Supplementary Information

Fluvial terrace formation in a mountainous area (2): influence of eustatism, tectonics and altitudinal distribution of watersheds based on an allostratigraphic study (Albania)

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APPENDIX 1

Active tectonics of Albania deduced from terrace geometry.

Green dot number (Fig 1)	Name of the fault	River	Vertical throw (mm.yr^{-1})	reference
1	GKT Gornja Klezna Thrust	Drin	2.5	(a)
2	TBT Tirana Back Thrust		0.4	(d)
3 4	LTT Lushnje-Tepelenë Thrust	Skumbin Vjoja	0.7-1 0.2	(c)
5 6	TT Tomorrica Thrust	Devoll Osum	0.4 0.3	(c)
7	EGNFS Elbasan Normal Fault	Skumbin	>1	(c)
8	BNF Bulcar Normal Fault	Devoll	0.3	(c)
9	WGNFS Korça Normal Fault	Devoll	>0.8	(c)
10	West Ersekë Normal Fault	Osum	1.3	(e)
11	Konista normal fault	Vjoja	>0.4	(e)
12	Papingo fault	Vjoja	0.6	(f)

Table 1, Appendix: *vertical throw rate deduced from paleoriver terrace offsets. See* ***Figure 1, main text*** *for the location. References: (a) Gachelin (1977); (b) Koçi et al. (2018); (c) Guzman et al. (2013); (d) Ganas et al. (2020) and Guzman et al. (2023); (e) Carcaillet et al. (2009); (f) Lewin et al., (1991).*

