ISSN: 0001-5113
AADRAY

ACTA ADRIAT.
37 (1/2): 9-15, 1996

UDC: 551.5 (262.3)
Professional paper

Ecological study of gas fields in the northern Adriatic

2. Climate characteristics

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Climate conditions in IVANA and IKA gas fields in the northern Adriatic are described. Main climatic elements: air temperature, humidity, cloud cover, fog and wind were analysed on the basis of the data collected in the gas fields IVANA from the period 1979 to 1985, and IKA from the period 1979 to 1983. Precipitation data from the coastal station Pula were also analysed.

2.1. INTRODUCTION

The Adriatic is a small adjacent sea of the Mediterranean. Its northern part, which is the shallowest, penetrates deeply into the European continent. Because of its shallowness and the vicinity of the continent (the Alps and the area of the western Europe) the climate of the northern Adriatic is quite different from the climate of the middle and southern Adriatic.

General climatic conditions of the northern Adriatic are presented in order to illustrate specific weather circumstances of this area. Because the high variability of these elements, the area is largely driven by sudden changes in climatic conditions.

Winter in the northern Adriatic is characterised by exchange of cyclones and anticyclones, which result in frequent exchanges of Bora (blowing from the northeast) and Scirocco (southeast) winds, the predominant winds in winter season. The location of the northern Adriatic towards the routes of cyclones and anticyclones results in its larger exposure to the north wind. Middle and southern Adriatic, on the contrary, are more exposed to the influence of Scirocco, which is more frequent than Bora. Differences in frequency between the strong and dry north wind Bora and mild and moist south wind Scirocco, result in different climate of the two regions.

Summer in the northern Adriatic is characterised by the Etesian winds due to the permanent influence of the Azores High from the west and the Karachi Low from the east. The Etesian circulation is manifested along the coast as the exchange of land and see breeze, and as NW wind at the open sea.

The open sea climate in the northern Adriatic is different from the coastal climate, which is evident from annual mean values of particular climatic elements between coastal station Pula and analysed gas fields.

The mean annual air temperature at the open sea is 15.7°C, while at the coast it is 13.6°C.

The mean annual insolation of the northern Adriatic is about 2400 hours of sunshine (Pula 2334, Mali Lošinj 2448).

The frequency of fog is significant in the northern Adriatic, compared to the rest of the Adriatic (TEŠIĆ i BROZINČEVIĆ, 1974). The mean annual number of foggy days at the coast is 10 days while open sea area has higher number of foggy days (15 to 20).

The amount of precipitation varies along the coast of Istra, but it is usually lower than 1000 mm per year, except in the Rijeka area (1489 mm) where precipitation is caused by mountain effect. There were no regular precipitation measurements in the open sea of the northern Adriatic, but, according to the some data, it could be taken that the amount of precipitation is lower in the open sea than along the coast.

The area of Istra has considerably higher frequency of thunder, compared to the rest of the Adriatic (MAKJANIĆ, 1978) . The annual mean number of days with thunder in the northern Adriatic was 44 days.

The snow is of little climatic importance in the northern Adriatic, as its frequency and quantity are very low. It melts quickly, both in the sea and on the land (Pula has an annual average of 5 snowy days).

2.2. MATERIALS AND METHODS

The meteorological data in the location IVANA were collected from the period 1979-1985, and the data on the location IKA from the period 1979-1983.

The wind was measured with the anemograph VT-1450, of the Italian production SIAP. Anemograph was placed 35 meters above the mean sea level, and the hourly values have been used. The temperature and the humidity, the total cloud cover and the fog have been measured at the climatic terms (7.00, 14.00, and 21.00 GMT).

Precipitation was not measured in IVANA and IKA fields, and data from the nearest coastal station Pula were used.

