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IMPROVING WATER REGIME IN MLACA TĂTARILOR PEATLAND

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Abstract
Following the project Restoration strategies of the deteriorated peatland ecosystems from Romania (PeatRo), it has been shown that Romania has 32 peatlands that need hydrological restoration taking into account the increasing of human activities and changes in land use. These peatlands are distributed in the Alpine region (30) and in the Continental region (2). In this paper, we started from the assumption that the evapotranspiration process can be reduced by decreasing the spread of colonizing species Betula pendula and Rhamnus frangula, in order to reduce the evapotranspiration rate. To establish the conditions for hydrology restoration, we used a conceptual model applied to the peatland functioning in order to quantify the water inflows (from runoff and rainfall) and outflows (overbank outflows, by evaporation, by colonizing species transpiration). To estimate the rate of evapotranspiration for these species, we used in the model as input data: height and diameter of the individuals, the number of individuals, the leaf area of individual, wind speed, temperature, humidity, the number of sun hours / day, the surface of the water table.
Model results show that evapotranspiration process can be reduced after implementation of specific restoration activities, demonstrating a real improvement on water regime.

Keywords: colonizing species, evapotranspiration, hydrologic regime, peatlands, restoration.

1. INTRODUCTION

Peatlands are a category of ecosystems with relatively low areas in Romania, which are capable of sustaining a large number of species of conservative and endemic interest.

Peatlands ecosystems can provide a range of ecosystem services such as, production services: food, water, wood, fuels; regulation services: carbon sequestration, regulation of water regime, water quality regulation, flood prevention or pollutant retention capacity; cultural services: education, religious significance, traditions, symbolic values and support services: peat formation, primary production, etc (Bonn et al., 2017).

According to the Mihăilescu, Strat, Cristea, & Honciuc, 2015, peatlands ecosystems have an unfavorable-inadequate conservation status in Romania. In order to ensure a favorable conservation status of the peatland ecosystems, it is necessary to maintain the populations size of the characteristic and endemic species.

Peatland ecosystems have unique particularities compared to other ecosystems, in particular because of their ability to form peat, to store large amounts of carbon, and to retain pollutants. In the case of degraded peatland ecosystems, especially those affected by the construction of drainage channels, affected by the modification of the water regime, affected by the spread of invasive

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species, affected by grazing or those affected by the peat exploitation, there was found a reduction in their capacity to form peat and to store carbon (Bonn et al., 2017).

In the case of drained peatlands, colonizing species may have an invasive character that can lead to a decrease in water level and to a increasing of the evapotranspiration rate. By increasing the spread area of the colonizing species may be affected characteristics species such as bryophytes (eg *Sphagnum magellanicum*, *Sphagnum centrale*), plant species (eg *Drosera rotundifolia*, *Carex nigra*, *Menyanthes trifoliata*, etc.) or animal species (*Emys orbicularis* , *Hyla arborea*).

2. MATERIALS AND METHODS

Within the PeatRo project (Restauration strategies of the deteriorated peatland ecosystems from Romania), during 22.09-30.09.2017 has been carried out restoration activities at the ROSCI0112 Mlaca Tătarilor site by specialists from the Institute of Biology of the Romanian Academy, specialists from S.C. MULTIDIMENSION S.R.L and other volunteers (Restauration strategies of the deteriorated peatland ecosystems from Romania (PeatRo), 2017).

The protected area of Mlaca Tătarilor has an area of approximately 4 ha and is located in Sibiu county in the proximity of the locality Arpaşu de Sus, at an altitude of 548 m. Also this area was declared a site of community importance for habitat 7150 - Depressions of peat substrates of the *Rhynchosporion* and for the species *Emys orbicularis* and *Triturus cristatus* (Ministry of Environment, Water and Forests, 2016)

The restoration activities of the Mlaca Tătarilor peatland were:

- Manual extraction of *Betula pendula* and *Rhamnus frangula* individuals from the central area of the peatland
- Building an soil dam that blocked the drainage channel in the north-east area of the peatland
- Construction of a twigs dam that blocked the drainage channel in the north-west of the peatland
- Construction of a water redirection channel located in the south-eastern part of the peatland
- Blocking access to the peatland (to prevent grazing) (Restauration strategies of the deteriorated peatland ecosystems from Romania (PeatRo), 2017)

In this paper we started from the hypothesis according to which: The rate of evapotranspiration in the Mlaca Tătarilor peatland can be reduced by decreasing the spread area of the colonizing species *Betula pendula* and *Rhamnus frangula*. We present in Fig. 1 the input streams in peatland (precipitation water, surface water) as well as outflows from the peat (surface leakage, evaporation of water, transpiration of the colonizing species (*Betula pendula* and *Rhamnus frangula*)).

