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ORIGINAL RESEARCH PAPER

Potential site selection in ecotourism planning using spatial decision support tool

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ABSTRACT: Northern areas of Pakistan have blessed with extremely beautiful natural landscapes, waterfalls, glaciated mountains, biodiversity rich valleys and forests and have extraordinary potential for ecotourism. Study is designed to propose potential sites for ecotourism in Kohistan, which is a least developed but biodiversity rich area of Pakistan. Poor planning and mismanagement of tourism practices have already disturbed the ecosystems of these highlands; there is a need to involve the local community in environmental conservation practices. As ecotourism has the potential to provide various new means of income for local people. Geographic Information System serves as a decision support tool in finding suitable locations for ecotourism by taking multiple factors into account and helps in devising strategy by providing ecotourism potential sites map in return. Same approach has been applied in the study with use of remote sensing and Geographic Information System based hybrid techniques. Thematic layers from classified image are overlaid with slope, elevation, soil, and vegetation density layers. Multiple criteria based decision is made from weighted overlay analysis which has given potential sites map. These potential sites can be appropriate places for trekking, skiing, white water rafting, sailing, mountain resorts, forest reserves and sports related activities. It is expected that implementing ecotourism in Kohistan will bring positive change in their economic life and it will be equally beneficial for tourism industry of Pakistan.

KEYWORDS: *Ecotourism model; Geographic Information System (GIS); Minimum distance classifier; Vegetation density; Weighted overlay*

INTRODUCTION

Ecotourism has changed the perspective of people who considers tourism as environmentally damaging activity; because it is more towards ecological conservation and sustainable management, also bring positive economic change (Stronza and Gordillo, 2008; Cheia, 2013). It promotes responsible travel to natural areas and enhances the wellbeing of local community (Kiper, 2013). It is a sustainable, responsible and environmental friendly approach towards fostering economic benefits for local people residing in the backward area like Kohistan. World Wide Fund for Nature-Pakistan WWF-P took the initiatives for promotion of ecotourism in northern Pakistan in 1999 (Israr *et al*., 2009). Poor management of tourist places is evident from existence of hotels and lodges along the streams, as found in Swat valley. They are discharging untreated sewage and affecting water quality. In short, unplanned tourism development

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activities especially mass tourism causes environmental quality degradation, thereby threatens sustainable development (Briassoulis, 2002). It results into lower visitor satisfaction and adverse impacts on resources (Lew, 1987). Establishment of pastoral and natural reserves is an effective way to stop environmental degradation in the areas that represent tourist attraction, but its success is largely dependent on local communities, private sector and government bureaucrats, in short policy developers and implementers (Nelson, 2004). Ecotourism, being main branch of tourism is a planned activity that requires careful assessment of environmental components prior to development like studies based on specie distribution, habitat management and restoration, ecosystem balancing and pollution control strategies (Donohoe and Needham, 2006). It constitutes only fraction of tourism which is world's largest industry (Goodwin, 1996).

Old research techniques involve survey and interview based studies prior to introduction of geographical models, these models contributed in studying visitor's behavior and spatially preferred network resources (Boers and Cottrell, 2007). Interview method has also been used with remote sensing techniques to check ecotourism potential of a specific site (Zambrano *et al.*, 2010). Use of Geographic Information System (GIS) is justified by spatially distributed nature of ecotourism containing interrelations of environmental factors with their relative significance. GIS decision support capabilities efficiently address complex nature of study as it requires selection of suitable locations and helps in decision making process of resource planning. It is proved to be the successful technology in the field of ecotourism planning (Chakrabarty, 2011). GIS can tackle many semi-structured spatial decision problems we often face in the real world (Guan Hi-ling *et al.*, 2011). Harnessing the ecotourism potential is important for every natural resource rich region, many techniques have been used but GIS is most effective for better determination of ecotourism sites as it reduces time and cost (Bahaire and Elliott-White, 1999).

