conclusion

Solar Paint Technology researched in University of Newcastle is the newest development in solar energy field. At this time, the research unit is looking for investors to establish commercial scale facilities to make Solar Paint products available in the market. Since, this is a very prospective technology for both poor and developed economies from poverty alleviation perspective and emission reduction perspective, sooner the better approach is suggested to transfer this innovation from Australia to Nepal for overall benefit of the nation to get rid of from exiting energy crisis. But, to be satisfied with practical demonstration, proposed pilot project will help to understand potential benefits of the technology in particular context of the country.

10. References

CBS, (2011), *National Population and Housing Census 2011 (National Report),* Kathmandu, Nepal, Central Bureau of Statistics, National Planning Commission Secretariat, Government of Nepal.

EIA, (2014), *International Energy Statistics.* [Online]
Available at:
http://www.eia.gov/cfapps/ipdbproject/iedindex3.cfm?tid=44&pid=45&aid=2&cid=regions&syid=2005&eyid=2011&unit=MBTUPP (Accessed 4 April 2014)

IPCC, (2007), *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment,* Cambridge, United Kingdom and New York, NY, USA, Cambridge University Press

NEEP, n.d. *Nepal Energy Efficiency Program: An Introduction.* [Online]
Available at: http://wecs-neep.gov.np/downloadthis/neep_introduction_(leaflet)_english.pdf (Accessed 13 November 2013)

UoN COE, n.d. *SOLARPAINT: AN OPPORTUNITY TO PARTICIPATE IN THE FUTURE OF SOLAR ENERGY.* s.l.:s.n.

WTO, (2012), *Trade Policy Review Report by Nepal,* s.l.: World Trade Organization, Trade Policy Review Body

Effects of Atmospheric Particulate Matters on Human Health Risk in Kathmandu Valley, Nepal

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Abstract

The oval shaped tectonic basin, Kathmandu valley, is located in the middle sector of Himalayan range which is surrounded by tiers upon tier of green mountains ranging from 500m to 3000m above the sea level. The valley has two narrow river gorges in the southwest and northwest edges and short hills in the southwest edge connecting the neighboring valley Banepa. The wind of the valley is usually exchanged by entering from the southwest and the northwest gorges and exit from the southeast short hills to the neighboring valley. Being surrounded by high hills and mountains the horizontal exist of the air pollutants produced from the valley without vertical dispersion is less possible. This has led sharp increase of particulate matter (PM) concentration in Kathmandu valley with rapid urbanization. PM measurement data from six different locations in the Kathmandu Valley recorded from October 2002 to March 2007 were used to investigate PM10 and PM2.5 concentration dynamics in the valley. Monthly average data of the urban areas, which have much higher concentrations than the rural areas, even exceeded the daily standard level of PM10, in Nepal, 120 µm/m3. The concentration of PM increased with the beginning of winter (October) and reached to the highest level in February, the end of winter showing continuous accumulation in the atmosphere. Summer hot weather with gentle breeze and precipitation during monsoon period (June to September) helps to remove PM10 from the atmosphere.

The observed data was correlated with past epidemiological studies across the globe and health risk was evaluated. Result has shown considerable mortality rate increase as well as respirable diseases increase in the valley residents.

1. Background

Particulate matter (PM) is one of the most persistent forms of air pollution throughout the world, and is a major environmental risk factor with a potential to significantly aggravate public health burden. PM can be classified into four categories based on aerodynamic diameter: ultrafine particles (UFP, <0.1µm), $PM_{2.5}$ (fine particles, <2.5 µm), $PM_{2.5\text{-}10}$ ("coarse" particles, 2.5-10 µm) and PM_{10} ("thoracic" particles, <10 µm). Prolonged exposure to these particles can contribute to significant human morbidity and mortality, as humans can inhale the particulates into the thoracic, which then moves to the lower regions of the respiratory tract, carrying the potential to induce harm by causing irritation, headache, fatigue, asthma, high blood pressure, chronic respiratory and cardiovascular disease, cancer, and even premature mortality (Brunekreef et al., 1995; Pope, 2007). Such health problems clearly have economic costs arising from expenses incurred in increased hospital admissions and emergency room visits for treating the disease, as well as loss of productivity in the form of absent days at work and school (Banerjee, 2001).

Rapid urbanization in the Kathmandu valley has resulted in a significant deterioration in air quality. Vehicular emissions, poor infrastructure, re-suspension of street dust and litter, black smoke plumes from brick kilns and other industries are the primary sources contributing to increased level of particulates in the Kathmandu valley. In addition, the bowl-shaped topography of Kathmandu valley, which is surrounded by 500m-1,000m high hills, and the prevalence of low wind speeds create poor dispersion conditions, predisposing Kathmandu to serious air pollution problems, thus limiting air pollution dispersion (MOEST, 2005), and therefore, residents in the valley are exposed to air pollution throughout the year, which often exceeds the safe levels.

In 2005, the World Health Organization (WHO) set exposure guidelines for annual and daily PM_{10} exposures. While there is no threshold value for PM, the maximum annual daily mean exposure of 20 µg/m^3 and the maximum 24-hour mean exposure of 50 µg/m^3 were recommended in order to minimize negative health outcomes associated with particulate matter air pollution. The Government of Nepal has divided PM_{10} concentrations into four categories defined as "Good" (0-60 µg/m^3), "Moderate" (61-120 µg/m^3), "Unhealthy" (121-350 µg/m^3), "Very Unhealthy" (351-425 µg/m^3) and "Hazardous" (>425 µg/m^3) (Giri et al., 2007). In this study, we estimate the health impacts from particulate matter exposure to Kathmandu valley residents in the form of mortality associated with PM_{10} exposure at the assuming three different exposure threshold values of 60, 90 and 130 µg/m^3.

2. Material and Methodology

2.1. Study area

Kathmandu valley is the most populated and rapidly urbanising area in Nepal, and consists of a population of 2.5 million people. The valley consists of Kathmandu, Lalitpur and Bhaktapur districts, and within these three districts are one metropolitan city, one sub-metropolitan city, 3 municipalities and a number of village development committees. Like other growing urban centers, the Kathmandu valley is particularly susceptible to episodes of high concentrations of PM_{10}. During the past three decades, the Kathmandu Valley's population has increased greatly and the valley has become highly urbanized. Sharp population increase with an annual average growth rate above 4.5% (CBS, 2011) and associated activities in the valley has worsened the air pollution (Sharma, 1997; Sapkota and Dhaubadel, 2002). But such high concentrations are likely not solely due to the rapidly growing population and urbanisation.

Both the climate and the physical geography of the valley contribute to problem. Because of the bowl-like feature of the Kathmandu valley, pollutants can remain in the atmosphere without dispersal as mountains restrict wind movement. In addition, temperature inversions can act like a cap above the valley and hold the pollutants within. The altitude of the valley also contributes to the problem by reducing atmospheric pressure by as much as 86 percent of the pressure at sea level, thereby reducing the efficiency of fossil fuel combustion and creating higher amounts of unburnt hydrocarbons (Collins and Scott, 1993).

2.2. PM data and measurements

Recognizing the air quality deterioration in the valley, the Ministry of Population and Environment of Nepal installed air pollution monitoring stations at six different locations located within 15 km of one another. These stations, shown in Figure 1, represent distinct areas in the valley: urban high traffic area (Putalisadak and Patan Hospital), urban residential area (Thamel), urban background (Bhakhtapur and Kirtipur) and rural village (Matsyagaon). Ambient PM_{10} data for a period of 4 years and 6 months, from March 2003 to February 2007, were obtained from these stations. At each station, a Low Volume Sampler LVS for PM_{10} without pneumatic movement of filters (Model 85-02 of M/S Instrumatic, Denmark) specifically designed for use in the Kathmandu valley in the Kathmandu Air Quality Monitoring Program was used. The samplers' eight filters mounted three feet above the ground automatically collected 24 hour samples that were recorded daily as an average PM_{10} concentration in microgram per cubic meter (μg/m^3). Samples were collected once a week and analyzed by an approved laboratory (Giri et al., 2007).

2.3. Estimation of ambient PM exposure

The results of PM_{10} measurement conducted at six sampling sites, within the Kathmandu valley area from March 2003 to February 2007, and demographic data from population census of 2011 is used for estimation of ambient PM exposure, assuming the PM_{10} concentrations in the valley's atmosphere is similar to that during the period of available data.

We calculated the exposure to PM_{10} in the Kathmandu valley as:

$$EPM_{10} = \sum \frac{P_i}{P} \times \left(CPM_{10_i} - RCPM_{10}\right)$$

Where,

EPM_{10} = Exposure to PM_{10}

P_i = Sub-population of the composite area corresponding to monitoring station i

P = Total population of the Kathmandu valley

CPM_{10_i} = Average annual concentration of PM_{10} in monitoring station i

$RCPM_{10}$ = Reference PM_{10} concentration

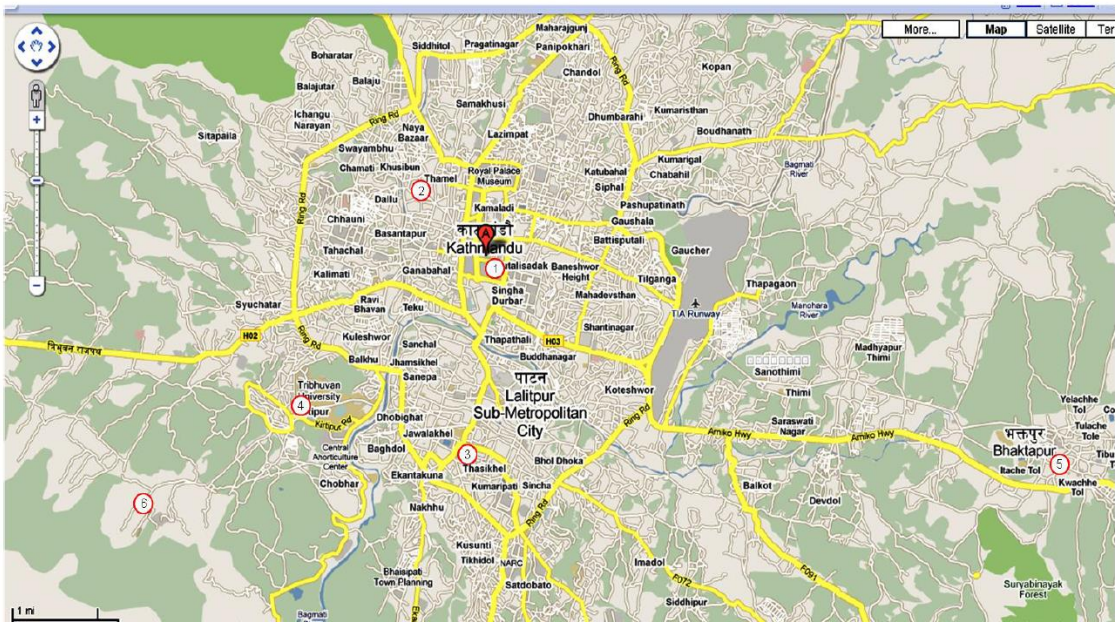

Figure 1: Air quality monitoring stations in Kathmandu valley.

1= Putalisadak, 2= Thamel, 3= Patan Hospital, 4= Kirtipur, 5= Bhaktapur, 6= Matsyagaon

We assume three different $RCPM_{10}$ with cut-off points at 60 µg/m^3, 90 µg/m^3, and 130 µg/m^3, as these concentrations fall under "good," "moderate," and "unhealthy" based on the classification by the government of Nepal. We apply these cut-off points to the exposure based on the average annual PM_{10} concentrations as well as average PM_{10} concentrations during the winter and dry months of November – January during when the PM_{10} concentrations are at the highest levels. Fitting these parameters into the above equation gives population-weighted exceedance of reference concentration of PM_{10} in the Kathmandu valley. Value of this indicator shows that proportion of the population is exposed to harmful concentration level PM_{10}.

2.4. Estimation of mortality associated with PM10 exposure

Mortality associated with PM_{10} was calculated following Giri et al. (2007) as:

$$EPM_{10}Mortality = AF_E \times BM$$

Where,

$EPM_{10}Mortality$ = Mortality associated with PM_{10} exposure

BM = Baseline mortality rate, assumed as the crude death rate

AF_E = Attributable fraction in exposed, also known as the attributable risk percentage in the exposed, which can be computed by direct use of relative risk of mortality as:

$$AF_E = \left(\frac{Relative\ Risk - 1}{Relative\ Risk}\right)$$

According to WHO (2000), a relative risk of long–term average PM_{10} exposure on natural mortality is 1.1 per 10 µg/m^3 increase in the PM_{10} concentration, which implies that individual exposed to long term

PM_{10} exposure is 1.1 times more likely to die than an individual who is not exposed to long term PM_{10} exposure.

Thus, the calculated AF_E in this case is (1.1-1)/1.1 = 0.09, which implies that 9% of death in those exposed to PM_{10} concentration higher than that of the reference value is entirely attributable to PM_{10}.

3. Outcomes, Results and Impact

3.1. PM10 concentrations

Table 1 summarises the minimum, maximum, and average PM_{10} concentrations at six stations measured in the valley during the period of 4 years from March 2003 to February 2007, as well as the winter (November – January) average. Similarly, Table 2 summarises the seasonal average PM_{10} concentrations during the period. The highest annual average concentrations of PM_{10} were observed in the urban high traffic areas of Patan and Putalisadak, with values ranging from 186 µg/m^3 to 211 µg/m^3, respectively. The lowest annual average concentration was observed for the rural village in Matsyagaon (48 µg/m^3). The urban residential area of Thamel, and Bhakhtapur and Kirtipur in the urban background had PM_{10} concentrations of 134 µg/m^3, 101 µg/m^3 and 71 µg/m^3, respectively. The rural area of Matsyagaon has lower ambient PM_{10} concentrations, which could be attributed to lower influence of traffic and polluting industries compared to the other stations. Seasonally, winter (November – January) and spring (February – April) were the worst period for PM pollution as the concentrations were much higher at all of the stations when compared to monsoon and post monsoon periods. At the busy traffic areas of Putalisadak and Patan, the average concentrations rose to as much as 287 µg/m^3.

