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An Investigation into the Impact of Pesticides on Ground Water

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ABSTRACT

Agriculture's irresponsible use of pesticides is an example of a human-caused activity that has contributed to groundwater contamination on a global scale. Prior to the creation of regulatory norms pertaining to pesticide application, the impacts of pesticides on groundwater must be assessed. This research examines the influence of pesticide use on the groundwater aquifer in an agriculturally dominant region of Mount Abu, Rajasthan, India. Using a model called Pesticide Influence Rating Index, a correlation between pesticide uses and its effects on groundwater quality has been developed (PIRI). As an example, five farms in the selected region in the Indian state of Rajasthan were studied. Four pesticides, name dchlorophyrifos, phorate, monocrotophos, and atrazine, were chosen for in-depth examination based on the occurrence of use of different pesticides in the research region. Samples of groundwater were collected and examined for pesticide residual levels. Comparing the measured residues to the PIRI model evaluations revealed that, while the detected standards were greater than the expected standards, the ratio appeared to fluctuate within a constant array. Consequently, multiplicative correction issues were included to the model predictions in order to accurately anticipate pesticide remains in a given region.

Key words: *Pesticides, Groundwater, Chlorophyrifos, Atrazine, Phorate, and Monocrotophos.*

Introduction

Water is one of our most precious natural resources in the world. All living organisms depend on water during their life. In addition, people use water for agriculture, industry, recreation, and household. Concerns exist in many countries about the quality of surface and ground water. In recent years, there have been concerns about pesticides entering both surface and ground water in many countries all around the world. It is extremely important that pesticide users understand the processes involved in pesticide contamination of ground and surface water.

Those who apply pesticides have a responsibility to use practices that minimize off-site movement of pesticides. Both surface water and ground water need to be protected from the introduction of pesticides. Groundwater is much more serious problem because pesticides do not degrade there as rapidly as in other environments, dilution of the contaminant concentration does not occur as rapidly, and ground-water is commonly used for irrigation and for drinking by man and domestic animals. A fundamental contributor to the Green Revolution has been the development and application of pesticides for the control of a wide variety of insectivorous and herbaceous pests that would otherwise diminish the quantity and quality of food produced. The use of pesticides coincides with the 'chemical age', which has transformed society since the 1950s. In areas where intensive monoculture is practiced, pesticides were used as a standard method for pest control. Unfortunately, with the benefits of chemistry there are also disbenets, some so serious that they now threaten the long-term survival of major ecosystems by disruption of predator-prey relationships and loss of biodiversity. Also, pesticides can have signicant consequences on human health. While agricultural use of chemicals is restricted to a limited number of compounds, agriculture is one of the few activities where chemicals are intentionally released into the environment because they kill things. The term 'pesticide' is a composite term that includes all chemicals that are used to kill or control pests. In agriculture, this includes herbicides (weeds), insecticides (insects), fungicides (fungi), nematocides (nematodes), and rodenticides (vertebrate poisons).

The modern era of pest control with synthetic organic pesticides began in the early 1940's with the introduction of the insecticide DDT and the herbicide 2,4-D. Since that time, many other pesticides have been developed for a variety of crop protection purposes, and their volume of use has increased tremendously. Pesticides have been found frequently in surface water; in the last several years, they have also been found in groundwater (Kole and Bagchi, 1995).

Water is precious and we need water not only this but agriculture, industry, leisure, and households also need water. Many nations worry about surface and groundwater quality. Pesticides have entered surface and ground water in numerous nations in recent years. Pesticide users must understand how pesticides pollute ground and surface water. Pesticide applicators must limit off-site migration. Pesticides should not enter surface or ground water as g groundwater is a bigger issue since pesticides don't dissolve as quickly, pollutant concentrations don't dilute as quickly, and people and animals drink and use it for irrigation. Pesticides have helped the Green Revolution by controlling insectivorous and herbaceous pests that might otherwise reduce food production. Since the 1950s, insecticides have changed civilization (Kole and Bagchi, 1995). Pesticides were often utilised in intense monoculture regions. Unfortunately, chemistry has drawbacks, some so severe that they endanger the long-term sustainability of important ecosystems by disrupting predator-prey interactions and losing biodiversity. Pesticides also harm humans. Chemicals are purposely introduced into the environment in agriculture because they harm creatures. Pesticides are all pesticides. Herbicides, fungicides, nematocides, insecticides, and rodenticides are used in agriculture. With the advent of DDT and 2,4-D in the early 1940s, synthetic organic insecticides revolutionised pest control (Chung and Chen, 2011). Since then, various crop protection chemicals have been created and used extensively. Pesticides have been observed in surface and groundwater for years.

