ASSESSMENT THE PB, CU AND CD DEPOSITION AT SOUTHERN BYPASS ROADSIDE SOIL IN DAMASCUS-SYRIA

MUNEER BASHEER AYOUB
Dept. of Environmental Sciences, Faculty of Science, University of Zakho, Kurdistan Region-Iraq
(Accepted for publication: June 9, 2013)

ABSTRACT

Contamination of heavy metals represents one of the most pressing threats to water and soil resources as well as human health, and the Assessment the Pb, Cu and Cd deposition was studied by analyzing soil samples, where have been collected from one site located near the Damascus Homs highway in Damascus-Syria (Southern Bypass road), Sampling plots were marked in each area at 5, 10,15,20,25,30,35,40,45 , 50 and 100 meters distance from the road, Three soil samples were taken from each distance in all selected sites, and all samples were analyzed first for soil texture, organic matter and pH then the samples have been digested and analyzed by atomic absorption spectrophotometer for total metal concentrations. The results indicated that soils of study area were clay loamy and it was basic in nature. Where total soil Pb, Cu, and Cd concentrations varied from 62.56, 13.55 and 2.11 To 0.021, 0.12 and 0.00 mg kg^{-1} respectively. The highest heavy metals concentration was found at a distance of 5 meters from the road, and contents of metals tended to decrease with increasing distance from the highway, where the lowest concentration at 100 meter. The results showed that the soil near the highway had significant enrichment, particularly in Pb, and to a lesser extent with Cu and Cd.

Dependence on the obtained results of heavy metals, the more we move away from the side of road, the fewer ratios of heavy metals will be obtained, and therefore safer distance for growing crops.

***Key words**:* Heavy metal, Clay loam, Roadside, Contamination

INTRODUCTION

Heavy metals are present in soils as natural components and due to the anthropogenic such as mining and smelting of metal ores, industrial emissions, applications of insecticides and fertilizers, traffic and domestic heating, all of that contaminated soils, water and air with large quantities of the toxic metals and contributed to elevated levels of heavy metals in the environment. Heavy metals are one of the most significant environmental problems, which is likely to become more serious and more widespread in the relative near future. They are harmful to humans, animals and tend to bioaccumulate in the food chain (Alloway, 1994). The threat that heavy metals pose to human and animal health is aggravated by their long-term persistence in the environment. Several technologies are available to remediate soils that are contaminated by heavy metals. However, many of these technologies are costly (e.g. excavation of contaminated material and chemical/physical treatment) or do not achieve a long-term nor aesthetic solution (Cao et al., 2002) and (Mulligan et al., 2001).Plant metal uptake is influenced by soil factors including pH, organic matter, texture and structure, and cation exchange capacity as well as plant species, cultivars and age. The mobility and availability of most heavy metals in the soil are generally low, especially when the soil is high in pH, clay and organic matter (Jung and Thornton, 1996) and (Rosselli et al., 2003). And High soil pH can stabilize soil toxic elements, resulting in decreased leaching effects of the soils toxic elements (Liu *et al*., 2005). In Syria, The main sources of heavy metals (Cu, Pb, Cr, Cd and Zn) in the air are traffic, domestic heating and long-range transport, In Damascus there are about 49% of the total registered vehicles, and the cars are powered by gasoline of 80% and operating 20% on diesel (Where the total number of tourist vehicles in diameter 227,639 Car 112,666 in the city of Damascus) ,This Southern Bypass road is the most intensive traffic road in Damascus with daily traffic volumes ranging from <10,000 to 20,000 vehicles per day and the amount of various pollutants released is about 64,310,168 tons Annual by transport recorded (170 584 car) In Damascus. and Pollutants emitted into the atmosphere from mobile sources comprise about 70% of all pollutants (Naes,2008).Although heavy metals constitute an insignificant portion among transport pollutants, they play a potential role in assessing the quality of the roadside environment, It is determined that plants near roads in Damascus accumulate heavy metals, mostly Pb, also Cr, Ni, Cd, Sr as well as Ti, Fe, Co, Cu, Zn and Zr . The existence of heavy metals in soils is a big environmental problem,

this could have long-term implications for the biological, chemical and physical properties of agricultural and forest soil and its fertility as well as productivity (Nicholson f.A et al.,2003). The heavy metals Cr, Cd, Pb, Ni, Cu,Zn take part in the biological turnover and their excess or lack of disturbance of the metabolism and inhibited vegetation (Adomaitis T et al.,2003).
Because of toxic metals, Pb and Cd appear to be the most dangerous to the environment; we aimed to do this research with the following overall objectives:
1) investigation of soil contamination of the studied site by Pb, Cu, Cd and accumulation of heavy metals depending on different distances from the Southern Bypass high road.
2) Determine the safety distance for cultivating crops near roadsides.

