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THE DEVELOPMENT OF THE TOOL FOR REAL-TIME NOTIFYING THE PEOPLE ABOUT LEVEL OF AIR POLUTION IN RECREATION ZONES

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Abstract.*The main goal of our research is to confirm the hypothesis of a relatively high level of air pollution in the city Kramatorsk and to create a tool for notifying the people of this information. This work demonstrate why the task of creating a convenient, accessible, functional, accurate interactive map of the state of environmental pollution in recreational areas of the city, which could allow residents to choose the least polluted recreation areas at the current time, is relevant.*

Keywords: *Interactive map, Air pollution, OpenStreetMap, API, Recreation zone, PM, Substance, Monitoring*

Introduction

The current environmental situation in Ukraine can be described as the maximum crisis, which was formed over a long period due to the neglect of objective laws of development and reconstruction of the natural resource complex of Ukraine. There were structural deformations of the national economy, in which preference was given to the development of raw-mining, the most environmentally dangerous industries in Ukraine. The level of contamination with various substances exceeds the norm not only in the so-called "work zones", but also in residential areas and recreational areas. Cities in industrial zones of Ukraine, in particular in the Eastern part of Ukraine, are most at risk. Recreational areas are created in order to allow people to relax and reduce the load received by the human body from the urbanized atmosphere of cities. But practice shows that the situation in recreation areas is also not satisfactory, and in some cases even more dangerous than in other places of the settlement. The most annoying thing is that most people do not even suspect that these places are as dangerous as, for example, work areas.

At the moment, Ukraine is gradually introducing automated monitoring systems for the state of environmental pollution, and even attempts to combine them into a single system are taking place. But almost no one thinks about convenient representation of the received and analyzed information for a wide audience, namely, for the population of the city. All this information, first of all, is often placed somewhere on the websites of local environmental departments, but not on the main pages of popular Internet resources of the city. enough to talk about creating targeted software that should be available to every resident of the city at hand. And, secondly, most often this information is presented in the form of dry figures with the specified maximum permissible concentration (MPC), and is not interpreted in any convenient way for the average user, and even more so does not report the possible consequences of the influence of exceeding the concentration of a substance on the human body.

1 Literature overview

Usually, cartography is defined as the science and art of creating and using maps. Arthur Robinson [1] defined the philosophy of the "Golden age of cartography" as follows: functional design or scientific creation of the principles of cartographic design, which is based on the perceptual and cognitive limitations of the target map user. This approach to map research has given rise to a communication model that describes the map as a conduit through which messages can be conveniently transmitted from the map creator to its user [2-4]. Also, some of the main views for cartography were supplemented during visual communication with advertising, art, education, and psychology in order to create specific recommendations for designing maps to avoid inconveniences during the transmission of these messages. Despite the fact that the communication model did not bring significant benefits through some differences in terms of practical, applied, critical, and social theory [5-8], the basic principles of design and use that took root in this era remain the basis of the modern cartographic curriculum to this day [9,10].

For geoinformative systems that include interactive maps, the interaction with them or how the user manipulates the map is central. Maps can be divided into two large groups: "dynamic" and "static", but instead of the concept of "dynamic", that is, those that can constantly change, the concept of "interactive" will be used in order to distinguish between the so-called "update" of the map that was caused by the system (animation, image shape, etc.) and what was caused by the user (opening the menu, entering any additional information). The digital revolution and the information age in ceneral, with the advent of new features, together prompted changes in the direction of how maps are created and used. Interactivity is one of the most important features of this kind [11,12].

To create a digital interactive map, it was decided to use public services with tools for creating and publishing custom maps. OpenStreetMap (OSM) was selected among all available services [13]. As noted in their reviews Gorchakov and Wagner [14, 15], OSM uses the same principles that formed the basis for the creation of Wikipedia. All the information on these maps was collected by a very large number of volunteers who provided data from street panoramas, satellite images, aerial photos, videos, and data from GPS trackers for this project. And despite its review of this service, it was concluded that for the city Kramatorsk, OSM maps contain more detailed and relevant information than all other services. The API documentation is also very convenient and freely available.

