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Impact of Agrochemicals on Drinking Water Quality of Surface and Groundwater Resources

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ABSTRACT

The Micro Enterprise sector has the potential to generate enormous economic gains and increased employment for women. Their families, communities and economy would benefit from realizing that potential. It has the potential to generate employment at an average of 4.5 lakhs in the rural economy of Kerala. Women Micro Enterprise opens up new scope of self-employment. We need a strong support policy to tap this rural potential. This paper tries to highlights the increasing importance of women Micro Enterprises in the rural segment of manufacturing and service related activities.

KEYWORDS : Agrochemical, Water Sources, Water Quality

Introduction

It is inevitable truth that agriculture is the main thriving lifeline for sustaining our country. With the population of our country reaching 1 billion marks on the year 2005 the, emerging question lies in front of us is how long we can continue to fulfill the demand and supply of the food for this ever increasing population load.

Several technologies have been introduced for producing higher yield of food as per requirement of the demand. In the process of attaining higher levels of food production for matching the demands of growing population during the past four to five decades, emphasis had been laid on intensive agricultural practices. But to add the woe technologies generated over the past several years has proved, having detrimental effect on the environment not only in our country but also in every parts of the world.

So, during this very process of increasing the crop yield from modern farming techniques reaching a landmark in most countries, and the environmental problems due to excessive use of chemical fertilizers and pesticides becoming a matter of concern, the need of sustainable agriculture is increasingly felt throughout the world. The overexploitation of the groundwater is causing aquifer contamination in certain instances, while certain others its unscientific development within insufficient knowledge of groundwater flow dynamic and geo-hydro-chemical processes has led to its mineralization (M. Dinesh Kumar and Tusshar Shah, 2000).

The excessive fertilization (eutrophication) of natural waters is one of the most significant causes of the water quality deterioration. Groundwater represents one of the most important water sources in India as it is in the rest of the globe and accounts for over 400 cubic km of the annual utilizable resource in the country. Due to the highly variable nature of the climate, groundwater has become a popular alternative for irrigation and domestic water use across India. The alluvial tract of the Gangatic plain, which extends over 2000km across central and northern India, has the best potential for groundwater extraction in the country. This large area possesses many favourable characteristics for groundwater storage and recharge, and the yield over most of the region has been estimated at moderate to high. But the over –withdrawal of groundwater and unwise use of resources has led to pollution of this relatively water resource as well. Many human activities are responsible for the pollution of groundwater. The anthropogenic activities shares major part of pollution load in particular urban water bodies. Pesticides and Herbicides, the chemicals that are used for pest and weed controlling, are carried along by rainwater, especially when much pesticide is used. Human beings are also contacted with pesticides via contaminated drinking water. Nitrates, which are often from fertilizer, can even cause a mortal form of anemia with children.

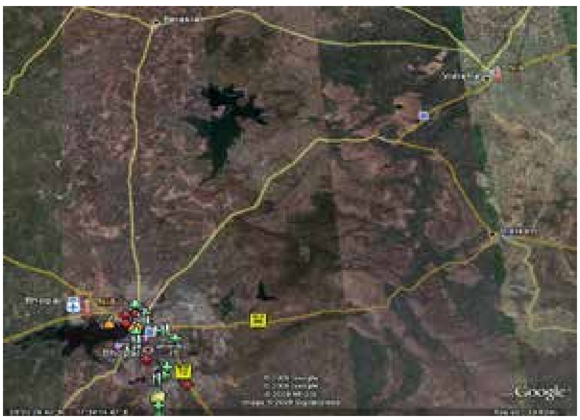
Agrochemical (or agrichemical), a contraction of agricultural chemical, is a generic term for the various chemical products used in agriculture. In most cases, agrichemical refers to the broad range of pesticides, including insecticides, herbicides, and fungicides. It may also include synthetic fertilizers, hormones and other chemical growth agents, and concentrated stores of raw animal manure.

