The international symposium of the IAP Water Program

"Enhancing Water Management Capacity in a Changing World: Science Academies Working Together to Increase Global Access to Water and Sanitation"

MINING INDUSTRY IMPACTS ON SURFACE WATER QUALITY IN SOUTH PART OF ARMENIA

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Fig.1. A Map of Armenia.

Armenia is located in the South Caucasus. It is bounded by Georgia on the north, Azerbaijan on the east, Iran on the south, and Turkey on the west. A land of rugged mountains and extinct volcanoes, its highest point is Mount Aragats (4,095m).

The capital is the city of Yerevan.



Fig.2. A schematic map of monitoring sampling sites in Araks river basin

River Araks - the largest tributary of River Kura - is one of the most essential water arteries to the Caucasus. The total river length is 1072 km, the watershed covers an area 102000 sq.km, 22790 of which falls on Armenia. Mean annual runoff is 9 km^3.

The river forms in Turkey and at a distance of 638 km from the head it enters the Ararat Valley flowing on it. Then the river overcomes the Zangezur Range peaks flowing on a narrow plain and here and there through a deep rocky canyon. The river waters are used predominantly for irrigation.

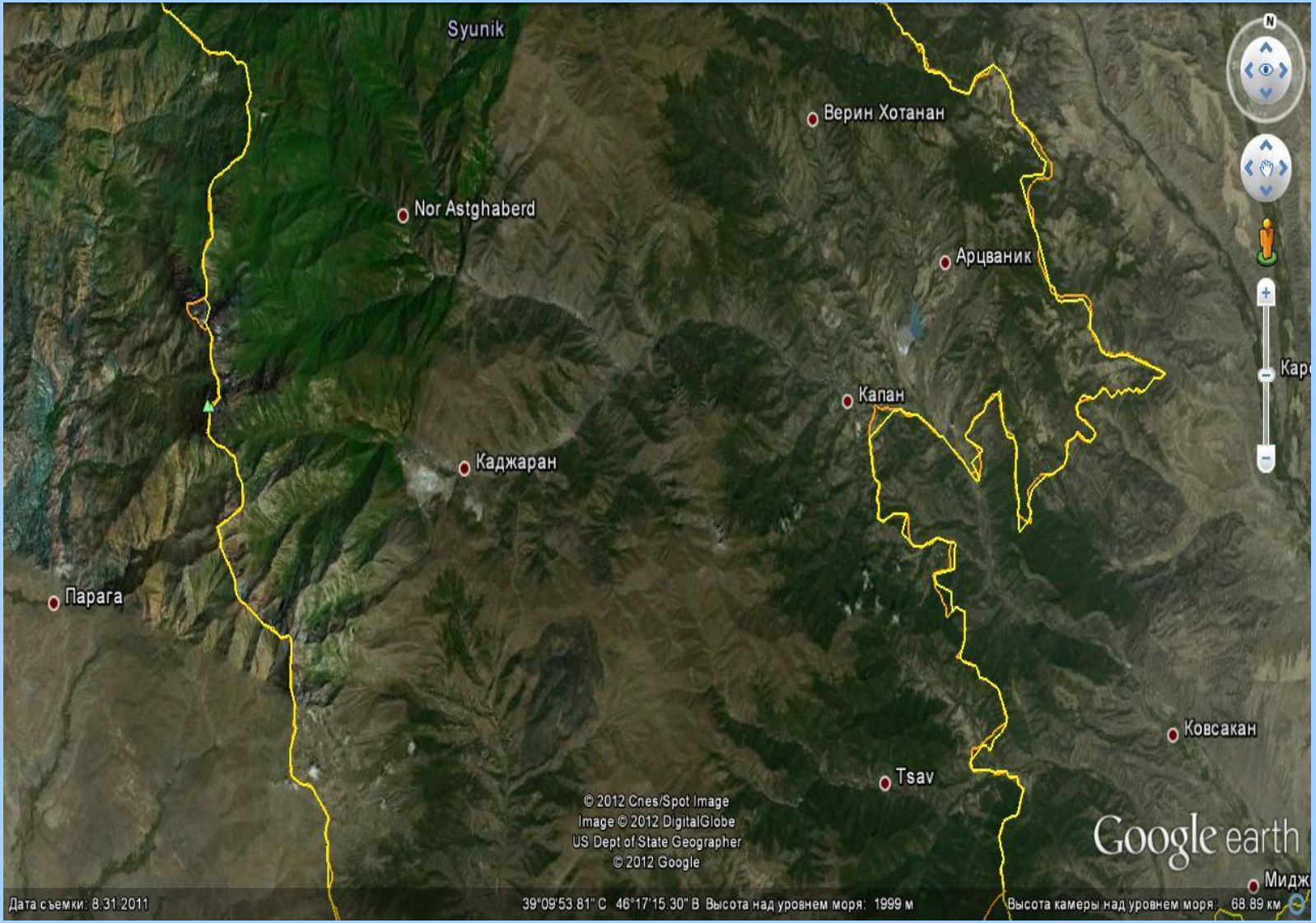


Fig.3. A Map of South part of Armenia.

