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IMPACT OF CREMATION CENTERS IN RIVER POLLUTION: A CASE STUDY FROM GOMTI RIVER, LUCKNOW, UTTAR PRADESH, INDIA

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ABSTRACT

The Gomti River is viewed as a symbol of purification not only by Hindus but other religious denominations too; its channel in Lucknow urban area is presently loaded with remnants of cremated dead bodies and municipal waste. As a consequence, the Gomti River, popularly called 'Life line of Lucknow', is slowly deteriorating with respect to water quality day by day. Ironically, the Government efforts to clean up the river have failed due to poor planning, technological mismanagement and corruption. The religious impact on the Gomti River is displayed by the pouring of ash of cremation centre in the river. Such cremation activities are known to produce cancer causing dioxins, trace metals, hydrochloric acid, carbon dioxide and sulfur dioxide which plays a role in river pollution. This is due to an exponential increasing in the human population in its urban area those catalyses these adverse effects. It would be safer to take the dead body in a crematorium to perform cremation into a furnace, which is known as a retort. The retort has the capacity to burn at temperatures of 1600 to 1800 degree Fahrenheit. These high temperatures ensure that the body is completely reduced to ashes. It would certainly minimize the quantity of harmful substances and ultimately reduce their impact on river pollution.

Keywords: *Gomti River, Lucknow, Cremation Centre, Pollution*

INTRODUCTION

Rivers play a very important role in human life as is evident from pre-historic settlements along the river bank. Present condition of most of rivers in India is becoming perilous day by day due to various anthropogenic activities. Pollution of river water and even soils of their flood plains are regular features of many Indian rivers.

These factors not only affect the human health, crop production and quality of life but also destroy the overall ecosystem of the river basins. Consequently, several good attempts have been made to study river water and soil pollution in various river basins in this country (Singh *et al.*, 1997; *et al.*, 2002; Maurya *et al.*, 2013; Central Pollution Control Board, 2002; Singh *et al.*, 2005) and other parts of World (Müller, 1979; Weiner, 2000 and Hilton *et al.*, 2006). Most of these studies are related to the pollution caused by industrial and human waste. However, little attention is given to the role of cremation waste in river pollution (Maurya, 2008; Maurya and Sharma, 2012). Indeed, the cremation spots are made considering religious viewpoint along the river banks of many Indian Cities. The resultant waste is causing pollution of river water and flood plain soil as well.

The Gomti River acts as a lifeline of Lucknow Urban Centre located in central part of the Ganga Alluvial Plain. Four cremation spots are located along the banks of Gomti River covering about 8 km river tract in urban area of Lucknow. Religious activities are perhaps creating the interferences between nature and human beings.

Consequently, a huge quantity of remnants of human dead bodies after their cremation along river bank is flown into the river channel. In addition, due to growth of urbanization the ever-increasing municipal waste is also added to river channel so as to increase the quantity of pollutants. No attention has been given so far to minimize these pollutants. Attempt is made to analyze the cremation waste and its harmful effects on the ecology of Gomti River. The main objective of this study is to present an overview of the religious factor and its harmful impact on the Gomati River. The study is significant in the sense that millions of people living in Lucknow depends and survive on this river.

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Study Area

Gomti River

The Gomti River flows in the northern part of the India and is a major tributary of the Ganga River system. It originates from a swampy area in the Piedmont Zone in District Pilibhit near Puranpur, located about 50 km south of the Himalayan foothills at an elevation of about 186 m above sea level (latitude $28^{\circ} 34'$ and longitude $80^{\circ} 07'$) and ultimately meets the Ganga River. Total length of the river is about 900 km and it drains a catchment area of about $30,437.25 \text{ km}^2$ located in an interfluvial region of the Ganga and Ghaghara Rivers. The Sai River is the major right bank tributary, which drains nearly one third of the Gomti River basin. Other tributaries are the Kathna Nadi, the Kalayani Nadi, the Behta Nala, the Pili Nadi, the Loni Nadi, Kundu Nala and the Athhi Nala.

The river is a major source of domestic water supply of the Lucknow city, the State capital of Uttar Pradesh. It has a gently sloping elongated drainage basin trending NW-SE characterized by homogenous lithological and climatological conditions. The average slope of the river in its upper reaches is 55 cm/km, whereas in the lower reaches it is 11cm/km. Maximum and Minimum elevation in the basin are about 186m and 80m above mean sea level, respectively. The degree of weathering increases with mean annual temperature and precipitation. The Gomati River basin experiences a humid sub-tropical climate with hot summers followed by heavy monsoon precipitation and cold winters. Annual rainfall in the region varies from 87 to 125 cm. The major part of the rainfall is concentrated in the monsoon months, July- October, with only few sporadic rains in the winter months. Maximum temperature is 47°C and in the winter months it is 20°C and minimum is about 2°C .

