Contribution of pack animals in reducing CO_2 emission in Central Himalaya, India

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The present study was undertaken in the six major valleys of Garhwal Himalaya, Uttarakhand to understand and quantify the contribution of pack animals in reducing CO_2 emission in Indian Central Himalaya. The study has demonstrated that horses and mules provide direct and indirect services to the society and country. The direct services include communication services in far-flung and remote areas not connected with the road network, where they transport essential commodities and also human beings to the religious shrines of Kedarnath, Hem Kund, Gangotri and Yamunotri. The indirect services include reduction in CO_2 emission.

Keywords: Carbon saving, CO_2 emission, direct and indirect services, pack animals.

THE resilience and adaptation in mountain regions have acquired important priorities in the present times, especially when climate change has become an overriding issue and its impacts are recognized to be felt globally. The present study describes an example of how the pack animals play a vital role in transportation in remote and far-flung areas of Uttarakhand Himalaya, and also contribute in reducing CO_2 emission. Road services in Uttarakhand are not encouraging[1], with 40% of villages located at a distance of less than 1 km from the road, 35% at 1–5 km and 25% at distances longer than 5 km. According to an estimate, there are more than 500 villages in Uttarakhand which depend totally on pack animals for their supply and transportation. The nomadic and transhumant communities in the Indian Himalaya, even today are totally dependent upon pack animals for transportation and their own movements from one place to another. More than one million visitors come to the Himalaya each year for pilgrimage, nature tours and sports, and pack animals are commonly used for the movement of both people and goods. To the best of our knowledge, no prospective studies of pack animals and their total contribution towards the economy of the people have been done in the Himalayan region so far, to assess their contribution towards saving CO_2 emission. This article attempts to estimate the changes in the rate of CO_2 emission if the present transportation of goods by pack animals is carried out by automobiles, i.e. the contribution of equines to carbon saving in the Himalaya while rendering transportation services. It also suggests an option for reducing CO_2 emission by utilizing pack animals in the transportation of non essential commodities in remote and rural areas.

Study area

The study was carried out in the six major valleys of Garhwal Himalaya, i.e. Kedarnath, Bhyundhar, Pinder, Urgam, Nandprayag and Nizmulla, with a total area of 30,000 km^2 (29°31′–31°26′N and 77°35′–80°6′E) where pack animals still play a major role in supply systems, including carrying tourists to Kedarnath and Bhyundhar. For this study, 60 villages spread at a distance ranging from 8 to 16 km away from the road head and two pilgrimage sites were surveyed in the six valleys (Figure 1), where the road network is not yet well developed and transportation still is dependent on pack animals. Kedarnath and Bhyundhar valleys are important sites due to their location and movement flow of pilgrims on horses and ponies. Most of the pilgrims hire pack animals for travelling to the Kedarnath shrine, which is located at a distance of 14 km from the road head, and Hem Kund located at a distance of 17 km from

Figure 1. Map of the study area.

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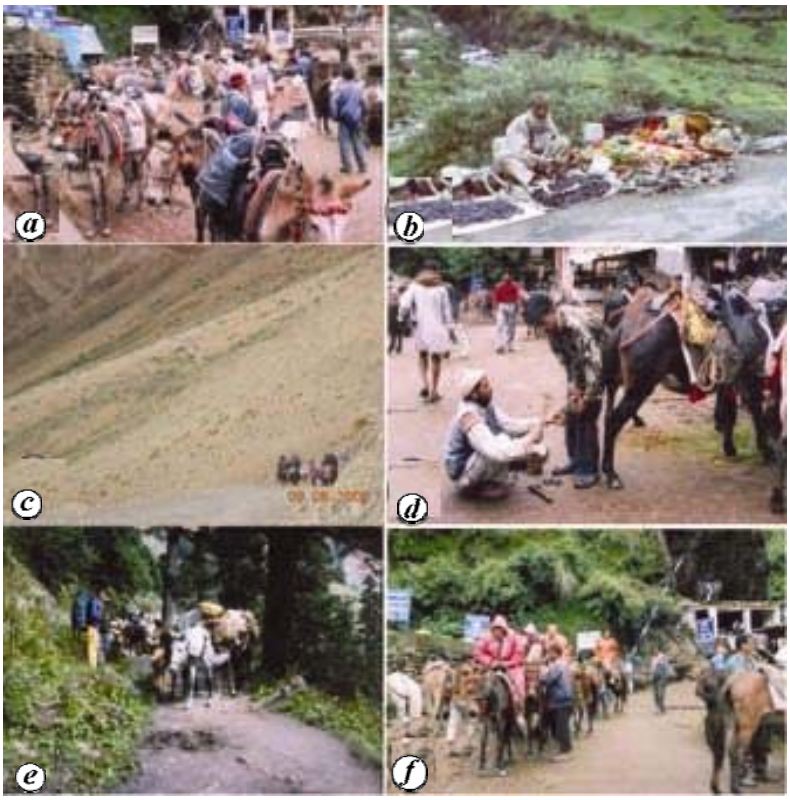