3.2. Estimation of ambient PM exposure- An impact study

Table 3 and 4 present the results of calculations of population-weighted exceedance of PM_{10} in Kathmandu valley under different reference PM_{10} concentrations based on the annual average as well as winter concentrations of PM_{10} at respective stations. The total population of Kathmandu valley was taken as the sum of the populations of Kathmandu, Lalitpur and Bhaktapur districts as per the national census of 2011, which was 25,17, 023 (CBS, 2011), and the reference PM_{10} concentration was taken as 60, 90 and 130 µg/m^3. Results show that more than half of the valley residents are exposed to particulate matter pollution even if we allow the “moderate” level adopted by the Government of Nepal on an annual basis, and 14% of the residents are exposed to “unhealthy” levels of pollution throughout the air and results from winter months (Nov to Jan is particularly alarming and exposed to concentration more than 60 µg/m^3 is applied. Similarly, when the concentration of 90 µg/m^3 is adopted, 99% of the valley residents are exposed to harmful particulate matters, and more than half of the residents are exposed to “harmful” levels adopted by the Government of Nepal. It should be noted that most countries in the world have a more stringent air PM_{10} standards at 50 µg/m^3. These results show that PM exposure could be a significant health hazard to the valley residents.

3.3. Estimation of mortality associated with PM10 exposure- An Impact study

Table 3 and 4 also show estimated mortality rates that could be attributable to the PM pollution based on different reference concentrations, based on the annual average and average during the winter months when the PM concentrations are much higher. Based on the assumption that the relative risk of long term average PM_{10} exposure on natural mortality is 1.10 per 10 µg /m^3 (WHO, 2000), our calculation of exceedance of PM_{10} exposure, and the crude death rate of 677 per 100,000 in the year 2011, at least 2400 deaths per year can be strongly attributed to the PM pollution even when the tolerance to the PM is considered at levels of 130 µg/m^3, as considered “harmful” levels by the Government of Nepal. During the winter, the situation is highly severe, with up to 60 percent of deaths in the valley being related to the PM pollution even when the much accommodating PM concentrations of 130 µg/m^3 is assumed. If the ambient air quality standard of 50 µg/m^3 of PM adopted by the more

developed nations was the tolerance limit, 100% of the deaths occurring in the valley would have some contribution from the exposure to PM.

Table 1: Annual minimum (Min), maximum (Max), average (Avg) and 4 years average concentrations of PM_{10} in Kathmandu valley in µg/m^3

Station	Mar 2003-Feb 2004			Mar 2004-Feb 2005			Mar 2005-Feb 2006			Mar 2006-Feb 2007			4 years average
	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg	
Matsyagaon	11	298	50	7	164	56	7	222	44	4	176	42	48
Kirtipur	15	269	80	10	257	78	8	318	65	10	203	62	71
Bhaktapur	23	384	131	11	337	101	15	358	96	11	298	75	101
Thamel	37	369	149	29	327	139	30	481	122	31	340	124	134
Putalisadak	36	474	208	27	446	203	36	633	202	51	668	230	211
Patan	49	399	180	48	405	190	37	579	202	35	507	170	186

Table 2: Seasonal average PM_{10} concentrations in Kathmandu valley in µg/m^3 between 2003 and 2007

Station	Winter (Nov – Jan)	Spring (Feb – Apr)	Summer (May – Jul)	Autumn (Aug – Oct)
Matsyagaon	60	74	31	30
Kirtipur	98	102	35	45
Bhaktapur	150	154	48	59
Thamel	203	160	71	103
Putalisadak	287	261	135	163
Patan	233	229	141	141

4. Challenges, Risk and Action Required

The data on PM_{10} recorded at various monitoring stations in the Kathmandu valley shows that the pollution level in the valley is very high, and exceeds the national ambient air quality standards (NAAQS) as well as WHO recommended concentration levels in the urban area and in areas with heavy traffic throughout the year. Our results showed that many people who live in the urban area of the Kathmandu valley might be exposed to very high PM_{10} levels and consequently may have higher rates of mortality compared to people in more developed countries. A report of the Ministry of Environmental Science and Technology (2005) revealed that the annual mortality rate due to then existing levels of PM_{10} in Kathmandu valley was approximately 900 per 1,000,000 inhabitants in 2003. This study also found that if the concentrations of PM_{10} in Kathmandu valley could be reduced to levels below 50 µg/m^3, 1,600 deaths could be avoided annually. Based on these results, at current levels of population, about 2200 deaths would result from the exposure to PM_{10}. The most conservative annual estimate that we came up with at the reference concentration of 130 µg/m^3 is 2400 deaths, so our estimate can be considered similar to this study. One of the most recent studies conducted by Shrestha (2012) found that the all-

cause mortality in the Kathmandu valley can increase by >2.5% for each 10 μg/m^3 rise in the PM levels, and that such effect could likely persist for up to 20 days.

Table 3: Population weighted exceedance of PM_{10} in Kathmandu valley and estimated associated mortalities at the reference PM_{10} concentrations of 60, 90 and 130 μg/m^3 respectively, based on annual average concentrations at the stations

Station	Valley population	Crude death rate	P_i/P (Giri et al. 2007)	CPM_{10} (μg/m^3)	$RCPM_{10}$ = 60 μg/m^3		$RCPM_{10}$ = 90 μg/m^3		$RCPM_{10}$ = 130 μg/m^3	
					EPM_{10}	Associated valley mortality	EPM_{10}	Associated valley mortality	EPM_{10}	Associated valley mortality
Kirtipur	2517023	6.7 per 1000 individuals	0.100547	48	-1.21	14385	-4.22	9273	-8.24485	2409
Bhaktapur			0.180808	71	1.99		-3.44		-10.6677	
Thamel			0.071633	101	2.94		0.79		-2.07736	
Putalisadak			0.068279	134	5.05		3.00		0.273116	
Patan			0.108983	211	16.46		13.19		8.827623	
Matsyagaon			0.469751	186	59.19		45.10		26.30606	
				Total	84.42		54.42		14.41691	

Although there is a lack of adequate studies evaluating the mortality associated with air pollution in Kathmandu valley, several studies have attempted an estimation of the health benefits from a reduction in air pollution to safe level in the Kathmandu valley. A World Bank study by Shah and Nagpal (1997) found that the cost of the health impacts was approximately NRs 210 million. The study, however, used a dose-response relationship based on research in the US, combining it with the estimated frequency distribution of PM_{10} exposure in Kathmandu Valley in 1990. Further, CEN/ENPHO (2003) estimated that the avoided cost of hospital treatment through a reduction in PM_{10} levels in Kathmandu to international standards was approximately NRs 30 million. However, this study did not cover the costs of emergency room visits, restricted activity days, respiratory symptom days, treatment at home, and excess mortality. Murty et al. (2003) estimated the annual morbidity and mortality benefits to a representative household from reducing PM_{10} concentrations to the standard of 100 μg /m^3 to be NRs 1,905. Likewise, Adhikari (2012) estimates that the health benefits from a reduction in air pollution from the current level to the national ambient air quality standard level in Kathmandu valley of Nepal would result in savings in excess of 4.3 million US Dollars each year for the metropolitan/sub-metropolitan cities of Kathmandu and Lalitpur alone.

Table 4: Population weighted exceedance of PM_{10} in Kathmandu valley and estimated associated mortalities (in percentage) at the reference PM_{10} concentrations of 60, 90 and 130 μg/m^3 respectively, based on average concentrations at the stations during the winter months of November to January

Station	Valley population	Crude death rate	P_i/P (Giri et al. 2007)	CPM_{10} ($\mu g/m^3$)	$RCPM_{10}$ = 60 µg/m3		$RCPM_{10}$ = 90 µg/m3		$RCPM_{10}$ = 130 µg/m3	
					EPM_{10}	Associated valley mortality	EPM_{10}	Associated valley mortality	EPM_{10}	Associated valley mortality
Kirtipur	2517023	6.7 per 1000 individuals	0.100547	60	0.00	100%	-3.02	99%	-7.03829	59%
Bhaktapur			0.180808	98	6.87		1.45		-5.78586	
Thamel			0.071633	150	6.45		4.30		1.43266	
Putalisadak			0.068279	203	9.76		7.72		4.984367	
Patan			0.108983	287	24.74		21.47		17.11033	
Matsyagaon			0.469751	233	81.27		67.17		48.38435	
				Total	129.09		99.09		59.08757	

However, Kathmnadu valley has seen tremendous urbanisation and increase in vehicular numbers and emissions in the last decade, so present day estimates of the cost of hospital treatment, mortality or saved lives by improving ambient air quality standards could be much higher. Immediate attention and action is required from concern authorities including all stake holders such as valley residents, industries, road traffic management, and policy makers to address the alarming ambient air quality in Kathmandu Valley.

5. Transfer of Knowledge

This research shows that Kathmandu valley dwellers are living in one of the hazardous atmospheric environment and knowingly or unknowingly they are welcoming number of respiratory and other related diseases in their life. It is essential to make aware of valley people about the particulate matter and its consequences including respiratory disease, cardiovascular disease and other areas where PM_{10} can have significant contribution. More, earlier (before 2007), daily PM_{10} was regularly reported in daily newspaper as well as in government website. However, such information has not been seen by authors for last 5 years. Authors believe that regular publishing data and emphasizing the data value and its hazard level will help to increase awareness among the residents of valley. A long term government program for minimizing the air pollution is felt necessary to curb alarming atmospheric pollution in Kathmandu valley.

6. Conclusions

Kathmandu valley has a serious problem of particulate air pollution, and majority of the valley residents are exposed to harmful levels of the PM in everyday basis. Although the population living in the urban area are exposed to dangerous levels of the PM, even those living in the rural areas can be exposed to the harmful levels during the winter months, which can result in a number of health hazards, including

death. PM pollution in the valley can continue to contribute to a large number of deaths in the valley if steps to improve the air quality in the valley is not undertaken.

7. References

Adhikari, N. (2012), *Measuring the health benefits from reducing air pollution in Kathmandu Valley. Kathmandu,* South Asian Network for Development and Environmental Economics (SANDEE) Working Papers, ISSN 1893-1891

Banerjee, S. (2012), *Economic valuation of environmental benefits and costs. In R.N. Bhattacharya (ed.),* Environmental Economics, An Indian Perspective*,* New Delhi, Oxford University Press

Brunekreef, B., Dockery, D.W., Krzyzanowski, M. (1995), *Epidemiologic studies on short term effects of low levels of major ambient air pollution components*. *Environmental Health Prospective*, 103 (2), 3-13

CEN/ENPHO, (2003), *Health Impacts of Kathmandu's Air Pollution*, Kathmandu, Kathmandu Electric Vehicle Alliance (KEVA), Clean Energy Nepal.

CBS, (2011), *National Population and Housing Census 2011* (*NPHC2011*), Kathmandu, Central Bureau of Statistics, National Planning Commission, Government of Nepal

Collins C.O. and Scott S.L. (1993), *Air pollution in the Valley of Mexico*, Geographical Review,

83(2), 119-133

Dongarra, G., Manno, E., Varrica, D. Lombardo, M. and Vultaggio, M. (2010), *Study on ambient concentrations of PM_{10}, $PM_{10\text{-}2.5}$, $PM_{2.5}$ and gaseous pollutants*, Atmospheric Environment*,* 44, doi:10.1016/j.atmosenv.2010.08.04114

Giri D., Murthy, V. K., Adhikary, P.R. and Khanal, S.N. (2007), *Estimation of number of deaths associated with exposure to excess ambient PM_{10} air pollution*, International Journal of Environment, Science and Technology, 4(2),183-188

Giri, D., Krishna Murthy, V., Adhikary, P.R. (2008), *The influence of meteorological conditions on PM_{10} concentrations in Kathmandu Valley,* International Journal of Environmental Research*,* 2(1), 49-60

MOEST, (2005), *Ambient Air Quality of Kathmandu Valley 2003-04*, Kathmandu: Ministry of Environment, Science and Technology (MOEST), Government of Nepal

Murty, M.N., Gulati, S.C. and Bannerjee, A. (2003), *Health Benefits from Urban Air Pollution Control*, Delhi, Institute of Economic Growth

Pope, C.A. (2007), *Mortality effects of longer term exposure to fine particulate air pollution: review of recent epidemiological evidence*, Inhalation Toxicology, 19(1), 33-38

Sapkota, B. and Dhaubadel, R. (2002), *Atmospheric turbidity over Kathmandu Valley*, Atmospheric Environment*,* 36, 249-1257

Shah, J. and Nagpal, T. (1997), *Urban Air Quality Management Strategies in Asia: Kathmandu Valley Report*. Washington D.C, World Bank

Sharma, C.K. (1997). Urban air quality of Kathmandu Valley "Kingdom of Nepal". *Atmospheric Environment* 31: 2877–2883

Shrestha, S.L. (2012), *Particulate air pollution and daily mortality in Kathmandu Valley, Nepal: associations and distributed lag*, The Open Atmospheric Science Journal, 6(1), 62-70

Just the Systems Transfer First!

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Abstract

This article is focused on system transfer approach to accelerate and achieve development goals of Nepal with example of portfolio management, flying doctors and road safety. Project portfolio management focuses on proper combination of projects covering areas of challenges and opportunities. Flying doctors covers the concept to serve rural community with targeted focus on reducing child and maternal mortality rate in Nepal. Road Safety aims to introduce the first overtaking lane and raise awareness in drivers and pedestrians.

1. Introduction

In general, priorities of life are usually sequenced in self, family, community and the country eventually. Most NRNs are self empowered along with the family. We need to transfer that empowerment towards the communities. Empowerment comes with four balanced things in life, *Man, Bal, Buddhi and Dhan* represented by *Buddha, Durga, Saraswati and Laxmi*. The more we use the more it grows.