Lucknow Urban Centre

Lucknow, the capital city of Uttar Pradesh state, is situated on $26^{\circ}52'$ latitude and $80^{\circ}56'$ longitude at 123 m above sea level in the Ganga Plain, northern India. It has uniform sub-tropical climate. Temperature varies from 45°C maximum in summer to 5°C in winter seasons. Mean average relative humidity is 60 per cent and rainfall 100 cm per annum. Average weather conditions lead to recognize six well marked traditional seasons i.e., Spring (March–April), Summer (May–June), Monsoon (July–August), Sharada (Sept.–Oct.), Hemanta (Nov.–Dec.) and Winter (Jan.–Feb.). The urban centre covers an area of about 250 km^2 . As per census 2001, the urban population of Lucknow is 23 42 239 out of which 11.7 per cent accounts for children population (below age of 6 yr). Satellite images of Lucknow city is shown in Figure 1 which provide valuable information about the urban expansion of the city along with all important city locations used in the present study. The basic information about the Lucknow urban centre is also given in Table 1.



Figure 1: Satellite Image of Lucknow Urban Centre (PAN and LISS III Merged) (Curtsey: UPRISAC, Lucknow)

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Table 1: Basic Characteristics of Lucknow Urban Center, the Ganga Plain, India

Geographical Location	Ganga Plain
Latitude	27° 52'
Longitude	80° 56'
Climate	Uniformed Tropical climate
Temperature range	4-44 °C
Rainfall	100 cm/annum
Urban Area	250 km ²
Total population	45,88,455 (2011)
Urban population	23,42,239 (2001)
Urban population below age of 6 year	2,76,747 (2001)
Hindus	70%
Muslims	26%
Jains	1.7%
Other Religions	2.3%
No. of house hold	3,02,613
Literates	10,28,077

Geomorphology of Lucknow

Lucknow is located on both banks of the Gomti River flowing through the central part of the Ganga Plain in the region of Ghaghara -Ganga interfluves. The Gomati River is an alluvial plain river, which is fed by ground water and sheet runoff.

In the Lucknow area, the Gomati River exhibits meandering characteristics, which are highly distorted indicating neotectonics activity in this region. This area exhibits three different geomorphic surfaces with their characteristics features, namely. The Upland Terrace Surface (T₂) or Upland Interfluve, River Valley Terrace Surface (T₁) and Active Flood Plain Surface (T₀). The upland surface is described as Older Alluvium or Bangar.

The ponds and lakes are usually associated with raised natural levees and alluvial ridges. Deposits of T₂ surface are seen in cliff sections, exposed (Kanker) horizons. T₁ surfaces are located within the Gomati River Valley, above the level of annual floods of the river. The T₁ surface is 5-10m above the T₀ surface; T₂ surface is about 15- 20 m above the T₁-surface. The geomorphology of Gomti River with in Lucknow area is shown in Figure 2. The Cis- Gomati area exhibits mostly higher surface. The main residential areas are located on Upland Terrace Surface T₂ free from annual river floods. The Upper part of T₁ surface was developed into parks and gardens with few monuments on raised grounds. The Bara Imambara is a fine example of using T₂ and T₁ surfaces to create split-levels. The T₂ surfaces extend in Chowk, Aminabad, Charbagh and Cantonment areas with a general altitude of about 124 m above mean sea level.

Husainabad, Kaiserbagh and Hazratganj are located on degraded T₂ and T₁ surfaces. Many new settlements in Lucknow, namely Nirala nagar, Maha nagar, parts of Gomati nagar (Trans-Gomati area) are located on the T₁ surfaces. During planning of these new residential areas, no consideration was given to geomorphic features and water outlets. Often natural drainages have been blocked and depressed areas with small ponds were converted to residential complexes without giving consideration to the water movement during monsoon rains.

MATERIALS AND METHODS

Methodology

In present study the methodology has been divided into two parts. The first part deals with the collection of basic information of the study area related to number of cremations per spot/month and quantity of wood used for burning of dead remains. The second part deals with the extensive field survey in and around the Gomti River in Lucknow to document the present day human activities.

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Data Collection

For present study, data were collected from Biakunth Dham Cremation centre. This study provides the data of ash of dead bodies poured in the river, quantity of wood and fuel used for burning of dead bodies, number of death per year within the Lucknow urban centre. All these data provide basic information to understand and to present an overview of the present day impact of pollution on the Gomati River at Lucknow.

