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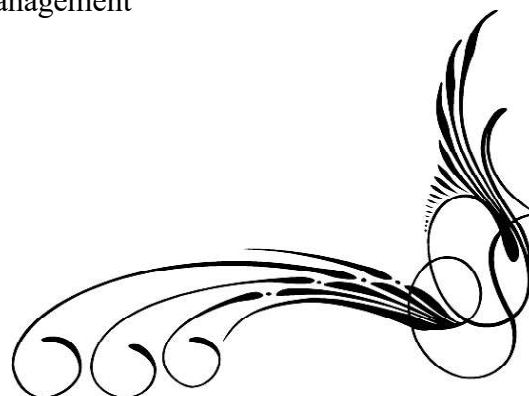
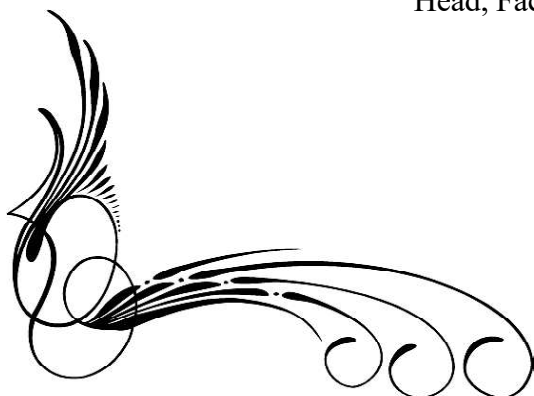
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## Editorial Note

*We extend acknowledgement to our benevolent readers on the occasion of successful completion of "AMC Journal." "Research Publication of Research Management Cell (RMC)", Aishwarya Multiple Campus (AMC), Dhangadhi, Kailali. The RMC of Aishwarya Multiple Campus has completed the second issue of the year 2020, (Vol. 2). It serves the purpose of readers who are interested in contemporary knowledge of natural and social science. It includes two sections. Section A includes articles related to natural science and section B includes articles related to social science.*

*Encouraging support of our benevolent readers, scholars, academicians, and members of advisory board inspired us to come up with this issue of the journal in time. It contains basically eight articles. Among them five articles are related to natural science and three articles are related to social science. This journal gives priority to the research work or project work conducted by the teachers and the students of AMC. Its main aim is to inspire the research scholars, teachers and students of the campus to write something about what they do, feel, and observe. The research course has taken different modes like thesis writing, field work report, project work report, and term paper assignments as integral part of the teaching and learning procedure. Publication of these research oriented activities in such type of journal encourages teachers as well as students in order to improve teaching and learning, and to enhance analytical and research skills.*

*We collected all articles from scholars of different fields and sent these articles for peer review work to related experts for their valuable suggestions. Then, we advised the writers to correct those articles. Finally, we again compiled those all articles and we edited them. This whole work was not possible without the sincere effort of the members of publication committee (Research Department), peer review team, editorial board, and advisory board. Long-time efforts and inspiration of these committees as well as benevolent creditors have made it possible to bring this issue into its present form. Therefore, we are always indebted to all learned scholars who have contributed their papers to publish this issue in time and valuable form. We also extend our gratitude to the advisory board and editorial board for their considerable assistance and sincere guidelines. We are further thankful to Prof. Dr. Hem Raj Pant, Prof. Dr. Chet Raj Bhatta, Prof Dr. M.L. Sharma Bhushal, Associate Prof. Dr. Mandev Bhatta, Dr. Jeevan Kafle, Dr. L.B. Thapa, Ass. Prof Mr. Mohan Singh Saud, Mr. Bhuwan Bahadur Bohara, for their sincere devotion to review articles of this publication. We are indebted to campus chief Mr. Dharma Dev Bhatta of AMC for his valuable support to publish this publication. We are also thankful to Mr. Kamal Prasad Bakhariya for this painstaking computer work.*

*Despite all these sincere efforts, the chance of human error cannot be avoided. Therefore, we would also like to take full responsibility of any kind of deficiency presented in the editorial aspect of this issue. Lastly, we expect creative comments and suggestions from learned scholars and readers for the forthcoming issue.*

Publication Committee  
Research Management Cell (RMC)  
Aishwarya Multiple Campus; Dhangadhi  
Nov. 2020



# AMC JOURNAL

Vol. : 2, Issue : 2, November, 2020

## Table of Content

<u>S.N.</u>	<u>Title of the Articles</u>	<u>Author</u>	<u>Page</u>
<b>Section A : [NATURAL SCIENCE]</b>			<b>1</b>
1.	Effects of invasive alien plant species ( <i>Ageratum houstonianum</i> and <i>Senna tora</i> ) on soil bacteria and fungi	Lal Bahadur Thapa	3
2.	Fungitoxic Efficacy of Some Essential Oils against <i>Fusarium oxysporum</i> Causing Wilt of Linseed	<i>Sanjay Kumar Jha<sup>1</sup> and Bikaram Kumar Sah<sup>1</sup></i>	12
3.	Estimation and Prediction of Kailali District Population Using Mathematical Models	Raghubir Bhatta	19
4.	A review on the impact of Great Lakes in Precipitation	Subash Adhikari, Ramesh Raj Pant, Ganesh Paudel, Namita Paudel Adhikari	31
5.	Impact of Invasive Alien Plant Species in Ecosystem and Peoples' Livelihood in Kailali, Nepal	Gunanand Pant <sup>1</sup> and Susila Bist	40
<b>Section B [SOCIAL SCIENCE]</b>			<b>47</b>
6.	Issues of Internal and International Migration in Sudurpachim Pradesh	Deepak Chandra Bhatt	49
7.	DROPOUT: RATE AND TREND IN AMC	Narayan Awasthi	59
8.	Is Punishment for the Purpose of Improvement in Character Traits of Students Justifiable?	Om Prakash Pandey	66







## SECTION - A NATURAL SCIENCE



# Effects of invasive alien plant species (*Ageratum houstonianum* and *Senna tora*) on soil bacteria and fungi

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## Abstract

Some of the alien plants have developed several strategies to become invasive and create multiple negative impacts in the invaded ecosystems. Such plant species are also known to alter the soil biota for the benefit of them and harming native plant species but such information is not enough yet. This study aims to know the effects of two invasive alien plant species (*Ageratum houstonianum* and *Senna tora*) which are highly problematic in Nepal on soil bacteria and fungi. For this, soil bacteria and fungi were cultured in potato dextrose agar (PDA) media. *A. houstonianum* and *S. tora* invaded and non-invaded soils were collected from Kalika Community Forest of Gauriganga Municipality, Kailali district of Nepal. Number of bacterial colonies, occurrence of fungal species and their frequency were measured. The number of bacterial colonies were found greater in the soil invaded by these invasive species comparing to the non-invaded soil. A total of 9 fungi were isolated from the invaded and non-invaded soils. Among them, the occurrence of *Absidia spinosa*., *Curvularia* sp., *Geotrichum* sp., *Gliocladium* sp., *Rhizopous stolonifer* and *Trichoderma harzianum* and frequency of all fungi differed with the types of soils. Results indicated that *S. tora* may replace the fungus *Rhizopous stolonifer* but accumulates *Curvularia* sp. The fungi *A. spinosa* and *Gliocladium* sp. were associated with *A. houstonianum*. As an antagonistic fungus *Trichoderma harzianum* was absent in the invaded soils, it is supposed that the invaded soil may increase the incidence of soil-borne diseases in native plants. In conclusion, these invasive alien plant species can bring changes in the soil bacterial and fungal communities and frequency as a mechanism of invasion success.

**Key words:** biological invasion, soil biota, culture and isolation, fungal frequency

## Introduction

The plant species growing outside of its natural range is termed as the alien plant species. They are also called as the non-indigenous or exotic or non-native species. If an alien species in the new environment spread rapidly from the point of introduction, becomes abundant and produces negative effects on the recipient ecosystem, it is called as the invasive alien plant species (Davis & Thompson, 2000; Kolar & Lodge, 2001). The invasive alien species, currently, are recognized as one of the main threats to

biodiversity as they are the leading cause of declining biodiversity and ecosystem services worldwide (Pejchar & Mooney, 2009; Mittermeier *et al.*, 2011; Pyšek *et al.*, 2020).

Among hundreds of alien species introduced in Nepal, 26 alien plants are categorized as the invasive species (Shrestha, 2016). Some of the examples are *Ageratina adenophora* (locally called Kalo Bnmara), *Chromolaena odorata* (Seto Banmara), *Mikania micrantha* (Lahare Banmara), *Lantana camara* (Kande Banmara), *Ageratum conyzoides* (Seto Gandhe), *A. houstonianum* (Nilo Gandhe), *Bidens pilosa* (Kalo Kuro), *Parthenium hysterophorus* (Pati Jhar), *Senna tora* (Chhinchhine Jhar or Tapre), *Xanthium strumarium* (Bhede Kuro) etc. (Shrestha, 2016). Many of them have distribution throughout the country from east to west but some of them such as *C. odorata* and *M. micrantha* are confined to the east to central Nepal. Most of these species are known to have negative impacts on soil, soil biota, native plant species and livelihood of people (Timsina *et al.*, 2011; Thapa *et al.*, 2016a, 2016b; Shrestha, 2016; Thapa *et al.* 2017; Shrestha *et al.*, 2019; Thapa *et al.* 2020a, 2020b).

There are several hypotheses to explain the mechanism of a successful invasion of alien plant species. For example, hypothesis of propagule pressure (Loockwood *et al.*, 2005), the enemy release hypothesis (ERH) (Colautti *et al.*, 2004) and the novel weapon hypothesis (NWH) (Callaway & Ridenour, 2004). The invasive alien plants have not only a single mechanism but also they develop several strategies to become invasive and create multiple negative impacts in the invaded ecosystem. Soil bacteria, fungi and animals are the major biotic components of soil. Among them, the interaction of invasive alien plant species with soil biota has become a common interest of invasion biologists. Previous studies have revealed that the invasive alien plant species alter the soil biota for the benefit of them and harming native plant species in the invaded range (Mangla *et al.*, 2008; Rout & Callaway, 2012; Xiao *et al.*, 2014).

Two of the invasive alien plant species that are *A. houstonianum* and *S. tora* are becoming highly problematic species in Nepal especially in far west Nepal (Personal observation). They have been invading roadsides, fallow and agricultural lands, margins and open canopies of forests. These species might have a role in changing soil biotic community composition for successful growth and spread in the invaded ecosystems (Reinhart and Callaway 2006). In this study, these two invasive alien plant species growing in Kalika Community Forest of Gauriganga Municipality, Kailali district of Nepal had been selected to investigate their impacts on soil bacteria and fungi.

## Materials and methods

### Invasive alien plant species

Two invasive alien plant species *Ageratum houstonianum* Mill. (locally called Nilo Gandhe) and *Senna tora* (L.) Roxb. (Chhinchhine Jhar or Tapre) were selected to study their impacts on soil bacteria and fungi. *A. houstonianum* belongs to the family Asteraceae and *S. tora* to the Fabaceae. Both the species are annual and herbaceous. The species *S. tora* was first reported in Nepal in 1910 (Shrestha, 2016) and *A. houstonianum* has been invading Nepalese ecosystem since few decades.

### Soil sampling

Kalika Community Forest in Gauriganga Municipality of Kailali district, Sudur Paschim Province, Nepal was selected for the site of soil sampling. The forest is located at 80° 46.918 E and 28° 45.079N. The elevation of the study area ranges from 150 to 180 masl. The forest was heavily invaded by *A. houstonianum* and *S. tora*.

The soil samples were collected from invaded sites by *A. houstonianum* and *S. tora* and non-invaded sites of the forest. Four transects (approximately 100 m) were made in the forest in each invaded and non-invaded sites. Plots of size 1×1 m<sup>2</sup> were sampled along each transect. There were 4 plots in each transect and the soil was collected from 4 corners of each plot (10 cm depth). The soils collected from the plots of each transect were mixed thoroughly to make a composite sample. There were 4 replicated composite samples of each invaded and non-invaded plots. Soil collected from *A. houstonianum* and *S. tora* invaded and non-invaded sites were put separately in sterile plastic bags. The samples were brought to the Central Department of Botany, Tribhuvan University, Kirtipur, Kathmandu and preserved in the refrigerator at 5±2°C until use.

### Serial dilution of soil, culture and identification

Soil serial dilution method (Germida, 1993) followed by pour plate technique was adopted for bacteria and fungi culture and isolation. The concentrations of the dilution were 10<sup>-2</sup> to 10<sup>-5</sup>. Dilution of 10<sup>-3</sup> to 10<sup>-5</sup> was used for the plating (Aneja, 2007). PDA (Potato Dextrose Agar) media was used to culture bacteria and fungi. Ten millilitres cool and sterile media was poured in Petri plate and above the molten media 1 ml dilution aliquots were poured. The PDA plates were then sealed with the paraffin tape and incubated until 24 - 48 h in an incubator at 25±2°C for bacteria. The plates were incubated for 7 to 15 days for soil fungi. There were 5 plates for each soil sample for counting bacterial colonies and 15 plates/soil sample for calculating the fungal frequency. The fungi were identified based on the morphological characteristics (colony colour, hyphae and reproductive parts) (Thom & Raper, 1945). Bacterial colonies were counted directly by visual observation.

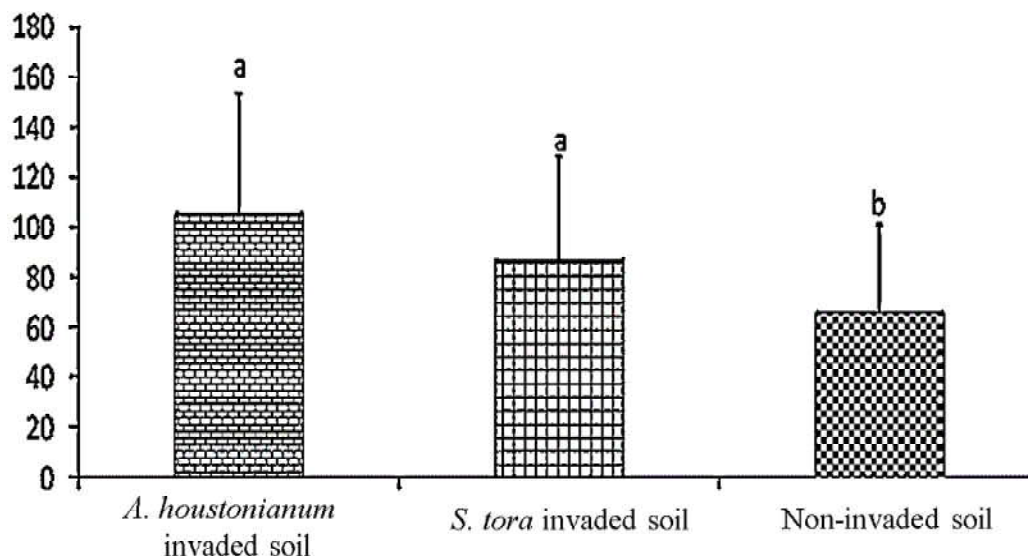
### Statistical analysis

The number of bacterial colonies among invaded and non-invaded sites were compared using one-way ANOVA. The analysis was performed in software R 10.3.

## Results

### Effect of *A. houstonianum* and *S. tora* on soil bacteria

The study showed that the number of bacterial colonies was greater in the soil invaded by *A. houstonianum* and *S. tora*. The number colonies in *A. houstonianum* invaded soil was 105.53/plate followed by the soil invaded by *S. tora* i.e. 86.93/plate. There was the least number of colonies in non-invaded soil (65.66/plate). The differences in the number of colonies were significant (P = 0.005) (Fig 1).



**Fig. 1** Number of bacterial colony in the petri plates containing soil samples after serial dilution. The letter above error bars indicate significant differences

### Effect of *A. houstonianum* and *S. tora* on soil fungi

A total of nine fungal species were isolated from the invaded and non-invaded soils (**Table 1**). Three fungal species *Absidia spinosa*, *Mucor racemosus* and *Rhizopus stolonifera* were the Mucoromycetes and two species (*Aspergillus flavus* and *Penicillium* sp.) were Eurotiomycetes. Likewise, Dothideomycetes was represented by *Curvularia* sp. and Saccharomycetes by *Geotrichum* sp. There were two species (*Gliocladium* sp. and *Trichoderma harzianum*) belonging to the class Sordariomycetes (**Table 1**).

