INVESTIGATING DEM NOISE REDUCTION AND RESOLUTION IN FLOOD MODELING: A CASE STUDY BASED ON THE LOGONE FLOODPLAIN, CAMEROON

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PROBLEM

Large areas of sub-Saharan Africa comprise wetlands and flat terrain prone to flooding (Rebelo et al., 2010). Seasonal flooding here plays an important role in agriculture, fishing and pastoralist dynamics (Westra and De Wulf, 2005) but also presents risk as natural hazard (Tarhule, 2005). Uncertainty in future climate and the impact of human modification of the landscape challenge traditional development of these economic activities (Niang, et al., 2014) and the preparedness for hazarous floods (Tschakert et al., 2010).

In an ongoing research on *Coupled Human and Natural Systems* (CHANS, see https://mlab.osu.edu/morsl for details), we study the feedbacks between floods, fishing and climate change in the Logone Floodplain, in the Far North region of Cameroon (Figure 1). Flood dynamics (timing and extent) is critical for the economical productivity of the area. We use a numerical model to simulate flooding, finding that topography, as represented by the latest version of the Shuttle Radar Topographic Mission DEM (SRTMDEM) at ~30-m spatial resolution, presents unrealistic spatial variability which require elimination before numerical simulations are executed. Here we present results of a work in progress in which we test methods for eliminating noise in the SRTMDEM and evaluate the sensitivity of the flood model to different spatial resolutions. Our main aim is to determine a good compromise between noise-reduction, spatial resolution, and simulation time.

