Impact of Solid Waste on Ground Water in Varanasi City

Pragya Singh[1], D. D. Maithani[1,] Virendra Kumar[2]

[1] Deptt. of Geography, H. N. B. (A Central University), Srinagar-Garhwal, Uttarakhand

[2]Remote Sensing Applications Centre-Uttar Pradesh Lucknow.

Abstract

Varanasi city is a religious Indian City with having 1597051 population and the extent of solid waste generated from the City is estimated to be 0.400 (Generation Rate Kg/capita/day). The solid wastes generated in Varanasi city are majorly disposed of as land fill in low lying areas. There has been a serious concern about the possible contamination of ground water when the wastes are, thus, disposed. For the present study two land fill sites – Aurangabad and Badi Gaibi were selected. The impact of urban solid waste disposal on ground water quality was investigated by obtaining two ground water samples from Aurangabad and Badi Gaibi landfill site. In the study reported here, environmental pollution impacts of a solid waste disposal site were investigated. Samples of groundwater from sites suspected to be affected by the dumpsite were analyzed for chemical, physical, including heavy metals.

Keywords: Solid waste; Groundwater; Remote Sensing & GIS ;

Introduction

Presently most of the waste is disposed in low-lying areas without taking proper precautions. This has led to the breeding of rodents, flies and other domestic pests and also tends to pollute the surface as well as ground water. Hence, it is necessary to adopt sanitary land filling techniques so that such problems are avoided (Jeevan Rao, 1994f). Impact of solid waste on ground water in the city is mainly sourced from heaps of garbage. The solid and liquid wastes generated out of the household and industrial activities are dumped and released in uncontrolled sites. On an average, 661 million tons of solid waste in a day is produced in the city, but only 87% of which is collected for ultimate disposal, and the rest is left uncollected. This is primarily due to lack of effective labour strength and fleet of vehicles for collection, transportation and disposal. These wastes are disposed off in the low lying areas of the city where the tanks and ponds are located, which were once important sources of ground water recharge in the city.

In study area, ground water table dropped by 2.13 m (7 feet) in 2006 from a level of 17.68 m (58 feet) in 2005. Report of the State Ground water Department states that the ground water in the city of Varanasi is depleting at a rate of 23 cm /a−1 (Report of the 'Hindustan' 2006). Lowering of ground water in the southern part is 9 times faster than the rest part of the city. (Mohan K., Srivastava A., et al., 2011)

Objective of the Study

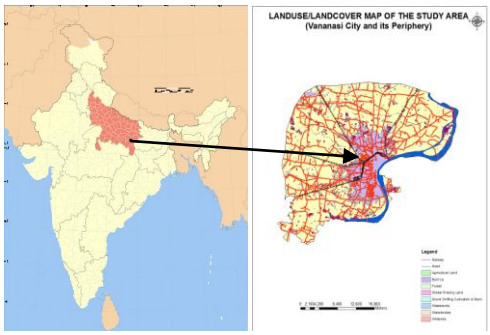
- The main aim of this study is find out the impact of solid waste on ground water quality in the study area.

Study Area

Varanasi as a city is situated on the left bank of Ganga river in broad crescent shaped. The urban agglomeration of Varanasi city stretched between 82° 56'E - 83° 03'E and 25° 14'N - 25° 23.5'N. The "Varanasi Urban Agglomeration" — an agglomeration of seven urban sub-units — covers an area of 112.26 km ^{2} . It is situated on the left part of the Ganga, where the latter forcer a 'gigantic bow'. The north ward flow of river imparts religious significance to the place. A relatively higher concave bank in the form of levees from Assi nala in the south to Varuna in north provides a 'dry points' location skirting the Ganga. Presently the city is expanding towards Sarnath the Ghazipur road in the north east, towards Shivpur along the Jaunpur road in the north west, towards BHU in the south west and towards Diesel Locomotive Work (DLW) in the south-west. Rapid growth of population over the last two decades has rendered the central part of the city over crowded and too congested. The City of Varanasi spreads over an area of 79.79 sq km. According to census 2011 the total population of the city is 1597051. Location of the study area with land use /land cover map are shown in the fig.1.

