Earth Surface Dynamics Discussions

Earth Surf. Dynam. Discuss., author comment AC3
https://doi.org/10.5194/esurf-2022-14-AC3, 2022

Reply on RC3

Stefan Hergarten

Author comment on "Theoretical and numerical considerations of rivers in a tectonically inactive foreland" by Stefan Hergarten, Earth Surf. Dynam. Discuss., https://doi.org/10.5194/esurf-2022-14-AC3, 2022

Dear Jean,
thanks for your constructive and encouraging comments! I am quite happy that all reviewers found the concept of carriers and redistributors useful. For me, developing this idea and pointing out that the redistributors are important for the dynamics of the alluvial plain is the main point of the paper, and I am aware that the numerical model used here has still several caveats. I think that I can submit a revised manuscript quite soon.

The numerical accuarcy -- your main concern -- is indeed an issue at some points. The value dt = 1e-3 was coming from an earlier series of simulations with focus on the scaling properties of depostion rates. There I used a much smaller dt = 1/16384 and measured rates over different time intervals, finding a strong effect of avulsions only for time intervals considerably greater than 1e-3. However, dt = 1e-3 might indeed be too large for the analysis of the time scale of network reorganization. Since rivers are only one pixel wide, the area covered by the carriers in a given time interval is also limited by the number of steps and thus by dt. This may indeed become a problem in the range close to the ocean. I started a simulation with a smaller dt in order to test whether the results shown in Fig. 13 are strongly affected by the value of dt.

In turn, I do not fully agree to your statements about the alluvial fans and would be happy to discuss this with you. You mention that you demonstrated that the size of the mountain catchment controls the size of the alluvial fan. In your recent ESurf paper, however, it rather seems to me as if you enforce this result by a very specific assumption on the catchment size. If I read it correctly, you apply Hack's law to the part of the rivers outside the mountain range alone and then simply add the catchment size A0 of the part located in the mountain range (your Eq. 10, A = A0+kx^p). If we did this for any point in a "regular" catchment, it would be completely wrong. Here it may work. Your approach predicts a very weak increase in A close to the mountain range (which makes sense to me), but how fast the catchment size "recovers" depends directly on A0, k, and p in your approach. So I am a bit afraid that your result on the size of the fans is more related to your very specific Hack's law than to the erosion model.

Anyway, it is not the point to question your result here. However, taking it for truth without further discussion for validating my simulations would not be sound. Without having tested it explicitly, I am quite sure that my simulation would predict that the size of the alluvial fans is propertional to the spacing of the biggest rivers leaving the mountain range and thus also proportional to the square root of their catchment size. So we would finally arrive at similar results, but for different reasons. In my opinion, this question should not be reduced to a few sentences in the recent manuscript, but requires a thorough consideration.

Best regards,
Stefan