Today, the existing standards for assessing and calculating the level of environmental pollution in Ukraine are quite outdated, even since the Soviet Union [16]. In addition, we do not have regulatory documents for regulating the concentration of fine dust (PM2.5), which is one of the most problematic polluting substance in the world [17]. But despite all this, when choosing a mathematical model for predicting the level of air pollution, we must rely on our current standards, since the technological processes and cleaning technologies at enterprises in Ukraine are also very outdated and do not meet modern European requirements. Suffice it to say that one of Kramatorsk's enterprises, a metallurgical plant, uses cleaning technologies from the 19th century. Therefore, to assess the state of air pollution in recreational areas, taking into account existing data, the calculation methods were used, described in detail in the works of Berlyand [16], Cherkesov [18], Vetoshkin [19].

2 Object, subject and methods of study

The object of our research is information protection of the population from environmental problems.

The subject of the study is the implementation of a convenient tool for displaying information on monitoring and forecasting the concentration of harmful substances in the atmospheric air in recreational areas of the city Kramatorsk.

As a research method, a mathematical model was developed for a comprehensive assessment and visualization of the level of air pollution in recreational areas of the city Kramatorsk.

The maximum predicted concentration in the center of a recreational area can be calculated using the formula [20]:

$$C_{mf} = \sum C_i - C_T/1000 \qquad (2.1)$$

C_{mf} – maximum predicted concentration (mg / m^3).

C_i – concentration from other sources (in our case plants) (mg / m^3).

C_T – the given concentration (average for the city, taken every 2 hours from the state website of the automated environmental monitoring system in the Donetsk region) (mcg / m^3).

Category C_i includes all substances that have flown from the plant to the selected recreational area, so the question here is the location of the zones and the distance to them from various sources of pollution. This parameter can be calculated using the formula:

$$C_T = \left(\frac{T_{max} - T_d}{T_{max}}\right) C_Z \qquad (2.2)$$

T_m – the maximum scattering distance of a substance is calculated using the formula [21]:

$$T_m = T_s \times V_f \tag{2.3}$$

T_s – the standard distance at zero wind speed at which the matter is dispersed, the standard is 5000 meters;

V_f – wind direction coefficient that varies from 0.5 to 1.5 depends on the wind direction and location of the SOURCE-ZONE line;

T_d – distance from the source of pollution to the recreational area;

C_Z – concentration of chemical substances that was released by the source of contamination (mg / m^3). In our case, we take the factories of our city as the source of pollution. Namely NKMZ, TPP, KZTS, FERROALLOY PLANT, EMSS, DONMET. The formula for calculating the concentration will look like this [16, 19-21]:

$$C_Z = \frac{A \times M \times F \times m \times n}{H^2 \times \sqrt[3]{V_1 \times \Delta T}} \tag{2.4}$$

A – coefficient which depends on the temperature stratification of the atmosphere that defines the terms vertical and horizontal dispersion of pollutants in the atmosphere ($C^2/^3\times$ mg $\times$ grad$^1/^3$g). The coefficient A is calculated for adverse weather conditions observed in summer during the daytime with an intensely developed vertically turbulent climate. For Ukraine this coefficient is equal to 200;

M – the amount of harmful substance that is released into the atmosphere (g/s);

H – the height of the pollution source above ground level (in our case, the height of the pipes) (m);

V_1 – volume of the gas-air mixture (m^3/s);

ΔT – the difference between the temperature levels of the exhaust gas-air mixture and the ambient temperature in degrees Celsius;

F – a dimensionless coefficient that takes into account the rate of precipitation of particles in the atmosphere – for sterny gas 1, for dust cleaning with an efficiency of at least 90 % – 2;

M – the dimensionless coefficient that takes into account the conditions of the gas-air mixture output in our conditions is taken as 1;

N – dimensionless coefficient, which takes into account the conditions of the gas-air mixture output in our conditions, is taken as 1.