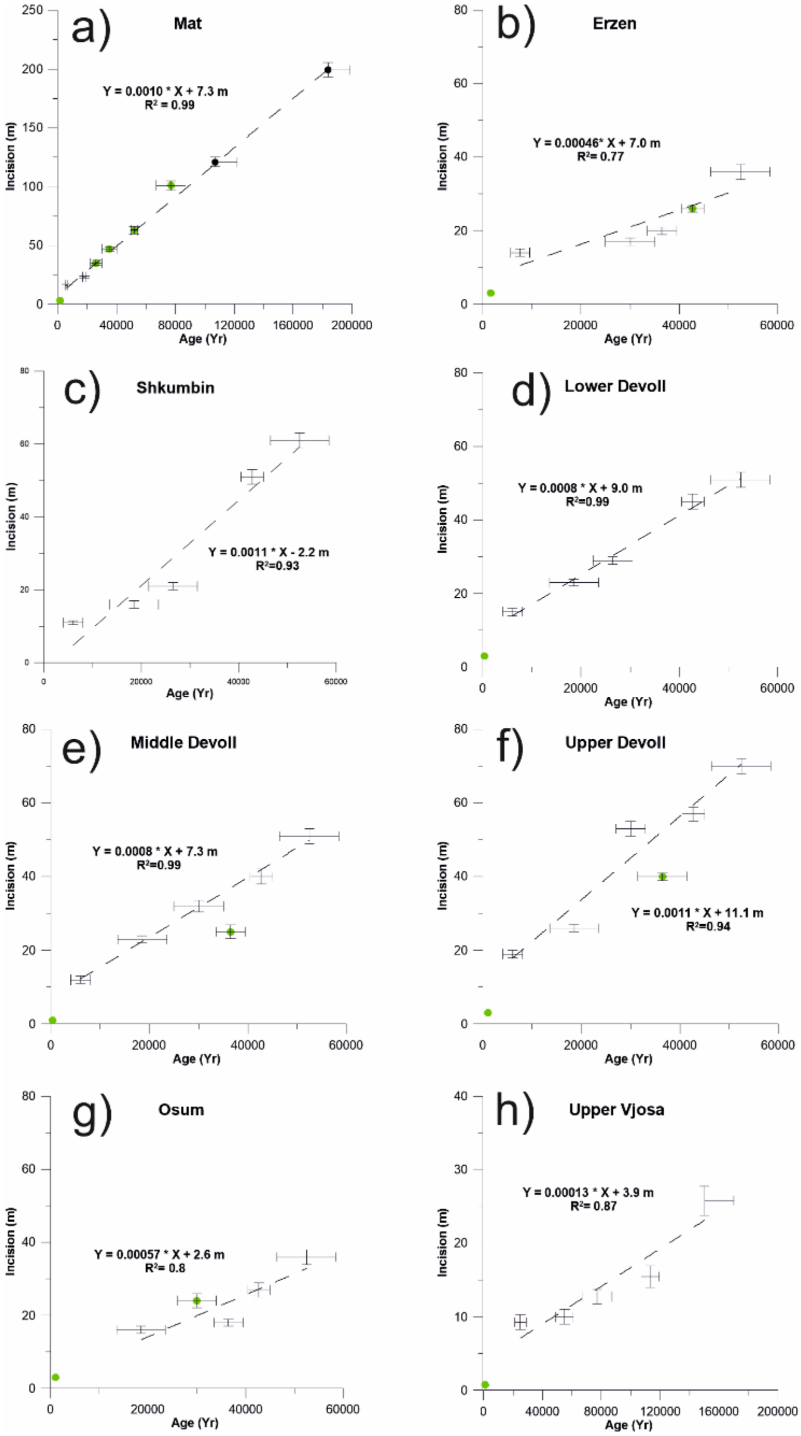

***Figure 1* Appendix:** *Average long-term incision rates along specific sites of the Albanian rivers (From north to south, see location on Figure 1). Abscissa and ordinate are the ages of the terraces (**Table 3 Appendix**) and the elevation above the river of the top of the coarse sub-units respectively. Long-term incision rates were estimated using a linear fit, whose correlation coefficient (R^2) indicates how correct the constant incision rate model is. Periodically (between ~30 ka and ~35 ka on the Devoll and Osum rivers), the top of the upper coarse subunits do not follow the long-term incision trend, due to the superposition of allostratigraphic units. The green dots refer to terraces not numerically dated and not considered in the interpolation.*

APPENDIX 2

Hypsometric study of Albania.

The hypsometric study of the Albanian river catchment has been performed from the 90-m digital elevation model (SRTM, 2013) and using the tools of QGIS.

The used modules are:

- Module Import SRTM30 DEM (SRTM, 2013).
- Module Fill Sinks (QM of ESP). Filling in pits and flats in a DEM. (Pelletier, 2008).
- Module Channel Network and Drainage Basins. Deterministic 8 based flow network analysis. (O.Conrad, 2003). Specification: grid; Menu: Terrain Analysis|Channels
- Module Upslope Area. Method: Deterministic 8. This is the classical method in which water flow moves from the center of one cell to the center of one of the cells surrounding the first cell. This restricts the flow direction to multiples of 45 using 8 flow directions (O'Callaghan et al. 1984).
- Quick OpenStreetMap in QGIS. To import waterway OSM data into a QGIS project

