

Vol. 3, No. 1, 2014

ISSN 2350-8566

The Journal of University Grants Commission



University Grants Commission, Nepal
Sanothimi, Bhaktapur, Nepal
Website: <http://www.ugcnepal.edu.np>

E-mail: ugc@ugcnepal.edu.np
Post Box: 10796, Kathmandu, Nepal
Phone: (977-1) 6638548, 6638549, 6638550
Fax: 977-1-6638552



Published by
**University Grants Commission
Nepal**

Vol. 3

No. 1

2014

The Journal of University Grants Commission



Published by

**University Grants Commission
Nepal**

Advisors

Parashar Prasad Koirala
Bhola Nath Pokharel
Hridaya Ratna Bajracharya

Editorial Board

Krishna Chandra Sharma
Pramod Kumar Jha
Dev Raj Adhikari
Anirudra Thapa

Managing Editor

Devendra Rawal

Asst. Managing Editor

Narayan Bhandari

Contents

1. Heavy Metal Concentration in Household Dust in Kathmandu Metropolitan Area	1
Pawan Raj Shakya, Neena Karmacharya and Chirika Shova Tamrakar	
2. Relationship between Foreign Trade and Economic Growth in Nepal: A Structural Break Analysis	11
Gautam Maharjan	
3. Chemical Extraction of Heavy Metals in River Sediments of Karra River, Nepal	26
Sadhana Pradhanang	
4. Biochemical Constituents in Some Edible Wild Fruits of Chitwan	35
Khaga Raj Sharma	
5. Tense, Aspect and Modality (TAM) in Koyee	43
Tara Mani Rai	
6. Mahatma Gandhi and the <i>Sadharanikaran</i> Model of Communication	63
Nirmala Mani Adhikary	
7. Current Status and Recent Trends of Abortion Service Utilization in Two Facilities of Chitwan District	77
Dinesh Kumar Malla	
8. A Conceptual Analysis of World Trade Organization (WTO) and its Impact on Nepalese Business	85
Dinesh Mani Ghimire	
9. Adaptive Modulation in Multiple Input Multiple Output (MIMO) System	101
Rajeev Prajapati, Norsang Lama and Sabin Bhandari	
10. Spatial Orientation of Angular Momentum Vectors of SDSS Galaxies having Redshift 1×10^{-1} to 1.005×10^{-1}	117
S.N. Yadav, B. Aryal and W. Saurer	
11. Evaluation of Crude Banana Powder as Formulation Additives and Comparison of its Mucoadhesive Property with Carbapol 934P	125
Sanjay K. Yadav, Lalit M. Pant, Gagan Paudel, Nabin Poudel and Rajan Shrestha	

12. Survival and Efficiency of <i>Bacillus thuringiensis</i> in Waste Water for Biological Control of Mosquito Breeding	134
Upendra Thapa Shrestha and Vishwanath Prasad Agrawal	
13. Pre-marital Sex Among Youth and Vulnerability in Contracting STI/HIV/AIDS in Nepal	140
Dhanendra Veer Shakya	
14. Reading the Grammar of Visual Image: A Functional Analysis	150
Ram Chandra Paudel	
15. Factors Associated with Anxiety Among Institutionalized Elderly in Kathmandu Valley	161
Rekha Timalsina, Pasang Doma Sherpa and Dan Kumari Dhakal	
16. Factors Affecting Utilization of Postnatal Care in Selected Village Development Committees (VDCs) of Lalitpur District	169
Kamala Dhakal, Tara Acharya and Prajina Shrestha	
17. Conflict between Humans and Urban Wild-life in Bhaktapur	181
Kamal Raj Gosai, Narayan Prasad Koju, Dikpal Krishna Karmacharya and Sarjina Basukala	
18. Motivating Factors and Satisfaction Level of Visitors at Sagarmatha National Park, Solukhumbu, Nepal	186
Dul Raj Chimariya	

Heavy Metal Concentration in Household Dust in Kathmandu Metropolitan Area

Pawan Raj Shakya*, **Neena Karmacharya**¹ and **Chirika Shova Tamrakar**

Department of Chemistry, Faculty of Science, Padma Kanya Multiple Campus
Tribhuvan University, Bagbazar, Kathmandu

¹Department of Botany, Faculty of Science, Padma Kanya Multiple Campus
Tribhuvan University, Bagbazar, Kathmandu

*Email: pawansh2003@yahoo.com

Abstract: *Dust samples have been collected from roadside houses of seven major locations in Kathmandu metropolitan area and trace element compositions have been determined by atomic absorption spectrophotometer (AAS). Results show significant content of Zn, Pb, Ni, Cr and Cd in the sampled household dusts as compared to the undisturbed (control) area. The mean concentrations of all the studied locations were found to be 76.2 mg/kg for Zn, 40.6 mg/kg for Pb, 29.9 mg/kg for Cr, 23.9 mg/kg for Ni and 8.2 mg/kg for Cd, respectively. Increases in these trace metals in the dust can most likely be attributed to rapid urbanization, increased vehicle emissions to the atmosphere and other anthropogenic sources. Elevated Zn abundances in household dust probably originate from traffic sources. Besides, the enrichment factor reveals that the household dust was most severely affected by Cd at almost all the locations. Also, correlations between metal levels in dust samples for all the metals were investigated.*

Keywords: *Environment, heavy metals, household dust, Kathmandu.*

Introduction

Solid matter, composed of soil, anthropogenic metallic constituents, and natural biogenic materials is called dust (Ferreira-Baptista & De Miguel, 2005). Dust is normally considered as household or street dust. It often contains a range of toxic metals with the composition and concentration being seldom constant (Fergusson & Kim, 1991). This is because of changes during weathering, the relatively short residence time in the environment, and also because the residence time is directly related to climate (Harrison *et al.*, 1981; Al-Khashman, 2007). Of the three materials, soil, sediments and dust (which derive primarily from the earth's crust and with which human beings come into contact), dust is the most pervasive. It is also the material that is now recognized as a significant source of trace metals in the urban environment. In some instances, the dust may represent a significant pollutant source. Moreover, three main factors known to influence the levels of trace element in dust have been reported as road traffic (automobiles), industry and weathered materials. The effect of the road traffic on trace metal content of dust samples have been investigated for various purposes such as agricultural studies and various pollution studies (Balci & Kucuksezgin, 1994; Somer & Aydin, 1985).

Kathmandu forms the core of the nation's most populous urban region. Like many cities of the developing world, the city has been facing rapid population expansion including poor infrastructure and squatter settlements, with severe environmental consequences including air, water and other forms of pollution. The number of vehicles in the country has grown 15 times in the last two decades. According to Department of Transport Management (DoTM), the number of vehicles has reached 1126763 in the first eight months of 2011. Over 72 per cent of all the vehicles ply in the central development region (Himalyan News Service, 2011). Hence, the major polluting source of many trace elements in Kathmandu has become automobiles (Tamrakar & Shakya, 2011; Karmacharya & Shakya, 2012).

Many of heavy metals such as Cr, Cd, Cu, Fe, Pb, Hg, Zn etc., are considered toxic to living organisms and even trace metals considered essential for life can be toxic when present at excessive levels that impair important biochemical processes and pose a threat to human health, plant growth and animal life (Morrison *et al.*, 1990). It has also been suggested that dust can be an important source of metal intake for young children due to inadvertent ingestion of the dust (Harrison *et al.*, 1981; Fergusson & Kim, 1991). Consequently, in recent years, public and scientific attention has increasingly focused on heavy metal contamination and its effect on humans and other living creatures (Wang *et al.*, 2005). In the urban environment, such pollutants are commonly found in dust which can be potentially harmful to roadside vegetation, wildlife, and neighboring human settlements (Turer *et al.*, 2001).

Considerable attention has been paid to the study of metal pollution in city air, roadside dusts and soils. However, there is a lack of concern of the presence of trace metals in household dust in the populous city of Kathmandu, where it has traditionally been assumed that such pollutants are rapidly dispersed by roadside dusts. This research, therefore, aims at quantifying the concentrations of heavy metals in household dust within the home environment in Kathmandu metropolitan area.

Materials and methods

Study area and sample collection: A total of 40 household dust samples (five replicates from each site) including those from undisturbed (control) area were sampled from seven major roadways of Kathmandu metropolitan area during a dry season (October to December). Sampling locations were selected keeping in view of traffic load, population density and anthropogenic activities. Offices and private residences, commercial buildings, shopping complexes, schools and hospitals were among the sources of sample collection. For the present study, sources of dust from such physical infrastructure except street dust were categorized as household dust unless and otherwise mentioned. A detailed description of the selected locations is given in Table 1.

Table 1. Description of different sampling locations of Kathmandu metropolitan area

Site No.	Sampling locations	Area code	Description of the nearby locations of sampling households
1	Tinkune	TKN	Traffic load, densely populated and commercial area
2	Chabahil	CBL	Traffic load, densely populated and commercial area
3	Gongabu	GGB	Heavy traffic load; main bus station; densely populated and commercial area
4	Kalanki	KLK	Heavy traffic; sub station; densely populated and commercial area; main entry point to Kathmandu city
5	Thapathali	THP	Traffic load; densely populated and commercial area
6	Sahid gate	SGT	Heavy traffic; central sub station and commercial area
7	Ratna park	RPK	Heavy traffic, central sub station; densely populated and commercial area
8	Shivpuri (Control; undisturbed area)	CTR	Low traffic; sparse residential and undisturbed area

Household dusts were collected repeatedly in adequate quantity by gentle sweeping of the floor area of about 1 m² by means of a soft plastic brush into a plastic dustpan and transferred into a polyethylene bag. The samples were brought to the laboratory and then sieved to exclude particles larger than 30 mesh. A portion of each of the five replicate samples was dried at 105°C for 24 h and weighed for analytical purpose. Control samples collected from undisturbed area were also treated in a similar manner.

Sample analysis: The pH in bulk household dust samples was analyzed by using a glass electrode in a 1:5 soil/water suspension and electrical conductivity at room temperature in a 1:5 soil/water suspension (Trivedy & Goel, 1986) on a CON 510 bench conductivity meter using a conductivity electrode (cell constant, K = 1.0). Organic carbon content was determined by the Walkley Black method modified by Jackson (1958). Briefly, dust samples were oxidized with 1N K₂Cr₂O₇ and H₂SO₄ and the residual K₂Cr₂O₇ titrated against 0.05N ferrous ammonium sulfate using a pinch of NaF, H₃PO₄ and diphenylamine indicator. Blank (with no dust sample) was run for standardization.

Determination of heavy metal: For each sample, 1.0 g of sieved dust was digested using tri-acid mixture (9 mL of 70% HNO₃, 1 mL of 60% HClO₄ and 6 mL of 48% HF) at 140 °C in Teflon bombs (Agemian & Chau, 1976). After digestion, boric acid was added to the solution and kept for about one week to allow complete formation of the gelatinous precipitate of borosilicate. Samples were then filtered through 0.45 µm millipore filter paper to obtain a clear solution. The filtrate was collected and stored in

polypropylene bottles prior to the total metal analysis by atomic absorption spectrophotometer (Hitachi model 180-270) for Cd, Cr, Ni, Pb and Zn using an air-acetylene gas mixture using hollow cathode lamp.

Background correction measurement was made by means of non-absorbing lines, and blanks were determined by completing a full analytical procedure without samples. After each analytical run, the calibration curve was displayed on the screen and a visual check was made for linearity and replication. Prior to each analysis, the instruments were calibrated according to the manufacturer's recommendations. All the standard solutions (1000 ppm) for Cr, Cd, Ni, Pb and Zn were certified and obtained from FLUKA AG, Switzerland. These solutions were diluted carefully to the required concentrations with doubly deionized water.

Enrichment factor: The amount of anthropogenically introduced metal in household dust of different study locations was estimated using an enrichment factor (EF_x). EF_x was calculated with respect to the natural concentration by using the following expression (Chan *et al.*, 2001; Madrid *et al.*, 2002):

$$EF_x = X/X_{ref}$$

where X is the concentration of the metal in each fraction ($mg\ kg^{-1}$) and X_{ref} is the background concentration of metal in each fraction ($mg\ kg^{-1}$) from the undisturbed area.

Statistical analysis: In the present study, all statistical analyses and data processing were done using Statistical Package for Social Sciences (SPSS) program on an IBM-PC computer. Descriptive statistics such as mean, range and standard deviation were used after multi-element analysis. Correlation coefficients value (r) at $p = 0.05$ between various metals were calculated by using Pearson's correlation test.

Results and discussion

Household dust properties: The pH of dust samples were relatively similar in all the locations, ranging from 7.5 (TKN) to 8.1 (RPK) (Table 2). The alkaline nature of the dust samples may be explained by the presence of carbonate (Yaalon, 1997) and high stability of pH due to small difference among the sites. The electrical conductivity was relatively high and variable in all the sites ranging from 0.09 mS/cm (THP) to 0.28 mS/cm (GGB) (Table 2). This indicates that the salt content in household dust depends on the location; the highest salt concentration in the household dust of Gangabu location are likely due to a spill of material rich in salts in the surrounding areas (Fuente *et al.*, 2006). The percentage of organic carbon (OC) ranged from 1.7% (CBL) to 3.5% (TKN). If the organic carbon content in the household dust from the undisturbed area is compared with the percentage of OC in dusts from other sampling locations of the present study, we can conclude that the amount of OC in the dust samples for all

locations is generally high (Table 2). Therefore, the elevated level of organic carbon in the household dust reflects that dust is an important sink of organic material in Kathmandu metropolitan area, which is subsequently transported by wind or runoff water and accumulated on buildings and/or streets. In addition, hydrocarbons, which come from vehicle oil or gasoline, and organic material from anthropogenic waste, may contribute to the organic carbon content in dust (Hassanien & Abdel-Latif, 2008; Stone *et al.*, 2010).

Table 2. Properties of household dust samples, mean (n = 5, standard deviation) from different sampling locations of Kathmandu metropolitan area

Parameters	Sampling sites							
	TKN	CBL	GGB	KLK	THP	SGT	RPK	CTR
pH	7.5 (0.1)	7.8 (0.2)	7.8 (0.1)	7.6 (0.2)	7.6 (0.3)	7.8 (0.2)	8.1 (0.4)	7.9 (0.2)
* EC(mS/cm)	0.20 (0.08)	0.25 (0.06)	0.28 (0.02)	0.24 (0.09)	0.09 (0.04)	0.15 (0.03)	0.13 (0.07)	0.04 (0.02)
**OC (%)	3.5 (0.7)	1.7 (0.5)	2.1 (1.1)	3.2 (0.7)	3.4 (1.8)	1.9 (1.0)	2.6 (0.6)	1.0 (0.4)

* Electrical conductivity; **Organic carbon

Heavy metals in household dust: The mean and standard deviation of heavy metal concentrations investigated in the studied samples are presented in Table 3. Results revealed that the mean concentration of all metals in the dust samples was found to be in order of Zn > Pb > Cr > Ni > Cd. Interestingly, the metal concentration order was found to be almost similar in all the locations including undisturbed area under investigation. The metal levels in the household dust (mean of all locations) of Kathmandu metropolitan area were 76.2 mg/kg for Zn, 40.6 mg/kg for Pb, 29.9 mg/kg for Cr, 23.9 mg/kg for Ni and 8.2 mg/kg for Cd, respectively. The values were significantly higher than those of the control location which recorded the mean concentration 35.9 mg/kg for Zn, 21.2 mg/kg for Pb, 14.6 mg/kg for Cr, 12.3 mg/kg for Ni and 2.8 mg/kg for Cd respectively.

Table 3. Heavy metals in household dust, mean (standard deviation; n = 5) 'mg kg⁻¹', from different locations of Kathmandu metropolitan area

Sampling sites	Cd	Cr	Ni	Pb	Zn
TKN	8.9(1.4)	18.7(3.5)	16.6(1.4)	27.8(3.8)	47.6(5.4)
CBL	6.2(0.9)	15.9(2.6)	21.9(5.1)	30.4(3.9)	73.9(10.2)
GGB	10.3(1.0)	19.5(3.2)	17.8(2.9)	22.8(2.9)	54.4(6.9)
KLK	3.6(0.2)	42.6(6.8)	29.4(3.9)	55.9(14.3)	61.5(11.5)
THP	5.2(0.3)	28.2(5.6)	19.8(5.3)	41.1(7.1)	78.9(15.9)
SGT	12.8(2.4)	37.1(4.2)	23.9(3.4)	47.4(7.9)	67.4(12.6)
RPK	10.7(3.2)	47.7(9.4)	38.1(7.8)	58.7(9.4)	149.4(23.4)
Kathmandu (mean all uses, n = 35)	8.2	29.9	23.9	40.6	76.2
CTR (Undisturbed area)	2.8(0.3)	14.6(3.2)	12.3(3.8)	21.2(3.7)	35.9(4.6)

Besides, the metal levels in the dust samples from the studied locations ranged from 47.6 (TKN) – 149.4 mg/kg (RPK) for Zn, 22.8 (GGB) – 58.7 mg/kg (RPK) for Pb, 15.9 (CBL) – 47.7 mg/kg (RPK) for Cr, 16.6 (TKN) – 38.1 mg/kg (RPK) for Ni and 3.6 (KLK) – 10.7 mg/kg (RPK) for Cd, respectively. Among the metals, Zn was found to be at significantly higher level in the dust samples from all locations. Similarly, among the studied samples, the household dust from RPK location recorded the highest concentration of almost all the metals under investigation. The undisturbed area (CTR), however, recorded comparatively the lowest levels of all metals under the similar experimental condition.

Adachi and Tainosho (2004) reported that tyre dust is a significant pollutant, especially as a source of Zn in the urban environment. Zinc, used as a vulcanization agent in tyres, was the most likely source in the dust samples in Kathmandu metropolitan area, resulting from attrition of motor vehicle tyre rubber exacerbated by poor road surfaces. Lubricating oils also contain zinc as additives such as zinc dithiophosphates (Jaradat & Momani, 1999). Similarly, Acosta *et al.* (2010) identified industrial activities and traffic as the main sources of Pb and Zn was related to recreational, domestic, and commercial sources.

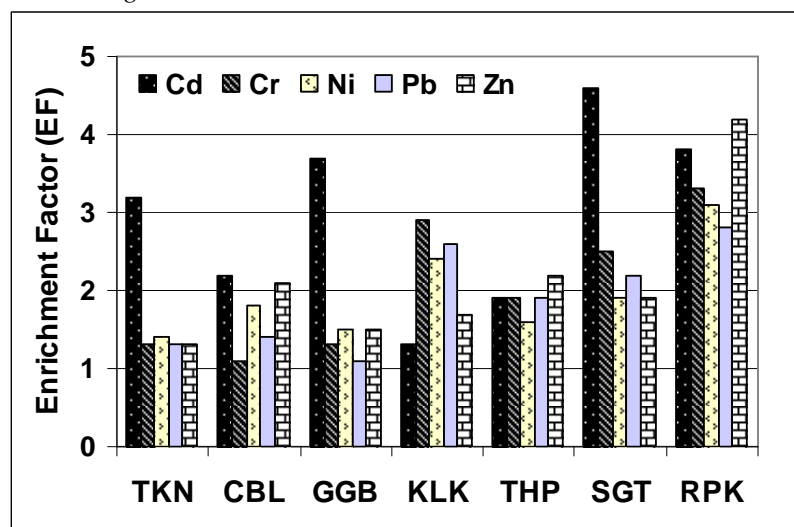
Lead is the element of most concern in environmental metal pollution. The lead source may be directly associated with emissions from vehicle exhausts using leaded gasoline. The residence time of Pb in the atmosphere is also very high being 150 years (Shams & Beg, 2000). So that even after phasing out of leaded gasoline in Kathmandu, it is likely to persist in the environment for a considerable period of time. Despite the sharp increase of unleaded fuel utilization, followed by a rapid decline of Pb levels in the atmosphere, the content of Pb in urban dust still remains high with a consequent associated risk for children via the soil-hand-mouth pathway (Bargagli, 1998).

The main source of nickel in dust is from the combustion of diesel fuel (Raju, 1997). This suggests that the extensive use of diesel in heavy vehicles, three wheelers, tractors and water pumps was contributing the elevated level in dust (Fergusson & Kim, 1991). Similarly, the common anthropogenic sources of cadmium in dust are metal plating, tyre enforced with metals, burning of tyres and bad roads (Yu *et al.*, 2003). The uses of cadmium-plated and galvanized equipment in food processing—cadmium-containing enamel and pottery glazes, and cadmium base pigments or stabilizer in plastics—may also be significance sources of contaminations (Akhter & Madany, 2003). Similarly, chromium in street dust is associated with the chrome plating of some motor vehicle parts (Al-Shayep & Seaward, 2001).

Enrichment in household dust: Taking into account the concentration of metals in undisturbed area (CTR) and other locations, enrichment factors were calculated. Household dust from Kathmandu metropolitan area is severely enriched by Cd (EF = 2.9), Cr (EF = 2.1), Ni (EF = 1.9), Pb (EF = 1.9) and Zn (EF = 2.1).

Also, it is observed that the degree of enrichment for each metal varies in household dust of the studied locations (Figure 1). Results show that dust samples from Tinkune, Chabahil, Gangabu and Sahidgate were enriched most by Cd while those from Kalanki and Ratnapark were found to be affected by Cr and Zn respectively. Among the studied locations, dust from Ratnapark was most severely enriched by Cr (EF = 3.3), Ni (EF = 3.1), Pb (EF = 2.8) and Zn (EF = 4.2) except Cd which was most severely enriched (EF = 4.6) in dust of SGT location. Results clearly show variability in enrichment factor in the household dust indicating that the interplay of sources of metals, human habits, populations, etc. of each location determines the metal concentration in dust samples (Charlesworth *et al.*, 2003; Ordonez *et al.*, 2003). Additionally, the dust metals may travel from the roads, through the windows and balconies, into the houses as those homes that have their windows opened often had a higher level of contaminants in their house dust. Body *et al.*, (1991) reported that those occupants who sweep their floors or dust on their furniture on daily bases, or use vacuum cleaners, had a lower level of metals inside their houses. Another finding of interest is that the color of the wall paint used in the house was another factor influencing the contamination levels.

Figure 1. Enrichment factors in different studied locations



Correlation coefficient analysis: Pearson's correlation coefficients for metals in household dust in Kathmandu metropolitan area is shown in Table 4. Inter-element relationship showed significant correlations between Ni and Cr ($r = 0.861$, $p < 0.05$), Pb and Cd ($r = 0.833$, $p < 0.05$), Zn and Cd ($r = 0.839$, $p < 0.05$), Zn and Cr ($r = 0.887$, $p < 0.05$) and Pb and Zn ($r = 0.874$, $p < 0.05$) indicating that the household dust contamination by metals originated from a common anthropogenic source. As the study area has no industrial

belt, we may assume that the heavy metals analyzed in household dust samples were derived almost exclusively from local traffic, construction and demolition activities and other household activities.

Table 4. Inter-element correlations for household dust samples from the study area

Element	Cd	Cr	Ni	Pb	Zn
Cd	1.000				
Cr	0.281	1.000			
Ni	0.085	0.861*	1.000		
Pb	0.833*	0.290	0.044	1.000	
Zn	0.839*	0.887*	0.254	0.874*	1.000

Significance level; * $p < 0.05$

Conclusion

The household dust from different major roadways (seven studied locations) in Kathmandu metropolitan area has an alkaline pH which may probably be due to a high amount of carbonates (calcite and dolomite) that can react with metals to form metal-carbonate complex/minerals. Its electrical conductivity is variable and the elevated level of organic carbon in household dust reflects that dust is an important sink of organic material in Kathmandu metropolitan area.

The mean metal concentrations in all the studied locations were found to be at higher levels than those obtained for undisturbed area. Dust samples from all those locations were found to be high in metal content in the order of $Zn > Pb > Cr > Ni > Cd$. Among the studied locations, the household dust from Ratnapark recorded the highest concentrations of almost all the metals under investigation. Although variability in enrichment factor (EF_x) was found in all the sites, the household dust in Kathmandu metropolitan area was found most severely affected by Cd. Therefore, we conclude that a monitoring plan is necessary to evaluate dispersion of metal concentration in dust in order to develop the proper measures for reducing the risk of human health and environment. Besides, further work would be required to establish whether the major source of heavy metals in the house dust particles is from indoor or outdoor origins.

Acknowledgements

We wish to acknowledge University Grants Commission, Sanothimi, Bhaktapur for the financial support through their mini research project. Besides, thanks are also due to Department of Applied Chemistry, Banaras Hindu University, Varanasi for AAS analyses.

References

- Acosta, J.A., Faz, A. & Martinez-Martinez, S. (2010). Identification of heavy metal sources by multivariable analysis in a typical Mediterranean city (SE Spain). *Environ. Monit. Assess.*, 169, pp. 519–530.
- Adachi, K. & Tainosho, Y. (2004). Characterization of heavy metal particles embedded in tyre dust. *Environmental International*, 30, pp. 1009-1017.

- Agemian, H. & Chau, A.S.Y. (1976). Evaluation of extraction techniques for the determination of metals in aquatic sediments. *The Analyst*, 101, pp. 761-767.
- Akhter, M.S. & Madany, I.M. (1993). Heavy metals in street and house dust in Bahrain. *Water, Air and Soil Pollution*, 66, pp. 111-119.
- Al-Khashman, O. (2007). Determination of metal accumulation in deposited street dusts in Amman, Jordan. *Environmental Geochemistry and Health*, 29, pp. 1-10.
- Al-Shayep, S.M. & Seaward, M.R.D. (2001). Heavy metal content of roadside soils along ring road in Riyadh (Saudi Arabia). *Asian J. Chem.*, 13, pp. 407-423.
- Balci, A. & Kucuksegin, F. (1994). Trace metal concentrations in surficial sediments from eastern Aegean continental shelf. *Chimica Acta Turcica*, 22, pp. 97-101.
- Bargagli, R. (1998). *Trace elements in terrestrial plants: An ecophysiological approach to biomonitoring and biorecovery*. Germany: Springer-Verlag, Berlin.
- Body, P., Inglis, G., Dolan, P. & Mulcahy, D. (1991). Environmental lead: a review. *Crit. Rev. Environ. Control*, 20, pp. 299-310.
- Chan, L.S., Davis, A.M., Yim, W.W.S. & Yeung, C.H. (2001). Magnetic properties and heavy-metal contents of contaminated seabed sediments of Penny's Bay, Hong Kong. *Mar. Pollut. Bull.*, 42, pp. 569-583.
- Charlesworth, S., Everett, M., McCarthy, R., Ordonez, A. & De Miguel, E. (2003). A comparative study of heavy metal concentration and distribution in deposited street dusts in a large and a small urban area: Birmingham and Coventry, West Midlands, UK. *Environ. Int.*, 29, pp. 563-573.
- Ferguson, J.E. & Kim, N. (1991). Trace elements in street and house dusts source and speciation. *Sci. Total Environ.*, 100, pp. 125-150.
- Ferreira-Baptista, L. & De Miguel, E. (2005). Geochemistry and risk assessment of street dust in Luanda, Angola: a tropical urban environment. *Atmos. Environ.*, 39, pp. 4501-4512.
- Fuente, D., Chico, B. & Morcillo, E. (2006). The effects of soluble salts at the metal/paint interface: advances in knowledge. *Port. Electrochim. Acta.*, 24, pp. 191-206.
- Harrison, R.M., Laxen, D.P.H. & Wilson, S.J. (1981). Chemical association of lead, cadmium, copper and zinc in street dust and roadside soil. *Environ. Sci. Technol.*, 15, pp. 1378-1383.
- Hassanien, M.A. & Abdel-Latif, N.M. (2008). Polycyclic aromatic hydrocarbons in road dust over Greater Cairo, Egypt. *J. Hazard. Mater.*, 151, pp. 247-254.
- Himaliyan News Service (2011, April 22). Vehicles grew 15 times in 20 yrs. *The Himalayan*, Retrieved from <http://www.thehimalayantimes.com>
- Jackson, M.L. (1958). *Soil chemical analysis*. New York: Y. Eagle Wood Cliff.
- Jaradat, Q.M. & Momani, K.A. (1999). Contamination of roadside soil, plants, and air with heavy metals in Jordan. *Turk J. Chem.*, 23, pp. 209-220.
- Karmacharya, N. & Shakya, P.R. (2012). Heavy metals in bulk and particle size fractions from street dust of Kathmandu city as the possible basis for risk assessment. *Scientific World*, 10, pp. 84-89.
- Madrid, L., Diaz-Barrientos, E. & Madrid, F. (2002). Distribution of heavy metal contents of urban soils in parks of Seville. *Chemosphere*, 49, pp. 1301-1308.
- Morrison G.M.P., Revitt D.M. & Ellis, J.B. (1990). Metal speciation in separate storm water systems. *Water Science and Technology*, 22, pp. 53-60.
- Ordonez, A., Loreda, J., De Miguel, E. & Charlesworth, S. (2003). Distribution of heavy metals in street dust and soils of an industrial city in northern Spain. *Arch. Environ. Contam. Toxicol.*, 44, pp. 160-170.

- Raju, B.S.M. (1997). *Fundamentals of air pollution*. New Delhi: Oxford and IBH Publishing Co. Pvt. Ltd.
- Shams, Z.I. & Beg., M.A.A. (2000). Lead in particulate deposits and in leaves of roadside plants, Karachi, Pakistan. *The Environmentalist*, 20, pp. 63-67.
- Somer, G. & Aydin, H. (1985). Determination of lead in roadside soil using anodic stripping voltammetry. *Analyst*, 110, pp. 631-633.
- Stone, E.A., Schauer J.J., Quraishi, T. & Mahmood A. (2010). Chemical characterization and source apportionment of fine and coarse particulate matter in Lahore, Pakistan, *Atmos. Environ.*, 44, pp. 1062-1070.
- Tamrakar, C.S. & Shakya, P.R. (2011). Assessment of heavy metals in street dust in Kathmandu Metropolitan City and their possible impacts on the environment. *Pak. J. Anal. Environ. Chem.*, 12, pp. 32-41.
- Trivedy, R.K. & Goel, P.K. (1986). *Chemical and biological methods for water pollution studies*. Aligarh: Environmental Publications, Oriental Printing Press.
- Turer D., Maynard, J.B. & Sansalone, J.J. (2001). Heavy metal contamination in soils of urban highways: Comparison between runoff and soil concentrations at Cincinnati, Ohio. *Water, Air and Soil Pollution*, 132, pp. 293-314.
- Wang X.S., Qin, Y. & Sun, S.X. (2005). Accumulation and sources of heavy metals in urban topsoils: a case study from the city of Xuzhou, China. *Environmental Geology*, 48, pp. 101-107.
- Yaalon, D.H. (1997). Soils in Mediterranean region: what makes them different? *Catena*, 28, pp. 157-169.
- Yu, K.N., Yeung, Z.L. & Kwok, R.C.W. (2003). Determination of Multi-element Profiles of Soils using Energy Dispersive X-Ray Fluorescence (EDXRF). *Appl. Radiat, Isot.*, 58, pp. 339-346.

Relationship between Foreign Trade and Economic Growth in Nepal: A Structural Break Analysis

Gautam Maharjan

Public Youth Campus (Faculty of Management), Tribhuvan University, Kathmandu
Email: maharjngautam@gmail.com

Abstract: *This paper aims to assess the impact of foreign trade volume and trade deficit on economic growth before and after trade liberalization in Nepal. The study has used correlation analysis, regression analysis as well as Chow test to analyse the relationship of variables. Similarly, there is a significant impact of foreign trade volume and trade deficit on economic growth before and after the trade liberalization periods as well. Chow test showed that the effect of foreign trade volume and trade deficit on economic growth before and after trade liberalization periods are significant. Finally, it is concluded that the impact of foreign trade volume and trade deficit on economic growth is significantly different before and after trade liberalization in Nepal.*

Keywords: *Foreign trade volume growth, economic growth, trade liberalization.*

Introduction

Foreign trade is an important factor to accelerate the economic development of a nation. Mostly, countries are involved in foreign trade to create employment, raise saving, increase foreign exchange earnings, and raise the productivity of investment (Hussain, 1996). Therefore, foreign trade activities play a vital role in developing countries like Nepal.

Khanal and Shrestha (2008) highlighted the trend of trade flow and investment in Nepal since 1975. It also reviewed the existing institutional mechanism of trade and investment coordination. After the 1990s, most of these policies have been formulated to enhance economic liberalization policies, as Nepal introduced a more liberal trade policy since 1992 (Khanal & Shrestha, 2008). So, the post-liberalization period for Nepal can be taken after the fiscal year 1990/91. In the pre-liberalization period, however, such liberalization policies were governed by state regulation and control. The reform, however, was expedited only after the restoration of multi-party democracy in 1990.

According to preliminary estimates, economy in FY 2012/13 was estimated to grow only by 3.56 percent at basic price and 3.65 percent at producers' price against the targeted 5.5 percent (MoF, 2013). Economic growth rate in the previous fiscal year was 4.5 percent, while, in the current fiscal year, the decreased food grain production resulted in the decrease of 3.7 percentage points in the agriculture sector, thereby accounting for the decline in aggregate economic growth rate. The non-agriculture sector in the current fiscal year, however, was estimated to grow by 4.98 percent,

which is higher by 0.68 percentage points compared to the previous fiscal year. In the current fiscal year, Gross Domestic Production (GDP) is estimated to reach Rs 170.01 billion with a growth of 10.8 percent from the previous fiscal year. In the previous fiscal year GDP totalled Rs 153.6 billion (Ministry of Finance, 2013).

Nepal's foreign trade has remained in deficit for the long period of time. Total trade deficit in the first eight months of the current fiscal year has grown up by 25.5 percent totalling Rs 309.55 billion (Ministry of Finance, 2013). Such trade deficit had recorded an increase of 17.1 percent in the same period of the previous year (Ministry of Finance, 2013).

The total export has increased by 5 percent and has reached Rs 51.1 billion in the first eight months of current fiscal year 2012/13. Such export had increased by 14.1 percent and reached Rs 48.6 billion in the same period of the previous year (Ministry of Finance, 2013) whereas the total import of goods during the review period totalled Rs 360.6 billion recording a growth of 22.1 percent as compared to 16.6 percent growth and a total of Rs 295.24 billion during the same period of previous year 2011/12. Such higher growth in imports in the current fiscal year as compared to the corresponding period of the previous fiscal year is attributable to the higher growth of goods import from India and other countries (Ministry of Finance, 2013).

One of the fundamental questions in economic development is how a country can achieve high economic growth. Foreign trade volume (including exports and imports) growth hypothesis has been regarded as one of the answers to this fundamental question. In open economy, development of foreign trade impacts GDP growth. The export-led growth hypothesis discussed by Findlay (1984) and Krueger (1978) maintains that higher exports accelerate the economic growth process.

Frankel and Romer (1999), Wacziarg and Welch (2003), and Alcalá and Ciccone (2004) diagnosed the effects of foreign trade in economic growth as a major factor. Sachs and Warner (1995) found that the growth rate of the economies with free trade regimes is higher than the closed economies. Edwards (1998) studied the relation between foreign trade and total factor productivity (TFP) in 93 countries and concluded that TFP growth is faster in more open economies.

Lewer and Van den Berg (2003) examined the size of the relationship between international trade and growth by not just considering its statistical significance but also regarding its economic significance and revealed that a one percentage point increase in growth of exports leads to a one-fifth percentage point increase in economic growth.

Kahya (2011) analyzed the relationship between foreign trade and economic growth in Turkey over the period 1980-2009 for investigating the dynamic relationship between GDP, exports and imports. The results suggested that imports were one of the significant determinants of the economic growth in Turkey whereas exports did not have important impacts on it.

Li, Chen and Wang (2010) analyzed the contribution of foreign trade to the economic growth of Jiangxi Province, China. The study adopted simple regression for researching the relationship between foreign trade including total exports and total import and GDP growth of Jiangxi province with the collected 30-year statistical data from 1978 to 2007. The result indicated that foreign trade has contributed a lot to the GDP growth. There is a positive correlation between the foreign trade and GDP. And, imports have significantly influenced the economic growth of Jiangxi province. Finally, the paper pointed out that in order to maintain the economic growth, Jiangxi must unswervingly implement the opening-up policy and be aware of trade protectionism.

Ram (2003) examined the nature, as well as the strength of the causal relationship between real export growth and real GDP growth for Fiji. Granger causality tests, under a VAR framework, were used to examine whether the growth in real exports causes a real GDP growth or vice versa. The results showed that growth in real exports does cause real GDP growth. Moreover, it was found that the trade-weighted trading partner GDP (lagged one year) and real imports, from the late 1980s, have played an crucial role in enforcing the relationship between real exports growth and real GDP growth.

Kwan and Cotsomitis (1991) used Granger causality test to study Chinese growth and foreign trade. They concluded that export promotes economic growth and there was a one-way causal relationship between the two. But Jung and Marshall (1985) analyzed the relationship between GDP and export of 37 developing countries in 1950-1981, and found that there was no causal relationship except Israel.

On the basis of the review of previous related studies, it is found that there is no investigation on the relationship between foreign trade volume growth and GDP growth of Nepal. Previous studies only focused on the relationship between foreign trade and GDP growth, without studying the impact of trade liberalization on foreign trade and real economic growth; and they have not applied Chow test. Hence, this study to some extent, tries to fulfil the above research gap.

From the previous studies, it brought to the light that the relationship between foreign trade and economic development has been studied by many scholars. It is widely accepted that foreign trade and economic development are positively and significantly related, although there are some counter-arguments, which say that it is difficult to differentiate between the effects of foreign trade and those other economic policies on growth (Lewer & Van den Berg, 2003). Liberalization gained more speed in Nepal since the first decade of 1990, as it started implementing liberal economic policies. Nepal has increasingly become integrated into the global economy and foreign trade has become one of the essential elements of economic development in the country for more than two decades. To study this issue, the following research questions have been developed:

- What are the average growth rates of exports, imports, total foreign trade volume, trade deficit, and real GDP in Nepal?
- What is the impact of foreign trade volume and trade deficit on economic growth in Nepal?
- Are there any significant differences in the impact of foreign trade volume and trade deficit on economic growth before trade and after trade liberalization in Nepal?

The main purpose of the study is to assess the change in the impact of foreign trade volume and trade deficit on economic growth before and after trade liberalization in Nepal. Other specific objectives are to identify the average growth rate of exports, imports, total foreign trade volume, trade deficit and real GDP in Nepal as well as to examine the impact of foreign trade volume and trade deficit on economic growth in Nepal.

Methodology

The research design of this study is descriptive as well as analytical. It is based on secondary data which have been collected from Economic Surveys, Nepal Rastra Bank Quarterly Economic Bulletins, unpublished official records of concerned Department/Ministry and Nepal Rastra Bank.

Considering trade liberalization in Nepal in fiscal year 1990/91, the data have been collected for thirty eight years from 1974/75 to 2011/12 to study the impact of total foreign trade volume and trade deficit on economic growth in Nepal. Total foreign trade volume is calculated as sum of exports and imports, but trade deficit is calculated as exports minus imports.

Since a structural break in 1990/91 as trade liberalization in Nepal, the data have been broken down into two periods: before trade liberalization period (17 years from 1974/75 to 1990/91) and after trade liberalization period (21 years from 1991/92 to 2011/12).

Statistical tools: The study has used arithmetic mean, standard deviation (S.D.), coefficient of variance (C.V.), correlation analysis, regression analysis and Chow test on the data of past 38 years.

Theoretical model for the variables relationship is as follows:

$$\text{Economic Growth} = f(\text{Total Foreign Trade Volume}) \quad (1)$$

$$\text{Economic Growth} = f(\text{Trade Deficit}) \quad (2)$$

The model hypothesizes that real GDP (i.e., economic growth) is a function of total foreign trade volume and trade deficit separately. Although economic growth might also be affected by some other factors such as government spending and investments, they are not included in this model because the researcher has tried to

examine primarily the causal relationship between economic growth and foreign trade volume as well as trade deficit. Therefore, other variables are excluded in this model.

Chow test: According to Gujarati and Sangeetha (2007), Chow test is used to assess the effect of structural change in the relationship between regress and regressors in time series data. In this study, the impact of foreign trade volume and trade deficit on economic growth before and after trade liberalization in Nepal (i.e., structural change) have been tested by using a Chow Test approach. Taking natural log in both sides, the following equations was obtained for this study.

$$\ln EG = \alpha + \beta \ln FTVG + U \quad (3)$$

$$\ln EG = \alpha + \beta \ln TD + U \quad (4)$$

Where, $\ln EG$ is natural log economic growth, $\ln FTV$ is natural log foreign trade volume, $\ln TD$ is natural log trade deficit. U is error term. β is coefficient of $\ln FTV$ as well as $\ln TD$ and α is constant. Before Chow Test, variances of two periods should be equal (Gujarati & Sangeetha, 2007).

In this study, σ_1^2 and σ_2^2 are the estimators of variance before and after trade liberalization in Nepal respectively. Similarly, n_1 and n_2 are the number of observations before and after trade liberalization periods in Nepal. Before Chow Test, σ_1^2 and σ_2^2 are tested in this study. For variance test analysis, following formulas are applied (Gujarati & Sangeetha, 2007):

$$\sigma_1^2 = \frac{RSS_1}{n_1-2}, \sigma_2^2 = \frac{RSS_2}{n_2-2}$$

$$F = \frac{\sigma_1^2}{\sigma_2^2} \text{ or } \frac{\sigma_2^2}{\sigma_1^2} \sim F_{(n-k), (n-k)}$$

By convention the larger of the two estimated variances is put in the numerator (Gujarati & Sangeetha, 2007). The RSS_1 and RSS_2 are the residuals sum of square before and after trade liberalization in Nepal respectively. RSS_{UR} is the total residual sum of square before and after trade liberalization (i.e., $RSS_{UR} = RSS_1 + RSS_2$). The RSS_R is residual sum of square for overall period. Similarly, k and df means the number of parameters, and degree of freedom respectively. For Chow Test Analysis, following formula is applied (Gujarati & Sangeetha, 2007).

$$F = \frac{(RSS_R - RSS_{UR})/k}{RSS_{UR}/(n_1+n_2-2k)} \sim F_{[k, (n_1+n_2-2k)]}$$

Following research hypotheses were set for the analysis:

Hypothesis 1: There is a positive significant impact of total foreign trade volume on economic growth.

Hypothesis 2: There is a positive significant impact of trade deficit on economic growth.

Hypothesis 3: There is a significant change in the impact of foreign trade volume and trade deficit on economic growth before and after trade liberalization in Nepal.

The limitations of this study is that it is related only to foreign trade and economic growth relationship in Nepal. It used only secondary data (i.e., from 1974/75 to 2011/12) and only limited statistical tools including simple average, standard deviation, coefficient of variance, correlation, regression and Chow test. It has not included some other factors like government spending and investments which may also affect economic growth.

Data analysis and discussion

Analysis of export growth, import growth, foreign trade volume growth, trade deficit growth and real GDP growth during the period from 1975/76 to 2011/12

Table 1 shows that the average mean, standard deviation (S.D.) and coefficient of variation (C.V.) of export growth (XG), import growth (MG), total foreign trade volume growth (FTVG), and real GDP growth (RGDPG) of the period from 1975/76 to 2011/12.

Table 1. Export Growth, Import Growth, Foreign Trade Volume Growth, Trade Deficit Growth and Real GDP Growth Before and After Trade Liberalization (*Figures in percent*)

Variable	Overall Period (1974/75 to 2011/12)			Before Liberalization (1974/75 to 1991/92)			After Liberalization (1991/92 to 2011/12)		
	Mean	S.D.	C.V.	Mean	S.D.	C.V.	Mean	S.D.	C.V.
XG	14.77	22.88	154.93	16.80	25.53	152.00	13.22	21.16	160.01
MG	16.62	10.53	63.35	17.55	8.31	47.36	15.92	12.11	76.06
FTVG	15.84	10.76	67.93	16.69	8.88	53.18	15.20	12.18	80.14
TDG	19.11	18.52	96.87	21.09	21.06	99.88	17.61	16.70	94.85
RGDPG	4.28	2.12	49.49	4.51	2.69	59.77	4.11	1.61	39.04

Adapted from Appendix 1

Export growth: The average mean and standard deviation (S.D.) of export growth (XG) of the overall period are 14.77 percent and 22.88 percent respectively whereas coefficient of variation (C.V.) is 154.93 percent. It means that C.V. is more than 100 percent which indicates that overall growth of the exports is more fluctuated.

Similarly, the mean, standard deviation and coefficient of variation of export growth before trade liberalization period are 16.80 percent, 25.53 percent and 25.53

percent respectively but these after trade liberalization period are 13.22 percent, 21.16 percent, and 160.01 percent respectively. Comparing these two periods, it is seen that average export growth after trade liberalization period is lower than before. But the coefficient of variation (C.V.) after liberalization period is higher than before. This means that trend of export growth is more fluctuating after the trade liberalization period than before.

Import growth: Similarly, the mean and standard deviation (S.D.) of import growth (MG) of the overall period are 16.22 percent and 10.53 percent respectively whereas coefficient of variation (C.V.) is 63.35 percent. This means that C.V. is less than 100 percent which indicates that overall growth of the imports is less fluctuating.

Similarly, the average mean, standard deviation and coefficient of variation of import growth before trade liberalization period are 17.55 percent and 8.31 percent, and 47.36 percent respectively but these after trade liberalization period are 15.92 percent, 12.11 percent, and 76.06 percent respectively. Comparing these two periods, it is seen that average import growth after trade liberalization period is lower than before. But the coefficient of variation (C.V.) after liberalization period is higher than before. This means that trend of import growth is more fluctuating the after trade liberalization period than before.

Total foreign trade volume growth: The average mean and standard deviation (S.D.) of total foreign trade volume growth (FTVG) of the overall period from 1974/75 to 2011/12 are 15.84 percent and 10.76 percent respectively whereas coefficient of variation (C.V.) is 67.93 percent. This means that C.V. is less than 100 percent which indicates that overall growth of the total foreign trade volume is less fluctuating.

Similarly, the average mean, standard deviation and coefficient of variation of total foreign trade volume growth before trade liberalization period are 16.69 percent and 8.88 percent, and 53.18 percent respectively but these after trade liberalization period are 15.20 percent, 12.18 percent, and 80.14 percent, respectively. Comparing these two periods, it is seen that average total foreign trade volume growth after liberalization period is lower than before. But the coefficient of variation (C.V.) after liberalization period is higher than before. Thus, the trend of total foreign trade volume growth is more fluctuating the after liberalization period than before.

Trade deficit growth: Similarly, the mean and standard deviation (S.D.) of trade deficit growth (TDG) of the overall period are 19.11 percent and 18.52 percent respectively whereas coefficient of variation (C.V.) is 96.84 percent. Hence, C.V. is less than 100 percent which indicates that overall growth of the trade deficit is less fluctuating.

Similarly, the average mean, standard deviation and coefficient of variation of trade deficit growth before trade liberalization period are 21.09 percent and 21.06 percent, and 99.88 percent respectively but these after trade liberalization period are 17.61 percent, 16.70 percent, and 94.85 percent respectively. Comparing these two

periods, it is found that average trade deficit growth after trade liberalization period is lower than before. Also, the coefficient of variation (C.V.) after liberalization period is lower than before. Thus, the trend of trade deficit growth is fluctuating at a lower rate the after liberalization period than before.

Real GDP growth: The mean and standard deviation (S.D.) of real GDP growth (RGDPG) of the overall period are 4.28 percent and 2.12 percent respectively whereas the coefficient of variation (C.V.) is 49.49 percent. This means that C.V. is less than 100 percent which indicates that RGDPG for overall period is less fluctuating and more consistent than others.

Similarly, the average mean, standard deviation and coefficient of variation of RGDPG before trade liberalization period are 4.51 percent and 2.69 percent, and 59.77 percent respectively but after trade liberalization period they are 4.11 percent, 1.61 percent, and 39.04 percent respectively. Comparing these indicators of two periods, it is seen that the average RGDPG growth after the trade liberalization period is lower than before. Also, the coefficient of variation (C.V.) after the liberalization period is lower than before. The trend of economic growth is less fluctuating, i.e., more consistent in the period after liberalization than before.

Correlation analysis

As per Table 2, 'r' denotes the correlation coefficient of economic growth (i.e., real GDP) with total foreign trade volume and trade deficit. It shows that the relationship of variables in a particular direction (i.e., positive or negative). 'n' denotes the number of observations for the particular periods and 'ln' means natural logarithm of the variables. Taking natural logarithm in all variables, the correlation coefficients of log economic growth (lnEG) with log total foreign trade volume (lnFTVG) and log trade deficit (lnTD) were calculated.

Correlation coefficient of lnEG with lnFTV and lnTD for the overall period from 1974/75 to 2011/12

Table 2 shows that the correlation coefficients of lnEG with lnFTVG and lnTD for the overall period from 1974/75 to 2011/12 are larger than 0.90. Also, p-values are less than 1 percent, which indicates the correlation between economic growth and total foreign trade volume as well as trade deficit for the overall period as being highly correlated and significant at 1 percent level.

Similarly, the correlation coefficients of lnEG with lnFTVG and lnTD before and after trade the liberalization period are more than 0.90. The p-values of them are less than 1 percent that indicates the correlation between economic growth and total foreign trade volume as well as trade deficit for the both periods are highly correlated and significant at 1 percent level.

Table 2. Correlation Coefficient of lnEG with lnFTV and lnTD for the Period from 1974/75 to 2011/12

Variable	Overall Period (1974/75 to 2011/12)			Before Liberalization (1974/75 to 1990/91)			After Liberalization (1991/92 to 2011/12)		
	r	p-value	n	r1	p-value	n1	r2	p-value	n2
lnFTV	0.997	0.000	38	0.996	0.000	17	0.995	0.000	21
lnTD	0.990	0.000	38	0.966	0.000	17	0.960	0.000	21

Regression analysis

The regression model considers economic growth as a dependent variable, and total foreign trade volume and trade deficit as independent variables. Taking natural log in the variables, the dependent variable- log economic growth(lnEG) was regressed on the independent variables- log total foreign trade volume (lnFTV) and log trade deficits (lnTD) separately.

Regression analysis of economic growth on total foreign trade volume: As shown in Table 3, the dependent variable- log economic growth (lnEG) was regressed on the independent variable- log total foreign trade volume (lnFTV).

Table 3. Regression Analysis of lnEG on lnFTV for Before and After Trade Liberalization Periods

Variable	Overall Period (1974/75 to 2011/12)			Before Trade Liberalization Period (1974/75 to 1990/91)			After Trade Liberalization Period (1991/1992 to 2011/12)		
	β	t-value	p-value	β	t-value	p-value	β	t-value	p-value
Constant	7.859	243.638	0.000	7.813	172.225	0.000	7.264	86.042	0.000
lnFTV	0.287	75.160	0.000	0.295	43.746	0.000	0.348	39.847	0.000
	Model 1: EG = 7.859 + 0.287 lnFTV +U			Model 2: EG = 7.813 + 0.295 lnFTV +U			Model 3: EG = 7.859 + 0.287 lnFTV +U		
	Adj. R ² =0.994	F(1, 36)=5648.971		Adj. R ² =0.992	F(1, 15)=1913.750		Adj. R ² =0.988	F(1, 19)=1587.744	
	RSS _r =0.050	F-prob.=0.000		RSS _r =0.006	F-prob.=0.000		RSS _r =0.011	F-prob.=0.000	

Regression analysis of lnEG on lnFTV for overall period from 1974/75 to 2011/12: F-value and probability of Model 1 is 5648.974 and 0.000 (i.e., 0.000 < 0.01) respectively which is significant at 1 percent level. So, the model is fitted linearly. Adjusted R square of this model is 0.994 (i.e., 99.4%) which means that only 99.4 percent of variation in lnEG is explained by the variation in lnFTV. Coefficient of lnFTV is 7.859 which resembles that change in one percent of foreign trade volume leads to change in 7.86 percent in economic growth.

Since p-value of lnFTV coefficient is 0.000 (i.e., 0.000 < 0.01), hypothesis 1 is accepted at 1 percent level of significance. It indicates that the foreign trade volume has a positive significant impact on economic growth of Nepal.

Regression analysis of lnEG on lnFTV for before liberalization period from 1974/75 to 1990/91: F-value and probability of Model 2 is 1913.75 and 0.000 (i.e., $0.000 < 0.01$) respectively which is significant at 1 percent level. So, the model is fitted linearly. Adjusted R square of this model is 0.992 (i.e., 99.2%) which means only 99.2 percent of variation in lnEG is explained by the variation in lnFTV before the liberalization period.

Coefficient of total foreign trade volume growth is 7.813 which indicates that the change in one percent of foreign trade volume leads to change in 7.81 percent in economic growth.

Since p-value of log FTV coefficient is 0.000 (i.e., $0.000 < 0.01$), hypothesis 1 is accepted at 1 percent level of significance. It indicates that the foreign trade volume growth has a positive significant impact on economic growth of Nepal before the liberalization period.

Regression analysis of lnEG on lnFTV for after liberalization period from 1974/75 to 1990/91: F-value and probability of Model 3 is 1587.744 and 0.000 (i.e., $0.000 < 0.01$) respectively which is significant at 1 percent level. So, the model is fitted linearly. Adjusted R square of this model is 0.988 (i.e., 98.8%) which means only 98.8 percent of variation in lnEG is explained by the variation in lnFTV after the liberalization period.

Coefficient of lnFTV is 7.264 which shows that change in one percent of foreign trade volume leads to change in 7.26 percent in economic growth after the liberalization period.

Since p-value of lnFTV coefficient is 0.000 (i.e., $0.000 < 0.01$), hypothesis 1 is accepted at 1 percent level. This indicates that the foreign trade volume has a positive significant impact on economic growth of Nepal after the liberalization period.

Regression analysis of economic growth on trade deficit: As per Table 4, the dependent variable- log economic growth (lnEG) was regressed on the independent variable- log trade deficit (lnTD).

Table 4. Regression analysis of lnEG on lnTD for before and after trade liberalization periods

Variable	Overall Period (1974/75 to 2011/12)			Before Trade Liberalization Period (1974/75 to 1990/91)			After Trade Liberalization Period (1991/1992 to 2011/12)		
	β	t-value	p-value	β	t-value	p-value	β	t-value	p-value
Constant	8.214	163.018	0.000	8.464	91.648	0.000	8.196	49.722	0.000
lnTD	0.268	41.655	0.000	0.223	14.498	0.000	0.271	14.882	0.000
	Model 4: EG = 8.214 + 0.268 lnTD +U			Model 5: EG = 8.464 + 0.223 lnTD +U			Model 6: EG = 8.196 + 0.271 lnTD +U		
	Adj. R ² =0.979 F(1, 36)=1735.131			Adj. R ² =0.929 F(1, 15)=210.194			Adj. R ² =0.917 F(1, 19)=221.468		
	RSS _e =0.179 F-prob.=0.000			RSS _e =0.055 F-prob.=0.000			RSS _e =0.088 F-prob.=0.000		

Regression analysis of lnEG on lnTD for overall period from 1974/75 to 2011/12: F-value and probability of Model 4 is 1735.131 and 0.000 (i.e., $0.000 < 0.01$) respectively which is significant at 1 percent level. So, the model is fitted linearly. Adjusted R square of this

model is 0.979 (i.e., 97.9%) which means only 97.9 percent of variation in lnEG is explained by the variation in lnTD. Coefficient of lnTD is 8.214 which depicts that the change in one percent of trade deficit leads to change in 8.21 percent in economic growth.

Since p-value of lnTD coefficient is 0.000 (i.e., $0.000 < 0.01$), hypothesis 2 is accepted at 1 percent level; thus, the trade deficit has a positive significant impact on economic growth of Nepal.

Regression analysis of lnEG on lnTD for before liberalization period from 1974/75 to 1990/91: F-value and probability of Model 5 is 210.194 and 0.000 (i.e., $0.000 < 0.01$) respectively which is significant at 1 percent level. So, the model is fitted linearly. Adjusted R square of this model is 0.929 (i.e., 92.9%) which means that only 92.9 percent of variation in lnEG is explained by the variation in lnTD. Coefficient of lnTD is 8.464. This depicts that the change in one percent of trade deficit leads to change in 8.46 percent in economic growth.

Since p-value of lnTD coefficient is 0.000 (i.e., $0.000 < 0.01$), hypothesis 2 is accepted at 1 percent level of significance. This indicates that the trade deficit has a positive significant impact on economic growth before the liberalization period.

Regression analysis of lnEG on lnTD for after liberalization period from 1990/91 to 2011/12: F-value and probability of Model 6 is 221.468 and 0.000 (i.e., $0.000 < 0.01$) respectively which is significant at 1 percent level. So, the model is fitted linearly. Adjusted R square of this model is 0.917 (i.e., 91.7%) which means that only 91.7 percent of variation in economic growth is explained by the variation in trade deficit. Coefficient of lnTD is 8.196 which shows that change in one percent of trade deficit leads to change in 8.20 percent in economic growth.

Since p-value of lnTD coefficient is 0.000 (i.e., $0.000 < 0.01$), hypothesis 1 is accepted at 1 percent level. This indicates that the trade deficit has a positive significant impact on economic growth after the liberalization period.

Chow test analysis for before and after trade liberalization periods

Analysing the impact of total foreign trade volume and trade deficit on economic growth separately, Chow Test has been applied to assess the change in coefficients of lnFTV as well as lnTD before and after the trade liberalization periods.

Table 5. Variance Test Analysis and Chow Test Analysis

Analysis	Degree of Freedom	Critical value of F (5% LOS)	Impact of lnFTV on lnEG		Impact of lnTD on lnEG	
			F-value	Result	F-value	Result
Variance Test	(19, 15)	2.33	1.45	Cal F < Critical F	1.26	Cal F < Critical F
Chow Test	(2, 34)	3.23	35	Cal F > Critical F	4.28	Cal F > Critical F

Source: Appendix 3 & 5

Variance test: Table 5 shows that the calculated F-value of estimators of variances in the relation of lnEG with lnFTV and lnTD are 1.45 and 1.26 respectively which are less than the critical value of $F_{(19, 15)}$ (i.e., 2.33) at 5 percent level of significance (LOS). This indicates that the estimators of variances are not statistically significant. As the result of variance test, Chow Test can be applied because variances are not significantly different before and after the liberalization periods.

Chow test: As per Table 6, the calculated values of $F_{(2, 34)}$ from the Chow Test Analysis are 35 and 4.28 for both impacts of lnEG on lnFTV and lnTD respectively which are greater than the critical value of $F_{(2, 34)}$ (i.e. 3.23) at 5 percent level of significance. Thus, the coefficients of lnFTV and lnTD are statistically significant for before and after the liberalization periods. So, the hypothesis 3 is accepted. Thus, there is a significant change in the impact of total foreign trade volume as well as trade deficit on economic growth before and after the trade liberalization.

Conclusion

The average mean of export growth, import growth and total foreign trade volume growth, trade deficit growth and real GDP growths are lower after the liberalization period, but standard deviations are higher except for the trade deficit growth and real GDP growth. From this point of view, situation of foreign trade and economic growth are not satisfactory after the liberalization period.

Similarly, the relationships of Nepal's economic growth with exports, imports and total foreign trade volume and trade deficit respectively were found to be positively correlated and significant. This result is similar with Kahya (2011) except for exports; Li, Chen and Wang (2010); and Findlay (1984) and Krueger (1978) but the result is contrary to the studies of Jung and Marshall (1985) that found no causal relationship between these variables in other countries studied, except Israel.

Lastly, Chow Test showed that the impact of foreign trade volume and trade deficit on economic growth are significantly different before and after the trade liberalization in Nepal. It may be due to the fact that the average total foreign trade volume growth and average trade deficit growth after the trade liberalization in Nepal is lower than before. And, high coefficients of variation before the trade liberalization show that the trend of growth rate before the trade liberalization period is more fluctuating than after liberalization.

Further research: In the view of the limitations of the present study, future studies should address the roles and interrelationships of various market variables to enhance the knowledge of economic growth in Nepal. Likewise, Nepal should develop policies to improve in the areas that affect its plans on export growth.

