SOLID WASTE POLLUTION VERSUS SUSTAINABLE DEVELOPMENT IN HIGH MOUNTAIN ENVIRONMENT: A CASE STUDY OF SAGARMATHA NATIONAL PARK OF KHUMBU REGION, NEPAL

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Introduction

Any waste that does not go up the stack or down the drain is solid waste. It is useless, unwanted or discarded material of industrial production and consumption. Solid waste which arises in association with diverse human activities (ESA 1991; Basnet 1993) is a major threat to the sustainable utilization of natural resources–air, water, soil, and natural scenery. Sustainable utilization means using renewable resources in a manner that does not eliminate or degrade them or otherwise diminish their renewable usefulness for future generations (Goodland and Ledec 1987: WCED 1987) while maintaining effectively constant stocks of natural resources (Howe 1979; Pearce, Barbier, and Markandya 1988).

The increasing quantity of solid waste is a serious environmental problem in Sagarmatha National Park, Khumbu (Basnet 1984), showing that even high altitude areas of Nepal are faced with pollution dilemma. Tourists–trekker, mountaineers, and others–dispose tins, cans, bottles, plastic bags, and papers on trails and camp sites. Similarly, lodges and hotels dispose such unwanted materials in the vicinity and pollute the environment. As a result, all the trekking routes and the camping places from Namche (3, 440 m) to the Base Camp (5,356) of the Mt. Everest (8,848 m), are littered. Because of such visual pollution, the tourist route from Lamosangu to Namche was nicknamed as 'garbage trail' (Shrestha 1982). However, no studies or surveys have been conducted for planning and mitigating serious problems mainly because (1) development efforts mainly concentrate in urban areas (e.g., solid waste management in Kathmandu, Patan, and Bhaktapur) Which are increasing both in size and number (NPC 1992), (2) lack of environmental

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awareness and public participation (Basnet 1992), (3) lack of understanding of the complex mountain ecosystem and the long-term impact of tourism of the sustainability of the whole system (Bjonness 1983; Basnet 1994). Therefore, the main objective of this study was to investigate and document the nature and the extent of solid wastes generated in Sagarmatha National Park. Guiding questions of the investigations were: What were the major sources of solid wastes? What were their major types and composition? What were the spatial and temporal pattern of their distribution? How extensive (concentration) was the solid waste pollution? What are the long-term ecological problems and their solutions for the sustainable use of high altitude natural resources?

Methods of Investigation

Study site: The study was conducted in Sagarmatha (Mt. Everest) National Park of Khumbu, Nepal. The park covers about 1,248 sq. km in the Eastern Himalayas of Nepal. It is a world heritage site. Mt. Everest, the highest mountain in the world, several other world-famous peaks, and the indigenous Sherpa culture of the park attract increasing numbers of tourists every year from around the world. At present, the park receives around 16,000 trekkers and mountaineers annually (Sagarmatha National) Park 1992; The Rising Nepal, 7 March, 1993).

Sampling: Sampling sites were selected along the tourist trekking trail from Namche to the Base Camp of Mt. Everest (fig. 1). The vicinities of resting places such as hotels, lodges, and camp sites were taken as the main sites. More emphasis was given to the higher altitudes from Lobuche (4,930 m) and beyond in sampling and collecting data.

Analysis: Physical analysis of solid wastes included sorting (categorizing), counting, measuring, and weighing. Solid waste disposal was broadly divided into two categories: rubbish and garbage. Rubbish included non-combustible and primarily inorganic materials, such as metals and glass while garbage included combustible and primarily organic materials much as plastics, papers, vegetable wastes and so on (Adedibu 1983; Lohani et al. 1984). From Gorakshep (5,200 m), the last lodging place before the Base Camp of Mt. Everest, about 3,175 m distance, each kind of disposal was counted at 2 m on either side of the road, thus covering about 12,700 sq.m. In the Base Camp and other main sites, the disposal piles were measured directly, 1 $\times$ 1 m quadrate plots were taken randomly; solid wastes in those plots were broadly classified (Lohani et al. 1984), and the different components in each of them were sorted, counted, and weighed by a spring balance. On the peak of

Kalapathar (5,545 m), all kinds of litter, tins, cans, and bottles scattered in certain area were counted to examine the general composition of the solid wastes at high altitude. Comparative analysis of different categories of solid waste disposal in different sites was done.