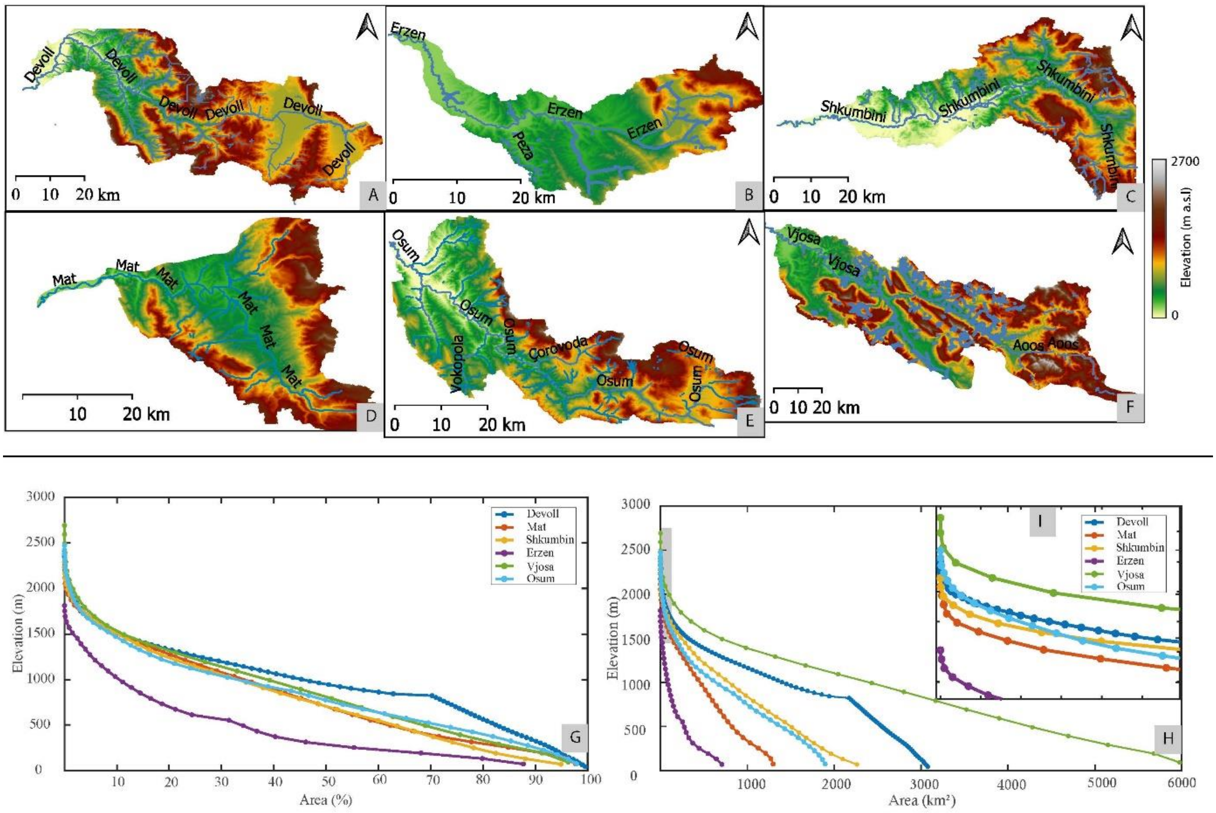

Figure 2 Appendix: *Top: Topographic map of the different river catchments. Bottom: hypsometric curves of the different river catchments expressed in cumulated percentage (left) or in cumulated surface (right).*

Morphologic parameters	Large Rivers			- Small Rivers		
	Vjosa	Osum	Devoll	Shkumbin	Erzen	Mat
Catchment area (km^2)	6300	2230[a]	3100[a]	3070	900	1215
River length (km)	272	125[a]	205[a]	81	75	85
Altitude at source (m a.s.l.)	1600	1100	1100	1150	1300	1200
Catchment maximum altitude (m a.s.l.)	2713	2523	2416	2373	1728	2246
Surface above ELA (2174 m a.s.l.) (km^2)[b]	~120	~12	~14	~11	0	~0.3

Table 2, Appendix: *Morphologic parameters of the Albanian rivers. Data were extracted from the 30-m digital elevation model (SRTM, 2013).*

[a] *Catchment area and river length: from the source to the confluence between the Devoll and Osum rivers. After this point, the Seman River continues for 70 km toward the Adriatic Sea.*

[b] *Surface above 2174 m a.s.l.: this altitude corresponds to the Equilibrium Line Altitude (ELA) in the area for the last glacial stage (Hughes, 2004).*

