



„OZONE DETECTOR” DO IT YOURSELF

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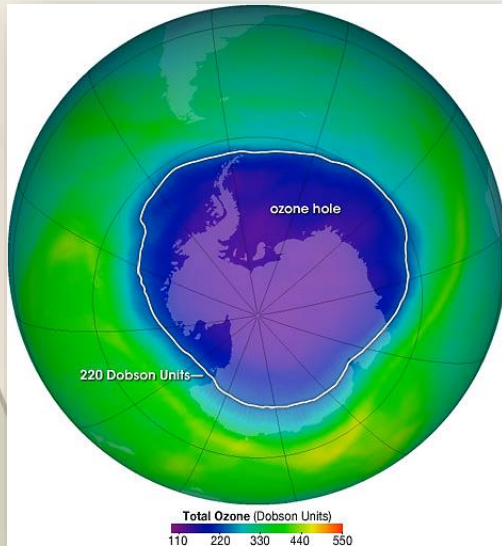
**SECONDARY SCHOOL MATE BLAŽINE LABIN
CROATIA**

INTRODUCTION

What is the role of ozone in the atmosphere?

Although they have the same chemical formula, the role of the two ozones is completely different. Ozone in the stratosphere is called "**good**" ozone because it protects the Earth's surface from dangerous UV-B radiation.

Ozone in the **stratosphere** is broken down by chemical compounds that appear on the Earth's surface by bacteria or humans and creates an „**ozone hole**”.



Tropospheric ozone, known as "**bad**" ozone, is created by human activity. Ozone in the lower layers of the atmosphere is **harmful** and it is necessary to monitor its presence, and how to monitor it exactly is what intrigued us and led to this work.

RESEARCH QUESTION

The GLOBE group of our school regularly monitors meteorological data, and occasionally the amounts of ground-level ozone with the ZIKUA ozone detector, which requires "indicator cards", which we were left without, and the acquisition of new ones requires importation from the USA.

On the Internet, we found an interesting method of making indicators in the form of "strips" that would measure the concentration of ground-level, i.e., "bad" ozone. We were interested in this method because it seemed possible and cheap, so we decided to try to make our own "ozone detector".

The members of the group will measure the ozone in the places where they live with the created "ozone detector", and with that we will cover the area of Labin and check the operation of the "ozone detector" in order to answer the question:

**IS IT POSSIBLE TO PREPARE AN "OZONE DETECTOR,,
IN THE SCHOOL LABORATORY?**

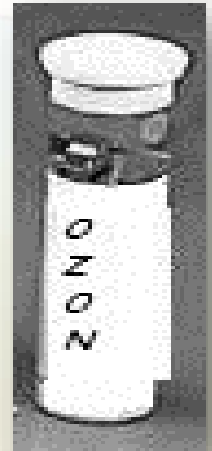
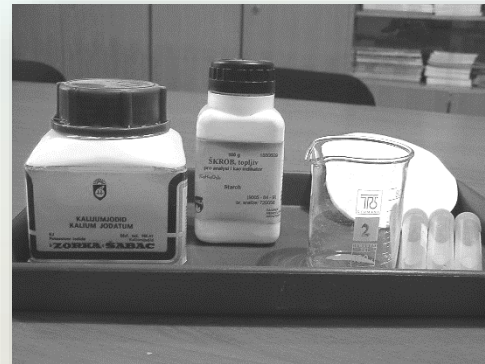
PARTICIPANTS AND WORK STAGES

36 students	WORK STAGES
2 students "leaders"	Idea and work plan
6 students "laboratory work"	Preparation of "ozone detector"
2 students "meteorologists"	Checking the "ozone detector"
2 students "GPS"	Determination of location coordinates
18 students „measuring ozone”	Ozone measurement at 6 locations
4 students "analysts"	Arrangement of data and display of results
2 students "presenters"	Preparation and presentation

RESEARCH METHODS

GLOBE PROTOCOLS USED:

- GPS, determination of location coordinates
- ATMOSPHERIC, determination of air humidity, ozone
- METEOROLOGICAL DATA, globe database



DEVICES: dryer, microwave oven, GPS, ZIKUA ozone detector, digital hygrometer.

ACCESSORIES: filter paper, scissors, ruler, cups, burner, container with cap, spray bottle.

CHEMICALS: starch, potassium iodide, deionized water.

"OZONE DETECTOR" PREPARATION



1. Measure 100 mL of distilled water and put it in a glass.
2. Add 1/4 teaspoon of starch.
3. Heat the mixture while stirring with a glass rod until it thickens and clears.
4. Remove the pan from the stove and add 1/4 tsp. of potassium iodide, with stirring.
5. Allow the solution to cool and thicken into a paste.
6. Place the filter paper on the glass plate, then apply the paste evenly on both sides of the paper with a brush.
7. Place the glass plate in the microwave oven set to maximum power for 60 seconds.
8. Cut the filter paper into 1 x 10 cm strips.
9. Immediately close the strips in a sealed container.
Keep them in a dark place.

COMPARISON OF "OZONE DETECTORS"

a. "ozone detector" exposure

The prepared strips is moistened with deionized water, so it is simultaneously exposed for 8 hours in a shaded place.