Appendix

Appendix 1. Growth and natural log of exports, imports, foreign trade volume and real GDP (EG)
(XG=Export Growth, MG = Import Growth, FTVG = Foreign Trade Volume Growth, TDG = Trade
Deficit Growth, RGDPG = Real GDP Growth)

FY	XG (%)	MG (%)	FTVG (%)	TDG (%)	RGDPG (%)	lnX	lnM	lnFTV	lnTD	lnEG
1974/75	-	-	-	-	-	4.49	5.20	5.60	4.53	9.48
1975/76	33	9	17	-14	4	4.78	5.29	5.76	4.38	9.52
1976/77	-2	1	0	6	2	4.76	5.30	5.76	4.43	9.54
1977/78	-10	23	11	69	3	4.65	5.51	5.86	4.96	9.57
1978/79	24	17	19	12	2	4.87	5.66	6.04	5.07	9.58
1979/80	-11	21	11	47	0	4.75	5.85	6.14	5.45	9.59
1980/81	40	27	30	21	9	5.08	6.09	6.40	5.64	9.67
1981/82	-7	11	6	22	5	5.00	6.20	6.46	5.84	9.72
1982/83	-24	28	16	51	1	4.73	6.45	6.61	6.25	9.73
1983/84	51	3	10	-7	9	5.14	6.48	6.71	6.18	9.81
1984/85	61	19	28	4	7	5.61	6.65	6.95	6.21	9.88
1985/86	12	21	18	25	5	5.73	6.84	7.12	6.44	9.93
1986/87	-2	17	12	26	2	5.71	6.99	7.24	6.67	9.95
1987/88	37	27	29	24	7	6.02	7.23	7.49	6.88	10.02
1988/89	2	17	14	24	5	6.04	7.39	7.62	7.10	10.07
1989/90	23	13	15	9	5	6.25	7.51	7.76	7.18	10.12
1990/91	43	27	30	20	7	6.60	7.75	8.03	7.37	10.18
1991/92	86	38	49	15	5	7.22	8.07	8.43	7.51	10.23
1992/93	26	23	24	20	3	7.45	8.27	8.64	7.69	10.26
1993/94	12	32	25	47	8	7.56	8.55	8.87	8.08	10.34
1994/95	-9	23	15	43	3	7.48	8.76	9.00	8.43	10.37
1995/96	13	17	16	19	6	7.59	8.92	9.15	8.60	10.42
1996/97	14	26	23	30	5	7.72	9.14	9.36	8.87	10.47
1997/98	22	-5	0	-13	3	7.92	9.09	9.36	8.72	10.51
1998/99	30	-2	6	-16	5	8.18	9.08	9.42	8.55	10.55
1999/00	40	24	29	13	6	8.51	9.29	9.67	8.68	10.61
2000/01	12	7	8	2	2	8.62	9.36	9.75	8.70	10.63
2001/02	-16	-7	-10	1	0	8.45	9.28	9.64	8.71	10.63
2002/03	6	16	13	23	4	8.52	9.43	9.77	8.91	10.67
2003/04	8	10	9	11	4	8.59	9.52	9.85	9.02	10.71
2004/05	9	10	9	10	3	8.68	9.61	9.94	9.11	10.74
2005/06	3	16	12	25	4	8.70	9.76	10.06	9.34	10.78
2006/07	-1	12	9	19	3	8.69	9.88	10.14	9.51	10.81
2007/08	0	14	11	20	6	8.69	10.01	10.24	9.70	10.86
2008/09	14	28	25	33	4	8.82	10.26	10.47	9.98	10.90
2009/10	-10	32	24	45	4	8.71	10.53	10.68	10.35	10.94
2010/11	6	6	6	6	4	8.77	10.59	10.74	10.41	10.98
2011/12	15	17	16	17	4	8.91	10.74	10.89	10.56	11.02

Source: Calculations based on data of various Economic Surveys, Ministry of Finance, GON

Appendix 2. Residual sum of the squares (RSS) and variances in the impact of lnFTV on lnEG

Period	Residual Sum of the Square		No. of observation (n)	No. of Parameter (k)	df = (n-k)	$\sigma^2 =$ RSS/df		
Before Liberalization	RSS ₁	0.006	n ₁	17	k	2	15	0.0004
After Liberalization	RSS ₂	0.011	n ₂	21	k	2	19	0.0006
Total	RSS _{UR} = RSS ₁ + RSS ₂	0.017	n ₁ +n ₂	38	2k	4	34	
Overall	RSS _R	0.052	n	38	k	2	36	

Appendix 3. Variance test and Chow test analysis in the impact of lnFTV on EG

	d.f.	F-value	Critical value of F (5% LOS)	Result
Variance Test	(19, 15)	$\sigma^2 / \sigma_1^2 = 1.45$	2.33	Cal F < Tab F
Chow Test	(2, 34)	$\frac{(RSS_R - RSS_{UR})/k}{RSS_{UR}/(n_1+n_2-2k)} = 35.00$	3.23	Cal F > Tab F

Appendix 4. Residual sum of the squares (RSS) and variances in the impact of lnTD on lnEG

Period	Residual Sum of the Square		No. of observation (n)	No. of Parameter (k)	df = (n-k)	$\sigma^2 =$ RSS/df		
Before Liberalization	RSS ₁	0.055	n ₁	17	k	2	15	0.0037
After Liberalization	RSS ₂	0.088	n ₂	21	k	2	19	0.0046
Total	RSS _{UR} = RSS ₁ + RSS ₂	0.143	n ₁ +n ₂	38	2k	4	34	
Overall	RSS _R	0.179	n	38	k	2	36	

Appendix 5. Variance test and Chow test analysis in the impact of lnTD on EG

	d.f.	F-value	Critical value of F (5% LOS)	Result
Variance Test	(19, 15)	$\sigma^2 / \sigma_1^2 = 1.26$	3.64	Cal F < Tab F
Chow Test	(2, 34)	$\frac{(RSS_R - RSS_{UR})/k}{RSS_{UR}/(n_1+n_2-2k)} = 4.28$	3.23	Cal F > Tab F

References

- Alcala, F. & Ciccone, A. (2004). Trade and productivity. *Quarterly Journal of Economics*, 119(2), pp. 613-646.
- Edwards, S. (1998). *Openness, productivity and growth: What do we really know?* (NBER Working Paper 5978).
- Findlay, R. (1984). Trade and development: Theory and asian experience. *Asian Development Review*, 2, pp. 23-42.
- Frankel, J.A. & Romer, D. (1999). Does trade cause growth? *The American Economic Review*, 89(3), pp. 379-399.

- Gujarati, D.N. & Sangeetha. (2007). *Basic econometrics* (4th ed.). New Delhi: Tata McGraw Hill Education Private Limited.
- Hussain, A. (1996). *Macro economic issues and policies: The case of Bangladesh*. New Delhi /Thousands oak/London: Sage publication.
- Jung, W. & Marshall, P. (1985). Exports growth and causality in developing countries. *Journal of Development Economics*, 18, pp. 1-12.
- Kahya, M. (2011). *An analysis of the relationship between foreign trade and economic growth in Turkey over the period 1980-2009* (unpublished master's thesis). Lund University, School of Economics and Management.
- Khanal, D.R. & Shrestha, P.K. (2008). *Trade and investment linkages and coordination in Nepal: Impact on productivity and exports and business perceptions* (Working paper series no. 52, February). Asia-pacific research and training network on trade.
- Krueger, A.O. (1978). *Foreign trade regimes and economic development: Liberalization attempts and consequences* (Working Paper). National Bureau of Economic Research.
- Kwan, C.C.C. & Cotsomitis, J.A. (1991). Economic growth and the expanding sector: China: 1925-1985. *International Economic Journal*, 5(1), pp. 105-117.
- Lewer, J.J. & Van den Berg, H. (2003). How large is international trade's effect on economic growth? *Journal of Economic Surveys*, 17(3).
- Li, Y., Chen, Z. & Wang, X. (2010). An empirical study on the contribution of foreign trade to the economic growth of Jiangxi Province, China. *iBusiness*, 2, pp. 183-187.
- MoE. (2013). *Economic Survey Fiscal Year 2012/13*. Kathmandu, Nepal: Ministry of Finance, Government of Nepal.
- Ram, Y. (2003). *An empirical examination of the export-led growth hypothesis in Fiji* (Working paper 2003/01). Suva, Fiji: Economics Department, Reserve Bank of Fiji.
- Sachs, J.D. & Warner, A. (1995). Economic reform and the process of global integration. *Brookings Papers on Economic Activity*, 1, pp. 1-118.
- Wacziarg, R. & Welch, K.H. (2003). *Trade liberalization and growth: New evidence* (NBER Working Paper 10152).

Chemical Extraction of Heavy Metals in River Sediments of Karra River, Nepal

Sadhana Pradhanang

Central Department of Environmental Science, Tribhuvan University, Kirtipur, Kathmandu

Email: sadhana.pradhanang@gmail.com

Abstract: *Five-step sequential extraction technique was used to determine the chemical association of heavy metals (Cu, Zn, Cd and Pb) with defined extraction scheme (exchangeable, carbonate, reducible, organic and residual phase) in sediment samples from Karra river, Hetauda, Nepal. Sediment samples were collected from 16 sites in the Karra river (upstream, industrial belt, downstream). The sequential extraction revealed that high percentage of metals was associated in the residual fraction. However, in most of the sites in the industrial belt, a significant proportion of metal was associated with the non-residual fraction which can be remobilized and released to the environment by various physical-chemical processes. This indicates influence of anthropogenic activities on the Karra river.*

Keywords: *Sequential extraction, heavy metals, sediment, Karra river, non-residual fraction.*

Introduction

In a river ecosystem, sediment is an important source of heavy metal pollutants as they have a long residence time (Forstner & Wittmann, 1983; Muller *et al.*, 1979). Sediment serves as a sink where contaminants can be stored and also act as a source of the pollutants to the overlying water and to the inhabitants of the ecosystem (aquatic organism). Therefore, it serves as the carrier and reservoir of the heavy metals and reflects the quality of the system (Chapman & Wang, 1999). Heavy metals are not permanently fixed on sediments and can be released back to the water column by changes in environmental conditions, such as pH, redox potential, and chelation in the aquatic environment (Forstner, 1987; Sutherland *et al.*, 2007; Rath, 2009). It provides a qualitative idea about reactivity and mobility of total metals present in sediments (Vicente-Beckett, 1992). Sediments are good indicator of water quality and reflect the effects of anthropogenic release. Numerous studies have been conducted on heavy metal pollution from different anthropogenic sources (Ma & Rao, 1997). It is important to know not only the total metal content but also the site of the metal in the sediment matrices (exchangeable, carbonate, Fe-Mn oxides, organic, residual fraction) which probably indicates the occurrence of different pollution sources (Jain *et al.* 2004).

The method of fractionation of trace metals in sediments are based on sequential extraction procedures. Sequential extraction is used to determine geochemical partitioning of heavy metals in soil, sediments and sludge (Howard & Shu, 1996). So it is widely used to estimate the amounts and proportions of metals in soil and to predict bio-availability and metal leaching (Jalali & Khanlari, 2008). The unbuffered salts, weak acids, reducing agents, oxidizing agents, and strong acids are generally

used as extractant in sequential extraction (Filgueiras, 2002). Tessier and Cambell (1987) reported that the information obtained is not only for research workers but also has importance for management inferences. In the present study, a sequential extraction was carried out using five step procedures as proposed by Tessier *et al.* (1979) which was followed to determine the partitioning of the trace metals Cu, Zn, Cd and Pb. The five step geochemical fractions including exchangeable, carbonates (acid-soluble), Fe and Mn oxides (reducible), organic matter (oxidisable) and residual (silicate fraction).

Exchangeable fraction

Generally, heavy metals in the exchangeable fractions are more mobile and are immediately available for biological uptake in the environment (Gadde & Laitinen, 1974). In case of non polluted soil, exchangeable fraction represented 2% of the total metal concentration (Filgueiras, 2002). The small concentrations of the exchangeable fraction imply poor metal accessibility to the bottom-dwelling organisms in this environment (Singh, 1999). The pH of the sediment plays a vital role, since it decreases the concentration of available trace metals in alkaline (pH 7.4 - 8.5) condition. The solubility of most of the trace metals and the capacity to form chelates in the sediment decreases in high pH (Forstner & Wittmann 1983).

Carbonate bound (Acid soluble fraction)

The fractions introduced by anthropogenic activities are adsorptive and exchangeable and are bound to carbonates fractions. These are considered to be weakly bonded (Salomons & Forstner, 1980; Pardo *et al.*, 1990). This fraction is an important adsorbent fraction for various metals when organic and Fe-Mn oxides are less abundant in the aquatic system.

Fe-Mn fraction (Reducible fraction)

Hydrous oxide of manganese and iron are extracted known sinks for heavy metals. This fraction is a scavenger for trace metals which precipitate as oxy - hydroxide of Fe and Mn, stable under oxic condition (Tessier *et al.*, 1979). Low Eh may induce the release of these metals.

Organic bound/Sulphide bonding (Oxidisable fraction)

Trace metals in this fraction may be bound to various form of organic matter including living organisms and detritus (Tessier *et al.*, 1979).

Residual (Silicate fraction)

This fraction contains mainly primary and secondary minerals which may hold trace metals within their crystal lattice. Metals in this fraction are not available under normal condition. The residual fraction could be considered as an inert phase corresponding to the part of the metal which cannot be mobilized (Ramos *et al.*, 1999).

Generally, heavy metals in the exchangeable and carbonate fractions are considered readily and potentially bio-available while the reducible and oxidizable fractions are relatively stable under normal condition (Filgueiras *et al.*, 2002). Metal

mobility increases in these order exchangeable > carbonate > reducible > organic > residual (Filgueiras *et al.*, 2002).

Materials and methods

A total of 16 sites for the collection of river bed sediment samples were selected along the bank of the Karra River, Hetauda, Nepal. The samples were collected from its upstream (US1-US2), industrial belt (IB1-IB12) and downstream portions (DS1-DS2) of Karra River. The sediment samples were collected in the month of May, 2007. Bed sediment samples were collected manually with the help of a plastic scraper and spatula from the uppermost 5 to 10 cm of the river bank where flow was low. Three random samples were taken from each site, which were homogenized and composite samples were stored in a plastic bag with zip lock.

In the extraction procedure by Tessier *et al.* (1979) the metals investigation was wide ranging, but four heavy metals (Cu, Zn, Cd and Pb) were analyzed in the sequential extraction (five steps).

Air dried samples were ground using a mortar pestle to a size about 63 μ m and subjected to the following extractions. All the extractions, except the final digestion, were conducted in 50 ml polypropylene centrifuge tubes to minimize losses of solid materials. After each successive extraction, the supernatant was separated by centrifuging at 7000 rpm for 30 minutes. The supernatant obtained in each of the extractions were collected. The residue was washed with 10 ml milli-Q water followed by centrifugation for 1 hour before the next extraction.

1. *Exchangeable*: One gram sediment sample was extracted at room temperature for one hour with 8 ml of 1M MgCl₂ (pH 7.0) with continuous agitations.
2. *Bound to Carbonates (Acid soluble fraction)*: The residue obtained from step 1 after leaching at room temperature with 8 ml of 1 M sodium acetate adjusted to pH 5.0 with acetic acid. The mixture was agitated for five hours.
3. *Bound to Fe-Mn Oxides (Reducible fraction)*: The residue obtained from step 2 through continuous agitation at 96°C with 20 ml of 0.04M NH₂OH.HCl in 25% v/v acetic acid for 6 hours.
4. *Bound to Organic Matter (Oxidisable fraction)*: The residue obtained from step (3), 3 ml of 0.02M HNO₃ and 5 ml of 30 % H₂O₂ were added and pH adjusted to pH 2.0 with HNO₃. The solution was agitated at 96°C for 2 hours and 3 ml of 30 % H₂O₂ (pH 2 with HNO₃) was added and sample was again agitated for 3 hours. After cooling, 5 ml of 3.2M ammonium acetate in 20 % (v/v) HNO₃ was added. The sample was diluted to 20 ml and agitated continuously for 30 minutes. The filtrate obtained in each step of the extraction was analyzed for heavy metals.
5. *Residual*: Residual obtained from step 4 was digested with HF/HNO₃/HClO₄ mixture. 100 mg of residue was taken in a Teflon beaker and 20 ml of acid mixture of HF, HNO₃ and HClO₄ (in the ratio 7:3:1) was added. The Teflon beaker was placed in bomb digestion unit and heated 100°C for 2 hours. After cooling volume was made up to 250 ml by adding milli-Q water.

The total metal concentrations were also determined by the acid digestion method using HF, HNO₃ and HClO₄ in the ratio of 7:3:1.

Metal ion concentrations in different extracts were determined by Shimadzu Atomic Absorption spectrophotometer (model AA-6000) using air-acetylene flame. Quantification of metals was based upon calibration of standard solution of respective metals. These calibration curves were determined several times during the period of analysis. The precision of the metal analysis was controlled by including triplicate samples in analytical batches and blank.

Results and discussion

Copper: Cu was observed in varying proportion in all phases in the upstream of the Karra river. Cu was found to be 78.6% of the total metal (69.3 mg/kg) which were predominantly in the residual form (Fig. 1). Much lower concentration were associated with exchangeable and carbonate fractions of the total metal. The contribution of Fe-Mn oxides and organic fraction to total metal was 6.3% and 3.4% (Fig. 1).

In the industrial belt, Cu fractions were distributed in exchangeable (6%), carbonate (5.5%), Fe-Mn oxides (26.3%), organic (27.0%) and residual (35.1%) of the total metal (312 mg/kg). For Cu, bound to organic matter (27%) was the highest due to the high affinity of Cu for organic matter (McGrath & Quevanviller, 1996). Large variation of Cu percentage could be found in different fractions at the different sites of the industrial belt. The maximum fraction was bound to organic fraction as well as reducible fraction. Results of the downstream samples have shown that the percentage of Cu extracted in different steps are: exchangeable (1.8%), carbonate (1.5%), Fe-Mn oxides (9.9%), organic (7%) and residual (79.8%) of the total metal (264 mg/kg).

Zinc: Zinc is one of the most commonly occurring heavy metals which is soluble and mobile under acidic condition. Zinc enters surface waters mostly from metals treatment plants and chemical plants. The results show that in the upstream of the Karra river, Zn concentrations were 3.8% and 4.9% of the total metal (67.48 mg/kg) in exchangeable and carbonate fraction, respectively.

Concentration of Zn at the upstream has been found to differ in Fe-Mn oxides and organic and residual fractions (Fig. 1). The concentration was high in the Fe-Mn oxide fraction (32.9%) and much lower (2.4%) in the organic fraction whereas the residual fraction was 56.0% of the total metal. In the industrial belt, under different fractions, percentage of total Zn extracted were 5.3%, 8.9%, 22.0%, 8.8% and 55%, respectively in exchangeable, carbonate, Fe-Mn oxides, organic and residual fraction. In the non-residual fraction, the mean concentration of Zn at sites IB9 (51.8 %) and IB12 (42.8 %) were found to be the highest of the total metal. High Zn fraction of Fe-Mn oxide indicates anthropogenic origin. In the downstream, high concentration of Zn (50%)

was found in residual of the total metal (1396 mg/kg). The general association of Zn was in the decreasing order: residual > Fe-Mn oxides > organic > carbonate > exchangeable.

Cadmium: The total mean concentration of Cd in the upstream (US1-US2) was noticed to be 0.56 mg/kg. The results indicate that Cd was present in the entire fraction. The concentration was lowest but toxicity was high. The dominant fraction was found in residual phase in the upstream of the Karra river but a significant portion of Cd was also found in carbonate fraction which poses risk to the environment.

The total metal concentration of Cd in the industrial belt (IB1-IB12) was found to be 0.30 to 3.87 mg/kg. In the industrial belt, the highest percentage (42.8%) of Cd was extracted only in the residual fraction. In the exchangeable fraction, carbonate, Fe-Mn oxide and organic fraction extracted Cd concentrations were 14.3%, 17.7 %, 8.5%, 16.5%, respectively (Fig. 1). However, the exact concentrations varied at different sites of the industrial belt.

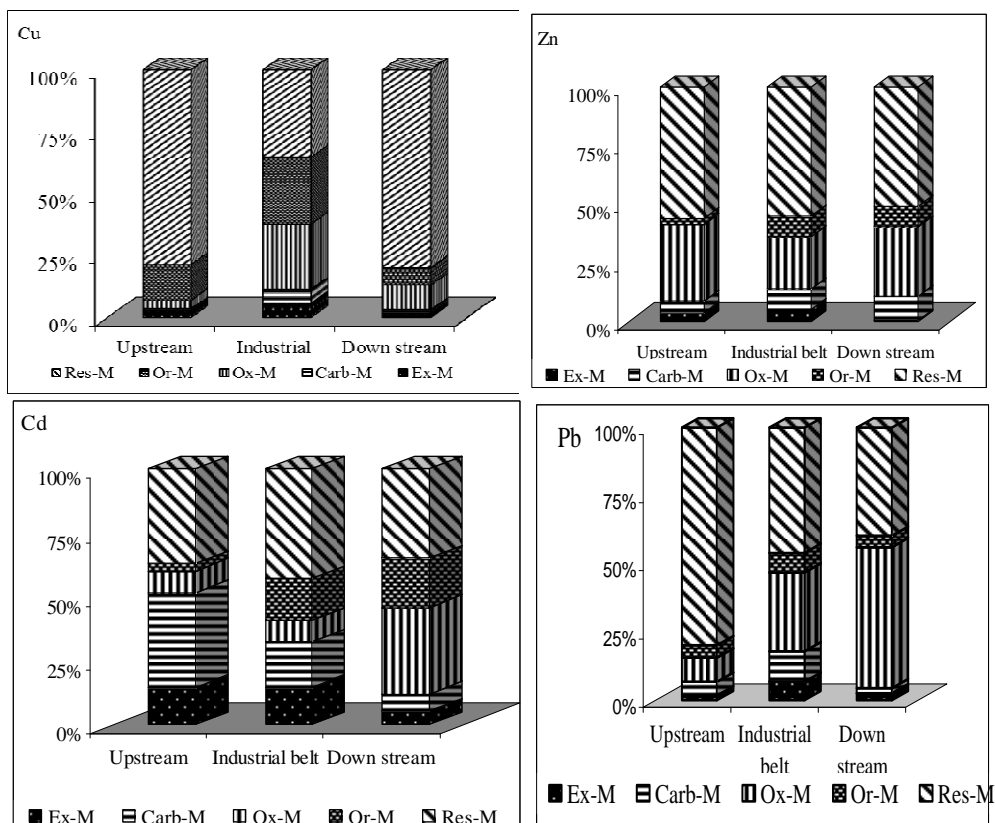
Significant amount of Cd was found in carbonate, exchangeable, organic, and Fe-Mn oxides forms which can create higher risk to the aquatic environment. The highest amount of Cd was found at sites IB8, IB9 and IB10. About 98% of Cd was found in the non-residual fraction at IB8. The most important reason of Cd pollution at the site IB8 was the mixing of untreated and treated effluents which have hazardous environmental impact. Once Cd has been incorporated into sediment, it does not re-dissolve in neutral or alkaline conditions, largely because in the anoxic conditions in the sediment cadmium sulphide is formed, which is insoluble (Dojlido & Best 1992; Panda, *et al.* 1995). A high concentration of Cd in the Karra river was due to chemical industry and stabilizing pigments used in the paint, dye and plastic industry

The total metal of Cd was found to be 0.67 mg/kg in the downstream (DS1- DS2) of the Karra river. A significant difference was encountered in Cd percentage in different steps of extraction at the downstream sites. Maximum percentage (33.7%) of Cd was extracted in the Fe-Mn oxide which is very risky to the environment when Eh is low and residual fraction (35.1%) of the total fraction.

Lead: Pb was mostly concentrated in the residual fraction, although it was also present in other fractions. In the upstream, lead was contained largely in the residual fraction. A significant amount of Pb was found to be associated with exchangeable, bound carbonate and Fe-Mn oxides fraction in the industrial belt which may cause risk to the aquatic life. At sites IB2, IB4, IB5 and IB7, Pb was more than 75% in non-residual fraction. The association of Pb with exchangeable fraction, bound carbonate and Fe-Mn oxides fraction indicates dominance of anthropogenic contamination sources like industrial effluent. Ramos *et al.* (1994) reported that Pb can make complexes with Fe-Mn oxides. The increase in industrial activity at these sites could be linked to the increase in the percentage of the most available forms of Pb in the sediments. In the

downstream of the Karra river, Pb concentration has been found to be high in Fe-Mn fraction (51.7%) and in residual fraction (39.7%). Jha *et al.* (1990) also reported that lead is mostly present in the Fe-Mn oxide fraction in Yamuna river at Delhi.

Fig. 1. Metal fraction in bed sediments of the Karra river (Exchangeable, carbonate, Fe-Mn oxide, organic and residual)



Recovery of the metal

The accuracy of the sequential extraction procedure, recovery values (%) was calculated by comparing the sum of five- steps sequential extraction procedure (exchangeable, carbonate, reducible, organic and residue) with the total metal concentration.

The recovery of the sequential extraction was calculated as follows:

$$\text{Recovery}_n = \frac{\sum_n \text{Sequential extraction}}{\text{Total metal digestion}} \times 100$$

The results of recovery showed in Tables 1 and 2 which indicate that sum of the five fractions with the good recoveries (81.1-109.0%).

Table 1. Recovery of the metals Cu and Zn

Sample sites	Cu			Zn		
	Sum of the extraction steps of metal (mg/kg)	Total metal (mg/kg)	Recovery (%)	Sum of the extraction steps of metal (mg/kg)	Total metal (mg/kg)	Recovery (%)
US1	73.11	70.42	103.82	47.88	52.67	90.91
US2	65.54	70.09	93.50	87.08	93.79	92.85
IB1	128.08	130.89	97.85	64.16	68.26	94.00
IB2	71.70	74.87	95.77	37.69	35.46	106.29
IB3	108.92	104.81	103.92	50.07	49.08	102.02
IB4	218.96	230.86	94.85	161.07	172.18	93.55
IB5	607.17	657.89	92.29	200.47	218.52	91.74
IB6	1165.93	1142.52	102.05	282.01	305.21	92.40
IB7	711.50	732.65	97.11	143.19	154.51	92.67
IB8	198.17	189.99	104.31	845.46	946.01	89.37
IB9	106.34	110.97	95.82	267.06	290.77	91.85
IB10	91.51	89.96	101.72	851.26	840.39	101.29
IB11	174.66	182.13	95.90	1476.82	1444.50	102.24
IB12	169.33	180.26	93.93	1810.09	1989.10	91.00
DS1	316.52	329.17	96.16	770.37	835.41	92.21
DS2	211.60	207.76	101.85	2021.61	1987.77	101.70

Table 2. Recovery of the metals Cd and Pb

Sample sites	Cd			Pb		
	Sum of the extraction steps of metal (mg/kg)	Total metal (mg/kg)	Recovery (%)	Sum of the extraction steps of metal (mg/kg)	Total metal (mg/kg)	Recovery (%)
US1	0.54	0.60	89.40	57.58	54.88	104.92
US2	0.57	0.66	86.36	92.58	100.10	92.49
IB1	0.44	0.50	88.00	108.60	104.59	103.83
IB2	0.62	0.69	89.60	78.50	88.72	88.48
IB3	0.54	0.60	90.00	108.26	106.22	101.92
IB4	0.30	0.32	93.75	72.83	75.53	96.42
IB5	3.09	3.50	88.29	66.06	74.14	89.10
IB6	1.17	1.10	106.36	72.55	76.22	95.18
IB7	2.64	3.04	86.84	69.78	77.20	90.39
IB8	3.24	3.50	92.57	70.06	76.51	91.58
IB9	2.28	2.41	94.68	21.41	22.38	95.67
IB10	1.29	1.22	105.74	158.03	172.57	91.58
IB11	2.98	3.33	89.55	37.77	40.24	93.85
IB12	3.87	3.99	96.99	73.30	82.04	89.34
DS1	0.78	0.90	86.86	31.23	34.10	91.58
DS2	0.57	0.60	95.48	55.69	62.81	88.66

Conclusion

The results of the present study indicate that residual fraction is the most dominant fraction for all the metals. However, in most of the sites in the industrial belt, a significant proportion of metal was associated with the non-residual fraction. This indicates the influence of anthropogenic activities on the Karra river. In the upstream of the Karra river, a high concentration of metals present are in inert phase (residual), being detrital and of lattice origin. The residual fraction was the most abundant fraction for all the metals in the sediments studied. A significant amount of Zn, Cu, Cd and Pb was associated with the non-residual fractions in industrial belt studied indicating that this metal was potentially more bioavailable than other metals. The low percentage of heavy metals in the exchangeable fraction suggests a weak bioavailability of metal in this environment. The suggested possible order of mobility of the heavy metal in Karra river sediments is: Cd > Zn > Cu > Pb.

Acknowledgement

The author gratefully acknowledges to the University Grants Commission (UGC), Nepal for financial support.

References

- Chapman, P.M. & Wang, F.Y. (1999). Appropriate applications of sediments quality values for metals and metalloids. *Environmental Science and Technology*, 33, pp. 3937-3941.
- Dojlido, J.R. & Best G.A. (1993). *Chemistry of water and water pollution*. England: Ellis Horwood.
- Filgueiras, A.V., Lavilla, I. & Bendicho, C. (2002). Chemical sequential extraction for metals partitioning in environmental solid samples. *Journal of Environmental Monitoring*, 4, pp. 823-857.
- Forstner, U. & Wittman, G.T. (1983). *Metal pollution in the aquatic environment*. Berlin: Springer Verlag.
- Forstner, U. (1987). *Metal speciation, separation and recovery*. Chelsea: Lewis Publishers.
- Gadde, R.R. & Laitinen, H.A. (1974). Studies of heavy metal adsorption by hydrous iron and manganese oxides. *Analytical Chemistry*, 46, pp. 2022-2026.
- Howard, J.L. & Shu, J. (1996). Sequential extraction analysis of heavy metals using a chelating agent (NTA) to counteract resorption. *Environmental Pollution*, 91, pp. 89-96.
- Jain, C.K., Singhal, D.C. & Sharma, M.K. (2004). Adsorption of zinc on bed sediment of River Hindon: adsorption models and kinetics. *Journal of Hazardous Materials*, 114, pp. 231-239.
- Jalali, M. & Khanlari, Z.V. (2008). Environmental contamination of Zn, Cd, Ni, Cu, and Pb from industrial areas in Hamadan Province, western Iran. *Environmental Geology*, 55, pp. 1537-1543.
- Jha, P.K., Subramanian, V., Sitasawad, R. & Van Grieken, R. (1990). Heavy metals in sediments of the Yamuna River (A tributary of the Ganges), India. *Science of the Total Environment*, 95, pp. 7-27.

- Ma, L.Q. & Rao, G.N. (1997). Chemical fractionation of cadmium, copper, nickel and zinc in contaminated Soils. *Journal of Environmental Quality*, 26, pp. 259-264.
- McGrath, D. & Quevanviller, P. (1996). Application of single and sequential extraction procedures to polluted and unpolluted soils. *Science of the Total Environment*, 178, pp. 37-44.
- Muller, G. (1969). Index of geoaccumulation in sediments of the Rhine river. *Geojournal*, 2, pp. 108-118.
- Panda, D., Subramanian, V. & Panigrahy, R.C. (1995). Geochemical fractionation of heavy metals in Chilka lake (east coast of India) – A tropical coastal lagoon. *Environmental Geology*, 26, pp. 199-210.
- Pardo, R., Barrado, E., Perez, L. & Vega. M. (1990). Determination and speciation of heavy metals in sediments of the Pisuerga river. *Water Research*, 24, pp. 337-343.
- Ramos, L., Fernandez, M.A., Gonzalenz, M.J. & Hernandez, L.M. (1999). Heavy metal pollution in water, sediments, and earthworms from the Ebro river, Spain. *Bulletin of Environmental Contamination and Toxicology*, 63, pp. 305-311.
- Rath, P., Panda, U.C., Bhatta, D. & Sahu, K.C. (2009). Use of sequential leaching, mineralogy, morphology and multivariate statistical technique for quantifying metal pollution in highly polluted aquatic sediments-a case study: Brahmani and Nandira rivers, India. *Journal of Hazardous Materials*, 163, pp. 632-644.
- Salomons, W. & Forstner, U. (1984). *Metals in hydrocycle*. New York: Springer.
- Singh, A.K., Hasnain, S.I. & Banerjee, D.K. (1999). Grain size and geochemical partitioning of heavy metals in sediments of the Damodar river – a tributary of the lower Ganga, India. *Environmetal Geology*, 39(1), pp. 90-98.
- Sutherland, R.A. & Tack, F.M.G. (2007). Sequential extraction of lead from grain size fractionated river sediments using the optimized BCR Procedure. *Water, Air, Soil Pollution*, 84, pp. 269-284.
- Tessier, A. & Campbell, P.G.C. (1987). Partitioning of trace metals in sediments: relationships with bioavailability. *Hydrobiologia*, 149, pp. 42-43.
- Tessier, A., Cambell, P.G.C. & Bisson, M.X. (1979). Sequential extraction procedure for the speciation of particulate trace metals. *Analytical Chemistry*, 51, pp. 844-851.
- Vicente-Beckett, V.A., Pascual, C.B., Kwan, C.S. & Beckett. (1991). Levels and distribution of trace metals in sediments of Laguna lake (Philippines) and its tributary rivers. *International Journal of Analytical Chemistry*, 45, pp. 101-116.

Biochemical Constituents in Some Edible Wild Fruits of Chitwan

Khaga Raj Sharma

Department of Chemistry, Birendra Multiple Campus, Bharatpur

Email: khagaraj_sharma33@yahoo.com

Abstract: This study explores major biochemical contents (carbohydrate, protein, lipid, pH ash and dry matter) in the edible wild fruits of Chitwan. Fourteen species were collected from different forests of Chitwan for the study. The study followed Benedict's test for carbohydrate, Lowry's method for protein, Soxhlet extraction for lipid, Paech & Tracey (1956)'s method for testing and measuring biochemical contents. All collected fruit samples were found containing water-soluble sugar ranging from in *Ficus bispida* 3.09% to 54.16%. *Annona squamosa*. *Ficus roxburghii* 15.29%, on *Myrica esculenta* 17.33% had moderate quantity of carbohydrate. The pH value in all fruits was found less than seven ranging from 4 in *Dillenia pentagyna* to 6.5 in *Eugenia operculata* and were found acidic. Total amount of dry matter varied from 14.48% in *Morus alba* to 65% in *Dillenia pentagyna*. Protein was found 1.9% in *Morus indica* to 8.5% in *Syzygium cumini*. The percentage of lipid in fourteen fruit species varied from 0.40% in *Ficus roxburghii* to 4.33% in *Artocarpus lakoocha*. The results showed that the ash content in these fruits ranged from 3.8% in *Emblica officinalis* to 1.8 percent in *Ficus bispida*. The ash content is slightly higher in these wild fruits of Chitwan compared to the fruits of Kathmandu valley.

Keywords: Edible wild fruits, biochemical content, nutrient.

Introduction

Edible wild fruits play a significant role in the rural economy of Chitwan by providing nutrient food supplement and also by generating alternative source of income to the poor people. Fruits collected by local people from natural forests are often seen sold in the local market. These fruits are found tasty and containing plenty of several important biochemical constituents such as protein, sugar, vitamins, minerals, organic acid and salt that are essential for human metabolism. Therefore, different species of wild fruits are cultivated commercially in most countries and are used in different forms for human consumption. In addition to these cultivated fruits, there are several other edible fruits which grow wild in nature. Although edible wild fruits are widely available, they are less popular and play only a minor role in human nutrition in many countries.

People of rural areas collect various edible wild fruits to support their every day life as additional nutrition. There are many important wild fruits which play significant role in Chitwan as supplementary food, specially for the people of rural areas where the availability of cultivated fruits are rather limited. The only source of fruits is the edible wild fruits available locally. Chitwan is very rich for edible wild

fruits such as *Artocarpus lakoocha*, *Eugenia operculata*, *Syzygium cumini*, *Zizyphus jujuba*, *Morus indica*, *Annona squamosa*, *Phyllanthus emblica*, *Ficus bispida*, *Tilia dispersa*, *Ficus roxburghii*, *Dillenia pentagyna*, *Ficus semicordata*, *Aegle marmelos*, *Emblica officinalis* etc. However, recently the supply of these fruits has tremendously reduced mainly because of increasing deforestation and over-exploitation of these valuable fruit plants. Sometimes these valuable plants grow in most inaccessible places of the forests and consequently a large amount of them is wasted. Though edible wild fruits play an important role in the nutrition of people and there is potentiality of growing these fruits in large scale in Chitwan, very little efforts have been made on their study. Fruit activities in horticulture and agriculture stations in Nepal have so far been almost exclusively limited to few cultivated fruits (Shrestha *et al.*, 1978) and no attention has been given towards edible wild fruits. In fact, it is not even well known to us at present exactly how many edible wild fruits are found in Chitwan. There is little information on their availability, distribution and food values. No serious attempt has yet been made so far to domesticate and cultivate these edible wild fruits in large scale. Therefore, this paper attempts to present bio-chemical constituents in edible wild fruits available in the forest of Chitwan district.

Materials and methods

At first, the information on the locality and fruiting season of these wild edible fruits were collected by consulting the local people based on literature on local flora. The local peoples, familiar to wild edible fruits, were identified before collecting the fruits. About half kg of each of the wild fruit was collected in polythene bags between the month of June and August as it is the season of ripening. In the present work, locally available fourteen fruits species were collected from different forests of Chitwan district. The fruits samples were collected from Haripur, Padampur, Jahadhari, Teekauli. The identification of the wild edible fruits and their local names are based on the information provided by the local people.

Biochemical investigations

The fruits were stored at 4°C until used; normally the fruits were biochemically processed within 24 h after they were collected. Unless mentioned otherwise, only the edible parts of the ripened fruits were used for the biochemical analysis. The undamaged and fresh fruits were crushed by a mortar. The pulp was kept on a piece of thin cloth and pressed through hand and juice was collected in clean centrifuge tubes. When juice was viscous it was diluted with the known amount of distilled water. The juice was centrifuged till the extract was obtained. The clear juice was employed for the determination of pH and soluble sugar content in the juice applying Benedict's method, estimation of protein by using Lowry's method, extraction of fat by using Soxhlet apparatus, determination of total ash content by using ashing method as suggested by Paech & Tracey (1956).

Fresh hand-pressed fruit juice was used for the determination of pH value in the fruit juice. The pH readings were directly noted with the help of a pH meter. A certain known amount of ripe fruits without inedible parts were dried in an incubator at 80°C for 24 h. The dried fruits thus obtained were reweighed. The difference in weight gave the amount of moisture present in fresh fruits, and percentage of dry matter was calculated by the relation:

$$\text{Dry matter (\%)} = \frac{\text{Weight of dried fruit}}{\text{Weight of wet fruit}} \times 100$$

Dry fruits obtained during dry matter estimation were finally crushed in an electric blender. Fine powder was obtained by passing through a layer of fine cloth and all powders were stored in labeled plastic containers until they were used. The readymade fruit powders were later used for the estimation of soluble sugar, protein, lipid and ash present in the fruits (Sharma, 2012).

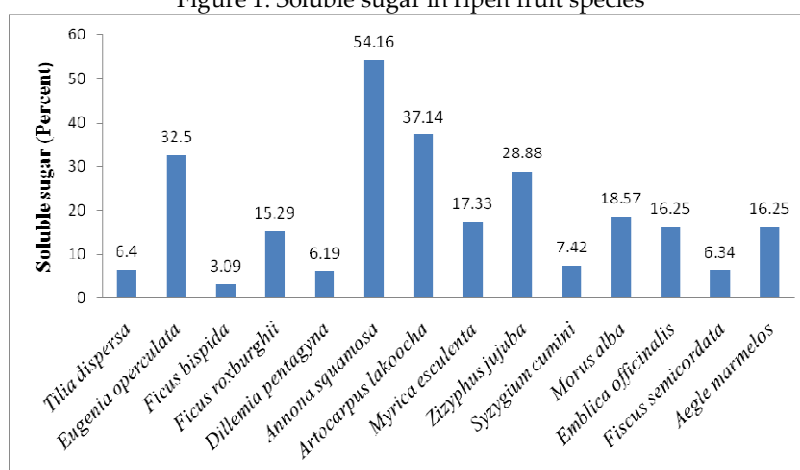
Results and discussion

Soluble sugar

Soluble sugar in the studied species varied from 3.09% to 54.16% (Fig. 1). The highest amount of sugar was found in *Annona squamosa* (54.16%) and lowest in *Ficus bispida* (3.09%) which is similar to the observation of Bajracharya and Bhandary (1980). The sugar content in the sample fruits was found slightly higher than in the fruit sample of Kathmandu valley.

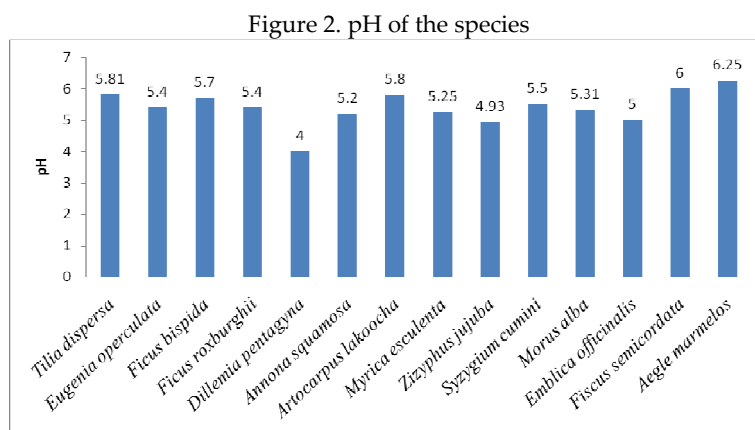
The *Annona squamosa* (54.16% sugar), *Artocarpus lakoocha* (37.14%), *Eugenia operculata* (32.5%) and *Zizyphus jujuba* (28.88%) are very good source of carbohydrate. Similarly, *Ficus roxburghii* (15.29% sugar), *Myrica esculenta* (17.33%) have a moderate level carbohydrate. These fruits are thus good source of energy for metabolic activities to human beings.

Figure 1. Soluble sugar in ripen fruit species



pH of fruits

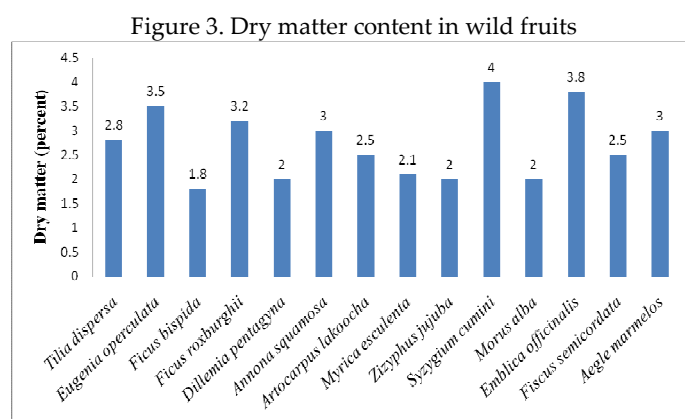
The pH value of collected wild edible fruits varied in each fruit species. All fruits studied were found to be acidic in character (Fig. 2).



While comparing the pH values of fruits, it ranged from 4 in *Dillenia pentagyna* to 6.5 in *Eugenia operculata*. Fruits with lower pH value means that they are acidic in character.

Dry matter

Dry matter is another important ingredient in edible wild plants. The amount of dry matter found in the collected wild edible plants varied from one fruit to another (Fig. 3). It varied from *Eugenia operculata* (14.48% dry matter) to *Dillenia pentagyna* (65%). It means that *Dillenia pentagyna* is rich in food value whereas *Morus alba* contains a low level of dry matter and thus have lesser food value.

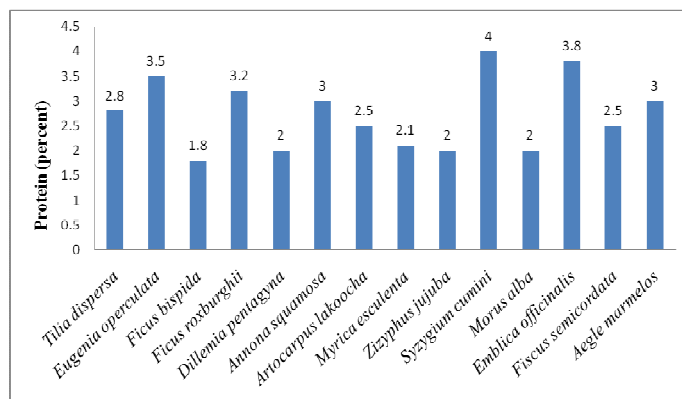


The result found is similar to the previous work done by Bajracharya (1980) on the edible fruits of Kathmandu. But some fruits like *Zizyphus jujuba* and *Syzygium cumini* have higher food value as they contain higher quantity of dry matter.

Protein

Syzygium cumini had highest (8.5%) level of protein among all fruits studied. Similarly, *Ficus semicordata* had very low level of protein (2%) and it is therefore a poor source of protein.

Figure 4. Protein found in the wild fruits

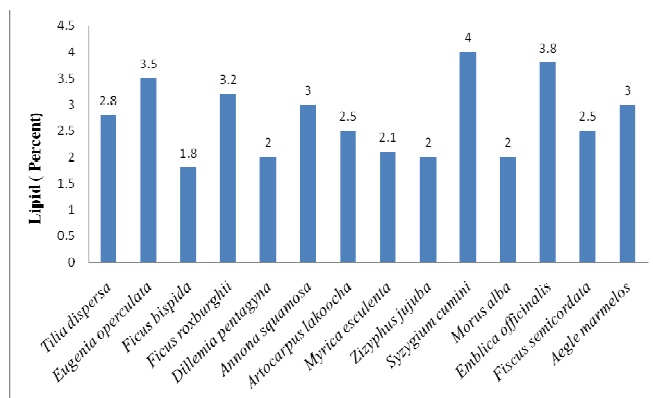


The present investigation showed that the protein content in some edible wild fruits of Chitwan ranged from 1.9% in *Morus alba* to 8.5% in *Syzygium cumini*. The protein content is slightly higher in the edible wild fruits of Chitwan compared to Kathmandu valley. The fruits having higher protein content can be a good source of food.

Lipid

The percentage of lipid found in fourteen fruit species ranged from 0.40% in *Ficus roxburghii* to 4.33% in *Artocarpus lakoocha* (Fig. 5). It shows that these fruits are poor source of fat.

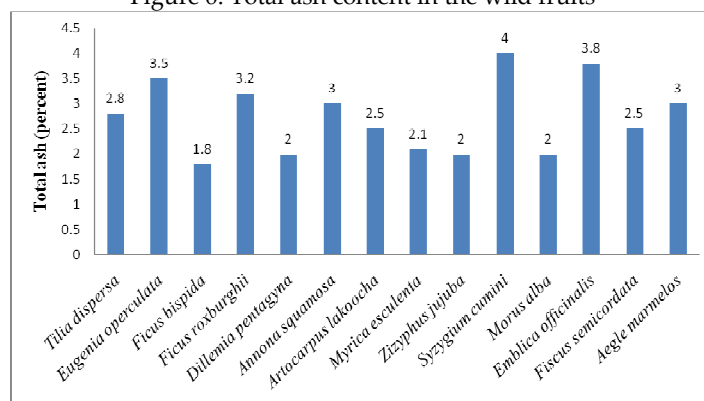
Figure 5. Lipid content in wild fruits



Total ash

Presence of ash is important for food value: the higher the level of total ash, the higher the food value of the fruits. Therefore, total ash contained in the fruits collected was determined. The ash content in fruits studied ranged from 1.8% in *Ficus bispida* to 4% in *Syzygium cumini* (Fig. 6). It shows that the ash content is slightly higher in these wild fruits of Chitwan than that of the fruits of Kathmandu valley ranging 0.3% in strawberry to 0.49% in blackberry (Bhandary, 1978). The ash content represents the total minerals content in fruits. As the ash analysis determines the proximate analysis for nutritional evaluation of fruits, *Syzygium cumini*, *Emblia officinalis* and *Eugenia operculata* contain higher food value compared to other wild fruits.

Figure 6. Total ash content in the wild fruits



Conclusion

All the edible wild fruits collected from the forest of Chitwan contain a lower level of lipid. However, the protein content in these fruits is found slightly higher compared to fruits from Kathmandu valley. The fruits available in Chitwan district have higher level of protein as well. These fruits can be used as a good source of food. But some fruits like *Zyzyphus mauritiana* and *Syzygium cumini* found in Chitwan district have higher food value as they contain a high level of dry matter which can supply necessary minerals for human body. The lower pH value of fruits of Chitwan means that they are acidic in nature. These fruits are thus good sources of energy for metabolic activities within human body. A higher level of total ash found in the fruits is the indicator of high food value which can be used as a good supplement to food at the time of scarcity or as an alternative food source in the region.

Acknowledgements

The author is grateful to the University Grants Commission for providing the grant for this research. The author is thankful to the Principal of Balkumari College, Chitwan for providing laboratory facilities, necessary chemicals and equipments. The author is equally grateful to the Department of Botany, Balkumari College for helping the author identify plant species.

References

- Baile, B.J. (1960). The post harvest biochemistry of tropical and sub-tropical fruits. *Advanced Food Research*, 10, pp. 293-354.
- Brown, B.I. (1967). Observations on physical and chemical properties of acerola fruits and puree. Queensland. *Journal of Agricultural Animal Sciences*, 23, pp. 599-604.
- Francesco, C.D.P., Sebastiana & Calbro, G. (1968). The composition of the pulp and seeds of *Anona cherimolia*. *Soc. Peloritans Sci. Fia. Mat. Nature*, 14, pp. 121-132.
- Genevois, L. (1972). Nutritional value of fruits. *Qual. Plant. Mater. Veg.*, 3, pp. 203-221.
- Harding, P.L. & Fisher, D.P. (1960). Seasonal changes in florida grape fruits. *U.S.D. A. Tech. Bull.*, p. 886.
- Hegazi, S. M. & Salem, A.S. (1972). Amino acid pattern of the egyptian apricot fruits. *J. Sci. Fd. Agric.*, 4, pp. 497-499.
- Inaba, M.A. & Sobajima, Y. (1971). Seasonal changes in the concentration of sugars and organic acids in peach fruits. *Sci. Rep. Kyoto. Perfect. Univ. Agric.*, 23, pp. 18-23.
- Leksan, K. (1971). The variability of chemical composition of some peach cultivars under economical circumstances in Slovenia. *Biotes. Univ. Ljuij*, 18, pp. 109-118.
- Malla, S.B. (1978). Department of Medicinal Plants. Ministry of Forestry, His Majesty's Government, Thapathali.
- Maskey, K. & Shah, B.B. (1982). Sugars in some Nepalese edible wild fruits. *Journal of Nepal Chemical Society*, 2, pp. 23-30.
- Miller, C.D. & Kanehiro, Y. (1961). The sodium content of Hawai-grown fruits and vegetable in relation to environment. *J. Food Sci.*, 1, pp. 31-37.
- Money, R.W. (1958). Analytical data on some common fruits. *J. Sci. Fd. Agric.*, 9, pp. 18-20.
- Noggle, G.R. & Fritz, G.P. (1977). *Introductory plant physiology*. New Delhi: Prentice Hall of India Private Limited.
- Osborn, R.A. (1964). Chemical composition of fruits and fruit juices. *Jr. A. O. A.* 6, pp. 1068-1086.
- Paech, K. & Tracey, M.V. (1956). Modern method of plant analysis. *Springer-Verlag*, 1, pp. 468-486.
- Painter, J.H. & Raese, J.I. (1965). Mineral contents of walnut hulls, shells and kornels. *Proc. Amer. Soc. Hort. Sci.*, 87, pp. 226-228.
- Parker, R.N. (1973). Forest flora for the Punjab with Hazara and Delhi. Dehradun: M/S Bishen Singh Mahendra Pal Singh.
- Rahman, F. (1970). Seasonal changes in sour oranges (*Citrus aurantium* Linn.), some biochemical studies. *Pak. J. Biochem.*, 3, pp. 14-17.
- Rathore, D.S. (1970). Effect of season on the growth and chemical composition of guava fruits. *J. Hort. Sci.*, 1, pp. 41-47.
- Saha, D.J. (1974). Changes in certain constituents of lapsi fruits during its development and ripening. Kathmandu: H.M.G. Mins. Fd. Irrig. Dept. Fd. Agric. Mar. Ser., Singha Durbar.

- Selvaraj, Y., Divakar, N.G. & Subramanyan, H.D. (1976). Studies on chemical composition of twenty strawberry varieties. *Journal of Food Science Technology*, 4, pp. 195-198.
- Shakir, A.L.S.H. & Hamdy, M.K. (1968). Analysis of aminoacids pigments and sugars of Iraqi dates. *Bulletin Ga. Acaem.Science*, 4, pp. 176-186.
- Sharma, K.R. (2012). Bio-chemical analysis of some edible wild fruits of Chitwan. A mini-research report submitted to University Grants Commission Nepal.
- Shrestha, A.B., Upadhyay, N.B. & Vareeland, C.C. (1978). Studies on fruit activities of horticulture and agriculture stations of Nepal. Kathmandu: HMG, Ministry of Food, Agriculture and Irrigation, Department of Agriculture, Fruit Development Division, Kirtipur.
- Shrestha, K.K. (1978). Studies on biochemical composition of some edible wild fruits of Kathmandu and its vicinities at different stages of maturity. Post-graduate dissertation submitted to Botany Instruction Committee, Tribhuvan University, Kritipur Campus for the partial fulfillment of Degree in Botany.
- Singh, S.C. (1968). Some wild plants of food value in Nepal. *Journal of Tribhuvan University*, 11, pp. 56.
- Srivastava, R.P. & Srivastava, R.K. (1964). Chemical composition of fresh and dried aonia fruits. *Science Culuret*, 9, pp. 446-447.

Tense, Aspect and Modality (TAM) in Koyee¹

Tara Mani Rai

PhD Student, Tribhuvan University, Kirtipur, Kathmandu

Email: raitaramani@yahoo.com

Abstract: *This paper examines the tense, aspect and modality system in Koyee language as a complex category. They appear to be so intricately related to each other sometimes they cannot be detached from each other morphologically. Koyee exhibits two types of tenses: past and non-past which are marked morphologically. Aspects are of two types: lexical and grammatical. There are two grammatical aspects of tense in Koyee: perfective and imperfective. There are two types of modality: epistemic and evaluative which have further sub-categories.*

Keywords: *Koyee language, tense, aspect, modality, mood, epistemic, deontic.*

Introduction

Koyee [*koji:*] is one of the Rai Kiranti languages of the Himalan sub-group within Tibeto-Burman group of Sino-Tibetan language family. The term 'Koyee' refers to the people as well as the language they speak. They call their language is *koji: bʌʔʌ*, which means Koyee language. This is one of the endangered and least studied languages of Nepal spoken by around 1271 people in Sungdel and Dipsung village development committees in Khotang district (Census, 2011).

After a brief introduction to the Koyee language, section 2 presents the tense and their marking suffixes particularly of past tense and non-past tense. In section 3 we discuss aspects under the subsection: lexical and grammatical aspects. Section 4 focuses on the mood whereas section 5 centers on modality. The section 6 presents the summary and findings of the research.

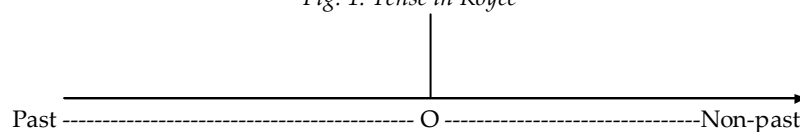
Tense: Tense is the grammatical expression of the relation of the time of an event to some reference point in time, usually the moment the clause is uttered (Givón, 2000). It normally indicates the time prediction in relation to some particular moment. This moment is typically the moment of speaking or writing (Katamba, 1993). Defining the tense, Givón (2001) states:

1 The original speakers of this language prefer to be called as Koyee. However, Hanßon (1991) mentions that renderings like Koi or Koyi [sic] (Koyee) from Koyu or Koyo appeared to result through a strong tendency in this language to pronounce a disyllabic of two vowels not as diphthongs. The ethno names like Koyu in Bhojpur, Koi, Koimee in Udayapur are prevalent where they do not speak Koyee language. Koyu people in Bhojpur have adopted Bantawa language whereas they have switched to Kirati Rodung (Chamling) language in Udayapur (Rai and Budhathoki, 2008).

Tense is fundamentally a pragmatic—rather than propositional semantic—phenomenon, anchoring the proposition to a temporal point outside itself. In the case of absolute tense, the clause, as it is uttered, is anchored to the current speech-act, performed by a particular speaker at the very time the clause is uttered (p. 286).

There are two basic tenses : past and non-past in Koyee as given in Fig. 1. There are morphological distinctions between past² and non-past tenses³. Koyee verbs are inflected to indicate these two tenses by means of different tense marking morphemes.

Fig. 1. Tense in Koyee



Past tense

<i>markers</i>	<i>gloss</i>	<i>function</i>
<-a ~ -u ~ -φ>	PST	past tense (preterite)

Points to anterior to time of reference are past. So past tense locates an event prior to the present moment. The past tense also known as preterite in Koyee is marked differently according to the person and number. In a transitive verb, the past tense suffix <-a> is used if there is singular subject of first person in the indicative sentences. The past tense suffix marker <-u> is used if the verb is intransitive. The examples (1a-b), (2a-b), (3a-b) presents the past tense in Koyee.

- (1) a. *aŋa dza: dzaŋa*
 aŋ-a dza: dza-ŋ-a
 I-ERG rice eat-1SG-PST
 'I ate rice.'
- b. *bihanŋΛ ts^haŋara dz^hoŋa*
 bihan-ŋΛ ts^haŋara-tsΛ dz^ho-ŋ-a
 mornig -EMPH goat-PL graz-1SG-PST
 'I grazed the goat in the morning.'

2 Remote past tense is not realized in Koyee as we find in Bhujel (Regmi, 2007) and Raji (Khatri, 2008).

3 Tense, aspect and modality (henceforth, TAM) may form a single complex category. In Koyee the TAM categories intersect/interact with each other so intensively in linguistic expression that sometimes it may be impossible to analyze one fully apart from another. A single affix may encode information from more than one of the domains of tense-aspect or tense-modality.

- (2) a. *aŋ ritsu*
 aŋ rits-u
 I laugh-PST
 'I laugh.'
- b. *aŋ reptsu*
 aŋ repts-u
 I stand-PST
 'I stood.'
- (3) a. *umwa dza: dza*
 um-wa dza: dza-ϕ
 3SG rice eat-PST
 'S/he ate rice.'
- b. *eina g^ha*
 eina g^ha-ϕ
 mirror shine-PST
 'The mirror shined.'

The examples (1a-b) show that the past tense marker <-a> appears if the subject is in first person singular in transitive verb that always precedes the first person number marker. Likewise, the past tense marker <-u> is realized in the case of intransitive verb as we saw in (2a-b). The past tense remains zero as in (3a-b).

Even the past tense marker <-a> appears in the second person singular subject in both transitive and intransitive verb as we discussed in the first person singular number. Consider the following examples (4a-c).

- (4) a. *ana dza: dzana*
 an-a dza: dzi-a-na
 2SG-ERG rice eat.PST-2SG
 'You ate rice.'
- b. *ana ʌtnasi*
 an-a ʌtn-a-si
 2SG-ERG returne-PST-RFLX
 'You returned.'

In the examples (4a), *ana dza: dzana* 'you ate rice' and in (4b) *ana ʌtnasi* 'you returned', the past tense marker <-a> has been used in the second person in Koyee.

(a) *First person*: The past tense marker <-a> with first person number and pronominal affixes are exemplified below in (5a-d).

- (5) a. *ʌntsua dza: dzjasu*
 ʌntsu-a dza: dzj-a-su

- | | | | |
|----|---------------------------|------|------------------|
| | 1DU.EXCL-ERG | rice | eat-PST-1DU.EXCL |
| | 'We two ate rice.' | | |
| b. | <i>intsia dza: dzjasi</i> | | |
| | intsi-a | dza: | dzj-a-si |
| | 1DU.INCL-ERG | rice | eat-PST-1DU-INCL |
| | 'We two ate rice.' | | |
| c. | <i>ΛηkΛa dza: dzjakΛ</i> | | |
| | ΛηkΛ-a | dza: | dzj-a-kΛ |
| | 1PL.EXCL-ERG | rice | eat-PST-1PL.EXCL |
| | 'We two ate rice.' | | |
| d. | <i>injia dza: dzjaki</i> | | |
| | injki-a | dza: | dzj-a-ki |
| | 1PL.INCL-ERG | rice | eat-PST-1PL.INCL |
| | 'We two ate rice.' | | |

The examples (5a-d), *antsua dza: dzjasu* 'we two ate rice.', *intsia dza: dzjasi* 'we two ate rice.', *ΛηkΛa dza: dzjakΛ* 'we two ate rice.' *injia dza: dzjaki* 'we two ate rice.' presents how the past tense marker <-a> appears in the pronominal affixes. If we observe the example (5a), we find that the first person dual exclusive marker reflected as the pronominalized form in the verb *dzi* 'eat'. Similarly we find first person dual inclusive, first person plural exclusive and first person plural inclusive respectively as pronominalized affixes.

