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INTRODUCTION

REVIEW OF LITERATURE

NEED/IMPORTANCE OF THE STUDY

STATEMENT OF THE PROBLEM

OBJECTIVES

HYPOTHESES

RESEARCH METHODOLOGY

RESULTS & DISCUSSION

FINDINGS

RECOMMENDATIONS/SUGGESTIONS

CONCLUSIONS

SCOPE FOR FURTHER RESEARCH

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APPENDIX/ANNEXURE

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CONTRIBUTIONS TO BOOKS

- Sharma T., Kwatra, G. (2008) Effectiveness of Social Advertising: A Study of Selected Campaigns, Corporate Social Responsibility, Edited by David Crowther & Nicholas Capaldi, Ashgate Research Companion to Corporate Social Responsibility, Chapter 15, pp 287-303.

JOURNAL AND OTHER ARTICLES

- Schemenner, R.W., Huber, J.C. and Cook, R.L. (1987), "Geographic Differences and the Location of New Manufacturing Facilities," Journal of Urban Economics, Vol. 21, No. 1, pp. 83-104.

CONFERENCE PAPERS

- Garg, Sambhav (2011): "Business Ethics" Paper presented at the Annual International Conference for the All India Management Association, New Delhi, India, 19–22 June.

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- Kumar S. (2011): "Customer Value: A Comparative Study of Rural and Urban Customers," Thesis, KurukshetraUniversity, Kurukshetra.

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WEBSITES

- Garg, Bhavet (2011): Towards a New Natural Gas Policy, Political Weekly, Viewed on January 01, 2012 http://epw.in/user/viewabstract.jsp

HAZARDOUS WASTES: INDUSTRIAL CONCENTRATION AND POLLUTION INTENSITY IN ANDHRA PRADESH

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ABSTRACT

Disposal of hazardous wastes emitting from industries is causing severe environmental pollution across the world. In this paper, we examine the profile of hazardous wastes generation in Andhra Pradesh, India, in terms of total generation of hazardous wastes, the number of hazardous wastes generating industrial units, composition of hazardous wastes, and pollution intensity of such wastes. We also estimate the Pollution Concentration Intensity, to ascertain the districts in which there is high concentration of polluting industries, and the District Pollution Intensity, and Vulnerability Index, to depict the pollution exposure rate of population of different districts of Andhra Pradesh. Our findings show that the maximum Pollution Concentration Index is for Vishakhapatnam district, followed by Srikakulam. Shares of Recycled and Disposable wastes are similarly highest in Vishakhapatnam district, followed by Ranga Reddy district. When estimating the Vulnerability Index, we find that Hyderabad district, which has the highest population density in Andhra Pradesh, was the most vulnerable to pollution from hazardous wastes, while Nizamabad district was the least vulnerable.Finally we look at economic and ecologically efficient ways of disposal of hazardous wastes, which will earn both profits, and reduce environmental pollution.

KEYWORDS
hazardous waste, pollution.

INTRODUCTION

Industrial Hazardous Waste is defined by the Ministry of Environment and Forest as "any substance, excluding domestic and radioactive waste, which because of its quantity and/or corrosive, reactive, ignitable, toxic and infectious characteristics causes significant hazards to human health or environment when improperly treated, stored, transported and disposed off" [MOEF rules 1989].

Industrial Hazardous Waste (HW) is generated by 18 categories of industries such as petrochemicals, pharmaceuticals, pesticides, paint and dyes, petroleum, fertiliser, asbestos, caustic soda, inorganic chemicals, general engineering, etc. These wastes are harmful in nature as they have high concentration of toxic elements which contaminate surface and ground water, posing major ecological and health risks. Their treatment and disposal also pose environmental and health hazards; therefore HW has to be handled and disposed off with proper care. With industrial development, the quantum of HW also increases, creating problems of safe disposal. Further, when similar types of industries converge to reap economies of agglomeration, it leads to further increase in the local concentration of HW pollution.

OBJECTIVES OF THE PAPER

The main objective of this paper is to identify locations where there is concentration of HW generating industries in different regions and districts of Andhra Pradesh (AP), and the need to ensure that further burden of pollution is not imposed therein, by not allowing the establishment of more polluting factories in such regions. We analyse the concentration of HW producing industries through the Pollution Concentration Index to depict the conglomeration of hazardous waste generating industries in different districts of AP. We also estimate Pollution Intensity, and Population Intensity to identify those districts in AP that are most vulnerable to HW pollution.

METHODOLOGY

Secondary data on the number of HW generating industrial units, and HW generated is taken from the Andhra Pradesh Pollution Control Board website (www.appcb.ap.nic.in) from Dec 2011 – Jan 2012, given for the year 2010. Data on population density is taken from www.apponline.com, the official AP government portal, in April 2012. Discussions on HW disposal were held with the staff of the official TSDF of AP.