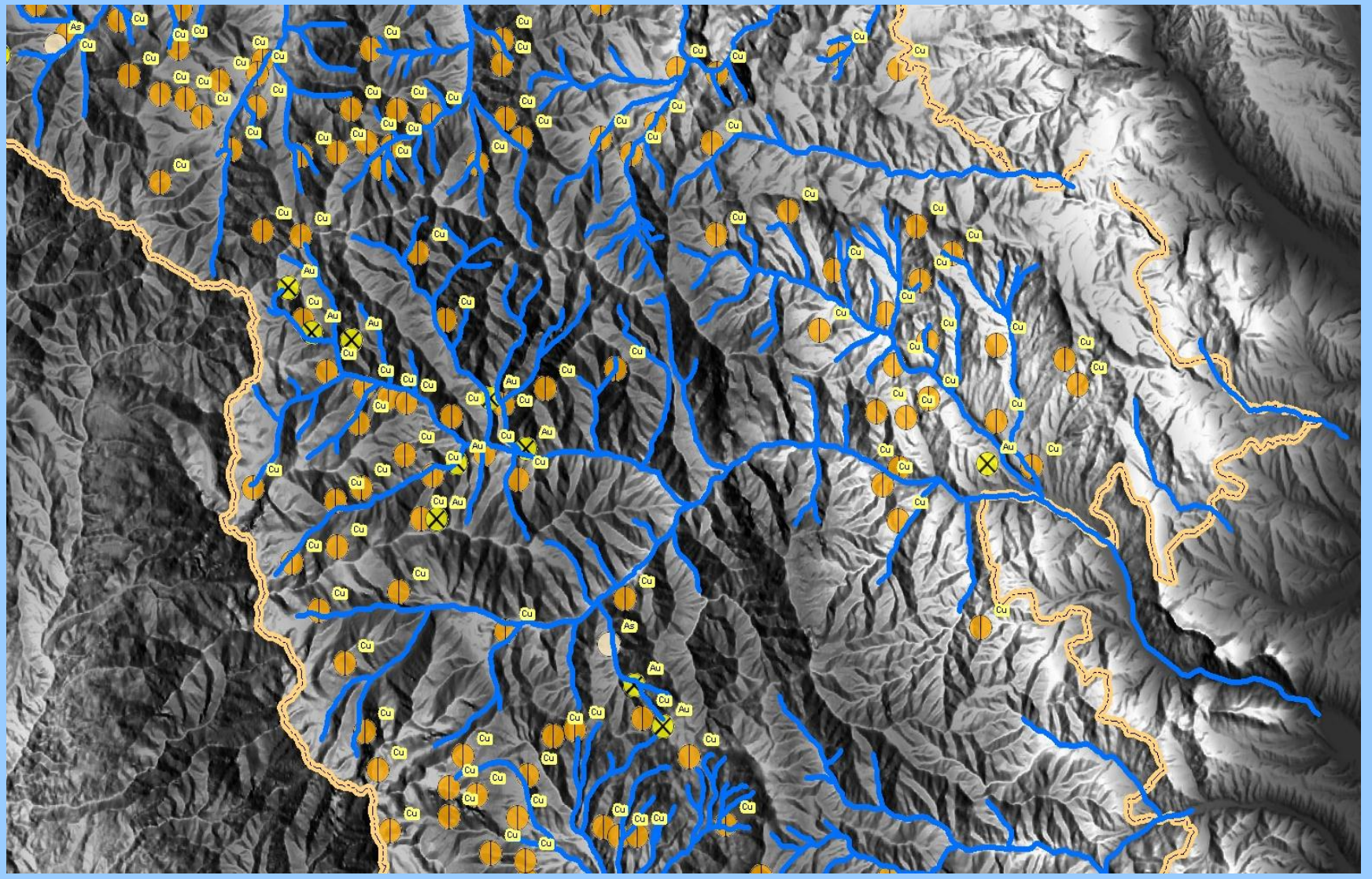


Fig.4. A Map of ore deposits in south part of Armenia and the ***River Voghchi*** watershed.

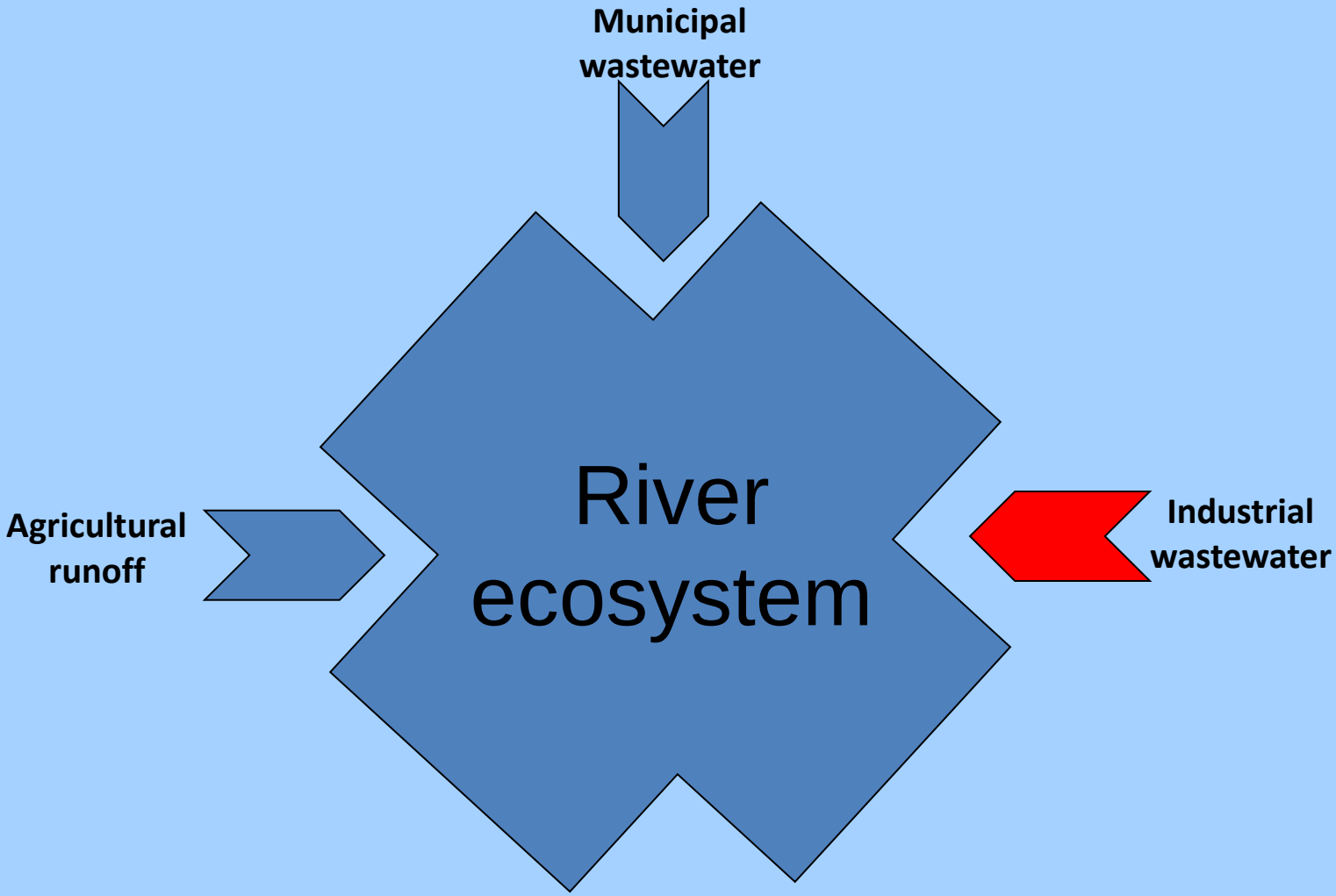


Fig.5. Scheme of pollution sources to the River *Voghchi*

Field Work

- regular sampling keeping QAPrP requirements
- conducting field measurements of 6 quality indices:
  - **pH**
  - **conductivity**
  - **turbidity**
  - **dissolved oxygen**
  - **temperature**
  - **salinity**
- Quantitive measurments
- Regular data protocoling

Implementation of QAPrP

- implementation of QA requirements:

  - **field work**

    transport blank,
    transfer blank
    equipment blank

  - **lab analyses**

    calibration blank
    lab QC sample (LCS)
    matrix spike
    dublicate

- implementation of MQO requirements (RSD% and MDL)

Scientific data processing

- Assessing water quality by basic ions (Ca, Mg, Na, Cl, K, SO_4, HCO_3, NH_4, NH_3, NO_2)
- Assessing water pollution with HMs

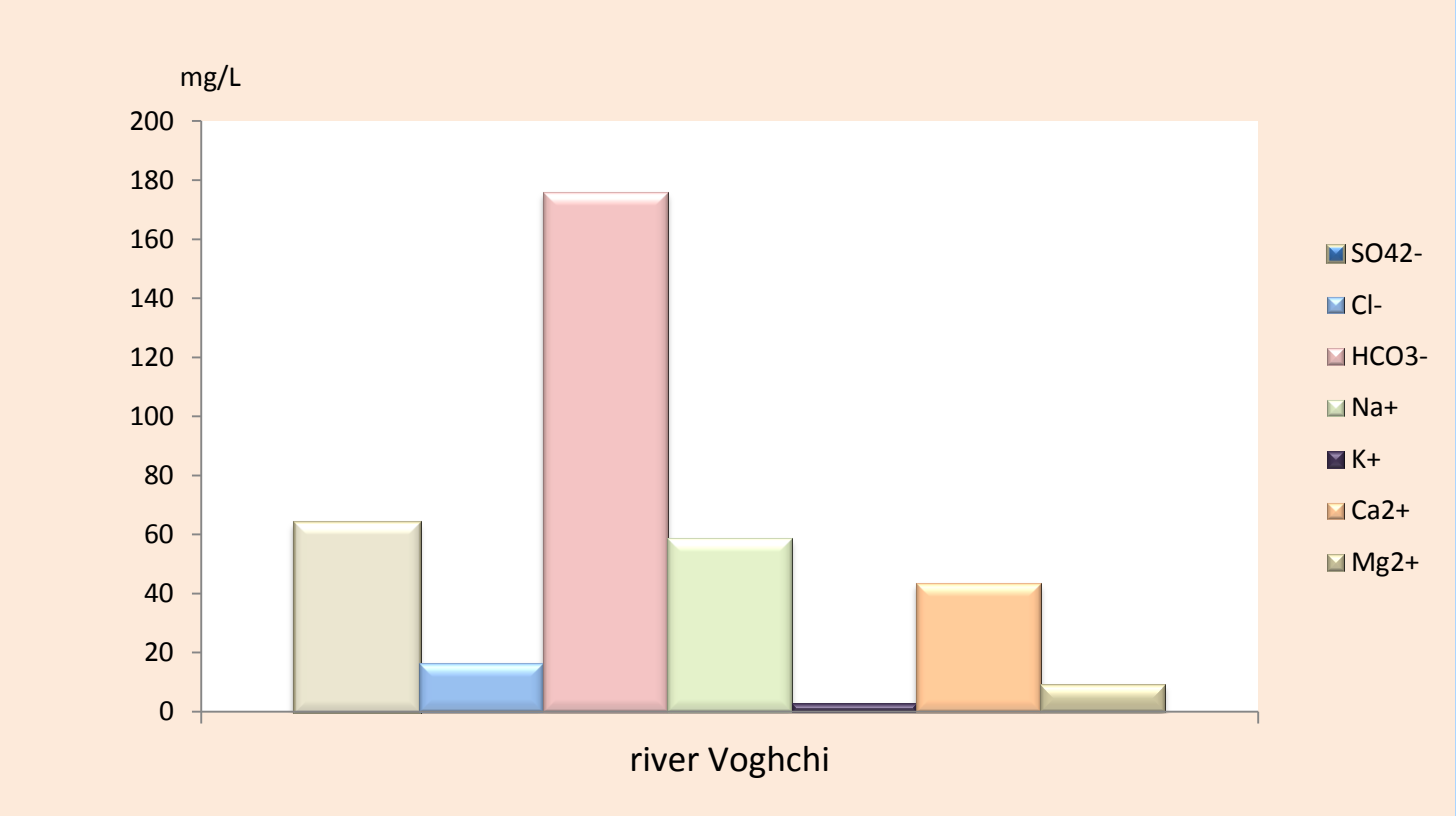
(Cu, Mo, Cr, Ni, Mn, Zn, Co, Cd, Pb, Ag, Hg, As)