Research findings and Discussions

Sources of solid waste: Observations and simple grade point analysis showed that tourists and tourist associated activities were the major source of solid waste pollution in the Mt. Everst area (Table 1). Mountaineers and climbers, followed by lodges and hotels, and trekkers were the top polluters, generating more than 90% of the total solid waste disposal in the area. Local people involved in subsistence agriculture and officials or short-term visitors like researchers were minor polluters.

Table 1: Polluters and their Rank (from highest to lowest)

Polluter	Ranks	Remarks
Mountaineers and climbers	1	including porters and guides
Lodges and hotel	2	associated with tourism
Trekker	3	including porters and guides
Local people	4	involved in subsistence agriculture
Other-e.g. officials	5	small number

Composition of Solid Waster Disposal

Physical analyses of the solid wastes of Sagarmatha National Park are presented in tables 2 and 3. Both rubbish and garbage (Adedibu 1983: Lohani et al. 1984) were abundant in Khumbu disposal. Rubbish formed the major component of the solid wastes, whereas garbage formed the minor fraction. The fraction of rubbish–metals (tins, cans, etc.) and glass–was very high everywhere. Sometimes it made up 100% (tables 2 and 3), as in the Base Camp of Mt. Everest. On an average, rubbish formed more than 66% of the total weights (range 66-78%) and more than 54% of the total numbers (range 54 - 80%). This reflected and nature of the high altitude solid waste, as mountaineers and trekkers travel light and carry 'quick fix' food and other items.

Spatial and Temporal Pattern

Rubbish formed 59% of the total numbers and 66% of the total weights of the waste disposal in the Base Camp (tables 2 and 3). In Gorakshep and Lobuche, rubbish represented 78% and 69% respectively of the total weights

of the solid waste. In the total counts of the wastes, Kalapathar had the highest percentage (80%) of rubbish in the Khumbu region. Recent products (e.g., tins, bottles, and plastics) were more abundant than the old ones in every site.

The density shows the extent of solid wastes in Khumbu (tables 2 and 3). Average densities of solid wastes (75 kg/m and 134 n/m) in the Base Camp were higher than the average densities in Gorakshep and Lobuche (tables 2 and 3). Such high density was due to the greater concentration and the longer period of stay of tourists, especially climbers and their guides and porters, in the Base Camp than in Gorakshep and Lobuche. Waste disposal accumulated year after year because of low temperature and the limited capacity of nature to dilute, disperse, and degrade them. From Gorakshep to the Base Camp route, on an average one item of solid waste disposal (bottles, tins, cans, plastic bags, papers) in every 4 m was recorded.

Long-term Effects of Solid Waste Pollution

There are both direct and indirect effects of pollution on environment and human welfare (e.g., Woodwell 1972; Munn et al. 1977). Direct effects range from the damage of materials and loss of aesthetic importance to the impairment of human health, thus creating socioeconomic impacts. Indirect effects are mainly long-term effects which range from change in ecosystem structure and behaviour to the climate change which in turn will affect socio-economy and the sustainability of the region (Basnet 1993). The major concern is the vicious circle situation of solid waste pollution because (i) beyond a certain level, pollution reduces the assimilative capacity of ecosystems, (ii) high altitude, low temperature, and possible slow microbial activities make the Mt. Everest area susceptible for environmental degradation.

Present Development

Realizing the ever-growing problem, the Ministry of Tourism in cooperation with the Police Mountaineering and Adventure Foundation and the Trekking Agents, Association of Nepal undertook a cleaning campaign in 1984 along the Sagarmatha trail and the Base Camp area of the World's highest mountain (The *Rising Nepal*, 6 June, 1984). Food containers dating from 1959 were also recorded during the cleaning campaign, and it is not surprising that 3-4 metric tones of garbage and rubbish were carried to Gorakshep for burial. This campaign was followed by many other national and international programs such as Himalayan Trust, Hotel Management and Tourism Training Center activities, Sagarmatha Pollution Control Project, and The Everest Environmental Expedition Project (Naumann 1993).