We use ratios, percentages and graphical methods to estimate the above parameters in our study.

REVIEW OF LITERATURE

Survey of literature showed that no studies have been conducted so far regarding industrial HW generation, distribution, and concentration in Andhra Pradesh. In this article we aim to fill this gap. Earlier studies have enquired into either the technical aspects of HW generation, or on their legal aspects in India.

A CPCB sponsored National Inventory of HW in India (2009) gives a detailed account of amount of HW generated, the number of HW industrial units in different states of India, and the HW generation, composition, and distribution within the country. An Indo-Japan project (2010) discusses the amount of HW produced in Gujarat, and suggests technical methods and funding for recycling, reuse, and reduction. The negative impacts of HW pollution have been described in a paper by TERI (2005), in general, as well as for specific areas of Gujarat, Maharashtra and Rajasthan. It specifies remedial measures to be implemented for HW disposal. Dua, A (2011), analyses the legal aspects of HW regulation in India, growth of HW generation, and offers suggestions to improve effective regulation. Ashok Pappu et.al (undated) examine potential recycling techniques of HW in India.

INDUSTRIAL HW REGULATIONS IN INDIA

Since money costs of disposal and pollution impacts, are external costs, industries tend to ignore them, and throw their wastes away indiscriminately. Therefore it is up to the government to ensure that HW is disposed of properly, without causing any environmental damage. The Ministry of Environment and Forests (MOEF) has passed a number of regulations giving guidelines for the safe disposal of HW. In 1989, the MOEF passed the Hazardous Waste (Management & Handling) Rules, which was later amended in the years 2000 and 2003. In 2008 the Hazardous Wastes (Management, Handling and Trans-boundary Movement) Rules was notified, for effective HW management. The stakeholders of hazardous waste disposal include:

1. *Central Government:* MOEF passes the Environmental Rules, and frames the regulations. The Central Pollution Control Board (CPCB) classifies hazardous wastes and proposes standards regarding treatment and disposal.
2. *State Pollution Control Boards (SPCB):* create inventories of the composition of hazardous wastes generated by industrial units in their states, and provide licenses for handling, and recycling waste materials. They have to identify disposal sites and plan facilities, called TSDF (transport, storage and disposal facilities), for proper and environmentally safe means of treatment and disposal of HW.
3. *HW producing industries:* The Hazardous Wastes Rules of 2008 of MOEF stipulates that all HW producing industries are responsible for "the safe and environmentally sound handling of their own generated HW". As per the Rules, all industries generating, treating, reprocessing, and disposing of HW, have to register with their SPCBs and with the available TSDFs. They also have to provide all information about the amount of HW generated, and disposal methods. The industries should first consider reusing, reprocessing, or recycling their HW. The remaining wastes that cannot be recycled should be

disposed off in PCB authorised disposal facilities. The generator of HW should get permission from the SPCB for handling hazardous waste before starting operation. A letter of authorisation is given to such industries, to enable them to start/continue production. [MOEF HW Rules, 2008]

4. *The Facility or Occupier:* The responsibility of treating and disposing of hazardous waste lies with the occupier of the facility (TSDF) handling HW. There are numerous directions given to the occupier regarding how it should be transported, stored, incinerated and disposed off [MOEF HW Rules, 2008]. TSDFs should also inform the PCB annually about the amount, composition and manner of treatment of HW.

HW GENERATED IN INDIA

A 2009 inventory undertaken by the CPCB showed that there were 36,165 hazardous waste generating industries in India, generating 6,232,507 MT of HW per annum. Of these, Recyclable HW comprised nearly 50%, followed by Disposable[1] HW 43.78%, and Incinerable wastes 6.67 % [CPCB, *National inventory of HW:* 2009]. In 2009, Gujarat had the largest share (28.76%) of HW generated in India, followed by Maharashtra (25.16%), while AP was the third largest generator of HW in India (8.93%).

From the information given by CPCB (Feb 2010), there were currently only 27 TSDFs in 12 states of India, while 35 notified sites and 64 identified sites were at various stages of development [CPCB website]. The annual capacities of the TSDFs range from 10,000 to 1.2 lakhs T/annum, with an operating life span of 15-30 years. This is just around 1/6th of the HW generated in India and totally inadequate to handle all the wastes. Also most disposal facilities seem to be undertaking only landfill and incineration of HW, but not recycling. In some cases, TSDF operators have not installed hazardous waste incinerators, as the quantity of incinerable hazardous waste generation is not adequate to be economical, or else generation it is not uniform.

HAZARDOUS WASTE GENERATION IN AP

Data from APPCB website showed that the total number of HW generating industrial units in AP was 3,222 in 2010, as compared to 1,739 in 2008, i.e. an average annual increase of about 43% over these two years. The share of HW generating industrial units in total industries in AP, which was around 48% in 2008, had increased to 71% in 2010. These include only the large and medium scale industries, as the small scale industries' inventories have not been taken. Thus the actual number of HW generating units and wastes may be much larger.