For correct calculations of predicting the concentration of harmful substances in recreational areas, we need to know the exact distance between all sources of harmful emissions and recreational areas. The shape of the Earth can be described as spherical. Calculating the distance using this method is more efficient and in many cases more accurate than calculating it for projected coordinates (in a rectangular coordinate system), because, first, you do not need to translate the graphic coordinates into a rectangular coordinate system (perform projection transformations), and, secondly, many projections, if they were incorrectly selected, can lead to significant length distortions due to the features of projection distortions. It is known that an ellipsoid rather than a sphere describes the Earth more accurately, but in this case we will consider calculating distances on the sphere. For distances, a sphere with a radius of 6372795 meters is used, which can lead to a calculation error of about 0.5% [22].

The mathematical model will be based on the spherical cosine theorem.

$$\Delta\sigma = 2\arccos\left(\sin\varphi_1 \sin\varphi_2 + \cos\varphi_1 \cos\varphi_2 \cos\Delta\lambda\right) \tag{2.5}$$

where $\varphi_1; \varphi_2$ – the latitude of two points in radians;

$\Delta\lambda$ – the difference of the coordinates in longitude;

$\Delta\sigma$ – the angular difference.

To convert the angular distance to metric, you need to multiply the angular difference by the radius of the Earth (6372795 meters), the units of the final distance will be equal to the units in which the radius is expressed, in this case – meters.

But, in our case, namely, in the case of relatively small distances and small bit depth calculations, the use of this formula can lead to significant errors associated with rounding. In order to prevent problems with small distances, the haversinus formula is used [22].

$$\Delta\sigma = 2\arcsin\left(\sqrt{\sin^2\left(\frac{\phi_2 - \phi_1}{2}\right) + \cos\phi_1 \cos\phi_2 \sin^2\left(\frac{\Delta\lambda}{2}\right)}\right) \tag{2.6}$$

Formula 2.6 is prone to the problem of antipodes points, and the following modification is used to solve it [22].

$$\Delta\sigma = \arctan\left(\frac{\sqrt{(\cos\phi_2 \sin\Delta\lambda)^2 + (\cos\phi_1 \sin\phi_2 - \sin\phi_1 \cos\phi_2 \cos\Delta\lambda)^2}}{\sin\phi_1 \sin\phi_2 + \cos\phi_1 \cos\phi_2 \cos\Delta\lambda}\right) \tag{2.7}$$

For convenient interpretation of information about the level of air pollution, the user needs to display data on the map in the form of recreational areas, painted in the appropriate color, which will change over the gradient.

First, we calculate the average ratio of the predicted concentration of substances to their corresponding MPC and hazard class according to the integrated assessment of atmospheric air pollution [23-24].

$$grad\varphi = \left(\sum_{i=1}^{n} \frac{C_p}{ПДК_{м.р.}} * k_h\right) / \, n \tag{2.8}$$

where $grad\varphi$ – the calculated coefficient for the gradient;

k_h – coefficient for calculating the force of exposure of a substance depending on its hazard class;

C_p – predicted maximum concentration of a substance in a recreational area;

$ПДК_{м.р.}$ – predicted maximum concentration of the corresponding substance in the recreational area;

n – the number of substances measured in the recreational area.

The color for the fill is defined in the RGB model (red, green, blue), where red, green, and blue are integer values from 0 to 255 for the red, green, and blue colors in the model, respectively. We introduce an additional modified coefficient for the gradient and values for colors in the RGB model. коефіцієнт для градієнту та значення для кольорів у моделі RGB.

$$grad\varphi_m = \begin{cases} (1 - grad\varphi) \, / \, k, grad\varphi < 1 \\ (grad\varphi - 1) \, / \, k, \;\; grad\varphi \geq 1 \end{cases} \tag{2.9}$$

when $grad\varphi_m > 1$ we accept $grad\varphi_m = 1$.

$$COL_{RGB} = \begin{cases} (255 - 255 * \; grad\varphi_m, 255, 0), grad\varphi < 1 \\ (255, 255 - 255 * \; grad\varphi_m, 0), grad\varphi \geq 1 \end{cases} \tag{2.10}$$

where $grad\varphi$ – is the calculated coefficient for the gradient;

$grad\varphi_m$– modified coefficient for the gradient;

k – coefficient for expanding the gradient with a small amplitude of values;

COL_{RGB} – ready color for painting in the RGB model.