Figure 2. ***a***, Pack animals getting ready at Gaurikund for movement to Kedarnath. ***b***, A shopkeeper sells horse-shoe nails, blinkers and items for decoration of pack animals. ***c***, Pack animals carrying pilgrims in high-altitude areas. ***d***, Horse-shoe nails being fitted on the hoofs before movement. ***e***, Pack animals carrying goods on high altitude track. ***f***, Tourists and pilgrims returning from Hemkund Sahib.

the road head (Figure 2). Since these two shrines are open only for four to six months (May–October), the rush of pilgrims is high. Three types of forests are found in the study area, viz. Himalayan temperate broadleaf forests, Himalayan temperate fir forest and sub-alpine fir–birch forests[2,3]. Meadows and grasslands are located above the sub-alpine forest.

Methods

In the absence of required information from the secondary sources on the population size and contribution of horses, mules and ponies to the rural economy of the people, data were generated from extensive surveys. Primary data were collected using questionnaires for household surveys, in the study area. These data were cross-examined and rectified by informal and formal meetings with the people engaged in transportation by pack animals (horse and mule owners, shopkeepers and a few rural people). The data were again cross-checked with the target groups and verified in numerous meetings and group discussions. The social survey was conducted between May and October. The benefits from pack animals to local people were found based on the questionnaire survey followed by group discussions with the villagers, owners of pack animals, pilgrims and other tourists and regulatory authorities at the district level (such as Zila Panchayat, who issue permit to the pack animals, and charge tax). The contribution of pack animals to carbon saving has been estimated based on the primary data collected on the total activities of the pack animals. Data for two years were collected for the full activities of the pack animals, including daily distance covered by them, number of working days in a year, average quantity of load carried and total quantity of load carried by them in a year.

The estimation of CO_2 emissions from the total diesel consumed has been made using the Code of Federal Regulations, which provides values for carbon content per gallon of diesel fuel which is used by the US Environmental Protection Agency (EPA) in calculating the fuel economy of a vehicle. The Intergovernmental Panel on Climate Change (IPCC) guidelines for calculating emissions summarize CO_2 emissions from a gallon of diesel = 2778 g × 0.99 × (44/12) = 10,084 g = 10.1 kg/gallon. As, 4.6 l = 1 gallon, therefore 221,588 l = 48,171 gallons. Thus 1 gallon of diesel emits 10 kg CO_2.

Data and analysis

Transportation of commodities, pilgrims and tourists

A great deal of energy and time of rural people in remote areas not connected with motorable roads is spent on transportation of domestic requirements such as foodgrains, liquid petroleum gas (LPG) cylinder, kerosene oil, construction materials, household utilities and agriculture produce. The transportation activities increase after the harvest of potato that is transported in huge quantities to the urban markets during September–November. In the studied valleys, pack animals pick up the carrying materials from the road head markets, and deliver them to the villages located at a distance of 3–20 km. The load that horses and mules carry ranges between 70 and 80 kg. The average transportation charges vary from Rs 80 in moderate to Rs 130 in highly sloping terrain for covering a distance of 10 km by an animal. The total number of horses and mules employed for transportation and as pack animals in the study area is presented in Table 1. There is great demand for horses and mules during the summer season (May–October) when around one million visitors (tourists, pilgrims and trekkers) visit Garhwal. During this period, around one thousand horses and mules migrate to Kedarnath and Bhyundhar valleys from the plains of Najibabad, Dhampur and Saharanpur, Uttar Pradesh.