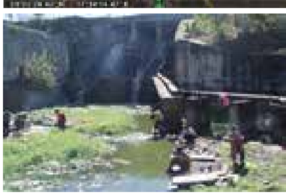
Many agrichemicals are toxic, and agrichemicals in bulk storage may pose significant environmental and/or health risks, particularly in the event of accidental spills. In many countries, use of agrichemicals is highly regulated.

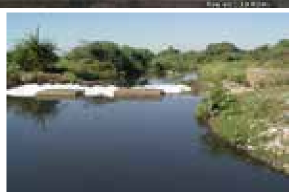
The accelerated use of agricultural chemicals over the past 20 to 30 years has profitably increased production but has also had an adverse impact on ground water quality in many of the major agricultural areas of the world. The pollution of ground water, related to nitrogen fertilizers and pesticides, from widespread, routine land application, as well as point sources has become a serious concern. Ground water contributions also impair surface water quality. Research, worldwide, has shown rates of nitrate-nitrogen (NO_3-N) increases in ground water typically between 0.1 to 1.9 mg/l per year for 10 to 20 years, concurrent with major increases in nitrogen fertilization. Many shallow ground water supplies now exceed the recommended NO_3-N drinking water standards. While many sources contribute nitrogen into the environment, synthetic fertilizers have become the major component. There are clear economic incentives to improve management; harvested crops often account for less than 50% of the purchased fertilizer inputs. Pesticides are appearing in ground water with unanticipated frequency, typically in 0.1 to 10.0 µg/l concentrations. While these concentrations are well below acute toxic levels (for most pesticides), many are of concern for possible chronic effects. Such widespread pollution is of real concern because of the potential for long-term and widespread exposure to the public of toxic substances through drinking water. While there are many uncertainties, agriculture must move forward toward solutions through better management.

The agricultural impacts on quantities of water, several respondents noted that flow volumes directly affect water quality. A given amount of contamination, whether it be nutrients, pesticides, sediment, or faecal coliforms, will have a greater impact on water quality when there is reduced flow (McColl, 1983; Hickey et al, 1989). The fact that flows tend to be lowest in summer, when agricultural activity is greatest, further exacerbates the problem.

Against the above scenario, the present study was conducted to evaluate the impact of agricultural residues especially N, P, K and other toxic substances if any on ground and surface water quality along Patra Nalla, which is one of the major channels in central Bhopal carrying huge quantity of domestic sewage generated from the densely populated residential areas. Flouride content found between 0.60-2.5 mg/l in groundwater samples collected from Guntur area of Andhra Pradesh and 26.5% of the sample exceeded the recommended limit of 1.5 mg/l prescribed for drinking purpose (N. Subba Rao et.al 2001). The increased concentration of total alkalinity found 4.8mg/l, chloride 3914 mg/l, nitrate 163 mg/l, lead 3.4 mg/l was reported in groundwater samples which were located in proximity of industrial units (J.A Aruldos et al. 2001).







Study area

Bhopal city was founded by Raja Bhoj in the eleventh century. Bhopal, developed over a period of over 900 years, is endowed with a number of water bodies Bhopal, "the City of Lakes". Upper & lower lakes,(Bhoj wetland)that provide livelihood & scenic beauty to the city. The total population of Bhopal is 1.4 million (2001 census).Lower lake of Bhopal receives seepage water from the upper lake & from the several streams rain water as well as sewage water from its catchment. The overflow of this lake drains into *Patra Nalla & then into Hallali* River which ultimately drains into Betwa River - a "Tributory of Yammuna".

The study area is village Islamnagar located in Bhopal. The Patra Nalla flows was the village which carries waste water from Lower Lake Bhopal and other Nallas. The natural drainage of storm water is reasonably good in Bhopal. In old Bhopal areas, the drainage is provided mainly by Patra Nalla which receives flow from number of small channels running across the city, like Gaji Khan Nalla, Ashoka Garden Nalla ,Maholi Nalla etc. Patra Nalla after collecting the storm water from these channels discharges it to the Islamnagar River 18 km from Bhopal which finally flows into Halali River.

