Influence of contamination with diesel oil on sandy loam soil sorptivity

Jerzy Weber[1], Edyta Hewelke[2], Dariusz Gozdowski[2], and Piotr Hewelke[2]

[1]Uniwersytet Przyrodniczy we Wroclawiu
[2]Szkola Glowna Gospodarstwa Wiejskiego w Warszawie

May 29, 2022

Abstract

This paper present results on soil contamination with petroleum hydrocarbons (PHs) on soil sorptivity and hydrophobicity under different soil moistures. The micro-infiltrometer method was used in laboratory experiment to determine the soil water repellency index (R) and the water drop penetration time (WDPT) test. The increase in PHs contamination contributed to soil repellency and caused a decrease in water sorptivity. The negative effect of contamination with PHs on soil sorptivity depended on soil moisture and was marked especially clearly after exceeding the critical moisture threshold. However, contamination by PHs did not reveal significant changes when ethanol was used instead of water. The R index and the WDPT test revealed a similar trend, inversely related to the level of soil contamination with PHs. The total amount of water available to plants in non-contaminated soil was 19.04%, while contamination equal to 100 g kg $^{-1}$ caused a decrease to 6.36%. Hydrophobization of water-conducting pore surfaces by petroleum hydrocarbons severely reduced infiltration and destroyed the existing hydrological system of naturally hydrophilic soil. The almost three-fold decrease in total amount of water has a fundamental influence on increasing the risk of soil drought. The soil water repellency causes a decrease in resistance to droughts and slows the alimentation process of soil water retention. The results obtained indicated that the interrelations presented between the level of PHs contamination, soil sorptivity, water repellency, and soil moisture are key to predicting the environmental effects of contamination and effective soil remediation.

Hosted file

`manuscript.docx` available at https://authorea.com/users/485661/articles/570974-influence-of-contamination-with-diesel-oil-on-sandy-loam-soil-sorptivity

Figure 1.

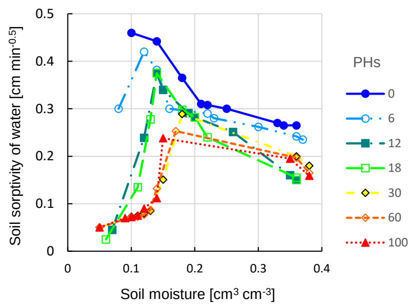

Soil sorptivity of water [cm min-0.5]
Soil moisture [cm3 cm-3]
PHs
0
6
12
18
30
60
100

Figure 2.

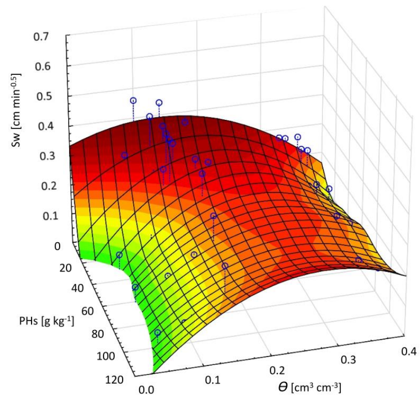

0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Sw [cm min-0.5]
20
40
60
80
100
120
PHs [g kg-1]
0.0
0.1
0.2
0.3
0.4
Θ [cm3 cm-3]

Figure 3.

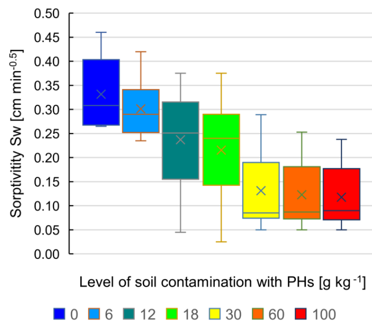

Sorptivitity Sw [cm min-0.5]
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Level of soil contamination with PHs [g kg-1]
0
6
12
18
30
60
100

Figure 4.