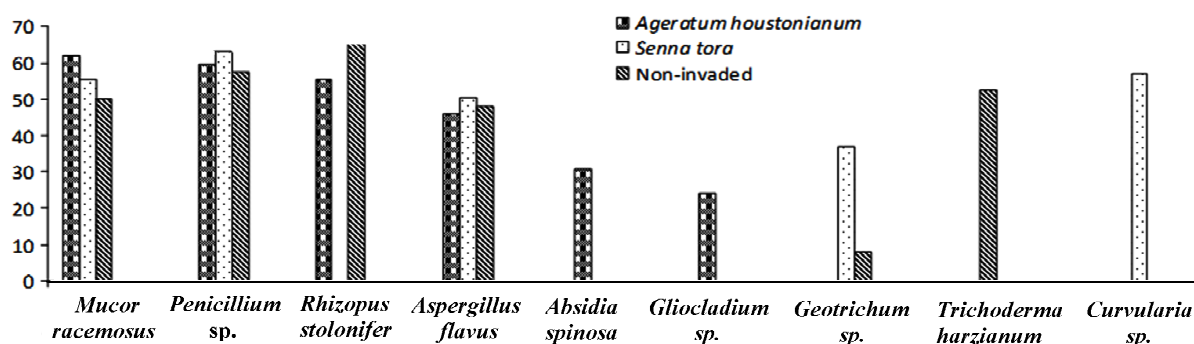
**Table 1.** List of soil fungi isolated form the invaded and non-invaded soil samples

SN	Name of species	Class	Soil type
1.	<i>Absidia spinosa</i>	Mucoromycetes	<i>A. houstonianum</i> invaded soil
2.	<i>Mucor racemosus</i>	Mucoromycetes	Invaded and non-invaded soil
3.	<i>Rhizopus stolonifer</i>	Mucoromycetes	<i>A. adenophora</i> invaded and non-invaded soil
4.	<i>Aspergillus flavus</i>	Eurotiomycetes	Invaded and non- invaded soil
5.	<i>Penicillium</i> sp.	Eurotiomycetes	Invaded and non-invaded soil
6.	<i>Curvularia</i> sp.	Dothideomycetes	<i>S. tora</i> invaded soil
7.	<i>Geotrichum</i> sp.	Saccharomycetes	<i>S. tora</i> invaded and non- invaded soil
8.	<i>Gliocladium</i> sp.	Sordariomycetes	<i>A. houstonianum</i> invaded soil
9.	<i>Trichoderma harzianum</i>	Sordariomycetes	Non-invaded soil

The fungal species *A. flavus*, *A. spinosa*, *Gliocladium* sp., *M. racemosus*, *Penicillium* sp., and *R. stolonifera* were isolated from the invaded soil by *A. houstonianum*. Among them, *A. flavus*, *M. racemosus*, *Penicillium* sp. and *R. stolonifera* were the most frequent fungi (**Fig 2**). The frequency of *M. racemosus* was (62.22%) followed by *Penicillium* sp. (60%), *R. stolonifera* (55.56%) and *A. flavus* (46.67%). The frequency of *A. spinosa*. and *Gliocladium* sp. had 31.11% and 24.44%, respectively (**Fig 2**).

A total of five fungi (*A. flavus*, *Curvularia* sp., *Geotrichum* sp., *M. racemosus* and *Penicillium* sp.) isolated from the invaded soil of *S. tora*. Among them, *Penicillium* sp. had the highest frequency (66.66%) followed by *Curvularia* sp. (57.77%), *M. racemosus* (55.55%), *A. flavus* (51.11%), and *Geotrichum* sp. (37.77%) (**Fig 2**).

Six fungi were isolated from the uninvaded soils where *R. stolonifera* had the highest frequency (66.66%) followed by *Penicillium* sp. (57.77%), *T. harzianum* (53.33%), *M. racemosus* (50.34%), *A. flavus* (48.88%) and *Geotrichum* sp. (8.88%) (**Fig 2**).



**Fig. 2** Frequency of various soil fungi isolated from invaded and non-invaded soils.

## Discussion and conclusion

Results show that the bacterial colonies were greater in *A. houstonianum* and *S. tora* invaded soils (**Fig. 1**). This indicates that these invasive alien plants are responsible to colonize a greater number of bacteria in their invaded soils. Types of bacteria and bacterial species were not identified in this study but the greater number of bacterial colonies in the culture plates suggests that the invasive species might have the ability to accumulate bacteria in the soil invaded by them. A similar result was found in case of other invasive species such as *Ageratina adenophora*. Chen *et al.* (2019) had found the ability of accumulation of bacterial genera *Clostridium* and *Enterobacter* by *A. adenophora* in its rhizosphere soil. They had suggested that the assembly of the bacterial community in the roots may be an advantageous strategy for such invasive species in competition with native plants. As there was lacking the evidence about the relationship of *A. houstonianum* and *S. tora* with soil bacterial communities, this study has given preliminary information about colonization of bacteria in *A. houstonianum* and *S. tora* invaded soils.



The fungal species isolated from the invaded and non-invaded soils (**Table 1**) were the common fungi found abundantly in the soil but interestingly, *A. spinosa*, *Curvularia* sp., *Geotrichum* sp., *Gliocladium* sp., *R. stolonifer* and *T. harzianum* were not found in all types of soils. Moreover, the fungal frequency differed with soil types i.e. the invaded soils by *A. houstonianum* and *S. tora* had altered the frequency of the soil fungi (**Fig. 2**). It indicates that alien plant invasion alters the composition of fungal communities in the soil.

The result also shows that *S. tora* may replace *R. stolonifer* but accumulates *Curvularia* sp. (**Table 1, Fig. 2**). *R. stolonifer* is the most common saprophytic fungus found in soil that decomposes a variety of dead organic matter (Wiedner & Glaser, 2013). The fungus *Curvularia* sp. is facultative pathogens of soil, plants, and cereals in tropical or subtropical areas (Sutton *et al.*, 2009; Santos *et al.*, 2018). From this result, it can be supposed that the invasive *S. tora* might be able to replace useful decomposer fungi and colonize the facultative fungal pathogens.

Similarly, the fungi *A. spinosa* and *Gliocladium* sp. were isolated from the soils invaded by *A. houstonianum* (**Table 1, Fig. 2**). Members of *A. spinosa* and *Gliocladium* sp. are saprophytic and also commonly found in soil but this study shows the association of these fungi with invasive *A. adenophora*. From the result, it can be assumed that *A. houstonianum* can have the ability to accumulate these additional saprophytic fungi with other common fungi such as *A. flavus*, *Penicillium* sp., *M. racemosus* and *R. stolonifer* (**Table 1**).

On the other hand, the *T. harzianum* was found associated only with non-invaded soil (**Table 1, Fig. 2**). *T. harzianum* is one of the important fungi that control other pathogenic fungi therefore it is an effective biocontrol agent against several soil-borne fungal pathogens such as *Pythium* (Hasan *et al.*, 2012). Absence of such important fungus in the invaded soil indicates that the invasion of *A. houstonianum* and *S. tora* has negative effects on these fungi. Furthermore, the replacement of this species from the invaded soil may increase the incidence of soil-borne diseases in native plants. This could be one of the strategies of invasive plants to inhibit native species in the invaded areas. Balami *et al.* (2017) had also reported the inhibitory effect of invasive *A. adenophora* invaded soil to *T. harzianum* and they have also concluded the same.

As suggested by many studies (e.g. Wolfe & Klironomos, 2005; Steinlein, 2013; Gaggini *et al.*, 2018) the invasion of alien plants can cause major shifts in the composition and function of soil communities. Inderjit & van der Putten (2010) also proposed that the invasive plants have ability to manipulate soil biota by enhancing pathogen levels or disrupting communities of root symbionts. This study has also revealed some supporting evidence on the impacts of invasive *A. houstonianum* and *S. tora* on the selected soil fungi. Additional information elucidating potential impacts of invasive alien species on

belowground biota would have great significance on understanding biological invasions.

In conclusion, the invasive species *A. houstonianum* and *S. tora* accumulate a greater number of soil bacteria. A total of 9 fungal species were isolated from the invaded and non-invaded soils. Among them, the occurrence of *A. spinosa*, *Curvularia* sp., *Geotrichum* sp., *Gliocladium* sp., *R. stolonifer* and *T. harzianum* and the frequency of all the fungi differed with the types of soils. The result shows that *S. tora* may replace *R. stolonifer* but accumulates *Curvularia* sp. The fungi *A. spinosa* and *Gliocladium* sp. were associated with *A. houstonianum*. The fungus *T. harzianum* was absent in the invaded soil indicating that the invaded soil may increase the incidence of soil-borne diseases in native plants. Hence, the invasion of alien plants can cause shifts in the fungal community composition and frequency and this could be a mechanism of invasion success. Future studies elucidating the potential impacts of invasive alien species on belowground biota would have great significance on understanding biological invasions.

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# Fungitoxic Efficacy of Some Essential Oils against *Fusarium oxysporum* Causing Wilt of Linseed

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## Abstract

*Fusarium oxysporum* f. sp. *Lentis* was isolated from the infected lentil. Plant pathogenicity test was carried out for the conformation of disease. The essential oils of i.e. *Thymus linearis*, *Elsholtzia eriostachya*, *Tanacetum nubigenum*, *Clinopodium umbrosum* were hydrodistilled in lab. Each essential oil was diluted into different concentrations as 2µl/ml, 1.5µl/ml, 1.0µl/ml, 0.5µl/ml concentration in 80% acetone. Fungitoxicity was assessed by inverted petriplate technique and poisoned food technique. Essential oil of *Thymus linearis* inhibited mycelium growth by 100%, 96.55%, 81.03%, 55.17% at 2µl/ml, 1.5µl/ml, 1.0µl/ml, 0.5µl/ml concentration respectively. Essential oil of *Elsholtzia eriostachya* inhibited mycelium growth by 94.73%, 82.14%, 57.38%, 28.38% at 2µl/ml, 1.5µl/ml, 1.0µl/ml, 0.5µl/ml concentration respectively. Essential oil of *Tanacetum nubigenum* inhibited mycelium growth by 56.8%, 36.8%, 26.3%, 12.3% at 2µl/ml, 1.5µl/ml, 1.0µl/ml, 0.5µl/ml concentration respectively. Essential oil of *Clinopodium umbrosum* inhibited mycelium growth by 49.1%, 32.7%, 21.3%, 11.4% at 2µl/ml, 1.5µl/ml, 1.0µl/ml, 0.5µl/ml essential oil concentration respectively. Thus comparative fungitoxicities of four essential oils were carried out against *Fusarium oxysporum* f. sp. *Lentis* (the causal agent of the wilting of lentil). The minimum inhibitory concentration (MIC) of *Thymus linearis* and *Elsholtzia eriostachya* showed at 2 µl/ml and 2.5 µl/ml concentration respectively. The statistical analysis showed that *Thymus linearis* and *Elsholtzia eriostachya* have good results against *Fusarium oxysporum* f. sp. *Lentis*.

**Kew words:** Essential oils, Fungitoxicity, Hydrodistillation, Inhibition, Isolation.

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## Introduction

Linseed is a traditional cash crop of Terai and Midhill Nepal. It is a winter crop in tropical zone and summer crop in cool zones (Kaul & Das, 1986). The oil of linseed is used for industrial purpose in soap and lubricant manufacturing. Due to these uses, linseed is being produced commercially in Nepal too. But Production is getting low due to several factors than expected. Fungal diseases are one of them while Wilt of Linseed by *Fusarium oxysporum* is a major one.

*Fusarium oxysporum* f. sp. *Lentis* (Schl), was 1<sup>st</sup> reported by Manandhar (1975); causing wilt disease of lentil. These are white abundant with purple ting flourish under moist condition. The colony forms sickle shaped conidia or almost straight rarely or weakly pediculate. The pathogen is soil borne or seed borne (Jones & Tisdale, 1992; Houston & Knowles, 1953).

The essential oils constituents have been regarded as antifungal agent. The presence of antifungal compounds in higher plants has been recognized as an important factor in disease resistance too (Thapliyal & Nene, 1967). But comparative efficacy of essential oils with synthetic fungicides has received little attention. Thus, the present study was undertaken to find out effectiveness of essential oils from *Thymus linearis* Benth. , *Tanacetum nubigenum* Hook & Thorns. , *Elsholtzia eriostachya* (Benth.) Benth. and *Clinopodium umbrosum* (M. Bieb.) K. Koch. Against *F. oxysporum* causing wilt disease of linseed plant at concentration of 2ul/ml, 1.5ul/ml, 1ul/ml, 0.5ul/ml.

## Materials and Methods

### *Plant Materials*

The plant species used were *Thamus linearis*, *Clinopodium umbrosum*, *Elsholtzia eriostachya* and *Tanacetum nubigenum*. All the plants were collected from Manang District of Nepal by Prof. Dr. V. N. Gupta and Prof. Dr. R. P. Chaudhary and identified in Central Department of Botany, TU, Kirtipur. The plants were completely shade dried at room temperature and packed in water proof packets for extraction of essential oils by hydrodistillation using Clevenger's apparatus (Clevenger, 1928).

### *Isolation of Essential Oils*

50 gm of shade dried sample species were surface sterilized using 0.1% Mercuric Chloride and washed with distilled water. It was poured into 1 ltr. Round bottom flask with 500 ml. water (1:10 w/v). The sample was then subjected to hydrodistillation for 6-8 hours in Clevenger's apparatus. The upper layer of condensed volatile fraction was dried over sodium sulphate and stored at 10°C (Rao & Shrivastava, 1994). The % yield was determined using following formula:

$$\% \text{ yield of essential oil} = \frac{\text{vol. of E.Oil}}{\text{Wt. of sample}} \times 100$$

The collected essential oil was diluted with 80% acetone (Rao & Shrivastava, 1994) and diluted into 2ul/ml, 1.5ul/ml, 1ul/ml, 0.5ul/ml for fungitoxicity assay.

### *Assessment of Fungitoxicity*



The test fungus collected from infected linseed plant stem was cultured in PDA media. The pure culture of fungus was maintained and was used for fungitoxicity assessment by poisoned food technique. 0.5 ml of each concentration of all Essential oils was poured in pre-sterilized petriplates with 9.5 ml PDA. 4 mm test fungus was inoculated upside down on medium at center of plate using a cork borrower. The plates were incubated at  $25 \pm 2^\circ\text{C}$  for a week following Bocher, 1938; cited in Rao & Shrivastava, 1994.

The minimum inhibitory concentration was determined measuring the triplicate colonies of test fungus in all concentrations of essential oils. The % inhibition was calculated averaging the 3 data and using the formula given by Arora and Dwivedi 1979 cited in Rao and Srivastava, 1994.

$$\% \text{ of inhibition of mycelium growth} = \frac{ge - gt \times 100}{ge}$$

Where:  $g_e$  = growth of mycelia colony after incubation in control set (Diameter of colony - diameter of inoculums disc)

$G_t$  = growth of mycelia colony after incubation period in treatment set (Diameter of colony – Diameter of inoculums disc).

### ***Spore measurement and Pathogenicity test***

Spore measurement was done by using Ocular micrometry and size of spore was calculated using following calibration formula:

$$\text{One ocular division (in mm)} = \frac{\text{No of division on stage micrometer}}{\text{No. of division on ocular micrometer}} \times 10 \mu\text{m}$$

Thus, the fungal spore of *Fusarium oxysporium* was measured by preparing slide and staining with lactophenol cotton blue. The pathogen pure culture was sprayed over potted healthy linseed to note down the symptoms and compare with previous ones. The pathogens were re-cultured and compared with previously cultured fungal slides. Thus, pathogenicity test was. All the incidences were photographed for future too.

## **Result and Discussion**

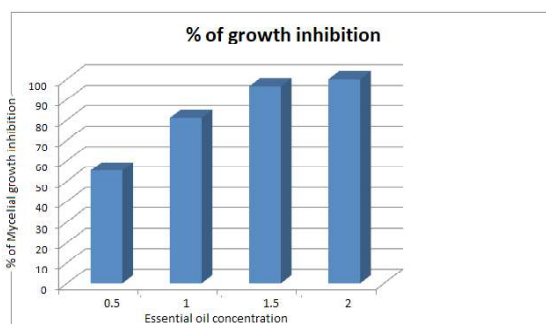
### ***Extraction of Essential Oil***

The yield of essential oil of *Thymus linearis*, *Tanacetum nubigenum*, *Clinopodium umbrosum* and *Elsholtzia eriostachya* was 1.6%, 0.8%, 1.0% and 2.0% respectively. Essential oils were hydrodistilled using Clevenger's apparatus as done by Tripathi et al. (1983), Renu et. al.(1985), Rao and Srivastava (1984) and Saxena et al. (1983). The amount of oils may have varied due to growth stage, ecological factors etc. of the plant species used as mentioned by Nilov and Ponta (1939), Gulati (1980) Pareek et al. (1980) cited in Rao and Srivastava (1994).

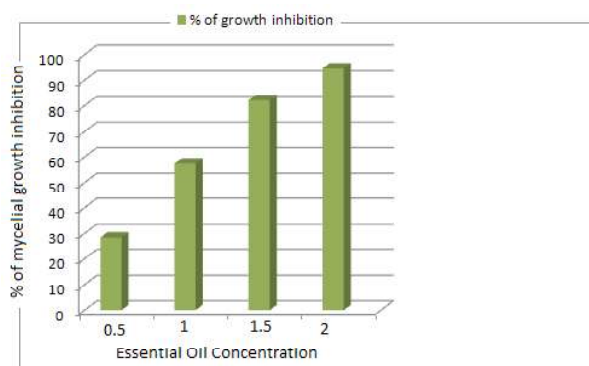
### Assessment of Fungitoxicity of Essential Oils

Antifungal activities of essential oils of *Thymus linearis*, *Elsholtzia eriostachya*, *Tanacetum nubigenum* and *Clinopodium umbrosum* was determined against *Fusarium oxysporum* f. sp. *Lentis* causing wilt of lentil disease. Different essential oils showed variable antifungal activities at different concentrations against *Fusarium oxysporum* f.sp. *Lentis*. The fungitoxicities was assessed in terms of percentage of mycelium growth inhibition. The test was done by Disc diffusion Plate method that showed significant reduction in fungal growth. More higher the concentration, more inhibition on mycelial growth was observed.

