USE OF A WEB-BASED GIS TOOL FOR LOCAL WASTEWATER PLANNING IN NORWAY

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Abstract

In Norway about 800 000 small scale on-site wastewater plants are in operation in rural areas. Lack of knowledge of the treatment performance of many of these wastewater plants is hampering proper catchment management, as improper wastewater treatment can have severe impact on water bodies by causing eutrophication and fecal contamination. To improve catchment management, the tool "WebGIS Wastewater" has been developed by the Norwegian Institute for Agricultural and Environmental research (Bioforsk). WebGIS Wastewater is a GIS-based application for registration and municipal administration of on-site wastewater treatment plants. Based on information of each individual plant, such as type, age, load and geographical location, WebGIS Wastewater estimates the treatment performance for the particular plant and the total impact on the recipient water bodies from all decentralized treatment systems within a catchment area. The tool helps local authorities estimate the impact of decentralized sewage treatment systems on recipient water bodies otherwise difficult to measure. In addtion operation, control, maintenance and rehabilitation of systems is facilitated.

Keywords: GIS, management tool, onsite/decentralized wastewater treatment, water pollution, operation and maintenance

Introduction

In Norway almost 20 % of the population live in sparsely populated areas where construction of centralized infrastructure for wastewater treatment is regarded neither cost effective nor sustainable, due to high cost of implementation and maintenance. Thus, these households rely on on-site wastewater treatment plants for proper treatment and disposal of their wastewater. On-site wastewater plants have been constructed since the beginning of the 20th century. The first systems had a simple design, where the main purpose was wastewater disposal. During the 70's and 80's, research on the environmental impact of onsite systems resulted in restrictions and regulations refining the design (Bouma 1975, USEPA 1980, Winneberger 1984). Thus, modern small scale and decentralized systems are high performance treatment units that equal and even exceed the performance of large conventional systems (Heistad et al. 2006).

Due to implementation of the European Union's water framework directive there has been increased focus on the quality of water bodies. An important challenge is to identify different sources of pollution within a catchment. Today, there are approximately 800 000 on-site wastewater treatment plants (< 50 pe) operating in Norway (SSB 2008). The population of systems is heterogeneous and includes both old and new systems, and a large variety in design and function. Wastewater inadequate private wastewater treatment plants can cause serious pollution of streams and lakes. The most problematic effects are eutrophication and fecal contamination of water bodies and drinking water sources.

In order to meet national and European standards, many Norwegian municipalities need to ensure that malfunctioning and/or outdated on-site wastewater plants has to be upgraded or replaced entirely. To facilitate administration of this work, the Norwegian Institute for Agricultural and Environmental research (Bioforsk) has developed a web-based GIS (geographical information system) application, called ''WebGIS Wastewater''. The tool was developed during the 1990's, as part of the research programme, ''Natural systems for wastewater treatment (1994-1997) which focused on water pollution from on-site wastewater plants (Jenssen & Syversen 1996). In 2007, WebGIS Wastewater was awarded with a prize in the national environmental competition, ''The Glass Bear'' (Glassbjørnen), (Bioforsk 2007).

Methods

WebGIS Wastewater is based on the map system Map Server (open source) with models developed at Bioforsk Soil and Environment Division. The models are used for calculations of the treatment performance in the different wastewater plants, and for estimation of the impact on water bodies from wastewater discharges within a catchment. The treatment performances of the wastewater plants are given as discharge concentrations of phosphorus (P), nitrogen (N) and organic matter, measured as biological oxygen demand (BOD). The calculations behind the models are based on empirical data obtained from more than 20 years of research of on-site wastewater treatment systems, including septic tanks, soil infiltration systems, sand filters, constructed wetlands and small package treatment units.

In WebGIS Wastewater each on-site wastewater plants is recorded with its geographic location on map. Based on registered input information, such as type (e.g sandfilter), design, size, and age versus load of wastewater, the model calculates treatment performance of the individual system and the total pollution load from all the treatment plants within a catchment. By assessing the treatment performance of each wastewater plant, every system is graded by an environmental impact index from 1-5, where the grade 5 characterizes a system with severe environmental impact. The model also allows storage of administrative data and can generate reports, tables, statistics and graphical presentations of the status within a catchment. It is therefore well suited both for administrative purposes, and as a tool for making priority plans.