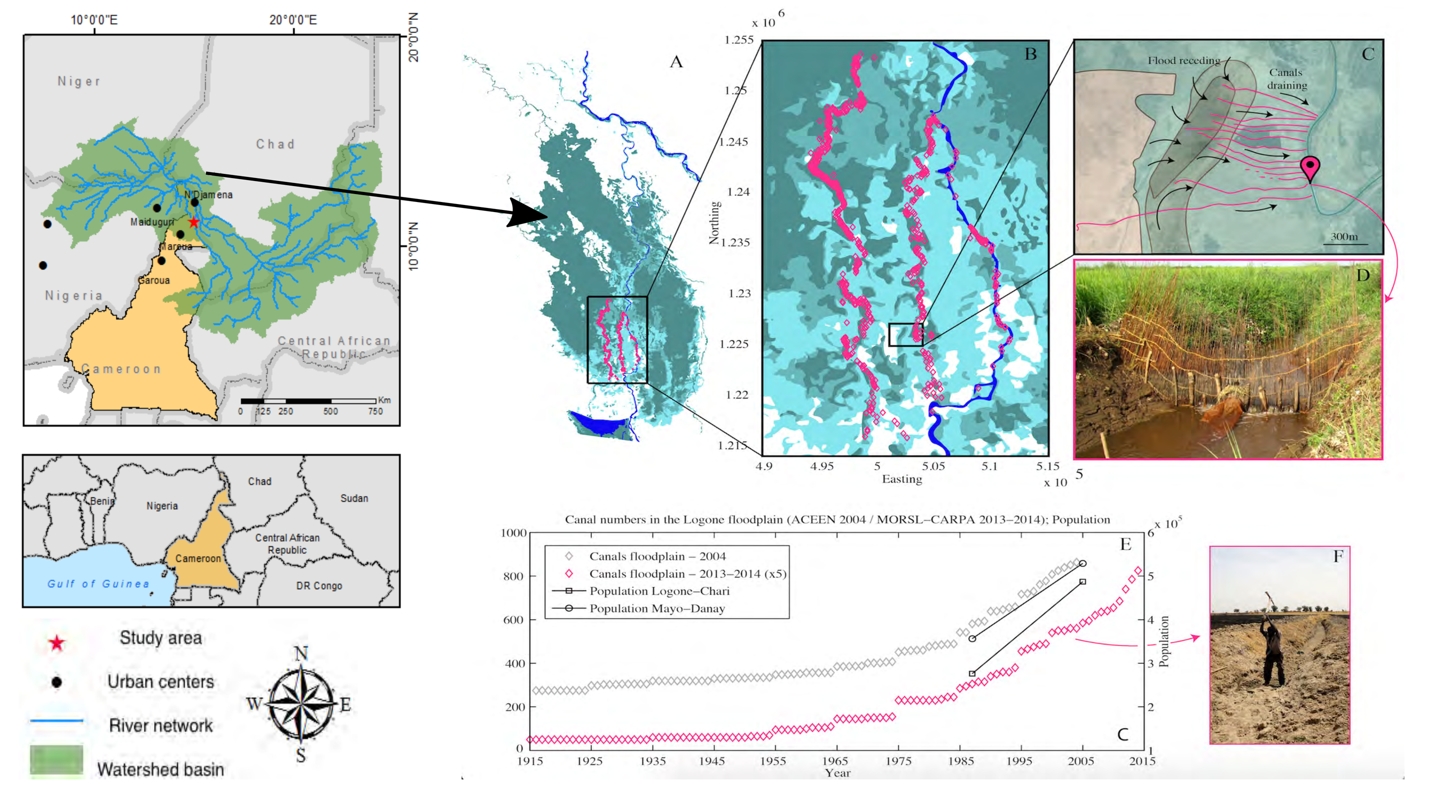

Figure 1: Study area featuring the location of the floodplain in the Far North Region (A). The Logone floodplain is undergoing hydrosocial transformations. Construction of fishing canals has speeded up (B, E), potentially modifying local hydrology and, through feedback loops, fishing production and local economy (C, F).

METHODS

We employ a Fast-Fourier Transform (FFT) to the SRTMDEM in order to detect a range of thresholds in which the topographic noise can be reduced. After noise-reduction, we reconstruct the SRTMDEM to its original resolution (~30-m) and regrid it to several spatial resolutions. We then simulate flooding dynamics using the LISFLOOD-FP numerical model (Neal et al.,2012), a grid-based code where channel network is parameterized at the sub-grid scale using channel geometry and friction. We assess model output against flood maps derived from Landsat images for the period 2001-2007 (Jung et al., 2011 and this work).

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MAIN FINDINGS TO DATE

The profile in Figure 2A reveals that the original SRTMDEM presents noise not seen in the terrain. In some places, slope angles in excess of 35° show up in sections less than 15-m long. From the range of normalized power spectra, using trial and error we selected one that supresses most of the noise but maximizes the representation of the main features of the floodplain (Figure 2D).

