

Bolivia Pilcomayo Heavy Metals Study

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1 Introduction

This document analyzes heavy metals in water, soil, sediment, vegetation, fish, humans, and animals collected in 2006 from the Pilcomayo River basin in Bolivia. Threshold lines are based on WHO, Codex Alimentarius, CDC, and Bolivian reference values.

Citations:

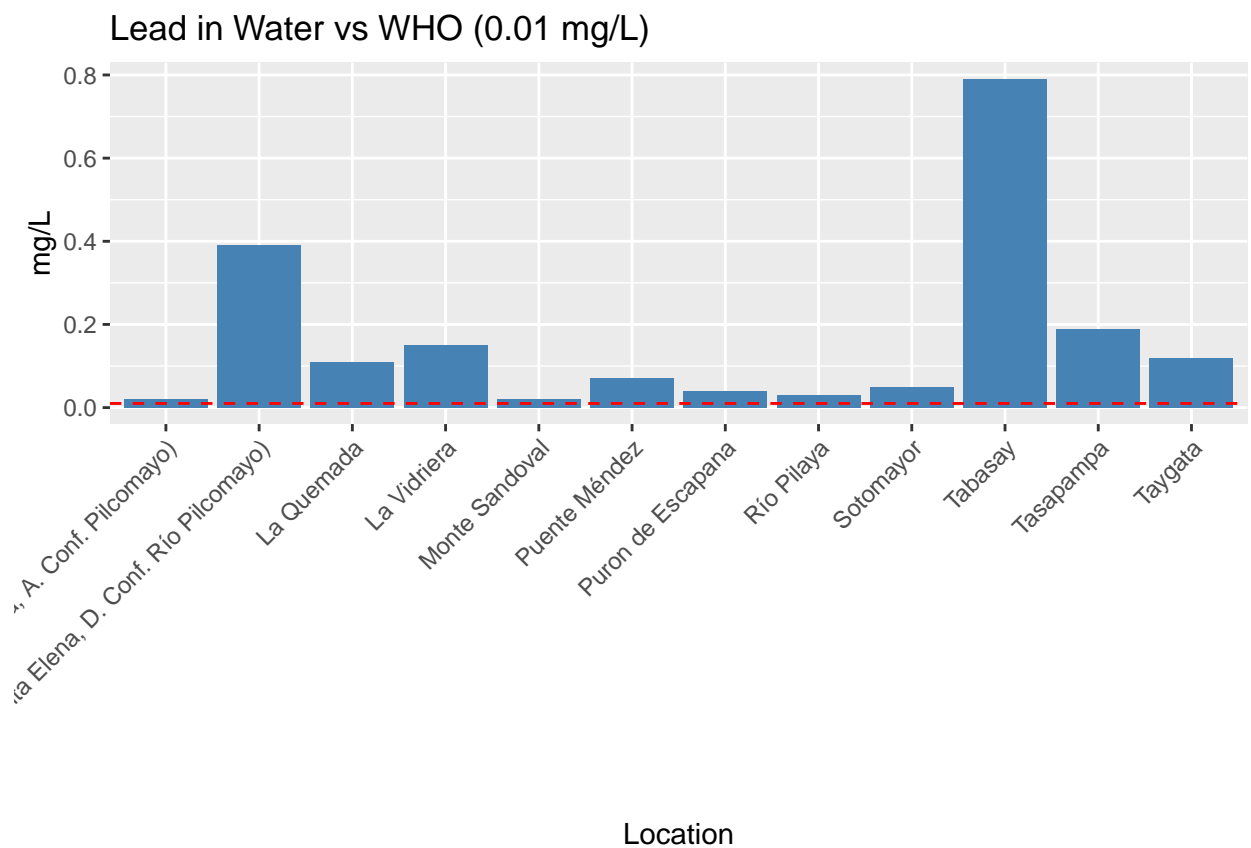
- WHO (2017). Guidelines for Drinking-water Quality. <https://www.who.int/publications/i/item/9789241549950>
- Codex Alimentarius Standard 193-1995 Rev. 2018
- CDC Lead reference value, 2021