Metabolites, which are developing groundwater pollutants, are found in different environmental compartments, including groundwater, due to pesticide usage. Agriculture pesticides may harm "non-target surface and subsurface living (micro) organisms". Pesticides and metabolites that harm microbial communities may jeopardise soil and groundwater ecosystem functions.

Most pesticide related side effects investigations have been performed in soils, as well as the primary effects were on microbial population, species existence or absence, gene expression, and functional diversity. Pesticides also select degrading bacteria. Pesticides have numerous mechanisms of action, which may explain their diverse impacts on microbial ecosystems and activities (Devi, 2009). Pesticides also affect soil microbial communities based on their kind, concentration, and time following use. They also rely on the soil's microbial community composition and microbial process diversity. Pesticides also affect microbial populations according to soil type, organic matter, pesticide concentration, and desorption and adsorption mechanisms. Some pesticide metabolites may be more persistent or hazardous than the parent chemicals. These variables make it harder to assess pesticide dangers and anticipate soil ecosystem health (Aravinna *et al.,* 2017). Because of the challenges of comparing data from research with varied experimental settings, pesticide dosages, and techniques, pesticide consequences might be conflicting. The examined mechanism affects pesticide bioavailability or biodegradation.

It is challenging to apply soil community awareness to groundwater habitats. First, pesticide levels in groundwater are modest relative to soil, with metabolite levels frequently greater than parent molecules. Second, aquifers vary from soil chemically, physically, and biologically. Groundwater has a steady temperature, no sunshine, and little nutrients. Some aquifers are isolated because transmission rates are so sluggish (Environews Forum, 2015). All of this affects microbial diversity and activity. Groundwater microbial populations depend on "lithoautotrophs that fix CO_2 and oxidise inorganic electron donors”. Even while soil microorganisms may be transferred into groundwater, previous research suggest that groundwater microbial range is distinct from that of surface soil. Groundwater has lesser biodiversity as well as biomass than soil and numerous unique microbial phyla. Finally, microbial communities vary among aquifers owing to classcategorization by limitedcircumstances, dispersion limits and drift across regions, kind of aquifer and its link to the surface, human actions, etc. (Agrawal *et al.,* 2010). Because of aquifers’ low nutritional content, adding exogenous organic substances like “pesticides and their metabolites”, even at low concentrations, might affect the microbial community’s biodiversity and activity. Pesticides as well as metabolites are persistent in groundwater. “Despite the separation of pesticide-degrading bacteria, pesticide biodegradation rates in aquifers are much lower than in topsoil”.

Therefore, it is necessary to do study on the influence that pesticides have on the microbial populations as well as the natural ecosystems that are related to them in groundwater. As was indicated earlier, pesticides and metabolites have the potential to influence the nitrogen cycle and, as a result, the microbial denitrification activity that is essential to the provision of ecologyfacilitieslike the generation of potable water (Gode *et al.,* 2017). As a result, the purpose of this research was to determine, under carefully measured settings, the effect that pesticides and metabolites have on the prospective denitrification actionbesides biodiversity of a groundwater microbial population. “One herbicide, S-metolachlor, and one propiconazole, fungicide, both of which belonged to separate chemical families, as well as their primary metabolites, ESA-metolachlor and 1,2,4-triazole, were chosen”. As was said before, these two active chemicals were selected because of the extensive usage they see in France and Europe, as well as the fact that they are found in groundwater Jeyaratnam, (2010).”In a batch experimental approach, these four chemicals were tested at two different concentrations, 2 and 10 g/l, which were comparable to those measured in groundwater”. The purpose of this testing was to investigate the effects that these compounds have on the microbial denitrification activity and biodiversity in groundwater. For the purposes of this investigation, groundwater was collected from an agricultural location that had previously been subjected to nitrate usage. The nitrite, nitrate, and nitrous oxide contents were tracked over time in order to evaluate the denitrification activity (Mohapatra, 1995). Genomic characterizations were used in order to evaluate the changes in bacterial biodiversity that occurred between the beginning and the conclusion of the experiment.