The growth of mycelium was inhibited by 100% at 2  $\mu$ l/ml, 96.55% at 1.5  $\mu$ l/ml, 81.03% at 1.0  $\mu$ l/ml and by 55.17% at 0.5  $\mu$ l/ml in the treatment of essential oil of *Thymus linearis* (Fig.1). Essential oil of *Elsholtzia eriostachya* inhibited mycelia growth by 94.73% at 2  $\mu$ l/ml, 82.14% at 1.5  $\mu$ l/ml, and 57.38% at 1.0  $\mu$ l/ml and by 28.38% at 0.5  $\mu$ l/ml concentrations in the treatment with the test fungus (Fig.2).



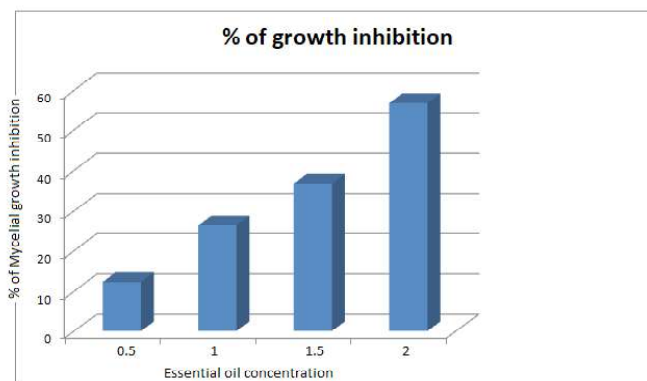
**Fig.-1:** Fungitoxicity of E. oil of *Thymus linearis* against *Fusarium oxysporum*



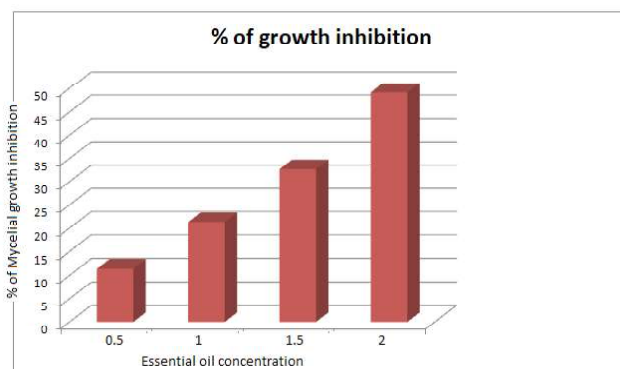
**Fig.-2:** Fungitoxicity of E. oil of *Elsholtzia eriostachya* against *Fusarium oxysporum*



Essential oil of *Tanacetum nubigenum* inhibited the mycelia growth by 56.80% at 2  $\mu$ l/ml, 36.80% at 1.5  $\mu$ l/ml, 26.30% at 1.0  $\mu$ l/ml and by 12.30% at 0.5  $\mu$ l/ml concentration in the treatment with the test fungus (Fig.3). Essential oil of *Clinopodium umbrosum* inhibited the mycelia growth by 49.10% at 2  $\mu$ l/ml, 32.70% at 1.5  $\mu$ l/ml, 21.30% at 1.0  $\mu$ l/ml and by 11.40% at 0.5  $\mu$ l/ml concentrations in the treatment with the test fungus (Fig.4).



**Fig.-3:** Fungitoxicity of essential oil of *Tanacetum nubigenum* against *Fusarium oxysporum*



**Fig-4:** Fungitoxicity of essential oil of *Clinopodium umbrosum* against *Fusarium oxysporum*

The difference in fungitoxicity at same concentration in different essential oils may be due to different chemical composition of the oils, Singh *et. al.* (1983), Maheshwari (1985), Philip and Damodaran (1985), Mahashwari *et al.* (1986) cited in Rao and Srivastava (1994). The result obtained from the study may not be true forever because the concentration of various ingredients in essential oil of the same plant species varies due to several factors such as growth stage, ecological factors etc. as mentioned by Nilov and Ponta (1939), Gulati (1980) Pareek *et al.* (1980) cited in Rao and Srivastava (1994). The comparative Fungitoxicities of all plant species in different concentrations applied are in Table1.

**Table-1:** Fungitoxicities of different essential oils in different concentrations

S.N.	E.oil conc <sup>h</sup> ( $\mu$ l/ml)	Mycelia growth inhibition (%)			
		<i>T. linearis</i>	<i>E. eriostachya</i>	<i>T. nubigenum</i>	<i>C. umbrosum</i>
1	0.5	55.17	28.38	12.30	11.40
2	1.0	81.03	57.38	26.30	21.30
3	1.5	96.55	82.14	36.80	32.70
4	2.0	100.0	94.73	56.80	49.10

### ***Determination of Minimum Inhibitory Concentration (MIC)***

Mycelial Growth inhibition was exhibited differently by different plant essential oils depending on the concentration used. *Thymus linearis* showed that 100% inhibition at 2  $\mu$ l/ml. It showed that MIC at 2  $\mu$ l/ml of oil concentration against *Fusarium oxysporum* f. sp. *Lentis* whereas *Elsholtzia eriostachya* showed minimum inhibitory concentration at 2.5  $\mu$ l/ml concentration. At 2.5  $\mu$ l/ml oil concentration 100% mycelium inhibited against *Fusarium oxysporum* f. sp. *Lentis*. The essential oil of *Tanacetum nubigenum* did not show 100% mycelium inhibition even at 4  $\mu$ l/ml oil concentration but it showed 95.50% of mycelia inhibition at 4  $\mu$ l/ml. The MIC Value of essential oil *Tanacetum nubigenum* and *Clinopodium umbrosum* was not determined due to lack of essential oil of these oils.

### **Conclusion**

From the research it could be concluded that the test plants harbored the fungitoxic principles the inhibited the mycelia growth of *Fusarium oxysporum* f. sp. *Lentis*. Out of four test plant essential oils the statistical analysis showed that *Thymus linearis* inhibited the mycelia growth with well-marked linearity at the concentration on of 2  $\mu$ l/ml

A perusal literature showed that the same experiment has not yet been done in Nepal. So this is the first study to assess fungitoxicities of essential oils against *Fusarium oxysporum* f sp. *Lentis*.

### **Acknowledgement**

We would like to express our sincere and deep gratitude the Professor Dr. Ram Kailash Prasad Yadav head of Central Department of Botany T.U., and former Head Prof Dr. P.K. Jha and I also cordial thanks to Prof Dr. Ram Deo Tiwari, and Professor Dr. RP. Choudhry Central Department of Botany T.U. for their guidance and valuable for his kind instruction and sound cooperation for producing this research work.

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# Estimation and Prediction of Kailali District Population Using Mathematical Models

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## Abstract:

The purpose of this study focused on exploring and determining an effective and plausible mathematical growth model for prediction of future Population size of Kailali District for the next forty years including next two censuses of 2021 and 2031. Kailali's Population is growing faster as science and Technology growing which become a burden to Government budget in allocation of the limited resources available. The Exponential and Logistic growth models were employed by using previous census data from 1991 to 2011 inclusive and analyzed. Carrying capacity of Kailali district and that of Dhangadhi municipality is calculated and using it future population is predicted.

## Keywords:

Population, estimation, parameters, prediction, mathematical models, logistic, exponential.

## 1. INTRODUCTION:

We cannot have sustainable development of a nation without stabilizing the population growth, as human Population increase the demands of resources increase as well [Venkatesha, 2017]. Chidumayo N. 2018 indicates that population studies are well addressed qualitatively neither quantitatively. However little has been done including [Blossfeld, 2014] exemplify that population studies are a better fit for social sciences as opposed to natural sciences where as mathematical models are used to transform different data sets into reality. The use of systematic and reliable examples from developed and developing countries portrays that chance of uncertainty demarcates the expected outputs from either sides. Developed countries are able to control the birth and mortality rate due to a stable economy and database established. This is contrary from developing countries become a burden due to the limited budget and unstable

economy which lead to failure in control of birth and mortality rates [Allman & Rhodes 2003]. In any country there is a need to have a desirable, monitored and known population that help the decision and policy makers to advise the government to reserve and allocate its resources accordingly [Wali 2011]. In the same view Richard and Robert (1997) argued that population growth runs contrary to food supply in the entire population relying on a theory that developed to justify the necessity of population studies. Population grows exponentially that means it increases as the birth rate rises due to the dynamic population we have in the world. There are countries that have managed to reduce the birth rate in order to manage the resources they have for the future generation. Studies are being done upon population growth in order to reflect on economic growth, employment, savings and environment, conservation of assets, investments and environmental impacts [Richard and Robert, 1997]. Recent studies about population foster for solving problems that are presumed to be happening in future that will lead to some difficulties in resource allocation especially in developing countries [Britton; 2003]. In order to obtain good and reliable estimates we need to employ mathematical models for the sake of obtaining precise and accurate estimations of parameters and predictions as stated in [Banerjee 2014].

Rapid population growth directly influence the poverty in economy, policy, culture, education and environment this lead to unsuitable exploring and cost of natural resources. Kailali district is one of the most populated district of Sudur Pachchimanchal province of Nepal. Its population is growing as fast as the way technology grows. The population of the district is increasing day by day. This continuous increase has great impact to the national resources and demand especially land utility, settlements and basic needs. Kailali is one of the five districts of Seti zone of Nepal - is located in South Western Part of Terai in the Sudurpashchim Province of Nepal. It has 3,235 Sq. Km area and among which 40 per cent is covered by plain terai land 60 per cent is covered by hills of Chure range (Periodic District Development Plan (Fiscal Year 2072/073 – 2076/077))

According to census 2011, total population of the district is 775,709. It is 2.93 percent of the total population of Nepal at that time. Thus, approximately is 3 percent of the population reside in this district. In comparison of previous census, population is increased by 2.29 percent growth rate, which is increased total population of 159,012 compared to previous census 2001. (Population Situation Analysis of Nepal; UNFPA Nepal 2017)

According to Periodic District Development Plan of Kailali District of Fiscal Year 2072/073 – 2076/077, from 2001 to 2011 (2058 to 2068 BS), 39 percent of population is below 16 years of age, 56 percent people are of active age (16-60 years) and 5 percent old people. During these years, the population growth decreased from 3.89 to 1.86 percent. Although there

has been decrease in population, according to population monograph, Kailali district is one of the most populated district where the number of immigration is increasing. In the district, population density is more than average density of Nepal. Average density in Nepal is almost 180 whereas in Kailali district it's 240 person/sq.km.

Population is the vital element of the nation rendering. Its projection has become one of the most serious problems in the world countries because when not well addressed it significantly affects planning, decision making for the socio-economic and demographic development. Due to this reason, mathematical modeling of population is needed that estimate and predict the population growth and allocation of resources. We need to employ mathematical models for the sake of obtaining precise and accurate estimations of parameters and prediction of population growth (Giordano, Weir, Maurice & Fox 2003]. Therefore, in this study Exponential model and Logistic model were used to estimate the model parameters and predict the future population size of the Kailali District in Sudurpachimanchal province.

## 2. Material and Methods:

The study used previous data obtained from the National bureau of Statistics in Nepal from 2001 to 2011. The study simulated and used the real data to estimate and fit them in two models namely exponential and Logistic growth model. The results obtained in the previous step were used to predict the future population of the Kailali district and the Dhangadhi city. The experimental processes were done with software and results were presented in terms of numerals, tables and graphs.

### 2.1. Exponential Model.

Malthus (1798) proposed a mathematical model of population growth. The exponential model is the model that relies on the assumption that population grows at a constant rate proportional to the original population size. Ideal conditions like unlimited environment, adequate nutrition, absence of predators and immunity from diseases are excluded in the model and the model is expressed in simple differential equation as follows;

$$\frac{dP}{dt} = \beta P$$

Where P is the total population size and  $\beta$  is the constant growth rate defined as the difference between the birth rate and death rate for a certain population size. We determine the solution of the first order differential equation as shown here below

$$\frac{dP}{P} = \beta dt$$

Integrating

$$\int_{p_0}^{P(t)} \frac{dP}{P} = \int_{t_0}^t \beta dt$$

$$\ln P(t) - \ln P_0 = \beta(t - t_0)$$

$$\ln(P(t) - \ln(P_0)) = \beta t \text{ (When } t=0)$$

$$\ln \frac{P(t)}{P_0} = \beta t$$

$$P(t) = P_0 \exp(\beta t) = P_0 e^{\beta t} \quad (1)$$

$\beta$  can be estimated from equation (2)

$$\beta = \frac{\ln(P(t) - \ln(P_0))}{t} \quad (2)$$

In the equation (1),  $P(t) \rightarrow \infty$  as  $t \rightarrow \infty$

## 2.2. Logistic growth model:

A Belgium Mathematician Verhulst, described that the population growth does not depends on the population size but also on how far this size is from its upper boundary which known as carrying capacity. The change in population by the logistic model is given by

$$\frac{dP}{dt} = rP \left(1 - \frac{P}{K}\right)$$

Where  $K$  is the maximum sustainable population (carrying capacity) and  $r$  is the growth rate,  $r$  and  $r/K$  are vital constants. For small population  $P \ll K$  then  $\frac{P^2}{K} \rightarrow 0$  and the logistic model reduces to exponential growth signifying that as  $P$  is greater than  $K$ , then the rate of growth becomes negative and population decreases. We can find the solution of the non-linear differential equation as follows;

$$\frac{dP}{P \left(\frac{K-P}{K}\right)} = r dt$$

$$\frac{KdP}{p(K-p)} = rdt$$

On integrating,  $\int_{P_0}^{P(t)} \left[ \frac{1}{P} + \frac{1}{K-P} \right] dP = rdt$

It follows  $\frac{P(t)(K-P_0)}{P_0(K-P(t))} = e^{rt}$

Rearranging the terms, we get  $P(t) = \frac{K}{1 + \left(\frac{K}{P_0} - 1\right)e^{-rt}}$  (3)

Taking limit of equation (3) gives

$$P_{max} = \lim_{t \rightarrow \infty} P(t) = K \text{ (Carrying capacity)}$$

Determination of the parameters and K:

Let  $P_0$  be Population at  $t = t_0 = 0$ ,  $P_T$  is Population at  $t = T$  and  $P_{2T}$  is Population at  $t = 2T$ , Then,

$$\frac{1}{K}(1 - e^{-rT}) = \frac{1}{P_T} - \frac{e^{-rT}}{P_0} \quad (4)$$

$$\frac{1}{K}(1 - e^{-2rT}) = \frac{1}{P_{2T}} - \frac{e^{-2rT}}{P_0} \quad (5)$$

Dividing equation (4) by (5) and simplifying, we get  $e^{-rT} = \frac{P_0(P_{2T}-P_T)}{P_{2T}(P_T-P_0)}$

$$0 < \frac{P_0(P_{2T}-P_T)}{P_{2T}(P_T-P_0)} < 1 \text{ then } r = \frac{1}{T} \ln \left( \frac{P_0(P_{2T}-P_T)}{P_{2T}(P_T-P_0)} \right)$$

By direct substitution into equation in equation (4), we get

$$K = \frac{P_T(P_0P_T - 2P_0P_{2T} + P_T P_{2T})}{(P(t))^2 - P_0P_{2T}} \quad (6)$$

The nature of graph of exponential and logistic mode is as shown in the following figure.

In logistic model rate of population growth decreases when population reaches nearer to carrying capacity.



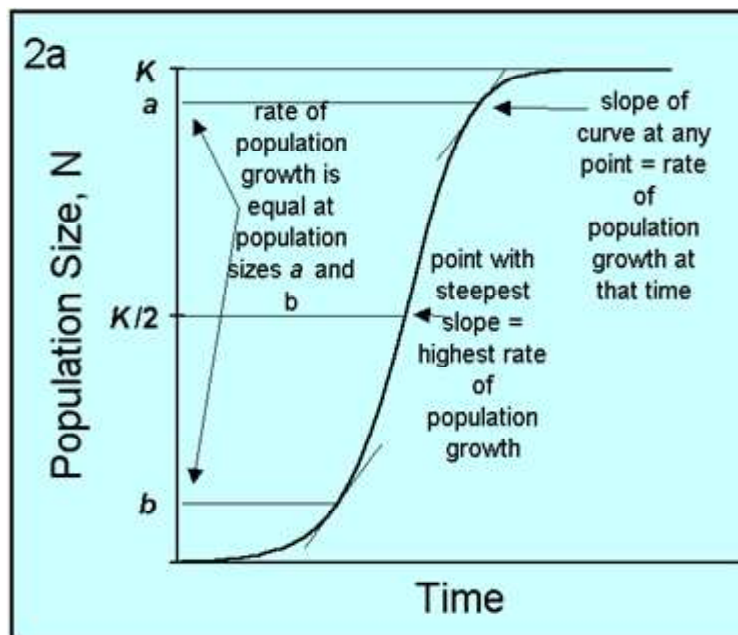


Figure 1

(Nature of population growth in Logistic Model)

The nature of population grow in logistic model as shown below. Due to different natural effects (like lack of resources like food, diseases etc) population growth is very slow or nearly constant when it value reaches to near to Carrying capacity  $K$ . Both exponential and logistic models originated from observations of biological re- production process. However, human population is believed to be dynamic, and then the growth rate cannot be constant as stipulated in the two models.

As per our study, we must show the implementation of this model based on constant growth rate and explain in mathematical terms however, the reality remains in controversy.