We repeated the measurements over seven days for the accuracy of the data.

b. determination of the amount of ozone

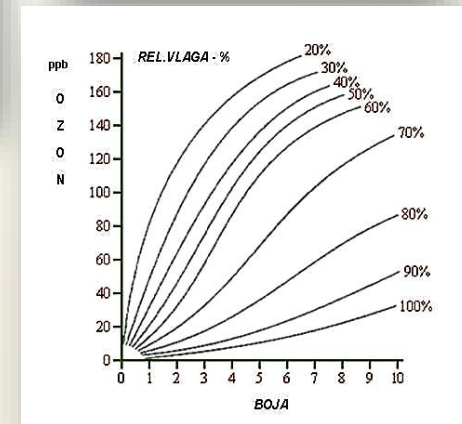
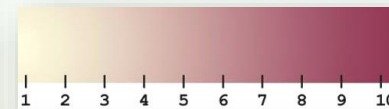
READING ZIKUA™ OZONE READER

The test strip is inserted into the ZIKUA reader and the amount of ozone is read in ppb.



Source : www.ecobadge.com

READING THE PREPARED «OZONE DETECTOR»



Source: www.chemheritage.org

c. the degree of accuracy of the "ozone detector" was calculated by comparing values and expressed in %

HOW TO MEASURE OZONE

The prepared strip is moistened with deionized water and exposed for 8 hours in a shaded place.

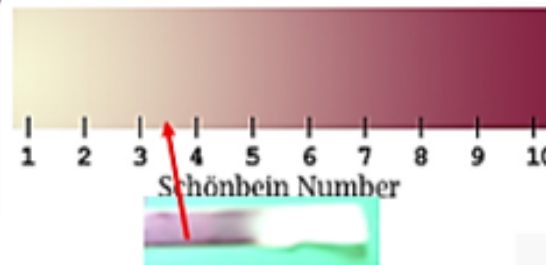
For data accuracy, the measurement is repeated seven days.

1. MEAN VALUE OF RELATIVE HUMIDITY IN THE AIR

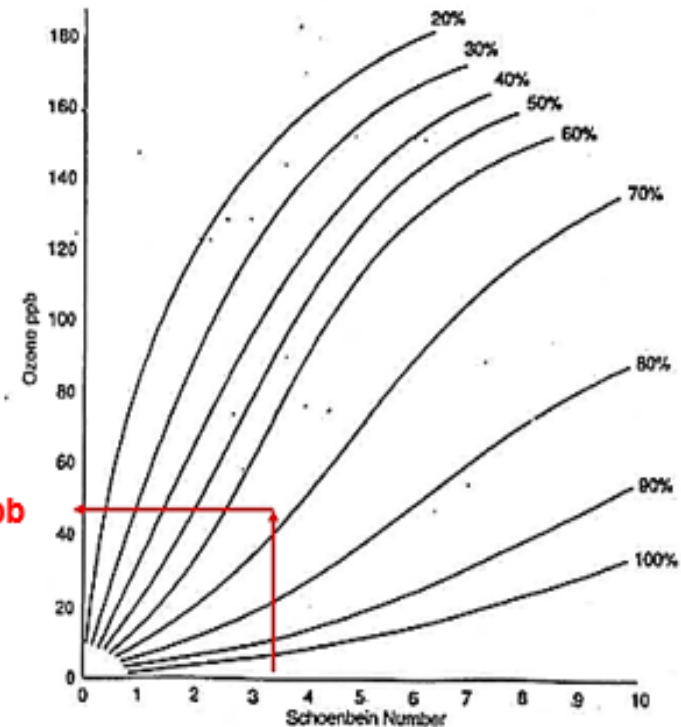
DATE AND TIME	% HUMIDITY
20.11. 7:00	65
20.11. 8:00	65
20.11. 9:00	68
20.11. 10:00	69
20.11. 11:00	69
20.11. 12:00	69
20.11. 13:00	70
20.11. 14:00	70
20.11. 15:00	72
MEAN VALUE	69

$$1 \text{ ppb} = 1.96 \mu\text{g m}^{-3}$$

2. READING THE NUMBER ACCORDING TO THE COLOR ON THE STRIP AFTER EIGHT HOUR EXPOSURE



47 ppb



3. OZONE CONCENTRATION READING

RESULTS

"OZONE DETECTOR" CHECK

Table 1. Comparison of mean values of tropospheric ozone measured by ZIKUA OZONE METER and "OZONE DETECTOR".

DAY	AVERAGE OZONE VALUE ppb ZIKUA OZONOMETER	AVERAGE OZONE VALUE ppb "OZONE DETECTOR"	DEVIATION %
1.	52	58	11,5
2.	50	56	12,1
3.	51	56	9,8
4.	45	50	11,1
5.	40	44	10,0
6.	47	52	10,6
7.	50	55	10,0
MEAN VALUE OF DEVIATION			10,7 ≈ 11

