Mine Lands Repurposing in the Context of Coal Transition:

Methodology and Tools

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Lessons Learnt by the World Bank for Coal Transition

1. **Building on** 11 coal closure investment projects (over $3 billion USD) in the 1990s and 2000s in Poland, Romania, Russia, and Ukraine.
2. **Comprehensive review and additional studies** from 2019; paradigm shift from closure to transition
3. **Retrospective assessment** of unaddressed, negative long-term environmental and social impacts
4. **Additional Studies** on coal mine closure and regional transition in China, Netherlands, UK and USA
5. **New approach developed** that promotes a comprehensive coal transition framework putting people and communities at the center and high emphasis on governance and environmental remediation and lands repurposing.

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The Just Coal Transition Framework (aka "3x3 Matrix")

Shaping a National Vision for Coal Phase-Down	• Understanding the linkages of **coal within the broader economy** • Scheduling the **timing and distribution of impacts** from a phasedown, including cost / benefit analysis • Platforms for **knowledge dissemination, consultation, capacity building** and exchanges between regions • Mobilizing the **public and private** investments for effective support		
Region Specific Implementation	**Pillar 1** Institutional Governance	**Pillar 2** People and Communities	**Pillar 3** Environmental Reclamation and Re-purposing Land & Assets
Phase 1: Pre-Closure Planning	• Strengthen institutions • Inclusive processes • Build vision / strategies for fiscal, macro-economic & socio-economic transformations with communities	• Early-stage dialogue and community engagement to ensure local voice and influence in planning • Appraisal of social sustainability outcomes • Pre-layoff social protection assessments & planning, labor profiles, user-needs	• Assessing land & assets • Preparing for reclamation and re-purposing • Resourcing ENV remediation costs
Phase 2: Closure	• Coordinating closure / decommissioning activities between enterprise and agencies	• Social assistance to workers, re-skilling, Active Labor Market Policies • Community engagement in prep, mgmt., repurposing of closed facilities	• Implementation of appropriate technical standards • Transfer of assets • Mitigation of methane
Phase 3: Regional Transition	• Special Purpose Entity coordinating transition project implementation • Managing funding sources	• Longer term re-skilling, education, Active Labor Market policies, preparing workers for Future Jobs • Locally-led, participatory planning for adaptive management • CDD/Smart Villages investments	• ENV remediation of select land & assets by private / public sector • Re-permitting and repurposing for private investors to sustain regional transformation

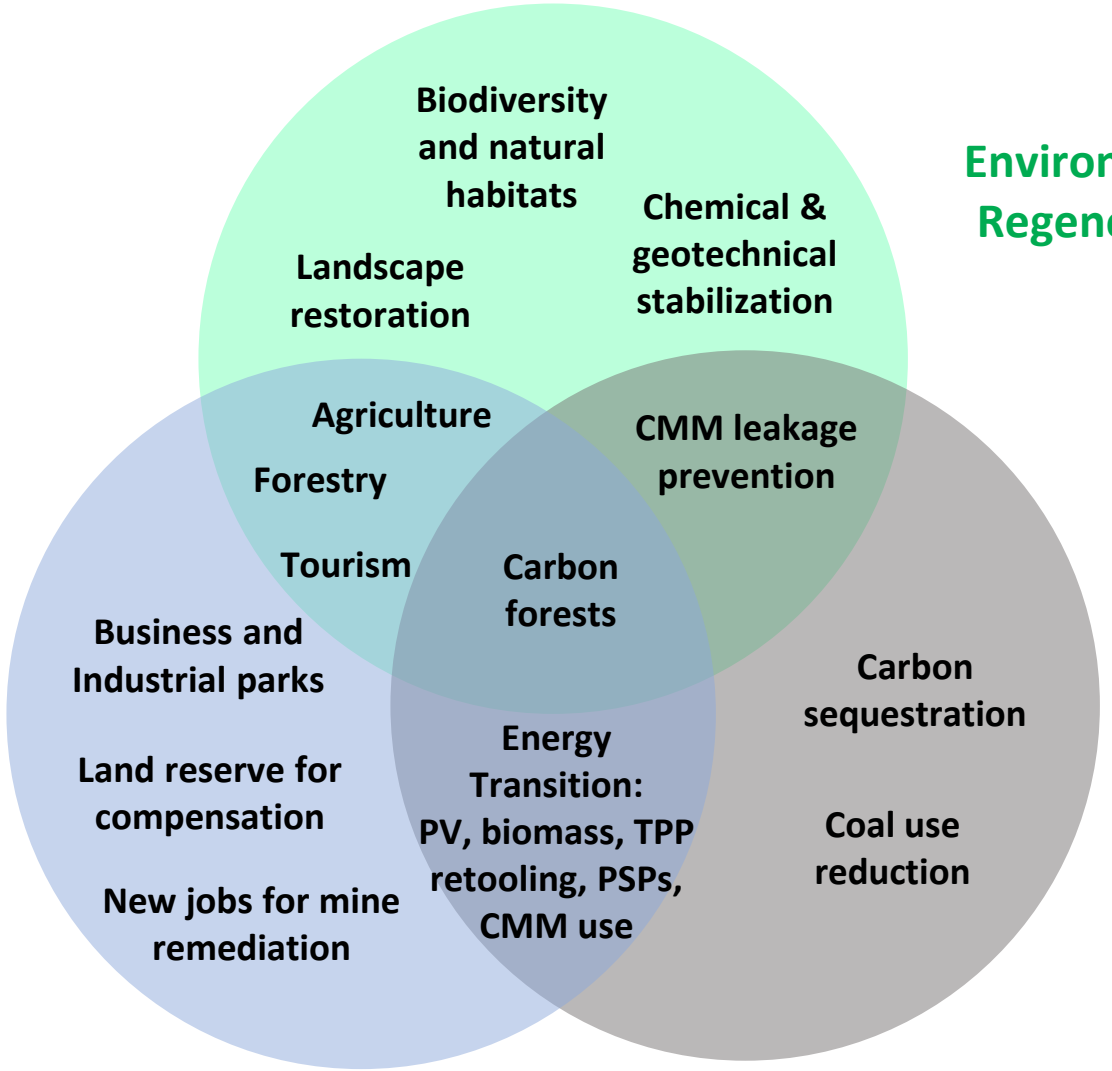
Objective of post-mining lands repurposing

“To enable the restoration of degraded lands for productive uses, and thus provide sufficient space to replace energy production and jobs lost due to coal transition, while enhancing environmental quality and avoiding unnecessary consumption of greenfields space.”

The use of **Land Repurposing Methodology and advanced tools for their application is key** to effective assessment of post-mining lands’ repurposing potential. “LURA” is an innovative tool to support optimized lands utilization.

How Land Repurposing Can Support ES Sustainability and mobilize investments

Objective of lands repurposing: "To enable the restoration of degraded lands for productive uses, and thus provide sufficient space to replace energy production and jobs lost due to coal transition, while enhancing environmental quality, fostering livable communities and avoiding unnecessary consumption of green space."

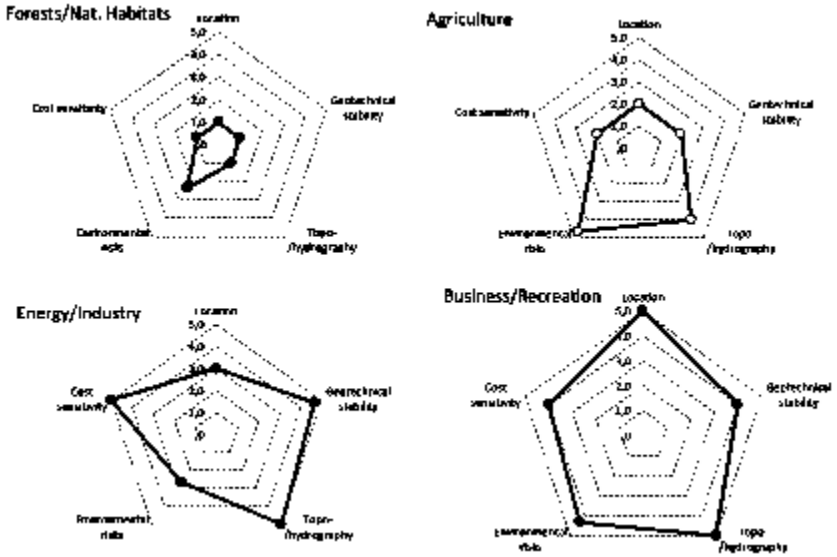


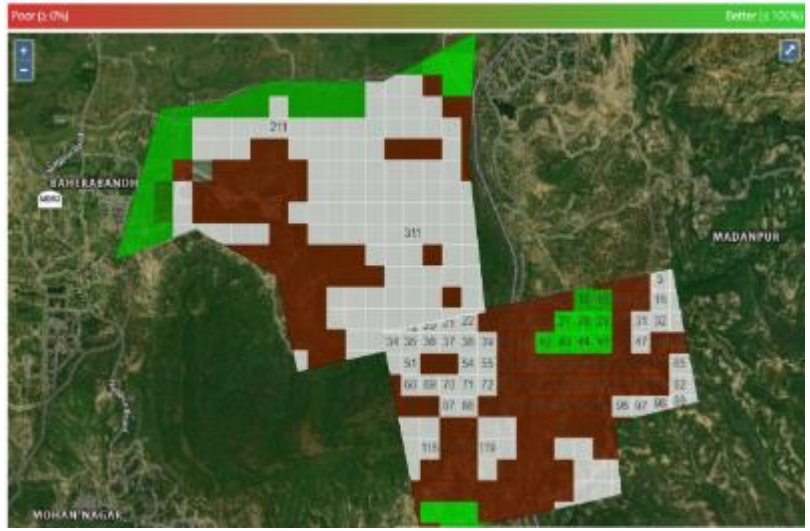
What is the LURA Tool?

LURA's main Characteristics

"LURA is a free, web-based, open-source tool that informs repurposing project design through geospatial mapping and by prioritizing recommended economic diversification alternatives, based on an assessment of the attributed characteristics and suitability of postmining land. ."

The objective data collection and assessment process, as well as the consultative and collaborative nature of LURA helps build and nurture trust and consensus among stakeholders.





LURA characterizes post-coal lands using five criteria: (1) topography / hydrography; (2) geotechnical; (3) environmental; (4) socio-geographic; (5) economic

For each criteria, a heat map is produced showing more and less favorable areas.

