CONTAMINATION SITES 2015
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PHYTOREMEDIATION TECHNOLOGY FOR CONTAMINATED SITES IN KHARKIV REGION, EAST UKRAINE

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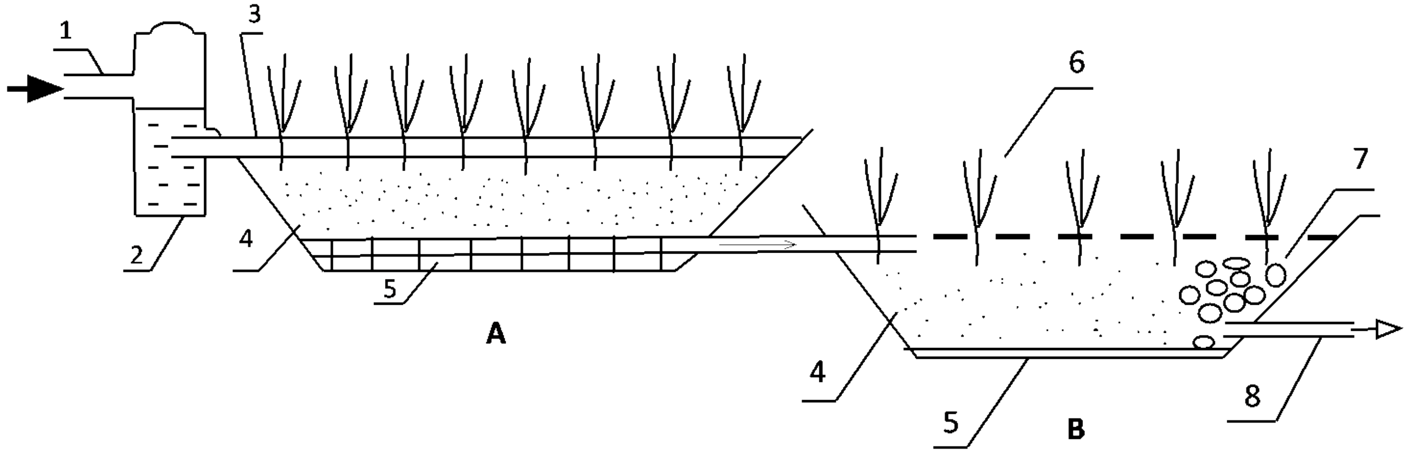
Problem statement

- Since 90^{th} of the last century phytotechnology is widely applied in East Ukraine for remediation of wastewaters, sludge and soil
- The most popular technology in Kharkiv region (c.a. 3000000 inhabitants) is constructed wetlands.

Constructed wetlands



A – vertical flow unit and *B* – horizontal subsurface flow unit:
1 – influent; 2 - sedimentation tank; 3 – clarified wastewater; 4 – filtering substrate; 5 – drainage pipes; 6 – macrophytes; 7 – drainage and 8 – effluent

Efficiency depends on inlet contaminants concentrations, hydraulic loading, pH, redox conditions, temperature, presence/absence of the consortium plants/bacteria, species variability and anthropogenic factors

Constructed wetlands generally show high efficiency in removal of suspended solids, BOD_5 and COD

The net life-cycle energy outputs can be used for biofuel production

Objectives

This work aimed at assessing the performance of CWs in Kharkiv region, Ukraine by

(i) monitoring chemical parameters (pH, BOD_5, COD, suspended solids, surfactants, orthophosphates and total nitrogen) of wastewaters effluents and influents on operated CWs in rural areas

(ii) evaluating the operating conditions of the CWs and their efficiency to treat domestic wastewaters

(iii) comparing their treatment efficiency to the conventional wastewater treatment facilities.