2 Water Samples

```
water <- read_csv("data/ITA_water_2006.csv")
```

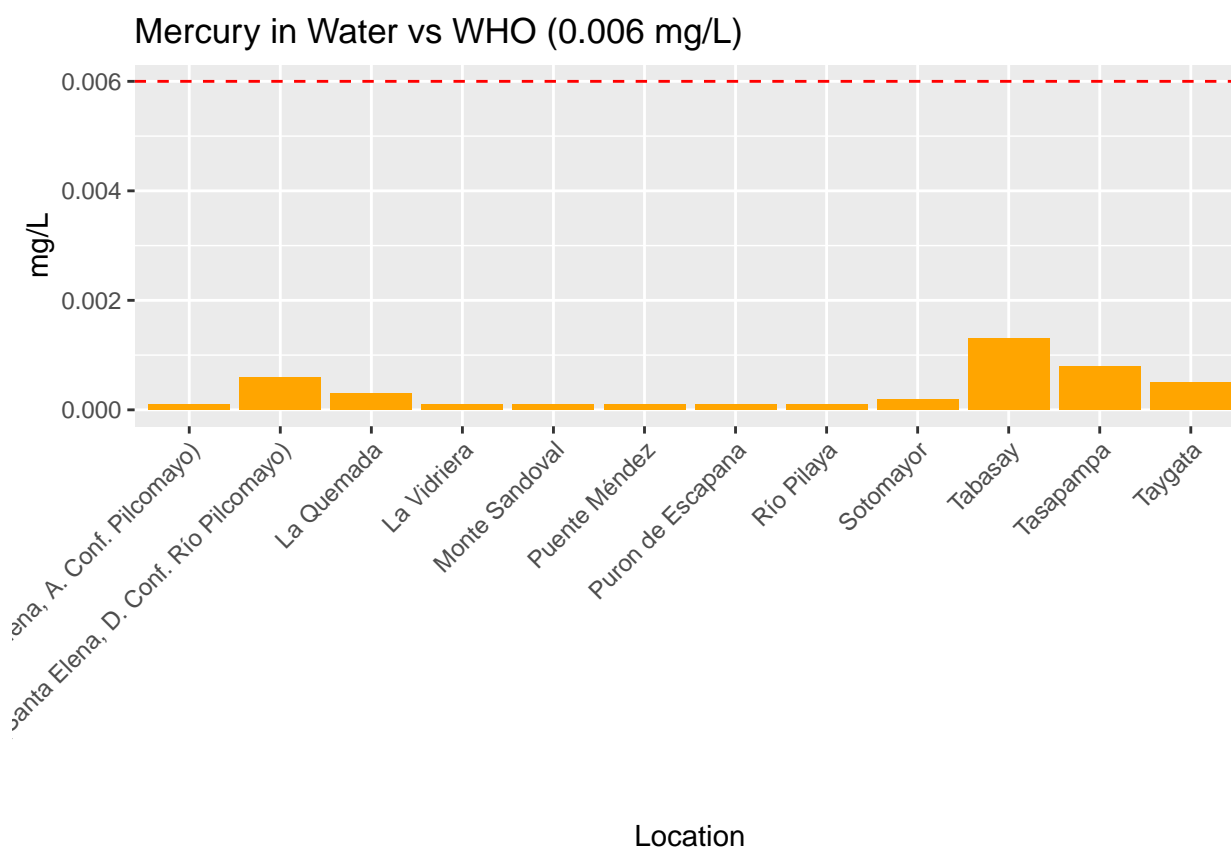
2.1 Lead in Water

```
ggplot(water, aes(x=Location, y=Pb (mg/l))) +  
  geom_col(fill="steelblue") +  
  geom_hline(yintercept=0.01, color="red", linetype="dashed") +  
  labs(title="Lead in Water vs WHO (0.01 mg/L)", y="mg/L") +  
  theme(axis.text.x=element_text(angle=45, hjust=1))
```



