Technical note about the monitoring of hydromorphological restoration/management of the Mur River (Styria, Austria)

BOKU

1. General presentation of the study site

The study site at the Austrian Mur River is located near Gosdorf in Styria. There, the Mur represents the border between Austria and Slovenia along about 34 km (see Figure 1). The Mur River originates in the Austrian Alps at an altitude of 1900 m above sea level and enters the Drau River in Croatia after approximately 450 km. At the study site, the catchment covers about 10,340 km²; the river length reaches 355 km. This study reach is characterized by a mean slope of 1.4‰ and lies in a tertiary basin. The mean discharge is 150 m³/s, the 1 year flood event reaches 700 m³/s. The highest discharges occur during snowmelt in May; second flow peaks occur in July/ August. The hydrograph therefore is moderate nival (Mader et al., 1996). The Mur is a gravel bed river; at the border reach, the bed material has a mean diameter of approximately 35 mm. The mean annual rainfall in Unterpulka (close to the study site) is around 812 mm/a (BMFLUW, 2014). At the border reach, the Mur River was once a wandering/braided river system.

Table 1: Main physical features of the pilot site

Pilot Site	Mur River
Drainage area (km²)*	10340
Location	Gosdorf
Length of the study reach (km)	1,0
Active channel width (m)	75 - 80
Channel slope (m/m)	0,0014
Planform morphology	Formerly: Wandering / braided Currently: straight

* At the study site

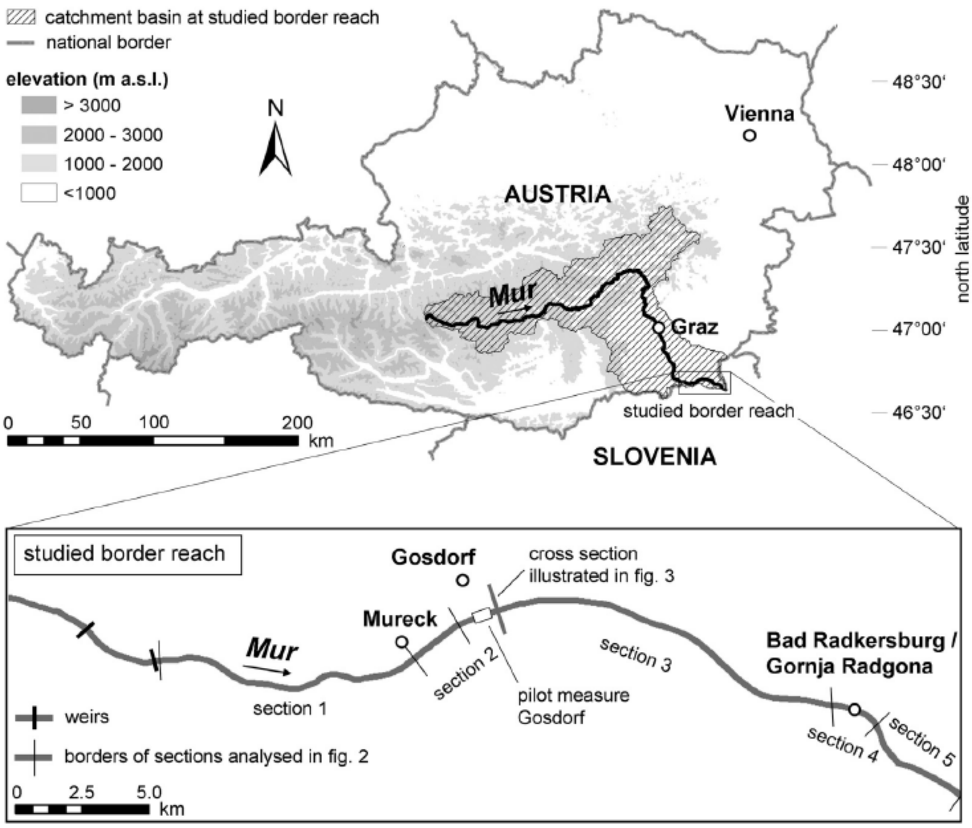

Figure 1: Mur River catchment and location of the studied border section (Klösch et al., 2011)