MATERIAL AND METHODS

Study Site and Sampling

Soil samples were collected at 20-08-2011from one site of roadside, at the south side of southern bypass (20 m width) at Al-Midan suburb, Al-Zahera district (33°29'30.65"N, 36°18'26.10"E)and also called the sixth cross-road on Damascus-Homs high way.

Figure 1 - Study site

The places (Distances) were chosen similar in geomorphology, habitat. Sampling plots were marked in each area at 5, 10,15,20,25,30,35,40,45 , 50 and 100 meters distance from the road.
Three soil samples were taken from each distance in all selected sites and analyzed independently; each soil sample consists of about 3 sub-samples collected from the sampling plot.
At each distance surface soil sample (10 cm) was taken using a stainless steel hand trowel, which was cleaned between samples to avoid cross-contamination (I. Grigalavičienė et al.,2004).
In total, 33 soil samples were collected.

Chemical Analyses

Soil samples air dried at laboratory temperature ,then grinding by porcelain (Ceramic) tool and sieving with sieve 2mm in order to separate soil particles (Joonki *et al*.,2006).
The Walkley-Black procedure is used for determination of organic matter because it is simple, rapid, and has minimal equipment needs (Nelson and Sommers, 1996).
Particle size distribution was analyzed following sieve method- sieve analysis involves a nested column of sieves with wire mesh cloth (screen), weighed sample is poured into the top sieve which has the largest screen openings. Each lower sieve in the column has smaller openings than the one above. At the base is a round pan,

called the receiver. The column is typically placed in a mechanical shaker. The shaker shakes the column, usually for some fixed amount of time. After the shaking is complete the material on each sieve is weighed. The weight of the sample of each sieve is then divided by the total weight to give a percentage retained on each sieve (ASTM,2006), and depending on these percentages and USDA texture triangle, the texture of soil samples was determined. Soil pH was measured by portable pH-Meter.

The soil samples were digested using the hot-block digestion procedure. Briefly, 10 mL HNO3 is added to 1 g sample in the hot block tube 50 ml, Place in the hot block and heat at an internal temperature of 95 C° for 15 minute, remove and cool the sample, add 2 mL of water and 3 mL of 30% H_2O_2 ,Cover the vessel with a watch glass return the covered vessel and heat at 95 C° without boiling for two hours, remove and cool the sample. Add 10 HCl mL and return to hot block at 95 C° for 15 minute, remove and cool the sample, Particulates in the digestate should then be removed by filtration, Filter the digestate through Whatman No. 41 filter paper (or equivalent) and collect filtrate in a 100-mL volumetric flask (USEPA Method 3050), total metal concentration were analyzed by a flame atomic adsorption spectrophotometer (Edgell, K.; 1988).

The acceptable values of heavy metals concentrations of (pb, Cd, Cu) in the soil were comprised with Data in the table1:

Table (1)- Concentration of heavy metals in soil (Sezgin et al.,2003)

Heavy metals	Acceptable ($mg.Kg^{-1}$)
Pb	100
Cd	3
Cu	50

The SPSS (Statistic Program for Social Sciences) statistical program package (Release 15.0) was used for statistical analyses of data.

RESULTS

Selected properties of the 10 collected soil samples are listed in Table 2 and each result is the average of three sample results for each site, and Charts for The total amounts of Pb, Cu and Cd are given in Fig.1.