Oladi and Bozorgnia (2011) used GIS tool in the assessment of recreational potential in Chitgar Forest Park by overlay analysis on slope, vegetation and soil maps to develop applicable ecotourism plans. Another study used vegetation density, slope, orientation, elevation and land shape map for overlay analysis in GIS, with objective of evaluating ecotourism potentials of Naharkhoran in Gorgan (Bozorgnia *et al.*, 2010). Normalized Difference Vegetation Index (NDVI) and elevation map have also been used to assess the extent of environmental degradation in Jazan and its negative effects on tourism (AL-Sheikh, 2012). Ramzanipour and Roshni (2011) assessed ecological ability of natural sites in developing ecotourism model. Dowling (1993) provided an Environmentally Based Tourism Development Planning Model at regional level that guides selection of significant features, critical areas and compatible tourism activities in which role of people is of utmost importance.

Baloch (2007) analyzed tourism condition in Chitral valley, and pointed out visitors' ignorant behavior and poor management of tourism departments as main reason behind dwindling tourism industry there. Current study is carried out in 2014 using satellite information to provide ecotourism potential sites in Kohistan with use of ArcGIS modeling function. Final product of the model is giving ecotourism hosting opportunities for local communities.

MATERIALS AND METHODS

Study area

Kohistan lies in Hazara Division on the Peshawar border in Khyber Pakhtunkhwa (Fig. 1)**.** The entire district is located along Himalayas from 34^0 48' to 35^0 51' latitudes and 72^0 48' to 73^0 56' longitudes, serving as a natural border of environmental region in chain of Himalayas, Korakoram and Hindukush mountains. Dassu is its capital with three main tehsils named as Palas, Pattan and Dassu.Naran, Kaghan, Allai and Siran lies in its east and south, Swat in its west while valleys of Chilas, Daril and Tagir are in its north, bounded on the North West by river Indus. Kohistan is divided into two parts by Indus River i.e. Swat Kohistan as western part and Hazara Kohistan, as an eastern part. Climate is extremely cold in winter and very hot in lower region; however summer season is pleasant in the upper Kohistan. Rain is intensively dependent on monsoon winds. Economy is based on herd raising, agriculture, apiculture, timber logging, hunting and mineral exploration.

Data collection and processing

LANDSAT 8 image for the month of June 2013 was preprocessed by histogram equalization and mosaiking of two images covering study area.It had 11 bands

embedded in a single scene, out of which band 5,4,3 multispectral bands of 30m spatial resolution were combined to a RGB product.Supervised classification was performed by collecting signatures for five classes i.e . water body, snow,open vegetation, tree cover and bareground.

Mean of training data was computed and used by Minimum distance classifier to assign classes to unclassified pixels. In order to extract vegetation information, normalized difference vegetation index was applied over band 5 and band 4. Vegetation gives higher reflectance in NIR band (0.845-0.885µm) and absorption in visible red band (0.63-0.68µm). Particular information about extent and density of vegetation was acquired by applying following equation.

$$NDVI = (band\,5 - band\,4)/(band\,5 + band\,4) \quad (1)$$

It gives values in the range of -1 to 1 where values greater than or equal to 0.6 indicates healthy and dense vegetation while values from o.3 to 0.2 represents grass and shrublands. Less than 0.2 indicates bareland and negative values discriminates water from other surfaces. Threshold based techniques were used to elaborate distribution of vegetation in the study area.

For snow cover extraction and discrimination from bright rock,soil and cloud green band (0.525 – 0.6 µm) was subtracted and then added with short wavelength infrared band (1.5 and 1.66µm) that gave us normalized difference snow index (NDSI). Formula is given below;

$$NDSI = (Band\,3 - band\,6)/(band\,3 + band\,6) \quad (2)$$

NDSI gives values opposite to NDVI where values for vegetation express in negatives and values greater than 0.4 represents snowcover (Fig. 2).

Terrain data was extracted from 30m Shuttle Radar Topography Mission Digital Elevation Model (SRTM DEM). It was used to classify land cover types like hills, mountains, valleys, river and mountains based on their particular elevation like valleys lie under 2000-3000m elevation. Elevation greater than 3000m has glaciated mountain spread. Moreover, slope calculation from DEM provides guess about extent of steepness and flatness of the area. After acquiring maximum information from satellite imagery, buffer around airport geographical location was employed to get the idea of accessible sites. All these layers were reclassified at common scale from 1 to 5 where scale 5 was depicting most suitable values and scale 1 used for unsuitability.