- Data collation for 3 period-

I -1988-1995 II-2003-2008 III – 2009-2011

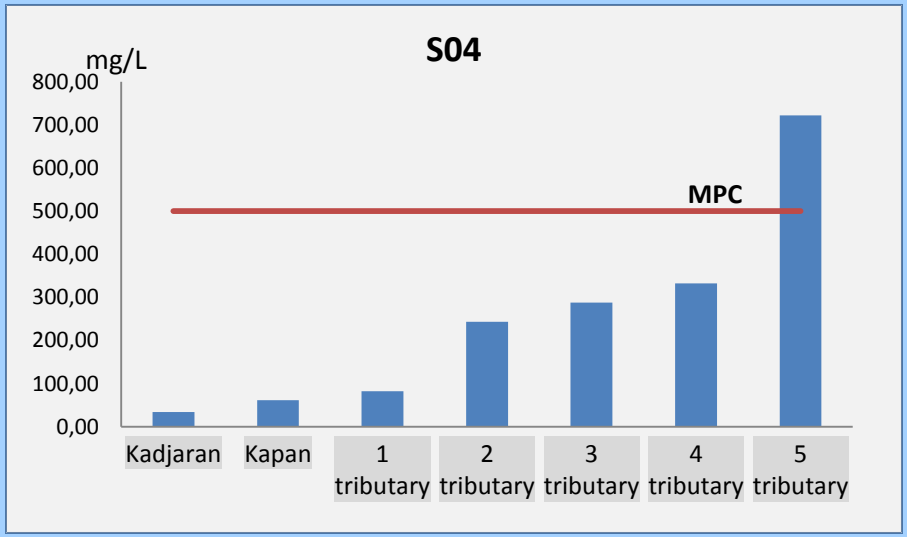
- Statistical data processing
- Determining excessive contents of HMs vs. the background
- Indicating pollution factors

Assessing water quality by basic ions



Contents of basic ions in the River Voghchi waters during 1988-1995

Assessing water quality by basic ions





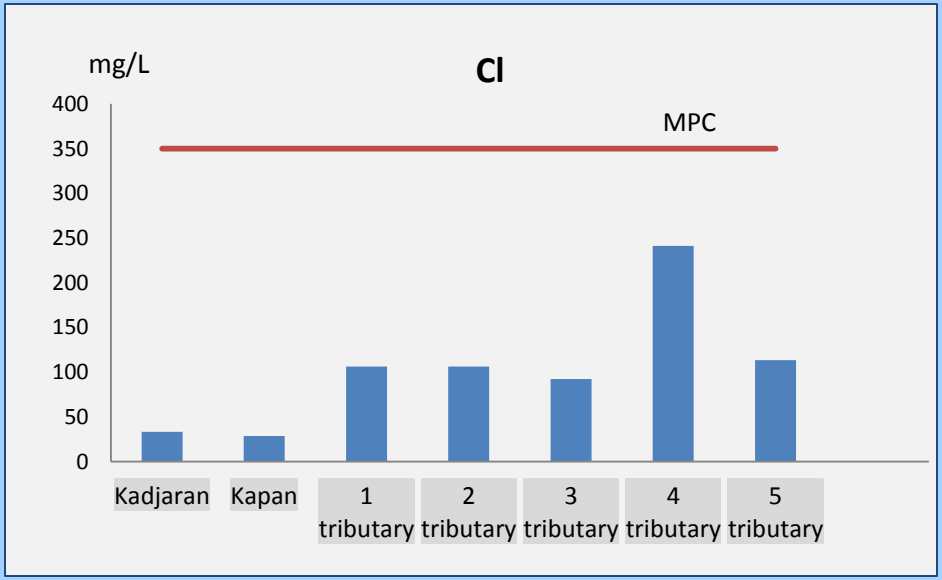
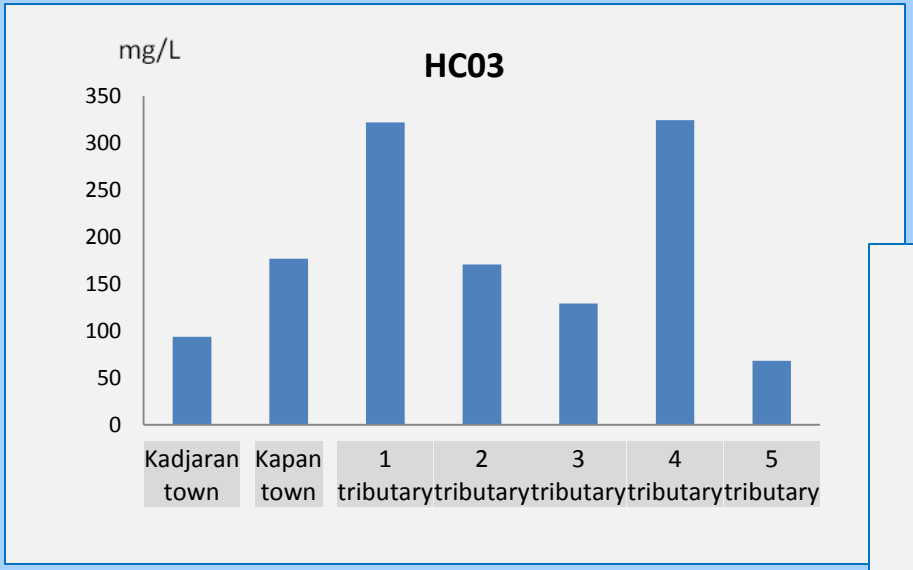
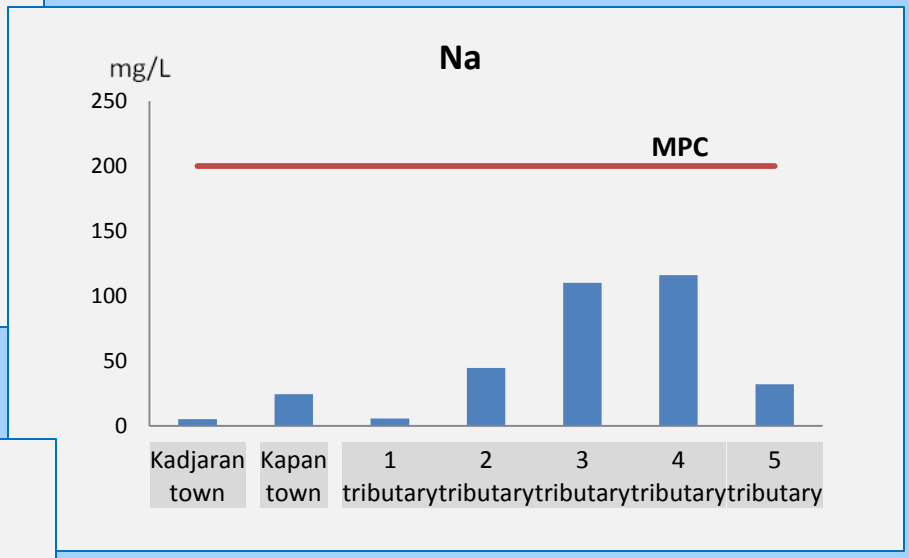