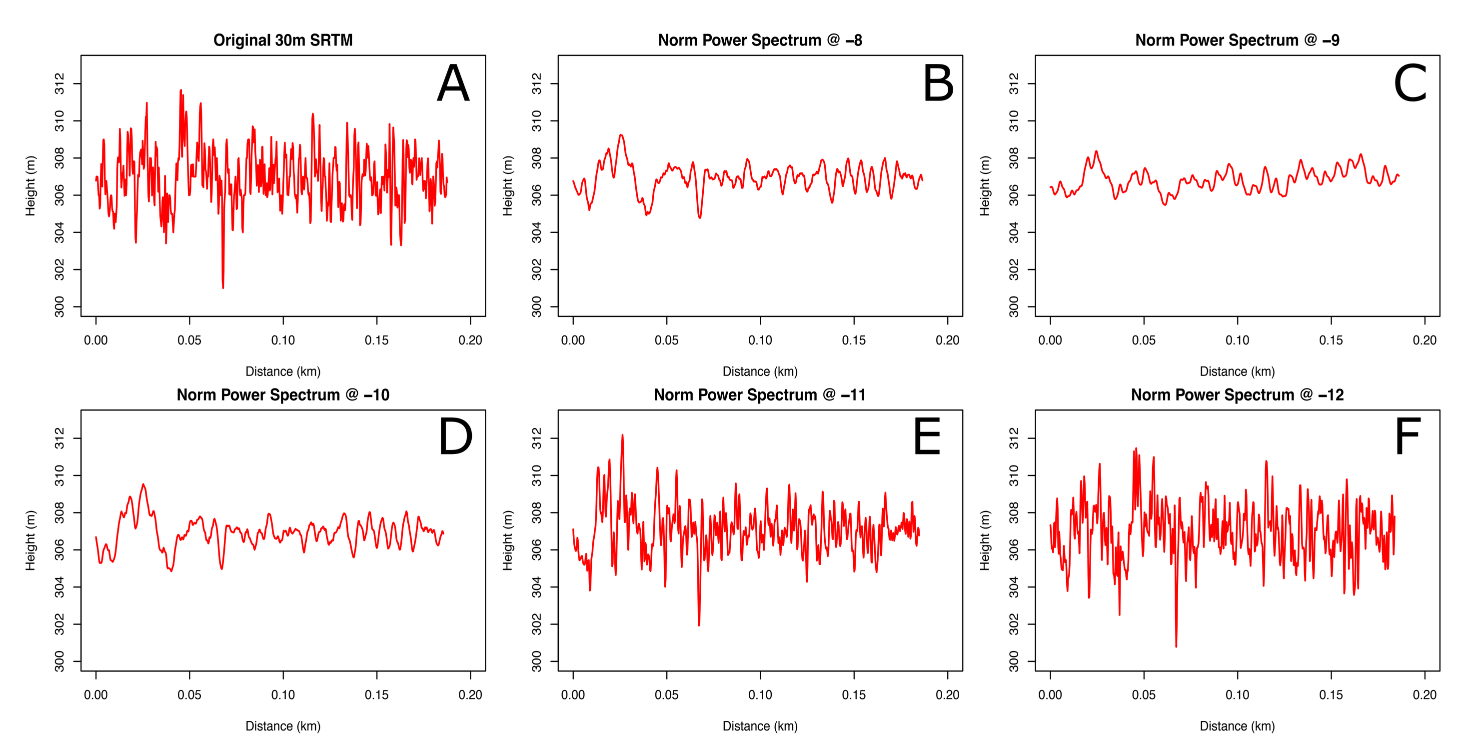
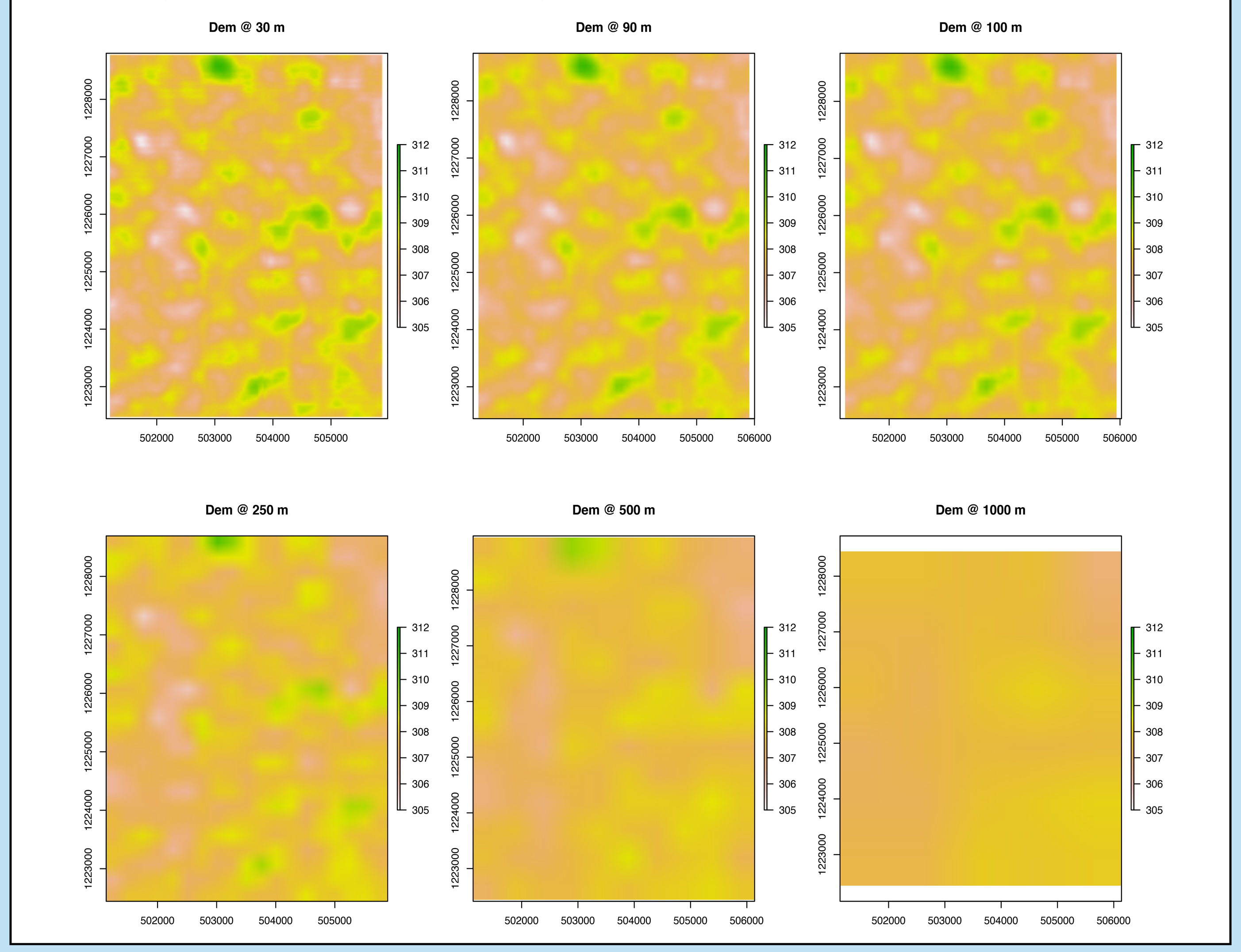


Figure 2: Select profiles of noise-reduced DEMs. The original, 30-m SRTMDEM displays unrealistic patterns (A) that seems to be partially eliminated using the normalized thresholds -8, -9 and -10 (B, C , D). We employ -10 as trade-off between noise reduction and preservation of main topographic patterns.