Methodology

Study area

The research region included Mount Abu, Rajasthan, India. The rich alluvial deposits make the area agricultural. Dairy, poultry, fisheries, and beekeepers follow agriculture. The region’s main issues include water table depletion, low soil fertility, limited land holdings, traditional agriculture, pesticide misuse, over fertilizing and incorrect spraying.

Five distinct farm areas, all of which may be found within three of the region’s communities and have been chosen for sampling and are shown in Figure 1. The information gathered from the farmers at the five monitoring sites includes data on the soil, samples of the groundwater, and information on the use of pesticides (Thakur *et al.,* 2015).

PIRI software

The potential impact of pesticides on surface and groundwater as well as their impacts on living species are quantified by PIRI using data on pesticide usage, the expected pathways via which chemicals will enter water resources, and asset value (Juraske *et al.,* 2017). Describe the hydrogeological parameters at the site, including the type of soil, organic matter content, slope of the land, recharge rate, soil loss, soil porosity, depth of the water table, precipitation and temperature, and hydro-meteorological conditions.

After calculating the “load factor (L), transport factor (T), and asset value factor (V)” associated with the pesticide, the total amount of damage is determined by multiplying these three factors together.

$$\text{Detriment} = LTV \qquad .. (1)$$

load factor of Pesticide

The “pesticide load factor” is dependent on how much pesticide was sprayed to how much of the research area. The i^{th} pesticide’s load factor (Li) is calculated from its rate of application (fi), dose (di), active ingredient fraction (ai), and percentage of the

Fig. 1. Study area.

area (pi) getting it.

$$L_i = f_i \times d_i \times a_i \times p_i \quad .. (2)$$

Pesticide transport factor

This component applies to both surface and groundwater, although this research solely considers groundwater movement (Zhao and Pei, 2012).

Transport to groundwater

Because of pesticide sorption on soil organic matter, pesticides travel through soil slower than water (Koc). "Retardation factor (RF)" is proportional to Koc.

$$RF = 1 + \frac{\rho f_{OC} K_{OC}}{\theta_{FC}} \quad .. (3)$$

where, soil bulk density, f_{oc}, and FC are in kg/m^3.

The groundwater AF might show pesticide degradation during transmission across the vadose zone as well as residence period (t).

$$AF_{GW} = \exp\left[\frac{-0.693 D\theta_{FC} RF}{q t_{1/2}}\right] = \exp\left[-t\frac{(\ln 2)}{t_{1/2}}\right] \quad .. (4)$$

$$t = \frac{D\theta_{FC} RF}{q} \quad .. (5)$$

where, $t_{1/2}$ = soil pesticide half-life, D = water table depth, q = soil water input (m/d). To account for the fact that microbial population number and organic carbon concentration vary greatly with soil depth, AF has been modified.

$$AF_{GW} = AF_{SZ} \times AF_{TZ \times} AF_{RZ} \qquad ..(6)$$

Where,
which is calculated by using Equation (5), AF_{SZ} = AF at surface zone;

AF_{TZ} = AF at the transitional zone, This is calculated by determining the soil's organic content at a depth of 0.4 metres and then applying that estimate to Equation (5);

AF_{RZ} = AF at the residual zone, which is calculated by Equation (5)

Attenuation factors estimate pesticide movement in groundwater (Tariq *et al.,* 2004). Groundwater pesticide mobility increases with attenuation factor. Site-specific pesticide burden is

$$\text{Groundwater Load} = \sum L_i AF_{GWi} = \sum L_i T_i \qquad ..(7)$$

Pesticide contamination in groundwater is caused by mixing in a given aquifer width and soil porosity. Pesticide residue (kg/m^3) is expected for the top "1.0 m of the aquifer mixing zone".

$$C_{GWi=}\ Li \times AW_{GW}i \times \frac{1}{\theta_s} \qquad ..(8)$$

The groundwater risk index compares this residue to allowable pesticide residual in groundwater.

$$\text{Groundwater Risk Index} = \frac{Cgw}{\text{Detectable or acceptable residue}} \qquad ..(9)$$

Asset value factor

This matters when comparing pesticide dangers to water bodies in various locations. Comparing pesticides affecting the same item, its value is negligible (Kumari *et al.*, 2008).