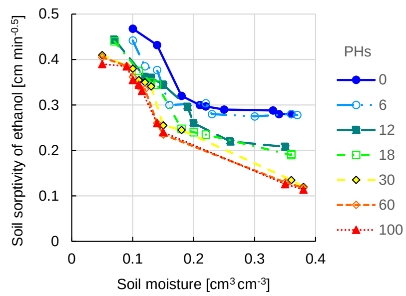
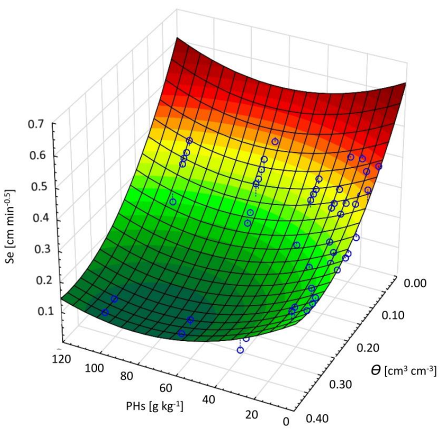

0.5
0.4
0.3
0.2
0.1
0
Soil sorptivity of ethanol [cm min^-0.5]
0
0.1
0.2
0.3
0.4
Soil moisture [cm^3 cm^-3]
PHs
0
6
12
18
30
60
100

Figure 5.



0.7
0.6
0.5
0.4
0.3
0.2
0.1
Se [cm min-0.5]
120
100
80
60
40
20
0
PHs [g kg-1]
0.00
0.10
0.20
0.30
0.40
Θ [cm3 cm-3]

Figure 6.

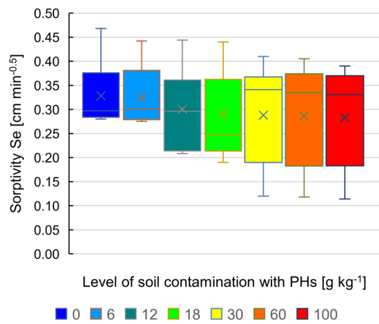

0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Sorptivity Se [cm min-0.5]
Level of soil contamination with PHs [g kg-1]
0
6
12
18
30
60
100

Figure 7.

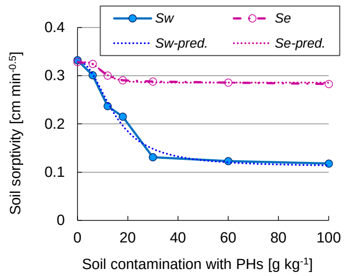

Sw
Se
Sw-pred.
Se-pred.
0.4
0.3
0.2
0.1
0
Soil sorptivity [cm min$^{-0.5}$]
0
20
40
60
80
100
Soil contamination with PHs [g kg^{-1}]

Figure 8.

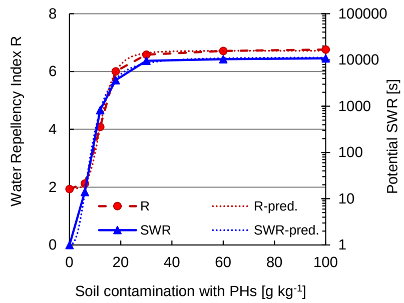
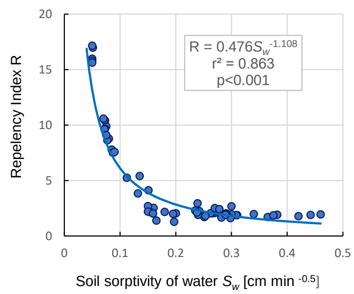

Water Repellency Index R
Potential SWR [s]
Soil contamination with PHs [g kg-1]
R
R-pred.
SWR
SWR-pred.
0
2
4
6
8
1
10
100
1000
10000
100000
0
20
40
60
80
100

Figure 9.



Hosted file

table 1.docx available at https://authorea.com/users/485661/articles/570974-influence-of-contamination-with-diesel-oil-on-sandy-loam-soil-sorptivity

Hosted file

table 2.docx available at https://authorea.com/users/485661/articles/570974-influence-of-contamination-with-diesel-oil-on-sandy-loam-soil-sorptivity

Hosted file

table 3.docx available at https://authorea.com/users/485661/articles/570974-influence-of-contamination-with-diesel-oil-on-sandy-loam-soil-sorptivity

Hosted file

table 4.docx available at https://authorea.com/users/485661/articles/570974-influence-of-contamination-with-diesel-oil-on-sandy-loam-soil-sorptivity