As Nepal is still classed as least development county, all NRNs are exposed to better system which can be transferred to Nepal. This article is focused on systems transfer approach to accelerate and achieve development goals with example of portfolio management, flying doctors and road safety. The required outcome can be achieved by finding root cause that is affecting our target and treating the root cause.

2. Portfolio Management

Project portfolio management deals with the coordination and control of multiple projects pursuing the same strategic goals and competing for the same resources, whereby managers prioritise among projects to achieve strategic benefits (Cooper et Al. 1997a). Miia M. in 2012 has studied inadequacy for assuming portfolio management as balanced judgment process and concluded that portfolio management can be viewed in other two perspectives, as negotiation and bargaining and as structural reconfiguration.

There are two ways to manage portfolio for an organisation to succeed i.e. doing project right by effective project management and doing the right project- resource allocation to achieve corporate objective. The goals for portfolio management are to have balanced or the right mix of projects, strategically aligned projects, right number of projects and maximise the value.

NRNs can lead the pathway of achieving a developed country by managing NRNs project portfolio that helps to accelerate development goals. We need to set our strategic goals to help Government and community in millennium development goals, transport safety improvement, corruption control and tourism promotion. We can take combination of large project and small packages in line with these strategic goals to tackle the root cause. These projects and packages should be able to transfer new system or improve existing system. Despite of dispersed focus of our energy, we need to solve problem from whole to the part. Instead of one person donating Rs 1 Crore, let's make small packages of Rs 1 Lakh where 1000 plus NRNs can participate and implement these packages in their community resulting in Rs 10Crs benifits to Nepal Aama. Let's make people power a real power.

Example of small package supporting education in a school “an Initiation from Nepal Engineers Association Australia Chapter” is describe below.

NEA Australia Chapter has established a soft system to support education at Shree Nava Jyoti Higher Secondary School Biruwa, Syangja by funding NRs.100,000. The system is school level constitution, registered at District Administration Office, Syangja as a non-profit organisation under the Social Organisations Registration Act 2034.

Txcche main objective of NEA funding is to establish a system to motivate students and teachers and support sustainable community level funding for routine maintenance of school’s assets.

Secondly, provide tools to facilitate donors/sponsors to establish scholarship fund in name of their preference (i.e. parents, organisation etc) with options to choose or design their own categories of scholarship.

Funding is deposited in saving account. Its interest is being used in for two categories of annual awards and for ongoing maintenance of school assets.

“NEA Australia- Student of the Year- Award” is awarded with annual interest earned from NRs.50,000 to a student scoring highest marks in Mathematics, Science and English in SLC

“NEA Australia- Teacher of the Year-Award” is awarded with annual interest earned from NRs.25,000 to teacher/s who achieves 100% students pass result in their subject in SLC.

The interest earned from remaining NRs.25,000 is used to maintain infrastructure of the school.

Above funding allocation is seed money only, top up on existing or establishing separate funds will be available to enthusiastic sponsor within the constitution.

The system can be implemented in any school in Nepal and have a reliable monitoring tools like annual audit, transparent decision and monitoring involving school management committee, District Education Office and District Administration Office. The system provides ongoing goodwill for any donors/sponsors and supports quality education by motivating students, teachers and provides sustainable periodic maintenance recourse at community level.

3. Flying Doctors

The Royal Flying Doctor Service of Australia (RFDS) is one of the largest and most comprehensive aeromedical organisations in the world. Using the latest in aviation, medical and communications technology, it delivers extensive primary health care and 24-hour emergency service to those who live, work and travel throughout Australia.

The RFDS began as the dream of the Rev John Flynn, a minister with the Presbyterian Church. He witnessed the daily struggle of pioneers living in remote areas where just two doctors provided the only medical care for an area of almost 2 million square kilometres. Flynn’s vision was to provide a ‘mantle of safety’ for these people and on 15 May 1928, his dream had become a reality with the opening of the Australian Inland Mission Aerial Medical Service (later renamed the Royal Flying Doctor Service) in Cloncurry, Queensland.

In the financial year ending June 2013, the 63 aircraft of the RFDS and a number of chartered aircraft undertook over 75,000 flights taking over 80,000 hours and covering a distance of nearly 27 million kilometres. RFDS treated on average 809 patients everyday across more than 80% of Australia (7,150,000 km2), an area nearly the size of the United States of America.

Flying doctors and nurses with a helicopter would be ideal solution. The aim is to transfer this successful system covering about one quarter of area of Nepal (147,181 km2). The system can improve overall health service with focused maternal health and child mortality for hilly districts still without road access.

For these targeted area pregnancy data can be collected and monitored at VDC level can be done by VDC secretary.

Nepal recorded infant mortality rate (per 1000 live births) of 108 in 1990 and 46 in 2013. Likewise, maternal mortality ratio (per 100,000 live births) was 850 in 1990 and 170 in 2013. While Australia is maintaining infant mortality ration less than 5 and maternal mortality ration less than 7. These are example data in two important areas. The introduction of flying doctors can be boon to geographically challenged areas.

The concept is summarised below.

- Cost: A$1.5M or 50% partnership with government or doner
- Stakeholders: Army (Operator + Maintainer), District Administration Office (Administration), District Development Committee (Data Collection and Monitoring)
- Beneficiaries: Rural Communities
- Stages: Begin with Far-Western Region; expand in future to Mid-Western and remaining 3 regions

4. Road Safety

In Australia, we are familiar with road safety rules, regulations and infrastructure facilities. We can feel the absence of modern infrastructures in Nepal for tackling growing number of road accidents.

With combination of strategic and local road network, Nepal has 62579 km of road network and 1,545,988 registered vehicles in 2013. In 2012-13, 13582 road accident accidents occurred, out of which 1816 were fatalities. This number is more than annual average lives lost during decade-long conflict. As per Traffic Accident Record, Traffic Directorate, majority of accidents are due to negligent driving 43.7%, high speed 18.7% followed by overtaking 8.8%. The road accidents cost for year 1994/95 alone was estimated to be more than £ 9 Million (0.4%) of GDP. When travelling between Mugling to Kathmandu, people pray to *'manakamana mai'* in every overtaking move. The move is so dangerous without proper sighting distance ahead and usually in higher speed. This section of road is just one example. There are several other dangerous situations and behaviours issues including both driver and pedestrians. Recently more rural roads are opened most of which does not meet curvature and gradient standards. Furthermore these roads are dirt roads only without any drainage arrangements. These are causing environmental disasters like landslides, flooding, and deforestation.

One of the partial solution tackle the main three issues of accidents (negligent driving, speeding and overtaking) will be introducing the first overtaking lane in the nation to raise awareness to driver and community with dedicated footpath for pedestrians and speed monitoring.

- Scope: feasibility and detail design for overtaking lane then Implementation by Nepal Government
- Cost: A$50K
- Stakeholders: Department of Road, Nepal Engineers Association, Contractors, Planners
- Beneficiaries: Road User and local community
- Stages: complete design and facilitate government to implement at least one overtaking lane in the country.

5. Conclusion

NRNs are un-official ambassador of Nepal to non-Nepalese contemporaries to promote Nepal. We also should be acting as ambassador to Nepal Aama to transfer systems/practices to help in achieving millennium development goals, corruption control, road safety and tourism. NRNs need to have its project portfolio covering all challenging areas with main focus on system transfer. Flying doctors and road safety initiatives can be implemented with some efforts. We need to look in to the other small

packages of smaller value where many NRNs can participate and implement these packages in their community resulting in cumulative benefits.

Let's tackle the root cause of the problem from whole to the part, not part to the whole. Life is too short, people will summarise our life in a one sentence. It is up to us to make that sentence. Let's do it. It's for me, you, us and Nepal Aama.

Let's transfer Systems, be innovative by turning ideas in to the benefits.

6. References

Thapa, A.J. (2013), *Status Paper on road safety in Nepal*, Department of Road

Cooper, R., Edgett, S. and Kleinschmidt, E. (1997), *Portfolio management in new product development*, Product Innovation Best Practice Series, Product Development Institute

Martinsuo, M. (2013), *Project portfolio management in practice and in context,* International Journal of Project Management, 31,794-803

Nepal Millennium Development Goals, (2013), *Progress Report 2013*, Government of Nepal, National Planning Commission, United Nations Country Team of Nepal

http://www.flyingdoctor.org.au/

http://www.indexmundi.com/

Determining the Helminth Communities in Environmental Water of Kathmandu, Nepal by Using NGS

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Abstract

Gastrointestinal helminthiases are endemic in Nepal especially among indigenous people living in poverty. However, little is known regarding the role of different socio-economic indicators on helminth infections in these communities. The main aim of this study is to identify the relationship between socio-economic factors and helminth infection in an indigenous community in Nepal.

A cross sectional survey was conducted in the Gaindakot Village Development committee, Nepal in July to August 2010. Total of 137 people of 10-60 years of age provided faecal samples for parasitology and answered a questionnaire on indicators of their socio-economic conditions.

Overall 54.0% of individuals were positive for helminth infection. The higher (74.3%, 69.6%, 57.8%, 56.9% and 63.6%) infection rate was found in the people worked as a laborer, without sanitation, inadequate water source, living in a mudded house and sharing house with animals respectively. The results were statistically significant ($P < 0.05$) except water use and house type. Correlation between socio-economic variable and helminth infection was very high (0.99-1). Hookworm infection was significantly associated with household sanitation ($P < 0.001$). While the risk of roundworm infection was significantly associated with low lying areas ($P = 0.005$).

The individual and social behavior had important role in helminth infection. Hookworm infection could be reduced by improved sanitation facilities and the utilization of safe water sources. In addition, health education programs aimed at indigenous laborers is likely to play a significant role in the reduction of roundworm infection in the community.

1. Background

It is estimated that, half of the people living in the Kathmandu depend on river for household water (NGOFUWS, 2005). Environmental water quality of Kathmandu has been significantly degraded due to direct disposal of raw sewage. The available infrastructures have failed to manage increased wastewater production. As a result, helminth infection is thriving in the population than never before (Gyawali, 2012). Interventions including mass chemotherapy had been implement to eliminate the helminth infection (WHO 2012) however, the infection rate is still very high due to the direct and indirect exposure to the contaminated water.

Next generation sequencing (NGS) methods have significantly increases sequencing throughput via the use of massively parallel sequencing (Sogin *et al.,* 2006). Amplification of highly variable gene 5.8S rDNA of ITS-1 and ITS-2 region has resulted in extreme sequencing of helminth communities. This has allowed for the identification of rare populations with low abundance. NGS method has been successfully utilized to identify bacterial communities in river water (Staley *et al.,* 2013).

2. Rational and Objectives

Infectious helminths have affected, and still affecting, community people in Kathmandu. The morbidity associated with such infections imposes a substantial burden of disease, which helps to establish and maintain a vicious circle of infection, poverty, decreased productivity, and inadequate socioeconomic development. The infections themselves may have an impact on other conditions such as malaria, HIV/AIDS, and the ability to respond effectively to a range of anti-infectious disease vaccine (WHO, 2012). Thus, it is essential to understand geographical and ecological circumstances of infectious helminths in Kathmandu. The abundance of infectious helminths and their geographical distribution in the environmental water in Kathmandu is poorly understood.

The main objectives of this study will be i) to determine the infectious helminth communities in various rivers in the kathmandu valley, ii) to estimate the potential health risk associated with the use of river water and, iii) to identify the spatial distribution of infections in the communities.

3. Method

3.1 Study area

Kathmandu is the capital and largest urban center in Nepal, located in the Hills region, at an elevation of 1,300 meters. Several rivers flow to the center of the valley. Water samples from Bagmati, Bishnumati, Manamati, Dhobikhola, Hanumante, Manohara, Mahadev, Nakkhu and Godawari Rivers at three different sites will be collected in sterilized 1L containers. All the samples will be collected in triplicate. Samples are then transported to the parasitology laboratory of Central Department of Zoology, Kirtipur and stored at 15^0C for 24 hours prior to filtration. Physical properties of water (pH, temperature) and geographical coordinates will be recorded during each sampling. In addition the distance of wastewater disposal point will be measured and antecedent 72 h rainfall data will be obtained from the Bureau of Meteorology (BOM).

3.2 Sample processing and DNA extraction

Water samples will be filtered through sieves with 150 µm opening to remove the large debris. The filtrate then passes through 8 µm polycarbonate filter paper (Sigma Aldrich, USA). The filter papers will be placed into a 15 ml centrifuge tube and phosphate buffer solution will be added. The tubes then placed in a PSU – 300 orbital shaking platforms (Keison products, UK) and shake for 2 h at 2000 rpm. After 30 min of settling, filter paper will be removed from the tubes and tubes will be centrifuged for 30 min at 4000 rpm. Pellet will be recovered from the tube and DNA will be extracted using a Power Soil kit (Mo-Bio Laboratory) with some minor modification. In brief, 60 µL of buffer C_1 will be added to each pellet and subjected to five cycles of freezing (-80ºC) followed by thawing (100ºC) in a water bath. After freeze- thaw, the DNA will be extracted according to the manufacturer's instructions. All DNA samples will be quantified using a NanoDrop spectrophotometer (NanoDrop Technology, USA).

3.3 PCR and illumina sequencing

ITS's-1 and ITS's-2 region of the 5.8S rDNA will be amplfied by PCR using cocktail of different primers designed for helminths (González *et al*, 2000; Pecson. *et al*., 2006; Traub *et al*., 2008; Areekul *et al*., 2010; Kramme *et al*., 2011; Boubaker *et al*., 2013). Barcode ID for Illumina adapter sequence including a six-base multiplexing identification barcode unique to each sampling site will be added in the primer sequence. PCR amplicons will be extracted from 2% agarose gels and purified using the QIAquick Gel Extraction kit (Qiagen, Valencia, CA, USA) according to the manufacturer's instructions. Purified amplicons are pooled in equal concentrations and paired-end sequenced on an illumina MiSeq platform at the University of Minnesota Genomics Center (Saint Paul, MN, USA).