Data collection

Pesticide data

Farmers were surveyed on pesticide use in particular areas and cropping patterns during the last two years. Owing to the proliferation of pesticide brands and varieties, shopkeeper/company advice, and insect resistance, farmers utilised a range of pesticides for the same crop. Four major planting patterns in the research region utilised 15 pesticides (Table 1).

From the above mentioned 15 pesticides, Chlorophyrifos, Phorate, Atrazine, and Monocrotophos were chosen for comprehensive examination by PIRI based on their frequency of use in sampling sites. Table 2 shows pesticide characteristics and use data for all 5 sample locations, including pesticide rate and spray nozzle size (SS). The literature provided the half-life (t1/2) and "soil sorption coefficient (Koc)" of the four insecticides.

Water sampling

Pesticide residue samples were taken from tube wells in 5 farms. Tube wells accessed the groundwater 20–50 m underground. In bore wells, fresh aquifer water was recovered after flushing for 5 minutes. High-quality black glass sampling bottles with Teflon stoppers were employed. To prevent pesticides from adhering to plastic or polyethylene con-

Table 1. Study area's pesticide list

S. No	Formulae	Class	Chemical Name
1	$C_9H_{11}Cl_3NO_3PS$	Insecticide	Chlorophyriphos 20% EC
3	$C_{12}H_{15}NO_3$	Insecticide	Carbofuran
4	$C_{17}H_{26}ClNO_2$	Herbicide	Butachlor
5	$C_{18}H_{14}BrCl_2N_5O_2$	Insecticide	Chlorantraniliprole 0.4% GR
6	$C_{23}H_{22}ClF_3O_2$	Insecticide	Bifenthrin
7	$C_9H_9N_3O_2$	Fungicide	Carbendazim 50% WP
8	$C_5H_8N_2S_4Zn$	Fungicide	Propineb 70% WP
9	$C_9H_{10}ClN_5O_2$	Insecticide	Imidacloprid
10	$C_{15}H_{17}Cl_2N_3O_2$	Fungicide	Propiconazole 25% EC
11	$C_8H_{14}ClN_5$	Herbicide	Atrazine
12	$C_{12}H_4Cl_2F_6N_4OS$	Insecticide	Fipronil 5% SC
13	$C_7H_{17}O_2PS_3$	Insecticide	Phorate 10% CG
14	$C_{13}H_{19}N_3O_4$	Herbicide	Pendimethalin 30% EC
15	$C_{22}H_{19}Cl_2NO_3$	Insecticide	Cypermethrin

tainers, water samples were moved to glass bottles.

Pesticide residues were measured using liquid–liquid extraction and gas chromatography. A well-rinsed 1-litre separator funnel held a 500 ml groundwater sample and 10 g of NaCl. Shaking the funnel thoroughly dissolved NaCl. Mixing briskly for two to three minutes with occasional pressure release, dichloromethane removed the residues twice. The separator funnel separated the layers. A 1-litre separating funnel drew the bottom aqueous layer. Three extracts were mixed and dried in a "well-rinsed 250 ml flat-bottom flask" by passing through an adsorbent containing anhydrous Na_2SO_4 over a tiny pad of glass wool. A vacuum rotary evaporator concentrated the extracts to 1.0 ml, then 10 ml of n-hexane was applied and concentrated to 1.0 ml. N-hexane and acetonitrile solvents brought the volume to 2.0 ml. Gas chromatography evaluated a concentrated 2.0 ml sample (GC)(Chaudhary *et al.,* 2002). The sensor detection limits were set using a 3:1 signal-to-noise ratio to identify measurable peaks. Analytical studies utilised the average of duplicate samples. The statistical analysis awarded zero values to concentrations below detection Table 3 shows findings.

Soil sampling

Based on physical assessment and farmer's experience, the research area was separated into homogeneous units to gather soil samples reflecting the soil state. The sampling site was cleaned. Each sampling unit took five samples. A 15-cm "V"-shaped incision was made at the sample point, as well as thick soil parts from top to bottom of the uncovered aspect were taken and put in a tidy receptacle for soil analysis.After mixing, stones, roots, pebbles, including gravels were separated from the samples. Quartering and coning produced a typical soil sample. Tabulated soil parameters (Table 4).