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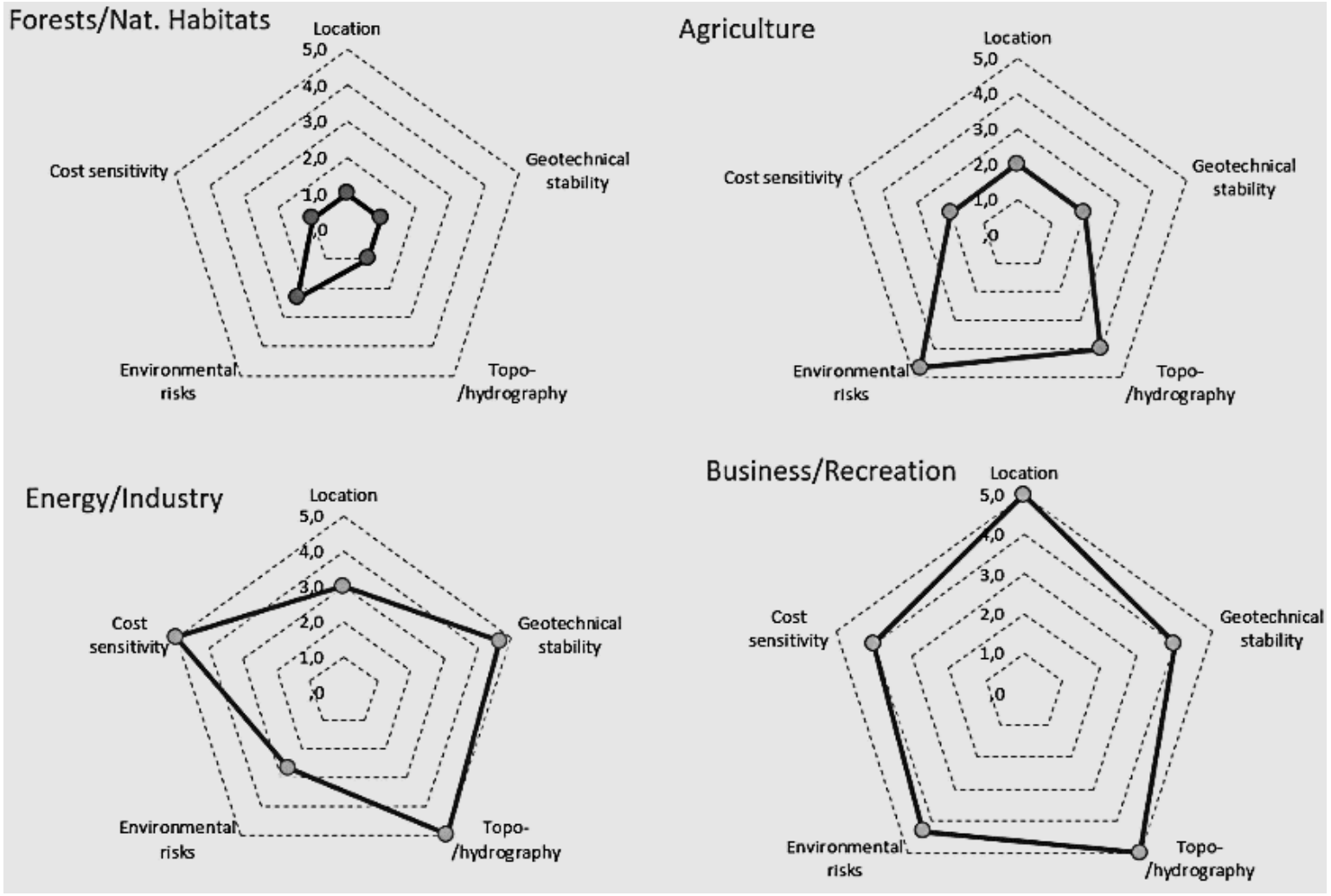
More Detail: How Can Post-Mining Lands be Characterized?

Land Classification Criteria:

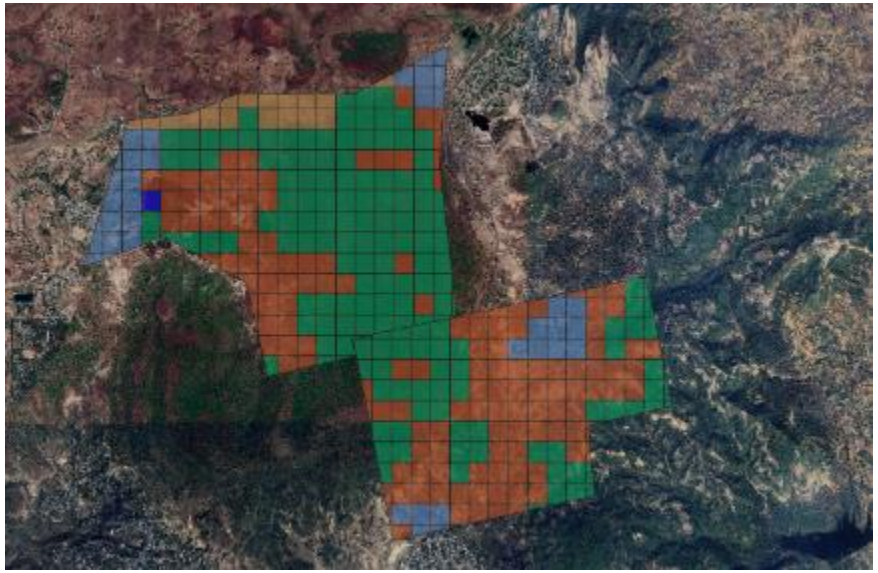
- **Geotechnical properties**: settlements, slope stability, erosion potential, collapses, sinkholes, surface subsidence
- **Topography and hydrography**: flooding, water logging, groundwater rise
- **Environmental risks**: soil chemistry, residual contaminations, ambient pollution, methane emissions
- **Location**: distance from urban / economic centers, transport infrastructure and energy grids
- **Cost sensitivity / added value**: how much would repurposing cost, what is the potential value gain.



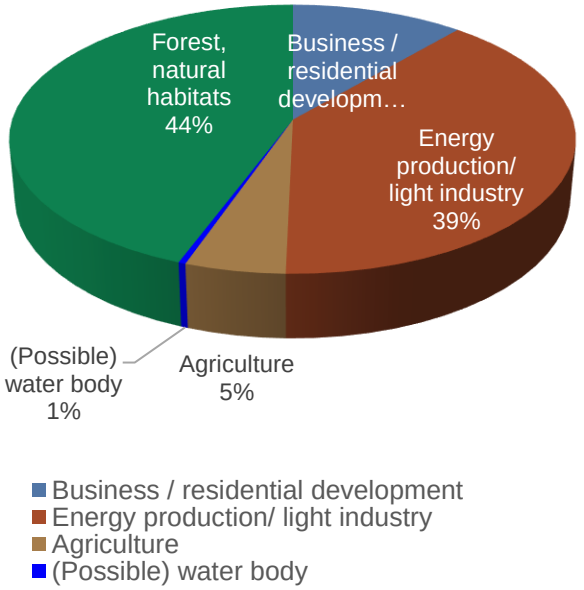
Typical scores for various utilization scenarios

Key Outputs: Maps and Statistical Information

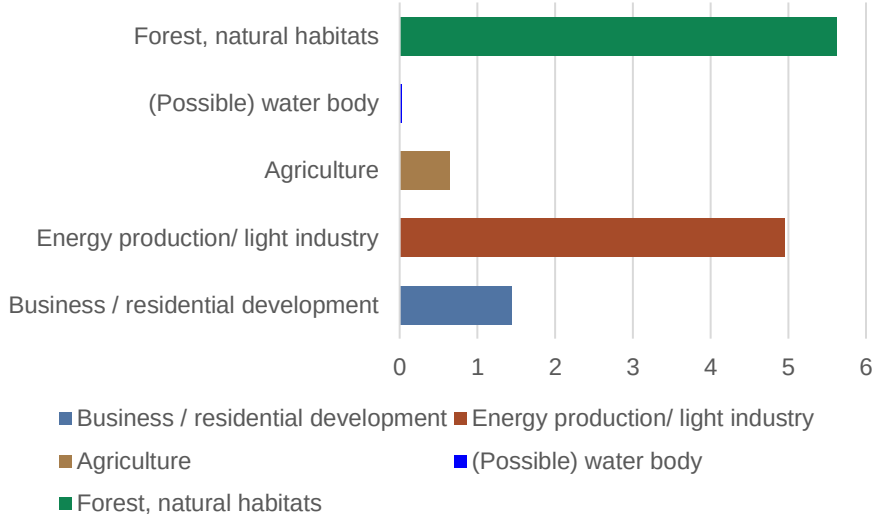
Repurposing Mapping



Optimal Land uses (%)



Land area type [km2]



LURA's outputs include several types of maps (criteria-specific heat maps, usage suitability maps, repurposing options map) as well as a variety of statistical functions (total percentages, absolute land areas in km^2).

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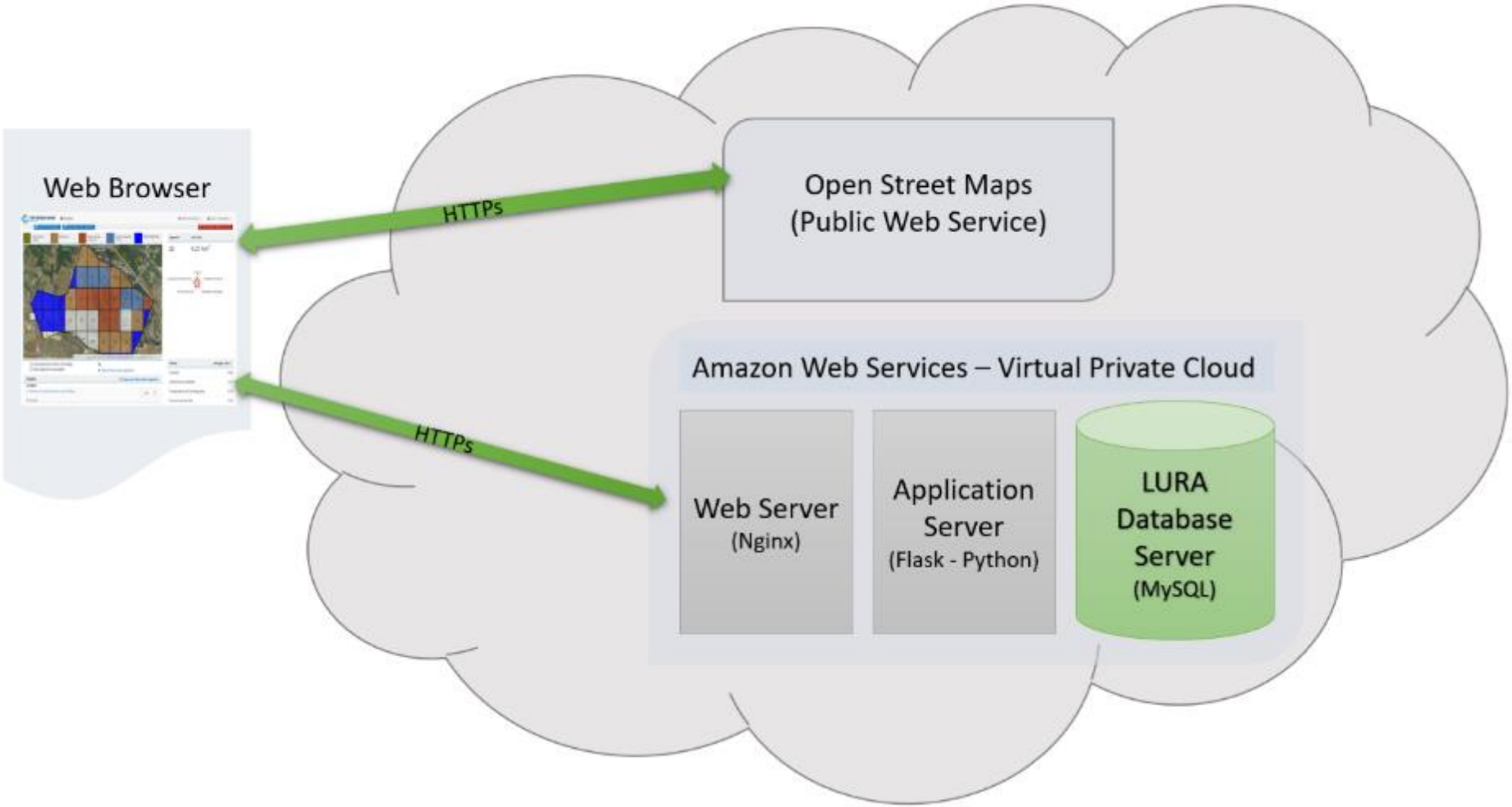
What is “LURA”?