Materials and methods

For the present study water samples were collected from the residential area along Patra Nalla to assess the pollution load & impact of agrochemical on groundwater.

The samples were collected twice at monthly intervals, as the study duration was 3 months. This was done to ensure results and to assess the actual water quality at consumer's end.

Sampling stations

The water samples have been taken along Patra Nalla in Islamnagar-Jagdishpura. These are as follows:

No.1: The first groundwater sampling point i.e., Hand pump which is situated in front of Qila i.e., Chaman Mahal. This groundwater is being used for drinking purposes.

No.2: The second groundwater sampling point i.e., Hand pump which is situated in front of Mandir.This groundwater is being used for household purposes.

No.3: The third groundwater sampling point i.e., Hand pump which is situated in front of Patra Nalla. This groundwater is also being used for household purposes.

No.4: The fourth groundwater sampling point i.e., Tube-well which is situated in front of agricultural field of Prabhulal Kushwah. This groundwater is being utilized for irrigation in agricultural fields.

No.5: The fifth groundwater sampling point i.e., Tube-well which is situated in front of agricultural field of Dineshlal Kushwah. This groundwater is also being utilized for irrigation in agricultural fields.

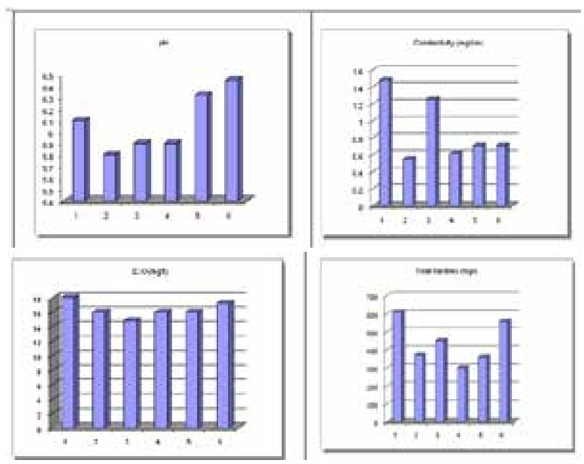
No.6: The sixth groundwater sampling point i.e., Tube-well which is situated in Bhanpur near the Bridge. This groundwater is being used for drinking purposes.

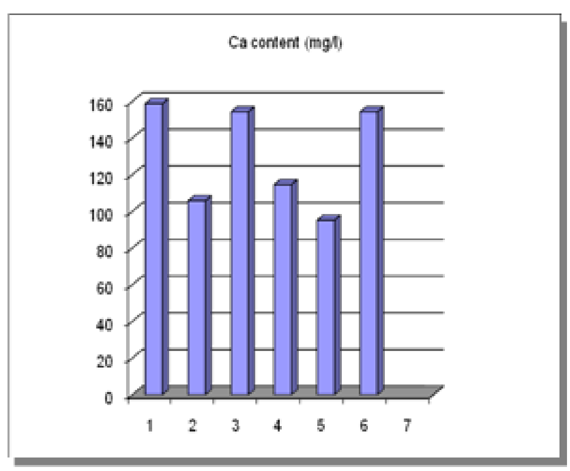
No.7: The seventh sampling point i.e., surface water (well) which is situated in front of Patra Nalla. This water is being used for washing purposes.

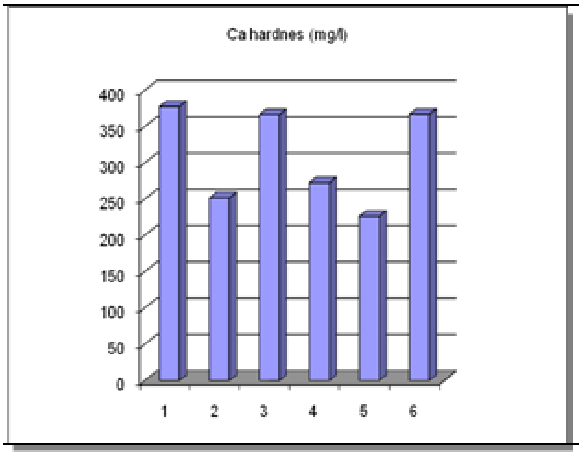
Samples of water were collected at monthly intervals for a period of three months from the identified sites along Patra Nalla for the analysis of defined parameters. Standard methods (APHA, 1999) have been followed in analyzing of identified parameters.

