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Tourism v/s Environment: A Case Study of Kashmir Valley

Samira Khan¹, Ibrahim Wani², Bilal Ahmad Bhat³

Abstract

Kashmir is one of the most preferred destination of national and international tourists. However, considering the description of the valley, which is primarily a mountainous region and hence an entirely sensitive area, significantly negative impacts are produced by even the slightest negative aspects attached with tourism industry operating therein. Present development at the cost of future is not acceptable; thus the tradeoff between environment and economy is one of the biggest aspects of sustainable tourism. This study focuses on biophysical carrying capacity which deals with the extent to which the natural environment is able to tolerate external interference and with creating a systematic balance between the negative effects of tourist influx against its socio-economic benefits. The outcomes of the analysis show that the valley has a tremendous potential to absorb tourism, but at the same time the results propose that for increasing human welfare we have to set environment at priority and limit tourism to the carrying capacity of the region; promote sustainable tourism.

Keywords: Tradeoff; Carrying Capacity; Natural Habit; Sustainable Tourism; Regression; R-square.

Introduction

Researchers have shown that an increase in the number of visitors does not only make the area over – crowded, but at the same time, it also leads to the over exploitation of the natural resources, leading to serious damage done to the natural habitat. The tradeoff takes an account of the damage done to the environment, including the generation of more pollution and the inability of the local authority to maintain a balance between environmental protection and the promotion of tourism.

The trade-off between the environment and the economy is one of the biggest questions of sustainable tourism. How do we balance the negative environmental effects of tourist influx against the socio-economic benefits of tourism?

Present development at the cost of future is not acceptable; thus the tradeoff is the most important issue to deal with. Environmentalists say, we have to stop tourism to an extent if we are to avert environmental change, while the industry argues, communities that rely on tourism will suffer if we stop tourism to an extent to distant places (Tackling Tourism's Economic Trade-off, 24th April 2009). The history of events can impact the community socioculturally, environmentally, economically and politically (Omoregie Etiosa 2012). The protected area are major tourism assets for a nation, particularly for developing countries providing sustainable benefit to the local community while funding for the maintenance and rehabilitation of the protected areas. It is reported that because of the heavy influx of tourists and improper management practices the problems of solid waste is increasing at an alarming

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rate (Pananjay et al 2011). The tourist industry generally overuses water resources for hotels, swimming pools, golf courses and personal use of water by tourists. This can result in shortage, waste of water and degradation of water supplies. The majority of visitors are always at the attraction for different purposes and motives such as research, amusement, visit, relaxation etc therefore they may not be aware of their behaviour during the trip of the attraction. Local people are important while developing a destination as a tourism attraction. The strategies should include awareness, education and self-employment opportunities and vocal trainings education programme for ecology preservation and natural resources and environmental conservation. In the literature we come across a number of studies like Mishra and Thangamni (1982), Chadha (1989), Chadha (1990), Chaurasia (1992), Ashworth and Turnbridge (1990), Pearson (2000), Cernat and Gourdon (2004), Romila (2004), Chawla (2006), Hazel H. (2007), David W. (2005), Zainub I. (2009), Stephanie (2009), Goodstein (2010), Kaloo (2012), Subramani (2012), Bijindra (2012), Lucian and Julien (2014), who discussed tourism development and environment.

Tourism has both bad and good effects on our art, craft and culture, on our beliefs and most important, on our environment. On the one hand tourism has led to the preservation of physical environment, historical sites and monuments and wildlife. On the other hand it has caused irreversible damage to some of these. The problem before the administration is that of protecting the environment from pollution and to maintain the ecosystem in balance. Increasing deforestation, unplanned infrastructural development, instruction and pollution have caused severe environmental disturbances in the natural phenomenon .When interrelation between plants, animals and human species and their environment gets disturbed it creates serious consequences for the tourism development also. Kashmir, which is known for its wonderful air, lovely scenery and excellent beauty, suffers some setbacks due to several things.

However, much tourism is desired to be developed with minimum acceptable pollutants. The present study views the potential and prospect of eco-tourism in J&K with special emphasizes on Tradeoff between environment and tourism. This investigation will try to find out a trade-off point between tourism and environment.

Purpose

The purpose of the is to study the following

objectives.

- 1. To study and understand the potential and prospects of eco-tourism in Kashmir valley with special emphasis on trade-off between the environment and tourism.
- 2. To study the possible factors effecting tradeoff decisions in relation to environment

Hypothesis

The study is carried out with the objectives to find out tradeoff between environment and tourism, in this background the following hypotheses has been verified.

- 1. The Valley of Kashmir being ecologically very sensitive needs sound policies to protect its environment.
- 2. Tourism Industry is the most important Industry from the economic point of view, so no trade-off estimation is needed.

Methodology

The methodology undertaken for investigation has been underlined the identification and quantification of environmental entities with the purpose to highlight the appropriate strategy to investigate the case study of Kashmir valley in the context of the trade -off between tourism and environment. The required data has been collected by integrating the primary as well as secondary research approaches. In order to find the inference the following tools of analysis has been widely utilized.

Regression Analysis

This is the technique of developing a statistical model, used to predict the value of the dependent variable by at least one independent variable and

Y = a + bx. Where, Y is the dependent variable, a is the intercept, b is the slope

Trend Analysis

A linear trend can be obtained by using the least squares method. The line has the equation y = a + bx, where x = 1,2,3..., b = slope of the line, and a = value of y when x =0. The coefficients of the equation, a and b, can be determined with usual notations as

$$a = \overline{y} - b_{yx} \overline{x}$$
 and $b_{yx} = Cov(x, y)/Var(y)$

6

Moving Average Method

Fitting of trend by the method of moving averages is based on computing a series of successive arithmetic means over a fixed number of years. This method smoothes out the fluctuations of the given data reducing the effect of extreme observations in the ser ies. If the cyclical variations are regular both in period and amplitude then this method eliminates the fluctuations to a great extent provided the period of the moving average is equal to or a multiple of the period of cycles and trend is linear.

The primary data required has been collected by questionnaire survey with 600 tourists of Kashmir Valley was conducted in order to obtain the first hand information. The questionnaires were distributed to six hundred tourists at various tourism destinations. In our study, it is observed that out of 600 tourists only 400 responded distinctly for the study and the response rate obtained was approximately 66.67 percent.

Results and Discussion

Kashmir is one of the most preferred tourist destinations, both for national and international visitors, which is evident from the constant inflow of tourists. The primary research conducted with the

Table 1: Frequency of the gender

Gender	Frequency	Percent (%)
Male	267	66.8
Female	133	33.2
Total	400	100.0

Table 2: Frequency of the age group

Age Group	Frequency	Percent (%)
Upto20	18	4.5
21-30	130	32.5
31-40	154	38.5
41-50	59	14.8
51-60	25	6.2
61 & above	14	3.5
Total	400	100.0

Table 3: Frequency of the occupational status

Occupational status	Frequency	Percent (%)
Business	157	39.2
Service	164	41.0
Student	42	10.5
Agriculturalist	22	5.5
Others	15	3.8
Total	400	100.0

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help of questionnaires administered to the tourists and have been designed to collect information regarding the purpose and duration of visit, mode of transport, styles of accommodation, occupational composition, traveling approach etc.

Demographic Information

The gender of the respondents is reported in **Table 1**, as 66.8% are males and 33.3% of them are females.

The age groups of the respondents as observed from **Table 2**, reveals that 38.5% of the respondents belong to the age group of 31-40. Following this, significant percentages of tourists in age groups of 21-30, 41-50, less than 20 and greater than 60 are obtained, revealing that the splendor of Kashmir is enjoyed by every age group.

The occupation of the respondents is apparent from the **Table 3**. It can be seen that 41% are in the service sector. It pertains, Kashmir is a state where tourism related packages like accommodation, food and transport can be easily afforded by the service class to stay and above all the tax burden is very low, relating that Kashmir is a reasonably priced, reasonable place to visit and offers great pleasure at a much reduced amount. Following this the respondents in the fields of business, learning, agriculture and others are also experimented with.

The modes of transportation opted by the visitors as reported in **Table 4**, reveals that 69.2% of the respondents used road and 30.8% of them went for air transport. Statistically, frequency distribution is not uniform (P<0.01). From the **Table 4**, it can be concluded that the association of most of the visitors with the service sector accounts for the reduced use of the air travel systems. Another factor may be the picturesque highway of J&K.

The associations of the respondents during their travel are perceived from the **Table 5** as 51.2 % of the

respondents are in family associations while the others are either in groups or single. The data refers to the fact that the state of affairs in the valley is not as debased as portrayed by the agencies.

The distribution in terms of travel planning can be observed from the **Table 6** as 64% of the respondents fall in the category of self-planning. Following this, the respondents in associations with travel agents and other associations are also surveyed. The above observation recounts that the tourism related authorities are not publicizing the beauty of Kashmir up to the level of satisfaction, thereby exemplifying

Table 4: Frequency of the transportation	Table 4:	Frequency	of the	transportation
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ode of transportation	Frequency	Percent (%)	Chisquare	P-valu
Road	277	69.2		
Air	123	30.8	59 29	< 0.01
Total	400	100.0		
Table 5: Frequency of	the association durin	ng travel		
Association during tra	vel	Frequency	Percent (%)	
Single		90	22.5	
Family		205	51.2	
Group		105	26.3	
Total		400	100.0	
Table 6: Frequency of the	e distribution by trav	vel planning		
Distribution by travel pl	anning	Frequency	Percent (%))
Self		256	64.0	
Conducted tours		78	19.5	
Other		66	16.5	
Total		400	100.0	
Table 7: Frequency of the	e purpose to visit			
Purpose to visit		Frequency	Percent (%)	_
Holiday		25	6.3	
Pilgrimage		274	68.5	
Business		44	11.0	
Adventure sport		24	6.0	
Education		13	3.2	
Other		20	5.0	
Total		400	100.0	
Table 8: Frequency of the	e tourist places visit	ed		
Tourist places visited		Frequency	Percent (%)	_
Pahalgam		232	58.0	
Gulmarg		98	24.5	
Srinagar		67	16.7	
Other		3	0.8	
Total		400	100.0	

the weak marketing strategies of the concerned departments.

The 'purpose of visit' can be noticed from the **Table 7** as 68.5% of the respondents are on

pilgrimage, revealing that pilgrim tourism is totally disproportionate in comparison with the other forms of travel. Subsequently, the respondents on holiday, business and educational trips, adventure sprees and other categories are examined.

The tourist destinations visited by the respondents are clear from the Table 8 as 58% of the respondents visited Pahalgam, pertinent with the pilgrimage tourism. Following this, the remaining percentage visited Gulmarg, Srinagar and other places of interest.

The frequency of number of visits of the respondents as observed from the Table 9 reveals that 80.2% of the respondents are on their first visit to the valley. Following this, the frequencies of the respondents on their second, third, and additional visits are also observed.

The accommodation of the respondents as observed from the Table 10 reveals that 54.2% of the respondents decide on hotels followed by the house

boats. Following this, the respondents preferring guest houses, lodges, and other arrangements are also experimented with.

The 'length of stay' of the respondents is observed from the Table 11 as 52.5% of the respondents are on a 4 – 6 days' stay. Following this, the respondents on a stay of 1-3 days, 7-9 days, and 10 days and above are also observed. Despite the fact that the valley has an enormous potential for tourism, the lack of information and resources holds the tourists from new-fanaled destinations.

The income of the respondents as observed from the Table 12, though this guestion was not answered by maximum visitors, yet the information collected shows that a middle class society mainly visits the

Table 9: Frequency of y	visits
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Number of visit	Frequency	Percent (%)
1 st visit	321	80.2
2 nd visit	50	12.5
3 rd visit	19	4.8
Frequently	10	2.5
Total	400	100.0
able 10: Frequency of the accommodation		
Accommodation availed	Frequency	Percent (%

Accommodation availed	Frequency
	017

		• •
Hotels	217	54.2
House boat	147	36.8
Lodges/guest houses	20	5.0
Other	16	4.0
Total	400	100.0

Table 11: Frequency of the length of stay

Length of stay	Frequency	Percent (%)
1-3 days	36	9.0
4-6 days	210	52.5
7-9 days	130	32.5
10 &above	24	6.0
Total	400	100.0

Table 12: Frequency of the monthly income

Monthly income	Frequency	Percent (%)
up to 15000	92	23.0
15001-25000	151	37.8
25001-35000	89	22.2
35001 & above	68	17.0
Total	400	100.0

Table 13: Frequency of the plan to revisit

Plan to revisit	Frequency	Percent (%)	Chisquare	P-value
Yes	203	50.8		
No	197	49.2	0.09	>0.05
Total	400	100.0		

valley, which is already prominent from the above study that 41% of the visitors belong to the service sector.

The Plan of Reconsidering a Visit to Kashmir

Most of the respondents show a positive response. As observed from the Table 13, 50.8% of the respondents plan to revisit while the remaining 49.2% show a negative riposte. Statistically, frequency distribution is uniform (P>0.05). The visitors do not want to revisit mainly because the facilities provided are not up to the mark when with roughly the same budget other pleasant destinations may possibly be explored.

