Co-benefits in smarter stormwater management: planning for strategic stormwater infiltration in urban areas using data from groundwater monitoring wells

Vers une optimisation de la gestion des eaux pluviales : planifier des zones d'infiltration stratégiques en milieu urbain

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RÉSUMÉ

VCS Danemark, service des eaux des communes de Nordfyn et Odense, souhaite favoriser le développement d'espaces naturels ainsi que de la résilience en milieu urbain au travers notamment de la mise en œuvre de techniques alternatives pour la gestion des eaux pluviales. Parmi les solutions envisagées, les éléments favorisant l'infiltration sont souvent privilégiés. Toutefois, l'infiltration des eaux pluviales ne devrait pas être recommandée en toute occasion, mais en fonction du contexte local, notamment hydrogéologique. Cet article présente une méthode d'estimation des zones à potentiel d'infiltration basée sur l'analyse du niveau des eaux souterraines via une base de données liées aux puits de captage privés et publics. Cette analyse représente donc une valeur ajoutée pour la base de données existante. Combinée avec différents éléments d'information, tels que des cartes de sols, cette analyse a permis la mise en place d'un système de notation simplifié présenté sous forme de carte afin d'assister les différents acteurs dans la planification d'éléments d'infiltration des eaux pluviales. Avec l'ajout de couches de données supplémentaires, l'analyse peut également être inversée afin de définir des zones à risque d'infiltration dans les conduites. Des développements sont actuellement en cours afin d'optimiser les données extraites des différents capteurs placés dans le système de drainage existant.

ABSTRACT

VCS Denmark, the water utility of the municipalities of Odense and Nordfyn, wants to promote the development of natural spaces as well as resilience in the urban areas through the implementation of SUDS and especially infiltration elements when possible. However, stormwater infiltration can only be recommended on locations where hydrogeological conditions are suitable in a local context. This paper presents a method for estimating the shallow, near-surface groundwater level based on a large database of geographically distributed monitoring wells carried out by contractors and services during construction, environmental investigations or water abstraction. This analysis therefore represents a co-benefit of the existing database. Combining these data with maps of the upper soil layer, this analysis has enabled us to implement a simplified notations system presented in the form of maps in order to assist the various actors to successfully place SUDS infiltration element in the urban areas and where not to. With the addition of additional layers of data, the analysis can also be reversed to define areas prone to infiltration-inflow into the pipes. Developments are currently underway to optimize the data extracted from the various sensors placed in the existing drainage system.

KEYWORDS

Extraneous water, Infiltration, Stormwater management, SUDS, Urban planning

1 OBJECTIVES

VCS Denmark has an ambition to promote the greening and resilience of the urban areas, which can be done though implementation of SUDS elements. With infiltration SUDS elements, the vulnerable creeks are protected from stormwater runoff, which can be devastating to the aquatic environment if not delayed. Therefore, the utility seeks to plan for more strategic infiltration in SUDS elements in the urban areas in order to manage stormwater in a more resilient way.

History has shown that it is very difficult to assess the potential for infiltration. With the presented tool, the utility come up with a simple strategic planning tool, thereby indicating that some areas of the city would be better suited for infiltration elements than other areas. In these areas it is important that we establish infiltration, because in other areas the possibility may not exist.

VCS Denmark area of service is at Funen in Denmark. The area is characterized by being relatively flat with low gradients. The natural drainage consists of several small creeks with very few main rivers. The urban areas are still expanding, thereby adding more impervious areas that needs drainage. The utility has a strategy to choose the best possible stormwater solution in each area, thereby choosing between different options of stormwater control measures, including SUDS. The method supports early planning stages of this strategy.

The objective of this project is to find the shallow, near-surface groundwater level in the city together with soil maps to provide information of where infiltration of stormwater through SUDS elements is possible.

2 METHODOLOGY

To find the level of the shallow groundwater, data from different types of monitoring wells are being used. These wells are all carried out by ex. contractors doing geotechnical drillings or utilities abstracting groundwater for water supply and all boreholes are registered in a national database, called Jupiter (GEUS, 2018a). The current database consists of more than 295.000 boreholes nationally. Especially the shallow geotechnical boreholes are important because they are made within urban areas for construction projects and they contain data about the groundwater level. This information from the monitoring wells are interpolated, resulting in a map indicating where the shallow groundwater level is around the city during summer and winter time, see Figure 1A and 1B. The groundwater level can be above ground, meaning that the water table is artesian (represented by red colours on the map), or it can be much below the surface (the blue colours on the map). Of course, some areas are highly affected by water abstraction wells where the water level fluctuates over time, which should be encountered for when extracting results and when considering the uncertainty in the maps.

2.1 Mapping the potential for stormwater infiltration

To find the stormwater infiltration potential, the summer and winter shallow groundwater level is scored against a map of the upper soil layer provided from GEUS in Denmark (GEUS, 2018b), see Figure 1C. This results in a score map, Figure 1D, indicating where SUDS elements with infiltration would most likely be successful, and where such elements should not be prioritized for stormwater management.

