Gravel Bed Rivers: Processes, resilience and management in a changing environment

PRE-CONFERENCE TOUR

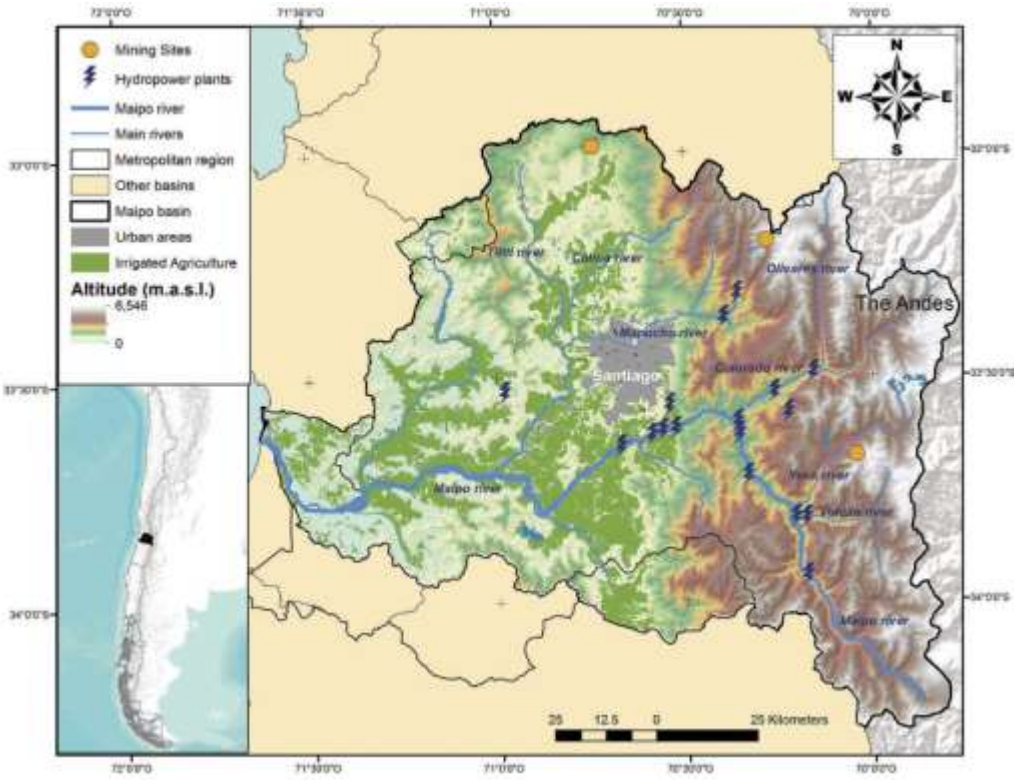
9th January 2023

Gravel Bed Rivers 9
Villarrica, Chile
10-13 January 2023

Welcome to the pre-conference tour of the Gravel Bed Rivers 9 congress!

We organized two alternative trips to the lower and the middle portion of the Maipo river (Cajon del Maipo) before its arrival to the so-called central valley, where the Maipo river flows just in the southern part of Santiago.

The Maipo basin closed where the river reach Santiago has an area of 4843 km^2, its elevation ranges from 850 to 6570 m a.s.l. The Maipo River and its tributaries are the primary source for drinking water, agriculture, hydropower, and industry in the region, which concentrates about 40 % of the country's population. The Maipo River is one the main sources of water for residential and commercial consumers, including industry and agriculture in the region. The regime is typical of a Mediterranean semi-arid area, with precipitation concentrated in winter especially as snow at the highest altitudes, and high rainfall variability. Discharge is high in spring and summer due to melting snowpack and glacier melting. The region has a Mediterranean-type climate, with precipitation concentrated in winter especially as snow at the highest altitudes, and high rainfall variability. Average precipitation in Santiago was around 308 mm yr^{-1}, but in recent years has been as low as 70 mm yr^{-1} due to a long-standing drought named mega-drought (Serrano-Notivoli et al., 2021). The basin has more than 800 glaciers covering about 8 % of the basin area and glacier runoff presents about 34 % of the total discharge in February and up to 67 % during summer months of dry years (Ayala et al., 2020).