Around 20–30% of pilgrims and tourists hire horses and mules for their use. To cater to this demand of the pilgrims and tourists, 2378 horses and mules were available in 2006 and around 3000 in 2007 for transportation and for carrying goods to Kedarnath and Hemkund Sahib. The number of pilgrims and tourists also increased from 812,016 in 2006 to approximately 917,000 in 2007. During the survey it was found that in the Kedarnath valley, the pack animals made two trips daily from Soneprayag to Kedarnath during the peak season of May and June, and also between July and October. In the Bhyundhar valley also, the pack animals made two trips from Govindghat to Hemkund Sahib from June to September, covering the rough land terrain. In the case of Pinder, Urgam, Nandprayag and Nizmulla valleys, the pack animals only transport commodities to various rural areas. Hence during potato harvest season, they all make two to three trips from road heads to different villages and the quantity of load is less during the rest of the year (Table 2). The horses, mules and ponies engaged in transportation take the designated pedestrian path of the village and hence do not cause much damage to the standing vegetation of the region. However, their droppings which do not decompose easily, get washed into the river causing water pollution. This is a matter of grave concern to the environmental activists, scientists and planners.

Contribution to carbon saving

The total load carried was converted into vehicular units, and accordingly the average vehicular trip required in a

Table 1. Total number of horses/ponies engaged in carrying tourists and rural commodities in different valleys of Garhwal Himalaya in 2006

Valley	Service rendered	No. of local horses/ponies	No. of outside horses/ponies	Total no. of horses/ponies
Kedarnath	Carrying pilgrims/tourists	1275 ± 14.43 (40.66)	465 ± 8.66 (51.95)	1739 (43.09%)
Bhyundhar	Carrying pilgrims/tourists	210 ± 5.77 (6.69)	430 ± 6.35 (48.04)	639 (15.86)
Pinder	Carrying rural commodities	900 ± 11.54 (28.70)	–	900 ± 11.54 (22.34)
Uargam	Carrying rural commodities	300 ± 5.77 (9.56)	–	300 ± 5.77 (7.44)
Nandprayag	Carrying rural commodities	300 ± 6.92 (9.56)	–	300 ± 6.92 (7.44)
Nizmulla	Carrying rural commodities	150 ± 5.77 (4.78)	–	150 ± 5.77 (3.72)
Grand total		3135	895	4028

*Values in parenthesis indicate total percentage of horses/mules.

Table 2. Estimation of total load carried by horses/mules in six valleys of Garhwal Himalaya

Valley	No. of horses and mules	Average distance covered per trip (km)	Average number of trips/day	Average number of working days	Average number of trips in one season/yr	Average approximate load carried (Qn.)*
Kedarnath	1739	14	1	120–130	424,680	339,744
Bhyundhar	639	17	2	90–100	126,340	101,072
Pinder	900	12	2	130–140	204,000	163,200
Urgam	300	10	3	140–150	102,000	81,600
Nandprayag	300	12	2	140–150	102,000	81,600
Nizmulla	150	10	3	130–140	51,000	40,800
Total	4028	12.5	2.5	125–135	1,010,020	808,016

*One horse/mule carries 80 kg of load.

Table 3. Estimation of required fuel in providing transportation services of load carried by horses/mules in the six valleys of Garhwal

Valley	Total material to be carried (Qn.)*	Total distance covered by vehicles (km)	Total no. of required vehicle trips	Estimated fuel consumption @ 6 km/l†	Estimated cost of fuel/diesel (Rs)‡
Kedarnath	339,744	594,552	42,468	99,092	3,170,944
Bhyundhar	101,072	214,778	12,634	35,796	1,145,472
Pinder	163,200	244,800	20,400	40,800	1,305,600
Urgam	81,600	102,000	10,200	17,000	544,000
Nandprayag	81,600	122,400	10,200	20,400	652,800
Nizmulla	40,800	51,000	5,100	8,500	272,000
Total	808,016	1,329,530	101,002	221,588	7,090,816

*Average 8 q of load carried/trip.
†Due to high altitude conditions average for diesel vehicle is less.
‡Cost of diesel @ Rs 32/l.

year was calculated. Based on the total number of vehicular trips, the total fuel required for the transportation of the total load carried by the pack animals was calculated (Table 3), and finally the carbon dioxide emission was calculated. The calculation was based on the most common mode of vehicular transportation in the remote and high-altitude areas of Garhwal Himalaya. Diesel jeep being the most popular mode of transportation was considered as the transportation unit, and accordingly all calculations were done. The total average estimated load carried by pack animals for one year was converted into diesel jeep unit by fixing the average load per diesel jeep to be 8 q (as revealed by jeep owners of the region). The total number of required vehicle trips was obtained by dividing the total material to be carried with the average quantity of material carried per jeep trip. Due to the steep climb and rough road conditions of high-altitude regions and poor conditions of available diesel jeeps, as normally prevalent in the region, the average mileage was calculated based on the responses of the jeep drivers, and hence the fuel consumption was calculated with the average mileage of 6 km/l. It has been found that for Indian conditions 20% of bad in-service vehicles contribute as much as 60% of total vehicular emissions[4]. The cost of diesel was calculated @ of Rs 32/l as prevalent in the present times. The details of this calculation are presented in Table 3. The total quantity of diesel thus saved was 221,588 l worth Rs 7,090,816, which is the contribution of pack animals in terms of carbon saving.