Fig.6. Contents of basic ions in the River Voghchi waters near Kadjaran town, Kapan town and in its tributaries for 2005-2007

Assessing water quality by basic ions





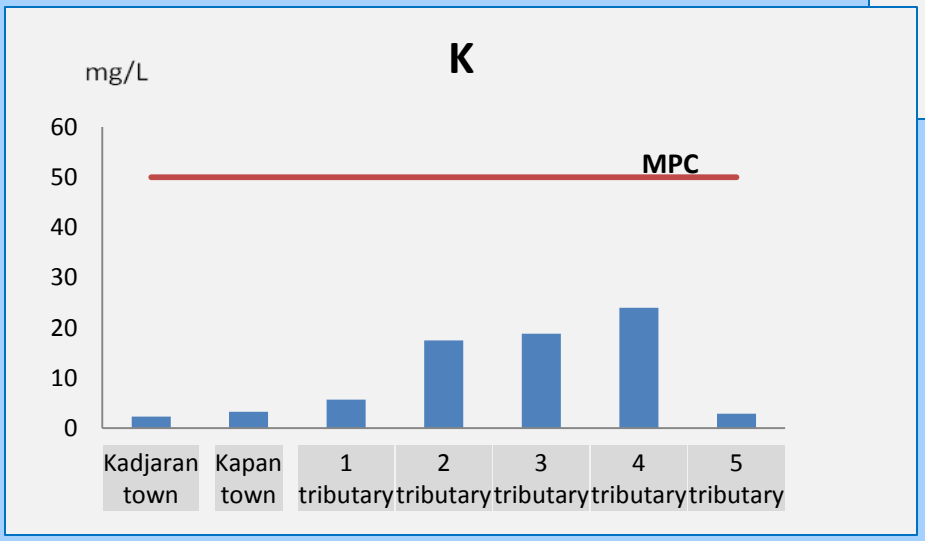
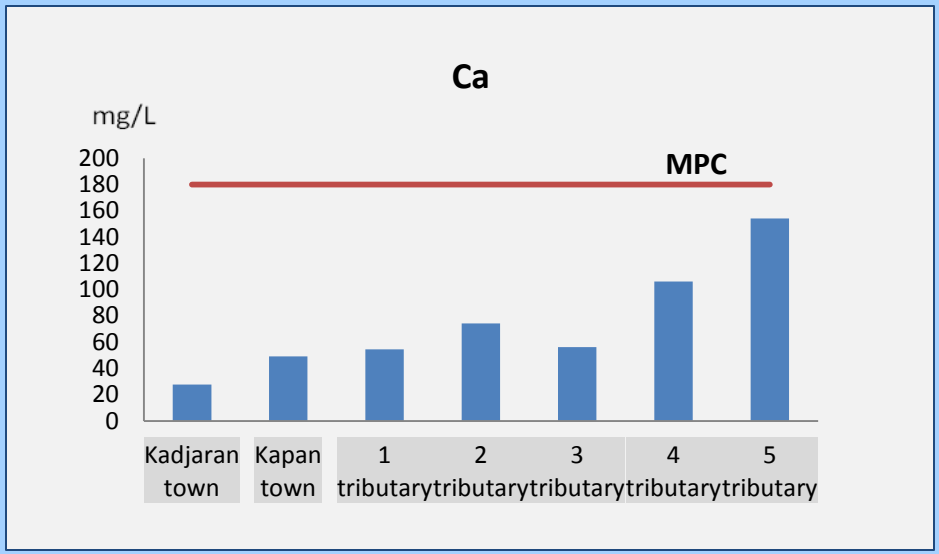


Fig.7. Contents of basic ions in waters of the River Voghchi near Kadjaran town, Kapan town and in tributaries for 2005-2007

Assessing water quality by basic ions



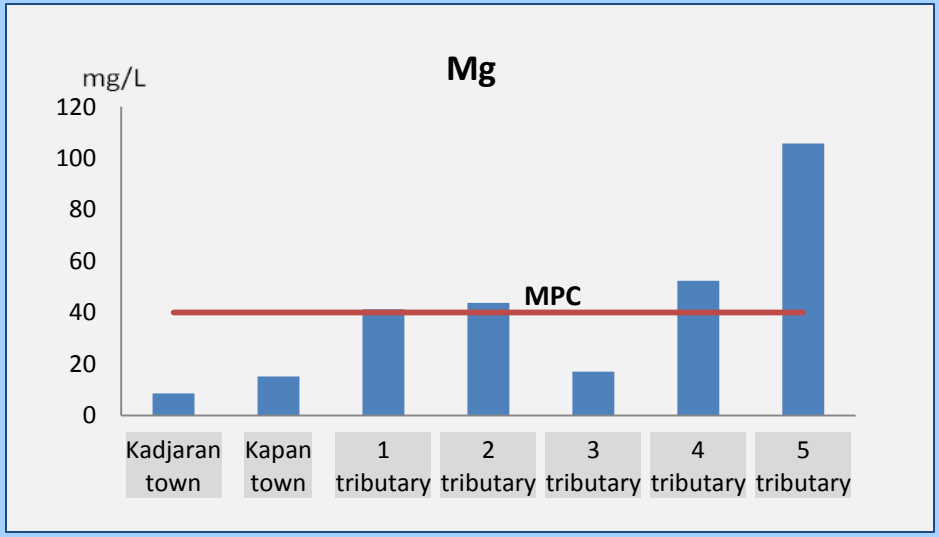
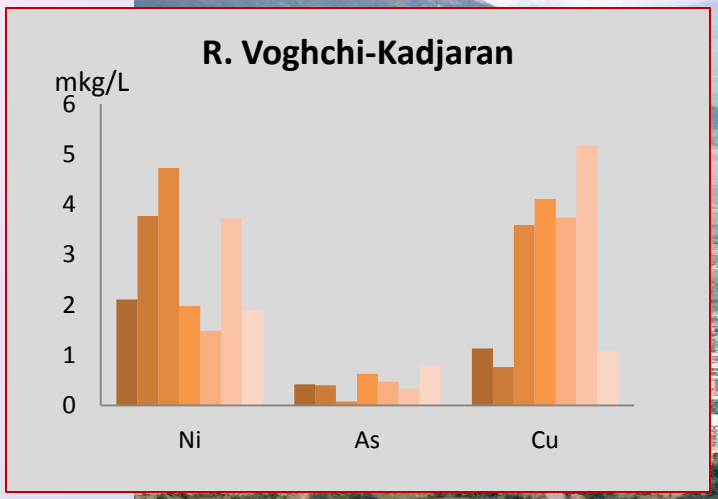
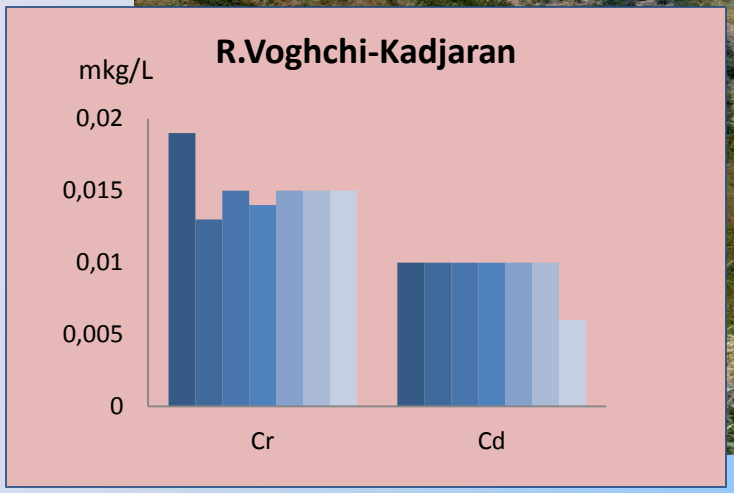