The Maipo basin and water uses (from Vicuña et al., 2018)

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Pre-Conference Tour Option 1: Middle Maipo valley

Lead by Cristian Escauriaza (Catholic University of Chile)

- **8:30**: Accreditation and Welcome at Universidad Diego Portales (UDP
- **9:20: Departure from UPD**
- **11:00: Canalistas del Maipo**. Visit to the hydraulics structures
- **13:00: Aguas de Ramon**. Debris Flow monitoring and modeling
- **14:30:** Return to UDP University

Pre-Conference Tour Option 2: Upper Maipo valley

Lead by Luca Mao (University of Lincoln, UK) and Alejandro Dussaillant (Aysén University, Chile)

- **8:30**: Accreditation and Welcome at Universidad Diego Portales (UDP
- **9:20: Departure from UPD**
- **11:45 – 12:45:** Estero Morales. Monitor sediment transport in a glacierized Andean basin
- **13:45 – 14:45: Estero San José.** LSPIV monitoring station
- **17:15:** Return to UDP University

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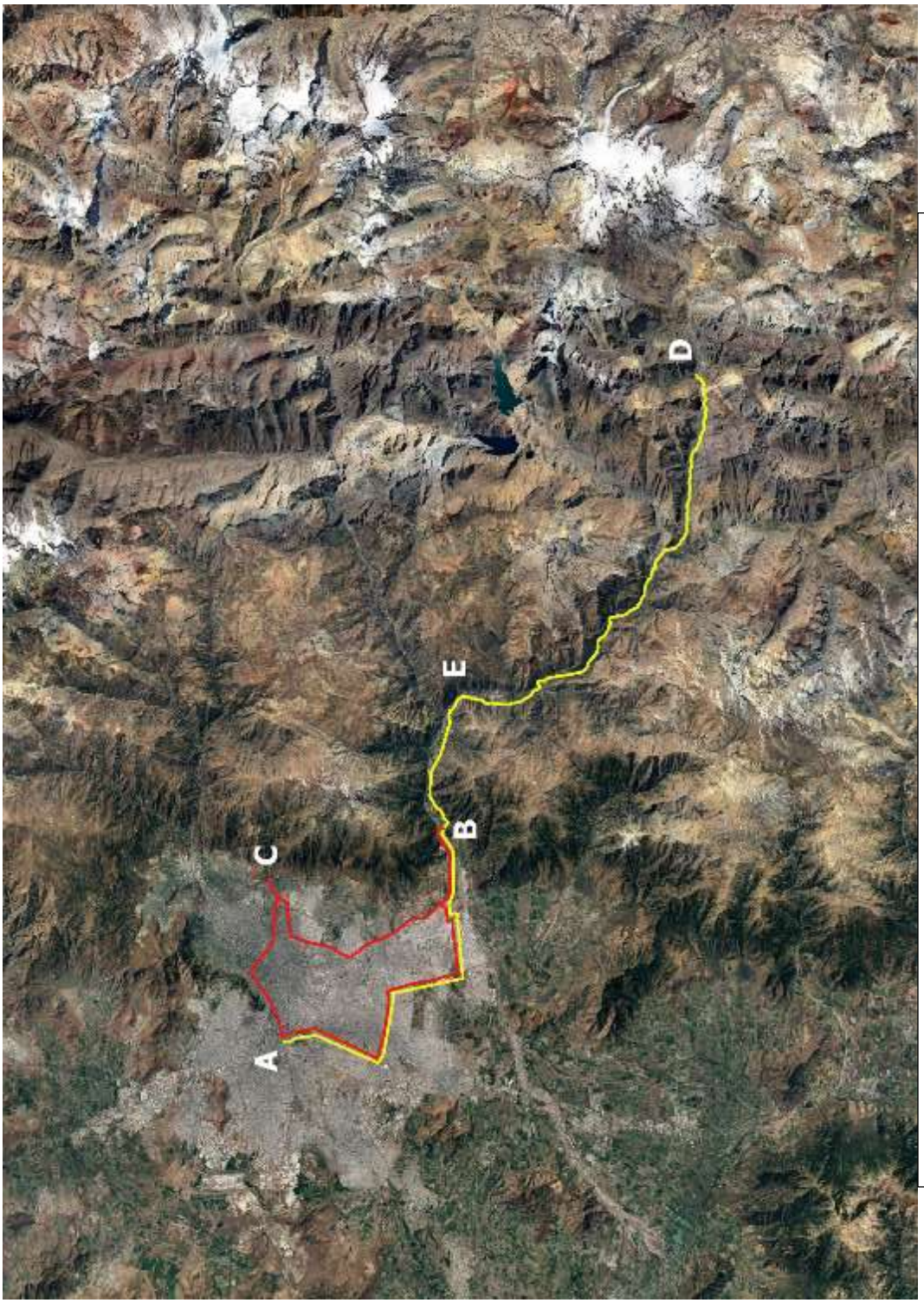