3.4 Sequence data processing

Mothur 1.33.0 will be used to process illumina sequence reads including trimming. Chimeras will be removed using UCHIME. Sequences will be aligned against the NCBI database. To control for differences in numbers of sequence reads at each site, while still capturing as much genetic diversity as possible, the number of sequence reads in each sample will be normalized by randomly subsampling to the number of reads in the sample with the fewest reads.

3.5 Data analysis

All statistics will be conducted at α = 0.05 level. Shannon, Shimpson, nonparametric Shanon and nonparametric Shimpson analysis will be conducted by using mother to determine the alpha diversity of helminths (Schloss *et al*., 2009). Weighted and unweighted UniFrac calculation will be performed to assess differences among sites based phylogenetic information (Lozupone and Knight, 2005). Distance matrices between samples will be calculated using the Bray-Curtis measure of dissimilarity (Bray and Curtis 1957) and use for nonmetric multidimensional scaling (NMDS) as well as analysis of molecular variance (AMOVA). Spearman rank correlations will be conducted to examine the relationship between pH, temperature, rainfall and distance of wastewater disposal system. These calculations will be performed using SPSS 21.0 (IBM, USA). Helminth community information will be interpolated with geographical coordinates and develop a helminth map of Kathmandu by using Arc GIS 10.1 (ESRI, USA).

4. Partner Agency

This research will be collaboration between Central Department of Zoology (TU) Nepal, NRN Australia, School of population health, (UQ) Australia and School of public health (GU).

5. Mechanism of Skill and Knowledge Transfer

Two masters student from TU will be conducted the research as a part of their dissertation under supervision of Associate Professor Dr Mahendra Maharjan. As a collaborator of this study TU will be provided their laboratory facility. Knowledge, skill and technical support require to carried out this research will be provided by Pradip Gyawali (UQ) by visiting to the TU. Pradip Gyawali will be in touch with University of Minnesota Genomics Center, where pair end illumina sequences will be developed. NRN Australia will be provided financial support to conduct the research.

6. Project Monitoring System

Associate Professor Dr Mahendra Maharjan (TU) and Birochan Shrestha (Griffith University) will be responsible for monitoring the progress of project and finance. Students undertaking this study will be responsible for conducting research and submitting a final report to NRN Australia. NRN Australia will be responsible for handing the findings to the government of Nepal.

7. Time

This research project is designed for a year and will be started from July, 2015 to July 2016. The final report will be submitted to the NRN Australia in August 2016. Descriptive time table for this research project can be seen in Table 1.

Table 1: Descriptive time table for the purposed research project

Tasks	Time

	Jul	Aug	Sep	Oct	Nov	Dec	Jun	Feb	Mar	Apr	May	Jun	Jul
Student selection													
Sample collection													
Sample process													
DNA extraction													
Sequencing													
Data analysis													
Report writing													
Report submission													

8. Budget

This research project will require a total of AuD $26,620.00 over the period of 12 months. The majority of funds will go towards laboratory equipment

, reagents. The detail budget breakdown can be seen in Table 2.

Table 2: Detail budget breakdown for the purposed research

SN	Particulars	Cost	Total
1	Masters Scholarship (2)	1,000.00	2,000.00
2	Laboratory reagents	2,500.00	2,500.00
3	Sequencing	500.00	500.00
4	Laboratory equipment	10,000.00	10,000.00
5	Travel (Domestic and International)	7,500.00	7,500.00
6	Communication	200.00	200.00
7	Stationary	1,500.00	1,500.00
8	Miscellaneous (10% of total cost)	2,420.00	2,420.00
		Grand Total	**26,620.00**

9. Anticipated Outcome and Impact

This research will identify pathogenic helminth communities that help to assess potential risk of infection from direct and indirect use of the environmental water. The infection map produced from this research will help to implement various intervention programs including mass chemotherapy to minimize the

infection. Students working in the project will learn latest technology and may transfer to other areas of public and environmental health. In addition the project will establish professional relationship between TU and UQ and could be beneficial for Nepalese students in future.

10. Challenges and Opportunities

Nepalese professionals' involve in the project will enhance their capability to conduct a research by using latest technologies and their report may be milestone for Nepalese government to produce a guideline for wastewater management. Findings of this research may open the possibilities for further research collaboration between TU and other international agencies including WHO. However, this study will adopt triplicate samples from each river as a result more studies may require to generalise the findings across the valley. The materials and kits that are used in this research can be expensive for future small scale study. Therefore, Nepalese collaborators may need more funding to keep the skill and knowledge.

11. References

Areekul, P., Putaporntip, C., Pattanawong U. and Jongwutiwes, S. (2010), *Trichuris vulpis and T. trichiura infections among schoolchildren of a rural community in northwestern Thailand: the possible role of dogs in disease transmission*, Asian Biomedicine, 4(1), 49-60

Boubaker, G., Macchiaroli, N., Prada, L., Cucher, M.A., Rosenzvit, M.C., Ziadinov, I., Deplazes, P.U., Saarma, H. Babba and Gottstein, B. (2013), *A Multiplex PCR for the Simultaneous Detection and Genotyping of the Echinococcus granulosus Complex*, PLoS neglected tropical diseases, 7(1), e2017

Bray, J.R. and Curtis, J.T. (1957), *An ordination of the upland forest communities of southern Wisconsin*, Ecological Monographs, 27, 325–349

González, L.M., Montero, E., Harrison, L.J., Parkhouse R.M.E. and Garate, T. (2000), *Differential diagnosis of Taenia saginata and Taenia solium infection by PCR*, Journal of clinical microbiology**,** 38(2), 737-744

Gyawali, P. (2012), *Parasitic Diseases of Indigenous Community (Kumal) in Nepal*, Nepal Journal of Science and Technology, 13(2), 175-178

Kramme, S., Nissen, N., Soblik, H., Erttmann, K., Tannich, E., Fleischer, B., Panning, M. and Brattig, N. (2011), *Novel real-time PCR for the universal detection of Strongyloides species*, Journal of medical microbiology, 60(4), 454-458

Lozupone, C. and Knight, R. (2005), *UniFrac: a new phylogenetic method for comparing microbial communities*, Applied and Environmental Microbiology, 71, 8228-8235

NGO Forum for Urban Water and Sanitation, (2005), *Delivering Water to the Poor: A Case Study of The Kathmandu Valley Urban Water Supply Reforms with a Special Focus on the Melamchi Project,* NGO Forum for Urban Water and Sanitation

Pecson, B.M., Barrios, J.A., Johnson, D.R. and Nelson, K.L. (2006), *A real-time PCR method for quantifying viable Ascaris eggs using the first internally transcribed spacer region of ribosomal DNA*, Applied and Environmental Microbiology, 72(12), 7864-7872

Schloss, P. D., Westcott, S. L., Ryabin, T., Hall, J. R., Hartmann, M., Hollister, E. B., Lesniewski, R. A., Oakley, B. B. (2009), *Introducing mothur: open-source, platform independent, community-supported software for describing and comparing microbial communities*, Applied and Environmental Microbiology, 75, 7537-7541

Sogin, M.L., Morrison, H.G., Huber, J.A., Mark W.D., Huse, S.M., Neal, P.R., Arrieta, J.M. and Herndl, G.J. (2006), *Microbial diversity in the deep sea and the underexplored "rare biosphere*", Proceeding of the National Academy of Sciences USA, 103, 12115-12120

Staley, C., Unno, T., Gould, T.J., Jarvis, B., Phillips, J., Cotner, J.B. and Sadowsky, M.J. (2013), *Application of Illumina next-generation sequencing to characterize the bacterial community of the Upper Mississippi River*, Journal of Applied Microbiology, 115, 1147-1158

Traub, R.J., Inpankaew, T., Sutthikornchai, C., Sukthana, Y. and Thompson, R.C. (2008), *PCR-based coprodiagnostic tools reveal dogs as reservoirs of zoonotic ancylostomiasis caused by Ancylostoma ceylanicum in temple communities in Bangkok*, Veterinary Parasitology,155(1-2), 67-73

WHO, (2012), *Research priorities for helminth infections: technical report of the TDR disease reference group on helminth infections*, Technical report no. 972, World Health Organization, Geneva, Switzerland

WHO, (2012), *Soil-transmitted helminthiases: eliminating soil-transmitted helminthiases as a public health problem in children,* progress report 2001-2010 and strategic plan 2011-2020, Geneva**,**1-74

Small Scale Mechanization Could Transform Mid-Hill Economy of Nepal

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Abstract

The Green Revolution of 1960s and 70s has brought about enormous positive impacts on livelihood of farming community in agriculture based economy of developing countries, however, Nepal was left far behind to reap that benefit. Improved crop varieties, fertilizer, irrigation, modern pest control and mechanization are essential inputs in order to reap full scale benefits from green revolution. After more than four decades from the start of green revolution, numerous discussion and reviews on this subject have cited poor state of farm mechanization as one of the main obstacles to economic prosperity of farming community, especially in the hills and mountains of Nepal. The statement is supported by the finding from a feasibility study that 92% of the total mechanical power available in Nepal was in Terai, while mid-hill and high hills shared only 8% (FBC 2006). Besides geographical barrier of rugged topography being unfavourable for farm mechanization, many other factors such as access to public transport, electricity, market centres, and simplified credit lending to farm entrepreneurs were accounted as major non-technology related obstacles for farm mechanization in mid and high hills.

The situation, however, has changed recently in the last 20 years. Rural road network in the mid-hills and in some parts of high hills have extended and so is the electricity. Communication network, including mobile phones, landlines and internet has penetrated geographical barriers. However, with the start of political instability in 1996, mass migration of youth from rural areas occurred resulting into severe shortage of farm workers especially in mid-hills and high hills. This trend is continuing with the outflow of rural youth to overseas for better employment opportunities which left farming to a few people as the last resort to survival. As a result, aged farmers have been left to become custodians of farmlands which are left uncultivated leading to soil erosion and deterioration of farmland ultimately being unsuitable to farming in future; the trend is growing alarmingly. This bleak situation of chronic shortage of farm workers and lack of interest shown by new generation to take up farming occupation together with some positive changes on road extension, electricity and communication network have warranted urgent need on the part of policy makers and stakeholders to adopt farm mechanization in mid-hills and high hills.

In fact, there is a light at the end of the tunnel. Government of Nepal has recently proposed Agricultural Mechanization Policy Nepal 2070 which is currently under review (in approval process). It has been anticipated that the policy will bring positive changes to availability of farm machinery and its parts as well as bring simplified credit lending process to farm entrepreneurs in order to purchase and repair farm machinery. Recently, many new agricultural graduates are taking up farming occupations such as dairy, poultry, goat, vegetable and pig farming which have been exemplified by media as bold initiatives. Those returning from working overseas may carry new skill, knowledge and capital with them could be

more easily attracted to invest in small to medium scale agri-business if the wave of farm mechanization could be created in the mid and high hills.

In this regard, Non-Resident Nepali Association (NRNA) could have a great role. NRNs living in different countries could work with government bodies, NGOs, local businesses and farming communities in Nepal by developing a proper channel of communication and working model and partnership. As an example, the initial efforts on the part of NRNA Australia is to form a pool of experts on farm mechanization, farming systems, and conservation agriculture who are willing and available to contribute their experience, skill and knowledge transfer to wider Nepali community back home through a model farm set up. Based on the pool of experts in Australia, a core team would be formed who would then carry out feasibility study and select a farming community in a representative mid hill location in Nepal; this community should be willing to develop their farm as a model farm to mechanization and conservation agriculture. The team will also consult with local stakeholders including government bodies, NGOs, local businesses and farming community to discuss how expertise of NRNA could be better utilized by farming community. Moreover, the team will review and assess successful case studies of small scale farm mechanization of hill agriculture such as that of India (e.g. Himanchal Pradesh), South Korea and other countries in order to submit report to NRNA NCC Australia. With the recommendation from the core team assigned for this task, NRNA NCC could raise funds to build and maintain small scale farm machinery infrastructure for the model farm. With all efforts and coordination of all stakeholders put in a right place, this model farm could be developed into a major learning hub for mid hill farm entrepreneurs to train them for commercial and conservation agriculture by operating in a community business model. Once NRNA NCC Australia demonstrates that such a model farm with successful mechanization, and conservation agriculture works well in the originally selected mid-hill location, then it could be an example for extrapolation to other locations in mid- and high hills across the country. Then NRNA NCC could share this knowledge and innovation to other countries through NRNA ICC. NRNs from other countries would also establish such model farms to other locations across Nepal. In this process of expansion of successful mechanisation and practice of conservation agriculture, experts of NRNA Australia could exchange their knowledge, skills and innovation to NRNs of other countries. Thus, there would be knowledge and skills exchange across NRNs in many countries where they live as well as among various stakeholders including policy makers and farming communities in Nepal and NRNs of other countries.

Thus In order to preserve hill agriculture and farmlands as well as to appreciate wise use of natural resources of the hills, small scale farm mechanization is urgently needed. NRNA, by utilizing the pool of experts, thus could help create model farm community group to facilitate transfer of skill, technology, knowledge and innovation from its members to wider Nepali community to Nepal and globally.

1. Agriculture in Nepal

Agricultural sector in Nepal has potential to provide employment and livelihood opportunities for farmers and rural people and also has a major role in leading growth of country's economy. However, farmlands are fragmented and farm sizes are small especially in mid- and high hills, which can pose both opportunities and challenges for planning and operation of small-scale mechanization. Moreover, rugged terrains, lack of agricultural roads, and terraced farm topography pose further challenges for machinery introduction and promotion. Government programs to introduce irrigation facilities and fertilizers have proved inadequate; their delivery hampered by the rugged mountainous terrain. Population growth and environmental degradation have caused minimal gains in agricultural production, owing more to the extension of arable land than to improvements in farming practices. Production of most crops particularly that of cereals, has been consistently decreased. Once an exporter of rice, Nepal now is a net importer. As most of the country is mountainous, there are pockets of food-deficit in most

of the remote districts, and this is quite severe in the Western region. Citing high cost factors on transportation from Tarai to hilly regions, businessmen often prefer to export food products across the border to India often aggravating food crisis in remote districts.