The hourly values of the wind speed were reduced to the 10 m height, according to the Pierson's formula (1964):

$$U_Z = U_{10} \left[1+\left(\frac{C_d^{1/2}}{k}\right) \ln \frac{z}{10}\right]$$

where U is the wind speed, Cd the drag coefficient, k is Von Karman's constant (k = 0.04) and z stands for the height, while the logarithmic wind profile has been assumed with the constant drag coefficient $Cd = 1.5 * 10^{-3}$.

The data from the platform have been processed according to 16 directions, the speeds are shown in m/s. Wind roses show the relative frequency (%) and mean values of wind speeds according to wind directions. Another kind of wind rose has been constructed, with relative frequency according to the directions of the particular speed classes.

The data from the Climatological Atlas of the Adriatic (1979), from the region No. 5, shown in Fig. 1.2. as hatched area were used for comparison with the data from gas fields. The data refer to the period from 1949 to 1970, as well as the data from the meteorological control station Pula.

2.3. RESULTS

The cold part of the year in the northern Adriatic is characterised by the exchange of cyclones and anticyclones, which further causes the frequent exchange of typical winds: Bora (NE) and Scirocco (SE).

The location of the northern Adriatic relative to the cyclone and anticyclone routes shows its exposure to the Bora wind rather than to the Scirocco wind.

Summer weather is characterised by Etesian circulation (MAKJANIĆ, 1978). The Etesian circulation along the coast results in exchange of winds from the sea and from the land, while at open sea it is regularly manifested as NW wind.

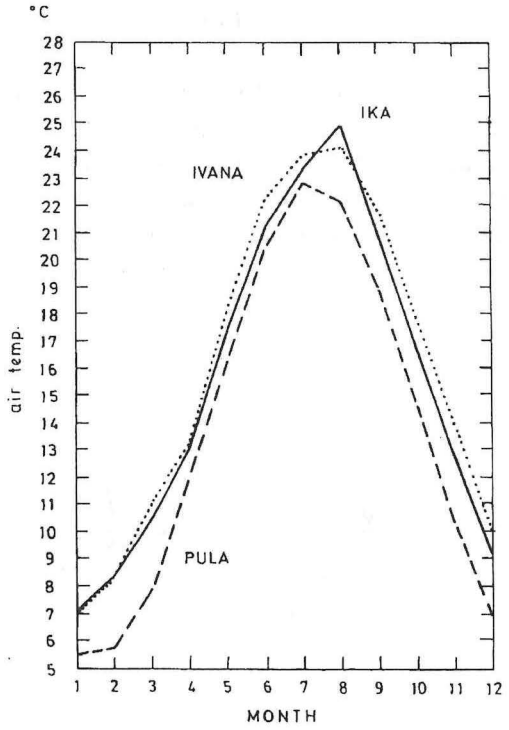

Fig. 2.1. Annual course of air temperature (monthly mean values) for IVANA and IKA fields, and the coastal station Pula.

2.3.1. Air temperature

Fig.2.1. shows the annual course of air temperature for the meteorological station Pula, and the locations IVANA and IKA. The annual maximum air temperature, both in IVANA and IKA is in August, while in Pula it is in July. The minimum temperature is found in all locations in January. The annual mean value in IKA is 15.7°C, in IVANA 15.8°C and in Pula 13.9°C. Annual amplitudes of monthly mean values are respectively 17.9°C, 17.1°C and 18.0°C for IKA, IVANA and PULA. IVANA and IKA have very close monthly mean values.

Maximum air temperature in IVANA and IKA delay one month after maximum temperature in Pula showing larger maritime surrounding of the gas fields.

2.3.2. Humidity

The annual course of the relative humidity in Pula, IKA and IVANA is shown in Fig. 2.2. The humidity along the coast is permanently lower than in open sea. The values are close in autumn, and separate in winter. Monthly mean relative humidity is always above 70%, which is above the values suitable for human life and work.