Conclusion and Recommendation

Solid waste pollution is identified as a component problem of the whole ecological and environmental complex which can be solved by immediate actions such as creating public awareness and cooperation, and proper long-term planning for the future development of ecotourism activities (Basnet 1992, 1993). This will improve the quality of life while using the resources within the carrying capacity of supporting ecosystem (IUCN 1991).

Both technical and nontechnical solutions are needed to tackle this problem. There are few technical options for managing and utilizing the solid wastes in such remote areas where material conversions, reclamations, are recycling are not easy. The most practical approach is to bury the wastes generated or adopting the principle 'dispose your waste in the most practical way today, and tomorrow will take care of itself'. Moreover, investing a little extra money and time and being environment consciousness ensure the sustainability of high altitude natural resources which will be passed from generation to generation for their use. Some of the recent developments described above are positive signs for achieving sustainable development of Sagarmatha National Park (Basnet 1993). Moreover, their lesson learnt from Sagarmatha National Park must be extended to other new protected areas which are of tourist interest for example, Barun National Park and Conservation Area. Prevention is better than cure.

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Map

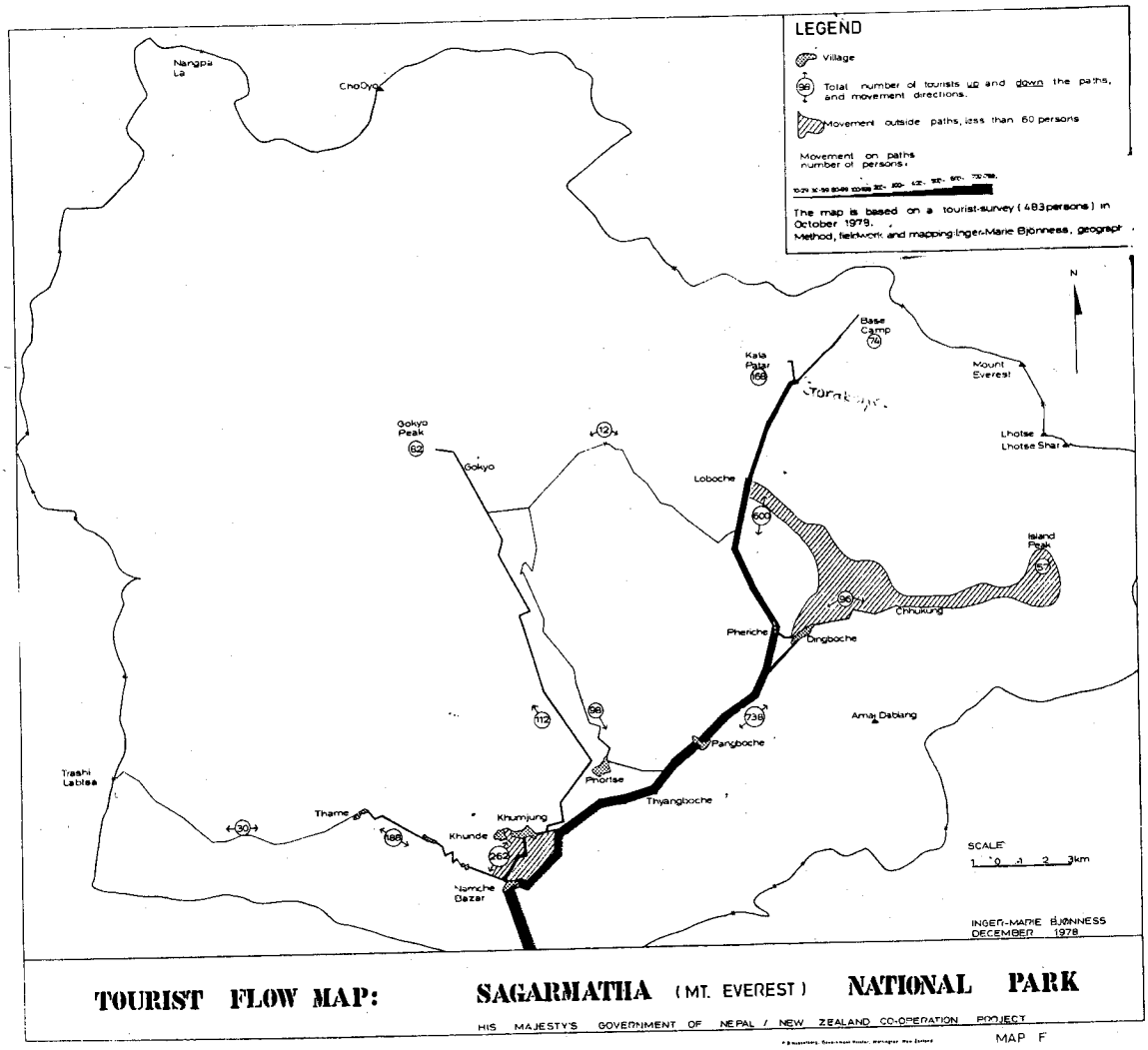
LEGEND
Village
Total number of tourists up and down the paths, and movement directions.
Movement outside paths, less than 60 persons
Movement on paths number of persons:
The map is based on a tourist-survey (483 persons) in October 1979.
Method, fieldwork and mapping: Inger-Marie Bjönness, geograph
N
Nangpa La
Cho Oyu
Base Camp
Kala Patar
Mount Everest
Lhotse
Lhotse Shar
Gokyo Peak
Gokyo
Loboche
Island Peak
Chhukung
Pheriche
Dingboche
Ama Dablang
Pangboche
Phortse
Thyangboche
Tsola Lablea
Thame
Khumjung
Khunde
Namche Bazar
SCALE
1 0 1 2 3km
INGER-MARIE BJØNNESS
DECEMBER 1978
TOURIST FLOW MAP: SAGARMATHA (MT. EVEREST) NATIONAL PARK
HIS MAJESTY'S GOVERNMENT OF NEPAL / NEW ZEALAND CO-OPERATION PROJECT
MAP F