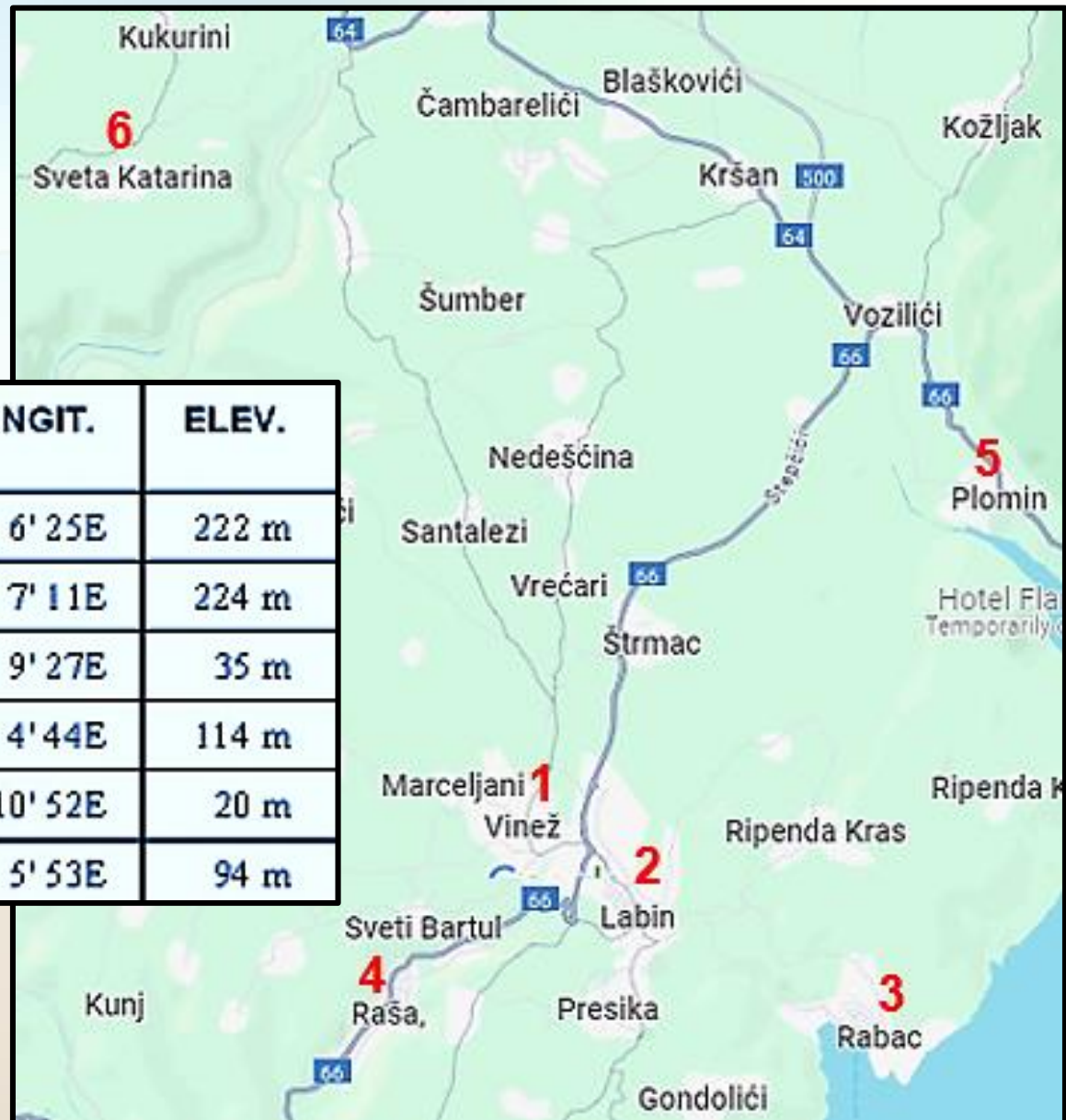
The results show that our "ozone detector" shows more values, which is caused by evaluating the color on the scale and reading the value on the diagram.

The deviation of the "ozone detector" did not discourage us because we are aware of the subjectivity of the method, which is often present even in expensive KIT such as those for determining the pH value, nitrates in water, etc.

OZONE MEASUREMENT AT LABIN AREA

The work covers
six localities
in the area of Labin.

LOCATIONS	LATITUDE	LONGIT.	ELEV.
1.VINEŽ	45° 5' 53N	14° 6' 25E	222 m
2.LABIN	45° 5' 42N	14° 7' 11E	224 m
3.RABAC	45° 4' 46N	14° 9' 27E	35 m
4.RAŠA	45° 4' 49N	14° 4' 44E	114 m
5.PLOMIN	45° 8' 12N	14° 10' 52E	20 m
6.KATARINA	45° 11' 20N	14° 5' 53E	94 m



OZONE CONTROL

Unlike the Montreal Protocol, which protects "good" ozone, there is no global agreement that protects us from the effects of "bad" ozone. However, many countries include surface ozone as part of their air quality standards and clean air regulations, such as limiting and regulating emissions from industry, power plants, and vehicles, and measures to limit emissions of hydrocarbons such as organic solvents and unburned vehicle fuels.



On the basis of Article 30, paragraphs 1 and 2 of the Air Protection Act (Official Gazette, No. 178/2004), the Government of the Republic of Croatia, at its session held on November 3, 2005, adopted

REGULATION ON OZONE IN THE AIR.



Recommended values of air quality (PV)

as the value below which the impact on human health and vegetation is not expected or when the permanent exposure.

