



Assessment of Pesticide Use and Heavy Metal Analysis of Well Water in JhikuKholra Watershed, Kavrepalanchowk, Nepal

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Abstract

Pannchkhaal Valley in Kavrepalanchowk district has been known for using heavy amount of pesticides in vegetable farms for over three decades. As the inorganic pesticides contain elements such as arsenic, cadmium, iron, aluminum, sulfates, lead, mercury and copper, they do not degrade readily and remain in the soil and water system for long time. Traces of these are also likely to leach to groundwater sources, which is depleting for various reasons including the climate change impacts. This study attempted to assess the extent of use of pesticides and its implication in the depleting ground water source, and examine if there is heavy metal contamination in well-water used for domestic purposes. The method employed to assess the extent of use of pesticides included desk study, field survey, focused group discussion and key informants, whereas water samples from the wells were analyzed in the laboratory to assess Lead, Copper and Mercury content in the well water. There is a growing awareness about the adverse effects of pesticides and yet all households interviewed in the study were found to be using pesticides. Nonetheless, a majority of the respondent believe that the use of pesticides has been progressively reduced. Well water analysis showed that the presence of Copper is within the accepted limit. Lead was found to be in considerable amount, but the Mercury concentration in the well-water was found to be very high from 0.008 to 0.037 in four wells studied in the valley. Though there is no indication of mercury based pesticides being used, high concentration of mercury in the well-water deserves a thorough examination of possible sources from where it is coming to water.

Keywords: Contamination, heavy metal, pesticides, Paanchkhaal, run off.

Introduction

Nepal is a Himalayan country with diverse culture, physiographic regions and climate. A majority of the people here are engaged in agriculture. Due to rapidly growing population the practice of traditional farming has been gradually changing to modern methods of farming using modern techniques and inputs. To maximize profit, especially from commercial farming, use of pesticides has become necessary in today's agriculture. Since the demand for the food products increases, it is expected that the use of pesticides would increase.

A study conducted in Tamaghat and Tinpile, VDCs in Paanchkhaal, summarizes rice, potato, maize, wheat, mustard, tomato, bitter gourd, chilli, brinjal, beans, gourd, cabbage and cauliflower as the major crops grown. More than 97 % farmers use pesticides for controlling various pests and diseases and very few (6 %) use on stored commodities (grains)¹.

Pesticide is a substance used for preventing, controlling, destroying, repelling or mitigating pest. These chemicals are poison that, in certain circumstances and does, kill organism harmful to crops². In Nepal, for eradication of malaria, the use of pesticides with DDT was first done³. The Nepal Malaria

Eradication Programs (NMEP) in the 1950's was the first major channel to utilize pesticides in Nepal⁴. Since then, the usage of pesticide has been rampant. Various environmental and health hazards has been seen due to misuse of pesticides in the country⁵. Due to mishandling of pesticides in Paanchkhaal valley people have noticed different health problems⁶.

Pesticides have become a major input in farming for better yield. However, due to excess use of pesticides, though the crops and vegetables are thriving, it might reduce the quality of water in the area when those pesticides get mixed with the water sources. They could get washed from farms into the river during rainfall or get percolated into soil contaminating the groundwater. Contamination of groundwater occurs when unwanted substances move through fractures or the soil profile to the saturated zone. The quality of ground water is affected by the use of various products in agriculture like pesticides, insecticides and other chemical agents used to kill pests and other soil micro-organism⁷. Pesticide enters surface and ground water primarily as runoff from crops and is most prevalent in agricultural areas⁸. Groundwater contamination is higher when there is no crop or when they are young. Pesticides not taken up by plants, adsorbed by soils or broken down by sunlight, soil organisms or chemical reactions may ultimately reach groundwater sources⁹. Some heavy metals like mercury, lead,

cadmium, arsenic, iron, aluminum and copper are used in pesticides. Traces of these heavy metals could reach the water sources through the same process when washed from soil. Pesticides continue to break down underground usually much slower than in surface layers of soil. Groundwater contaminated with pesticides away from the original point of application can lead to contaminated well samples years later in a different location⁹.