Despite the FFT filtering, detectable banding persists in the reconstructed DEM (Figure 3). Depressions and protuberances are further filtered when the DEM is regridded to coarser cell-size to an extreme in which there is almost no significant variation in topography. This may affect the skill of the model to simulate flooding patterns.

The comparison between simulations at different resolutions and Landsat-derived total inundated area shows that the model consistently follows observations and reproduces the length of the flooding season, although there is under-estimation of some high floods (2001, 2002, 2004, and 2007) and some offset in timing. Non-flooded periods are correctly simulated (Figure 4).

Figure 3: Reconstructed 30-m DEM an regridding to 90, 100, 250, 500, and 1000-m. Smoothing is evident at cell-sizes larger than 500-m.



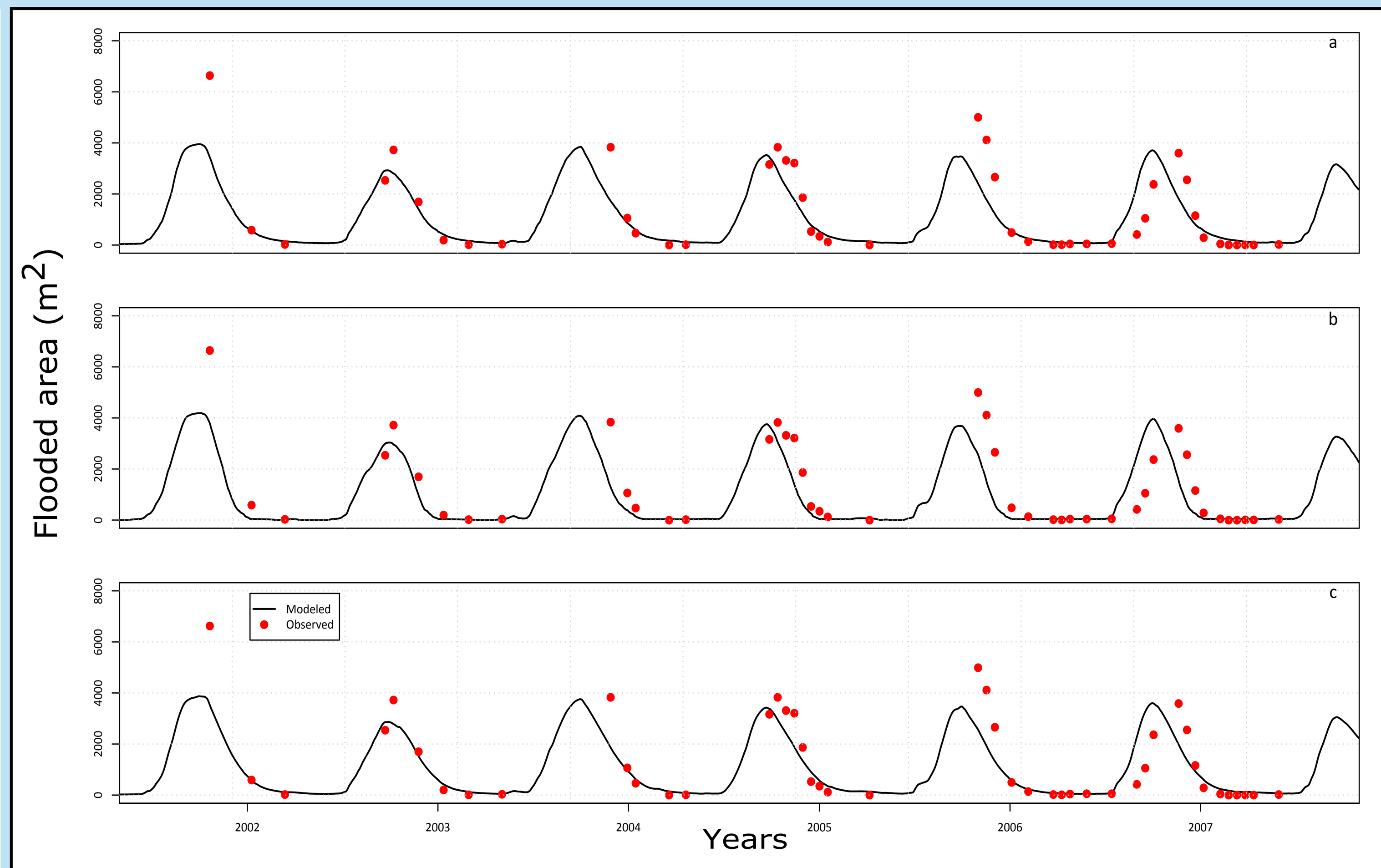
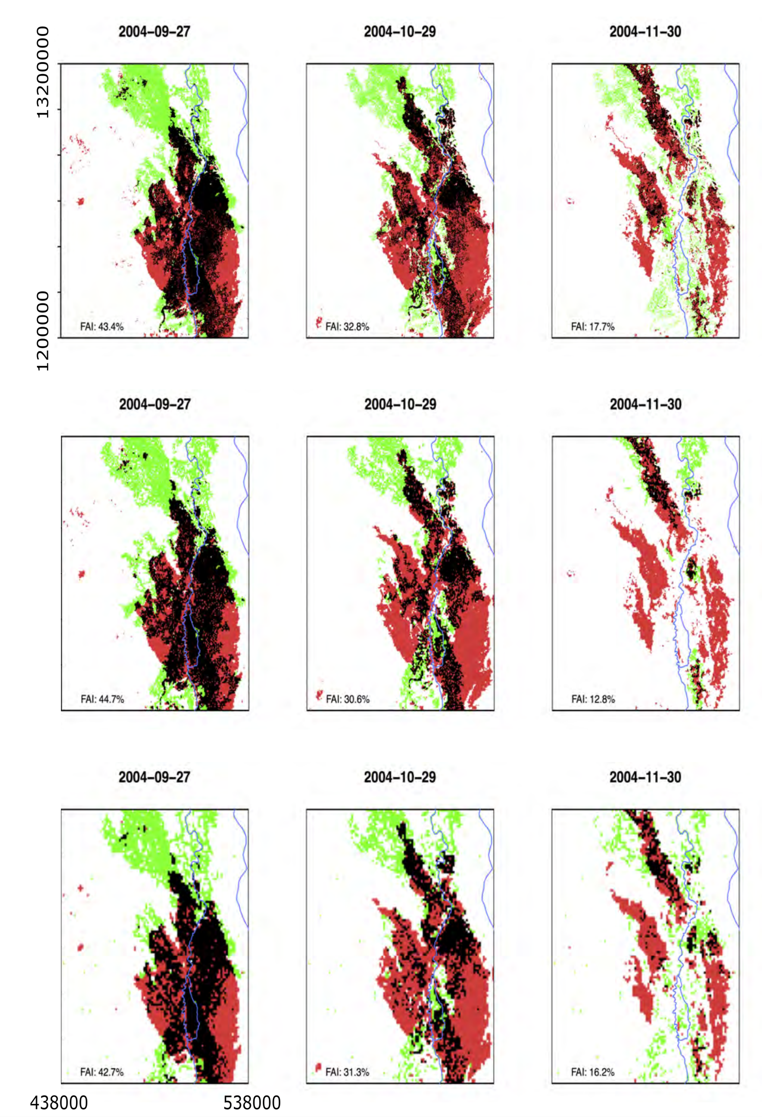


Figure 4: Observed (red dots) versus modeled flooded area (black curves) at 250 (a), 500 (b), and 1000-m (c) cell-size.

Figure 5 is an example of a comparison between model output and flooding extent derived from Landsat. Modeled spatial distribution is consistent among resolutions. Inundated areas to the northern section do not match observations. On the other hand, two areas to the south never get flooded as observations show they should.

Figure 5: Example of Landsat-derived flooding maps versus model output in 2004. Black cells represent agreement between model and observations. Red cells denote observed but no modeled flooding. Green cells represent modeled but not observed flooding. Upper panels correspond to 250-m cell-size, middle panels to 500-m, and lower panels to 1000-m. FAI is a flood index: higher numbers indicate better spatial match between model and observations.



CONCLUSIONS AND FUTURE DIRECTIONS

* FFT noise reduction, although powerful, needs considerable trial and error testing in order to guarantee a reasonable trade-off between topographic signal and noise.
* Model output result insensitive to DEMs at different spatial resolutions.
* We are running more simulations with changes in other boundary and initial conditions, such as friction parameters and satellite precipitation.
* We will couple this model to IPCC projections and two agent-based models of fish and population dynamics in order to understand human-landscape feedback loops.

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