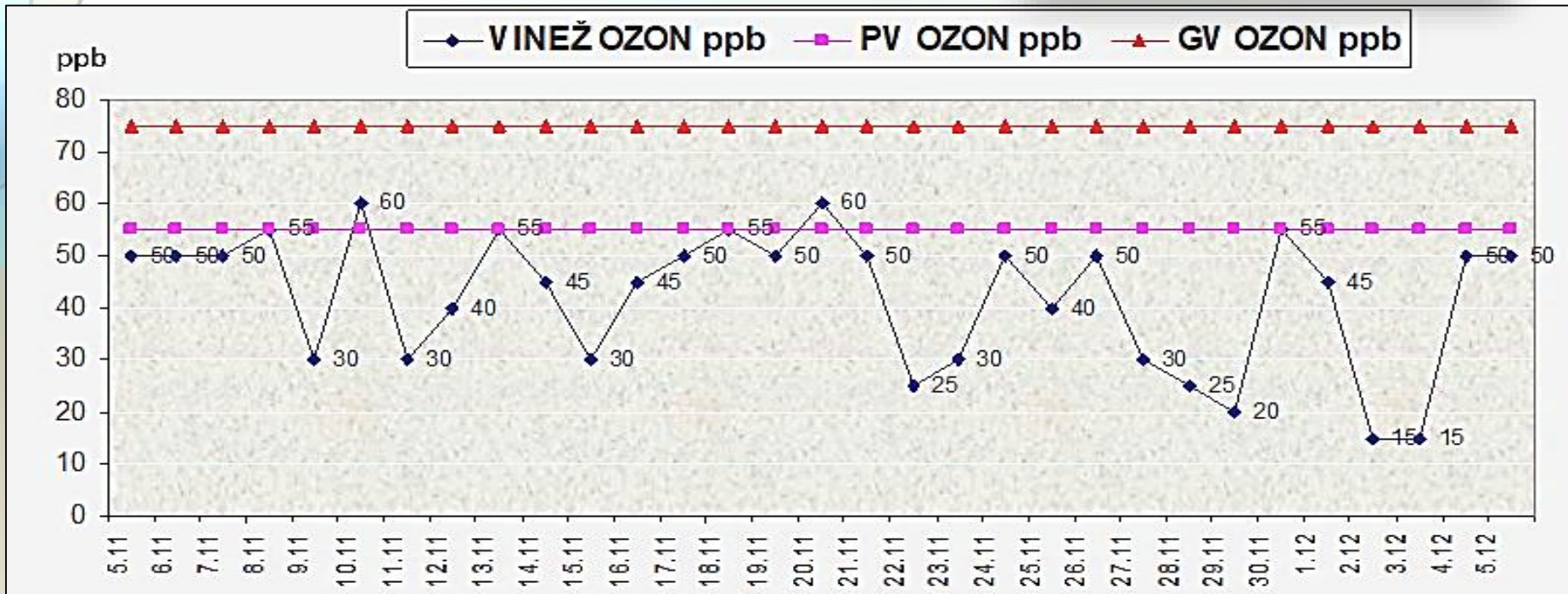
Air Quality Limit Values (LV)

as the value below which no adverse effects expected in healthy people, but the long-term impact of exposure to risk their possible impact on vulnerable groups.

PV	LV (GV)
120 $\mu\text{g}/\text{m}^3$ (55 ppb)	160 $\mu\text{g}/\text{m}^3$ (75 ppb)
Should not be exceeded more than 25 days per calendar year.	Must not be exceeded more than 25 days per calendar year.

1. VINEŽ

Rural village with about 1000 inhabitants, relief opened in the vicinity of which is the industrial zone.