These 3,222 industrial units generated a total of 1,089,962 MT of hazardous wastes (HW) in 2010, a growth of 48% pa over 2008 [APPCB website]. The growth of Hazardous Wastes generated was thus about 5% greater than the growth of its generating industrial units in these two years.

The HW generated in AP during 2010 consisted of 58% recyclable, 38% disposable (landfill), and 4% incinerable wastes [APPCB website]. Although recyclable is the largest portion, both the TSDFs in AP do not recycle HW, but dispose them off in landfills. This is both an uneconomical and environmentally unsafe way of treating recyclable wastes.

REGIONAL HW GENERATION IN AP

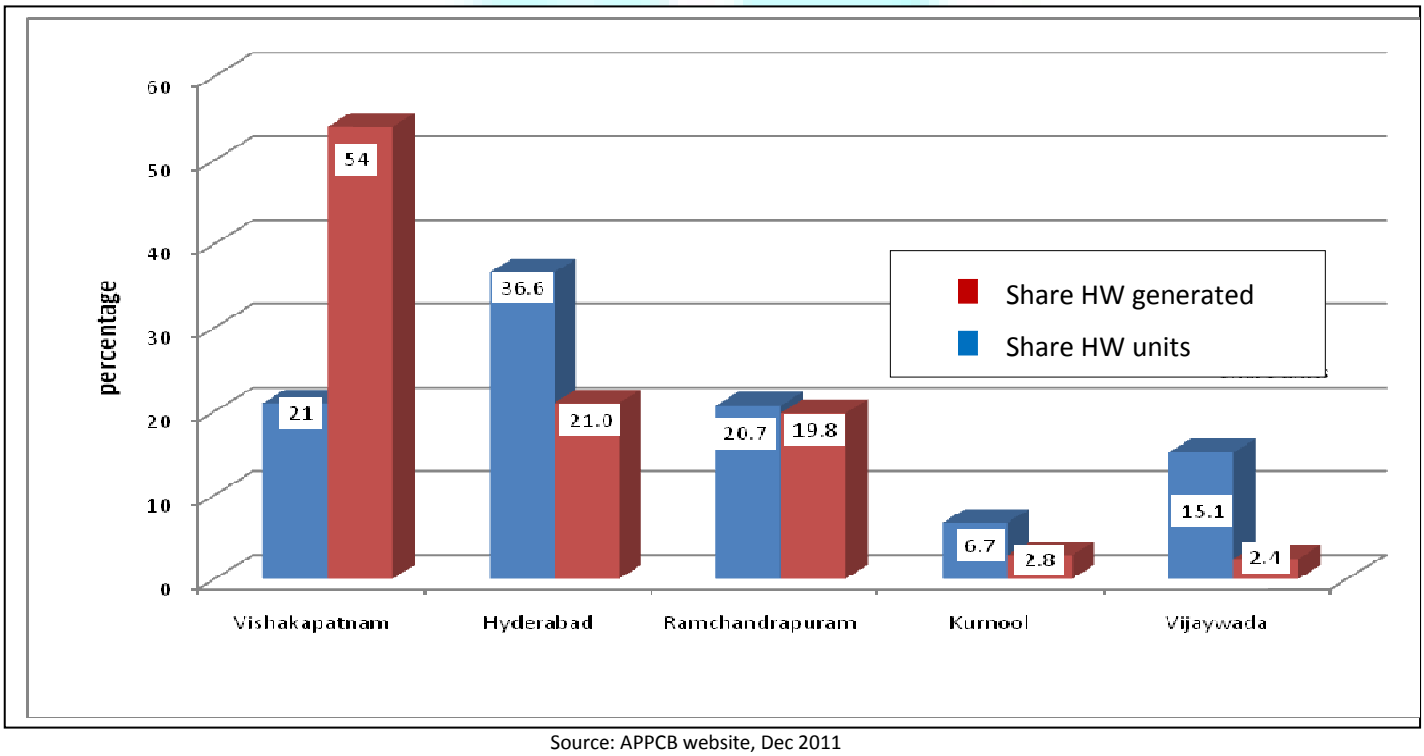
AP consists of three regions: Telengana, Andhra and Rayalaseema, divided into five industrial zones. These are Hyderabad, Ramchandrapuram, Kurnool, Vijayawada, and Visakhapatnam Zones, covering the 23 districts of Andhra Pradesh. The first two zones cover 10 districts of Telengana; the last two cover 9 districts of Andhra region, while Kurnool covers 4 districts of Rayalaseema.