LURA is a GIS-cloud based easy to use application for mine lands classification



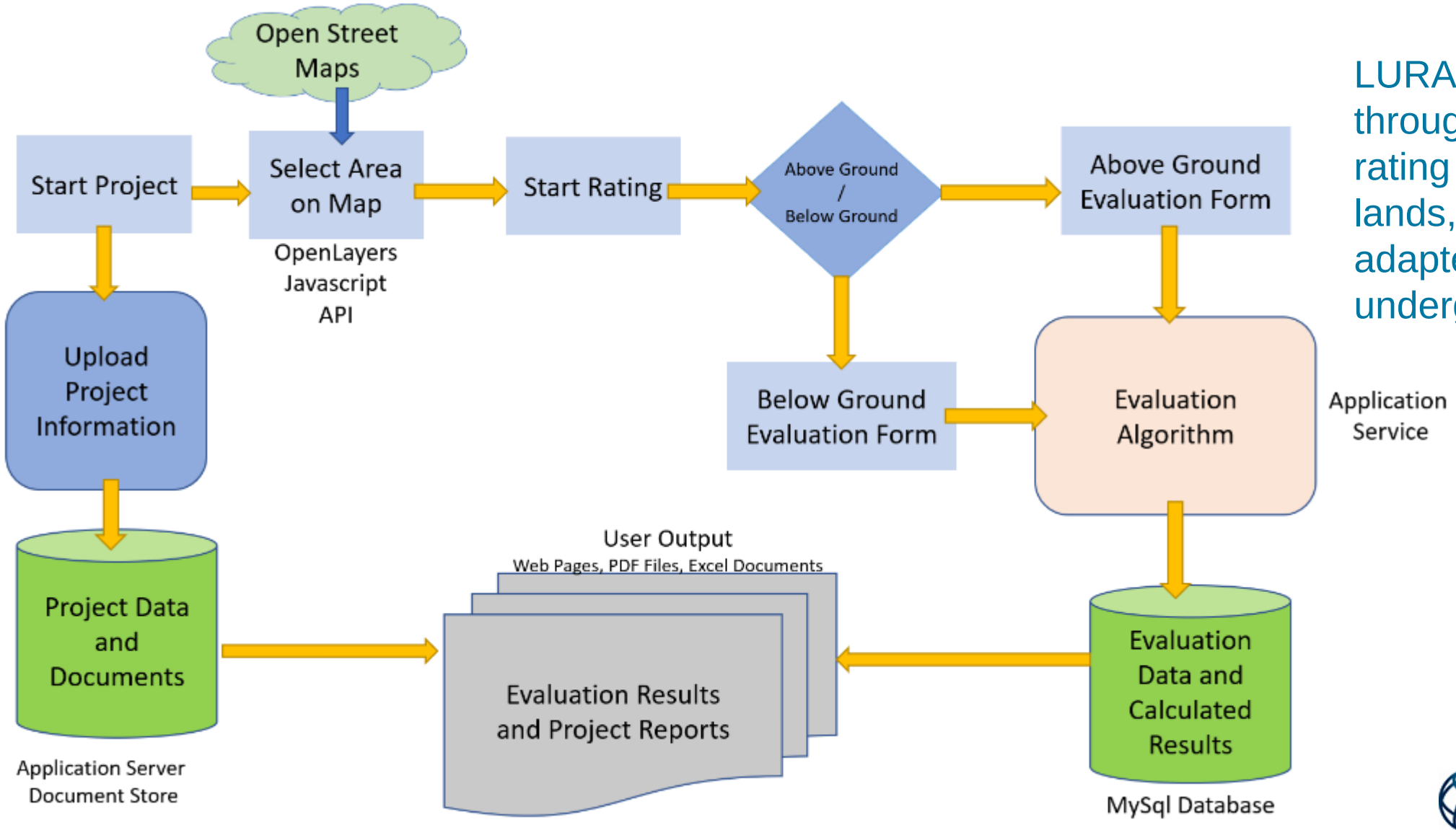
LURA is a cloud based application, accessible via a web browser.

Application is developed in Python using the Flask framework.

It utilizes OpenLayers and OpenStreetMaps for georeferencing and map displays and outputs.

Application and Database is designed to be hosted on any Cloud Service Provider (currently AWS)

How does LURA work?



LURA takes the user through a step-by-step rating process for mine lands, which can be adapted for open pit or underground mines.

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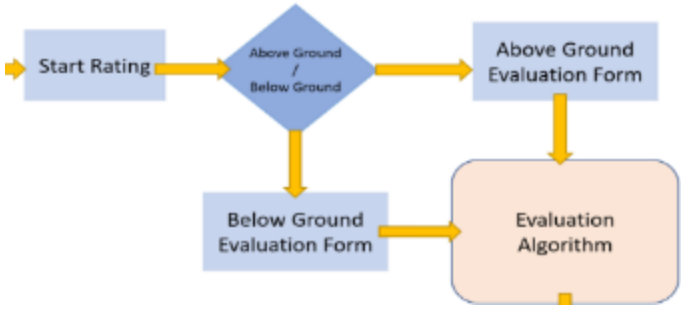
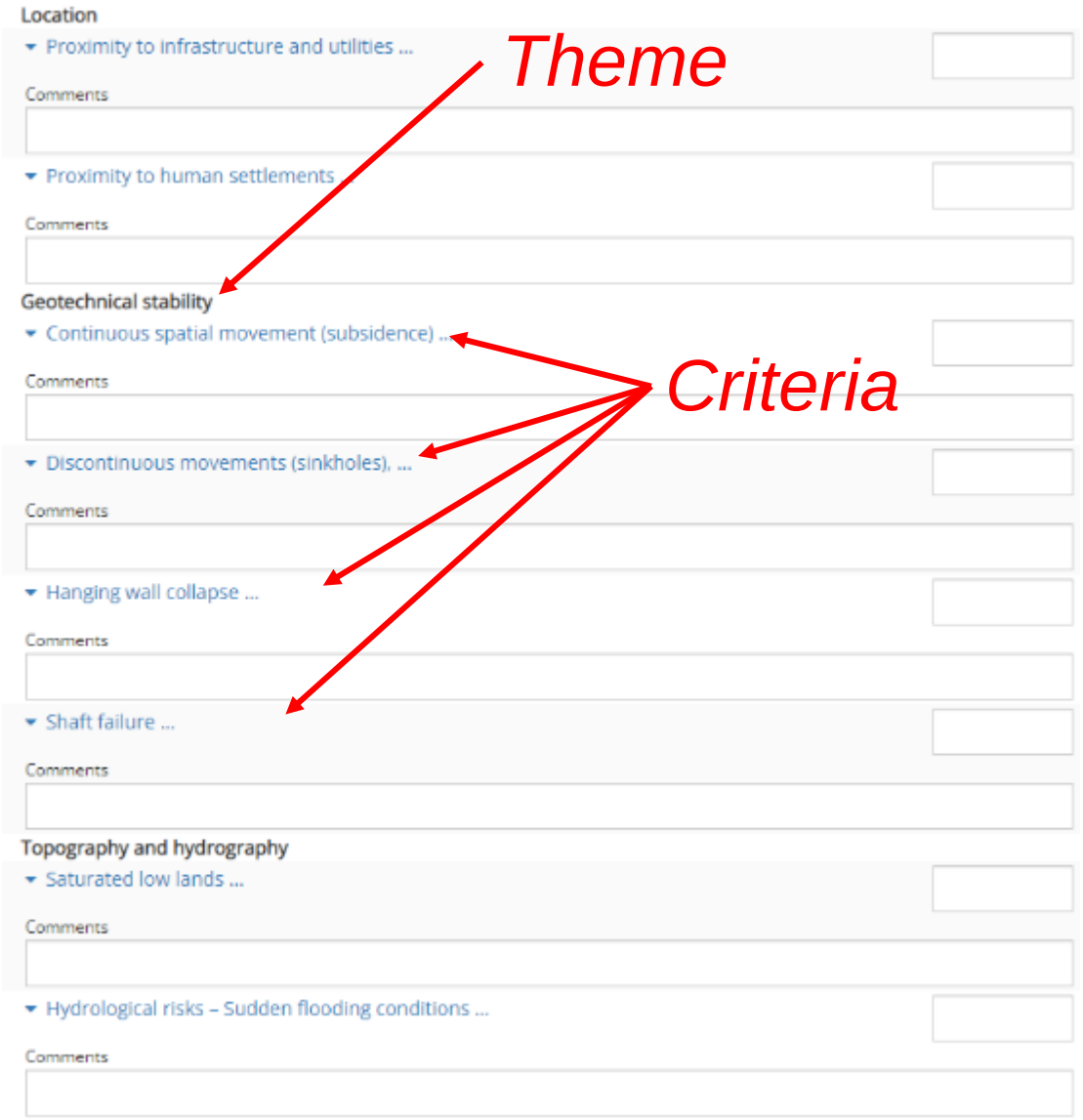
LURA's Rating themes and criteria



Five (5) themes are used for rating either above or underground mined land:

1. Location
2. Geotechnical stability
3. Topography and hydrography
4. Environmental risks
5. Development opportunities



Each theme has a number of criteria, which are rated individually to calculate a weighted average rating.

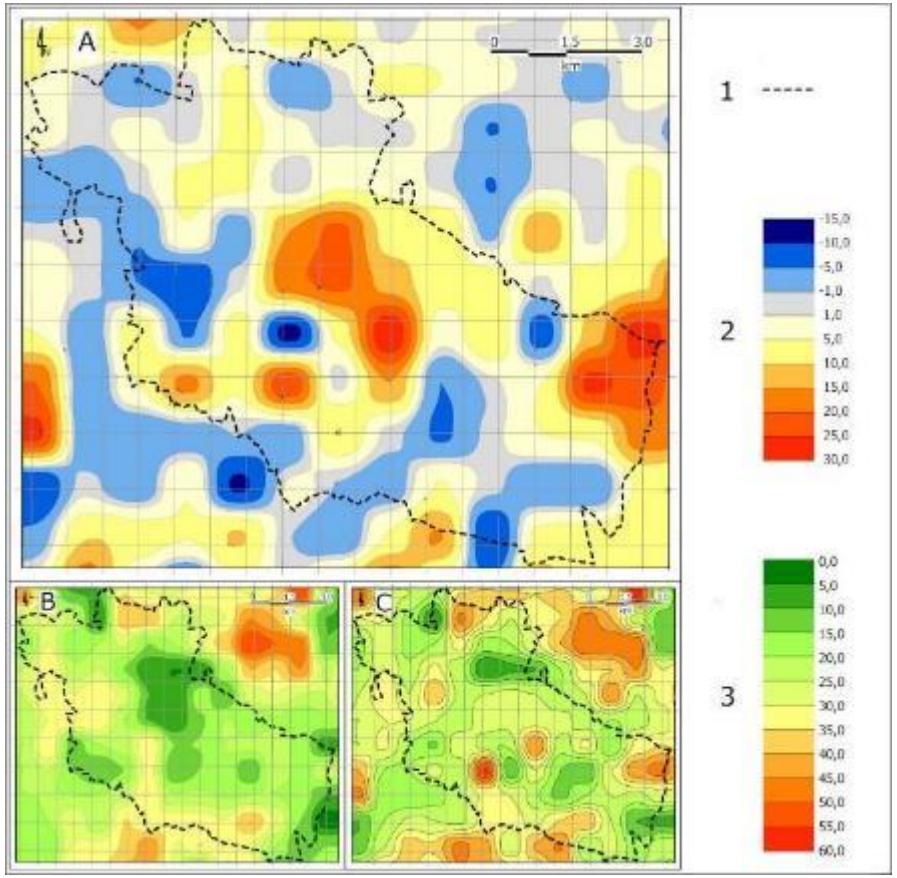
Typical Data Sources for Land Use Rating

Drone overflight survey imagery, giving detailed surface information form a post mining area (Ombilin Mine, West Sumatra, Indonesia).