3 The results of in-depth development of separate modules of software complex for realization of an interactive map of air pollution

To get records from the database for a certain date, we need to use the function shown in Fig. 3.1-3.2. It accepts the date that the user selected as a parameter. In order to pull out a record for a certain time, taking into account the possible error of a few seconds/minutes, we make a time interval of ±20 minutes, which will be specified as a query parameter in the database. In order to make a correct query, we also need to convert the received dates to the "American" format "MM-DD-YYYY" by working with an array of characters. Next, this function connects to the database, dynamically generates a query depending on the selected date, and writes the corresponding data to the variables of the "Air" object, processing an exception if it is not possible to connect to the database.

```
public int GetValues(DateTime date, int id)
        {
            int id_predict = 0;
            string lowdate = date.AddMinutes(-20).ToString();
            string highdate = date.AddMinutes(20).ToString();

            char[] bufstring = lowdate.ToCharArray();

            char[] lowstring = lowdate.ToCharArray();
            lowstring[0] = bufstring[3];
            lowstring[1] = bufstring[4];
            lowstring[3] = bufstring[0];
            lowstring[4] = bufstring[1];

            bufstring = highdate.ToCharArray();

            char[] highstring = highdate.ToCharArray();
```

Figure 3.1– function for requesting data from the database regarding the predicted maximum concentrations in recreational areas for a certain date

```
highstring[0] = bufstring[3];
          highstring[1] = bufstring[4];
          highstring[3] = bufstring[0];
          highstring[4] = bufstring[1];

          lowdate = new string(lowstring);
          highdate = new string(highstring);

          OleDbCommand selectCommand = new OleDbCommand();
          DataTable table = new DataTable();
          try
          {
             OleDbConnection objConnection = new
OleDbConnection("Provider=Microsoft.Jet.OLEDB.4.0; Jet OLEDB:Engine Type=5; Data
Source=F:\\Downloads\\BD.mdb");
             selectCommand.CommandText = "SELECT TOP 1 Prediction.id_prediction,
Prediction.prediction_CO, Prediction.prediction_NOx, Prediction.prediction_O3,
Prediction.prediction_PM10, Prediction.prediction_SO2 FROM Prediction WHERE
Prediction.id_rz = " + id.ToString() + " AND Prediction.date_time BETWEEN #" +
lowdate.Replace('.', '/') + "# AND #" + highdate.Replace('.', '/') + "# ORDER BY
id_prediction DESC;";
             selectCommand.Connection = objConnection;
             selectCommand.CommandType = CommandType.Text;
             OleDbDataAdapter adapter = new OleDbDataAdapter(selectCommand);
             adapter.Fill(table);
             table.PrimaryKey = new DataColumn[] { table.Columns["id_prediction"] };
             id_predict = Convert.ToInt32(table.Rows[0][0]);
             CO.Value = Convert.ToDouble(table.Rows[0][1]);
             NOx.Value = Convert.ToDouble(table.Rows[0][2]);
             O3.Value = Convert.ToDouble(table.Rows[0][3]);
             PM10.Value = Convert.ToDouble(table.Rows[0][4]);
             SO2.Value = Convert.ToDouble(table.Rows[0][5]);
          }
          catch (OleDbException exc)
          {
             table = null;
             MessageBox.Show(exc.Message, "Помилка", MessageBoxButtons.OK,
MessageBoxIcon.Error);
          }
          finally
          {
             selectCommand.Connection.Close();
          }          return id_predict;          }
```

Figure 3.2 – continuation of the database data query function with respect to the predicted maximum concentrations in recreational areas for a certain date

For better visual perception, a function was created to determine the color of the recreational area on the city map (from green to red) in RGB format, which is shown in figure 3.3. The color is calculated depending on the concentration of the harmful substance corresponding to the MPC and the hazard class, according to the integrated assessment of air pollution (formulas 2.8-2.10).

```
private Color DefinePolygonColor()
    {
      double level = ((Air.ValueCO.Value / Air.ValueCO.MPC) *
Air.ValueCO.Hazardclass + (Air.ValuePM10.Value / Air.ValuePM10.MPC) *
Air.ValuePM10.Hazardclass + (Air.ValueSO2.Value / Air.ValueSO2.MPC) *
Air.ValueSO2.Hazardclass + (Air.ValueNOx.Value / Air.ValueNOx.MPC) *
Air.ValueNOx.Hazardclass + (Air.ValueO3.Value / Air.ValueO3.MPC) *
Air.ValueO3.Hazardclass) / 5;
      Color color;
      if (level < 1.0)
      {
        level = (1.0 - level) / 0.4;
        if (level > 1.0) level = 1.0;
        color = Color.FromArgb(150, Convert.ToInt32(255 - (255 * level)), 255, 0);
      }
      else
      {
        level = (level - 1.0) / 0.4;
        if (level > 1.0) level = 1.0;
        color = Color.FromArgb(150, 255, Convert.ToInt32(255 - (255 * level)), 0);
      }
      return color;
    }
```

