Annex 3: The concept of Sediment Connectivity and its implementation in ArcGIS Pro

In a sense, Connectivity illustrates material pathways. It is used to compare the source-sink connection degrees of different points within a catchment. There are several ways to classify Connectivity. For example, in line with Bracken & Croke, (2007) there are three main types of Connectivity according to the material that is transferred: (i) “landscape” (ii) “hydrological”, and (iii) “sedimentological” Connectivity. Another classification involves a distinction between statical and dynamic conceptions, calling them “structural” (relating to surface conditions) or “functional” (relating to processes) Connectivity (Baartman et al., 2020; Shakesby et al., 2016).

To translate Connectivity’s qualitative estimates to comparable indicators we use the concept of Connectivity Index (Najafi et al., 2021). In this study, the Connectivity Index (IC) as described in Borselli et al. (2008) is used to measure structural Connectivity. The Index is a function of two components: the amount of material that exists in a source point A (upslope component) and the weighted distance from A to a sink point B (downslope component). Point A is any point in a catchment for which we assign a connectivity value. The source points in this case are the water streams of the catchment. Point B is the first location on a stream reached by the sediment exported by each point A.

Sediment Connectivity Index (IC) in ArcGIS Pro

Input data:

elevation (DEM_25m), C-factor shapefile (C_burned), roads (road_network), Water bodies (---)

Computation:

1) Slope without value lower than 0.05

a) Calculate Slope from the Spatial Analyst toolbar (Percent rise), name the new theme Slope_dem_sc1.
b) Select Raster Calculator from the Spatial Analyst toolbar, build an expression: "%Slope_dem_sc1%" <= 0.005. Name the new theme S1
c) Select Rater Calculator. Build the expression (("%S11%" == 0) * "%Slope_dem_sc1%") + ("%S1%" * 0.005)

2) Target points

2nd scenario:

a) create a raster map of water bodies from the Spatial Analyst toolbar, (Conversion tools-polyline to raster)
b) give 0 value to water bodies and value 1 to other area from the Spatial Analyst toolbar, select Reclassify. Name the new theme rivers_raster1

3rd scenario:

a) create a raster map of road netork from the Spatial Analyst toolbar, (Conversion tools-polyline to raster)
b) give 0 value to roads and value 1 to other area from the Spatial Analyst toolbar, select Reclassify. Name the new theme roads_raster1

4. Flow Direction (2nd scenario)

a) Run Flow Direction from Spatial Analyst, with DEM layer. Name the result flowdir.
b) Build an expression in Raster Calculator: "%"rivers_raster1%"* "%flowdir "%. give the new theme name RIVERDIRMASK
c) Run Flow Accumulation([RIVERDIRMASK). Name the new theme RIVERACCMASK1

5. *Flow Accumulation without null value (2nd scenario)*
   a) Select Raster Calculator and build an expression: "%RIVERACCMASK1%"+1. Give the new theme name ACCFinalRi

6. *Computation of downslope component, Ddn (2nd scenario)*
   a) Select Raster Calculator and build an expression: 1/("%C_burned%"* "%S1%"). Name the new theme inv_CS
   b) Run flow length (RIVERDIRMASK), downstream. With input weight raster: inv_CS. Name the new theme X
   c) Select Raster Calculator build an expression: (("%X%" ==0)* "% inv_CS %")+ "%X%"
   d) Name the resulting layer Ddn

4. *Computation of Dup component (2nd scenario)*
   a) Run Flow accumulation (RIVERDIRMASK), weight raster: C_burned. Name the result FlowAcc_river1.
   b) Run Flow accumulation (RIVERDIRMASK), weight raster: S. Name the result FlowAcc_river2.
   c) Select Raster Calculator build an expression: ("%*FlowAcc_river1*%" +"%C_Burned%") / "% ACCFinalRi %".Name the result Cmeanriv
   d) Select Raster Calculator build an expression: ("%*FlowAcc_river2*%" +"%S%") / "% ACCFinalRi %". Name the result Smeanriv
   e) Select Raster Calculator build an expression: "%Smean_ri%"* "%Cmean_ri%"* SquareRoot("%ACCFinalRi %"*625). 625 is our pixel size. Name the result Dup.

5. *Computation of IC (2nd scenario)*
   a) Select Raster Calculator and build an expression: Log10("%Dup%"/"%Ddn%")