The objective of this research was to assess the pesticide use and examine the presence of heavy metal in well water. The study also has attempted to establish linkages, if any, between pesticides uses and change in water quality due to heavy metal.

Material and Methods

This study was conducted in small valley named Paanchkhaal of Jhiku Khola Watershed in Kavrepalanchowk District, Central Nepal. Occupying 20.19 sq. km., Paanchkhaal valley is famous for vegetable production. The assessment of pesticide uses was

based on survey method. The local people were interviewed and the house for the questionnaire was selected who fetch the common nearby well water for drinking purpose and use pesticides for agricultural purpose. Also, secondary data was collected from the local organization regarding the pesticide use. Four sampling locations for well water were selected from the Paanchkhaal valley as given in table-1 and figure-1. From each site, three samples were stored in sterilized bottles to prevent any contamination for laboratory analysis. Preservatives were added and all of them were correctly labelled.

Table-1
Sampling Locations

Sample No.	Location (VDC)	Ward No.
1	Tamaghat	6
2	Kafledi	4
3	Paanchkhaal	5
4	Hokse	1



Figure-1
Sampling Sites in Paanchkhaal Valley via Google Earth

Lead, Copper and Mercury were assessed for heavy metal in water in the laboratory. The analyzed data have been compared with World Health Organization Guideline Value (WHOGV) and National Drinking Water Quality Standard (NDWQS). The numerical score with water quality is given in table-2. Atomic Absorption Spectrophotometer (AAS) method was used for the detection of heavy metals. It was necessary to treat the sample properly prior to estimation of the trace metals levels on it. The pre-treatment may be either the concentration of the sample or the complete acid digestion to convert undissolved metals to the solution. The concentration or the reduction in volume can be carried out by the slow evaporation of the sample over hot plate in an acidic condition.

Table-2
Numerical score with water quality

Parameters	Unit	WHO	NDWQS	Result			
				Sample			
				1	2	3	4
Pb	mg/l	0.01	0.01	<0.05	<0.05	<0.05	<0.05
Cu	mg/l	1	1	<0.01	<0.01	<0.01	<0.01
Hg	mg/l	0.001	0.001	0.018	0.008	0.037	0.017

WHO GV: World Health Organization Guideline Value, 2006 Update, NDWQS: National Drinking Water Quality Standard, 2062 (Nepal)

Procedure of the Concentration: Proper amount (100-150 ml) of the sample in a 250 ml capacity acid washed beaker was taken. 1.0 ml of concentrated nitric acid was added and evaporated slowly over hot plate. After adequate reduction in volume, the interior of the beaker were cooled and washed with small amount of water. The content was transferred in a volumetric flask (10 ml) and the beaker was washed with a small portion of the water. Each washing was transferred to the same volumetric flask and finally adjusted volume up to mark with water.

Procedure of the Sample Digestion: Appropriate volume (50-100 ml) of the well-mixed sample was taken into a clean beaker. 5.0 ml concentrated nitric acid and a few boiling chips were added on it. Heat over hot plate carry out slow evaporation to the lowest possible volume. As per need, heating was continued by adding conc. Nitric acid till it gave light colored clear solution. After digestion, the beaker was cooled and the interior walls were washed with small amount of water and then filtered if necessary. Filtrate was transferred into the volumetric flask and after cooling down to room temperature the required volume was adjusted with water. After the pre-treatment of the sample, determination of the trace metal level was carried out by direct air-acetylene flame method whereas mercury was determined by Cold Vapor method as well.

Results and Discussion

All farmers in the study area use pesticides to control pest or

disease. The insecticides, herbicides, fungicides and rodenticides have been broadly classified under pesticides and their use has been done accordingly in need. Both cereals and vegetables suffer from pest problem and all sampled household have been using pesticides for more than three years. 15 % families use pesticides three to five times during the crop cycle whereas 85 % families use pesticides more than five times during the crop cycle. The mostly used pesticides are given in table 3.

