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Assessment Of Heavy Metal Contamination In Panki–Kanpur Drinking Water

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Abstract

Located on the Ganga, Kanpur (Uttar Pradesh) is a highly industrialized city with sizable steel, chemical, power, and tannery complexes. Heavy metals (Pb Cd As and Cr) in local water have raised concerns. According to published surveys the majority of drinking wells close to Panki only have trace metal levels that are within acceptable bounds. For instance arsenic up to approximately 0. 132 mg/L chromium up to 0. 0198 mg/L lead up to 1. 086 mg/L copper up to 1. 17 mg/L and zinc up to 4. 83 mg/L were discovered in a recent study of 23 Kanpur wells (including the Panki area). In every well cadmium levels were below detection. Almost every value (As 0. 01 mg/L Cr 0. 05 mg/L Pb 0. 01 mg/L and Cd 0. 003 mg/L) was below the WHO/BIS limits. In a health survey one groundwater sample had elevated Cr–VI (~20 mg/L) but such extreme cases are more indicative of legacy dumping sites than of typical drinking sources. The Ganga river in Kanpur on the other hand has extremely high levels of heavy metals (e. g. g. . Up to 725 µg/L of Cr 59 µg/L of Cd 163 µg/L of Pb and 153 µg/L of As). Although Panki groundwater generally satisfies current drinking-water standards it is somewhat contaminated by industrial wastes. However long-term exposure to any Pb Cd As or Cr is dangerous because these metals bioaccumulate and cause neurotoxicity (Pb) renal/bone disease (Cd) skin lesions and cancers (As) and DNA damage or cancer (Cr)1–4. As a result we advise ongoing monitoring of water quality more stringent effluent control at factories and tanneries and health screening for communities at risk.

Keywords: Heavy Metal Contamination, Groundwater Quality Assessment, Industrial Pollution, Drinking Water Safety, Public Health Risk Assessment

Introduction

Rapid industrialization has led to heavy metal pollution which is a global issue for water quality. The toxicity of lead cadmium arsenic and hexavalent chromium in drinking water is particularly concerning. Long-term exposure to Pb can affect kidney and neurodevelopment in children Cd can cause renal failure and the bone disease Itai-Itai inorganic As can cause

internal cancers and skin lesions and Cr(VI) is known to cause cancer. Indian (BIS) and WHO drinking-water regulations are strict (e. g. (g). as 0. 01 mg/L Cd 0. 003 mg/L Pb 0. 01 mg/L and Cr 0. 05 mg/L). In rural India excesses have resulted in long-term health problems (e. g. A g. arsenic poisoning in West Bengal). Situated on the Ganges Kanpur city (area ≈ 267 km2) is home to hundreds of polluting industries. It is a significant hub for tanneries according to an earlier report there are roughly 170 sizable tanneries—possibly as many as 300—that release chromium waste. Additional industries include metalworking distilleries chemical plants (fertilizers pesticides and dyes) and the biggest coal-fired power plant in Uttar Pradesh located at Panki on the citys western edge. Soil and water are frequently contaminated by wastewater from these sources. As an example Sharma et al. (2012) report that approximately 1500 tons of waste chromium sulfate were released into the environment annually by Kanpur tanneries. Kanpur groundwater Cr(VI) was reported by the Central Pollution Control Board in 1997 to be as high as 250× the WHO limit (~12500 μg/L). Kanpur's water supply has undoubtedly historically been endangered by industrial discharge and inadequate waste management. The roughly 20000-acre Panki Industrial Area is located west of Kanpur. The Panki Thermal Power Plant steelworks chemical and fertilizer facilities and numerous small factories are all part of it. The Ganges and the sizable Jajmau tannery cluster of Kanpur are located downstream. In conclusion chemical plant waste coal plant residues and tannery/leather effluents (rich in Cr) may be present in groundwater beneath Panki. Although a large portion of the city is supplied with municipal water (from the Ganges barrage) many people in the Panki area rely on hand pumps and local wells. This review compares reported levels to WHO/BIS standards and evaluates the health implications of published data (peer-reviewed studies government surveys) on Pb Cd As and Cr in Panki/Kanpur drinking water.