Table (2) soil properties

Property / Distance	Percentage of each type of soil % Clay-sand-silt	Texture	Organic Matter %	pH	Pb $mg\cdot kg^{-1}$	Cd $mg\cdot kg^{-1}$	Cu $mg\cdot kg^{-1}$
5	35- 24- 41	Clay Loamy	2.04	8.14	62.56	2.11	13.55
10	35- 23- 42	Clay Loamy	2.01	8.11	61.66	2.00	12.87
15	35- 24- 41	Clay Loamy	2.04	7.97	53.44	1.88	11.12
20	35- 24- 41	Clay Loamy	2.02	7.95	45.87	1.21	9.22
25	36- 24- 40	Clay Loamy	2.02	7.98	32.87	0.89	7.43
30	36- 24- 40	Clay Loamy	2.02	7.97	26.52	0.66	3.43
35	36- 25- 39	Clay Loamy	2.03	7.96	15.64	0.24	1.99
40	35- 24- 41	Clay Loamy	2.04	7.96	8.89	0.11	1.33
45	35- 24- 41	Clay Loamy	2.00	7.89	8.11	0.098	1.22
50	36- 24- 40	Clay Loamy	2.04	7.86	7.12	0.078	0.98
100	35- 24- 41	Clay Loamy	2.01	7.81	0.021	0.00	0.12

The highest concentrations for all metals were found at a distance of 5 meters from the highway and they tended to decrease with the increasing distance from the highway and the lowest was at a distance 100 meter.

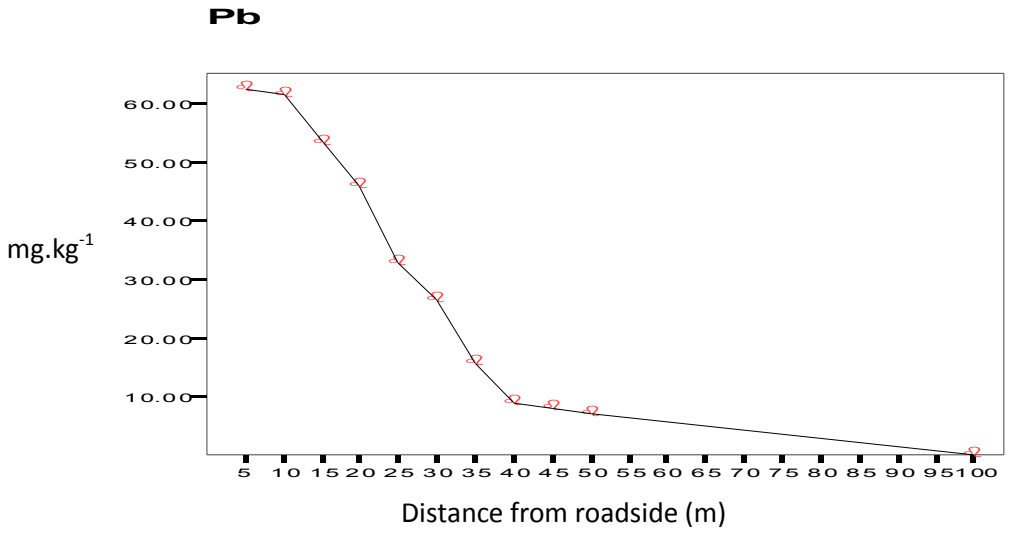
The total concentrations of Pb ranged from 7.12 to 62.56 $mg\cdot kg^{-1}$ for the first 50 meters and it was 0.021 for 100 meter, and at a distance of 5 m the total amount of Pb was 8.78 times higher than the one obtained from road side soils at a distance of 50 m from the highway.

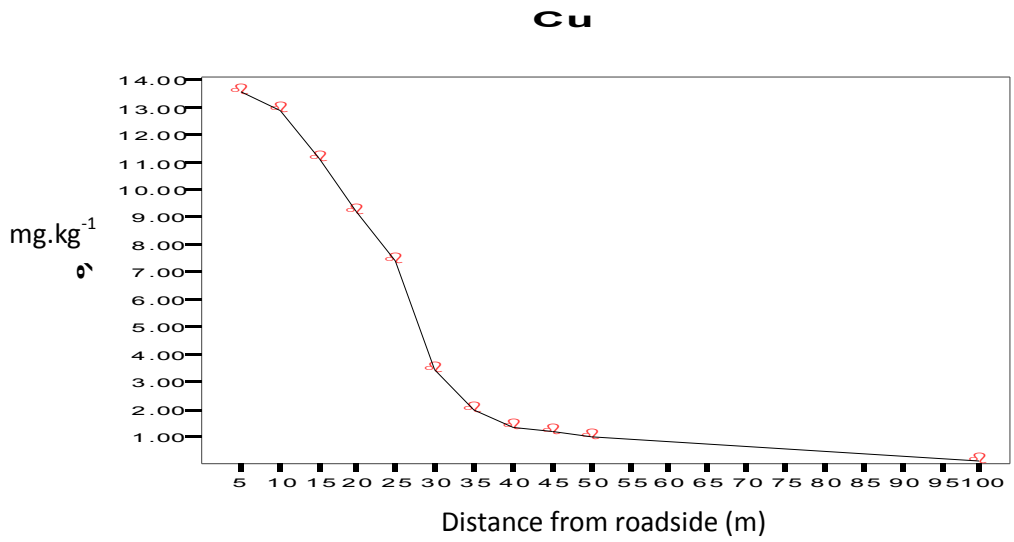
The accumulation of Pb content in roadside soils with the distance from the highway was expressed by following regression equation: $Y = - 0.747 X + 54.798$, $R^2 = 0.702$.