2.2 Mercury in Water

```
ggplot(water, aes(x=Location, y=`Hg (mg/l)`) ) +  
  geom_col(fill="orange") +  
  geom_hline(yintercept=0.006, color="red", linetype="dashed") +  
  labs(title="Mercury in Water vs WHO (0.006 mg/L)", y="mg/L") +  
  theme(axis.text.x=element_text(angle=45, hjust=1))
```

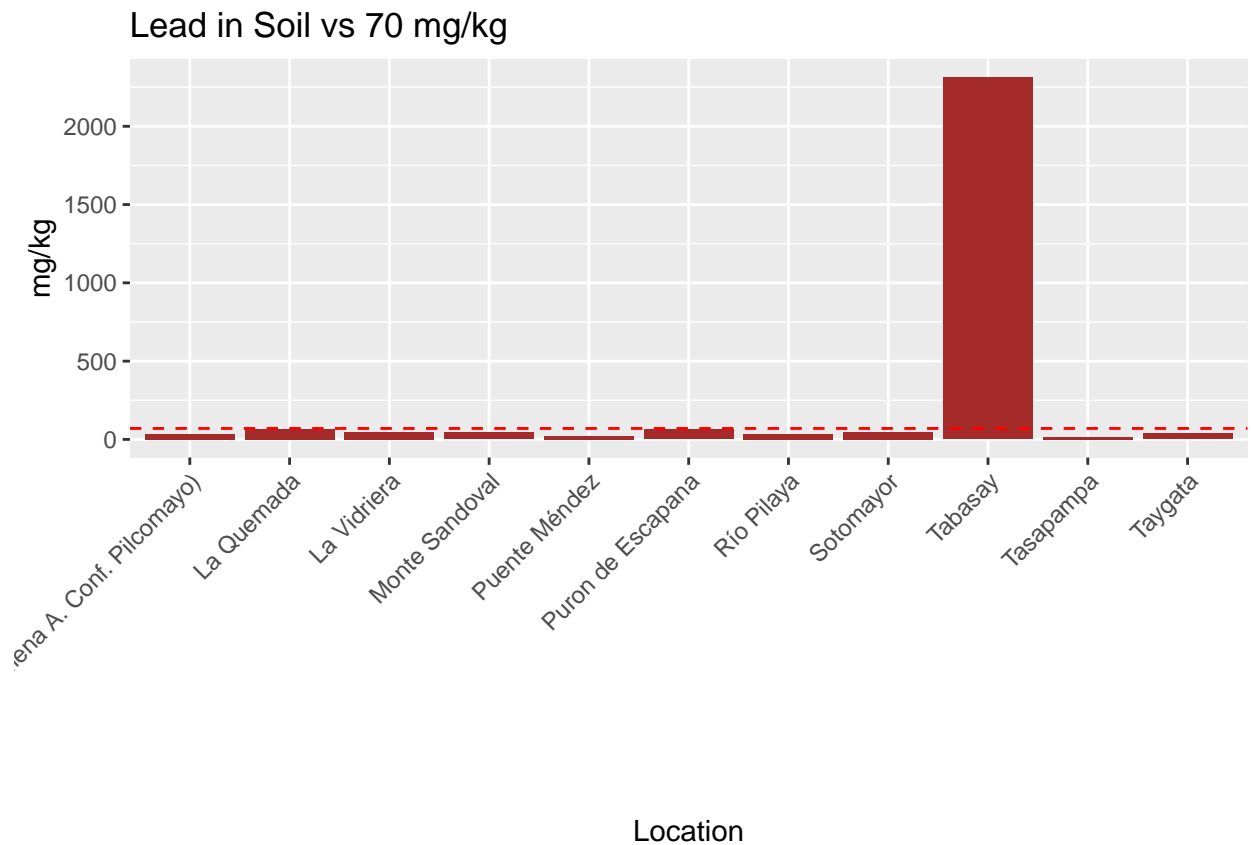


3 Soil Samples

```
soil <- read_csv("data/ITA_soil_2006.csv")
```

3.1 Lead in Soil

```
ggplot(soil, aes(x=Location, y=`Pb (mg/kg)`) ) +  
  geom_col(fill="brown") +  
  geom_hline(yintercept=70, color="red", linetype="dashed") +  
  labs(title="Lead in Soil vs 70 mg/kg", y="mg/kg") +  
  theme(axis.text.x=element_text(angle=45, hjust=1))
```