Option 1 - A: UDP University: B: Canalistas del Maipo; C: Aguas de Ramon

Option 1 - A: UDP University: D: Estero Morales; E: Estero San Jose

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Pre-Conference Tour Program (Middle Maipo valley)

Monday 9th January 2023

Meeting point: Universidad Diego Portales (UDP)

Fac. Ingenieria y Ciencias; Ejercito Libertador 441, Auditorium Floor-1
https://w3w.co/watching.never.music
reachable using: Metro station Line 2, station Toesca and walk 5 min
or: Metro station Line 1, station Los Heroes and walk 10 min

8:30 - 9:00: Accreditation and Welcome coffee at UDP

9:00 - 9:20: Inaugural Welcome

- Welcome from the Dean of the Facultad de Ingeniería y Ciencias UDP (3 min)
- Welcome from the Local Organizing Committee (5 min)
- Pre-conference tour explanation (Middle Maipo Valley): Cristián Escauriaza and Alonso Pizarro (15 min)

9:20: Boarding on the transfer bus and departure from UDP
https://w3w.co/lookout.bunk.visit

11:00: Arrival at Pirque Reserva Río Clarillo/Canalistas del Maipo, visit to the hydraulics structures (intakes, weirs, bank protections, channels)

12:00: Departure from Canalistas del Maipo to site of gravel mining in the Maipo River

13:00: Arrival at site of gravel mining

14:00: Departure from gravel mining site to Santiago

14:30: Arrival at UDP University (https://w3w.co/lookout.bunk.visit). From there it's just a 10- minutes' walk to a bus station from which there are frequent buses to Santiago Airport (https://www.centropuerto.cl/ (Frequency every 20 min and fee CLP 2,000 / USD 2.00). This field trip is to be preferred by those who booked a flight to Temuco for the late afternoon of Monday 9th January. The flights from Santiago to Temuco are operated by:

- LATAM Airline Monday 9 th 18:31 – 19:55 (CLP 26,824 / USD 30.15)

- SKY Airline Monday 9 th 17:20 – 18:41 (CLP 35,990 / USD 40.46)

There are several options for reaching Villarrica from Temuco Airport, including buses, vans and private taxis, with costs ranging from approx. 5 to 30 USD.

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Pre-Conference Tour Program (Upper Maipo Valley)

Monday 9th January 2023

Meeting point: Universidad Diego Portales (UDP)

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reachable using: Metro station Line 2, station Toesca and walk 5 min
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8:30 - 9:00: Accreditation and Welcome coffee at UDP

9:00 - 9:20: Inaugural Welcome

- Welcome from the Dean of the Facultad de Ingeniería y Ciencias UDP (3 min)
- Welcome from the Local Organizing Committee (5 min)
- Pre-conference tour explanation (Estero Morales): Luca Mao and Alejandro Dussaillant

9:20: Boarding to the transfer bus and departure from UDP
https://w3w.co/lookout.bunk.visit

11:45: Arrival at Baño Morales village, visit to the Estero Morales and entrance to the El Morado CONAF Natural Park (https://w3w.co/roared.delegating.teams).