### 3. RESULTS:

Change in population, size and growth rate:

Gender	2001		2011		Growth Rate 2001-2011
	Population	Percent	Population	Percent	
Male	3,12,311	50.64	3,78,417	48.78	1.92
Female	3,04,386	49.36	3,97,292	51.22	2.66
Total	6,16,6977	100	7,75,709	100	2.29

Source: National Census,2001, 2002 (2057, 2058 B.S)

To estimate the population of Kailali District:

- (a) We need to determine the parameter (growth rate) using exponential growth model in equation (1). By using the actual population of  $(t_0, P_0) = (0, 616697)$  and  $(t_1, P_1) = (10, 775709)$  (Population of 2001 is 616697 (base year) and population of 2011 is 775709)

$$\beta = \frac{\ln(775,709) - \ln(616,697)}{10} = 0.0229 = 2.29\%$$

Hence, the general solution for exponential model is given by;  
 $P(t) = 6,16,697e^{0.0229t}$

$$P(T) = 6,16,697e^{0.0229 \times 20} = 6,16,697 \times 1.581 = 9,74,941.83, \text{ where } T=t=20$$

$$P(2T) = 6,16,697e^{0.0229 \times 40} = 6,16,697e^{0.0229 \times 40} = 15,41,294.33$$

- (b) By using equation (6) we estimate the Carrying Capacity of Kailali District.

$(P_0, P_T, P_{2T}) = (616697, 974942, 1541294)$  The better choice of  $P_T$ , and  $P_{2T}$  lead to better approximation of K.

$$K = \frac{P_T(P_0P_{2T} - 2P_0P_{2T} + P_TP_{2T}) - 9,74,942(6,16,697 \times 9,74,942 - 2 \times 6,16,697 \times (15,41,294) + 974,942 \times 15,41,294)}{(P(T))^2 - P_0P_{2T} \quad (9,74,942)^2 - 6,16,697 \times 15,41,294}$$

$$K = \frac{974942 \times 202892548879}{517446} = 9,74,942 \times 392103.81 = 3,82,27,84,74,255$$

$$= 382,278,474,255$$

$$P_{max} = \lim_{t \rightarrow \infty} P(t) = K = 382,278,474,255$$

Also, we can calculate r as

$$r = \frac{1}{T} \ln \left( \frac{P_0(P_{2T} - P_T)}{P_{2T}(P_T - P_0)} \right) = \frac{1}{20} \ln \left( \frac{616697(1541294 - 974942)}{1541294(974942 - 616697)} \right) = \frac{1}{20} \ln \left( \frac{890419196844}{552160869030} \right)$$

$$= \frac{1}{20} \ln(1.613) = 0.0239$$

Similarly, r can also be calculate

$$P(t) = \frac{K}{1 + \left( \frac{K}{P_0} - 1 \right) e^{-rt}}$$

$$7,75,709[1+(\frac{382,278,474,255}{6,16,697} - 1)e^{-rt}] = 382,278,474,255$$

$$7,75709[1+619879.5e^{-10r}] = 382,278,474,255$$

$$[1+619879.5e^{-10r}]=492811.70$$

$$619879.5e^{-10r}] = 492811.70e^{-10r} = 0.7950$$

$$r = 0.02294$$

The general solution for Logistic growth model with constant growth rate of

$r = 2.29\%$  is given by

$$P(t) = \frac{K}{1 + (\frac{K}{P_0} - 1)e^{-rt}}$$

$$P(t) = \frac{382,278,474,255}{1+619879.5e^{-0.0229t}} \quad (7)$$

a) Population of Kailali district using logistic model in 2021 will be

$$P(t) = \frac{382,278,474,255}{1+619879.5e^{-0.0229t}} = \frac{382278474255}{1+619879.5e^{-0.0229 \times 20}} = \frac{382278474255}{392104.213} = 9,74,941$$

b) Population of Kailalidistrict in 2031 will be

$$P(t) = \frac{382,278,474,255}{1+619879.5e^{-0.0229t}} = \frac{382,278,474,255}{1+619879.5e^{-0.0229 \times 30}} = 1225833.502$$

Using this equation (7), with the help of software, we can estimate population of the Kailali district from 2001 to 2040.

T	p(t)
1	630982.3289
2	645598.5165
3	660553.2754
4	675854.4485
5	691510.0599
6	707528.3201
7	723917.6293
8	740686.5826
9	757843.974
10	775398.8015
11	793360.2711
12	811737.8023
13	830541.0329
14	849779.8237

T	p(t)
15	869464.264
16	889604.6769
17	910211.6245
18	931295.9136
19	952868.6014
20	974941.0012
21	997524.6881
22	1020631.506
23	1044273.572
24	1068463.285
25	1093213.331
26	1118536.688
27	1144446.639
28	1170956.769

T	p(t)
29	1198080.982
30	1225833.502
31	1254228.883
32	1283282.017
33	1313008.139
34	1343422.839
35	1374542.067
36	1406382.142
37	1438959.762
38	1472292.011
39	1506396.37
40	1541290.723

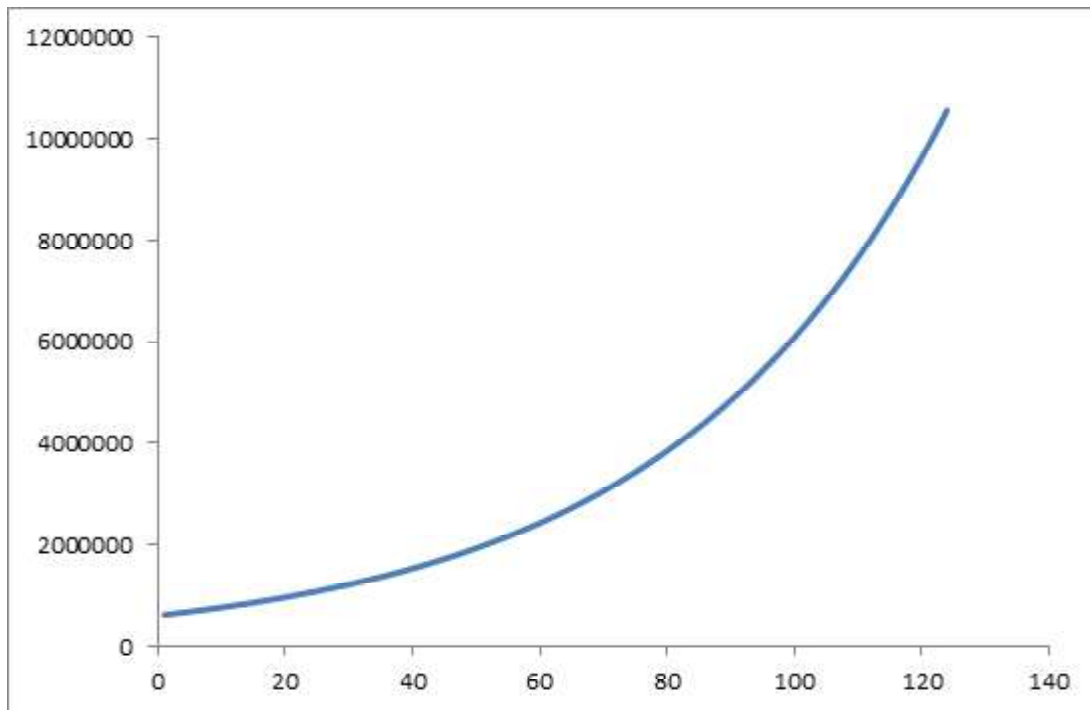


Figure 2 Population Estimation of Kailali District

- c) Population of Kailali district using exponential model in 2021 will be

$$P(T) = 6,16,697e^{0.0229 \times 20} = 6,16,697 \times 1.581 = 9,74,941.83$$

- d) Estimation of population of Dhangadhi Sub metropolitan city:

$$P(t) = 1,47,741e^{0.0229t} \quad (p_0 = 1,47,741 \text{ according to census 2011})$$

After five year population of Dhangadhi city will be

$$P(5) = P(t) = 1,47,741e^{0.0229 \times 5} = 1,79,210$$

And after 10 years it will be  $P(10) = P(T) = 1,47,741e^{0.0229 \times 10} = 2,08,906$

After 20 years the population of the city is

$$P(20) = P(20) = 1,47,741e^{0.0229 \times 20} = 2,33,565.077$$

$$\text{Carrying capacity of the city } K = \frac{P_T(P_0P_T - 2P_0P_{2T} + P_TP_{2T})}{(P(T))^2 - P_0P_{2T}}$$

$$= \frac{208906 (147741 \times 208906 - 2 \times 147741 \times 233565 + 208906 \times 233565)}{(208906)^2 - 147741 \times 233565.077} = 4,55,393$$

e) Estimation of population is also given by

$$P(t) = \frac{K}{1 + \left(\frac{K}{P_0} - 1\right)e^{-rt}} = \frac{4,55,393}{1 + \left(\frac{455393}{147741} - 1\right)e^{-rt}}$$

Population after 5 years will be

$$P(t) = \frac{455393}{1 + \left(\frac{455393}{147741} - 1\right)e^{-0.0229 \times 5}} = \frac{455393}{2.86} = 1,59,228$$

After 15 years it will be

$$P(15) = \frac{455393}{1 + \left(\frac{455393}{147741} - 1\right)e^{-0.0229 \times 15}} = \frac{455393}{2.47} = 1,84,370$$

which is the population at the end of 2025.

After 20 years it will be

$$P(20) = \frac{455393}{1 + \left(\frac{455393}{147741} - 1\right)e^{-0.0229 \times 20}} = \frac{455393}{2.317} = 1,96,544.$$

This is the population of Dhangadhi city at the end of 2030.

We summarize the whole population growth in the following two diagrams in figure 3

**Exponential versus logistic population growth**

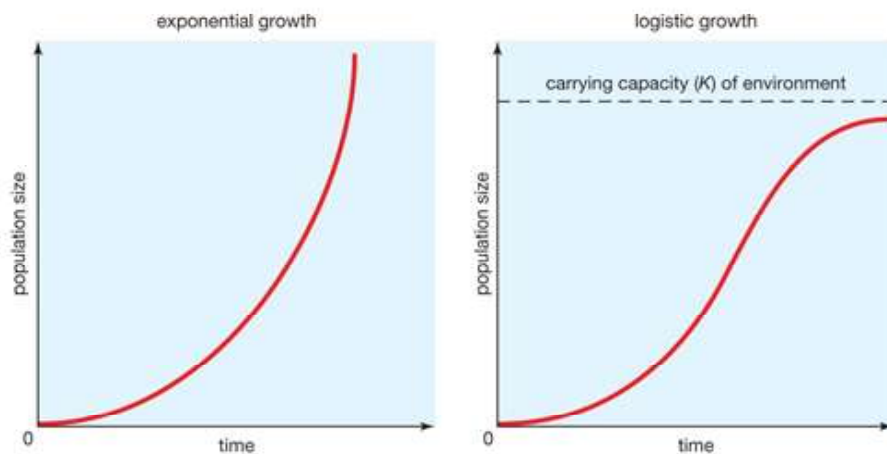


Figure 3

#### 4. DISCUSSION

It shows that Kailali district has a monotonic increase of population. The predicted population size by exponential and logistic model are very closer to each other. This indicates that the variation is very small. As time (t) increases the absolute error increases in Exponential growth model become more bigger which is not good in measurement and prediction. This model is not reliable when time (t) is large. Figure 3 shows that the Logistic growth model is more reliable and effective model in Human population estimation. Above figures shows the nature of population growth in two models. These models show the great deviation from the actual population which is due to low growth rate of the actual population. To determine what model is better and acceptable is not easy, but in this study we proposed and applied a logistic growth model which also is deterministic model by using same data to predict future population. Population of the district is estimate for next forty years. This study help us also to predict the next two census of 2021 and 2031. We can also predict the population of the city at any time period.

#### 5. CONCLUSION

We have discussed and implemented the procedures of estimating and predicting population growth of the Kailali district. We used Exponential and Logistic models to determine the parameters of the model that triggered the best prediction of the future population in more than 20 years. Finally, it was observed that the population parameters from the two models have a slightly significant difference that leads to a better selection of which model to use. We predicted the population size of Kailali for the next forty years and population of Dhangadhi city for two censuses of 2021 and 2031 was predicted. We conclude that a logistic model is the best fit for deterministic trend of the model leading a precise, plausible and accurate prediction.

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# A review on the impact of Great Lakes in Precipitation

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## Abstract

Great Lakes affect the precipitation pattern in the areas around. Taking the fact into consideration, the impacts of the lake on precipitation have drawn international attention both globally and in the Third Pole region. The characterization of lake effect precipitation is governed by the lake and surrounding temperature with a significant difference in temperature between air mass crossing over the Lake and lake water. Indeed, the lake effect precipitation consequences when the cold air traverses for an adequate distance over the Lake coupled with relatively warm water that picks up moisture and heat which precipitates out over the lake or along the downwind shore. Lake and land breezes and lake cooling and heating effects are responsible for lake effect on precipitation and other climatic variables which are influenced by multiple factors like size of the lake, fetch, topography, moisture, wind direction and time.

**Keywords:** Great Lakes, Lake effect precipitation, Lake-Land breeze, Lake cooling, and heating effect, the Third Pole region

## Precipitation

The Earth's surface is enclosed by 70.8% of water which consists of 97% seawater and 3% freshwater (Downing et al., 2006) while 5% of freshwater is accessible for

expedient purposes (Arya et al., 2011). Lakes harbor 90% of the earth's freshwater surface (Chidambaram et al., 2010). Due to its incredible size and adequate fetch, the large lakes produce a significant influence on the local and



regional precipitation patterns (Fig.1). Lake results in the three major climatic special effects i.e. by regulating the maximum and minimum temperatures of the region, augmenting cloud cover and precipitation over downwind of the lakes throughout winter period due to the existence of relatively large amount of heat and moisture, weakening of summer convective precipitation over the lakes owing to the larger atmospheric stability by the relatively cooler water (Scott and Huff, 1996). Topographical features nearby the lakes also transform the precipitation pattern and other climatic variables (Braham and Dungey, 1984; Scott and Huff, 1996; Laird et al., 2010; Laird et al., 2016).

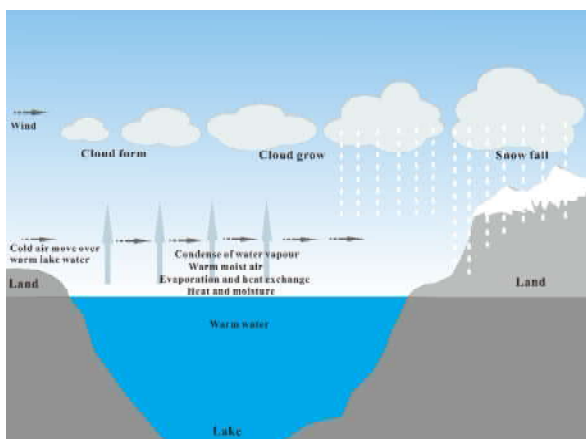


Figure.1 Lake effect on precipitation. The figure is modified and redraw from <https://blogs.nasa.gov/whatonearth/tag/clouds/>

Great lakes not only have a strong influence on ecosystem and livelihood supplying adequate water for agriculture and hydropower (Ferguson,

1985) but also, may have a substantial effect on local and regional climate, especially precipitation. Since the lake affects the precipitation pattern in the spatiotemporal scale, in the line and issue with the aforementioned background, the relevant literature is reviewed from the global and the Third Pole region for this study.

### Current research progress

Large numbers of published research works are accessible associated with lake effect precipitation in various parts of the world. The impact of the great lakes on regional climate and its hydrological assessment has been emerging as dominant research areas due to its large size with enough fetch, and multiple application of ecological and environmental interaction through different natural processes (geological, atmospheric and evapo-crystallizations) and anthropogenic activities. The two phenomena i.e. lake breeze and land breeze (Fig.2), and lake cooling and heating effect play a pivotal role in fluctuating the climatic variables (precipitation, temperature, and relative humidity, etc.) of surroundings. Moreover, the specific heat capacity and evaporation of water in great lakes could be the potential source that may alter the precipitation pattern influencing the ecosystem and environment around the lake basin. Hence, the major existing literature on lake effect precipitation in global and the Third Pole region are briefly discussed as follows.

## Overview from Global Level

Lakes are an interactive component of the climate system that strongly affects the climate in the surrounding area due to the differences in the specific heat capacities between the land surface and Lake Water. The impacts of large lakes on the local and regional climate were estimated by analyzing variables such as precipitation, air temperature, wind speed, etc. around lakes such as within an 80 km buffer zone (Scott and Huff 1996).

Various researchers documented the seasonal impacts of the lake on precipitation and the proliferation of snowfall in the downwind area during the colder periods. The advancement of lake-effect snowstorms and their characteristics have long been documented for the Great Lakes region in North America (Peace and Sykes, 1966; Dewey, 1975; Laird et al., 2001; Rodriguez et al., 2007). The research investigated by Scott and Huff (1996) in Lake Superior, established that the 52% of

the moisture evaporated from the lake, precipitates downwind areas during the winter period, triggering a significant increase in the lee-side snowfall. Moreover, the author perceived the effect of the lake increases thunderstorm activity in inland areas during the monsoon season. The majority of climatological modifications occur during short periods of intense positive surface heat fluxes (Laird and Kristovich, 2002), which often results in significant lake-effect snowstorms (Reinking et al., 1993).

