Reactivation of former watercourses to support urban stormwater management

Simperler L., Glanzer M., Ertl T., Kretschmer F.*

University of Natural Resources and Life Sciences Vienna, Institute of Sanitary Engineering and Water Pollution Control, Muthgasse 18, 1190 Vienna, Austria

*corresponding author: e-mail: florian.kretschmer@boku.ac.at

Abstract

In recent decades many urban water courses have been heavily modified by land gaining measures aiming at canalising, straightening and draining existing water systems. Additionally, urbanisation causes a higher degree of sealing which results in higher surface runoff during rainfall. To support related problem-solving, the presented work investigates the question of whether the reactivation of former water courses could make a positive contribution to urban stormwater management. Based on the case study of an Austrian municipal area the research work follows a two-target approach: First, the collection, digitalisation and verification of the former water courses in the investigated area based on historical maps and recent planning documents. Second, a GIS-based overlap of the verified (still existing but inactive) natural water courses with the current sewage and stormwater network to derive potential options for relieving the strain on the entire urban drainage system. Results show, that reactivation of former water courses can be an interesting and promising component of an integrated and thus more natural urban stormwater management approach.

Keywords: Climate change, surface runoff, sewer system, integrated planning

1. Introduction

After the 19th century many rivers have been straightened and oxbows have been drained to create more room for settlements and cities in Europe and other industrialized parts of the world. Rivers were structurally modified in favor of human usage. Many national examples are illustrating the significant modification of a large proportion of surface water (EEA, 2016). Based on a river mapping from 2001 only 21 % of German rivers are classified as “unaltered” or “moderately altered” (BMU/UBA, 2002). In Finland more than 90 % of the rivers with a total length of around 159,000 kilometers are regulated or otherwise modified (NRIF, 2019). Consequently, natural processes such as meandering were impaired and retention areas were removed. These lost characteristics are especially important to buffer flood peaks and the eventual risk of damage.

Another adverse effect of urbanization is the progressing degree of sealing. On average, the degree of sealing in Austria totaled about 41.2 % of land which is consumed for settlements and infrastructure areas in 2018 (BMNT/UBA, 2019). As a result, rainwater retention and rainwater infiltration are disturbed causing negative effects on the whole water circle. The soil water storage capacity of unsealed land is lost and the risk of flooding in case of heavy rainfall events is increasing in many cities (Skougaard Kaspersen et al., 2017).

In sanitary engineering one primary goal and state of the art is the proof of flood safety. As an alternative to conventional sewer systems the implementation of sustainable green infrastructure (infiltration, evaporation, temporary storage etc.) in urban stormwater management acquires an increased importance nowadays (Fletcher et al., 2015). Green infrastructure relieves the strain on the entire urban drainage system and as another positive effect the rainwater remains in the natural water circle (Burns et al., 2012).

Scattered residues of oxbows in form of small channels and trenches exist in the city of Wiener Neustadt in Austria. This study examines if there is a connection between the still existing channels and the receiving water and if they could be used for urban stormwater management.

2. Material and Methods

2.1. Case study site

The city of Wiener Neustadt is situated in the southern Vienna basin in Lower Austria, Austria. This basin consists of a thick sediment layer that provides a large groundwater reservoir. Alongside the main receiving water in the city there are still residues of oxbows. Some of these remaining channels are used as a sort of drainage system in case of heavy rainfall events or high levels of groundwater. Based on several old site maps and an on-site inspection it was examined if there are still connections between the oxbows and the receiving water.

2.2. Inventory and digitalization

In cooperation with the municipal utilities of Wiener Neustadt an investigation area was defined, and old site plans were provided. Primary data sources were an old plan with former river courses from 1917 plus several plans of an existing drainage system. These site plans were digitalized and incorporated into a GIS model using the open source software QGIS (see Figure 1). Based on the currently digital land register and the overlapped digitalized old river courses several possible locations of oxbow residues could be determined.

Figure 1. *left:* old site plan extract of the investigated area with river courses form 1917, *right:* digital orthophoto extract with currently existing river course (blue), the old river courses from 1917 (pale blue) and narrow premises which could be a possible inticator for residues of oxbows (green)

To achieve a better knowledge of the hydrological interrelations of the study site several other relevant projects and studies were incorporated into the GIS model (e. g. the digital cadaster of the municipal sewer, groundwater level data, flood-discharge zones, potential road drainage systems). To verify the data of the digitalized site plans and to accurately localize the still existing channels an on-site inspection was performed (see Figure 2).

Figure 2. example for a still existing channel from the case study site (2019)

For the local inspection a questionnaire was designed to examine the status quo of residual channels. Important questions were if a channel is still existing and if it is open or encased. Some other data about the vegetation, the presence of water and the connection to the main receiving water were also collected. Following the on-site inspection, the verified and additionally collected data was added to the existing GIS model. Based on the questionnaire potential measures were defined for the still existing channels.

3. Results and Discussion

One main result of this case study was an inventory of the present state of the natural channel system in the city of Wiener Neustadt. Through incorporating old plans in a GIS model and having a local inspection of the study site it could be verified that alongside the main receiving water there is still an existing spacious drainage system. Some sections of this drainage system are natural open channels and some of the channels are partially encased.

For both types of channels potential further steps to incorporate them in the local stormwater management were defined. For open channels it is important to groom the vegetation and to prevent an obstruction of the channel base. This enables the funneling of potential stormwater run-off or drained groundwater to the nearest receiving water or other drainage systems.
An inspection of the encased channels (CCTV inspection robot, manhole zoom camera) could provide information about the present conditions of the pipe. Flushing the duct would be another option to proof the connectivity of the existing encased channels to any receiving water.

4. Conclusion

With the knowledge that there is still an existing partially natural channel system, preservation is important for further rainwater management measures. In the course of new construction work it is particularly important to indicate premises with channels on it and to preserve them. Using already existing natural channel infrastructure like in this case study for stormwater management facilitates restoring the natural water cycle.

References

European Environment Agency (EEA), 2016. Rivers and lakes in European cities. Past and future challenges. EEA report No 26/2016, 8.

Bundesministerium für Umwelt, Naturschutz und nukleare Sicherheit/Umweltbundesamt (BMU/UBA), 2002. https://www.umweltbundesamt.de/themen/wasser/fluesse/zustand#textpart-2 (accessed 13. Mai 2019)

Natural Ressources Institute Finland (NRIF), 2019. https://www.luke.fi/en/natural-resources/fish-and-the-fishing-industry/fish-and-environmental-changes/ regulated-rivers (accessed 13. Mai 2019)

Bundesministerium für Nachhaltigkeit und Tourismus (BMNT/UBA), 2018. http://www.umweltbundesamt.at/umweltsituation/raumordnung/rp_flaecheninanspruchnahme/bodenversiegelung (accessed 13. Mai 2019)

P. Skougaard Kaspersen et al., 2017. Comparison of the impacts of urban development and climate change on exposing European cities to pluvial flooding. *Hydrology and Earth System Sciences*, vol. 21, no. 8, pp. 4131–4147.

T. D. Fletcher et al., 2015. SUDS, LID, BMPs, WSUD and more – The evolution and application of terminology surrounding urban drainage. *Urban Water Journal*, vol. 12, no. 7, pp. 525–542.

M. J. Burns, et al., 2012. Hydrologic shortcomings of conventional urban stormwater management and opportunities for reform. *Landscape and Urban Planning*, vol. 105, no. 3, pp. 230–240.