Field Survey

Five field surveys were conducted to collect the onsite data and relevant photographs of the Gomati River sites where the pollution impact of human activities is more pronounced. Field surveys have been carried out on April 09, 2013; January 09 to 11, 2016 and November 19 to 21, 2016 and to observe the religious impact on river Gomati in Lucknow. During the field work, four sites are observed where ash of dead bodies was poured into the river. The conditions of river pollution covering the whole stretch of the Gomati River in Lucknow were observed and recorded in the present study.

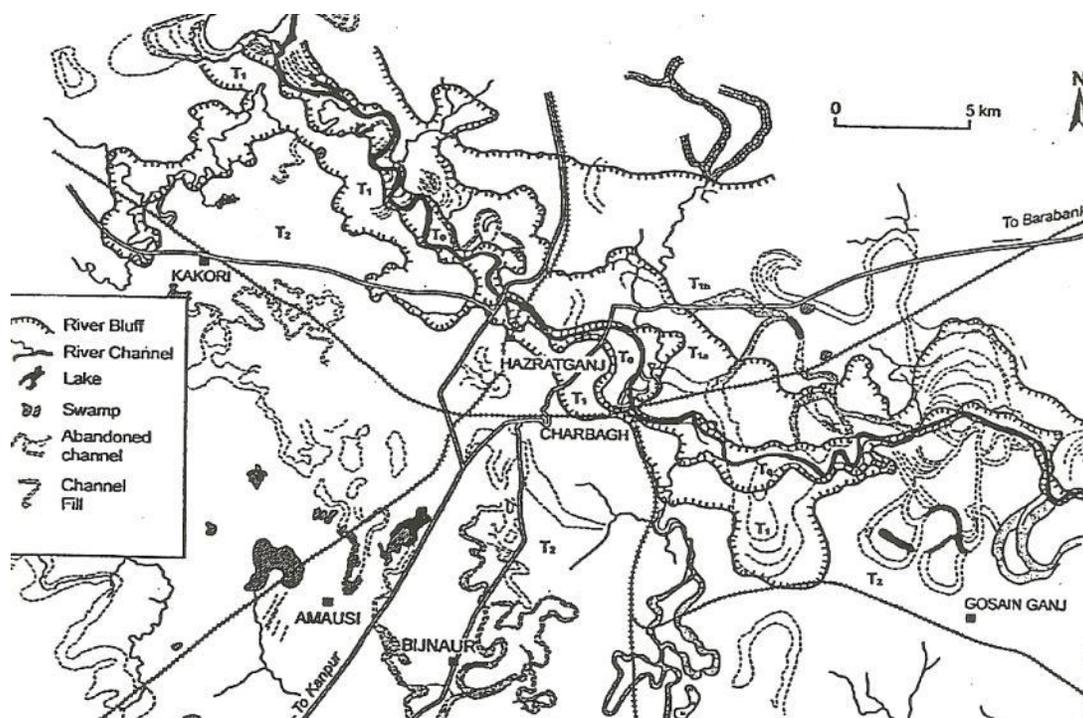


Figure 2: Geomorphology of the Gomati River at Lucknow, Based on survey of India Toposheet (Source: Prof. I.B.Singh)

RESULTS AND DISCUSSION

It is a matter of culture for anthropogeny since thousands of years to pour the remnants of burnt dead bodies into river. Likewise, there are four sites of Gomti River where the ashes are dumped in large amounts everyday in Lucknow. The present scenario of the impact of dead bodies on Gomati River is very ironical. The components of ash are the bone, enamel and cartilage and traces of dentine. Scanning these components at elemental level provides an insight that it is dominantly composed of carbon di oxide, calcium phosphate, magnesium phosphate, sulphur di oxide and traces of nitrogen di oxide, nitrates and nitrogen mono oxide. Sulphur di oxide is a harmful compound that has an adverse affect on Lungs (Weiner, 2000; Srivastava, 2006). Cremations are known to produce cancer causing dioxins, trace metals, hydrochloric acid, carbon dioxide and sulfur dioxide which plays a role in river pollution. It has been estimated that in four centers organizing the cremation of dead bodies, about 5300 people are cremated every year on an average in only one of them that is Baikunt Dham. By and large, about 300 kg of wood

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is needed for cremation for single dead body that varies from person to person. The figures take an exaggerating form when the amount of wood is multiplied with the average number of deaths per annum. This comes to about 15900 quintals of wood burnt every year on one particular site mentioned above. On the average approximately 20 to 25 kg of ash is produced by the burning of single dead body. The estimation of number of cremation in a year is shown in Figure 3.