With the start of political instability in 1996, mass migration of youth from rural areas occurred resulting into severe shortage of farm workers especially in mid- and high hills. This trend, since then, has continued with outflow of rural youth to overseas for better employment opportunities. As a result, aged farmers have become custodians of farmland. Many farms are left uncultivated leading to soil erosion and deterioration and ultimately may turn into marginal lands unsuitable to farming in future. The trend of migration does not seem abated even after peace restoration in the country, which warrants a chronic shortage of farm labour and resultant soil erosion and land degradation.

However, in the last 10 years, there have been some encouraging developments in mid- and high hill areas. Rural road network and electricity have been extended in the mid-hill and some parts of high hill. Moreover, there has been incredible progress in communication network. Meanwhile, Government of Nepal (GoN) has recently proposed agricultural mechanization policy which aims to make available farm machinery and parts to farm entrepreneurs for purchase and repair. Success stories of some new agricultural graduates and people returning from foreign employment taking up farming occupations have been published by broadsheet newspapers. Dairy, poultry, goat, vegetables and pig farms have been proven to be profitable and such farms can be seen in the areas surrounding cities and town centres. In order to retain such a positive move toward commercialization in agriculture, GoN needs to address root causes that are dragging mid-hill farmers to emerge from subsistence farming.

2. Current Status of Agricultural Mechanization and Conservation Agriculture in Nepal

A census carried out in 2001-02 has shown that the proportion of farms using tractors and threshers was less than 10% in comparison to farms who used pump sets/motors for irrigation of 14.3%. Only 1.97% farms used power tillers and 26.1% of farm households used iron plough indicating that power tillers were not as popular as tractors and threshers. The 2011-12 Census also showed similar trend; there were less than 1% farms using power tillers but 28.01% farms using iron plough-the most basic farm tilling technology. Likewise, only 22.04 percent farm households used tractors and 20.96 percent used threshers. In pursuant to such a poor growth of farm mechanization GoN has tabled a draft of the Agricultural Business Promotion Act, which aims to ensure market access to farmers and attract private sectors in commercial agriculture, envisages contract farming provisions and farm mechanization.

By virtue of topography, farmland in the mid and high hill is sloping up to 30%, where terrace farming is the most common practice. In such a situation, soil erosion during monsoon is the most serious problem. Loss of fertile top soil by wind and water is a great challenge to retain productivity in such a slopping land. Conservation Agriculture (CA) and farm machineries have been successfully practiced in low-lying areas of south and southeast Asia but there are no or negligible reports on practising CA on hilly areas although farm machines have been used in many hilly areas of China, India and South Korea. In Nepal, CA and small tilling and planting machines have recently been introduced by CIMMYT (International Maize and Wheat Centre) in a mid-hill district of Palpa in western Nepal.

CA is an approach to production system management; it complies with the notions of sustainable production intensification. CA consists of three basic principles or components: no or minimum soil

tillage; partial or full use of crop residues; and sustainable crop rotations. Thus, for the establishment of rainfed and irrigated crops at field level and for up-scaling of rain fed or irrigated CA systems, including arable systems, crop-livestock mixed-farming systems, or horticulture systems, or plantation systems, the approach requires specific mechanization measures to allow crops to be established with no or minimum soil disturbance, to protect top soil by organic cover, and to manage crop rotations and soil and agro-ecosystem health. CA together with sustainable mechanization keeps up soil health and significantly reduces soil erosion. Despite budgetary subsidies to purchase and use farm machines like power tillers, harvesters, planters and seed drills, and herbicides and pesticides sprayers, participation of youth in the farm sector, particularly in the mid- and high hills, is still dwindling because the sector is not much attractive due to unavailability of clearly profitable farming technology.

3. Why Mechanization of Hill Farms and CA Essential?

The low agricultural productivity is often cited because of poor state of farm mechanization, uneconomic farm size and inadequate & untimely delivery of farm inputs and support services. As a result, farming has not been perceived as a prestigious and profitable occupation. While the majority of farms are occupied by small and marginal households in the mid-hill, the trend of agricultural lands remaining fallow is increasing. Since largely subsistence agriculture does not create year-round employment opportunities for rural people, most youth migrate to city centres and overseas for jobs. This has created a shortage of manpower during peak operation seasons such as planting and harvesting. This in turn has created additional problems in rural Nepal: (i) reduction of agricultural production and (ii) additional burden to elderly, women and children creating imbalance in family and social lives.

Experiences from the recently mechanized neighbouring countries such as India, Bangladesh and China reveal farm mechanization as a crucial input for improving agricultural production. Without farm power and appropriate tools, implements and machines farmers would struggle to emerge from subsistence farming. Following increased demands for food and agricultural products already straining existing natural resources base, urgent need of developing production systems with integration of sustainable mechanization has been obvious. As mechanization promotes farm intensification, mechanization and sustainable intensification with CA would pave way to future farming as a business enterprise. Sustainable intensification implies protection of natural resources and ecosystem hand-in-hand with intensified food and fibre production practices and methodologies. Thus, farm mechanization and CA form an integral plank in the implementation of sustainable crop production and intensification approaches.

4. Challenges and Opportunities of Mechanization and CA in Hills

4.1 Small scale land holdings

Arable land cultivated in Nepal is only 21% of the total physical land area. This land mass is concentrated in the southern Terai plain and mid-hill region. The National average size of farm holding is 0.96 ha of which mountains and high hills have 0.68 ha, mid-hills have 0.77 ha and Tarai has1.26 ha. The national average parcel size is 0.24 ha and average no. of parcel holding is 4 (NGO Federation). Moreover, High Level Commission on Scientific Land Reform (2010) has categorized farmer groups based on size of farmland ownership; Landless and marginal farmers (33% household) have less than

0.3 ha average farm size, small to medium farmers (63% household) have 0.3 ~3.0 ha farm size, large farmers (3.3% household) have 3.0 ~10.0 ha farm size and extra-large farmers (0.1%) household have greater than 10 ha farm size. In a study conducted by Nepal et al (2009) in Eastern Nepal, it has been concluded that farm mechanization is the most influential factor in agricultural commercialization in Nepal. The contexts clearly justify rationale behind authors' call for small scale mechanization and conservation farming in order to commercialize small to medium farm size in the mid-hills. Moreover, rugged terrain of mid-hills, lack of agricultural roads to most farm lands, and terraced farm topography poses different challenges in the machinery introduction and promotion as compared to the Terai plain.

4.2 Land lease and contract farming in the mid-hills

Contract farming initiatives could provide producers easier access to market and credit facilities. Furthermore such initiatives create avenues for land consolidation. GoN has envisaged such initiatives in the proposed Agriculture Business Promotion Guidelines. After implementation of the proposed guidelines, it will bind both buyers and producers legally; they can claim reparation if any of the parties breach the contract. This provision would largely support commercial agriculture. The existing law fails to address leasehold farming practices since land owners are reluctant to allow tenants cultivate their land for continuous long-term, fearing the leasers might claim tenancy. Thus the proposed guidelines can address problems related to land leasing and are also expected to increase land productivity through optimum utilisation of land and water resources. With contract farming, mechanization can help both land owners and leasers for the production and processing of crops timely. In the near future, mid-hill cereal farmers will have to compete with high value crops in terms of value of their land and irrigation water being used for cultivation. Hence they will need to adopt mechanization and follow contract farming and commercial agriculture.

4.3 Support systems for farm inputs and services

Currently agricultural support system in Nepal is very primitive in nature. There is lack of comprehensive policies for agrarian reform and associated farm inputs (seed, fertilizer, pesticides, etc.) and support services resulting in low productivity. As a result, farming has not been perceived as a socially prestigious and profitable occupation by general public. To retain productivity of resources including land and water, support systems, including agricultural extension services, delivery of farm inputs and credit lending schemes have to be modernized. Extension should be service-oriented and be quick in providing targeted response to a call for help. Inputs should be delivered timely in adequate quantity and small credit lending schemes be developed without the need of collaterals. Some of the resources that are currently poured on policy and programs targeting food security could be diverted to strengthening such support systems so that overall agricultural productivity enhanced and resultant tangible outcomes would address country's food security issues in the long-term and more effectively.

5.Some Paradigm Shifts

In recent years, there have been some changes in attitudes, thinking and practices in the farming sector in Nepal. For example, new agricultural graduates are gradually adopting farming and have emerged as new generation farm entrepreneurs in dairy, poultry, goat, vegetable and pig farming. Farming is also gradually attracting Nepalese returning from overseas employment. Many of them carry new skill,

knowledge and capital to invest in small to medium scale agri-business. If such wave of commercialization could be maintained in mid hills where problem of low productivity is prevalent, a great many youth would be attracted to the farm entrepreneurship. In addition, recently the GoN has also been active to promulgate and enact Agricultural Mechanization Policy Nepal. It has been anticipated that the policy will bring positive changes to availability of farm machinery with easy access to purchase as well as repair and maintenance. All these changes have great potential to initiate and promote farm mechanization and CA.

6. A Proposed Model Farm: Mechanisation and CA

As per guidelines and the project developed by NRNA Australia NCC and NRNA ICC and based on the recommendation by the project core team, initially a few model farms will be chosen in the representative mid-hill regions of Nepal. These model farms will be used to disseminate skill, knowledge, and innovation on major staple crops- maize, rice and wheat. The project will initially start with only a few model farms so as to gain confidence of all stakeholders and will be replicated in a number of farms in the subsequent years.

Rice-wheat and rice-maize systems are dominant cropping systems in the irrigated fields of mid-hill, often receiving priority attention by farm entrepreneurs. In the first step, experts and farm entrepreneurs will conduct community participatory adaptive trials with mechanised planting and harvesting of maize, rice and wheat. This will be tested together with CA technologies such as crop rotations, stubble retention, and minimum tillage by introducing round-up ready and basta group of herbicides for weed control. GOs, NGOs and private sector working in the area will be involved in supplying seeds, fertilizers, machines, chemicals and marketing of farm produce. The CA machines that could be used would be tilling and planting machines (small-sized power tillers; smaller-sized power tiller operated seeders), weed control machines (small machines for controlling weeds; sprayers for spraying herbicides such as Roundup and many other herbicides often used in CA), and harvesting/threshing and post-harvest machines (small-scale harvesters, threshers, combines, maize shellers, etc.). The cultivation technology to be tested could be residue management of maize, rice and wheat (complete residue retention; partial residue retention; no residue retention, etc.) using the planting machines. In rice, direct seeded rice (DSR) would be a potential technology as it is less labour intensive and CA friendly.

Conservation farming with the use of appropriate machinery would an integrated package of NRNA SKI transfer model which could have a great potential in the mid-hills because of numerous technical and socio-economic reasons mentioned above. Such a technology has been proven successful in similar geographic and socio-economic settings of India (Himanchal Pradesh) and South Korea. As such an integrated package has not yet been practiced at a commercial scale in Nepal, we acknowledge that expertise is limited locally to kick start such an innovative project. Hence NRNA Australia with the help of global NRNA experts on mechanization and conservation farming could contribute their skill and knowledge significantly to this project. Once the project succeeds in the model farms, it will multiply at commercial scale in numerous farms and have real potential to impact on the mid-hill economy of Nepal.

7. Mechanisms of SKI Transfer by NRNA

In this regard, Non-Resident Nepali Association (NRNA) could have a great role to play. NRNs living in different countries could work toward developing working models and partnerships for transfer of initiatives as mentioned above so that hill farming can be commercialised, profitable and sustainable. We propose that NRNA Australia take initiatives in creating a pool of experts on cropping systems, farm mechanization and CA from among NRN communities in Australia and other countries. Based on that pool, a core team could be formed who, together with local experts, stakeholders and farmers, could then carry out feasibility study and select a few farming communities in representative mid-hill locations in Nepal. Such communities should be willing to develop their farm as a model farm for mechanization and CA in future. The NRNA core team should also discuss with local stakeholders including government bodies, NGOs, private sector, local businesses and farming communities about how expertise of NRNs could be better utilized. The team should review and assess successful case studies of small scale farm mechanization of hill agriculture of India (e.g. Himanchal Pradesh), South Korea and China and will also visit and learn about the CA and mechanization works initiated by CIMMYT-Nepal in the Palpa district. With the recommendation from the core team assigned for this task, NRNA-NCC and NRNA-ICC could raise funds which could be used by the project to purchase small scale farm machinery infrastructure for the selected model farms. Streamlining coordination of all stakeholders, the model farms could be developed into major learning hubs to mid-hill farm entrepreneurs for CA and farm mechanization. Once NRNA-NCC Australia demonstrates such initiatives in mechanization and CA, then it could share such skills and knowledge through various training sessions, using its core pool of experts via model farms. Thus, there would be effective SKI transfer from NRNs residing overseas to farmers in Nepal. And also there would be SKI exchange across various stakeholders including policy makers and farming communities in Nepal.

8. Acknowledgements

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9. References

Nepal, R. and Thapa, G.B. (2009), *Determinants of agricultural commercialization and mechanization in the hinterland of a city in Nepal*, Applied Geography, 29 (3), 377-389

High Level Commission on Scientific Land Reform, (2010), *Reports on Suggestions to Government of Nepal, Kathmandu*

FBC, (2006), *Feasibility Study on Agriculture Mechanization in Terai Region of Nepal*, Report submitted to Agricultural Engineering Directorate, Harihar Bhawan, Lalitpur

NGOFederation:http://www.ngofederation.org/index.php?option=com_content&view=article&id=66:small-peasant-agriculture-and-land-reform-in-nepal-politics-of-contestations-and-contradictions&catid=36:president-blog&Itemid=73

Sustainable Hydropower Development and Operation for Nepal: Skills, Best Practice Knowledge and Technology Transfer

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Abstract

Hydropower and water resources development presents significant opportunities for investment and economic development of Nepal. However, if it's not sustainably developed, it can also bring significant social, environmental, hydrological, technical, financial and political risks that may lead to failure of the project. Application of Best Management Practice Frameworks, developed by peak international professional bodies, including World Commission on Dams (WCD) and International Commission on Large Dams (ICOLD), provides better understanding of impacts, benefits and risks and their sharing measures and basin scale policies leading to successful hydropower and integrated river basin development. The critical skills and knowledge transfer opportunities in Nepal includes an innovative application of these best practice management frameworks in five major areas including the risk and sustainability assessment studies; climate change and extreme hydrological studies; dam-break and downstream impacts assessment; integrated river basin management; and stakeholders and multi-criterion analysis.