1. *Telengana Region* comprising of Hyderabad and Ramchandrapuram industrial zones, had the highest share of HW generating factories (57%), but contributed only 41% of HW generated in the state.
2. *Andhra Region* consisting of Vishakhapatnam and Vijayawada industrial zones, with 36% of HW generating industrial factories, generated 54% of the State's HW.
3. *Rayalaseema* (Kurnool zone) had a very small share of both HW generating units and wastes.

- **HW GENERATION IN THE FIVE INDUSTRIAL ZONES OF AP**

APPCB data sources showed that while the maximum share of HW generating *industrial units or factories* was in the Hyderabad Zone (36.6%), followed by Vishakhapatnam Zone (21%), the latter had the maximum share of HW *generated* (54%). This could be due to the opening of the Pharma City near Vizag, and the relocation of chemical and pharmaceuticals to the coastal city [Figure 1]. The other four zones had proportionally lower generation to industrial units' ratio.

FIGURE 1: SHARE OF HW GENERATED AND HW GENERATING UNITS IN FIVE INDUSTRIAL ZONES OF AP



Source: APPCB website, Dec 2011

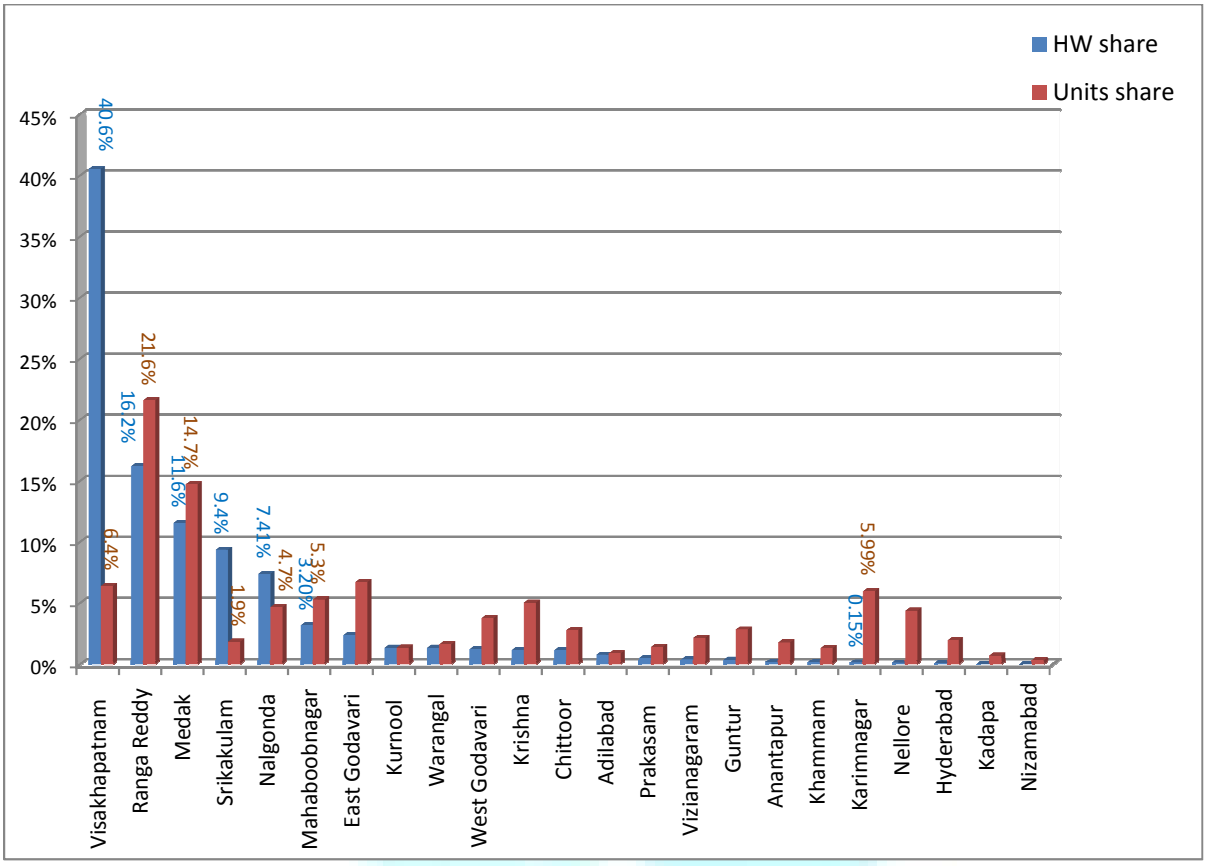
[1] Wastes that can be dumped in landfills

- **0DISTRICT WIDE HW GENERATION**

We now look into the distribution of factories and amount of HW generated in the 23 districts of AP. We find that 69% of HW generating factories was concentrated in just 6 districts of the state in 2010. 85% of HW generated was from just 5 districts (Table 1). This shows that the amount of HW generated is highly concentrated in a few districts.

