The main changes made in the work are presented based on the referee suggestions. The remaining modifications will be presented in the final version.

Proposed title: "Flood risk assessment in an ungauged and damming stream, based on geomorphological aspects. Case study: De Los Sauces river, Córdoba, Argentina".

Proposed objective is: "to evaluate the flood risk of an alluvial floodplain intervened with dams applying a semi quantitative methodology that emphasizes on geomorphological aspects.

Sect. 5. Results

Subsect 5.1.Geomorphological and Topographic Characterization

The study area is located in the proximal sector of the alluvial paleofan (Neogene-Quaternary) of the De Los Sauces River, where the current course presents different incision degree and varied development of the fluvial belt.

In this context, five geomorphological units were recognized (Fig.4).

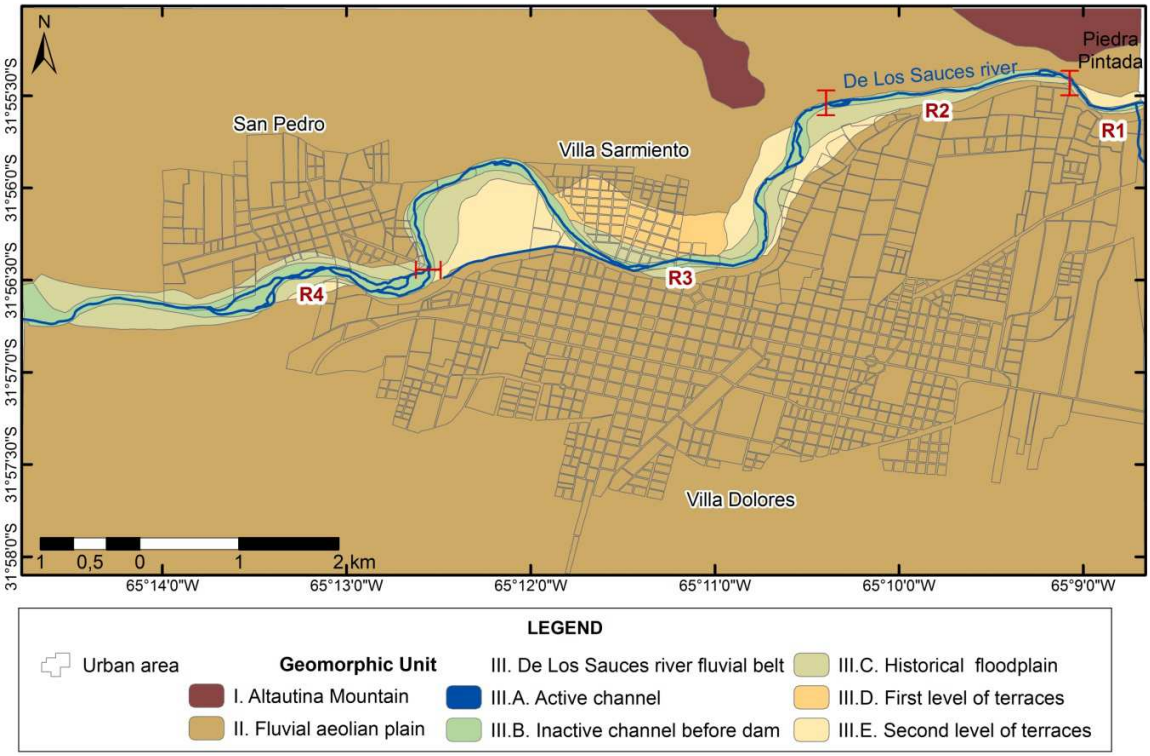

Figure 4. Geomorphological Map of the study area.

I-Fluvio-aeolian Plain: corresponds to the oldest surface of the paleofan. The relief is very gently undulated, where the loessical layers and longitudinal dunes are interdigitated and/or overlaying the paleochannels and overflow lobes of the De Los Sauces River. It has a slope to the west on the order of (0.55)

and a height with respect to the active channel that decreases in that direction from 8 to 2-3 m approximately when entering the middle sector of the paleofan.