Some of the preceding researches have also noted the major economic and social effects caused due to such storms (Schmidlin et al., 1992; Schmidlin, 1993; Schmidlin and Kosarik, 1999). Thus, the Lake effect snowstorms

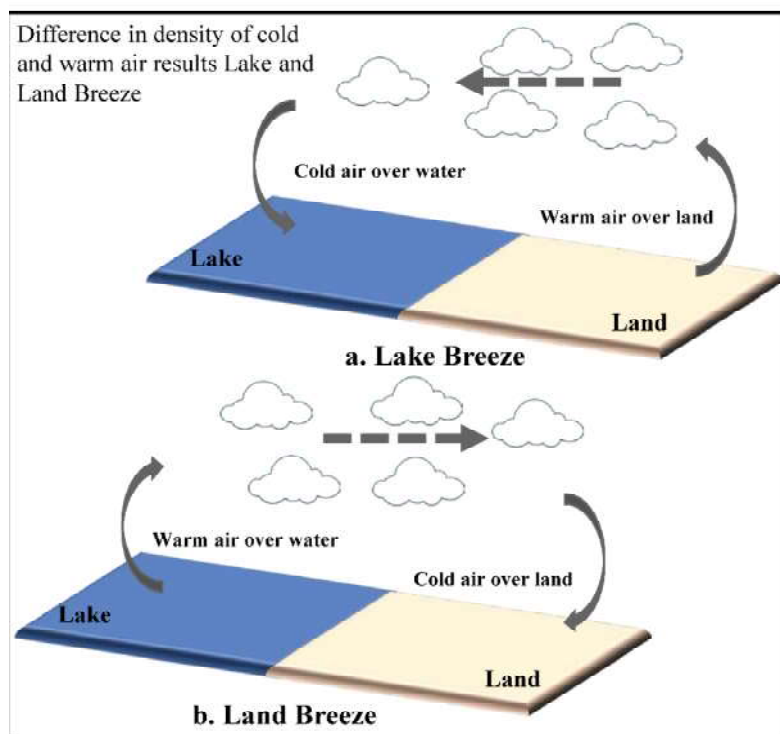


Fig .2 Phenomena of Lake Breeze and Land Breeze. The figure is modified and redraw from <https://www.islandnet.com/~see/weather/graphics/photos/landbrz.gif>

are important portions of the climate which have substantial economic and social influences on communities adjacent to the Great Lakes.

Miner and Fritsch (1997), hypothesized that the destabilization of the air mass overland upwind of the lake through afternoon heating by radiation may have a contribution to the development of lake effect precipitation. When air mass traverses over the lake, the relative warming surface of lake consequences the alteration in temperature very quickly and with more than half of the changes occurring within the first 10 minutes of air-lake interaction and within about 3 km of the windward coastline that produce very obvious lake effect on precipitation particularly, for the downstream area (Sousounis and Fritsch, 1994; Kristovich et al., 2000). A characteristic morning maximum and afternoon/evening minimum in lake effect precipitation frequency were detected, with the major differences at sites within the Snowbelt regions. Moreover, the hourly precipitation observations at a site 55 km east of Lake Michigan over a 20 year long term period was inspected by Ruhf and Cutrim (2003) and revealed that during the winter months, a peak in precipitation accumulated near 0600 eastern standard time (EST) and a secondary peak in the evening hours.

The relative importance of multiple factors recognized to result in lake effect precipitation was inspected to achieve insight into the physical mechanisms

controlling the diurnal evolution of lake effect precipitation (Kristovich and Spinar, 2005; Laird et al., 2009). The Lake effect events characteristically subsist with major differences between lake water and air temperature. The effect of lakes on precipitation conditions occur as a result of the phenomenon of lake-land breeze and lake cooling and heating effect. This course attributable to the difference in specific heat capacities of water and land and dissimilarities in the density of cold air and warm air. When the sun rises, the warm air above land blows towards lake establishing Lake Breezes yet when sunset, the warm air above the lake blows towards the land demonstrating the land breeze. The aforesaid, mechanism directly associated with horizontal temperature gradients and depth of the heated region (Moroz, 1967; Pielke, 1974). Over the lakes and their downwind shore region, the lake caused an average change in cloud, and precipitation amounts decrease by 5-15% in monsoon and increases by 5-45% during the winter period in comparison with upwind areas (Jr and Jones, 1972).

Considerable, climatic research has been accomplished in the region of the Great Lakes, specifically for Lake Michigan and Ontario focusing on short-range mesoscale forecasting and monitoring of wintertime variables over Lake Ontario (Reinking et al., 1993). The effect of Lake on temperature has been assessed by Kopec (1967), in Lake Superior and perceived the noticeable higher air temperatures along the northern shores in

winter and lower values in summer in contrast to areas away from the lake at the same latitude. Similar outcomes for winter, based on modeling efforts of cyclones over the Great Lakes were established by; Boudra (1981); Sousounis and Fritsch (1994). Sun et al (2015), executed a series of experiments to inspect the response of precipitation over the Lake Victoria Basin (abbreviated as LVB) to the variations of lake surface temperature (LST) using the Weather Research and Forecasting (WRF) Model and claimed that the LST distribution exerts significant influence on the observed rainfall pattern. Furthermore, the area and location of the rain band were relatively persistent under different LST forcing, signifying that the details of the rainfall pattern over LVB were not only strongly influenced by LST but also the broad rainfall pattern is likely controlled by the atmospheric circulation and orography in the region.

The frequency, timing, and environmental circumstances of lake effect precipitation observed for long term period (1996 to 2009) throughout wintertime over Lake Tahoe and Pyramid located in the northern California and western Nevada demonstrated the mean surface air temperatures below freezing, mean surface wind speeds of  $< 2.0 \text{ ms}^{-1}$  (notably weaker than during lake effect in other areas), a mean lake-air temperature difference of  $11.5^{\circ}\text{C}$ , and mean lake surface temperature difference of  $11.5^{\circ}\text{C}$  (Laird et al., 2016). Ekhtiari et al. (2017), explored the effects of the Lake Sobradinho, one of the giant reservoir in

Northeastern Brazil, on the local atmospheric and boundary-layer conditions and demonstrated that the lake affects the surface temperature of the air in the adjoining area as well as its humidity and wind patterns. Specifically, Lake Sobradinho cools down the air temperature during the day and warms up during the night by several degrees relying on the large-scale meteorological conditions. Lake Tanganyika, the African Great Lakes are characterized as the biggest reservoirs of freshwater (Semazzi, 2011) demonstrating the annual mean heat loss increase by 13% and 18%, respectively for latent and sensible heat fluxes, that consequences the unstable atmosphere affecting regional temperature (Verburg and Antenucci, 2010).

The research conducted by Huziy and Sushama, (2017) focused on the assessment of climate change effect on lakes and hydrology as well as, the influence of lakes on projected changes to regional climate and surface hydrology, particularly stream flows, for Northeast Canada. This revealed the effect of lakes and interflow on projected changes to the regional climate and hydrology for the study region using a single regional modeling system. The rise in water temperature produce more evaporation which leads stronger precipitation (Subin et al., 2012; Notaro et al., 2013; Bartùková et al., 2014; Li et al., 2015) and the property of lake as the energy sources or sinks rely on the relative temperature of the water and the overlying air. The effect of Lake Taihu, the third-largest freshwater lake in



China, on local summer precipitation is negative throughout daytime and positive in the night. The lake effect differs between areas and with the time of day and occurs primarily on the downwind shore. A composite analysis for a representative declined precipitation region articulates that during daytime in the summer, the combination of reduced air temperature and latent heat flux, along with intensified divergence and downdraft, acts together to stabilize the lower atmosphere and suppress thermal convective activities, ultimately resulting in less precipitation over this region (Gu et al., 2016).

Therefore, the preceding references elucidate that the lake effect is apparent in different regions in global but the exact nature and gradient of the effect vary significantly. Thus, the review of scientific papers focusing on lake effect climate from the global level delivers the broad ideas on the mechanism and impact of lake effect on the precipitation pattern in the spatiotemporal scale.

### Overview from the Third Pole region

The Third Pole region (Fig.3) is one of the distinct landscapes with Tibetan Plateau and adjoining mountains with the youngest, highest and largest geomorphological unit considered to play a dynamic role in the earth's aquatic and terrestrial ecosystem (Guan et al., 2013). The massively elevated Tibetan Plateau (hereafter TP) host different ecoregions influenced by Indian monsoon in summer and westerly in the dry period (Chen et al., 2009). It resides numerous lakes, rivers, marshes, and the reservoirs under the alpine climate with the pristine environment.

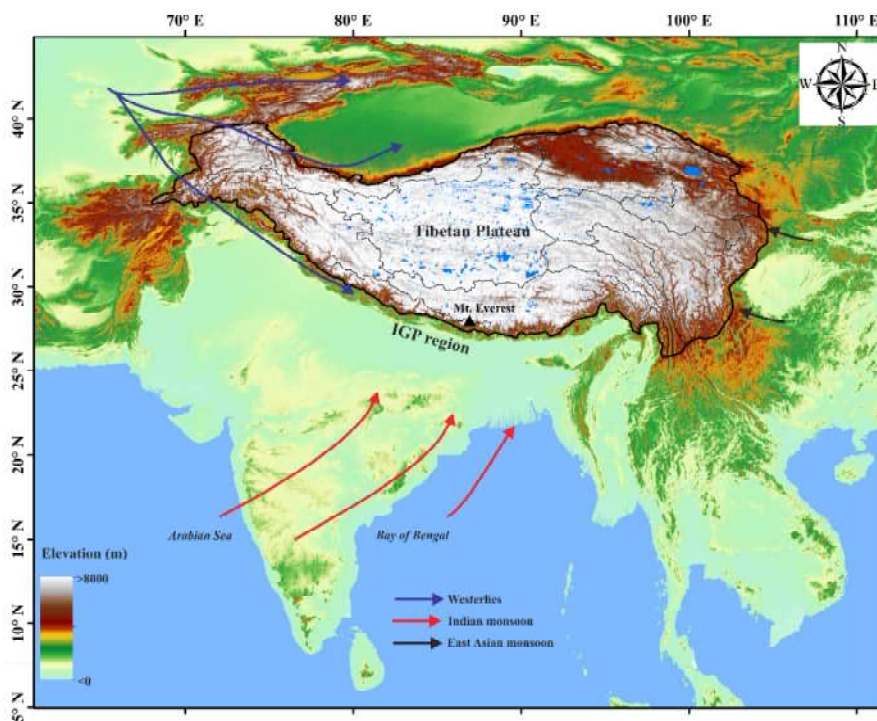


Fig.3. The Third Pole region and atmospheric circulation

It harbors more than 1200 lakes with a total area of more than 47,000 km<sup>2</sup> (Zhang et al., 2015) which may impact on precipitation due to the large size and enough fetch. TP is recognized as the water tower of Asia (Bandyopadhyay and Ghosh 1995; Liu et al., 2009; Dong et al., 2010; Yao et al., 2012) demonstrating the large number of biggest and deepest lakes that affect the regional precipitation pattern in spatiotemporal scale, for instance, the Nam Co Lake (Dai et al., 2016).

Lake evaporation is the major factor for precipitation and evaporation is maximum in winter. The spatiotemporal variability of lake effect on precipitation in the Nam Co basin was investigated by Dai et al. (2016) and revealed that lake cooling and heating effect in summer and winter respectively, were responsible for spatiotemporal differences of precipitation within the basin. It is essential to monitor the lake surface temperature for appropriate weather and climate forecast over TP. The study on Ngoring and Gyaring Lake by Wen et al (2014), using WRF-CLM model uncovered that lake mostly shrink the maximum temperature all year round and enhance the minimum temperature excluding March because of the high specific heat capacity that makes lakes to absorb or release more heat energy for the same temperature change compared to land that increases precipitation in the adjoining region. Lazhu et al (2016), simulated the lake temperature and evaporation by the Flake model and quantified the magnitude, decadal change

and contribution of the water balance changes in one of the largest lakes of Tibetan Plateau (Nam Co). The research entitled effect of lake surface temperature (LSTs) on the summer precipitation over the TP was investigated by Xiao (2016), using Weather Research and Forecasting model and argued that convective precipitation rise with an increase in lake surface temperature suggesting the effect of moisture produced from the lake.

As a consequence, aforesaid literature interprets that the study of lake effect on precipitation in the spatiotemporal scale in the great lakes of TPR is significant and essential for future perspectives as TP is harbor numerous biggest lakes.

## Conclusions

Average spatial and temporal distributions of precipitation over the large Lakes investigated the seasonal and temporal estimates of lake-induced changes in precipitation and other climatic variables. Lake effects are most noticeable in precipitation and vary considerably in both temporal and spatial scale influencing precipitation in higher amount during late autumn and winter when there is a significant temperature difference between lake water and air mass moving over it (water typically much warmer than the air flowing over the lakes). The characteristics of lake effect precipitation patterns are determined by different climatic conditions and phenomenon and thus the spatiotemporal

variation in the pattern may vary greatly. In addition, the direction of a wind, the temperature of the water and surrounding environments also play a vibrant role for the aforementioned mechanism.

The lake effect precipitation pattern has been noted from worldwide in different lakes, primarily due to the large size and enough fetch which let the wind pass and coupled over the lake for a longer period resulting in substantial lake effect. Especially, the Lake Breeze, Land Breeze, Lake cooling, and heating effects are fundamental tools and important components for lake effect climates which assist to balance the regional environments providing suitable ecological conditions near and around lakes. The Tibetan Plateau harbors the biggest lake in Asia that plays a significant role in precipitation patterns. Despite the great concern and significance of great lakes, the review of the literature revealed that the large size of the lake and enough fetch affect the precipitation pattern.

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# Impact of Invasive Alien Plant Species in Ecosystem and Peoples' Livelihood in Kailali, Nepal

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## ABSTRACT

The present study was carried out in the Dewariya village (Jokhar Taal area) of Dhangadhi Sub-Metropolitan city, Kailali district, Nepal. This study has documented impacts of invasive alien species on ecosystem and livelihood of community people. A total 17 IAPs were reported from the Jokhar Tal area. The most of the species were from the family Asteraceae. Local people of the village have perceived the negative impacts of IAPs on water and forest ecosystems and the peoples' livelihood. The people have noticed that the IAPs are replacing local native species, altering soil and water quality, reducing crop yield and affecting their livelihood. Rapidly increasing population, urbanization, transportation, and other disturbances are the contributing factors promoting invasion in the study area. Two of the species *E. crassipes* and *P. stratiotes* were found highly problematic to the Jokhar Taal. Hence, these invasive species should be controlled and managed in time for conservation of local native species and Jokhar Taal diversity.

**Keywords:** Invasive plants, weeds, Jokhar Taal, invasion, native species

## INTRODUCTION

Any species, native to one area or region, that have been introduced into an area outside their normal distribution, either by accident or on purpose, and which have colonized or invaded their new home, threatening biological diversity, ecosystems and habitats, and human well-being are considered as the invasive alien plant species (IAPs) and the process is biological invasion (Tiwari et al. 2005; Gaertner et al. 2009). The IAPs display strong vegetative growth, abundant seed production capacity, high seed germination rate, long-lived seeds, rapid maturation of a sexually reproductive stage and high ability to establish over large areas, phenotypic plasticity, and ability to survive on various food types and in a wide range of environmental conditions (Tiwari et al. 2005).

Humans are a major vector for introducing the IAPs from one part of the world to another in an attempt to satisfy various social, economic and cultural needs. The IAPs include herbs, shrubs, trees and vines that grow rapidly, form dense thickets and negatively impact native species and natural communities (Tiwari et al. 2005). Most commonly the IAPs are found along the road sides and disturbed areas (Kohli et al. 2009). Human movement and global trade have increased the intensity of biological invasion worldwide.

The problem of invasive species is prevalent both in developed as well as developing countries, but their impact is likely to be higher in developing countries like Nepal due to lack of expertise and limited resources available for their management (Shrestha 2016). With the widest elevation gradient and heterogeneous geomorphology of Nepal, organisms from anywhere of the world may find suitable habitat and climatic condition in Nepal. IUCN-Nepal during 2002- 2003 reported 21 alien species of flowering plant in Nepal (Tiwari et al. 2005) and later on additional four species are also included in the list (Shrestha 2016). Far west region of Nepal is also highly impacted by various invasive alien species but the studies on their diversity, distribution and impacts are very limited. This study has documented impacts of IAPS on ecosystem and livelihood of community people in Dhangadhi Municipality of Kailali district, Nepal.

## **MATERIALS AND METHODS**

### **Study Area**

The study was conducted in Dewariya village of Kailali district which is situated in Province 7 of Nepal. Kailali district is roughly rectangular in shape and spread latitude from 28° 22' N to 29° 5' N, and longitude from 80° 30' E to 81° 18' E covering an area of 3235 sq. km. It receives rainfall varying between 17-75mm precipitation falls annually. The temperature ranges from 5 to 43°C. Based on topography, 59.7% and 40.3% of area of the district lies in Terai and Chure hill respectively. Based on land use pattern, forest and shrub area covers 66.76%, agriculture and covers 27.815 and remaining 5.43 areas is covered by others.

Dewariya village lies to eastern side of Dhangadhi Sub-Metropolitan City and near the Dewariya village there is a Jakhori Tal which is a beautiful area for picnic spot also. The village is about 5 km far from the main city Dhangadhi. The Jakhori Tal lies in Dewariya Botanical garden with the total area of 149.50 ha. Elevation of the area is 183 m from sea level. This area is rich in biodiversity especially for medicinal plant but invasion of alien species has created serious problems around the Jakhori Tal. Since it is one of the important wetlands it provides lots of credit in the presence of many

medicinal as well valuable plant species. Different ethnic groups live in this area like Tharu, Brahmin, and Chhetri.