Ranga Reddy district with the highest share of HW generating units of about 22% contributed just 16% of HW. Vishakhapatnam district however, with just 6.42% of HW generating units had a massive share of total HW generated (41%), other districts had even lower shares of generation and HW producing units (Figure 2). This shows that at the district level also, the share of HW generated does not match the share of HW generating factories.

FIGURE 2: HW GENERATED AND HW GENERATING INDUSTRIES SHARE - DISTRICTS OF AP 2010



Source: APPCB website Dec. 2011

Looking at the figure 2 above, we observe that the ranking of districts according to the amount of HW generated does not match their ranking in terms of number of HW factories. In other words, districts with a small share of total hazardous industrial *units* could have a higher share in total HW *generated,* showing greater concentration of pollution.

The pollution concentration within a district thus depends on not only its share of total waste generated, but also on the number of industrial units generating these wastes. As can be seen from the above table, Vishakhapatnam with a smaller share of industrial units than Ranga Reddy had the maximum share of HW generated. This indicates that pollution intensity is not just the conglomeration of a large number of polluting units, but depends on the amount of HW generated per factory. So merely looking at the number of HW units in a district does not depict its Pollution Concentration.

We now estimate the Pollution Concentration Index or PCI [Panth P.2004, Panth P. and R.A.Shastri 2011], to identify districts with the highest concentration of HW pollution.

POLLUTION-CONCENTRATION INDEX (PCI)

As discussed above, while certain zones have high share of HW generating units, their share of HW generated may be low, and vice versa. Hence it is necessary to take note of both these factors in the estimation of the Pollution Concentration Index. This index measures the share of a district in HW generation to its share of HW units.

$$PCI = \frac{\text{Share of total HW generated in a district}}{\text{Share of total HW industrial units in the district}}$$

Thus if a district has a 20% share in HW generated, but only 5% of the HW industrial units then its PCI= 20/5 = 4. This denotes that this district's generation of HW is 4 times higher than its share of HW industrial units in AP. As a thumb rule we may posit that there is high pollution concentration if PCI>1,

Using this index, some surprising results emerge in terms of the pollution intensity of various districts in AP. PCI of different districts are shown in Table 1. Three districts have high HW Pollution Concentration, shown by their PCI> 1. These include Vishakhapatnam with a PCI of 6.3 (denoting a 6 times higher share in total HW, to its share of HW industrial units), followed by Srikakulam ranking second, with PCI = 5, and Nalgonda (PCI= 1.58). Six districts have PCI > 0.5, while the others have much lower PCI, Nizamabad having the least value.

TABLE 1: POLLUTION CONCENTRATION INDEX OF DISTRICTS OF ANDHRA PRADESH (2010)

Rank	Districts	PCI	Rank	Districts	PCI
1	Visakhapatnam	6.315	13	West Godavari	0.327
2	Srikakulam	5.043	14	Krishna	0.233
3	Nalgonda	1.581	15	Vizianagaram	0.191
4	Kurnool	0.993	16	Guntur	0.134
5	Adilabad	0.882	17	Khammam	0.133
6	Warangal	0.822	18	Anantapur	0.109
7	Medak	0.786	19	Hyderabad	0.062
8	Ranga Reddy	0.750	20	Kadapa	0.052
9	Mahaboobnagar	0.603	21	Nellore	0.033
10	Chittoor	0.414	22	Karimnagar	0.026
11	Prakasam	0.357	23	Nizamabad	0.006
12	East Godavari	0.355			

Source: Estimated from above data.

Thus although there is massive HW generated in AP, it is not uniformly distributed, with some districts having high concentration of pollution generation. Knowledge of HW concentration in various districts would help in policy decisions regarding future location of HW generating industries in AP. For, even though there may be economies of scale in terms of concentration of similar industries in an area, there will also be negative externalities due to the high concentration of HW, as for instance in Vishakhapatnam, Srikakulam, and Nalgonda districts.

HW COMPOSITION IN DISTRICTS OF AP

To dispose of HW, it is necessary to know its physical characteristics. HW consists of Recyclable, Landfill (Disposable), and Incinerable wastes. Recycling of HW seems to have great potential, as the wastes can be reused for further production[2] [Ashok Pappu et.al. not dated]. Land filling of wastes raises the danger of chemicals leaching into ground water and soil. Similarly incineration burns wastes creates air pollution.

SHARES OF HW COMPOSITION IN AP

Data taken from APPCB website shows that recyclable HW forms the major share of total HW (58%) in AP, followed by disposable (38%) and finally incinerable wastes (4%). The following table gives the type and shares of different types of HW over the five industrial zones in AP, 2010.