1. Background, Rationale and Relevance

Water being one of the major natural resources of Nepal, hydropower development has been identified as one of the key areas for country's socio-economic development. Nepal has very big potential of hydropower generation of 85,000 MW but the country is making very slow progress to harness it.

Nepal's first hydropower plant was established at Pharping (0.5 MW) in 1911 (only 29 years after the world's first plant in Wisconsin USA in 1882) with aid from British during Prime Minister Chandra Shamsher Rana's time. After commencement of the planned development in 1956 (1st 5 Yr Plan 1956-61), in almost 60 years in 2014, Nepal's hydropower generation stands only 705 MW in wet season. As the most of the existing schemes are Run-Of-River/Peak Run-of-Rover (RoR/PRoR) except Kulekhani I, the winter/dry season generation is even low, approximately 250-300 MW (approx. 25% of the peak demand of 1,100 MW). Out of current 705 MW generations, the Government of Nepal (GoN) developed only 473 MW (in 60 years) and the private sector 232 MW (in 21 years) which is very minimal. The projects under construction will generate 1,200 MW (all are RoR except 14 MW Kulekhani III) in 4 years, but the energy projection has shown that still the short fall will remain 600 MW. In fact, Nepal has huge potential to export energy to neighbouring countries like India and Bangladesh which has huge energy market; it is behind in meeting the domestic demand and hence facing acute load-shedding of 18 hours a day, making very difficult for normal life and social, commercial and industrial development and leaving the country behind in poverty.

Medium to large scale projects (RoR or storage) with 1,500-2,000 MW could be sought in 10 years horizon just to meet domestic demand. Due to substantial upfront costs, the private sector can play a critical role in hydropower development. Therefore GoN has taken a policy of private and public-private partnership model of hydropower project financing. Whilst hydropower presents significant opportunities for the economic development of nations, if not sustainably developed, it also can bring significant social, environmental technical, financial and political risks from the development and operation of the project.

The key of successful, sustainable hydropower development is understanding and managing risks from early planning through to design, construction and operation of the project. Generally, the private sector has not been in much confidence and attracted in financing/developing hydropower schemes. Also, the GoN is in loss in major power purchase from some ROR projects developed by the private sector. This has been caused due to lack of understanding and managing the risks in the project, particularly technically, hydrological risk related contractual issue of Power Purchase Agreement (PPA). The storage hydropower may have higher risks than ROR projects but also can provide more benefits if the risks are properly understood and managed. Appropriate analysis and assessment of project can provide better understanding of the risks, increase the confidence of the private investor leading to the development of acceptable risk management and sharing measures amongst the project partners (developer, financer, operator and the government).

1.1 Analysis and assessment frameworks

Various peak international and professional bodies have set best practice decision making frameworks, guidelines and standards for planning, feasibility studies, design, construction and operation of sustainable dams and hydropower systems which can provide better understanding and management of social, environmental, technical, financial, political/governance risks/issues at the various stages of the project.

The World Commission on Dams (WCD) established a comprehensive guideline for the development of dams. The WCD's final report (WCD, 2000) describes technical, financial, economic, environmental and social performances and an innovative framework for the development of water and energy projects. The WCD framework covers key seven areas of strategic priorities for improved planning of dams, including (1) comprehensive options assessment (2) addressing outstanding social issues from existing dams before building new ones, (3) gaining public acceptance for key decisions, (4) ensuring compliance, (5) sustaining rivers and livelihoods (6) recognising entitlements and sharing benefits and (7) sharing river for peace, development and security. The WCD has developed a set of 26 guidelines covering a wider range of technical, environmental, social, economic, financial risks and issues for good practice for assessment of these seven strategic priority areas. The WCD recommendations form the basis for many decision-making processes around the world including in Australia, East Asia and Brazil and constitute international soft law for successful integrated river basin management, dams and hydropower projects.

International Commission on Large Dams (ICOLD) has set standards and guidelines to ensure that dams are built and operated safely, efficiently, economically, and is environmentally sustainable and socially equitable. ICOLD has published several technical guidelines, is the world's leading professional organization, dedicated to advancing the art and science of dam engineering and promoting the wise

and sustainable development and management of water and hydropower resources. Australian National Committee on Large Dams (ANCOLD) has developed dam hazard, risk assessment and dam safety management guideline including hydrologic, seismic, social and environmental risks of the dam failure.

The practice has shown that properly planned and developed hydropower projects following the WCD and ICOLD framework, standards and guidelines with sound scientific and technical analysis and assessment has given positive economical, social, environmental and commercial outcomes of the project. The decision making under WCD framework, use of ICOLD/ANCOLD involves stakeholder analysis; life cycle analysis; multi-criteria decision analysis; integrated planning, policies and assessment of river at basin scale and project level to improve understanding and management of social, environmental, hydrologic, geologic, construction and economic risk and mitigation measures. It has been found that NRNA has opportunities to skill, best practice knowledge to implement these frameworks and guidelines and the technology to improve the above mentioned assessment and analysis.

2. Aims and Objectives

The objectives of the study are to use the WCD and ICOLD/ANCOLD framework in two selected storage hydropower projects case studies possibly:

- Upper Karnali Hydropower Project (300 MW)
- Budhi Gandaki Hydropower Project (600 MW)

For such large storage hydropower projects, it appears that the Government of Nepal has no definite pricing policy which is due to lack of understanding of risks and overall sustainability of the project. Also, there are no integrated river basin management plans (e.g. irrigations, water supply, flood control, fishers, recreation uses of water) or no update of such plans and the compliance requirements which is critical element of for development of medium to large ROR and storage projects. The outcomes of implementation of WCD and ICOLD framework, guidelines and standards would provide the technical input required for pricing policy and developing integrated plans and compliance requirements at river basin scale.

We aim to apply a SWOT analysis (Gallego-Ayala and Juízo, 2011) for sustainability and risk assessment of the selected hydro-power case studies and to identify the strength, weaknesses, opportunities and threats (risks) for better management of river basin from social, ecological and economic perspectives.

In addition, we will also commission a comparative study hydro-power development and integrated river basin management practice among Nepal, Australia and Brazil. In particular, the comparison between Nepal and Brazil would be sticking because these two countries are considered as the top two countries for highest hydropower potential.

3. Study Design and Methodology

The project team will use WCD/ICOLD frameworks for Comprehensive Option Assessment of the Upper Karnali and Budhi Gandaki hydropower projects as case studies. The strategic priorities described in WCD are as relevant to projects already at an advanced stage of planning and development as they are to the selection of a project in the earlier options assessment stage.

This study will be conducted in phases and initial estimation has shown that it may take up to 1-2 year to be completed.

Phase 1- Risk and Sustainability Assessment

In Phase 1, we aim to apply SWOT framework to identify the strength, weaknesses, opportunities and threats (risks) in current practices of hydropower development and river basin management. It helps to identify the gaps and opportunities for better management and development of river basin in the future from social, environmental, hydrological and economic perspectives.

Similarly, SWOT framework will be used to analyze the selected hydro-power case studies. It allows drawing lessons from different modes of hydro-power development in the form of their strengths,

weaknesses, opportunities and threats (risks). In turn, it contributes to risk management and policy making by minimising weaknesses and threats and exploiting strengths and opportunities of each of the development models in practice.

Phase 2- Multi-criteria Analysis

We aim to use Analytic Hierarchy Process (AHP) to analyze hydro-power development and integrated river basin management (IRBM) related issues. It is a mathematical model for solving complex decision making problems based on multiple criteria (Saaty, 2013). It is useful when the decision-making process involves diverse stakeholder groups and multiple alternatives where perceptions of individuals, groups, or both are under consideration.

We will use AHP to examine the current framework of IRBM and the hydro-power development based on different models across the range of stakeholders. AHP method involved following five steps:

- Identifying the stakeholder groups and management alternatives,
- Developing a decision hierarchy,
- Determining the stakeholders' preferences,
- Developing preference model and synthesizing priorities, and
- Calculating overall (global) priorities for evaluating management alternatives.

In the first step, SWOT and AHP analysis can be combined while identifying the stakeholders, which can be done using focus groups, workshops, brain storming with experts. Depending on the scope of study and decision maker's judgments, different weights can be allocated to the preferences of different stakeholder groups to calculate their priorities in relation to IRBM and hydropower development. In the case of hydro-power development, management alternatives include three modes currently in practice (or an additional mode) – public, private, and public-private partnership or any other relevant management approach.

In the second step, the decision hierarchy is developed based on information collected in the initial stage or literature review. The decision hierarchy consists of major heads called criteria and sub-heads called sub-criteria (factors) which lead to the alternatives. The top level hierarchy consists of the overall goal (production of additional hydro-power in a sustainable way); second level hierarchy consists of social, economic, technical, and ecological criteria relevant to the overall goal. The third level could include sub-criteria such as local management capacity, continued supply of power, protect local watershed, protect the interests of local stakeholder, improve local livelihood, improve stakeholder linkages, capacity building, and technology transfer, management strengthening etc. Depending on the complexity of the goal the hierarchy can have multiple levels. The final level in the hierarchy is the management alternatives.

In the third step, hierarchy elements at each level are set for comparison with all others in a pair wise manner considering the preceding hierarchy level at the ultimate objective. While making comparison between two elements participants/stakeholder/individual use personal judgment based on experiences or perceptions to indicate relative preference of one factor over the other. In the fourth step, the individual preference scores obtained in the third step are used to synthesize local priorities of each hierarchy element

Finally, in the fifth step, the overall (global) priority values are calculated from the top of the hierarchy by multiplying the local priority of a hierarchy level element by the priority value of the level just above it.

4. Knowledge/Skills Transfer Mechanisms and Local Partners

Dr. Hari Pandit, Professor Hydraulic/Hydropower Engineering Institute of Engineering; Tribhuvan University **-** Dr Pandit is a Hydropower Expert. Dr. Pandit has completed many projects being responsible for identification, field survey and feasibility study of micro, mini, small, medium and large Hydropower projects. Mr. Pandit was involved as a Hydraulic/ Hydropower Engineer in preparing detail project report for Likhu IV Hydroelectric Project (120MW), Chainpur-Seti (454 MW). He is responsible as a design engineer for Kali Gandaki Kovan (400 MW). Dr Pandit has coordinated and conducted several training courses in hydropower engineering. He has served as a Resource Person for several

National as well as International Trainings and Workshops. He is also the author of several training and course manuals.

Dr Laxmi Prasad Devkota, Executive Chairman Budhi Gandaki Hydropower Project and Director, National Development Research Institute **–** Dr. Devkota is a Hydrologist. He was involved in preparing hydrological reports for Melamchi water supply project, and several hydropower projects including Chainpur-Seti Upper Kali Gandaki, Modi, Mugu-Karnali, Humla-Karnali to name a few. Dr Devkota has served as a Member of National Planning Commission as well.

Dr. Khem Raj Sharma, Professor, Nepal Engineering College**;** Dr. Sharma was instrumental in designing the Postgraduate Course on Integrated Water Resources Management in Nepal Engineering College. He has involved in various studies including Begnas Lake Watershed Integrated Water Management. He worked in Department of Irrigation for 20 years.

Local partners will provide updated information on various aspects of the project Specific role of local partner further include helping research team in developing options/alternatives for AH.

Synergy with Other SKI Projects

The project has synergy with SKI project proposed by Dr Dipak Paudyal titled "Benefits of utilization of Remote Sensing in Nepal – A Review of technology and applications". The remote sensing technology can be used for hydropower and integrated river basin planning and assessment.

5. Expected Outcomes

It is expected that the project will provide better understanding and management of the risks and sustainability of selected hydropower projects. The local partners will be more familiar to implement the critical area of WCD/ICOLD framework for dams and hydropower development of any size: small, medium or large.

The best practice knowledge on implementation of these frameworks and improved understanding of technical, social and environmental risks and management measures will be shared. The knowledge and data gathered from the case study projects will be published in technical/scientific journal which will have scientific impact of the project. Three authors are academics at reputed universities in Nepal and Australia. The knowledge gain can be used in teaching and further research.

6. Challenges, Risks and Opportunity

This project complements Nepal government's effort hydro-power development that carter country's development discourses. It directly contributes to knowledge generation from an objective analysis of existing policy and peoples' preferences. A major challenge is data collection/availability required for implementing WCD/ICOLD frameworks and AHP analysis.

A joint committee led by a member of the research team, a member from local partner and a member nominated by NRN Australia will be established to monitor project progress. The NRN Australia nominated member acts as a leader of the monitoring team, which will advise the research team as and when needed. A close link will be maintained between research team and local partners to share the knowledge generated from this research in to different policy forum in Nepal. The initial phase of this project entirely focuses on knowledge generation. In the subsequent phase, it is envisaged that skills on IRBM and hydro-power development will be generated and transferred through various schemes.

7. Conclusions

WCD and ICOLD frameworks, guidelines and standards can be implemented for hydropower and river basin assessment in Nepal. These frameworks and guidelines provides better understanding in sustainable dams and hydropower development and risk management.