### Method of Data Collection

The survey was carried out during 2018 to 2019. During the visits, the natural growth form of IAPs were observed and recorded. Plant samples were collected for herbarium and identification. The plants were identified with the help of different published and authentic literatures (Hara and William 1979, Hara et al., 1982, 1978).

A comprehensive survey was conducted in Jakhor Taal area for the study of ecological and socio-economic impact of invasive alien plant species. The local resident population of Dewariya village was interviewed using a set of questionnaire about the present status of IAPs in the locality and their impact on biodiversity and livelihood. A total 15 individuals were selected for interview. Judgmental sampling method was applied for selection of interviewee. Supplementary information was sought from forest management officers and the local people of that area. Focus group discussions were also conducted in the village to verify the information gathered from interview. The group included 8 persons represented from school teachers, elder persons, and community leaders.

## RESULTS

### IAPs in the Jokhar Tal Area

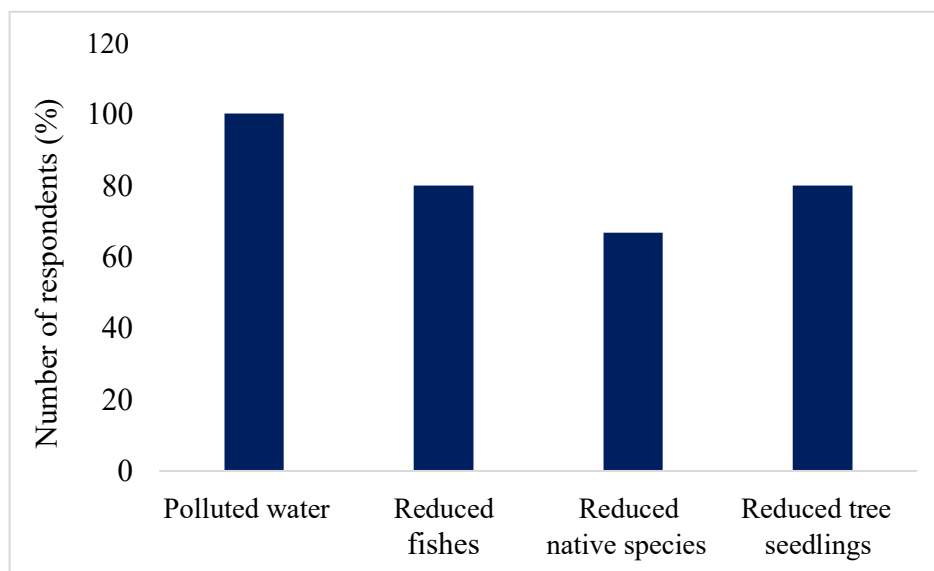
A total 17 species of IAPs were found in Jokhar Tal area. The species belonging to Asteraceae family were *Ageratum houstonianum*, *A. conyzoides*, *Bidens pilosa*, *Xanthium stramonium*, *Parthenium hysterophorus*, and *A. adenophora*. Two species (*Alternanthera philoxeroides* and *Amaranthus spinosus*) were from family Amaranthaceae. Other species were *Pistia stratiotes* (Araceae), *Senna tora* (Fabaceae), *Ipomoea carnea* (Convolvulaceae), *Hyptis suaveolens* (Lamiaceae), *Mimosa pudica* (Mimosaceae), *Oxalis latifolia* (Oxalidaceae), *Argemone mexicana* (Papaveraceae), *Eichhornia crassipes* (Pontederiaceae) and *Lantana camara* (Verbenaceae). The species *E. crassipes* and *P. stratiotes* were aquatic species found in the water body.

### Ecological Impacts

According to the local people, the IAPs are responsible to disrupt the ecology of a natural ecosystem. They have been displacing the native plant and animal species as well as degrading the landscapes and diverse biological resources. IAPs are reducing the amount of space, water, sunlight and nutrients in soil. Local people also perceived that the hydrology of Jokhar Tal has been altered. The water is turbid and unfit for use

due to invasion of *E. crassipes* and *P. stratiotes*. These floating type of aquatic IAPs have formed thick and extensive mats on the Jokhar Tal and blocking both sunlight and air for flora and fauna. They have also disturbed flow of water supply. Native species seedlings regeneration and herbaceous native species have been decreased in the locality after invasion of *A. houstonianum*, *A. conyzoides*, *B. pilosa*, *X. stramonium*, *P. hystrophorus*, and *A. adenophora*.

Among the 15 respondents, 100% respondents told that the invasive species has polluted water in the Jokhar Taal, 80% told that the aquatic species have reduced fishes, 64% said that native species have been reduced and 80% perceived that the tree seedlings are also reduced by invasion (Fig.1).

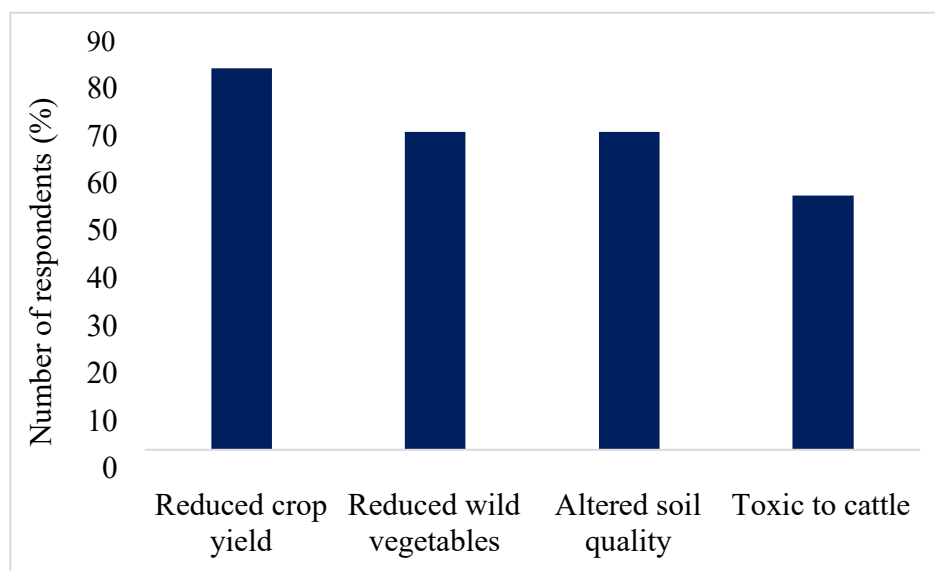


**Fig. 1** Perception of respondents about impact of IAPs on ecosystem

### Impacts on Livelihood

According to the local people, *A. mexicana* is a worst species as it has spines on leaves and it pricks on hands or legs. Another noxious weeds are *A. houstonianum*, *A. conyzoides*, *B. pilosa*, *X. stramonium*, *P. hystrophorus*, and *A. adenophora* which have covered the Jokhar Tal area and replacing useful wild herbs and vegetables. The fishes in the lake are harmed by *E. crassipes* and *P. stratiotes*. According to the local people, *I. carnea*, *X. strumarium*, *A. houstonianum*, *L. camera*, etc. are toxic to domestic cattle. *L. camara* has been causing food- web level impacts and decrease habitat suitability for wildlife.

In agro-ecosystems, farmers have experienced remarkable loss in yields and quality of crop due to the invasion. Agricultural crops particularly wheat, rice, mustards and vegetables were outcompeted by *A. conyzoides* and their productivity has been declined. *A. maxicana* has been affecting on germination and seedling of crops. *B. pilosa*, *C. occidentalis*, *P. hystrophorus* are responsible to reduces soil fertility. *X. strumarium* is also common in wheat field being a problematic weed. According to 80% respondents the invasive species have reduced crop yield, 67% respondents said that the IAPs have reduced wild vegetables and altered soil quality and reduced soil fertility. About 53% of respondents perceived the toxicity of invasive species such as *I. carnea*, *X. strumarium*, *A. houstonianum*, *L. camera* to their cattle (Fig. 2).



**Fig. 2** Perception of respondents about impact of IAPs on livelihood

## DISCUSSION

Present project work attempts to examine the impacts of IAPs in Jakhar Taal area of Kailali district. A total 17 species of IAPs found in Jokhar Tal area have negative impacts according to the local people rather than positive impacts. They have impacted in water ecosystem, forest, soil, native species, agriculture and livelihood of community people. Most commonly the species such as *A. houstonianum*, *A. conyzoides*, *B. pilosa*, *X. stramonium*, *P. hystrophorus*, and *A. adenophora* were dominant in the Jokhar Tal area. Other species were *A. philoxeroides*, *A. spinosus*, *P. stratiotes*, *S. tora*, *I. carnea*, *H. suaveolens*, *M. pudica*, *O. latifolia*, *A. mexicana*, *E. crassipes* and *L. camara* were also found problematic according to the local respondents. *A. houstonianum*, *A. conyzoides*, *B. pilosa*, *X. stramonium*, *P. hystrophorus*, and *A. adenophora* have allopathic effect on

neighboring flora by which they are capable to replace most of the associated native herbaceous species (Bhowmik et al. 2007, Thapa et al. 2020). In Jakhor Taal area these species were also found highly problematic including forest near the Taal and agricultural lands. Their allelopathic effect might have impacted the native species in the areas and crop plants in the agricultural fields. Most of the local respondents agreed this fact of suppression of the growth of all native plants species by alien plant invasion around the lake area.

The anthropogenic disturbance was also found near settlement and Jokhar Tal area. The disturbance might have obviously increased the level of invasion around the lake area. Human movements, cattle grazing, stumping of tree, movement of vehicles, garbage waste, etc. might have enhancing the diversity and dominance of IAPs. Animal movement, transportation and human activities are responsible in arrival and distribution of IAPs in the Joker Tal area. The moist land around the Taal area with open canopy might have created the best habitat for the growth, reproduction and rapid colonization of IAPs. Therefore, it is urgent to control and manage IAPs in the study area.

## CONCLUSION

A total 17 species of IAPs were reported from the Jokhar Tal area. The most of the species belongs to family Asteraceae. The local people have perceived the negative impacts of IAPs on water and forest ecosystems and the livelihood of community people in the study area. The people have reported that the IAPs are replacing native species, altering soil and water quality, reducing crop yield and affecting their livelihood. Rapidly increasing population, urbanization, transportation, and other disturbances are considered as the factors promoting invasion in the study area. Two species *E. crassipes* and *P. stratiotes* are highly problematic to the Jokhar Taal. Hence, these invasive species should be controlled and managed in time for conservation of local native species and Jokhar Taal diversity.

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## SECTION - B SOCIAL SCIENCE





# Issues of Internal and International Migration in Sudurpachim Pradesh

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## Abstract

Internal migration in Sudurpachim province is permanent whereas the international migration to India and other countries is seasonal. Basically, internal migration is the vertical migration from hilly regions to terai regions. Those who have economically poor select their working destination in India. It is because of easy access for entry and exit, identified land, similarities in language, climate and geographically. This article has qualitative analysis of Internal and International migration from and in Sudurpachim Pradesh. Basically, Secondary data are analyzed to understand the scenario of Internal and International migration. The flow of migration from rural hilly region to terai or town areas is rapidly increased. Due to this, hilly or rural areas has brain drain and active population is going to reduce continuously. Its effect has seen on unbalanced urbanization in terai region and low production on agricultural sector in hilly region. This article shows the trend of migration and it will support to formation of the migration policy in the province.

**KEY WORDS:** Internal and International Migration, Sudurpachim Pradesh, Seasonal Migration, Permanent Migration, Brain Drain, Migration Policy

## Background

Migration is the movement of people from one place to another. In general, if people leave their origin, birthplace or leaving place and go to new destination for any purpose is called migration. Mostly, people leave their origin for their livelihood. For getting food, shelter or searching better opportunities, people moved from one place to another

place for the period is called seasonal or temporary migrants and if they started to live long for same destination is called permanent migrants. People are mostly migrated to India as a seasonal labour migration from mid and far-western province (Bhatt, 2016). Similarly, rural or hilly people migrate to terai areas of the province. There are no alternative jobs in rural and hill areas and so people choose India migration.

"Some people (resourceful) migrate towards Gulf Countries, Malaysia and other third countries but having low status people are chooses their destination to India (Bhatt, 2019)". Due to absence of young people in village, development activities of local level is affected and mostly, its effect seen on agricultural production sector too. Hundreds of far western people having weak and poor family backgrounds move to India for their survival and searching job opportunities. Migrants are found as illiterate and have weak socio- economic status. Migrant workers in their destination feel harassment because of their lack of education. Due to low educational status, most of the migrants get only labour work (Bhatt, 2015). Their income from labour work is low and they can just run their livelihood. The utilization of remittance is unproductive sector. Rural people have been migrating to India for work since the generations. There is not formal data for India migration but it is imagined that about 35-40 Lakh Nepalis are staying in India. Beside this, Nepalis are migrating to India for the purpose of religious, business, entertainment, recreation, education and health treatments. Push factors from origin and pull factors in destination are equally responsible for rapid migration in the Sudurpachim Pradesh.

### **Internal Migration in Sudurpachim Pradesh**

In terai of Sudurpachim Pradesh, Kailali and Kanchanpur are the potential destinations for internal migration from hilly areas of the region. In earlier days, there was lack of food in hilly areas due to over population, so they used to choose terai for agricultural and livestock purpose. At that time, there was fear of malaria in terai and people used to migrate unwillingly but their poverty was the main push factor from hilly region. Nowadays, the trend of migration is found changed. In terai region, there is the access on facilities (agriculture, education, health, physical infrastructure, transportation, market, employment, security, entertainment and etc) and growing development activities, so people are lured to migrate in the region. Terai region become pull factor for the migration. The social relationship and political awareness is developed in this region in comparison to hilly region. The people who are educated in hilly region, they come to terai for searching better opportunities and those having economically sound choose town area or terai region for their better settlements (house construction/Gareedi) and trade, business, market or other better opportunities. If we analyze the CBS figure of last four decade, It is calculated that the the population is

reduced in hilly region and rapidly increased in terai districts. The CBS data is as follows:

Table-1: Population of districts in Far-western region (Sudurpachim province) of Nepal

Year	1981		1991		2001		2011	
Districts	Pop.	HHs.	Pop.	HHs.	Pop.	HHs.	Pop.	HHs.
Bajhang	124010	21513	139092	25090	167026	28588	195159	33786
Bajura	74649	12693	92010	17542	108781	20378	134912	24908
Doti	153132	28170	167168	31557	207066	36465	211746	41440
Accham	185212	33441	198188	38934	231285	44005	257477	48351
Darchula	90218	13436	101683	17617	121996	21029	133274	24618
Baitadi	179136	26655	200716	35300	234418	40387	250898	45191
Dadeldhura	86853	14683	104647	18501	126162	21980	142094	27045
Kanchanpur	168971	26365	257906	40056	377899	60158	451248	82152
Kailali	257905	35241	417891	60928	616697	94430	775709	142480
<b>Total</b>	<b>1320086</b>		<b>1679301</b>		<b>2191330</b>		<b>2552517</b>	

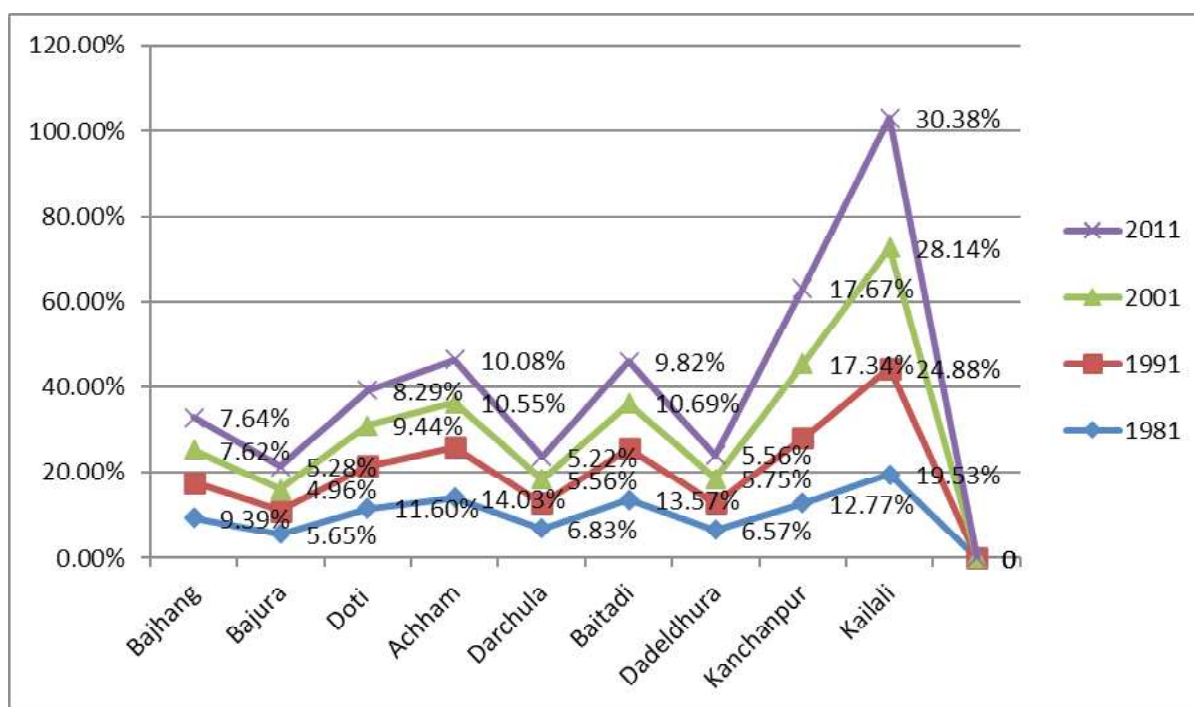
Source: CBS, 2014

By reviewing the above CBS (2014) figure, the population in terai districts is much increased in comparison to hilly districts. As compared to total population of Sudurpachim province (then far-western region), the population of Bajhang district was 9.39%, 8.28%, 7.62% and 7.64% in 1981, 1991, 2001 and 2011 census of Nepal respectively. Similarly, the population of Baitadi was 13.57%, 11.95%, 10.69% and 9.82% in each census. Though the population in each hilly district is gradually increased with population growth, it is analyzed that the total percentage of population in comparison to province is going to decrease in each census reports. The population of Kanchanpur (terai district) was noted as 12.77%, 15.35%, 17.34% and 17.67% in each census. While it is noted as 19.53%, 24.88%, 28.14% and 30.38% in Kailali district in 1981, 1991, 2001 and 2011 census respectively.