Study area

(i) 37 CWs were selected at the first step and 80% of them were excluded later because of the 'non operating' conditions

(ii) nine so called 'bioplato' hybrid CWs were assessed

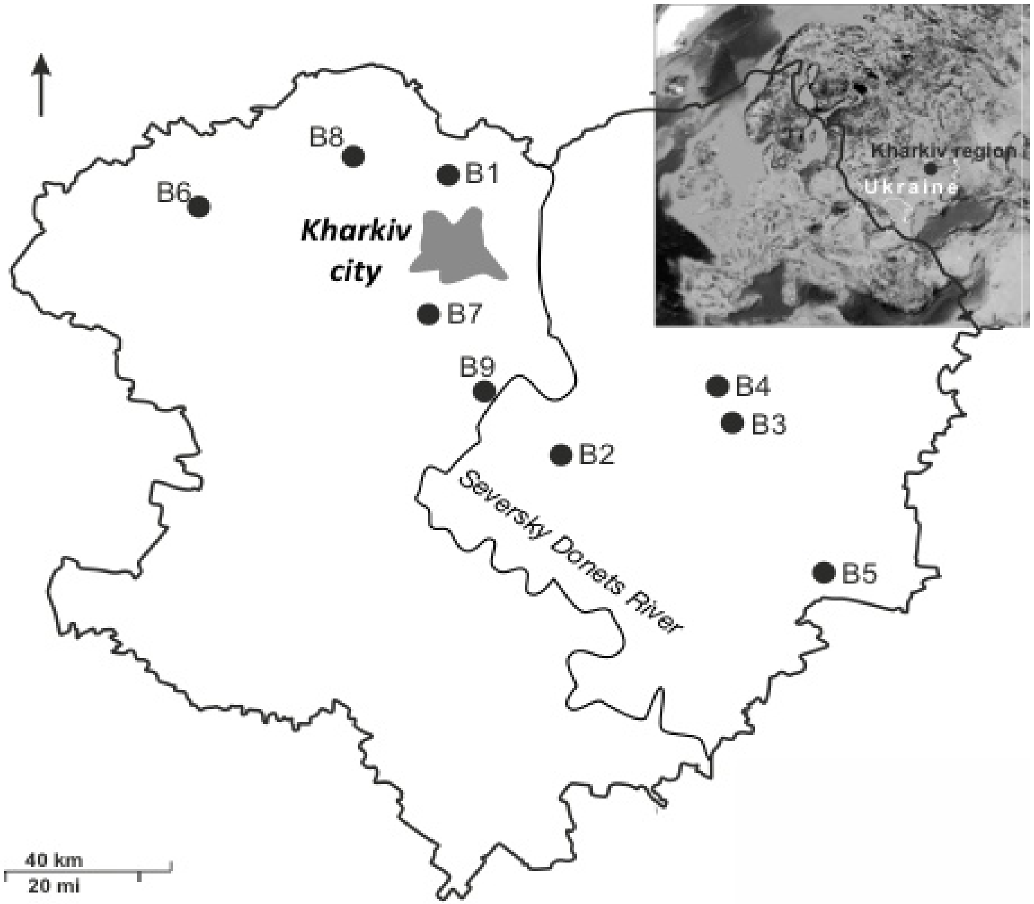
(iii) CWs were located in different parts of the region and were designed in the same way

(iv) B1, B3, B4, B6 and B9 treat domestic wastewaters from small towns and rural settlement

(v) B7 and B8 treat effluents from hospitals

(vi) B2 prison

(vii) B5 orphan house



Kharkiv region:
c.a. 31,000 sq. km
c.a. 3,000,000 inh.
Contintental climate

Sampling strategy and methods

Wastewater samples were taken at each site from inlet and outlet points in October 2012, 2013 and 2014.

Samples were analyzed on pH, hardness, mineralization, SS, COD, BOD_5, surfactants, orthophosphates, NH^+_4, NO^-_2, NO^-_3 and DO.

The removal efficiency was estimated using the following formula:

$$\Delta C_i\,(\%) = (1 - C_i^{out} / C_i^{in}) \times 100\%$$

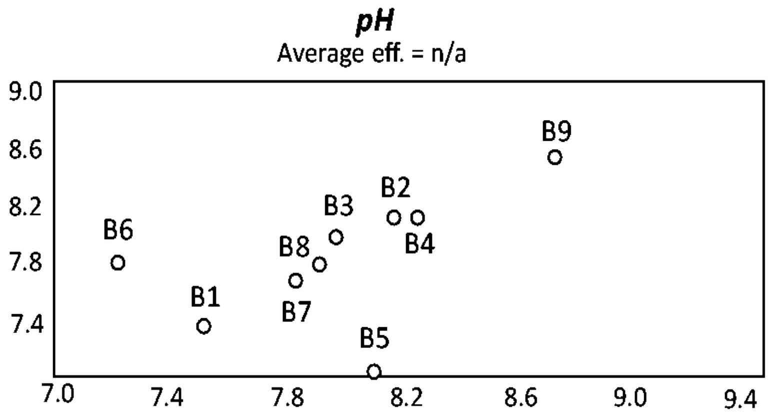
According to the removal efficiency CWs were ranked as:

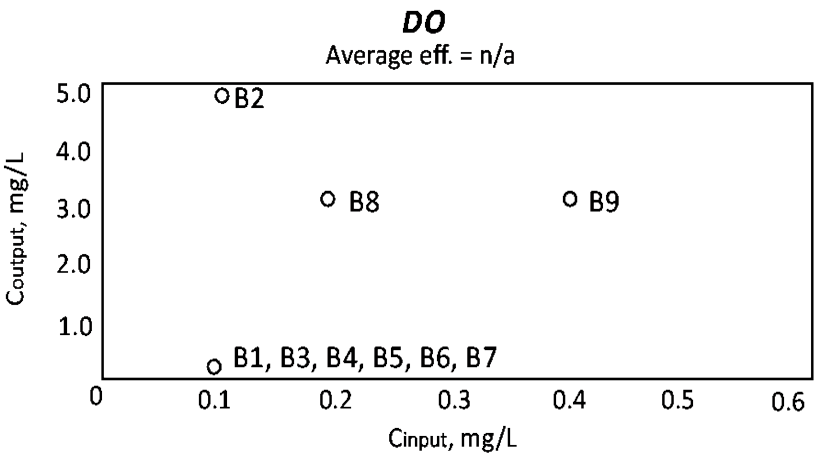
(i) low efficiency facilities (less than 50%);

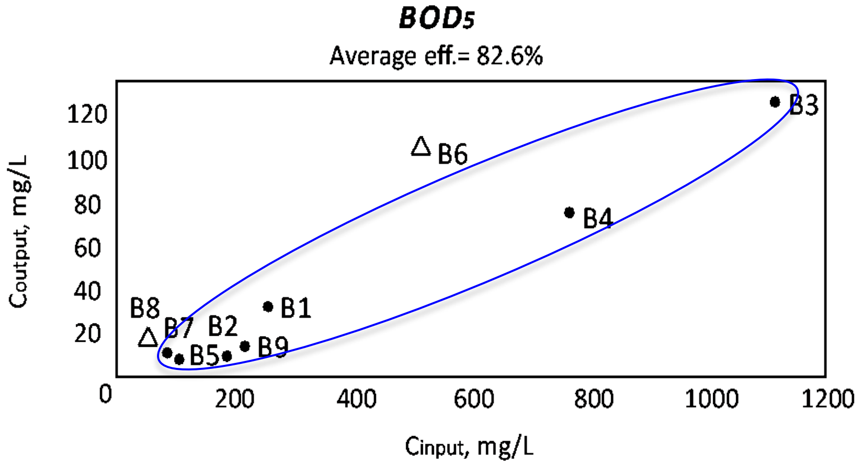
(ii) medium efficiency facilities (from 50 to 80 %)

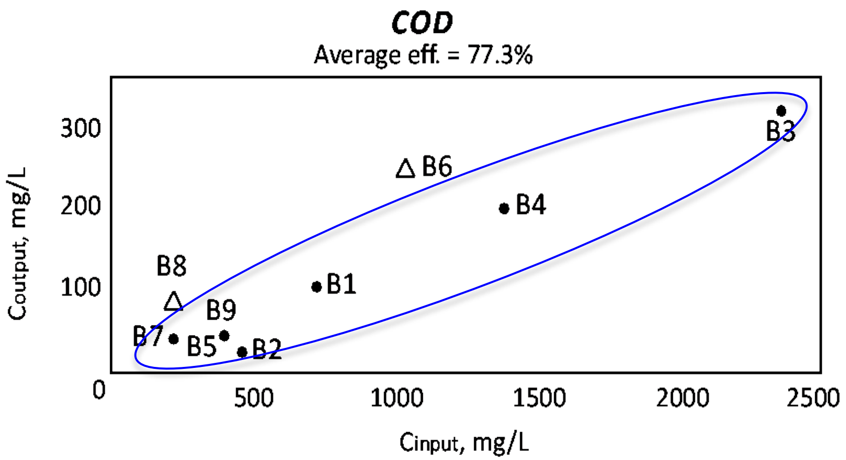
(iii) high efficiency facilities (more than 80%).