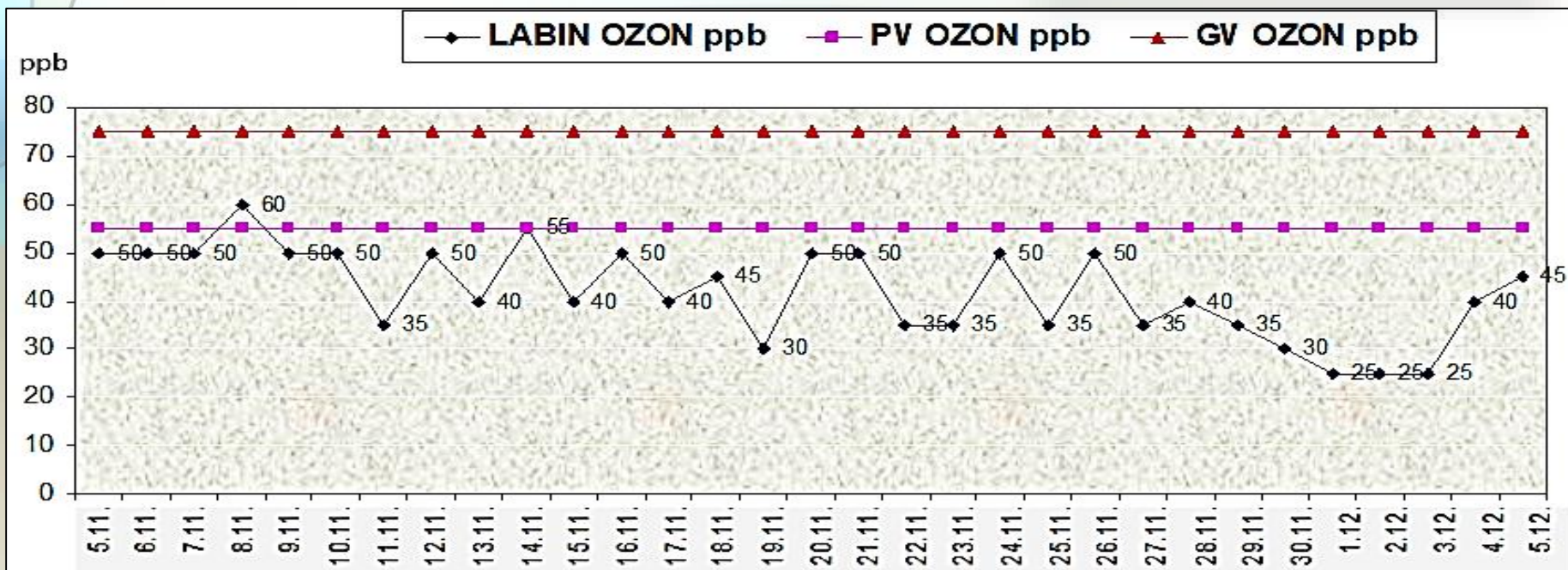


Graph 1. Mean values of ozone - VINEŽ

From the 1st graph shows that the PV exceeded only twice so it can be concluded that the impact of the industrial zone negligible, which probably helps relief openness location.

2. LABIN

City with 12,500 residents,
relief is open,
with no major industrial facilities.

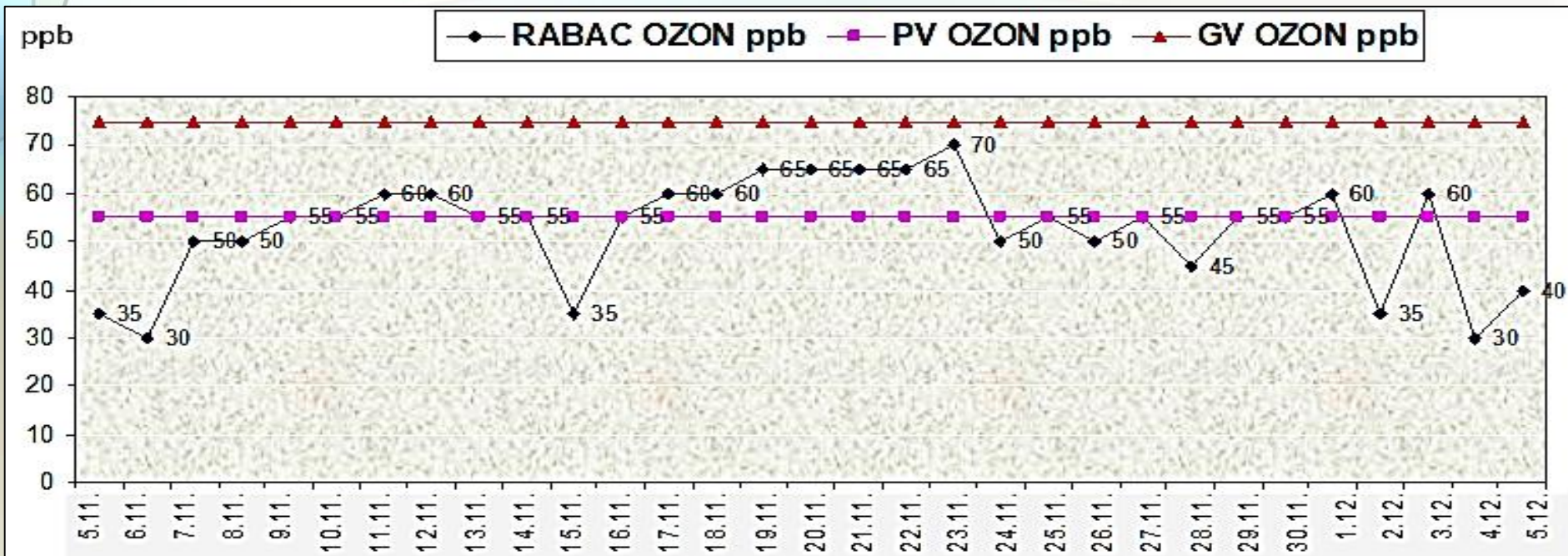


Graph 2. Mean values of ozone – LABIN

2th graf shows that the PV exceeded only once through the measuring period, which corresponds to the expectations with respect to good relief openness.

3. RABAC

Tourist town on the coast, with about 1500 inhabitants, relief open to the sea near which there are no major industrial facilities.