From the **Table 14**, it is strikingly evident that the natural beauty of Kashmir attracts most of the people. The future of tourism industry is diligently related to the natural beauty, thus its maintenance is extremely imperative. It is seen that 63.3% of the respondents fall for the natural beauty. Following this, the frequencies of the respondents yearning for

Major attractions	Frequency	Percent (%)	Chisquare	P-value
Natural beauty	253	63.3	313.1	<0.01
Handicrafts	44	11.0		
Trekking	57	14.2		
Other	46	11.5		
Total	400	100.0		

Table 14: Frequency of the major attractions

handicrafts, trekking and other attractions are also calculated. Statistically, frequency distribution is not uniform (P<0.01).

The result shows that the visitors are just captivated by the natural beauty of the valley. This either confirms the importance of ambiance in the



Major attractions

Fig. 1: Percentage of the major attractions





Fig. 2: Percentage of the recommendations

industry of tourism or in economic terminology it shows that nature and tourism are complementary to each other.

Tourism is an asset, an endowment of the nature on the state. Unless we are not able to spawn the requisite infrastructure and other facilities of international standards for the tourists, in consideration with the environmental norms, the real benefits will not flow to our people. Demographic and socio economic characteristics somehow portray the basic differences that are the real determinants of the traveler's behavior. It may be assumed that the best way to gauge the successful management of tourism development is to determine the level of consumer satisfaction.

Service and business classes constitute the largest group of visitors to the valley with sightseeing and pilgrimage as the major purposes. The principal mode of haulage is road transport. "Contented Tourist" itself is the best tourism promotional method as it is noticeable from our field survey that many tourists visit valley on the recommendations of their friends and relatives. In chorus, the disappointed tourists prove injurious to the interests of tourism industry. The analysis shows that the tourists are attracted mainly by the natural beauty of Kashmir; so under such circumstances the concerned are suggested to take care of the pristine environment, which is the basic stuff of the industry. It is encouraging that tourists visiting Kashmir encourages plays a significant role in encouraging others to visit (p<0.01).

Environmental Effect of Pilgrim Tourism/Tourist Destinations in Kashmir Valley: Pahalgam A Growing Concern

Pahalgam is situated at an altitude of 2,133 meters amidst lofty deodars, fir and pine trees, junipers and many other conifers. The place gets lively during the tourist months of the summer, as well as during the weeks before the Amaranth Yatra. There is something about the pure and re-vitalizing air of Pahalgam. Perhaps dense pine and cedar forests make it oxygen rich. Limited accessibility combined with limited telecom connectivity makes it an ideal getaway from the grind of daily life and professional stress. The town is at the junction of the Aru and Sheshnag rivers surrounded by, fir-covered mountains with bare, snow-capped peaks rising behind them. The Aru flows down from the Kolahi glacier beyond Lidderwat while the Sheshnag from glaciers of the great Himalayas.

According to the mountaineers from Jawahar Institute of Mountaineering (JIM) in 2008, the glacier has receded by half since 1985. The glacier is not safe to study because it is hollow and in places has 200foot-deep (61 m) crevasses. The sounds of cracking ice can be heard from either side of the glacier, which indicates an imminent collapse.

Tourism in Kashmir is of different forms. Pilgrimage tourism, in particular, is of most significant forms, which is advantageous as well as disadvantageous for the society of Kashmir. Around 600,000 pilgrims have so far performed Yatra during 2012. (Digest of statistics and economics) Concerned

Year	Number of Yatries	Moving average	Growth Rate
1989	95238	81097.67	-0.85
1990	4824	65372.33	-94.95
1991	15599	38553.67	223.26
1992	54638	25020.33	250.27
1993	56000	42079.00	2.49
1994	37000	49212.67	-33.93
1995	60000	51000.00	62.16
1996	120000	72333.33	100
1997	79035	86345.00	-34.14
1998	149920	116318.33	89.69
1999	114366	114440.33	-23.72
2000	173334	145873.33	51.56
2001	119037	135579.00	-31.33
2002	110793	134388.00	-6.93
2003	153314	127714.67	38.1
2004	400000	221369.00	161.44
2005	388000	313771.33	-3
2006	265000	351000.00	-31.7
2007	213565	288855.00	-19.4
2008	498198	325587.67	133.2
2009	373419	361727.33	-25.04
2010	458212	443276.33	22.7
2011	542355	457995.33	18.4
2012	600000	533522.33	10.6

Table 15: Incoming pilgrim tourists (Sri AmarnathJiYatra) into the valley from 1989-2012

authorities like tourism department is only concerned on the huge tourist flow but care less particularly about the adverse impact on the environment.

The **Table 15** shows tremendous increase in Pilgrim tourism. It can be seen that the inflow of devotees visiting the holy shrine have been unremittingly increasing at an alarming rate over the period of time. No doubt there are various fluctuations in the devotees' influx but on the whole there has been a steady increase in pilgrims visiting the Holy cave. The number of pilgrims starts declining after 1990 due to turmoil in the valley, but after normalcy in valley the arrival of pilgrims again picked up due to the joint efforts of agencies involved. The Government take an initiative to provide various types of facilities and amenities to the Pilgrims for their safety and security. From the **Table 15** we can see that there is a continuous increase in tourists arrival after a major dip in 1990 and now the position is so that there is a continuous increase in tourist arrival after a major dip in 1990 and now the position is so that there are almost 1.2 lakh people visiting Amarnath Ji (ceiling on tourist arrivals has been imposed by the government). It is only because of these determined efforts that the

Equation		Model Summary			Pa	rameter Estimat	es		
	R ²	F	df1	Df2	Sig.	Constant	b1	b2	b3
Linear	.790	82.946	1	22	.000	-4.547E7	2.284E4		
Logarithmic	.790	82.550	1	22	.000	-3.468E8	4.566E7		
Inverse	.789	82.155	1	22	.000	4.585E7	-9.129E10		
Quadratic	.791	83.343	1	22	.000	-2.264E7	.000	5.710	
Cubic	.791	83.742	1	22	.000	-1.503E7	.000	.000	.002
Compound	.757	68.698	1	22	.000	5.741E-121	1.155		
Power	.758	68.778	1	22	.000	.000	288.688		
S	.758	68.858	1	22	.000	300.511	-5.776E5		
Growth	.757	68.698	1	22	.000	-276.865	.144		
Exponential	.757	68.698	1	22	.000	5.741E-121	.144		
Logistic	.757	68.698	1	22	.000	1.742E120	.866		

Table 16: Model Summary and Parameter Estimates

Fitted Trend Equation is given by

 $Yt = 56435.0 - 7194.85^{*}t + 1201.20^{*}t^{**}2$

number of pilgrim tourists enhance again and went to 1,10793 in 2002 and 6,00,000 in 2012. On the whole it is ostensible from the data provided by the authorities that there has been a terrific growth in the inflow of Pilgrims visiting the valley.

Forecasting Yatris arrival is important as it would enable tourist related industries like airlines, hotels, food and catering services, etc., to plan and prepare their activities in an optimal way. From the data it is observed that Yatris arrivals has generally increased over the years and obviously it is not a stationary time series. On the basis of fitting various models as reported in **Table 16** using statistical software SPSS version 20, taking number of Yatris visiting as dependent variable and year as independent variable, we forecast by applying a suitable model on the basis of the highest value of R-square.

The Accuracy Measures obtained from the data for the best fitted model are MAPE (Mean Absolute Percentage error) = 68.9261, MAD (Mean Absolute Deviation): 48442.2 and MSD (Mean Squared Deviation) = 3990588826 and R² =0.791. The model having the smaller value of MAE, RMSE and MAPE is considered as a good model for forecasting. The





S. No.	Year	Yatris (000)
1	2008	498
2	2009	373
3	2010	458
4	2011	542
5	2012	600
6	2013	606.1
7	2014	643.4
8	2015	680.7
9	2016	718
10	2017	755.3
11	2020	1056.2
12	2025	1484.6

Source: Calculated by scholars

forecasting is of course based on the assumption that events, like government policy, promotion campaigns, natural or man made events, etc., do not change drastically.

The forecasts are given in the **Table 17**. The data presented in **Table 17**, shows that under the assumption of stable conditions in the valley the number of pilgrims will go on increasing as observed from **Table 17**. Forecasting the number of pilgrim tourists it is prominent from above analysis that the arrival will go on mounting as 643000 in year 2014, 680000 in 2015,718000 in 2016 and in year 2025 the growth will reach to 1484.6. The terrific increase in the limited capacity of the destination is an alarming bell for the valley as a whole.

The apex institution of India has recently raised two more points on AmarnathYatra in the Kashmir valley. One, the most important from study point of view is, how this large number of people – seven times more than the handling capacity to be specific –had been permitted to visit the cave. The apex institution has issued notice to the central and state governments and also the chief of the Amarnath shrine board, seeking their explanation on the points raising environmental issues vis-a-vis the fragile nature of the area. The apex court has rightly observed that the govt. is duty bound to control the pollution. On the basis of statement published in a local daily Greater Kashmir on 17 July 2012, this infers that the apex court found the number of pilgrims during 2011 as 542,355 being seven times more than the handling capacity of the destination. Thus estimating roughly the handling capacity of the destination is equal to 77,479 only and any further increase in influx would cause injuries to the pristine environment of the said destination. Tourism in Kashmir valley to an extent has been limited to pilgrimage by domestic tourists. The total figures on entry of domestic tourists into the valley has a significant input of such tourists and it should be the effort of the State administration to make the

Table 18: Compound growth rate of Total number of Devotees visiting Amarnath

Variable	C.G.R (percent)	Standard Error of C.G.R	't' value
Total	13.7	2.45	2.840*

Source: Calculated by Scholar.*Significant at 5 percent level

movement of such pilgrims safe for the environment; the environment that should be prevailing in the future to attract the tourists in large. The compound growth rate of total number of devotees visiting Amarnath is reported in **Table 18**.

Conclusion

The study have expressed concern over the number of people participating in the AmarnathYatra which is having a negative impact on the area's ecology and to a some extent expressed support for government regulated limits on the number of pilgrims permitted to make the trek. The heavy rush of yatris creates a condition of excessive pollution. The sustained increase in tourist influx to Pahalgam cheers the concerned departments up, but there is something that will soon give a bad taste. A study by the directorate of ecology and environment has expressed serious concern over the surging scale of pollution and excessive use of polyethylene carry bags that have choked the streams in this region. In the earlier times these forests were so dense and that wild animals/birds would be seen roaming in the lanes of old towns especially in the winter season.

According to the Department of environmental Science, University of Kashmir, State pollution Control Board (SPCB) the physio -chemical properties of water quality of River Lidder indicate some parameters exceeding the prescribed permissible standards of IS resulting in significant degradation of water quality. This has created the epidemic threat in the villages dependent on these nallahs for portable water. The study maintains that although no industry with severe air emissions exists in pahalgam but the inflow of heavy vehicles and all types of two wheelers, four wheeler, trucks, buses, carriage vehicles, passenger vehicles, yatri load carriers, armed force convoys, building material carriages, carriages transporting tents etc. is disturbing the eco balance of the place. In view of the environmental concerns, the Government of Uttranchal has restricted the number of pilgrims visiting Gomukh and other Gangotari glaciers, the origin of the holy river Ganga to only 150 per day, while in Kashmir per day 20,000 the Amarnathyatris are allowed for Darshan near Kolihi Glacier which is a colossal source of drinking water for residents in south Kashmir. According to the surveys done by various environment and ecological departments, the Kolahai glacier has shrunk by 18 percent during the last three decades. Pumping of a millions of Pilgrims to Amarnath will vandalize the fragile

environment of Kashmir as the number of Pilgrims is much more than the assimilative or carrying capacity of the place. The ecosystem is a delicate phenomenon that cannot be thrown open to wanton exploitation or abuse. Preserving biodiversity in an area of increasing biodiversity erosions is not an option today; it is rather a necessity for a sustainable tourism development agenda. Given the huge environment issue related to it, the Amarnath Yatra should never be looked through the political prism but must be acknowledged as an economic activity which producing output that adds to environment pollution.

The present method being adopted for disposal of solid wastes at Pahalgam is of serious health concern, particularly during rainy season and high humidity conditions. The landfill sites, which are not well maintained, are prone to ground water contamination due to leachate percolation. Open dumping of garbage serves as breeding ground for disease. Strategies for better Environment Management are only beginning to see the light of the day. On one hand local authorities are incapable of handling the additional burdens of the floating population due to the lack of resources and on the other hand most Religious institutions which benefit directly from offerings made by Pilgrims, as well as local business are not contributing to improve the environment. Thus willingness to pay (WTP) is totally ineffective and yet it is the paramount of these institutions to feel the moral responsibility of propagating religious faith while incorporating environmental concerns.