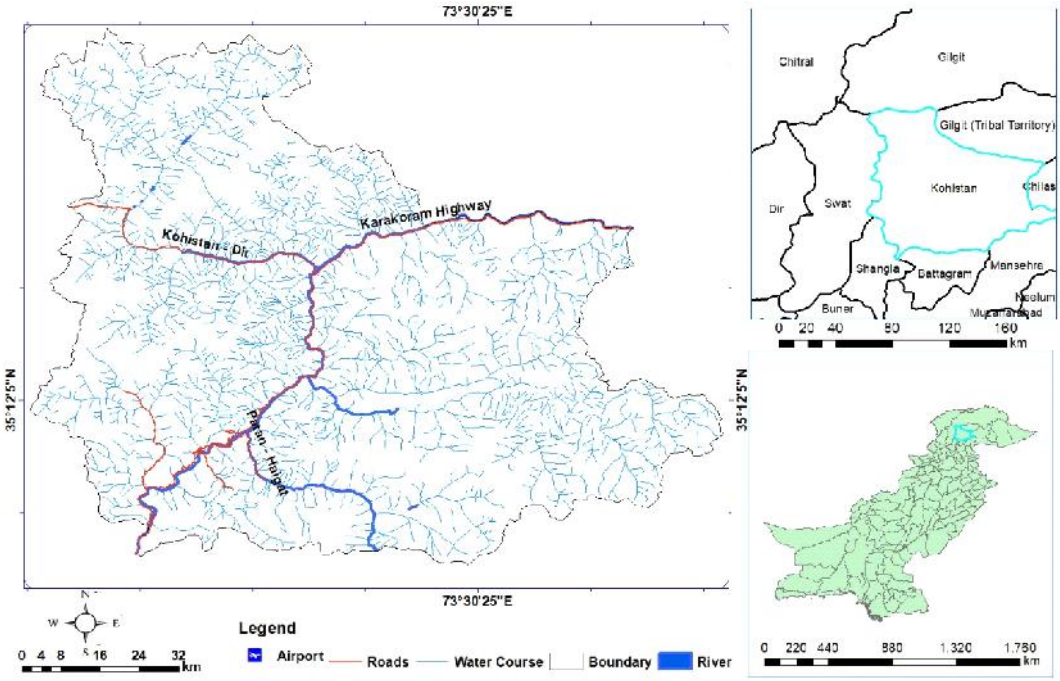

Fig. 1: Location Map of Kohistan District, Khyber Pakhtunkhwa province, Pakistan

Weights were assigned to each parameter based on their relative importance in eco-tourism. Significant importance was given to aesthetically appealing green areas closer to a water body. Scale and weights associated with these parameters are mentioned in the Table 1. Following rankings were used in weighted overlay analysis (see ecotourism model in Fig. 3) which gave five suitable ecotourism potential sites based on rankings. Only most suitable place was extracted by applying condition of raster pixels containing values equal to 5 as an indicator of most suitable place based on multi decision criteria. Maximum eight neighboring pixels were included through majority filter. Most suitable ecotourism site was allocated through multi-criteria decision analysis.