(b) *Second person*: The past tense marker <-a> with second person number and pronominal affixes are exemplified below in (6a-b), and (7a-b).

- | | | | |
|--------|------------------------------|---------|-------------|
| (6) a. | <i>antsiwa dza: dzjasina</i> | | |
| | antsi-wa | dza: | dzj-a-sina |
| | 2DU-ERG | rice | eat-PST-2DU |
| | 'You two ate rice.' | | |
| b. | <i>anitsΛa dza: dzjani</i> | | |
| | anitsΛ-a | dza: | dzj-a-ni |
| | 2PL-ERG | rice | eat-PST-2PL |
| | 'You all ate rice.' | | |
| (7) a. | <i>anitsΛa umnusi dzjasi</i> | | |
| | anitsΛ-a | um-nusi | dzj-a-si |
| | 2PL-ERG | that.DU | eat-PST-2DU |
| | 'You two ate them two.' | | |

- b. *ania umnusi dzjani*
 ani-a um-nusi dzj-a-ni
 2PL-ERG that -DU eat-PST-2DU
 'You all ate them two.'

The examples (6a-b) and (7a-b) present the the past tense marker <-a> used in the second person with pronominal affixes.

(c) *Third person*: The past tense marker <-a> with third person number and pronominal affixes are illustrated in (8a-b).

- (8) a. *umwa dza: dza*
 um-wa dza: dz-a
 3SG-ERG rice eat-PST
 'S/he ate rice.'
- b. *umwa umts Δ dzani*
 umwa umts Δ dz-a-ni
 3SG-ERG rice eat-PST-PL
 'S/he ate them all.'
- c. *umnusija umnusi dzasi*
 um-nusi-ja um-nusi dz-a-si
 3-DU-ERG that-DU eat-PST-3DU
 'They two ate them two.'
- d. *umnusija umts Δ dzasi*
 um-nusi-ja um-ts Δ dz-a-si
 3-DU-ERG that-PL eat-PST-3DU
 'They two ate them all.'
- e. *umts Δ a umts Δ dzani*
 umts Δ -a um-ts Δ dz-a-si
 3PL-ERG that-PL eat-PST-3DU
 'They all ate them all.'

The above mentioned examples show person and number affixes in the finite verb *dzi* 'eat' with the past marker <-a>. The past tense marker <-a> precedes the person and number affixes in the finite verb and the third person object suffix marker follows the subject suffix marker.

Non-past tense

<i>markers</i>	<i>gloss</i>	<i>function</i>
<-e, -t Δ >	NPST	past tense (non-preterite)

The basic non-past tense marker <-e> appears to be in the intransitive verb roots to denote non-past tense if there is third person singular of agent as in (9a-b).

- (9) a. *umu k^hutse*
 umu k^huts-e
 3SG go.3SG-NPST
 'S/he goes.'
- b. *umu hire*
 umu hir-e
 3SG get angry-NPST
 'S/he gets angry.'

In the examples (9a-b) we find the roots of intransitive verbs *k^hutse* 'goes' and *hire* 'gets angry' preceding the non-past tense marker <-e>.

The non-past tense suffix <-t_A-d_A> is inflected in the verb if there is first person singular subject as in (10a-b).

- (10) a. *aŋ k^hat_A*
 aŋ k^hΛ-t_A
 1SG go-NPST
 'I go/will go.'
- b. *aŋ b^hat_A*
 aŋ b^hΛ-t_A
 1SG cry-NPST
 'I go/will go.'
- c. *aŋ dza dzaŋd_A*
 aŋ dza dza-ŋ-d_A
 1SG rice eat-1SG-NPST
 'I eat/ will eat rice.'
- d. *aŋ biŋd_A*
 aŋ bi-ŋ-d_A
 1SG give-1SG-NPST
 'I give/will give.'

4 The non past tense marker <-d_A> is the allomorph of <-t_A> which falls in the same place of articulation.

The non-past tense marker <-da> is found to be inflected in the transitive verb root if there is the third person singular subject as in (11a-b).

- (11) a. *umwa dza: dzada*
 um-wa dza: dza-da
 3SG-ERG rice eat-NPST
 'S/he eats/ will eat rice.'
- b. *umwa kitap bida*
 um-wa kitap bi-da
 3SG-ERG book give-NPST
 'S/he gives/ will give book.'

The non-past tense marking is not found to be inflected in the verb root if the first and second person subject holds the duality and plurality. Instead, the person and number affixes play crucial role to show the agreement to the verb root.

First person with number affixes in the finite verb *dza* 'eat' is presented below as in (12a-b).

(a) *First person*

- (12) a. *intsija dza: dzesi*
 intsija dza: dze-si
 1DU.EXCL rice eat.NPST-1DU.EXCL
 'We two eat/will eat rice.'
- b. *inkija dza: dzeki*
 inkija dza: dze-ki
 1PL.INCL rice eat.NPST-1PL.INCL
 'We all eat/will eat rice.'

The example (12a-b) presents that the first person affixes in the finite verbs where the non-past tense marker <-e> is realized as the inherent complex category.

Second person with the number affixes in the finite verb *dza* 'eat' is presented below in (13a-b).

(b) *Second person*

- (13) a. *antsija dza: dzjasi*
 antsija dza: dzeja-si
 2DU rice eat-2DU
 'You two eat/will eat rice.'
- b. *anits^Λ dza: dzeni*
 anits^Λ dza: dze-ni
 2PL rice eat-2PL
 'You all eat/will eat rice.'

The third person with number affixes in the finite verb *dza* 'eat' is presented below. But the non-past tense marker <-*da*> is realized in the third person as in (14a-b).

(c) *Third Person*

- (14) a. *umts_{AA} dza: dzadani*
 umts_Λ-a dza: dza-da-ni
 3PL-ERG rice eat-NPST-3PL
 'They two eat/will eat rice.'
- b. *umnusija dzesini*
 umnusi-ja dze-sini
 3DU-ERG eat-3PL
 'They two ate them two.'

The examples (14a-b) shows that the third person number in the finite verb followed by the past tense marker <-*da*>.

Aspects: Aspect is a form of verb that indicates the way in which an action is regarded. Aspect indicates whether an event, state, process or action that is denoted by a verb is completed or in progress (Katamba, 1993:221). According to Givón (2001) there are two types of aspects: lexical and grammatical.

Lexical aspects: Lexical aspects are discussed here firstly on the basis of the states of affairs and lexical aspects and secondly tests for determining the lexical aspect of the verbs in Koyee have been discussed.

The states of affairs and lexical aspects: Each language has linguistic means for describing states of affairs (Givón, 2001). It typically consists of verbs and other predicating elements, which express the situation, event, process or action, and noun phrases and other referring expressions, which denote the participants. Mostly languages consist of aspects of a state of affairs

These states of affairs in a language are coded by lexical aspect of verbs (also referred to as Aktionsart). There are four basic classes of the lexical aspect of verbs: states, achievements, accomplishments, and activities. They were proposed originally in the Vendler (1967). Givón (2001) also classified the verbs in terms of their inherent temporal properties as stative verbs, compact verbs, accomplishment verbs and activity verbs. The following correspondence can be maintained in between them:

Table 1. Types of Aspect

Aspect	
Perfective	Imperfective
past	activity
non-past	accomplishments
	achievement
	state

The lexical aspect of verbs (Vendler,1967) is defined as follows: states are non-dynamic and temporally unbounded. Activities are dynamic and temporally unbounded. Achievements code instantaneous changes, usually changes of state but also changes in Activities as well. They have an inherent temporal point. Accomplishments are temporally extended changes of state leading to a terminal point. The lexical aspect of the verbs may be characterized by $[\Sigma \pm \text{static}]$, $[\pm \text{telic}]$ and $[\pm \text{punctual}]$:

- (15) a. State [+static], [-telic] and [-punctual]
 b. Activity [-static], [-telic] and [-punctual]
 c. Accomplishment [-static], [+telic] and [-punctual]
 d. Achievement [-static], [+telic] and [+punctual]

The lexical aspects of verbs correspond to the state-of-affairs.

Table 2. State of affairs.

Aspect	
Lexical aspect of verbs	States-of-affairs
a. states	situations
b. achievement	events
c. accomplishment	process
d. activities	actions

Lexical aspect tests: There will be discussed how to determine the Aktionsart type of each verb in Koyee. For this purpose we mainly use the tests for determining the Aktionsart type proposed in Van Valin and Lapolla (1997).

- (16) *States*
- | | | | |
|-----------------|---------------|------------------------------------|--------------|
| a. <i>hermu</i> | 'be angry' | b. <i>jaiʔmu</i> | 'to wish' |
| c. <i>koʔmu</i> | 'to know' | d. <i>pʌtemumu</i> | 'to believe' |
| e. <i>baʀmu</i> | 'be tall/big' | f. <i>halalats^huʔmu</i> | 'be red' |
- Achievements*
- | | | | |
|-----------------------------|---------------|------------------------------|------------|
| a. <i>t^huʔmu</i> | 'to spit' | b. <i>hulmu</i> | 'to cough' |
| c. <i>ʌpmu</i> | 'to shoot' | d. <i>p^hʌlmu</i> | 'to jump' |
| e. <i>jaʌiʔmu</i> | 'to beat/hit' | f. <i>p^hʌʌʔmu</i> | 'to slap' |
- Accomplishments*
- | | | | |
|----------------------------|-------------|-----------------------------|-------------|
| a. <i>humulimu</i> | 'to arrive' | b. <i>humu</i> | 'to come' |
| c. <i>leʔmu</i> | 'to leave' | d. <i>k^hʌimu</i> | 'to go' |
| e. <i>ŋermu</i> | 'to finish' | f. <i>d^hʌʔmu</i> | 'to obtain' |
| g. <i>t^himu</i> | 'to fall' | h. <i>miʔmu</i> | 'to die' |

i. <i>ts^huʔmu</i>	'to born'	j. <i>mumu</i>	'to sit down'
k. <i>.repmu</i>	'to stand'		
<i>Activities</i>			
a. <i>d^hurmu</i>	'to break'	b. <i>lʌmt^himu</i>	'to walk'
c. <i>kamamumu</i>	'to work'	d. <i>ts^hʌmumu</i>	'to dance'
e. <i>dzimu</i>	'to eat'		

Lexical aspects as an inherent aspect appear as to combine with various grammatical aspects. The main function of the lexical aspects is to add the communicative perspective to grammatical aspects. The stative verbs in Koyee do not satisfy the perfective interpretation because they lack terminal boundary.

Grammatical aspects: In many languages, indeed in the entire language families (including Tibeto-Burman), there are two main aspectual distinctions realized: perfective and imperfective (Givón, 2001:345). Grammatically, the languages may possess the aspects as:

- Perfective: past, past-progressive
- Imperfective: present-progressive, future habitual

Perfective (PFV)

Past perfective (PST PFV): The perfective refers to the situation as a complete whole in which suitable aspect is used to express a terminative, punctual or inceptive dimension of the situation described by the verb (van Driem, 1993). It may code a situation (i.e. events, processes, and change of state) which was terminated and bounded before one absolute reference point, the time of speech. Perfective aspect in Koyee indicates the action accomplished prior to the moment of speaking as in (17a-b).

- (17) a. *bʌktsi k^hutsa*
 bʌktsi *k^huts-a*
 younger brother go-PST
 'Younger brother went.'
- b. *hʌria dza: dza*
 hʌri-a *dza:* *dza-φ*
 Hari- erg rice eat-PST
 'Hari ate rice.'

The events (17a-b) occurred in-sequence and completed preceding only one absolute reference time.

Perfect (PRF): In Koyee, the perfect aspect seems to be between the past-perfective aspect and the present perfect. Both aspects code the events which either occur or at the very least are initiated prior to the temporal reference time. These events are supposed to have been completed and bounded prior to the reference time.

Non-past perfect (NPST PRF): The non-past perfect may be used to denote the result state. This is known as the resultative state or perfect of result. In Koyee, the perfect aspect is morphologically marked with a separate suffix. It is marked with the suffix <-m> in the verb root. And, the main verb is followed by the 'be' verb.

- (18) a. *aŋa sʌʌ g^huduŋam go:di*
 aŋa sʌʌ g^hudu-ŋa-m go:di
 1SG-ERG frog bring.down-1SG.PST-NMLZ be.-3SG.NPST
 'I have brought down some frog.'
- b. *aŋa dza: dzaŋam go:*
 aŋ-a dza: dzaŋa-m go:
 I-ERG rice eat-PRF be.NPST
 'I have eaten rice.'
- c. *aniwa dza: dzjanim go:*
 ani-wa dza: dzja-ni-m go:
 you-ERG rice eat-2PL-PRF be.NPST
 'You have eaten rice.'
- d. *umuwa dza: dzaʔm go:*
 umu-wa dza: dzaʔ-m go:
 3SG-ERG rice eat-PRF be.NPST
 'S/he has eaten rice.'

In (18a-d) the events occurred are supposed to have happened prior to the reference time the results can be perceived in the present time.

Past perfect (PST PRF): The 'be' verb does not inflect in non-past, but inflect in the past as in the examples (19a- c).

- (19) a. *aŋa dza: dzaŋam gʌdi*
 aŋ-a dza: dzaŋa-m gʌdi
 I-ERG rice eat-PST.1SG.PRF be.PST
 'I had eaten rice.'
- b. *anija dza: dzjanim gʌdi*
 ani-ja dza: dzj-a-ni-m gʌdi
 you-ERG rice eat-PST-PL-PRF be.PST
 'You had eaten rice.'
- c. *aniwa dza: dzjanim go:*
 umu-a dza: dzj-aʔ-m gʌdi
 3SG-ERG rice eat-PST-PERF be.PST
 'S/he had eaten rice.'

Completive (COMPL): This aspect codes events in the event. The marker < *ɲir* > is used as the completive aspect in Koyee. There are two types of completive aspects: non-past completive and past completive. They are discussed as follows:

The completive aspect in Koyee may be viewed as the events completed in the right moment. The examples (20a-b) may clarify this aspect.

- (20) a. *uk bʌdze tsʰʌʎɪram go*
 uk bʌdze tsʰʌʎ-ɲir-a-m go
 one o'clock become-COMPL-PST-NMLZ be.3SG-PST
 'It has got to be after 1 o'clock.'
- b. *umnʌ tsuktsu mitsaɲira*
 um-nʌ tsuktsu mits-a-ɲir-a
 3sg-gen grand pa die-past-compl-pst
 'His father is dead.'

Imperfective: The imperfective aspect looks at the situation from inside and is concerned with the internal structure of the situation. The imperfective aspect is both semantically and formally marked in Koyee. The imperfective aspect can be divided into three types: habitual, perfective, and progressive.

Durative (DUR): The durative marker⁵ < *dzi* > is combined with any tense categories : past and non-past. This marker is used in both transitive and intransitive verbs in Koyee as in (21a-b).

- (21) a. *aɲ ne ipdzitszu tsʰa*
 aɲ ne ip-dzi-tszu tsʰa
 1SG TOP sleep-DUR-1SG.PST HS
 'I was sleeping'
- b. *kʌɲkʰabi tsemnadzinasi m tsʰa*
 kʌɲkʰa-bi tsem-na-dzi-nasi-m tsʰa
 water-loc play-GAP-DUR-3SG-PST-NMLZ PST
 'He was playing in the water.'
- c. *umuwa heʎʌ hul-e-dze-m ɲis-tʌ*
 3SG-ERG now cough-NPST-DUR.3SG.NPST-NMLZ hear-1SG/3SG.NPS
 'I hear him coughing now.'

The examples (21a-c) indicate the durative marker < *dzi* > used in non-past and past.

5 The durative marker possesses the allomorphs < *dza ~ dze ~ dzja* > of the marker < *dzi* >. They are used according to the tense, person and number the discourse contains.

Progressive (PROG): Progressive indicates the action viewed as being in progress. Progressiveness is similar to continuousness, which is definable as imperfective which is not occasioned by habitually (Comrie 1997). The progressive aspect in Koyee expressed by the suffix⁶ <-t^hΛ> in the verb root is followed by the verb 'be'. Except in the third person singular of agent, the past and non-past tense, number, and pronominal suffixes are inflected with the 'be' verb.

- (22) a. *aniwa u ʔu kΛktset^hΛtseni*
 ani-wa u ʔu kΛktse-t^hΛ-tseni
 you-ERG field dig-PROG-NPST.2PL
 'You are digging up the field.'
- b. *umua dza: dzat^hΛda*
 umu-a dza: dza-t^hΛ-da
 3SG-ERG rice eat-PROG.3SG.NPST
 'S/he is eating rice.'
- c. *Λntsua dza: dzet^hΛtsisu*
 Λntsu-a dza: dze-t^hΛ-tsi-su
 1DU.EXCL rice eat-PROG.1DU.EXCL
 'We two are eating rice.'
- d. *iηki dza: dzet^hΛtsiki*
 Λntsua dza: dze-t^hΛ-tsi-ki
 1DU.INCL rice eat-PROG.1DU.INCL
 'We two are eating rice.'

Habitual (HBT): Habituality describes a situation which is characteristic of an extended period time (Comrie, 1976 ,p.28). There is no distinct system to indicate habituality in Koyee. Consider the following examples.

- (23) a. *aη dza: dzaηdΛ*
 aη dza: dza-η-dΛ
 I rice eat-1SG-NPST
 'I eat rice.'
- b. *aηa tumlo muηdΛ*
 aη-a tumlo mu-η-dΛ
 I-ERG work do-1SG-NPST
 'I do work.'

6 The allomorphs of the durative aspects are <t^hΛ~ t^hΛd ~ t^hΛts ~ t^hΛts> which may be interchangeably used in terms of the tense, person and number the sentence carries out. The marker <-ba> is also used as suggested by Lahaussais (2009).

Table 3. Aspects and their markers

Markers	Gloss
<-φ>	Prefective (PFV)
<-t ^h Λ>	Progressive (PROG)
<-dzi>	Durative (DUR)
<-φ>	Prefective (PFV)
<-m>	Perfect (PER)
<-ηjɪr>	Completive (COMPL)
<-φ>	Habitual (HABT)

Modality: Modality is overlapped with tense and aspect. It is concerned with the notions of necessity, possibility and certainty, etc, especially as they are marked by obligatory inflections on the verb (Watters, 1998). Since Tibeto-Burman languages are mood and modality oriented, Koyee is also oriented to it.

In this section, we analyze the Koyee modality system in terms of the main distinction between epistemic and evaluative (deontic) judgement (Givón, 2001). The categories of the modality code the speaker's judgement. This is concerned with the propositional information indicated by special grammatical markings in the verb.

Epistemic modality: The main function of epistemic modality is to indicate the degree of commitment of the speaker to the truth or future truth of the proposition. It may be combined with any of the tenses, either in the same morphemes or in combinations of morphemes. The epistemic modalities include probability, certainty and evidentiality.

Probability: Probability is the kind of modality which is used to indicate that the situation described in the proposition is probably true. It is marked by the verb inflection *-woi*. It may appear with any of the tenses. The following are the examples:

- (24) a. *umtsa dza dzadani woi*
 umts-a dza: dza-da-ni-woi
 3SG-ERG rice eat-NPST-HON-PROB
 'They might eat rice.'
- b. *bΛktisa dza dzada woi*
 bΛjtsi-a dza: dza-da-woi
 brothr-ERG rice eat-NPST-PROB
 'The brother might eat rice.'

Certainty: Certainty denotes the the speaker emphasizing that the proposition is true. In Koyee, the certainty is realized as <-ηΛ>. It is directly attached to the root of the verb. It may be combined with any of the tenses, either in the same morphemes or in the combinations of morphemes. The following are the examples:

- (25) a. *aŋa bin-e-ŋΛ*
 aŋ-a bin-e-ŋΛ
 1SG-ERG give-NPST-CERT
 'I will certainly give you.'
- b. *rama an tsuŋΛ sitsena*
 ram-a an tsu-ŋΛsits-e-na
 Ram-ERG 1SG real-CERT give-NPST-2SG
 'Ram will certainly give you.'

Evidentiality: There is found binary contrast in grammaticalized evidentiality: direct evidentiality (directly experienced) and indirect evidentiality (indirect evidence) in Koyee. Koyee lacks separate morphemes for indicating evidentiality.

- (26) a. *umu kim k^hutsa*
 umu kim k^huts-a
 3SG house go-PST
 'He went home (as I directly witnessed).'
- b. *bΛktsi ritsu*
 bΛktsi rits-u
 brother laugh-PST
 'The brother laughed.'

Negation: In terms of truth value, negation (Neg-assertion) occupies the extreme end on the scale of propositional modalities (Givón, 2001). The ranking of the epistemic modalities by the truth value is presupposition > R (realis) -assertion > IRR (irrealis)-assertion > NEG-assertion⁷ (*ibid*: p. 369). It is a marked phenomenon in all the languages of the world. According to Payne (1997) negation can be analyzed as lexical, morphological and analytic typologically across the languages of the world. Lexical negation describes a situation in which the concept of negation is an essential part of the lexical semantics of a particular verb. In morphological negation, the morphemes that express negation, on the other hand, can be with the verb. Analytic negation, on the other hand, can be expressed either by negative particles or by finite negative verbs.

In Koyee, a simple clause employs the strategy of morphological negation. The negative prefix <-Λ> attaching to the verb negativizes the verb forms.

7 Givón (2001) states the negation and propositional logic as: a) Presupposition= taken for granted to be true (necessary truth) b) R-assertion= strongly asserted to be true (factual truth) c) IRR-assertion= weakly asserted to be not true (possible truth) d) NEG-assertion= strongly asserted to be not true (falsely)

The following sentences show the contrast of negation to the corresponding positive sentences.

- (27) a. *umua dza dzada*
 umu-a dza: dza-da
 3SG-ERG rice eat-NPST
 'S/he eats/will eat rice.'
- b. *umua dza Δ dzada*
 umu-a dza: Δ -dza-da
 3SG-ERG rice NEG-eat-NPST
 'S/he eats/will eat rice.'
- c. *anija dza: dzeni*
 ani-ja dza: dz-e-ni
 2PL-ERG rice eat-NPST-2PL
 'You eat / will eat rice.'
- d. *anija dza: Δ dzeni*
 ani-ja dza: Δ -dz-e-ni
 you-ERG rice NEG-eat-NPST.2PL
 'You eat / will eat rice.'
- (28) a. *intsija olon h Δ ptsasi*
 intsi-ja olon h Δ pts-a-si
 1DU.INCL-ERG milk drink-PST-1DU.INCL
 'We (two) drank milk'
- b. *intsija olon Δ h Δ ptsasi*
 intsi-ja olon Δ -h Δ pts-a-si
 1DU.INCL-ERG milk NEG-drink-PST-1DU.INCL
 'We (two) drank milk'
- c. *Δ h Δ ksa olon h Δ ptsak Δ*
 Δ h Δ ksa-a olon h Δ pts-a-k Δ
 1DU.EXCL-ERG milk drink-PST-1DU.EXCL
 'We (two) drank milk'
- d. *Δ h Δ ksa olon Δ h Δ ptsak Δ*
 Δ h Δ ksa-a olon Δ -h Δ pts-a-k Δ
 1DU.EXCL-ERG milk NEG-drink-PST-1DU.EXCL
 'We (two) drank milk'

In Koyee, <me? Δ > appears to be the lexical negative marker. It can be observed through the following examples:

- (29) a. *id^Λ aŋu kim*
 id^Λ aŋu kim
 this my house
 'This (is) my house.'
- b. *id^Λ aŋu kim meʔ*
 id^Λ aŋu kim meʔ
 this my house NEG
 'This (is) not my house.'
- (30) a. *umts^Λ aŋu l^Λp^hj^Λ*
 umts^Λ aŋu l^Λp^hj^Λ
 this.PL my shoes
 'Those (are) my shoes.'
- b. *umts^Λ aŋu l^Λp^hj^Λ meʔe*
 umts^Λ aŋu l^Λp^hj^Λ meʔe
 this.PL my shoes NEG
 'Those (are) not my shoes.'

The negativization in Wh and Yes/No question is presented below.

- (31) a. *renukawa dza: dzada*
 renuka-wa dza: dza-da
 Renuka-ERG rice eat-NPST
 'Renuka eats/ will eat rice.'
- b. *renukawa dza: ^Λdzada*
 renuka-wa dza: ^Λdza-da
 Renuka-ERG rice NEG-eat-NPST
 'Does Renuka not eat rice?.'

Above, the highlighted verb *Λ-dza-da* denotes the rising intonation.

- (32) a. *b^Λtsia asina dza: dza*
 b^Λtsi-a asina dza: dza
 brother-ERG yesterday rice eat-PST-3SG
 'The brother ate rice yesterday.'
- b. *b^Λtsia asina s^Λama ^Λdza*
 b^Λtsi-a asina s^Λama ^Λdza
 brother-ERG rice what NEG-eat.PST
 'What did brother not eat yesterday?.'

- c. $\lambda\eta k\lambda\lambda$ *olon* $h\lambda ptsak\lambda$
 $\lambda\eta k\lambda$ -a olon $h\lambda pts$ -a-k λ
 1DU.EXCL-ERG milk drink-PST.1DU.EXCL
 'We (two) drank milk'
- d. $\lambda\eta k\lambda\lambda$ *olon halo* $\lambda h\lambda ptsak\lambda$
 $\lambda\eta k\lambda$ -a olon halo λ - $h\lambda pts$ -a-k λ
 1DU.EXCL-ERG milk when neg-drink-PST.1DU.EXCL
 'When did we (two) drink milk?'

Evaluative (Deontic) modalities: Evaluative (deontic) modality is to describe internal or external ability of the wilful agent with respect to the completion of the predicate situation. They may be combined with any of the tenses, either in the same morpheme or in combinations of the morphemes. In Koyee, there are two evaluative modalities which are encoded by verbal affixes. They include ability and obligation.

Ability: The ability is an agent of the verb which has the mental or physical ability to complete the action of the main verb. It is marked by <-*tsap*>.

- (33) a. $a\eta a$ *d^hindara semu tsapd λ*
 $a\eta a$ d^h indara semu-tsap-d λ
 I-ERG tiger kill-OBLG-NPST
 'I can kill the tiger.'
- b. $a\eta a$ *d^hindara semu tsapdu η*
 $a\eta a$ d^h indara semu-tsapdu- η -a
 I-ERG tiger kill-OBLG-1SG-PST
 'I could kill the tiger.'

Obligation: The obligation refers to the agent obliged to perform the action of the verb. It is indicated by the marker -*ts^ho[?]o*. In the obligation of the verb is bound to complete the action of the main verb, e.g,

- (34) a. ana *bulu bimun λ ts^ho[?]o*
 an -a bulu bimun λ ts^ho[?]o
 2SG-ERG money give-PART OBLG
 'You have to give the money.'
- b. an *kimbi* *k^him μ ts^ho[?]o*
 an kimbi k^him μ ts^ho[?]o
 2SG house-LOC OBLG
 'You have to go home.'

In Koyee, declarative and interrogative moods are inflected for all tense, person and numbers. Imperative mood is restricted to the second person, optative mood is related to the third person and hortative mood shows the relation with the first person duality and plurality.

Conclusion

In this article, we observed the tense, aspect and modality in Koyee. They appear to be as the complex category. Tense, aspect and modality interact so intensively that sometimes they cannot be detached from each other. In Koyee, a single affix may encode information from more than one of the domains of tense-aspect or tense-modality. Undoubtedly, Koyee exhibits a complex aspectual system. Koyee has two types of tenses: past and non-past which are morphologically marked. There are two types of aspects: lexical aspects and grammatical aspect. Further, the grammatical aspect consists of two types as perfective and imperfective. They are also subcategorized as past perfective, perfect, completive, durative and habitual. There are two types of modalities: epistemic and evaluative (deontic) modality. They may be combined with any of the tenses. Epistemic modality indicates the degree of commitment of the speaker to the truth or future truth of proposition in Koyee. On the other hand, evaluative modality expresses the internal and external ability.

Abbreviations

1	= first person	2	= second person	3	= third person
ADV	= adverb	CAUS	= causative	CERT	= certainty
COMPL	= completive	CONC	= concessive	DAT	= dative
DU	= dual	DUR	= durative	EMPH	= empathic
ERG	= ergative	EXCL	= exclusive	GEN	= genitive
HABT	= habitual	IMPFV	= imperfective	INCL	= inclusive
LOC	= locative	MNR	= manner	NEG	= negative
NMLZ	= nominalizer	NPST	= non-past	PART	= particle
PL	= plural	POSS	= possessive	POST	= postposition
PFV	= perfective	PRF	= perfect	PST	= past
PTCP	= participle	PUR	= purposive	SG	= singular
SEQ	= sequential				

References

- Bickel, B. (1996). *Aspect, mood and time in Belhare*. Zurich: Universitat Zurich.
- CBS. (2012). *Population census 2012: National report*. Kathmandu: Central Bureau of Statistics.
- Comrie, B. (1976). *Aspect*. Cambridge: CUP.
- Comrie, B. (1985). *Tense*. Cambridge: CUP.
- Doornenbal, M. (1970). *A Grammar of Bantawa*. The Netherlands: LOT.
- Ebert, K. (1997). *A Grammar of Athpare*. München : LINCOM EUROPA.
- Givón, T. (2001). *Syntax: An introduction*, Vols. I-II. Amsterdam: John Benjamins.
- Hanßon, G. (1991). *The Rai of eastern Nepal: Ethnic and linguistic grouping findings of the linguistic survey of Nepal*. Werner Winter ed. Kathmandu: LSN and CNAS.
- Katamba, F. (1993). *Morphology*. London: Macmillan Press Ltd.

- Palmer, F. (1983). *Grammar*, 2nd ed. English Book Society, Middle Sex: Penguin Books Limited.
- Payne, T.E. (1997). *Describing morphosyntax: A guide for field linguistics*. Cambridge University Press.
- Poudel, T. (2007). *Tense, aspect and modality in Manipuri and Nepali*. München: LINCOM EUROPA.
- Rai, T.M. (2011). Nominal morphology in Koyee. A mini research report submitted to Nepal Sanskrit University, Kathmandu.
- Regmi, D.R. (2007). The Bhujel language. A Ph.D. dissertation submitted to the Dean Office of Humanities and Social Sciences, Tribhuvan University, Kirtipur, Kathmandu.
- van Driem, G. (1993). *A Grammar of Dumi*. New York: Mouton de Gruyter.
- Vendler, Z. (1967). *Linguistics in philosophy*. New York: Cornell University.
- Whaley, L.J. (1997). *Introduction to typology: The unity and diversity of language*. Thousand Okas, London, New Delhi: SAGE publication.
- Yadava, Y.P. and Warren Glover (eds.). (1999). *Topics in Nepalese linguistics*. Kathmandu: Royal Nepal Academy.

Mahatma Gandhi and the *Sadharanikaran* Model of Communication

Nirmala Mani Adhikary

Department of Languages and Communication, Kathmandu University, Dhulikhel

E-mail: nma@ku.edu.np

Abstract: *The paper presents an appraisal of Mahatma Gandhi as a communicator and argues that his way of communication can be theorized by the Sadharanikaran model of communication (SMC). In this course, it presents a Bharatavarshiya perspective on communication with reference to the sadharanikaran model. It not only delineates the fundamentals of the SMC but also treats of Sahridayata—the core concept of the model.*

Keywords: *Ahimsa, communication, Mahatma Gandhi, Moksha-in-life, Sadharanikaran Model of Communication, sahridayata, sancharyoga, satyagraha.*

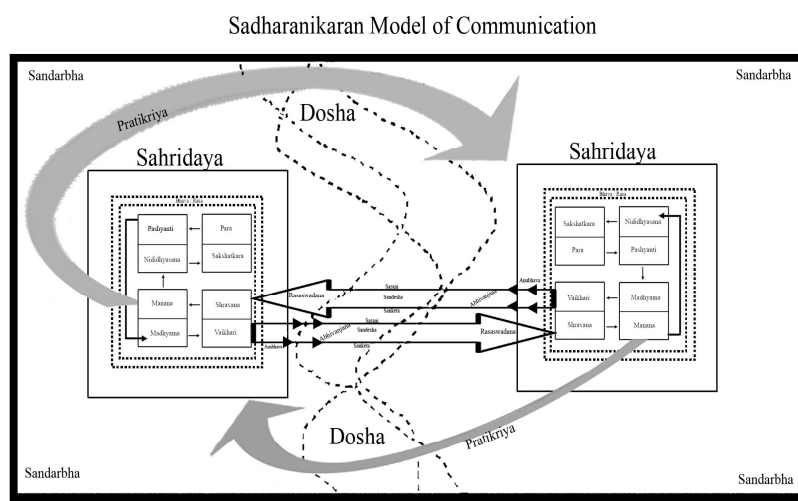
Introduction

Mahatma Gandhi's life and his ideas can be and has been approached from various perspectives. Some scholars have studied his life and works from the viewpoint of communication (Beatty *et al.*, 1979; Bode, 1992, 1994, 2000; Carlson, 1986; Chakravarty, 1995; Chaudhari & Starosta, 1992; Gregg, 1938; Jain, 2000; Gonsalves, 2010; Kumar, 1984; Merriam, 1975; Naess, 2005; Prasad, 2003; Rothermund, 1993; Santionis, 2006; Singhal, 2010; Singh, 1979; Starosta & Chaudhari, 1993; Starosta & Shi, 2007; Wilkins, 2009). However, a Gandhian theory of communication is yet to be developed even though there is substantial ground in this regard. The apathy of communication scholars in this regard is echoed in what is observed by Sethi (1978) in another context: "Mahatma Gandhi has been hailed as a prophet but has seldom been properly understood. We . . . have eulogized, romanticized and mythologized Gandhi but never properly conceptualized him" (p. 28).

As "a great mass communicator" (Yadava, 1998, p. 185), who "has been considered more as an oracle or prophet" (Sethi, 1978, p. xiv of Introduction), Mahatma Gandhi certainly deserves more attention from communication researchers. The present paper is an endeavor to persuade communication scholars for further exploration of Mahatma Gandhi and his works from the perspective of communication. In the following section, the paper describes the *Sadharanikaran* Model of Communication (SMC) and delineates its fundamentals followed by a further discussion on *Sahridayata*—the core concept of the SMC. The final section of the paper claims that Mahatma Gandhi's way of communication can be theorized as the SMC.

The *Sadharanikaran* model of communication (SMC)

The *sadharanikaran* model of communication (SMC) has been developed in order to visualize a Bharatavarshiya/Hindu view on communication in diagrammatic form. The model primarily draws on *Natyashastra* of Bharata Muni and *Vakyapadiya* of Bhartrihari and illustrates the process of communication from a Hindu viewpoint. It was initially presented in 2003 (Adhikary, 2003), and later in 2010, its revised version was presented (Adhikary, 2010a). The diagram presented here is the revised one.



The SMC is a systematic presentation of the process of attaining mutual understanding, commonness or oneness among communication parties. It illustrates how the communicating parties interact in a system for the attainment of *saharidayata*.

The model comprises the following elements:

1. *Sahridayas* (*Preshaka*, i.e., sender, and *Prapaka*, i.e., receiver)
2. *Bhavas* (Moods or emotions) and *Rasas* (Sentiments)
3. *Abhivyanjana* (Expression or encoding)
4. *Sandeha* (Message or information)
5. *Sarani* (Channel)
6. *Rasaswadana* (receiving, decoding, interpreting the message, and finally achieving the *rasa*)
7. *Doshas* (Barriers)
8. *Sandarbhya* (Context)
9. *Pratikriya* (Process of feedback)

The description of various elements shown in the figure and their interrelations in the process of communication has not been presented here (for elaboration on the elements of the SMC, see Adhikary, 2003, 2007, 2009, 2011b). It is to mention here that the concepts drawn on and mentioned in the model (e.g., *sadharanikaran*, *sahridayata*, and *rasaswadana*) are formal concepts that are firmly established on Sanskrit poetics as well as Hindu religious-philosophical knowledge systems. The state of common orientation, commonality, mutual understanding or oneness is represented by the concept of *sahridayata* in Hindu poetics, aesthetics, and allied disciplines.

Sadharanikaran as a concept/theory should not be confused with the *sadharanikaran* model. The former, which is one of the significant theories in Sanskrit poetics, has its root in *Natyashastra* of Bharata Muni, and is ascribed to Bhattanayaka for its theorization (Sastri, 1991, p. 299; Vatsyayan, 1996, p. 146). The latter (that is, the *sadharanikaran* model of communication) is a model of communication that incorporates insights from both the traditions of *Natyashastra* and *Vakyapadiya* as well as modern discipline of communication in order to visualize a Bharatavarshiya/Hindu perspective on communication (Adhikary, 2003, 2007, 2008, 2009, 2010a, 2010b, 2010c, 2010d, 2011a, 2011b, 2011c, 2012a, 2012b, 2013).

The term *sadharanikaran* is derived from the Sanskrit word *sadharan*; and has been translated into English as "commonality" (Misra, 2008, p. 18), "generalized presentation" (Vedantatirtha, 1936, p. 35), "simplification" (Yadava, 1998, p. 187), and "universalization" (Dissanayake, 2006, p. 4). There may be different ways to define it⁸, but, As Yadava (1998) observes, "Conceptually it means achieving oneness or commonness through sharing" (p. 187). In the tradition of *Natyashastra*, *sadharanikaran* is understood as that point in the climax of a drama when the audience becomes one with the actor who lives an experience through his/her acting on stage and starts simultaneously reliving the same experience. The process has been described as *rasaswadana*. When *sadharanikaran* happens, sharing or commonness of experience takes place in full form. The essence of *sadharanikaran* is to achieve commonness or oneness among the people.

Sadharanikaran, as the communication process, consists of *sahridayas* as the communicating parties. As a technical term, the word "sahridays" refers to people with a capacity to send and receive messages. They are the parties who are engaged in communication and capable of identifying each other as the sender and receiver of the

8 Misra (2008) says, "*Sadharanikarana* is a very difficult term and in my opinion, it has not been explained properly. In a significant way, there is more confusion than explanation of this *sadharanikarana*. *Sadharanikarana* is not generalization, but is the expansion of the self at the cost of the self itself, and it is death of all the mental states in which one's mental state is merged. This expansion or this merger is brought out by certain known and yet unrealized forms, by words, gestures, melodies patterns, figures or structures, whatever they may be." (p. 143)

process. A *sahridaya* is a person in such a state of emotional intensity, which is coequal or parallel to that of other(s) engaged in communication. Ideally, the term refers to such persons who are not only engaged in communication but also have attained a special state: *sahridayata*. As such, a *sahridaya* is one who has attained *sahridayata*. Thus, *sadharanikaran* is the process of attaining *sahridayata*, and the SMC illustrates the process.

In brief, a Bharatavarshiya/Hindu perspective on communication—with reference to the SMC—can be presented as follows:

- Hinduism envisions the notion of a non-linear, two-way communication process resulting in mutual understanding of the communicating parties. In this light, the SMC envisions communication for communion. *Sahridayata* is the core concept upon which the meaning of *sadharanikaran* resides. Communicating parties become *sahridayas* with the completion of the process of *sadharanikaran*.
- In Bharatavarshiya/Hindu society, complex hierarchies of castes, languages, cultures, and religious practices are prevalent. Despite these, successful communication is possible. *Sahridayata* helps those communicating to pervade the unequal relationship that prevails in the society, and the very process of communication is facilitated.
- The interrelationship between the communicating parties is of crucial importance. Here, not the cause of the relationship but the relationship itself is significant. For instance, the *guru-shishya* relationship is always considered sacred in itself. There is no dominance by the sender; rather, there is equal importance to both the communicating parties.
- *Abhivyanjana* (expressing or encoding) and *rasaswadana* (understanding or decoding) are considered the fundamental activities in communication. In other words, they are decisive junctures in *sadharanikaran* (communication).
- The Hindu mode of communication emphasizes more on internal or intrapersonal activity. Communication involves more experience within than objective rationality of the sensory organs.
- The intended meaning of any message can be ascertained due to the *sandarbha* (context) without determining the actual intention in the mind of the speaker. Thus, due to the context, a text can retain its objective meaning.
- The scope of communication from Hindu perspectives is broad. As envisioned in the model, communication is broader enough to deal with all of the three dimensions of life: *adhibhautika* (physical or mundane), *adhidaivika* (mental), and *adhyatmika* (spiritual). In social or worldly context, communication is such a process by which, in ideal conditions, humans achieve *sahridayata*. In mental context, communication is the process of gaining true knowledge as well as similar mutual experience. But that is not the whole story; it has spiritual dimension, too.

- The goal of communication as envisioned in Hinduism is certainly achieving commonness or mutual understanding. But the goal would not be limited to just this extent. Just as Hinduism always emphasizes to achieve all of the *purushartha chatustayas* (i.e., four goals of life: *artha*, *kama*, *dharma* and *moksha*), the model also conceives communication capable of attaining all these goals. Thus, the model is in perfect consonance with the Hindu worldview.

Sanchar, as envisioned in the SMC, has already been proved as a means for attaining *moksha* (Adhikary, 2007, 2010b, 2010c). Considering the tradition that *yoga* refers to any system or method for the attainment of *moksha* and already establishing *sanchar* such a means, there is nothing for not considering *sanchar* as *yoga*. Thus, it is evident that the process of communication (*sanchar*) can be accepted as a kind of *yoga* provided that the process results in the attainment of *moksha*. Hinduism has set *moksha* as the highest of *purushartha chatustaya* (four goals of human life) and has introduced different paths, that is, different kinds of *yoga*, for the attainment of *moksha*. The *sancharyoga* is an addition in this regard (ibid).

Thus, communication, as envisioned in the SMC, qualifies not only as a process of *sadharanikaran* in worldly settings but also as a means for attaining *moksha*-in-life. In addition, it has been established that the process of communication (*sanchar*) can be accepted as a kind of *yoga*. This provides sufficient ground for the communication discipline to qualify for being considered as a *vidya* in Bharatavarshiya/Hindu milieu.

Approaching communication as a *vidya* does not imply to discard the *avidya* aspect. As mentioned above, the Hindu mode of communication deals with all of the *adhibhautika* (physical or mundane), *adhidaivika* (mental), and *adhyatmika* (spiritual) dimensions of life. Whereas the communication discipline is *avidya* in the physical and mental domains, it becomes a kind of *vidya* by incorporating the notion of *sancharyoga*. The co-existence of *vidya* and *avidya* aspects in the communication discipline (*sancharshastra*) does not invite any contradiction or problematic situation; rather, it heightens the significance of the discipline in Hindu orthodoxy. Because one who knows *vidya* and *avidya* together attains immortality through *vidya* by crossing over death through *avidya* ("*Vidyamchavidyam cha yastadveda ubhayam saha, Avidyaya mrityum tirtva vidyayaamritamashnute*" —*Ishavasya Upanishad*-11).

Sahridayata: Communication for communion

Sahridayata is a state of common orientation, commonality or oneness. *Sadharanikaran* is the attainment of *sahridayata* by communicating parties. When senders and receivers accomplish the process of *sadharanikaran*, they attain *sahridayata* and become *sahridayas*. In other words, communicating parties, for e.g., actor and audience, become *sahridayas* when they are engaged in a communicative relation leading to the attainment of *sahridayata*; and it is in this stage *sadharanikaran* is accomplished. Thus, the essence of *sadharanikaran* is to achieve mutual understanding,

commonness or oneness among the people. Here, communication results in communion.

The concept *sahridayata* comes from the word *sahridaya*. Whereas the former refers to a quality, characteristic, or state of being or becoming, the latter names a person of that faculty. Thus, a *sahridaya* is one who has attained *sahridayata*.

As Misra (2008, p. 97) rightly analyzes, the word *sahridaya* has two components: *saman* (same, equal, harmony, being) and *hridaya* (heart, becoming). He draws on the following Rigvedic sutra to clarify its meaning: "*Samani va aakutih saman hridayanivah saman mastu somano yatha vah susahasatih,*" that is, "let our minds be in harmony, our hearts be in harmony, let our thinking be in harmony, our thought processes be in harmony so that we can live for a meaningful living of all-together".

Also, Misra (2008) draws on "Samanjasya Sukta" (*Atharvaveda* 6.64):

Live in harmony, in accord with each other, understanding each other, suffused with each other, with your hearts mingling as the Gods did, in the earlier times with an understanding of their interrelationship. That the Gods also desire that the mantras of the humans be the same. Similarly their meetings and interaction and being are same comprehending all their vows, their consciousness pervading them is the same. Men invoke the Gods, with the same voice and vision, we invoke you, and supplicate you, let the same consciousness flow through us that our thoughts are the same, our hearts are the same and our minds are the same, so there can be greater accord between you and us. (qtd. in p. 72)

Misra emphasizes the need to understand the role of *vak* in the Hindu context of emotion in order to understand the Hindu poetic experience and the concept of *sahridaya* (p. 69). He has also drawn on two other concepts—*sakhya*, participatory communion, and *samvad*, a sounding together—while delineating the meaning of *sahridayata*.

Vedic teaching "Be humane and humanize others" (*Rigveda*–10.53.6) is significant for understanding *sahridayata*. As Saraswati (2001, pp. 35-36) observes, Vedas instruct humans "that all people should be mutually bound with each other; each one affectionately attracting the other, the way a cow showers her love and affection for her new-born calf" (*Atharvaveda*–3.30.1). And, everyone should look upon each other with a friend's eye (*Yajurveda*–36.18).

Sahridayas have "common sympathetic heart" (Yadava, 1998, p. 188). In such background, *sahridayata* can be considered as "social preparedness" that "entails living amongst people, sharing their joys and sorrows but encompassing the entire humanity within, becoming a citizen of a world" (Misra, 2008, p. 93). With such preparedness, universalization of *bhava* is possible and *rasa* experience is successful.

Aspects of *sahridayata* have been one of the major concerns of Sanskrit literary criticism. Kalidasa, Abhinava, Bhavabhuti, and Kuntaka, including others, have discussed about *sahridaya* and *sahridayata*, and emphasized on combination of both 'being' and 'becoming' in this regard.

Joshi (2001) has drawn on Abhinavagupta, who portrays the poet and the reader as components of one universe:

The poet, poetic activity and *sahridaya* form the three aspects of one universe, the world of artistic creation (*Kavya-samsara*). Abhinavagupta describes the poet and the *sahridaya* as the twin aspects of the goddess of learning. At one end of creative activity is the poet and at the other is the appreciator. The poet creates the world of poetry and the *sahridaya* enjoys it. (p. 101)

Whereas the poet is concerned with 'creation' of message, the appreciator is concerned with its appreciation. In fact, 'creation' and 'appreciation' are interrelated. It is *sahridayata* that keeps the poet (sender) and the reader (receiver) in the 'universe' and they become able to share the poem (message).

For Kalidasa, as Misra (2008) observes, *sahridayata* is to become *pariyutsuk*, that is,

to be quickened to the ebb and flow of life. It is neither to give visual pleasure, nor to feast to the tune of pleasurable sound, it is an angst, an agitation which dislocates through its pain, the person comfortably ensconced in his genial environment, through, quickening him for a moment to the call and the pull from afar, as empathy is inevitable. (p. 94)

In this situation, "there is always a possibility of the mite of individual existence being driven away to merge with the universal desire" (ibid.).

For Bhavabhuti, *sahridayata* is the consciousness (*chaitanya*) given to the heart to experience joys and sorrows (p. 95). For Kuntaka, a *sahridaya* not only "can hear all the pulses, all the heartbeats that the outer world offers, "but also" can conjoin the two impulses together of the excessive attachment of lover and the excessive detachment of the yogi" (pp. 101-102). Ideally, "Whoever is *sahridaya* has an intense concentrated memory, meditative *dhyana-yoga*, intellect, intense luminosity of creative and receptive faculty and the universe dissolves into this light to open anew" (Misra, 2008, p. 92).

In sum, *sahridayata* should be understood as

a poetic expression used for being or having common orientation. *Sahridaya* is not coterminous with predisposition in favor or against. It is much more than personality characteristics. It means identification of the 'communicator' with 'receiver' of communication. ...

The postulate is that the greater the identification the greater is the success of communication. (Yadava, 1998, p. 188)

It is culture that provides the basis for *sahridayata*. "This notion of *sahridaya* is not an elitist notion as even an illiterate or a rustic person can imbibe the quality" (Misra, 2008, p. 16). Thus, it is not something exclusive. However, it is not that anyone in any condition can become a *sahridaya*. The role of culture is crucial in the attainment of *sahridayata* and becoming of *sahridaya* (p. 101-102, 114).

Treating *sahridayata* as a state of being and becoming, which is within the reach of commons, seems in consonance with the Hindu worldview. It is not an exclusive faculty; however, it certainly has prerequisites. Culture sets the foundation of *sahridayata* on which an individual has to undergo a natural course of evolution.

The concept of *sahridayata*, along with the concept of *rasa*, should not be limited in the domain of drama, poetry and aesthetics only. These concepts can be, and, in fact, have been, interpreted in the domain of modern communication discipline (Adhikary, 2010d). In this course, the concept of *sahridayata* has been redefined and reinterpreted in order to designate the term for particular purpose in theorizing communication from Hindu perspective and presenting a model (the SMC). Thus, *sahridayata* is treated as a 'construct'—a combination of concepts, but with contextual import (ibid.).

Bharatavarshiya/Hindu society is made up of complex relationships consisting of various—sometimes even conflicting—factors such as hierarchies of castes, social status, languages, cultures, and religious practices. In this background, asymmetrical relationships between communicating parties are prevalent in most of the cases. However, Hindus of different castes, social status, languages, cultures and religious cults are capable of enjoying the very process of communication. Hindus have been able to receive and understand diverse, even contradictory, perceptions. Moreover, the ethics as conceived in Hinduism also envisions communion between communicating parties.

It implies that there exists *something* that is binding the people and facilitating communication. Any model of communication, which claims to be of Hindu perspective or worldview, should be capable of identifying and incorporating that factor. In the SMC, the term *sahridayata* has been used to represent that factor, which binds the people as the communicating parties and facilitates the process of communication.

The introduction of the term *sahridayata* into communication is essentially due to its qualification in this regard. What had been said regarding *sahridaya* and *sahridayata* in the context of poetry is clearly sufficient for generalization to any form of communication. As it is done in other scientific disciplines also, there involves reinterpreting and/or redefining of the concept(s) and developing construct(s).

Whereas the concept(s) of *sahridayata* discussed and delineated in various Sanskrit texts envision an ideal state of being and becoming, the term as a 'technical term' in the SMC has been used in broader sense, and "refers to people with a capacity to send and receive messages" (Adhikary, 2009, p. 74). Though ideally (as concept as

discussed earlier) *sahridaya* is a person not only engaged in communication but also having attained a special state (*sahridayata*) it is not the only case in the framework of the SMC. Here, any parties engaged in communication and capable of identifying each other as sender and receiver of the process are also considered the *sahridayas*. It is to emphasize here that the SMC incorporates both the ideal (former) and general (latter) meanings of *sahridayata*.

In brief, *sahridayata*, as a 'technical term' or the 'construct', represents a wide range of relationship between communication parties. In the broadest sense, *sahridayas* are any such people who have capacity to send and receive messages. However, ideally, *sahridayata* is the state of common orientation, commonality or oneness, and *sahridayas* are those who have attained this state.

In the SMC, *sahridayata* provides explanation on how different communicating parties become able to pervade the unequal relationship that prevail in the society and the process of communication is facilitated. In other words, the term is meant to embody the sum of all those factors due to which the asymmetrical relationship between communicating parties does not hinder the two-way communication and hence mutual understanding. And, this approach of communication for communion certainly contributes to the peace prevailing in society (for further discussion, see: Adhikary, 2012b).

Theorizing Gandhi's communication

The reverence Gandhiji earned from the people made him "Mahatma" and that reverence came from the trust people had over him. He based his movement "on the highest values and concepts which only saints have upheld" (Das, 1979, p. 208). His attempts "to reconcile the often coarse demands of political struggle with higher principles of religious and moral belief" (Cortright, 2007, p. 21) is noteworthy here. Mahatma Gandhi embodied "a highly credible, saintly, moral authority who influenced others through his daily acts and simple presence" (Singhal, 2010, p. 105).

As Das (1979) observes, Mahatma Gandhi's emergence

rested on certain values and concepts, which were in consonance with the inner ethos of a traditionally religious society in which even the most illiterate and the ignorant were conscious of the distinction between the right and wrong, virtue and vice, morality and immorality, trust and betrayal, and courage and timidity. (p. 189)

Mahatma Gandhi "stood for a simple and, more or less, self-sufficient living in the rural surroundings" (Narayan, 1976, p. 57). Gandhiji's movement "was a movement with the support of the mass of the most miserable and the down-trodden who constituted the real India" (Das, 1979, p. 208). He "started with the masses and tested his principles in terms of their welfare. His was a genuine mass line" (Sethi, 1978, p. xiv of Introduction). As Yadava (1998) observes,

He adopted 'Mass-line' approach to educate and mobilize millions of people for freedom struggle. This he did despite poor means of mass communication. ... Gandhiji succeeded in communicating with the masses through the mass-line of the Congress workers at various levels occasionally aided with his small journals and publications. In certain places and situations folk forms of entertainment and communication facilitated the process of bringing home the concept of national freedom even to the single village folks. (pp. 185-186)

With various strategies for *Sadharanikaran*, such as employing religious and cultural connotations, use of religious and cultural symbols and rituals, employing the fast and silence as tools of communication, emphasis on the *charkha* and wearing particular type of clothes,⁹ Mahatma Gandhi successfully created *Sahridayata* with the vast masses of then India. For instance,

The *charkha* (or "spinning wheel") although materially a hand-cranked spinning device used to make thread and yarn, represents a rich metaphor of Gandhian communicative wisdom: a non-verbal symbol of village labor, human dignity, self-reliance, self-discipline, social cohesion and mobilization, as also standing for actionable participation, protest, and progress.

The *charkha* also symbolized Gandhi's emphasis on "putting the last first," an unequivocal belief in the well-being for the poor, the marginalized, and the overlooked. (Singhal, 2010, p. 104)

Gandhiji universalized each of his concepts which were begun in narrower contexts (Sethi, 1978, p. 47). "He broke all barriers, territorial, social, religious, etc" (ibid.), and this is why he could get *sadharanikaran* in effect. Again to quote Yadava (1998),

It is well-nigh impossible to sum up Gandhian approach to communication in a few sentences. However, essentially Gandhiji followed the mass-line approach to communication, identifying himself with the masses, turning his personal experience into public programme, adopting simple language and using parables, proverbs and quotations from *Bhagavad Gita*, *Ramayana* and other sacred

9 In *Natyashastra* tradition, Gandhi's acts of employing religious and cultural connotations, use of religious and cultural symbols and rituals, wearing particular type of clothes etc. can be understood as the *Vibhava* which is crucial component in the process of *Rasaswadana*. It is to note that, according to Bharata, *Rasa* emerges from the combination (*samyoga*) of *Vibhava*, *Anubhava* and *Vyabichari Bhavas*.

scriptures. His salt *Satyagrah* is an excellent example of communicating effectively with masses. By undertaking *Dandi March* and defying British control over salt, an item of daily consumption in every home, Gandhiji in a masterly manner conveyed opposition to foreign rule and need for home rule to millions of people throughout the country. His fasts and even silence were exercised in communication with people (p. 186).

Yadava observes that "Gandhiji identified himself with the masses, becoming *Sahridaya* with masses, thereby succeeded in having effective communication with them" (p. 188).

When the *Sadharanikaran* Model of Communication and the core concept of this model (that is, *Sahridayata*) are understood in continuum with Mahatma Gandhi's concepts of *Satyagraha* and *Ahimsa* (nonviolence), theorizing Gandhian communication practices through the SMC certainly seems rational. A *Satyagraha* can be seen as an act of communication, and hence all the activities conducted during the *Satyagraha* bear communication dimension.

In Gandhian context, *Satyagraha* "is a process of educating public opinion, such that it covers all the elements of society" (Jain & Matukumalli, 1996). Gandhi's *Satyagraha* consists of "an ongoing task of communicating well: sharing, cooperating, building desire and determination to communicate, developing and refining skills, giving commitment constitute praxis of the first order" (Starosta & Shi, 2007, p. 12).

It is pertinent here to observe the non-violent resistance practiced by Gandhiji and his followers from communication perspective. According to Gregg (1938),

Non-violent resistance is in effect a sort of language, a means of communicating feelings and ideas. It uses the expression of the face, glances of the eye, tones, intensities and modulations of the voice movements and postures of the limbs and body,—just as in all personal communication. In prolonged situations it may also use writing and printing. Its means of expression are as ample as those of any language. Even in situations where words can be used little or not at all, conduct alone may be a rapid, accurate, and efficient means of communication (pp. 54-55).

Later on, Gregg writes: "Non-violent resistance, followed up with moderate wisdom, offers a solution which gives satisfactory scope for the energies of both parties" (Gregg, 1938, p. 66), and "it enhances their energies, as a result of the subsequent good feeling".

Thus, the similarity of broad theoretical outlook between the *Sadharanikaran* Model of Communication and the Gandhian concept of *Satyagraha* is self-revealing. Similarly, there is conceptual resemblance between *Sahridayata* as envisioned in the

SMC and Ahimsa as envisioned by Gandhiji. In Gandhian communication, *Ahimsa* can be considered humans' "greatest instrument for achieving fraternity ... by which social fabric is made" (Sethi, 1978, p. 37). In this process, *Ahimsa* can be understood as "positive love" (Cortright, 2007, p. 12). Further research will shed light on the similarity of worldview between *Sahridayata* and *Ahimsa*.

Concluding remarks

As a discipline of knowledge, "communication needs all the theorization it can get" (Cobley, 1996, p. 32). Studying Mahatma Gandhi's life and works "from the disciplinary lens of communication" (Singhal, 2010, p. 103) certainly enriches the discipline in this regard. Though communication scholars have been approaching Gandhi from communication perspective their endeavors so far are yet to develop Gandhian theory and model of communication. Meanwhile, it seems that Mahatma Gandhi's way of communication can be theorized by the *Sadharanikaran* model of communication (SMC). At least, this model provides the basis for theorizing communication from Gandhian perspective.

References

- Adhikary, N.M. (2003). *Hindu awadharanama sanchar prakriya [Communication in Hindu concept]*. A dissertation presented to Purvanchal University, Nepal in the partial fulfillment of the requirements for the Degree of Master of Arts in Mass Communication and Journalism.
- Adhikary, N.M. (2007). *Sancharyoga: Verbal communication as a means for attaining moksha*. A dissertation presented to the Faculty of the Graduate School of Pokhara University, Nepal in the partial fulfillment of the requirements for the Degree of Master of Philosophy.
- Adhikary, N.M. (2008). The *sadharanikaran* model and Aristotle's model of communication: A comparative study. *Bodhi: An Interdisciplinary Journal*, 2(1), pp. 268-289.
- Adhikary, N.M. (2009). An introduction to *sadharanikaran* model of communication. *Bodhi: An Interdisciplinary Journal*, 3(1), pp. 69-91.
- Adhikary, N.M. (2010a). *Explorations within: Theorizing communication and positing media ethics paradigm from Hindu perspective*. Paper presented at the Media Research Conference, March 25-26, Kathmandu, Nepal.
- Adhikary, N.M. (2010b). Communication and *moksha-in-life*. *Ritambhara: Journal of Nepal Sanskrit University Research Center*, 14, pp. 183-195.
- Adhikary, N.M. (2010c). *Sancharyoga: Approaching communication as a vidya in Hindu orthodoxy*. *China Media Research*, 6(3), pp. 76-84.
- Adhikary, N.M. (2010d). *Sahridayata* in communication. *Bodhi: An Interdisciplinary Journal*, 4(1), pp. 150-160.
- Adhikary, N.M. (2011a). Theorizing communication: A model from Hinduism. In Y.B. Dura (Ed.), *MBM anthology of communication studies* (pp. 1-22). Kathmandu: Madan Bhandari Memorial College.
- Adhikary, N.M. (2011b). *Sanchar mimamsa*. Kathmandu: Media Educators' Association of Nepal.