References

- 1. Bagri S.C. & Gupta. S.K. 'Tourism in Garhwal', Himalaya Publishers. 2003.
- Bhat Bilal A., Raja T.A. and Akhter R. Statistical Models and their Applications to Meteorology, Sci. for Better Tomorrow, 2008.p.393-402.
- Bijendra K. Punia. "Tourism management problems and prospects" Department of Geography and Environmental Studies, Mekelle University, Ethiopia, IJRESS, 2012; 2(1).
- Cernat Lucian and Gourdon Julien. 'Sustainable tourism – the need for a comprehensive methodological framework', Institute for Development Policy and Management, University of Manchester. 2004.
- Chadha S.K. 'Environmental holocaust on Himalaya', Ashish Publishing House New Delhi. 1989.

- 6. Chadha S.K. 'Ecology of Kashmir. Natural resources of western Himalayas', APH New Delhi. 1990.
- Chaurasia B.P. 'Environmental pollution Consequences and measures'; Chaugh publications. 1992.
- 8. Chawla Romilla. 'Tourism and development series', Sonali Publications New Delhi. 2006.
- 9. David Waiver. Sustainable Tourism, Theory and Practices, Kindle edition Elsevier. 2005.
- G.B.G. Pananjay K.Tiwari; G.B.G.Shashi; and S.C.Tiwari. 'An Overview of Potential Ecotourism Resources and Their Prospects in Valley of Flowers National Park, Uttaranchal, India, Caspian Journal of Environmental Science, 2011; 9(1):105-110.
- 11. G.H. Kaloo. "Kashmir mirror reflection, International Journal of Current Research and Review, 2012; 4(4).
- 12. Goodstein S. Eban. 'Economics and the Environment'. John Wiley & Sons, Sixth Edition. 2010.
- Hazel Handerson. "Ecologists vs Economists" Cambridge University Press, 2nd edition. 2007.
- 14. Massive Hindu Pilgrimage Melting Sacred Glacier", News.nationalgeographic.com
- Lucian Cernat and Julien Gourdon. "Sustainable tourism – the need for a comprehensive methodological framework" Institute for Development Policy and Management, University of Manchester. 2004.
- Mishra and Thangamani. 'Tourism dual effect's, Himalyian Publications, New Delhi. 1982.
- 17. Omoregie Etiosa. The Impacts of Event Tourism on Host Communities Case: The City of Pietarsaari Doctoral Thesis of Tourism Program, University of Applied Science Central Ostrobothenia. 2012.
- Pearson Charles. S. 'Economics and the global environment', Published: Cambridge University Press, 2000; 24:583.
- Romila Chawla. Cultural Tourism and Development, New Delhi, Sonali Publications Stephanie Draper (2009), 'Tackling tourism's economic trade-off', 24th April http:// www.forumforthefuture.org/blog/tacklingtourisms-economic-trade. 2004.
- Shafi M. Tourism Dynamics in a Developing Economy. Srinagar-India, Gulshan Publisher Kashmir. 1994.
- T. Subramani. Study of Air Pollution due to Vehicle Mission in Tourism Centre, International Journal of Engineering Research and Application, 2012; 2:1753-1763.
- Zainub Ibrahim. Tourism Development and the Environment on the Egyptian Red Sea, Coast. A thesis, presented in University of Waterloo. 2009.

Determination of Geomorphological Characteristics of Karpri-Kalu Watershed Using GIS Techniques

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Abstract

A Watershed is an ideal unit for management of resources like land and water for mitigation of the impact of natural disasters for achieving sustainable development. It provides a powerful study and management unit, which integrates ecological, geographical, geological, and cultural aspects of the land. GIS technique is used to estimate the morphological characteristics of watershed. Delineation of watershed using GIS is mainly based on the Digital Elevation Model (DEM) data. The study area, watershed, 8.04 Km², is located in Sangamner Tehsil of Ahmednagar district and lying between 74° 20' 36'' E to 74° 23' 6'' E longitude and 19° 21' 34'' N to 19° 23' 56'' N latitude. The average annual rainfall is 379 mm. Various operations were done to prepare contour and drainage maps. Areal, linear and relief aspects of watershed were estimated. The parameters worked out includes Stream order, Stream length ratio, Bifurcation ratio, Basin length, Length of overland flow, Form factor, Circulatory ratio, Elongation ratio, Stream frequency, Drainage density, Constant of channel maintenance, Maximum relief, Relative relief, Relief ratio and Ruggedness number. 4th order stream is trunk order. Total lengths of streams and total numbers of streams in each order are decreasing with increasing order. Bifurcation ratio for the watershed is 3.166. The form factor for the area is 0.424. From the value of elongation ratio 0.734, it is observed that the watershed is less elongated. The drainage density value for the basin area is 2.024Km/Km² that is basin is poorly drained. The study will be useful for the planning of watershed harvesting and groundwater recharge projects on watershed basis.

Keywords: Watershed; Morphometric Analysis; GIS; Karpri-Kalu; Linear; Areal; Relief Aspects.

Introduction

A Watershed is an ideal unit for management of resources like land and water for mitigation of the impact of natural disasters for achieving sustainable development. It provides a powerful study and management unit, which integrates ecological, geographical, geological, and cultural aspects of the land. The watershed is also a useful concept for integrating science with historical, cultural, economic, and political issues. Water (movement, cycling, use, quality, etc.) provides a focus for integrating various aspects of watershed use and for making regional and global connections (Yongsheng Ma). The response of a particular watershed to different hydrological processes and its behaviour depends uponvarious physiographic, hydrological and geomorphological parameters. Though these are watershed specific and thereby unique, the characterization of a watershed provides an idea about its behaviour.

Morphometry is defined as the measurement and mathematical analysis of the configuration of the earth's surface and of the shape and dimension of its landforms (Clarke, 1966). Morphometric methods, though simple, have been applied for the analysis of area-height relationships, determination of erosion surfaces, slopes, relative relief and terrain characteristics, river basin evaluation, and watershed

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prioritization for soil and water conservation activities in river basins (Kanth, T. A.).

Quantitative morphometric characterization of a drainage basin is considered to be the most appropriate method for the proper planning and management of watershed, because it enables us to understand the relationship among different aspects of the drainage pattern of the basin and also to make a comparative evaluation of different drainage basins, developed in various geologic and climatic regimes (Pingale S. M. *et al.*).

The measurement of morphological parameters is laborious by the conventional methods, but using the latest technology like GIS, the morphometric analysis of natural drain and its drainage network can be better achieved. Various morphometric parameters needs to measure in a drainage basin include stream order, stream length, stream number, and basin area.

Others morphometric parameters are basin shape factor (e.g. circularity ratio, elongation ratio, form factor and compaction ratio), basin perimeter, bifurcation ratios, drainage density, stream frequency and drainage intensity (Shaikh M. and F. Birajdar). Geographic Information Systems (GIS) technology has played critical roles in all aspects of watershed management, Basic physical characteristics of a watershed such as the drainage network and flow paths can be derived from readily available Digital Elevation Models (Tim U. S.).

DEM describes the elevation of any point in a given area at a specific spatial resolution. For the present study Remote Sensing and Geographical Information System (GIS) is used as tools for managing and analyzing the spatially distributed information. Arc GIS is powerful software to analyze, visualize, update the geographical information and create quality presentations that brings the power of interactive mapping and analysis.

Geomorphological analysis helps in better understanding of hydrological system of watershed which is useful for carrying out management strategies.

Study Area

The study area is located in Sangamner tehsil of Ahmednagar district and lying between 74°20'36'' E to 74° 23' 6'' E longitude and 19° 21' 34'' N to 19°23' 56'' N latitude. Area of watershed is 8.04 Km². The average annual rainfall is 379 mm. Watershed is found under water scarcity zone.

Data Used and Methodology

Topography is defined by a Digital Elevation Model (DEM) that describes the elevation of any point in a given area at a specific spatial resolution. The DEM is used to delineate the watershed and to analyze the drainage patterns of the land surface terrain. The parameters such as slope gradient, the stream network characteristics such as channel slope, length, and width are derived from the DEM. The generation of depression less DEM is always the preparatory step for morphometric analysis of drainage basin. Hydrology tool under Spatial Analyst Tools in Arc GIS-10.1 software is used to extract drainage channels, and other parameters.

Linear Aspects

Stream Number and Stream Order

The order of the stream is based on the connection of tributaries. Stream order is a fundamental property of stream networks as it relates to the relative discharge of a channel segment. In the present study, the channel segment of the drainage basin has been ranked according to Strahler's stream ordering system. According to Strahler (1957), the smallest fingertip tributaries are designated as order 1. Where two first order channels join, a channel segment of order 2 is formed, where two of order 2 join, a segment of order 3 is formed and so forth. The trunk stream through which all discharge of water and sediment passes is therefore the stream segment of highest order (Vinoth M.).

Stream Length

Stream length is the length of all the streams having order u. It indicates the contributing area of the basin of that order. Generally, the total length of stream segments is maximum in first order streams and decreases as the stream order increases (Soni S. et al). The extent of stream length in a watershed reveals the characteristics size of various components of drainage network and its contributing surface area.

Stream Length Ratio (RI)

It is the ratio of mean length of stream (Lu) of particular order to the mean stream length of next lower order (Lu-1) (Horton, 1945). It is expressed as,

$$Rl = \frac{Lu}{Lu - 1}$$

•

• Bifurcation Ratio (Rb)

The term bifurcation ratio (Rb) is used to express the ratio of the number of streams of any given order to the number of streams in next higher order (Horton, 1945).

$$Rb = \frac{Nu}{Nu+1}$$

Where, Nu= No. of streams of particular order

Nu+1= No. of streams of next higher order.

Length of Overland Flow

It is defined as the length of flow of water over the ground, before it becomes concentrated in defined stream channels (Horton, 1945). It is half the reciprocal of drainage density (Dd).

Areal Aspects

• Form Factor (Ff)

It determines about the shape of the basin. Form factor is defined as the ratio of basin area to the square of the basin length (Horton, 1932).

$$Ff = \frac{Aw}{Lb2}$$

Where, Aw= basin area

Lb= basin length

• Circularity Ratio (Rc)

Circulatory ratio (Rc) is estimated as the ratio of the basin area (A_w) to the area of a circle (Ac) having circumference equal to the perimeter of the basin (Miller, 1953).

$$Rc = \frac{Aw}{Ac}$$

The value of "C" generally changes from 0 (a line) to 1 (circle). The higher the value of "C" more the circular shape of the basin and vice versa.

• Elongation Ratio (Re)

It is the ratio between the diameter of the circle of the same area as the drainage basin and the maximum length of the basin (Schumm, 1956).

$$Re = \frac{Dc}{(Lb)max}$$

Where, Re = Elongation ratio, dimensionless.

Dc = Diameter of circle having same area as the given drainage basin, m.

Lb max. = Maximum basin length parallel to the principle drainage lines, m

High Re values indicate that the areas are having high infiltration capacity and low runoff. Values nearing 1.0 are typical of regions of low relief, whereas values in the range of 0.6 to 0.8 are generally associated with strong relief and steep ground slopes.

Drainage Density (Dd)

It is the ratio of total length of channels of all orders in the basin to the drainage area of the basin (Horton, 1945).

Constant of Channel Maintenance(C)

It is the ratio between the area of the drainage basin and total length of all the channels, expressed as square meter per meter. It is also equal to reciprocal of drainage density (Dd).

• Stream Frequency (Sf)

Stream frequency was introduced by Horton (1945). It is defined as the total number of stream segments of all orders per unit area.

$$Sf = \frac{\Sigma Nu}{Ab}$$

Where, Ó Nu = Total no of stream segment.

Ab = Basin area.

• Drainage Factor (Df)

It is ratio of stream frequency to the square of drainage density.

Relief Aspects

• Maximum Relief (H)

It is the maximum vertical difference between highest and lowest point in the watershed. Relief is an indicative of the potential energy of a given watershed above a specified datum available to move water and sediment down slope.

Maximum Basin Relief

It is elevation difference between basin outlet and

highest point located on the perimeter of basin.

Relief Ratio

It is the ratio of relief (H) to the horizontal distance(L) on which relief was measured (Schumm, 1956).

$$Rn = \frac{H}{L}$$

Relative Relief (Rr)

It is the ratio of maximum watershed relief to the perimeter of watershed (Melton, 1957).

$$\operatorname{Rr} = \frac{H}{P} \times 100$$

Where, Rr = Relative Relief, %

H = Maximum basin relief, m

P = Basin perimeter, m.

Ruggedness Numbers (Rn)

Ruggedness number (Rn) is a product of relief (H) and drainage density (D) in the same unit (Strahler 1958). The areas of low relief but high drainage density are regarded as ruggedly textured as areas of higher relief having less dissection.

 $Rn = H \times D$

Result and Discussion

Linear Aspects

Total number of 29 streams are identified of which 22 are 1st order streams, 4 are 2nd order, 2 are 3rd order and one is indicating 4th order stream. Total length of 1st order streams is 7.143 Km, 2nd order streams 7.381 Km, 3rd order streams 1.726 Km and 4th order stream is 0.031 Km. The mean stream length of the watershed is found to be 0.324, 1.845 and 0.863 km for 1st, 2nd and 3rd order streams respectively. It is observed that total length of 2nd order stream is very small.