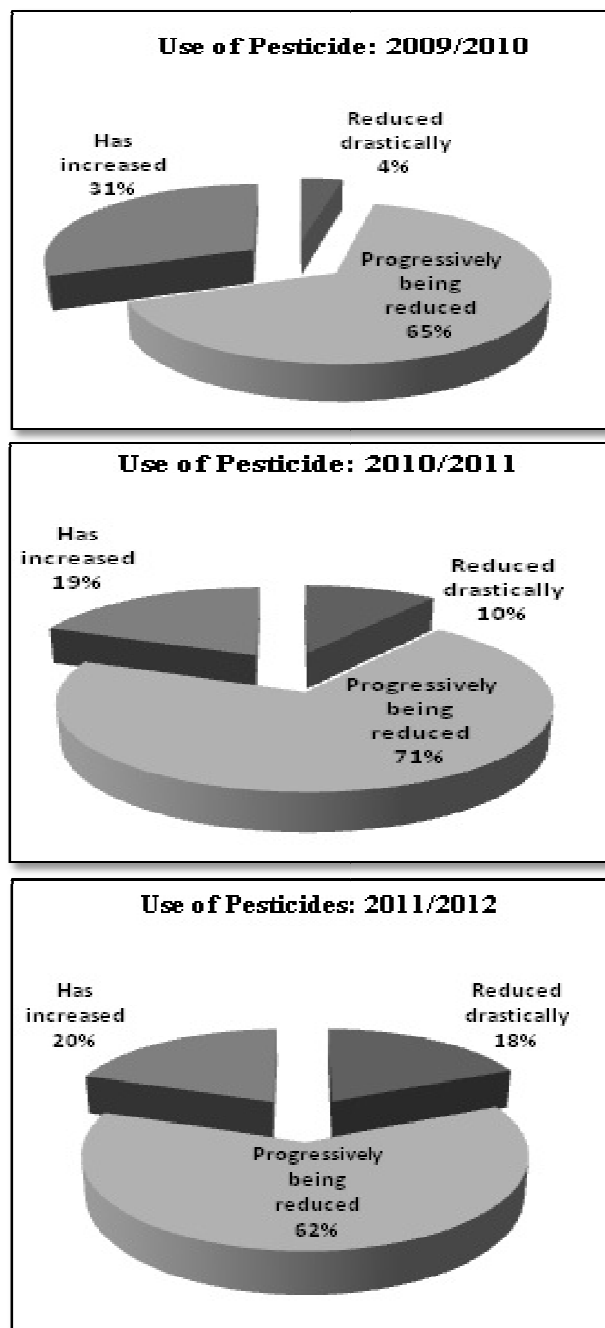


Figure-2
Latest Scenario of Pesticide Use by Farmers via Interview

Table-3
Mostly Used Pesticides in the Sampling Area

Kingstar (Acrobat 50% WP)
Indofil M – 45
Novan
Krilaxyl

Figure-2 shows the latest scenario of pesticide use based on survey among 163 farmers interviewed. The figure shows the decreasing trend in use of pesticides in the last two years¹⁰.

The result of table-2 indicates the ground water status. Copper was present below threshold amount in all the sampling location. Water was contaminated with Lead and Mercury though the concentration of Lead was found to be slightly tolerable. Mercury in sample 1 to sample 4 is found to be 0.018, 0.008, 0.037 and 0.017 respectively. In all the four location, the mercury is found to be in higher concentration.

Paanchkhaal is a valley surrounded by hills. There is no possible natural source of mercury in the study area. Also there was no any painted structure nearby for possible anthropogenic sources. Mercury compounds were added to paint as a fungicide until 1990¹¹. Also, due to wide spread spraying of the herbicides, they can be found in water supplies (underground sources) and feed into other water system. Although generally diluted out, they can reach critical levels during heavy rains. Therefore the possible contamination of the water is the pesticides that have been used in the cultivable land since several years ago.