Time series of Google Earth images can be used to track and document mine development (Suvodol Mine, Bitola, North Macedonia)

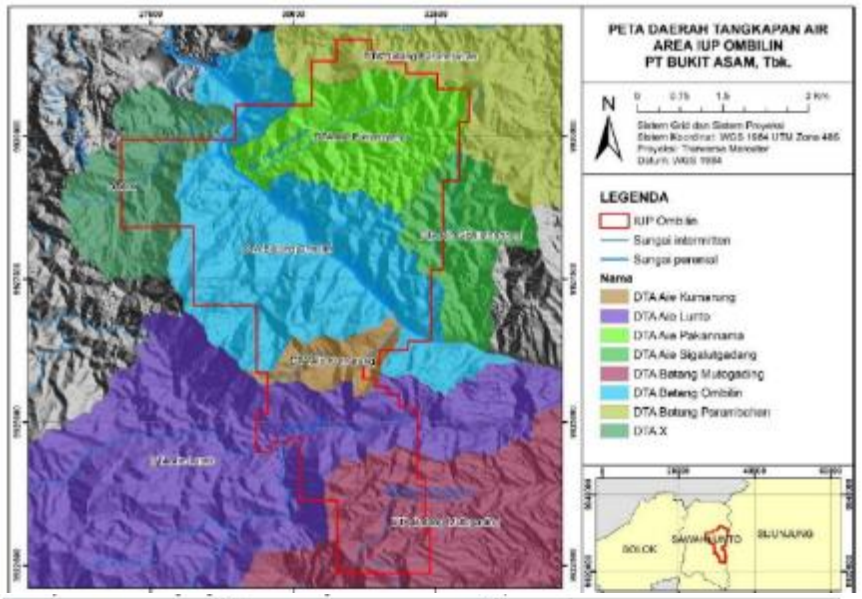
Typical Data Sources for Land Use Rating

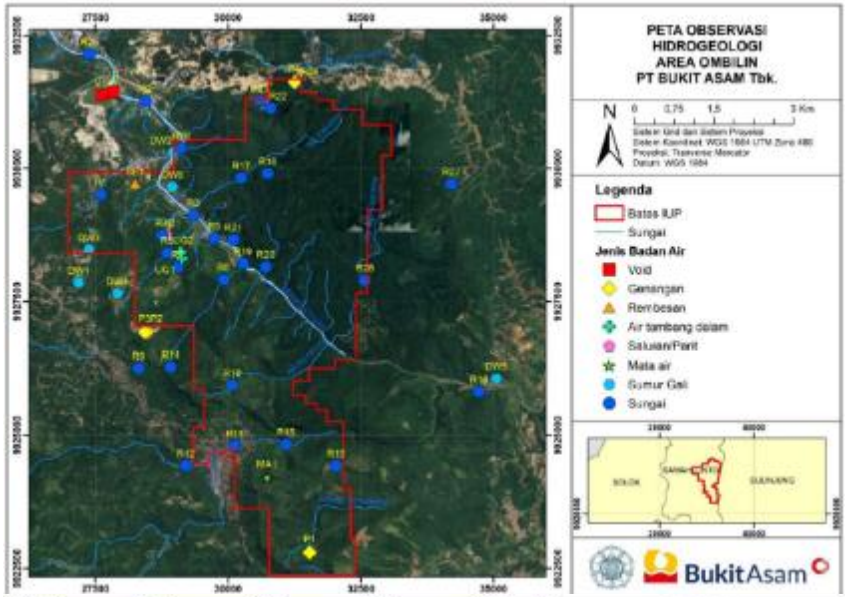
Historical aerial image of a former gasification plan, phenol and fertilizer factory on a concession consisting of a Lignite mine and TPP (unpublished report, The World Bank)

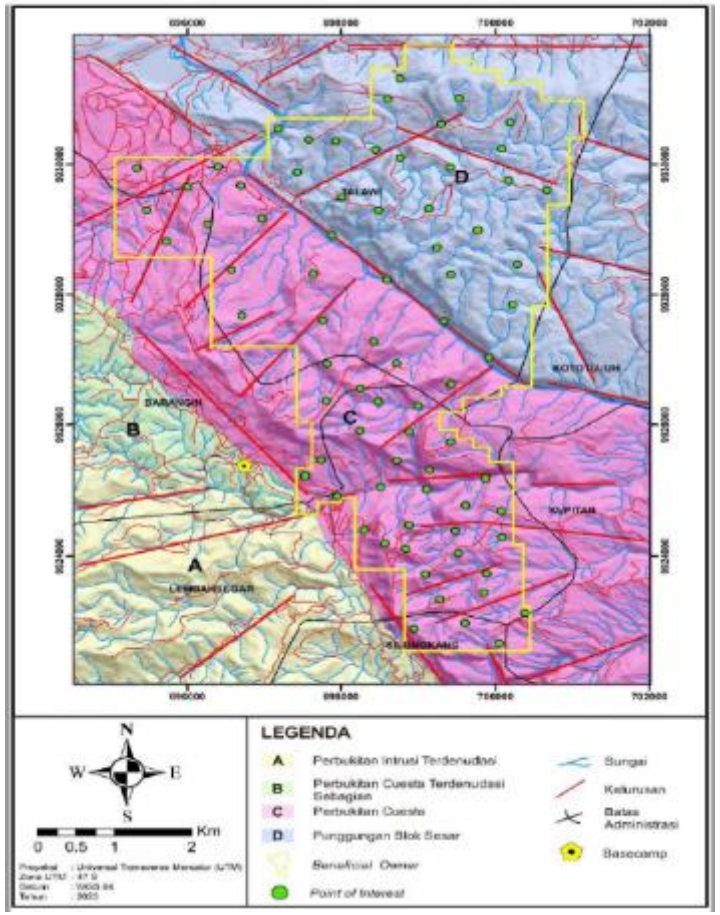


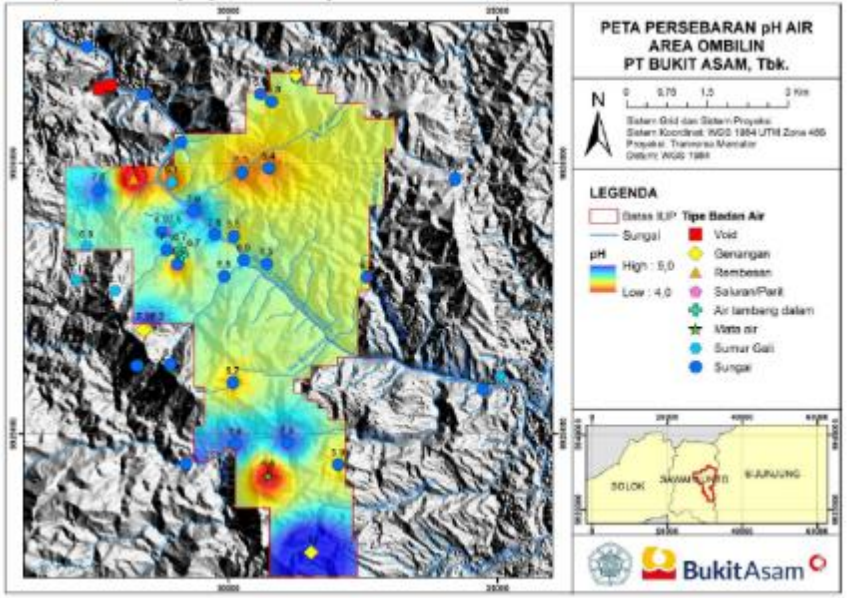
Subsidence map for a mining community in Silesia, Poland (https://us.edu.pl/instytut/inoz/en/2022/05/19/bytom-miasto-ktore-sie-zapada/)

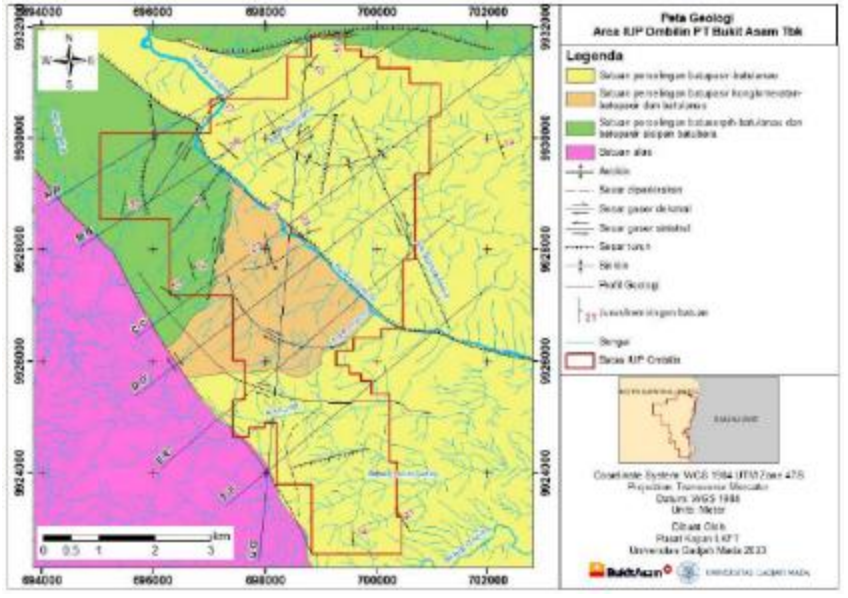
Typical Data Sources for Land Use Rating







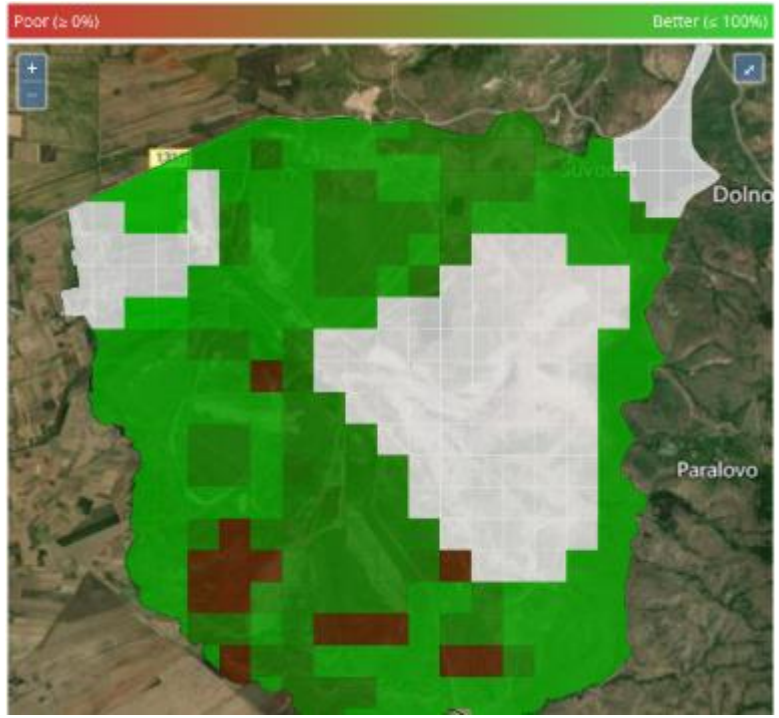




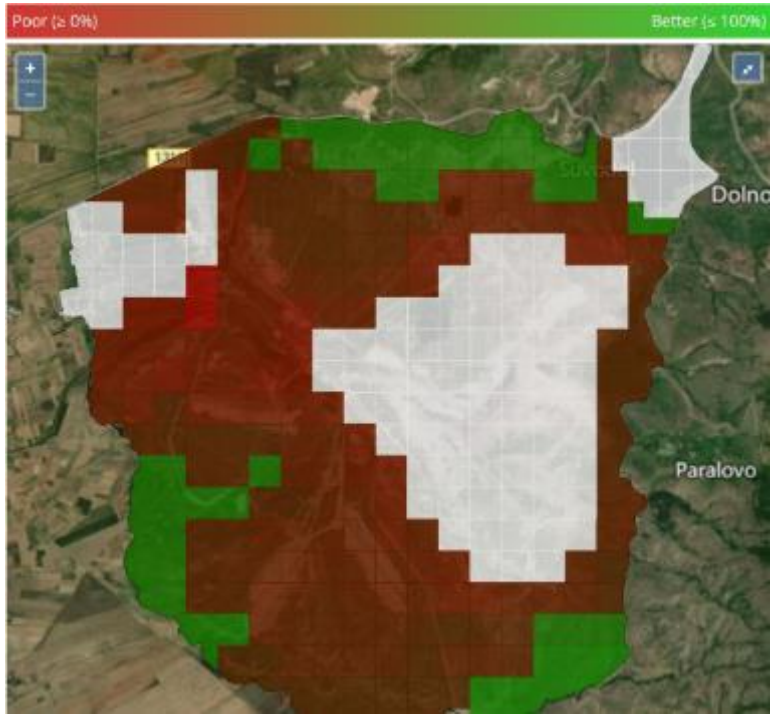
Samples from the Indonesian Mining GIS Database