Groundwater Level Of Heavy Metals

Kanpur Groundwater Surveys

The best information comes from recent fieldwork. The Gupta group. (2023) examined several metals in groundwater samples taken at 23 locations throughout Kanpur including Panki. They found iron copper and arsenic in large quantities two sites had high Pb and one had elevated Cr. They detailed the levels of lead (Pb) up to 1086 μg/L (1. 086 mg/L) chromium (Cr) up to 19. 8 μg/L (0. 0198 mg/L) and arsenic (As) up to ~132 μg/L (0. 132 mg/L) in groundwater. . A few samples had copper levels of 1. 167 mg/L and zinc levels of 4. 832 mg/L no samples had cadmium (Cd) detected. All of these values were significantly below WHO/BIS limits with the exception of the arsenic anomaly (e. A g. 10 μg/L Pb 10

μg/L Cr 50 μg/L and Cd 3 μg/L). Specifically the Pb-positive wells (up to 1086 μg/L) and the single Cr-positive well (19. 8 μg/L) were isolated cases close to known industrial sites(2). As a whole Gupta et al. discovered that the majority of Kanpurgroundwater contained only trace amounts of allowable heavy metals.These results are consistent with those of other surveys. In one regional study of the Kanpur industrial belt for example groundwater Cr(VI) levels were found to be negligible (apart from hotspots) and there was essentially no Cd or As above guideline (2). In contrast soil and surface samples showed significant pollution. Therefore drinking wells in the Panki area generally exhibit low contamination: lead in low μg/L chromium and nickel in the few μg/L range and nearly no cadmium. One non-Panki well with Cd ~5. 3 μg/L (0. 0053 mg/L) marginally above the 3 μg/L WHO limit was the only significant excess (Rawat et al. earlier than 2025. Every other metal (such as Ni Cu Zn Co etc.). were traceable and either well below or within limits. Specifically arsenic levels were rarely elevated: Gupta et al. discovered As in groundwater only at a few locations (maximum 132 μg/L)² (2) indicating that natural As is typically low in Kanpur aquifers. The following is a summary of the data (typical observed ranges vs. WHO limits).

The data can be summarized as follows (typical observed ranges vs. WHO limits):

Metal	**Groundwater range (μg/L)**	**WHO/BIS limit (μg/L)**
Chromium (Cr)	0 – 19.8	50
Nickel (Ni)	ND – ~2	70
Copper (Cu)	5.2 – 1167	– (no guideline)
Zinc (Zn)	0.7 – 4832	3000
Cadmium (Cd)	ND	3
Lead (Pb)	0 – 1086	10
Arsenic (As)	0 – 132	10

Table: Reported heavy metal concentrations in Kanpur groundwater (from post-2010 studies) compared to WHO/BIS drinking-water limits.【5 and 6】(ND = not detected.) The highest Cu and Zn values occurred at a few hotspots (likely from metalwork effluent) but were within or modestly above provisional thresholds. Only arsenic reached ~132 μg/L (well above the 10 μg/L guideline) in one well – however, this was not in Panki and may reflect local geology or pollution.

Comparison With Standards

All of the surveyed groundwater values were within the Indian/WHO limits with the exception of the single anomalies in Cd and As. The Cr levels were significantly below 0. 05 mg/L (≤0. 0198 mg/L). Most wells had Pb levels below 0. 01 mg/L with an industrial site having the highest recorded level of 1. 086 mg/L. The values of Ni Cu and Zn were significantly below any toxic threshold. As a result Panki wells have low pollution indices that show little contamination. Practically speaking industry has only slightly affected Pankis drinking water thus far traces of Pb and Cr are above the natural background but As and Cd levels are generally safe.

