

Navigating the twin transition: The imperative for modernized education in climate-resilient resource management in Bosnia and Herzegovina

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RESOURCE CONTEXT

BiH's centuries-old mining tradition contributes just 1.3% of GDP today.

The circular-economy paradigm reframes historic tailings and slag as untapped reservoirs of Critical Raw Materials (Cu, Zn, Pb, Co, REEs) essential for renewable-energy technologies.

Unquantified Coal Bed Methane (CBM) offers a transitional baseload energy source.

INSTITUTIONAL HURDLES

A decentralized political structure and Yugoslav-era regulatory framework create overlapping jurisdictions, political patronage and permitting delays.

Geospatial data — elevation models, land boundaries, geological layers — is fragmented and unshared; digital cadastres rarely match legal ownership.

CLIMATE VULNERABILITIES

The Balkans face shifting rainfall, prolonged droughts and extreme weather.

The October 2024 atmospheric river dropped hundreds of L/m² in under six hours.

With transport infrastructure built 1968–1975, flash floods can sever logistics chains and breach historical tailings dams.

CONVERGING URGENCY FACTORS

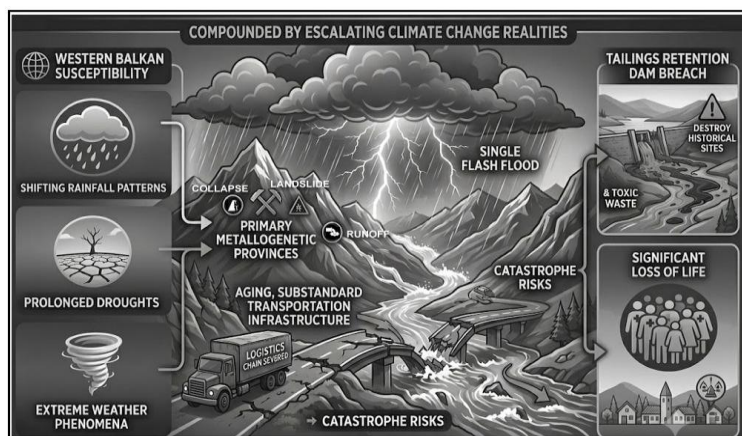


Fig. 1 Urgency factors for updated modeling, planning and education (Source: Authors, AI-assisted)

A single flash flood can sever logistics chains, breach tailings retention dams and cause significant loss of life.

Climate-informed, resilient planning is no longer optional.

GEOSPATIAL DATA

Curricula must train professionals in GIS, drone-based remote sensing and 3D mapping to untangle land-rights legacies, digitize terrain data and enable participatory community mapping.

DEPOSIT MODELING

Education must emphasize 3D deposit modeling, geostatistics and international-standard resource estimation, plus predictive forecasting and Digital Twins to simulate infrastructure vulnerabilities before disaster strikes.

EXTRACTION METHODS

Engineering programs should prioritize hydrometallurgical CRM recovery, bioleaching and safe CBM capture (San Juan Basin analogs), embedded in a Just Transition offering reskilling for the current coal workforce.

THE UNIVERSITY PIVOT

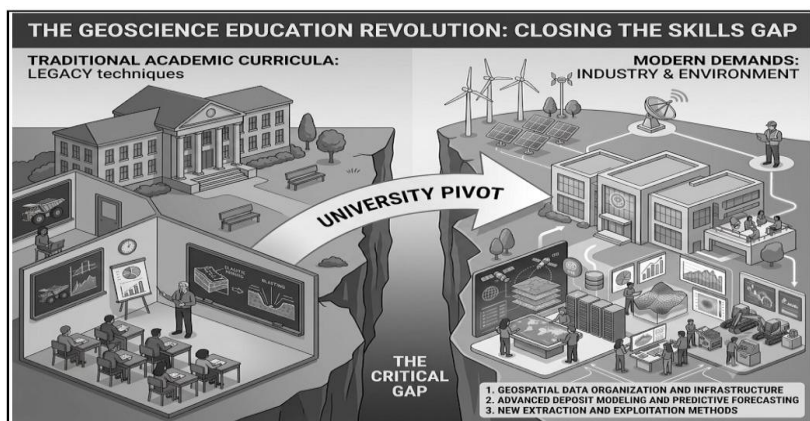


Fig. 2 Education paradigm shift required for Bosnia and Herzegovina (Source: Authors, AI-assisted)

Closing the gap: from legacy extraction techniques to GIS, predictive modeling and green extraction.

Reskilling and upskilling connect traditional curricula to modern industry & environmental demands.

EUROPEAN ALIGNMENT

- EU Skills Agenda names the twin green-digital transition as the central driver of future skills demand.
- The Bologna Rome Ministerial Communiqué commits BiH to align study programs with labour-market needs.
- UNESCO's Futures of Education calls for anticipatory, not reactive, curriculum renewal.

OPERATIONALIZING REFORM

- Systematic labour-market and skills-needs assessment.
- Structured consultation with employers, regulators and donors.
- Benchmark against EQF; embed DigComp & GreenComp outcomes.
- Continuous monitoring: graduate tracking and employer feedback loops.

CONCLUSION

- BiH's geological wealth can power the green transition while remediating legacy environmental burdens.
- Progress requires moving decisively beyond decentralized bureaucracy and geospatial data opacity.
- Human capital is the lever: interdisciplinary education, reskilling and upskilling secure an economically robust, ecologically resilient and socially just transition.