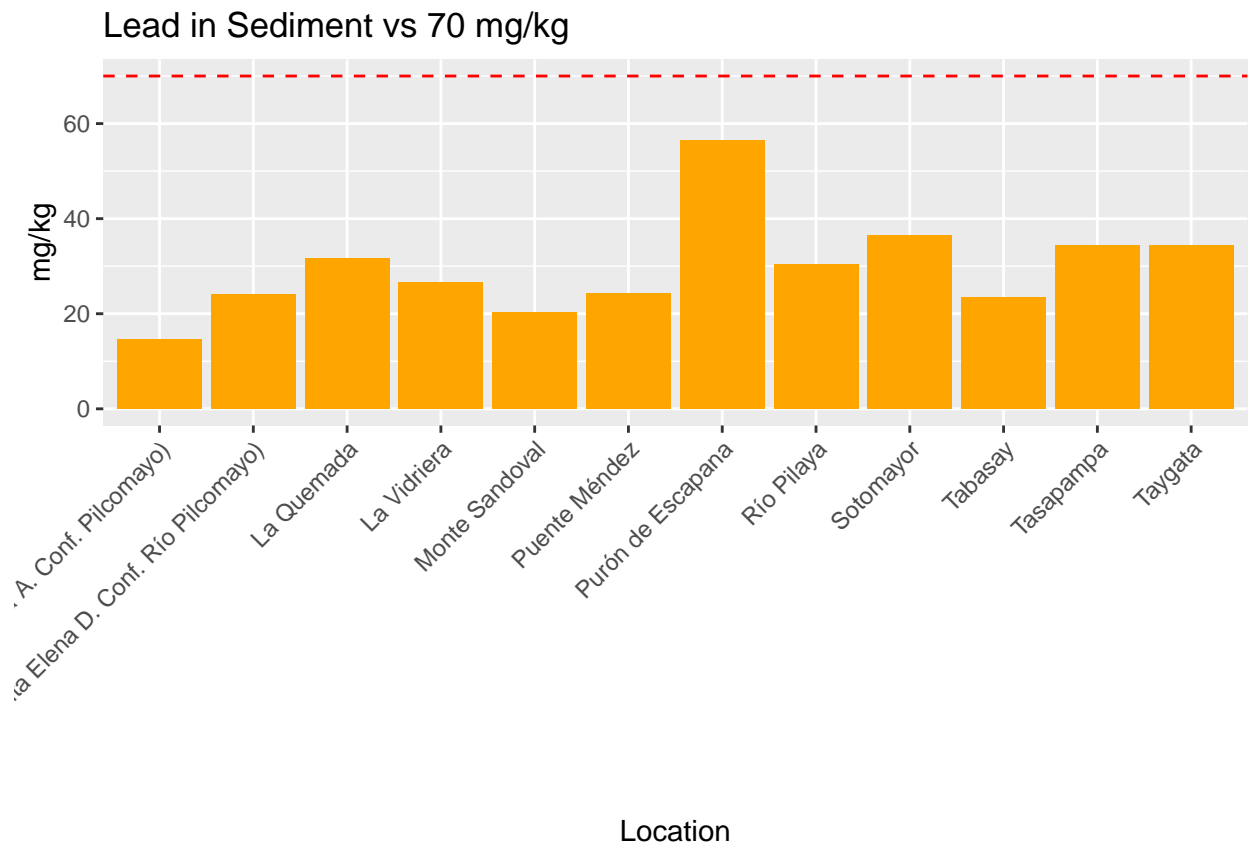


4 Sediment Samples

```
sediment <- read_csv("data/ITA_sed_2006.csv")
```

4.1 Lead in Sediment

```
ggplot(sediment, aes(x=Location, y=`Pb (mg/kg)`)) +
  geom_col(fill="orange") +
  geom_hline(yintercept=70, color="red", linetype="dashed") +
  labs(title="Lead in Sediment vs 70 mg/kg", y="mg/kg") +
  theme(axis.text.x=element_text(angle=45, hjust=1))
```