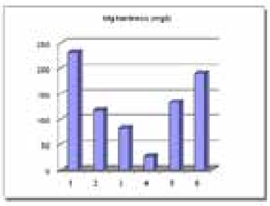
Results

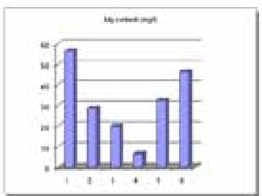
The result obtained on various parameters during the course of study is shown in following Figure.

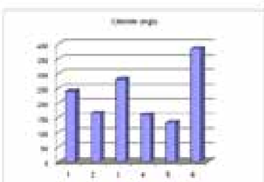


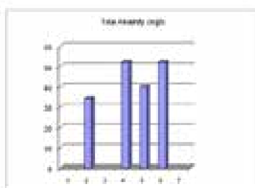


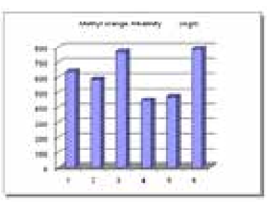


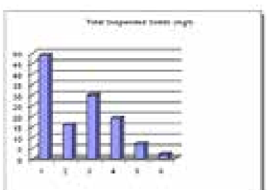


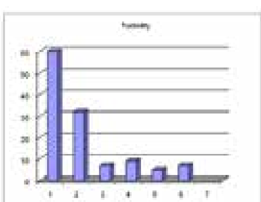


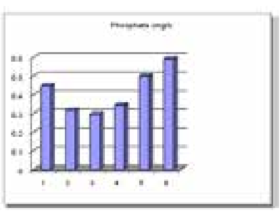


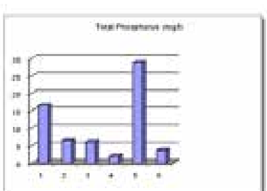


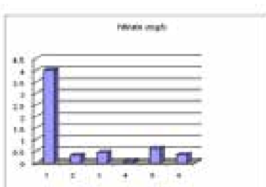












1. pH: The value of pH during investigation varied from 5.87 to 6.45 mg/l. The minimum value of 5.87 mg/l was observed at station no. 2; whereas the maximum value of 6.45 mg/l was recorded within the water sample collected from station no.6.

2. Conductivity: The value during investigation varied from 0.61 to 1.48 Ms/cm. The minimum value of 0.61 mg/cm was observed at station no.2; whereas the maximum value of 1.48 mg/cm was recorded within the water sample collected from station no. 1.

3. Dissolved Oxygen: The value during investigation varied from 14.8 to 17.2 mg/l. The minimum value of 14.8 mg/l was observed at station no.3; where as the maximum value of 18 mg/l was recorded within the water sample collected from station no.1.

4. Total Hardness: The value during investigation varied from 300 to 610 mg/l. The minimum value of 300 mg/l was observed at station no. 4; where as the maximum value of 610 mg/l was recorded within the water sample collected from station no.1.

5. Calcium Hardness: The value during investigation varied from 226.8 to 378 mg/l. The minimum value of 226.8 mg/l was observed at station no. 5; where as the maximum value of 378 mg/l was recorded within the water sample collected from station no.1.

6. Calcium Content: The value during investigation varied from 95.25 to 158.76 mg/l. The minimum value of 95.25 mg/l was observed at station no. 5; where as the maximum value of 158.76 mg/l was recorded within the water sample collected from station no.1.

7. Magnessiun Hardness: The value during investigation varied from 27 to 232 mg/l. The minimum value of 27 mg/l was observed at station no. 4; where as the maximum value of 232 mg/l was recorded within the water sample collected from station no.1.