Typical Outputs of the LURA Tool and their Use for Post-Mining Master-Planning

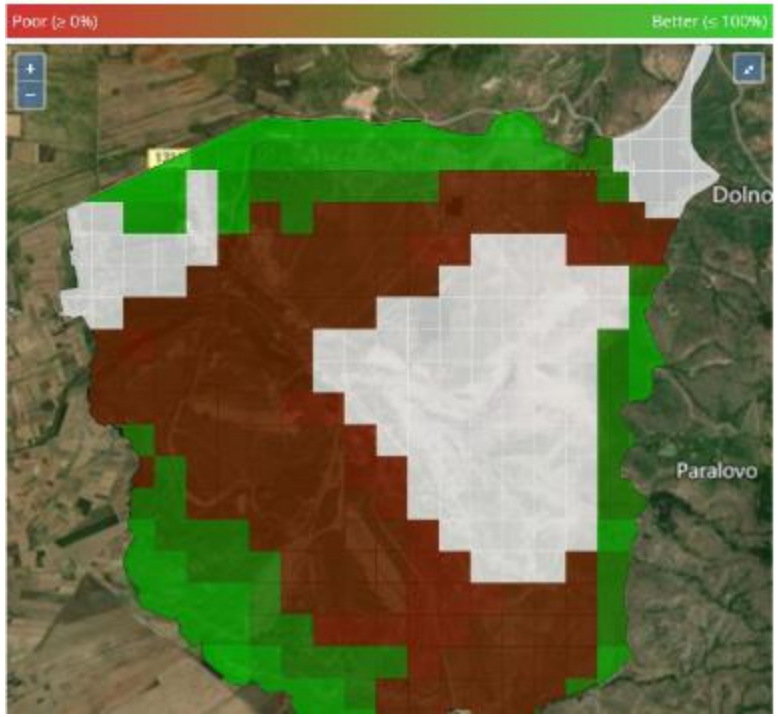
Heat Maps for Selected Criteria



Geotechnical



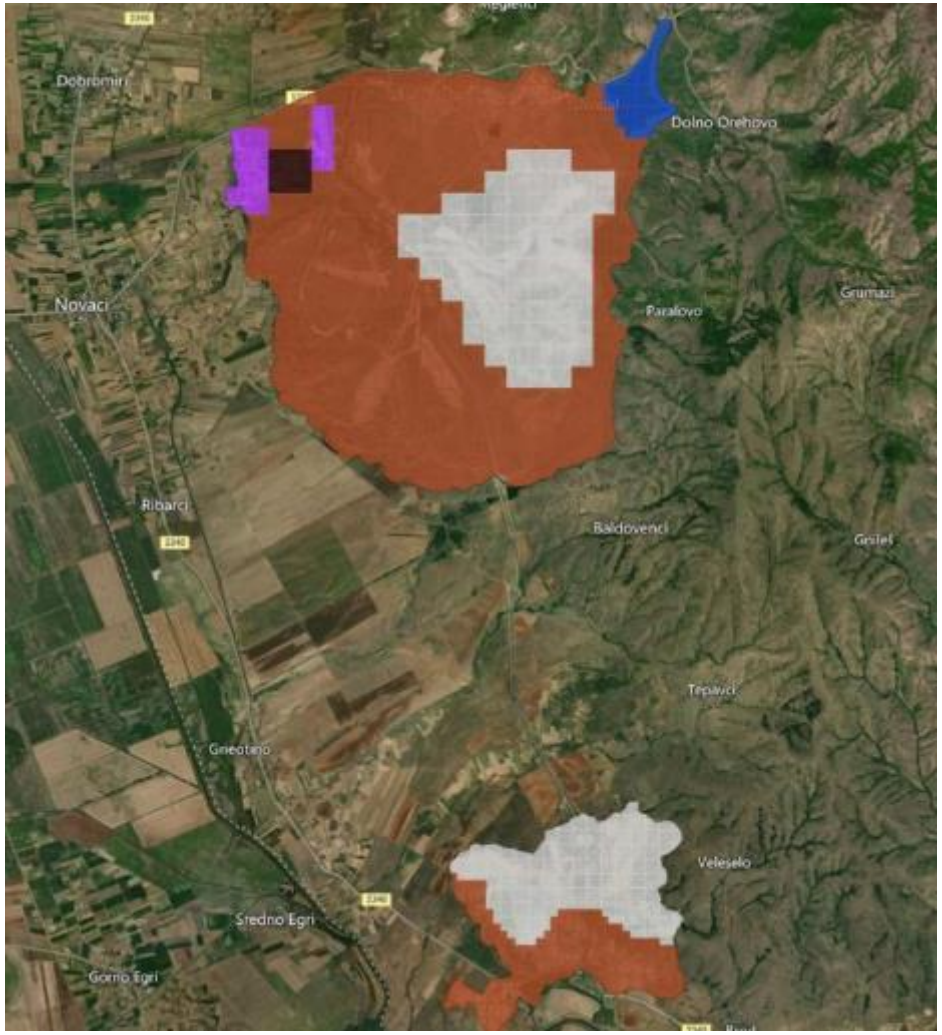
Environmental



Location

Heat maps visualize conditions for specific criteria (here geotechnical stability, environmental risks and liabilities, and location) for an assessment area; the color coding shows more favorable conditions in green, more unfavorable conditions in red shades.

Output: Land Utilization Zones



Two examples of repurposing maps, depicting optimum zones for PV (orange-brown), agriculture (beige) and residual ponds (blue). Grey areas indicate continued coal extraction, purple is the location of a TPP.

(Examples from Kosovo and North Macedonia)

Applicability Maps for Land Usage Categories

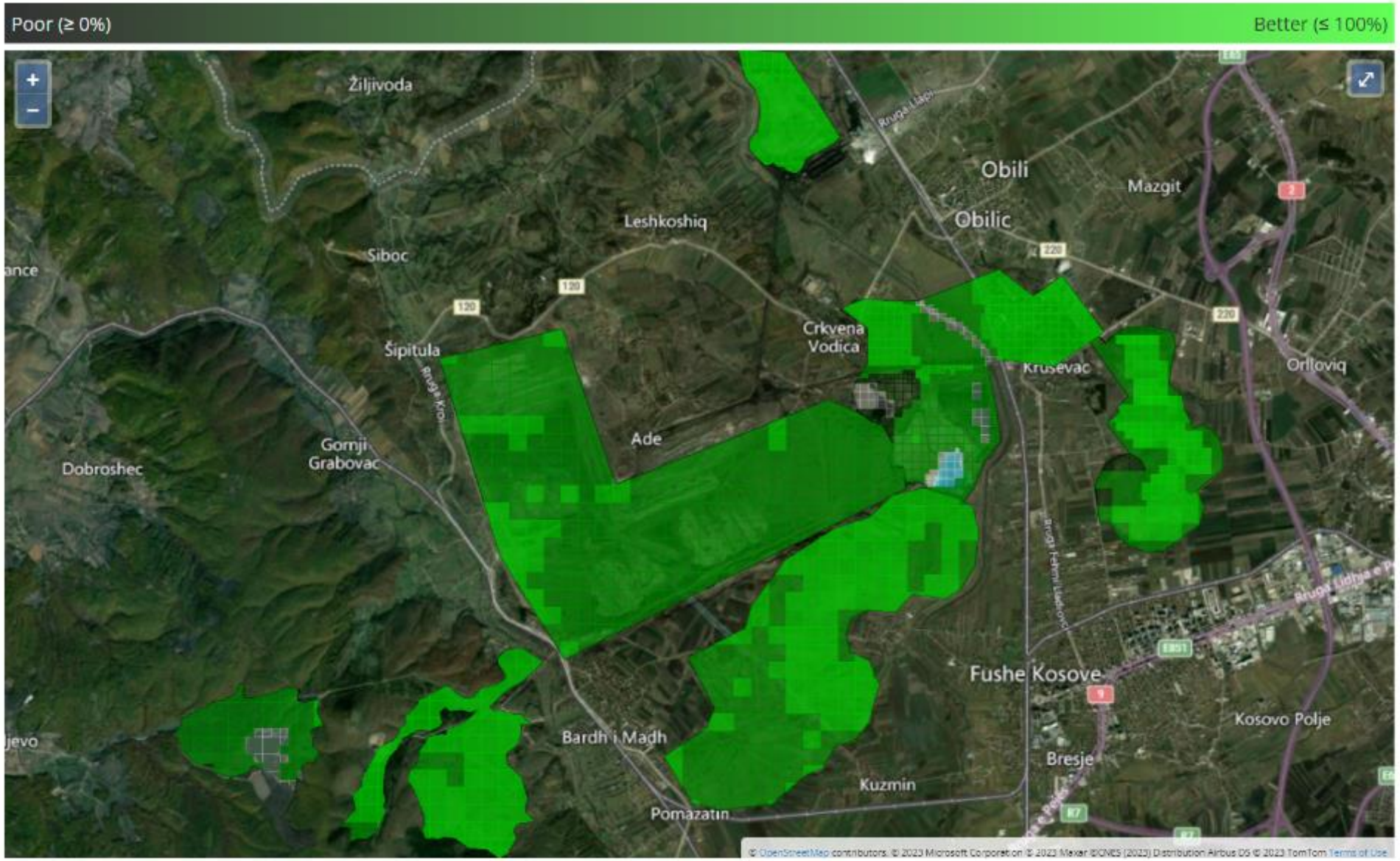
Agriculture

Energy Production

Business / Residential

Applicability maps depict the suitability of area segments for the selected Land Usage category, ranging from Light Green (most applicable) to Transparent Dark Green (not suitable). Parts of the area that cannot be used are not colored at all.

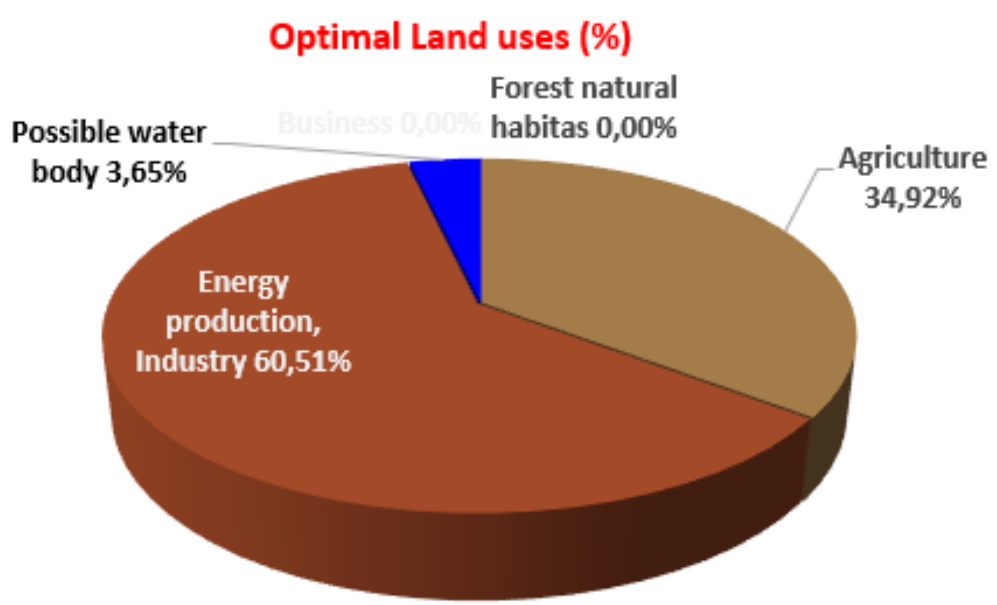
Output: Land Suitability Maps for Selected Uses