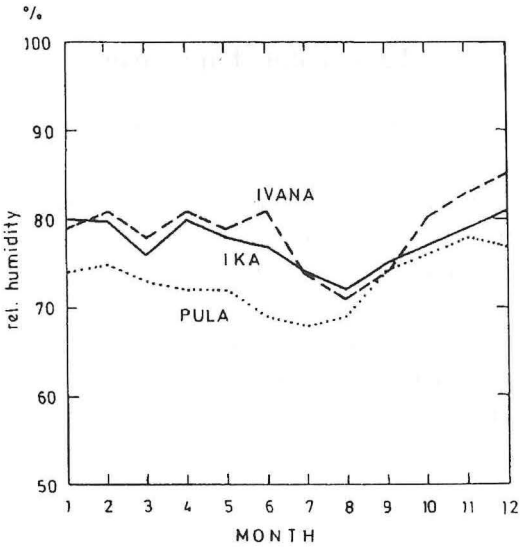

Fig. 2.2.Annual course of relative humidity (monthly mean values) for IVANA and IKA fields and the coastal station Pula.

2.3.3. Precipitation

The precipitation was not measured in IVANA and IKA fields. The annual precipition course for the coastal station Pula is shown in Fig. 2.3.

The mean annual precipitation was 833 mm. The maximum was recorded in November and minimum in summer months. Precipitation appears mostly as rain and rarely as hail or snow.

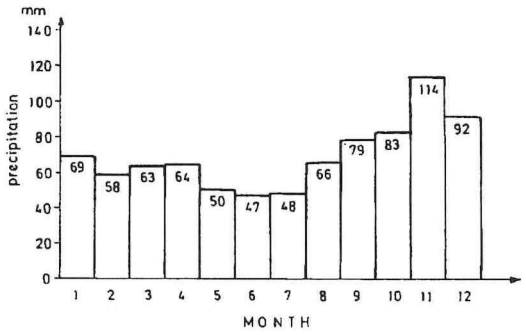

Fig. 2.3.Annual course of precipitation amount in Pula (monthly mean values).

2.3.4. Total cloud cover

In the locations IKA and IVANA the total cloud cover is permanently lower than on the coast (Fig.2.4.). The greatest difference appears in winter. This indicates that precipitation should be lower at the open sea than on the coast, as well.

In the more southerly location IKA the mean annual cloud cover is slightly lower (3.2) than in the location IVANA (3.4).

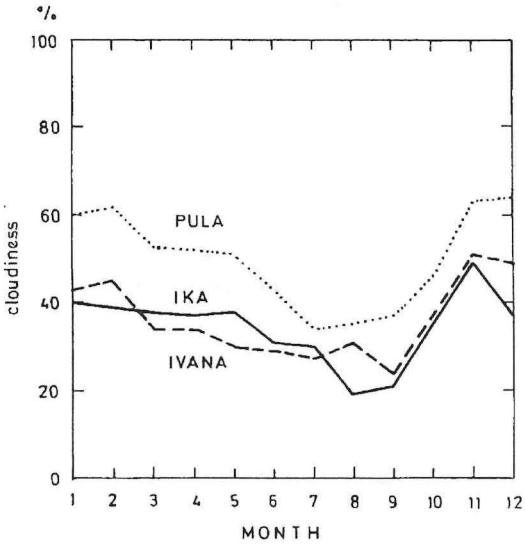

Fig. 2.4.Annual course of total cloud cover (monthly mean values) in percentage (%) for IVANA and IKA gas fields and coastal station Pula.

2.3.5. Fog

In the northern Adriatic fog appears more frequently than in the other parts of the Adriatic. Fig.2.5. (TEŠIĆ i BROZINČEVIĆ, 1974) shows that highest frequency of fog is in winter, while in summer it practically does not appear. Further off the coast the frequency of fog rises.