Table 4. The findings of soil testing

Sampling station	Soil pH	Type of soil	Percentage of Organic content
1	8.1	Sandy silt	0.45
2	8.3	Clayey silt	0.90
3	8.2	Silt	0.60
4	7.9	Clayey silt	0.60
5	8.1	Silt	0.75
6	8.4	Silt	0.60
7	8.2	Clayey silt	0.75

Table 5. Tube well depth and whole irrigation

Sampling station	Tube well Irrigation (mm)	Tube well depth (m)
1	2,700	40
2	2,050	25
3	1,650	40
4	1,850	30
5	2,100	20
6	1,850	45
7	1,850	45

Engagement of PIRI software

The organic material partition coefficient, total rainfall, environmental persistence, water table depth, type of soil, total irrigation, and soil organic content are required by the software used to estimate pesticide leakage into groundwater. If not explicitly entered, the programme employs soil type-specific bulk density and moisture content. For flat terrain, the programme calculates the recharge rate using soil type, rainfall, and irrigation.

Results and Discussion

PIRI's assessments of the load and mobility of pesticide residues in groundwater

PIRI calculated pesticide residue/load and groundwater movement. The model assigns major risks to

Table 3. Residues of pesticides in groundwater.

Sample No.	Pesticide concentration (μg/l)			
	CPS (Chlorpyrifos)	Phorate	Monocrotophos	Atrazine
1	0.00	0.01	0.00	0.00
2	0.00	0.01	0.14	0.09
3	0.01	0.01	0.06	0.01
4	0.01	0.01	0.03	0.01
5	0.03	0.03	0.11	0.09
6	0.00	0.02	0.01	0.00
7	0.01	0.01	0.00	0.06

pesticides and labels them using Equation's scoring system (9). 3–7 are model-assigned groundwater pesticide load risk ratings and movement for each sample site. Table 6 shows the attenuation factor as well as pesticide residue/load groundwater contamination potential for each test location.

The PIRI-estimated pesticide residues/loads are contrasted to the reported concentrations of the four pesticides in all five water samples to contrast the actual risk to PIRI predictions.

Sample 1

Atrazine, phorate, as well as chloropyriphos had "Very high," "High," and "Medium" total groundwater load risk ratings. Field 1 was monocrotophos-free, so the software rated its risk as "Very low." Atrazine as well as phorate had medium mobility, while chloropyrifos and monocrotophos had very poor mobility.

Sample 2

Atrazine, phorate, monocrotophos, and chloropyriphos were rated "Very high," "High," and "Low" for total groundwater load. Despite low dose, chloropyrifos was not seen. Atrazine, monocrotophos, phorate, and chloropyrifos had medium, low, and very low mobility, respectively, in silty clay soil at 40 m borewell depth.

Sample 3

Phorate was graded "Medium" while the other pesticides "Very low" since they were not sprayed in the field. Phorate mobility was "Low" with "Silt" soil and 30 m borewell depth.

Sample 4

Monocrotophos, phorate, chloropyrifos, and atrazine were graded "High," "Medium," and "Low" groundwater contamination risks. Monocrotophos

Table 6. PIRI assessments of each sample's potential for groundwater pollution and risk score