Fig.8. Contents of basic ions in the River Voghchi waters near Kadjaran town, Kapan town and in its tributaries for 2005-2007

Assessing water pollution with HMs





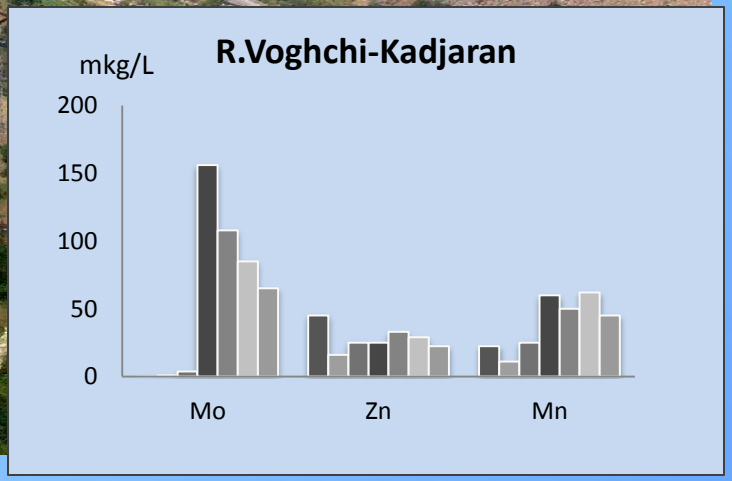


Fig.9. The assessment of pollution of River Voghchi near Kadjaran town with HMs for 2008

Assessing water pollution with HMs

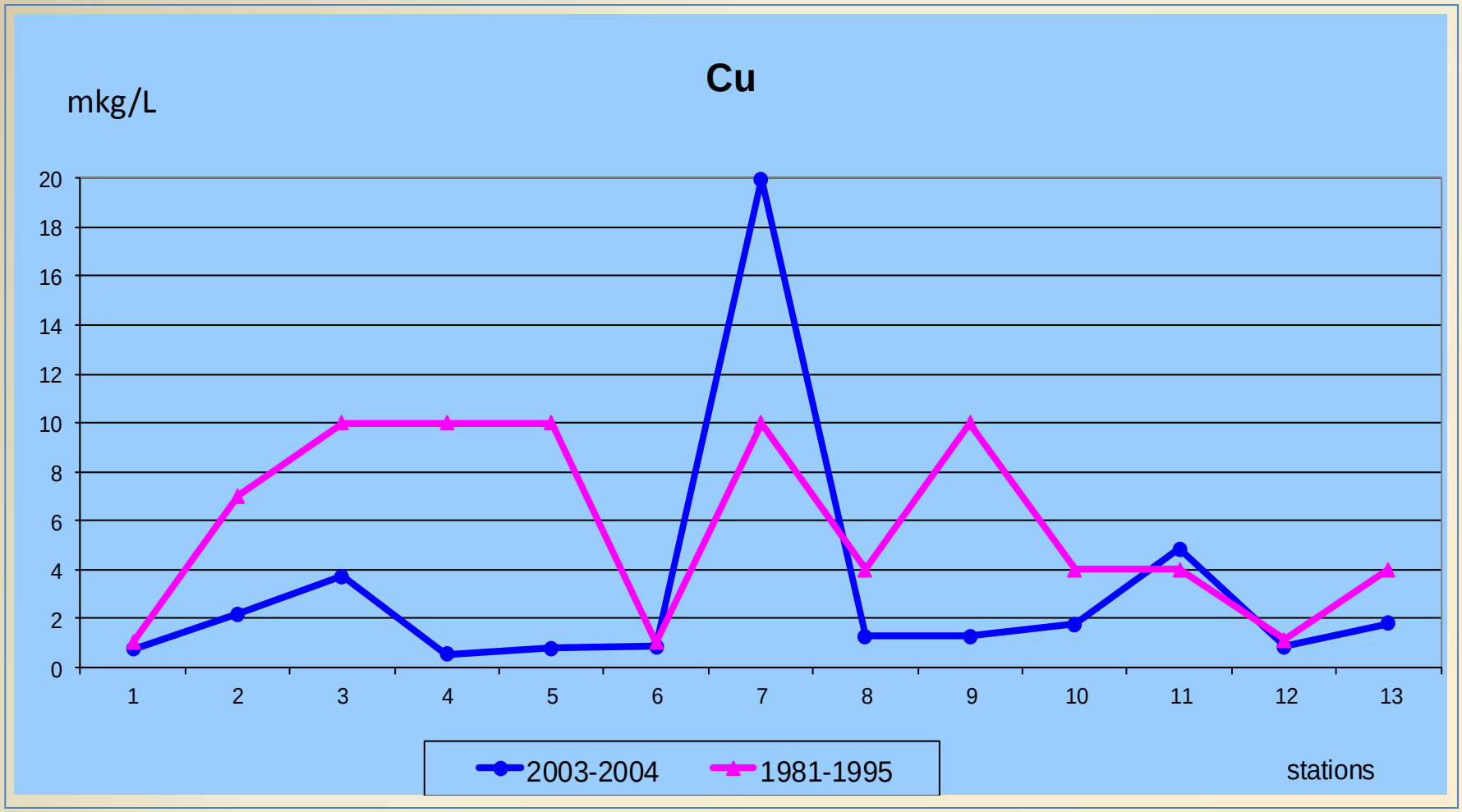


Fig. 10. Contents of copper in river waters at monitoring stations

(station 7 – Voghchi –Kapan)