- Adhikary, N.M. (2011c). *Athato sanchar-jijnasa: The sadharanikaran model of communication*. A paper presented at the International Conference on Diversity and Plurality in Media: Reflections of Society, December 27-28, Bhopal, Madhya Pradesh, India.
- Adhikary, N.M. (2012a). Indigenous theorization of communication. *Rural Aurora*, 1, pp. 172-181.
- Adhikary, N.M. (2012b). Hindu teaching on conflict and peacemaking. In L. Marsden (Ed.), *Ashgate research companion on religion and conflict resolution* (pp. 85-104). Farnham, Surrey (UK): Ashgate Publishing.
- Adhikary, N.M. (2013, forthcoming). *Theory and practice of communication: Explorations from Natyashastra of Bharata*. Bhopal: Makhanlal Chaturvedi National University of Journalism and Communication.
- Beatty, M.J., Behnke, R.R. & Banks, B. J. (1979). Elements of dialogic communication in Gandhi's second round table conference address. *Southern Speech Communication Journal*, 44(4), pp. 386-396.
- Bode, R.A. (1992). Gandhi's non-violent rhetorical perspective. *North Dakota Journal of Speech and Theatre*, 5(1), pp. 39-55.
- Bode, R.A. (1994). Gandhi's theory of nonviolent communication. *Gandhi Marg: Quarterly Journal of the Gandhi Peace Foundation*, 16(1), pp. 5-30.
- Bode, R.A. (2000). A Gandhian perspective on communication and communicators: Unique assumptions and ethical standards. *Journal of the Northwest Communication Association*, 29, pp. 32-40.
- Carlson, A.C. (1986). Gandhi and the comic frame: "Ad Bellum Purificandum." *Quarterly Journal of Speech*, 72(4), pp. 446-445.
- Chakravarty, N. (1995). Mahatma Gandhi: The great communicator. *Gandhi Marg: Quarterly Journal of the Gandhi Peace Foundation*, 16(4), pp. 389-397.
- Chaudhari, A.G. & Starosta, W.J. (1992). Gandhi's salt march: A case study of *Satyagraha* with rhetorical implications. *World Communication*, 21(1), pp. 1-12.
- Cortright, D. (2007). *Gandhi and beyond: Non-violence for an age of terrorism*. New Delhi: Viva Books.
- Das, M.N. (1979). Emergence of Gandhi in Indian politics: A review of value and concepts. In B.C. Das and G.P. Mishra (Eds.), *Gandhi in to-day's India* (pp. 189-208). New Delhi: Ashis Publishing House.
- Dissanayake, W. (2006). Postcolonial theory and Asian communication theory: Toward a creative dialogue. *China Media Research*, 2(4), pp. 1-8.
- Jain, N.C. (2000). Gandhian concept of human rights and responsibilities. *Education in Asia*, 20(1), pp. 23-27.
- Galtung, J. (1989). Principles of nonviolence: The great chain of nonviolence hypothesis. *Nonviolence and Israel/Palestine* (pp. 13-33). Honolulu: University of Hawaii Press.
- Gonsalves, P. (2010). *Clothing for liberation: A communication analysis of Gandhi's swadeshi revolution*. New Delhi: Sage.
- Gregg, R.B. (1938). *The power of non-violence*. Adhmedabad: Navajivan Press.

- Jain, N.C. & Matukumalli, A. (1996). The role of silence in India: Implications for intercultural communication research. *Education in Asia: Journal of the Asian Academy of Education and Culture*, 16(2-4), pp. 152-158.
- Joshi, N. (2001). *Some aspects of Sanskrit literature and literary criticism*. Delhi: Eastern Book Linkers.
- Kumar, K.J. (1984). Gandhi's ideological clothing. *Media Development*, 31(4), pp. 19-21.
- Merriam, A.H. (1975). Symbolic action in India: Gandhi's non-verbal persuasion. *Quarterly Journal of Speech*, 61(3), pp. 290-306.
- Misra, V.N. (2008). *Foundations of Indian aesthetics*. Gurgaon, Haryana: Shubhi Publications.
- Naess, A. (2005). Gandhian nonviolent verbal communication: The necessity of training. *Gandhi Marg: Quarterly Journal of the Gandhi Peace Foundation*, 27(1), pp. 89-99.
- Narayan, S. (1976). *India needs Gandhi*. New Delhi: S. Chand & Co.
- Prasad, K. (2003). Gandhian theory of political communication. In K. Prasad (Ed.), *Political communication: The Indian experience* (Vol. 1, pp. 43-72). Delhi: B.R. Publishing.
- Rothermund, I. (1993). The Gandhian pattern of communication. In K.S. Nair and S.A. White (Eds.), *Perspectives on development communication* (pp. 81-88). New Delhi: Sage.
- Santonis, A. (2006). Gandhian ethics: Non-violence, religion and communication. *Journal of the Asian Research Center for Religion and Social Communication*, 4(1), pp. 62-76.
- Saraswati, S.V. (2001). *Vedic concept of God*. Delhi: Vijayakumar Govindaram Hasananda.
- Sastri, G. (1991). Sanskrit poetics. In S.K. Chatterji (Ed.), *The cultural heritage of India, Vol. V, Languages and literatures* (pp. 293-302). Calcutta: The Ramakrishna Mission Institute of Culture.
- Sethi, J.D. (1978). *Gandhi today*. New Delhi: Viva Publishing House.
- Singhal, A. (2010). The Mahatma's message: Gandhi's contributions to the art and science of communication. *China Media Research*, 6(3), pp. 103-106.
- Singh, K.J. (1979). Gandhi and Mao as mass communicators. *Journal of Communication*, 29(3), pp. 94-101.
- Starosta, W.J. & Chaudhari, A.G. (1993). I can wait 40 or 400 years: Gandhian *Satyagraha* west and east. *International Philosophical Quarterly*, 33(2), pp. 163-172.
- Starosta, W.J. & Shi, L. (2007). Alternative perspective on Gandhian communication ethics. *China Media Research*, 3(4), pp. 7-14.
- Vatsyayan, K. (1996). *Bharata: The Natyashastra*. New Delhi: Sahitya Akademi.
- Vedantatirtha, N.C. (Gen. Ed.). *Mammata Bhatta's Kavyaparakasha*. The Calcutta Sanskrit Series No. VI.
- Wilkins, L. (2009). Mohandas Gandhi: Fellowship of power. In C.G. Christians and J.C. Merrill (Eds.), *Ethical communication: Moral stances in human dialogue* (pp. 173-179). Columbia: University of Missouri Press.
- Yadava, J.S. (1998). Communication research in India: Some reflections. In J.S. Yadava & P. Mathur (Eds.), *Issues in mass communication: The basic concepts* (pp. 177-195). New Delhi: Indian Institute of Mass Communication.

Current Status and Recent Trends of Abortion Service Utilization in Two Facilities of Chitwan District

Dinesh Kumar Malla

Birendra Multiple Campus, Tribhuvan University, Bharatpur, Chitwan
Email: dineshmalla13@yahoo.com

Abstract: *The purpose of this study was to assess the trend of abortion in FPAN, Chitwan and MSI, Narayangargh, Chitwan from 2008 to 2012, and to find out the characteristics of women who received abortion service from the two facilities in 2012. Altogether 2156 clients—606 from FPAN and 1550 from MSI—were studied. Data were analyzed using statistical package for social science version 16 and frequency, percentages were calculated. The number of abortions declined from 1068 to 682 and 2936 to 2013 in FPAN and MSI, respectively over the period of last five years. It was found that 46% of those who received abortion in FPAN and 48% in MSI were women from upper castes, followed by the disadvantaged group and Janjatis—33% and 26%, respectively. In FPAN and MSI, the highest percentage—33% vs 37% and 31% vs 33%—of those who received abortion were the women with SLC and above level of education and women with secondary level of education, respectively. Women having two or more children shared 68% of abortions in FPAN and 57% in MSI. Regarding the family planning methods accepted after abortion, 23% did not accept any in FPAN, while the proportion in MSI was 75%. Acceptance of condom, pills, and depo together was 34% and only 5% accepted long-term contraception, i.e., intrauterine device/ implant. It was the first abortion for 66%, second for 27%, and third or more for 8% of women. In FPAN, 58% of abortions were conducted between 6-7 weeks of gestation period, followed by 15% between 8-9 weeks of gestation period, the proportion in MSI was 62% and 22%, respectively.*

Keywords: *Abortion, prevalence, Chitwan.*

Introduction

The two targets identified by WHO for assessing progress in improving maternal health (MDG 5) are: reducing the maternal mortality ratio (MMR) by three quarters between 1990 and 2015 and achieving universal access to reproductive health by 2015 (WHO, 2011).

Among the 210 million women estimated to become pregnant each year worldwide, 80 million of the pregnancies are unintended (WHO, 2012). Globally, unsafe abortions account for 67900 maternal deaths annually (13% of total maternal mortality) and significantly contribute to morbidity among women. Deaths from unsafe abortions are preventable by the provision of safe and accessible abortion care. In Nepal, twenty-seven percent of currently married women have an unmet need for family planning, with 10 percent having an unmet need for spacing and 17 percent having an unmet need for limiting. Fifty percent of women have an unmet need for family planning (MoHP, 2012).

The uptake of modern contraceptive methods worldwide has slowed in recent years, from an increase of 0.6 percentage points per year in 1990–1999 to an increase of only 0.1 percentage points per year in 2000–2009. An estimated 215 million women in

the developing world have an unmet need for modern contraceptive (Guttmacher Institute, 2012).

Abortion has been legalized in Nepal since September 2002 and under this law, Comprehensive Abortion Care (CAC) service is being provided through listed service providers and health facilities since 2004. Abortion services have continued to expand over the years. By the end of 2009, there were 286 clinics, representing the public, non-governmental organizations (NGOs), and private/commercial sectors providing abortion services (Thapa *et al.*, 2012). According to Nepal Demographic and Health Survey 2011, only 38 percent of women between 15-49 years of age believed that abortion in Nepal is legal. Nearly two-fifths of women did not know under what circumstances abortion in Nepal was legal, especially the women in rural areas, who had no education and who fell in the lowest wealth quintile (MOHP, 2012).

Nearly 59% of women of Nepal in the age group of 15-49 years knew a place where a safe abortion could be obtained. Regarding the places that provide safe abortion reported by women, government sector was mentioned by 71%, private sector by 58% and non-government sector by 29%. Knowledge of a safe abortion place was higher among urban, educated, and wealthier women (MOHP, 2012). Among non-government organizations, Marie Stopes International (MSI) is the largest provider of contraceptive services across the nation. In 2011 MSI performed more than 75% of all safe abortions in Nepal and prevented 65000 unsafe abortions (MSI, 2013).

In one study of Nepal done among women attending a hospital for induced abortion, the median age was 26, and most women were married with an average of two living children. Already having the number of desired children was the primary reason for termination of pregnancy for nearly three out of five women. 42% cited finances as the reason for abortion. About two-fifths reported of having used a modern contraceptive method at the time the unwanted pregnancy occurred (Thapa *et al.*, 2010).

The Family Planning Association of Nepal (FPAN), Chitwan and MSI, Narayangarh, Chitwan are the two facilities that provide the CAC service to a very large proportion of the total clients in the district. A study using the records of the clients could reflect upon the characteristics of the clients of the district. This study identified the trend and the characteristics of women who have had abortions at these services. In addition, differences in the abortion service utilization in terms of ethnicity, educational status, age, contraceptives use in the last 6 months, etc, identified the group seeking for more abortion. This would help prioritize the population for family planning and abortion services.

Methodology

This study describes the characteristics of women of Chitwan district who had received abortion from the study facilities in 2012. Two centers providing abortion

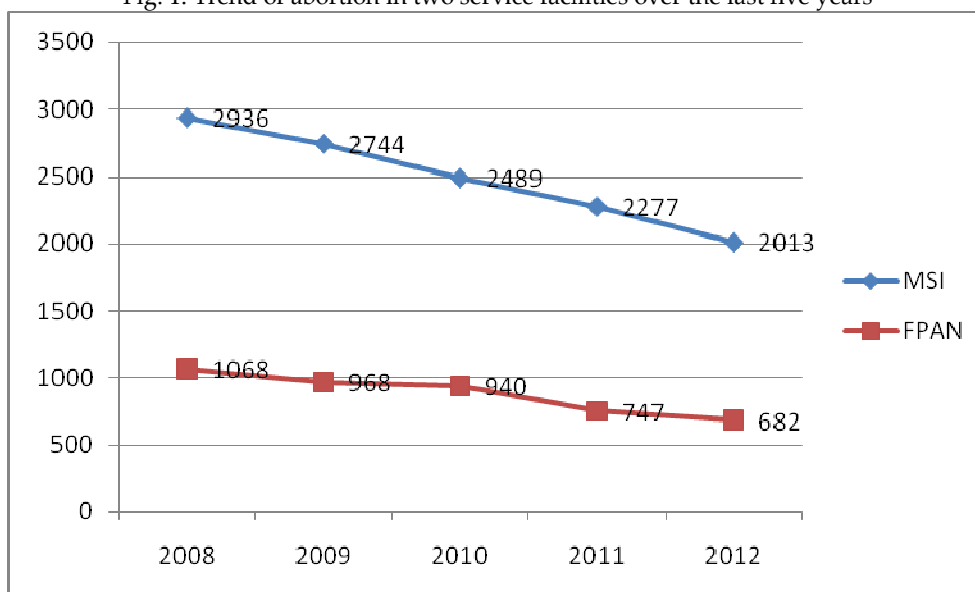
services, i.e., FPAN and MSI based in Bharatpur municipality of Chitwan district were studied. For assessing the trend, the total number of abortions conducted during last five years—from 2008 to 2012—from the both centers were taken into account. To determine the characteristics of women who had received the abortions in 2012 from the centers, information of altogether 2156 clients, which is the total number of the recipients of abortion services at both centers, were studied. Therefore, there was no sampling done among the clients.

First, coordination with the district public health office (DPHO), Chitwan, was made. The format of the data collection tool was developed to record required data from the records of the study centers. Data collection was done by the enumerators and the researcher himself. Statistical package for social sciences (SPSS) version 16 was used for data entry and analysis. This study used univariate analysis to meet the study objectives.

Results

The number of abortion clients in FPAN gradually decreased from 1068 in 2008 to 682 in 2012. Similarly, the number of abortions in MSI declined steadily by 923 from 2936 in 2008 to 2013 in 2012. (Fig. 1).

Fig. 1. Trend of abortion in two service facilities over the last five years



Socio-demographic characteristics of women: About 46% and 48% of women from upper castes, followed by 33% and 26% from disadvantaged group and Janjati, received abortion services from FPAN and MSI, respectively. About one third (33%) in FPAN and more than one third (37%) in MSI had SLC and above level of education. An equal

proportion of women (31%), who received abortion in both the centres, had secondary level of education. Only 3% in MSI and 6% in FPAN of the total clients were illiterate mothers. About one third (31% in FPAN and 32% in MSI) of the total abortion cases were done by women in the age-groups of 25-29 years, while women in the age group of 35 and above occupied 17% in FPAN and 12% in MSI. In FPAN 68% and in MSI 57% of the women who had abortion, had two and more children and 7% and 14% of women who received abortion from the two facilities had no child (Table 1).

Table 1. Socio-demographic characteristics of women who had abortion in two centres

Characteristics of women	Abortion Service Centres		
	FPAN	MSI	Total
Ethnicity			
Dalit	66 (11)	133 (9)	199 (9)
Disadvantaged Janjati	199 (33)	398 (26)	597 (28)
Disadvantaged non-dalitterai caste	1 (0.2)	24 (2)	25 (1.2)
Religious minorities	7 (1.2)	9 (1)	16 (1)
Relatively Advantaged Janjati	57 (9.4)	243 (16)	300 (14)
Upper caste group	276 (46)	743 (48)	1019 (47)
Total	606 (100)	1550 (100)	2156 (100)
Educational status			
Illiterate	36 (6)	42 (3)	78 (4)
Literate	84 (14)	338 (22)	422 (20)
Primary (1-5 class)	100 (17)	116 (8)	216 (10)
Secondary (6-10 class)	188 (31)	484 (31)	672 (31)
SLC and above	198 (33)	570 (37)	768 (36)
Total	606 (100)	1550 (100)	2156 (100)
Age groups			
15-19 years	18 (3)	103 (7)	121 (6)
20-24 years	143 (24)	448 (29)	591 (27)
25-29 years	187 (31)	489 (32)	676 (31)
30-34 years	161 (27)	318 (21)	479 (22)
35-39 years	76 (13)	157 (10)	233 (11)
40-44 years	21 (4)	35 (2)	56 (3)
Total	606 (100)	1550 (100)	2156 (100)
Number of children			
No child	42 (7)	220 (14)	262 (12)
One child	154 (25)	443 (29)	597 (28)
Two and more children	410 (68)	887 (57)	1297 (60)
Total	606 (100)	1550 (100)	2156 (100)

Data in parenthesis represent percentage.

Family planning methods accepted after abortion: In FPAN, 23% of clients did not accept any family planning method after the abortion, while three quarters of clients of MSI did not accept family planning methods. The remaining portion was shared by condom (25.4%), pills (17.3%), depo (24%), and others in FPAN and condom (7.4%), pills (8.7%), depo (6.1%), and others in MSI. The proportion of male and female sterilization combined together was only 0.2% in FPAN and 0.4% in MSI (Table 2).

Table 2. Family planning methods accepted after abortion.

FP method accepted	Abortion Service Centres		
	FPAN	MSI	Total
No method accepted	140 (23)	1154 (75)	1294 (60)
Condom	154 (25.4)	115 (7.4)	269 (12.5)
Pills	105 (17.3)	135 (8.7)	240 (11.1)
Depo	146 (24)	95 (6.1)	241 (11.2)
Female/male sterilization	1 (0.2)	5 (0.4)	6 (0.3)
IUD	31 (5.1)	6 (0.4)	37 (1.7)
Implant	29 (4.8)	40 (2.6)	69 (3.2)
Total	606 (100)	1550 (100)	2156 (100)

Data in parenthesis represent percentage.

Frequency of abortion among women receiving abortion from the two centres: It was the first abortion for 69% of women receiving the service from FPAN, and for nearly 65% of women in MSI, followed by second time abortion for 25% and 27% of clients in two centers respectively. It was fourth or more times for 2% and 3% of women respectively (Table 3).

Table 3. Frequency of abortion among women receiving abortion from the two centers

Abortion number	Abortion Service Centres		
	FPAN	MSI	Total
First	418 (69)	1006 (65)	1424 (66)
Second	150 (25)	423 (27)	573 (27)
Third	26 (4)	77 (5)	103 (5)
Fourth and more	12 (2)	44 (3)	56 (3)
Total	606 (100)	1550 (100)	2156 (100)

Data in parenthesis represent percentage.

Gestation period during which abortion service was received: About 58% and 62% of clients had received abortion service between 6-7 weeks of gestation period, and only 6% and 10% had received the service between 10-12 weeks of gestation, from FPAN and MSI, respectively (Table 4).

Table 4. Gestation period during which abortion service was received by women

Gestation period	Abortion Service Centres		
	FPAN	MSI	Total
4-5 weeks	37 (6.1)	84 (5.4)	121 (5.6)
6-7 weeks	350 (57.8)	964 (62.2)	1314 (60.9)
8-9 weeks	93 (15.3)	334 (21.5)	427 (19.8)
10-12 weeks	36 (6)	153 (10)	193 (9)
Bulky	90 (14.9)	11 (0.7)	101 (4.7)
Total	606 (100)	1550 (100)	2156 (100)

Data in parenthesis represent percentage.

Discussion

According to the staff at the both facilities, the number of abortions in both the centers was gradually declining over the last five years, which could be due to the increasing number of abortion service facilities available in the district and an increased availability of emergency contraceptive methods. A study done by World Health Organization also found that the rate of induced abortion has marginally decreased globally from the year 1995 to 2008 (WHO, 2012).

This study found out that the highest portion of abortion was received by women in the age group of 25-29 years. Thapa *et al.* (2010, 2012_b) also found out that the highest portion (31%) of abortion was received by women in this age group. Similar results were also found in a study conducted by Bankole *et al.* (1999).

With respect to the level of education, Thapa *et al.* (2012_b) found out that 41% occupied by women who attended 6-12 class, and 29% by illiterates; whereas figures in this study stood at 67% and 4% respectively. It could be due to the higher educational level and lower illiteracy rate among the general population of the district. Regarding the contraceptive methods accepted by the clients after having abortion, in FPAN, a large proportion (67%) of the clients accepted condom, pills and depo together, only 10% accepted IUD and Implants together. Another study conducted by Ipas also showed similar level of post-abortion contraception use among CAC clients with 39% using condom, followed by depo-provera 21%, pills 15% and others, and about 1 in 5 (19%) clients did not accept any method (Ipas, 2009).

In FPAN, about 23% accepted no modern method of contraception following an abortion, but a much bigger portion of women (75%) who had received abortion service from MSI did not accept any modern contraceptive method following the abortion. Nepal Demographic and Health Survey found out that 41% of women who had an abortion in the five years preceding the survey used a contraceptive method after the abortion (MOHP, 2012).

Thapa *et al.* (2012_a) in their study found out that the incidences of repeat abortion rose sharply with age and parity of 2 and more, and was higher among those who had no intention of having child in the future (16.5%) compared to (42.2%) women with no intention to have children either first or additional, and those attaining a primary or secondary level of education.

Conclusions

The number of induced abortion clients has declined gradually in both the abortion service facilities over the last five years. Almost half of the clients in both the centers were from upper castes/ethnicity, the highest portion of abortion in both centers was received by women having SLC and above level of education. A little more than three fifth of abortions were received between 6-7 weeks of gestation period and less than one percent were conducted after 12th week of gestation. Sixty percent of clients did not accept any modern contraceptive method; sterilization method was accepted by less than one percent; condom/pills/depo-provera together accounted for thirty four percent; and only five percent accepted for long-term contraceptive methods—IUD and Implants. A significant portion of women have had repeat abortion.

Recommendations

Effective counseling to women visiting the facilities for abortion is required to increase the acceptance of modern family planning methods to prevent repeat abortions. This is especially needed to increase FP acceptance in both centers (FPAN & MSI), more so in MSI as their FP acceptance rate is much lower. Long term FP methods need to be focused to prevent repeat and unwanted pregnancies and abortions.

Acknowledgements

I am thankful to University Grants Commission Nepal for their financial support for the study. My sincere thanks to Family Planning Association of Nepal, Chitwan, and Marie Stopes International, Narayangargh, Chitwan for providing the required data for the study. I am also grateful to the District Public Health Office, Chitwan for its cooperation.

References

- Bankole, A., Singh, S. & Haas, T. (1999). Characteristics of women who obtain induced abortion: A worldwide review. *International Family Planning Perspectives*, 25 (2), pp. 68-77.
- DPHO. (2012). Population of Chitwan district, 2010/2011. Chitwan: District Public Health Office (unpublished).
- Guttmacher Institute. (2012). Facts on induced abortion worldwide. Geneva: World Health Organization.
- Ipas. (2009). An exploratory study of complications from comprehensive abortion care, Improvement of the quality of the quality of CAC services in Nepal. Kathmandu: Ipas.

- MoHP. (2011). Annual Report 2009/2010. Government of Nepal, Ministry of Health and Population, Department of Health Services, Kathmandu.
- MOHP, New ERA & ICF International Inc. (2012) Nepal demographic and health survey (2011). Ministry of Health and Population, New ERA, and ICF International, Calverton, Maryland; Kathmandu, Nepal.
- MSI. Where in the world. Accessed on May 25, 2013. Available from <http://www.mariestopes.org/where-in-the-world#nepal>
- Thapa, S., Malla, K. & Basnett, I. (2010). Safe abortion services in Nepal: Initial years of availability and utilization. *Health Popul.*, 11(3), pp. 55-68.
- Thapa, S. & Neupane, S. (2012_a). Risk factors for repeat abortion in Nepal. *Int J Gynecol Obstet.* <http://dx.doi.org/10.1016/j.ijgo.2012.07.016>
- Thapa, S. Neupane, S., Basnett, I. & Read, E. (2012_b). Women having abortion in urban Nepal: 2005 and 2010 compared. *Kathmandu Univ. Med. J.*, 39(3), pp. 8-13.
- WHO. (2011). Unsafe abortion. Global and regional estimates of the incidence of unsafe abortion and associated mortality in 2008. Sixth edition. Geneva: World Health Organization.
- WHO. (2012). Information sheet: Safe and unsafe induced abortion. Global and regional levels in 2008, and trends during 1995-2008. Available from www.who.int/reproductivehealth. Accessed on February, 20, 2013. World Health Organization.

A Conceptual Analysis of World Trade Organization (WTO) and Its Impact on Nepalese Business

Dinesh Mani Ghimire

Central Department of Management, Tribhuvan University, Kirtipur, Kathmandu

Email: dineshmani11@hotmail.com

Abstract: *The Nepalese economy has experienced a major transformation during the decade of the 1990s. After the restoration of democracy, Nepalese politics provided direction towards economic growth of the country. Apart from the impact of various unilateral economic reforms undertaken since 1991, the economy also had to reorient itself to the changing multilateral trade discipline within the newly written GATT/WTO framework. The unilateral trade policy measures have encompassed exchange-rate policy, foreign investment, external borrowing, import licensing, custom tariffs and export subsidies. Trade stimulates economic growth as well as creates employment. The basic principles of the WTO make the system economically more efficient and cut the production and marketing costs. It gives consumers more choice, and a broader range of qualities to choose from.*

Keywords: *World Trade Organization, liberalization, exports, imports, industries.*

Introduction

There are 31 accession negotiations under way and others in prospect for countries that are seeking membership in the World Trade Organization (WTO). Most of these countries are former centrally planned economies, often referred to as economies in transition. Trade policy is currently at a crossroads and so is the trade diplomacy of least developing countries like Nepal. The failure of the "traditional import substitution" policies of the 1950s-1970s has been followed by the failure of trade liberalization by the developing countries in the 1980s and 1990s. Developing countries felt that they had made a greater commitment to liberalize trade than had developed countries, through Uruguay Round Agreements (URAs) and Structural Adjustment Programmes and Stabilization Programmes (Agrawal, 2006).

Nepal looks to the World Trade Organization not only as a vehicle for promoting global trade but also as an institution that ensures fair, just and inclusive trading regime where the concerns and aspirations of all the countries, small and big, rich and poor, are well heard of and listened to. We expect that a fair trading system would help us bring about a structural change in our economy with the promotion of trade which would stimulate growth and help us reduce poverty. We are still waiting for that development dividend from the successful conclusion of this round. For us, that would be a true measure of the development dimension, which would be able to correct the deficit in the existing international trading structure. The Nepal-India treaty of 1950 imposed debilitating socio-economic pressures upon the Nepalese. These come through the high dependency on India even for the supply of daily necessities (Pyakhuryal, 2004).

Economic liberalization, as a part of globalization, has given bitter experiences to Nepal at the initial phase. The privatization of public enterprises, consistent with the overall liberalization in Nepal, did not bring the desired results because of the sloppiness present while executing the task. It rather gave a totally different view of privatization putting the advocates of the policy in an awkward position. As it is, the backlashes of privatized enterprises were there, like anywhere else—the mass retrenchment of workers from their jobs forfeiting their income. This not only hampered their livelihood but also took away their opportunities for better health and education for the family members.

The WTO which stands on a foundation of totally liberalized economic and trade policies, does not mention the traumatic experience that nations have to go through in the process of liberalization. Advocates of privatization of public enterprises console the afflicted ones to forbear the results as only a natural short-term consequence. Many developing countries, including Nepal, have faced the difficulty of observing the liberalization conditions set by the Bretton Woods institutions and supported by the WTO (Smith, 1995). WTO membership because of the likely economic and social disruption an economy could be subjected to if it is unable to afford the cost of liberalization and privatization. Fair prices, right prices, a competitive market, availability of better quality products, access to world resources at relatively lower costs, benefits from expanded opportunities, are some of the brighter aspects of the membership. With the realization of these aspirations, Nepal started its accession negotiations in 1989. The 5th WTO's Ministerial Conference, at Cancún (Mexico), approved the accession package on 11 September 2003 (Stern, 2000). On 24 March 2004, the Government of Nepal notified the WTO that the process of ratification and acceptance of the Protocol of Accession had been completed. According to the established practice, the entry into force of the Protocol occurred 30 days later — on 23 April 2004 (Khadka, 2004).

It is a fact that the least developed countries continue to be marginalized from the mainstream of world economy with a declining share in world trade, investment and output. It should be a matter of great concern to all of us. In today's globalized world, interdependence and inter-connectivity have intensified in an unprecedented manner. We cannot remain aloof from each other. If gains are to be reaped from the multilateral trading system in an equitable manner, there is no denying that the international rules guiding them should incorporate development-friendly provisions and rules which are conducive to promote the share of trade of vulnerable countries thereby reversing the trend of marginalization of the least developed countries. We would like to be part of that globalizing trend, which is inclusive and also caters to the interests of the needy and the poor.

Low level of economic development, structural bottlenecks and grinding poverty has seriously constrained the trading and development capabilities of the LDCs.

Although Nepal had applied for General Agreement on Tariffs and Trade (GATT) membership as early as in 1989, when efforts to renew trade and transit treaty with India had failed, the accession process could not take off. The government decided to re-initiate the membership process in 1995. In the same year, Nepal obtained an observer status in GATT. With the establishment of the World Trade Organization (WTO) to replace the GATT process, the working party established for the GATT accession became the WTO working party and consequently, Nepal submitted the Memorandum on Foreign Trade Regime in July 1998. Queries raised and clarifications sought over the memorandum, by WTO member countries, were answered by Nepal in April 1999. Against this background, the paper examines the opportunities offered by WTO membership that could lead to a higher dynamic path of overall economic development and the underlying challenges (Bhandari, 2005).

One of the benefits of WTO membership is the ability of members to obtain a better understanding of their counter-parts' trade practices by using trade policy reviews. To encourage transparency and measure its impact, the Trade Policy Review Mechanism includes detailed periodic reviews of each member's trade regime. The reviews are based on a policy report that a country submits under examination and a report prepared by a group economists of WTO Secretariat. Over time, these trade policy reviews have proved to be useful in identifying the needs for technical assistance (World Bank, 2009).

One of the functions of the WTO is to resolve the trade disputes that arise among its members. The Dispute Settlement Understanding (DSU), which is another product of the Uruguay Round, had created a better-built and more efficient system for resolving such disputes. The DSU performs its tasks by establishing procedures for consultations, legal arguments before a panel of experts and the opportunity to acquire appellate reassessment. The Dispute Settlement Body (DSB) assumes the responsibility of settling disputes. It also has the sole authority of establishing the mentioned panels to arbitrate the disputes that arise between members as well as to either accept or reject the findings of panels and the Appellate Body – a standing appeals body of seven independent experts (Chadha, 1998).

Economic growth is enhanced and boosted by free-flowing and stable trade; with the potential of creating more job opportunities. It can also assist in the reduction of poverty; and frequently it achieves both ends. The country that decreases its own trade barriers is the one that benefits most. The exporting countries exporting also benefit, yet to a lesser extent. In a number of cases, export sectors employees enjoy higher pay and greater job security; however, previously protected producers and their workers face new competition when trade barriers are decreased where some survive by becoming more competitive and quickly adapting, for example by finding new employment, while others do not (WTO, 2009).

Liberalization under the umbrella of the WTO is the result of negotiations. When countries believe that the necessary adjustments are not constructed, they resist demands to open the relevant sections of their markets. This is not the only factor that led to recent changes in wage levels; in addition, there are a number of other external features that result in the altering of wage levels as well (WTO, 2006f). The alternative to trade protection is expensive as it raises the costs and promotes inefficiency. An OECD calculation argues that imposing a 30% duty on imports from developing countries would actually reduce US unskilled wages by 1% and skilled wages by 5%. Protectionism can partly cause the damage of lower wages in the protectionist country (Brown, 1999).

Nepal has bound its tariff on agricultural goods at an average 42 percent and industrial goods at an average of 24 percent. There is no tariff rate quota. The Aggregate Measurement of Support (AMS) is nil in the schedule, implying that Nepal cannot provide trade and production distorting subsidies above the *de minimis* level of 10 percent. Nepal is also not allowed to provide export subsidies except as exempted by the provisions of special and differential treatment (Pandey, 1999).

In the non-agricultural sector all tariff lines, barring few on cements, petroleum products, arms and ammunition have been bound. The average final bound rate is about 24 percent. Most of the information technology products are bound at zero.

In the services sector, Nepal has made commitments in 11 sectors and 70 sub sectors. Nepal has made horizontal commitment to keep the first three modes of service supply generally unrestricted except for some conditions. The modes 1 and 2 horizontal commitments are limited only by the provision to provide a maximum of \$2000 to Nepali people travelling abroad. It has kept the mode 3 horizontal market access unrestricted and has made a further commitment to make the conditions of ownership, operation and juridical form and scope of activity for foreign suppliers no more restrictive than those prevailing on the date of accession (Statistics, 2009). Likewise, it will accord horizontal national treatment on mode 3 supply except that foreign suppliers will have to obtain permission and approval through well-defined procedures, and that they are not entitled to incentives and subsidies. Nepal has put conditions, largely in the form of limit to foreign equity participation, in the supply of services across the mode 3 in all 53 service sectors, in which it has made some liberalizing commitments.

In addition, Nepal has also made commitments to make its legal regime compatible with the WTO including that related to intellectual property rights. As per the Legislative Action Plan agreed upon by Nepal during its accession to the WTO, Nepal has agreed to amend/enact 38 legislations to make its legal regime compatible with the WTO. Nepal has made commitments to comply with all WTO trade rules latest by the end of 2006. For instance, Nepal has made commitment to fully implement the provisions of Agreement on Technical Barriers to Trade and Agreement on Sanitary and Phytosanitary Measures by 1 January, 2007 (Maskey, 2001).

Table 1. Status of Nepal's accession process to the WTO

Process	Date
Application	May 1989
Working Party Established	June 1989
Memorandum	August 1999
Questions and replies on the Memorandum	June 1999 October 2001
Working Party Meetings	May 2000
Tariff Offers	July 2000 May 2002
Services Offers	July 2000 May 2002
Agricultural Data	September 1998 July 1999

Sources: www.amad.org

Nepal is now at a latter stage of the accession process. The process, particularly for LDCs, is the main issue of interest to Nepal as it guides commitments in market access and other fields. It also determines the starting point for future negotiations. Nepal can barely afford to prepare an institutional and legal framework or provide adequate skilled human resources to carry out the negotiations in its favor. The Integrated Framework for Trade Related Technical Assistance for LDCs, as endorsed at the WTO Doha Summit has a special bearing on Nepal's capacity-building for overcoming the existing supply side constraints and its ability to negotiate expeditiously in trade development (Government of Nepal, 2010).

During the initial stage of preparing for accession, Nepal received assistance from UNDP to enable an international consultant to be engaged in preparing a country memorandum on Foreign Trade. The project for Nepal's accession to WTO commenced, with UNDP assistance, in July 1999. One of the core functions of the project was to support the Government through counseling and strengthening its negotiating capacity during the accession process. The project is coordinated with the WTO Division at the Ministry of Industry, with regard to conducting studies and creating awareness of the implications of WTO on Nepal's various specialized sectors of the economy. The project has, so far, produced comprehensive study reports on the impact of WTO on Nepal's merchandise trade, agriculture, textiles and clothing and customs valuation. It has also examined the WTO agreements on SPS, TRIPs and the services trade as well as domestic legislation related to the WTO system. As part of the awareness campaign, in partnership with major stakeholders, the project organizes information seminars/workshops and interactions on the multilateral trading rules under the WTO regime in different parts of the country (Shrestha, 2001).

Private sector involvement has increased in business interactions and institutional mechanisms in preparation for WTO accession, and the feeling of national ownership is intensifying. The Federation of Nepalese Chambers of Commerce and Industry (FNCCI), the apex body of the Nepalese private sector, and the Garment Association of Nepal (GAN), a commodity association vulnerable to WTO agreements on textiles and clothing, have already set up WTO cells within their organizations in order to keep abreast of WTO mechanism development and future courses of action. This has greatly helped in disseminating information and maintaining a dialogue with the government on WTO issues.

Table 2. Contribution of customs duties to total tax revenue

Year	Total tax revenue	Revenue from tariffs	Share of tariff revenue in tax revenue (%)
1985	3150.8	1065.1	33.80
1990	7284.1	2684.9	36.86
1995	19660	7017.9	35.70
1996	21668	7327.4	33.82
1997	24424.1	8309.1	34.02
1998	25926.6	8499.9	32.78
1999	28753	9517.5	33.10
2009	33152.5	10813.3	32.62
2010	38865	12552.1	32.30

Sources: Unprivileged documents, MOF/GON

Nepal probably has the most liberal tariff structure among South Asian nations and other developing countries. Since the early 1990s, the government has liberalized its foreign trade regime by reducing import tariff rates and delicensing exports and imports. This is underlined by Nepal's un-weighted average tariff rate, which is less than 9 percent and the reduced peak tariff rate, which is currently 40 percent. There are only five existing tariff slots of 10-20 percent. There are a significant number of tariff lines at zero percent. To simplify the customs administration, additional duties were abolished in 1994 (Shrestha, 2010).

Though ambition for the Ministerial was scaled down and it was not expected to decide on major issues such as modalities for tariff reduction in agriculture and non agricultural market access, some important decisions were made during the Ministerial. The implications of these on Nepal, which participated in the Sixth Ministerial for the first time as a full-fledged member, are described in the following sections.

Agriculture: Agriculture has been the 'make or break' issue in WTO negotiations. Huge domestic and export subsidies in the developed countries have distorted international

trade in agriculture. At the time of the establishment of the WTO, Members agreed to discipline the agriculture sector by reducing domestic and export subsidies. In the present round of trade negotiations, Members are negotiating on the new reduction commitments and time period. The end of export subsidies is likely to increase the world prices of agriculture commodities. This could result in higher food bill for a net food importing country like Nepal. However, increased prices may act as an incentive for farmers to grow more.

Nepalese exports of agriculture products are concentrated in few products and also in few countries. The major market for vegetable fats, wheat, lentils, cardamom, oil seeds is India whereas the major market for sugar is Europe. The issues of market access, particularly in developed countries, and the domestic supports are not Nepal's priority areas, whereas export competition and the peripheral issues for most of the developed and more advanced developing countries such as food aid, preference erosion, special safeguard measures bear significant importance for Nepal.

Non Agricultural Market Access (NAMA): As Nepal has already bound 99.3 percent of its tariff lines and LDCs are not required to make further reduction commitments on market access in this round, the outcome of this round is not going to alter Nepal's import tariffs on industrial goods. Thus, Nepal's interest in this area is market access for its manufactured goods including garments in developing and developed country markets. Decisions in Hong Kong indicate that the present negotiations in this area are likely to result in tariff reductions in developing countries and duty-free and quota-free access to Nepalese exports in the developed countries.

WTO membership for Nepal: Opportunities and challenges

The policy framework: Since the restoration of multiparty democracy in 1990, Nepal has adopted a policy of political, economic and social reforms. These reforms are directly linked to the strategy of creating an open economy effectively integrated into the global economic and trading system. As far as economic reforms are concerned, they cover all sectors of the economy, including monetary, trade and foreign investment and pricing policies. They have resulted in creating an environment conducive to private sector development. Reform in the trade sector has resulted in transforming a controlled, regulated and inward looking foreign trade regime into an open and liberal one. Tariff rates have been rationalized and reduced. Quantitative restriction has been abolished. Foreign exchange has been made convertible for current accounts transactions. Nepal is now treating all foreign investors on a non-discriminatory basis. Rather it has been increasingly providing national treatment to foreign companies and creating conducive environment for health competition and foreign direct investment. The current policies are guided by the need to increase the supply of tradable items, both goods and services, to attract foreign investment and to gain better market access

for exports. During the eight five-year plan, a new commerce policy was formulated and implemented. The broad policy framework was aimed at transforming the trade sector to make it open, competitive and market oriented. The main objectives of the new policy were to increase domestic and international trade through the creation of open and liberal environment conducive for private sector participation; to diversify trade by identifying, developing and producing new exportable commodities; to reduce trade deficits by enhancing exports in a competitive and sustained way; to establish backward linkages of export sectors to other sectors of the economy; and to promote employment intensive trade structure. The government has also formulated and implemented new export policy, import policy, foreign exchange management policy and internal commercial policy to achieve these objectives (NPC, 1992).

The Ninth Plan sets a long-term goal of integrating the trade sector into the globalization process by making it fully competitive and market-oriented, and aims to achieve one per cent share in the global trade by 2015. It has identified the following major strategies for achieving these objectives (NPC, 1998):

- i) Making trade sector fully liberal, competitive and market oriented to achieve high and sustained economic growth;
- ii) Promoting exports, particularly of high quality products, providing high priority for identification and establishment of an effective linkage between industry, trade, agriculture and other economic sectors and adoption of policy for smooth inflow of new technology and management;
- iii) Institutional reforms, particularly, in better equipping the exporter with information about the international market conditions;
- iv) Achievement of full convertibility in foreign exchange through reform in monetary and fiscal policies; and
- v) Accession to the WTO and development of requisite infrastructures to maximize the benefits of WTO membership.

In order to promote international trade and diversify it both commodity-wise and geographically, Nepal has entered into bilateral trade agreements with other countries. Nepal has trade relations with more than 50 countries, including the European Community, and bilateral agreements containing most-favored nation treatment have been signed with 17 countries. In 1991, Nepal signed with India a Treaty of Transit and a Treaty of Trade under which Nepal receives preferential treatment on the exports of goods based on the certificate of origin, and the transit facility, Nepal is an active member of the South Asian Association for Regional Cooperation (SAARC) which concluded the South Asian Preferential Trading Arrangement (SAPTA)—a regional trade agreement, in December 1995.

While continuing to attach great importance to developing bilateral relations with its trading partners, given the typical textbook case of two country (Germany and

USA), two-commodity (carpet and garments), it is necessary for Nepal to pursue the strategy of integrating itself into the multilateral trading system based on the WTO not only to expand export volume but also to diversify its structure and mitigate the risks of volatile export earnings. However, membership in the WTO is like joining a club. Like all clubs, the WTO bestows benefits on members, but there are some costs as well; it offers rights, but with them come obligations; it provides new opportunities, but also some challenges (Agrawal, 2006).

Opportunities: A WTO membership allows countries to design development strategies and trade policies in a more predictable and stable trading environment. It offers an expansion of trading opportunities because of low tariffs and elimination of non-tariff barriers in member states. The multilateral discipline of greater stringency ensures a more secure and predictable trading environment and provides more certainty in trade relations. Moreover, improved transparency in trade policies and practices of trading partners enhances the security of such relations. Nepal would also have access to the WTO dispute settlement mechanism to defend its trade interests. Not the least, membership provides an instrument to advance the trade and economic interests through effective participation in WTO multilateral trade negotiations. The specific disadvantages of non-membership are the portrayal of an adverse image, particularly for potential investors, of remaining outside the system.

A WTO membership would help to lock in the ongoing liberalization process and increase the credibility of initial reform. This credibility would help governments to resist demands from politically influential interest groups to raise import barriers in the future (Hertel, 2008). At the theoretical level, as claimed by economists, Nepal has and could benefit from liberalization through better allocation of national resources towards industries with the strongest advantages, enhanced learning and newer technology from interacting more with the rest of the world, greater flexibility, via trade, for dealing with shocks and discouragement for rent seeking activities.

It has been argued that some of the Nepalese businessmen are accumulating wealth, through lawful tampering of rules and regulations and through lobbying and pleading for special protection, rather than creating it through enhanced efficiency and improved productivity (Pandey, 1999). The obligatory requirement of transparency and self-discipline in economic policy making bestowed by a WTO membership would provide better environment for 'entrepreneurship'. Moreover, the WTO membership would help insulate policy making from interest groups and directly reduce unproductive rent-seeking activities-the root of all economic and social malaise. This can be a major advantage towards providing a sound economic governance.

The most visible achievement of the Uruguay Round was the commitment on market access through reduction in tariffs and elimination of WTO inconsistent non-

tariff measures and their binding. In this round of trade negotiation, developed countries committed to reduce trade-weighted average tariff by 40 percent, from the pre-UR level of 6.2 percent to the post-UR level of 3.7 percent. The negotiation helped expand the 'bindings' to cover 99 percent of imports. Duty free access of industrial product imports from developing countries was expanded from 20 percent to 45 percent. Similarly, in the case of developing countries, the reduction commitments include the expansion of bindings to cover 61 percent of imports, compared to the pre-UR level of 13 percent. Reduction of ceiling rates for tariffs led to a decline of 30 percent in the trade weighted average tariff of developing economies (WTO, 2010). In agricultural commodities, Non-Tariff Measures (NTMs) are supposed to be eliminated or converted into their tariff equivalents. Subsequent to this 'tariffication', developed country tariffs were to be reduced by an average of 36 percent over 6 years from their 1986-88 base, and 24 percent over ten years in the case of developing countries.

Domestic policies causing distortions to production and trade have to be cut back. Developed countries have agreed to reduce 'total aggregate measurement of support' or Total AMS—the annual level of support expressed in monetary terms for all domestic support measures where government funds are used to subsidize farm production and income—by 20 percent cuts over 10 years. Similarly, with respect to export subsidies, developed countries have agreed to cut the value of export subsidies by 36 percent over the six years period starting in 1995. Developing countries have also agreed to reduce the quantities of subsidized exports by 21 percent over six years over 10 years for developing countries. Estimates of the overall gains in growth of world trade volume expected from the Uruguay Round trade liberalization was provided by the GATT Secretariat. The estimated increase in the volume of trade in goods, once the liberalization has been fully implemented, ranges from 9 percent to 24 percent; in terms of actual trade flows, the gains would range from \$244 billion to \$668 billion (GATT, 2009). However, these gains are not equitably distributed across regions and countries, the magnitude of benefits being proportional to the level of development. Studies estimating the effects of liberalizing agriculture trade, taking into account the schedule of bindings, offers, and commitments into reductions, indicate a relatively small effect of liberalization on agriculture. Moreover, there are loopholes for 'dirty tariffication' which could nullify the achievement on tariff binding. Thus, it would be naïve to expect the WTO membership to do 'miracles' immediately and provide substantial improvements in market access over the existing bilateral and multilateral preferences accorded to Nepal. Nonetheless, these market access commitments definitely improve, at least in the medium and long run, opportunities for Nepal to expand and diversify its exports as it provides a secure and predictable trading environment.

Freedom of transit: Article (v) of the GATT 1994 provides for freedom of transit to members countries. The relevant part of the article states 'there shall be freedom of transit through the territory of each contracting party via the routes most convenient

for international transit, for traffic in transit to or from the territory of other contracting parties, via the routes most convenient for international transit, for traffic in transit to or from the territory of other contracting parties. The article further states that 'no distinction shall be made based on the flag of vessel, the place of origin, departure, entry, exit or destination, or any circumstances relating to the ownership of goods, of vessels or other means of transport' and 'traffic shall not be subject to any unnecessary delays or restriction'. Being a landlocked country, secure transit rights would be a major achievement for Nepal. Once Nepal becomes a member of the WTO she would have the legal right to transship goods through India, using the convenient port, for entry or exit. Such transit traffic could be with neighboring countries, or with overseas countries via neighboring countries' port (Gill, 2010).

Access to dispute settlement body: The WTO agreement provides for a common system of rules and procedures applicable to disputes arising under any of its legal instruments (WTO Agreement Article III.3 and IV.3; Understanding on Rules and Procedures Governing the Dispute Settlement). It ensures a stronger, faster, impartial, and a binding mechanism for dispute settlement. It has been claimed, with considerable justification, that the WTO's best achievement is the Dispute Settlement Body (DSB). A WTO membership would accord Nepal the right to challenge any unilateral measures taken by trading partners, which are against her economic and trade interest, if they are inconsistent with the WTO provisions. However, Nepal's willingness to invoke the relevant provisions, lodge formal complaints and retaliate for favorable decisions against major trading partners and donor countries is an open question. It is possible; nonetheless, that Nepal may raise complaints against other developing countries for violating any UR agreements, provided the legal expertise and financial resources are available.

Avoiding costs of non-membership: As Nepal's major trading partners are members of WTO, she cannot afford to remain outside the system and pursue development policies in isolation. Moreover, the rights and obligations of the UR agreements are applicable only to member countries. For example, not only non-member countries will not benefit from the provisions of Agreement on Textiles and Clothing, liberalization of agriculture through Agreement on agriculture, but they can also face with new restrictions applied to their exports without any time limits. Similarly, member countries can discriminately use anti-dumping and countervailing measures and safeguard measures against non-member countries, whereas 'injury test' is a precondition for taking such measures against member countries (Batshur, 2009).

Obligations: The acceding country needs to undertake to comply with the rules and multilateral disciplines of the WTO agreements which bear directly on their trade policies and pay a 'membership fee' in terms of specific concession on tariff rates,

commitments on agriculture subsidies and commitments on trade in services. It will need to prepare or adapt existing laws and regulations for compliance with the obligations established in the various agreements; such as TRIPs Agreement; the Agreement on the Pre-shipment Inspection and the Agreement on the Application of Sanitary and Phytosanitary Measures. Similarly, in order to meet transparency obligations for a number of agreements, inconsistent domestic regulations have to be notified to WTO.

Tariffication and liberalizations: In general, the WTO agreements oblige member countries to commit progressive liberalization of trade. They can protect domestic industries only by tariff; such negotiated and reduced tariff rates are to be 'bound' – setting the upper limit of the applicable tariff rates. Reversing or modifying liberalization commitments is possible in principle, but these are subject to negotiation with and compensation to affected parties.

Reduction of subsidies: The Agreement on Subsidies and Countervailing Measures deems subsidy to be exempt if there is financial contribution by a government or public body such as direct transfer of funds or potential direct transfers of funds or liabilities; government revenue that is otherwise due, is foregone or not collected, the provision or purchase of goods or services other than general infrastructure or any form of income or price support (Article I). WTO members must notify on all subsidy programmes to the WTO Secretariat on an annual basis and commit to reduce progressively. The subsidy reduction commitment depends on the type of subsidy, its per unit value, the policy objective, its duration and trade effects (Article 25). Subsidies contingent upon export performance and subsidies to domestic over imported goods are prohibited. However, being a least developed country, Nepal could be exempted on the prohibition of export subsidies (Article 27, 2(a)) and subsidies to domestic over imported goods could be provided till 2003, which, as explained below, depends upon the terms and conditions of the accession negotiation. Similarly, subsidies which could nullify or impair benefits accruing directly or indirectly to another member and have injurious impact to the domestic industry and serious prejudice to the interests of another member could be challenged in Dispute Settlement Body (Rolf, 2005).

Protection of intellectual property rights: Agreement on trade-Related aspects of intellectual property rights (TRIPs) specifies a full set of rules encompassing all the major areas intellectual property rights (Lardy, 2002). Which include copyright, contiguous copyrights, trade mark, geographical indications, industrial design, semiconductor circuit diagrams and trade secrets. Nepal, being at the low end of the spectrum of generation and use of intellectual property, has not yet enacted laws covering all these aspects. Specifically, it suffers from a virtual void in legislation in

areas relating to geographical indications, layout design of integrated circuits, industrial designs, and undisclosed information on trade secrets, anticompetitive practices, and contractual license, among others. Naturally, Nepal will need new legislation in many areas, including patent protection of pharmaceutical and chemical products. The existing Acts on patent design, copyrights, trademark etc. need to be amended and the prevailing terms of protection and enforcement will have to be extended. Besides, the national laws should have provisions to handle other aspects of the agreement, viz, acquisition and maintenance of intellectual property rights (IPR), dispute prevention and settlement and institutional arrangements.

Trade-related investment measures: The Agreement on Trade-Related Investment Measures (TRIMs) requires that no Member will apply any TRIM that is inconsistent with the provisions of Article III (National Treatment) or Article XI (General Elimination of Quantitative Restrictions) of the GATT, unless it can be justified under GATT exceptions. As an illustration, the Agreement provides five types of GATT inconsistent TRIMs in the annex of the Agreement. The list involves measures which require a particular level of purchase or use of products of domestic origin or which restrict the volume or value of imports to an amount related to the level of exports. Though there is no provision in Industrial Enterprise Act 1992 and Foreign Investment and Technology Transfer Act 1992 that directly violate these provisions, the domestic labour requirement could be interpreted as 'local content' and may attract the attention of the TRIMs Agreement. All TRIMs inconsistent with the Agreement must be notified within ninety days and TRIMs that are so notified must be eliminated within seven years. Moreover, a commitment needs to be made that any measures inconsistent with TRIMs agreement will not be adopted in future.

Liberalization of services sector: The General Agreement on Trade in Services (GATS), based on the desire to establish a multilateral framework of principles and rules for trade in services with a view to the expansion of such trade under condition of transparency and progressive liberalization, require Nepal to adopt liberal policies in the services sector. It covers all services except those supplied in the exercise of government authority through four 'modes' of supply: cross border movement of service product, movement of consumers to the country of importation, the establishment of commercial presence in the country where the service is to be provided and temporary movement of natural persons to another country in order to provide service there.

There are no general obligations to offer national treatment and market access to foreign suppliers. These obligations are confined to the sectors and sub-sectors specifically included in the individual schedule of commitments of each member, subject to any limitations with respect to each mode of supply (UNVTAD, 1998).

However, the agreement stipulates that a member shall not maintain or adopt (Article XVI):

- i) Any limitation on the number of services providers;
- ii) Any limitation on the total value of services transaction;
- iii) Any limitation on the total number of services operation;
- iv) Any limitation on the total number of natural persons that may be employed in a particular services sector;
- v) Any measures which restricts or requires specific types of legal entity or joint venture through which a service supplier may provide a service;
- vi) Any limitation on the participation of foreign capital in terms of maximum percent limit on foreign share holding or the value of individual or aggregate foreign investment.
- vii) Any limitation on the participation of foreign capital in terms of maximum percent limit on foreign share holding or the value of individual or aggregate foreign investment.

Challenges: There is nothing as such that a WTO membership can offer Nepal on a 'golden plate'. Benefits do not derive automatically but depend on her ability to identify and take advantages of trading opportunities; fulfill multilateral trade obligations; formulate and pursue development strategies within the framework of those obligations; and, above all, defend her economic, finance and trade needs. Thus, we need not delude ourselves into thinking that the world order will be benevolent to us even as we ourselves cannot do that favor for us.

Consequently, acceding countries are pressed to accept more stringent commitments, than the WTO members themselves do, if they want to accede to the WTO. Such commitments include (i) non-application of the rights available under the WTO Agreements, such as special and differential provisions for least developed countries and Tariffication and special safeguards in agriculture (WTO-minus); (ii) areas not covered by WTO agreements like privatization, investment regime and bindings of export tariffs (WTO-plus); and (iii) stricter concessions and commitments on goods and services than those accepted by the UR participants such as 100 percent bindings of industrial tariffs, lower concessions and wider coverage of specific commitments on services and participation in the plurilateral agreements.

The commitments Nepal makes during the accession negotiation will have far reaching impacts on trade and economic development of the country. Thus, it is necessary to ensure that all commitments fall within the parameter of Nepal's national development goals. But her ability to defend her national interest in the accession negotiation is limited by the lack of knowledge, experiences and negotiating skills as well as limited resources and infrastructure. The accession negotiation also requires a mix of information pooling and coordination between the relevant government

bodies. Moreover, 'national consensus' among stakeholders on terms of accession is necessary not only to safeguard economic, finance and trade interests but also to fulfill post-membership obligations.

Conclusion

For a landlocked country like Nepal, one distinct advantage of joining the WTO is that it entitles the member state with the right to transit facilities. A perennial access to transit facilities will be of no small achievement for Nepal in the light of its desire to open itself to the outside world. But this in itself is not enough, unless Nepal raises its efficiency and international competitive edge in both product specialization and diversification.

Will Nepal's membership in the WTO yield a positive contribution to distributional equity benefiting the majority of its people? Will it have sufficient competitive advantages in promoting economic growth and social stability to ensure a better future for the Nepalese? Is there a basic normative consensus for the membership among all the stakeholders of the society? Nepal should attempt to furnish answers to these and many other questions and whet the appetite of those whose are interested in this area.

The major trading partners of Nepal, including South Asian Countries, are WTO members and there are specific disadvantages of non-membership that arise from the adverse image of remaining 'outside the system'. Against this backdrop, the choice for Nepal is between WTO membership and isolation. Nepal cannot afford to choose the latter option. The first option requires Nepal to pay a 'membership fee' in terms of new obligations and commitments. However, it would be fallacious to assume that WTO membership involves only costs. Of course, it provides opportunities, but the onus is on Nepal itself to realize those opportunities. In fact, the WTO membership, including accession negotiation, is a great challenge, unless Nepal is able to safeguard its national interest within the WTO framework. The country will have to create dynamic competitive advantages by enhancing efficiency, improving productivity and dismantling supply bottlenecks through appropriate policy measures. Otherwise, the gains of WTO membership will remain a distant reality.

References

- Agrawal, R. (2006). Key Elements for Business. *Sixth WTO Ministerial Conference*. Hong Kong: UNCTAD: International Trade Centre, p. 6.
- Agrawal, R. (2006). Key Elements for Business. *Sixth WTO Ministerial Conference*. Hong Kong: UNCTA/WTO: International Trade Centre, pp. 37-55.
- Batshur, G.A. (2009). *Services in Doha: What's on the table?* Washington D.C.: World Bank.
- Bhandari, S.S. (2005). *Nepal's accession to the WTO challenges and opportunities for Nepal*. Kathmandu: Action Aid Nepal and Law Associates Nepal.

- Brown, D.A. (1999). *Measurement and modeling of the economic effects of trade and investment barriers in services*. Atlanta, G.A.: World Service Congress.
- Chadha, R.A. (1998). *Rationalising tariff and non-tariff barriers on trade: Sectoral impact on Indian economy*. New Delhi: Tariff Commission, Government of India.
- GATT. (2009). *GATT and its business contribution in world*. NY: International Review of Financial Analysis.
- Gill, R. (2010). World Trade Organization and its implication in economy. London: *Journal of Business Economy*.
- MOF. Government of Nepal. (2010). *Economic Survey*. Kathmandu: MOF.
- Hertel, T.A. (2008). Poverty and the WTO: Impact of the Doha development agenda. *Journal of Business and Industrial Marketing*, pp. 59-68.
- Khadka, K. (2004). WTO and its threat to Nepalese economy. *The Rising Nepal*, p. 4.
- Lardy, N. (2002). *Integrating China into the global economy*. Washington D.C.: Brookings Institution Press.
- Maskey, B. (2001). *Small and medium enterprises development in Nepal*. Kathmandu: Centre for Development and Governance.
- Pandey, P. (1999). *WTO and Nepal: Opportunities and challenges*. Kathmandu: NEFAS.
- Pyakhuryal, B. (2004). Trade facilitation: Assessing Nepal's status in current international trade practices. *WTO and South Asia Post Canun Agenda*, pp. 137-151.
- Rolf, A.A. (2005). *Turning hills into mountains? Current commitments under the general agreement on trade in services and prospects for change*. NY: *Journal of World Trade*.
- Shrestha, A. (2001). World Trade Organization (WTO), Globalization and Nepal. *POLSAN*, pp. 18-28.
- Shrestha, P. (2010). Nepal's membership to WTO: Implications and concerns. *Journal of Management*, p. 9.
- Smith, M. (1995). International Financial Institutions and the World Trade Organization: Making the linkage work. *Canadian Foreign Policy*, pp. 23-30.
- Statistics, C.B. (2009). *National accounts of Nepal*. Kathmandu: CBS.
- Stern, R.K. (2000). *The stakes for the Asian economies in the forthcoming WTO negotiations*. Manila: Asian Development Bank.
- World Bank. (2009). *World development indicators*. Washington D.C.: WB.
- WTO. (2009). *Understanding World Trade Organization*. Geneva: WTO.
- WTO. (2010). *Annual report on WTO*. Washington, D.C.: World Trade Organization.

Adaptive Modulation in Multiple Input Multiple Output (MIMO) System

Rajeev Prajapati*, Norsang Lama and Sabin Bhandari

*Department of Computer and Electronics Engineering

Kantipur Engineering College, Kathmandu

Email: rajeev@kec.edu.np, norsanglama@kec.edu.np, sabinbhd@kec.edu.np

Abstract: *In this paper, we propose an adaptive modulation in Multiple Input Multiple Output (MIMO) system which results in significant improvement in the Bit Error Rate (BER) and increased data rate of the system than that of fixed modulation scheme. Hence, considerable improvement in an information rate is achieved. Performance of the BER probability of the channel with variable signal to noise ratio will change with channel quality in case of the non adaptive modulation scheme. In some application, the system will require minimum BER. Hence fixed modulation scheme will not perform better in such application. With the use of the adaptive modulation scheme, the system will automatically cope with the changing channel condition and accordingly select the modulation scheme for maintaining minimum required BER. The throughput of the system is found to be improved with the use of adaptive modulation in MIMO system. For simulation, Rayleigh channel model has been considered.*

Keywords: *Adaptive modulation, BER, MIMO, quadrature amplitude modulation.*

Introduction

Multiple-input and Multiple-output (MIMO), is the use of multiple antennas at both the transmitter and receiver to improve communication performance. The terms input and output refer to the radio channel carrying the signal, not to the devices having antennas (Gowarishankar & Demirkol, 2005). MIMO technology has attracted attention in wireless communications because it offers significant increases in data throughput and link range without additional bandwidth. Adaptive modulation is a term used in wireless communications to denote the matching of the modulation, coding and other signal and protocol parameters to the conditions of the radio link. Adaptive modulation is a method to improve the spectral efficiency of a radio link for a given maximum required quality (error probability) (Svensson, 2007).