II-De Los Sauces River fluvial belt: it extends downstream from Piedra Pintada location and is the result of different incision pulses from De Los Sauces River during the Upper Holocene to the Present. It has a width between 300 and 1,500 m, associated with straight (bedrock) and meandering/braided (alluvial) channel reaches. It includes two discontinuous levels of terraces (III.D and E-Fig. 4) and a small floodplain (III.C-Fig. 4) associated with the active channel (III.A-Fig. 4).The oldest terrace level (T1) has a height of 3-4 m and the lower level (T2) of 2-3 m, above the channel bottom. The streambed sediment are coarse gravelly (cobbles, boulders) – sandy (very coarse) and poorly sorted. The grain size decreasing slightly downstream of bedrock reach (< boulders).

The channel of De Los Sauces River shows variability, not only linked to geological controls but as a result of the operation of the Medina Allende dam and human occupation. In fact, the reduction of waterflow seems to have an immediate effect downstream by initially fostering the sediment deposition. Subsequently, the total interception of sediment by the dam slowly takes over and inverts this tendency. A slightly smaller aggradation (or slightly larger degradation) rate with respect to the natural conditions (no dams) seems to represent the dominant effect of damming in the long term evolution of De Los Sauces river channel. The deposition of fine sandy sediments in the streambed increases, and consequently, grain size sorting decrease. In general, the bedrock segment do not exhibit significant morphological changes (except the channel width), while the alluvial channel lost its braided behavior, although it maintained its sinuosity, prevailing a semiconfined single channel with and erosive behavior. The channel width was reduced up to 85%, generating a historical floodplain. The channel was segmented in four parts considering the most relevant morphological and morphometric characteristics in pre and post dam conditions (Table 1).

Table 1. Most relevant morphological and morphometric characteristics of the channel in pre and post dam conditions.

U.II.3 Active Channel		**Types of river channel**	**Channel Patterns**	**Height Bank (m)**	**Length (km)**	**Slope (%)**	**Width (m)**	**Width channel reduction (%) 1970-2017**
R1	Pre-dam	Bedrock	Straight Single Channel (SI:1.1	3-4	--0.5	0.5	15-20	50-75
	Post-dam				0.5		5-7	
R2	Pre-dam	Alluvial	Straight Single Channel (SI:1.1)	3-4	3.5	0.4	120-150	90
	Post-dam						12-16	
R3	Pre-dam	Alluvial	Meandering with overlay braided, mobile bars	3-6	5.8	0.32	40	80

	Post-dam	Alluvial	Meandering (SI: 1.6) Single channel dominate and secondary channel, locally (BI: 2), very vegetated and stable bars				8	
R4	Pre-dam	Alluvial	Meandering Braided	2-5	4	0.32	70-60	85
	Post-dam	Alluvial	Multichannel (SI: 1.2, BI: 4) Irregular, erosive and secondary channels. Ponds presence by mining				10-12	

SI: Sinuosity Index, BI: Braiding Index

Subsect 5.4.Analysis of flood risk

Subsect 5.4.1Fluvial flood hazard

-**Susceptibility analysis**

Five susceptibility classes were defined (Table 3) which were evaluated in each geomorphological unit (Fig. 7). As can be observed in the map, the susceptible zones are those located in the most modern fluvial belt. Taking into account that it is incised in the paleo alluvial fan and then deepened, these zones have very low susceptibility.

Table 3. Susceptibility classes evaluated for each geomorphological unit

SusceptibilityClasses	Geomorphic Unit			Land Use
High	Inactive channel Post dam	+  -	Reach R1	Engineering works (bridges, walkway, fords, duct and small dike), local roads, mining
			Reach R2	
			Reach R3	
			Reach R4	
Moderately High	Historical floodplain			Mining, motocross circuit
Moderate	Second terrace level (T2)			Mining, irrigation channels
Moderately Low	First terrace level (T1)			-
Low	Fluvial aeolian plain			-