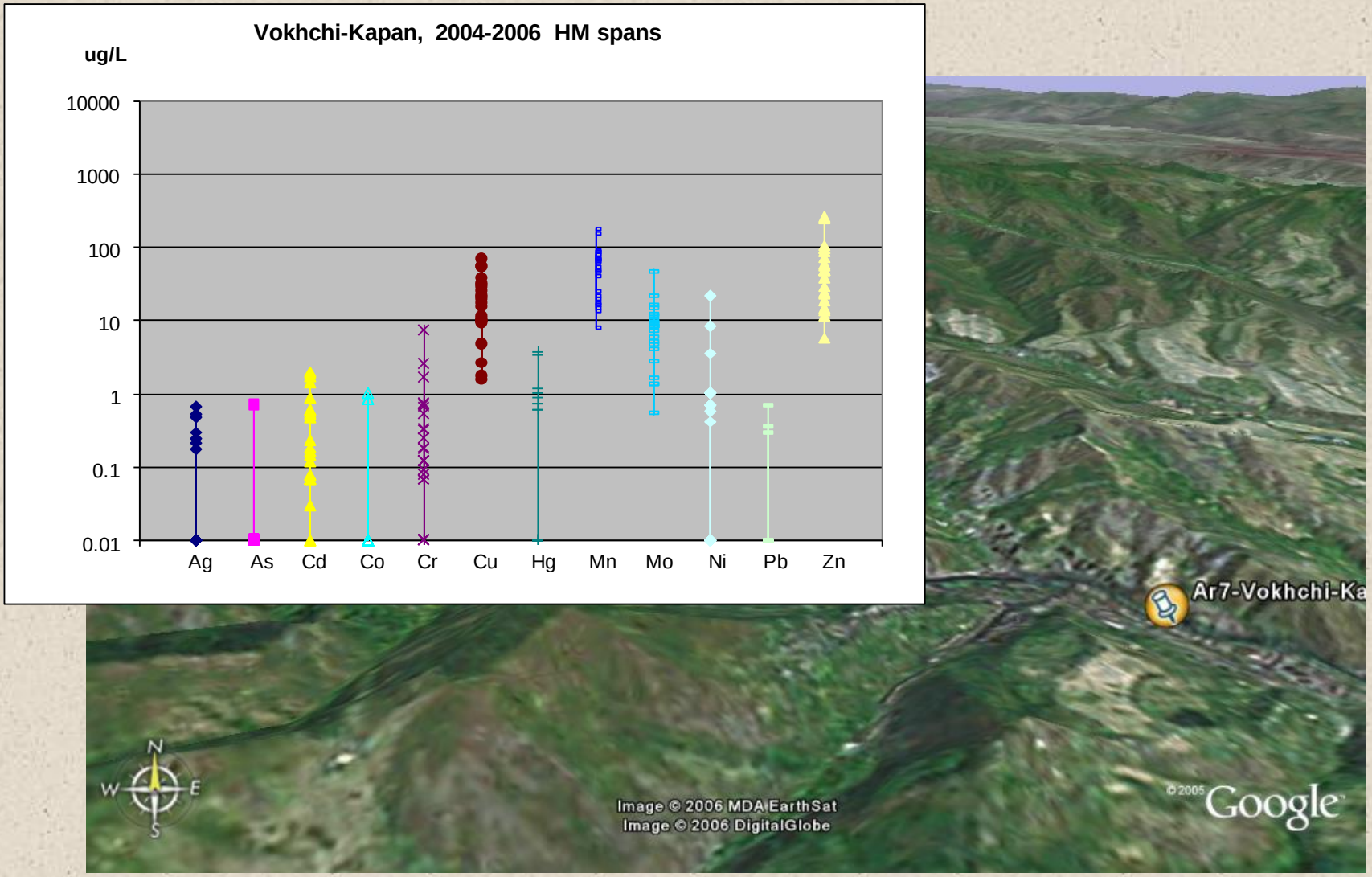
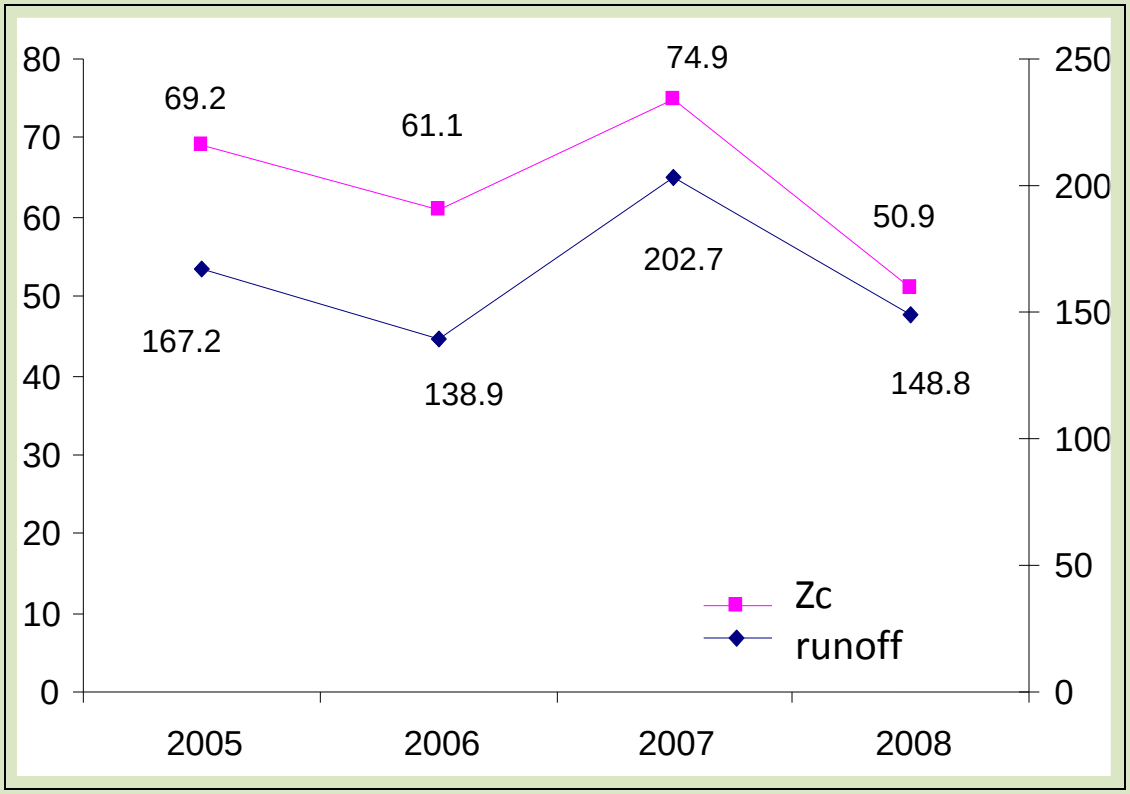


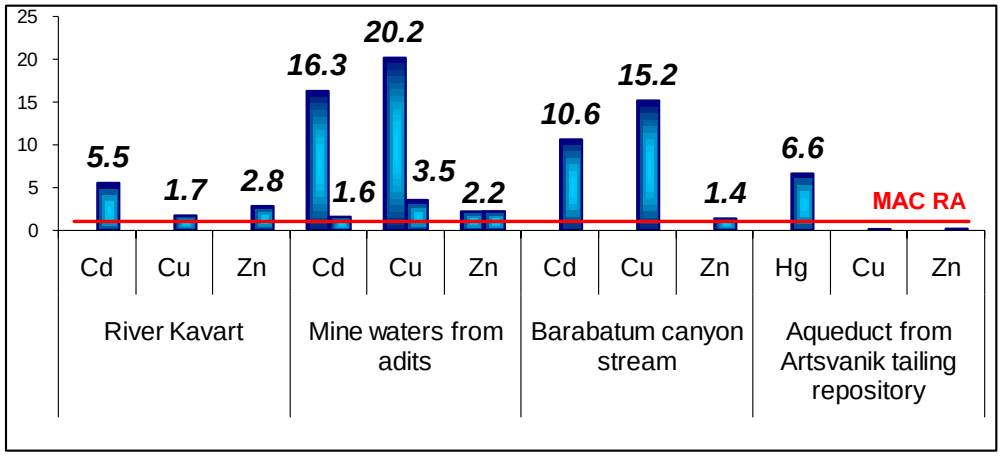
Fig.11. Concentration of HMs in the River Voghchi near Kapan town for 2004-2006



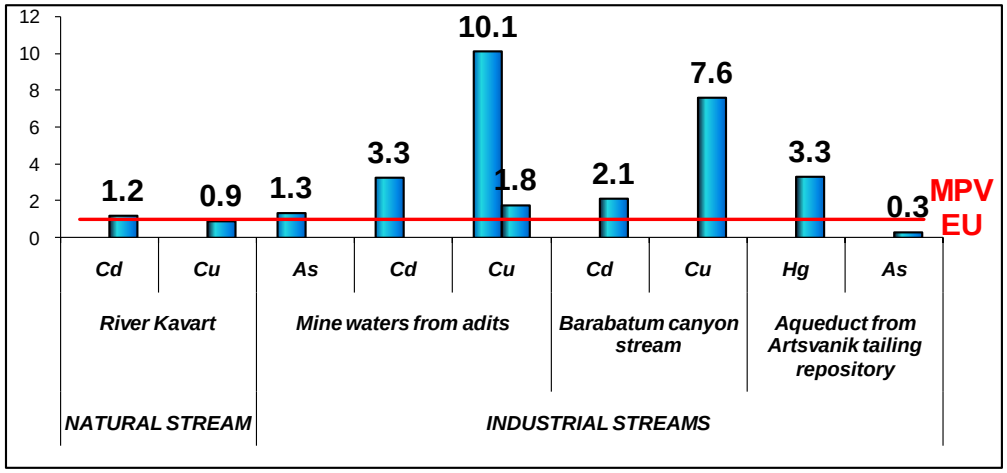
For period of unstable economy the total value of summary concentration index of HMs for the river basins as a whole indicates that the dynamics of its variations positively correlates to that of the value of annual water runoffs from the watershed.

