MODELLING OF THE WETLAND PROCESSES BASED ON THE PRIMROSE DATABASE – AN ASSEMBLE OF DATA FROM 28 EUROPEAN TREATMENT WETLANDS.

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Abstract: The paper presents a treatment wetland database where data have been collected within the EU 5th FP RTD project PRIMROSE, (2000 – 2003). The PRIMROSE database is the first assemble of a wide-ranging set of information concerning the construction, performance, plant and wildlife habitat use, and economy from 28 European treatment wetlands. Most systems treat domestic wastewaters. The database contains data about: location, climatic condition, design, load / performance, wildlife, vegetation and costs. Regressions for wetland nutrient removal can be obtained from the dataset. The database may also be useful to test models for nutrient flow in watershed. The data is free and available on Internet.

Keywords: Constructed wetlands, database, design, nutrient removal performance, modelling.

INTRODUCTION

Natural and constructed wetlands have been used for receiving and treating a broad variety of wastewaters for over 20 years. Hundreds of treatment wetlands exist in the Europe, and new systems are designed and implemented. In modelling of nutrient transport in watershed, there is a need for empirical basis for factors and coefficients to put into the model at different stages, and for testing the different parts of the models. This article gives an introduction to the PRIMROSE database that can give input to the works of modelling watershed nutrient flows.

The North American Wetland Treatment System Database (NADB) (Knight 1994). has provided a basis for empirical removal coefficients for typical American constructed wetlands. These data do however lack some typical European wetland characteristics regarding size and designs since the two most common types of wetlands used in the North America are larger free water surface (FWS) and vegetated submerged bed (VSB). The Primrose database is the first assemble of

28 North European wide-ranging wetland treatment systems, with information concerning the construction, climatic conditions, nutrient removal performance, plant and wildlife habitat use, and economy.

TYPES AND LOCATION OF THE WETLANDS IN THE DATABASE

All wetlands are in the northern part of Europe, ranging from nemoral to arctic climatic conditions. The location, climatic region and wetland type is presented in table 1.

Table 1. Data from 28 locations in northern Europe collected in the PRIMROSE database.

Site name	Constructed wetland type	Waste water type	Climatic region	Country
Alhagen	FWS 1	Municipal waste water	Boreal	Sweden
Brannäs	FWS 1	Municipal waste water	Boreal	Sweden
Ekeby	FWS 1	Municipal waste water	Boreal	Sweden
Magle	FWS 1	Municipal waste water	Boreal	Sweden
Tveter	GWS	Municipal waste water	Boreonemoral	Norway
Skalstugu	FWS 1	Municipal waste water	Boreal	Norway
Bogstad	GWS	Municipal waste water	Boreonemoral	Norway
Skjønhaug	FWS 1	Municipal waste water	Boreonemoral	Norway
Spillhaug	FWS 2	Landfill leachate	Boreal	Norway
Haugstein	GWS	Municipal waste water	Boreonemoral	Norway
Østegården	GWS	Municipal waste water	Boreonemoral	Norway
Bølstad	GWS	Landfill leachate	Boreonemoral	Norway
Grimsdal	GWS	Municipal waste water	Arctic	Norway
Berg	FWS 1	Agricultural runoff	Boreal region	Norway
Nowa Slupia	GWS	Municipal waste water	Nemoral	Poland
Darzlubie	GWS	Municipal waste water	Nemoral	Poland
Mniow	FWS 1	Municipal waste water	Nemoral	Poland
Kompsa	OGF	Peat mining drainage	Boreal	Finland
Hovi	FWS 1	Agricultural runoff	Boreonemoral	Finland
Lakeus	FWS 1	Municipal waste water	Boreal	Finland
Alastaro	FWS 1	Agricultural runoff	Boreal	Finland
Flytträsk	OGF	Agricultural and forest runoff	Boreonemoral	Finland
Ruka	OGF	Municipal waste water	Boreal	Finland
Aarike	OGF	Municipal waste water	Boreonemoral	Estonia
Kodijärve	GWS	Municipal waste water	Boreonemoral	Estonia
Tänassilma	FWS 2	Municipal waste water	Boreonemoral	Estonia
Põltsamaa	FWS 2	Municipal waste water	Boreonemoral	Estonia
Kõo	Combined	Municipal waste water	Boreonemoral	Estonia

FWS 1=Free water surface system, FWS 2=Free water surface system with little vegetation, GWS=Ground water flow in porous media systems, Combined=Combined overland and ground water flow.

