A model-based classification of confined meandering rivers

Hossein Amini[1], Federico Monegaglia[2], Stefano Lanzoni[3], Guido Zolezzi[2], and Marco Tubino[2]

[1]University of Trento, Italy
[2]University of Trento
[3]University of Padova

November 22, 2022

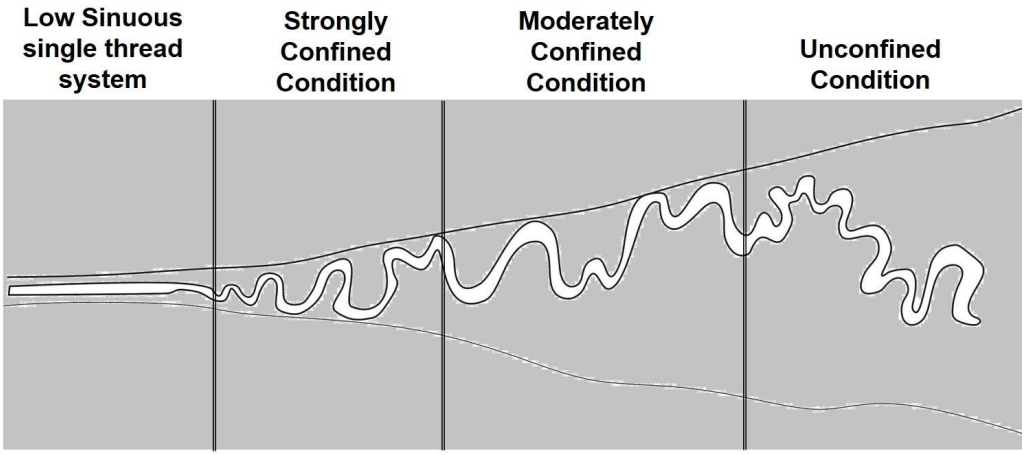
Abstract

Confined meandering rivers are bounded between valleys and they are limited in their lateral migration compared to free meandering ones. In this study, we designed a model-based analysis to investigate types of confined meandering rivers. To simulate cases, we used the model developed by (Bogoni et al. 2017) based on a semi-analytical solution for flow and bed morphology ((Zolezzi and Seminara 2001). According to the result of (Lewin and Brindle 1977) the categorization of this type of meandering river should be based on the potential of evolution. We defined a confinement ratio as the ratio between the confined valley width and the meander belt width that the river would theoretically reach without geological confinement. Such unconfined meander belt width has been computed through long-term morphodynamic model simulations. This differs from previous work (Camporeale et al. 2005), semi-empirically suggesting an unconfined meander belt being nearly 3 times the modeled, linearly most unstable, intrinsic meander length. Our results indicate the existence of four different types of confined meandering rivers, which represents the most important point of this work. Compared to previous work, our classification adds a new class and reclassifies one of the previous types. Our proposed classes are; "Moderately confined condition" for confinement ratio in the range 0.1-1, "Strongly confined condition" for confinement ratio in the range 0.03-0.1. For a smaller confinement ratio than 0.03 we obtain a low sinuosity, single thread river, and for a confinement ratio greater than 1, we retrieve a free meandering river. Preliminary testing of our model-based classification with data from real confined meandering rivers shows promising results.

Posted on 22 Nov 2022 — CC-BY 4.0 — https://doi.org/10.1002/essoar.10508674.1 — This a preprint and has not been peer reviewed. Data may be preliminary.

A model-based classification of confined meandering rivers

Hossein Amini Federico Monegaglia Stefano Lanzoni Guido Zolezzi Marco Tubino



Abstract

Confined meandering rivers are bounded between valleys and they are limited in their lateral migration compared to free meandering ones. In this study, we designed a model-based analysis to investigate types of confined meandering rivers. To simulate cases, we used the model developed by (Bogoni et al. 2017) based on a semi-analytical solution for flow and bed morphology ((Zolezzi and Seminara 2001). According to the result of (Lewin and Brindle 1977) the categorization of this type of meandering river should be based on the potential of evolution. We defined a confinement ratio as the ratio between the confined valley width and the meander belt width that the river would theoretically reach without geological confinement. Such unconfined meander belt width has been computed through long-term morphodynamic model simulations. This differs from previous work (Camporeale et al. 2005), semi-empirically suggesting an unconfined meander belt being nearly 3 times the modeled, linearly most unstable, intrinsic meander length. Our results indicate the existence of four different types of confined meandering rivers, which represents the most important point of this work. Compared to previous work, our classification adds a new class and reclassifies

one of the previous types. Our proposed classes are; “Moderately confined condition” for confinement ratio in the range 0.1-1, “Strongly confined condition” for confinement ratio in the range 0.03-0.1. For a smaller confinement ratio than 0.03 we obtain a low sinuosity, single thread river, and for a confinement ratio greater than 1, we retrieve a free meandering river. Preliminary testing of our model-based classification with data from real confined meandering rivers shows promising results.

Works Cited

Amini, H., et al. “Modeling the Planform Development of Confined Meandering Rivers.” *River Flow 2020*, 2020, pp. 517–523., doi:10.1201/b22619-73.

Bogoni, Manuel, et al. “Modeling Meander Morphodynamics over Self‐Formed Heterogeneous Floodplains.” *Water Resources Research*, vol. 53, no. 6, 2017, pp. 5137–5157., doi:10.1002/2017wr020726.

Camporeale, C., et al. “On the Long‐Term Behavior of Meandering Rivers.” *Water Resources Research*, vol. 41, no. 12, 2005, doi:10.1029/2005wr004109.

Frascati, Alessandro, and Stefano Lanzoni. “Morphodynamic Regime and Long‐Term Evolution of Meandering Rivers.” *Journal of Geophysical Research*, vol. 114, no. F2, 2009, doi:10.1029/2008jf001101.

Seminara, G., et al. “Downstream and upstream influence in river meandering. Part 1. General theory and application to overdeepening.” *Journal of Fluid Mechanics*, vol. 438, 2001, pp. 183–211., doi:10.1017/S002211200100427X

Lewin, J; Brindle, B J. “Confined meanders.” *Journal of* River channel changes. Wiley Chichester. 1977.