Stream length ratio for the basin varies between 0.035 to 5.694. The stream length ratio (RL) is estimated of 5.694, 0.467 and 0.035 for II/I, III/II and IV/III orders, respectively.

In the present study, Rb varies from 2 to 5.5 with an average of 3.166. It is estimated of 5.5, 2 and 2 for I/II, II/III and III/IV orders, respectively. Rb is not same from one order to its next order. It is observed that watershed is neither elongated nor circular in shape. The high value of Rb indicates structural complexity and low permeability (Pankaj, 2009). It also indicates that the value of Rb is not same from one order to next order. The higher value of Rb indicated strong structural control on the drainage pattern. This shows it's usefulness for hydrograph shape for watersheds similar in other respect. An elongated watershed has higher bifurcation ratio than normal and approximately circular watershed (Singh, 2003). It is indicated that the watershed chosen for the study is not circular in shape and would produce delayed peak flow.

Basin length of basin is 4.355Km. It is the longest length of basin from the head water to the point of confluence.

The term "length of overland flow" is used to describe the length of flow of water over the ground before it becomes concentrated in definite stream channels. The length of overland flow is 0.2470. The watershed is having less structural disturbances, having higher overland flow.

Areal Aspects

The form factor for the study area is 0.424. For perfectly circular basin it should be greater than 0.78. Smaller the value of form factor more will be elongated basin and high peak flows of shorter durations.

The value of Circulatory ratio for the watershed is0.35. The value of Rc is influenced by the length and frequency of streams, geological structures, land use/land cover and slope of the basin.

The elongation ratio of watershed is 0.734. The varying slopes of watershed can be classified with the help of the index of elongation ratio, i.e. circular (0.9-0.10), oval (0.8-0.9), less elongated (0.7-0.8), elongated (0.5-0.7), and more elongated (< 0.5). It is observed that the watershed is less elongated.

The stream frequency of the watershed is 3.606. The value of stream frequency (Fs) for the basin exhibit positive correlation with the drainage density value of the area indicating the increase in stream population with respect to increase in drainage density. The stream frequency is dependent more or less on the rainfall and the temperature of the region.

The drainage density of the watershed is 2.024Km/Km². A low drainage density indicates permeable subsurface strata and is a characteristic feature of coarse drainage which generally shows values less than 5.0. A low value of the drainage density indicates a relatively low density of streams

and thus a slow stream response (Singh, 2004). Drainage texture is one of the important concepts of geomorphology which means the relative spacing of drainage lines.

Value of Constant of channel maintenance(C) for the basin is 0.494Km which is reciprocal of drainage density.

Relief Aspects

The maximum relief for the watershed is 0.4846Km. Relative relief for the watershed is 0.352.

The relief ratio for basin is 0.0111. Watershed area indicates the presence of basement rocks that are exposed in the form of small ridges and mounds with lower degree of slope. The Rh normally increased with the decreasing drainage area and size of the watersheds for a given drainage basin (Gottschalk, 1964). It measures overall steepness of watershed and also considered as an indicator for the intensity of erosion process occurring in the watershed. The high value of relief ratio is characteristics of hilly region.

The Ruggedness number for the basin is 0.980Km. This number represents that if drainage density is increased, keeping relief as constant then average horizontal distance from drainage divide to the adjacent channel is reduced. On the other hand, if relief increases by keeping drainage density as constant, the elevation difference between the drainage divide and adjacent channel will increase.

Summary and Conclusion

Geographical Information System (GIS) tools are used in the drainage delineation and their updation. Morphometric analysis is carried out through updated drainage. Linear aspects, areal aspects and relief aspects of the basin are measured for the analysis. The number of streams of various orders in watershed are counted and their lengths from mouth to drainage divide are measured with the help of GIS software. Total area and perimeter of basin is 8.042Km² and 13.74Km. respectively. Basin length is 4.355Km and average basin width is 3.07Km. Total number of streams in the basin are 29. The highest order of stream is fourth order. The number of lower order streams are more than higher order stream. Both total lengths of streams and total numbers of streams in each order are decreasing with increasing order as explained by Horton (1945) and increasing mean stream length with increasing order as explained by Strahler (1964). From bifurcation ratio it is observed

that there are less structural disturbances in the watershed. The length of overland flow is 0.2470. The drainage density value for the basin area is 2.024Km/ Km² that is basin is poorly drained. The Form factor and circulatory ratio for the watershed is 0.424 and 0.35 respectively. The circularity ratio is influenced by stream length, stream frequency (Fs), geological structures, land cover, climate, relief and slope of the basin. It is an important parameter, which indicates the stage of the basin. The elongation ratio of watershed is 0.734. The watershed has less elongated shape and having strong relief and steep ground slope. The value of stream frequency (Fs) for the basin exhibit positive correlation with the drainage density value of the area indicating the increase in stream population with respect to increase in drainage density. Maximum relief and relative relief of the basin is 0.4846Km and 0.352 respectively. Relief ratio is 0.0111. According to Schumm (1956), there is direct relationship between the relief and channel gradient. There is also a correlation between hydrological characteristics and the relief ratio of a drainage basin. The study will be useful for the planning of watershed harvesting and groundwater recharge projects on watershed basis.

References

- BhamareDipika, RajaneeSalunkhe, DeepikaMavale and R.D. Bansod(2015) Determination of Geomorphological Characteristics of Dahikute Watershed Using Drainage Network Derived from GIS Technique. International Journal of Tropical Agriculture © Serials Publications, 2015; 33(4,5): 3119-3125.
- Clarke, J.I. Morphometry from Maps. Essays in geomorphology. Elsevier Publ. Co., New York, 1966; 235-274.
- Gottschalk, L.C., Reservoir sedimentation. In: V. T. Chow (edition), Handbook of Applied Hydrology, McGraw Hill Book Company, New York, section 1964; 7-I.
- Horton, R.E. Drainage basin characteristics, Transaction American Geophysical Union, 1932; 13: 350-361.
- Horton, R.E. Erosional development of streams and their drainage basins: Hydrological approach to quantitative morphology, Geological Society of America Bulletin, 1945; 56(3):275-370.
- Ingle V.K, A. K. Mishra, A. Sarangi, D. K. Singh and V. K. Seghal. Hydrologic behaviour of Tapi river catchment using morphometric analysis. Journal of Applied and Natural Science, 2014; 6 (2):442-450.
- 7. Kanth, T.A. Morphometric analysis and

prioritization of watersheds for soil and water resource management in Wular catchment using Geo-spatial tools", Inter. J. of Geo., Earth and Environ. Sci., 2012; 2(1):30-41.

- Melton, M.A. An analysis of relations among elements of climate, surface properties, and geomorphology, Technical report. 11, Proj. NR 389-042, office of Naval Research, Department of Geology, Columbia University, New York. 1957.
- Miller, V.C. A quantitative geomorphic study of drainage basin characteristics on the Clinch Mountain area, Virgina and Tennessee, Columbia University, Department of Geology, Technical Report, Number 3, ONR, New York. 1953.p389-402.
- Pankaj, A., and Kumar, P. GIS-based Morphometric Analysis of Five Major Sub-watersheds of Song River, Dehradun District, Uttarakhand with Special Reference to Landslide Incidences, Journal of Indian Society of Remote Sensing, 2009; 37(1).p.157–166.
- Pingale Santosh M., Harish Chandra, H. C. Sharma and S. Sangita Mishra. Morphometric analysis of Maun watershed in Tehri-Garhwal district of Uttarakhand using GIS. International Journal of Geomatics and Geosciences, 2012; 3(2):373-784.
- Patil N. P., A.S. Kadale and G.S. Mhetre. Assessment Of Morphometric Characteristics Of Karwadi-Nandapur Micro Watershed Using Remote Sensing And Geographical Information System. International Journal Of Scientific & Technology Research, 2015; 4(4):175-179.
- Schumn, S.A. Evolution of drainage systems and slopes in badlands at Perth Amboy, New Jersey, Geological Society of America Bulletin, 1956; 67(5): 597–646.
- 14. Shaikh Mustaq and Farjana Birajdar. Analysis of Watershed Characteristics Using Remote Sensing and GIS Techniques. International Journal of

Innovative Research in Science, Engineering and Technology. 2015; 4(4):1971-1976.

- Singh, R.K., Bhatt, C.M., and Prasad, V.H. Morphological Study of a watershed using remote sensing and GIS techniques, Hydrology Journal Indian association of hydrologists, 2003; 26(1-2): 55-66.
- Singh, A., Nestmann, K., Franz, and Eldho T.I. Estimating hydrological parameters for Anas catchment from watershed characteristics, International Conference on Advanced Modelling Technique for Sustainable Management of Water Resources, 2004.p.30-33.
- Soni Sandeep, ShashikantTripathi and Abhishek Kr Maurya. GIS Based Morphometric Characterization of Mini Watershed - RachharNala of Anuppur District Madhya Pradesh. International Journal of Advanced Technology & Engineering Research (IJATER). 2013; 3(3):32-38.
- Strahler A.N. Quantitative analysis of watershed geomorphology, Transaction of American Geophysical Union, 1957; 38(6):913-920.
- Strahler A.N. Dimensional analysis applied to fluvially dissected landforms. Geol. Soc. America Bull., 1958; 69:279-300.
- Tim U. S. and S. Mallavaram. Application of GIS Technology in Watershed-based Management and Decision Making. Watershed Update, 2003 July -August; 1(5):1-6.
- Vinoth M. Characteristics of Drainage Morphological Studies Using GIS in Kolli Hills, Central of Tamil Nadu, India. International Journal of Remote Sensing & Geoscience (IJRSG). 2014; 3(3):10-15.
- 22. Yongsheng Ma. GIS Application In Watershed Management. Nature and Science, 2004; 2(2):1-7.

Awareness, Attitude and Practice of University Students Towards Household Waste Management in Kashmir Valley

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Abstract

Household waste is an environmental and public health problem, especially for the large cities in any country. People around the world are aware of the impact of improper waste disposal practices, but the negative attitude of implementation gives rise to chaotic situations. The aim of the present study is to know the awareness, attitude and practice of students towards household management in Kashmir valley. A well designed and validated questionnaire based on the literature available on the topic was used to collect the information from a sample of 400 students selected randomly from different Universities of Kashmir valley. The data collected was analyzed using appropriate statistical tools with the help of statistical software SPSS version 20. The results obtained from this study reveal that both students male as well as female are aware about household waste management. It is observed that shortage of storage bins, inefficient collection and large stray dog population has severely damaged the environmental condition of the valley. Further, acute absence of waste segregation at the source all types of materials are being disposed along with municipal solid waste which make waste handling very risky especially dumping and disposal points. The lack of governance, unplanned urban settlement and encroachments, inadequate infrastructures for waste collection, transportation and management are the major constrains in designing a suitable waste management plan for the valley. It is concluded that there is an urgent need of giving mass awareness of solid waste and e-waste disposal practices.

Keywords: Environment; Waste Management; Awareness; Practice; E-Waste; Kashmir.

Introduction

The growing concern with environmental issues and their impact on general awareness is one of the most noticeable phenomena in recent years globally but the practices of basic concepts waste disposal are often neglected. We are born from the earth, we return to the earth and we sustain by the earth. Hence the environment in which we live is very important and it directly affects our lives. It is said that man is the product of his environment. Environmental problem is a global concern and it has no boundary. There is a fundamental link between all natural elements and if a man abuses or exhausts one element, the natural world as a whole will suffer. Holy Prophet Muhammad (PBUH) acknowledges that God's knowledge and power covers everything. Therefore, abusing one of his creations, whether it is living being or a natural resource, is a sin. He (PBUH) considered all of God's creations to be equal before God and he believed animals, land, forests and water resources have rights. According to Holy Quran (4:126), "To Allah belongs all that is in the heavens and in the earth, for Allah encompasses everything". Recently, Bilal et al (2016) discussed attitude of students