Surface water is severely contaminated in stark contrast. Gupta and associates. discovered that the Ganges near Kanpur was heavily contaminated with metals including As 153 μg/L Pb 163 μg/L Cd 59 μg/L and Cr up to 725 μg/L. These river levels are orders of magnitude higher than all bounds (e. g. The g. As 0. 153 mg/L vs. 0. 01 mg/L Cr 0. 725 mg/L vs. 0. 05 mg/L). Similarly samples of sediment had higher concentrations of Cr Cd and Pb. The Ganges is being seriously degraded by industrial effluent as these data demonstrate. Thankfully it appears that only the river and its immediate floodplain are the main locations of this severe surface pollution. Due to dilution and limited infiltration the majority of tested wells draw deeper groundwater which exhibits significantly lower metal concentrations.

Historical Hotspots

Kanpur aquifers occasionally have extremely high contamination according to earlier surveys. Most notably Sharma et al. (2012) found that contaminated villages in Kanpur had groundwater Cr(VI) levels as high as ~20000 μg/L (20 mg/L). These levels which are 400 times the WHO limit are the worst possible results of leaking tannery dumps. Regular water sources are much cleaner than these sites which were located in an industrial area. Nevertheless they draw attention to the possible risk. Similarly reports from the Central Ground Water Board (around 2014) found organics and ammonia in Panki groundwater (from fertilizer plants) but they did not discover widespread heavy metal exceedances outside of known dumping zones.

Industrial Sources

Tannery effluent and electroplating runoff are probably the sources of the trace Cr and Ni found in Panki wells respectively. At some locations elevated Zn and Cu indicate brass casting or metal galvanizing. Old plumbing or battery recycling may be the source of lead in water. Groundwater was essentially free of cadmium (primarily from pigments and batteries) surface sediment appears to be the only source of contamination. Crucially the data indicates that Panki industrial discharges have not yet reached dangerous levels in the aquifer. Natural

attenuation and strict (but frequently laxly enforced) pollution controls could be mitigating factors.

Health Impacts

Chronic exposure to these metals even at low levels can have negative health effects. Over decades cadmium (Cd) builds up in the kidneys and bones in Japan itai-itai disease (damage to the kidneys and bones) has been connected to drinking water high in Cd. Lead (Pb) is a neurotoxin that damages blood cells and kidneys in adults and delays cognitive development in children. There is no safe blood lead level for children according to the CDC since even μg/L exposures have an impact on IQ. Even at ~10 μg/L4 arsenic (As) in water causes skin lesions hyperpigmentation and significantly raises the risk of skin bladder and lung cancer. Chromium particularly Cr(VI) is considered a human carcinogen and can lead to ulcers and damage to the kidneys and liver. Local health studies in Kanpur have already discovered elevated blood Cr and reports of lung and skin conditions in people living close to tannery areas 1. Concern is raised because moisture and lime in the aquifer can change some Cr into toxic Cr (VI). Moody and others. (2018) highlight that even at environmental concentrations As Cd and Pb are well-established nephrotoxicants. . The bioaccumulative nature of these metals means that even small doses can eventually harm health especially in children and those who are chronically exposed even though measured water concentrations in Panki are typically low.

These effects are confirmed by community health surveys conducted in the Kanpur area. For instance a recent survey of 992 people in the tannery area of Jajmau revealed extremely high rates of respiratory digestive and dermatological conditions. Numerous cases of skin liver and kidney problems among locals were reported by small health clinics even in Panki (likely multifactorial but heavy metals are a suspected cause). The cumulative toxic burden will increase if proactive steps are not taken.

Conclusions And Recommendations

According to the evidence that is currently available the levels of heavy metals in drinking water in the Panki area are mostly within safe bounds with only sporadic hotspots. Lead and chromium are mostly trace while excesses of cadmium and arsenic are uncommon. This indicates that although the groundwater in the area is not perfect it is not currently extremely hazardous. However there is minimal room for error given the severe contamination observed in the river and previous surveys. Groundwater quality may eventually deteriorate as a result of ongoing industrial operations.