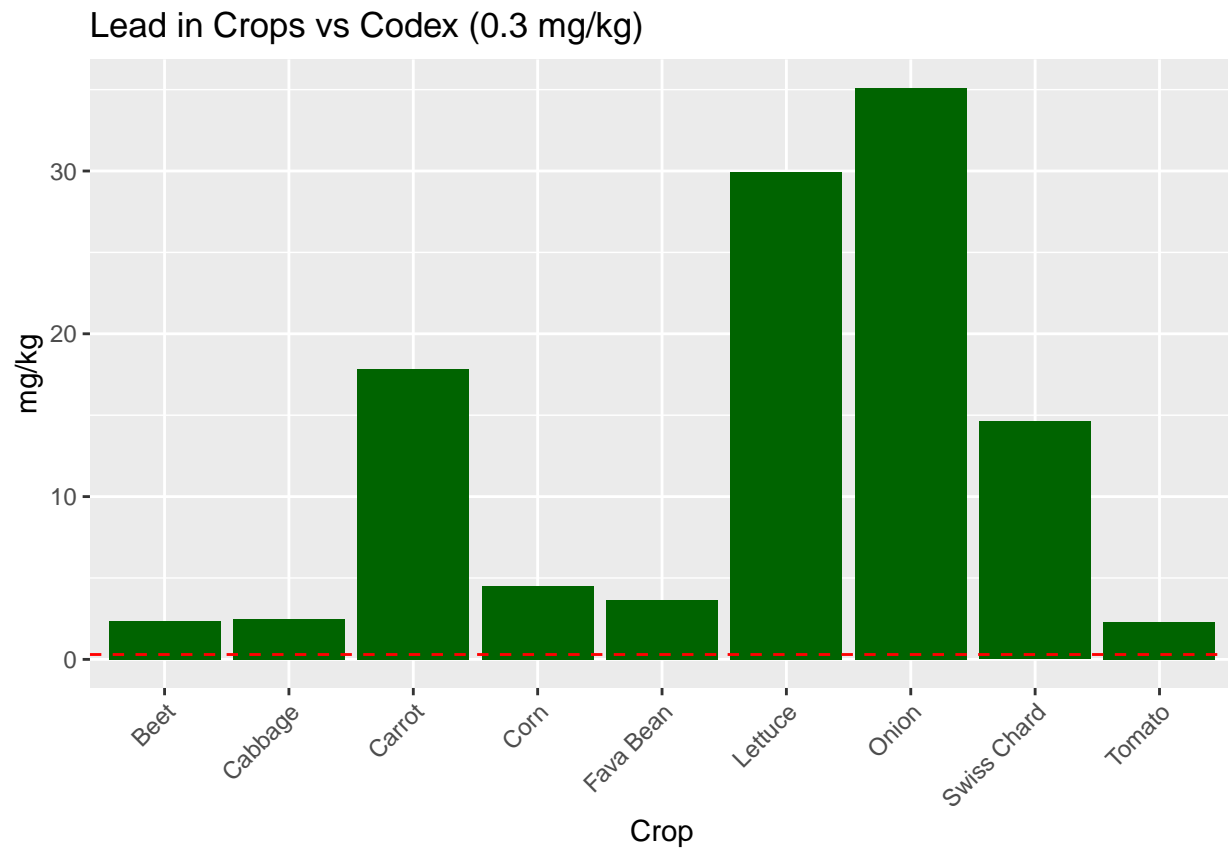


5 Vegetation Samples

```
veg <- read_csv("data/ITA_veg_2006.csv")
```

5.1 Lead in Vegetation

```
ggplot(veg, aes(x=Crop, y=Pb (mg/kg))) +
  geom_col(fill="darkgreen") +
  geom_hline(yintercept=0.3, color="red", linetype="dashed") +
  labs(title="Lead in Crops vs Codex (0.3 mg/kg)", y="mg/kg") +
  theme(axis.text.x=element_text(angle=45, hjust=1))
```