Based on the IPCC guidelines for calculating emissions, CO_2 emission from a gallon of diesel = 10.1 kg/gallon, whereas 4.6 l = 1 gallon; therefore 221,588 l = 48,171 gallons. One gallon of diesel emits 10 kg CO_2; therefore, 48,171 gallons of diesel emits 481,710 kg of CO_2. Thus, the contribution of pack animals in terms of carbon dioxide savings is 481,710 kg CO_2, and in terms of diesel savings, it is worth Rs 7,090,816. The six valleys studied cover almost one-third of the physical area of the Garhwal region. Hence for the full Garhwal region in terms of carbon dioxide savings has been estimated as 1,445,130 kg CO_2 and in terms of cost of fuel savings to be Rs 21,272,448. Hence, pack animals can play an important role in reducing the emission of greenhouse gases (GHGs) such as CO_2. The concern to reduce concentrations of GHGs in order to mitigate global warming has led to the global agreement on the Kyoto Protocol.

Discussion and conclusion

The contribution of farm animals to the rural economy in mountain areas has been well quantified and analysed[5], whereas the contribution of pack animals is less studied so far. No survey or study is available to suggest the potential demand of horses as pack animals in the Himalayan region. The study concludes that the total carbon savings in the Himalayan region due to its topography and complexity is quite high in terms of area compared with the plains of our country. However, this fact has not been highlighted in the present form earlier, so as to work on a mechanism to compensate the region for less CO_2 emissions. It is well recognized that communities that manage forests in a sustainable manner contribute to stabilizing atmospheric CO_2 concentrations by maintaining a carbon pool in the terrestrial ecosystem. The role of forests as a carbon sink is well established. Even the Kyoto Protocol recognizes it, but provides no incentives to non-industrialized countries to reduce or stop deforestation or maintain healthy forests. Similarly, communities which still use pack animals for the transportation of their commodities also contribute in reducing CO_2 emissions, and deserve some form of incentive for their efforts. Thus, the contributions of pack animals in reducing the carbon emissions are also in tune with the Kyoto Protocol, which has suggested reduction of GHGs by a minimum of 5% by 2012, compared to a 1990 baseline as decided by the industrialized countries in December 1977 in Kyoto.

In order to reduce the overall emission of GHGs, many initiatives have been taken by different countries, including research on and promotion, development and increased use of, non-renewable and renewable forms of energy. Recently, in several countries policy makers have initi-

ated a shift from dedicated fuel efficiency and atmospheric pollution regulation to pure transport policies like road pricing, parking and collective transport. This has several benefits as it addresses both the pure transport-related externalities like congestion, traffic accident, etc. and has a large beneficial impact on air pollution[4]. While technology solutions include use of biofuels and hybrid vehicles, lifestyle changes can also help in a big way. Simple changes like walking, cycling and use of pack animals can help reduce CO_2 emissions considerably. The present study in a few valleys is an example of the total contribution of pack animals and the mountain societies to carbon saving, and hence, requires immediate attention of the global society in the light of Kyoto Protocol. People of Central Himalayan region have contributed in the reduction of CO_2 emissions by using pack animals for transportation services. Although construction of roads is a top priority for people from such remote and far-flung regions, incentive should be there to encourage the use of pack animals for transportation. Construction of roads should be done and automobiles for human transportation should be provided. However, for the transportation of goods and services of non-essential commodities, pack animals should be encouraged to save further emission of CO_2 and to encourage employment in the rural and remote areas in tune with the Gandhian philosophy of utilizing the local resources.

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ACKNOWLEDGEMENTS. We thank the Director, G.B. Pant Institute of Himalayan Environment and Development, Kosi-Katarmal, Almora for providing facilities to undertake this work and the three anonymous reviewers for valuable suggestions to improve the manuscript.

Received 11 September 2007; revised accepted 22 May 2008