Figure 3.3 – function for determining the color of the recreational area in accordance with its level of pollution

To work with polygons on the interactive map, we created functions for creating and updating polygons, which are shown in figure 3.4, and which will already be painted in the appropriate color for the level of pollution. Polygons belong to an object of the "GMapPolygon" type, and are stored in it as a layer that belongs to a collection of layers.

```
public void UpdatePolygon(GMapPolygon polygon)
    {
      polygon.Fill = new SolidBrush(DefinePolygonColor());
      polygon.Stroke = new Pen(Color.Black, 1);
```

```
            polygon.IsHitTestVisible = true;
        }
        public TextBox CreateDisplayData()
        {
            TextBox textbox = new TextBox();
            textbox.Name = name;
            textbox.Multiline = true;
            textbox.Location = new Point(1010, 150);
            textbox.Size = new Size(160, 126);
            textbox.Visible = false;
            textbox.Font = new Font("Calibri", 15);
            textbox.Text = Air.ValuePM10.Value.ToString() + " / " +
Air.ValuePM10.MPC.ToString() + Environment.NewLine +
Air.ValueCO.Value.ToString() + " / " + Air.ValueCO.MPC.ToString() +
Environment.NewLine + Air.ValueSO2.Value.ToString() + " / " +
Air.ValueSO2.MPC.ToString() + Environment.NewLine +
Air.ValueNOx.Value.ToString() + " / " + Air.ValueNOx.MPC.ToString() +
Environment.NewLine + Air.ValueO3.Value.ToString() + " / " +
Air.ValueO3.MPC.ToString() + Environment.NewLine;
            return textbox;
        }
```

Figure 3.4 - functions for creating and updating polygons on the map

For drawing on the map the logos of pollutant sources with relevant information about ground-level concentrations, was created a function for creating of "markers" that are stored as a marker layer that belongs to a collection of layers. The function is shown in figure 3.5. The logo of a plant or other source of pollutants is set as a marker, and information about ground-level concentrations is set as text that is displayed when the mouse hovers over the marker.

```
        public void SetLogo(GMapOverlay overlay) {
            GMapMarker marker = new GMarkerGoogle(
            new PointLatLng(xcoord, ycoord),
            new Bitmap(logo, bitmapX, bitmapY));
            marker.Tag = name;
            marker.ToolTipText = name + "\n\n Розрахункові приземні
концентрації:\nCO: " + CO.Value.ToString() + " мг/м3\nNOx: " +
NOx.Value.ToString() + " мг/м3\nSO2: " + SO2.Value.ToString() + " мг/м3\nO3: " +
O3.Value.ToString() + " мг/м3\nПил: " + PM10.Value.ToString() + " мг/м3";
            marker.ToolTipMode = MarkerTooltipMode.OnMouseOver;
            overlay.Markers.Add(marker);}
```