In order to estimate the evapotranspiration rate before and after the restoration activities, it was necessary to first estimate the transpiration rate of *Betula pendula* and *Rhamnus frangula* individuals and the rate of water evaporation before and after the restoration activities.

<u>Estimation of the transpiration rate for *Betula pendula* and *Rhamnus frangula* individuals</u>

To estimate the transpiration rate, it was necessary to first estimate the foliar surface of the individuals of *Betula pendula* and *Rhamnus frangula*.

For *Betula pendula* we considered: individuals with a diameter of 2, 5, 10, 20 cm, foliar surface/ individual (m^2) for each diameter (Gorbon et al., 2003), estimated number of individuals in the peatland for each diameter. After we multiplied the foliar surface/individual (m^2) for each diameter with the estimated number of individuals in the peatland for each diameter, we have obtained the foliar surface/ number of individuals of *Betula pendula* expressed in m^2 for each diameter. Thus, after I summarized the foliar surfaces for each diameter, we found the total foliar surface for all individuals of *Betula pendula*.

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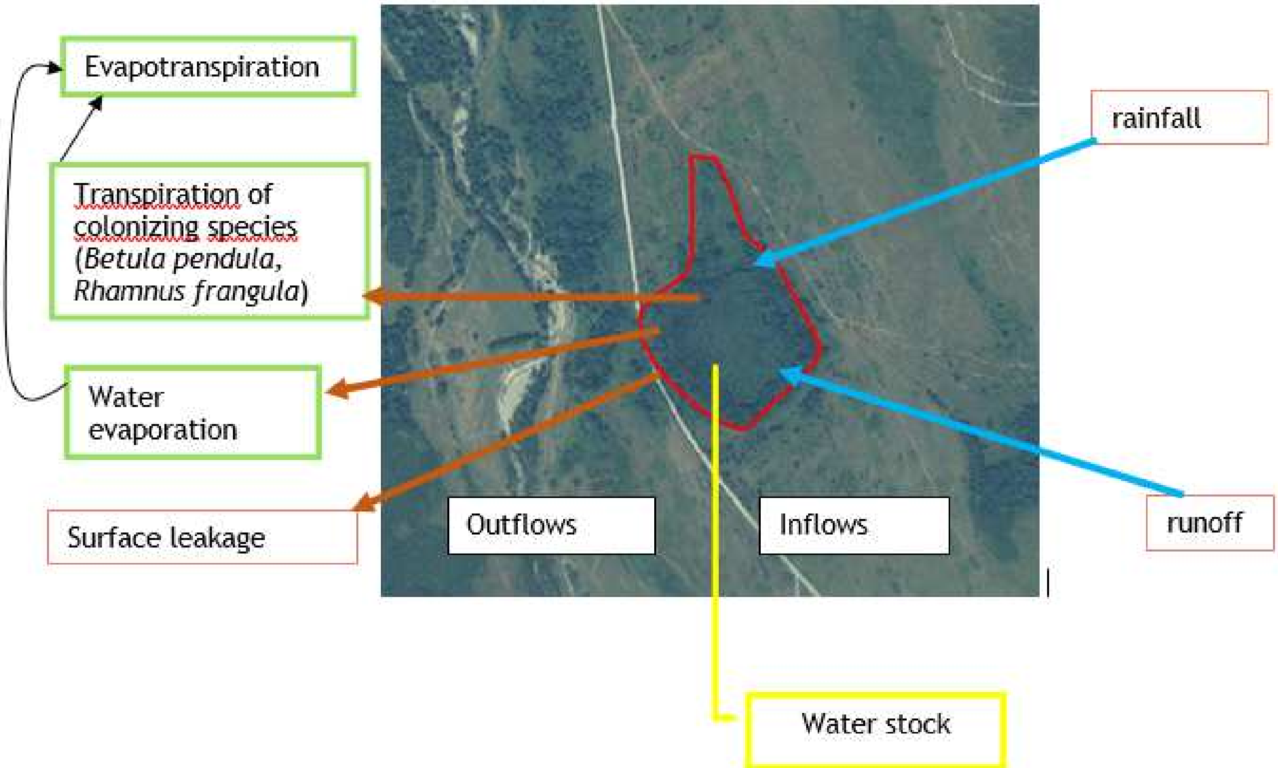