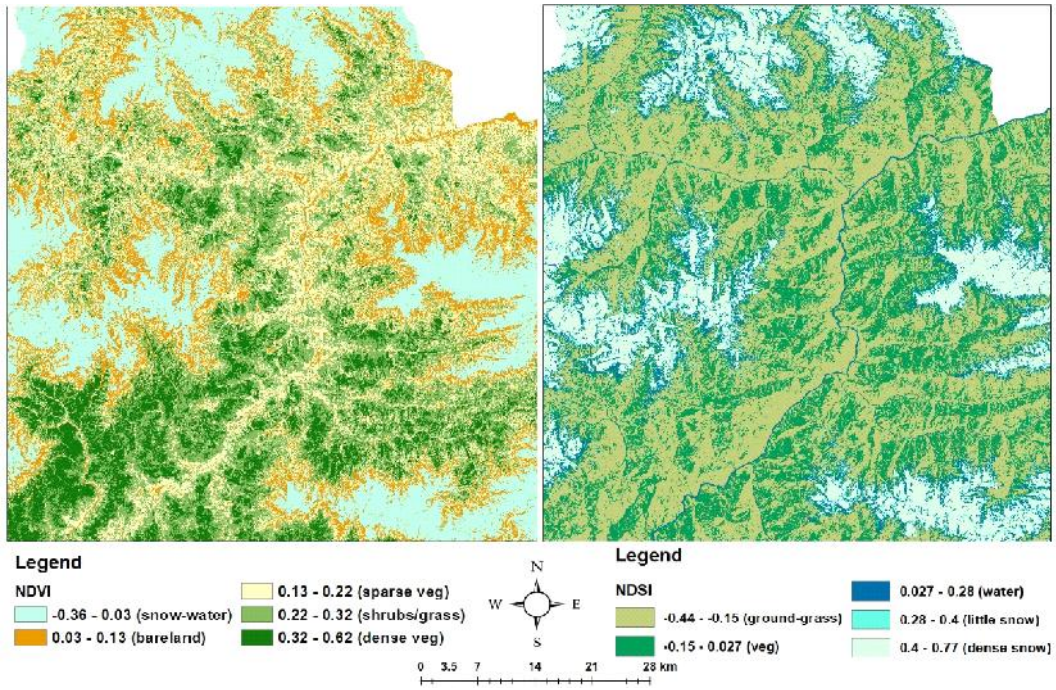

Fig. 2: Classification of NDVI and NDSI images.

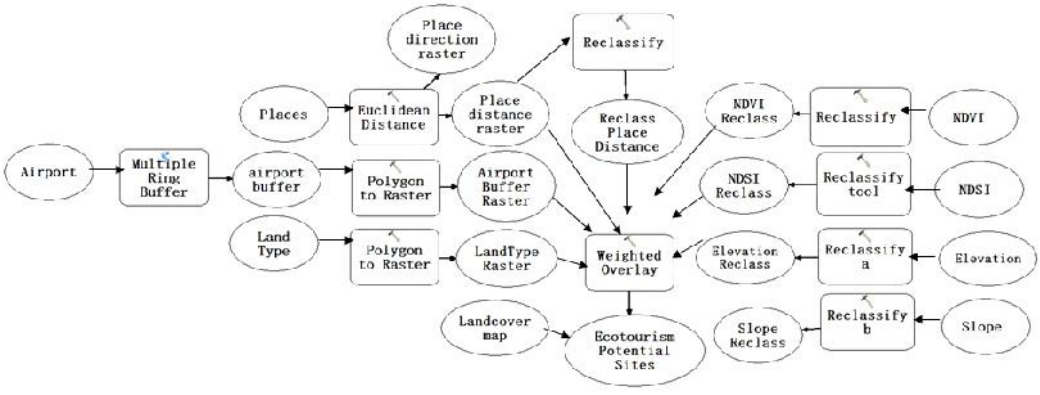

Fig. 3: Eco tourism potential site analysis model

Table 1: Spatial data rankings and weights for weighted overlay analysis

Parameters	Ranks	Suitability	Weights	Parameters	Ranks	Suitability	Weights
Slope				Distance among places			
<85	5	Highly suitable	10	0 - 1.2 km	4	High	10
86-87	4	High		1.2 - 2.7 km	3	Moderate	
87-88	3	Moderate		2.7-4.3 km	3	Moderate	
88-89	2	Low		4.3 - 6.6 km	4	High	
89-89.9	1	unsuitable		6.6 - 12 km	5	Highly suitable	
NDVI				Airport Buffer			
-0.36 0.03	1	unsuitable	17	0 - 10km	5	Highly suitable	12
0.04 0.13	2	Low		0 - 20km	4	High	
0.14 0.22	3	Moderate		0 - 30km	3	Moderate	
0.23 0.32	5	Highly suitable		0 - 40 km	2	Low	
0.33 0.62	5	Highly suitable		0 - 50km	1	unsuitable	
Elevation				NDSI			
664 - 1200 m	5	Highly suitable	12	-0.44 - -0.15	2	low	12
1200 - 1828 m	4	High		-0.15 - 0.02	3	Moderate	
1828 - 2500 m	3	Moderate		0.028 – 0.28	4	High	
2500 - 3675 m	2	Low		0.29 – 0.4	5	Highly suitable	
3675 - 5850 m	1	unsuitable		0.41 – 0.77	5	Highly suitable	
Land Type				Landcover Type			
Colluvial Slopes	5	Highly suitable	12	snow	3	Moderate	15
Miscellaneous Land Types	1	unsuitable		ground	2	Low	
Subrecent piedmont terraces	5	Highly suitable		open vegetation	5	Highly suitable	
Old Piedment terraces	4	High		tree cover	5	Highly suitable	
Subrecent River plains	3	Moderate		water	4	High	
Recent river plains	5	Highly suitable					
Old Glacial drift	1	unsuitable					