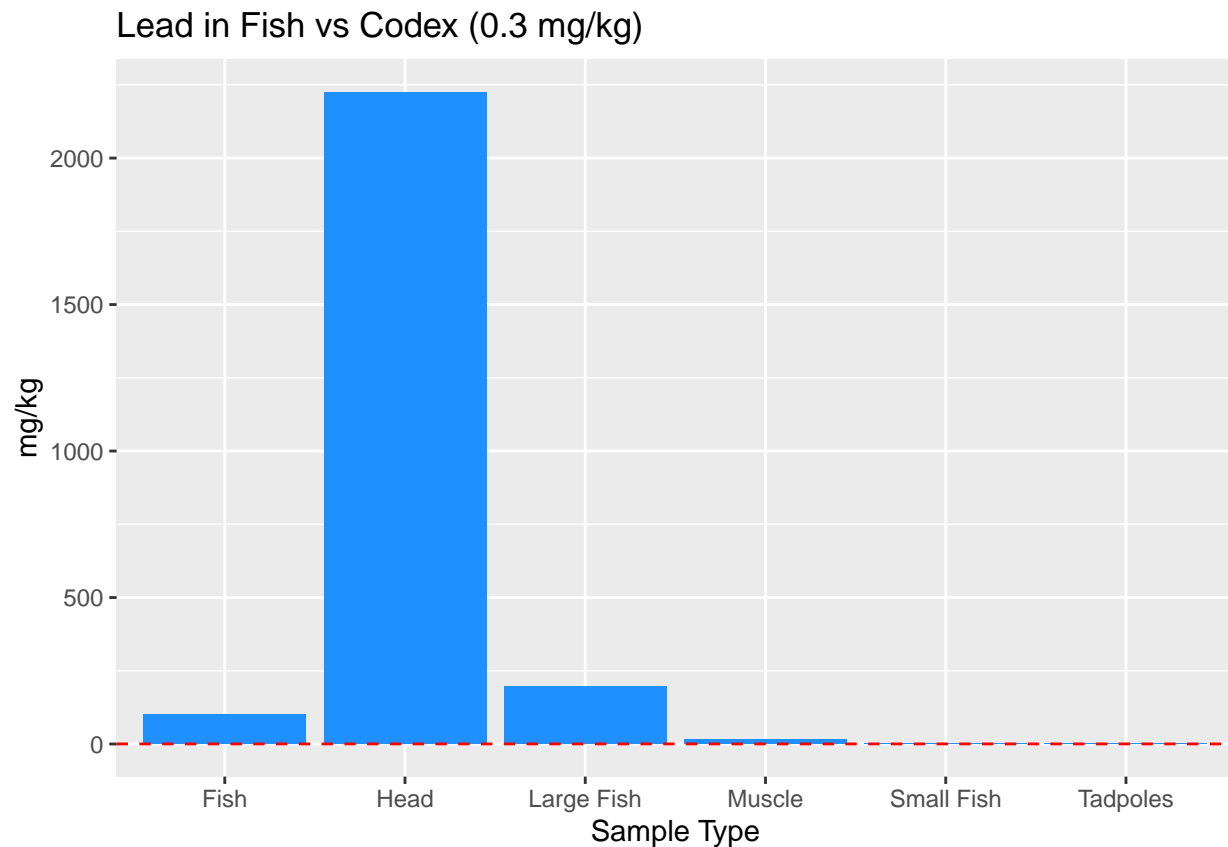


6 Fish Samples

```
fish <- read_csv("data/ITA_fish_2006.csv")
```

6.1 Lead in Fish

```
ggplot(fish, aes(x=`Sample Type`, y=`Pb (mg/kg)`)) +
  geom_col(fill="dodgerblue") +
  geom_hline(yintercept=0.3, color="red", linetype="dashed") +
  labs(title="Lead in Fish vs Codex (0.3 mg/kg)", y="mg/kg")
```