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towards environmental awareness and protection in Kashmir valley. Around the world; efforts are being made to make people aware about environmental protection. One of the main causes of environmental degradation is improper management in the disposal of solid waste and it is observed as a major cause of pollution and outbreak of diseases in many parts of the world. There is no permanent solution for environmental problems but we can reduce and control waste generation by proper awareness and practice. Proper management of the waste generated is most important in this matter. Waste management is defined as a science that addresses the logistics, environmental impact, social responsibility and cost of an organizations' waste disposal. The proportion of different constituents of waste varies from season to season and place to place, depending on the lifestyle, food habits, standards of living, the extent of industrial and commercial activities in the area, etc (Katju, 2006). Solid wastes comprise all the wastes arising from human and animal activities that are normally solid, discarded as useless or unwanted. The solid waste generation sources are mainly residential, commercial slaughterhouses, institutions, organization like hospitals, hotels and restaurants, small scale industries, construction and demolition waste (debris) etc. Solid wastes are organic and inorganic waste materials produced by various activities of the society, which have lost their value to the first user. Improper transport and disposal of solid wastes pollutes all the vital components of the living environment (i.e., air, land and water) at local and global levels. There has been a significant increase in solid waste generation throughout valley in the last few decades. This is largely due to rapid population growth and economic development. Poor collection and inadequate transportation are responsible for the accumulation of solid waste at nearly every nook and corner of the valley. According to Tchobanoglous et al (1993), solid waste management may be defined as the discipline associated with the control of generation, storage, collection, transfer and transport, processing and disposal of wastes in a manner that is in accord with the best principles of public health, economics, engineering, conservation, aesthetics, and other environmental considerations that are also responsive to public attitudes. Management of municipal solid waste continues to remain one of the most neglected areas of urban development in India and same is the case of Kashmir valley. Solid Waste Management (SWM) has 3 basic components namely collection, transportation and disposal. Comprehensive solid waste management incorporates a diverse range of activities including

reduction, recycling, segregation, modification, treatment and disposal which have varying levels of sophistication (Zagozewski et al, 2011). The objective of SWM is to reduce the quantity of solid waste disposed off on land by recovery of materials and energy from solid waste in a cost effective and environmental friendly manner (MF, 2009). It is estimated that 1, 60000 MT (Metric Tonne) of municipal solid waste is generated daily in India. According to the 2001 census, per capita waste generation in India is 0.5 Kg/day (Vinod & Venugopal, 2010). Waste management activities generate potential environmental benefits if managed properly (Gentil et al, 2009). There has been hardly any effort in the past to create community awareness, either about the likely perils due to poor waste management or the simple steps that every citizen can take. This could have helped in reducing waste generation and promote effective waste management. But this scenario has changed. Nowadays more and more people are taking interest in environmental issues, as they have started to experience the ill-effects of ecological issues. Now environmental education is welcomed by all categories of people. It is an attempt to reorient education so that environmental competence is restored as one of its basic aims along with personal and social competence (Shobeiri et al, 2007). Environmental problems are many. It is mounting high with new problems like disposal of e-waste. E-waste is a collective terminology for the entire stream of electronic equipment such as TV, refrigerators, telephones, air conditioners, computers, mobile phones etc. that has reached its End of Life (EOL) for its current user. Such devices are generally considered toxic when disassembled or incinerated and are typically targeted for hazardous disposal or are slated for necessary recovery and reuse (MF, 2009).



Fig. 1: E-waste e.g., TV, Radio, telephones, air conditioners, computers, mobile phones etc.

Most of the Bulk consumers, viz., Hospitals, Banks, Educational institutions and other Govt. Offices in

Kashmir valley are not aware of the disposal of Ewaste. E-waste generation in the State of Jammu and Kashmir has been estimated to be approximately 3260.4 tons for the year 2012-13. Similarly, there is other threat to the environment, that is improper management of hospital waste. Hospitals and other health-care establishments have a "duty of care" for the environment and for public health, and have particular responsibilities in relation to the waste they produce. Today, hospitals/clinics use a wide variety of drugs including antibiotics, cytotoxics, corrosive chemicals, radioactive substances, which ultimately become part of hospital waste. The introduction of disposables in hospitals has brought in its wake many ills such as inappropriate recycling, unauthorized and illegal re-use, and an increase in the quantity of waste. There is an urgent need of proper segregation and disposal of biomedical waste. The hazards of waste disposal from hospitals/ clinics can be divided into two main areas. First, there is a wider environmental burden of a variety of hazardous products and second, the more immediate risks of potentially infectious materials that can been countered by individuals handling the waste. There is an urgent need of proper segregation and disposal of biomedical waste (Figure 2).



Fig. 2: Improper Hospital Waste Disposal in Kashmir valley

The Ministry of Environment and Forests, Government of India has notified the new draft Biomedical Waste (Management and Handling) Rules, 2011 under the Environment Protection Act, 1986 to replace the earlier Bio-medical Waste (Management and Handling) Rules, 1998 and amendments thereof. Unfortunately, we observe violation of these rules in our valley. Hygiene starts from home. Our household waste accounts for major amount of solid rubbish. Some are reusable and others non-reusable. All these constitute megatons of municipal wastes. If it is not properly disposed off, the consequences are dangerous (Yadav & Mishra, 2004). So there is an urgent need to streamline and sensitize young minds to the environmental problems and concerns. It is the education which makes human beings

knowledgeable to environment and problems related to it. Students must have awareness about environmental problems so that they can play their role very effectively in proper waste management (Tartiu, 2011). Hence this study was an attempt to know how far the students are aware and practicing proper waste management?

Materials and Methods

A questionnaire was given to 400 students selected randomly from different Universities of Kashmir valley. The study was carried out at SKUAST-Kashmir, Kashmir university and Central University Kashmir in Kashmir valley. Purpose and method of the study undertaken was explained to the students to get their consent. The instrument of research was a validated self administered questionnaire based on literature available on the topic. The questionnaire was designed to assess students' knowledge, attitude and practice on waste management at home. The questionnaire besides basic information included ten questions related to awareness, five questions each regarding practice and attitude in waste management. The data collected was tabulated and analyzed using appropriate statistical tools using SPSS (version 20), p value less than 0.05 is considered as significant at 5% level of significance.

Results and Discussion

The sample represented 200 (50%) male and 200 (50%) female students between the age group of 19-24 years. The data presented in **Table 1** presents the distribution of study population as per the characteristics Habitat, Family status, Family type and Family size. It is observed that majority of the respondents both male as well as female were from urban areas, from middle class families, nuclear type family and having family size 5-6 members. Statistically, non-significant difference was observed between the male and female student respondents (p>0.05).

The data presented in **Table 2**, reveals that statistically there is a non-significant association in awareness of household waste management issues and gender in all the items (p>0.05). It was observed that majority of the respondents both male as well as female never attended any awareness programme conducted by local authority or any institute regarding household management, were not aware of principle of waste management and do not know

the complications of improper waste management, do not know how to dispose the e-waste. Further, majority of the respondents male as well as female accepted that local authorities have a role to play in the management of household waste, know the effective mechanism for household waste management, know the complications of improper waste management, were not aware of disposal of ewaste, agreed to have environmental topics in curriculum and were eager to know about environmental problems. Here, it is important to note that we have examined students irrespective of their subject. It is reported that e-waste is the fastest growing segment of the solid wastes in India (0.01-1%). This rate is growing at an alarming pace and a

Characteristics		Male Stud	ents (n1=200)	Female Stu	dents (n2=200)	Chi	p-value
		No.	%	No.	%	square	-
Habitat	Urban	121	60.5	134	67	1.828	>0.05
	Rural	79	39.5	66	33		
Family	Low	23	11.5	18	9	0.679	>0.05
Status	Middle	177	88.5	182	91		
	High	0	0	0	0		
Family	Joint	57	28.5	66	33	0.950	>0.05
Туре	Nuclear	143	71.5	134	67		
Family Size	Up to 4	17	8.5	13	6.5	4.760	>0.05
	5-6	146	73	132	66		
	Above 6	37	18.5	55	27.5		

Table 1: Characteristics of the studied population

Table 2: Awareness of students towards household waste management

S. No.	Question Asked	М	ale	Female		Chi Square	P-value
		Yes (%)	No (%)	Yes (%)	No (%	•	
01.	Did you ever attend any awareness programme conducted by local authority/ Institute regarding house hold waste management?	12(6)	188 (94)	10 (5)	190 (95)	0.192	>0.05
02.	Do you know the principle of waste minimization?	54 (27)	146 (73)	47 (23.5)	153(76.5)	0.649	>0.05
03.	Do you think that local authorities have a role to play in the management of house hold waste ?	192 (96)	8 (4)	193 (96.5)	7 (3.5)	0.069	>0.05
04.	Do you know about segregation of waste?	62 (31)	138 (69)	67 (33.5)	133 (66.5)	0.286	>0.05
05.	Do you know the effective mechanism for house hold waste management?	106 (53)	94 (47)	98 (49)	102 (51)	0.64	>0.05
06.	Do you know the complications of improper waste management?	58 (29)	142 (71)	47 (23.5)	153 (76.5)	1.562	>0.05
07.	Are you aware of e-waste?	62 (31)	138 (69)	49 (24.5)	151 (75.5)	2.107	>0.05
08.	Do you know how to dispose the e-waste?	18 (9)	182 (91)	13 (6.5)	187(93.5)	0.874	>0.05
09.	Do you have environmental topics in your curriculum?	114 (57)	86 (43)	103 (51.5)	97 (48.5)	1.218	>0.05
10.	Are you eager to know about environmental problems?	174 (87)	26 (13)	161 (80.5)	39 (19.5)	3.104	>0.05

high percentage of electronics are ending up in the waste stream releasing dangerous toxins into the environment. So it is the need of the time to review this serious situation. In India, approximately 95% of total E-waste management is done by informal/ unorganized sector. No reliable figures are available

as yet to quantify the e-waste. In spite of the higher literacy rate and well developed educational systems and status in the J&K state, there is lack of practicing proper waste management among people of Kashmir, whether young or old. There is no difference in students' practice about waste management based on type of family they belong. This shows the growing trend of negative attitude to social commitment which was existing since long back in joint families. Our study showed that there is a serious lack of awareness about e-wastes and its management among both the groups. In this era of cybernetics, young generation is being influenced by cyberphilia. As a result, worldwide e-wastes are generated uncontrolled and unchecked. Chinese domestic e-waste stockpiles are approaching a peak (Liu et al, 2006) and as of March 2009, approximately 4, 00,000 tons of e-wastes are produced in India.



Fig. 3: Garbage on roadside in Kashmir valley

The data presented in **Table 3**, reveals that statistically there is a non-significant association in attitude of students towards minimizing household waste and gender in items (ii), (iii) and (iv) (p>0.05). Both groups male as well as female are committed to minimize the wastes, segregate household waste and to avoid throwing the wastes outside their premises (p<0.01 and p>0.05, **Table 3**). Regarding practice of proper waste management, students male as well as female do not have proper ideas and practice of waste segregation, conversion of waste to kitchen compost (p>0.05). A large amount of solid wastes are generated from homes and its major source is Household waste. The quantity of solid waste grows faster than population and our results obtained in this study are in agreement with the earlier studies (Vinod & Venugopal, 2010). Solid waste disposal has been identified as a major cause of pollution and environmental threat globally and very specially to Kashmir valley, globally known as Paradise on earth. In spite of the higher literacy rate and well developed educational systems and status in the valley, there is lack of practicing proper waste management among people of the valley, whether young or old. The findings of our study have made it clear that students are well aware of the importance of waste management. But they are lacking in the practice of proper waste management. This study findings support the studies conducted by Ifegbesan (2008). Further, we found that there are serious drawbacks in the practicing of proper waste management among students of Kashmir valley irrespective of gender. This may be due to insufficient motivation from parents and teachers at the stage of growth period when they were preoccupied with preparation of qualifying examinations for future studies. This study revealed a most noteworthy and an eye opening situation prevailing in families i.e., owing household wastes outside their premises. It is observed that 37% (male) and 39.5% (female) participants responded with the answer 'yes' when asked about throwing household waste outside home? It demands a major shift in people's selfish attitude, not concerned about the serious negative impact on a residential neighbourhood. It is an environmental abuse to be corrected at the earliest if we want to save the mother earth our valley. It is reported that students with better awareness towards social duty are more aware towards environmental awareness (Astalin, 2011).

Table 3: Attitude of study population towards minimizing the household waste

S. No.	Question Asked	Má	nle	Fen	nale	Chi	P-value
		Yes (%)	No (%	Yes (%)	No (%	square	
01.	Are you committed to minimize the waste?	146 (73)	54 (27)	121 (60.5)	79 (39.5)	7.040	<0.01
02.	Do you segregate house hold wastes?	102 (51)	98 (49)	93 (46.5)	107 (53.5)	0.81	>0.05
03.	Do you use kitchen waste as compost?	6 (3)	194 (97)	11 (5.5)	189 (94.5)	1.536	>0.05
04.	Do you throw your household waste outside your home?	74 (37)	126 (63)	79 (39.5)	121 (60.5)	0.265	>0.05
05.	Do you see garbage on roadside while coming to college/University?	194 (97)	6 (3)	183 (91.5)	17 (8.5)	5.582	<0.05

Another significant finding of our study is that 97% (male) and 91.5% (female) participants responded that they are seeing garbage on roadside (**Figure 3**) while coming to University from residence, which proves the filthiest condition of the roads and the severity of improper waste management.

The data presented in **Table 4**, reveals that statistically there is a non-significant association in attitude of students towards practice regarding minimizing household waste and gender in items (i) and (v) (p>0.05). However, statistically, there is a

significant difference between male and female respondents when question (ii), (iii) and (iv) was asked (p<0.05). A large amount of solid wastes are generated from homes. Household waste is a major source of solid waste. The quantity of solid waste grows faster than population (Vinod & Venugopal, 2010). We found that there are serious drawbacks in the practicing of proper waste management among students of Kashmir valley irrespective of gender. Everyone has to play an important role in minimizing household waste.