In this paper, we make a systematic investigation of adaptive modulation in MIMO system. Adaptive modulation systems invariably require some channel information at the transmitter (Zhou *et al.*, 2005). This could be acquired in time division duplex systems by assuming the channel from the transmitter to the receiver is approximately the same as the channel from the receiver to the transmitter. Alternatively, the channel knowledge can also be directly measured at the receiver, and fed back to the transmitter. The impact of imperfect channel knowledge and feedback quantization error on adaptive modulation in MIMO systems can be investigated (Svensson, 2007). Adaptive modulation systems improve the rate of

transmission, and/or bit error rates by exploiting the channel information that is present at the transmitter. Especially over fading channels which model wireless propagation environments, adaptive modulation systems exhibit great performance enhancements compared to systems that do not exploit channel knowledge at the transmitter.

Due to the limited size of the equipment, it is difficult to improve data rate only using number of antennas. So, multi-level quadrature amplitude modulation (M-QAM) is used to increase transmission rate (Han *et al.*). Quadrature Amplitude Modulation (QAM) conveys two digital bit streams by modulating the amplitude of two carrier waves using amplitude shift keying digital modulation technique (Rappaport, 2003). The two carrier waves are out of phase with each other by 90°. QAM is used widely in communication applications because of bandwidth conserving property. Different forms of QAM are available with some common forms being 8QAM, 16QAM, 32QAM, 64QAM, 128QAM and 256QAM. Data rate of higher level QAM system is higher than that of lower level QAM system. It must also be noted that when using higher level of QAM, better signal-to-noise ratios (SNRs) are needed to overcome any interference and maintain a certain bit error ratio (BER). Adaptive M-QAM modulation based rate maximization algorithm for closed loop system can improve the throughput of around 23% at 20dB and above (Gowarishankar & Demirkol, 2005).

The channel considered in this work is Rayleigh fading channel. Rayleigh fading model is used when there are many objects in the media where the signal is transmitted, resulting in the scatter of the signal before arriving at the receiver end. This scattering of signal is due to attenuation, reflection, refraction and diffraction of the signal from high buildings present in metropolitan cities where there is no presence of a strong line of sight (LOS). Rayleigh fading is a statistical model which assumes that the magnitude of the signal that has passed through transmission medium will vary randomly, or fade, according to Rayleigh distribution (Ahmed *et al.*, 2010).

Use of the MIMO system improves the quality of the received signal and improves the average gain of the overall system. This article focuses on the advantages of using the MIMO system in communication link and to compare the result with the conventional Single Input Single Output (SISO) system. The objectives of this work are: to study MIMO system, to compare the BER performance of different levels of QAM technique for MIMO system, and to increase the throughput of the MIMO system using adaptive modulation technique.

Materials and methods

The material used in this study is MATLAB Simulation. The over-view of the overall system block diagram is presented in Fig. 1.

Figure 1. Overall system block diagram

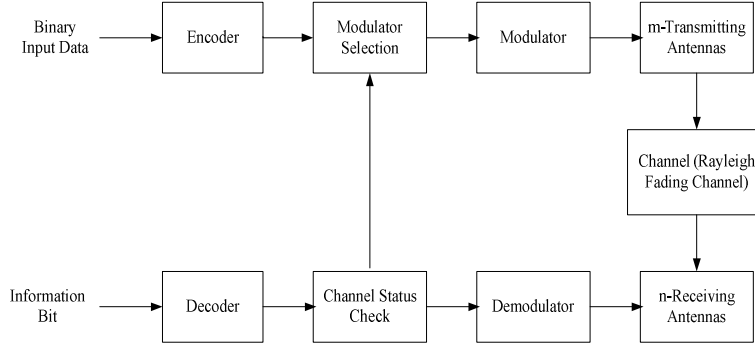


Fig. 1 shows the overall system diagram of our proposed model. Here, the system takes digital data as an information bit. The information bit that is being considered can be of any length. The information bits are passed through the modulator selection switch followed by the modulator. The modulator selection switch determines which modulation scheme is to be used depending up-on the condition of the channel. The choice of one modulation scheme is provided by the channel status check. The modulated signal is transmitted by the m-transmitting antennas. The signal is received by the n-receiving antennas through the channel. The channel considered here is Rayleigh fading channel. Finally the information bits are retrieved from the received signal by the decoder.

Channel Status Check takes information from the stored pilot symbols and determines the quality of the channel. Information is then sent back to the Channel Switch for adaptation decisions. If the channel is facing much fading and noise then the channel status check feedbacks the modulator selection to choose lower order QAM. Similarly, if the channel condition is good, then the channel status check feedbacks the modulator selection to choose higher order QAM.

There were few assumptions made during the research work. The channel assumed was Rayleigh fading channel and the channel experience by each transmit antenna is independent from the channel experienced by other transmit antennas.

MIMO system model: The channel between the transmit antennas and the receive antennas takes the form of a matrix. The signal paths between each transmit and receive antenna pair is a channel coefficient in the matrix (Han *et al.*). In a single user MIMO model with m transmit and n receive antennas, the MIMO system equation is given by,

$$\begin{bmatrix} y_1 \\ y_2 \\ \vdots \\ y_n \end{bmatrix} = \begin{bmatrix} h_{11} & h_{12} & \dots & h_{1m} \\ h_{21} & h_{22} & \dots & h_{2m} \\ \vdots & \vdots & \dots & \vdots \\ h_{n1} & h_{n2} & \dots & h_{nm} \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ \vdots \\ x_m \end{bmatrix} + \begin{bmatrix} n_1 \\ n_2 \\ \vdots \\ n_n \end{bmatrix}$$

In the matrix form, $y = Hx + n$

Where H is the channel matrix of size $n \times m$, y is the $n \times 1$ received signal vector, x is the $m \times 1$ transmitted signal vector, and n is $n \times 1$ additive white Gaussian noise vector with zero mean and variance σ^2 (Han *et al.*).

MIMO channel capacity: The capacity of SISO channel is derived from information theoretic point of view. It is a well accepted fact that capacity can be increased without increasing the bandwidth and transmitting power by just putting more antennas at transmitter and receiver side.

A generalized capacity formula for (m, n) MIMO system is,

$$C = \log_2(\det [IM + (\rho/m) HH^\dagger]) \text{ bps/Hz}$$

In this equation, “det” means determinant, IM means $m \times n$ identity matrix, “†” means transpose conjugate and ρ is the average SNR at the receiver (Khan & Vesilo).

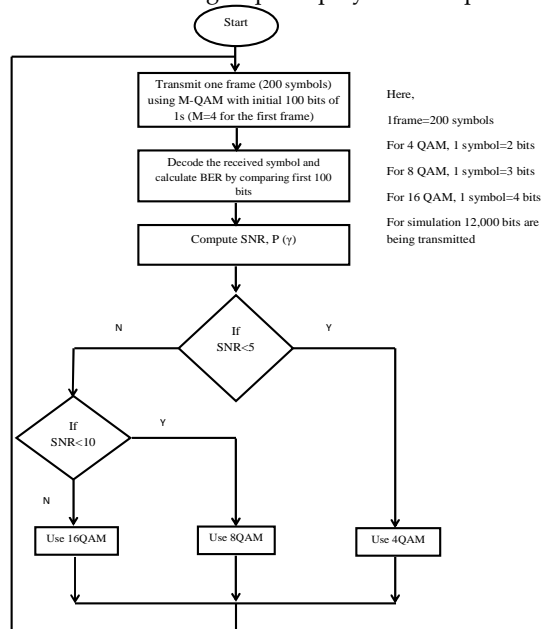
The probability of symbol error for M-QAM over Rayleigh fading channel with diversity N is given by

$$P(\gamma) = 0.2 \log_2 M \left[\frac{N(M-1)}{N(M-1) + 1.5\bar{\gamma}} \right]^{-N}$$

Where, M is the order of QAM modulation, N is diversity order; γ is the SNR and $\bar{\gamma}$ is the mean symbol SNR (Ahmed *et al.*, 2010).

Adaptive modulation model

Figure 2. Flowchart showing steps employed in adaptive modulation



Simulation and results

Simulation models

Simulation model for BER

- Generate random binary sequence of +1's and 0's.
- Group them into symbols as per QAM type and send symbols in one time slot.
- Multiply the symbols with the channel and then add white Gaussian noise.
- Equalize the received symbols.
- Perform demodulation and count the bit errors.
- Repeat for multiple values of SNR and plot the simulation and theoretical results.

Simulation model for adaptive modulation in MIMO system

- Number of bits transmitted 12000 bits first and again 24000 bits is transmitted to analyze the nature of adaptive modulation.
- One frame has 200symbols.
- Frame size of QAM=400 bits, 8QAM=600, 16QAM=800 bits.
- The first 100 bits of each frame is known at the receiver which is used to analyze the channel condition.
- The first frame is sent using QAM.
- Receiver analyzes first 100 bits and computes BER and then finds the SNR level.
- When $SNR < 5$, QAM is used. $5 < SNR < 10$, 8QAM and $SNR > 10$, 16 QAM.
- The process is repeated until total bits are transmitted.

Results

For the study of MIMO system, first the capacity of the system for various antenna systems i.e., Single Input Single Output (SISO), Single Input Multiple Output (SIMO), Multiple Input Single Output (MISO) and MIMO was performed. Also, comparison between BER and SNR for different levels of QAM system was performed. Fig. 3 shows the simulated output of capacity of various antenna systems. From the output obtained it is clear that the capacity of multiple antenna system is much higher than that of SISO at higher SNR region and also MIMO systems yields more capacity than SIMO and MISO systems.

Fig. 4 shows the comparison of BER for 4QAM, 8QAM and 16QAM modulation scheme in MIMO system. BER of 4QAM was found to be better than both 8QAM and 16QAM at all SNR values. Indeed this should be so because of small spacing in the constellation of higher levels of QAM which increases the probability of error in decoding. However, at higher SNR values 8QAM and 16QAM also have sufficiently lower BER.

Figure 3. Simulation result of comparison of capacity of SISO, MISO, SIMO and MIMO system

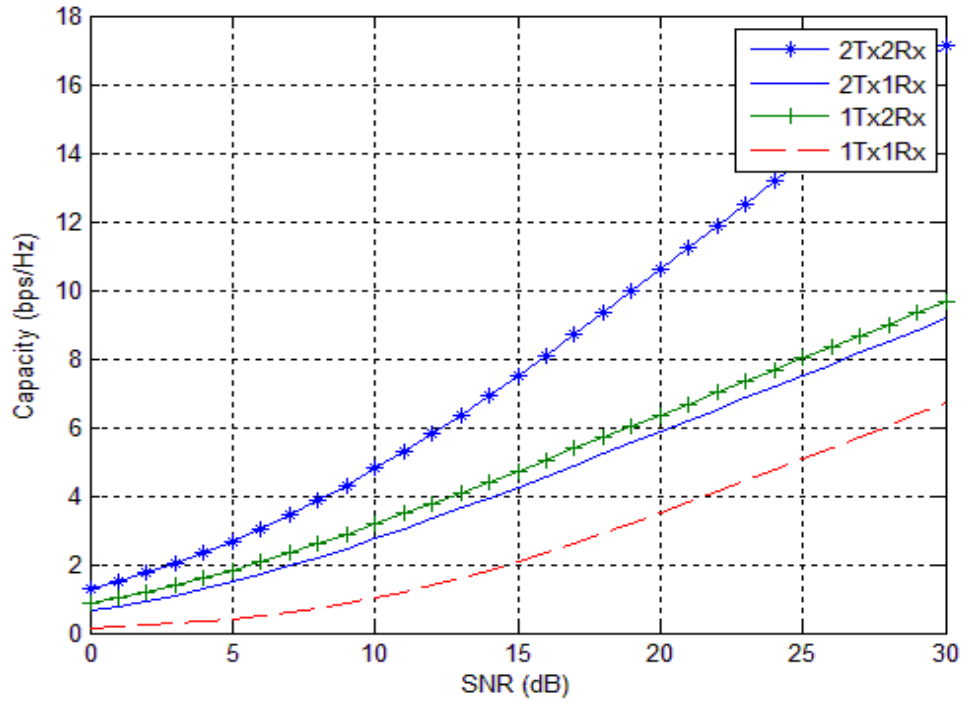


Figure 4. Comparison of BER of QAM, 8QAM and 16QAM system for 2x2 MIMO system

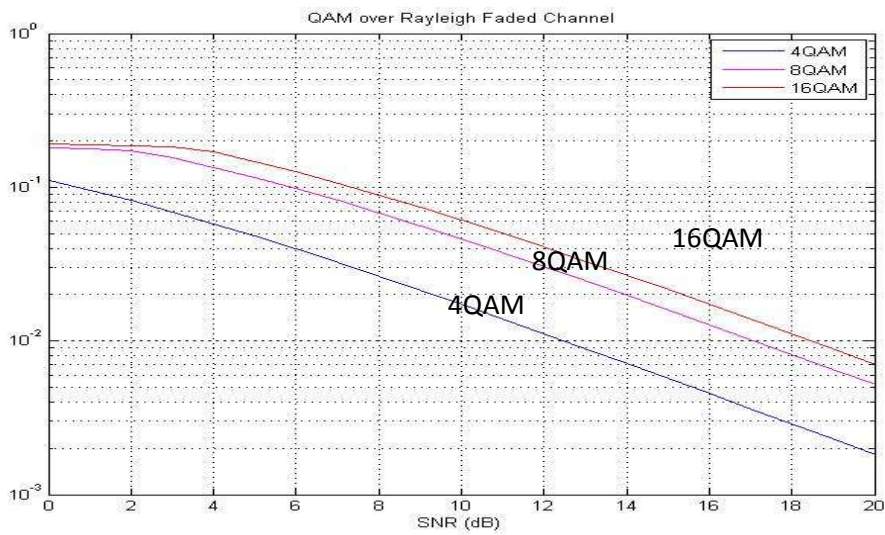
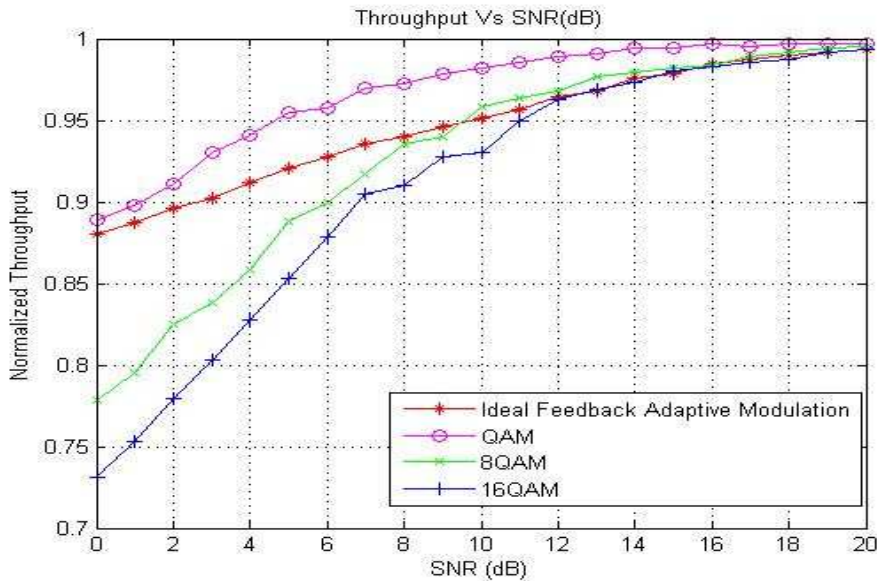


Fig. 5 shows the simulation output showing the normalized throughput for QAM, 8QAM, 16QAM and Adaptive Modulation in MIMO system. The normalized throughput describes the successful (no symbol error) rate of data transmission. It can be observed that at higher SNR the normalized throughput is almost same for all modulation schemes. The normalized throughput using Adaptive modulation is found to be better than that of 8QAM and 16QAM. However, as seen in Fig. 5, the throughput of QAM is better than that of Adaptive modulation. But, the time taken to transmit same number of bits is more for QAM than adaptive modulation as shown in Fig. 6 thereby providing advantage of adaptive modulation over QAM. With the increase in SNR, the time taken to transmit the bit sequence using adaptive modulation becomes almost similar to 16QAM. Thus changing the order of modulation according to the channel condition (received SNR) takes the advantages of 4QAM (i.e. maintains the quality of received signal at lower SNR) and 8QAM/ 16QAM (i.e. higher data rate at high SNR with sufficient quality).

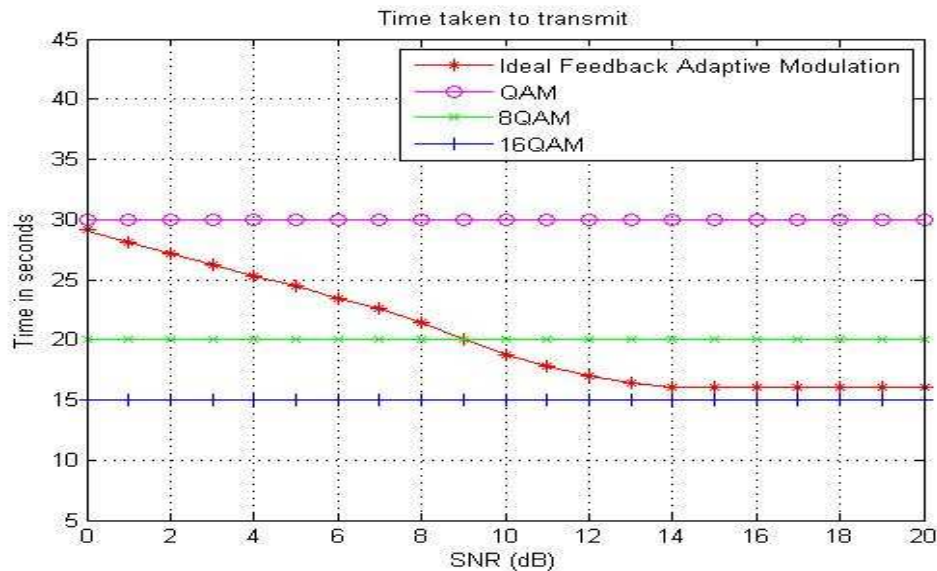
Figure 5. Simulation result showing normalized throughput for QAM, 8QAM, 16QAM and ideal feedback adaptive modulation in 2x2 MIMO system (when transmitting 12000 bits)



In a practical scenario, there is always some delay in the information reaching from the receiver to modulation selector in the feedback system. Thus there is always some degradation in performance due to this feedback delay. The feedback data when received at the transmitter is processed, and the modulation scheme is appropriately selected.

The simulation results of normalized throughput and time taken to transmit data for QAM, 8QAM, 16QAM and occurs. The feedback data of modulation selection consists of 8 bits. Using 4QAM, these 8 bits of data are transmitted from receiver to modulation selector in Adaptive modulation in 2×2 MIMO system including the feedback delay as shown in Figs. 7 and 8. While adding delay, processing delay at both transmitter (to select the modulation scheme) and receiver (calculation of SNR) is assumed to be 1ms. Thus, in one feedback, processing delay of 2ms Rayleigh fading channel is reported. It is assumed that transmitting 400 bits takes 1 second, the feedback data, i.e. 8 bits takes $8/400$ seconds=2ms. Thus an over head of 4ms (2ms + 2 ms) occurs in the total system.

Figure 6. Simulation result showing time taken to transmit the bit sequence for QAM, 8QAM, 16QAM and ideal feedback adaptive modulation in 2×2 MIMO system (when transmitting 12000 bits)



It is seen that the normalized throughput of practical feedback adaptive modulation is less in comparison to that of ideal feedback adaptive modulation and also the time taken to transmit practical feedback adaptive modulation is found to be higher than that of ideal feedback adaptive modulation scheme. Thus in practice implementing adaptive modulation will degrade the performance as compared to ideal adaptive modulation technique due to the various delays involved like processing time and feedback time. Thus using adaptive modulation in MIMO system, it is observed that at higher SNR the normalized throughput is almost same for all modulation schemes. The normalized throughput using Adaptive modulation is found to be better than that of 8QAM and 16QAM. The throughput of QAM is

better than that of Adaptive modulation but the time taken to transmit same number of bits is more for QAM than adaptive modulation, thereby providing advantage over QAM. With the increase in SNR, the time taken to transmit the bit sequence using adaptive modulation becomes almost similar to 16QAM. Due to the delay involved (processing time and feedback time) there is slight decrease in the performance of adaptive modulation but still it is better than fixed modulation schemes.

Figure 7. Simulation result showing normalized throughput for QAM, 8QAM, 16QAM and Adaptive Modulation in 2x2 MIMO system including feedback delay (when transmitting 12000 bits)

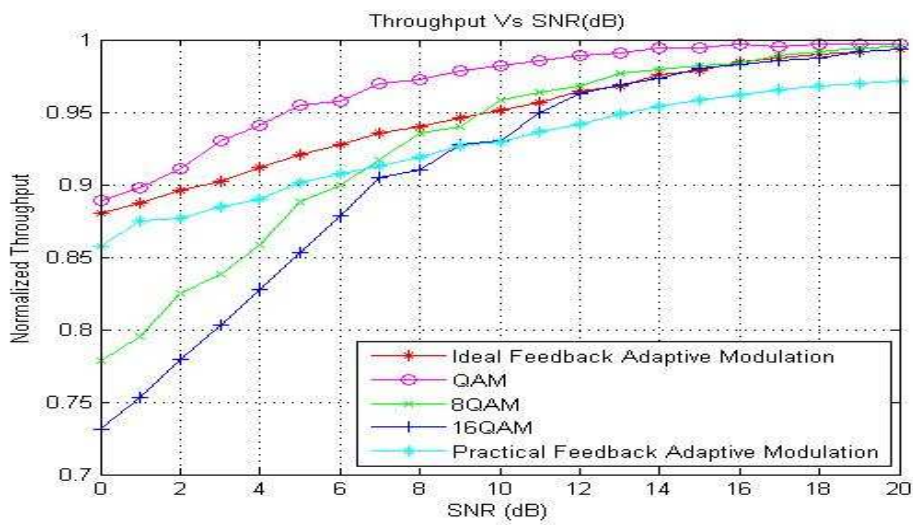
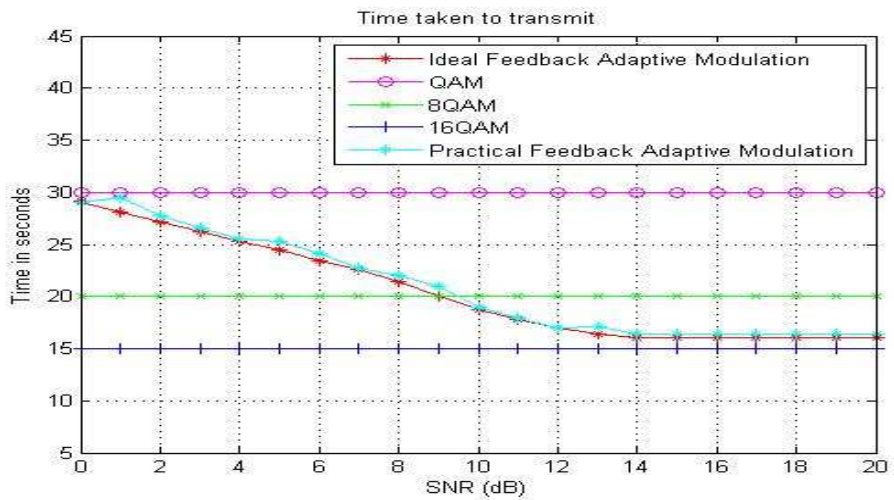


Figure 8. Simulation result showing time taken to transmit the bit sequence for QAM, 8QAM, 16QAM and Adaptive Modulation in 2x2 MIMO system including feedback delay (when transmitting 12000 bits)



From Figs. 9 and 10, it is seen that the normalized throughput of practical feedback adaptive modulation is less comparison to that of ideal feedback adaptive modulation and also the time taken to transmit practical feedback adaptive modulation is found to be higher than that of ideal feedback adaptive modulation shceme. Thus in practice implementing adaptive modulation will degrade the performance as compared to ideal adaptive modulation technique due to the various delays involved like processing time and feedback time.

Figure 9. Comparison of normalized thruhput between ideal feedbcak adaptive modulation and practical feedback adaptive modulation (when transmitting 12000 bits)

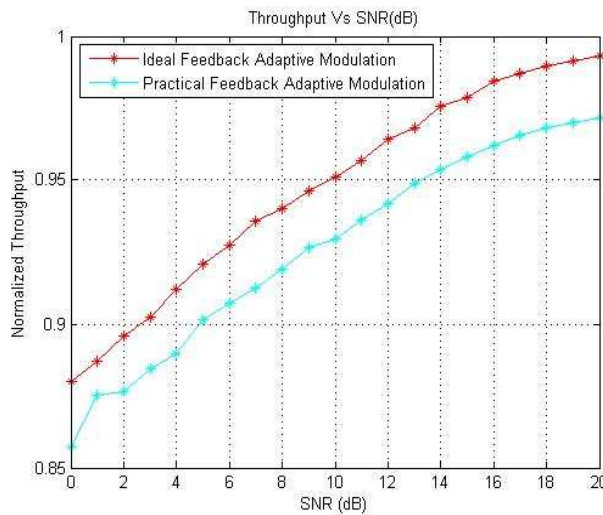


Figure 10. Comparison of time taken to transmit using ideal feedbcak adaptive modulation and practical feedback adaptive modulation (when transmitting 12000 bits)

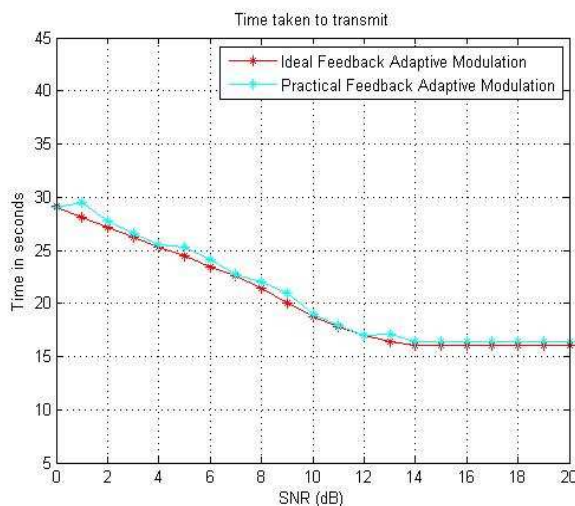
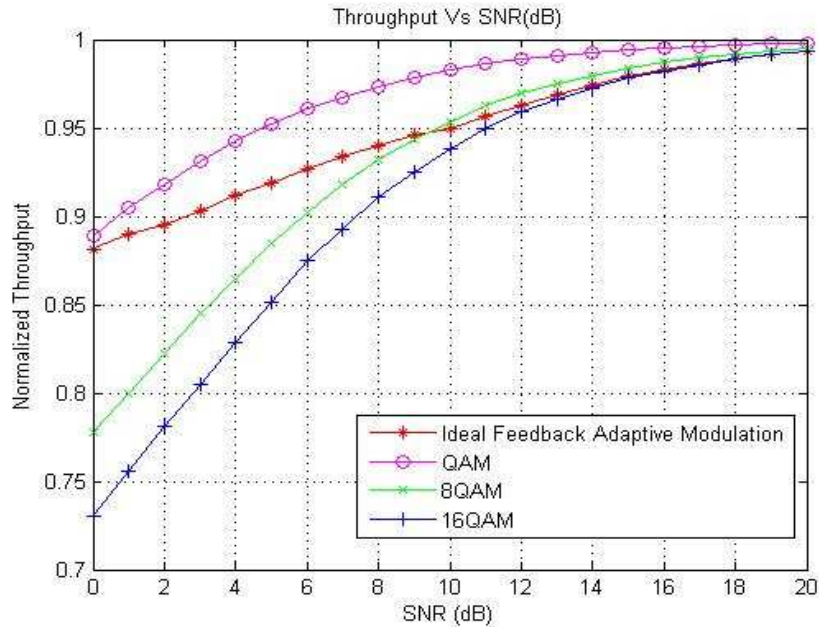


Figure 11. Simulation result showing normalized throughput for QAM, 8QAM, 16QAM and ideal feedback adaptive modulation in 2x2 MIMO system (when transmitting 24000 bits)



Since the number of transmitted bits i.e. 12000 bits, is arbitrarily assumed, it is necessary to show that the characteristics of adaptive modulation in MIMO system remains same even if the number of transmitted bits is varied. For this, simulation is done for transmitting 24000 bits and the obtained simulated results are as follows:

Figs. 12 and 13 show the simulation output showing normalized throughput for QAM, 8QAM, 16QAM and ideal adaptive modulation in MIMO system when transmitting 24000 bits. The nature of output is same as that with 12000 bits. The simulation results of normalized throughput for QAM, 8QAM, 16QAM and ideal adaptive modulation in MIMO system obtained in Figs. 5 and 11 shows the same nature, similarly the simulation results showing time taken to transmit the bit sequence for QAM, 8QAM, 16QAM and ideal feedback adaptive modulation in MIMO system obtained in Figs. 6 and 12 show the same nature.

Figs. 13 and 14 show the simulation output showing normalized throughput for QAM, 8QAM, 16QAM and practical adaptive modulation in MIMO system when transmitting 24000 bits. The nature of output is same as that with 12000 bits. The simulation results of normalized throughput for QAM, 8QAM, 16QAM and practical adaptive modulation in MIMO system obtained in Figs. 7 and 13 shows the same nature, similarly the simulation results showing time taken to transmit the bit sequence for QAM, 8QAM, 16QAM and practical feedback adaptive modulation in MIMO system obtained in Figs. 8 and 14 show the same nature.

Figure 12. Simulation result showing time taken to transmit the bit sequence for QAM, 8QAM, 16QAM and ideal feedback adaptive modulation in 2x2 MIMO system (when transmitting 24000 bits)

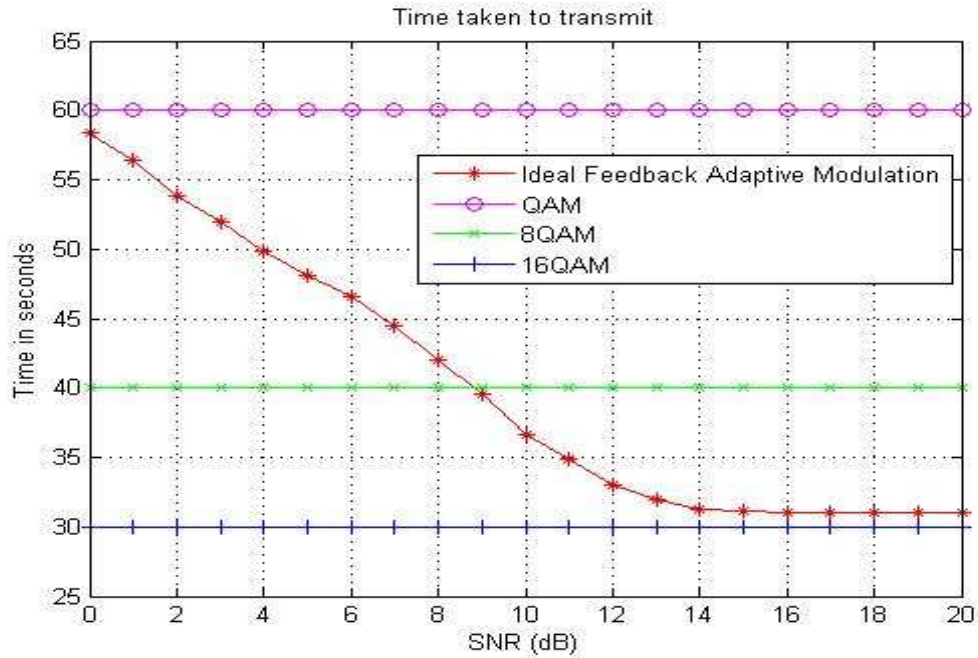


Figure 13. Simulation result showing normalized throughput for QAM, 8QAM, 16QAM and Adaptive Modulation in 2x2 MIMO system including feedback delay (when transmitting 24000 bits)

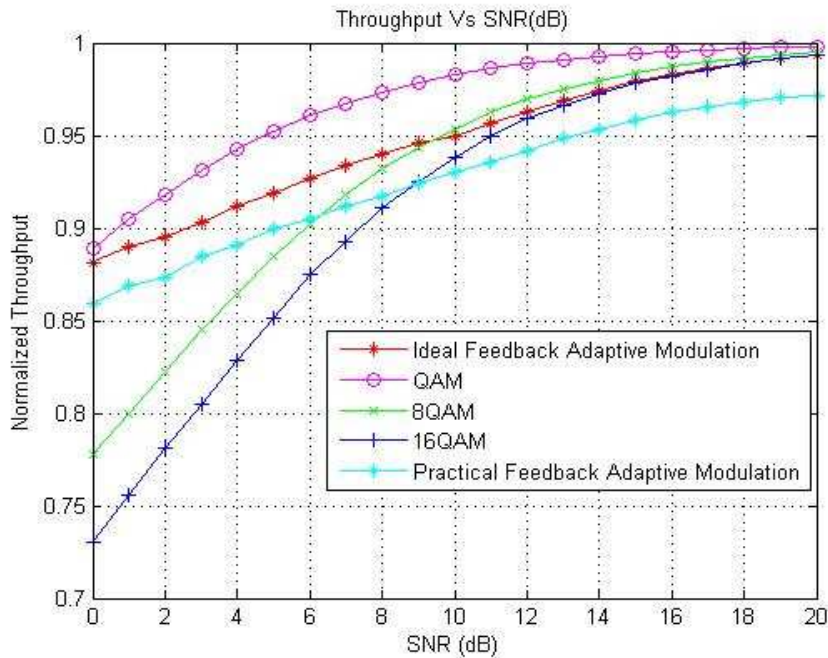


Figure 14. Simulation result showing time taken to transmit the bit sequence for QAM, 8QAM, 16QAM and Adaptive Modulation in 2x2 MIMO system with including feedback delay (when transmitting 24000 bits)

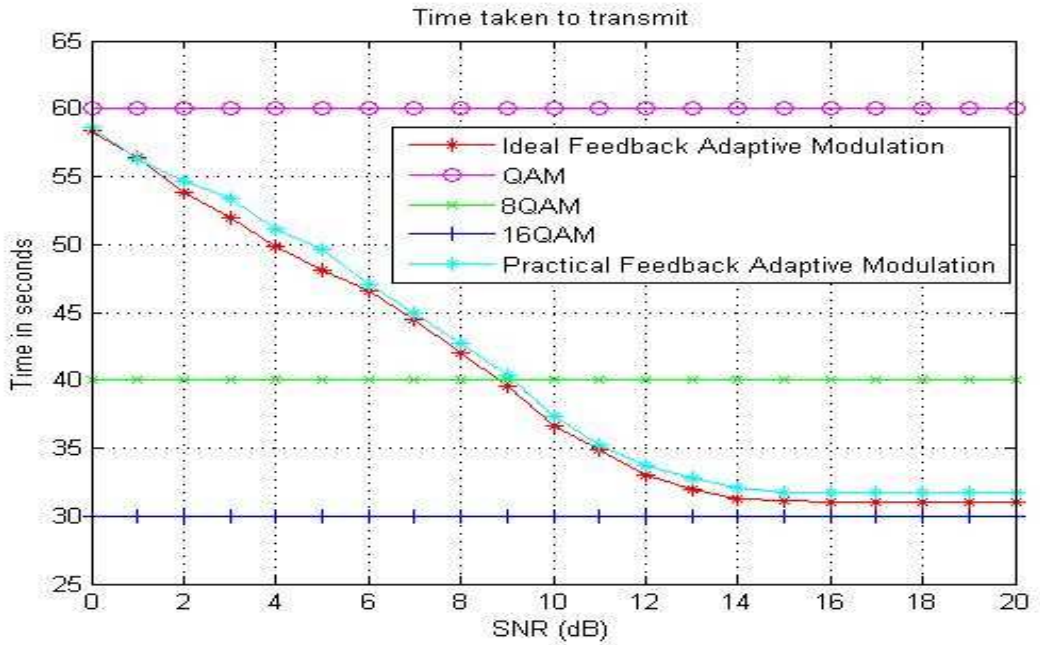


Figure 15. Comparison of normalized throughput between ideal feedback adaptive modulation and practical feedback adaptive modulation (when transmitting 24000 bits)

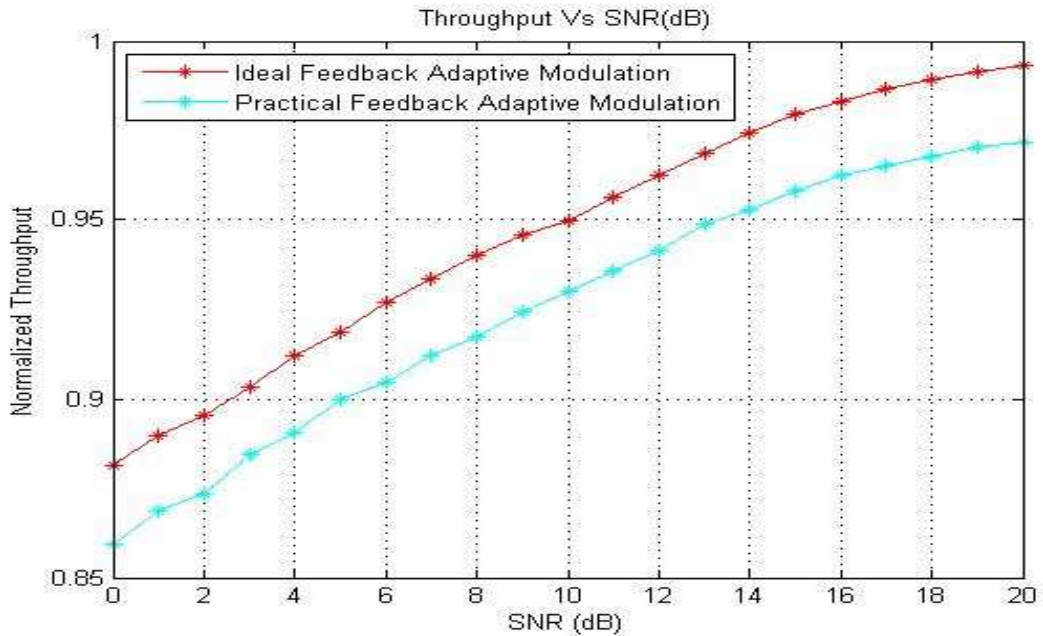
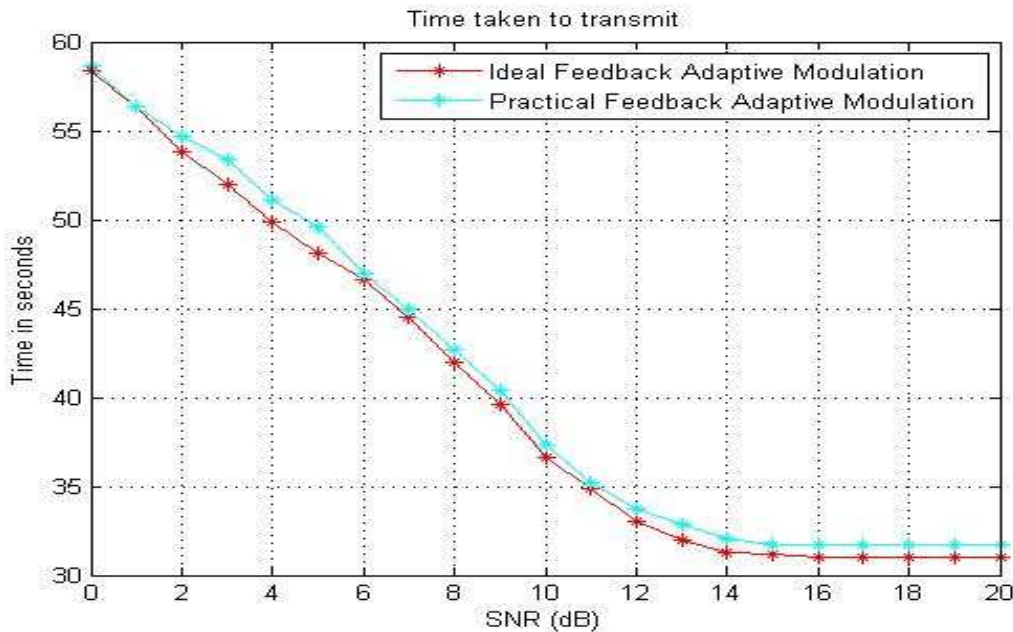


Figure 16. Comparison of time taken to transmit using ideal feedback adaptive modulation and practical feedback adaptive modulation (when transmitting 24000 bits)



Discussion

From this research work, it was seen that higher capacity can be achieved by the means of MIMO system than conventional SISO system. Also, better BER is achieved in MIMO system than SISO system by employing different levels of QAM. The BER of 4QAM is low at lower SNR values and at higher SNR values, 8QAM and 16QAM also maintain sufficiently low BER. In a different perspective, the time taken to transmit a symbol decreases with higher level of QAM. For any system, it is desired to have faster data transmission with minimum error. Since the channel varies in accordance to time, the received SNR also varies with time. When the channel is experiencing deep fading, it is better to use lower order QAM (4QAM). If the channel condition is good, then use of higher order QAM (8QAM or 16QAM) is preferred for higher data transmission rate and maintaining the quality of the received signal. Thus, a feedback system is needed which informs the transmitter about the channel condition. Appropriate selection of the order of modulation is done by the transmitter by means of feedback data. This technique to increase data rate with sufficient performance is adaptive modulation. With the use of adaptive modulation technique it is seen that the normalized throughput of the system is increased while still maintaining lower BER. In practice, when implementing adaptive modulation in MIMO system, there is a slight degradation in the performance as compared to ideal adaptive modulation technique which is due to the various delays involved like processing time and

feedback time. Nevertheless, adaptive modulation in MIMO system is still better to be implemented in wireless communication to achieve high speed communication without compromising the quality at all channel conditions.

Limitations

The simulations performed here are only for single user MIMO system. However in practice, the communication systems consist of a number of users sharing the same channel. The analysis and simulation for such multi user MIMO system (MU-MIMO) is not done in this research work. Also only two transmitting antennas and two receiving antennas i.e 2×2 MIMO system is considered here in this research work. However, increasing the number of transmitting and receiving antennas, i.e., 3×3 or 4×4 . MIMO system, increases throughput of the system and the result will be better than the result obtained here in this research work with 2×2 MIMO system. Only Rayleigh fading channel is considered during simulations and the work can also be carried for Ricean fading channel.

Conclusions

In this paper, the channel capacity of SISO, MISO, SIMO and MIMO system were compared and it was found that the capacity of multiple antenna system is much higher than that of single antenna system. BER performance of M-QAM MIMO systems was investigated under Rayleigh fading channel. BER of 4QAM was found better than both 8QAM and 16QAM at all SNR values. However, at higher SNR values 8QAM and 16QAM also had sufficiently lower BER. Also, we analyzed adaptive modulation in MIMO system with which high data rate with minimum BER at all channel conditions can be achieved.

Acknowledgements

This research has been supported by Kantipur Engineering College, Kathmandu, Nepal. We would also like to thank Department of Electronics and Computer Engineering, Pulchowk Campus, Nepal for the valuable suggestion and guidance.

References

- Ahmed, M.R., Ahmed, Md. R., Robin, Md. R.A., Asaduzzaman, Md., Hossain, Md. M. & Awal, Md. A. (2010). Performance analysis of different m-ary modulation techniques in fading channels using different diversity. *Journal of Theoretical and Applied Information Technology*, Khulna University.
- Bäoölcskei, H. & Paulraj, A.J. (2002). *Multiple-input multiple-output (MIMO) wireless systems* (2nd ed.). CRC Press.
- Gesbert, D., Shafi, M., Shiu, D., Smith, P. & Naguib, A. (2003). From theory to practice: An overview on MIMO space-time coded wireless systems. *IEEE Journal on Select Areas in Communication*. 21(3), pp. 281-302.

- Gowarishankar, R. & DEMIRKOL, M.F. (2005). *Adaptive M-QAM modulation for MIMO systems*. University of Hawaii at Manoa, Honolulu, USA.
- Han, J., Tao, X. & Cui, Q. *Lower bound of BER in M-QAM MIMO system with ordered ZF-SIC receiver*. China: Beijing University of Posts & Telecommunications, Beijing.
- Haykin, S. (2001). *Communication systems*. John Wiley & Sons, Inc.
- Khan, A. & Vesilo, R. *A tutorial on SISO and MIMO channel capacities*. Australia: Macquarie University, Sydney.
- Lo, T.K.Y. (1999). *Maximum ratio transmission*. IEEE Trans. on Communications, 47, pp. 1458–1461.
- Rappaport, T.S. (2003). *Wireless communications: Principles and practice* (2nd ed.). Prentice Hall.
- Svensson, A. (2007). *An introduction to adaptive QAM modulation schemes for known and predicted channels*. Proceedings of the IEEE, 95(12).
- Tse, D. & Viswanath, P. (2005). *Fundamentals of wireless communication*. UK: Cambridge University Press.
- Zhou, Z., Vucetic, B., Dohler, M. & Li, Y. (2005). *MIMO systems with adaptive modulation*. IEEE Transactions on Vehicular Technology, 54(5).

Spatial Orientation of Angular Momentum Vectors of SDSS Galaxies having Redshift 1×10^{-1} to 1.005×10^{-1}

S.N. Yadav, B. Aryal and W. Saurer*

Central Department of Physics, Tribhuvan University, Kirtipur, Kathmandu

*Institute of Astroparticle Physics, Innsbruck University, Innsbruck, Austria

Abstract: We planned to study spatial orientation of 44831 SDSS (Soloan Digital Sky Survey) galaxies that have red shift 0.10 to 0.11 (radial velocity 30000 km/s to 33000 km/s). In this paper, analysis of only spatial orientations of 2124 SDSS galaxies of red shift 0.10000 to 0.1005 (radial velocity 30000 km/s to 30150 km/s) using seventh data released (2008 October) are presented. Our main aim is to understand the origin of rotationally supported large scale structure (e.g. spiral galaxies) by analyzing non-random effects in galaxy orientation. The database of narrowband was made available through our collaboration with institute of astro-particle physics, Innsbruck University, Innsbruck, Austria. The two dimensional observed data (inclination angle, position angle and diameters) are converted into three dimensional rotation axes (polar and azimuthal angles) using 'position angle-inclination method'. We intend to study the non-random effects and to check dependency in the spatial orientation of galaxies in a large scale structure. The expected isotropic curves are obtained by removing the selection effect by performing a random simulation generating 10^6 virtual galaxies. The observed and expected distributions are compared by three statistical tests namely, chi-square test, auto-co relation test, Fourier tests. In general our results support the Hierarchy model. This model assumes that the angular momentum of galaxies oriented randomly with respect to the reference co-ordinate system. In this work, the equatorial co-ordinate system is taken as the reference co-ordinate system. In a few samples, the local anisotropy is observed, suggesting a gravitational tidal interaction between neighboring galaxies, probably an early merging process in which the gravity tend to distort the randomly oriented angular momentum vectors.

Keywords: Surveys, galaxies, clusters, redshifts of galaxies, evolution of galaxies, statistics, model, angular momentum.

Introduction

The evolution processes of the Universe are not well understood till date. Galaxies are much less well understood than stars. In order to understand the density fluctuations in detail, a complete knowledge of angular momentum of rotationally supported system is essential. We have studied the distribution of angular momentum vectors of SDSS galaxies that have redshift 0.1000 to 0.1005. For this, we used the position angle inclination method (Flin & Godlowski, 1986) to solve the problem. Three existing models essentially allow us to know when and how they have formed and how their constituents have been changing with time. These are:

Pancake model (Doroshkevich, 1973): In this model, the formation of clusters took place first and it was followed by their fragmentation into galaxies due to adiabatic fluctuations. Here the spin vector tends to lie within the cluster plane.

Hierarchy model (Peebles, 1969): It predicts that the directions of the spin vectors should be distributed randomly. According to this model, galaxies were first formed and then obtained their angular momenta by the tidal force while they were gathering gravitationally to form a cluster.

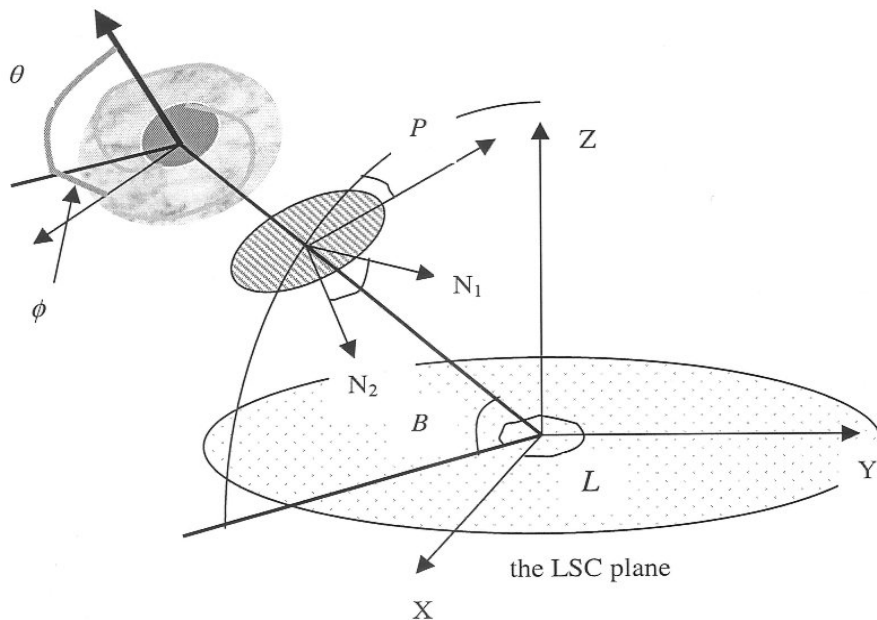
Primordial vorticity theory (Ozernoy, 1978): It predicts that the spin vectors are perpendicular to the cluster plane. According to this premise, the first flattened rotating proto-clusters were formed due to the cosmic vorticity in the early universe.

Model	Hypothesis	Predicted alignment (w.r.t. the cluster plane)
Pancake model	Fragment	Parallel
Hierarchy model	Fragmentation-clustering	Random
Primordial vorticity theory	Clustering	Perpendicular

Theory: The existence of superclusters indicates that galaxies in the universe are not uniformly distributed; most of them are drawn in to a group and cluster. Those groups and clusters and additional isolated galaxies form larger structures called superclusters.

Spatial orientation of galaxies: The image of the galaxy that we obtained with help of the ground-based or satellite-based telescopes is two dimensional projection of galaxy in the celestial sphere. The major diameter, minor diameter, position angle etc. are two dimensional data of the three dimensional galaxy.

Fig. 1. The coordinate system used for the derivation of polar and azimuthal angle of the galaxy rotation axes.



Conversion of two dimensional data to three dimensional data:

Inclination angle (i) of the galaxies can be found by the formula given by Holmberg is,

$$\cos^2 i = \frac{(q^2 - q^{*2})}{(1 - q^{*2})}$$

Where, $q=b/a$, a is major diameter, b is minor diameter, q^* is the flatness factor whose value is 0.1 for Sd spirals and 0.23 for the elliptical ones. For the galaxies with unknown morphology, $q^*=0.20$ is assumed.

The position angle inclination method (Flin & Godloski, 1986) is used to convert these two dimensional data into three dimensional azimuthal and polar angle (θ) of spin vector of galaxies in term of the equatorial co-ordinate system as given in Fig. 1.

$$\sin \theta = -\cos i \sin \delta \pm \sin i \sin p \cos \delta \tag{2}$$

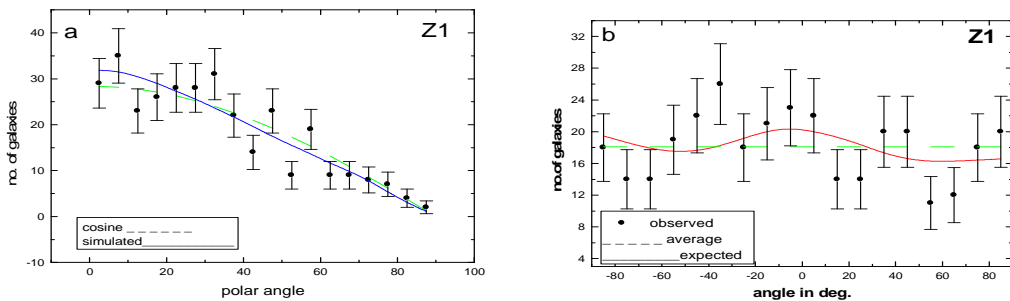
$$\sin \phi = (\cos \Theta) - 1 [-\cos i \cos \delta \sin \alpha + \sin i (\sin p \sin \delta \sin \alpha + \cos p \cos \alpha)] \tag{3}$$

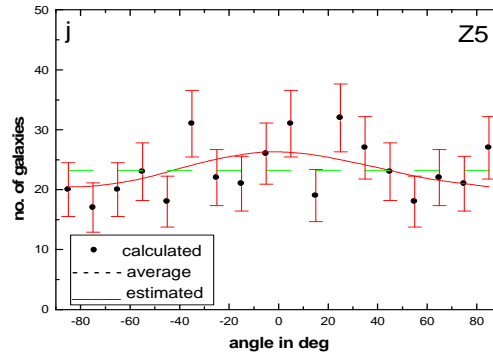
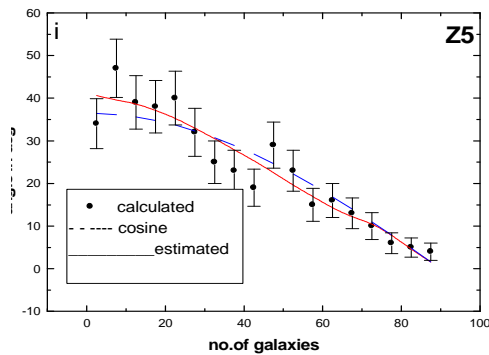
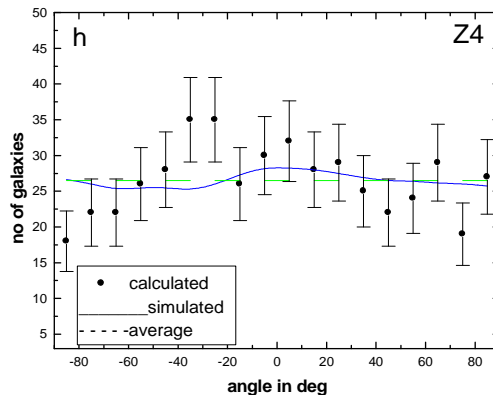
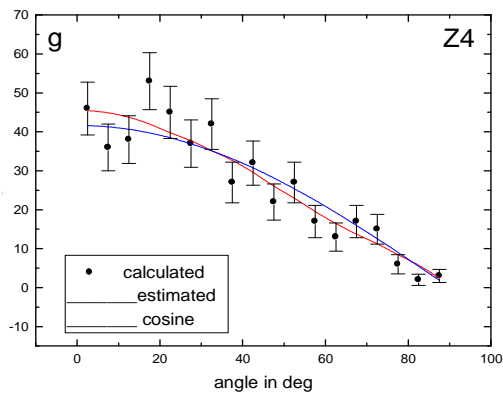
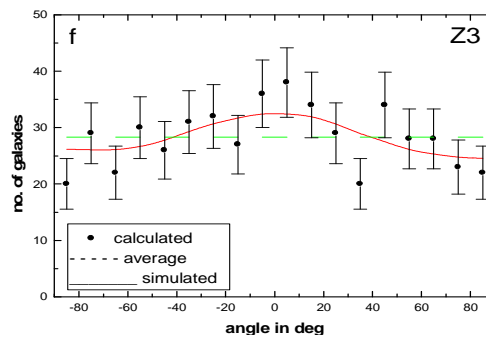
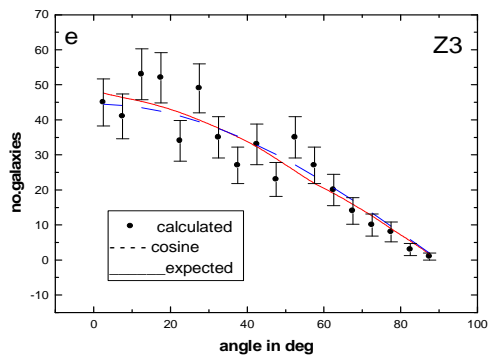
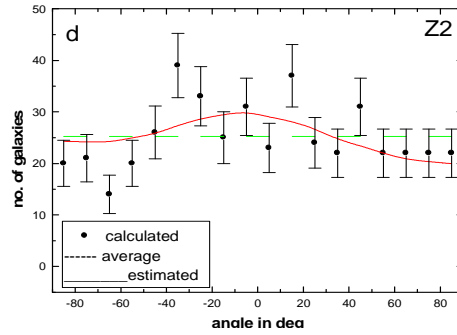
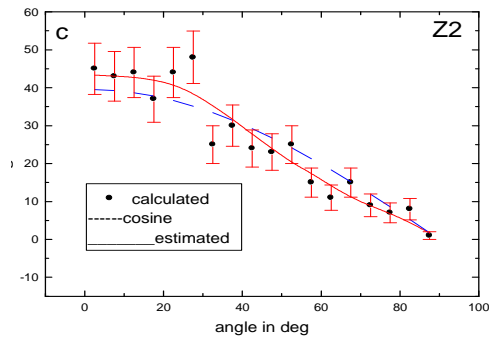
Where, P is the position angle; δ is the angle of declination; i is the angle of inclination; α is the right ascension.

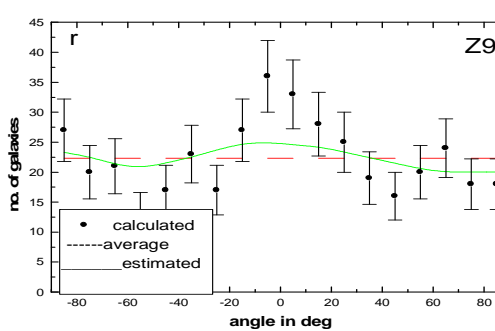
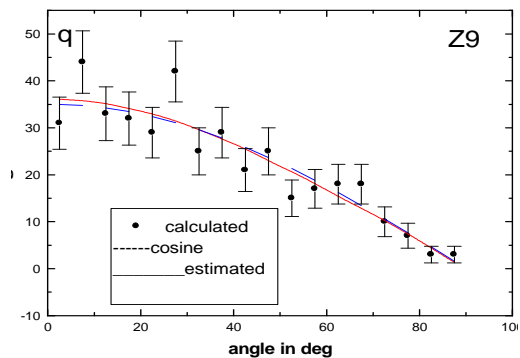
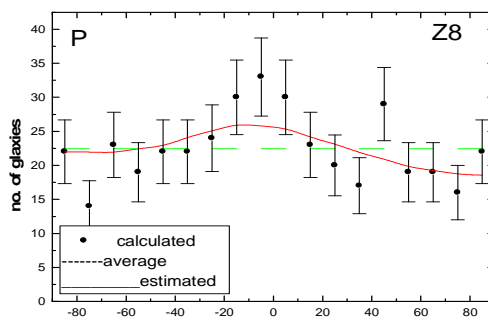
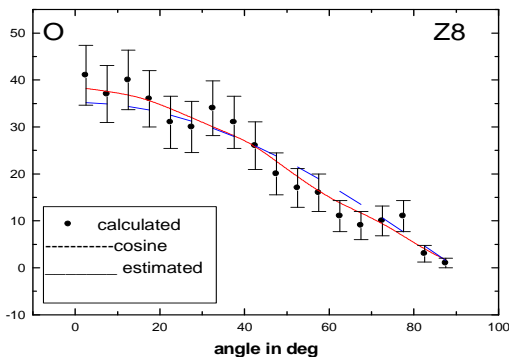
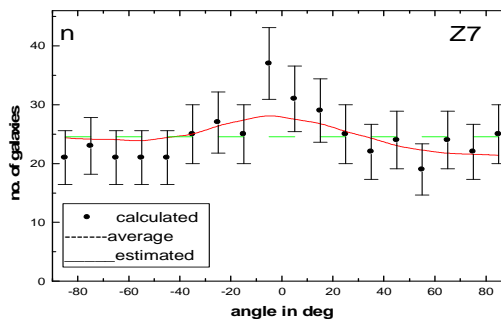
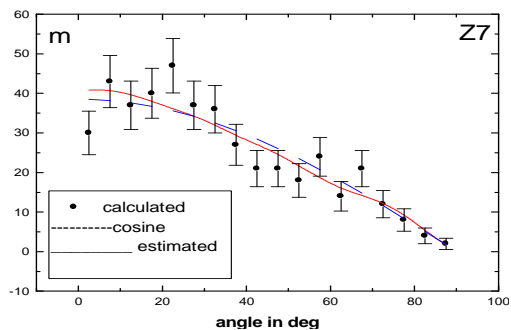
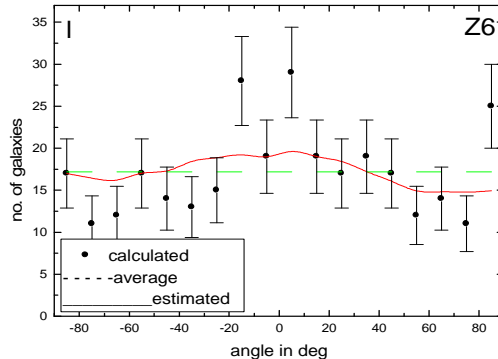
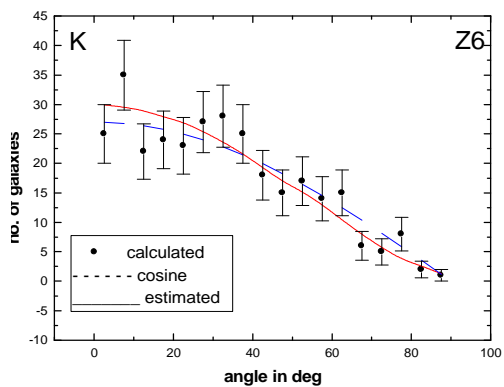
We performed the numerical simulation to minimize the selection effect due to the position angle and the inclination, creating 10^6 virtual galaxies for the entire data by using MatLab-6.1 (Aryal & Saurer, 2000, 2001). In this case, we ran the simulation by two ways, fitting a linear equation and not fitting the linear equation.