Inputs vs. outputs concentration - 1



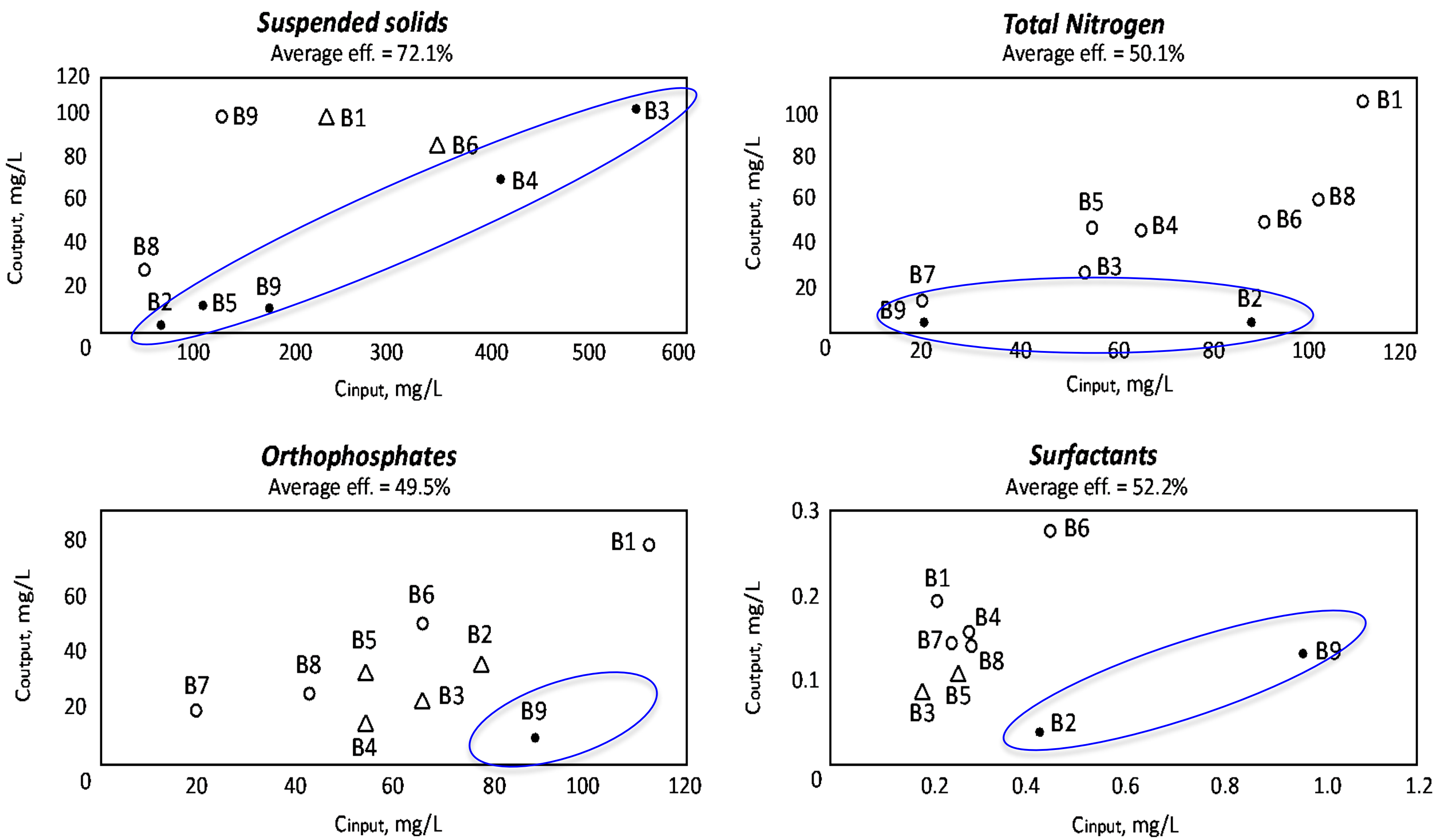






BOD5 and COD – high removal on most of CW