Figure 1. The conceptual model applied to the protected area of the Mlaca Tătarilor

For *Rhamnus frangula* we considered: individuals with a diameter of 2.5 cm, foliar surface/ individual (m^2) for a diameter of 2.5 cm (Eschenbach and Kappen, 1996), estimated number of individuals in the peatland wich have a diameter of 2,5 cm. After we have multiplied the foliar surface/individual (m^2) with the estimated number of individuals in the petaland for a diameter of 2.5 cm, we have obtained the foliar surface / number of individuals of *Rhamnus frangula* expressed in m^2.

To estimate the transpiration rate of *Betula pendula* individuals: we multiplied the foliar surface/ number of *Betula pendula* individuals with the transpiration rate expressed in Kg H_2O /m^2/ day (Kramer and Kozlowski, 1979) and we obtained the transpiration rate for the individuals of *Betula pendula* at 5, 10, 15, 20, 25, 30 days. Also, the transpiration rate at the given day intervals is summed.

To estimate the transpiration rate of *Rhamnus frangula* indviduals: we multiplied the number of individuals of *Rhamnus frangula* with the transpiration rate expressed in Kg H_2O/individual/day (Singh & Thompson, 1993) and we obtained the transpiration rate for individuals of *Rhamnus frangula* at 5, 10, 15, 20, 25 , 30 days. The transpiration rate for *Rhamnus frangula* at the given day intervals is also summed.

<u>Estimating the evaporation rate of water before and after the restoration activities</u>

To estimate the water evaporation rate before restoration, we used weather data (Weather archive in Făgăraş, 2016) for wind speed (m/s), temperature (degrees Celsius) and humidity (%) for 12 months of 2015.

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Also, to find the number of hours of sunshine/day from 2015, we used a sunrise and sunset computer (Sunrise and sunset computer from world, 2016), and to find the evaporation rate of water (mm/day), we used monthly data on wind speed (m/s), temperature (degrees Celsius), humidity (%) and number of hours of sun/day that we entered in an evaporation calculator (Lenntech, 2016).

After we found the water evaporation expressed in mm/day we converted into liters/m^2. Also following field measurements with GPS we found out the surface water storage before and after the restoration. Thus, after multiplying the water evaporation rate (liters/m^2) with the surface water storage before and after the restoration, we found out the evaporation rate of water before restoration and after restoration for a period of 12 months.

Estimating the evapotranspiration rate before restoration and after restoration

To estimate the evapotranspiration rate before restoration for each month of the year, we summed up the transpiration rate of *Betula pendula* and *Rhamnus frangula* with the evaporation rate of water before restoration, and we obtained the evapotranspiration rate for each month of the year before the restoration activities. Also in the same way we calculated the evapotranspiration rate after restoration, but the transpiration rate for the two species we summed up with the evaporation rate of water after restoration. For the two evapotranspiration rates we converted from kg of water/month into m^3 of water/month (Figure 4).

Calculations of the transpiration rate for the two species, some of the evaporation rate estimates and those for estimating the evapotranspiration rate were made in the Excel program (Report on the cost-benefit assessment of the restoration/reconstruction activities for all types of peatland ecosystems affected by draining Case study: Protected area Mlaca Tătarilor (ROSCI0112), 2016)