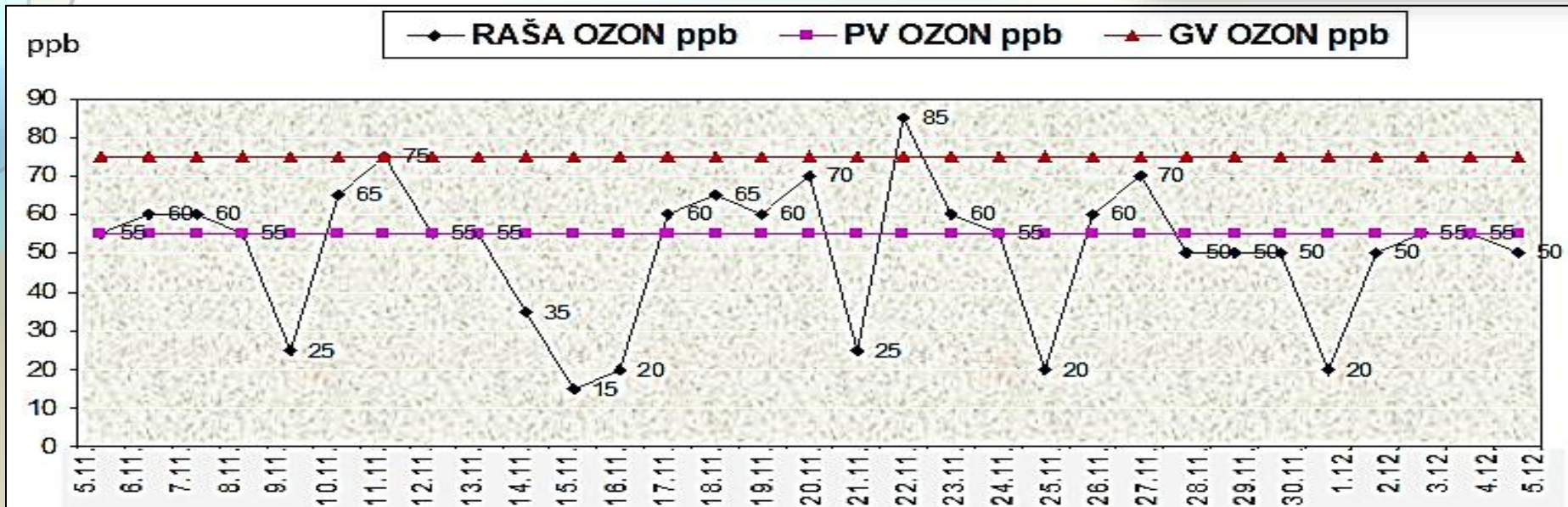


Graph 3. Mean values of ozone - RABAC

From the 3th graph seen that the PV often exceeded what we think is expected given the position of the location by the sea is full of pine trees.

4. RAŠA

Old mining village with 2000 inhabitants, relief closed, near which there are factories:
LIME FACTORY MOST RAŠA and **CEMENT FACTORY HOLCIM, KOROMAČNO**

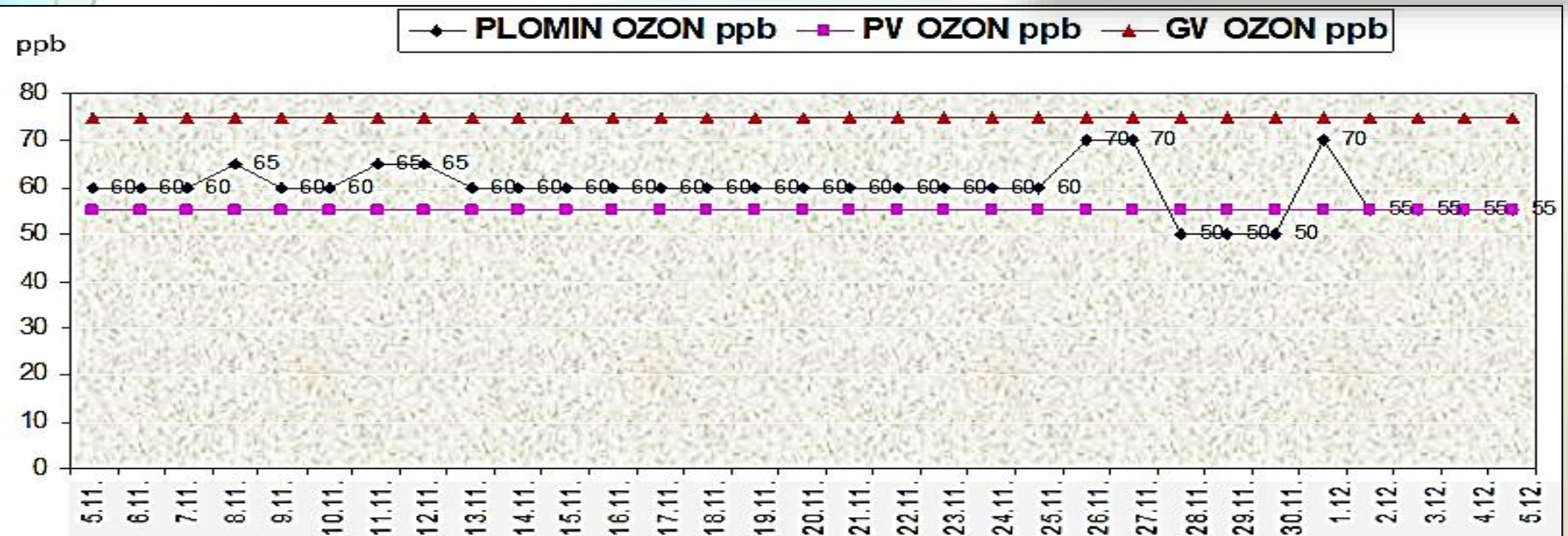


Graph 4. Mean values of ozone - RAŠA

As Raša relief valley near the sea and the river Raša, ozone, as shown in Graph 4, varies greatly, which is likely to affect the microclimate, as it is often present in Raša fog and high humidity and poor air circulation. It is possible the impact of industrial plants near the Raša.

5. PLOMIN LUKA

Fishing village by the sea, with about 200 inhabitants, only relief open to the sea, where there is a POWER PLANT TE Plomin.