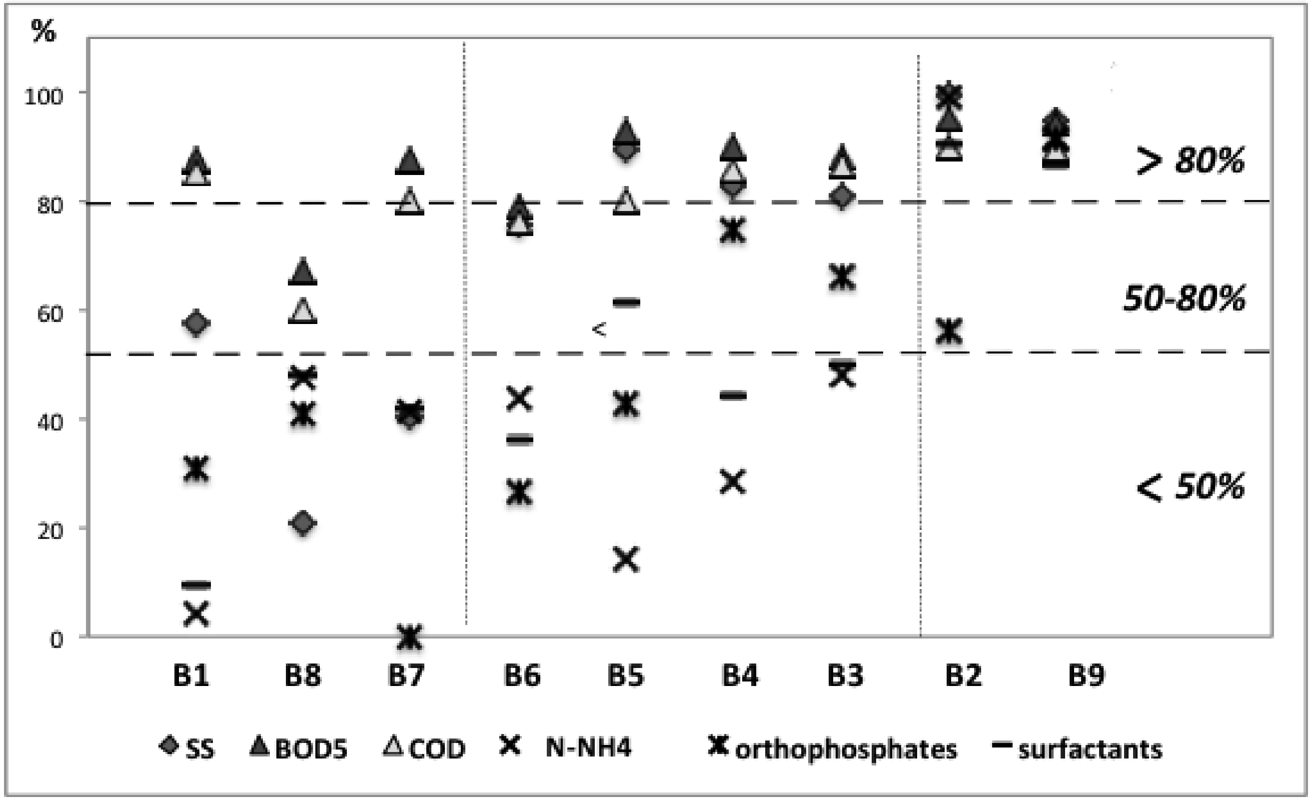
Inputs vs. outputs concentration - 2



Total N – low removal on most of CW