Limit for anisotropy: In the chi-square test: $\chi^2 < 0.050$. In the auto-correlation test: The auto-correlation coefficient ($c/c(\sigma)$) $\geq \pm 1$. In the fourier test, the first order fourier coefficient $\Delta 11/\sigma$ ($\Delta 11$) $\geq \pm 1.5$. The 1st order fourier probability $\{p(>\Delta 1)\} < 0.15$

Fig. 2. The polar angle (θ) and azimuthal angle (ϕ) distributions of galaxies that have redshift range 0.1000 to 0.1005. divided into ten sub samples each redshift at the range of 5×10^5 . The solid line represents expected isotropic distributions. The cosine and average distribution (dashed) are shown for the comparison. The solid circles with error bar represent the observed distribution.







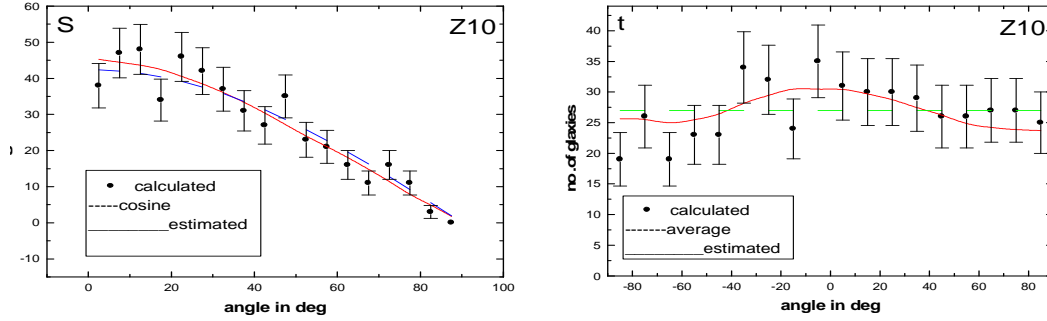


Table 1. Statistics of the azimuthal and polar angle distribution of galaxies in samples Z1, Z2, Z3, Z4, Z5, Z6, Z7, Z8, Z9 and Z10. The first column represents the samples. In the table, $P (>\chi^2)$ represents the chi square probability in the second column. Similarly, $C/C (\sigma)$ represents the auto-correlation coefficient in the third column. The last two columns give the first order Fourier coefficient $\{\Delta 11/\sigma (\Delta 11)\}$ and first order Fourier probability $P (>\Delta 1)$.

Sub bin		P	C/C (σ)	$\Delta 11/\sigma (\Delta 11)$	P ($>\Delta 1$)	Result
Z1	ϕ	0.622	0.924	0.603	0.436	isotropic
Z1	θ	0.535	-1.397	-0.531	0.853	isotropic
Z2	θ	0.714	-0.824	-0.198	0.943	isotropic
Z2	ϕ	0.268	0.423	0.913	0.507	isotropic
Z3	θ	0.887	-0.619	0.633	0.899	isotropic
Z3	ϕ	0.408	-0.281	-0.430	0.815	isotropic
Z4	θ	0.495	-0.415	0.177	0.937	isotropic
Z4	ϕ	0.574	1.222	2.022	0.053	mixed
Z5	θ	0.671	0.071	-0.191	0.970	isotropic
Z5	ϕ	0.738	-0.987	-0.105	0.859	isotropic
Z6	θ	0.64	-0.445	-1.057	0.524	isotropic
Z6	ϕ	0.178	-0.024	1.121	0.318	isotropic
Z7	ϕ	0.986	0.258	0.926	0.555	isotropic
Z7	θ	0.552	0.038	-0.137	0.944	isotropic
Z8	θ	0.988	0.188	0.448	0.879	isotropic
Z8	ϕ	0.745	-0.021	1.085	0.502	isotropic
Z9	θ	0.574	-1.272	-0.200	0.975	isotropic
Z9	ϕ	0.365	1.707	1.591	0.208	mixed
Z10	θ	0.643	-0.404	-0.141	0.953	isotropic
Z10	ϕ	0.960	-0.065	0.556	0.578	isotropic

Results and discussion

We studied the spatial orientation of spin vectors of galaxies having redshift range 0.1000 to 0.1005 (radial velocity 30000 km/s to 30150 km/s), which were compiled from the SDSS DR7. The two-dimensional parameters were transformed into three dimensional parameters (polar angle and azimuthal angle of galaxies rotation axes) using the 'position angle-inclination' method (Flin & Godlowski, 1986). For the removal of selection effects in the database, we used the method proposed by Aryal and Saurer (2000) and obtained the isotropic distribution curves by running a numerical simulation.

The table above gives statistical parameters for polar and azimuthal angle and the figures above show the polar angle and azimuthal angle distributions of galaxies of samples Z1, Z2, Z3, Z4, Z5, Z6, Z7, Z8, Z9 & Z10 of the SDSS data. In both cases, it is clear that the cluster is isotropic. In all the cases, the value of chi-square probability are more than 0.05 i.e., isotropic. In case of auto-correlation test, the value of c is less than 1 for polar angles i.e., isotropic while the value of azimuthal angle for Z9 & Z4 shows weak anisotropic and all the remaining samples show isotropic. All the values of first order forier-coefficient show isotropic except Z9 & Z4.

Value of $\Delta 11/\sigma$ ($\Delta 11$) lies between -1.5 and +1.5; this indicates that the random orientation of spin vector obey the Heirarchy Model. According to the Heirachy Model (Peeble, 1969), the direction of the spin vector is randomly oriented. Galaxies were first formed and then they obtained their angular momenta by the tidal force while they were gathering gravitationally to form a cluster. Those galaxies grow by subsequent merging of protogalactic condensation (Kauffermann *et al.*, 1999) or even by the merging of the already fully-formed galaxies (Mihos & Hernquist, 1960). In this scheme, one could imagine that the large irregularities, like galaxies, grew under the influence of gravities forming small imperfections in the universe. Few statistics such as c/c (σ) for azimuthal angle shows anisotropic. This result suggests that the preferred orientations in the substructures should show acorrection with the merging environment, leading to the formation of cluters of galaxies. We have to study the cause of an isotropic in few cases in detail in future work by dividing the data into several samples.

Acknowledgements

We have great pleasure to thank the anonymous reviewer and our seniors for suggestions and help. We are thankful to Innsbruck University, Austria for providing the data. S.N. Yadav also is grateful to the University Grand Commission for their generous funding of his Ph.D. work. We acknowledge Prof. Lok Narayan Jha, Prof. Uday Raj Khanal, Prof. M.M. Aryal and others for their help during work. I would also like to thank my family members for their support.

References

- Aryal, B. & Saurer, W. (2000). *Astronomy and Astrophysics Journal*, 364, L97.
- Doroshkevich, A.G. (1973). *Astrophysics*, 14, L11.
- Flin, P. & Godlowski, W. (1986). *Monthly Notices Roy. Astron. Soc.*, 222, p. 52.
- Kauffmann, G., Colberg, J., Diaferio, A. & White, S.D.M. (1999). *Monthly Notices Roy. Astron. Soc.*, 303, p. 188.
- Mihos, J.C. & Hernquist, L. (1996). *Astrophysics Journal*, 464, p. 641.
- Ozernoy, L.M. (1978). The large scale structure of universe. In M.S. Longair and J. Einasto (Eds.), *Proc. IAU Symp. No. 79*. Reidel, Dordrecht, p. 427.
- Peebles, P.J.E. (1969). *Astrophysics Journal*, 155, p. 393.

Evaluation of Crude Banana Powder as Formulation Additives and Comparison of Its Mucoadhesive Property with Carbapol 934P

Sanjay K. Yadav*, Lalit M. Pant, Gagan Paudel, Nabin Poudel and Rajan Shrestha
Kathmandu University Dhulikhel, Kavre

*Email: sanjay.y.s@gmail.com

Abstract: *The present investigation is concerned with the evaluation of crude banana powder as formulation aids and comparison of its mucoadhesive properties with carbapol 934P polymer. Diclofenac Potassium is used as a model drug for the formulation and evaluation of tablets. The formulation of tablets that bind to the gastric mucin or epithelial cell surface are useful in drug delivery for the purpose of increasing the contact time of the drug with the absorbing membrane. The tablets were prepared by direct compression, aqueous wet granulation and non aqueous wet granulation method using isopropyl alcohol. Fifteen formulations were prepared using varying proportion of carbapol 934P, crude banana powder and polyvinyl pyrrolidone. The tablets were tested for weight variation, hardness, friability, assay, disintegration, mucoadhesive strength and in-vitro drug dissolution study. The in vitro release of diclofenac potassium was performed under sink conditions (Phosphate buffer pH6.8, $37\pm 0.5^{\circ}\text{C}$, rpm 50) using USP dissolution apparatus type I. Carbapol 934P showed better mucoadhesive property than that of banana flour as the polymer concentration was increased. On increment of polymer concentration from 10% to 60% in case of Carbapol 934P force of adhesion increased from 1.716 N to 4.684 N while force of adhesion increased from 0.662N to 1.716 N when the banana flour concentration was increased from 10% to 60%, respectively. This reveals that the both crude banana flour and Carbapol 934P have mucoadhesive property but Carbapol 934P has better mucoadhesive property. The formulations with Carbapol 934P and banana flour that used aqueous wet granulation method showed sustained effect with F2 formulation being optimum in case of Carbapol 934P while F6 formulation of crude banana showed optimum sustained effect. A better sustained effect was seen in formulation with use of Carbapol 934P.*

Keywords: *Diclofenac potassium, mucoadhesive strength, Carbapol 934P, crude banana powder, invitro dissolution.*

Introduction

The oral route of drug administration is the widely used and most accepted route but different nature of drugs such as lipophilic leads to an unsatisfactory oral drug delivery system. It is due to the insufficient retention time in gastro-intestinal (GI) tract and the difference in gastric emptying rate. We can increase the bioavailability of such drugs by formulating different formulations like controlled release, bioadhesion release and by coating to release the drug at the targeted site (Vincent & Joseph, 1987; Collett, 2002). Mucoadhesive systems now play a major role in this field due to their interesting potential. Besides acting as a platform for sustained release dosage forms, bioadhesive polymers can themselves exert some control over the rate and amount of drug release, thus, contributing to the therapeutic efficacy of mucoadhesive drug

delivery system (Lordi, 1991; Banker & Rodes, 2002; Shah & Rocca, 2004; Andrews, 2009).

Bioadhesion is defined as an "ability of a material to adhere to a biological tissue for an extended period of time." In the case where polymer is attached to the mucin layer of a mucosal tissue, the term "mucoadhesion" is used. Mucoadhesive dosage forms have three distinct advantages: a) These dosage forms are readily localized in the region applied to improve and enhance the bioavailability of drugs. b) These dosage forms facilitate intimate contact of the formulation with the underlying absorption surface. This allows for the modification of tissue permeability for absorption of macromolecules such as peptides and proteins. c) Mucoadhesive dosage forms also prolong the residence time of the dosage form at the site of application and absorption to permit dosage once or twice a day (Boltenberg, 1991; Shojaei, 1998; Gómez *et al.*, 1999).

Banana was chosen for the study of its mucoadhesiveness as it contains lectin which is a newer generation mucoadhesive and has the following properties: a) it is least effected by mucus turnover rates, b) site specific drug delivery is possible. Carbapol 934P is mucoadhesive polymer whose suitability was proved. Hence, in the present work, an attempt was made to formulate mucoadhesive oral tablets for diclofenac potassium using different polymer in order to increase the retention time in gastrointestinal tract and bioavailability to obtain desired therapeutic efficacy (Lehr *et al.*, 1992; Sachan & Bhattacharya, 2009).

Materials and methods

Diclofenac potassium was a gift sample from Deurali Janta Pvt. Ltd, Kathmandu. Ripe banana fruit, goat intestine mucosa were purchased from a local market in Banepa. Carbapol 934P, PVP were obtained from the lab of Department of Pharmacy, Kathmandu University.

Formulation of mucoadhesive tablets

The drug, polymers and excipients were mixed homogeneously over a butter paper for 15 min in ascending order of mixing process. The mixture (300 mg) was then compressed using a 10 mm round punch in a single-stroke using 10-station rotary machine for formulation F1 to F4. For formulations F5 to F8, aqueous wet granulation was performed and compressed. For formulations F9 to F15, non aqueous wet granulation was performed and compressed (Table 1) (Abbas *et al.*, 2009).

Evaluation of mucoadhesive tablets

Weight variation: Twenty tablets from each formulation (F1 to F15) were weighed using an electronic balance and the average weight was calculated.

Friability: Friability is the measure of tablet strength. Roche type friabilator was used for testing the friability using the following procedure. Twenty tablets were weighed accurately and placed in the tumbling apparatus that revolves at 25 rpm dropping the tablets through a distance of six inches with each revolution. After 4 min, the tablets were weighed and the percentage of loss was determined.

$$\% \text{ Loss} = \frac{\text{Final weight} - \text{Initial weight}}{\text{Initial weight}} \times 100$$

Thickness: The thickness of six randomly selected tablets from each formulation was determined in mm using a vernier calliper. The average values were calculated.

Hardness: Tablets require a certain amount of strength or hardness and resistance to friability, to withstand mechanical shocks of handling during the manufacture, packaging and shipping. The hardness of the tablets was determined using Monsanto hardness tester. It is expressed in kg/cm². Five tablets were randomly picked from each formulation and the mean and standard deviation values were calculated.

Assay

Standard preparation: Accurately weighed 75 mg of Diclofenac potassium in 100 ml of volumetric flask and dissolved it in sufficient 0.1M sodium hydroxide to produce 100 ml Pipette 1 ml of the resulting solution in 50 ml volumetric flask and made up the volume with buffer solution of pH 6.8 (Bhanja *et al.*, 2010).

Sample preparation: Accurately weighed, crushed and mixed pellets blend equivalent to 75 mg of Diclofenac in 100 ml volumetric flask, and dissolved it in sufficient 0.1 M sodium hydroxide solution to produce 100 ml and stir for 1 h. Pipette 1 ml of the resulting solution in 50 ml of volumetric flask and add sufficient buffer of pH 6.8 to produce 50 ml. Measured the absorbance of standard and sample solutions at 275 nm using pH 6.8 buffer as blank and calculated the result by comparison.

Mucoadhesion: Goat mucosa was used as a model mucosal surface for Bioadhesion testing. Immediately after the slaughter, remove the mucosa from the goat and transport it to laboratory in tyrode solution and keep it at 40°C. The composition of tyrode solution (g/L) is sodium chloride 8, potassium chloride 0.2, calcium chloride dihydrate 0.134, sodium bicarbonate 1.0, sodium dihydrogen phosphate 0.05 and glucose 1.0 (Shoaib *et al.*, 2006).

Fabrication of assembly: The goat intestinal mucosa was cut into strips/pieces and washed with tyrode solution. At one time of testing, a section of goat intestinal mucosa was secured keeping the mucosal side out on the upper glass vial using

thread. The vial with the goat intestinal mucosa was stored at 37°C for 2 h. Then one vial with a section of goat intestinal mucosa and another vial were fixed on a height adjustable pan. On a lower vial, a tablet was placed with the help of bilayered adhesive tape, adhesive side facing downward. The height of the lower vial was adjusted so that a tablet could adhere to the goat intestinal mucosa on the upper vial. A constant force was applied on the upper vial for 2 min, after which it was removed and the upper vial was then connected to the balance.

Then the weight on the right side pan was slowly added in an increment of 0.5 g, till the two vials just separated from each other. The total weight required to detach two vials was taken as a measure of Mucoadhesive strength. From this Mucoadhesive strength, the force of adhesive was calculated. (Park & Robinson, 1993; Shoaib *et al.*, 2006; Rowe *et al.*, 2009).

$$\text{Force of adhesion} = \frac{\text{Mucoadhesive strength}}{100} \times 9.81$$

Disintegration: For the study of disintegration time, six tablets of each formulation were taken. The water medium with volume of 900 ml at 37°C was taken as the disintegration medium.

In-vitro dissolution: The In-vitro dissolution study was conducted as per the United States Pharmacopoeia (USP). The rotating basket method is used to study the drug release from the tablets. The dissolution medium consisted of 900 ml of phosphate buffer (pH 6.8). The release was performed at 37°C ± 0.5°C, at a rotation of speed of 50 rpm; 10 ml samples were withdrawn at the predetermined time intervals (1 to 8 h) and the volume was replaced with fresh medium. The samples were filtered and analyzed for Diclofenac potassium, after appropriate dilution, by UV spectrophotometer at 276 nm. The percentage (%) of drug release was calculated in comparison with a standard solution having a known concentration of Diclofenac potassium as the reference standard in the same medium.

The calculation was done by using the formula:

$$\% \text{ DP} = \frac{\text{As} \times \text{Cc}}{\text{Au} \times \text{Cs} \times 900 \times 100 \times \text{Df}}$$

Au and As are absorbance obtained from the solution under test and standard solution respectively. Cs is the concentration of standard solution in mg/ml. Cc is the tablet label claim. 900 is the total volume of dissolution medium. 100 is the conversion factor to percentage. Df is the dilution factor.

Table 1. Formulation of oral mucoadhesive tablet.

Batch No/ Components	Diclofenac potassium (mg)	Carbapol 934P (mg)	Banana flour (mg)	Magnesium stearate (mg)	Lactose (mg)	PVP	Batch size (mg)
F1	75	30	-	5	190	-	300
F2	75	60	-	5	160	-	300
F3	75	120	-	5	100	-	300
F4	75	180	-	5	40	-	300
F5	75	-	30	5	190	-	300
F6	75	-	60	5	160	-	300
F7	75	-	120	5	100	-	300
F8	75	-	180	5	40	-	300
F9	75	-	15	5	190	15	300
F10	75	-	30	5	175	15	300
F11	75	-	45	5	160	15	300
F12	75	-	60	5	145	15	300
F13	75	-	120	5	85	15	300
F14	75	-	180	5	25	15	300
F15	75	-	-	5	205	15	300

Results and discussion

Weight variation

The weight variation test was conducted for each batch of all formulations F1 to F15 as per I.P. and the results are shown in Table 2. The weight variation test for all the formulations complies with the IP limit ($\pm 7.5\%$).

Friability

The friability test for all the formulations were done as per the standard procedure I.P. The results of the friability test are shown in Table 2. The data indicates that the friability was less than 1% in all formulations ensuring that the tablets were mechanically stable.

Thickness

The thickness of the tablets was found to be almost uniform in all formulations, F1 to F15. The thickness was found to be in the range of 2.8 to 3.2 mm. None of the formulations (F1 to F15) showed any deviation. Hence, it is concluded that all the formulations complied the thickness test (Table 2).

Hardness

The adequate tablet hardness is necessary requisite for consumer acceptance and handling. The measured hardness of the tablets of each batch of all formulations i.e., F1 to F15, were ranged between 27.0 to 57.8 Newton (Table 2).

Assay

The assay of each batch of all the formulation (F1 to F15) was evaluated as per the standard protocol (Table 2). The results indicate that the percentage of drug content found was 95.33% to 104.84%. Hence, it is concluded that all the formulations followed acceptable limits as per the Indian Pharmacopoeia i.e., $\pm 5\%$.

Mucoadhesion

The *in vitro* mucoadhesive strength study was performed (Table 2). On the modified physical balance and measure, the force (N) required detaching the tablet. The mucoadhesion characteristics were affected by the concentration of the mucoadhesive polymers. An increase in concentration of polymer increased the mucoadhesive strength of formulation. F4>F3>F2>F8>F1>F7>F14>F13>F6>F12>F11>F5>F10>F9>F15 is the adhesive force order.

Disintegration

The disintegration test was conducted for formulations F9 to F15. Disintegration time was found to be between 7 min 59 sec and 32 min 25 sec.

In-vitro dissolution

The formulations F1, F2, F3 and F4 contained drug and Carbapol 934P in amount of 10%, 20%, 40%, and 60% respectively. The *in vitro* cumulative drug release profile of formulations F1, F2, F3 and F4 showed 100.56%, 87.32%, 44.28% and 24.82%, respectively. Among these four formulations, F2 was found to have the highest percentage of drug release. During the study, it was observed that the tablets were initially swollen and showed sustained release over a period of 8 hours except F1 which showed maximum release in 6 h (Fig. 1).

Similarly, the formulations F5, F6, F7 and F8 drug contained Crude banana powder in amount of 10%, 20%, 40%, and 60% respectively. The *in vitro* cumulative drug release profile of formulations F5, F6, F7 and F8 showed 102.24%, 92.43%, 77.19% and 99.42%, respectively. Among these four formulations, F8 was found to have the highest percentage of drug release. During the study it was observed that the tablets were non-erodible and showed sustained release over a period of 8 h (Fig. 2).

Similarly, the formulations F9, F10, F11, F12, F13, and F14 drug contained Crude banana powder in amount of 5%, 10%, 15%, 20%, 40%, and 60%, respectively. These all formulations contained 15 mg PVP. The *in vitro* cumulative drug release profile of formulations F9, F10, F11, F12, F13 and F14 showed 95.69%, 98.69%, 99.87%, 99.51%, 87.16% and 75.04%, respectively in 15 min, 30 min, 1 h, 1 h, 6 h and 8 h, respectively. Among these four formulations, F11 was found to have the highest percentage of drug release. The formulation F15 contains 15 mg PVP only. The *in vitro* drug release is 95.99% in 15 minutes (Fig. 3).

It was concluded that by increasing the concentration of Carbapol 934P in the formulation, the drug release rate from the tablets can be decreased. But by increasing the concentration of crude banana powder, the drug release rate at first decreases and then increased. This may be due to an increased hydration (or) swelling characteristics of polymers with increased concentrations.

Figure 1. Dissolution Profile of Carbapol 934P.

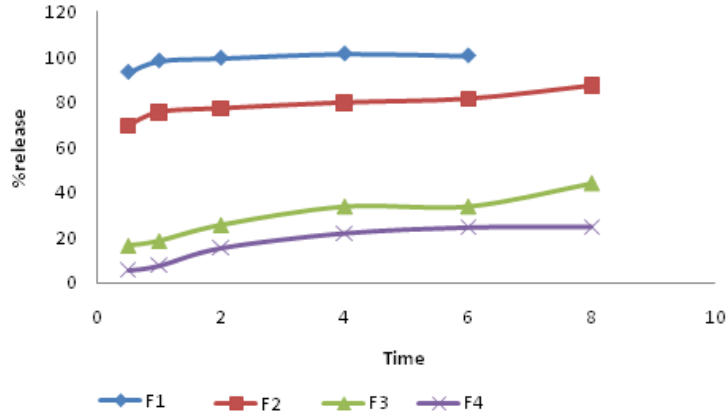


Figure 2. Dissolution Profile of Crude Banana Flour.

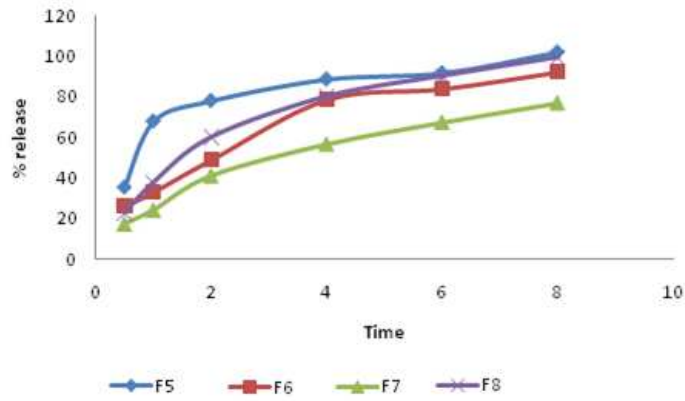


Figure 3. Dissolution Profile of Crude Banana Flour with PVP.

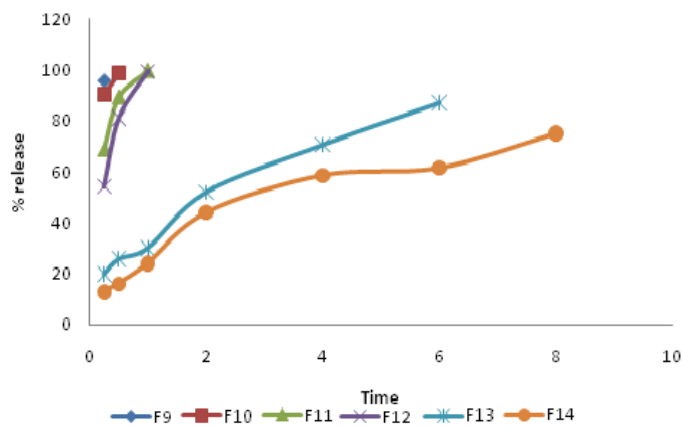


Table 2. Physiochemical parameters of oral mucoadhesive tablets

Formulation code	Average weight (g)	Hardness (Newton)	Friability	Thickness	Assay	Force of mucoadhesion (Newton)
F1	0.2972 ± 0.01	40.00 ± 4.41	0.29%	2.9±0.06	103.900	1.716
F2	0.3043 ± 0.01	32.00 ± 7.17	0.14%	3.1±0.04	97.510	3.163
F3	0.3076 ± 0.01	36.40 ± 3.36	0.15%	3.1±0.06	95.330	3.874
F4	0.3034 ± 0.01	54.80 ± 9.62	-	3.3±0.00	103.330	4.684
F5	0.2957 ± 0.01	57.80 ± 5.35	0.30%	2.8±0.08	101.330	0.662
F6	0.3046 ± 0.01	55.60 ± 4.56	0.14%	2.8±0.12	97.670	1.079
F7	0.2997 ± 0.01	54.00 ± 7.31	0.15%	2.8±0.07	97.670	1.446
F8	0.2981 ± 0.01	47.00 ± 2.00	0.14%	2.8±0.11	101.650	1.716
F9	0.3010 ± 0.01	47.40 ± 3.36	0.15%	2.9±0.06	101.330	0.402
F10	0.3120 ± 0.01	39.40 ± 2.50	0.15 %	3.0±0.09	101.270	0.613
F11	0.3035 ± 0.01	33.80 ± 3.03	0.29%	2.9±0.04	104.840	0.701
F12	0.3112 ± 0.01	34.60 ± 6.64	0.30%	3.0±0.08	100.670	0.760
F13	0.3051 ± 0.01	36.00 ± 2.88	0.15%	3.1±0.07	104.000	1.110
F14	0.3069 ± 0.01	27.00 ± 1.22	-	3.2±0.04	100.670	1.250
F15	0.3040 ± 0.01	39.00 ± 8.04	0.29%	2.9±0.04	104.380	0.220

Conclusion

The sustained release mucoadhesive tablets of Diclofenac potassium by using banana flour were successfully formulated. The polymer that is responsible for mucoadhesive property in banana is lectin that has low mucin turnover rate (Lehr, 2000; Smart, 2004; Andrews, 2009; Shah & Rocca, 2004). So, this research has led to the possibility of developing tablet formulations containing lectin that can be given to patients with altered mucin turnover rates in diseases like gastric ulcer, cystic fibrosis, ulcerative colitis to increase the retention time of tablet in gastrointestinal lining.

However, the mucoadhesive strength of tablets with banana flour was found to be low as compared to that of tablets using Carbapol 934P. The banana flour was found to possess the property of a binder. The study revealed that on increment of banana flour concentration, consistent increase in disintegration time was observed.

Acknowledgements

We would like to express our special thanks to Prof. Dr. Panna Thapa the Head of Department for providing the opportunity to conduct this project as a partial fulfillment of requirement of B. Pharm. degree. We are highly indebted to Assistant Prof. Dr. Uttam Budhathoki, Mr. Rajan Shrestha, Dr. Rajendra Gyawali for guidance as well as for providing necessary information.

References

- Abbas, F.M., Saifullah, R. & E., A.M. (2009). Assessment of physical properties of ripe banana flour prepared from two varieties: Cavendish and dream banana. *International Food Research Journal*, 16, pp. 183-189.
- Andrews, G.P. (2009). Mucoadhesive polymeric platforms for controlled drug delivery. *Eur. J. Pharm. Biopharm*, pp. 505-518.
- Banker, G.S. & Rodes, C.T. (2002). Sustained and controlled release drug delivery system. *Modern Pharmaceutics*, 121, pp. 501-513.
- Bhanja, S., Ellaiah, P., Martha, S.K., Sahu, P.K., Tiwari, S.P., Panigrahi, B.B., *et al.* (2010). Formulation and in vitro evaluation of mucoadhesive buccal tablets of timolol maleate. *International Journal of Pharmaceutical and Biomedical Research*, pp. 129-134.
- Boltenberg, B. (1991). Development and testing of bioadhesive fluoride containing slow release tablets for oral use. *J. Pharm. Pharmacol.* 43, pp. 457-461.
- Carreno-Gómez, B., Woodley, J. & Florence, A. (1999). Studies on the uptake of tomato lectin nanoparticles in everted gut sacs. *Int. J. Pharm.*, 183(1), pp. 7-11.
- John Collett, C.M. (2002). Modified release per-oral dosage form. In M.E. Aulton (Ed.), *Pharmaceutics the science of dosage form design* (pp. 289-306). London: Harcourt Publishers Limited.
- Lehr, C., Bouwstra, J., Kok, W., Noach, A., Deboer, A. & Junginger, H. (1992). Bioadhesion by means of specific binding of tomato lectin. *Pharma. Res.*, 9(4), pp. 547-553.
- Lehr, M.C. (2000). Lectin-mediated drug delivery: The second generation of bioadhesives. *J. Control Release*, pp. 19-29.
- Lordi, N.G. (1991). Sustained release dosage forms. In H.A. Leon Lachman (Ed.), *The theory and practice of industrial pharmacy* (pp. 430-456). India: CBS Publishers & Distributors Pvt. Ltd., New Delhi.
- Park, K. & Robinson, J.R. (1993). Mucoadhesive polymers as platforms for oral controlled drug delivery. *Method. J. Control Release*, pp. 51-59.
- Rowe, R.C., Sheskey, P.J. & Quinn, M.E. (2009). *Handbook of pharmaceutical excipients*. London: Pharmaceutical Press And American Pharmacists Association.
- Sachan, N.K. & Bhattacharya, A. (2009). Basics and therapeutic potential of oral mucoadhesive microparticulate drug delivery systems. *IJPCR*, 1(1), pp. 10-14.
- Shah, U.K. & Rocca, J.G. (2004). Lectins as next-generation mucoadhesives for specific targeting of the gastrointestinal tract. *Drug Deliv. Tech.*, 4(5).
- Shoaib, M.H., Tazeen, J., Merchant, H.A. & Yousuf, R.I. (2006). Evaluation of drug release kinetics from ibuprofen matrix tablets using HPMC. *Pak. J. Pharm. Sci.*, pp. 119-124.
- Shojaei, A.H. (1998). *Buccal mucosa* as a route for systemic drug delivery. *J. Pharm. Pharmaceut. Sci.*, pp. 15-30.
- Smart, D.J. (2004). Lectin-mediated drug delivery in the oral cavity. *Advanced Drug Delivery Reviews*, pp. 481-489.
- Vincent, L.H. & R. Joseph, R. (1987). *Controlled drug delivery fundamentals and applications*. New York: Informa Healthcare.

Survival and Efficiency of *Bacillus thuringiensis* in Waste Water for Biological Control of Mosquito Breeding

Upendra Thapa Shrestha and Vishwanath Prasad Agrawal

Research Laboratory for Biotechnology and Biochemistry (RLABB), Sanepa, Lalitpur

Email: upendrats@gmail.com

Abstract: Bacterial insecticides have been used for the control of nuisance and vector mosquitoes for more than three decades. *Bacillus thuringiensis* is the most commonly used one due to its broad spectrum of insecticidal property, environmental friendliness because it is safe to non-target insects. The only limiting factor in the use of *B. thuringiensis* as a bio-mosquitocide is their survival in waste water, the natural breeding sites of mosquito. The study was thus carried out to evaluate the survival and efficiency of *B. thuringiensis* in such different niches. Seven crystal protein producing isolates were selected for insect bioassay against the mosquito larva of *Culex* species both in the lab and waste water and further processed for survival tests. Among the isolates, S₆ was found to be highly potent showing 100% efficiency in killing the mosquito larva in their natural habitat. Other isolates were also found to be highly efficient showing 70-90%. These isolates not only showed mosquitocidal properties but were also found to be growing in the same environment. The *B. thuringiensis* grew in the waste water to a bacterial count of 10⁸ in 7 days but the number gradually plunged in the subsequent month. In the 30th day, the number of *B. thuringiensis* isolates was found to be 10⁶ even in such polluted water. This property of *B. thuringiensis* adds to their prominent characteristic as bio-mosquitocide which can be commercialized for the control of many mosquito borne diseases.

Keywords: *Bacillus thuringiensis*, crystal protein, niches, bio-mosquitocides, survival.

Introduction

Insecticidal products based on the soil bacterium *Bacillus thuringiensis* are an environmental friendly alternative to synthetic insecticides for biological control of agricultural pests and disease vectors. The use of *B. thuringiensis* has increased in the last decade due to its low toxicity to the environment and non-target insects. The toxicity of *B. thuringiensis* is due to proteins contained in the crystal inclusion produced during the sporulation stage called Cry proteins (Ben-Dov *et al.*, 1999; Schnepf *et al.*, 1998). Different types of Cry proteins of *B. thuringiensis* are effective against many insects including various Lepidoptera (moths and butterflies), Diptera (flies and mosquitoes), and Coleoptera (Beetles) species. Some strains have also been found to kill off nematodes (Edward *et al.*, 1988).

Despite advances in medical science and new drugs, mosquito-borne diseases including malaria, filariasis, dengue and viral encephalitis remain the most widespread diseases affecting humans. World Health Organization (WHO) estimated that there are more than two billion people worldwide living in the areas where these diseases are endemic. Over one million people die from mosquito-borne diseases every year and millions more experience pain and suffering from illnesses transmitted

by mosquitoes (AMCA, 2013). Nepal being a developing country is no exception regarding such problems. These diseases cause significant morbidity and mortality especially in Terai regions of Nepal. Approximately 20.36 million people (73% of Nepal population) live in malaria-endemic districts. Among them, 5.9 million live in high risk areas of 13 districts (Nepal Malaria Strategic Plan 2011-2016, 2011). Many more people are facing problems of other vector borne diseases. Thus, there is an urgent need for new agents and strategies to control this alarming situation. One of the potential strategies may be the use of *B. thuringiensis* as a biological control method of mosquitoes in their natural habitats.

In our previous studies we found *B. thuringiensis* as an effective agent for the control of mosquito larva (Shrestha *et al.*, 2006, 2007). The survival of *B. thuringiensis* in waste water and mosquito breeding sites is equally important for its use as a biological control method. However, none of the literature focused on the survival of *B. thuringiensis* in such niches. So, in our study, we have evaluated the potential of *B. thuringiensis* to survive in waste water to control the mosquito larva. This property of *B. thuringiensis* was expected to be commercialized.

Methods

Isolation and identification of B. thuringiensis: One potent strain of *B. thuringiensis* isolate (S₆) was revived from the previous master culture preserved in the Research Laboratory for Biotechnology and Biochemistry (RLABB) and three soil samples from Sagarmatha National Park-SNP (S₂, S₇ and S₁₁) were reprocessed to isolate *B. thuringiensis*, following acetate selection method to avoid any contamination (Travers *et al.*, 1987). Further identification was carried out by gram staining, spore staining and crystal protein staining, biochemical tests, sugar utilization tests and hydrolysis tests as described in Bergey's Manual of Systematic Bacteriology (Claus & Berkeley, 1986).

Insect bioassay: Mosquito larva of *Culex* species were collected from mosquito breeding places in the local area. Bacterial cultures were grown to the stationary phase, the suitable phase for the sporulation and production of δ endotoxin (Drobniewski & Ellar, 1989). The assay was set in duplicate to read reproducible results. Each set was performed with 10 larva and 100 ml of sterilized water with 0.3 ml of 5% brewer's yeast. Five milliliter of *B. thuringiensis* culture of stationary phase was added in each and allowed to stand for upto three days (Bhattarai, 2002). The number of deaths in each set was recorded for one, two and three days each so as to know the efficiency of individual activities of the respective isolates. The insect bioassay was also carried out in waste water collected from the mosquito breeding site without addition of any nutrients.

Survival and efficiency of B. thuringiensis in waste water: Water samples from mosquito breeding sites were collected. Five milliliter of broth culture of *B. thuringiensis* (broth

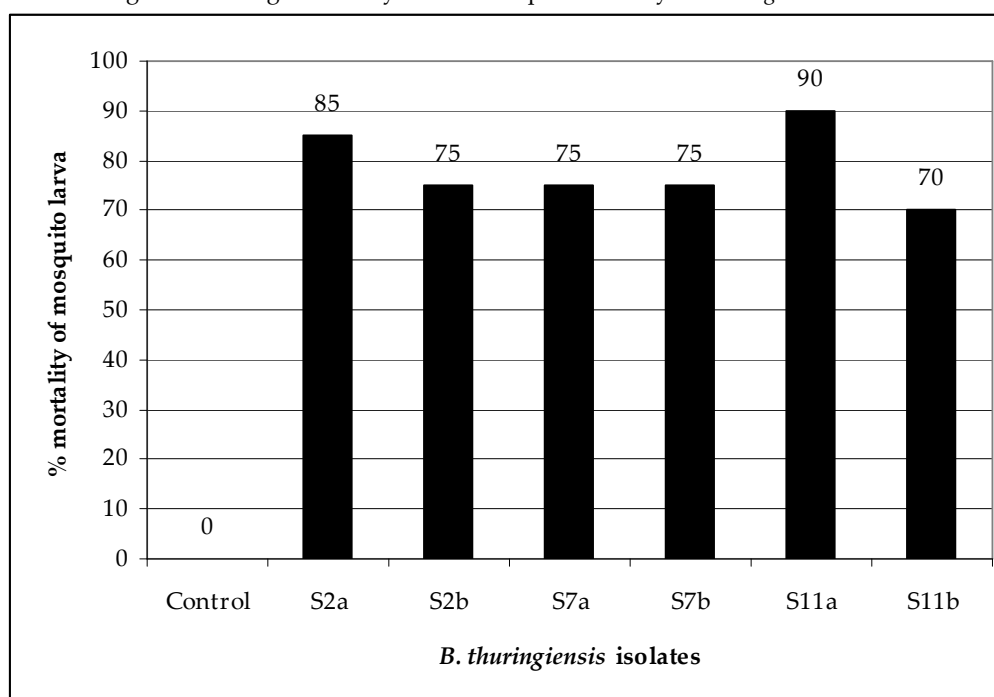
density greater than McFarland Standard No. 4 = 12×10^8 /ml) isolates aged 3 days were inoculated into it. Quantitative measurement of *B. thuringiensis* isolates was done by Plate count method. The survival time was recorded for 30 days. The remaining bacteria were again inoculated in waste water containing mosquito larva and the mortality of mosquito was again recorded.

Results

Altogether, seven potent isolates were selected; one potent strain of *B. thuringiensis* isolate (S₆) was revived from the previous master culture preserved in RLABB and six other *B. thuringiensis* were isolated and identified from three soil samples (S₂, S₇ and S₁₁). All new isolates were crystal protein producers.

Insect bioassay: Insecticidal properties of sample S₆ were found to be the highest among the seven isolates with a 100% mortality rate of mosquito larva. S_{11a} and S_{2a} followed the mortality rate of 90% and 85% respectively. All isolates were found to be very potent (Fig. 1).

Fig. 1. Percentage mortality rate of mosquito larva by *B. thuringiensis* isolates



Survival and efficiency of B. thuringiensis: The initial concentration of bacteria in waste water after the inoculation was 6×10^9 per 100 ml of waste water ($5 \times 12 \times 10^8$ per 100 ml = 6×10^9 per 100 ml). The growth of *B. thuringiensis* in waste water was found to increase for seven days and plunge gradually in subsequent days till 30th day. *B. thuringiensis*

isolates were found to be alive in the waste water for 30 days or more. The number of *B. thuringiensis* was found to be higher in control, autoclaved waste water, in comparison with the test (Table 1).

Table 1. Enumeration of *B. thuringiensis* isolates in waste water till 30 days from inoculation

Isolates code	Number of <i>B. thuringiensis</i> per 100 ml in					
	1 day (inoculation)	3 days	7 days	14 days	21 days	30 days
Control	6×10^9	9.2×10^{10}	3.96×10^{12}	1.73×10^9	6.0×10^8	2.2×10^6
S _{2a}	6×10^9	8.35×10^9	1.47×10^{11}	1.12×10^8	1.00×10^7	3.0×10^6
S _{2b}	6×10^9	7.2×10^9	1.21×10^{11}	0.99×10^8	1.1×10^7	5.0×10^6
S ₆	6×10^9	6.1×10^9	3.1×10^{10}	0.35×10^8	1.23×10^7	0.6×10^6
S _{7a}	6×10^9	1.10×10^{10}	0.94×10^{11}	0.87×10^8	0.8×10^7	5.0×10^6
S _{7b}	6×10^9	7.1×10^9	1.38×10^{11}	0.66×10^8	0.85×10^7	4.0×10^6
S _{11a}	6×10^9	2.33×10^{10}	4.49×10^{11}	1.38×10^8	1.55×10^7	6.0×10^6
S _{11b}	6×10^9	8.9×10^9	4.19×10^{11}	1.19×10^8	1.50×10^7	4.50×10^6

Discussion

All seven potent isolates selected in our study possessed visible delta endotoxin. The study by Frederiksen *et al.* (2006) reported 38 strains containing visible protein crystals, whereas 12 strains were positive for a *cry* gene with no visible protein crystals but detected by Polymerase Chain Reaction (PCR). Many studies showed that some strains of *B. thuringiensis* may possess visible crystal proteins whereas some may not.

The majority of *B. thuringiensis* strains are toxic to larvae of the order Lepidoptera (Huber-Lukac *et al.*, 1986). Of the 7 isolates tested against the mosquito larva in our study, S₆ was the most effective one accounting for 100% efficiency within three days. Most of them were highly efficient in killing the larva, ranging from 70% to 100% efficiency (Fig. 1). Vector control products such as VectoBac® and Teknar® based on *Bacillus thuringiensis* subsp. *israelensis* are most commonly used to control larvae. The insecticidal properties of these bacteria are due primarily to insecticidal proteins which are Cyt1A, Cry11A, Cry4A and Cry4B (Federici *et al.*, 2003). Similarly, some other bacteria such as *Clostridium bifermentans*, have been discovered to possess mosquitocidal properties (Delécluse *et al.*, 2000). In addition, *Bacillus sphaericus* has also been used in the market with the commercial name VectoLex® for the control of mosquito vectors (Federici *et al.*, 2003). Although numerous bacteria have been applied as mosquitocidal products, *B. thuringiensis* has been most effectively used till now because of their broad-spectrum of mosquitocidal Cry proteins.

The growth of *B. thuringiensis* in waste water was found to soar till the seventh day and plunge gradually in subsequent days till 30th day. The initial concentration of bacteria in waste water after the inoculation was 6×10^9 per 100 ml of waste water

($5 \times 12 \times 10^8$ per 100 ml = 6×10^9 per 100 ml). The number gradually increased to about 10^9 - 10^{10} within 3 days and soon rose to 10^{11} in 7 days. Instead of the presence of many grazers and phages, the bacteria were found to overcome and multiply in waste water. Soon after the seventh day, the number of bacteria started to decrease gradually. The previously inoculated bacteria, *B. thuringiensis* were hardly isolated after 30 days. The number of *B. thuringiensis* was found to be higher in control in comparison with the test (Table 1). The survival of *B. thuringiensis* isolates was recorded for 30 days and found to be alive in the waste water. Likewise, Menon & Mestral (1985) found that *B. thuringiensis* survived for longer period in fresh and marine waters. Though it is very difficult to describe the actual chemical and physical niche of the waste water, the possible reasons behind the fluctuation of bacteria density with incubation period might be due to the temperature and pH of water toxic chemicals, enormous groups of microbes (protozoa, bacteria, phages etc.) and higher animals including insects which feed on the bacteria and the available nutrients. However, the bacteria were found to be highly efficient mosquitocidal agents even in such polluted water.

Conclusion

B. thuringiensis, a soil bacterium, was found to survive and multiply in waste water for many days. They appear to be a safe and efficient bio-insecticide against mosquitoes in different habitats.

Acknowledgements

We express our sincere gratitude to University Grants Commission (UGC), Sanothimi, Bhaktapur for financial support for this research work and Mr. Jaya Bhandari and Mr. Sarobar Ghimire for helping with the lab work.

References

- American Mosquito Control Association*. (AMCA). (2013). Mosquito-Borne Diseases website, <http://www.mosquito.org/mosquito-borne-diseases>.
- Ben-Dov, E., Wang, Q., Zaritsky, A., Manasherob, R., Barak, Z., Schneider, B., ... Margalith, Y. (1999). Multiplex PCR screening to detect cry9 genes in *Bacillus thuringiensis* strains. *Appl. Environ. Microbiol.*, 65, pp. 3714-3716.
- Bhattarai, S. (2002). Insecticidal activities of *Bacillus thuringiensis* against *Culex quinquefasciatus* and *Spodoptera litura*. A dissertation submitted to Central Department of Microbiology, Tribhuvan University as a partial fulfillment of Master of Science in Microbiology.
- Claus, D. & Berkeley, R.W.C. (1986). Genus *Bacillus* Cohn 1872. In *Bergey's Manual of Systematic Bacteriology* Vol. 2. (Eds. Sneath, P.H.A) Baltimore: Williams & Wilkins. pp. 1105-1138.

- Delécluse, A., Juárez-Perez, V. & Berry, C. (2000). Vector-active toxins: structure and diversity. In J.F. Charles, A. Delécluse & C. Nielsen-LaRoux (Eds.), *Entomopathogenic bacteria: From laboratory to field application* (pp. 101-125) Dordrecht, The Netherlands: Kluwer.
- Drobniewski, F.A. & Ellar, D.J. (1989). Purification and properties of a 28-kilodalton hemolytic and mosquitocidal protein toxin of *Bacillus thuringiensis* subsp. *darmstadiensis* 73-E10-2. *J Bacteriol.*, 171, pp. 3060-3067.
- Edwards, D.L., Payne, J. & Soares, G.G. (1990) Novel isolates of *Bacillus thuringiensis* having activity against nematodes. U.S. Patent 4, 948, 734.
- Federici, B.A., Park, H.W., Bideshi, D.K., Wirth, M.C. & Johnson, J.J. (2003). Recombinant bacteria for mosquito control. *The Journal of Experimental Biology*, 206, pp. 3877-3885.
- Frederiksen, K., Rosenquist, H., Jorgensen, K. & Wilcks, A. (2006). Occurrence of natural *Bacillus thuringiensis* contaminants and residues of *Bacillus thuringiensis* based insecticides on fresh fruits and vegetables. *Appl. Environ. Microbiol.*, 72(5), pp. 3435-3440.
- Huber-Lukac, M., Jaquet, F., Luethy, P., Huetter, R. & Braun, D.G. (1986). Characterization of monoclonal antibodies to a crystal protein of *Bacillus thuringiensis* subsp. *kurstaki*. *Infect Immun* 54, pp. 228-232.
- Menon, A.S. & Mestral, J.De. (1985). Survival of *Bacillus thuringiensis* var. *kurstaki* in waters. *Water, Air and Soil Pollution*, 25(3), pp. 265-274.
- Nepal Malaria Strategic Plan 2011-2016. (2011). Revised version December 2011. Government of Nepal, Ministry of Health and Population, Department of Health Services, Epidemiology & Disease Control Division, Teku, Kathmandu, Nepal.
- Nepal, C.C. (2000). Managing Resistance to *Bacillus thuringiensis* Toxins. Environmental Studies, University of Chicago
- Schnepf, E., Crickmore, N., Van Rie, J., Lereclus, D., Baum, J., Feitelson, ...Dean, D.H. (1998). *Bacillus thuringiensis* and its pesticidal crystal proteins. *Microbiol. Mol. Biol. Rev.*, 62, pp. 775-806.
- Shrestha, U.T., Sahukhal, G.S., Pokhrel, S., Tiwari, K.B., Singh, A. & Agrawal, V.P. (2006). Delta-endotoxin immuno cross-reactivity of *Bacillus thuringiensis* isolates collected from Khumbu base camp of Mount Everest region. *Journal of Food Science Technology Nepal*, 2, pp. 128-131.
- Shrestha, U.T., Sahukhal, G.S., Pokhrel, S., Tiwari, K.B., Singh, A. & Agrawal, V.P. (2007). Strong mosquitocidal *Bacillus thuringiensis* from Mt. Everest. *Our Nature*, 5, pp. 67-69.
- Travers, R.S., Martin, P.A. & Reichelderfer, C.F. (1987). Selective process for efficient isolation of soil *Bacillus* spp. *Appl Environ. Microbiol.*, 53, pp. 1263-1266.

Pre-marital Sex Among Youth and Vulnerability in Contracting STI/HIV/AIDS in Nepal

Dhanendra Veer Shakya

Central Department of Population Studies, Tribhuvan University, Kirtipur, Kathmandu

Email: shakyadv@gmail.com

Abstract: *This study examines the sexual behaviour of Nepalese youth in terms of pre-marital sex and factors associated with it. Data files of 2006 Nepal Demographic and Health Survey (NDHS) were used as the main source of data in the study. The respondents selected were youth aged between 15-24 years that included 2427 females and 643 males who have had the experience of sexual intercourse. The binary logistic regression model is used in multivariate analyses for predicting a dichotomous discrete outcome from a set of independent variables which are continuous, discrete and categorical. The outcomes of the logistic regression are interpreted mainly with the help of indicator-odds-ratio. Nearly one-half of Nepalese youth males had pre-marital sex and most of them had unprotected first sex. Levels of education and their residency in urban area are attributed for the practice of pre-marital sex. Similarly, currently not-working youth males, engaged in agriculture and belonging to the age cohort of 15-19 years and non-migrant youth females were also more likely to be involved in pre-marital sex. Likewise, more Janajati youth males and those living in Western Region would also likely to practice pre-marital sex. As more youth males were found involved in pre-marital sex and had unprotected first sex, they can be considered to be vulnerable in contracting STIs/HIV viruses because sexual intercourse with irregular or casual partners is considered as a highly risky practice if done without protection.*

Keywords: *Youth, pre-marital sex, STIs/HIV/AIDS, vulnerable, regression and odds ratio.*

Introduction

Sexuality is an instinct imprinted into the genes of each living creature. Attraction to the opposite sex has been the key factor behind reproduction and survival of species. Most of the species are born with only seasonal sexual necessities. They mate and reproduce only at a limited time of a year. Human beings, on the other hand, have active sexual instincts throughout his/her life right from the very day he/she discovers his/her sexuality. Sex in itself, is not wrong at any age but pre-marital sex may harm the mental development of adults in several forms with the danger of possible communication of diseases as pre-marital partners may not be aware of diseases that spread through intercourses; and getting pregnant through pre-marital sex is another disaster (prokerala.com).

A comprehensive set of goals was drawn up in the 2001 United Nations General Assembly Special Session (UNGASS) on Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome (HIV/AIDS) that included: reducing HIV prevalence among young people aged between 15-24; and ensuring that young people aged between 15-24 have the knowledge, education, life skills and services to protect

themselves from HIV. Young people aged between 15–24 accounted for about 42 percent of new adult HIV infections in 2010, and 5 million young men and women are currently living with HIV. AIDS will not be halted until young people have the knowledge and capacity to avoid behaviours that put them at risk. The great challenge is reaching out to many young people who are not aware of their vulnerability to HIV. Many young people in the age group between 15–24 engage in unsafe sexual behaviour and a significant number continue to be infected. There is strong consensus, based on evidence, that girls and young women remain disproportionately vulnerable to HIV infection (UNICEF, 2011).

Sexually Transmitted Infections (STIs) including HIV mainly affect sexually active young people. Causes of the increased rates of STIs/HIV in young people are complex. The main reasons include biological factors, risky sexual behaviour such as early initiation into sex, pre-marital sex, bisexual orientation, having multiple sexual partners, transmission dynamics and treatment-seeking behaviour. As cited in McManus and Dhar (2008), researches indicated that attitudes, outlooks, norms and beliefs around sexual behaviour determine the intended sexual behaviour of young people. Bridging the gap between knowledge and practice, particularly with respect to the use of condoms, has emerged as a major behaviour changing communication to reduce adolescents' vulnerability to STIs and unwanted pregnancies.

A study of Rahman *et al.* (2007) found that many youth clients of Female Sex Workers (FSWs) had their first sexual exposure before the age of 18 and some of the clients started sexual relations as early as 11-14 years of age. Youth's first sexual exposure was influenced by peers/friends and peers/friends accompanied them in such exposures. Youth clients had exposure to pornography and after watching pornographic films many were induced to visit sex workers. Clients have been identified as the bridging population for the HIV/AIDS epidemic. They have high rates of STIs and a low STI care-seeking behaviour, although they have knowledge about HIV/AIDS.

There is a growing evidence of increased pre-marital sexual activities among young people (UNFPA, 2004). While generalization is difficult, studies indicated that between 20 and 30 percent of young men and up to 10 percent of young women have pre-marital sexual experiences. Women have a higher incidence of STIs than men because of their greater biological susceptibility.

Those who engage in pre-marital sex have a high risk of contracting STIs and the most common STI is the Human Papilloma Virus (HPV), an incurable virus that can cause genital warts and, as cited in Maher (n.d.), is present in nearly all cervical cancers. Cervical cancer and HIV were the leading causes of sexual behaviour-related deaths among women while HIV was the single leading cause of such deaths among men. Each year 3 million teens are infected with an STIs, and two-thirds of all new STI infections occur among young people under the age of 25.

Sexual activities among adolescents have been reported to be increasing worldwide. Early and pre-marital sexual practice is becoming common and is one of the risky sexual behaviours of young people. Personal desire to experiment, peer pressure and economic needs were the most frequently mentioned reasons for the school-going adolescents to commence pre-marital sex (Seme & Wirtu, 2008). Oindo (2002) cited that many worldwide studies on adolescent sexual behaviour show that young people's pre-marital sexual encounters are generally unplanned, infrequent and sporadic—a pattern that pre-disposes the youth to unwanted pregnancies and sexually transmitted infections.

Many studies clearly show the gap between knowledge and sexual behaviour of youth. Most of them know that abstinence and monogamy were protective measures against HIV infection and are aware of condom use but they are still likely to have pre-marital sex with more than one partner without using condoms.

Method

This study used the Data Files of 2006 Nepal Demographic and Health Survey in analyzing the determining factors for pre-marital sex among youth (15-24 years). In this study, only youth (15-24 years), who have had sexual experience, are selected and examined for the purpose of analysis. The study used weighted data, and the weighted sample size of the respondents is 3070 youth (2427 females and 643 males).

The binary logistic regression model has been used for data analysis as it predicts a dichotomous discrete outcome from a set of independent variables that may be continuous, discrete, categorical, or a mix of any type. The relationship between dependent and independent variables is not a linear function in the logistic regression; instead it has a logit link function which is the logit transformation of θ , i.e., probability of an event. Statistical Package for Social Sciences (SPSS), version 18, (PASW Statistics 18) was used to perform the task.

The outcomes of the logistic regression are interpreted with the help of indicators like odds ratio, model χ^2 , $-2 \log$ likelihood, Cox and Snell R^2 , Nagelkerke R^2 , and Hosmer and Lemeshow's χ^2 goodness of fit along with different levels of significance and 95 percent confidence interval as well in the case of odds ratio.

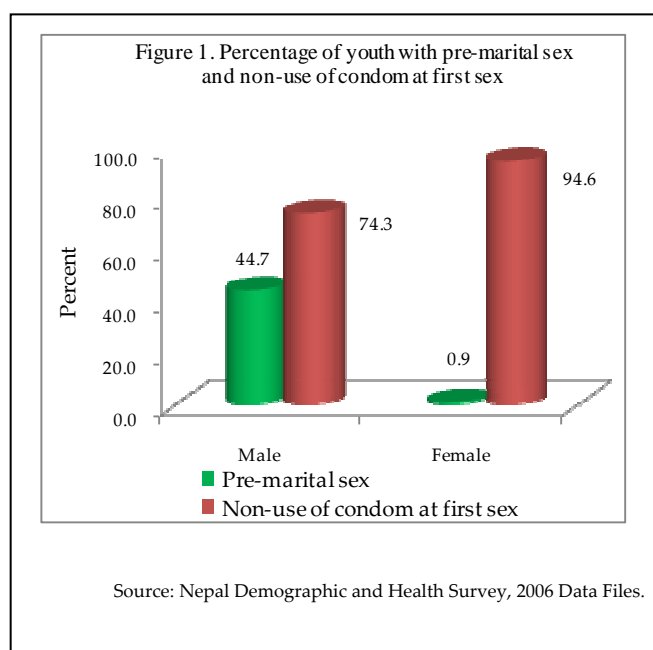
The study has defined vulnerability in contracting STIs/HIV/AIDS as a set of activities, behaviours and knowledge of youth which might put them at risk of contracting the disease through their risky sexual practices and lack of knowledge about the modes of safer sex.

Results and discussion

Sexual behaviour of Nepalese youth, especially of males, can put them at risk in contracting STIs including HIV/AIDS, because 2006 NDHS data show that out of total male youth who have had sexual experience, nearly one-half of them (45%) had pre-marital sex (Fig. 1). However, the figure for females was negligible and most of them

had their first sex only after marriage. Similarly, most of youth in Nepal are not found using condoms during their first sexual intercourse. Almost 95 percent of female youth and three-quarters of males (74%) had not used condoms during their first sexual intercourse (Fig. 1).

The overwhelming majority of females, whose partners did not use condoms, during first sexual intercourse can be expected as many of them had their husbands as the first sex partner. So, they may not have felt it necessary to have their husbands use condoms during the first intercourse. However, they too might be at risk if their husbands practiced risky sexual behaviours outside the wedlock. Male youth's risky sexual behaviour was also indicated by the fact that among those who did not use condom during first sexual intercourse, about one-half of them had first sex partner other than their spouses or non-regular cohabiting partners (calculated from 2006 NDHS Data Files).



Sex partners other than a spouse include commercial female sex workers, irregular partners, girl friends or non-live-in partners, casual acquaintances and others. So, it implies that Nepalese male youth have greater probability of contracting infection from unsafe sex, and this can be the major cause for the transmission of infection to their wives also, if they are married. In this way, married females can be the victim of the infection without having multiple sex partners even if they have the knowledge about the infection, modes of transmission and prevention.

A WHO study (2005) also indicated that engaging in sexual intercourse before marriage is becoming more common among youth as there is an increase in the number of youth who had experienced pre-marital sex. Pre-marital sexual experience among youth indicates that generally once one gets initiated into pre-marital sex, a repeat act either with the same partner or with another is more likely. Many adolescents engage in pre-marital sex without adequate knowledge about the means of avoiding pregnancy and STIs.