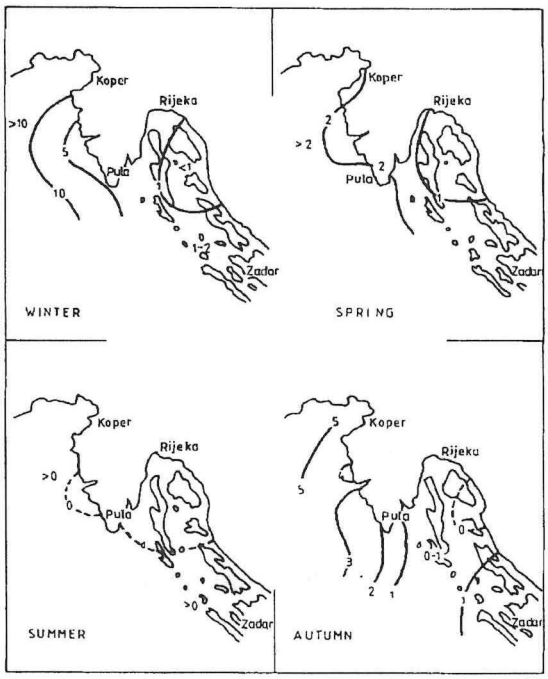

Fig. 2.5.Spatial distribution of mean seasonal foggy days in the northern Adriatic (according to TEŠIĆ and BROZINČEVIĆ, 1974).

2.3.6. Wind

Annual wind roses for IKA and IVANA show little difference (Fig.2.6.). On IVANA, located more to the north, the NW wind is more frequent, while on IKA it is the NE wind. Both locations are dominated by the winds of NW, NE, SE and SW directions. Those directions are either parallel or vertical to the axis of the Adriatic.

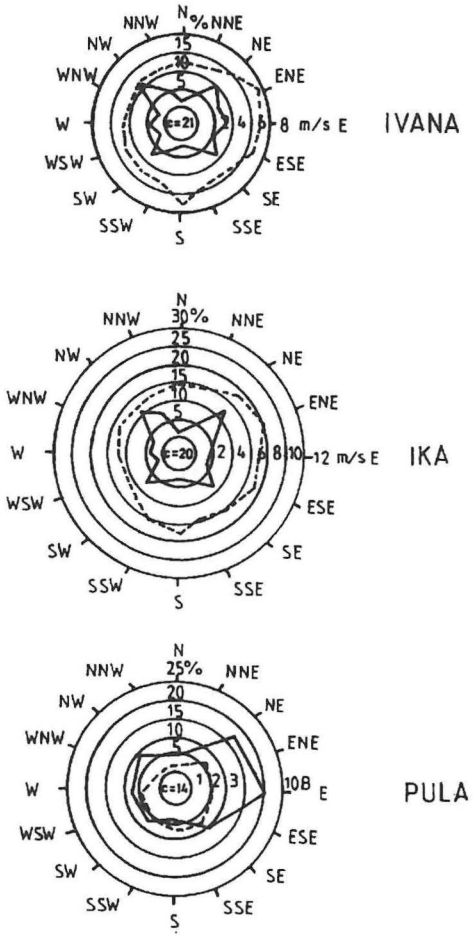

Fig. 2.6.Annual wind roses for IVANA and IKA fields (mean frequency, mean speed-) and wind frequency from eight directions in Beaufort scale for Pula station.

The wind rose for Pula (Fig.2.6.) could not be directly compared to the wind roses for IKA and IVANA, since it has been produced by observing the eight directions, and the wind force has been estimated according to Beaufort scale. Nevertheless, it is obvious that the predominant wind in Pula is from the coast, with the absence of the alongshore directions.

The seasonal wind roses for IVANA (Fig.2.7.) show considerable seasonal differences. In winter the most frequent winds are the NE and NW winds, while ENE and E show the highest mean speed. In spring the winds are mostly from the south quadrant (SE and SW), the NE and NW directions also being frequent.

Summer is characterised by frequent calm, and also SE, NE, NW and SW winds. The average speed is practically the same for all directions (about 6 m s^{-1}).

In autumn the predominant winds are again from the north quadrant (NE and NW). The mean speed of the NE needs to be pointed out: it was about 8.0 m s^{-1}.