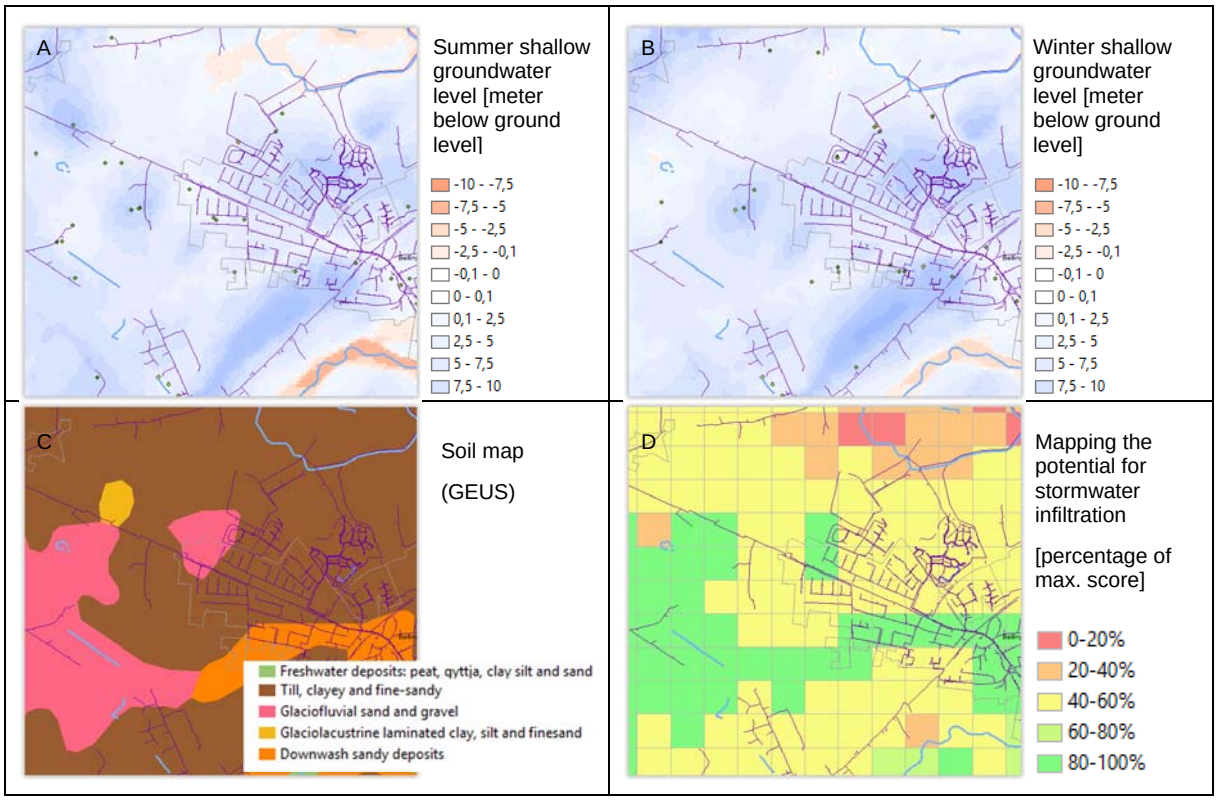

Figure 1: The figures represent a section of the city. 1A and 1B represent the summer and winter shallow groundwater level. 1C represents a soil map the same place, and 1D is the resulting score-map of the information from the three datasets. The urban drainage pipes are shown on the map to indicate the location of the city.

As can be seen in Figure 1, there is a high potential for infiltration of stormwater in the western part of the map, where subsurface consists of glaciofluvial deposited sand and gravel in combination with shallow groundwater levels are more than 2 m below ground, which will give the highest score. Stormwater runoff from new development in these areas could probably be managed by local infiltration elements.

2.2 Extraneous water

Mapping of the shallow groundwater level can also give an indication of whether the existing sewage pipes drain the groundwater locally due to infiltration-inflow into leaking pipes. If we are better aware of which areas are affected by infiltration-inflow, then we can better understand what strategic options for stormwater management are feasible. Often it is shown that relining public pipes would give the same amount of extraneous water in the pipes as before, because private pipes are not relined in such projects and infiltration-inflow will thus happen there. The hypothesis is that this would happen in areas where the shallow groundwater level is high and above the invert level of the existing pipes. This analysis will be carried out in the future.

3 OUTLOOK

The mapping of the shallow groundwater level is at this stage quite simple, but static. It has been shown still to be reasonable and we can use it for several tasks in the utility. For example, contractors can use it for giving an indication (and only indication) of whether they probably need to calculate measures to secure buoyancy their planned constructions. The method supports a new way of using “free” data for new purposes. Today the shallow groundwater level maps are a part of the utility’s web-solution, giving every employee in the utility and the municipalities the possibility to use the maps in planning processes.

LIST OF REFERENCES

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