The total content of Cu in roadside soils varied from 0.98 to13.55 $mg\cdot kg^{-1}$ and it was 0.12 for 100 meter.

The highest total Cu concentration was determined at a distance of 5 m from the highway and it was 13.82 times greater than total Cu concentration at a distance of 50 meters.
The increasing distances from the highway total concentration of Cu decreased.
The accumulation of Cu content in soils with the distance from the highway was expressed by following regression equation:
$Y = - 0.158 X + 11.141$, $R^2 = 0.635$.

The total amount of Cd in soils at selected areas ranged from 0.078 to 2.11 $mg \cdot kg^{-1}$ and 0.00 for 100 meter.
The highest total content of Cd was determined at a distance of 5 meters and it was 27 times higher than at a distance of 50 meters from the highway, while with increasing distance from the highway the total content of Cd decreased.
The relationship between the distance from the highway and content of Cd was expressed by the following equation:
$Y = - 0.025 X + 1.691$, $R^2 = 0.609$.





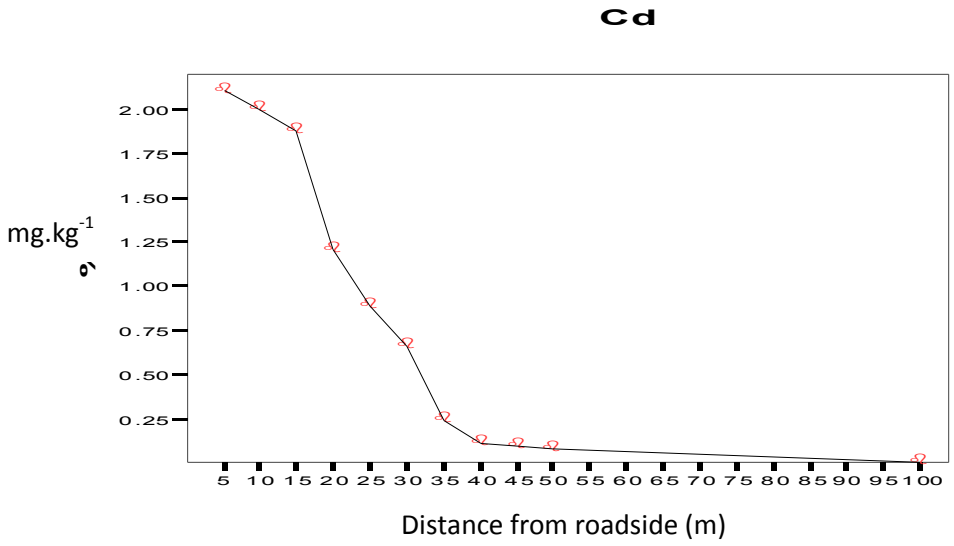


Fig 1 total concentrations of heavy metals at Southern Bypass Road of Damascus

The statistical analysis showed correlations between relative percentage of Heavy metals with the distance from the highway for Pb ,Cu and Cd .
ANOVA showed that there are statistically significant differences among the concentrations of studied heavy metals and the change in the distance, where F value was enough big and sig level was less than 0.05 as in the table 3.

Table (3) - ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Pb	Between Groups	16297.693	10	1629.769	98304.494	.000
	Within Groups	.365	22	.017		
	Total	16298.058	32			
Cu	Between Groups	808.053	10	80.805	4913.535	.000
	Within Groups	.362	22	.016		
	Total	808.415	32			
Cd	Between Groups	20.912	10	2.091	1362.464	.000
	Within Groups	.034	22	.002		
	Total	20.946	32			

Our analysis have indicated that pH of soils varies greatly.
The greatest pH value 8.14, was determined at a distance of 5 m from the highway and, pH value gradually declined with far from the roadside.
Decreasing in pH of soils has not been accompanied by relative increases in percentage value of heavy metals.