DATASET CHARACTERISTICS

The database contain data about:

- Location –geographical and climatic conditions
- Wetland design – construction parameters, design drawings and pictures
- Load / performance – measurements of 19 parameters that gives information about the sites performance regarding to water treatment. The parameters are: BOD, calcined residues, chloride, COD, conductivity, NH_4, NO_3, N-total, O_2, O_2 saturation, pH, PO_4, P-total, Q, SS, E.coli, temperature TOC, turbidity.
- Wildlife – data about registered species in the wetland area.
- Vegetation – data about plant species in the wetland.
- Planning and design costs, construction costs, maintenance costs.

The PRIMROSE database contain data from 11060 water samples analysed on average 4,14 parameters, total up to 45 812 analysis. The distribution of analyzed parameters is given in table 2.

Table 2. Analysed water parameters in the PRIMROSE database per January 2004.

Parameter	***In (n)***	***Out (n)***	***Parameter***	***In (n)***	***Out (n)***
N-tot	*2153*	*2089*	*Calcined res.*	*16*	*28*
NH4-N	*2073*	*1996*	*O_2*	*93*	*185*
NO3-N	*1451*	*1777*	*O_2 saturatio*	*28*	*44*
P-tot	*2087*	*2025*	*Conductivity*	*758*	*708*
PO4-P	*1318*	*1388*	*E.coli*	*7*	*8*
TOC	*268*	*246*	*pH*	*1406*	*1597*
COD	*1381*	*1195*	*Chloride*	*421*	*341*
BOD	*1343*	*1259*	*Q*	*9515*	*3106*
Turbidity	*307*	*285*	*SS*	*1539*	*1371*
Total measurements	*45812*				

USING THE DATABASE FOR EVALUATING WETLAND PERFORMANCE

The database has built in some analyze tools as:

- Climatic and seasonal variation of performance (warm and cold periods). This is made to give the user an idea of how winter temperatures influences nutrient removals with different systems.
- Compare graph. The user chooses parameters and two wetland sites to compare their performance (figure 1). This graph gives the user opportunity to compare different systems or similar systems under various conditions as climatic factors, different discharge or nutrient load levels.
- Performance timeline graph. The user chooses parameters and one wetland site (figure 2). This graph gives an idea of the fluctuations of the removal performance.
- Retention graph. The user chooses two parameters (XY) and one wetland site. The effects of Y parameters from the chosen X parameters are presented with a trend line. The R^2 value is calculated (figure 3).

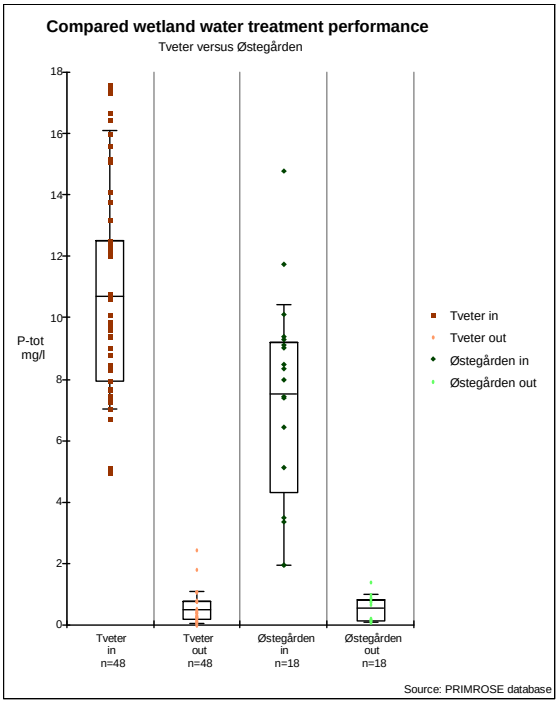

Figure 1. Comparing nutrient removal efficiencies between two wetlands.