TABLE 2 - INDUSTRIAL ZONES SHARE OF DIFFERENT TYPES OF HW

Shares in total HW types	Share disposable	Share recyclable	Share incinerable
Hyderabad Zone	20.8%	22.2%	7.4%
Ramchandrapuram Zone	22.5%	16.0%	**49.1%**
Kurnool Zone	3.7%	2.3%	0.3%
Vijayawada Zone	2.9%	1.7%	8.4%
Vishakhapatnam Zone	**50.2%**	**57.8%**	34.9%
Total	100%	100%	100%

Source: APPCB website Dec 2011. Bold letters show maximum shares

Vishakhapatnam had the highest share of both Disposable (50%) and Recyclable wastes (58%), followed by Ramchandrapuram and Hyderabad. While Ramchandrapuram had the highest share of Incinerable wastes 49%, Vishakhapatnam stood second at 35%, with Kurnool the least.

- **SHARE OF DIFFERENT TYPES OF HW WITHIN INDUSTRIAL ZONES**

We now look at the share of different types of HW within each Zone. The data is shown row-wise. At the district level, 62% of Vishakhapatnam's was recyclable, followed by Hyderabad with 61%. In case of disposable waste, Kurnool's HW was 51% disposable, followed by Vijayawada with 46%. Kurnool's had 14% incinerable HW, the highest in all the regions.

TABLE 3 - ZONE-WISE SHARES OF DIFFERENT TYPES OF HW 2010

Industrial Zone	Share disposable	Share recyclable	Share incinerable	Total
Hyderabad Zone	37.6%	**61.0%**	1.4%	100%
Ramchandrapuram Zone	43.4%	**46.8%**	9.8%	100%
Kurnool Zone	**50.8%**	48.7%	0.5%	100%
Vijayawada Zone	**46.2%**	40.0%	13.8%	100%
Vishakhapatnam Zone	35.5%	**62.0%**	2.5%	100%
Total AP	38.2%	57.9%	3.9%	100%

Source: APPCB website, Dec 2011

- **COMPOSITION OF HW – DISTRICT LEVEL**

The composition of HW at district levels also differs. For instance from Table 5, it can be seen that while Visakhapatnam had the largest amount of Disposable and Recyclable wastes, Medak had the most Incinerable waste. Five districts had no incinerable wastes, while Nizamabad has zero Disposable wastes.

[2] However it is not known if the end result will be more hazardous types of wastes, or whether they would be converted into less harmful compounds.

TABLE 4: COMPOSITION OF HW – DISTRICT LEVELS AP

District	No of units	Disposable HW	Recyclable HW	Incinerable HW	TOTAL HW
Visakhapatnam	207	**172,849.62**	**257,042.08**	11,022.62	440,914.31
Ranga Reddy	697	78,651.10	95,305.94	2,431.11	176,388.14
Medak	475	51,660.64	60,118.89	**14,169.36**	125,948.89
Srikakulam	60	11,438.65	88,150.94	2,458.65	102,048.24
Nalgonda	151	35,905.89	37,757.65	6,840.12	80,503.66
Mahaboobnagar	171	5,040.92	29,038.15	720.09	34,799.16
East Godavari	217	17,982.24	7,662.46	354.99	25,999.69
Kurnool	44	6,658.23	8,074.76	0	14,732.99
Warangal	53	1,865.30	12,823.98	1.80	14,691.08
West Godavari	122	3,962.17	9,471.31	15.41	13,448.89
Krishna	163	4,589.14	5,570.33	2,653.10	12,812.57
Chittoor	90	7,777.69	4,791.60	1.20	12,570.49
Adilabad	29	5,800.00	2,829.00	0	8,629.00
Prakasam	46	4,794.00	15.51	725.98	5,535.49
Vizianagaram	70	1,862.50	1,556.19	1,084.73	4,503.42
Guntur	92	1,339.84	2,643.02	170.00	4,152.86
Anantapur	58	629.00	1,366.00	134.00	2,129.00
Khammam	43	1.10	1,930.04	0	1,931.14
Karimnagar	193	21.27	1,648.30	1.88	1,671.45
Nellore	142	1,301.56	232.70	39.90	1,574.16
Hyderabad	64	511.34	816.11	1.35	1,328.79
Kadapa	23	105.00	296.57	0	401.57
Nizamabad	12	0	25.80	0	25.80
TOTAL:	3,222	414,747	629,167	42,826	1,086,740

Source: APPCB website, Dec 2011

EXPOSURE RATE TO POLLUTION

The HW Regulations of 2008 specify that all HW generating industries should register with TSDF, as well as send their wastes to them for disposal. AP was the first state in India to set up a TSDF. Now it has two such sites owned and operated by RAMKY Enterprises – M/s. Hyderabad Waste Management Project (HWMP) at Dundigal in Ranga Reddy District, and M/s Coastal Waste Management Project (CWMP) near Visakhapatnam.

From information given by RAMKY only 2800 (88%) of the 3300 HW generating units in AP had registered with them in 2010-11, and of these only 600 units (19%) were compliant using their services regularly. This raises serious doubts regarding the fate of the rest of HW generated by the non-compliant factories in the state; for, HW being dumped indiscriminately increases risk to human health and environment, making the surrounding environment and population vulnerable to HW pollution.