8. Magnessium Content: The value during investigation varied from 6.56 to 56.37 mg/l. The minimum value of 6.56 mg/l was observed at station no. 4; where as the maximum value of 56.37 mg/l was recorded within the water sample collected from station no.1.

9. Chloride: The value during investigation varied from 133.86 to 384.61 mg/l. The minimum value of 133.86 mg/l was observed at station no. 5; where as the maximum value of 384.61 mg/l was recorded within the water sample collected from station no.6.

10. Total Alkalinity: The value during investigation varied from 34 to 52 mg/l. The minimum value of 34 mg/l was observed at station no. 2; where as the maximum value of 52 mg/l was recorded within the water sample collected from station no.4 & 6.

11. Methyl Orange Alkalinity: The value during investigation varied from 448 to 790 mg/l. The minimum value of 448 mg/l was observed at station no. 4; where as the maximum value of 790 mg/l was recorded within the water sample collected from station no.6.

12. Total Suspended Solids: The value during investigation varied from 2 to 49 mg/l. The minimum value of 2 mg/l was observed at station no. 6; where as the maximum value of 49 mg/l was recorded within the water sample collected from station no.1.

13. Turbidity: The value during investigation varied from 5 to 60 FAU. The minimum value of 5 FAU was observed at station no.5; where as the maximum value of 60 FAU was recorded within the water sample collected from station no.1.

14. Phosphate: The value during investigation varied from 0.296 to 0.591 mg/l. The minimum value of 0.296 mg/l was observed at station no. 3; where as the maximum value of 0.591 mg/l was recorded within the water sample collected from station no.6.

15. Total Phosphorus: The value during investigation varied from 1.980 to 28.92 mg/l. The minimum value of 1.980 mg/l was observed at station no. 4; whereas the maximum value of 28.92 mg/l was recorded within the water sample collected from station no.5.

16. Nitrate: The value during investigation varied from 0.055 to 4.005 mg/l. The minimum value of 0.055 mg/l was observed at station no. 4; where as the maximum value of 4.005 mg/l was recorded within the water sample collected from station no.1.

Discussion

Water is one of the critical inputs for the sustenance of mankind. It is used both in terrestrial and aquatic environment for various activities, balancing the ecological system of global environment. Water is the important natural source, which is abundant in nature and cover about 2/3ds of earth surface. However, only 1% of the water resource is available as fresh water (i.e., surface water-rivers, lakes, reams, and ground water) for human consumption and other activities. The major uses of water are for irrigation (30%); thermal power plants (50%), while other uses are domestic (7%) and industrial consumption (~12%) (De, 2002).The United Nation's report on "Water for People, Water for Life" (the first ever UN system wide evaluation on global water resources-2003) has put India a poor 120th for water quality among 122 nations covered. Only Belgium and Morocco are ranked worse than India. The quality indicator value was based on quality and quantity of fresh water (especially ground water), waste water treatment facilities, legalities like application of pollution regulations, India's quality indicator value stood at -3.1 while for best ranked country Finland it was 1.85. The UN evaluation also ranked India 133 in a list of 180 countries for its poor water availability (1880m3 per person per year). Kuwait was ranked the poorest on water availability. Against the National average target of 135 lpcd of water and 180 lpcd per capita in large cities, the per capita availability is low and ranges from 165 lpcd in a few larger towns to about 50 lpcd in smaller towns. The availability of water in urban slums is about 27 lpcd. Urbanization has given rise to a number of environmental problems such as water supply, wastewater generation and its collection, treatment and disposal in urban areas. In most cases wastewater is let out untreated and it either percolates into the ground and in turn contaminates the groundwater or is discharged into the natural drainage system causing pollution in downstream areas. Sewage and not the industrial pollution accounts for more than 75 per cent of the surface water contamination in India. Due to negligence, groundwater is also increasingly getting contaminated. In India less than 50% of the urban population has access to sewage disposal system. Most of the existing collecting systems discharge directly to the receiving water without treatment. Garbage, domestic and otherwise, is directly dumped into water bodies or roadside, which can often be washed into streams and lakes. The municipalities dispose off their treated or partly treated or untreated wastewater into natural drains joining rivers or lakes or used on land for irrigation or fodder cultivation or into sea or combination of these. Toxic chemicals from sewage water transfer to plants and entire in the food chain and affect public health.

