Channel-floodplain connectivity drives vegetation dynamics in semiarid floodplains

A remote sensing analysis of the Naryn river corridor in Kyrgyzstan, Central Asia

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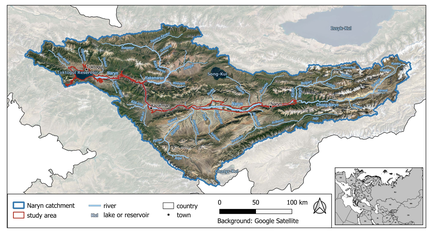
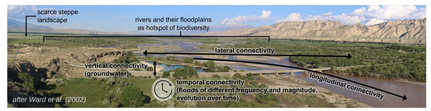
Introduction



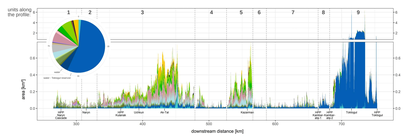
The Naryn river is over a length of about 600 km **one of the last still free flowing rivers** in the world. The study area is located in the centre of the Naryn catchment and covers the whole valley bottom of the river (1313 km²). The relative importance of the **ecological and physical processes as well as anthropogenic effects** on floodplain forest succession trajectories are not yet understood as the riparian ecosystems along the Naryn have not been investigated yet in detail.

Understanding the succession trajectories of the complex landscape patches within the floodplain is crucial for **biodiversity conservation** and **environmental management** as ongoing plans for **dam construction** are likely to heavily modify the channel and therefore the current natural riparian ecosystem structure and function. The floodplains moreover provide **ecosystem services** and are used, among other things, for grazing and as a source of wood.

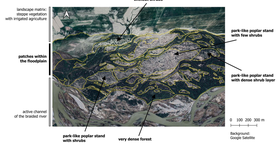
lateral, longitudinal, vertical & temporal connectivity → **dynamics** → **hydro-morphological disturbances** → **heterogeneous habitat mosaics**



The floodplain habitats within a river corridor as well as the ecosystem services they provide depend on hydro-morphological disturbances arising from connectivities. In particular rejuvenation and thus community structure of floodplain forests depends on the interaction of flow regime and hydromorphology.

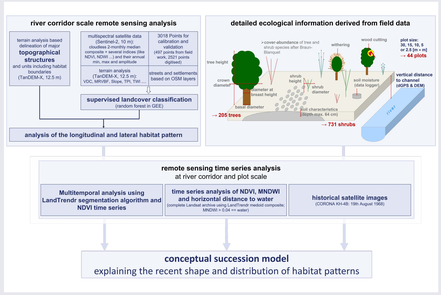


The floodplain **habitats** are heterogenously distributed along the **longitudinal profile** of the Naryn river. Hotspots of contiguous floodplains occur in laterally unconfined areas - right downstream of hydropower projects and thus affected by modification of sediment and hydrological regimes.

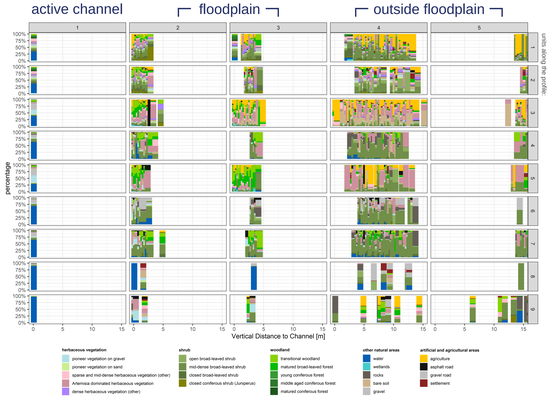


Habitat patches of different characteristics shape the floodplain in the semiarid environment.

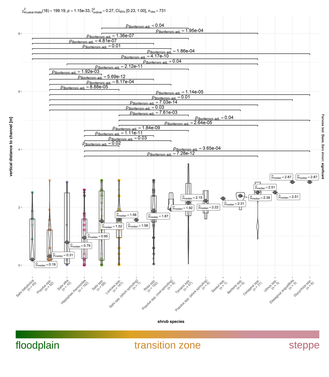
Methods



?‖ How are the floodplain habitats structurally distributed? What processes are responsible for their formation and distribution?

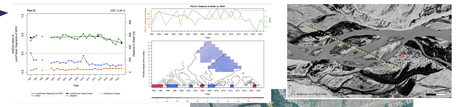


Habitats show a clear **lateral** distribution arising from the **connectivity** to the active channel. Extended and contigous forest patches only occur in low **vertical distance** and therefore in areas well connected to the active channel. In particular pioneer vegetation and thus rejuvenation exists only in the lowest and most connected topographic zone.

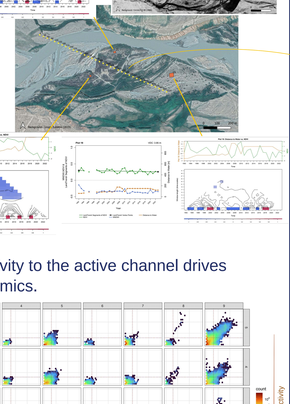


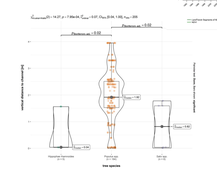
Plot scale data collected in the field gives evidence of topographic zonation with a **transition from floodplain species to steppe species**. Rejuvenation of typical floodplain tree species is only found below 1.52 m vertical distance - the zone with the highest **connectivity** to the active channel.