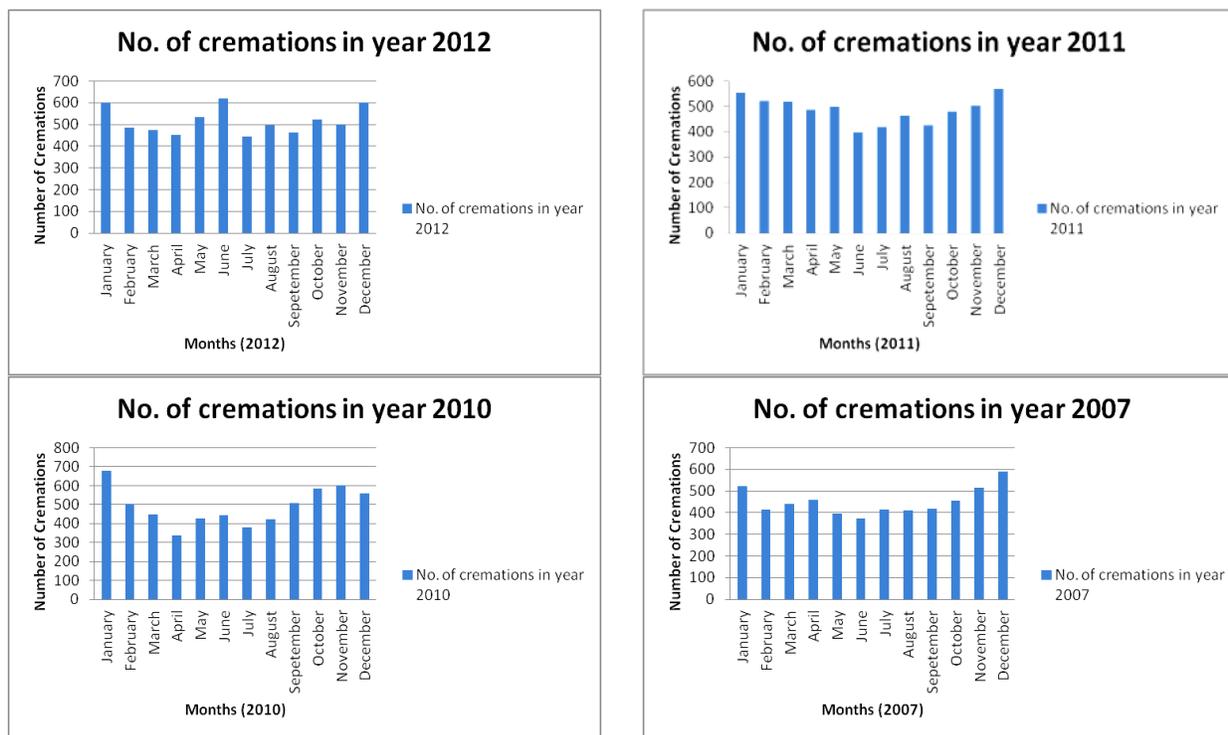


Figure 3: Bar Diagrams Showing the Annual Variation in Number of Cremations at Baikunt Dham in 2012(A), 2011(B), 2010(C) and 2007(D) Year wise Data by Courtesy- Lucknow Nagar Nigam

The ash which is dumped in the river water adds a huge amount of carbon compounds admixed with phosphate of component that comprises bone enamel and other hard part of human body. Table 2 lists basic chemical characteristic of Gomti river water (Singh *et al.*, 2004). It is evident that the amount of many constituents listed in the table exceeds the standard tolerable water for domestic purposes. Currently, it is unsafe for humans to drink or bathe in the water. The problem advances with increasing deaths and unplanned deforestation. As an example in the Gullale Ghat number of dead bodies is burned and the ash is directly dumped into the river as shown in Figure 4A and B. When a person dies and if the family members opt for cremation, the body of the person is taken to a crematorium to be burnt. The ashes, which are known as remains, are then given to the family members. The ashes, in fact, are dried bone pieces which have been powdered using a device known as cremulator. An average human body takes from two to three hours to burn completely and will produce an average of 3 to 9 pounds (1.4 to 4.1 kilograms) of ash. The amount of ash depends usually on the bone structure of the person and not so much their weight (Ellenberg, 2008). Therefore, this amount represents about 15 to 20 percent of the total ash produced in manual cremation.