We now estimate the vulnerability of various districts to HW exposure. This is the product of regional pollution intensity and regional population intensity. [P. Panth and R.A. Shastri, Feb 2011]

1. REGIONAL POLLUTION INTENSITY

It measures the pollution intensity per thousand sq. km. This measure stems from the idea that the spread of HW per region/district decides the ability of the region/district to 'bear' or 'endure' pollution. The larger the area, the greater is the volume of air/water/land over which pollutants can be dispersed. An area of one thousand square kilometres will have half the ability to carry pollutants than an area of two thousand square kilometres.

$$\text{Regional Pollution intensity} = \frac{\text{HW generated in a region or district}}{\text{Area of the region or district}}$$

This shows the area over which HW can be disposed off in each district of AP. Results are given below in Table 5.

2. VULNERABILITY INDEX

Between two regions with the same pollution intensity per sq. km., the one with a larger population density will be more vulnerable to the effects of pollution. We call this the "Exposure Rate to Pollution" or the "Vulnerability Index" that assesses the vulnerability of a district's population to industrial pollution. District wise population density is estimated from the 2010 provisional figures of Census 2011, and results are shown in Table 5.

Vulnerability Index = (Regional Pollution intensity/ sq km) × Regional population density

1. *District Pollution intensity*: In Table 5, Column 2 is estimated by dividing HW of each district by its area. This gives the amount of HW disposed of by industrial units in a square Km in their respective districts. The larger the area, the more dispersed the pollution. The lowest pollution density is in Nizamabad, and the highest is Visakhapatnam, followed by Ranga Reddy, Srikakulam and Medak. Hyderabad stood 6th in pollution intensity in terms of area[3].
2. *Population density*: Column 2 shows that population density or population per sq km is highest for Hyderabad district. This is almost 4 times more than the next populated district of Ranga Reddy. The other districts have much lower population densities.
3. *Vulnerability Index or Population Exposure Levels*: is given in the third column, i.e. district level pollution into the number of persons per sq km, in Metric tonnes. The higher the population density, the more the number of persons who are exposed to pollution and greater is their vulnerability to HW pollution. Hence we can also call this the *Vulnerability Index.* From table 5 it can be seen that the largest number of vulnerable population is in Hyderabad district. Due to its high population density it has the highest population exposure levels. It is followed by Visakhapatnam, Ranga Reddy, Srikakulam, and Medak.

[3] However these are only average levels; it is possible that there will be higher concentration of pollution in a few areas within a district, where toxic wastes are dumped.

TABLE 5 - THE VULNERABILITY INDEX

Districts	Regional Pollution intensity (MT/sq km)	Population density (persons/ sq km)	Vulnerability Index (MT/person/ sq km)	Relative exposure*
1	**2**	**3**	**4 = 2 × 3**	**5**
Nizamabad	0.003	296	0.95	1
Kadapa	0.03	171	4.45	5
Khammam	0.12	163	19.62	21
Ananthapur	0.11	193	21.50	23
Nellore	0.12	206	24.75	26
Karimnagar	0.14	299	42.30	44
Prakasham	0.31	176	55.27	58
Adilabad	0.54	156	83.66	88
Guntur	0.36	395	144.04	151
Kurnool	0.83	202	168.41	177
Chittor	0.83	249	206.12	216
Vizianagaram	0.69	347	240.75	252
Warangal	1.14	254	289.01	303
Mahaboobnagar	1.89	194	366.61	384
Krishna	1.47	485	714.68	749
W.Godavari	1.75	496	865.74	908
E.Godavari	2.41	456	1,098.13	1,151
Nalgonda	5.67	230	1,306.15	1,369
Medak	12.98	279	3,622.62	3,798
Sirkakulam	17.59	440	7,746.99	8,121
Rangareddy	23.52	500	11,750.42	12,318
Visakhapatnam	39.37	346	13,630.64	14,289
Hyderabad	6.64	19239	1,27,823.10	1,33,997

Source: Pollution data from APPCB website Dec 2011, Area and Population from www.aponline.com, April 2012

* Taking Nizamabad as the norm, the relative vulnerability positions of other districts are estimated.

1. *Relative Exposure Positions*: Taking Nizamabad with the lowest Population Exposure levels as the norm, we estimate the relative levels by which other districts exceed the norm. The relative positions of the various districts are shown in Column 4, showing the enormous gap between Nizamabad (1) and Hyderabad[4] (134,000) exposure levels! It also shows that the population of Hyderabad is 134 thousand times more vulnerable than Nizamabad to industrial pollution. Hyderabad is followed by Visakhapatnam, Ranga Reddy, Srikakulam and Medak. Other districts' levels of vulnerability are also shown.