RESULTS AND DISCUSION

According to minimum distance supervised classification, total classified area is 65034.32 sq. km, out of which 37% area is largely covered by water bodies that includes river, streams, gullies and melted snow in the month of June. Afterwards, 31% area is occupied by grasses, shrubs and local crop fields. Glaciated mountains and seasonal snow covered areas occupies 9 % of total land area. Only 7% area is covered by trees or forest that is the minimum ratio while 16% area is either occupied by residing communities or barren land as expressed by Fig. 4. Thus, area has the potential for conserving existing green sources as it requires restoration of natural resources for sustainable management. It also has shallow loamy soil type, suitable for construction and crop production as well.

The medium textured loamy soil being nutrient rich and organic soil is considered as an ideal medium for gardening and agricultural activities. Elevation wise, areas above 3200m elevation are covered by snow, scrubs and alpine stony deserts. Below 3200m, alpine pastures, valleys and hills are prominent features. Terraces and crop field are found below 2200m elevation.

Considering all these factors, ecotourism can be ideal activity at lower elevation, closer to valley and residential areas for community income support, nearby road, airport and water bodies for ensuring access to the potential sites. Based on these priorities, weights were assigned to selected parameters. Results have highlighted five potential sites for ecotourism as shown in the Fig. 5. Among which best site possess all above mentioned qualities as required covering Khakran, Shamail, Shera Kot, Gul Bagh,kato, Hoogat, Palas valley, Dodar, Karin, Yakh, Bagh, Kuz, Shrial, Khargai, Dhop Banda and Datol Banda. Most suitable green areas are closer to Pattan airport and adjacent to Karakorum highway. They lie at meeting Point of Indus River and its tributaries as evident from Fig. 5. At every location community resides at flat slopes, so they may get benefits from tourism activities. These areas also have potential for trekking, boating, rafting and outing. Thus these sites fulfill all the requirements for ecotourism activities.

There is need to develop resort, restaurants and natural reserves to get maximum benefits from aesthetically appealing beauty of Kohistan. Development of the ecotourism sites and replenishment of existing tourism infrastructure is the important consideration for the betterment of the society. But it requires Government's attention, community participation, sustainable resource planning and capacity building of local communities. Social and environmental factors are more dominant than economic factor in the success of ecotourism with increasing community participation and will (Wu *et al*., 2010). Community can be engaged in managing jungle boat trips, wilderness trails or other transport related services (Rahman, 2010). Ecotourism promises low infrastructure development and less environmental problems. Our domestic tourism is largely dependent on Murree, Swat and Kaghan valleys (Israr *et al*., 2009). Thus, harnessing the potential of these explored sites will not only attract domestic and international tourist community through planned management and proper advertisement but also it will involve local community in resource conservation based activities.