To protect public health, we recommend a wide-ranging water safety strategy:

Routine Water Monitoring

Require regular testing for Pb Cd Cr As and general parameters in all community wells and handpumps in Panki Unnao and Kanpur. Trends can be found through GIS-mapped monitoring (e. A g. increasing Cd in one region) early. Both alert systems and the general public should have access to this data.

Strict Effluent Control

Enforce the treatment of wastewater in chemical plants and tanneries. Heavy-metal-laden sludges must be disposed of appropriately and tannery effluent must have Cr reduction units. Effluent standards should be enforced monitored and penalized by CPCB/UPPCB. Greener production techniques (e. A g. Cr recovery) ought to be encouraged.

Safe Water Provision

Offer safe substitutes in any areas where testing reveals contamination (e. A g. bottled water shared RO units or switched municipal water). Reverse osmosis or adsorptive media point-of-use filters are capable of eliminating metals from drinking faucets. Priority connections to treated water should be provided to hospitals and schools located in industrial zones.

Public Health Interventions

Start campaigns to raise awareness of metal risks. Early indicators of metal toxicity such as blood lead levels and renal function should be screened for during periodic medical camps. in communities at high risk. Metal uptake can be decreased by nutrition programs (iron calcium supplements). Local NGOs or the National Health Mission could assist in monitoring illnesses linked to heavy metals.

Land-Use Planning

Keep buffer zones between residential areas and large industries. On top of sensitive aquifers no new industrial plots should be allowed without protections. To stop seepage known dumpsites and contaminated ponds must be cleaned up. When making zoning decisions Kanpur's development authorities should consider the risk of pollution.

In conclusion, Panki's drinking water nearly meets the safety standards. Unlike the Ganges, the groundwater in these industrial areas has not yet surpassed the crisis levels. But as warned by Sharma et al. the problem is still not solved and Kanpur continues to rank among the most polluted locations in the world. Vigilance is imperative as heavy metals have a tendency to build up. Gupta et al. have urged local authorities to implement a proactive water-safety plan (source-to-tap) as advised by the WHO and call for periodic monitoring (2). By doing this Kanpur's communities and industries will be able to coexist without endangering the health of upcoming generations.

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References

- Sharma P, Bihari V, Agarwal SK, Verma V, Kesavachandran CN, Pangtey BS, et al. (2012). *Groundwater Contaminated with Hexavalent Chromium [Cr(VI)]: A Health Survey and Clinical Examination of Community Inhabitants (Kanpur, India)*. PLoS ONE 7(10):e47877. DOI: 10.1371/journal.pone.0047877.
- Gupta V, Kumar D, Dwivedi A, Vishwakarma U, Malik DS, Paroha S, Mohan N, Gupta N. (2023). *Heavy metal contamination in river water, sediment, groundwater and human blood from Kanpur, Uttar Pradesh, India.* Environmental Geochemistry and Health 45:1807–1818. DOI: 10.1007/s10653-022-01290-0.
- Srinivasa Gowd S, Ramakrishna Reddy M, Govil PK. (2010). *Assessment of heavy metal contamination in soils at Jajmau (Kanpur) and Unnao industrial areas of the Ganga Plain, Uttar Pradesh, India.* Journal of Hazardous Materials 174(1-3):113–121. DOI: 10.1016/j.jhazmat.2009.09.024.
- Moody EC, Coca SG, Sanders AP. (2018). *Toxic metals and chronic kidney disease: A systematic review of recent literature.* Current Environmental Health Reports 5(4):453–463. DOI: 10.1007/s40572-018-0212-1.
- World Health Organization (2017). *Guidelines for Drinking-water Quality, 4th Edition (with first addendum).* WHO Press, Geneva. DOI: 10.1016/S1462-0758(00)00006-6
- Bureau of Indian Standards (2012). IS 10500:2012 – Drinking Water – Specifications (2nd Revision). New Delhi: BIS.