Sample	Pesticide	PIRI estimates			
		Groundwater risk rating	Groundwater pollution potential (kg/ha)	Groundwater pollution potential (ppb)	Attenuation factor
1	Atrazine	Very High	0.04	30.00	0.002
	Chloropyriphos	Medium	0.02	4.98	0.002
	Phorate	High	0.03	13.40	0.002
	Monochrotopos	Very low	0.31	0.00	0.00
2	Atrazine	Very High	0.29	29.60	0.002
	Chloropyriphos	Low	0.01	1.00	0.002
	Phorate	High	0.11	11.98	0.002
	Monochrotopos	High	0.24	24.59	0.002
3	Atrazine	High	0.00	20.68	0.002
	Chloropyriphos	High	0.00	5.88	0.002
	Phorate	High	0.03	13.20	0.002
	Monochrotopos	High	0.11	17.56	0.002
4	Atrazine	Very low	0.00	0.00	0.002
	Chloropyriphos	High	0.12	12.40	0.002
	Phorate	Medium	0.02	2.36	0.002
	Monochrotopos	High	0.08	8.78	0.002
5	Atrazine	Very low	0.20	0.00	0.002
	Chloropyriphos	Very low	0.05	0.00	0.002
	Phorate	Medium	0.13	2.57	0.002
	Monochrotopos	Very low	0.17	0.00	0.002
6	Atrazine	Very low	0.00	0.00	0.002
	Chloropyriphos	Very low	0.00	0.00	0.002
	Phorate	Medium	0.03	2.85	0.002
	Monochrotopos	High	0.00	10.65	0.002
7	Atrazine	Medium	0.30	3.85	0.002
	Chloropyriphos	Medium	0.05	2.24	0.002
	Phorate	Medium	0.13	2.65	0.002
	Monochrotopos	Very high	0.00	30.75	0.002

and chloropyrifos had "Low" movement, whilephorateand atrazine had "Very low" movement.

Sample 5

All four pesticides have "High" groundwater load risk ratings. Atrazine, phorate, and monocrotophos had "Low" mobility due to "Silty clay" soil and 25 m borewell depth. "Very low" chloropyrifos.

Conclusion

Insecticides and fungicides are two types of pesticides. Insecticides kill insects while fungicides kill fungi. However, because of the extensive use of phytosanitary products, the presence of pesticide residues in the world's groundwater resources is a global problem. This is especially true in the world's least developed nations, where the application of plant protection products is carried out at an exceptionally high rate. Since the beginning of this cen-

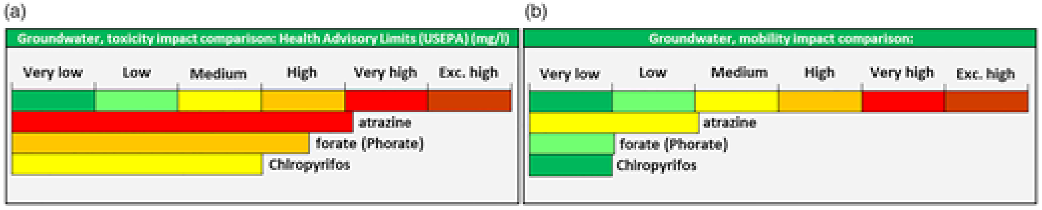

Fig. 3(a). The load of pesticides in groundwater, and (b) the mobility of sample 1.

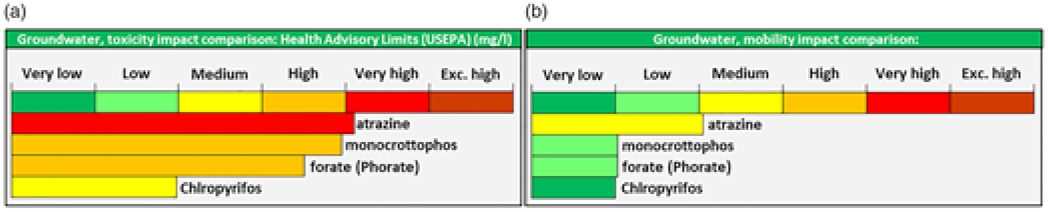

Fig. 4(a). The load of pesticides in groundwater, and (b) the mobility of sample 2.

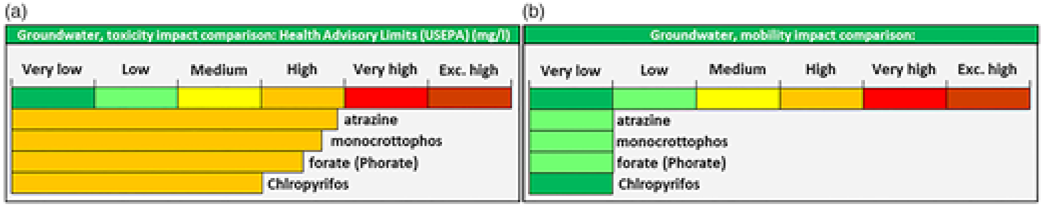

Fig. 5(a). The load of pesticides in groundwater, and (b) the mobility of sample 3.