APPENDIX 3: Time correlation between the terraces of the different rivers

River	Vjosa	Osum	Paleo-Devoll	Erzen	Mat	Drin	Regional nomenclature	Regional abandonment ages (ka)
Terrace	T10$_{(vj)}$	T10(os)	T12(pa)	-	-	T6(dr)	T12	>350 ?
	T9(vj)	T9(os)	T11(pa)	-	T9$_{(ma)}$	T5(dr)	T11	>193
			U10(pa)				U10$_{(pa)}$	
	T8$_{(vj)}$	T8(os)	T9(pa)	T7(er)	T8$_{(ma)}$		T10	90-117
	T7$_{(vj)}$	-	-	-	T7$_{(ma)}$	-	T9	68-87
	T6$_{(vj)}$	T7$_{(os)}$	T8$_{(pa)}$	T6$_{(er)}$	T6$_{(ma)}$	-	T8	52 (-2/+3)
	-	T6$_{(os)}$	T7$_{(pa)}$		-	-	T7	42 (-0.5/+1.5)
	-	pT5$_{(os)}$	pT6(pa)	T5$_{(er)}$	T5$_{(ma)}$	-	T6	35.5 (-1/+2)
	T5$_{(vj)}$	T4(os)	T5$_{(pa)}$	T4$_{(er)}$	-	-	T5	29.5 (±1)
	T4$_{(vj)}$	-	T4$_{(pa)}$	-	T4$_{(ma)}$	-	T4	25 (-2/+1)
	T3$_{(vj)}$	T3$_{(os)}$	T3$_{(pa)}$	-	T3$_{(ma)}$	T4(dr)	T3	16.5-22
	-	T2$_{(os)}$	-	-	-	T3$_{(dr)}$	T2	11-12
	T2(vj)	-	T2$_{(pa)}$	T3$_{(er)}$	T2$_{(ma)}$	T2$_{(dr)}$	T1	5.7-6.3; 7.6-10
	T1$_{(vj)}$	T1(os)	T1(pa)	T2$_{(er)}$	T1$_{(ma)}$	T1(dr)	T0	0.2-1
				T1$_{(er)}$			T0	0-0.2

Table 3, Appendix: *Correlation of the local terrace nomenclatures with a regional nomenclature for the terraces identified along the Albanian rivers. The light green cells refer to dated levels; light yellow and white cells refer to not dated levels, well correlated or poorly correlated, respectively. The colored cells on the right side refer to the color code of* ***Figure 5 (Main text)****. The regional ages of the terraces (last column) are from Guzmán et al. (2023).*