The extremely high wind speeds (gust peak speed 30 m s^{-1}) occur on the average eight times a year, most frequently from November to March, from the directions of NE, ENE, ESS, SE and SW. The wind speed over 30 m s^{-1} can also occur in August when the cyclonic systems reaching from the Atlantic are stronger than the influence of the Azores High.

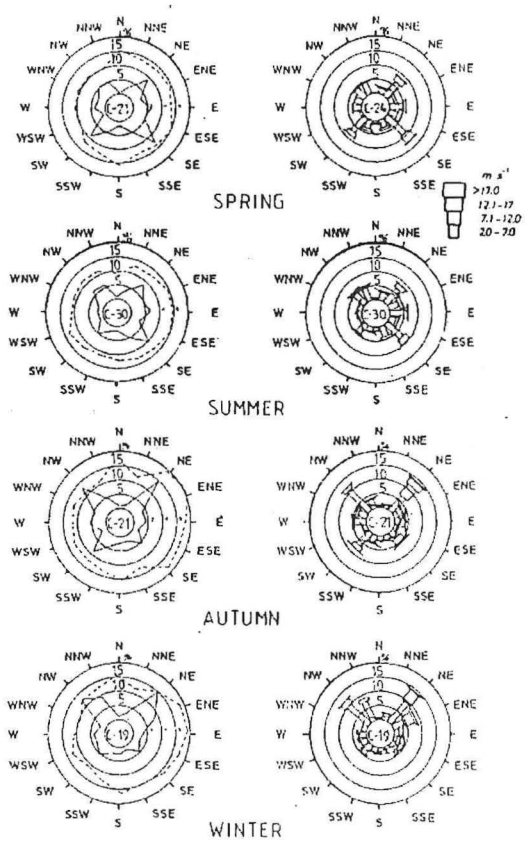

Fig. 2.7.Seasonal wind roses for IVANA field (mean frequency , mean speed (left); direction frequency according to the speed class intervals (right).

According to the data the following extreme wind speeds are calculated for return period of 100 years, using Jenkinson's solution of Fisher-Tippett distribution of extreme values (MAKJANIĆ, 1977). Following results are obtained for particular wind speeds:

a) 3 hours mean speed at 35 m s^{-1}
b) 1 hour mean speed at 40 m s^{-1}
c) maximum gust of 64 m s^{-1}

The winds usually have stable directions, even during the extreme speeds, which can cause high waves.

2.4. CONCLUSIONS

The annual mean air temperature on IVANA is 15.8°C, on IKA it is 15.7°C. The air temperature on the sea is higher throughout the year than on the coast, and the annual amplitudes are slightly lower.

Humidity on gas fields IVANA and IKA, with its monthly values over 70% is permanently higher than on the coast.

Precipitation was not measured on the gas drilling platforms, but the values for Pula have been given instead (annual mean value being 833 mm). The total cloud cover on gas fields is permanently lower than on the coast, especially in winter.

IVANA and IKA locations are dominated by NW, NE, SW and SE winds, which are either parallel or vertical to the axis of the Adriatic. There is a slightly stronger NW wind on IVANA while NE wind was stronger on IKA. The seasonal differences are considerable.

The extreme wind speeds, with gusts over 30 m s^{-1}, occur on average eight times a year, most frequently from NE and ENE directions (Bora), ESE and SE directions (Scirocco), and the SW direction.

It is therefore obvious that short-term meteorological events in the northern Adriatic can generate significant local meteorological forcing, which have to be taken into consideration in all works in the sea during gas/oil exploitation or in the case of accidents.

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Ekološka studija plinskih polja u sjevernom Jadranu

Klimatske osobine

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KRATKI SADRŽAJ

Opisani su glavni elementi klime i vremena na sjevernom Jadranu. Analizirani su temperatura zraka, vlaga, naoblaka, vidljivost (magla) i vjetar na osnovi podataka prikupljenih na plinskim poljima IVANA iz razdoblja 1979 do 1985, i polja IKA iz razdoblja 1979 do 1983. Analizirana je i oborina sa najbliže obalne postaje Pula.