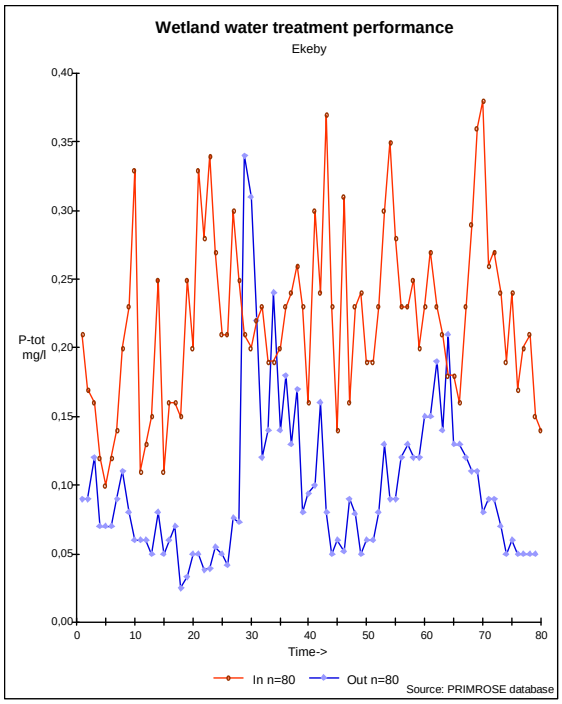

Figure 2. Nutrient removal efficiencies on a wetland is graphed in a timeline.

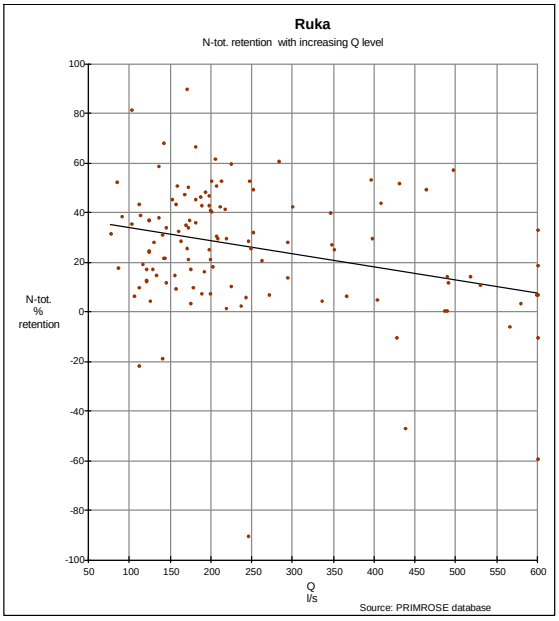

Figure 3. “Y by X” - graphs can be plotted for user defined parameters.

USING THE DATASET IN WATERSHED MODELLING

Regressions for wetland nutrient removal can be obtained from the database using external statistical software by exporting adequate subsets from the database. Table 3 gives examples of a regression for N-tot removal efficiencies by hydraulic load per square meter free surface wetland with rate boundaries from which they were derived. Similar extractions of the dataset can be used as a base for modelling specific issues. Another way of using the database may be to test an existing model, or to test coefficients used in a model, to see if the model comply with real data from similar conditions as the model is applied upon. The data is for free use as reference data in modelling work, but data may not be published without permission from respective wetland contact person.

Table 3: Example of a regression for N-tot removal from free water wetland systems (FWS) derived from the database.

Regression	R^2	N	Standard error removal	Data range	
				Q/A	C** mg/l
N-tot removal% = 45,62 – 282,09Q/A*	0,23	648	20,5	0,00002 -0,1928	1,4 - 196

* Q/A=hydraulic load per square meter ($m^3/d/m^2$)

** C= Inlet concentration

AVAILABILITY

The database is available as a free download on:

www.jordforsk.no/fagnat/Primrose/primrose_databasewp1.htm.

Download size is 45MB. The Primrose database is built in FileMakerPro and can run on both Windows and Macintosh systems.

Reference for the database is:

Borch, H., A. Poom, T. Mæhlum & B. Kløve. 2003. Primrose database - Constructed wetland for water treatment. CD-ROM ver. 1.0. Jordforsk 76/03. ISBN:82-7467-472-3.

It is the intention of the authors to increase the dataset by including more data from wetlands from a broader range of climatic regions and construction concepts. We will appreciate contact with persons who have dataset that they are willing to submit.

REFERENCES

Knight, R.L. 1994 - *Treatment wetland database now available.* Water Environmental Technology 6, 2, 31-33.