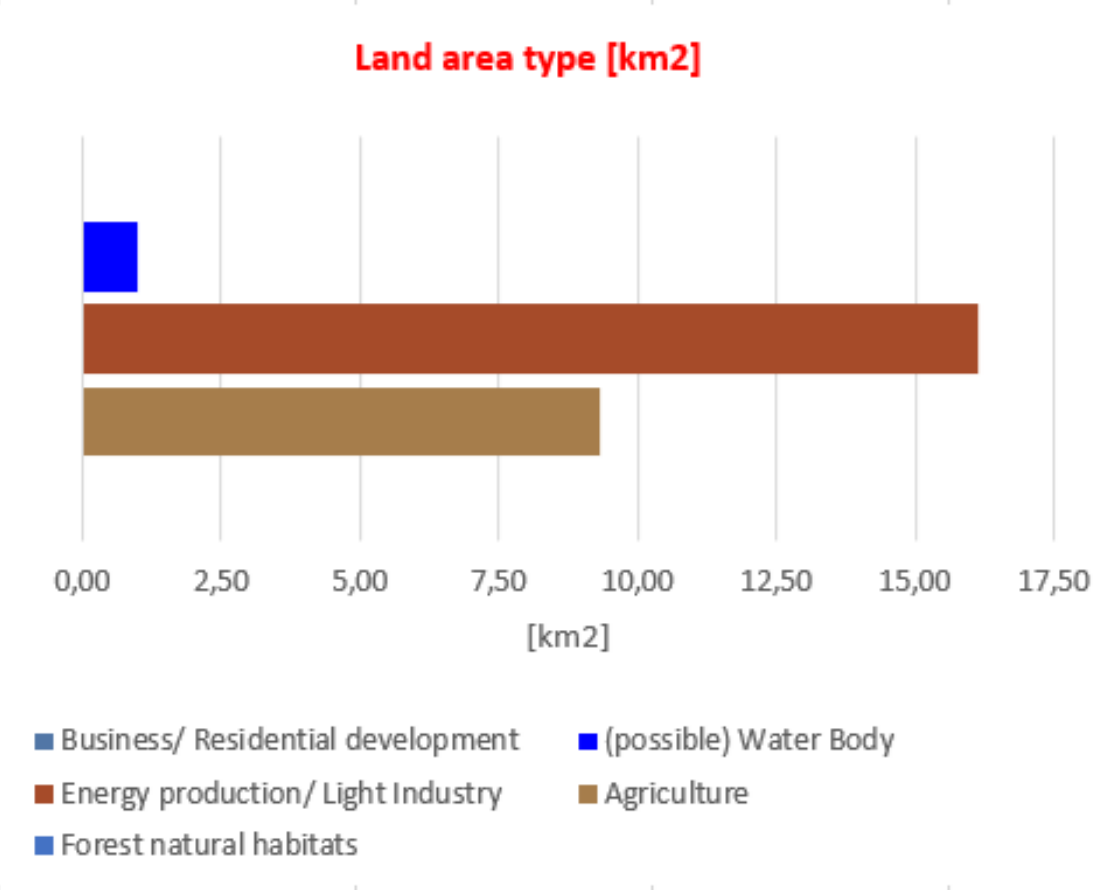


This map visualizes the suitability of lands for a specific utilization scenario, here **renewable energy / light industry** (e.g. PV)

Brighter shades of green indicate better suitability, while darker shades indicate less favorable conditions.

Output: Percentages and Area Sizes of Utilization Zones



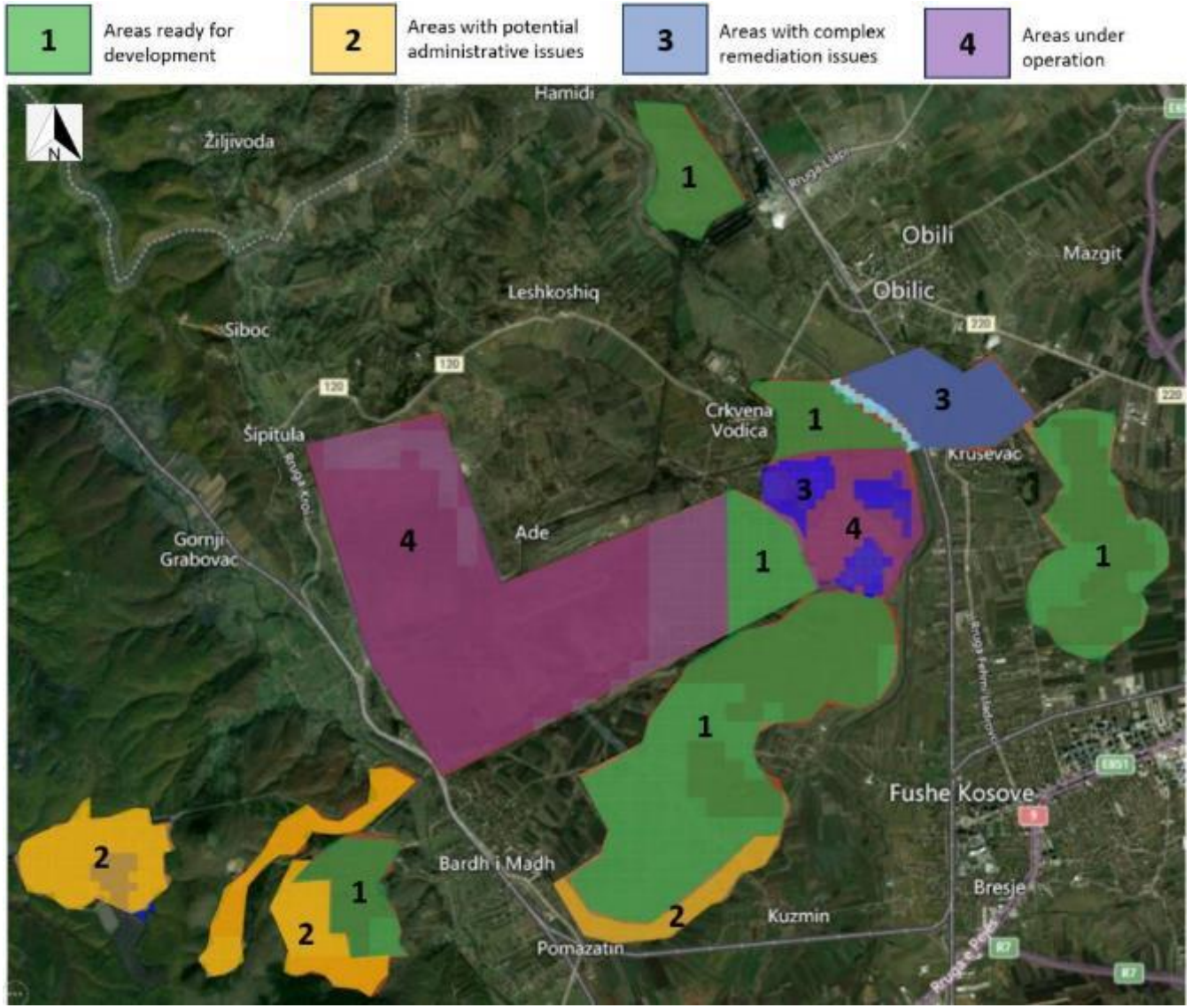


LURA's outputs include a variety of statistical functions. Here the total percentages as well as absolute land areas are shown for an assessment tha consisted of multiple sub-areas (example from Kosovo).

Output: Sequencing Maps

Understanding the **sequencing of investment areas** according to their readiness can be important. Here are some examples how a real-life project could look regarding readiness for repurposing:

1. Areas ready for development: “low-hanging fruit”, available now for (almost) immediate repurposing with minor physical or administrative conditions;
2. Areas with potential administrative issues: in principle available but may have complex ownership or stakeholder issues (“soft barriers”), e.g. the informal uses of lands that are not under active operation;
3. Areas with complex remediation issues: in principle available for repurposing, but may have complex “technical barriers” to overcome before investment ready; e.g. areas with major environmental or geotechnical liabilities;
4. Areas under mining operation: will become available only after coal extraction has terminated; LURA is projecting their characteristics / repurposing potential to the state after basic closure works.



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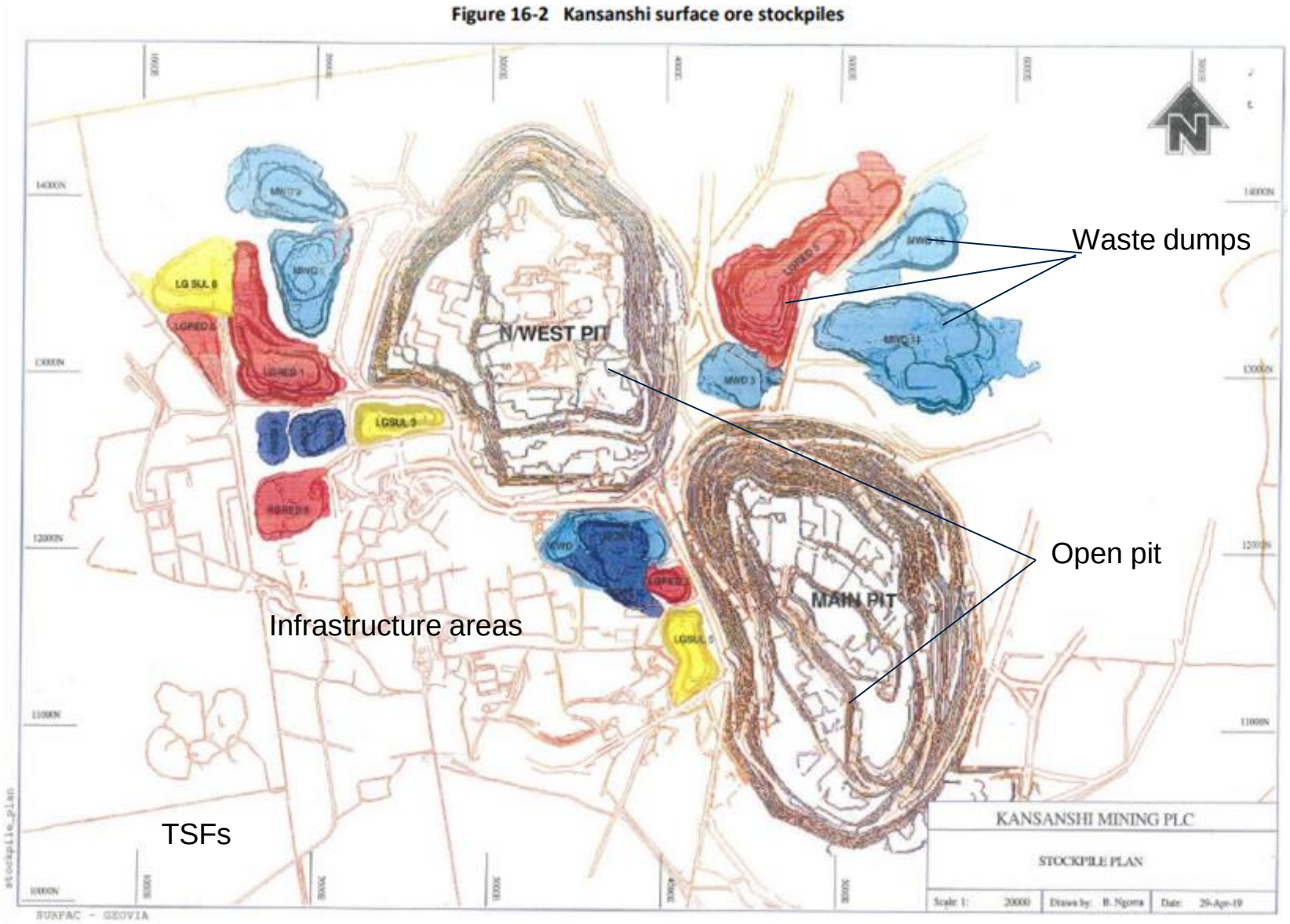
Mine Lands and Assets Repurposing vs. Mine Reclamation