Fig.12. Variations in the value of total summary index of HM concentration (Z_c) and water runoff from the rivers watershed (south part of Armenia) for *2005-2007*

MPC-EXCEEDING VALUES OF HEAVY METALS IN THE SURFACE WATERS OF THE CITY OF KAPAN



Maximum acceptable concentration RA



Maximum permissible values by WHO(2004) Guidelines for Drinking-Water

Fig. 13. The assessment of HMs values in the surface and industrial waters near Kapan town for 2006 (Saghatelyan A.et al, 2007)

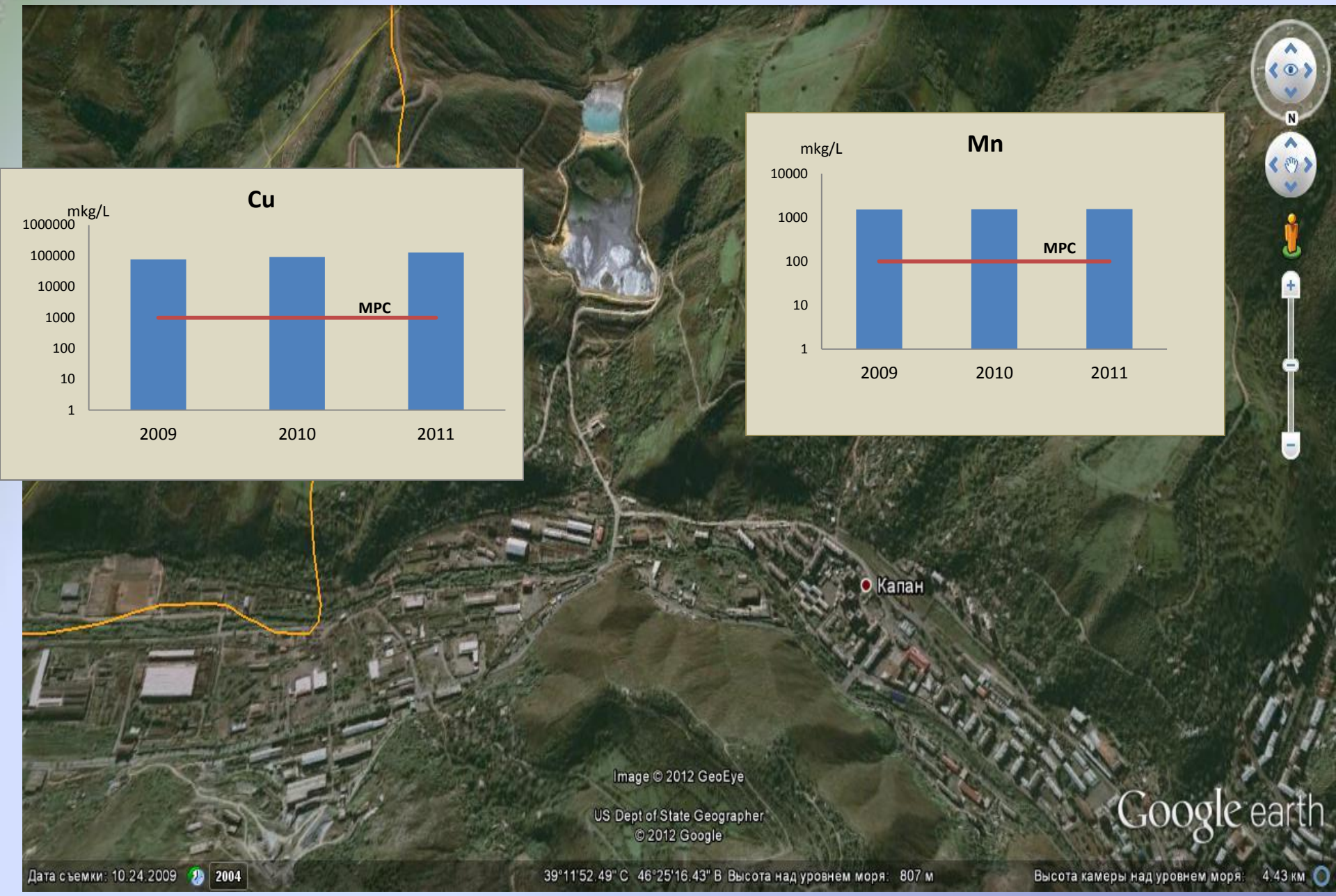


Fig.14. ***Cu*** and ***Mn*** in the River Voghchi near town Kapan in period 2009-2011

(Environmental Impacts Monitoring Center report)