3. RESULTS AND DISCUSSIONS

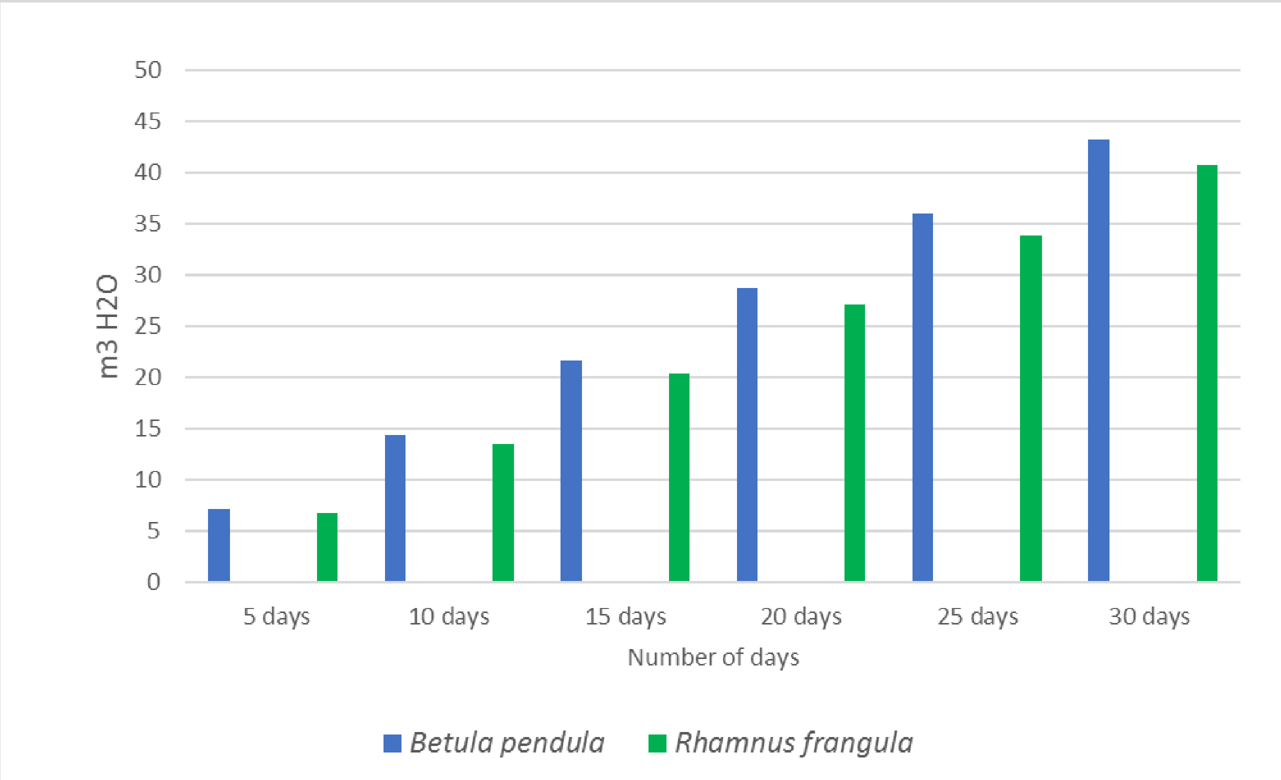

Figure 2. Estimation the transpiration rate for individuals of Betula pendula and Rhamnus frangula

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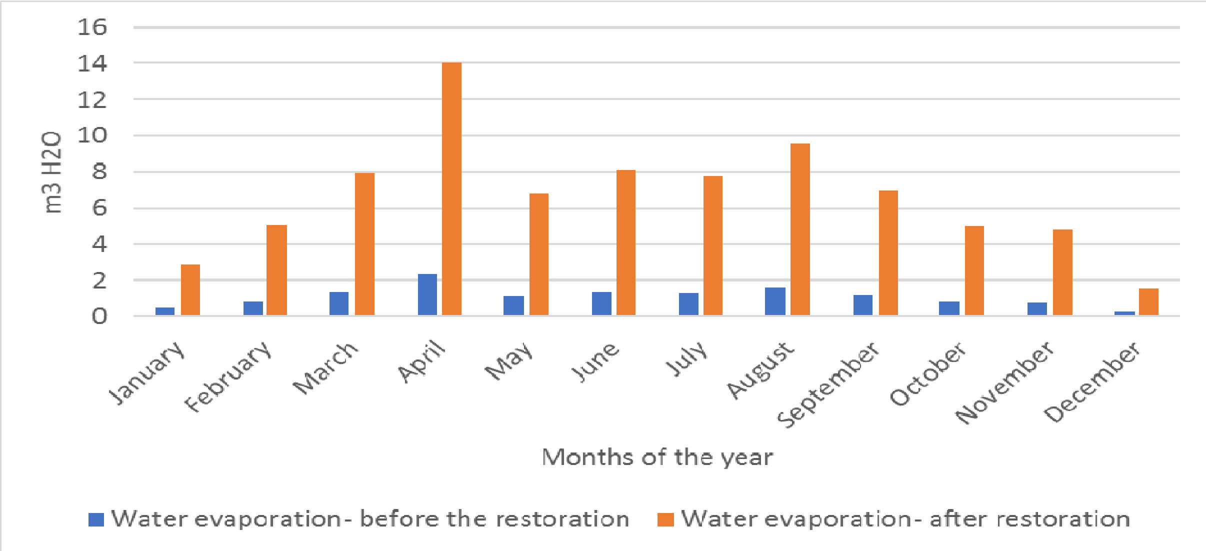