Linking Repurposing with Mine Closure Standards

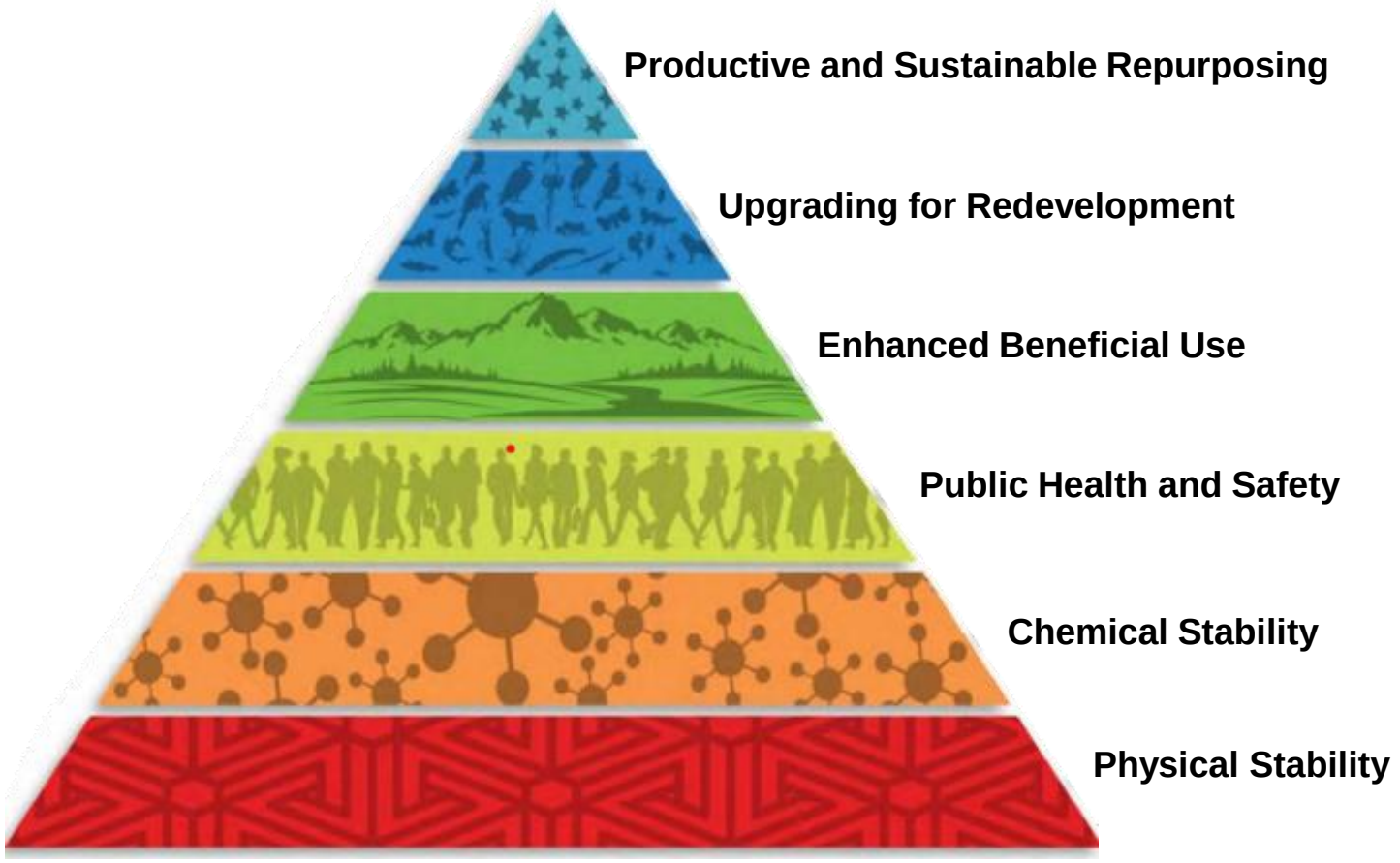


Mine closure design and planning

- Most mines constitute a highly complex system with numerous components
- Need to develop a clear post closure vision
- An important part of this is the anticipated post closure land use

Linking Repurposing with Mine Closure Standards

Is there a difference between remediation and repurposing?



Additional measures beyond requirements to repurpose and thus upgrade lands to allow productive re-use and encourage investments

Usually contained in the approved mine closure plan as compulsory measures to obtain the closure permit

Linking Repurposing with Mine Closure Standards

!!! Mine closure standards oriented towards post-closure risk reduction and sustainability are essential to ensure successful repurposing !!!

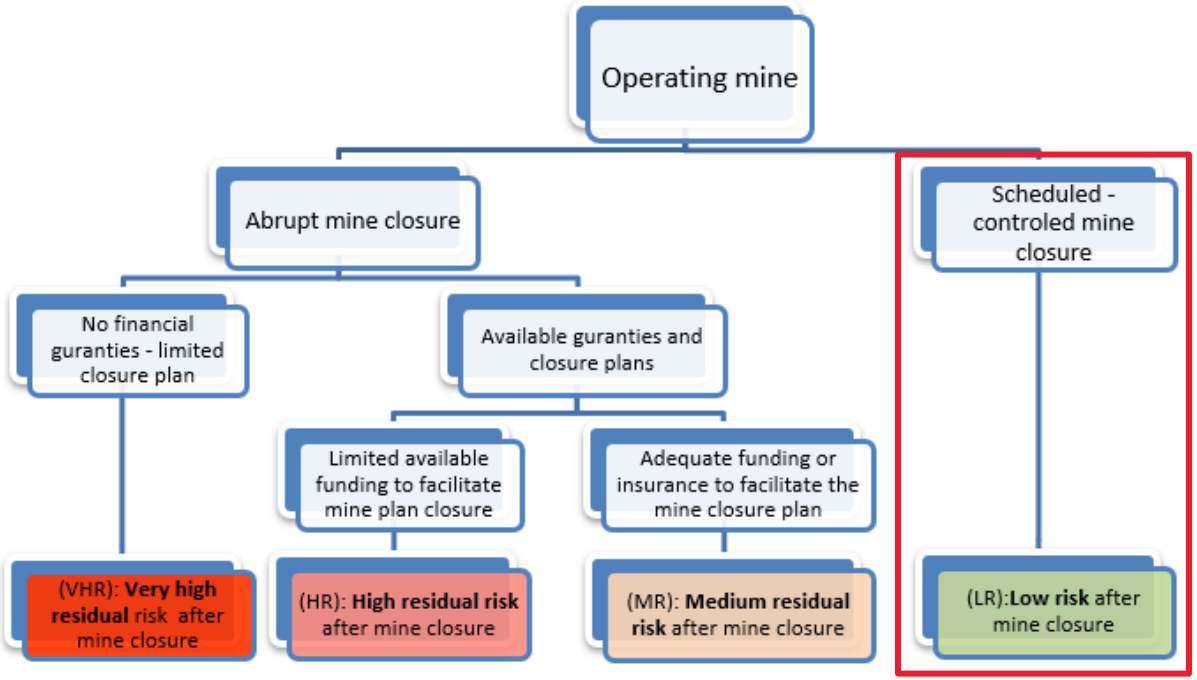
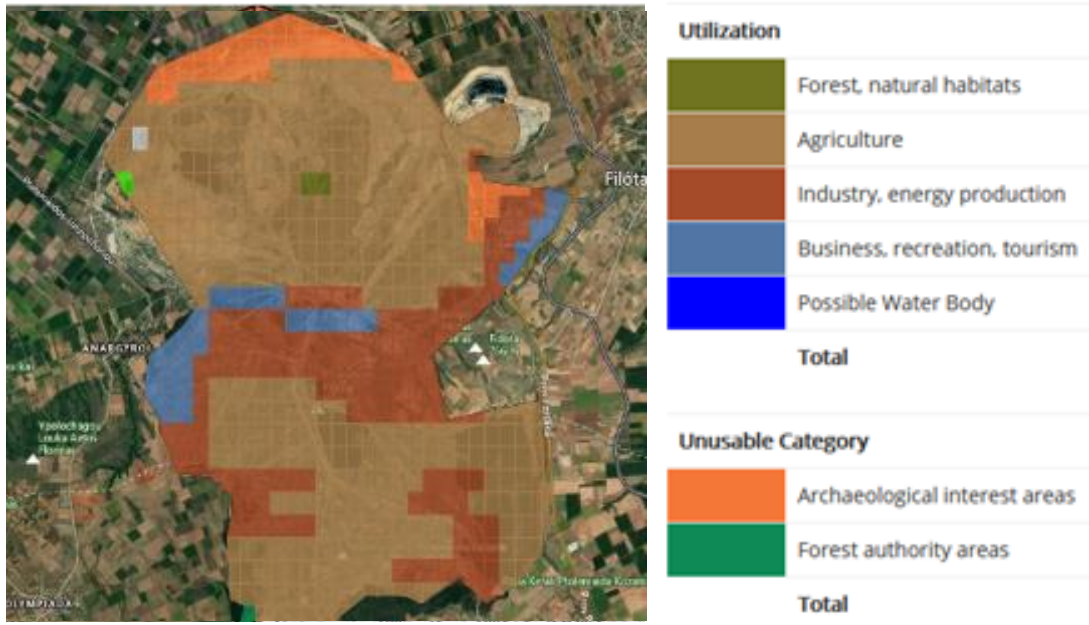


Figure 11: Hierarchical mine closure residual risk assessment

(MINE CLOSURE: A Toolbox for Governments, World Bank)

- Legal frameworks
- Time
- Financial assurance
- **Purpose / vision**



Amyntaio mine land use rating map

Good closure ensures social license for continued mining operations

Module Three: Post Closure Standards—A Practitioners Workbook

Standards to improve mine post closure and transition periods

MINE CLOSURE

Leading Practice Sustainable Development Program for the Mining Industry

Australian Government

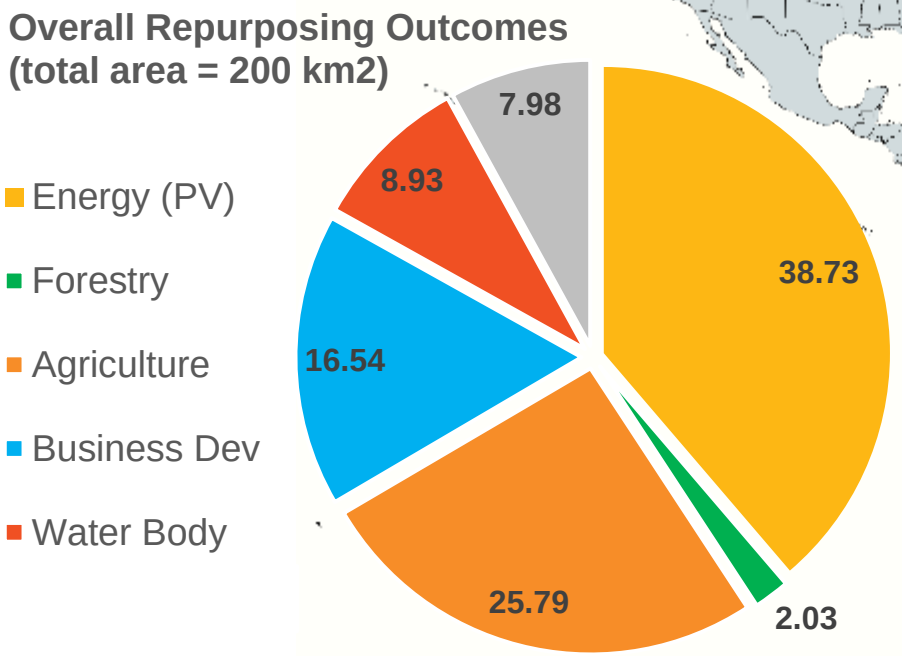
Estimating the Future Value Gain through Mine Lands Repurposing