From above data, it is analyzed that the population growth is increased in terai region. The population growth in each hilly district is gradually increased but the percent of population in the region is decreased which means absentee population was migrated to terai region or other places. On the other side, the total percentage of population is increased in terai region which shows the population from hilly regions could be

migrating towards it. The analysis of vertical migration is shown clearly in figure below. The graph shows the trend of migration is increased in terai region in each census.

Figure: Trend of Vertical Migration (Hilly region to terai region) with census



The fertile and productive land of plain region having rapid economic growth is the main pull factor for vertical migration. The rapid migration towards plain region is either by the pull factor of terai or push factors (geographical constraints, low production in agriculture, weak physical infrastructures, lack of drinking water and irrigation, lack of quality education and health, unemployment, poverty, lack of access on goods and service, lack of market linkage, lack of skilled human resources and etc) of hilly or rural areas. Similarly, the distribution of the national or regional budget is increased in terai region due to high population. Political representatives in government and administration of the terai region is higher than hilly region because of high population. Due to the reason, terai is developing fast than hilly or mountain regions, as a result people from the hilly regions are getting attracted towards it. It has adverse effect in population of hilly region. If this rapid migration is not stopped in time, it could be the cause of harsh population decrease in hilly region within two decades in future.

The impact of rapid migration in destination is not found positive however, the living standard of the people in terai is getting higher and are enjoying more in comparison to hilly people. It has created the environmental degradation in terai region. Due to rapid migration, the natural resources are getting depleted (i.e. deforestation, fragmentation of land, water pollution etc.) and increasing the unbalanced and unmanaged urbanization. Furthermore, it creates social crimes (theft, robbery, prostitution, trafficking, rape, etc), conflict (resource, regional, political, social, religious, economical etc.), discrimination (caste, gender, class, etc), decreased the 'We feeling' sentiments, social unity and brotherhood, unhealthy competition, separation of family (joint to separation) and many more negative impacts.

Similarly, the impact of regular flow of migration in hilly region is not found satisfactory. Flow of migration reduces the population in hilly region, which brings to effect on agriculture too (low production, barren land, increased wild animal and disturbed on agriculture practices, disturbance of ecosystem). It causes the scarcity of labour workers for community development activities. People are feeling loneliness and insecure due to low population. The number of people can be counted in figures in rural villages. Schools are getting merged due to drop in student number. Ultimately, flow of migration in hilly region get effect on overall development process.

For mitigating the rapid migration, government should make the concrete policy. Government should allocate sufficient budget for building physical infrastructure and other needful development activities. Plans should be made in such a strategic way by establishing the pull factors in hilly region which will control the flow of migration and will attract the people towards their origin back.

### **India Migration as an International Migration**

Few people having access on opportunities and economic rich from Sudurpachim province select their working destination to Gulf countries, Malaysia or other countries but those having poor and rural background select their destination to India (Bhatt, 2018). Though there is not formal data for India migration, the population of India migration is imagined about 35-40 Lakhs where at least 6-7 lakhs people from Sudurpachim province are working into different cities of India. From rural areas of Sudurpachim province, about 80% of total population is migrated to India for work (Bhatt, 2018). The cause of selection of India as their destination is because of having social relationship and networking, easy entry -exit, open border, less tiresome (No visa, No passport, No health certificate) and low cost (investment) on migration process.

## Causes of India Migration

Mainly, there are two causal factors to raise the India migration for searching opportunities (Bhatt, 2017).

**1. Push factors at origin:** There are lots of factors which support to push people from rural areas.

- 1.1. Rural poverty and starvation: There is lack of food in rural areas, low production in agriculture, lack of irrigation, modern technology and skilled human resources, unproductive, small land size, lack of hybrid seed and fertilizer, lack of market linkage etc.
- 1.2. No opportunities at origin, Lack of access on physical infrastructure and development activities
- 1.3. Unemployment at origin and searching better opportunities
- 1.4. Political and social conflict
- 1.5. Natural disaster

**2. Pull Factors in India**

- 2.1. Open border
- 2.2. Low transportation cost reach at destination
- 2.3. Any time job facility
- 2.4. Comparatively short distance than other destinations
- 2.5. Any time can return or quit job (In case of emergency)
- 2.6. Easy access (Exit-Entry, no passport and visa, no certificate of health and others)
- 2.7. Strong/ traditional networking and linkage
- 2.8. Easy and understandable language
- 2.9. If needed, can change nature of job and destination
- 2.10. Similar geographic model and climate
- 2.11. Cultural and religious similarities

## Issues (problems) of India migration

1. There is not formal or authentic data of Nepalis migrants to India;
2. No pre identification of the nature of jobs and proper destination;
3. Lack of skilled manpower and knowledge ;



4. Open border;
5. Chances of being robbed/looted/cheated at transits, border areas and destinations;
6. Missing case;
7. Migrants do change their destination and jobs and as a result, there is no job permanency;
8. No aware on health (HIV/ AIDS);
9. Remittance collected and carry by hands;
10. Migrants use to carry luggage (mobile, TV, luxury materials) or they spent money at destination rather than saving;
11. Utilization of remittance (buying land, house construction and other unproductive sectors) rather to use remittance on income generating or productive sectors;
12. In case of robbery in destination (working station), police unnecessary give trouhere to Nepalese migrants;
13. In case of any police case, it is difficult to register the cases;
14. Border security or the police do unnecessary troucher by asking bill of the materials (in case of luggages);

**Positive Impact of India migration**

1. Improvement of livelihood
2. Quality education of children
3. Access on health facility
4. Enterprenuership and business development
5. Awareness Increases
6. Market linkage and networking

**Negative Impact of India migration**

1. Reducing population in rural areas and hilly region;
2. Lack of skilled human resources (Brain Drain);
3. Remittance increases the trend of buying land in terai for construction of house, then their families migrate to terai or town region, which ultimetly increase migration;



4. Loss of social norms, cultures and values
5. Increases social crimes: theft, rape, murder and violation,
6. Low production in rural areas or barren land
7. Lack of skilled manpower and physical infrastructure and development activities
8. Missing, death and accident, wounded
9. Chances of HIV/AIDS and other diseases

### **Conclusion**

The migration of Sudurpachim province is typical where internal migration within the province is vertical and permanent migration i.e. hilly districts to terai districts and international migration towards India or other countries is seasonal migration. Mostly people having economically sound choose their working destination to abroad whereas those who are economically poor select their destination to India. Seasonal migration to India is arisen due to unemployment or lack of opportunities in rural areas or districts. Internal migration should be managed with the effective plan of settlement area and agricultural area. Government policy should be centered to develop the hilly areas so that people from the areas couldn't choose their new destination and those who already migrated, can back to their origin.

### **Recommendation for safe and prestigious migration**

1. For managing internal migration, government should make the clear policy. Local government should prepare the plan to control the land fragmentation in terai region. Similarly, they should make policy by identifying the agricultural land and land to settlement (management of urbanization) for safer migration;
2. Rural areas should be made potential for the developmental activities. Push factors should be reduced by introducing the pull factors at origin;
3. There should be kept the clear data for migrants towards India. The system of giving recommendation to migrants should be created by respective rural/municipalities office so that it will support to open the bank account in India and utilization for safer and easy transportation. With the help of that account, they will send their remittance safely to their families;
4. Government of other development agencies should support (fund, materials, skill enhancement for entrepreneurship, trainings for income generation, soft

loan etc.) the migrants who sent the remittance through bank account. It has two benefits: utilization of remittance in the productive or income generating sectors which creates employment and reduce further migration, and the practice of sending the remittance through bank increases which helps to calculate the total remittance collected from India;

5. Government should utilize the skill and knowledge of labours what they had learned in India;
6. There should be health and life Insurance
7. Though India migration is not kept in foreign employment categories, but the system should be kept like them(foreign employee);
8. Human Right Commission should also play active role to search missing, wounded, death, cheated, misleded or other cases;

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## DROPOUT: RATE AND TREND IN AMC



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### **Abstract**

*This article tries to examine the dropout rate: gender wise and caste wise as well as its trend in Aishwarya Multiple Campus. The three academic years of B.B.S. and B.Sc. were selected to study as samples. Magnitude of dropout rate of the boys is higher than that of the girls. Regarding caste, it is higher in Rana, Muslim, Madhesi and Dalit despite their low enrollment in the campus. Regarding Brahmins and Chhetris, former's dropout rate is decreasing whereas latter's rate is increasing on average. The dropout trend is decreasing in B.Sc. but increasing in B.B.S. on average.*

**Key words:** Dropout, dropout rate, dropout trend, gender, caste

### **Introduction**

Aishwarya Multiple campus, established in 2063 B.S., is a T.U. affiliated public campus situated in Dhangadhi, Kailali. It has been running the two programs: B.Sc. under the Institute of Science and Technology, and B.B.S., under the faculty of management. The campus has launched the former program in 2063 B.S. and the latter in 2064 B.S. In this campus, total enrolled students do not complete their graduation. There is a variation between the total number of students enrolled and the total number of students who fill up exam form in their final year. Generally, the students number decreases. So, objective of this study is to examine dropout rate and its trend in this campus.

Dropout means leaving high school, college, university or another group for practical reasons, necessities, disillusionment with the system from which the individual in question leaves. 'Someone who leaves school without finishing their course of study is a dropout' (GAO, 2002). The effect of 'dropout is not limited to the individual but society and nation as well' (Education Quarterly, 2011, P.56). In any educational program dropout is perhaps the most critical form of educational wastage, it represents

a staggering loss (UNESCO, 1984). Dropout is one of the factors that determine quality of education. The education process 'which expedite the transformation of the inputs into outcome are also inseparable in the quality, which include the teaching learning process, continuing education of teacher, leadership and co-curricular activities' (Education Quarterly, 2011, P. 37).

Dropout rate is 'the percentage of the students enrolled in given grade in an academic year who are not enrolled in any grade during the following school year' (DOE, 2008). Even in higher education there is problem of dropout. In this campus too, the students number decreases in their final year. This study basically focuses on the students of the academic year 2070\74, 2071\75 and 2072/76 of this campus as the population of this study.

For this study, number of dropouts of these three academic years is found out. On its basis, trend line is plotted and dropout trend is studied with the help of regression coefficient. From the data, regression coefficient is studied. Time series depicts "the relationship between two variables: one being time (t) and another being the variable value ( $y_t$ ) under consideration (Stapit, 2016, P.354)". In this study, unit of time is taken as a whole academic year and the dependent variable is dropout.

So, on the basis of total population, purposive sampling is used to find out dropout students' number, dropout rate, and dropout trend of this campus is studied on gender and ethnic basis.

### Limitations of the study

This study has some limitations. First, it is related only with Aishwarya Multiple Campus. Second, the data collected only belong to the first year that is the year of enrollment and the successive final year. The study does not focus on the second and the third year. Third, only the three academic years: 2070\74, 2071/75, 2072/76 has been taken as sample of the study. Fourth, gender wise dropout rate is not easy to find out because there are some names common for male and female students, namely, Laxmi, Ishwari, Durga. Fifth, so far caste wise dropout rate is concerned, some surnames like Poudel, Ghimire, Bhandari, Bohara fall in two categories: Brahmin and Kshetri.

### Methods and materials

Data were collected from Aishwarya Multiple Campus office basically after taking permission of the administration. The admission registers and their Samastigat forms of the academic years: 2070/74, 2071/75, 2072/76 were collected from the campus records. From admission register, it is easy to find out the total number of enrolled

students. Similarly, the total number of students who filled up the fourth year exam form was collected with the help of Samastigat form. In both of the faculties, the gap between the number of the total enrolled and the final year students was found. The number of enrolled and final year students are taken as input and output respectively.

Total dropout= Total enrolled - total final year students

$$\text{Dropout rate} = \frac{\text{Total dropout}}{\text{Total enrolled}} \times 100 \%$$

In the same way, gender wise and ethnic wise dropout is found out.

## Results

With the help of the following tables, multiple bar diagram and trend line, following results regarding rate and trend of dropout has been found out.

Table 1: Total number of enrollment and dropout

Academic Year		B.Sc.			BBS		
		Total	Boys	Girls	Total	boys	Girls
2070	Enrolled	74	53	21	73	44	29
	Drop out	16	12	4	28	18	10
2071	Enrolled	71	49	22	57	36	21
	Drop out	14	12	2	19	17	2
2072	Enrolled	46	36	10	95	51	44
	Drop out	13	9	4	32	21	11

Source: Campus Survey

Table 2: Total and gender wise dropout rate

Dropout Rate						
Year	B.Sc.			BBS		
	Total	Boys	Girls	Total	Boys	Girls
2070 B.S.	21.62162	16.21622	5.405405	38.35616	24.65753	13.69863
2071 B.S.	19.71831	16.90141	2.816901	31.57895	29.82456	3.508772
2072 B.S.	28.26087	19.56522	8.695652	33.68421	22.10526	11.57895

Source: Campus Survey

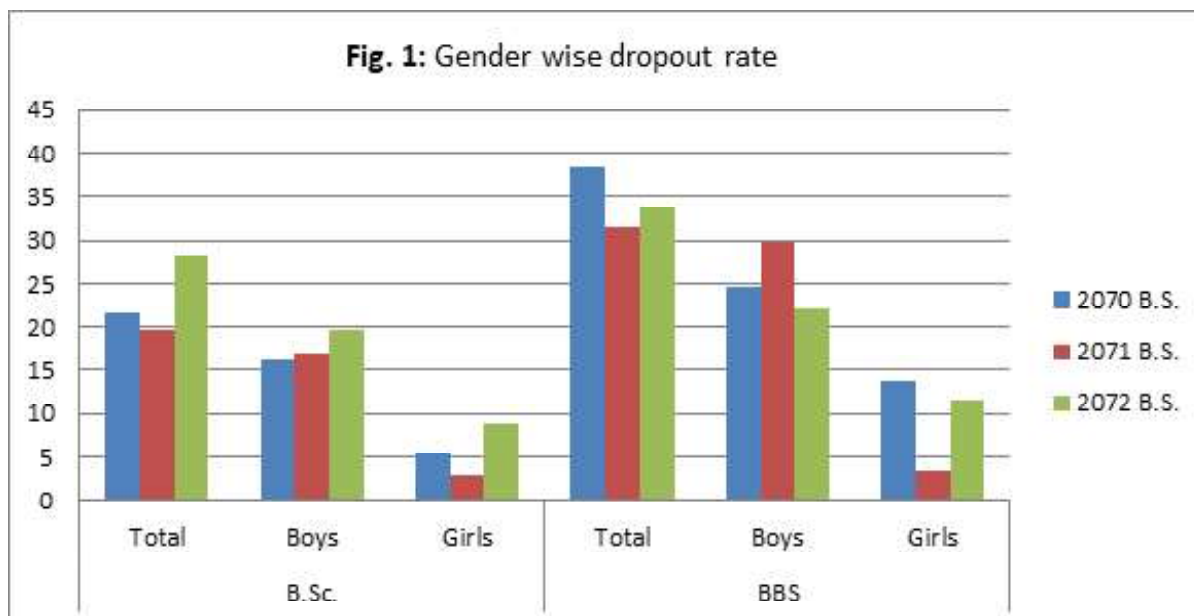
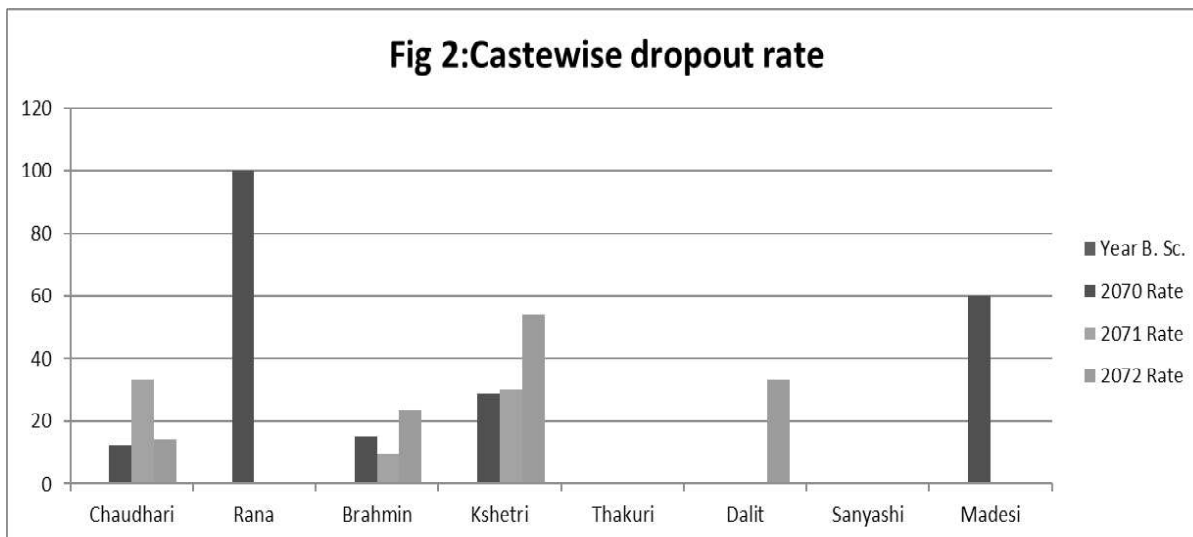