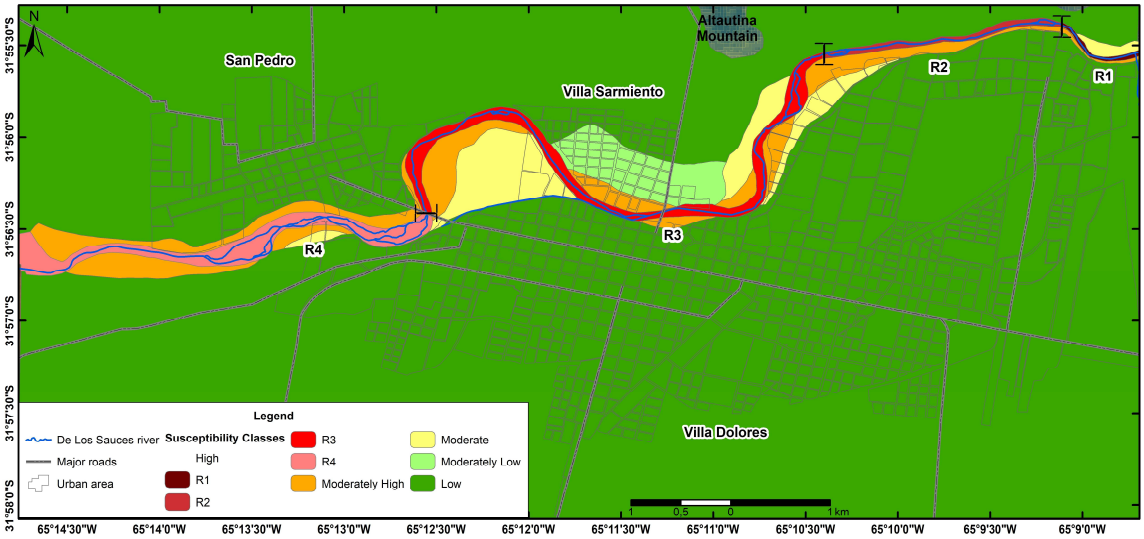

Figure 7. Flood susceptibility map associated with De Los Sauces River.

-Threat Analysis

Three threat scenarios were defined according to the hydrological analysis, including flows of different magnitude and recurrence. On the other hand, for the scenarios 1 and 2, the threat was subdivided into two classes according to the channel characteristics and intervention degree and type, which condition the flow behavior (distribution, waterstage). The highest class corresponds to reaches R1-R2 (Tables 1 and 4) which are narrower, straight, on bedrock/alluvial and with the highest slope. There the flow is conducted at high velocity and show the highest stages. The lowest class was defined for the alluvial channel reach, which is wider, sinuous, multichannel and highly impacted by mining (Reaches 3 and 4 – Tables 1and 4). In this case, the roughness increases, the water stage and flow velocity are lower.

Scenario 1: Discharge values between 30 and 80 m^3s^{-1} are considered, which include floods of low magnitude and recurrence periods less than 10 years. These are related to the streams not intervened and to the opening of the dam sluice gates.

In March 2015 a scenario of these characteristics occurred. The dam was at the limit of its storage capacity, so 4 sluice gates were opened evacuating a flow close to 30 m^3s^{-1}.

Scenario 2: Discharge values considered are between 80 and 300 m^3s^{-1}. In this case, moderate magnitude flood events are included, with a recurrence of 20-30 years associated to the tributaries that drain the scarp of the Grandes Mountains and come together downstream of Boca del Río dam. The events recorded in 1981 and most recently on February 4, 2014 represent this situation. In that event, Las Tapias and Chuchiras streams evacuated an estimated discharge of 129 and 200 m^3s^{-1}, respectively, while for De Los Sauces river a value of 130 m^3s^{-1} was estimated. This scenario also considers discharges associated with the partial opening of sluice gates dam.

Scenario 3: Discharges of great magnitude and with recurrences greater than 50 years were estimated. This scenario would be associated to an extraordinary event added to an inadequate management of the dam. The reservoir would reach its maximum storage capacity evacuating a flow of approx. 1,200 m^3s^{-1} through the total opening of the 8 sluice gates.

- **HazardAnalysis**

In the Table 4 and Figs. 8, 9 and 10 the hazard maps for the three threat scenarios are showed.