Table	4. Attitude	of	students	towards	practice	of	minimizina	household	waste
Table	Annuuc	U1	students	10 10 103	practice	UI.	mmmzmy	nouscholu	vvasic

S. No.	Question Asked		Male	Fei	male	Chi	P-value
		Yes (%)	No (%)	Yes (%)	No (%)	square	
01.	Improper waste disposal is a threat to environment.	184 (92)	16 (8)	191 (95.5)	9 (4.5)	2.09	>0.05
02.	Household waste management is the sole responsibility of my parents.	116 (58)	84 (42)	85 (42.5)	115 (57.5)	9.61	<0.01
03.	Household waste disposal is the sole responsibility of the local authorities.	174 (72)	56 (28)	167 (83.5)	33 (16.5)	4.014	< 0.05
04.	I am also responsible for the generation of house hold waste.	182 (91)	18 (9)	135 (67.5)	65 (32.5)	33.58	< 0.05
05.	I also have a role to minimize the house hold waste.	188 (94)	12 (6)	191 (95.5)	9 (4.5)	0.452	>0.05



Fig. 4: Waste management in Kashmir University and around Dal Lake (Source: field work, 2016)

Conclusion

This study conducted in Kashmir valley tries to look at the crucial aspect of household waste management awareness among university students. In conclusion giving social duty awareness along with waste management awareness may improve the practice of waste management. Awareness program of waste management is greatly needed for students as well as parents. This can be given in the schools/ colleges during parent teacher meetings or in community based programs. For this purpose, education departments of the states/country can implement environmental education programs to the teachers at all levels of education. Whether students are from joint family or nuclear family there is no significant difference in their awareness, practice and attitude (p>0.05). The findings of the present study have made it abundantly clear that waste management is a serious environmental problem in Kashmir valley, and students are aware of it.

Throwing household waste outside home is a selfish attitude and an environmental abuse which need to be corrected. With collective efforts from the part of government, educational institutions and NGOs, proper guidance can be given in this neglected area of waste management. It is the birth right of every citizen to live in a pollution free environment, to get good air to breathe and to have safe water to drink. As long as these basic rights are denied or a conducive atmosphere is not created, a nation cannot claim of its amazing and sustainable development. To conclude, the study throws a light on the existing knowledge, attitude and practice of the University students in Kashmir valley. All this means that we

have to look at our waste management holistically and draw up an integrated plan for sustainable waste management of our pristine valley. The most important returns of household waste management are; improvement in health, promotion of hygiene, contribution to conservation of resources. It may require the foundation of a board-based interagency committee included authorities to establish a mechanism for consensus on waste management issue. This study indicates that there is an urgent need to train the people ingeneral regarding the same. The world belongs to all of us. We must co-operate and work together for a better world, a better future, and a better environment.

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References

- Astalin, P.K. Environmental Awareness in Relation to Awareness towards Social Duty and Some Educational Factors affecting it among Higher Secondary Students. Journal of Education and Practice, 2011; 2(3):54-62.
- Bhat Bilal A. et al. Environmental Awareness Among College Students Of Kashmir Valley In The State Of Jammu And Kashmir And Their Attitude Towards Environmental Education, International Journal of Innovative Research and Review, 2016; 4 (2):20-25.
- 3. Draft Bio-Medical Waste (Management and Handling) Rules, 2011.
- 4. http://moef.nic.in/downloads/publicin formation/salient-features-draftbmwmh. pdf

- Gentil, E., Clavreul, J., and Christensen, T.H. Global warming factor of municipal solid waste management in Europe. Journal of Waste Management and Research, 2009; 27(9):850-860.
- Ifegbesan, A. Exploring secondary school students' understanding and practices of waste management in Ogun State, Nigeria. International Journal of Environment and Science Education, 2010; 5(2):201-215.
- Katju C. V. Solid Waste Management: World Bank, Report 1994, 2006. World Web Page: www.devalt. org/newsletter/jun04/lead.htm.
- 8. Liu, X., Tanaka, M., and Matsui, Y. Electrical and electronic waste management in China: progress and barriers to overcome. Journal of Waste Management and Research, 2006; 24:92-101.
- Ministry of Finance (MF). Position Paper on the Solid Waste Management Sector in India. Department of Economic affairs, Ministry of Finance, Government of India. 2009.
- Shobeiri, S.M., Omidvar, B., and Prahallada, N.N. A Comparative Study of Environmental Awareness among Secondary School Students in Iran and India. Int. J. Environ. Res., 2007; 1(1):28-34.
- Tartiu, V. Evaluation of attitudes and knowledge regarding municipal waste among students, Case study: Bucharest Academy of Economic studies. J. Economia. Seria Management, 2011; 14(1):263-276.
- Tchobanoglous, G, Theisen, H and Vigil, S. Integrated Solid Waste Management: Engineering Principle and Management Issue. International Ed. McGraw - Hill Book Co. Singapore, 1993.p.12-43.
- Vinod, A., and Venugopal, K. Environmental Studies. 1st ed. Calicut University Central Cooperative Stores, LTD No. 4347. 2010.
- 14. Yadav, P.R., and Mishra, S.R. Human Ecology. N. Delhi, Discovery Publishing House. 2004.
- Zagozewski, R., Judd Henry, I., Nilson, S., and Bharadwaj, L. Perspectives of past and present waste disposal practices: A community based participatory research project in three Saskatchewan first nations communities. J. Environmental Health Insights, 2011; 5:9-20.

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WQI at Different Stations along the Mula River

V.K. Balsane¹, R.D. Bansod²

Abstract

The present study was intended to calculate Water Quality Index (WQI) of a Mula River Rahuri, Ahmednagar District in order to ascertain the quality of water for public uses and other purposes. This paper deals with the study on the influence of environmental parameters on the water quality of reservoir. Water Quality Index, indicating the water quality in terms of index number, offers a useful representation of overall quality of water for public as well as in the pollution abatement programmes and in water quality management. In this study Water Quality Index was determined on the basis of various physico-chemical parameters like pH, Electrical Conductivity, Total dissolved Solids, Total Hardness, dissolved oxygen, calcium, Magnesium, Biochemical Oxygen Demand, Chemical Oxygen Demand.

Keywords: Reservoir; Physico-Chemical Parameters; Drinking Water Quality.

Introduction

The surface water bodies, which are the most important sources of water for human activities are unfortunately under severe environmental stress and are being threatened as a consequence of a developmental activities. Mula reservoir which lies in Rahuri Tehsil of Ahmednagar district to provide water for domestic, irrigation as well as industrial purposes. It is with this background, the present work was carried out between 2013 and 2014. Water guality index provides a single number that expresses overall water quality at a certain location and time based on several water quality parameters. A single number cannot tell whole story of water quality, there are many other water quality parameters that are not included in the index. However, a water quality index based on some very important parameters can provide a simple indicator of water quality. Water quality indices incorporate data from multiple water quality parameters into a mathematical equation.

Study Area

Mula Basin is situated on 19° 21' 30" N latitude, and 74° 34' 30" E longitudes at 555.650 m above mean sea level. The Mula rises on the eastern slopes of the Sahyadri between Ratangad and Harishchandragad. For the first 25 km., it flows parallel to the Pravara draining the southernmost Kotul valley of Akola taluka. The river is incised in a deep valley almost from its source and its steep valley-sides are highly dissected by deep gullies formed by mountain torrents which rush into the main stream. Skirting the large market village of Kotul it takes a bend to the south, winding past the rocky precipitous slopes at the foot of Baleshwar hills. It then flows through the southwest parts of Sangamnertaluka and follows an easterly course between Shevgaon and Parnertalukas flowing in a deep bed between rugged hills on the north and the table land of Vasunda on the south. It then takes a sudden turn to the north-east and enters the plains in the same direction for another 30 km. It joins the Pravara at the village of Tilapur. The total

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length of the river from its source to its confluence with the Pravara is 145 km.; except in lower parts of its course on account of an entrenched course, the Mula is used for agriculture only in alluvial flats on the foot of the rugged ledges cutting into the riverbed. Sample locations were shown in **Figure 1**.



Fig. 1: Sample locations along the Mula River

Table 1: Standard method for River water analysis

Materials and Methods

The Reservoir water samples of Mula Dam were collected aseptically in 1 L plastic bottles and analyzed for various properties. These bottles were properly labeled and then the sample bottles were kept in the Refrigerator. Standard methods for river water analysis were given in **Table1**.

In this study, Water-quality index (WQI) was calculated for assessing the water quality at Mula Reservoir in pre, post monsoon and rainy season 2013-14. WQI of Mula reservoir was calculated as proposed by Tiwari and Mishra (1985). WQI is calculated by using standards of drinking water quality recommended by the World Health Organization (WHO), Bureau of Indian standards(BIS) and Indian Council of Medical Research (ICMR). The weighted arithmetic index method has been used for the calculation of WQI of the water Sample. Further, quality rating or sub index (q₂) was calculated using the following expression (1). In order to calculate WQI nine important parameters pH, dissolved oxygen (DO), total dissolved solids(TDS), electrical conductivity(EC), Calcium(Ca), magnesium(Mg), Alkalinity, Hardness and BOD used. These parameters maximum contribute for the quality of reservoir.

$$q_{n} = 100[V_{n} - V_{i_{0}}] / [S_{n} - V_{i_{0}}]$$
(1)

	D 1		
Sr. No.	Particulars	Methods	Reference
1.	pН	Potentiometric	Jackson(1973)
2.	EC	Conductometric	Jackson(1973)
3.	Alkalinity	Potentiometric titration	APHA, 2000
4.	Hardness	Titrimetric (EDTA)	APHA, 2000
5.	BOD	Winkler titration	Franson(1985)
6.	COD	Reflux	Franson(1985)
7.	TDS	Gravimetric	Franson(1985)
8.	Ca ⁺⁺ and Mg ⁺⁺	Versenate titration	Page et al. (1982)
9.	DO	Winkler method	APHA, 2000
10.	Temperature	Thermometer	APHA, 2000

Let there be n water quality parameters and quality rating or sub index (q_n) corresponding to n^{th} parameter is a number reflecting the relative value of this parameter in the polluted water with respect to its standard permissible value.

 q_n = Quality rating for the nth water quality parameter

 V_n = Estimated value of the nth parameter at a given sampling station.

 S_n = Standard permissible value of the nth

parameter.

 V_{io} = Ideal value of nth parameter in pure water. (i.e., 0 for all other parameters except the parameter pH and Dissolved oxygen (7.0 and 14.6 mg/l respectively).

Weightage

Factors which have higher permissible limits are less harmful because they can harm quality of river

water when they are present in very high quantity. So weightage of factor has an inverse relationship with its permissible limits. Therefore

$$W_n \alpha 1/S_n$$
 or $W_n = K/S_n(2)$

Values of K are calculated as: $K = \frac{1}{\Sigma(\frac{1}{2\pi})}$

$$\Sigma(\frac{1}{Sn}) = \frac{1}{Sn(pH)} + \frac{1}{Sn(DO)} + \frac{1}{Sn(EC)} + \frac{1}{Sn(TDS)} + \frac{1}{Sn(Ca)} + \frac{1}{Sn(mg)} + \frac{1}{Sn(hardness)} + \frac{1}{Sn(Alalinity)} + \frac{1}{Sn(BOD)}$$
(4)

The weightage of all the factors are calculated on the basis of the above equation.

The overall Water Quality Index was calculated

by aggregating the quality rating with the unit weight linearly.

Where, K = constant for proportionality

 W_n = unit weight for the nth parameters.