Table 2: Comparative Solid Waste Analysis (No.%) of different sites

(1) Base Camp

Plot No.	Rubbish			Carbage					Den-sity n/m²	Average Density
	Metal	Class	Avg. %	Veg.	Plastic	paper	Other	Ave %		
1.	34.41	4.30			11.83	40.86	8.60		93	
2.		40.57			35.90	0.61*	22.92		493	
3.		100.0							29	
4.		4.14	59		10.1	75.15	10.65	41	169	134
5.	39.0	2.0			16.0	36.0	7.0		100	
6.	41.77	4.71			16.47	29.41	7.65		162	
7.	100.0								17	
8.	100.0								10	
(2) Gorakshep										
1.	53.93	4.49	58		10.11	20.23	11.24	42	89	89
(3) Lobuche										
1.	33.72	6.98			9.30	30.23	19.77		86	
2.	20.41	28.57	54		10.20	26.53	14.29	46	49	69
3.	49.32	23.29			12.33	15.07			73	
(4) Gorakshep - Rase Camp										
1.	61.01	1.59	63		12.73	11.80	12.87	37		
(5) Kalapathar										
1.	40.17	40.17	80		6.84	12.82		20		

* very large packing boxes.

Table 3: Comparative Solid Waste Analysis (wt %) of different sites.

(1) Base Camp

Plot No.	Rubbish			Carbage					Density n/m²	Average Density
	Metal	Class	Avg. %	Veg.	Plastic	paper	Other	Ave %		
1.	41.11	17.23		14.04	1.4	14.04	12.17		59.33	
2.		23.50		5.46	19.13	30.06	21.86		126.21	
3.		100.0	66					34	84.38	74.50
4.		25.61		10.99	1.70	36.35	25.36		47.32	
5.	37.19	7.77			1.65	45.46	7.93		60.50	
6.	47.65	26.72			3.25	11.55	10.83		69.25	
7.	100.0									
8.	100.0									
(2) Gorakshep										
1.	64.7	13.16	78		1.43	10.97	9.76	22	65.14	65.14
(3) Lobuche										
1.	27.14	19.49		19.83	0.84	24.36	8.35		57.48	
2.	18.36	52.92	69		0.86	18.36	9.50	31	51.44	65.31
3.	29.12	59.77			1.15	9.96			87.0	

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