It is the thinking of the authors that NRNA should work to establish a joint-project in Nepal with a relevant stakeholder to detail implementation of these frameworks and use the outcome in policy input on hydropower development and financing

8. Acknowledgements

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9. References

Ananda, J. and Herath, G. (2003), *The use of analytic hierarchy process to incorporate stakeholder preferences into regional forest planning*, Forest Policy and Economics, 5, 13-26

Australian National Committee on Large Dams

Duke, J.M. and Aull-Hyde, R. (2002), *Identifying public preferences for land preservation using the analytic hierarchy process*, Ecological Economics, 42, 31-145

Fertel, C., Bahn, O., Vaillancourt, K. and Waaub, J.P. (2013), *Canadian energy and climate policies: A SWOT analysis in search of federal/provincial coherence*, Energy Policy, 63,139-1150

Gallego-ayala, J. and Juízo, D. (2011), *Strategic implementation of integrated water resources management in Mozambique: An A'WOT analysis,* Physics and Chemistry of the Earth, 36,1103-1111

Helms, M.M. and Nixon, J. (2010), *Exploring SWOT analysis—Where are we now? A review of academic research from the last decade*, Journal of Strategy and Management, 3

International Commission on Dams

Ponce, R.D., Vásquez, F., Stehr, A., Debels, P. and Orihuela, C. (2011), *Estimating the Economic Value of Landscape Losses Due to Flooding by Hydropower Plants in the Chilean Patagonia*, Water Resources Management, 25, 2449-2466.

Saaty, T.L. (2013), *The modern science of multicriteria decision making and its practical applications: The AHP/ANP approach,* Operations Research, 61, 1101-1118

Wang, G., Fang, Q., Zhang, L., Chen, W., Chen, Z. and Hong, H. (2010), *Valuing the effects of hydropower development on watershed ecosystem services: Case studies in the Jiulong River Watershed, Fujian Province, China*. Estuarine, Coastal and Shelf Science, 86, 363-368.

World Commission on Dams, (2000). *Dams and Development: A new framework for decision making*

Benefits of utilization of Remote Sensing in Nepal – A Review of technology and applications

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Abstract

Remote sensing comprises a group of techniques that allows for the analysis and application of data of the Earth's surface acquired by using variety of airborne and satellite sensors. Application of remote sensing and associated geospatial technologies have increasingly been regarded as mainstream ICT application in recent times. Remote sensing techniques are utilized to get an understanding of both natural and manmade activities on the surface of the Earth. We often hear about the military application of this technology, but its strengths truly lie in huge economic and environmental benefits it can provide. In the context of developing country like Nepal, where physical infrastructures are often lacking or inadequate and many areas are inaccessible, understanding the terrain using remote sensing provides significant benefits to those involved in the management of natural and manmade resources in the country.

In this paper, the author will draw on his vast experience, advising users in the adoption and utilization of Remote Sensing technology, in many parts of the world. The huge advantage of adoption of this technology in Nepal is that the technology and analytical processes developed in one country situation can be replicated with only minor adjustments to the methods and processes. Remote Sensing derived analysis and methods do not hugely change and therefore technology transfer can be more readily achieved. Investment required can be minimal compared to many other technology transfer scenarios, hence very well suited for a developing country like Nepal. Remote Sensing is rapidly going mainstream as part of a comprehensive ICT technology and regarded as a part of broader spatial data infrastructure of the nation. From a practical point of view this means that Remote Sensing can be developed as a viable commercial industry in Nepal even going to the extent of servicing neighboring economies of China and India, as these countries invest heavily in geospatial technology.

In this paper, application of Remote Sensing technology in Nepal in specific sectors will be discussed including remote sensing data requirement and analysis techniques. The specific topics covered will include adoption of Remote Sensing for precision agriculture, commercial forestry, Water Resources management , Environmental monitoring and emergency responses in times of disasters (such as fire, flood, earthquakes) and in Urban planning.

1. Introduction

Remote sensing is a group of techniques that allows for the analysis and application of data of the Earth's surface acquired by using variety of airborne and satellite sensors. This paper focuses in application of remote sensing but in a broader context of spatial information/GIS. Spatial technologies can assist in making sound decisions that can benefit an organization, the community or a nation. In this paper I have discussed applications that I think are relevant, thought provoking and address a current need in Nepal.

Remote sensing provides a powerful way to analyse spatial data/imagery and support decision making processes in both government and industry. Mapping of fragile forest ecosystems to assessing impacts of natural disasters and monitoring urban growth, remote sensing technologies can be central in making key decisions.

A distinct aspect of remote sensing is that it is not discipline specific meaning that professionals from many industries can benefit from the technology. Remote Sensing is therefore truly interdisciplinary in nature. While making decisions that involve spatial parameters we often need to come with a "right answer" and technology of remote sensing in combination with GIS assist us to find the "right answer".

There are many textbooks and publications that talk about the technical aspect of remote sensing. The purpose of this paper is not to dwell and talk about the technical prowess of remote sensing but to discuss some of the economic and social benefit the technology provides to a developing country like

Nepal. The paper attempts to identify key application areas where the technology might be used. The paper will discuss the benefits the technology brings to the nation with minimal investment and relative ease of use in technology transfer.

2. Relevance of REMote sensing IN NEPAL

As human beings we have always sought to look at our surroundings from vantage points. The advantage of looking at our surroundings from high above has many benefits. We have a wider field of view to monitor the terrain around us for making intelligent decisions as well as securing ourselves from many calamities. In a modern context viewing the Earth surface from platforms such as satellite and aircrafts provides us similar advantages. Additional benefit is that plethora of instruments can be fitted in these platforms to capture the images of the Earth's surface that are relevant to our own applications. The instruments or sensors on board may be large and medium format digital cameras, multispectral or hyper spectral sensors, LiDAR or Radar among others. All of these techniques – the science, technology and art of obtaining information about objects from a distance – take us well beyond the human capabilities. This method of collecting and utilizing data is called Remote Sensing. A detailed description on how these technologies can be used in a broader context of GIS or Spatial Information Systems is explained by Aronoff (2005). Some if these data gathering techniques are well suited for a developing country like Nepal where physical infrastructures (such as roads) are limited and communication systems are still developing. There are many applications remote sensing technology can provide to a developing nation like Nepal such as in natural resources management, geology, archaeology, Defence and national security and many more. For the purpose of this paper I have identified 3 important application areas namely; Agriculture and Forestry; Water Resources/ disaster management and Land use planning

Forestry and Agriculture

For a nation to prosper it is critical that food supplies are regularly monitored. Techniques of remote sensing are used to map and estimate the supply of the agricultural produce in the national economy; an important aspect for food security of the nation. Information obtained from remote sensing methods, provide important economic intelligence. On the supply side it will help estimate the production and help set pricing and policy goals for various produces. In situations when the yield is likely to come below expectations (e.g. drought, excessive rain etc.) it will allow policy makers to make policy adjustments in advance to cater for any impending situations or famine. Many nations that export agricultural produce often keep tab not only their own productions but that also of the competing nations that produce similar crops. This allows in deciding price futures and contract settlement prices. If Nepal becomes a net food importing nation it also provides a means to negotiate a future price settlement based on production and demand – saving millions of rupees on imports.

The techniques of remote sensing can be applied to monitor and mapping of field crops such as rice and wheat, cash crops such as sugarcane or horticultural or fruit produce. From a technical point of view many of the methods of mapping and monitoring are well established (Paudyal, 1994; Paudyal, 1995; Paudyal et al 1995). The challenge is to apply these methods into the local environmental conditions.

Precision Farming is another area where remote sensing is widely used. However, in Nepal, the author believes that due to smaller field sizes, rolling terrain and diversified cropping patterns the technology may not be fully exploited. However if consolidation of agricultural land should take place in future this technology is certainly applicable.

One huge area of application of remote sensing is in forestry. The application can be either for environmental reason or for commercial forestry. As the economy of Nepal and neighboring countries grow, Nepal has a huge potential to plant export oriented commercial forest in areas where agricultural crops may not be suitable or uneconomic to grow. Commercial forestry can co-exist with fruit trees and other horticulture related activities. By very definition commercial forestry needs regular monitoring from its plantation to harvesting and remote sensing can play an important role in mapping and providing information on various bio-physical parameters to estimate forest biomass and tree heights.

Springate-Bagginski et al (2003) have discussed the role of one such project in Nepal. Satellite based Remote Sensing is considered an operationally useful method for vegetation and forest management. Forest managers worldwide have used several vegetation indices (Asner, 998) for monitoring the heath

of the forest and crops as well as horticulture. There is a great potential of enhanced economic and market intelligence that this technology can provide and add to national income.

Water Resources, Disaster Management and Mitigation

Water resource is considered to be one of the most important natural resources in Nepal. Water resources play a vital role in generation of electric power, irrigation and water supply. Water resources (or lack of it) can also be destructive at times of flood (or drought). It is therefore important to map the spatial distribution of surface water. Imagery can be used (directly and indirectly) to monitor distribution as well as fluctuation in its levels. Nepal is a country endowed with several perennial river systems. While rivers constitute important resource for the country we also need to monitor these for their destructive behaviours. Excessive rainfall during the monsoon season often add to the volume of water in the river systems and breaching of banks and flooding is often seen when the rivers descend from the hills into flatter topography of the Terai region of Nepal. It is for this reason the author has decided to include and discuss these related applications under one heading.

From a politico-economic perspective monitoring of water resources in Nepal is important as the statistics and data thus derived can be important to negotiate business outcomes with neighboring countries or for specification in tender documents or for building of new hydroelectric plants or irrigation infrastructures. Remote sensing has potential to save huge amount of money and reduce project lead times. Both qualitative and quantitative analyses are needed for adequate monitoring of the health of the surface water systems. Nepal has often suffered in negotiation with neighboring countries because of a lack of adequate baseline data and remote sensing can be used to improve the quality of data policy makers can use. Remote sensing equips water resource managers with authoritative and actionable information. This will then allow for more accurate assessment and management of water resources at a national level. Pathak (2008) discusses some issues associated with utilising Remote Sensing and GIS technology in Nepalese context and supports the use of these technology to make an appropriate decisions, decisions that are friendly towards the environment as well as towards the social and economic wellbeing of the area.

River systems in Nepal often show their fury during heavy rainfall periods causing huge losses of lives and property in the catchments and downstream. While it may not be possible to avert these disasters a sound management reduces the impact of such events. Essentially, disaster management and recovery system consists of three components (a) Early Warning (b) Detection and Monitoring and (iii) Mitigation and Relief. As an example Paudyal and Abernethy (2009) discuss the role of remote sensing in rapid response mapping application in NSW due to a storm event.

Remote sensing methods can be very useful in helping in providing important data for establishment of the disaster management and recovery system. Data gathered from Earth observing satellites can be used to supply important spatial information to carry out hydrologic analysis critical for the above mentioned tasks.

Kumar & Reshmidevi (2013) eloquently summaries the contribution of remote sensing for mapping water resources and flood and drought events. It is in this context that, near-real time monitoring of flood, drought events, and irrigation management are possible to with the help of high resolution satellite data using the techniques of remote sensing.

Land use planning

It is well known that land use and land management practices have great impact on natural resources, the environment and agricultural production. The availability of consistent and reliable spatial information on land uses is critical for sustainable natural resource management. Land use is considered ‘foundation’ data sets in many countries of the world. In Nepal where countrywide mapping is limited and no historical baseline data is available, land use/land cover mapping is even more critical. Land use describes what the land is used for such as agriculture, mining, residential or conservation etc. A slight variation is the land cover of the area which describes the physical surface of the earth such as forest, grasslands, and water or urban. It is important that for a country like Nepal both Land use and Land cover data are important part of spatial infrastructure.

Land cover data is commonly used to identify environmental quality of nations land areas. Cropping

and forest areas may be fragmented by various social and development activity and these need to be identified. A good quality decisions for planning requires that quality data be available at hand. Remote sensing technology can be used to crate thematic maps using variety of image classification techniques (Paudyal et al, 1992). Thematic maps provide for identification and mapping of all important land cover types present in the area. Land use maps will also provide a baseline for urban and regional planning. Land use thematic data is often critical for planning and zoning. Remote sensing allows frequent updates of the land use land cover maps thus providing for a valuable currency useful for planning and visualization.

3. Contribution of Remote sensing

Remote Sensing is often utilized in combination with GIS. In Nepalese context the technology can be best utilized in forming policy and planning decisions in several sectors. The applications can be as fundamental as creating land use foundation dataset through to sectors such as Agriculture and forestry that can directly contribute to the national economy.

The geospatial community has increasingly recognised remote sensing as an extremely useful tool for resource management. Imagery, maps and image derived datasets are widely used these days by government bodies and private industries alike. Remote sensing can contribute in its many facets but the author identifies 3 reasons for which the technology of remote Sensing is highly valued.

Provision of repetitive and consistent observation

The most important contribution that remote Sensing can make is in the provision of timely and consistent information. Vital information needs to be collected over the country both over the short, the medium and the long term. The information is required for managing our natural resources as well as utilizing both the renewable resources (forestry, agriculture, and water) or non-renewable resources (mining) and its economic and social impact on the country and the population. A systematic and repeat observation is also needed for environmental monitoring, planning and emergency managements in times of natural disasters.

It provides the country with most current and important information about the not only land and the water resources but also man made infrastructures (roads, power lines, dams etc.)

Creating and maintaining Baseline data

Availability of accurate and timely spatial data form cornerstone of development. Whether it is design and alignment of highways and roads, deciding on the transmission line corridors, monitoring of agriculture, forestry or mining resources a suitable baseline data is critical. Remote sensing provides an important starting points in creation of the baseline data sets. Creation of foundation datasets required for engineering applications such as contour maps and digital elevation models can be created by remote sensing or associated technologies (e.g. photogrammetry). Many may not be aware that majority of GIS based spatial data layers have been created using remote sensing data in one way or the other. Some tasks done using traditional means of surveying can also be accomplished using remote sensing methods. Accurate and timely spatial information is vital for successful inception and completion of any project. Remote sensing methods provide vital information in creating such baseline data.

Monitoring and change detection

Remote Sensing and GIS techniques are very useful in identification and mapping of change. One such application is finding areas with rapid urban growth or urban sprawl. Identifying change that occurs over time is an area important for many disciplines such as forestry, agriculture, environmental monitoring and many more. There can be financial and economic value in capturing change such as in commercial forestry and precision agriculture. Developments of method in change detection can lead to a development of remote sensing based service industry in Nepal.