2. Hydromorphological restoration/management

Between 1875 and 1891 the Mur River was systematically channelized, which included bank protections which forced the Mur into a narrow channel. At that time, channel incision was already expected and was desired to increase the discharge capacity to mitigate floods. The formerly braided river system was narrowed from 1200 m to 76 m in the border reach (Figure 2). This resulted in larger river radii and hence shorter length, which ultimately increased the channel slope as well as the transport capacity. Additionally, at the beginning of the 20th century, the construction of a chain of hydroelectric power plants started, leading to an interruption of sediment supply from upstream. Figure 3 shows a map with types and locations of hydropower plants in the Mur catchment, which are currently operating. Based on these new boundary conditions, the riverbed began to incise. Between 1970 and 2000, the mean degradation in the 34 km long border reach was about 0.5 m, the maximum about 1.2 m. This means a deficit of approximately 900,000 m³ for the period from 1977 – 1995, which is depicted in Figure 4.

The channelization led to various ecological and economic problems such as scouring and destabilisation of bank protections, decoupling of river and floodplain and lowering of the groundwater table which affected the drinking water supply. The morphological change of the Mur River severely impacted the fish and macrozoobenthos population by a loss of suitable habitats. However, given the surrounding floodplain forest which is preserved as a Natura 2000 area, and given the remaining connectivity to downstream reaches (no barrier between the study site and the confluence with the Danube), the border section of the Mur River has a high potential for restoration.
With increasing incision, the thickness of the gravel layer above the underlying tertiary sediment decreased. The tertiary sediment may possess a higher erodibility given its much finer grains. Additionally, fine sediment, once eroded, is transported as suspended load, hence not contributing to the formation of the river bed. Accordingly, there is a high risk of a riverbed breakthrough, meaning a sudden drop of bed and water levels during in short time.

Figure 2: The Mur River before (Franziszeische Landesaufnahme 1806-1869) and after the regulation near Gosdorf (Österreichisches Staatsarchiv, 2014)