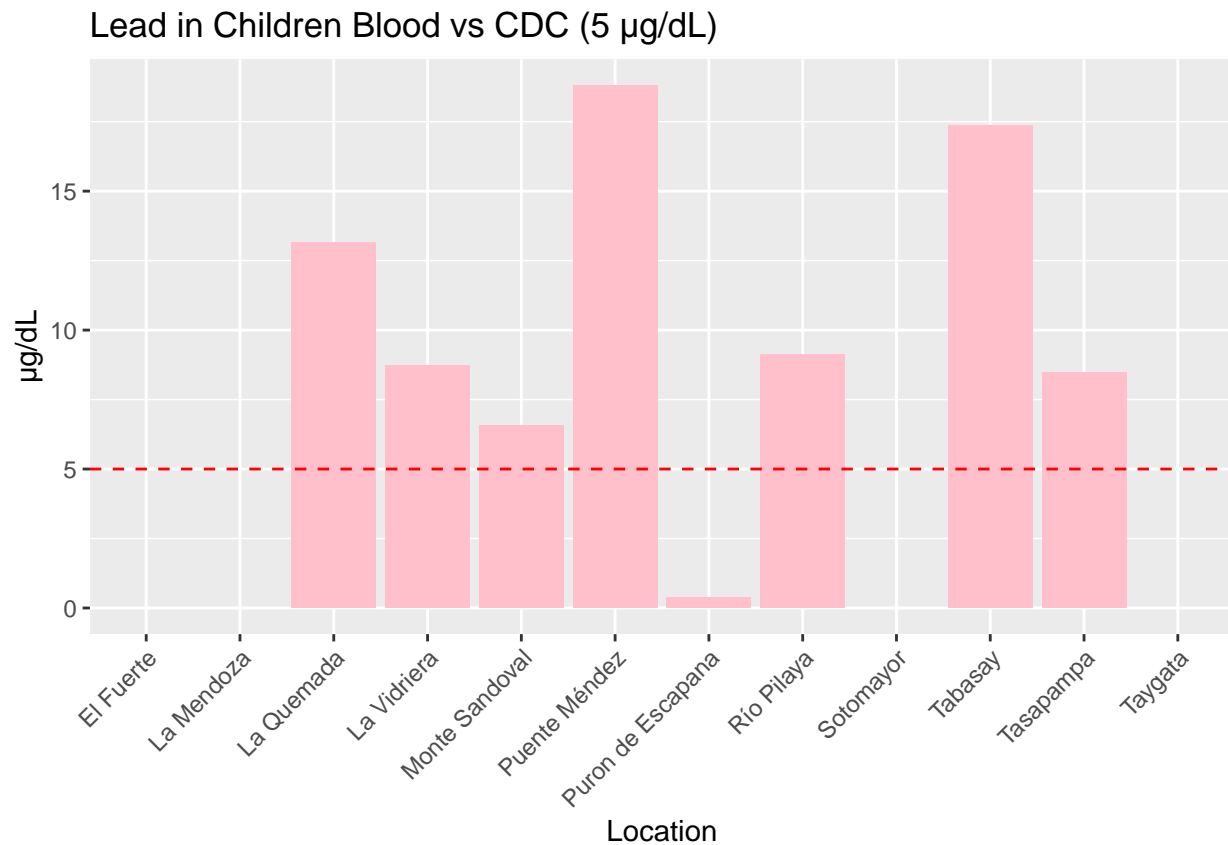


7 Human Blood Samples

```
human <- read_csv("data/ITA_human_2006.csv")
```

7.1 Lead in Children

```
ggplot(human, aes(x=Location, y=`Pb [µg/dl] Children`)) +  
  geom_col(fill="pink") +  
  geom_hline(yintercept=5, color="red", linetype="dashed") +  
  labs(title="Lead in Children Blood vs CDC (5 µg/dL)", y="µg/dL") +  
  theme(axis.text.x=element_text(angle=45, hjust=1))
```