Table 4. Flood hazard classes considering three threat scenarios

GEOMORPHIC UNIT	SUSCEPTIBILITY CLASSES		THREAT (Scenario 1)	HAZARD (Scenario 1)	THREAT (Scenario 2)	HAZARD (Scenario 2)	THREAT (Scenario 3)	HAZARD (Scenario 3)
Channel	High	R1	Moderately Low (R1-R2)	Moderately High (R1-R2	Moderately High (R1-R2	High (R1-R2)	Very High	Very High
		R2						
		R3	Low (R3-R4)	Moderate (R3-R4)	Moderate (R3-R4)	Moderately hight (R3-R4)		
		R4						
Floodplain	Moderately High		Very Low	Moderately Low	Moderately low	Moderate	High	High
Terrace 2 (T2)	Moderate		-	-	-	-	Moderately High	Moderately High
Terrace 1 (T1)	Moderately Low		-	-	-	-	Moderate	Moderate
Fluvio-aeolian Plain	Low		-	-	-	-	Moderatey Low	Moderately Low

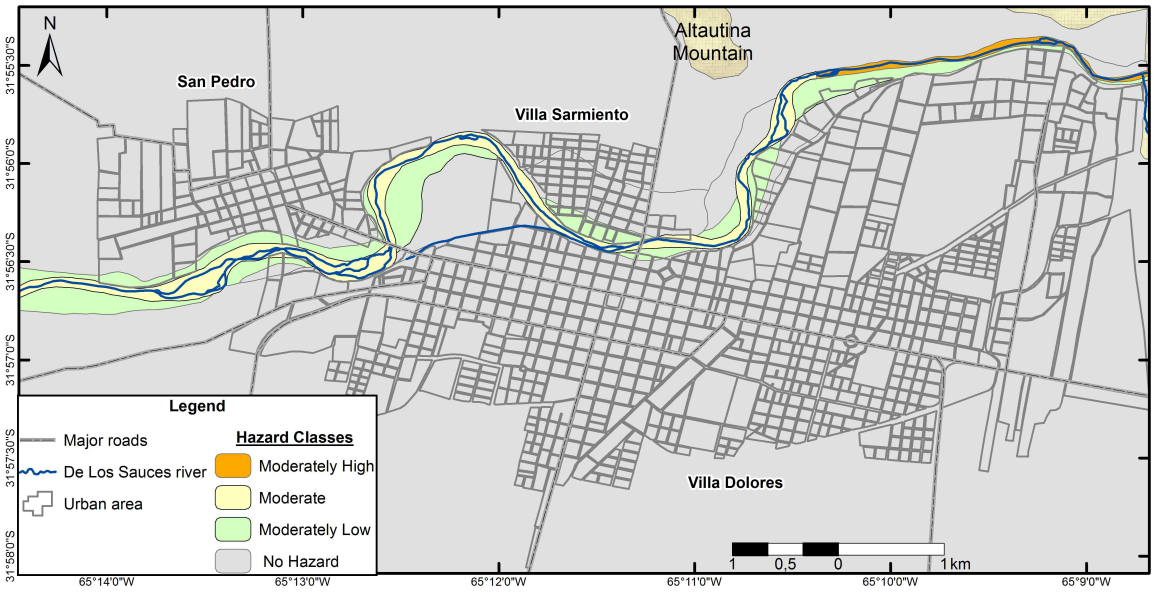

Figure 8. Flood hazard map associated with the De Los Sauces River for the first threat scenario.