Results and discussion

Today, more than 50 municipal administrations in Norway use WebGIS Wastewater. One of the main motivations for the utilization is without doubt the European Union's Water framework directive and the subsequent need to assess where an upgrade of small on-site wastewater treatment plants should be prioritized. For this the aforementioned environmental impact index indicates from which on-site system the pollution is most serious, hence facilitating prioritization.

Watersheds are often shared between two or more municipalities, which motivates finding their relative contribution of pollutants to the watershed. Although not necessary, using the same tool between municipalities allows for comparisons with little difficulty. This is seen among others in the Norwegian watersheds of Halden and Jæren (Turtumøygard & Blankenberg 2006; Turtumøygard & Eggen 2008).

The web-based GIS tool is under continuous development and improvement thanks to frequent dialogue between developer and user. A web based tool is in itself potentially very dynamic and general improvements at the central server can immediately be seen by all users. The possibility to tailor versions of the tool for municipalities with special needs is also crucial. The characteristics of catchments can vary significantly between different regions, and the tool can thus be flexible and incorporate functions particular to the needs of the municipality in question without being seen by all users. This could be special biological or chemical parameters of particular interest to estimate water quality in a region, where models/functions are added to the tool. In the same way, special reports can be made that compile data in different manners according to the need of the user and outside of what are the standard reports that the tool can produce.

A GIS tool that estimates pollutant loads from decentralized on-site wastewater treatment plants to watersheds within a region is expected to be increasingly important to authorities, local and central, guided by the Water framework directive. It shows the catchment areas where it is most cost-effective to upgrade decentralized wastewater treatment. The tool can ultimately be integrated with a tool for estimating pollution from agricultural run-off, which in Bioforsk's package is called WebGIS Run-off. This gives a more complete picture of the sources of pollution to water bodies.

Conclusions

WebGIS wastewater was developed by Bioforsk in order to create a tool for control and administration of on-site wastewater treatment plants. Today, more than 50 municipalities in Norway are using the model in their daily work of managing decentralized sewage systems. The problem faced by many municipalities with measuring the effects of improving decentralized wastewater treatment is dealt with through a tool that rather estimates the effects based on certain models and parameters. The model is also used for estimation of the environmental impact on-site wastewater treatment

plants acts upon water bodies within a catchment, and creates as such an argument for upgrading malfunctioning wastewater plants.

References

Bioforsk (2007). WebGIS avløp fikk Glassbjørnens diplom. Localized 28.09.2010 on world wide web: http://www.bioforsk.no/ikbViewer/page/forside/nyhet?p_document_id=42243

Bouma, J. (1975). Unsaturated Flow During Soil Treatment of Septic Tank Effluent. Journal of the Environmental Engineering Division, Vol. 101 (6), pp. 967–983

Heistad, A., Paruch, A. M., Vråle, L., Ádám, K. and Jenssen, P.D. (2006). A high–performance compact filter system treating domestic wastewater. Ecological Engineering, Vol 28 (4), pp. 374–379

Jenssen, P.D. & Syversen, N. (1996). Programmet Naturbasert Avløpsteknologi (NAT). Vann 31 (1), pp. 81–85.

Kraft, P.I. and Turtumøygard, S. (1997). GIS i kommunalt avløp. Delrapport 2, modellbeskrivelse. Jordforsk rapport, pp. 94. 30.

SSB (2008). Avløp og rensing i spredt bebyggelse. Localized 28.09.2010 on world wide web: http://www.ssb.no/emner/01/04/20/avltab/

Turtumøygard, S. & Blankenberg, A.G. (2006). Gis i avløp for Haldenvassdraget. Bioforsk Rapport 1/130, 18 pp.

Turtumøygard, S. & Eggen, G. (2008). WebGIS avløp for Klepp. Bioforsk Rapport 3/109, 18 pp.

U.S. Environmental Protection Agency (EPA). (1980). Design Manual for Onsite Wastewater Treatment and Disposal Systems, U.S. Environmental Protection Agency Municipal Environmental Res. Lab., Cincinnati, Ohio.

Winneberger, J.H.T. (1984). Septic Tank Systems – A Consultant's Toolkit, Butterworth Publishers, Boston, Massachusetts, USA.