The river is abused by those who worship it; Hindu rituals, such as placing dead bodies and cremation ashes into the water, quickly defile its sanitation. Many families cannot afford a proper burial or a complete cremation due to the high price of fuel wood. Others wish to bestow additional luck in the afterlife to the deceased often use the river as a cemetery (Wax). Those with sicknesses and diseases come to the river to bathe, hoping that the water’s divine powers will heal them. The river is a crowded tourist

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sensation as well, drawing pilgrims from around the world. To add to all of this, residents of Lucknow even use the water for practical purposes, such as washing clothing and dishes. The worlds of industry, religion, and daily life collide into a destructive explosion of pollution hammering the river each day. It is tragic that something so holy and revered could be so miserably contaminated. The trade-off between India's growing economy and the importance of clean water in the Gomati leans heavily against the favor of the river.

Modernization, industrialization, and urbanization have taken heavy tolls as they have quickly swept through the Gomati sub basin and the Ganges basin at large. For example the Gomti Nagar and its recent extension, a posh locality of Lucknow, is perhaps the violation of the law of nature by confining the river channel and encroaching its flood plain.

According to the World Health Organization, dirty water is the leading cause of child deaths in India. The coliform bacteria count is about 3,000 times higher than the level that is considered safe. Hundreds of thousands of children in India die because of dirty water annually. The environment that these children grow up in, is unsafe and unnecessary, but because their lifestyle revolves around drinking water from the Gomati, they have no choice. Indian natives put it well by saying, "The Gomati is beloved by her people. It has been a symbol of India's age-long culture and civilization, ever changing, ever flowing, yet ever the same Gomati." However, reality has to sink in for the population of India soon. The pollution of the Gomati River causes health problems, steady fall in farming and more so the culture of Lucknow is getting modified. Pollution from industrial carelessness, untreated sewage, religious rituals, and other unsanitary deposits into the river are destroying it, and destroying a sacred deity for the Hindu religion – whether or not they choose to realize it.

Table 2: Basic Chemical Characteristics of Gomati River Water from Three Sites at Lucknow Urban Centre

Parameters	Units	Gaughat Station	Pumping	Mid-Lucknow	Pipraghat
Temperature	°C	26		26	26
Electronic Conductivity	µS cm ⁻¹	357		403	443
pH		8		8	8
Total Solids	mg/l	278		303	322
Total dissolved solids	mg/l	241		258	277
Total suspended solids	mg/l	38		25	45
Total alkalinity	mg/l	209		212	222
Total Hardness	mg/l	166		176	184
Calcium Hardness	mg/l	96		109	111
Dissolved oxygen	mg/l	7		4	1
Biological Oxygen Demand		3		11	17
Chemical Oxygen Demand		10		26	32
Chloride	mg/l	5		8	12
Flourine	mg/l	0.5		0.6	0.8
Potassium Phosphate	mg/l	0.3		0.3	0.5
Sodium Phosphate	mg/l	8		12	13
Potassium	mg/l	5		6	7
Sodium	mg/l	27		30	35
Calcium	mg/l	38		43	44
Magnesium	mg/l	17		17	18
NH ⁴ -N	mg/l	0.1		0.8	0.9
NO ₃ -N	mg/l	0.2		0.7	1
TKN	mg/l	2		4	5
Total Coliform	MPN/100ml	5.6E+03		2.4E+09	1.9E+10

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**Figure 4a: Photograph Showing the Burning of Dead Body at Gullale Ghat, Lucknow;
Figure 4b: Photograph Shows the Ash from the Gullale Ghat Cremation Centre, which Ultimately Dumped into the Gomati River**

Conclusion

The present study concludes as follows:

1. Ashes of dead bodies consist of bone, enamel and cartilage and traces of dentine. Scanning these components at elemental level provides an insight that it is dominantly composed of carbon di oxide, calcium phosphate, magnesium phosphate, sulphur di oxide and traces of nitrogen di oxide, nitrate oxide and nitrogen mono oxide.
2. Due to pouring of ash of cremation spots into the river increases the BOD and COD which adversely affect the aquatic ecosystem. Sulphur di oxide is a harmful compound that has an adverse affect on Lungs.
3. The traditional Cremation requires huge quantity of wood and damages the environment not only by harmful gases released by burning but also because of deforestation to meet out the requirement of the wood. The modern crematorium are definitely the better options which saves the deterioration of river system due to very low remaining ash content as well as saving our trees.

It can be suggested that natural characteristics of the Gomti River is ruined by the several human Hindus activities in the name of religion. This study acts as a key to enrich our understanding of how humans and our religion add pollutants in rivers. The protection of Gomati River is the need of the hour for future generations.

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