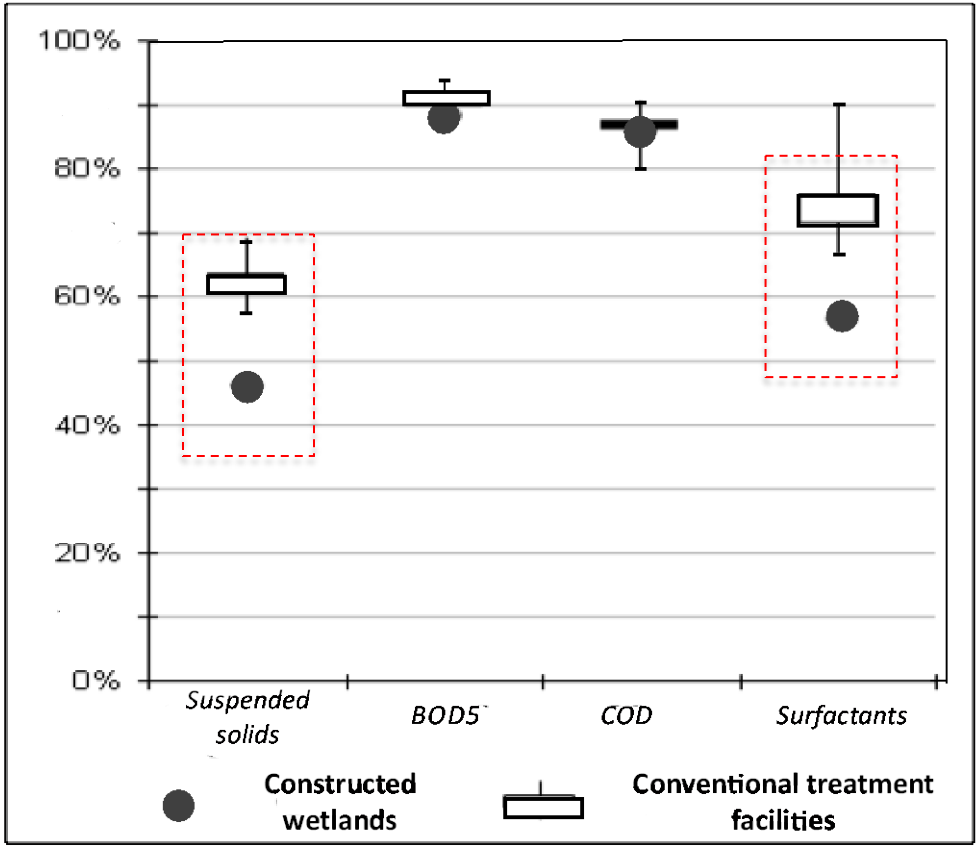
Surfactants and orthophosphates – high removal only on few CW