DISCUSSION

The studied site (Southern Bypass road) is characterized by high traffic density and duration of stopping and slowing traffic especially in rush hour traffic. This study was conducted on soils samples taken from roadside at distance 5 to 100 meters to determine the heavy metal concentration, the total amounts of heavy metals (Pb, Cd and Cu) in the roadside soils at a distance of 5-10 meters from the road in comparison with a distance 50 and 100 meters are significantly higher and it indicates that the soil near this highway is polluted.
The results of this research showed that the soils near the highway had significant enrichment, particularly in Pb and to a lesser extent with Cu and Cd. The rate of heavy metals contents at the same distance from the road followed the order: Pb > Cu> Cd.
Obtained data of easily mobile amounts of heavy metals in roadside soils indicate that the results depend on many factors such as metal and soil qualities, and distance from the highway.

Soil pH values were the highest close to the highway and in the distance pH value declined possibly because of the impact of flora.

The availability of Pb, Cu and Cd in soil is generally linked with soil pH, texture, and interactions with other nutrients, increased soil pH may also reduce the availability of them to plants through increased adsorption at cation exchange sites.

It is important to evaluate soil pH in order to choose relevant solutions for extraction of heavy metals.

Soil organic matter can either increase or decrease the availability of Pb,Cu and Cd by binding it or increasing its mobility.

All the obtained results were much lower than the certified results for the concentrations of heavy metals in the soil.

Further detailed research is required for more accurate evaluation of the heavy metals accumulation in soils and environmental pollution impact for the quality of roadside soils.

REFERENCES

Adomaitis T., Mažvila J., Eitminavičius l. Acomparative study of heavy metals in the soils of cities and arable lands. Ekologija, Vilnius, 3, 12, 2003.

Alloway BJ. Toxic metals in soil–plant systems. Chichester, UK: John Wiley and Sons; 1994.

ASTM International - Standards Worldwide. (2006). ASTM C136-06.

Cao X, Ma LQ, Chen M, Singh SP, Harris WG. Impacts of phosphate amendments on lead biogeochemistry in a contaminated site. Environ Sci Technol 2002;36:5296–304.

Edgell, K.; USEPA Method Study 37 - SW-846 Method 3050 Acid Digestion of Sediments, Sludges, and Soils. EPA Contract No. 68-03-3254, November 1988.

Grigalavičienė, V. Rutkovienė, V. Marozas. The Accumulation of Heavy Metals Pb, Cu and Cd at Roadside Forest Soil, 2005.

Joonki Y ,Xinde C ,Qixing Z ,Lena Q.Ma: Accumulation of Pb, Cu, and Zn in native plants growing on a contaminated Florida site. Science of the total environment 368:456-464.,2006.

Jung MC, Thornton I. Heavy metal contamination of soils and plants in the vicinity of a lead–zinc mine, Korea. Appl Geochem 1996;11:53–9.

Liu, H., A. Probst, and B. Liao. 2005. Metal contamination of soils and crops affected by the Chenzhou lead/zinc mine spill (Hunan, China). Science of the Total Environment, 339: 153-166.

Mulligan CN, Yong RN, Gibbs BF. Remediation technologies for metal-contaminated soils and groundwater, an evaluation. Eng Geol 2001;60:193–207.

Nelson, D.W. and L.E. Sommers. 1996. Total carbon, organic carbon, and organic matter. In: Methods of Soil Analysis, Part 2, 2nd ed., A.L. Page et al., Ed. Agronomy. 9:961-1010. Am. Soc. of Agron., Inc. Madison, WI.

Nicholson f.A., Smith s.R., Alloway b.J., Carlton-smith c., Chambers B.J. An inventory of heavy metals inputs to agricultural soils in England and Wales. The Science of the Total Environment. 311, (1-3), 205, 2003.

Rosselli W, Keller C, Boschi K. Phytoextraction capacity of trees Growing on metal contaminated soil. Plant Soil 2003;256:265–72.

Sezgin, N., Ozcan, H.,K., Demir, G., Nemlioglu, S & . Bayat, C. 2003. Determination of heavy metal concentrations in street dusts in Istanbul E-5 highway, Environ. Int., 29, 979–985.

Naes H. Air pollution occurring by cars ad traffic in Damascus city, Damascus University, 2008.

