CASiMIR Vegetation

Background

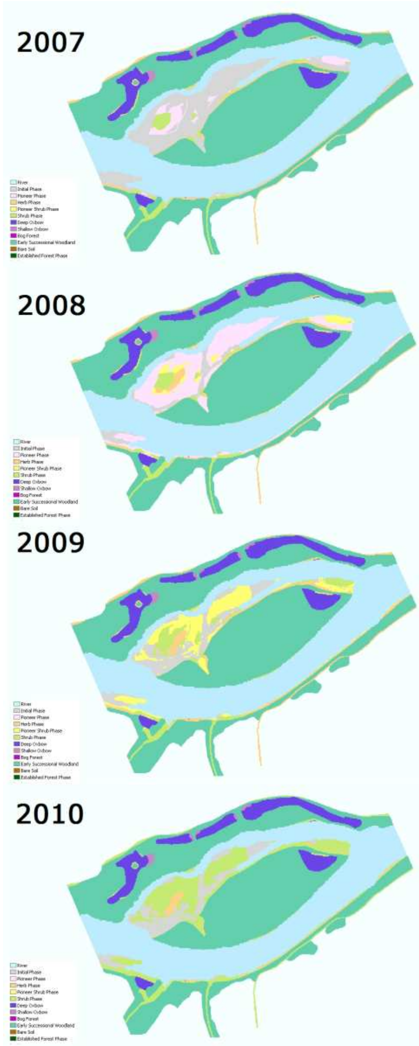
Riparian vegetation state and behavior is described at best by the shifting mosaic concept: "The individual landscape elements (e.g., islands, gravel bars, water bodies) exhibit high turnover… yet the relative composition of landscape elements remain relatively constant "(Ward & Tockner 2002). Such paradigm implies that, for an effective study of riparian vegetation, both spatial and temporal dimensions must be taken in account.

Main drivers of vegetation establishment, renewal and disruption are the water elevation, during the recruitment season, and the floods. The former accounts for the soil moisture required by seeds to germinate and successfully establish while the latter disrupts the existing vegetation by mechanical action, sedimentation, erosion and physiological stress. Through these actions, floods create also new nursery sites where seeds can potentially germinate.

Method

The model concept assumes that vegetation development depends by the functional relationship among hydrology, physical processes and vegetation communities. In the model conceptualization, physical processes are represented by height over mean water, shear stress as indicator of morphodynamic disturbance and flood duration. These factors allow the successful establishment and development of the vegetation or its retrogression to the initial stage. Vegetation is classified in succession series, typically woodland, reed and wetland series. Succession series are in turn made up of succession phases which are vegetation development stages defined by age ranges (years).

CASiMIR Vegetation is divided in three submodels, namely: recruitment, morphodynamic disturbance and flood duration; the simulation time step is one year; the simulation time step is one year.



Recruitment submodel evaluates wheather or not there will be sucesfull establishment (recruitment) of vegetation. The module applies the concept of the "Recruitment box model" (Mahoney & Rood, 1998) extenteded also to vegetation different than cottonwood and willow species. The module concept states that recruitment can occur only on open, barren soil (initial phase) and that each succession series has one or more regions, which are suitable for the recruitment. Regions are defined by riparian zone (either bank or floodplain zone) and bands defined by relative elevation above water.

Morphodynamic disturbance submodel uses the shear stress as indicator of morphodynamic disturbance. This submodel evaluates if the maximum shear stress of the year is larger than the succession phases resistance (expressed in N/m^2). Where this condition is met, the succession phase is completely recycled to the initial phase. Each succession phase has a different shear stress resistance.

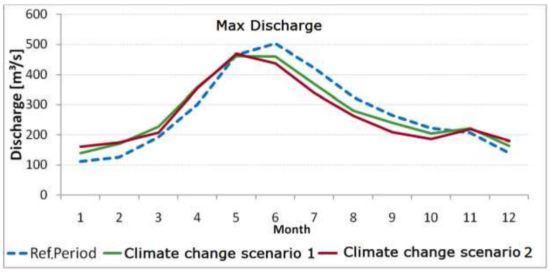
Flood duration is used as indicator for physiological stress and represents the amount of time a floodplain area is inundated during a season or a year. In the flood duration submodel, it is considered that a succession phase (Impacted Phase) will be retrogressed to to a younger succession phase (Recycled Phase) in response to a flood duration impact. Impacts are classified into high, medium, and low classes depending on number of days flooded during vegetation period. Flood duration impacts (low, medium and strong) yield partial or total recycling on vegetation. In the first case, the succession phases is completely recycled to the initial phase while in the second, the impacted phase is retrogressed to a previous phase.

The model thus conceived allows a wide applicability of the developed tool and the fruition of its results by either scientific, policymakers or stakeholders audiences. The model outputs are in fact both spatial (maps) and tabular. These two formats allow immediate visualization, therefore suitable also for non trained or non scientific personnel.

Applications

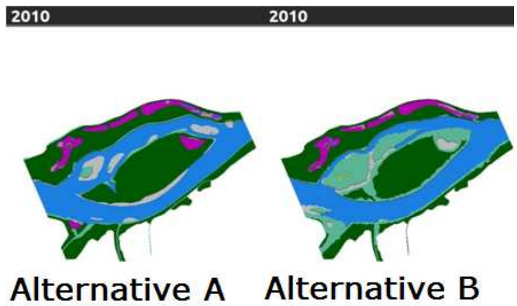
1. Climate Change

River hydrology is inherently bound to precipitations regime, consequently it is legitimate to argue that changes in the precipitation regime will ultimately yield effect also on the well-being of riparian vegetation. Within this scope, exploiting the relationship between climate and hydrology, it is possible to forecast the outcomes of long term climate change effects on vegetation.



2. River restoration

River restoration measures are often expensive and resource intensive, yet the consequences of different project alternatives are uncertain. Applying CASiMIR Vegetation can aid river makers in the selection of the most fit alternative by comparing simulation results based on different restoration scenarios.



3. Dam Operations

Despite the large impacts caused by dams, recent research advancements showed that is possible to operate the dam reservoirs in a less impacting way. Yet, the effects of environmental flows on riparian vegetation might take decades before been evident. Adopting a simulation strategy to forecast the potential benefits of such flows will result in a more effective dam operation schema.

Conclusion

CASiMIR vegetation is tool which can fit many needs. Generally speaking, it can be used to forecast the outcomes of river-bed morphological changes or hydrologic alterations. Further application is represented by the possibility of replicating natural reference conditions which are at nowadays impossible to observe. Such references are an indispensible dataset for assessing baseline conditions and the degree of alteration brought by hydraulic works and therefore to benchmark restoration objectives or minimum flow requirements.

References

Mahoney, J. M., & Rood, S. B. (1998). Streamflow Requirements for Cottonwood Seedling Recruitment-An Integrative Model. *Wetlands*, *18*(4), 634-645.

Ward, J. V., Malard, F., & Tockner, K. (2002). Landscape ecology : a framework for integrating pattern and process in river corridors. *Landscape Ecology*, *17*(Suppl.1), 35-45.