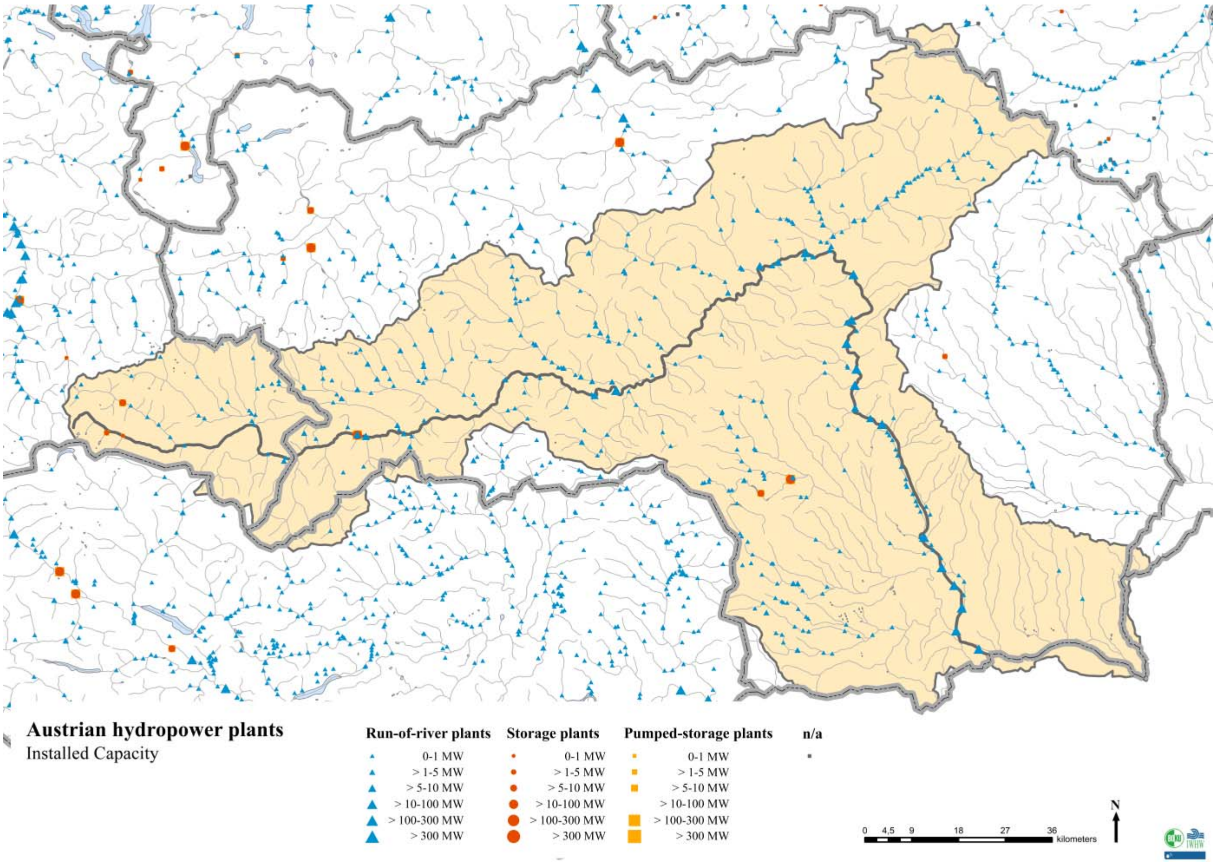

Figure 3: Types and locations of hydropower plants in the Mur catchment (Wagner et al., 2015).

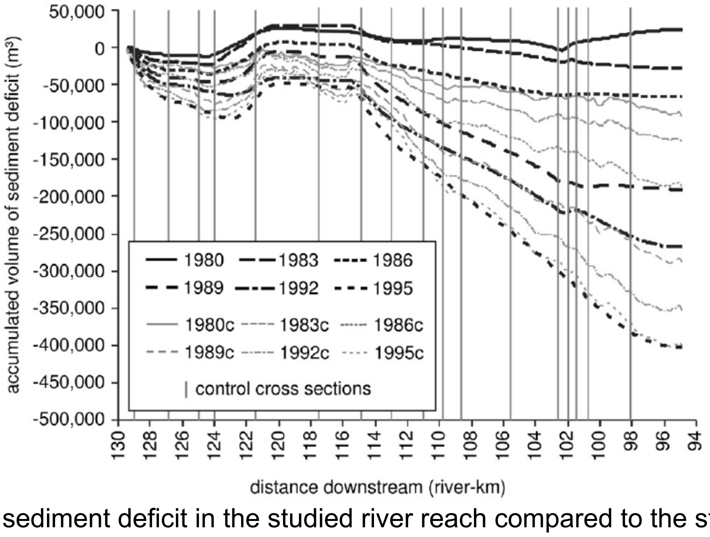

Figure 4: Volumetric sediment deficit in the studied river reach compared to the state in 1977 and calibration results (labeled with ‘c’) from the sediment transport model. Modified in Klösch et al. (2011) based on the work of Hengl et al. (2001)

As a basis for the implementation of countermeasures, in 2001 the Basic Water Management Concept for the border section of the Mur River was completed. In 2006 and 2007 a pilot measure was implemented according to the recommendations from the concept (e.g., Habersack et al. (2001), Hengl et al. (2001)), which included the removal of bank protection over 1 km in length and the replenishment with gravel, which was derived from a newly dredged side channel. Figure 5 shows a schematic drawing of the functionality of the measures at Gosdorf (left) and the left riverbank after implementation of the measures (right). The pilot reach was one of several successive measures suggested by the Basis Water Management Concept, which aimed for temporarily (for 60 years) stabilising the river bed until options were found to restore sediment supply through the weirs upstream.