Figure 3.5 – function for creating a marker for a pollutant source

To determine the exact distance between the source of emissions and the recreational area, was created a function to determine the distance, depending on the geographical coordinates of objects, shown in figure 3.6. The function makes calculations using the formula 2.7. Only two pairs of geographical coordinates are needed as parameters for this function: sources of pollutants and recreational areas. The radius of the earth is set by a constant.

```
...
{
        const int EarthRadius = 6372795;
        const int defaultRadius = 5000;
        double lat1 = xcoord * Math.PI / 180;
        double lat2 = x1 * Math.PI / 180;
        double long1 = ycoord * Math.PI / 180;
        double long2 = y1 * Math.PI / 180;
        double cl1 = Math.Cos(lat1);
        double cl2 = Math.Cos(lat2);
        double sl1 = Math.Sin(lat1);
        double sl2 = Math.Sin(lat2);
        double delta = long2 - long1;
        double cdelta = Math.Cos(delta);
        double sdelta = Math.Sin(delta);
        double y = Math.Sqrt(Math.Pow(cl2 * sdelta, 2) + Math.Pow(cl1 * sl2 - sl1 * cl2
* cdelta, 2));
        double x = sl1 * sl2 + cl1 * cl2 * cdelta;
        double ad = Math.Atan2(y, x);
        double dist1 = ad * EarthRadius;
...
}
```

Figure 3.6 – function for calculating the distance between the recreational area and the emission source by geographical coordinates

To calculate the maximum concentration of harmful substances in recreational areas, we need to take into account the number of harmful substances that are the main sources of pollution in the city, for this we will use the formula (Fig. 3.7) calculation of maximum surface concentrations at emission sources (formula 2.4).

```
public void FactoryConcentration(Substance.Name name, double tempout)

        {

            if (name == Substance.Name.CO) concCO = (160 * CO.Value * 0.9) / (Math.Pow(sourceheight, 2) * Math.Pow(airvolume * (temperature - tempout), 1 / 3));

            if (name == Substance.Name.NOx) concNOx = (160 * NOx.Value * 0.9) / (Math.Pow(sourceheight, 2) * Math.Pow(airvolume * (temperature - tempout), 1 / 3));

            if (name == Substance.Name.O3) concO3 = (160 * O3.Value * 0.9) / (Math.Pow(sourceheight, 2) * Math.Pow(airvolume * (temperature - tempout), 1 / 3));

            if (name == Substance.Name.PM10) concPM10 = (160 * PM10.Value * 2.5 * 0.9) / (Math.Pow(sourceheight, 2) * Math.Pow(airvolume * (temperature - tempout), 1 / 3));

            if (name == Substance.Name.SO2) concSO2 = (160 * SO2.Value * 0.9) / (Math.Pow(sourceheight, 2) * Math.Pow(airvolume * (temperature - tempout), 1 / 3));        }
```

Figure 3.7 – the function of calculating the maximum ground level concentrations from emission sources

In figure 3.8 is the function for predicting the maximum possible concentrations in recreational areas, taking into account current concentrations, maximum surface concentrations near emission sources, distance from the source to the recreational area, and wind direction, using the example of PM10 dust.

```
{
...
            predictedConcentrationPM10 = Math.Round(back_pm10 / 1000.0 + (pm10_1 * isFarther1 / defaultRadius * wind_fac1) + (pm10_2 * isFarther2 / defaultRadius * wind_fac2) + (pm10_3 * isFarther3 / defaultRadius * wind_fac3)
                + (pm10_4 * isFarther4 / defaultRadius * wind_fac4) + (pm10_5 * isFarther5 / defaultRadius * wind_fac5) + (pm10_6 * isFarther6 / defaultRadius * wind_fac6), 6);
...
}
```

Figure 3.8 – function for predicting maximum possible concentrations in recreational areas

3.1 Interface Elements of the interactive PC map " CleanKramatorsk»

The software package "CleanKramatorsk: ZEPHYR" is an interactive map of the city Kramatorsk, which shows the main sources of emissions of pollutants into the atmosphere in the form of logos of these sources, the main recreational areas of the city in the form of painted planes in the color corresponding to the overall level of pollution (from green – the lowest to red-the highest) and interface elements for interaction with the map user. The interface with the main elements is shown in figure 3.9.