Large scale urbanization, a consequence of economic development is leading to production of huge quantities of effluents in India and posing serious environmental problems for their disposal. Sewage sludge (bio solids) generation in India is also increasing at a faster rate as more and more waste water treatment facilities with enhanced efficiencies are being developed. Sewage sludge and effluents are frequently disposed off on agricultural lands for irrigation/manures purposes that create both opportunities and problems.

Thus the importance of reuse and recycling of treated sewage and industrial effluents has been realized on account of two distinct advantages: reduction of pollution in the receiving water bodies and reduction in the requirement of fresh water for various uses. Reuse of municipal wastewater after necessary treatment to meet industrial water requirement is being practiced in India. Numerous environmental studies have shown that deep groundwater in rural watershed are less susceptible to pollution by agricultural activities than shallow groundwater, because they are farther from the ground surface where agrochemicals are applied. Less permeable geologic units prevent the infiltration of impacted shallow groundwater into the deeper zone. In addition, pollutants from agrochemicals tend to get retarded or degraded as they move to the deeper zone.

Shallow groundwater & surface water systems in rural areas are vulnerable to contamination by the excessive application of agrochemicals, Such as fertilizers, pesticides, and lime. Nitrogen fertilizer is one of the biggest agrochemical sources.

The microbiological contamination of groundwater has profound and severe implications for public health, particularly in small communities and developing countries where groundwater is often the preferred source of drinking water. Although natural groundwater is usually of good quality, this can deteriorate rapidly due to inadequate source protection and poor resource management. Contaminated groundwater can contribute to high morbidity and mortality rates from diarrheal diseases and sometimes lead to epidemics. The disposal of excreta using land-based systems is a key issue for groundwater quality and public health protection. The use of inappropriate water supply and sanitation technologies in peri-urban areas leads to severe and long-term public health risks. 240 samples were found positive for E. coli and 149 samples positive for salmonella out of 270 samples collected from Akola City of Maharashtra, India (Shilpa D. Joshi and M. Mussadiq,2003).

The use of poorly constructed sewage treatment works and land application of sewage can lead to groundwater contamination close to water supply sources. Microbiological, in particular virus survival in these circumstances is not well understood, but there are indications of extended pathogen survival and therefore increased public health risk.

Conclusion

During present investigation, values observed for most of the parameters were found within the standards. Further information collected from the farmers and villagers does not reveal any cases of health hazards due to drinking water.

Parameter	Range	BIS limit	Conclusion based on present observation
1.pH	5.91 to 7	6.5 to 8.5	Range values were observed almost within limits and did not seem to have significant affect on drinking purpose
2.Dissolved Oxygen	0.8mg/l to 18mg/l	6.0	DO values were found to be highly variable. However DO in general do not have significant effect on metabolic activities on human beings.
3.Total Dissolved Solids	329.4mg/l to 1012.6mg/l	500	Total Dissolved values were some times observed above limits and may be a cause of concern
4.Total Hardness	230mg/l to 610mg/l	300	Like total dissolved solids, total hardness was also observed to be fluctuating during the period of investigation.
5.Calcium Hardness	210mg/l to 378mg/l	200	Calcium hardness was also observed on higher side when compared with the standards.
6.Magnessium Hardness	8mg/l to 232mg/l	100	Magnesium values were also recorded to be highly fluctuating some times crossing the limits.
7.Chloride	132.8mg/l to 384.61mg/l	250	Chloride concentration like magnesium values were recorded to be highly fluctuating often crossing the limits.
8.Nitrate	0.055 mg/l to 6.771mg/l	20	Nitrate values as per Indian Standard were observed in the safe limits
10.B.O.D	2.00 mg/l to 14 mg/l	2	BOD values some times depicted higher values than the standard.

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