HW DISPOSAL IN ANDHRA PRADESH

Our analysis shows that due to the high rate of non-compliance (81%), the environment and population of AP are at great risk from HW pollution. This is more in certain districts than in others. Therefore it is necessary to chalk out different methods to reduce, reuse, and recycle HW.

- **PROFITS FROM RECYCLING**

The present method of dumping recyclable wastes into landfills is not optimum economically or ecologically. Data shows that more than half the HW in AP can be recycled, which will considerable reduce vulnerability of the environment and population. Since recyclable wastes form the bulk of HW generated in AP, dumping them in landfills means loss of a huge amount of physical resources that could have been used for further production.

The costs to industries of disposing of their recyclable wastes can be reduced if industrial units undertook to recycle and reuse them. This will not only save them the costs of disposal, but also generate income through recycling. The opportunity cost of Recyclable HW presently disposed in landfills is:

Profits from recycling = Revenue earned from recycling − costs of recycling + savings of disposal costs

Similarly, if the TSDF takes up the task of recycling HW, it can earn huge profits, and perhaps reduce its disposal charges to the member factories. Thus districts like Vishakhapatnam which has nearly 62% recyclable wastes can significantly reduce their HW burden through recycling.

It has been shown in many studies that recycling generates enough revenue to cover the initial costs of plant and material required for recycling [TERI, 2005]. A study by Panth, P [2008] showed that the rate of payback of recycling wastes from waste streams ranged from 6 months to 5 years.

- **PROFITS FROM INCINERABLE WASTES**

Similarly incinerable wastes can be used to generate power, and the ash used in various industries. Both these methods turn HW into economic resources, and not pollutants. Incineration merely burns up high calorific wastes which produces energy. Incineration converts the solid wastes to air pollution and ash. Some very toxic gases may be released in the process, and the problem of disposing off the ash also arises. The CPCB is encouraging co-processing of incinerable wastes, i.e. as raw material and as a source of energy to replace fossil fuels in energy intensive industries such as cement, lime, steel, glass, and power generation. In the case of cement kilns the high temperatures ensure complete destruction of harmful pollutants. Further, metal and non-metallic wastes are captured in the clinker substances of cement and rendered harmless. A number of successful projects have been undertaken wherein incinerable wastes have been used to generate energy for cement plants; these should be extended to all Incinerable HW in the country. [CPCB Feb.2010]

SUMMARY

AP generated the third largest amount of Hazardous Wastes in India in 2010. While the number of HW producing factories is highest in Telengana, the amount of HW generated is highest in Andhra region.

Data showed that there is no match between number of HW generating units and total HW generated in different districts of AP. Thus Visakhapatnam district with a smaller share in HW generating units, had the highest share in amount of HW generated, while Ranga Reddy had the largest number of HW generating factories, but only 2/3 of HW generated compared to Vishakhapatnam.

Since HW generated per district does not follow the same ranking as the HW units, an index showing the relative concentration of pollution in each district – called the Pollution Concentration Index (PCI), was estimated. To estimate the Pollution Concentration Index (PCI), the share of a district in total HW production is divided by its share in total HW units. If PCI is greater than unity, it shows a high level of concentration of polluting units in that area. Again Visakhapatnam emerged first with the highest PCI, with its rate of HW generation more than 6 times its share in HW producing units, followed by Srikakulam and Nalgonda districts.

The PCI shows that future location of polluting industries should not be permitted in these districts, as it will lead to more environmental problems. Similarly location of these industries in highly vulnerable areas such as Hyderabad should be avoided in future, to reduce the risk factor of pollution to the local population and environment.

[4] This is the maximum level of exposure; the actual depends on how many industrial units are compliant.

Although APPCB conducts regular inspections, and imposes penalties, obviously this is not enough to deter the non compliant industries. Data from TSDF showed just 19% compliance of HW units in AP, which means that the other 81% industrial units are indiscriminately dumping their wastes. The larger the area of a district, the more dispersed will be the HW currently being dumped. This is the basis for calculating the Pollution Intensity Index. But the larger the population density, the greater will be the vulnerability of the population to HW pollution. The Vulnerability Index estimated for all 23 districts shows that Hyderabad district, with the highest population density is the most vulnerable to HW pollution.

HW consists of recyclable, disposable and incinerable wastes. Recyclable wastes forms the major share of HW generated in AP. There is great potential to recycle HW, and to generate energy through incineration. However, in AP neither of these methods is being used to reduce HW pollution, and to earn profits from wastes, showing economic and ecological inefficiency by both the industries and TSDF.

The problem of HW disposal and treatment needs to be better organised in AP, with stricter regulations, inspections, and penalties imposed on non-compliant industries. Recycling of HW has to be taken up on a large scale, so that nearly 50% of the HW in AP can be recycled – reducing pollution and generating profits. Incineration of wastes for power generation should also be taken up, to reduce pollution.

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