Table 3: Caste wise dropout rate in B.Sc

Year	B. Sc.	Chaudhary	Rana	Brahmin	Kshetri	Thakuri	Dalit	Sanyashi	Madesi
2070	Enrolled	16	1	26	21	4	0	1	5
	Drop out	2	1	4	6	0	0	0	3
	Rate	12.5	100	15.38	28.57	0	0	0	60
2071	Enrolled	18	1	21	20	9	1	0	1
	Drop out	6	0	2	6	0	0	0	0
	Rate	33.33	0	9.52	30	0	0	0	0
2072	Enrolled	7	1	17	13	5	3	0	0
	Drop out	1	0	4	7	0	1	0	0
	Rate	14.28	0	23.53	53.84	0	33.33	0	0

Source: Campus Survey



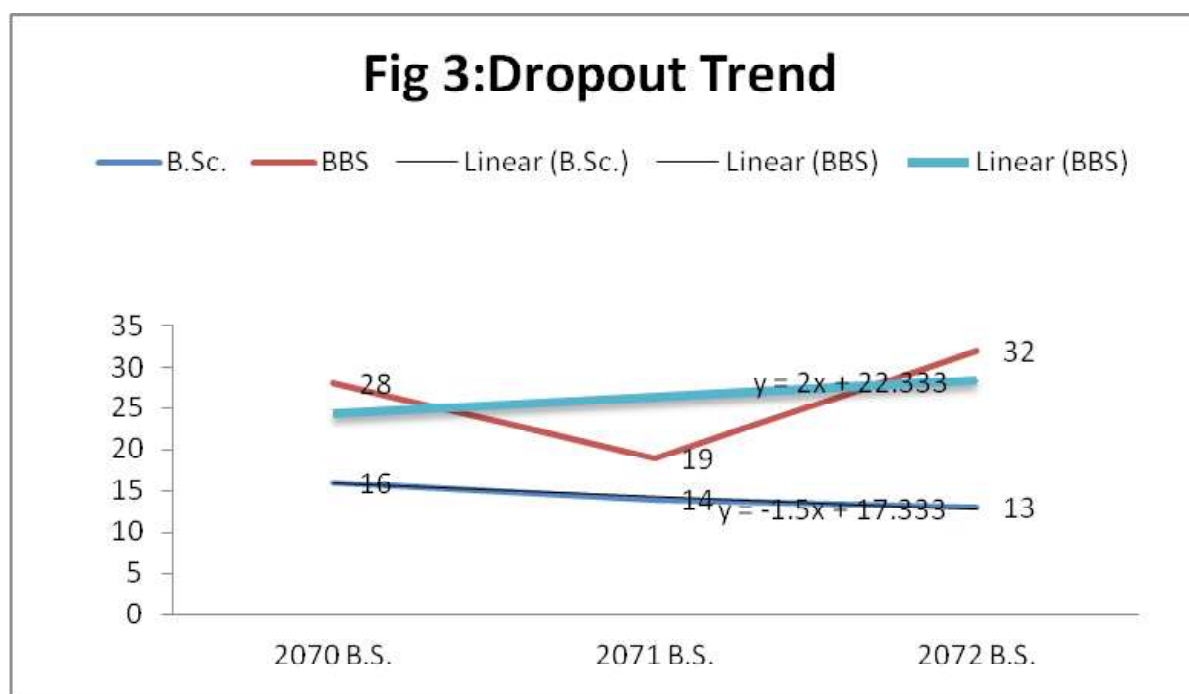
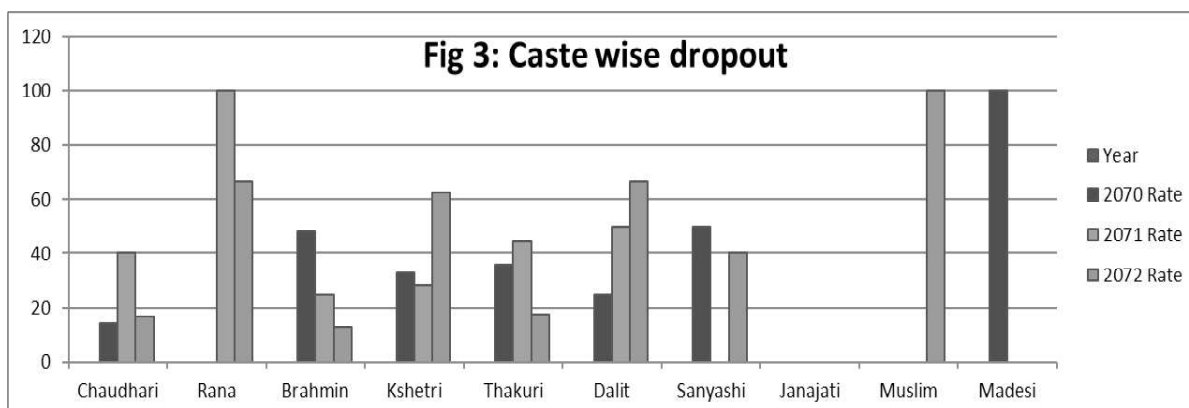
Source: Campus Survey

Table 4: Caste wise dropout rate in B.B.S.

Year	B.B.S.	Chaudhary	Rana	Brahmin	Kshetri	Thakuri	Dalit	Sanyashi	Janajati	Muslim	Madesi
2070	enrolled	7	1	25	18	14	4	2	0	0	2
	Drop out	1	0	12	6	5	1	1	0	0	2
	Rate	14.29	0	48	33.33	35.71	25	50	0	0	100
2071	enrolled	10	1	20	14	9	2	1	0	0	0
	Drop out	4	1	5	4	4	1	0	0	0	0
	Rate	40	100	25	28.57	44.44	50	0	0	0	0
2072	enrolled	6	3	31	24	17	6	5	2	1	0
	Drop out	1	2	4	15	3	4	2	0	1	0
	Rate	16.67	66.67	12.90	62.5	17.65	66.67	40	0	100	0

Source: Campus Survey





## Conclusions

On the basis of above results found about dropout rate and trend in AMC, following conclusions have been drawn:

- Dropout rate of boys is higher than that of girls in both of the programs: B.B.S. and B.Sc.
- In comparison, dropout rate of B.B.S. is higher than that of B.Sc.

- Despite low enrolled number, dropout rate of Rana, Dalit, Muslim and Madhesi is higher in both of the programs.
- Dropout rate of Chhetri students is increasing on average.
- Dropout rate of Brahmins is decreasing in B.B.S. whereas increasing in B.Sc. on average.
- Dropout rate of Chaudhary students is increasing on average.
- Dropout rate of Thakuri students in B.sc. is zero and decreasing, on average, in B.B.S.
- In B.Sc, dropout trend is negative, that is, decreasing.
- In B.B.S, dropout trend is positive, that is, increasing.

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# Is Punishment for the Purpose of Improvement in Character Traits of Students Justifiable?

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## Abstract

The purpose of this article is to study whether punishment for improvement in character traits of the students is justifiable or not. Corporal punishment, which was a very common practice in our schools and classroom in the past, is a debatable issue at present. As qualitative research, the study is based on the real-life experiences of the participants i.e. students and teachers. Fifteen participants were selected purposively for the research purpose who were directly connected to the punishment practices. As punishment is directly related to the psychology of the punishment giver and receiver, the study is based upon Interpretive Phenomenological Analysis (IPA). The study revealed that besides very few positive impacts, punishment has a directly negative impact on students. Additionally, the study suggests that alternative measures like counseling could be adopted instead of punishment.

## Keywords

Punishment, discipline, school, teachers, practices, corporal, physical, psychological

## Introduction

Punishment in schools is one of the most controversial issues in the modern schooling culture of our society. It became debatable only since the last few years because it was widely accepted as the only means to maintain discipline in school in the past. Despite lots of controversies, it is still a very common practice in our classrooms as well as in

our school premises. Most commonly in Nepal, the teachers punish their students if they fail to submit their assignments in time or they break the disciplinary rules inside the classroom. In some boarding schools, there are practices of punishing the students for breach of the dress codes, language codes too. Similarly, sometimes not only the teachers but also the school administration is also involved in the

punishment activities. The students are called in the administration department and given different types of punishments. Generally, the students accused of involving in the fights/gang fights, disobeying the teachers, being involved in some kind of immoral activities, breaking the codes of conduct designed by the school authority are given corporal punishment.

Here, the term punishment can be classified into two types: physical and psychological or verbal punishment. In physical punishment, the students are hit, kicked, slapped or used different physical forces in order to give physical pain to the students. Although, the adults are protected by laws from being physically harmed for violating rules, children are still not protected because banning corporal punishment from schools is really challenging (Dupper & Dingus, 2008). Physical punishment is a legally permissible physical attack on children. The most common forms are spanking, slapping, grabbing, and shoving a child "roughly" with more force than is needed to move the child. Hitting a child with an object is also legally permissible and widespread (Wauchope and Straus 1990). Likewise, psychological/ verbal punishment refers to calling the students by bad names, shouting at students, threatening them, scolding students with bad words, etc. People are divided in favor of and against the topic. People in support of corporal punishment think that it is an essential component to maintain discipline in the classroom setting. But the

people who are against corporal punishment think that it, psychology and physically affects the students more negatively than the positive ways (Goodman, 2017). Regarding corporal punishment Durrant (2012) says, "In 1990, research showing an association between physical punishment and negative developmental outcomes was starting to accumulate, and the Convention on the Rights of the Child had just been adopted by the General Assembly of the United Nations; however, only four countries had prohibited physical punishment in all settings."(p.1373)

### Historical Background

In the past, physical punishment was generally accepted as the mandatory tool to elicit behavioral compliances. However, the concept in those days was completely distinct from physical abuse. The perspective towards physical punishment started to change as different researchers found a connection between 'normative' physical punishment and child aggression, delinquency and spousal assault in their later married life (Brown, 2009). In the Gurukula system, the student had to follow strict rules and regulations. The Instruction was focused but discipline was considered to be more important than teaching. The Discipline inculcated through strict obedience to laws and regulations of student life, discipline that was rooted in morality and religion. To develop character, the emphasis was given on moral earnestness, lying

slandering and backbiting were never to be indulged in. They were to observe strict celibacy even in thought and speech. The Punishment was totally prohibited in the school system of the Vedic period. Students received very sympathetic treatment from their teacher. Their personality was respected. Teachers had to use sweet and gentle speech in dealing with students. (Maheshwary, 2014).

### Objectives of the Study

In light of the foregoing discussion, this study focuses on the following objectives:

- Ø To explore students' and teachers' perceptions towards punishment.
- Ø To analyze the impact of punishment over students.

### Review of the Relevant Literature

Although no researches have been conducted on this topic in the context of Nepal, many more researches have been conducted on the topic of corporal punishment throughout the world. It is obvious that the review of the existing literature provides guidelines for conducting research. So, I have attempted to give an account of the relevant literature on the topic.

Most of the researchers found that punishment has detrimental effects on a child's psychology. In his research, Goodman (2017) criticized corporal punishment in schools and compared it with abuse done against students

psychologically as well as physically. Although punishment is a kind of socially acceptable form of violence, the message given by it is entirely wrong and corruptible. Furthermore, he claims that there is no more evidence that schools that use it are any more disciplined or orderly than ones that don't. If anything, the effects of it seem to be more negative than positive and serve to undermine the teacher-pupil relationship. He further explores that there is no evenness in the way of giving punishment. It is also power centered. For instance, boys tend to be given the punishment more than girls, and African- Americans seem to be given the punishment more often than white school children for similar offenses.

In the Joint Statement made by Durrant & Ensom (2012) on Physical Punishment of Children and Youth finds the evidence is clear and compelling – physical punishment of children and youth plays no useful role in their upbringing and poses only risks to their development. The conclusion is equally compelling – parents should be strongly encouraged to develop alternative and positive approaches to discipline.

(Skinner, 2003, Chapter 9, para. 3), one of the most recognized behavioral learning theorists also opposed the theory of punishment. He defined punishment as unpleasant and painful (stimuli) that decreases the likelihood of a certain behavior to occur again if it occurs after a certain behavior. Punishment as the technique of controlling/ correcting

unwanted behaviors as it causes harm to the person being punished and produces negative emotions and future behavioral problems. Furthermore, he opined that between reward and punishment reward is more practical and effective means to strengthen and enforce the positive behaviors and emotions among the learners. To sum up reward has positive effects on learning, which encourages pupils to learn more, whereas punishment always discourages or demotivates pupils to learn. Punishment has always detrimental effects not only in their school life but also in their future life.

Straus (1991) in his findings supports the theory that although physical punishment may produce conformity in the immediate situation, in the long run it tends to increase the probability of deviance, including delinquency in adolescence and violent crime inside and outside the family as an adult (p.133). Similarly, Simons & Wurtele (2010) claim that there is intergenerational cycle of violence done to the children. The parents who experienced corporal punishment during their childhood take it as the useful tool for maintaining discipline. Likewise, the children who are frequently punished, also support spanking to be used as a disciplinary method and adopt similar measures with their peer and siblings.

## Methodology

This research follows the qualitative research methodology. As the above-mentioned issue covers physical as well

as the psychological reaction of the participants, the Interpretive Phenomenological Analysis (IPA) tool has been applied to analyze the research problem. As a popular methodological framework in qualitative research, the main focus of IPA studies is based on examining how individuals make sense of their life experiences (Smith & Pietkiewicz, 2014). IPA, that is consistently concerned with psychology with subjective experience and personal accounts, connects with much longer intellectual currents in phenomenology and hermeneutics (All port,1953; James, 1890). The main aim of IPA is to explore the detail of the participants' perceptions regarding the topic under exploration. Furthermore, Smith & Pietkiewicz (2014) say, 'The main concern in IPA is to give full appreciation to each participants' account (case). For this reason, samples in IPA studies are usually small, which enables a detailed and very time-consuming case by case analysis'. For this research 15 participants were selected altogether, using purposive sampling. Out of them, 10 were students of studying at the tenth standard, who had been punished time and again for different reasons. Likewise, the remaining 5 participants were the teachers teaching at the same level, who have the experience of punishing students as the main tool of disciplinary condition. To elicit rich and detailed accounts of experiences of the participant, the researcher has used semi-structured interviews using open-ended questions.



## Discussion and Analysis

To reveal the impact of punishment, the participants were approached personally by the researcher with two sets of semi-structured questionnaires: one for the teachers and another for the students. All the students interviewed had the experience of being punished time and again. As they were asked about the main reasons why they were punished, most of the respondents agreed that they were punished for not completing homework on time. However, some of them pointed out the violence of codes and conducts of school. The next question asked to them was about the type of punishment. The majority of the students named various kinds of physical punishment like being slapped, being beaten with sticks, etc. However, few of them agreed that they were given psychological punishment like being scolded, threatening about low scores in practical marks, etc. When the students were asked whether they think the punishment is necessary to improve in the character traits of the students, most of them disagreed. In fact, some of them said it is desirable. They opined that the students may be punished according to the circumstances but it is not obligatory.

The next question asked was about the impact of punishment over the students. The majority of the students agreed that punishment has a negative impact on the students. One feels depressed, humiliated after being punished which may have a negative impact on his/her learning and overall development. However, some of them opposed and said that punishment

has some positive effects too. Punishment helps students to omit their ill-behaves and help them to adopt good habits forcefully. The last question was asked about the alternative measures to the punishment to improve the character traits of the bully students. There were multiple responses to the question. Some of them opined about moral lessons, whereas many others responded that counseling would be better for them. Some of the students told that people should let them learn from their mistakes. People learn from their mistakes and correct them themselves after a time period.

Similar kinds of questions were asked to the teachers to explore their experiences regarding the punishment given to the students. They had also similar kinds of opinions as the students did. However, concerning the kind of punishment, most of them preferred to a different kind of psychological punishment than physical punishment. Another point is that many more teachers opined that punishment has some positive impacts on the students. And some of the teachers agreed that punishment has no impact over the bully students.

## Conclusion

Based on the results of this qualitative study it is concluded that despite its bad effects, corporal punishment is a very common practice in our schools and classrooms. However, people are divided into two groups. Some have favored punishment, and many more have opposed such practices. As a researcher



and a teacher I, myself, believe that punishment has negative effects over the students. Punishment creates fear of the teacher on the children, as a result, they get frightened of the teacher which keeps them away from respecting the teacher. Similarly, the children are harmed emotionally as well as physically by the punishment. The ones who are punished badly cannot forget the punishment in their adulthood too. There can be many parenting strategies or techniques to control our children's behavior. The children do not deserve punishment; they deserve guidance but not control. Parents do not need to bribe their children to be good. Children want to be good naturally. People must trust their children. Children should be encouraged to be good instead of being forced to be good.

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