S_n= Standard value for nth parameters.

$$WQI = \acute{O}q_n W_n / \acute{O}W_n$$
(5)

(3)

Table 2: Drinking Water standards recommending Agencies and unit weights.(All values except pH and Electrical Conductivity are in mg/L)

Sr. No.	Parameters	Standards	Recommended agency	Unit Weight
1.	рН	6.5-8.5	ICMR/BIS	0.2190
2.	Electrical conductivity	300	ICMR	0.371
3.	Total Dissolved Solids	500	ICMR/BIS	0.0037
4.	Alkalinity	120	ICMR	0.0155
5.	Hardness	300	ICMR/BIS	0.0062
6.	Calcium	75	ICMR/BIS	0.025
7.	Magnesium	30	ICMR/BIS	0.061
8.	Dissolved Oxygen	5.00	ICMR/BIS	0.3723
9.	Biological Oxygen Demand	5.00	ICMR	0.3723

 Table 3: Water Quality Index (WQI) and status of water quality (Chatterji and Raziuddin 2002)

Water Quality Index	Water Quality Status
0-25	Excellent water quality
26-50	Good water quality
51-75	Poor water quality
76-100	Very Poor water quality
>100	Unsuitable for drinking

Results and Discussion

Table 4: Physicochemical properties of stagnant surface water sample in Mula River (Pre-season) 2/2/14 to 7/2/14

Location	Ca (mg/l)	Mg (mg/l)	рН	Ec	TDS (mg/l)	COD (mg/l)	BOD (mg/l)	DO (mg/l)	Hardness (mg/l)	Alkalinity (mg/l)	Temp (°c)	WQI
BaragaonNandur	3.2	0.3	8.6	0.543	347.5	970	3.3	7.0	0.09375	44	15	53.83
RahuriBudruk	2.5	0.7	8.7	0.932	596.5	1310	25	7.1	0.28	96	14	167.65
RahuriKhurd	2.5	0.4	8.3	0.671	429.4	890	5.2	7.0	0.16	44	15	61.07
Deswandi	4.3	2.3	8.5	0.279	178.5	1310	25	8.5	0.53488	56	13	161.27
Aradgaon	8.9	0.8	8.5	0.136	87.04	1100	21	2.3	0.08989	150	12	50.25
Valan	6.2	2.1	8.1	0.214	136.96	510	3.0	7.1	0.33871	70	13	48.08
Manori	5.2	2.1	8.3	0.217	138.8	630	2.7	4.1	0.40385	30	13	55.96
Manjari	6.1	2.0	8.5	0.134	85.76	210	2.8	0.8	0.32787	80	14	67.76
Panegaon	6.8	2.9	8.2	0.147	94.08	1010	3.2	1.3	0.42647	98	16	65.76
Mula Dam	2.1	0.2	7.6	0.112	71.68	45	0.1	0	0.09524	30	14	15.33
Kotul	4.3	2.3	8.1	0.240	153.6	112	1.2	0	0.53488	20	17	17.98
LahitKhurd	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	-
Borbanwadi	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	-
MandaveKhurd	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	-

Table 5: Physicochem	ical prope	rties of flow	ing water s	ample in M	ula River (Po	st-season) 37'	12/14 to 7/12	/14				
Location	Ca (mg/l)	Mg (mg/l)	Hq	Ec	TDS (mg/l)	COD (mg/l)	BOD (mg/l)	DO (I)gm)	Hardness (mg/l)) Alkalinity (mg/l)	Temp (°c)	MQI
BaragaonNandur	2.5	1.4	8.2	0.447	286.1	840	6.4	0	0.56	14	15	84.79
RahuriBudruk	2.2	0.1	8.1	0.844	540.2	1300	32	1.3	0.045	46	14	212.38
RahuriKhurd	1.5	1.2	8.4	0.761	487.0	490	11.4	1.9	0.8	22	15	107.61
Deswandi	4.1	2.0	7.8	0.179	114.5	1200	31	0	0.48	26	13	207.54
Aradgaon	8.2	1.2	6.6	0.125	80	910	33	2.9	0.146	30	12	205.17
Valan	3.3	3.4	6.5	0.239	152.9	830	7.3	7.0	1.030	10	15	62.50
Manori	6.3	2	7.5	0.209	133.7	320	5.4	6.3	0.317	5	13	55.67
Manjari	5.1	2.0	7.6	0.135	86.4	110	7.2	1.8	0.391	20	19	78.09
Panegaon	6.4	2.9	T.T	0.190	121.6	811	9.0	2.7	0.453	48	18	86.39
Mula Dam	2.2	0.2	7.8	0.110	70.4	100	13.6	0.1	0.090	10	13	117.21
Kotul	4.4	2.3	8.1	0.443	283.52	115	12.4	7.0	0.522	05	17	95.99
LahitKhurd	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	
Borbanwadi	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	
MandaveKhurd	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	
Table 6: Physicochem	nical prope	rties of surfa	ce water s	ample in Mi	ula River (Rai	ny season) 5/	6/14 to 13/6,	/14				
Location	Ca (mg/l)	Mg (Il/gm)	Нď	Ë	TDS (I/gm)	COD (mg/l)	BOD (mg/l)	(I/gm)	Hardness (mg/l)	Alkalinity (mg/l)	Temp (°c)	WQI
BaragaonNandur	2.9	0.2	7.8	0.499	319.4	950	6.1	1.1	0.068	10	15	76.08
RahuriBudruk	2.4	0.5	8.0	0.823	526.7	1605	25	1.2	0.208	26	12	175.46
RahuriKhurd	2.5	1.4	8.2	0.651	416.6	870	10.4	1.5	0.56	20	1	101.50
Deswandi	3.9	2.2	8.5	0.317	202.1	1309	21	0.3	0.564	15	10	162.29
Aradgaon	7.3	1.8	8.5	0.132	84.48	1090	23	2.1	0.246	10	12	167.67
Valan	4.1	1.1	8.1	0.223	142.9	925	6.3	4.0	0.268	05	13	72.36
Manori	4.9	1.3	8.3	0.310	198.4	620	4.4	3.3	0.265	03	17	66.54
Manjari	5.9	0.4	8.4	0.143	91.52	245	5.2	0.8	0.067	12	12	78.28
Panegaon	6.0	0.3	8.0	0.153	97.92	1005	8.0	1.7	0.05	28	16	86.38
Mula Dam	2.5	0.4	7.6	0.101	64.64	115	5.4	0.3	0.16	05	10	72.42
Kotul	2.9	1.5	8.3	0.449	287.4	125	13	1.4	0.517	02	17	115.95
LahitKhurd	7.6	1.5	8.4	0.445	284.8	1310	21	1.7	0.197	Dry	16	157.46
Borbanwadi	8.1	1.9	8.2	0.432	276.4	947	31	1.9	0.234	Dry	21	206.54
Mandavekhurd	7.8	0.2	8.0	0.441	282.2	246	43	2.8	0.025	Dry	19	263.60

The above water quality is also supported by the following physicochemical parameters variations observed during the different season of the study. Among all the physicochemical parameters selected for the Water Quality Index calculations, pH is an important parameter which determines the suitability of water for various purposes. In the present study pH ranged between 6.5 to 8.6. In many of the collections the pH remained exactly neutral. However, when the average values for three seasons are taken into account the waterbody was found to be slightly alkaline. Ambasht (1971), Petre (1975), Shardendu and Ambasht (1988), Swarnalatha and Narasingarao (1993) and Sinha (1975) have also made similar observations in their studies on different waterbodies. Electrical conductivity and total dissolved solids were also found to be very high. The concentration of dissolved oxygen regulates the distribution of flora and fauna. The present investigation indicated that the concentration of dissolved oxygen fluctuated between 0 mg/l and 8.5

mg/l. seasonally, the concentration of dissolved was more during rainy season and least during post season. The Bio-chemical oxygen demand is a parameter to assess the organic load in a water body. Many researchers have recorded higher BOD values in polluted water. The BOD concentration ranged between 0.1mg/I to 43mg/I indicating the fact that the water body is eutrophic. From the foregoing observations of the physicochemical parameters, it can be concluded that the water body shows the characters of eutrophication except the case of Mula Dam and Kotul. Low dissolved oxygen, high biochemical oxygen demand indicate the entropic status of water body. Hence, application of Water Quality Index technique for the overall assessment of the water quality of a water body is a useful tool. Water Quality Index value of fourteen sampling locations on the basis of calculations of physicochemical parameters for all the seasons were shown in Figure 2.



Fig. 2: Showing the Water Quality Index value of fourteen sampling locations on the basis of calculations of physicochemical parameters.

References

- Akkaraboyina, M.K. and Raju, B.S.N. "Assessment of Water Quality Index of River Godavari at Rajahmundry", Universal Journal of Environmental Research and Technology, 2012; 2(3): 161-167.
- APHA. Standard methods for the examination of water and wastewater (Edition 20th). Washington, DC: American Public Health Association. 1998.
- APHA. "Standard Methods for The Examination of Water and Wastewater". 21st Ed. Washington, DC: American Public Health Association (APHA). 2005.
- Amadi, A.N., P.I. Olasehinde, E.A. Okosun and J. Yisa. Assessment of the Water QualityIndex of Otamiri and Oramiriukwa Rivers. Phys. Int., 2010; 1:116-123.

- Chaterjee, C and Raziuddin, M. Dtermination of water quality index (WQI) of a degraded river in Asanol Industrial area, Raniganj, Burdwan, West Bengal. Nature, Environment and pollution Technology. 2002; 1(2):181-189.
- ICMR. "Manual of standards of quality for drinking water supplies", Indian Council of Medical Research, Special Report No.44, 1975.p.27.
- Sinha, S.K. Potability of some rural ponds water at Muzaffarpur (Bihar) - A note on water quality index, J. Pollution Research, 1995; 14(1):135-140.
- Tiwari, T.N. and Mishra, M.A. "A preliminary assignment of water quality index of major Indian rivers", Indian J. Environ. Protection. 1985; 5:276-279.

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Stabilisation of Wastewater by Lemna minor: A Microcosm Study

A.K. Haritash¹, Nikhil Mittal¹, Ruby Aggarwal¹, Swamini Khurana¹

Abstract

The present study was undertaken to determine the efficacy of *Lemna minor* (duckweed) in stabilisation of untreated mixed wastewater. It was observed that Lemna can efficiently remove dissolved solids and organic matter in a microcosm operated under sunlight. The removal of BOD₅ and COD was of the order of 50% and 75%, respectively. Microscopic examination of the roots confirmed the role of roots in entrapment of suspended solids and organic matter over the roots. The DO levels in wastewater increased to about three times during the treatment. The biomass, chlorophyll *a* and *b*, and carotenoid content had significant increase, and ratio of chlorophyll *a*/chlorophyll *b* was almost constant. No biochemical or physiological stress of wastewater over *Lemna* could be reported during the study. The study concluded that *Lemna minor* can be used for stabilisation of low strength mixed wastewater, particularly for remote and small communities.

Keywords: Lemna Minor; Rhizoremediation; Wastewater Stabilisation; Chlorophyll.

Introduction

Constructed wetlands (CWs) are being used throughout the world for wastewater stabilisation (Gersberg et al., 1986), removal of nutrients (Haritash et al., 2015), suspended solids (Noe et al., 2010; DeBusk et al., 1995), pathogens (Alaerts et al., 1990) and even toxic pollutants (Miranda et al., 2000). Such systems are becoming more popular in developing countries because they require less energy, less technical know-how, and are efficient in removal. The plants growing in wetlands have major functional role in pollutant removal through filtration, absorption, and sedimentation. The treatment takes place in root zone primarily, and is referred to as rhizo-remediation. The plant roots along with sediments act as a matrix for filtration and subsequent decomposition and absorption. The role of sediments/packing matrix and microorganisms can not be overlooked as they play

a major role in removal depending on the type of pollutant, its physico-chemical properties, and the conditions prevalent in CWs (Haritash et al., 2017). Still, most of the studies designate vegetation to have the major role in treatment. Vegetation in wetlands can broadly be classified as submerged, emergent, and floating depending on the layer of water in which it is present. Submerged and emergent plants have a stable/fixed root system in sediments, whereas the roots of floating macrophytes remain suspended freely in water column. Lab-scale mesocosm studies on floating macrophytes are effective to determine the treatment efficiency of plants exclusively since the packing matrix may be excluded. Most of the studies on floating macrophytes deal with water hyacinth, water pennywort, and duckweed (EPA, 1988; Brix, 1997) etc. Whereas pennywort is confined to North Africa, Europe, and Florida, and water hyacinth is an intensive weed; duckweed is useful because of its wide geographic distribution (Alaerts et al., 1996), high nitrogen and protein content

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(Mbagwu & Adeniji, 1988), and significant treatment efficiency (Tripathi et al., 1991). It is commercially grown in lagoons in south-east Asian regions for the treatment of sewage and industrial wastewater, culturing fish (World Bank, 1992), fodder production (Leng, 1995), and extraction of proteins from it. The present study was undertaken to determine the removal efficiency of Lemna minor towards organic matter and dissolved solids in a lab-scale microcosm. Lemna removes the organic matter and suspended solids with the help of its roots suspended in water column. Sediments were not included in the microcosms, so as to determine the treatment efficiency of Lemna alone. Parallel experiments were undertaken to study the effect/stress of wastewater over physico-biochemical characteristics of vegetation to arrive at the efficacy of Lemna towards wastewater stabilisation.

Materials and Methods

The present study was undertaken in microcosm made of plastic tubs. Healthy fronds of Lemna were collected from a pond located in the campus of Delhi Technological University (DTU), Delhi. The pond receives untreated domestic wastewater from residential colonies around it; and a part from the hostels of DTU. The wastewater being used in the study was collected from the inlet of pond and its physicochemical properties were determined immediately after collection using standard methods as prescribed by APHA (1998). The wastewater was classified as low-strength against the value of COD (Almeida, 1999). Two plastic tubs (15 L) were filled with the wastewater to a volume of 10 L, and 200 g (fresh weight) of Lemna minor was added to each. One of the tubs was kept in sunlight (average photoperiod of 10 hours), and the other was kept under artificial fluorescent light to study the

possibility of treatment under artificial light. Samples were collected after 3 days, and later at regular intervals of 7 days for 21 days to study the degree of treatment with respect to time. The microscopic examination of roots of *Lemna* was also done to confirm their role in filtration and absorption of suspended solids and organic particles from the wastewater.