Arrangement of CWs according removal efficiency



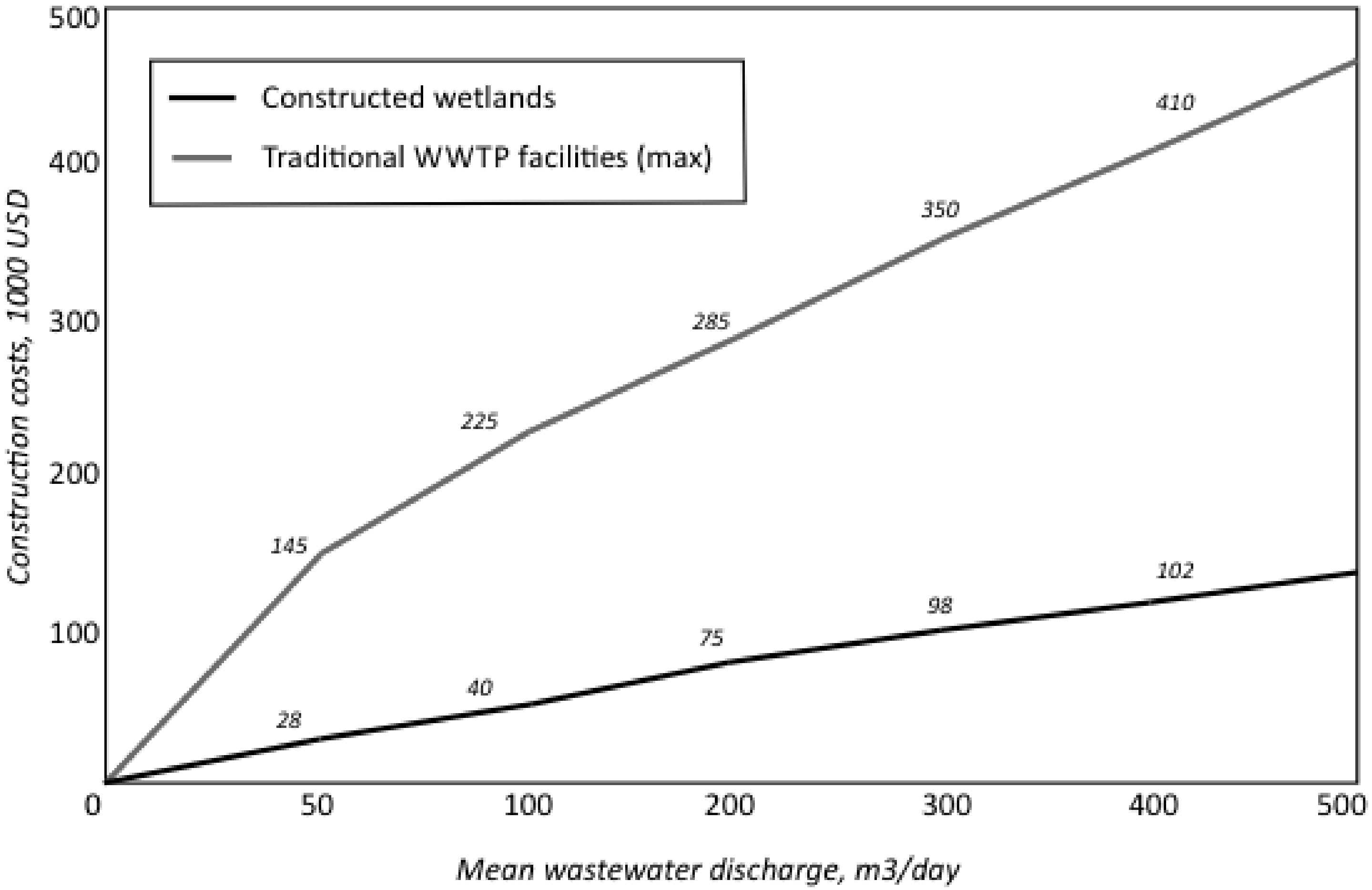
(i) Functioning and/or maturation issues (clogging, shading, matrix, saturation, decrease in retention time, appearance of preferential hydraulic pathways, etc.)
(ii) The system enhancement and continuous control

The comparison of the removal efficiency of conventional WWTF and CWs in Ukraine



CWs had lower removal efficiency of surfactants and SS

The comparison of the construction costs of conventional WWTF and CWs in Ukraine



The minimum maintenance to increase the removal efficiency of CWs

(i) keeping unit surface wet but non-flooded while macrophytes emerge

(ii) keeping stable wastewater table level as required for summer and winter operation regimes

(ii) cleaning sedimentary tanks and removal of excess sludge when needed

(iv) measuring wastewater flow rate

(v) regulate extra wastewater volume to prevent treatment units overfilling

(vi) overall supervising and keeping the constructed wetland site in proper conditions

Public awareness

- What the public afraid of?
- changes…(landscapes, transport, new people)
- pollution…(i.e. wells, gardens, air)

- Why?
- no additional information (board, explanations)
- no public involvement

- What to do?

Understand and Follow community interests!

Conclusions

- CWs in Kharkiv region were efficient to remove organics (by BOD_5 and COD indicators) and SS
- The removal efficiency of contaminants at CWs was mainly dependent on inflow concentration, design, maintenance parameters and operating conditions
- CW has the same level of the removal efficiency of organics as WWTF, but lower construction and maintenance costs
- Operational conditions should be adjusted to the inflow concentrations and received wastewater volume
- The further development of the research will be focused on the nitrogen removal in CWs, application of phytoremediation for contaminated sites after military actions.

Prohody CW built in 1998, Kharkiv region