The monitoring and identifying the pace and pattern of urbanization has been a major challenge for policy makers and urban planners. Agricultural and forest areas are lost to houses, highways/roads and other commercial buildings during the process of urbanization. This may result in huge environmental challenges both at local and at regional and national levels. Understanding the nature of these changes is vital to national economy and wellbeing ensuring that the fragile ecosystem is not impacted by the urban sprawl. In addition monitoring of water resource is critical for Irrigation and food security, hydroelectricity generation, and emergency management at times of floods and landslides.

4. Technology Transfer: Opportunity and Challenges

Remote sensing and GIS has a potential to assist with planning, monitoring and executing of spatially oriented projects in developing countries. The combined use of geospatial technologies allow for data acquisition and monitoring, planning, modeling, analysis and visualization. GIS data sets in Nepal are often outdated. With appropriate implementation strategies, Nepal will benefit from using these techniques that have the ability to update existing maps and critical spatial infrastructure.

It is therefore in this context and understanding that any technology transfer project has to be implemented. Remote/Sensing and GIS technology transfer is influenced by 2 broad factors (a) technical or education/learning issues (ii) organizational issues. NRNA skill transfer process could certainly act as a catalyst to break some of these impediments. Some of the impediments associated with skills and knowledge transfer are:

1. Availability and cost of remotely sensed data
2. Accessing existing archives of data
3. Availability of software and analysis tools
4. Domain specific expertise and skills in an operational environment
5. Computing infrastructures/Hardware specific issues
6. Availability of skilled manpower
7. Ability of institutions to plan and deliver desired outcomes
8. Implementation and project management

It is important to find a way to allevaiate if not completely eliminate these impediments for technology transfer to happen smoothly. These constrains are nothing new and often faced in many countries. The benefit of Remote Sensing/GIS based knowledge transfer is that it suddenly revolutionize information systems infrastructure; it is a modern system. It has the capacity to integrate into existing IT infrastructure. Spatial technologies provide a cost effective decision making tool for the planners and decision makers. This will help make good quality decisions that help in making decisions that are robust and sustainable.

5. Conclusions

Remote sensing and geospatial technologies can be utilized across many disciplines. It is therefore imperative that from a Skills transfer point of view we identify a project where remote sensing becomes a significant part of the overall scope of the project. Given the importance of Water resources in the development of Nepal and frequent flooding and other disaster events such as landslides/mudslides etc. remote sensing and GIS technology should be well suited in a water resource based project. It is the thinking of the author that NRNA should work to establish a joint-project in Nepal with a relevant stakeholder to

(a) set up baseline water resources data base and

(b) take an initial step towards development of disaster preparedness system for early warning and recovery based on spatial information.

There are many practitioners of Remote Sensing in Nepal with in-country knowledge and qualification. The biggest problem, the author believes though is structural; integrating spatial information as part of an operational system. A well established and functional institutional system is required to derive

economic and social benefit from spatial data infrastructures. Many remote sensing based projects in Nepal are of research nature and we need to transfer our knowledge and skills to elevate these projects to a practical and operational level. Many developed nations utilize remote sensing technology in an operational context. In these countries the technology is integrated in the core planning and business systems. This author believes that Nepal can leapfrog to take advantage of these technologies. A knowledge transfer workshop with support from NRNA with potential stakeholders in Nepal would be a good starting point.

6. References

Aronoff, S. (2005), *Remote Sensing for GIS managers*, ESRI press, USA

Asner, G (1998), *Biophysical and Biochemical Sources of Variability in Canopy Reflectance*, Remote Sensing of Environment, 64:234-253.

Kumar, D & Reshmidevi, (2013), *Remote Sensing Applications in Water Resources* Journal of the Indian Institute of Science, IISc Press, Bangalore Vol. 93, No. 2, pp. 163-188

Pathak, M. **(**2008), *Application of GIS and Remote Sensing for Hydropower Development in Nepal*

Hydro Nepal Journal, Issue 3, 26-29.

Paudyal, D (1994), *An Assessment of Spaceborne Radar Remote Sensing for Monitoring Tropical Agriculture*. Doctoral Dissertation. Asian Institute of Technology, Bangkok, Thailand.

Paudyal, D & Abernethy D. (2009), *Utilisation of Leica ADS40 Digital Sensor data in the state of NSW, Australia : an Assessment of the requirements of Software Technology and Methods for Rapid Response Mapping Application*. Map World Forum, Hyderabad, India Feb 10-13

Paudyal D, Aschbacher J, Pongsrihadchulchai A, Karnchanasutham S, Rodprom C and T. Le Toan (1995), *Assessment of ERS-1 SAR data for Rice Crop Mapping and Monitoring*. Proceedings IGARSS'95, Florence, Italy, July 10-14 pp. 2183-2185

Paudyal D, Dallemand J, Lichtenegger J, Kaufmann V and Reichart P (1992), *Combined Analysis of ERS-1 SAR and Visible / Infrared Remote Sensing Data for Land Cover / Land Use Mapping in a Tropical Zone : A Case Study in Guinea.* Proceedings First ERS-1 Symposium Cannes, France, 4-6 November, ESA Publications Division, ESTEC, Noordwijk, The Netherlands. pp.555-561.

Springate-Bagginski O, Dev O, Yadav N, and Soussan, J *(2003), Community Forest Management in the Middle Hills of Nepal: The Changing Context* Journal of Forest and Livelihood 3(1) July.

The Industry to Care for Senior Citizen: A Potential Area for Skill, Knowledge and Innovation transfer to Nepal

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Abstract

Nepal has been changing rapidly in various aspects including societal, political, cultural and economic fronts. Recent trend of younger generation migrating overseas for employment has, on one hand, increased the household income, while on the other hand changed the individual family structures as well as the overall demographic structure of the country. This change has created many challenges and opportunities. New and different set of ideas and skills are now needed to be able to capitalize from these new opportunities and deal with the new challenges. In this paper, we consider the creation of an industry to care for senior citizen, as an important area for today's Nepal. This is a much needed industry and will contribute substantially to the betterment of Nepal and Nepali by, in particular, creating new employment opportunities and managing the life of elderly population in a dignified and respectful way. If mastered with international standards, this industry could open new opportunities for Nepal to become the carer of elders from around the globe. We will identify and elaborate how NRN-ICC can, using the knowledge and skills of its members worldwide, assist in not only the transfer of skills but also development of regulations necessary for sustainable development of this critically important area.

1. Introduction

Providing a life of dignity and respect to our parents and parents of fellow Nepalis is the most fundamental responsibility and duty of our life. Unlike the western society, where the responsibility of caring elderly people is mostly assumed by the government, the Nepalese society expects the children of the elderly take the responsibilities of their parents. Over the past few decades, Nepal has been changing rapidly in various fronts. Be it the financial difficulties, socio-cultural neglect and discrimination, lack of job opportunities, quest for new life, attraction of modern infrastructure and western societies or aspiration to achieve the dream of being a global citizen, we have left our country, our soil, our friends and family but most importantly our parents and guardians alone in Nepal at the time of their life when they need us the most. Nepalese are now part of the world's labour market. Today, millions of Nepalis are working in foreign countries all around the world. Such activities have helped reduce the poverty by about 40% from 1995 to 2010 (Central Bureau of Statistics, Nepal 2013). At the same time, the availability of younger generation to assist their elderly relatives has also been reducing as the rate of population growth has decreased from 2.25% in 2001 to 1.35% in 2011 (Central Bureau of Statistics, Nepal 2013). Furthermore, globally people are live longer (Australian Institute of Health and Welfare 2014). This has also been adding an extra pressure to the caring needs of the elder people. Therefore, we need to keep promoting younger generation is economically active to fight against poverty, and provide them options with different ways of fulfilling their responsibilities. An industry to care for elderly people can certainly assist in this direction.

From a different perspective, Nepali started to migrate heavily in 80s and 90s and the trend has continues. Early immigrants to developed countries are now in the age of retiring and are making hard decision to select the place for their retirement. If we can offer a place they can depend on to provide a quality retirement life, they are always ready to migrate back to their motherland. This provides another opportunity for the growth and sustainability of elderly care business in Nepal.

Current Scenarios

The Nepalese family structure defines the shared responsibilities of the family members. Caring of elderly parents is the responsibility of sons. Even when the sons are separated, one the sons often takes the responsibility of caring their parents. When such an option is not available, other relatives may step up for this responsibility. In the present scenario when the younger generation is highly active in financial activities, and are often living overseas in most of the time, different arrangements could be made. House maids are arranged to assist the parents. Sometimes, the parents are invited to live overseas with their children. The option of Nursing home is explored only when the elderly parents become seriously sick.

In many countries, having elderly parents living with their children is not feasible for legal or economical reasons. Even in the first world countries when elderly people move to live with their children, they find themselves lost in an unknown place among unknown people. Therefore, the best place for elderly parents to live is in their own place among their own people. It is much easier for elderly parents to live life in their own place with good care rather than joining their children in foreign countries and living measurable life.

The society is changing slowly and steadily in Nepal and all developing countries. As much as there is value of our family value and existing culture, practical life is getting difficult and elderly people are lacking the care they need because of fast and busy life of their children and their families. A home where children can feel comfortable leaving there parents and parents comfortable being there is a critically lacking service in Nepal.

Goals and Objectives

To the best of knowledge of the authors, there are no elderly care facilities operating in Nepal as an industry, family run or corporate. Long term goal of this project is to develop a sustainable elderly care industry in Nepal that is relevant to our family values, culture, socio-economic status.

2. Elderly Care Facilities

In western world, different types of elderly care facilities are available. Here we will discuss a few of them.

Caring Needs

As people age, their needs change as well. They may start requiring physical support to perform some daily activities as well as emotional support. The level of support requires may keep increasing. Physical ache and pain become more common. Gradually, their friends and relatives start passing away. Therefore, frequent assessment of caring need and support is required.

In-home and community care

Elderly people need assistance not only when they are very sick, but also in other times as they are sometimes unable to perform some daily activities. Some of such types of support include Domestic Assistance, Home Maintenance, Meals, Shopping, Medication Supervision, Personal Care, Pharmaceutical Deliveries, Social / Recreational Support and Transport. In general, such support requirement is based on the occasional need of the elderly person under care.

Assisted Living

When the need of care increases, caring in home and community might not be feasible. In such cases, the elderly could be moved to live in a supported living home. Such supported living homes

include serviced apartments which provide regular service of care. Elderly people living in such apartment may require assistance regularly and frequently. Therefore a service of 24/7 assistance is provided to all such homes.

Residential Aged Care (Nursing Home)

As the elderly person gets older, they often require undergoing through intense medication to solve their medical conditions. Their risk of fall and injury also increases. Therefore, living independently with frequent but minimal support may not be an option. Based on the care required, an elderly person could be placed in a low care or a high care facility.

Payment Options

As we are proposing to establish the aged care as an industry, we need to formulate a business model to develop and sustain such industry. A few options that could be explored are: (i) pay as you go, (ii) monthly (or annual) membership fee, (iii) lifetime payment and (iv) reverse payment through fixed property. The pay as you go and membership fee models could be useful when the caring needs is infrequent, and the service has to be provided in the home of the elderly person. The cost of caring increase with the increase caring needs. The last two options could be used to pay for such costs.

3. Opportunities

As discussed earlier, there are two types of targeted people: (i) those living overseas but have caring responsibility of their parents, and (ii) Nepalese people living overseas and retiring. In addition, attracting people from developed countries has a huge potential because of increasing health-care cost and depleting/inflating social security services in those countries. Many people are willing to retire in developing countries. This business can tap to those people as well. NRN doctors and nurses could also help in identifying potential customers. NRN can also play a role in establishing collaboration with governments of Nepal and overseas. In addition, a joint venture with nursing homes/rehab center facilities in US, UK and Australia might also be possible.

4. Challenges

We identify the following challenges in establishing the industry for aged care in Nepal.

Physical Infrastructure

As discussed earlier, elderly people have different needs. For non-home care facilities, appropriate infrastructure is required considering not only their physical, emotional and spiritual needs, but also their social, entertainment and security needs.

Human Resources

A wide range of human resources is required for this type of industry. Some examples include: infrastructure managers, personal assistants, nurses, doctors, physiotherapists as well as spiritual leaders. On one hand, this will create a large number of job opportunities while on the other hand, regular training and practice will be required to maintain the quality of the aged care.

Legal Hurdles

To our knowledge, Nepal does not have a particular law to monitor and guide this type of industry.

Therefore, this type of industry could fall under complicated policies, regulations and laws making it harder to establish such industry. Furthermore, collaboration with governments of developed countries would require strong legal framework reflecting the laws of the other countries such as the Aged Care Act 1997 (ComLaw 1997). Passing such a law through the parliament could be another hurdle.

Cultural Adoption

Even though we have clearly identified the need for an aged care industry, our culture could come as a major hurdle. Caring elderly is taken as a responsibility of all. In such an environment, taking money to care for elderly could be viewed as unethical and immoral.

5. Summary and Recommendations

In this paper, we identified and outline a need of an industry to care for elderly people in Nepal who can afford to pay for it. We also identified the relevant opportunities and challenges. This area is culturally as well as legally sensitive. Therefore, a clear roadmap is needed to succeed.

NRN can play a vital role in developing as well as promoting this industry in Nepal. We can invest in infrastructure and training facilities, assist government to legislate the necessary bills and lobby with foreign governments to collaborate in using such facilities.

6. References

Australian Institute of Health and Welfare, (2014), *Life Expectancy*, viewed 30 May 2014, <http://www.aihw.gov.au/deaths/life-expectancy/>

Central Bureau of Statistics, Nepal, (2013), *Nepal in Figures* , <http://cbs.gov.np/wp-content/uploads/2014/Nepal%20in%20figure/Nepal%20In%20Figures%202013_English.pdf>

ComLaw, (1997), *Aged Care Act 1997*, <http://www.comlaw.gov.au/Details/C2013C00389>