Fig-1

Location Map of the Study Area



Material and Data used

In order to fulfill the necessity of the study, following data were collected to perform objective of the study.

- **Topographical Data**
  Survey of India (SOI) topographical map 63O/2, 63O/3, 63O/4, 63K/14, 63K/15. 63K/16 are used for the base map study on the scale of 1:50000.

- Primary data collection
- Data used Collateral/ Ancillary data from various state/central Govt. departments.
- **Satellite Data**
- **RESOURCE SAT-2 LISS-III Data (FCC)**

  Satellite data of Indian Remote Sensing Satellite RESOURCE SAT-2/ (23.5m resolution) acquired in 2012 was used for the Preparation of base-layer-Road/Railway/Transport network and Landuse/Landcover map of the study area that was collected and produced in a digital format from UP-RSAC through Landuse and Urban Survey Division (GIS Section). The performance of Resource sat-2/ LISS-III is summarized in table-1.

Table-1: IRS-1C/1D LISS-III Performance Summary

Specification	Value
Orbit/Cycle Visits / year	341
Semi major axis	7195.11km
Altitude	817 km
Inclination	98.69 deg
Eccentricity	0.001
Number of Orbits/day	14.2083
Orbit period	101.35 min
Receptivity	24 days
Distance between adjacent paths	117.5 km
Distance between successive ground tracks	2820 km
Ground trace velocity	6.65 km/sec
Equatorial crossing velocity	10:30 AM (At Descending node)
IGFOV	23.5 m
Spectral Bands	B2, B3, B4 and B5
Swath	141 km
Quantization	7 bits SWIR band has 10 bit quantization, selected 7 bits out of 10 bits will be transmitted by the data handling system
No. of gains	4

Methodology

A simple methodology has been adopted in carrying out the study. Preparing the data is a primary requirement before undertaking image interpretation and subsequent analysis. Preparation of database is described hereunder: Satellite data which is available in a raster form needs to be geo-referenced to a map coordinate system so as to generate spatial information to be used subsequently in a GIS environment. The IRS P6 satellite LISS-III sensors having the resolution 23.5m simultaneous data has been used for the preparation of base-layer Road/Railway/Transport network and Landuse/Landcover map using on screen digitization in Arc-GIS software version 10 on 1:24000 scale.

In order to know the impact of wastes on ground water quality, water samples from 2 sites (hand pumps) around garbage dumps were analyzed. At two sites (Aurangabad and Badi Gaibi), samples were taken in summer season and the results are listed in Table-28.The ground water from these two sites appears to be unremarkably affected by the solid waste dump in terms of chemical contents. The considered parameters analysis was done in the laboratory of the Remote Sensing Applications Centre, Uttar Pradesh, Lucknow.

Result and Discussion

As per findings (Table-2) of analysis of dumping Site-1 and Site-2, observation shows that except Hardness almost all parameter are within limit as per IS:10500, while due to dumping of wastes in both the sites only Hardness of ground water is majorly affected.

Table-2: Ground Water Quality

Parameters	Value		Acceptable limits (As per IS-10500:2012)	Maximum Permissible limits (As per IS-10500:2012)
	Site-1	Site-2		
1. Alkalinity(mg/l)	186	190	200	600
2. pH	7.02	6.97	6.5 – 8.5	No Relaxation
4.Total dissolved solid (TDS) (mg/l)	351	410	500	2000
5.Sulphate(mg/l)	15	18	200	400
6. Hardness (mg/l)	429	407	200	600
14. Nitrate(mg/l)	2.17	1.82	45	No Relaxation

Conclusion

It is concluded that solid waste is majorly affecting the hardness of ground water in both the waste disposal sites in the study area. This was observed mainly to be due to the indiscriminate dumping of wastes into the environment. This is a major threat to human population, especially those within the area. Consequently, it is therefore recommended that effective disposal mechanism of waste in Varanasi city, be introduced that would enhance sustainable development. In addition, a program of effective monitoring of water quality needs to be re-emphasized.