Figure 3. Estimation the evaporation rate of water in Mlaca Tătarilor peatland

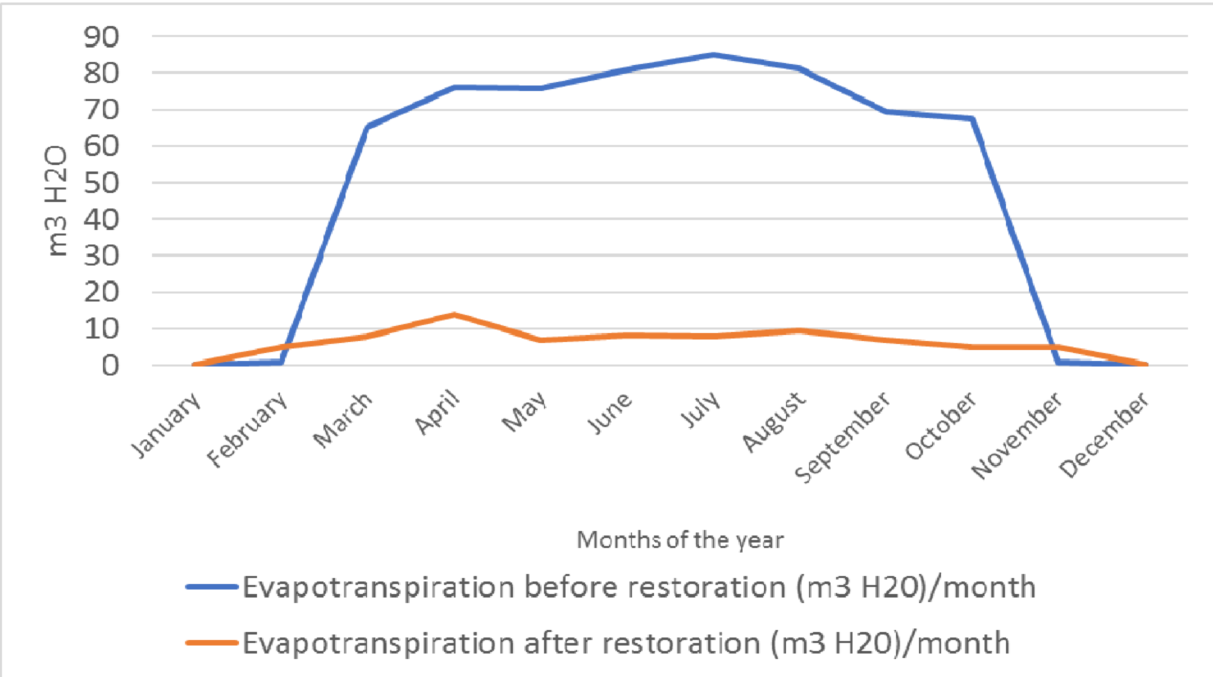

Figure 4. Evapotranspiration rates in Mlaca Tătarilor peatland

The transpiration rates are expressed for a period of 30 days and are summed up. It can also be observed that the transpiration rate is higher for *Betula pandula* because this species has a transpiration rate of 0.240 Kg H2O/m^2/day while *Rhamnus frangula* has a transpiration rate of 0.110 Kg /H2O/individual/day (Figure 2).

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Thus, in Figure 3, it can be seen that the water evaporation rate is higher after the restoration because the surface of the open water is 8450 m^2 while before the restoration the surface of the open water was 1400 m^2.
Following the summation of the transpiration rate for individuals of *Betula pendula* and *Rhamnus frangula* over a period of 30 days and the rate of water evaporation before restoration, we obtained the evapotranspiration rate before restoration. In the case of the evapotranspiration rate after the restoration, we did the same. Thus, in Figure 4 it can be seen that the evapotranspiration rate has decreased by over 90% due to restoration activities.