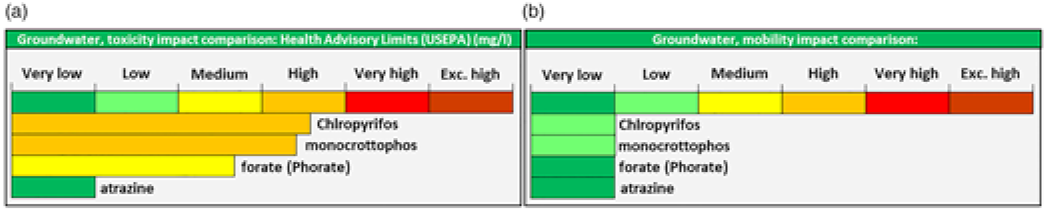

Fig. 6(a). The load of pesticides in groundwater, and (b) the mobility of sample 4.

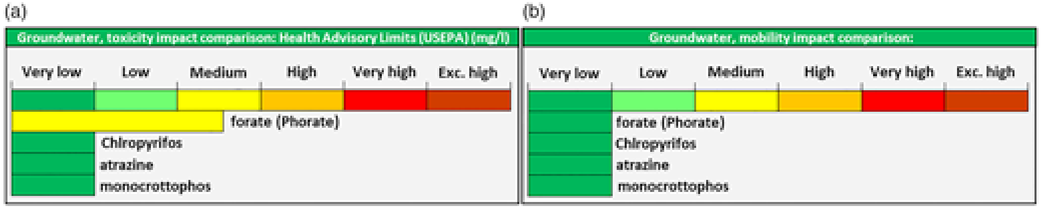

Fig. 7(a) The load of pesticides in groundwater, and (b) the mobility of sample 5.

tury, herbicides, particularly triazine as well as urea compounds, have been the pesticides that have been found the most often. Because groundwater is the main body of fresh water in many regions of the globe, the contamination of soil and water bodies by pesticides used in agriculture may constitute a significant danger to marine ecosystems as well as to the resources used to produce drinking water for humans. Leaching of pesticides via the soil and unsaturated zone, as well as infiltration of pesticides through riverbanks and riverbeds, are the two main causes of diffuse pesticide input pathways into groundwater. As a result, the groundwater resources are susceptible to contamination, which exemplifies the susceptibility of groundwater to experience a change in its condition as a direct result of the actions of humans. The mechanisms of degradation, adsorption, and transport are essential to understanding the capacity of a pesticide to pollute groundwater bodies and its ability to remain persistent in the environment. The physicochemical features of pesticides, as well as the characteristics of the soil, the location, and the management strategies that are used, are the primary elements that determine their destiny.

Declaration of Completing Interest: The author declare that he has no known competing financial interest or personal relationships that could have appeared to influence the work reported in this paper.

Table 7. Every sample point has pesticide correction features.

Sample No.	Pesticide residues (ppb)											
	Phorate			Chloropyrifos			Atrazine			Monocrotophos		
	CF (b1/a1)	Estimated value (a1)	Observed value (b1)	CF (b1/a1)	Estimated value (a1)	Observed value (b1)	CF (b1/a1)	Estimated value (a1)	Observed value (b1)	CF (b1/a1)	Estimated value (a1)	Observed value (b1)
Sample 1	0.8	13.4	10.0	2.0	5.0	10.0	2.0	30.0	60.0	–	0.0	0.0
Sample 2	0.8	12.0	10.0	–	1.0	0.0	3.0	29.6	90.0	5.7	24.6	140.0
Sample 3	2.3	13.2	30.0	5.1	5.9	30.0	4.4	20.7	90.0	6.3	17.6	110.0
Sample 4	4.2	2.4	10.0	0.8	12.4	10.0	-	0.0	10.0	3.4	8.8	30.0
Sample 5	3.9	2.6	10.0	-	0.0	0.0	-	0.0	0.0	-	0.0	0.0
Sample 6	7.0	2.9	20.0	-	0.0	0.0	-	0.0	0.0	0.9	10.7	10.0
Sample 7	3.8	2.7	10.0	4.5	2.2	10.0	2.6	3.9	10.0	2.0	30.8	60.0
Average correction factor	3.3			3.1			3			3.7		

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