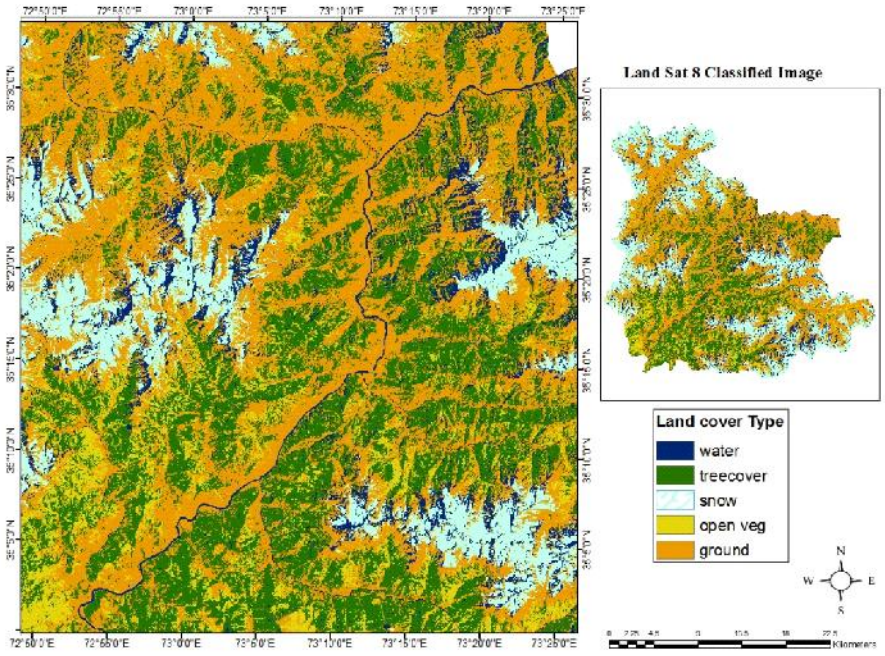

Fig. 4: Supervised classification of LANDSAT 8 image

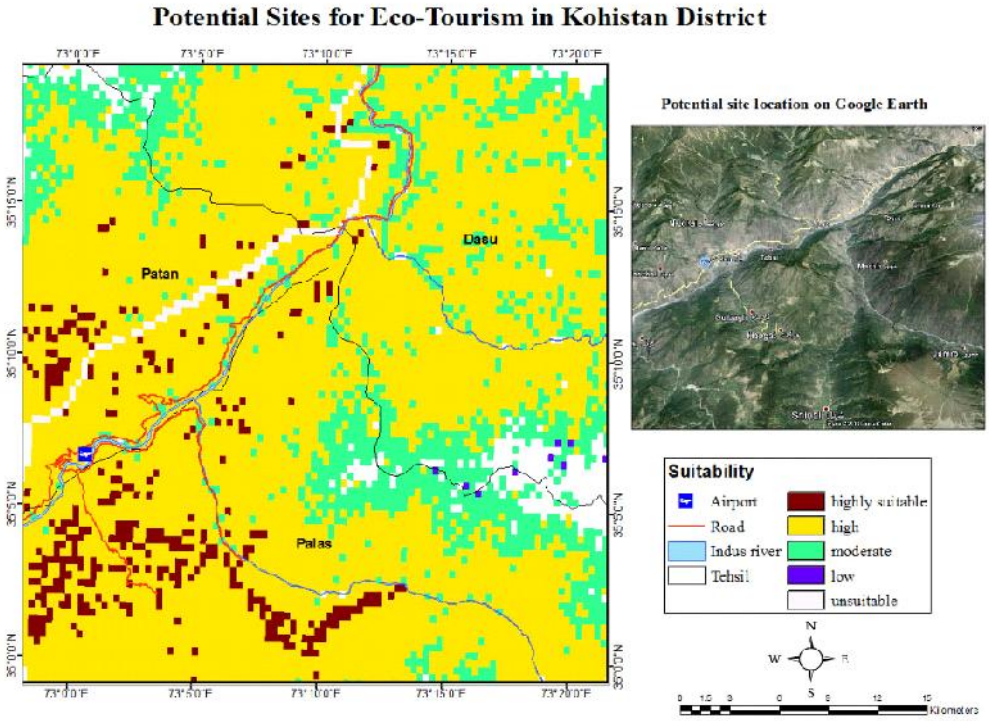

Fig. 5: Potential Sites for Eco tourism.

CONCLUSION

There is a dire need of proper planning in the development of ecotourism spots for sustainable use of nature gifted resources and progress of tourism industry. Kohistan possesses strong potential for recreational activities due to abundance of adventurous and beautiful sites; their proper management can serve as a ladder for creating opportunities for community livelihoods.GIS has proven to be an effective tool and study has provided eco tourism suitability analysis model applicable to other hilly areas. The study will assist the Government and policy makers to invest in those areas that have the potential of providing socio economic benefit to local community through ecotourism. Proper utilization of the explored potential sites will not only ensure sustainable use of natural resources but also improve the livelihoods of local community.

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CONFLICT OF INTEREST

The author declares that there is no conflict of interests regarding the publication of this manuscript.

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