Socio-economic factors determining pre-marital sex

The 2006 NDHS data reveal that incidences of pre-marital sex in Nepal increases with the increase in the level of education. Almost 73 percent of male youth, who had higher than the secondary level of education, were involved in pre-marital sexual activities, followed by 51 percent of those who had secondary level of education. Similarly, about 33 percent males, who had only primary level of education, were found to have pre-marital sexual intercourse, followed by 18 percent of those who did not have any education.

Four-fifth of currently not working Nepalese male youth compared to two-fifths of those who work had pre-marital sex. Likewise, one-half of male youth from a well-to-do families had experienced pre-marital sex against 37 percent of poor. Similarly, a higher proportion of males in occupation category 'idle' (82%) had pre-marital sex. Three-fifth of males living in urban area, compared to two-fifths in rural area, had the same experience. A higher proportion of male youth with frequent exposure to different mass media had pre-marital sex compared to those who were less exposed to them.

Table 1 shows the outcomes of multivariate regression analysis while controlling the effect of other variables listed in the same table. The results show a positive correlation between the levels of education and pre-marital sex. Male youth with higher and secondary levels of education (OR=8.23, $p \leq .001$ and OR=3.54, $p \leq .01$ respectively), and female youth having secondary and primary levels of education (OR=5.18, $p \leq .05$ and OR=4.47, $p \leq .05$ respectively) were more likely to engage in pre-marital sex compared to those without education. Similar results were found in the studies conducted in India, as cited in Nag (1995), where pre-marital sexual experience of college students was not found to be rare as perceived widely. Neighbours, relatives, prostitutes, friends and fiancées have been the partners. The pre-marital sexual partner of a male student is often found to be a married woman who may be a relative or a neighbour.

However, currently working male youth than not working ones and those engaged in non-agriculture occupations were less likely to have pre-marital sex with odds ratios of 0.23 ($p \leq .001$) and 0.56 ($p \leq .05$) respectively.

Table 1. Effects of selected socio-economic, demographic and cultural and spatial factors on pre-marital sex, using logistic regression

Variables	Male		Female	
	Odds ratio	(95% CI)	Odds ratio	(95% CI)
<i>Socio-economic variables</i>				
Educational level				
No education	Ref.		Ref.	
Primary	1.948	(.883-4.295)	4.466*	(1.276-15.636)
Secondary	3.542**	(1.592-7.877)	5.175*	(1.263-21.206)
Higher	8.231***	(2.787-24.307)	7.896	(.483-129.133)
Current working status				
No	Ref.		Ref.	
Yes	.229***	(.095-.553)	2.162	(.440-10.625)
Wealth status				
Poor	Ref.		Ref.	
Non-poor	.946	(.602-1.487)	1.618	(.531-4.935)
Occupation				
Agriculture	Ref.		Ref.	
Not working	.406	(.111-1.492)	.346	(.043-2.799)
Manual	.628	(.364-1.082)	.393	(.029-5.388)
Non-agriculture	.557*	(.317-.980)	.599	(.076-4.740)
Place of residence				
Rural	Ref.		Ref.	
Urban	1.999*	(1.115-3.584)	5.555**	(1.689-18.267)
Reading newspaper/magazine				
Less than once a week	Ref.		Ref.	
At least once a week	.962	(.545-1.700)	.727	(.091-5.815)
Almost every day	1.362	(.670-2.769)	.290	(.004-20.103)
Listening to radio				
Less than once a week	Ref.		Ref.	
At least once a week	1.247	(.630-2.471)	.463	(.132-1.625)
Almost every day	1.637	(.894-2.998)	.881	(.301-2.579)
Watching television				
Less than once a week	Ref.		Ref.	
At least once a week	.960	(.559-1.651)	.367	(.076-1.760)
Almost every day	1.366	(.788-2.368)	.486	(.136-1.732)
<i>Demographic variables</i>				
Age group (in years)				
15-19	Ref.		Ref.	
20-24	.366***	(.242-.555)	.962	(.367-2.525)
No. of HH members	.889**	(.818-.967)	.931	(.755-1.147)
No. of men (15-59 years)	.894	(.696-1.148)	1.214	(.630-2.338)
No. of women (15-49 years)	na	na	na	na

Migration status				
Non-migrant	Ref.		Ref.	
Migrant	.782	(.473-1.294)	.141***	(.056-.357)
Visitor	1.012	(.408-2.511)	-	-
<i>Cultural variables</i>				
Religion				
Hindu	Ref.		Ref.	
Bouddha	.589	(.282-1.231)	-	
Other±	1.032	(.430-2.475)	-	
Caste/ethnicity				
Brahmin/Chhetri	Ref.		Ref.	
Janajati†	2.057*	(1.072-3.945)	2.275	(.567-9.135)
Occupational caste	.831	(.424-1.628)	2.817	(.628-12.646)
Other Hill origin	1.158	(.442-3.035)	.439	(.015-13.268)
Tharu & Yadav‡	1.288	(.656-2.531)	4.598	(.971-21.772)
Other <i>Tarai</i> origin	.999	(.450-2.214)	3.128	(.408-23.964)
<i>Spatial distribution</i>				
Ecological zone				
Hill	Ref.		Ref.	
Mountain	1.035	(.476-2.249)	.472	(.030-7.385)
<i>Tarai</i>	1.143	(.708-1.844)	1.244	(.401-3.858)
Region				
Central	Ref.		Ref.	
Eastern	.815	(.460-1.447)	.566	(.145-2.206)
Western	1.965*	(1.141-3.384)	.479	(.120-1.910)
Mid-western	1.157	(.615-2.175)	.597	(.140-2.538)
Far-western	1.332	(.659-2.693)	.469	(.091-2.407)
	n = 642		n = 2419	
	Model $\chi^2 = 162.309^{***}$		Model $\chi^2 = 56.842^{**}$	
	-2 LL BM = 883.098		-2 LL BM = 258.808	
	-2 LL = 720.789		-2 LL = 201.966	
	$R_{CS}^2 = .223$ & $R_N^2 = .299$		$R_{CS}^2 = .023$ & $R_N^2 = .229$	
	H & L's $\chi^2 = 8.798$		H & L's $\chi^2 = 4.701$	

Source: Nepal Demographic and Health Survey, 2006 Data Files.

Note: Results are the outcomes of multivariate logistic regression controlling the variables presented in the table.

LL = log likelihood; LL BM = log likelihood base model; R_{CS}^2 = Cox and Snell R^2 ; and R_N^2 = Nagelkerke R^2 ; H & L's χ^2 = Hosmer and Lemeshow's χ^2 goodness of fit.

Ref.: Reference category; na: Not applicable; ±: Includes Muslim, Kirat, Christian and other; †: Includes Newar, Gurung, Magar, Tamang, Sherpa, Rai and Limbu; and ‡: Also includes Ahir and Rajbanshi.

— It indicates no case (or relatively small number of cases) in reference value of dependent variables in either corresponding reference or predicted categories of independent variables.

* $p \leq .05$, ** $p \leq .01$ and *** $p \leq .001$.

Youth residing in urban areas are more likely to experience pre-marital sex (OR=2.00, $p \leq .05$ for males and OR=5.56, $p \leq .01$ for females). Results from a survey in India on urban youth also illustrated that they do not think it wrong for unmarried boys and girls having a sexual relationship if they loved each other (McManus & Dhar, 2008).

Demographic factors determining pre-marital sex

Three-fifth of males in the age cohort of 15-19 years, compared to 38 percent between 20-24 years, had pre-marital sex. Similarly, a higher portion of non-migrant males than migrant ones had practiced pre-marital sex (54% vs. 41%), but it was just the reverse in the case of females (0.6% vs. 3.2%).

Males between 20-24 years were less likely to engage in pre-marital sex compared to those in between 15-19 years (OR=0.37, $p \leq .001$). A study among urban men in Pakistan also revealed that most of pre-marital sexual debuts occurred between the age of 16 and 20 years (Mir *et al.*, 2008). Men who have had pre-marital sexual experience may enter their marriage already infected or have been exposed to an STIs thus placing their wives at risk for infection because of the low rate of condom use in both marital and non-marital unions.

A number of household members is negatively correlated with pre-marital sex for male youth with statistical significance ($p \leq .01$), but the value of odds ratio is close to one (0.89), indicating a lesser effect in the magnitude (Table 1). Similarly, migrant female youth were less likely to have pre-marital sex than non-migrant ones with odds ratio of 0.14 ($p \leq .001$).

Cultural factors and spatial distribution determining pre-marital sex

A slightly lower proportion of Hindu males (44%) than the Buddhist and other religious group (48%-49%) had pre-marital sex. A relatively higher proportion of Janajati, Brahmin/Chhetri and other hill origin youth males (59%, 53% and 48% respectively) were engaged in pre-marital sex compared to rest of the caste/ethnic males (around 30% each). Similarly, a higher proportion of males living in the hilly region (53%) and Western Region (55%) had pre-marital sex than those living in other regions of Nepal. But, in the case of females, there was not much difference among them in terms of such categories.

Janajati males and those living in the Western Region, compared to Brahmin/Chhetri and those living in the Central Region, were more likely to practice pre-marital sex as shown by the values of odds ratios (OR=2.06, $p \leq .05$ and OR=1.97, $p \leq .05$ respectively). But, none of the cultural variables and spatial factors considered in the study significantly correlated with the practice of pre-marital sex (Table 1).

The logistic regression model values, presented in Table 1, are significant with the 95 percent confidence intervals of significant odds ratios and model χ^2 values. The values of -2 log likelihood presented in the model are reduced to that levels by the

values of model χ^2 from the baseline model, and the improvement in the model shown by the values are significant for both the sexes ($p \leq .001$ for males and $p \leq .01$ for females). Cox and Snell R^2 value indicated 22.3 and 2.3 percent variance explained by the model for the practice of pre-marital sex for males and females respectively. Likewise, Nagelkerke R^2 value explains 29.9 and 22.9 percent of variance on. The values of Hosmer and Lemeshow's χ^2 goodness of fit are not significant for both the sexes ($p > .05$); it indicates that the predicted values in the model do not differ significantly from the observed data.

Conclusions

Nearly one-half of Nepalese male youth had pre-marital sex. Levels of education and their residency in urban areas are attributed for practice of pre-marital sex. Currently not-working male youth, engaged in agriculture and who one in the age group of 15-19 years, and non-migrant female youth were also more likely to get involved in pre-marital sex. Likewise, Janajati youth males and those living in Western Region were also likely to practice pre-marital sex. Youth who engage in pre-marital sex may be vulnerable in contracting STIs including HIV/AIDS, if they are involved in such practices unprotected.

References

- Maheer, B. (n.d.). *Why wait: The benefits of abstinence until marriage*. Washington D.C.: Family Research Council.
- McManus, A. & Dhar, L. (2008). Study of knowledge, perception and attitude of adolescent girls towards STIs/HIV, safer sex and sex education: A cross sectional survey of urban adolescent school girls in south Delhi, India. *BMC Women's Health*, 8(12). Retrieved from <http://www.biomedcentral.com/1472-6874/8/12> accessed on 17 January 2012.
- Ministry of Health and Population (MOHP), New ERA & ORC Macro. (2006). *Nepal demographic and health survey, 2006. Data files*. Kathmandu/Calverton, Maryland: MOHP/New ERA/ORC Macro.
- Mir, A.M., Reichenbach, L., Wajid, A. & Khan, M. (2008). *Study of sexually transmitted infections among urban men in Pakistan: Identifying the bridging population*. Islamabad: Population Council.
- Nag, M. (1995). Sexual behaviour in India with risk of HIV/AIDS transmission. *Health Transition Review*. 5(Supplement), pp. 293-305.
- Oindo, M.L. (2002). Contraception and sexuality among the youth in Kisumu, Kenya. *African Health Sciences*, 2(1), pp. 33-40.
- Rahman, M., Haseen, F., Gazi, R., Khan, S.I., Kelly, R., Ahmed, J., Chowdhury, F.A.H., Rahman, D.M.M., Huq, M., Hossain, E., Bhuiya, M.U., Imam, H., Sarma, H., Islam, M.Z.A., Bhuiya, R.I., Rahman, M., Hossain, Z. & Bhuiya, S.J. (2007). *An analysis of social, behavioural and biomedical risk factors of adolescents and youth clients of female sex workers: Implications for STI/HIV/AIDS interventions in Bangladesh*. Bangladesh: ICDDR,B.

- Seme, A. & Wirtu, D. (2008). Pre-marital sexual practice among school adolescents in Nekemte town, east Wollega. *Ethiopian Journal of Health and Development*, 22(2), pp. 167-173.
- United Nations Children's Fund (UNICEF), Joint United Nations Program on HIV/AIDS (UNAIDS), UNESCO, United Nations Population Fund (UNFPA), International Labour Organization (ILO), World Health Organization (WHO) & The World Bank. (2011). *Opportunity in crisis: Preventing HIV from early adolescence to young adulthood*. New York: UNICEF.
- United Nations Population Fund (UNFPA). (2004). *Sexually transmitted infections: Breaking the cycle of transmission*. New York: UNFPA.
- World Health Organization (WHO), Western Pacific Region. (2005). *Sexual and reproductive health of adolescents and youth in the Philippines: A review of literatures and projects 1995-2003*. Manila: WHO.
- www.prokerala.com/relationships/ accessed on 17 January 2012.

Reading the Grammar of Visual Image: A Functional Analysis

Ram Chandra Paudel

Central Department of English, Tribhuvan University, Kirtipur, Kathmandu

Email: rcpaudel52@gmail.com

Abstract: *In this paper an attempt has been made to analyze the visual images by applying the linguistic tools (ideational, interpersonal, and textual metafunctions) developed by M.A.K. Halliday in his An Introduction to Functional Grammar. The paper has analyzed twelve visual images to demonstrate how the three types of functions (in their modified forms "representational," "interactive," and "compositional" functions) are realized in visual analysis. The central argument of this paper is that visual images, although they are often treated as transparent, innocent and descriptive medium of communication, are not transparent as such and, at times, the sign/image producers' perspectives and/or interests are embedded in them refracting the reality in various ways.*

Keywords: *Functional grammar, metafunctions, representational, interactive, and compositional meanings, gaze, demand, offer, distance, position, point of view.*

Introduction

Verbal mode of communication is still a dominant mode in official and academic communication system and is used exclusively to describe the speculative and philosophical ideas that cannot be easily depicted visually. Because of its arbitrary nature and symbolic status, however, verbal message is often less effective in the act of communication than the visual one. The present-day communication system, at least in the popular media such as magazines, newspapers, television and films, is dominated by pictorial mode. Previously unheard of high-tech gadgets such as high pixelate cameras, smart television sets, laptops, tablet PCs, and smart cell phones have become very common objects of everyday use. At least in the urban scene, images are everywhere: they "bombard" the audiences through television channels and films. The real "blood and flesh" humans are distanced by the virtual humans through Skype and other channels of communication. There are blurred boundaries between the real humans and the unreal ones. Images can be copied infinitely but the copy is no more a copy, but more like its original. Today, humans in corporate and some of the state-owned premises are constantly surveyed by the ever-watchful close-circuit cameras.

Normally visual images, maps, sketches, photographs, diagrams are considered to be more authentic and transparent modes of communication as they are used with the verbal texts for not just to illustrate them but to make the verbal text more credible. It is true that visual messages are relatively less arbitrary and more effective in communicating messages, but they are not always transparent and innocent mode of communication. The image maker's interests are embedded in the message and

power relationships are reflected at various levels: distance, position, angle, composition, structure and interaction. In this paper an attempt has been made to explore various meanings at three levels: representation, interaction and composition. For this purpose, the visual tools developed by Gunther Kress and Theo van Leeuwen in their work *Reading Images: The Grammar of Visual Design* have been utilized. The images selected here are eclectically chosen on the basis of their relevance to the analysis.

Halliday (2004) posits that English clause is a composite affair, a combination of three different structures deriving from distinct functional components: the ideational (clause as representation), the interpersonal (clause as exchange), and the textual (clause as message) (2004). Transitivity structures, he adds, express representational meaning through participants, processes and circumstances; mood structures express interactional meanings between speaker and the audience through their interaction. Theme structures express the organization of the message through the text forming devices.

In their book, *Reading Images*, Kress and van Leeuwen (2006) have applied Halliday's functional linguistics in the analysis of visual messages. They treat forms of communication employing visual images more seriously than they have hitherto been treated. They take the view that language and visual communication both realize the same systems of meaning that constitute human culture, but that each does so by means of its own specific forms independently (p. 17). They have extended this idea to images, using a slightly different terminology: "representational" instead of "ideational," "interactive" instead of "interpersonal," and "compositional" instead of "textual."

The grammar of visual image

Any image, Kress and van Leeuwen contend, not only represents the world (whether in abstract or concrete ways), but also plays a part in some interaction and constitutes a recognizable kind of text (a painting, a political poster, a magazine advertisement, etc.) (Jewitt & Oyama, 2008). Like in the verbal message, there are three elements in a visual syntax: "participants," "processes," and "circumstances." Participants can be interactive (those who produce and consume/view images) and representative (those who are depicted on the pages or screens). Circumstances are further classified as means, setting and accompaniment (Kress & van Leeuwen, 2006). As illustrated by Kress and van Leeuwen (2006), images may involve two kinds of processes: "narrative processes" and "conceptual processes" (p. 74).

Narrative process relates participants in terms of doings and happenings, of the unfolding of actions, events, or processes of change. Conceptual patterns represent participants in terms of their more generalized, stable or timeless essences. They do

not represent participants as doing something, but as being something, or belonging to some category, or having certain characteristics or components. Narrative pictures are recognized by the presence of a "vector." A vector, as described by Kress and van Leeuwen, is a line, often diagonal, that connects participants, for instance, an arrow connecting boxes in a diagram, or the outstretched arms (p. 57). The vector expresses a dynamic "doing" or "happening" kind of relation. The vectors may be formed by bodies or limbs or tools in action, but there are many other ways to turn represented elements into a diagonal line of action (p. 57).

Like the verbal syntax, the visual syntax can be transitive (transactive) as well as intransitive (non-transactive) involving two or more participants as subject/actor and object(s)/goal(s). In the transactive actional process, the actor is a participant from which the vector emanates, or which itself, in whole or parts, forms the vector (Kress & van Leeuwen, 2006). When images have only one participant, this participant is the actor. The resulting structure is "non-transactional." The action in a non-transactional structure has no "goal," "is not done to" or "aimed at" anyone/anything. Non-transactional action process is therefore analogous to the intransitive verb (the verb that does not take an object) in language. When a narrative visual proposition has two participants, one is the actor, the other the goal. The goal is the participant at whom/which the vector is directed, hence it is also the participant to whom/which the action is done or at whom the action is aimed (Kress & van Leeuwen, 2006). In photo plate 1 (A) the male participant is the actor and the female is the goal. In Halliday's scheme it is the material process of acting/doing with the agent acting voluntarily. In other words, the actor is responsible for what is happening. In Kress and van Leeuwen's scheme, this is an example of transactional actional process in which the male participant is the actor and the female is the goal.

Sometimes the participant is not acting/or doing anything but just looking at something. The eyeline, the direction of the gaze creates a reaction rather than an action. Such a reaction can, again, be transactive or non-transactive. It can be that we see both the persons (or perhaps animal) who is looking and the object(s) of his/her gaze (transactive reaction). The latter is known as the phenomenon. When the vector is formed by an eyeline, by the direction of the glance of one or more represented participants, the process is "reactional" (Kress & van Leeuwen, 2006) (p. 64). The reactor, the participant who does the working, must necessarily be humans or human like animals – with pupils and capable of facial expression. The phenomena may be formed either by another participant, the participant at whom or which the reactor is looking or by a whole visual proposition (Kress & van Leeuwen, 2006). In photo plate 1 (B) the female participant is looking at the male so the female is here the reactor and the male is the phenomenon.

Photo plate 1

A



Source: Poudel, 2013, p. 67

B



Source: Kress & van Leeuwen, 2006, p. 68-69

C



Source: Poudel, 2013, p. 88

D



Source: Thornborrow & Shan, 1998, p. 162

E



Source: Prettejohn, 2005, p. 141

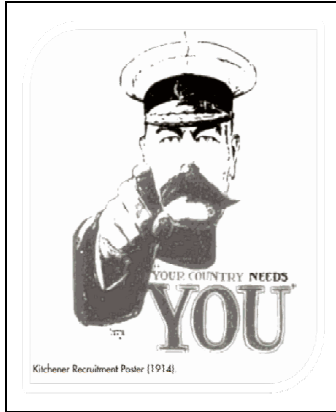
F



Source: Paudel, 2013, p. 77

Photo plate 2

A



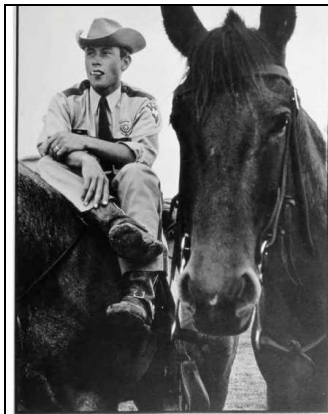
Source: Edley, 2001, p. 120

B



Source: Prettejohn, 2005, p. 99

C



Source: Kress & van Leeuwen, 2006, p. 142

D



Source: van Leeuwen, 2008, p. 140

E



Source: Prettejohn, 2005, p. 112

F



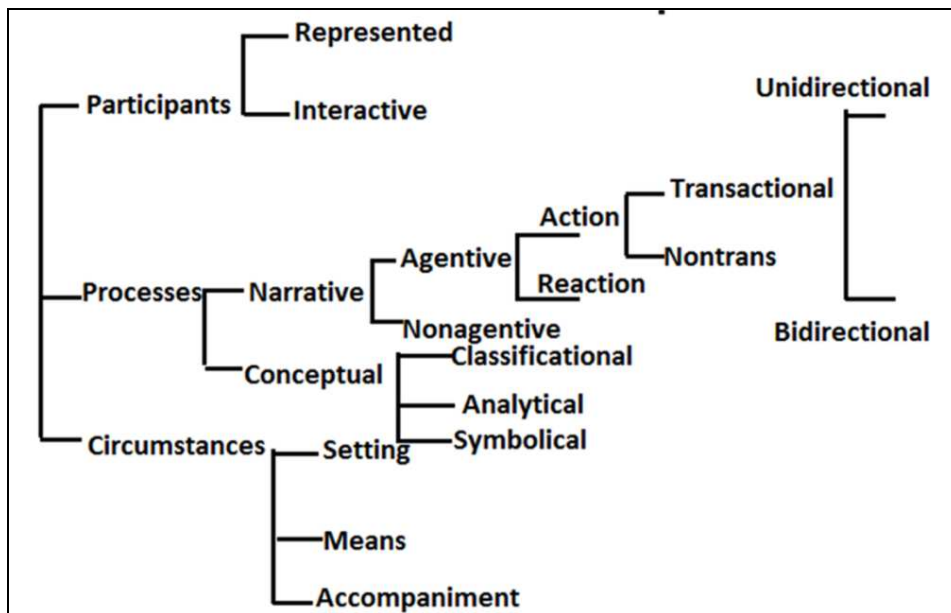
Source: Scholes et al., 1991, p. 1482

In some pictures, the two types of functions can be realized in the same image. For instance, in photo plate 1 (C), the two participants involve bidirectional involving actors and reactors, goals and phenomena at the same time. The participants are acting and reacting at the same time. Their physical, mental involvement is reciprocal. So they have double role of acting and reacting.

Classificational processes relate participants to each other in terms of a “kind of” relation, a taxonomy: at least one set of participants being “subordinate” and the other as “superordinate” (Kress & van Leeuwen, 2006) (p. 81). Taxonomies represent the world in terms of a hierarchical order. In the flow chart the highest ranking officials are presented first. Analytical processes relate participants in terms of part-whole structure involving two kinds of participants: carrier (the whole) and attributes (parts) (p. 89). Symbolic processes are about what a participant *means* or *is*. In this process either there are two participants (the carrier and the symbolic attribute) or there is only one participant, the carrier, and in that case the symbolic meaning is expressed through the carrier itself (p. 108). In photo plate 1 (D) the body of a pregnant woman is juxtaposed with a car in order to show that the car is as cozy, protective as the womb. The image is not narrating any event as such but "suggesting" something. One participant (the carrier) stands for some another which readers/viewers are supposed to supply.

The Fig. 1 summarizes the major elements that are realized in a visual syntax.

Figure 1.



By looking at the image on the pages of magazines of television monitor, one can infer three dimensions of an image: the "distance" of the image from the viewer, the "contact" (whether the represented participant has direct or oblique contact to the viewer) and the "angle" of vision (whether the camera is held low, eye-level or high). The distance of the image has deeper implications in meaning. Extreme close shot (camera touching the body) depicts the image in an unnatural way. The pores of the skin are visible and the strands of hair look like wires. The close shot (two feet away) depicts certain part of the body (face) closely. Such images imply intimacy between inmates or lovers as one can touch and kiss the other (at least in the imaginary level). Whispering sound is audible at this distance. This distance is normally allowed between intimate partners. The medium shot indicates personal relationship among/between participants. Soft-spoken words are audible. This type of distance is implicated among the family members or friends involving informal and personal relationships. The painting *The Wife of Pygmalion* by George Frederic Watts in 1868 in photo plate 1 (E) shows the upper half body of a woman who is depicted at a distance in which spectators can imagine that she is within the reach of hands to touch.

Long distance can be of two types: social and public. Social distance is the distance of classroom and office seminar and official formal ceremonies with limited number of people. Normally images in this shot are taken from the distance of ten feet. The public distance is the distance in which images are depicted/photographed from the distance of, say, 50 feet, in which images are miniaturized since they lose their individual identity. The images are indistinguishable and treated grossly. Only the shouting is audible in this shot. So the meaning of distance of the image may be most personal (intimate) to least personal or impersonal relationships between/among participants. Another interpretation can be that participants may clear individual identity in the close and medium distance and they may have no individual identity at all. The people depicted in photo plate 1 (F) are photographed from the helicopter as miniaturized forms. They look as if they were ants.

The meaning of contact or lack of contact is established by the position of the image (whether the image is facing the camera or not). If there is direct eye-contact and other gestural indications of direct address, then the meaning is that of the "our world" as opposed to "their world" when the participants have back or oblique angle. In verbal message the use of first and second person pronouns indicated our world whereas the use of third person pronouns indicates the distanced world of theirs. One of the most frequent ways in which represented participants are depicted is by using direct address to the camera/viewers. The participant depicted seems to be interpellating/hailing the viewers as "hey, you!" There is a fundamental difference between picture from which represented participants look directly at the viewer's eyes, and pictures in which this is not the case. When represented participants look at the viewer, vectors formed by participants' eye line, connect participants with the

viewers. Contact is established, even if it is only on an imaginary level. This visual configuration has two related functions. In the first place it creates a visual form of direct address. It acknowledges the viewers explicitly addressing them with a visual "you." In the second place it constitutes an *image act*. The producer uses the image to do something to the viewer. It is for this reason that Kress and van Leeuwen have called this a "demand": the participant's gaze (and the gesture if present) demands something from the viewer, demands that the viewer enter into some kind of imaginary relation with him or her. The relation may be that of social affinity, disdain, inferior, superior, and so on. The same applies to gestures (Kress & van Leeuwen, 2006) (p. 122-123). A hand can point at the viewer, in a visual "Hey, you there, I mean you," or invite the viewer to come close, or hold the viewer at bay with a defensive gesture, as if to say: stay away from me. In each case the image wants something from the viewer - wants them to do something. In doing this, images define who the viewer is (male, inferior, to the represented participants) and in this way exclude other viewers.

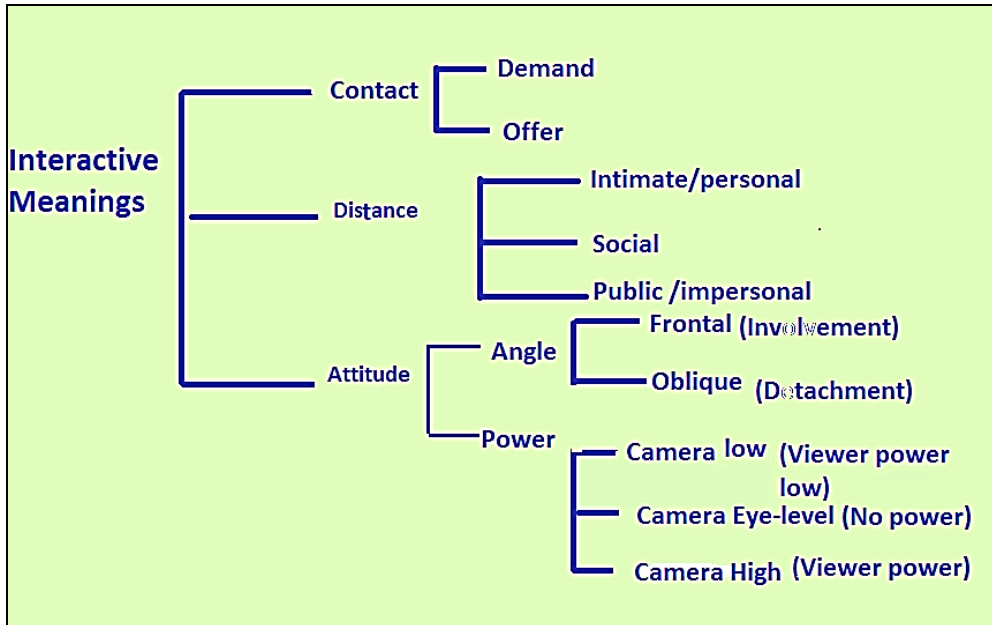
Other pictures address us indirectly. Here the viewer is not the object, but the subject of the verb "look," and the represented participant is the object of the viewer's dispassionate scrutiny. No contact is made. The viewer's role is that of an invisible onlooker. For this reason, Kress and van Leeuwen have called this kind of image an "offer" - it "offers" the represented participant to the viewer as items of information, objects of contemplation, impersonally, as though they were specimens in a display case (Kress & van Leeuwen 124). The image in photo plate 2 (B) is an example of offer that is offered by the image maker to the viewers.

A high angle, it is said, makes the subject look small and insignificant, a low angle makes it look imposing and awesome. If a represented participant is seen from a high angle, then the relation between the interactive participant and the represented participants is depicted as one in which the interactive participant has power over the represented participant - the represented participant is seen from the point of view of power. If the represented participant is seen from a low angle, then the relation between them is depicted as one in which the represented participant has power over the interactive participant. If, finally, the picture is at eye level, then the point of view is one of equality and there is no power difference involved (Kress & van Leeuwen, 2006) (p. 146). Power is realized in visual images through the position of the camera at the time taking a shot. The image in photo plate 2 (C) shows a soldier and a horse which are shown more powerful than the viewers. While taking the photographs of people in power the photo-journalists hold the camera and take the shot to imply that the leaders are in power.

The images of children in photo plate 2 (D) are photographed from the high angle in order to imply that the children are powerless but the viewers who see them are in the privileged positions. Taken as a whole, power is involved in the depiction of an

image. If the camera is held low, that means the depicted person is of higher status and the vice versa.

Figure 2. The interactive (interpersonal) meaning



Information values are realized by the placement of the elements of a composition. The idea is that the role of any particular element on the whole will depend on whether it is placed on the left or on the right, in the center or in the margin or in the upper or lower part of the picture space or page (Jewitt & Oyama, 2008). In societies which use Roman or Devanagari scripts, the direction of the reading of a text (left to right, from top to bottom) has led to different cultural values being awarded to the left and the right. According to Kress and van Leeuwen (2006) left/right placement creates a given/new structure (p. 186). The elements placed on the left are presented as "given," whereas the elements placed on the right are presented as "new." For something to be "given" means that it is presented as something the viewer or the reader already knows, as a familiar and agreed departure point for the message. For something to be "new" means that it is presented as something not yet known and not yet already agreed upon by the viewer or the reader, hence as something to which the viewer must pay a special attention. The "new" is therefore problematic, contestable, the information at issue, while the "given" is presented as commonsensical and self-evident (Kress & van Leeuwen, 2006 (p. 186); Jewitt & Oyama, 2008 (p. 148)). In verbal mode, the left-most information is the point of departure, but in the visual mode it can be the center and other most salient information on the composition.

As for top and bottom, again, if some of the constituent elements are placed on top and others at the bottom, then what is placed on top is presented as what Kress and van Leeuwen call the "ideal" and what is placed at the bottom as the "real." For something to be "ideal" means that it is presented as the idealized or generalized essence of the information, and hence ideologically most salient part. The "real" then opposed to this is that its meaning potential is "down-to-earth" (2006, p. 148). This can become more specific information or more real information, more practically oriented information.

Centrally, finally, means what it is: what is placed in the center is thereby seen as what holds the "marginal" elements together. The marginal elements are then in some sense the elements that are held together by the center – belonging to it, subservient to it and so on, depending on the context (Kress & van Leeuwen, 2006) (p. 149).

If visual composition makes use of the center, placing one element in the middle, and the other elements around it, we will refer to the central elements as "center" and elements around it "margins." For something to be represented as center means that it is presented as the nucleus of the information on which all the other elements are in some sense subservient. The margins are ancillary, dependent elements. In many cases the margins are very similar to each other so that there is no sense of division between given and new and/or ideal/real elements among them. Not all margins, however, are equally marginal (Kress & van Leeuwen, 2006) (p. 200). In photo plate 2 (E), the image of the descending God is put at the top to show the ideal position and power. The common people depicted at the bottom shows the "real" position or the ground reality of real people. The top position implies the heaven, hence sky, which also implies dream or fantasy of common people of God.

The photo plate 2 (F) is a shot taken from the Film *Citizen Kane* in which the child (Kane) is at the center, although outside home. The weight of the foregrounded figures shows the power of participants. For instance, Mr. Thatcher's hat seems more imposing than the forelorn father on the left. The centralized position of Mr. Thatcher is more prominent than Kane's father.

The systematic study of the visual meaning is a recent phenomenon. Even if the pictorial mode seems to dominate the present day communication system, visual study has not been given much priority; as a result, most academics may run the risk of being visually illiterate. Therefore, this type of analysis, I believe, can enhance the knowledge of visual images and people can read between the images in order to understand the meanings of visual images in terms of composition, representation and interaction.

References

- Edley, N. (2001). Analyzing masculinity: Interpretive repertoires, ideological and subject positions. In M. Wetherell, S. Taylor and S.J. Yates (Eds.), *Discourse as data: A guide for analysis* (pp. 189-228). London: Sage.
- Halliday, M.A.K. (2004). *An introduction to functional grammar*, 3rd ed. London: Herder Arnold.
- Jewitt, C. & Oyama, R. (2008). Visual meaning: A social semiotic approach. In V. Leeuwen and C. Jewitt (Eds.), *Handbook of visual analysis* (pp. 134-156). London: Sage.
- Kress, G. & Theo van, L. (2006). *Reading images: The grammar of visual design*. London: Routledge.
- Paudel, R.C. (2013). *Elements of film*. Kathmandu: Tethys Academy.
- Prettejohn, E. (2005). *Beauty and art*. Oxford and New York: Oxford UP.
- Scholaes, R., Nancy, R.C., Carl, H.K. & Michael, S. (1991). *Elements of literature: Essay, fiction, poetry, drama film*. Oxford: Oxford UP.
- Thornborrow, J. & Shan, W. (1998). *Patterns in language*. London: Routledge.
- van Leeuwen, T. (2008). *Discourse and practice: New tools for critical discourse analysis*. Oxford and New York: Oxford UP.

Factors Associated with Anxiety Among Institutionalized Elderly in Kathmandu Valley

Rekha Timalisina, Pasang Doma Sherpa and Dan Kumari Dhakal

Nepal Institute of Health Sciences, Kathmandu

Email: rekha.timalisina@gmail.com

Abstract: *The elderly people not only face physical problems as they age, but they also experience mental health related problems. The main objective of the study was to identify the level of anxiety and the factors associated with it among institutionalized elderly in Kathmandu Valley of Nepal. The cross-sectional descriptive analytical study design was used among 173 respondents who were selected by purposive sampling. Interviews were carried out using socio-demographic and other variables related tools, especially the partially adopted coping checklist and HAM-A tool. The data analysis was done by using Epidata software and SPSS version 16. Descriptive statistics and inferential statistics i.e., chi-square test and odds ratio were calculated. The findings revealed that 56 (32.4%) respondents had anxiety. Out of them, 36 (20.8%), 11 (6.4%) and 9 (5.2%) respondents had mild, moderate and severe anxiety, respectively. Out of 45 male respondents, 10 (22.2%) had anxiety as compared to 45 (35.2%) out of 128 female respondents. The respondents who had chronic physical health problems (CPHP), worries, dissatisfaction with old-aged homes and even those who used coping strategies like visiting different places, were found to have anxiety. Based on these findings, it can be suggested that new coping strategies as well as activities for mental diversion should be sought to prevent institutionalized elderly from anxiety.*

Keywords: *Elderly, anxiety, old-age, institutionalized.*

Introduction

Ageing is a universal phenomenon and natural biological process of the life cycle causing a progressive decrease in functional as well as mental capabilities. Feeling anxious or nervous is a common emotion for people of all ages and a normal reaction to stress. Feeling anxious can help people handle problems and unfamiliar situations, and even avoid danger. It is normal to feel anxious about illnesses, new social interactions, and frightening events. But when one feels anxious often and the anxiety is overwhelming and affects daily tasks, social life, and relationships, it may be considered an illness (Geriatric Mental Health Foundation, 2009).

The overall current prevalence for all types of anxiety disorder was found to be 17.1% and the lifetime prevalence was found to be 18.6% (Kirmizioglu *et al.*, 2009).

Studies in lonely elderly population of males, living in geriatric homes and of age group between 60 to 70 (Taha & Abdel, 2005) as well as studies in elderly females of Ludhiana City, India (Mehrotra & Batish, 2009) and elderly home residents in Iran (Etemadi & Ahmadi, 2009) showed that economic status, social relations, dissatisfaction with old age, lack of favorite activities, behavior of family members, stress and strain, loneliness and feeling of neglect were the significant factors leading to anxiety.

Several studies in Nepal show that the long established culture and traditions of respecting elders are eroding. Younger generations move away from their birthplace for employment opportunities elsewhere. Consequently, many elderly people today are living alone and are vulnerable to mental problems like loneliness, depression and many other physical diseases (Dahal, 2007).

In today's competitive society, the individuals of productive age group are busy and they do not get time to look after and listen to the problems of the elderly people. So, the elderly need to search for a better option for their difficult life. In Nepalese society too, the elderly would like to stay in old-aged homes for their better life. Old-age homes provide residential care for elderly who are destitute or homeless and for people who are not able to function independently. There is an Old-Age Home within the premises of temple Pashupati Nath (Pashupati Bridrashram) for the destitute elders. Ministry of Women, Children and Social Welfare operates the old-age home that has the capacity for only 230 elderly people. This is the only shelter for elderly people run by the government which was established in 1976 as the first residential facility for elders. There are about 71 organizations registered with the government and they are spread all over Nepal. These organizations vary in their organizational status, capacity, facilities, and the services they provide. Most of them are charity organizations. At present, about 1500 elders are living in these old-age homes (Geriatric Centre Nepal, 2010).

No studies has yet been conducted in Nepal for identifying the level of anxiety and factors associated with anxiety among institutionalized elderly. Therefore, this study aims to identify the level of anxiety by using HAM-A tools and explore the relationship between anxiety and socio-demographic, individual and contextual factors.

Methods

In this research, the cross-sectional descriptive analytical study design was used. The study area were Samaj Kalyan Kendra Briddhashram, Nishahaya Sewa Sadan, Old Age Management/Social Welfare Trust, Matatritha Bridhashram, Tapasthali Old Aged Homes, Divya Sewa Niketan, Kathmandu; Siddhi Smriti Bridhashram, Sahara Care Centre, Bhaktapur; Senior Citizen Home and Dev Corner Bridhashram, Lalitpur. Out of 412 elderly living in these institutions, 173 respondents who were 60 years and above, willing to participate, able to listen and give response, had no severe psychiatric disorder and had no severe sickness and disability in terms of having neurological problems, were included by means of purposive sampling. Interviews were conducted to collect data individually using socio-demographic and other variables. The partially adopted coping checklist developed by Rao *et al.* (1989) had been employed. The HAM-A tool developed by Hamilton (1959), was used to identify anxiety. The data analysis was done by using Epidata software and SPSS 16 version. Inferential statistics namely Chi-square test was used at 5% level of significance and

Odds Ratio was calculated for exploring the association between independent variables on anxiety among elderly living in old-aged homes. An ethical approval was taken from Nepal Health Research Council before conducting the study. The privacy right of the respondents was protected by taking informed consent before collecting data.

Results

Regarding types of organization, 88 (50.9%) respondents were from private organization, whereas 2 (1.2%) were from cooperative organization. Regarding age, majority 70 (40.5%) respondents were between 70-79 years age group and minority 11 (6.4%) respondents were between 90-99 years (Table 1). Regarding sex, majority 128 (74.0%) respondents were females and 45 (26.0%) respondents were males. It may be due to the fact that majority of old-age homes provide shelter for elderly females only. Regarding education, most of the respondents i.e., 127 (73.4%) were illiterate and minority 46 (26.6%) were literate. Regarding marital status, majority of respondents i.e., 108 (62.4%) were widows/ widowers and minority of respondents i.e., 23 (13.3%) were in others group (Table 1).

Table 1. Types of organization, age, sex, education and marital status of respondents (n=173)

Characteristics		Frequency	Percentage (%)
Types of organization	Private	88	50.9
	Government supported	83	48.0
	Cooperative	2	1.2
Age (in years)	60-69	30	17.3
	70-79	70	40.5
	80-89	62	35.8
	90-99	11	6.4
Sex	Female	128	74.0
	Male	45	26.0
Education	Literate	46	26.6
	Illiterate	127	73.4
Marital status	Married	42	24.3
	Unmarried	23	13.3
	Widow/Widower	108	62.4

Table 2. Anxiety level of respondents (n=173)

Anxiety Level	Frequency	Percentage (%)
Normal	117	67.6
Mild anxiety	36	20.8
Moderate anxiety	11	6.4
Severe anxiety	9	5.2
Total	173	100.0

Table 2 displays that 117 (67.6%) respondents had no anxiety and 56 (32.4%) respondents had anxiety. According to HAM-A tool, out of 56 respondents, 36 (20.8%), 11 (6.4%) and 9 (5.2%) respondents had mild, moderate and severe anxiety respectively. Out of 45 male respondents, 10 (22.2%) had anxiety as compared to 45 (35.2%) out of 128 female respondents. This results shows that more female respondents had anxiety than male respondents.

Table 3. Association between Anxiety and Socio-demographic Factors (n=173)

Characteristics	Anxiety		P-value	Odds ratio (OR)	95% Confidence interval
	Present No. (%)	Absent No. (%)			
Types of organization					
Government supported*	27 (32.5)	56 (67.5)	0.966	0.986	0.521-1.865
Private	29 (32.2)	61 (67.8)			
Sex					
Male*	11(24.4)	34 (75.6)	0.186	1.676	0.775-3.622
Female	45(35.2)	83 (64.8)			
Marital status					
Married*	52 (34.7)	98 (65.3)	0.099	0.397	0.128-1.228
Unmarried	4 (17.3)	19 (82.6)			
Education					
Literate*	15 (32.6)	31 (67.4)	0.968	0.985	0.480-2.024
Illiterate	41(32.2)	86 (67.8)			

p< 0.05: Significant

Table 3 displays that there was no association between anxiety and socio-demographic factors. But odd ratio showed that females were more at risk of having anxiety (OR1. 676 CI 0.775-3.622). The respondents who were from private organizations, unmarried and illiterate (OR 986 CI 0.521-1.865, OR 0.397 CI 0.128-1.228, 0.985 CI0.480-2.024) had a lower chance of having anxiety.

Table 4. Association between anxiety and individual factors (n=173)

Characteristics	Anxiety		P-value	Odds ratio	95% Confidence interval
	Present No. (%)	Absent No. (%)			
CPHP	55 (36.4)	96 (63.6)	0.003*	12.031	1.575-91.908
GI problem	32(44.4)	40 (55.6)	0.050	1.948	0.995-3.814
Respiratory	26 (42.6)	35 (57.3)	0.192	1.563	0.797-3.063
Hypertension	31 (43.1)	41(56.9)	0.106	1.733	0.888-3.383
Diabetes mellitus	11 (47.8)	12 (52.2)	0.217	1.750	0.715-4.286
Musculoskeletal	24 (42.9)	32 (57.1)	0.207	1.548	0.783-3.060
Others	12 (36.4)	21 (63.6)	0.994	0.997	0.447-2.230
Worries	55 (36.4)	96 (63.6)	0.003*	12.031	1.575-91.908
Financial security	33 (44.0)	42 (56.0)	0.055	1.929	0.983-3.782
Lack of social relation	25 (40.3)	37 (59.7)	0.406	1.329	0.679-2.600
Dissatisfaction with old age	39 (38.2)	63 (61.8)	0.505	1.277	0.623-2.619

Lack of favourite activities	36 (42.4)	49 (57.6)	0.086	1.817	0.916-3.605
Fear of future	45(36.0)	80 (64.0)	0.812	0.900	0.377-2.149
Dissatisfaction with old aged homes	25 (47.2)	28 (52.8)	0.044*	2.024	1.016-4.033
Dissatisfaction with officials	19 (39.6)	29 (60.4)	0.582	1.219	0.602-2.471

*p< 0.05: Significant

There was association between anxiety and CPHP (p value 0.003, OR 12.03, CI 1.575–91.908) and anxiety and worries (p value 0.003, OR 12.03, CI 1.575–91.908). Regarding issue of worries, there was association between anxiety and dissatisfaction with elderly homes (p value 0.044, OR 2.024, CI 1.016–4.033) but there was no association between different CPHPs and issue of worry (Table 4). Hence, the OR showed that the respondents had 1.948, 1.750, 1.733, 1.563 and 1.548 times risk of having anxiety in those having GI problems, DM, HTN, respiratory and musculoskeletal problems respectively. Elderly with other problems showed the low risk (OR 0.997) of having anxiety. OR of having different issues of worry showed that the respondents had 1.929, 1.817, 1.329, 1.277, and 1.219 times risk for having anxiety in those who were worried regarding financial security, lack of favorite activities, lack of social relation, and who were dissatisfied with old age and officials at the elderly homes. The risk of anxiety was low (OR 0.900) in those having fear of future (Table 4).

Table 5. Association between anxiety and individual factors (n=173)

Characteristics	Anxiety		P-value	Odds ratio	95% Confidence interval
	Present No. (%)	Absent No. (%)			
Feeling of Stress	51 (35.2)	94(64.8)	0.073	2.496	0.895-6.959
Coping strategies	18 (31.6)	39 (68.4)	0.466	0.769	0.380-1.558
Go to religious places	23 (30.3)	53 (69.7)	0.194	0.635	0.320-1.269
Listening to religious music	18 (41.9)	25 (58.1)	0.273	1.505	0.722-3.137
Shares the problems with peers	10 (83.3)	2 (16.7)	0.000*	11.220	2.353-53.507
Visit in different places	35 (35.4)	64 (64.6)	0.947	1.025	0.492-2.135
Pray to god	3 (25.0)	9 (75.0)	0.441	0.590	0.152-2.285
Reading religious books	14 (46.7)	16 (53.3)	0.139	1.845	0.815-4.176
Crying alone	25 (42.4)	34 (57.6)	0.133	1.697	0.850-3.389
Self blame	6 (35.3)	11 (64.7)	0.991	1.006	0.349-2.900
Take cigarettes	18 (45.0)	22 (55.0)	0.126	1.785	0.846-3.767
Staying alone	1(25.0)	3 (75.0)	0.666	0.607	0.061-5.987
Others					

*p< 0.05: Significant

Chi-square test showed no association between anxiety and feeling of stress (Table 5). But the OR showed that the respondents with stress were 2.496 times at risk of having anxiety. Regarding different coping strategies used by the respondents,

there was significant association between anxiety and visits to different places to relieve stress (p value 0.000) but there was no association between anxiety and other coping strategies. Concerning emotion focused coping strategies (EFCS), the respondents who used coping strategies like visiting different places had 11.220 times risk and those who cried alone had 1.845 times risk of having anxiety. Concerning avoidance coping strategies (ACS), those who stayed alone had 1.785 times risk and those who took cigarettes had 1.006 times risk of having anxiety. Those who used self-blame coping strategies {i.e., passive avoidance coping strategies (PACS)} had 1.697 times risk of having anxiety; those who shared problems with peers {(i.e., seeking social support coping strategies (SSSCS))} had 1.505 times risk and those who used praying {i.e., religious coping strategies (RCS)} had 1.025 times risk of having anxiety. On the contrary, those who used other RCS like going to religious places, listening to religious music and reading religious books were found to have low risk of having anxiety (OR 0.769, 0.635 and 0.590 respectively). There was also low at risk to those who used other coping strategies with OR 0.607.

Table 6. Association between Anxiety and Contextual Factors (n=173)

Characteristics	Anxiety		P Value	Odds Ratio	95% Confidence Interval
	Present No. (%)	Absent No. (%)			
Duration of stay					
<1 Year*	10 (32.3)	21 (67.7)			
>1 Year	46 (32.4)	96 (67.6)	0.988	1.006	0.438-2.310
Caregivers availability	20 (27.8)	52 (72.2)	0.276	0.694	0.360-1.340
MDA	31 (28.2)	79 (71.8)	0.120	0.596	0.310-1.340
Religious activities	21 (25.3)	62 (74.7)	0.239	0.576	0.228-1.452
Prabachan	8 (33.3)	16 (66.7)	0.526	1.370	0.517-3.627
Others	11 (34.4)	21 (65.6)	0.355	1.519	0.624-3.696

p< 0.05: Significant

There was no association between anxiety and duration of stay, anxiety and caregivers' availability, anxiety and mind diversional activities (Table 6). But the OR showed that the respondents who stayed in old-age homes for more than 1 year had 1.006 times risk of having anxiety than those who stayed for less than 1 year. The lack of caregivers' availability did not carry any risk for depression. The OR regarding availability of different MDAs revealed that the respondents who used other types of MDA and religious sermons (prabachan) as their diversional activity had 1.519 and 1.370 times risk of having anxiety respectively whereas those respondents who used religious activities as MDAs were at low risk of developing anxiety with OR 0.576.

Discussion

Regarding their anxiety level, 117 (67.6%) respondents had no anxiety and 56 (32.4%) respondents had anxiety. According to HAM-A tool, out of 56 respondents, 36 (20.8%), 11 (6.4%) and 9 (5.2%) respondents had mild, moderate and severe anxiety respectively. Out of 45 male respondents, 10 (22.2%) had anxiety as compared to 45 (35.2%) out of 128 female respondents. This results shows that female respondents had more anxiety than male respondents (Table 2). Other studies revealed that out of 250 elderly, 10.8% of the respondents had anxiety (Chowdhury & Rasania, 2008) and out of 120 elderly, the prevalence of anxiety was 18.3% (Etemadi & Ahmadi, 2009). Yet another study revealed that 5.8% of the respondents had anxiety disorders (Singh *et al.*, 2012) and the rates of anxiety disorders were found to be higher among females at 15.3% as compared to males at 5.3% (Chowdhury & Rasania, 2008).

There was no association between anxiety and socio-demographic factors. But odd ratio showed that females were more at risk of having anxiety (OR 1.676 CI 0.775-3.622). The respondents who were from private organizations, unmarried and illiterate (OR 0.986 CI 0.521-1.865, OR 0.397 CI 0.128-1.228, 0.985 CI 0.480-2.024) respectively had a lower chance of having anxiety (Table 3). One similar study concluded that psychiatric disorders were more prevalent in females and illiterates (Singh *et al.*, 2012).

There was no association between anxiety and duration of stay, anxiety and caregivers' availability, anxiety and mind diversional activities. But the OR showed that OR regarding availability of different MDAs revealed that the respondents who used prabachan as their diversional activity had 1.370 times risk of having anxiety whereas those respondents who used religious activities as MDAs were at low risk of developing anxiety with OR 0.576 (Table 5). Therefore, it can be concluded that the respondents had anxiety even though they had different types of mind diversional activities in their organization. These activities seemed not enough to divert their mind and reduce their anxiety. Hence other needs should be explored to help the elderly accordingly.

Conclusion

The above findings and discussion revealed that 56 (32.4%) respondents had anxiety, out of which, 36 (20.8%), 11 (6.4%) and 9 (5.2%) respondents had mild, moderate and severe anxiety respectively. This study also concludes that more female respondents had anxiety. The respondents who had CPHP, worries, dissatisfaction with old aged homes, and even those who used coping strategies like visiting different places were found to have anxiety. This study also concluded that the female respondents, those who have DM, HTN and GI problems, respiratory and musculoskeletal problems, having other worries, worries regarding financial security, lack of favorite activities and lack of social relation led to more risk of having anxiety. Moreover, the respondents having worries regarding dissatisfaction with old age and

dissatisfaction with elderly home officials as well as fear of future and dissatisfaction with environment of the elderly homes were more at risk of having anxiety. Surprisingly, the respondents who used coping strategies like EFCS, ACS, PACS and SSSCS were found to be more at risk of having anxiety. Based on these findings, it can be recommended that factors associated with anxiety among institutionalized elderly should be further examined in longitudinal research with mixed approach and proper management should be used for the prevention of anxiety.

Acknowledgements

It is our duty to express the heartiest gratitude to the University Grants Commission for awarding the research grant. Our efforts would have been in vain without the guidance of Professor Dr. Shishir Subba. We would like to acknowledge and express thanks to Department of Nursing, Nepal Institute of Health Sciences, Boudha, Kathmandu. Finally, we express our warm appreciation and thanks to all respondents for their cooperation and valuable time to participate in the study.

References

- Chowdhury, A. & Rasania, S.K. (2008). A community based study of psychiatric disorders among the elderly living in Delhi. *The Internet Journal of Health*, 7:1, Cited from www.ispub.com/journal/the-internet-journal-of-health/volume-7-number-1/a-community-based-study-of-psychiatric-disorder.
- Dahal, B.P. (2007). *Elderly people in Nepal, what happened after MIPPA 2002?* Nepal Participatory Action Network, UNSCAP. Cited from www.unescap.org/esid/psis/meetings/AgeingMipaa2007/NEPAN.pdf
- Etemadi, A. & Ahmadi, K. (2009). Psychological disorders of elderly home residents. *Journal of Applied Sciences*, 9, pp. 549-554.
- Geriatric Center Nepal. (2010). *Status report on elderly people (60+) in Nepal on health, nutrition and social status focusing on research needs*. Cited from www.globalaging.org/health/world/2010/nepal.pdf.
- Geriatric Mental Health Foundation. (2009). Anxiety and older adults. Cited from <http://www.gmhfonline.org/gmhf/consumer/factsheets/anxietyoldradult.html>.
- Hamilton, M. (1959). The assessment of anxiety states by rating. *British Journal of Medical Psychology*, 32, pp. 50-55.
- Kirmiziloglu, Y., Dogan, O., Kugu, N. & Akyuz, G. (2009). Prevalence of anxiety disorders among elderly people. *International Journal of Geriatric Psychiatry*, 24(9), pp. 1026-1033.
- Mehrotra, N. & Batish, S. (2009). Assessment of problems among elderly females of Ludhiana city. *Journal of Human Ecology*, 28(3), pp. 213-216.
- Rao, K., Subhakrishna, D.K. & Prabhu, G.G. (1989). Development of a coping checklist: a preliminary report. *Indian Journal of Psychiatry*, 31(2).
- Singh, P., Kumar, K. & Reddy, P.K. (2012). Psychiatric morbidity in geriatric population in old age homes and community: a comparative study. *Indian Journal of Psychological Medicine*, 34(1), pp. 39-43.
- Taha, T. & Abdel, R. (2005). Anxiety and depression in lone elderly. Cited from www.globalaging.org/health/world/2006/egptelderly.pdf

Factors Affecting Utilization of Postnatal Care in Selected Village Development Committees (VDCs) of Lalitpur District

Kamala Dhakal, Tara Acharya and Prajina Shrestha

Nursing Campus Maharajgunj, Kathmandu

Email: kdhakal77us@yahoo.com

Abstract: *A descriptive cross sectional study on “Factors Affecting Utilization of Postnatal Care in Selected Village Development Committee (VDC) of Lalitpur District” was conducted to identify mothers’ knowledge about postnatal care, to find out the utilization of postnatal care, and to identify the factors affecting the utilization of postnatal care. The population of the study was married women of the reproductive age group (15–49 years old), residing in study areas, who had a live baby from 45 days to 12 months old. A total of 250 women were interviewed by using census method from June 2012 to September 2012 at Godawari, Thaiba and Harisiddhi Village Development committee (VDC) of Lalitpur district. Semi structured questionnaires were used and data were analyzed as per the objectives by using descriptive and inferential statistics.*

Keywords: *Postnatal care, factors, utilization.*

Introduction

Postpartum care is the most neglected aspect of maternity care and as a result, more research is needed on issues related to postpartum maternal health. Although there is little evidence to support the timing and content of postpartum visits, there is evidence that this is a time of increased health needs for both mother and baby. Postpartum care visits provide opportunities to assess the physical and psychological well-being of the mother, counsel her on infant care and family planning and give appropriate referrals for pre-existing or developing chronic conditions (Gilany & Hammad, 2008).

The majority of women in developing countries receive almost no postpartum care after delivery. For example, in very poor countries and regions, such as those in the Sub-Saharan Africa, only 5% of women receive postnatal care. The recent findings by the WHO, UNICEF and UNFPA show that a woman living in Sub-Saharan Africa has 13 out of 16 chances of dying in pregnancy, childbirth and after childbirth. The factors which prevent women in developing countries from getting postnatal care include: distance from health services; cost including direct fees and the cost of transportation, drugs and supplies; multiple demands on women’s time; women’s lack of power in decision-making within the family; and poor quality of services including poor handling by health providers (WHO, 2004).

Utilization of postnatal care is related to their availability, socioeconomic, demographic and cultural factors such as women's age, education, employment and autonomy as well as perception of women and their families regarding the need for care (Gilany & Hammad, 2008).

About half of Nepalese women receive some antenatal care from a skilled birth attendant and only 29% attend four times. Nearly 8% of women deliver at home. Only 19% deliveries are assisted by a skilled birth attendant. Only one third or 33% of post partum mothers receive postnatal checkups. One in five women received care within the first 24 h, and 4% of women were seen within 1-2 days of delivery. 19% of mothers received postnatal care from a skilled birth attendant (SBA). One in five mothers had a pelvic examination during their postnatal checkup. The neonatal care concept is still new in the community and the health system. Neonatal signs of health danger are commonly not recognized (MOHP, USAID, New ERA, 2006).

A study regarding the utilization of postnatal care among rural women in Nepal found that women who had received postnatal care after delivery was as low as 34%. Less than one in five women (19%) received care within 48 h of giving birth. Women in one village had less access to postnatal care than women in the neighboring one. Lack of awareness was the main barrier to the utilization of postnatal care (Dhakal *et al.*, 2007).

Rationale

The kind of complications following childbirth such as chronic pain, impaired mobility, damage to the reproductive system, genital prolapse and infertility are also more common in developing countries (UNFPA). Postnatal care is one of the most important maternal health-care services not only for the prevention of impairment and disabilities but also for the reduction of maternal mortality and morbidity.

Mothers who are expected to receive postnatal services at a health facility of their choice after delivery vary by age, socio-economic backgrounds and educational levels. However, there is great concern as small number of women turn up for postnatal services. Therefore, the factors that cause the under-utilization of postnatal services should be investigated.

Objectives

The study has following objectives:

General objective: To find out factors affecting the utilization of postnatal care

Specific objectives: To identify mothers' knowledge about postnatal care; to find out the utilization of postnatal care; to identify the factors affecting the utilization of postnatal care

Materials and methods

A descriptive cross-sectional study was conducted in three VDCs (Village Development Committee) of Lalitpur district, Nepal. They were Harisiddhi, Thaiba and Godawari VDCs. The study population comprised of married women in the

reproductive age group (15–49 years old), residing in study areas, who had a live baby from 45 days to less than 12 months old. A total of 250 respondents were interviewed by using purposive sampling technique. A semi structured questionnaires was used for the collection of data. The knowledge and utilization score was categorized as adequate, medium and inadequate on the basis of score gained by the respondents. Both descriptive and inferential statistics were used to analyze the data.

Ethical consideration: The research proposal was reviewed and approved by the Research Division, University Grants Commission, Sanothimi, Bhaktapur. Written approval was taken from Nepal Health Resaerch Council, Kathmandu. The respondents were explained about the purposes and objectives of the study and a verbal informed consent was taken. Privacy and comfort were maintained while collecting information.