12:45: Departure from Baño Morales towards Santiago

13:45: Arrival at San Jose del Maipo to visit experimental river monitoring station (https://w3w.co/glazes.psyches.contempt).

14:45: Departure from San Jose del Maipo to Santiago

16:30: stop at Terminal Alameda Bus Station (https://w3w.co/happily.risking.mice). From this station there are overnight buses that will reach Villarrica around 7:00 AM on Tuesday 10th January. More information can be found here (https://www.recorrido.cl/en). From Alameda Bus Station it's easy to reach other bus stations from which other coaches companies have overnight buses to Villarrica, for example Terminal Parque Bicentenario (https://new.turbus.cl/turbuscl/) and Terminal Parque Araucano (Jac and ETM; https://www.recorrido.cl/es/bus/buses-jac-pasajes)

17:15: Arrival to UDP University (https://w3w.co/lookout.bunk.visit).The Estero Morales site is located in the middle of the Andean cordillera, and it's unlikely that we will be able to reach the Airport on time to get the late afternoon flights to Temuco. Who joins this trip should consider using an overnight bus trip to Villarrica instead.

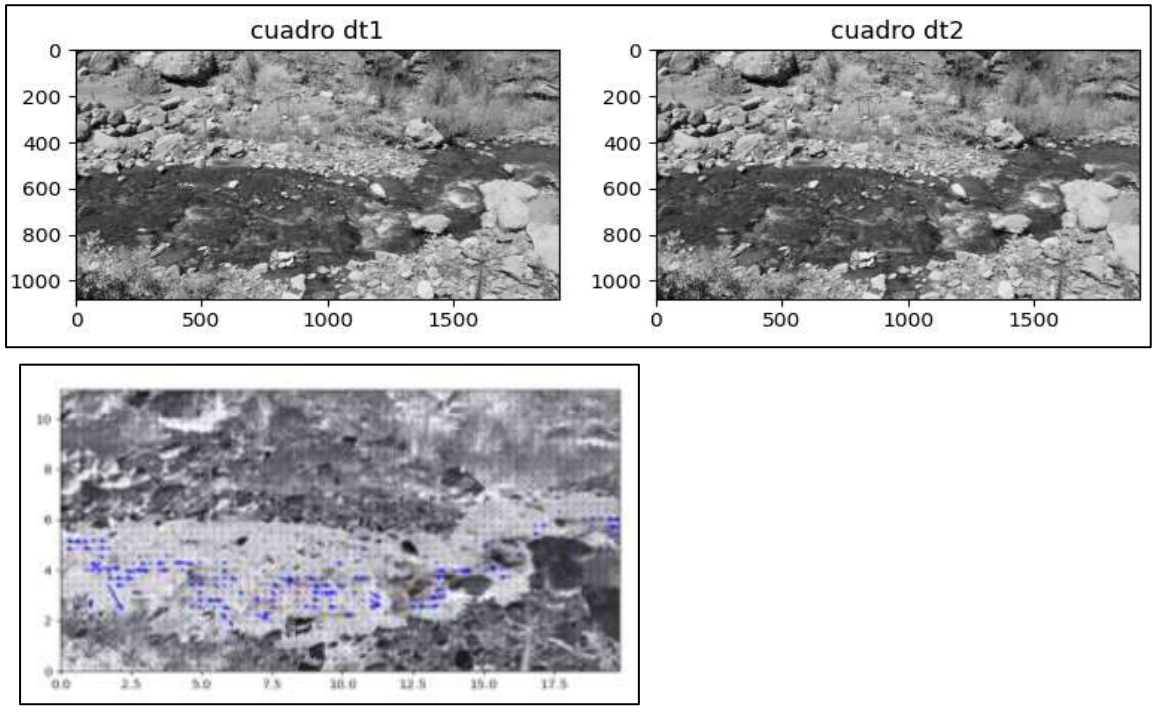
Estero Morales

The Estero Morales is a high-gradient stream in the central Chilean Andes. The basin extends for 27 km^2, with an elevation between 1,780 and 4,497 m.a.s.l. There are several relatively small glaciers above 2,700 m.a.s.l. The climate is Mediterranean, with precipitation (550 mm) occurring mainly as snowfall from April to September, and runoff mainly results from snow and glacier melt. At the confluence with the Maipo river the stream is steep (0.14 m/m), and the channel width is approximately 7 m, featuring step-pool sequences. The site was equipped with a pressure transducer and a multiparameter water quality probe to monitor water temperature, electrical conductivity, and turbidity with a 10-min time interval. Bedload was measured using a combination of methods, integrating both direct and indirect techniques. For monitoring continuously the transport of coarse particles, a 0.5mlong Japanese acoustic pipe sensor was fixed on the channel bed. The sensor was calibrated in order to transform the signal into bedload sediment transport rates. The calibration was carried out by taking direct bedload samples using 0.3 m wide Bunte samplers. Coarse sediment mobility in Estero Morales was also investigated using natural clasts equipped with 23-mm-long radio frequency identification (RFID) passive integrated transponder tags. The monitoring station was completely destroyed by a flood occurred in 2017, but bedload monitoring and processes in high-gradient streams will be discusses in the field using evidence gathered in the particular cross-section.