To study the biochemical stress of wastewater over *Lemna*, dilutions of the order of 20%, 40%, 60%, and 80% alongwith a control and raw wastewater (100%) were prepared in separate plastic pots of 2.0 litres capacity. One litre of respective dilution was transferred to each pot alongwith 0.5 g of *Lemna*. The physico-biochemical parameters like root length (cm), fresh weight (g), Chlorophyll 'a' (mg/ml), chlorophyll 'b' (mg/ml), and carotenoids (mg/ml) were determined in the beginning and after 10 days to estimate the stress of wastewater over *Lemna*, if any. Determination of chlorophyll was done as described by Arnon (1949) using the following equations

Chlorophyll a (mg/ml) =12.7(A_{663}) - 2.69(A_{645}) Chlorophyll b (mg/ml) = 22.9 (A_{645}) - 4.68 (A_{663}) Carotenoids (mg/ml) = [1000 A_{470} - 3.27(chl a) - 104(chl b)]/227

Results and Discussion

Based on the results obtained in present study, duckweed was found to have the capacity for wastewater stabilisation and removal of organic matter in the presence of sunlight. The experiment under artificial light failed since duckweed could not survive under the artificial light. During the treatment, the pH shifted from near neutral (7.2) to slightly alkaline (8.1) confirming to addition/ production of basic species during stabilisation (Table 1).

Day	рН	EC (mS/cm)	TDS (mg/l)	Cl· (mg/l)	DO (mg/l)	BOD (mg/l)	COD (mg/l)
0	7.2	6.82	1280	278	1.8	23	200
3	8.2	7.15	800	234	2.5	20	180
7	8.1	7.74	800	179	4.8	18	70
14	8.1	6.51	760	154	5.0	15	50
21	8.1	6.35	700	140	6.0	12	50

Table 1: Characteristics of wastewater during its stabilisation by Lemna minor

High concentration of organic matter may also contribute to reducing/slightly acidic conditions as a consequence of reduced dissolved oxygen (DO) levels. Degradation/mineralization of organic carbon results in production of CO_2 , a part of which dissolves in water in near neutral/slightly acidic conditions resulting in formation of bicarbonate and subsequently carbonate, both of which add basicity

to water. The degradation of organic matter in a duckweed based system may also result in production of such species having basic nature. The degradation/removal of organic matter results in improved level of DO with time as is observed in the present study. The DO concentration increased almost three times from 1.8 mg/l to 6.0 mg/l during the treatment. BOD₅ and COD were significantly reduced with a removal efficiency of 50% and 75%, respectively, in the treatment period of three weeks (Table 1). COD removal of the similar order (73-84%) has been observed in lab scale experiments treating municipal wastewater in Turkey (Ozengin & Elmaci, 2007) and Netherlands (Korner et. al, 1998). The low BOD and COD removal efficiency of duckweed may be attributed to its growth over water surface, which inhibits diffusion of atmospheric oxygen in water, and comparatively reduced photosynthetic activity in water column because of reduced sunlight penetration, resulting in low DO levels underneath the duckweed layer (Brix & Schierup, 1989). However, transport of oxygen from leaves to roots, lead to formation of an aerobic zone in rhizosphere (Alaerts et al., 1996). The major pathway for degradation of organic matter was addition of DO to wastewater through the roots of duckweed, and action of microbes associated with roots, over the organic matter. The mineralised matter may be easily absorbed by duckweed/associated microbes for growth and metabolism. Apart from it, the dissolved nutrients (nitrate and phosphate), and micronutrients (Na, K, Fe etc.) are also absorbed from wastewater. Microscopic examination of roots of Lemna revealed the association/entrapment of suspended solids and organic particles on sheath of extra cellular enzymes particularly over root-tip (Figure 1).



Fig. 1: Root tip of *Lemna* with a sheath of extracellular enzymes and organic particles sticking over it (Resolution: 10*40; Motic, China)

Change in redox state and dynamic chemical equilibrium, too, results in natural precipitation of dissolved impurities. As a result, constantly decreasing total dissolved solids (TDS) and electrical conductivity (EC) values were observed confirming to removal of other dissolved species as well.

The experiments on determination of stress revealed that duckweed underwent no biochemical stress during wastewater treatment. Since wastewater is rich in nutrients (CNP), the plant had easy availability of nutrients and improved growth and metabolism. Significant increase in biomass (fresh weight) of duckweed is an indicator of assimilation of extraneous carbon, water, and other nutrients from wastewater. Although accumulation of biomass was observed, decrease in root length was observed for all the dilutions with no regular trend (Table 2).

Dilution of waste	Root le (cm	ngth)	Fresh v (g	weight g)	Chlorop (µg/	ohyll 'a' 'ml)	Chlorop (µg/	ohyll 'b' 'ml)	Carotenoi	id (μg/ml)
water (%)	Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final
Control	2.9	1.6	0.5	1.02	9.87	5.16	5.59	3.15	0.074	0.035
20	2.9	2.0	0.5	1.34	9.87	6.31	5.59	4.60	0.074	0.048
40	2.9	1.3	0.5	1.19	9.87	5.82	5.59	4.26	0.074	0.048
60	2.9	2.0	0.5	1.54	9.87	6.94	5.59	6.03	0.074	0.066
80	2.9	1.5	0.5	1.03	9.87	13.60	5.59	8.48	0.074	0.069
100	2.9	1.2	0.5	0.73	9.87	18.87	5.59	14.78	0.074	0.078

Table 2: Biochemical characteristics of Lemna minor at different dilutions of wastewater

It may be ascribed to presence of some other pollutant (heavy metals) in the collected wastewater, or the degeneration of soft outer tissue of roots due to physical stress during transfer of duckweeds to experimental tubs. Significant improvement in chlorophyll 'a' and chlorophyll 'b' concentration over the control was an indicator of improved plant health, which may be ascribed to higher nutrient availability with increasing fraction of wastewater. Dilution of raw wastewater resulted in comparatively lower levels of chlorophyll and carotenoids. The Chl'a'/Chl'b' ratio revealed no stress over duckweed. Decreasing trend of Chl'a'/Chl'b' ratio may be an indicator of stress (Wolf, 1956). Since the ratio was almost constant, and total chlorophyll had increased in all the dilutions, no stress over duckweed may be reported. Similar increasing trend for carotenoid confirmed the observation that duckweed was not exposed to any stress during the treatment of domestic wastewater.

Conclusion

The study concluded that *Lemna minor* can be an effective option for the stabilization of untreated lowstrength wastewater. It could efficiently remove the organic load in terms of BOD₅ and COD in the presence of sunlight to a level of 50% and 75%, respectively, in a period of three weeks. The retention period, however, may be reduced by increasing the pond area. The roots of Lemna were found to have major role in removal of suspended and organic particles from wastewater. The use of raw wastewater (without dilution) is recommended since it favors easy availability of nutrients, and improved growth of plants. The duckweed-based stabilization ponds may be used for remote small rural communities, and the stabilized wastewater can be utilized for aquaculture, horticulture etc.

References

- Alaerts, G.J., Mahbubar, R., Kelderman, P. Performance analysis of a full scale duckweed covered sewage lagoon. Water Research, 1996; 30(4): 843-852.
- Alaerts, G.J., Veenstra, S., Bentvelsen, M., VanDuijl, L.A. Feasibility of anaerobic sewage treatment in sanitation strategies in developing countries. IHE, Report Series 20, Delft. 1990.
- Almeida, M.C., Butler, D., Friedler, E. At source domestic wastewater quality. Urban Water, 1999; 1:49-55.
- APHA, AWWA, WPCF, Standard methods for examination of water and wastewater, 20th ed., Washington (DC): APHA. 1998.
- 5. Arnon, D.I., Copper enzymes in isolated chloroplasts, polyphenoxidase in *Beta vulgaris*. Plant Physiol., 1949; 2(1):1-15.
- Brix, H., Do macrophytes play a role in constructed treatment wetlands? Water Sci. Technol., 1997; 35(5):11-17.
- Brix, H., Schierup, H.H., The use of aquatic macrophytes in water pollution control. Ambio., 1989; 18:101-107.

- DeBusk, T.A., Peterson, J.E., Reddy, K.R., Use of aquatic and terrestrial plants for removing phosphorus from dairy wastewater. Ecological Engineering, 1995; 5:371-390.
- Gersberg, R.M., Elkins, B.V., Lyon, S.R., Goldman, C.R. Role of aquatic plants in wastewater treatment by artificial wetlands. Water Research, 1986; 20(3):363-368.
- Haritash, A.K., Sharma, A., Behal, K. The potential of *Canna lily* for wastewater treatment under Indian conditions. International Journal of Phytoremediation, 2015; 17(10):999-1004.
- Haritash, A. K., Dutta, S., Sharma A. Phosphate uptake and translocation in a tropical Canna-based constructed wetland. Ecological Processes, 2017; 6:12, DOI 10.1186/s13717-017-0079-3.
- Korner, S., Lyatuu, G.B., Vermaat, J.E. The influence of Lemna gibba on the degradation of organic material in duckweed-covered domestic wastewater. Water Research, 1998; 32(10):3092-3098.
- Leng, R.A., Stambolie, J.H., Bell, R. Duckweed-a potential high-protein feed resource for domestic animals and fish livestock. Research for rural development, 1995; 7:1-11.
- Mbagwu, I.G., Adeniji, H.A. Nutritional content of duckweed (*Lemna paucicostata* Hegelm.) in the Keinji lake area, Nigeria. Aquatic Botany, 1988; 29:357-366.
- Miranda, G., Quiroz, A., Salazar, M. Cadmium and lead removal from water by duckweed *Lemna gibba* L. (Lemnaceae). Hydrobiologica, 2000; 10(1): 7-12.
- Noe, G.B., Harvey, J.W., Schaffranek, R.W., Larsen, L.G. Controls of suspended sediment concentration, nutrient content, and transport in a subtropical wetland. Wetlands, 2010; 30:39-54.
- Ozengin, N., Elamaci, A. Performance of duckweed (*Lemna minor* L.) on different types of wastewater treatment. J. Env. Biol., 2007; 28(2):307-314.
- Tripathi, B.D., Srivastava, J., Misra, K. Nitrogen and phosphorus removal capacity of four chosen aquatic macrphytes in tropical freshwater ponds. Environ. Conserv., 1991; 18:143-147.
- US Environment Protection Agency (EPA). Design Manual. Constructed wetlands and aquatic plant systems for municipal wastewater treatment. Cincinnati (OH): Office of Research and Development, Center for Environmental Research Information. 1988.p.83.
- 20. Wolf, F.T., Changes in chlorophylls *a* and *b* in autumn leaves. Am. J. Bot. 1956; 43:714-718.
- World Bank, Mirzapur Duckweed Research Project. Project paper, The World Bank, Bangladesh Office, Dhaka. 1992.

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Include summary of key findings (primary outcome measures, secondary outcome measures, results as they relate to a prior hypothesis); Strengths and limitations of the study (study question, study design, data collection, analysis and interpretation); Interpretation and implications in the context of the totality of evidence (is there a systematic review to refer to, if not, could one be reasonably done here and now?, What this study adds to the available evidence, effects on patient care and health policy, possible mechanisms)? Controversies raised by this study; and Future research directions (for this particular research collaboration, underlying mechanisms, clinical research). Do not repeat in detail data or other material given in the Introduction or the Results section.

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Standard journal article

[1] Flink H, Tegelberg Å, Thörn M, Lagerlöf F. Effect of oral iron supplementation on unstimulated salivary flow rate: A randomized, double-blind, placebo-controlled trial. J Oral Pathol Med 2006; 35: 540-7.

[2] Twetman S, Axelsson S, Dahlgren H, Holm AK, Källestål C, Lagerlöf F, et al. Caries-preventive effect of fluoride toothpaste: A systematic review. Acta Odontol Scand 2003; 61: 347-55.

Article in supplement or special issue

[3] Fleischer W, Reimer K. Povidone iodine antisepsis. State of the art. Dermatology 1997; 195 Suppl 2: 3-9.

Corporate (collective) author

[4] American Academy of Periodontology. Sonic and ultrasonic scalers in periodontics. J Periodontol 2000; 71: 1792-801.

Unpublished article

[5] Garoushi S, Lassila LV, Tezvergil A, Vallittu PK. Static and fatigue compression test for particulate filler composite resin with fiber-reinforced composite substructure. Dent Mater 2006.

Personal author(s)

[6] Hosmer D, Lemeshow S. Applied logistic regression, 2nd edn. New York: Wiley-Interscience; 2000.

Chapter in book

[7] Nauntofte B, Tenovuo J, Lagerlöf F. Secretion and composition of saliva. In: Fejerskov O, Kidd EAM,

editors. Dental caries: The disease and its clinical management. Oxford: Blackwell Munksgaard; 2003. p. 7-27.

No author given

[8] World Health Organization. Oral health surveys - basic methods, 4th edn. Geneva: World Health Organization; 1997.

Reference from electronic media

[9] National Statistics Online—Trends in suicide by method in England and Wales, 1979-2001. www.statistics.gov.uk/downloads/theme_health/ HSQ 20.pdf (accessed Jan 24, 2005): 7-18. Only verified references against the original documents should be cited. Authors are responsible for the accuracy and completeness of their references and for correct text citation. The number of reference should be kept limited to 20 in case of major communications and 10 for short communications.

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