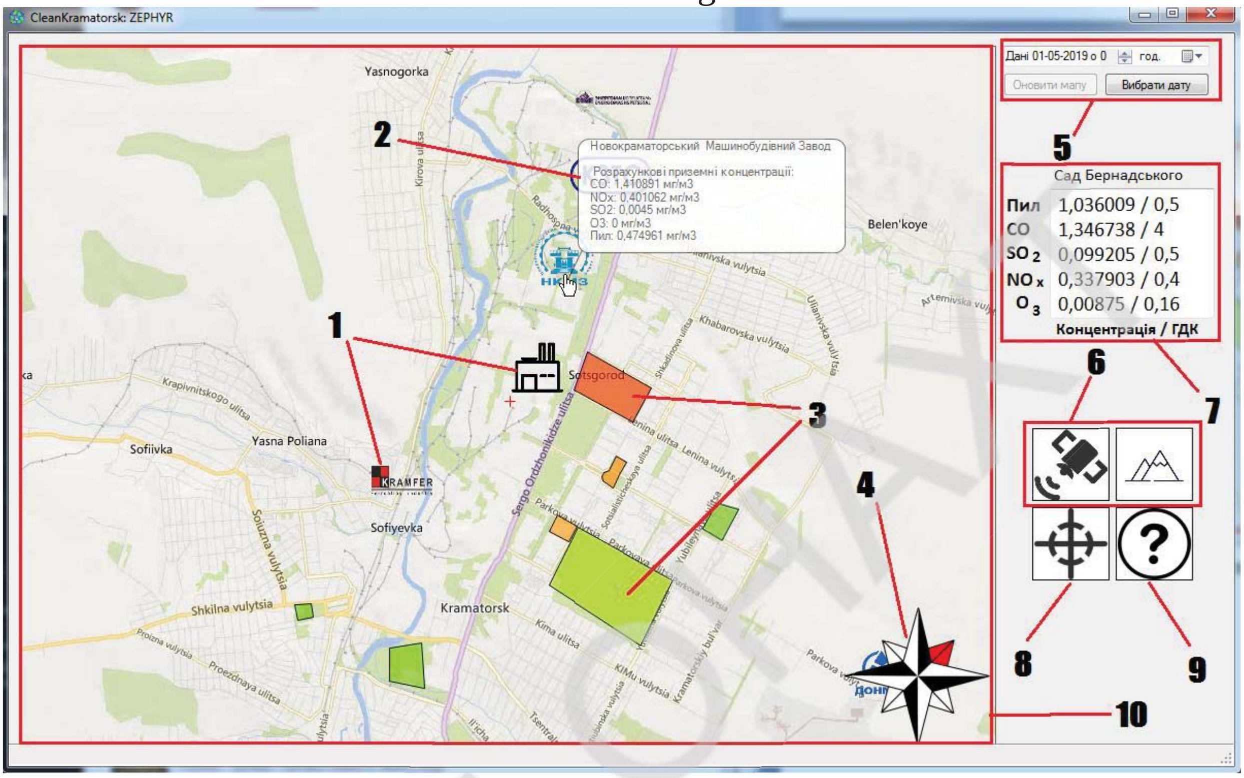

Figure 3.9 – interface elements of the «CleanKramatorsk» interactive PC map

Explanation of interface elements:

1– logos of sources of pollution with harmful substances;

2 – information about ground-level concentrations of harmful substances (appears when hovering over the logo with the mouse);

3 – recreational areas of the city;

4 – wind rose, which shows the current wind direction (the part painted in red);

5 – menu for selecting the date for which data will be displayed on the map. It includes a calendar for selecting a specific day of the year, an element for selecting a specific measurement hour (only even-numbered hours are selected), a "select date" button for checking the availability of data for the selected date, and a "update map" button for displaying data for the selected date (becomes active if the data check is successful);

6 – buttons for switching map mode: satellite and topographic;

7 – information about concentrations and the name of the recreational zone that the user is currently viewing (changes when the mouse hovers over a specific recreational zone);

8 – "set default position" button, which sets the default coordinates and scale when clicked;

9 – button for calling help;

10 – interactive map.

Conclusions

Based on the analysis of the existing literature and the conducted research has developed a comprehensive mathematical model for the assessment of air pollution in recreational areas of Kramatorsk, which consists of determining the exact distance between the pollution source and recreational area, forecasting the level of concentration of individual substances in the recreational area and determining the overall state of pollution, resulting in a specific color corresponding of the recreation area on an interactive map. A software product was developed in the form of an interactive map to inform the people about the projected level of air pollution in recreational areas of the city Kramatorsk. Based on the obtained forecast data, the hypothesis about the increased level of environmental pollution in the city Kramatorsk can be considered confirmed.

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