



**Institute for Water and Environment (IWU)**  
Hydraulic Engineering & Water Resources Management  
**Institute of Applied Geosciences (AGW)**  
General Geology Group

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## **Master thesis**

on the subject

### **Energy-based sediment ageing using tumbler experiments to mimic field conditions and smart pebbles to quantify cumulative mechanical work**

Supervisory team: Prof Mário J. Franca (IWU), Prof Nevena Tomašević (AGW)

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#### **Background / Motivation**

A fundamental challenge in sediment transport research is whether cumulative mechanical work (impacts, rotation, collisions), and not just transport distance, controls particle shape, mass loss, and downstream signatures. Recent work proposes that accelerometer-equipped sediment proxies can reveal the energy responsible for attrition, helping shift from purely, and often meaningless, spatial to energetic interpretations of sediment evolution. This aligns with field evidence that lithology-specific distributions and mass-loss rates enclose the hydrological history in alpine catchments.

#### **Scope of the work**

This MSc thesis uses smart-pebble sensing, laboratory tumbling experiments, and theoretical modeling to build an energy-based sediment ageing framework. The study is foreseen to include the following activities:

- Literature review
- Instrument a smart pebble with accelerometers and gyroscopes to measure impact intensity, collision frequency, rotational dynamics, and calculate cumulative mechanical work.
- Run controlled tumbler experiments, simultaneously acquiring temporally resolved shape, mass, and diameter evolution for natural sediments.
- Develop empirical relationships linking cumulative mechanical work to: mass loss; shape and size evolution.
- Use lab-derived energy–shape relationships to infer the hydrological age of sediments collected along known pathways in alpine basins.
- Data analysis and interpretation of evolution trajectories of sediment geometric characteristics and mass.

- Discussion of the results
- Redaction of the master thesis

**Remarks**

This master's thesis is conducted in tandem with a parallel thesis in Geology, focusing on the influence of rock properties and geological history on degradation within fluvial systems. The thesis will be developed in collaboration with the IHE Delft (Dr. Alesandro Cattapan). This project is suitable for a student with an interest in hydro-sedimentary processes and sensor development. Laboratory experience and data treatment skills are advantageous. The work can contribute to ongoing research on sediment continuity, climate impacts, and geomorphic response times in alpine environments.