LandTrendr Segmentation (Kennedy et al. 2010 and 2018) Analysis (left) and Rolling Window Correlation using *NonParRolCor* (Polanco-Martínez & López-Martínez 2023; right)

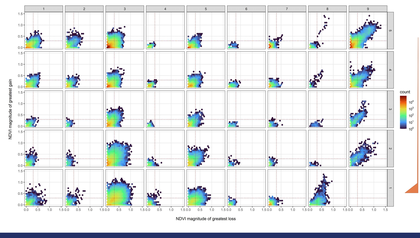


The **vertical distance** to channel as well as the **horizontal distance** to water are a significant parameter explaining the distribution of the tree (▸) and shrub (◂) species.





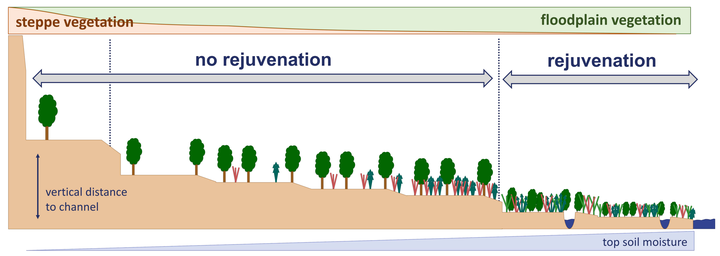
Lateral connectivity to the active channel drives vegetation dynamics.



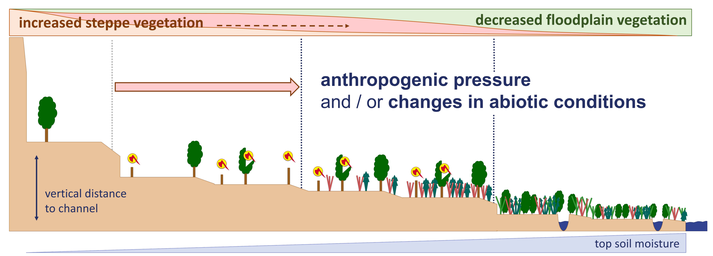
Discussion & Conclusion

A combination of field study and remote sensing shows that ...

! ‖ *semiarid floodplain ecosystems depend on connectivity and are sensitive to changes of abiotic conditions.*

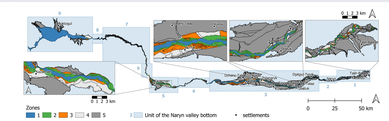


Access to water supply indicated by vertical distance above channel is the key driver for the composition, distribution and density both for the trees and the shrubs. Changes of abiotic factors will therefore cause a transition to steppe vegetation.

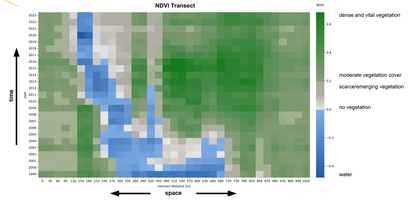


Anthropogenic pressure from wood cutting on areas lacking rejuvenation leads to acceleration of the transition to the succession stage of steppe (with solitary poplars). The construction of dams is likely to accelerate this process due to changes in abiotic conditions caused by flow alteration and channel incision.

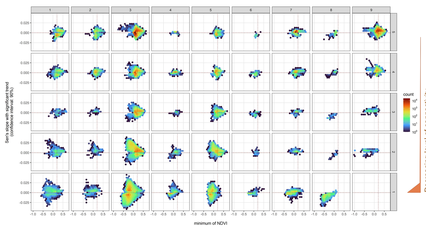
Results



The study area is divided in nine units following mainly morphological characteristics and in **topographical zones** providing the basis to determine the lateral extent of the floodplain area. These zones are an indicator for the connectivity to the active channel. The topography of the study area is very heterogenous and causes significant **variations in confinement** controlling the distribution of floodplain area.

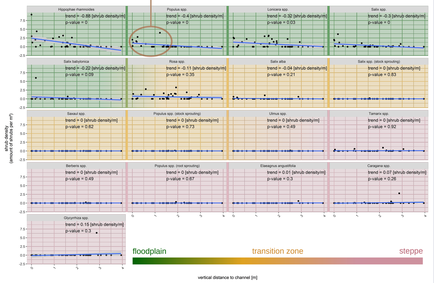


Spatio-temporal development along a transect across active channel and floodplain reveals complex interaction of channel and vegetation development.



High lateral connectivity to the active channel leads to a much higher proportion of significantly positive trends.

The possibility of rejuvenating the poplar stand is very limited.



Remote sensing as well as field data show that the vertical distance to channel and thus lateral connectivity has a significant influence on the density and composition of the shrub layer as well as on ecosystems ability to rejuvenate.

Acknowledgements

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