The Estero Morales basin and San Francisco Glacier with the location of monitoring station; Picture of the impact acoustic pipe installed in the monitored cross section where bedload samples were collected in the Estero Morales using Bunte-traps.

Estero San José de Maipo monitoring station

The station was installed in recent times and is operational on the Estero San Jose, which experienced recent floods affecting the Maipo valley and the water provision to Santiago. The monitoring station is equipped with low-cost but robust equipment for monitoring liquid discharges and early warning system. The system uses modules OpenPIV y OpenCV in Python to monitor continuously the surface flow velocity



Installation in the Estero San Jose with microcomputer Raspberry Pi, camera Hikvision, solar panel and LiDar; Images of velocity vectors calculated using LSPIV.

Health and Safety notes

- Bring water, suncream and a hat;
- It is likely to be very hot;
- Hiking boots would be recommended;
- The trip leader will carry a first aid kit;
- Poor mobile phone coverage in the upper part of the Maipo valley

Further reading

Ayala, Á., Farías-Barahona, D., Huss, M., Pellicciotti, F., McPhee, J., and Farinotti, D.: Glacier runoff variations since 1955 in the Maipo River basin, in the semiarid Andes of central Chile, The Cryosphere, 14, 2005–2027, https://doi.org/10.5194/tc-14-2005-2020, 2020.

Carrillo, R., Mao, L. (2020). Coupling Sediment Transport Dynamics with Sediment and Discharge Sources in a Glacial Andean Basin. Water, 12, 3452.

Farías-Barahona, D., Wilson, R., Bravo, C., Vivero, S., Caro, A., Shaw, T., . . . Braun, M. (2020). A near 90-year record of the evolution of El Morado Glacier and its proglacial lake, Central Chilean Andes. Journal of Glaciology, 66(259), 846-860. doi:10.1017/jog.2020.52

Henriquez-Dole L., Uson T.J., Vicuña S., Henriquez C. Gironas J., Meza F. (2018). Integrating strategic land use planning in the construction of future land use scenarios and its performance: The Maipo River Basin, Chile. Land Use Policy, 78, 353-366

Mao, L., Carrillo, R. (2017). Temporal dynamics of suspended sediment transport in a glacierized Andean basin. Geomorphology, 287, 116-125.

Mao, L., Toro, M., Carrillo, R., Brardinoni, F., & Fraccarollo, L. (2020). Controls over particle motion and resting times of coarse bed load transport in a glacier-fed mountain stream. Journal of Geophysical Research: Earth Surface, 125, e2019JF005253. https://doi.org/10.1029/2019JF005253

Mao, L.; Carrillo, R.; Escauriaza, C.; Iroume, A. (2016). Flume and field-based calibration of surrogate sensors for monitoring bedload transport. Geomorphology, 253, 10-21.

Ravazzolo, D., Mao, L., Escauriaza, C., Pastén, P., Montecinos, M (2019). Rusty river: Effects of tufa precipitation on sediment entrainment in the Estero Morales in the central Chilean Andes. Science of the Total Environment, 652, 822-835.