References

- Census of India Series, 1951, 1961, 1971, 1981, 1991, 2001 and 2011,Uttar Pradesh.
- Campolo MP, Andrenssi P, Soldati A (2002). Water quality control in the river. Arno. J..Sci. Direct, 36:2673-2680.
- City Development Plan for Varanasi under Jawaharlal Nehru National Urban Renewal Mission (JNNURM) Rapid Assessment Report, May 2006
- Dernbach H, Henning KD. Purification steps for landfill gas utilization in cogeneration modules. Resour Conserv 1987;14:273– 82.
- Doeglas D.J., 1946. Interpretation of the results of mechanical analyses. Journal of Sedimentary Petrology 16(1): 19–40.
- Fatoki OS, Lujiza N, Ogunfowokan OA (2002). Trace metal pollution in Umtata River, Water SA, 28 (2): 183-190.
- Flyammer, P., (1995). Leachate quality and environmental effects at active Swedish municipal landfill. In: R.Cossu, H.T. Christensen and R. Stegmann (eds.), Regulations, environmental impact and aftercare. Proceedings Sardinia 95, Fifth International Landfill Symposium, Vol III. Sardinia, Italy, 557pp.
- Mohan K., Srivastava A., Rai P.K., 2011. Ground Water in the City of Varanasi, India: present status and prospects. *Quaestiones Geographicae* 30(3), Bogucki Wydawnictwo Naukowe, Poznań, pp. 47–60,
- Goorah, S., Esmyot, M., Boojhawon, R. (2009). The Health Impact of Nonhazardous Solid Waste Disposal in a Community: The case of the Mare Chicose Landfill in Mauritius. Journal of Environment Health, 72(1) 48-54
- Gopal D, Singh R P and Kapoor R C . Ground water pollution by solid wastes. A case study, pollution Research, Enviro media 10 : 111-116(1991).
- ISI, (Indian Standards Institution). Specification for drinking water IS: 10500, New Delhi (1983).
- Karanth, K.R., (1989). Ground water assessment, development and management. Tats McGraw-Hill, New Delhi.
- Laftouhi, N.,Vanclooster, M., & Jalal, M., (2003). Groundwater nitrate pollution in the Essaouira Basin (Morocco).CR Geosciences, 335, 307-317.
- Lee, J., Alkarkhi, A. F. M., Kadir, M. O. A. & Ahmad, A., (2011). Electrocoagulation of chemical, mechanical polishing (CMP) waste water treatment with alluminium electrodes: parameter optimizing using response surface methodology (RSM). Journal of Industrial Research and Technology, 1(1), 24-31.
- Morales-Suarez-Varela, M. M., Llopis-Gonzalez, A., & Tejerizo-Perez, M.L., (1995). Impact of nitrates in drinking water on cancer mortality in Valencia, Spain.European Journal of Epidemiology, 11, 15-21.
- Nicholas, D.J., & Nason, A., (1957). Determination of nitrate and nitrite, Methods Enzymology, 111, 320-343.
- Namade, P.N., & Srivastava, N.S., (1997). Nitrate (NO3-. N) status of groundwater in Tribal belt of Satpura Valley. Indian Journal of Environmental Protection, 17, 430-433.
- Pawar, N. J., & Shaikh, I. J., (1995). Nitrate pollution of groundwaters from shallow basaltic aquifers, Deccan Trap Hydrologic Province, India. Environmental Geology, 25,197-204.
- Singh R.L. (1955) Banares : A Study in Urban Geography, Nand Kishore & sons Varanasi.
- Singh K.N. (1981) Geography of Tourism and Recreation. Inter India Publication, New Delhi. P. 09.