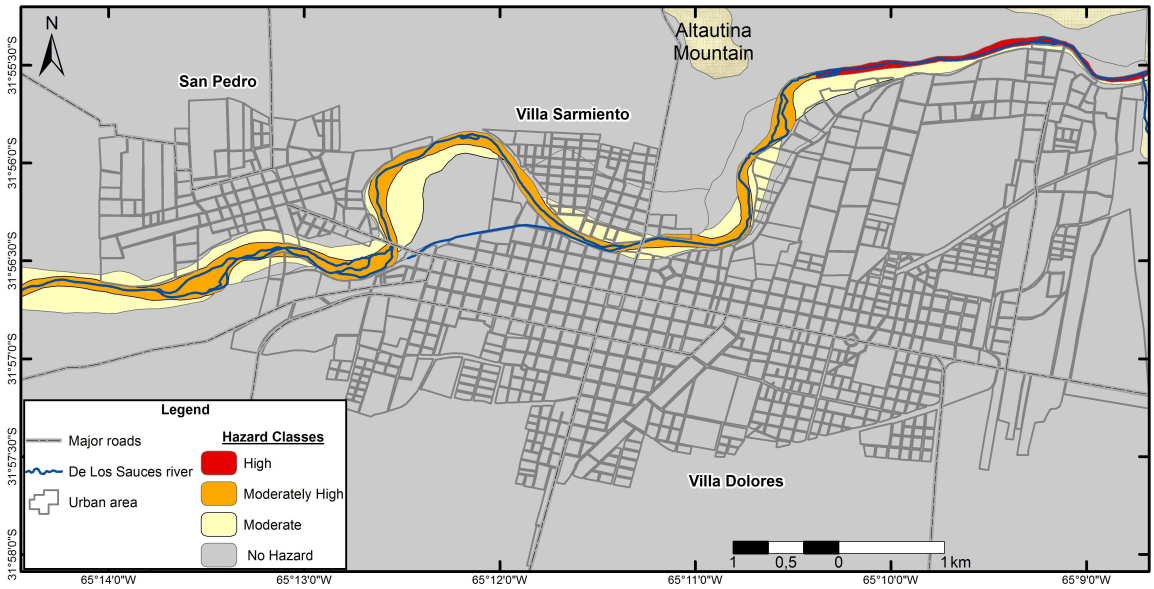

Figure 9. Flood hazard map associated with De Los Sauces River for the second threat scenario.

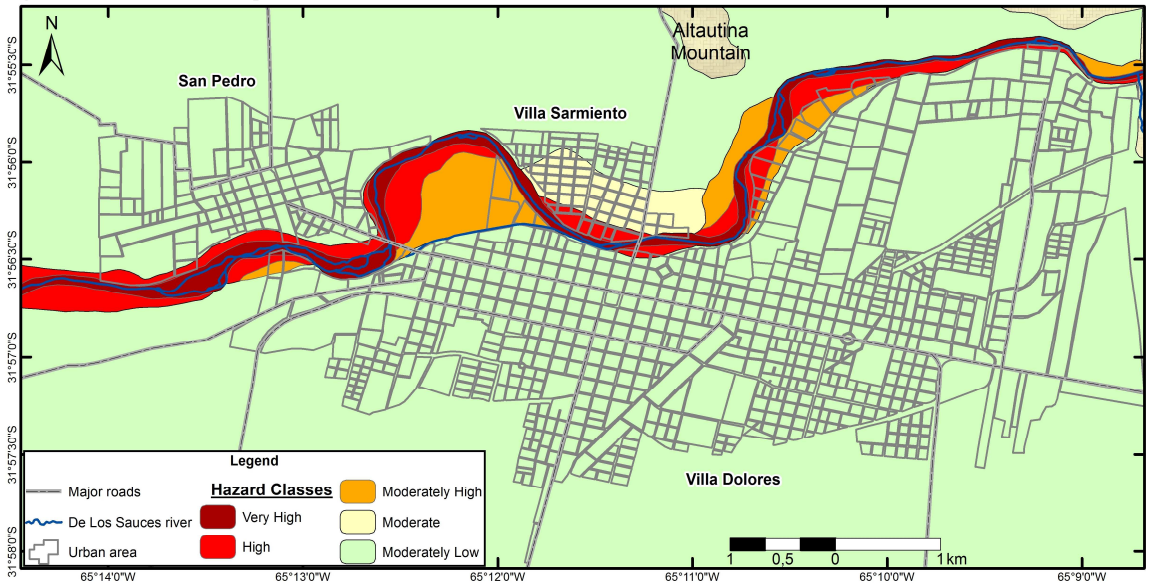

Figure 10. Flood hazard map associated with De Los Sauces River for the third threat scenario.

The vulnerability map is the same as that presented in the submitted paper. Therefore flood risk maps will change according to the flood hazard maps. They will be presented in the final version.