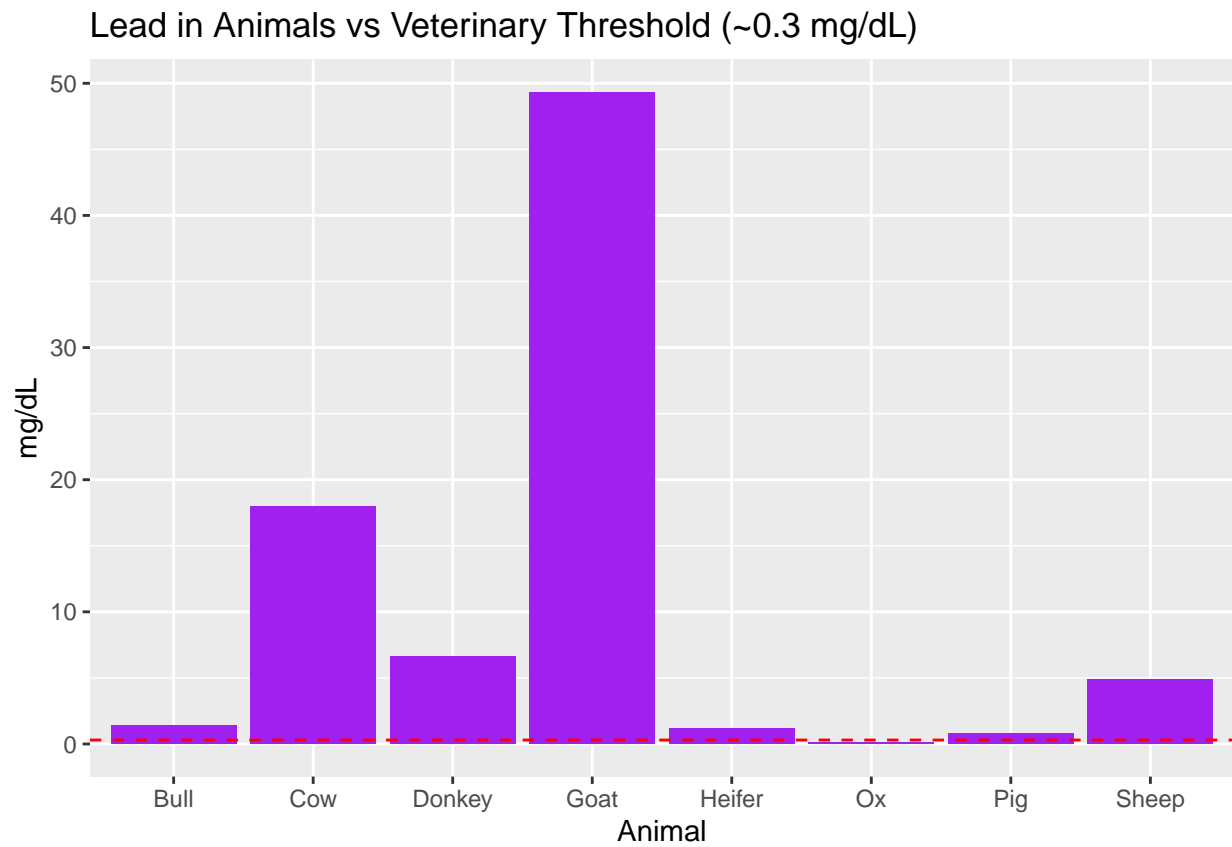


8 Animal Blood Samples

```
animal <- read_csv("data/ITA_animal_2006.csv")
```

8.1 Lead in Animals

```
ggplot(animal, aes(x=Animal, y=`Pb (mg/dL)`)) +
  geom_col(fill="purple") +
  geom_hline(yintercept=0.3, color="red", linetype="dashed") +
  labs(title="Lead in Animals vs Veterinary Threshold (~0.3 mg/dL)", y="mg/dL")
```

9 Conclusion

This summary compares observed results to WHO, Codex, CDC, and Bolivian references. Future work could include spatial mapping or seasonal trends.