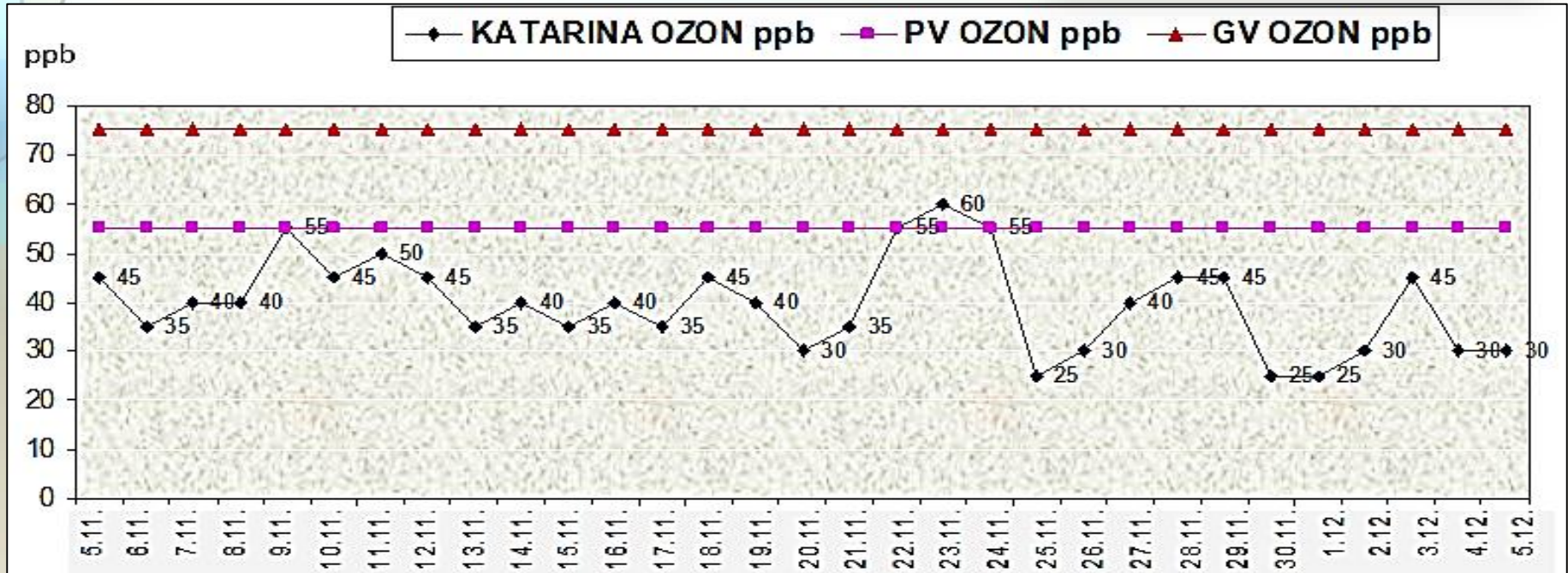


Grph 5. Mean values of ozone – PLOMIN LUKA

As seen from graph 5, the value of ozone is found between PV and GV, which is probably the impact of openness and poor relief and work of POWER PLANT.

6. KATARINA

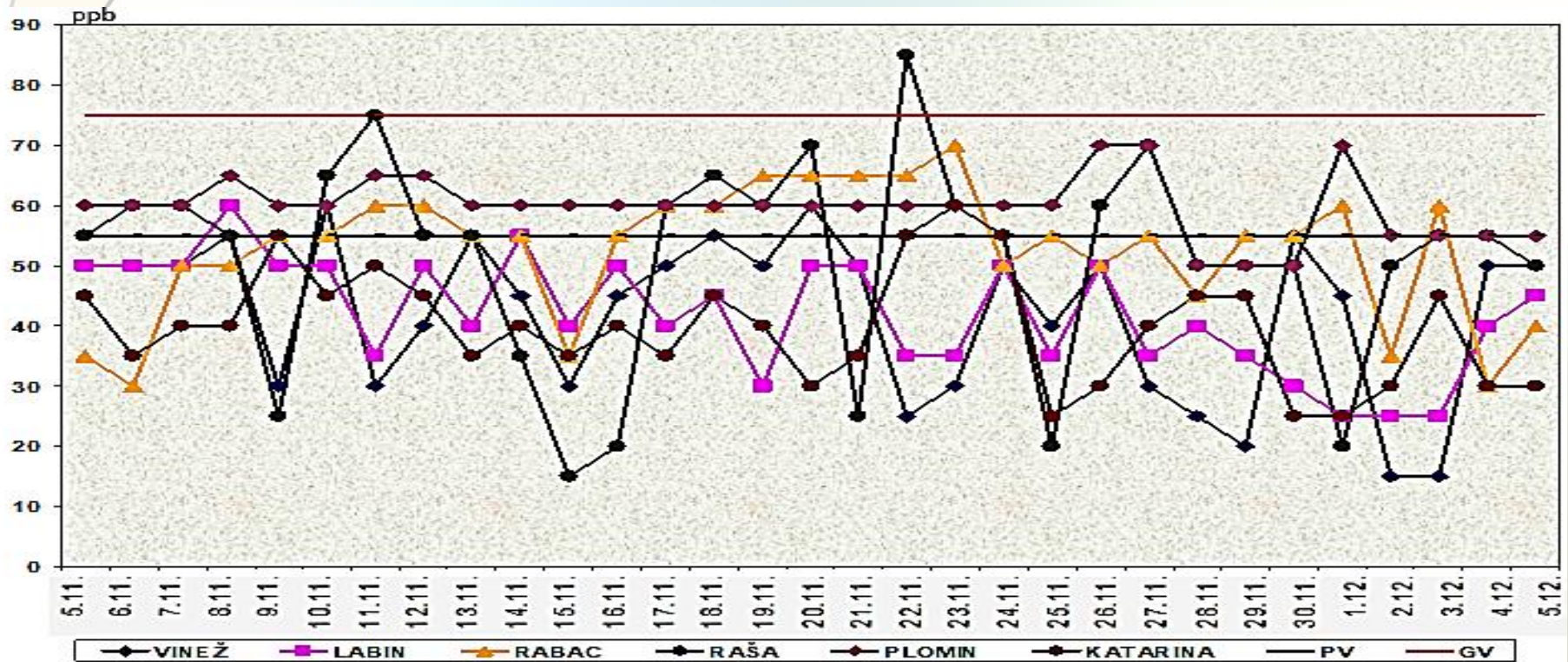
Rural village with about 500 residents,
relief opened,
near which there is ROCKWOOL
stone wool factory.