Results

Table 1. Socio-demographic profile of respondents (N=250)

Items	Frequency	Percent
Age		
Below 20	21	8.4
20-35	227	90.8
Education		
Illiterate	25	10
Literate without school	48	19.2
class 1 to 8	69	27.6
Class 9 to 12	62	24.8
Above 12	46	18.4
Gravida		
Primi	155	62
Multi	94	37.6
Grand Multi	1	0.4
Child Sex		
Female	117	46.8
Male	133	53.2
Place of Delivery		
Home	12	4.8
Hospital	238	95.2

Table 1 provides information regarding socio-demographic information of the respondents. A majority (90%) of the respondents were between 20 to 35 years of age. Among them 90% of the respondents were literate and 10% of the respondents were illiterate. Out of 250 respondents only one that is 0.4% was grand multi whereas 62% of the respondents were primi.

More than half that is 53.2%, of the respondent's had male child whereas 46.8% had female child. Among them 95.2% of the respondents delivered in a health facility whereas only 4.8% of the respondents delivered at home.

Postnatal care

Table 2. Distributions of respondents according to knowledge on mother based postnatal care

N=250

Items	Frequency	Percent
Definition of postnatal care		
Care for mother and baby for 45 days after delivery	174	69.6
Care for mother and baby before 45 days of delivery	21	8.4
Care for pregnant women	52	20.8
Care for women during labour	3	1.2
Postnatal Check up		
Yes	238	95.2
No	12	4.8
Time of Postnatal Check		
Within 2 days	68	27.2
3 to 5 days	37	14.8
5-9 days	34	13.6
After 10 days	37	14.8
Others	74	29.6
Vitamin A taken		
Yes	202	80.8
No	41	16.4
Do not know	7	2.8
Kegal Exercise Performed		
Do not know	123	49.2
Yes	33	13.2
No	94	37.6
Use of Family Planning		
Yes	122	48.8
No	128	51.2

Out of 250 respondents, 69.6% of them gave the correct definition of the term "postnatal care".

Among them 95.2% of the respondents did postnatal check up after delivery. Out of them, 95.2% of the respondents who had delivered at a hospital, received a postnatal visit within 24 hours; only 13.6% of the respondents had done postnatal check up within 5-9 days of delivery.

Among them 80.8% of the respondents took vitamin A after the delivery whereas 16.4% of the respondents said they did not take vitamin A. Almost half, that is 49.2% of the respondents don't know about kegal exercise only more than one tenth that is 13.2%, of the respondents performed kegal exercise after the delivery. Less than half, that is 48.8%, of the respondents used contraceptives after the delivery.

Table 3. Distributions of respondents according to knowledge on postnatal danger signs of mother (N= 250)

Danger Signs	Frequency	Percent
Do not Know	9	3.6
Fever	189	75.6
Heavy vaginal bleeding	223	89.2
Foul smelling Vaginal Discharge	131	52.4
Lower Abdomen Pain	111	44.4
Convulsion	112	44.8
Redness Around Nipple	71	28.4
Yellow Or Weak Body	79	31.6
Continuous Vomiting	119	47.6

Three-fourth, that is 75.6%, of the respondents considered fever as a danger sign. Less than half, that is 44.8%, of the respondents took convulsion as a postnatal danger sign. More than one forth, that is 28.4%, of the respondents said that redness around nipples was a postnatal danger sign.

Table 4. Distributions of respondents according to knowledge on baby based postnatal care

Items	Frequency	Percent
Expose Baby to Morning Sunlight		
Do not Know	5	2.0
Yes	210	84.0
No	35	14.0
Cord care		
No care	91	36.4
Keep dry	73	29.2
Keep oil	83	33.2
Others	3	1.2

Starting Time of First Breast Feeding		
Within 1 h	199	79.6
1 to 8 h	36	14.4
After 8 h	12	4.8
Not remember	3	1.2
Discard Colostrums		
Yes	12	4.8
No	237	94.8
Do not know	1	.4
Time of Starting Weaning		
Below five month	39	15.6
Five to six month	147	58.8
Not started yet	64	25.6
Knowledge on Time of Weaning		
below five month	7	2.8
five to six month	216	86.4
above six month	27	10.8

Among them 84% of the respondents told that they exposed their baby to morning sunlight after the delivery whereas 2% of the respondents were unknown about it. Out of them 29.2% of the respondents kept the umbilical cord of their baby dry after the delivery.

Out of 250 respondents, 76, that is 30.4%, of their child were below 5 months. Among the total respondents, 58.8% of them had given weaning to their child between 5-6 months of age. 86.4% of respondents told that weaning must start within 5-6 months of birth.

Table 5. Distributions of respondents according to knowledge on neonatal danger signs (N=250)

Neonatal danger sign	Frequency	Percent
Unable to Breastfeed	238	95.2
Increase Or Difficult Respiration	186	74.4
Lolaema Or Sustaema	106	42.4
Redness Around Umbilicus	79	31.6
Red Eye or Infection	88	35.2
Convulsion	131	52.4
Cyanosed Baby	168	67.2
Excessive Weeping	182	72.8
Yellowish Baby	136	54.4
Stiffness of Baby	136	54.4
High Fever	182	72.8

Out of 250 respondents, 95.2% of the respondents said inability to breast-feeding was a neonatal danger sign. A slightly more than 52.4% of the respondents said that convulsion was a neonatal danger sign. Only more than one forth, that is 31.6%, of the respondents said redness around umbilicus was a neonatal danger sign.

Table 6. Distributions of respondents according to knowledge level on postnatal care

Knowledge level	Frequency	Percent
Inadequate knowledge	50	20.0
Medium knowledge	149	59.6
Adequate knowledge	51	20.4
Total	250	100.0

Among 250 respondents, more than half (59.6%) scored "moderate knowledge". Less than one forth, that is 20.4%, of the respondents scored "inadequate knowledge".

Table 7. Distributions of respondents according to utilization of postnatal care

Utilization	Frequency	Percent
Inadequate utilization	41	16.4
Medium utilization	165	66.0
Adequate utilization	44	17.6
Total	250	100.0

Among 250 respondents (66%) had "medium utilization" of postnatal care. Whereas 16.4% of the respondents had "inadequate utilization" of postnatal care.

Factors affecting utilization of postnatal care

Table 8. Association between knowledge & utilization of postnatal care

		Utilization level			Total	P Value
		Inadequate utilization	Medium utilization	Adequate utilization		
Knowledge level	Inadequate knowledge	35 (70%)	15 (30%)	0	50	0.000*
	Medium knowledge	6(4.02%)	141(94.63%)	2(1.34%)	149	
	Adequate knowledge	0	9(17.64%)	42(82.35%)	51	
Total		41	165	44	250	

***Wilcoxon sign test**

Out of 50 respondents with inadequate knowledge, 35 (70%) had inadequate utilization, while 15 (30%) had moderate utilization of postnatal care. Out of 149 respondents with moderate knowledge of postnatal care, 94.63% had moderate utilization of postnatal care. So using Wilcoxon sign test at 95% confidence level, researchers found significant associations between knowledge and the utilization of postnatal care (p-value=0.000).

Table 9. Association between age and utilization of postnatal care

		Utilization level			Total	P-Value
		Inadequate	Medium	Adequate		
Age	below 20	4(19.04%)	12(57.14%)	5(23.80%)	21	0.465*
	20-35	36(15.85%)	152(66.96%)	39(17.18%)	227	
	35 and above	1(50%)	1(50%)	0	2	
Total		41	165	44	250	

***ANOVA F-test (21, 228) = 1**

This table also revealed that there is no significant difference between age and the utilization level at the 95% confidence level as p-value>0.05 (0.465-using ANOVA F test). The sum square of regression's degree of freedom is 21 and sum square of errors for degree of freedom is 228.

Table 10. Association between education level and utilization of postnatal care

		Utilization level			Total	P-Value
		Inadequate	Medium	Adequate		
Education	Illiterate	8(32%)	16(64%)	1(4%)	25	0.041*
	Literate without school	8(16.66%)	30(62.5%)	10(20.83%)	48	
	class 1 to 8	12(17.39%)	45(65.21%)	12(17.39%)	69	
	Class 9 to 12	8(12.90%)	42(67.74%)	12(19.35%)	62	
	Above 12	5(10.86%)	32(69.56%)	9(19.56%)	46	
Total		41	165	44	250	

***Linear-by-linear association test**

Out of 69 respondents who had education upto class 8, 17.39% had inadequate utilization of postnatal care, 65.21% of the respondents had moderate utilization of postnatal care, and 17.39% of the respondents had adequate utilization of postnatal care.

There is also significant association between the level of education and the utilization of postnatal care as p-value >0.05 (0.041) using Linear-by-Linear association test.

Table 11. Association between money management difficulties/economic status and utilization of postnatal care

		Utilization level			P Value	
		Inadequate	Medium	Adequate	Total	
Difficulties /status	Very difficulties/Lower	13(39.39%)	15(45.45%)	5(15.15%)	33	
	Some difficulties/Middle	14(13.08%)	66(61.68%)	27(25.23%)	107	
	No difficulties/Higher	14(12.72%)	84(76.36%)	12(10.90%)	110	
Total		41	165	44	250	0.000*

***Pearson Chi-square test**

Out of 107 respondents who had financial difficulties to manage postnatal care, 13.08% had inadequate utilization, 61.68% of the respondents had moderate utilization and 25.23% of them had adequate utilization of postnatal care.

There is association between financial difficulties and the utilization of postnatal care at the 95% confidence level as p- value < 0.05 (0.000).

Table 12. Association between counseling by health person and utilization of postnatal care

		Utilization level			P Value	
		Inadequate	Medium	Adequate	Total	
Proper counseling not given by health person	No	31(19.13%)	97(59.87%)	34(20.98%)	162	
	Yes	10(11.36%)	68(77.27%)	10(11.36%)	88	
Total		41	165	44	250	0.021*

***Pearson Chi-square test**

Among 162 respondents who had been counseled properly by the health professional, 19.13% of them had inadequate utilization, 59.87% of them had moderate utilization and 20.29% of the respondents had adequate utilization of postnatal care. Table 12 also shows that there is association between counseling and the utilization of postnatal care at the 95% confidence level as p value < 0.05 (0.021).

Table 13. Association between place of delivery and utilization of postnatal care

		Utilization level			P Value	
		Inadequate	Medium	Adequate	Total	
Place of delivery	Home	11(91.66%)	1(8.33%)	0	12	
	Hospital	30(12.60%)	164(68.90%)	44(18.48%)	238	
Total		41	165	44	250	0.000*

***ANOVA F-test (4, 245) = 9.003**

Among 12 home deliveries, 91.66% of the respondents had inadequate utilization, only 8.33% of the respondents had moderate utilization and none of them had adequate utilization of postnatal care. There is also significant difference between the place of delivery and the utilization of postnatal care at the 95% confidence level as p-value 0.000.

Discussion

In this study 98.4% of the respondents told that the postnatal care is needful to all postnatal mothers. This finding is supported by the study about factors associated with the lack of postnatal care among Palestinian women based on a cross-sectional study of three clinics in the West Bank. The study states that the majority of women (66.1%) considered postnatal care as a necessity and only 36.6% of women obtained proper postnatal care (Dhaher *et al.*, 2008). Similarly, in this study 95% of the mother got postnatal checkup within 24 h, 42% of the respondents received postnatal check up within 3 days and only 13.6% of the respondents received postnatal check up within 7 days. This finding is supported by a study on factors affecting the use of maternal health services conducted in Madhya Pradesh, India based on a multilevel analysis which states that 61.7% of the respondents used ANC at least once during their most recent pregnancy whereas only 37.4% women received PNC within two weeks of delivery (Jat *et al.*, 2011). This finding is also supported by the study on antenatal and postnatal care service utilization in southern Ethiopia; it revealed that the level of ANC and PNC service utilization as 77.4% and 37.2%, respectively (Regassa, 2011).

The present study revealed that only 20% respondents had adequate knowledge about postnatal care, however, 59.6% had moderate knowledge and 20.4% of the respondents had inadequate knowledge. This result is supported by a study about the use of postpartum health services in rural Uganda based on the knowledge, attitudes, and barriers. It revealed that there was a low-level of knowledge about postpartum care services among the respondents of the two communities, also lacked awareness about postpartum care and its benefits (Nabukera *et al.*, 2006).

In the present study, 54% of respondents told that the reason for the improper utilization of postnatal care was the lack of knowledge about it. The factors affecting the utilization of postnatal care were education, financial difficulties and the proximity of the care center. There is significant association between the level of education and the utilization of postnatal care at the 95% confidence level as p value 0.041. There is association between financial difficulties and the utilization of postnatal care at the 95% confidence level as p value 0.000. There is association between the proximity of care center and the utilization of postnatal care at the 95% confidence level as p value 0.033. This finding is supported by the study on whether differentials

exist between urban and rural areas in Bangladesh. Findings reveal that there exist marked differentials among urban and rural mothers in receiving postnatal care (PNC) from medically trained providers. It was found that urban illiterate mothers receive two times more postnatal care from medically trained providers than rural illiterate mothers (Rahman, 2010). This findings is also supported by a study about the use of antenatal and postnatal care carried out in rural southern Tanzania. The study revealed that women were generally positive about both antenatal and postnatal care. Among common reasons mentioned for the lack of postnatal care was lack of money, and despite perceived benefits of postnatal care for children, there was a total lack of postnatal care for the mothers. This finding is also supported by a study about factors associated with non-utilisation of postnatal care services in Indonesia, which revealed that the prevalence of non-attendance at postnatal care services was consistently higher in rural areas than in urban areas. Maternal factors associated with the lack of postnatal care included low household wealth index, low education levels, lack of knowledge of pregnancy-related complications, and the distance to health services providers. Infants of high birth rank and those reported to be smaller than average were less likely to receive postnatal care (Titaley *et al.*, 2009).

Conclusion

This study shows that only 20% of the respondents had adequate knowledge on postnatal care; only 17.6% of the respondents had adequate utilization of postnatal care and there is strong association between knowledge and the utilization of postnatal care.

There was a low level of knowledge and the utilization of postpartum care among the respondents. The main factors affecting the utilization of postpartum care were: misconceptions, education, ethnicity, distance to health facilities and economic status. Similarly, respondents also reported that they could not receive information from the health professionals and encountered rude behaviour by some health providers. In the effort to improve postpartum care services, there is an urgent need to improve postpartum services and make them more accessible and user friendly.

So efforts to improve postnatal care should focus on addressing proximity to the care center, economic access, educational status, place of delivery, counseling. Antenatal and postnatal care can offer important opportunities for linking the health system and the community by encouraging women to deliver with a skilled attendant. Health education should focus on both antenatal and postnatal care, encouraging scheduled postnatal check up.

References

- Dhaher, E. (2008). Factors associated with lack of postnatal care among Palestinian women: A cross-sectional study of three clinics in the West Bank. *BMC Pregnancy and Childbirth*. 8, p. 26.

- Dhakal, S. (2007). Utilization of postnatal care among rural women in Nepal. *BMC Pregnancy and Childbirth*, 7, p. 19.
- Gilany, A.H. & Hammad, S. (2008). Utilization of postnatal care in Al-Hassa, Saudi Arabia. *Middle East Journal of Family Medicine*, 6(9), pp. 23-26.
- Jat, J.R. (2011). Factors affecting the use of maternal health services in Madhya Pradesh state of India: A multilevel analysis. *International Journal for Equity in Health*, 10, p. 59.
- Ministry of Health & Population, USAID, New ERA (2006). Nepal demographic & health survey. Kathmandu: The Author.
- Mrisho, M. (2009). The use of antenatal and postnatal care: perspectives and experiences of women and health care providers in rural southern Tanzania. *BMC Pregnancy and Childbirth*, 9, p. 10.
- Nabukera, S.K. (2006). Use of postpartum health services in rural Uganda: Knowledge, attitudes, and barriers. *J. Community Health*, 31(2), pp. 84-93.
- Rahman, M.M. (2010). The determinants of use of postnatal care services for mothers: Does differential exists between urban and rural areas in Bangladesh? *The Internet Journal of Epidemiology*, 8(1).
- Regassa, N. (2011). Antenatal and postnatal care service utilization in southern Ethiopia: A population-based study. *Afr. Health Sci.*, 11(3), pp. 390-397.
- Titaley, C.R., Dibley, M.J. & Roberts, C.L. (2009). Factors associated with non-utilization of postnatal care services in Indonesia. *J. Epidemiol Community Health*, 63(10), pp. 827-831.
- United Nations Family Planning Association (UNFPA). Population issues: Safe motherhood: Maternal morbidity. Surviving childbirth, but enduring chronic ill-health. [<http://www.unfpa.org/mothers/morbidity.htm>]
- WHO. (2004). *Alma ata declaration*. WHO report. Cited from <http://www.euro.who.int/AboutWHO/Policy/>

Conflict between Humans and Urban Wild-life in Bhaktapur

Kamal Raj Gosai, Narayan Prasad Koju, Dikpal Krishna Karmacharya* and Sarjina Basukala

Khwopa College, Dekocha, Bhaktapur

*Global Primate Network-Nepal

Email: kamal_gosai2002@yahoo.com

Abstract: The study was carried from September, 2011 to February, 2012. The objectives of this study were to identify diverse mammalian species, to explore the issues of conflict between human and wildlife, and to recommend the best ways to reduce the human-wildlife conflict. A survey was conducted by walking through fixed transect lines and using a questionnaire among local people. Two hundred respondents from different places were questioned. 75% of them were Newars and 85 % had farming occupation. Six line transects of total 16.489 km long were traveled collecting and recording footprints, feces, scrapes, scratches, shelters or burrows, calls and quills of mammals. Altogether 184 indirect signs (frequency) of 11 different species were collected and observed through these fixed transect lines. The least relative frequency (2.7%) was of jungle cat and the highest frequency (26.63%) was of farm rat. Fifteen species of mammals with total 950 signs were directly observed and counted. The occurrence of species was confirmed through indirect signs and direct observation. Eight species of animals: Small Indian Mongoose (*Herpestes giganteus*), Shrew (*Sorex* sp), *Rhinoliphus* spp. etc were directly observed. A total population of 950 animals belonging to eleven species were recorded, in which *Pteropus giganteus* composed 843 individuals. 40% respondent had lost their livestock and 6 people had been killed by leopards. All the respondents complained about the nuisance caused by rats.

Keywords: Wildlife conflict, mammals, footprints, scrapes, feces, urban area.

Introduction

Information on biodiversity such as wildlife distribution, home range, community interaction, and their contribution to ecosystem development is essential for effective conservation and management of wildlife and the protected areas (Basnet, 1998). The expansion of human influence into even the remotest corners of the globe, and the ever increasing pressure on the remaining natural resources, has greatly intensified the issue of human-wildlife conflict in a wide variety of situations. Human-wildlife conflict has been defined as a situation 'when the needs and behavior of wildlife impact negatively on the goals of humans or when the goals of humans negatively impact the needs of wildlife' (Dickman, 2008). The current situation of anthropogenic dominance means that humans must now take responsibility for managing and maintaining the diversity of wild species and ecosystems (Hutton & Leader-Williams, 2003), but even such management for conservation can also have impacts in terms of human-wildlife conflict. Certain mammal species are well adapted to the life in urban sprawls. Rodent species, such as the brown rat (*Rattus norvegicus*) and the house rat (*Mus domesticus*) are mainly associated with human settlements and struggle to compete with other species in more natural habitats. Other species such as the fox

(*Vulpes vulpes*) are increasingly utilizing urban areas as an opportunity to scavenge, which suits their opportunistic feeding habits and they can find the resting places easily (Haigh & Lawton, 2007).

Human-wildlife conflicts are common phenomena from the past and have become significant problems throughout the world (Bhattarai, 2009). Lack of guarding, poor fencing and trenching was the main reason for crop damage in Barandhabar Corridor forest, Chitwan. *Machan* with *mukka* and trenches was the most effective traditional methods of guarding against wild-life encroachment. Crop damage is a serious issue that has developed some negative attitudes towards wildlife protection (Bhattarai & Basnet, 2004).

An urban area features a mix of different habitats such as gardens, allotments, amenity, grasslands, industrial areas, derelict grounds and woodland. As the human-made environment grows and the wild habitats become scarcer, towns and cities may become increasingly important to wildlife. Most wild mammal species, however, struggle in urban areas; they can, however, easily survive in urban areas if certain habitat becomes vital for the species home range and provides access to other areas with suitable corridors. Many animals come to urban areas for different purposes and adapt to the urban environment. The declining rate of urban wildlife and increasing number of other wildlife species have become quite serious recently. Because of urbanization, there is a negative impact on the wildlife that has been the least studied area in context of Nepal.

Therefore, this study has been carried out with the following objectives:

- To explore mammalian wild species of Bhaktapur
- To study the problem of conflict between human and wildlife
- To recommend ways to reduce the human-wildlife conflict

Study area

The study area Bhaktapur (27°26'-27°44' N; 85°21'-85°32' E) is 13 km east from the capital city, Kathmandu, and has 17 wards. The main rivers of Bhaktapur are Hanumante and Manohara. There are more than 35 ponds (natural and artificial) Bhaktapur has humid subtropical climate (DDC, 2002).

Materials and methods

The study was carried out for four months from September 2011 to February, 2012. Six line transects of total 16.489 km was traveled while collecting and recording footprints, feces, scrapes, scratches, shelters of burrows, calls and quills of mammals. The presence of animal was recorded and confirmed by indirect and direct method in the following areas of transects: Nilbarahi to Changu, Dekocha to Jhaukhel, Jhaukhel to Pikhel, Katunje to Gundu, Tathali ward no. 4 to Tathali ward no. 7, Jagati to Doleshwor Mahadev temple. Locations for line transects were randomly selected.

Transects were followed during dawn and dusk. GPS, Camera trap, mouse trap, light sources, mist net, measuring tape were used to collect the data. Camera trap was used at Dekocha, Chhaling, Nil Barahi, Sipadol, Suryabinayak, Katunje, Gundu, Tathali and Bageshwori for nocturnal survey. Five mouse traps were randomly placed at 12 places— Dekocha (3 sites), Chhaling, Nil Barahi, Changu Narayan, Sipadol, Suryabainayak, Katunje, Gundu, Tathali and Bageshwori. A size of 4 cm×10 cm×10 cm mouse traps were used. They were placed on the trails of rodents. Grass and other insulated materials were kept in the trap to prevent injuries to trapped mammals. Mist nets of 3 m×3 m were used to capture bats. They were used at three different places— Katunje, Dekocha and Sipadol. Structured and Semi-structured questionnaires were used for discussion with the locals. A total of 200 copies of questionnaires were used in all seventeen wards of Bhaktapur Municipality, randomly selected 3 wards of each VDCs and 6 wards of Madhyapur.

Results

A total of 1184 indirect signs were collected and observed. Scat, scratch, pugmark of leopard were sighted in forested areas of Suryabinayak, Nangkhel, Chittapol and Telkot; pellets of barking deer were observed in forested regions of Telkot and Suryabinayak; needles of porcupine was observed in forests of Nagarkot, Seepadol, Nangkhel; burrows of Chinese pangolin were found only in forested areas of Suryabinayak and Seepadol; calls of golden jackals were heard and their droppings were observed in Liwalibi, Dekocha, Jhaukhel; and diggings of wild boar were seen in Telkot and Nilbarahi forests. In addition, pugmarks of jungle cat were seen in Chhaling and burrows of mole rats and farm rats were seen in Suryabinayak and Liwalibi area. The lowest frequency (2.7%) was of the jungle cat and of the highest frequency (26.63%) was of the farm rat.

Eight species of mammals namely Small Indian Mongoose (*Herpestes aurupunctuatus*), Orange-Bellied Himalayan Squirrel (*Dremomys lokriah*), Rhesus Macaque (*Maccaca mullata*), field rat (*Bandicota maxima*), Indian flying fox (*Pteropus gangeteus*), Shrew (*Sorex* sp), *Rhinoliphus* spp. etc) were sighted. A total population of 950, including all the species was recorded. Among them, 843 individual wild animals were sighted in Sallaghari forest.

Socioeconomic status of respondents: Among 200 respondents, 150 were Newars, 20 were Chhetris, 10 Brahmins, 10 Dalits and 10 Tamangs. One hundred seventy respondents were farmers, 18 shopkeepers, 2 drivers, 4 teachers, 5 government servants and 1 priest. One hundred twenty one were female and 79 were male.

Crop depredation: All the respondents faced problems from rats at home as well as in their cropland. It was very hard to generate the total amount of damage done by wildlife in fields because the respondents were unable to quantify the amount of

damage to crops done by rats. According to the respondents 90 kg of rice and 560 kg of wheat were damaged by rats every year that is equivalent to NRs 11200 worth of loss of rice and NRs 3250 worth loss of wheat. Rats not only raided wheat and paddy but also potato, garlic, soya and beans. Mongeese affected chilly, cauliflower, paddy, wheat, bamboo root and pumpkin. Bats raided guava and persimmon groves. Squirrels invaded persimmon groves; deer invaded maize, wheat and rice field; jackals and wild boars destroyed wheat field; monkeys invaded fruits and potato; porcupine invaded maize and soybean.

Wildlife-livestock conflict: From the research, it is found that leopards took away children, goat, chicken, cow, buffalo, dog, sheep etc. Jackals, yellow throated martins and mongeese took away chicken and ducks. Eighty respondents complained that they lost their livestock because of wildlife. Some respondents even suspected about the presence of tigers in nearby forest which is ecologically not possible.

Wildlife and human casualties: At Chittapol VDC, a leopard injured one individual, at Karkigaon and Dahagaon, two people were killed; at Kakrabari one was killed. The incidents have brought fear among people and imprinted the feeling that leopard kills people almost every year in the study area. In Seepadol VDC, the villagers are affected by leopards and barking deer; in Nankhel VDC and Chittapol VDC, the villagers were affected by the leopard. According to the respondents, the conflict with the leopard and monkeys is increasing.

Retaliation methods used by the locals: Dogs were used to scare away leopards, yellow throated martins, mongeese and squirrels. Catapults were also used to scare them. Majority of respondents near the forest area used dogs to scare away leopards but dogs in turn became an easy meal for leopards. Fencing the field by bamboo (*Phagramites karka*) helped locals to get rid of jackals. Spreading bones of buffalo or any dead domestic animals in the field attracted jackals. This helped to get rid of rats in fields. People also get rid of rats by pouring a sticky and viscous liquid (remaining of alcohol preparation) in pots installed in fields. Rats enter the pot, get drowned and are killed. According to the respondents, keeping paste of honey and garlic in a corner of home also deter rats. BY tying long strips of clothes on a pole during windy days, people scare rats from their field as the clothes produces scary noise when the wind blows. Mouse traps were also used by many respondents. Rat poison was also used by all the respondents and few of them used fencing to reduce damage from rats.

Discussion and conclusion

Fifteen species of mammals were recorded in Bhaktapur District. The wildlife-human conflict was a serious problem in the district. There were many species that are posing threat to human beings and their crops and cattle. House rats and field rats are the serious problem for the crops and leopards are the serious problem to people and

their cattle in Nankhel and Seepadol area. Barking deer invaded maize crop, dogs were preyed by leopards. Other animals such as squirrel, jackal, cat, mongoose, yellow throated martin, bat, wild boar and porcupine also cause damage to crops and properties. Goats were the most abundant livestock and 80% deaths in goats were due to depredation in Maharashtra, India (Rahalkar, 2008). This shows that the animals found in the local areas have conflicts with locals. Rice, maize and potato are the crops which are affected the most as they are cultivated more. The most disturbing animal in Chhaling is squirrel because of cultivation of perssimon. Monetary loss is more due to animals invading wheat field than rice field.

Awareness about the ecological role of leopard, wild boar, squirrel, mongoose, jackal and other mammals found in the study area have to be given to the locals where the conflict is serious. Also appropriate compensations should be provided to the affected people. Unfavorable crops to the wildlife should be cropped. Fencing of crops should be done to reduce conflicts the boundary of crops.

Acknowledgements

The researchers would like to thank University Grants Commission (UGC) for providing fund to conduct this research. We would like to thank Supreme Prajapati, Deena Shrestha, Samjhana Kawan and Neel Kamal Koju for their volunteer support. We are grateful to Roopak Joshi, principal of Khwopa College for providing logistics support and we are thankful to all respondents for sparing time with us.

References

- Basnet, K. (1998). Biodiversity inventory of Shey Phoksundo National Park. Wildlife Component, Report series # 34. WWF Nepal, Kathmandu. p. 49.
- Bhattarai, B.P. & Basnet, K. (2004). Assessment of crop damage by wild ungulates in the eastern side of Barandabhar corridor forest, Chitwan., Proceedings of IV National Conference on Science and Technology., March 23-26, p. 1979.
- Bhattarai, B.R. (2009). *Human-Tiger (Panthera tigris tigris) conflict in Bardia National Park, Nepal*, MSc Thesis, Ernst Mortiz Arndt University of Greiswald, p. iii.
- DDC, (2002). District Development Committee Report, Bhaktapur, Nepal.
- Dickman, A.J. (2008). *Key determinants of conflict between people and wildlife, particularly large carnivores, around Ruaha National Park, Tanzania*, PhD Thesis, Universal College London (UCL) and Institute of Zoology, Zoological Society of London, p. 26.
- Haigh, A. & Lawton, C. (2007). Wild mammals of an Irish urban forest. *Irish Naturalists' Journal*. 28(10).
- Hutton, J.M. & Leader-Williams, N. (2003). Sustainable use and incentivedriven conservation: realigning human and conservation interests. *Oryx*, 37, pp. 215-226.
- Rahalkar, K. (2008). *Attitudes of local people to conflict with leopards (Panthera pardus) in agricultural landscape in Maharashtra, India*, MSc Thesis, Center for Wildlife Studies and National Centre for Biological Sciences, UAS-GKVK Campus Bangalore, p. iii.
- Shrestha, R. (2007). *A case study on human-wildlife conflict in Nepal (with particulare reference to human-elephant conflict in eastern and western Terai regions)*. Species Program, WWF International, pp. 30-31.

Motivating Factors and Satisfaction Level of Visitors at Sagarmatha National Park, Solukhumbu, Nepal

Dul Raj Chimariya

Department of Rural Development, Patan Multiple Campus, Patan Dhoka, Lalitpur, Nepal

Abstract: *The concept sustainable tourism development is based on the ideas of prosperity, conservation and steady sharing of benefit to the nation along with locals. This article aims to find out the exact motives that stimulate people to visit a place. People's interest and risk taking behaviour have been changing and they wish to do same thing differently. So, people want to remain aloof from various tensions or get engaged in some sort of activities to test their inherent quality (physical and mental). Risk bearing and exploring of new segment of nature is the main driving factors behind the tourists visiting Sagarmatha National Park.*

Keywords: *Motivation, satisfaction, tourism, risk taking behavior.*

Introduction

Human motivation is basically a discovery of people's needs and their ways of fulfilling them. A clinical psychologist, Maslow (1943) identifies five main stages of needs: physiological, safety, love (social), esteem and self-actualization. He proposes that the needs are hierarchical; one level of needs is to be satisfied before a higher level of need is stimulated. The theory is extremely popular due to its simplicity. It is widely adoptable in many areas, including tourism. However, motivation for tourism is a hybrid concept (Dann, 1981). It is discretionary, episodic, future-orientated, dynamic, socially influenced and evolving. Most researches on tourism motivation are based on the Content Theory and are markedly similar to Maslow's need hierarchy. Dann (1977) has used a survey data on visitors' attitudes towards Barbados and developed the concept of 'push' and 'pull' factors and also concepts such as 'anomie' and 'ego enhancement'. 'Push' is the reason to travel while 'pull' is the attraction of a destination.

These factors are important in influencing a decision to travel. The concept of anomie refers to a state where people find that they are established in routine and feel the need for a change. The concept of ego-enhancement creates the desire to travel to a place where the person can be totally himself and will be respected as such. Pearce (1982) comments that Dann simplifies travel motivation into a limited aspect of Maslow's theory. He is of the view that Dann's 'anomie' is simply a restatement of Maslow's love and needs for belonging and that 'ego-enhancement' is similar to the concept of self-esteem needs.

Lawler (1973) summarized the basis of the Expectancy Theory when he states that as "the strength of a tendency to act depends on the strength of an expectancy that the act will produce a certain outcome and on the attractiveness of the outcome to the actor". The idea was based on the earlier work of Murry (1938). The first effort to apply the Expectancy Theory was made by Vroom (1964) who explained motivation in term of the environment of work. When the concept of the environment of tourism is applied, the formula will answer all of these three questions: where do people prefer to go on holiday? why do they want to go there ? And whether or not they want to go on holiday at all ?

Satisfaction studies have shown that different destinations have different variables that are important to tourists, from which satisfactions are derived. A study by Haber and Lerner (1991) in the Negev, Israel, on fifty-three tourism ventures shows that the most important index for customer satisfaction is the entrepreneurial variable. Tourists value the uniqueness of the ventures' management more than the scenery of the setting. Kozak and Rimmington (2000) surveyed 250 British tourists during the off-season in Mallorca using self-completed questionnaires at the islands airport departure lounge. They found that the items rated as most satisfactory by tourists are facilities and services. Feelings of safety and security; hygiene and sanitation are also measured and rated as giving high satisfaction (organizational variables). A study by Musa (1998) on 314 divers on Sipadan which also used self-completed questionnaires, revealed that their level of satisfaction was high and this was mainly due to the island's outstanding marine bio-diversity and easy nature.

Study area

Sagarmatha National Park (SNP) was established in 1976 with the help of the New Zealand Government and was listed as a World Heritage Site in 1979 (Rogers, 1998). Its boundaries extend to the Tibetan border in the north to the Rowalin valley in the west and to the Arun valley in the east. The altitude of the area varies from 2805 meters at the Jorsalle entrance to 8848 meters at the peak of Mount Sagarmatha. The area covers 1148 sq km. Bio-climatically, Sagarmatha region lies in the transitional area of horizontally demarcated bio-climatic regions (central and eastern Nepal) and above vertically demarcated subtropical bio-climatic zones. This merit harbors a wide range of ecological niche for the inhabitation of a number of globally and economically significant flora and fauna in its unique and scenic landscape. In Nepal, a total of 11 species of endemic flowering plants have been recorded by Shrestha and Joshi (1996) which a number of IUCN and cites listed floral and faunal species including high altitude medicinal herbs, globally endangered animals like snow leopard, musk deer, red panda etc. have been enumerated in the area.

Methods

Following four methods were used for the research:

Sample survey method- Sample survey was done to get the information at the household level. As people are the homogenous universe “simple random sampling” was used. In the case of the tourist respondents, which is highly heterogeneous universe, simple random was thought to be erroneous. As a result, purposive sampling was used. While so doing repetition of the tourists of one nation more than two times was avoided. A combination of these two types of sampling was used because the study was carried out on heterogeneous visitors and homogeneous local people.

Observation method- As the research included the condition and prospects of the study area, observations were inevitable. Hence the researcher elicited information by staying in close proximity of the study area during the study period.

Opinion collection method- This method was applied to draw information and vision from different informants. Somewhat elaborated interviews, with some in writing too, was taken from the key informants as these people are likely to furnish with valuable knowledge and visions to make the research’s finding more qualitative and meaningful.

Secondary method- As the study deals with relatively a bigger yet under studied problems and as the research covers only few people and as there are other limitations of primary sources of information regarding reliability and validity concerns of results, books, data, information from NTB and ministry of culture tourism and civil aviation, dissertation of various individuals, seminar paper, research reports, related websites and online publications etc. were used as secondary sources.

Research tools- Separate standardized survey questionnaires/schedules were used for 120 respondents of visitors, 30 entrepreneurs (hotels, lodges, and teahouses) and 20 villagers. To state more precisely, schedules of the questionnaires were filled by the researcher himself while questioning the respondents. As all the respondents wouldn’t be able to answer on their own, it was an imperative to do so. In addition, there is probability of distortion in the reporting to create certain social effects. In case of entrepreneurs too, as the questionnaire included the issues like benefit sharing with the people which could restrict them from reporting candidly what they think, it was filled by the researchers with the clarifying questions and follow-up questions when necessary. In case of tourists, however, it remained in the form of questionnaire, to be filled by themselves. All these questionnaire/schedules contained both the open ended and closed questions. While close ended or fixed alternative questions are better to get the desired information, a wider range of open-ended questions are more useful to elicit information on complex issues. Interviews are taken from various key informants giving the respondents a wide range of flexibility in their responses.

However, to make it more qualitative and focused" interview guideline" was used. Data were presented, processed and analyzed by using bar graphs, line graphs, pie charts, tables and percentage analysis etc.

Results and discussion

General visit trend: 91.6% of the tourists to SNP are first timers while 8.4% are repeat tourists (Field survey, 2010). It appears that the park still has a greater portion of tourists who come for the first time. To develop tourism in SNP, we need to open more areas located within SNP for the visitors to motivate them.

The reduction in the percentage of tourists arriving as part of a organized group may be illustrative of the slowly changing global trend. However, only 13.8% of the tourists travelled alone compared to 46.0 percent of those who travelled independently with their friends or relatives. This suggests that even though a slightly larger number of tourists now travel independently, the number of those who travel alone may be diminishing. About 46 percent prefer to travel independently with a porter/guide (4.9) or with partners, friends and relatives. The mean length of stay in SNP for all tourists is 11days (Field survey, 2010).

The majority of tourists 51.7 percent consider themselves as novice high altitude tourists. 35.8 percent of tourists consider themselves as intermediates, while only 12.5 percent consider themselves as "experienced". The research found that novice tourists are greater among the age group of 20-29 years, and experienced tourists are mainly from the age group between 30-49 years. Males tend to rate themselves higher in terms of self- rating high altitude experience than females. 70.9% of males rated themselves as "experienced" as opposed to only 29.1% of female tourists. The greater portion of novice tourists come from Australasia (66.7%), UK and Ireland (61.9%), North America (54.7%). Tourists from North and Western Europe and other parts of the world rate themselves relatively more experienced than other nationalities (Field survey, 2010).

Motivation and risk taking behaviour in the mountain setting: Mountain climbing and travelling to high altitude destinations are considered as adventurous activities. This is because both have the element of risk involved in them. Johnston (1989) studied the risk associated with enjoyment in New Zealand by using an open ended questionnaire of trampers, skiers, hunters, climbers and day walkers. She found that the climbers mentioned risk elements in a greater proportion than did other groups, which suggest that they are indeed seeking adventure. If climbing is risky, why do people climb? Bratton *et al.* (1979) conducted a study on 266 members of Calgary Section Climbers to find the reason why people climb. Among the main motives observed are social experience, health and fitness, excitement, expression, relaxation, competence achievement and the love of nature. Hard rock climbers are more motivated by reasons that reflect achievement and challenge.

Table 1. Best destination of visitors of Sagarmatha

SN	Various destination	Tourists	Percentage (%)	Ranking
1	Everest base camp	3990	23.19	1
2	Kalapaththar	3011	17.50	2
3	Gokyo	2613	15.19	3
4	Tengboche	1823	10.60	4
5	Island peak	1082	6.29	5
6	Thame	885	5.14	6
7	Namche	803	4.67	7
8	Cholapass	619	3.60	8
9	Pheriche	550	3.20	9
0	Khumjung	507	2.95	10
11	Dingboche	266	1.55	11
12	Chhukom	264	1.53	12
13	Pangboche	202	1.17	13
14	Record not available	173	1.01	14
15	Renzola pass	144	0.84	15
16	Amalapsa pass	75	0.44	16
17	Khongmala pass	72	0.42	17
18	Khumjung + pangboche	33	0.19	18
19	Tasinga	31	0.18	19
20	Amadablam	15	0.09	20
21	Nangpala + Evererst base camp	14	0.08	21
22	Rowaling	11	0.06	22
23	Meharcross	8	0.05	23
24	Gokyo Everest camp	3	0.02	24
25	Lobuche	3	0.02	25
26	Gokyo cholapass	2	0.01	26
27	Lobuche peak	2	0.01	27
28	Gokyo/ Kalapaththar	1	0.01	28
29	Laudha gumba	1	0.01	29
	Total	17203	100.0	

Source: Sagarmatha National Park, 2009

Acceptable levels of risk and challenge are often a function of the individual's past experience and skill (Ewert & Hollenhorst, 1989). As participants gain experience, perception of risk decreases and perception of competence increases (Priest, 1992); since the concept of risk is evolving according to experience and competency, often

recreationists change their perception of risk. Among Everest climbers, Ullman (1964) states that they alter the situation by the increasing risk and /or by handicapping the competence to enhance the uncertainty for as long as possible. Since the Everest is now climbed even by tourists who have previously never used crampons (Krakauer, 1997), experienced climbers alter their motivation so that the climbing of Everest remains a great challenge.

Best destination: Sagarmatha is the best destination for trekking and large number of visitors of SNP mostly visit for the sheer beauty of Mt. Everest and its surrounding (Table 1). Cultural study and religious tourists have contributed in a smaller scale. During the field survey, it was discovered that most of the visitors of SNP are fascinated by the wonderful trekking opportunity in the astonishing setting of mountains and hills.

SNP offers various trekking sports. Among them climbing Mt. Everest is ranked as the highest which alone contributes 23.19% of total visitors of SNP. Kalapaththar 17.50%, Gokyo 15.19%, Tengboche 10.60% and Island Peak 6.29% are other major contributing spots for the visitors of SNP. Among them Gompa and others cultural motivators have lesser influence in this area.

Travel motivation of tourists to SNP: An interviewee suggested that the main motivating factors be further divided into major five components. In bold letters are the risks taking motivations. The top five motivations among tourists to SNP as shown in Table 2 are “to trek/climb mountains” (12.5%) “to enjoy scenic beauty” (11.9%), ‘to wide experience’ (3.6%), ‘to view Sagarmatha’ (4.2%), ‘to encounter wilderness/ untouched nature’ (4.2%).

The risk-taking motivations are not considered as the main motivation of the visitors to SNP. For travellers, ‘risk’ is not generally an important motivation (2.7%). However, a gentler wording of risk taking motivations, for example ‘to be adventurous’ is rated fairly high (3.3%). Travel motivations ‘for spiritual reasons’ (2.5%) and ‘to be closer to God’ (1.7%) are among the lowest rated motivations for visiting Sagarmatha National Park (Table 2).

Motivation factors in this study have been chosen based on literature, personal conversation and pilot testing. They are rather a list of all the possible motivations among tourists who visit SNP. The purpose is to classify the motivational factors into several meaningful and correlated groups and use them for statistical analysis.

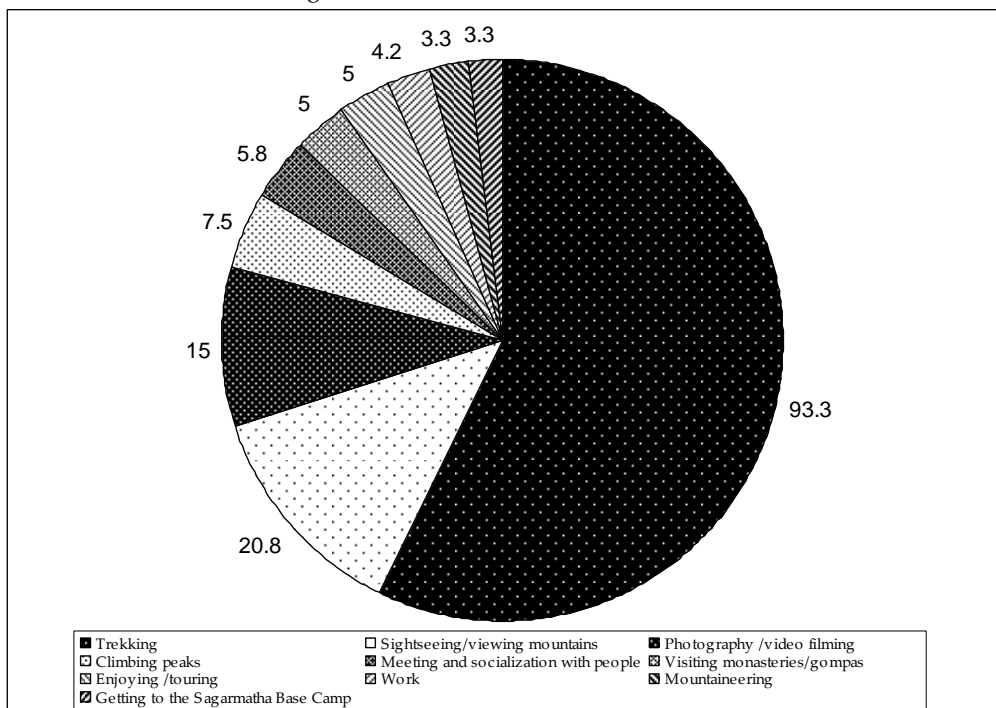
Table 2. Motivation factors of SNP

SN	Motivations	Frequency	Percentage
1	To trek/climb mountains	45	12.5
2	To enjoy scenic beauty	41	11.9
3	To widen my experience	13	3.6
4	To view Sagarmatha	15	4.2
5	To encounter wilderness/ untouched nature	15	4.2
6	For a totally new and different experience	15	4.2
7	To take photographs	12	3.3
8	To be adventurous	12	3.3
9	To appreciate flora and fauna	10	2.7
10	To get away from life's pressure	12	3.3
11	To meet and socialize with local people	8	2.2
12	To enjoy the company of friends and family	10	2.7
13	For my personal Development	7	1.9
14	To relax and rejuvenate	10	2.7
15	To learn about Sherpa culture	7	1.9
16	To enjoy a leisurely walk	9	2.5
17	To test my physical strength and endurance	10	2.7
18	A break from modern technology	9	2.5
19	To visits gompas and monasteries	6	1.7
20	To do things which only few could do	9	2.5
21	To meet and socialize with others trekkers	8	2.2
22	To learn how to cope with difficult situations	8	2.2
23	To test against challenges of nature	9	2.5
24	To experience solitude	8	2.2
25	To learn about Buddhism	10	2.7
26	To test my mental skill	8	2.2
27	To experience the elements of risk	10	2.7
28	For spiritual reasons	9	2.5
29	To be alone	9	2.5
30	To be closer to the God	6	1.7
	Total	360	100

Source: Sagarmatha National Park, 2009

Tourist activities: Although 100 percent of tourists who visit SNP have to be involved in trekking, only 93.3% (Fig. 1), mentioned trekking as the main activity. The other important activities are 'sightseeing/viewing mountains' (20.8%), 'photography/video filming' (15.0%) and Climbing peaks (7.5%).

Figure 1. Main activities of tourists in SNP



It was found during the field survey that a majority of visitors of SNP wished to test their physical endeavor and maximize their entertainment. Some of them enjoyed themselves with viewing and sightseeing. Meeting and socialization with people, visiting monasteries/gompas and mountaineering are other interests of visitors.

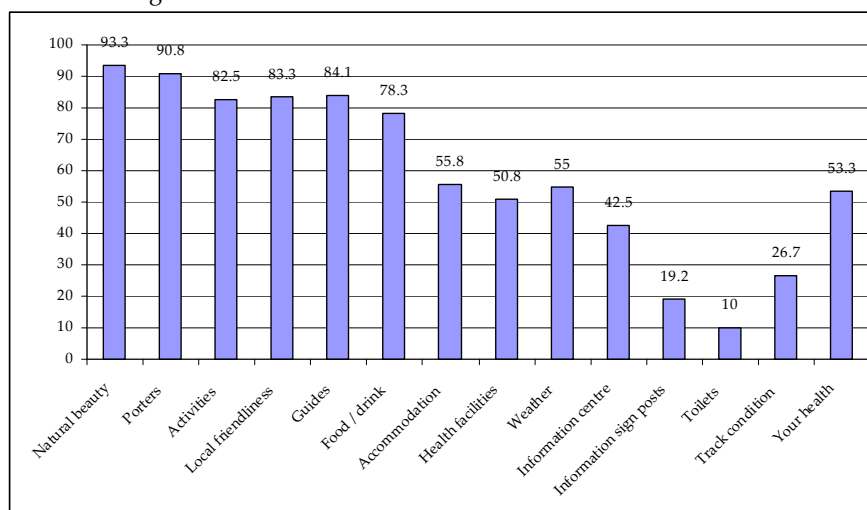
Satisfactions with selected items: Satisfaction arises from a number of causes and also from their combination. Tourists visiting SNP rate their satisfaction highly on 'natural beauty' (93.3%), porter (90.8%), activities (82.5%), local friendliness (83.3%) and guides (84.1%). Items rated between neutral and satisfied are food/drink (78.3%), accommodation (55.8%), health services (50.8%), track condition (26.7%), whether (55%), and information centre (42.5%) (Fig. 2).

Levels of general satisfaction are significantly associated with accommodation, activities, natural beauty, health, guides, food/drinks, local friendliness, toilets and track condition. However, most tourists rated activities, natural beauty, guides and local friendliness as 'very satisfactory'.

Accommodation, health, food/drinks, information, centre, and trekking condition were rated less favourably. Facilities such as bathrooms were highly rated. Most respondents rated them as "dissatisfied". Health facilities and synagogues are not significantly related as satisfactory. Thus, is probably due to the failure of respondents

to answer the questions on these items in the questionnaire. Many tourists have no opinion on health facilities.

Figure 2. Satisfaction of tourists in SNP with the listed items



Best aspects of the visit to SNP: Table 3 shows that the best aspect of visiting SNP as experienced by most visitors are activity orientated, a combination of enjoying the scenery (48.3%), viewing peaks (27.5%), trekking (10.0%) and physical exercise (7.5%). A noticeable need for social interaction with other tourists is also obvious as tourists considered meeting and enjoying friendly people (25.0%) together with enjoying the companionship of friends/family (5.0%) as the best aspects of their travel. Sherpa culture is rated fourth as the best aspect (19.1%) their experience of SNP.

Table 3. Best aspects of tourists' visit to SNP

SN	The best aspects of the visits(n=120)	Frequency	Percentage
1	The beauty of scenery and sites	58	48.3
2	Viewing the Himalayas /peaks	33	27.5
3	Meeting and socializing with friendly people	30	25.0
4	Sherpa culture	23	19.1
5	Meeting local people	20	16.7
6	Enjoying nature and untouched wilderness	12	10.0
7	Trekking enjoyment	12	10.0
8	Viewing Sagarmatha	11	9.1
9	Doing physical exercise	9	7.5
10	Sherpa friendliness	8	6.7
11	Climbing peaks/ mountaineering	7	5.8
12	Enjoying friends/family companion	6	5.0

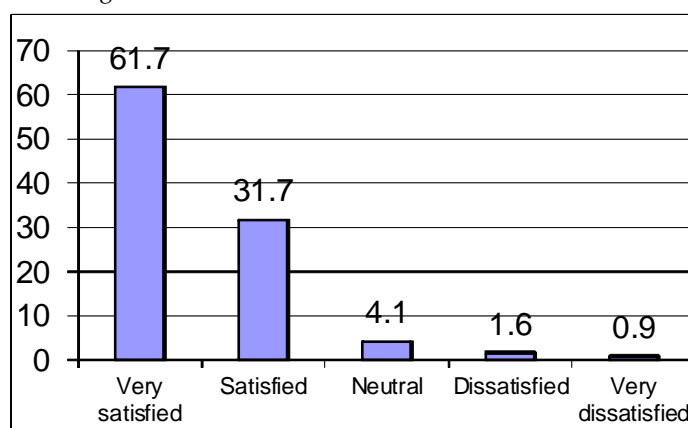
Source: Field survey, 2010

Worst aspects of the visit to SNP: The research found that the five worst aspects of visiting SNP are bad weather (21.7%), getting sick (19.1%), toilets (14.2%), rubbish/litter (10.9%) and crowd (8.3%) (Field survey, 2010). Among tourists visiting SNP, bad weather generally signifies 'rain and low visibility. Bad weather is recorded as the first detrimental factor.

Apart from this, getting sick is the worst aspect of the visit to SNP (19.1%). Toilets in general are also among the worst experience in SNP (14.2%). From the observation and personal conversations, rubbish and litter (10.9%) are mainly caused by local people or porters. Crowding is among the worst of the social impacts (8.3%) especially during the peak season. During the season (October and November), 300-400 people visit SNP everyday. Tourists also observed unsanitary and unhygienic practices among service providers (3.3%) (Field survey, 2010).

Overall satisfactions: Tourists who were 'very satisfied' constituted 61.7% and 'satisfied' 31.7%. Tourists who rated 'neutral' 4.1% to 'very dissatisfy' are only 0.9% of the total sampled (Fig. 3). The one-sided pattern of tourist satisfaction observed in the study is commonly seen in many tourist destinations and this may cause difficulty in further statistical analysis. Further researchers should be conducted to bring other motivational factors such as push factors of visitors.

Figure 3. Overall satisfaction level of visitors to SNP



Tourists from Northern and Eastern Europe are most satisfied with their visit to SNP (79.2% very satisfied), followed by tourists from UK and Ireland (72.2%) and North America (66%) (Field survey, 2010). High educational attainment is related to higher satisfaction level. There is no significant relationship between the types of travel and the level of satisfaction. Satisfaction level is higher during the winter season as compared to the peak and rainy seasons. This could be the result of some special conditions. During winter, the area is covered with snow with lack of clear visibility. Age and gender are not significantly related to satisfaction.

Conclusion

Tourism is dependent on other variables. For example, an increase in the accommodation facilities without the respective increase in the capacity of air and road transport facilities and other auxiliary facilities will be of no use. Therefore, a proper coordination and a balanced growth in the various sectors of tourism industry is necessary.

No matter how attractive a site may be, it cannot be sold in the international travel market unless such site is accessible to the tourists. Therefore, transportation is significant for the development of tourism. Since Nepal is landlocked, it is accessible to the tourists by land and air transportation only. The ability of the tourists to pay for the trip is the other side of motivating factors for visitors.

A number of lodges in the park have also increased to an extent that the supply exceeds the demand leading towards unhealthy competition. Also, the increasing numbers of tourists have affected the peaceful environment of the park resulting in landscape degradation, trail trampling, loss in vegetation, loss in flora and fauna, pollution, and littering with non-biodegradable waste including discontinuation and degradation of the indigenous Sherpa culture. Besides, tourism has adversely impacted the environment of the very economy which has benefited from it. Tourists complain of services and the degrading quality of destination; and even locals complain about the lack of coordination and existing loopholes in development procedures which have failed to fulfill their needs and requirements. Similarly, in order to develop sustainable tourism in Sagarmatha National Park, motivating factors and satisfaction level of visitors should also be examined which are the prime factors of tourism promotion in the region.

References

- Adams, V. (1992). *Tourism and Sherpa annals of tourism research*, 19(3).
- Baker, G.C. (1993). Nepal-Sagarmatha forestry report 1993 visit. Rangiora: New Zealand Forest Research Ltd.
- Bjoness, I.M. (1983). *External economic dependency and changing human adjustment to marginal environment in the high Himalaya, Nepal*. Mountain Research Development, 3(3).
- Brower, B. (1991). *Sherpa of Khumbu: People livestock and landscape*. Delhi: Oxford University Press.
- Danaher, P.J. & Aweiler, N. (1996) Customer satisfaction in tourist industry: A case study of visitors to New Zealand. *Journal of Travel Research*, 34 (Summer), pp. 89-93.
- Fitzgerald, C. (1988). An analytical review of consumer satisfaction in relation to New Zealand tourism, unpublished Marketing honours dissertation, University of Otago, Dunedin, New Zealand.
- Franken, D.A. & Raij, W.F. (1981). Satisfaction with leisure activities. *Journal of Leisure Research (Fourth Quarterly)*, 13(4), pp. 337-352.
- Furer-Haimendorf, C.V. (1984). *The Sherpas transformed: Social change in a Buddhist society*. New Delhi: Sterling Publisher.

- Gurung, C.P. & DeCoursey, M.A. (2000). *Too much too fast: Lesson from Nepal's lost kingdom of Mustang*. Tourism and Development in Mountain Regions. UK: CABI Publishing, Wallingford.
- Gurung, H. (1991). *Tourism carrying capacity in the mountain region of Nepal*. Kathmandu: UNDP.
- Helms, M. (1984) Factors affecting evaluation of risks and hazards in mountaineering. *Journal of Experiential Education*, 8.
- Heung, V.C.S. & Cheng, E. (2000). Assessing tourist' satisfaction with shopping in the Hong Kong special administrative region of China. *Journal of Travel Research*, 38, pp. 396-404.
- Houston, M.D. (1987). *Deforestation in Khumbu*. Mountain Research and Development, 7.
- Jefferies, B. (1982). Sagarmatha National Park: The impact of tourism in Himalaya. *Ambio*, 11.
- Joshi, D.P. (1982). The climate of Namche bazaar: A bioclimatic analysis. Mountain Research and Development.
- Kozak, M. & Rimmington, M. (2000). Tourist satisfaction with Mallorca, Spain, as an off-season holiday destination. *Journal of Travel Research*, 38, pp. 260-269.
- Krippendorff, J. (1987). *The holiday makers: Understanding of the impact of leisure travel*. Butterworth-Heinemann: Oxford.
- Lawler, E.E. & Suttle, J.L. (1973). Expectancy theory and job behaviour. *Organizational behaviour of human performance*, 9, pp. 482-503.
- McIntosh, R.W. & Goeldner, C.R. (1984). *Tourism principles, practices, philosophies*, (4th ed.). Ohio: Grid Publishing Inc., Columbus.
- Mills, A.S. (1985). Participation motivation for outdoor recreation: A test of Maslow's Theory. *Journal of Leisure Research*, 17(3), pp. 184-199.
- Moutinho, L. (1987). Consumer behaviour in tourism. *European Journal of Marketing*, 21.
- Murry, H.A. (1938). *Exploration of Personality*. New York: Oxford University Press.
- Parasuraman, A., Zeithaml, V.A. & Berry, L.L. (1985). A conceptual model of service quality and its implications for future research. *Journal of Marketing*, 49.
- Pearce, P.L. (1982). The social psychology of tourist behaviour, International series in experimental.
- Robinson, D.W. (1997). Strategies for alternative tourism: The case of tourism in Sagarmatha National Park, Nepal. In L. France (Ed.), *Sustainable tourism*, Earthscan Publication Pvt.
- Rogers, P. & Aitchinson, J. (2000). *Towards sustainable tourism in the Everest region of Nepal*. Kathmandu: IUCN Nepal and ICPL.
- Rubenstein, C. (1980). Vacation: Expectation, satisfaction, frustration and fantasies. *Psychology Today*, 14, pp. 62-66 & pp. 71-76.
- Ryan, C. (1995). *Researching tourist satisfaction: Issues, concepts, and problems*. New York: Routledge.
- Sherpa, M.N. (1982). *Sherpa culture: Ways of life, festivals and religion of the Sherpa people*. Kathmandu: KMTNC.
- Ullman, J.R. (1964). *American on Everest*. New York: Lippincott.
- Vroom, V.H. (1964). *Work and motivation*. New York: Wiley.
- Weaver, D.B. (1998). Eco-tourism in Nepal. *Eco-tourism in less developed world*, UK: CAP International, Wallingford.

Guidelines for submission

- Articles for submission must be in English. They must be original and not previously published in any other journals either in printed or in electronic form. They also should not be under review for publication in any journal.
- Submission must include a cover page that bears the author's name, an abridged résumé of the author, title of the article and an abstract with key words. The name of the author should not appear in any part of the article.
- The articles must be within 3,000 to 5,000 words, including illustrations, graphs, and charts; must be double spaced throughout. Both a hard and soft copy of the file in MS Word (preferably MS Word 7) using 12 point font must be sent to the address indicated below.
- Articles must follow the APA guidelines:
 - Amao, Y. & Komori, T. (2004). Bio-photovoltaic conversion device using chlorine-es derived from chlorophyll from *Spirulina* adsorbed on a nanocrystalline TiO₂ film electrode. *Biosensors Bioelectron*, 19, pp. 843-847.
 - Bredow, W.V. (2007). Civil-military relations and democracies. In H. Strachan and A. Herberg-Rothe (Eds.), *Clausewitz in the twenty first century* (pp. 266-282). New York: Oxford University Press.
 - Cohen, E.A. (2002). *Supreme command: Soldiers, statesmen, and leadership in wartime*. New York: Anchors Books.
 - Singh, J.S., Raghubanshi, A.S., Singh, R.S. & Srivastava, S.C. (1989). Microbial biomass acts as source of plant nutrients in dry tropical forest and savanna. *Nature*, 338, pp. 499-500.
- The authors will be held accountable for their views and, therefore, the articles published in the journal do not reflect the views or policies of either UGC or the Editorial Committee.
- The journal follows a blind submission policy and articles will anonymously be reviewed by peers.
- Articles based on the research funded by UGC will be given preference.
- Drawings, photographs, slides, tables, charts, maps, etc, must be numbered and the sources listed.
- The decision of the Editorial Board will be final.

Email address for article submission:

publications@ugcnepal.edu.np