Figure 5: Schematic drawing of the functionality of the measures at Gosdorf (left) and the left riverbank after implementation of the measures (right) (Klösch et al., 2011)

Figure 6 shows the volumetric change of the inserted sediment in the main channel of the Mur River within the pilot measure. The graph shows a positive effect in terms of riverbed stabilization. Also in the downstream, regulated channel, the bed levels rose. However, it has to be considered that the durability of this measure is time-constrained, as anticipated in the Basic Water Management Concept. Therefore the border section of the Mur River is still at risk of a bed breakthrough and loss of the gravel bed, once the supply with sediment from the banks reduces below the sediment transport capacity of the downstream channel.

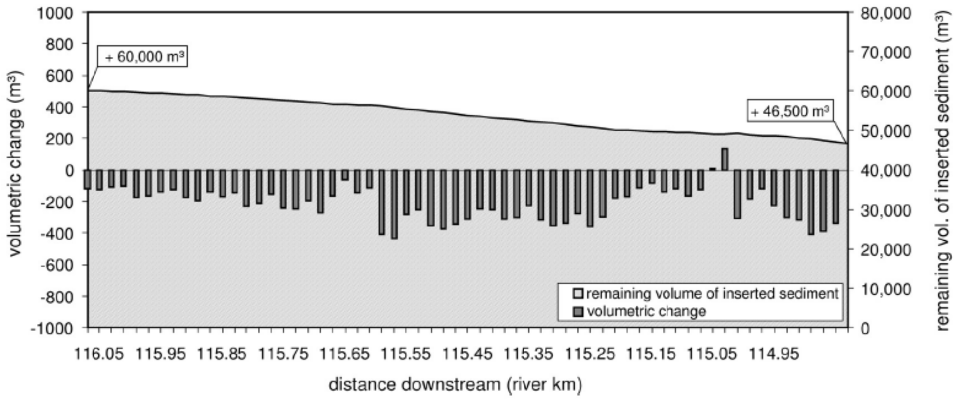

Figure 6: Mass balance and volumetric changes in the entire restored section between December 2007 and July 2008 (Klösch et al., 2011)

3. Monitoring activities

3.1. General objectives of the monitoring program

The aim of our monitoring activities within HyMoCARES is to compare the developed hydromorphological state with assumptions and calculations made in the planning phases of the Basic Water Management Concept and in the specific design of the pilot reach. We aim to derive the restoration potential of reaches such as Gosdorf, which lack sediment supply, and finally to derive recommendations for future planning.

3.2. Physical monitoring

A monitoring of bank retreat will be conducted through repeated terrestrial photogrammetry of the entire bank section. The obtained images will deliver digital elevation models at high spatial resolution after being analysed by the photogrammetric software PhotoScan (AgiSoft). By performing a regression of the obtained data - under consideration of the hydrology between eroding events - the bank retreat and hence bedload supply can be determined for a longer period. Eventually, the analysis will deliver the maximum retreat possible at this reach, as well as the time needed to reach this state. This data will show the lateral dynamics of a river in case of sediment deficit and provide an important basis for a revision of the Basic Water Management Concept, by delivering onset thresholds and rates of bank erosion at the study site.

The tertiary sediment, which is the underlying sediment below the gravel layer, will be investigated for its erodibility, as it determines the risk of increased erosion rates once the gravel layer is eroded. Based on this data and on the experiences collected with conducting the analyses, an indicator developed in D.T2.2.1 will be tested. The erodibility will be measured with the Jet-Test, a device directing a water jet onto the sediment surface which allows to measure parameters describing the erodibility.

3.3. Ecological monitoring

In the EU Interreg SI-AT project DRA-MUR-CI the reach was monitored for fish species, the colonisation by wading birds and bank-nesting birds, reptiles, ambhibians and vegetation, which included the colonisation by neophytes.

4. References

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