Graph 6. Mean values of ozone – KATARINA

From the 6th graph see that the PV exceeded only once,
which corresponds to the expectations with respect to good relief openness.
For now, the impact of industrial plants in the vicinity
is not significant.

COMPARISON MEASUREMENT RESULTS



Graph 7. comparison of the values for the all location

By comparing all locations, it is evident that the ozone amounts in Labin area are within the permitted limits because they rarely exceed the PV, and only once the GV for the measurement period.

COMPARISON OURS RESULTS WITH OFFICIAL RESULTS

Data for KATARINA was available to us on the website <http://zrak.zzjiz.hr> we once again checked the accuracy of the "ozone detector" by comparing ours results with the official results.

Srednja vrijednost:

80,399

Maksimalna vrijednost:

80,399



Graph 8. comparison of the values for the location KATARINA with values measured by the DEPARTMENT OF PUBLIC HEALTH OF ISTRIAN COUNTY.

The amounts of ozone in Labin are within the permitted limits because they rarely exceed the PV, and only once the GV for the measurement period. It is observed that slightly higher concentrations of ozone occur at the locations RABAC, PLOMIN and RAŠA, which can be connected to the relief characteristics of these locations.

CONCLUSION

- ❑ The accuracy of the measurement of the "ozone detector" is satisfactory, as can be seen from the chapter: Checking the "OZONE DETECTOR" and COMPARISON OF THE RESULTS WITH THE OFFICIAL RESULTS OF THE PUBLIC HEALTH INSTITUTE OF THE COUNTY OF ISTRIA Using the prepared "ozone detector" at six locations in Labin area, we monitored the amount of ozone and the results showed that the values were within the limits prescribed by the Air Protection Act of the Republic of Croatia and the Regulation on Ozone in the Air.
- ❑ We have confirmed that our values are slightly higher than the official values of ZZJZIZ, but good enough to monitor the state of the environment.
- ❑ Through our work, we have shown that it is possible to create an "ozone detector" in a school laboratory and thereby enable ozone monitoring in an area with much less resources than those required to purchase commercial tests for ozone.

"SMALL CALCULATION"

AND THE ANSWER TO THE RESEARCH QUESTION

	DO IT YOURSELF «ozone detectors» STRIPS	ZIKUA™ Ozone Test Card Reader	OZONE LAB™ Ozone Test Strips
SOURCE SALE PRICE	http://www.didakta.hr/kemija	http://www.forestry-suppliers.com/	http://www.ozoneservices.com/
QUANTITY	Filter paper for 300 strips 0.93 € 5 grams of starch 0.80 € 1 gram of potassium iodide 0.13 € 1 L of deionized water 0.66 € 	 160,63 € 300 test cards 348,68 €	 1 Test Strips 2,29 € 300 strips 687,00 €
TOTAL PRICE	2,62 €	509,31 €	687,00 €

Our wish was to show that with a little good will and with minimal resources, every school can prepare "ozone detector" that can be used to monitor the amount of ozone in the air, and in this way provide students with a research approach to understanding the importance of knowing the quality of the air, problem of global proportions.

SOURCES

- **THE GLOBE PROGRAM,**
www.globe.gov
- **CHEMISTRY OF OZONE DETECTION STRIPS,**
www.chemheritage.org/EducationalServices,
- **ZIKUA TEST OZONE READER,**
www.ecobadge.com,
- **ONEČIŠĆENJE ATMOSFERE I GLOBALNO ZAGRIJAVANJE,**
<https://www.pmf.unizg.hr/geol/predmet/oagz>
- **ŠTO JE TO OZON I GDJE SE NALAZI?**
www.azo.hr,
- **STANJE OKOLIŠA,**
www.zzjiz.hr/okolis_zrak.htm,
- **ZAKON O ZAŠTITI ZRAKA,** («Narodne novine«, broj 178/2004),
- **UREDBA O OZONU U ZRAKU,** («Narodne novine«, broj 178/2004).