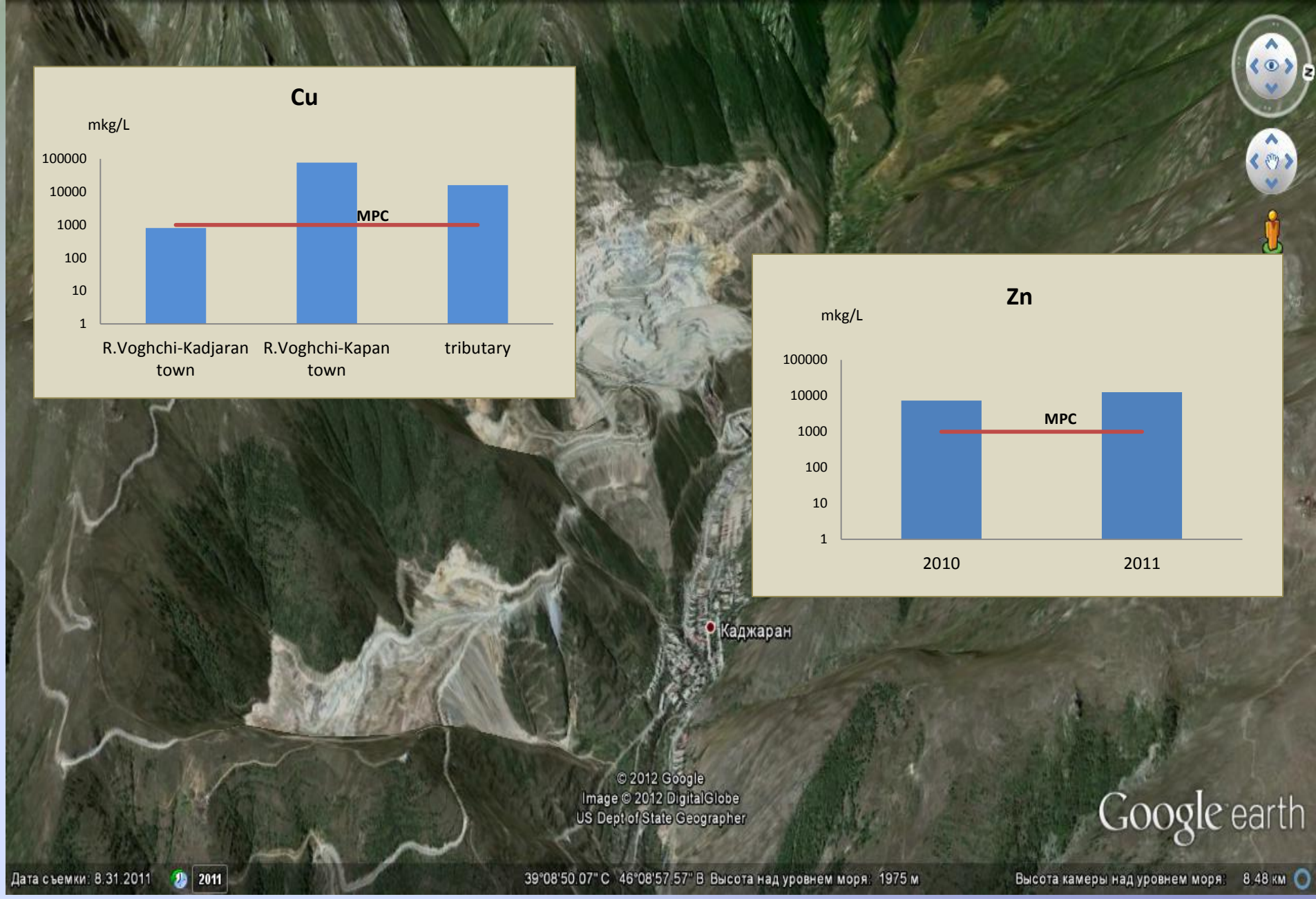


Fig.15. Content of ***Cu*** and ***Zn*** in water of the River Voghchi in period 2009-2011

(Environmental Impacts Monitoring Center report)

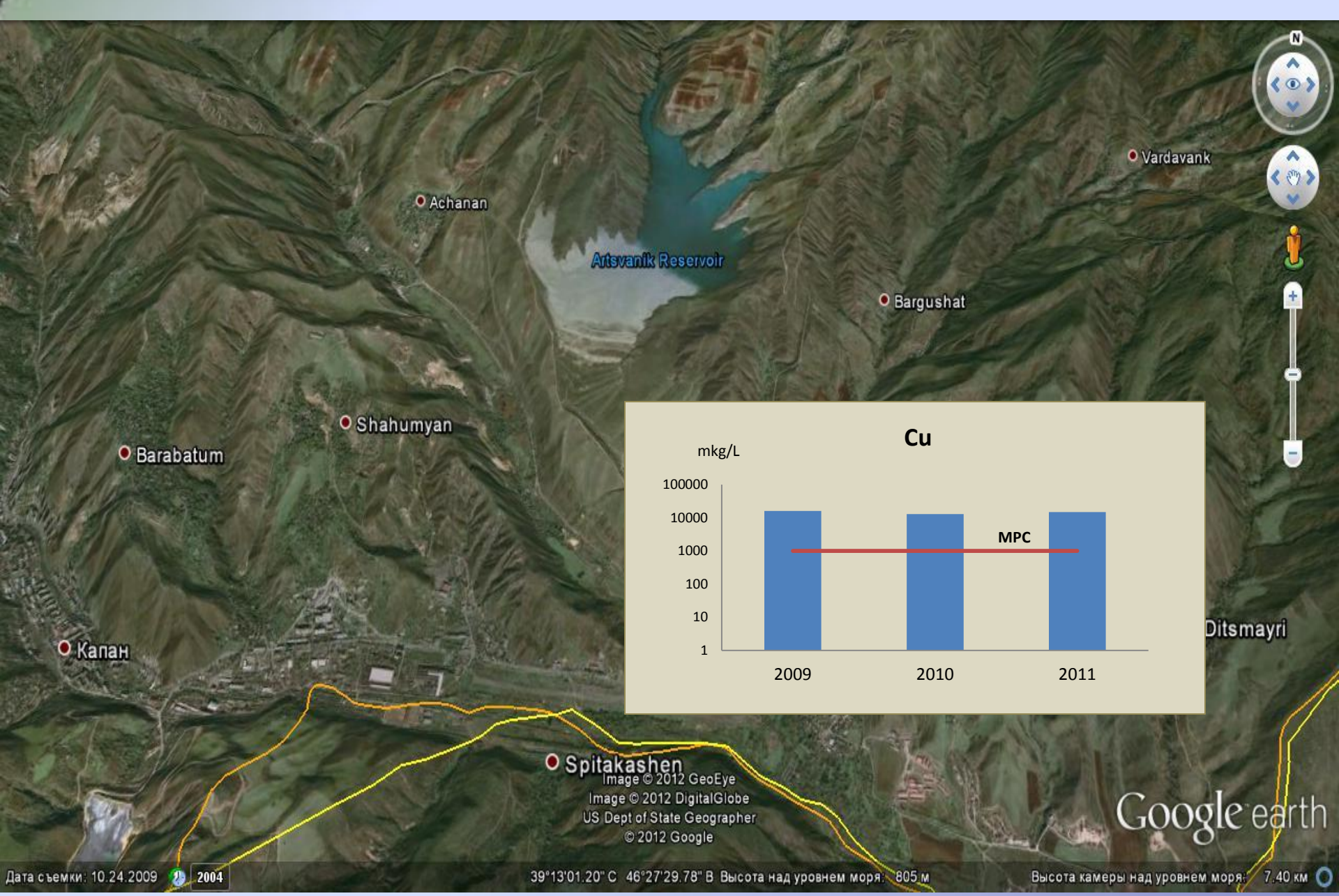


Fig.16. ***Cu*** in water of tributary of the River Voghchi in period 2009-2011

(Environmental Impacts Monitoring Center report)

Statistical data processing

River Araks Basin

River Voghchi

winter

	Valid	Spearman	p-level
Q & Co	11	0.83	0.00
Ec & Salinity	11	0.77	0.01
Salinity & As	9	0.75	0.02
Salinity & Cr	11	0.78	0.00
Salinity & Ni	11	0.79	0.00
Cr & Ni	11	0.75	0.01
Cu & Zn	11	0.78	0.00
Mn & Zn	11	0.79	0.00

spring

	Valid	Spearman	p-level
Eh & Co	11	0.75	0.01
Ec & Salinity	12	0.90	0.00

summer

	Valid	Spearman	t(N-2)	p-level
Q & Salinity	12	-0.75394	-3.62915	0.004619
TDS & T	12	0.72154	3.29551	0.008074
Ec & Salinity	12	0.75262	3.61449	0.004733
Cr & Co	12	0.703041	3.12622	0.010759
Cr & Ni	12	0.765125	3.75773	0.003736
Mn & Zn	12	0.763574	3.73944	0.003850
Ni & Co	12	0.759284	3.68964	0.004179

autumn

	Valid	Spearman	t(N-2)	p-level
TDS & T	12	0.65035	2.70733	0.022034
Ec & Salinity	12	0.75262	3.61449	0.004733
TDS & Cr	12	0.86865	5.54462	0.000246
Mn & Co	12	0.616042	2.47310	0.032930
Mn & Zn	12	0.781087	3.95568	0.002705
Ni & Cr	12	0.631579	2.57603	0.027604

Conclusion

For the period of the USSR collapse low concentrations of HMs and ions were indicated.

For period of unstable economy we can conclude that priority in formation of total geochemical stream of HMs is given to chemical runoff from watershed river basins through both surface and surface-slope washout. Therefore, though point pollution sources exert a local impact, nonetheless in formation of total geochemical stream of HMs in the basin scattered source is dominant, which is manifested in a washout from the watershed.
The concentration of ions in this period were in limits of permissible values, except the Mg.

The period of industry stabilization is characterized by an abrupt increase in pollution of surface waters of the River Voghchi and tributaries, expressed in extremely dangerous exceeding of maximum permissible values for some HMs.
Among the ions high concentrations of sulfate were indicated.



T h a n k y o u