Burning of coal and oil that contains small amounts of mercury is found throughout the environment besides being carried by rain. Incineration of materials that contain mercury such as dry cells could release mercury as well. Applications of mercury-based pesticides in agricultural land get washed into nearby surface waters or percolate into underground water via soil. In Paanchkhaal, no other activity releasing mercury was found. Hence pesticide could be the possible source of contamination. Since, from the survey, it is found that the use and consumption of the pesticides has been declining, the huge concentration of mercury found in the water could be due to run-off from various places in the watershed as sampling was done in the monsoon season.

Conclusion

Despite the use of pesticides for long period and in an unmanaged manner, the water quality of the study area is found to be satisfactory. The heavy metal analysis for copper was found to be within the standard limit. Lead was found to be in a considerable amount, while the Mercury was found to be in a very high concentration in all water samples. Since the water samples were taken in the monsoon season, the runoff from various places around the well location within the watershed perhaps added to the mercury concentration.

The persistent use of mercury-based pesticides probably contributed to larger concentration which came along with runoff from around the area. As a precaution to avoid any handling error, the sample analysis was repeated again in the laboratory for the possible contamination of heavy metals.

Though the application of mercury-based pesticides used in the past could not be verified but high concentration of mercury infers mercury-based pesticides being used as there is no possible natural source of mercury. Other anthropogenic sources were not seen either. Since the sampling was done in the monsoon, high concentration of mercury seen in the well water is due to possible runoff from higher altitude within the watershed where mercury-based pesticides have been used. Besides, in winter, concentration could be seen more due to less water available in the wells. If it is indeed due to runoff from other areas, it is suggested that more sampling tests should be carried out.

References

1. CEAPRED, Baseline Survey of Pesticides Use at JhikhuKhola Catchment Area. Centre for Environmental and Agricultural Policy Research. Extension and Development, Bakhundole, Lalitpur, Nepal, (2000)
2. Dahal L.A., Study on Pesticide Pollution in Nepal. National Conservation Society Implementation Project, Kathmandu, Nepal, (1995)
3. Neupane F.P., Country Profile: Agricultural entomology in Nepal, *Review of Agricultural Entomology*, **83(12)**, 1291-1304, (1995).
4. Gupta S.C., Use of Pesticides in Relation to Environment: A Case Study of Kavrepalanchowk District., *M.Sc. Dissertation, Pokhara University, Nepal*, (2005)
5. Klarman W.L., Pesticide Use in Nepal. ARPP Consultancy Report No. 9 submitted to Winrock International Institute for Agricultural Development, US Agency of International Development, Kathmandu., (1987)
6. Pujara D.S. and Khanal N.R., Use of pesticides in Jaishidihi sub-catchment, Jhiku Khola Water shed, Middle Mountain in Nepal *Lands chaftsökologie und Umweltforschung*, **38**,168-177, Braunschweig (2002)
7. Yadav Gaurav, Pandey Devendra N. and Patel Dharmendra Kumar, Assessment of Ground Water Quality and its Impact on Health of people around Rewa City, MP, India, *International Research Journal of Environmental science.*, **3(7)**, 70-72, July (2014)
8. Mandour R.A., Existence of Insecticides in Tap Drinking Surface and Ground Water in Dakahlyia Governorate, Egypt in 2011, *The International Journal of Occupational*

- and Environmental Medicine*, 3(1), January (2012)
9. WSHL, n.d. URL: [http:// www.slh.wisc.edu/ehd/pamphlets/ pesticide.dot](http://www.slh.wisc.edu/ehd/pamphlets/pesticide.dot) (assessed August (2012))
 10. Pragatishil Multipurpose Cooperatives Ltd., Paanchkhaal, Kavre, Article on Pesticides Minimization on occasion of International Cooperatives year (2012)
 11. U.S. Environmental Protection Agency. National Emissions Inventory of Mercury and Mercury Compounds: Interim Final Report. Office of Air Quality Planning and Standards, Research Triangle Park, NC.EPA-453/R-93-048. (1993)