4. CONCLUSIONS

In the case of drainaged peatland ecosystems, it is recommended that their restoration be done by manual works with the help of specialists and volunteers.
By removing the colonizing species from the drained peatland ecosystems, the water regime will be restored and the necessary support for the development of the characteristic species will be ensured.
It is important that after restoration work, to be implemented a monitoring program in order to see if the peatland ecosytems are improving their state to a favorable conservation status.
It is also important for the local population to be informed about restoration activities, in order to be aware about the role of habitats and characteristic species in the provision of ecosystems resources and services.
Individuals of *Betula pendula* have a higher transpiration rate because the transpiration rate/ m^2/day is higher than the individuals of *Rhamnus frangula*, and are individuals of different ages. The water evaporation rate is higher after the restoration activities, because the surface of the open water has been enlarged.
The hypothesis aceptance confirms that: the evapotranspiration process in the Mlaca Tătarilor peatland can be reduced by diminishing the spreading area of the colonizing species *Betula pendula* and *Rhamnus frangula* – improving signicantly the hydrological regim of the peatland.

5. REFERENCES

Bonn, A., Holden, J., Parnell, M., Worrall, F., Chapman, P.J., Evans, C.D., Termansen, M., Beharry-Borg, N., Acreman, M.C., Rowe, E., Emmett, B., Tsuchiya, A. (2017). *Ecosystem services of peat – Phase 1 Project code: SP0572, Defra, 1-3*, Retrieved May 14, 2017, from www.randd.defra.gov.uk

Eschenbach, C., Kappen, L. (1996). *Leaf area index determination in an alder forest: a comparison of three methods, Journal of Experimental Botany*, *47*, 1457-1462.

Gorbon, N., Pinty, B., Verstraete, M., Widlowski, J.L., (2003). *Allometric Relationships of Selected European Tree Species, Institute for Environment and Sustainability EUR 20855 EN, EC Joint Research Centre, 8-14*

Kramer, P., Kozlowski, T. (1979). *Physiology of Woody Plants, United States of America: Academic Press, Inc*, 409-419. Retrieved May 06, 2017, from https://books.google.ro/books?hl=ro&lr=&id=yzOtjD7KA4kC&oi=fnd&pg=PP1&dq=kramer+p+kozlowski+theodore&ots=MKkOucE2lk&sig=0bBn5av5cRE5kmTNt5zZ0zTZILI&redir_esc=y#v=onepage&q=kramer%20p%20kozlowski%20theodore&f=false

Mihăilescu, S., Strat, D., Cristea, I., Honciuc, V. (2015). *Synthetic report of the conservation status of species and habitats of community interest in Romania*, Constanța: Dobrogea.

Singh, K.A., Thompson, F.B. (1993). *Effect of lopping on water potential, transpiration, regrowth, 14C-photosynthate distribution and biomass production in Alnus glutinosa, Tree Physiology*, *15*, 197-199.

**** PLANUL DE MANAGEMENT AL ROSCI0122 MUNȚII FĂGĂRAŞ ŞI ROSPA0098 PIEMONTUL FĂGĂRAŞ.* Retrived March 23, 2016, from http://www.mmediu.ro/app/webroot/uploads/files/2016-03-23_Planul_Management_Muntii_Fagaras_Piemontul_Fagaras.pdf

**** Restauration strategies of the deteriorated peatland ecosystems from Romania (PeatRo)*. (2017). Retrieved from http://www.ibiol.ro/peatro/rezultate.htm

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*** *Report on the cost-benefit assessment of the restoration/reconstruction activities for all types of peatland ecosystems affected by draining Case study: Protected area Mlaca Tătarilor (ROSCI0112)*, (2016) Institute of Biology - Bucharest, Romanian Academy.

*** *Weather archive in Făgăraş*, Retrieved December 06, 2016, from https://rp5.ru/Arhiva_meteo_%C3%AEn_F%C4%83g%C4%83ra%C5%9F

*** *Sunrise and sunset computer from world*, Retrieved December 08, 2016, from http://www.fasterre.s21.o12.pl/timeadate.eu/pages/ro/sunrise-calc-ro.html

*** *Evaporation of water*, Retrieved December 10, 2016, from http://www.lenntech.com/calculators/evaporation-of-water.htm

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