APPENDIX 4: Photographs of typical geomorphologic features

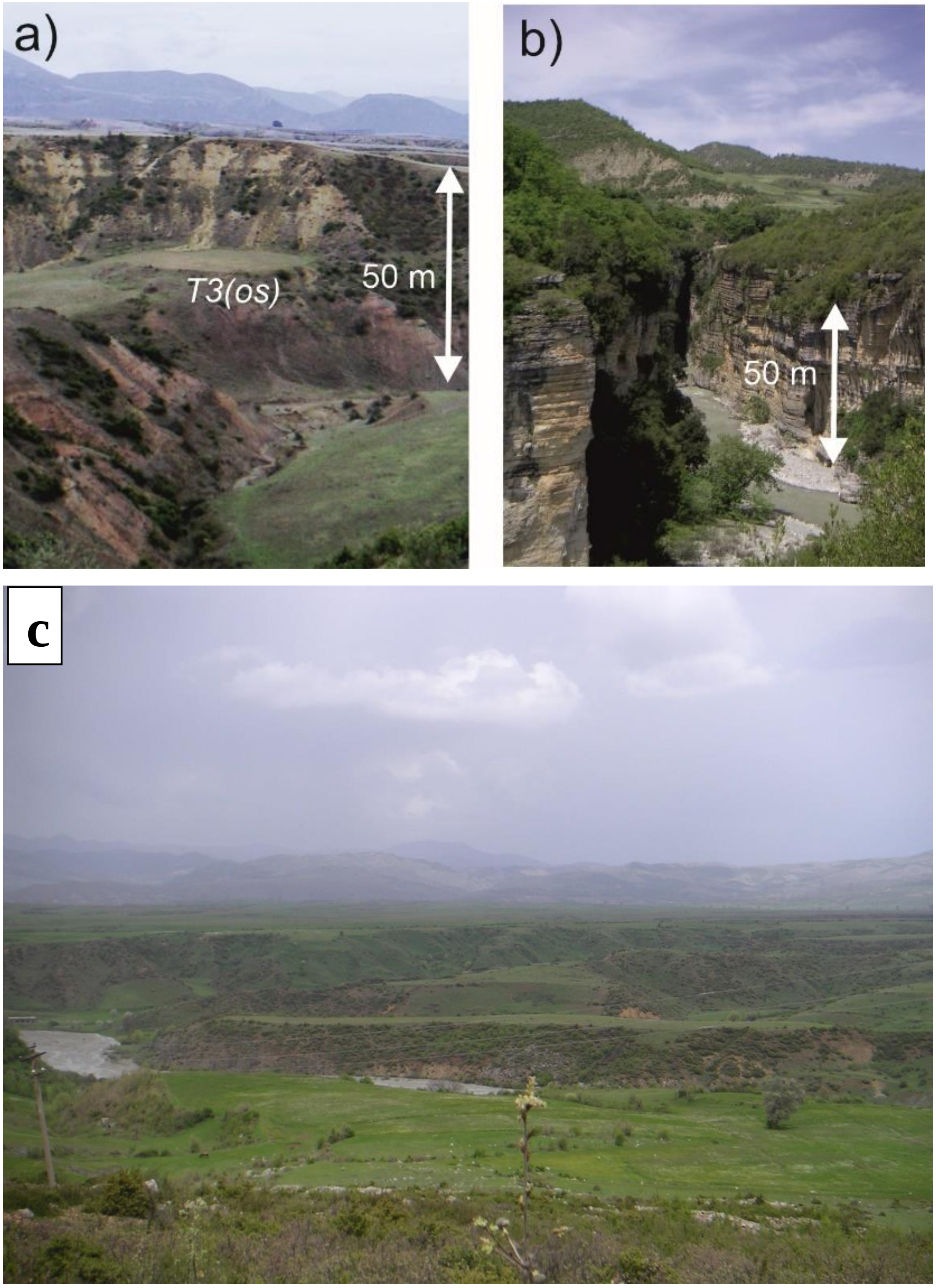

***Figure 3, Appendix**: Features along the Osum river; **a)** and **c)** Ersekë graben: fill-cut terrace $T3_{(os)}$ beveled in older thick sedimentary unit ($T8_{(os)}$ or $T9_{(os)}$); **b)** deep gorges within Cretaceous limestone along the middle reach of the Osum river.*

Figure 4, Appendix: *strath terraces of the Erzen River;* ***a)*** *Nested relationships between* $T7_{(er)}$, $T6_{(er)}$ *and* $T3_{(er)}$; ***b)*** *Strath at the base of* $T6_{(er)}$.

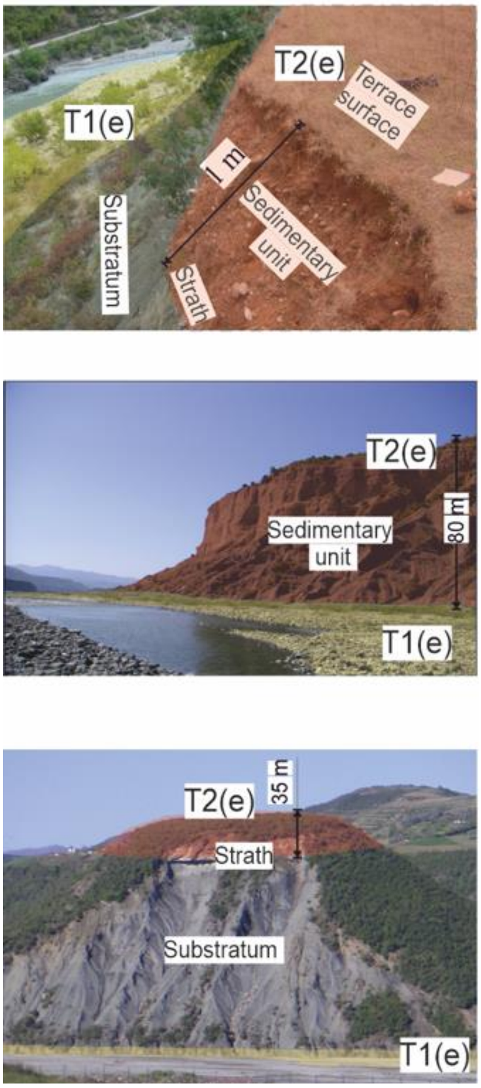

Figure 5, Appendix: *A sketch of the different geometries of the allostratigraphic units beneath the terraces:* ***a)*** *example of a strath terrace (Mat River);* ***b)*** *example of a fill terrace (Vjosa River);* ***c)*** *example of a fill terrace above a strath (Devoll River).*