تقييم تراكم الرصاص, النحاس والكوبالت في تربة جوانب طريق المتحلق الجنوبي لمدينة دمشق– سوريا

الملخص

يعد التلوث بالمعادن الثقيلة احد أكثر القضايا تأثيراً لموارد المياه والتربة إضافة إلى الصحة البشرية, حيث تم تقييم تراكم الرصاص, النحاس والكوبالت عن طريق تحليل عينات ترابية تم جمعها بالقرب من الطريق السريع دمشق- حمص والمسمى بالمتحلق الجنوبي على الشكل التالي:5,10,15,20,25, 30,35,40,45,50,100 لنحصل على 11 نقطة تحليل, ومن كل نقطة تم اخذ ثلاث عينات .حيث تم تحليل العينات أولا بهدف التعرف على قوام التربة و المادة العضوية ودرجة الحموضة فيها ومن ثم تم هضمها وتحليلها باستخدام المطياف الذري الضوئي لتحديد تراكيز المعادن الثقيلة. أظهرت النتائج أن قوام الترب في منطقة الدراسة كان طينية لومية وذات طبيعة قلوية. أما بالنسبة لتراكيز المعادن الثقيلة فكانت على الشكل التالي: الرصاص (13.55-62.56 ملغ/كغ), (النحاس (0,021- 2,11 ملغ/كغ) والكوبالت (0.00 – 0,12 ملغ/كغ). حيث تم ملاحظة تراكيز مرتفعة على بعد 5 م , وكلما ابتعدنا من الطريق قلت نسب هذه التراكيز, في حين كان التركيز الأقل على بعد 100 م من الطريق.كما ان الترب بالقرب من الطريق كانت بشكل معنوي غنية بالرصاص وبدرجة اقل بالنحاس والكوبالت. وبناءاً عليه فإنه فكلما ابتعدنا عن الطريق تقل نسبة المعاد الثقيلة المتراكمة في التربة وبالتالي مكان أأمن لزراعة المحاصيل.

هەڵسەنگاندنا ڕێژا هەبوونا رساسی و زیڤی و کوبالتی دناڤ ئاخا (متحلق جنوب) ی دەوربەرێ دیمەشقێ – سوریا

پوختە

پیس بوونا ژینگەهێ ب کانزایێن گران ژ بابەتێن کایگەری لسەر ئاڤێ و ئاخێ هەی ، زێدەباری کاریگەرییا وێ لسەر ڕەوشا ساخلەمی یا مروڤان . مە نموونەییێن ڤەکولینێ ژ ئاخا ریکا دناڤبەرا حمص و دیمەشقدا ئەوا دبێژنێ (متحلق جنوب) ی کومکرینە ب ڤی شێوەی : 5,10,15,20,25, 30,35,40,45,50,100 , ژبۆ دەرهێنانا (11) خالێن شروڤەکاری ، و مە ژ هەر هەر خالەکی سێ نموونە وەرگرتینە . پاشی شروڤەکرنا وان نموونان ژبۆ زانینا هیز و ڕێژا وێ ئاخێ و چەوانییا سەردەریکرنا وێ و شروڤەکرنا وێ و دیارکرنا ڕێژا کانزایێن گران دناڤدا ، د ئەنجاماندا هێزا ئاخێ دیار دبیت ل دەڤەرێ کا هەرییە یان ئاساییە و بهێزە ، و ڕێژا هەبوونا کانزان دناڤ ئاخێدا ب ڤی شێوەی بوون رساس (13.55–62.56 ملغ/كغ), (زیڤ 0,021– 2,11 ملغ/كغ) وکوبالت (0.00 – 0,12 ملغ/كغ). ل جهێن بلند ب (5 م) هاتیە تێبینی کرن . چەند مە خو ژ ڕێکێ دویر ئێخستبا ڕێژا هەبوونا کانزان کێم د بوو ، کو ڕێژا کێم ب (100 م) بوو ، ئەڤ ئاخا د ڕێکێدا زۆر ب رساسی یا دەولەمەندە و ب پلەیەکا کێمتر ژ زیڤی و کوبالتی ، ب ڤی شێوەی ئەم چەند خو ژ ڕێکێ دویربێخن دێ ڕێژا هەبوونا کانزایێن دناڤ ئاخێدا کێم بیت ، هەروەسا جهەکی باشە بۆ چاندنێ .