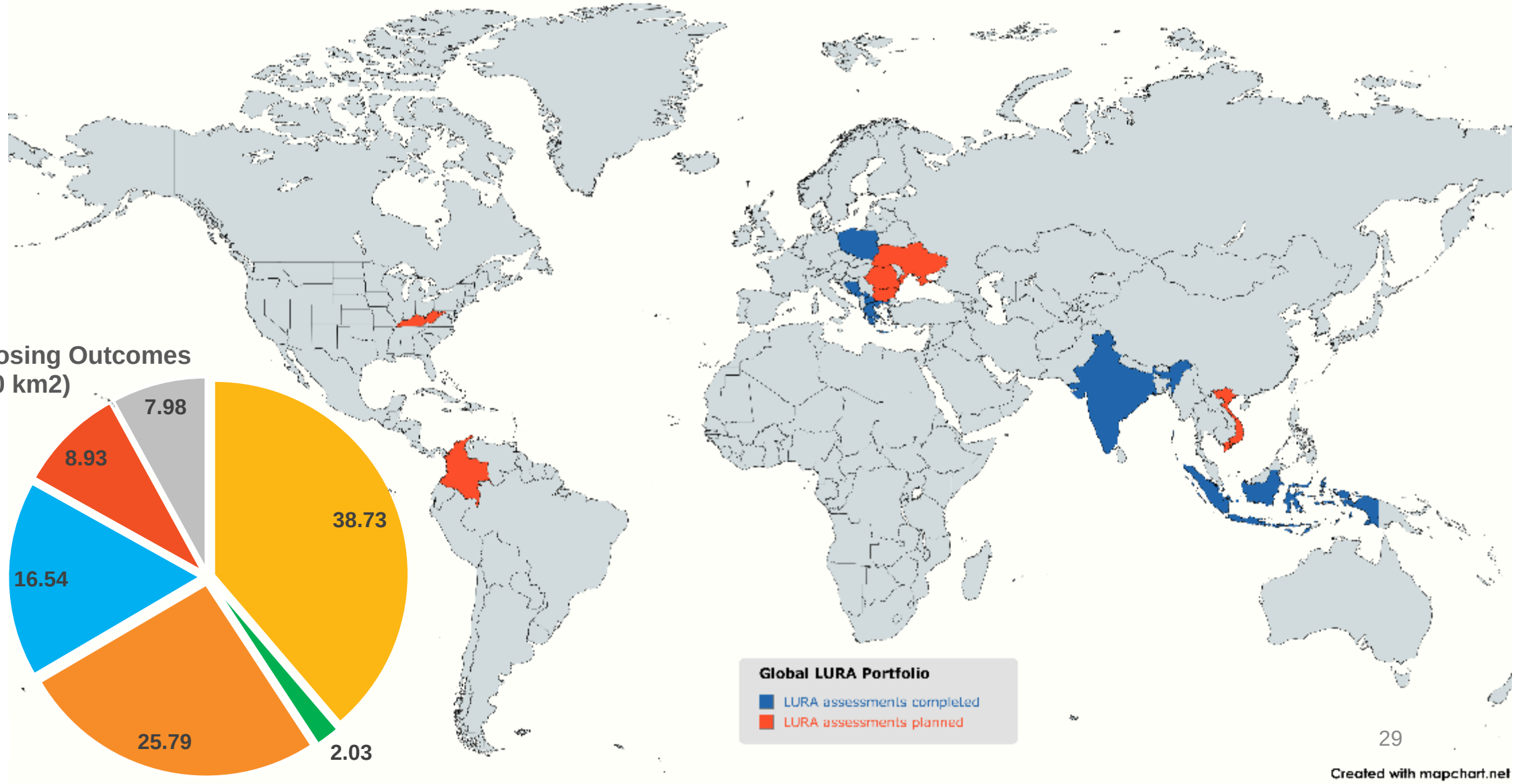
The Value Proposition for Land Reclamation & Repurposing

Unlocking Value Through Smart Repurposing Planning:

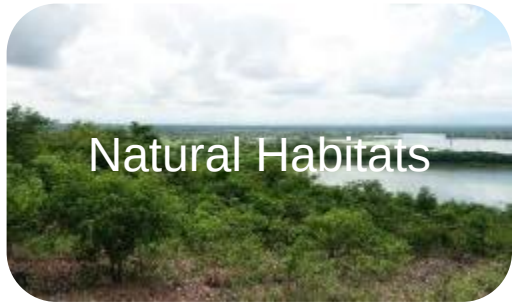
- **Determine the potential value appreciation of repurposed lands**: Estimate value per unit area for the various typologies of lands identified by LURA within the mining concession
- **Assess potential for future income streams** from productive land use: e.g. concessions for RE, lease for business or commercial parks, rental income from residential developments…
- **Coordinate repurposing planning with mine operation -** combine good practice approach to "mining for closure" and land repurposing planning in the pre-closure phase
- **Optimizing repurposing to maximize cost effectiveness** – included in capabilities of LURA

Brief Recap of LURA Implementation up to Date





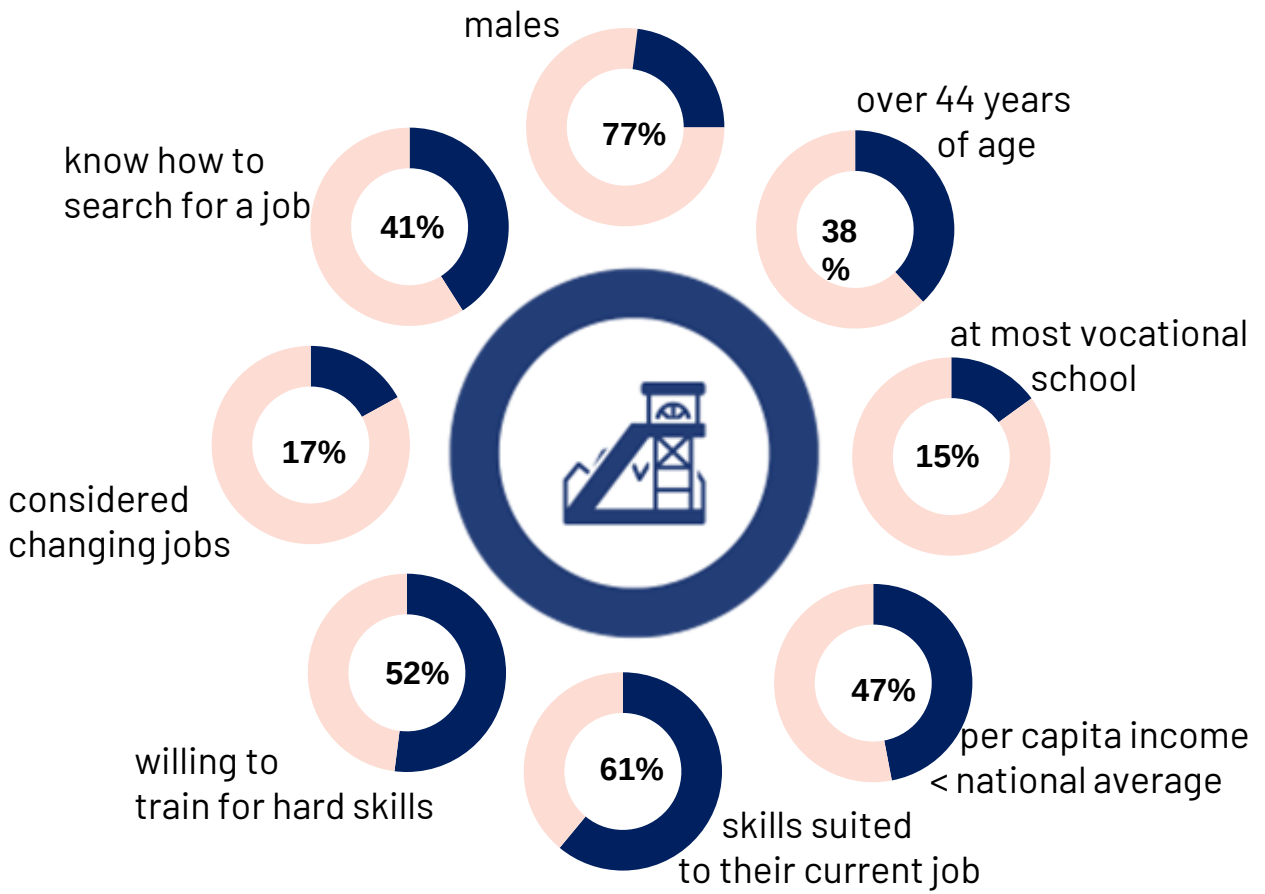
Examples of Post-Mining Land Uses



…and various other specialized uses

The Link to Labor and Socio-Economic Assessments

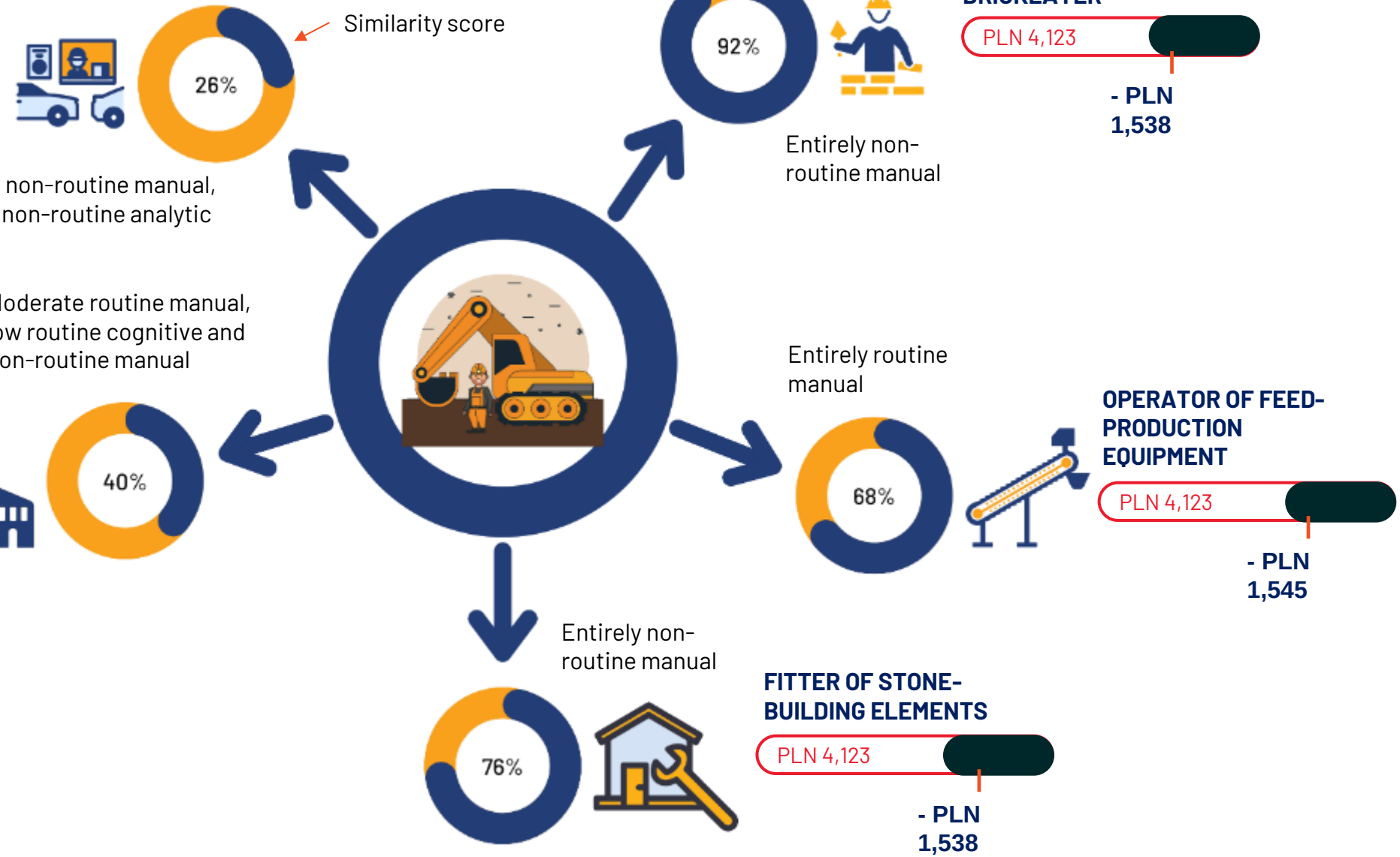
Who will be looking for jobs, which skills do they bring? Understanding and profiling coal mine workers



Source: World Bank Skills and Preference Survey (2021), BKL (2019).

Example: Potential job transition pathways for an underground miner

Moderate routine manual, low routine cognitive and non-routine manual, Average Salary = PLN 4,123



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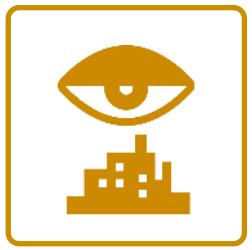
Labor market assessments to support preparation for coal transition



Labor demand analysis, including from potential land repurposing projects

Analysis of labor demand based on (i) online job postings in both private and public job portals); (ii) assessment of number and types of jobs generated through potential alternative land repurposing project and general investments as part of the regional economic development plan

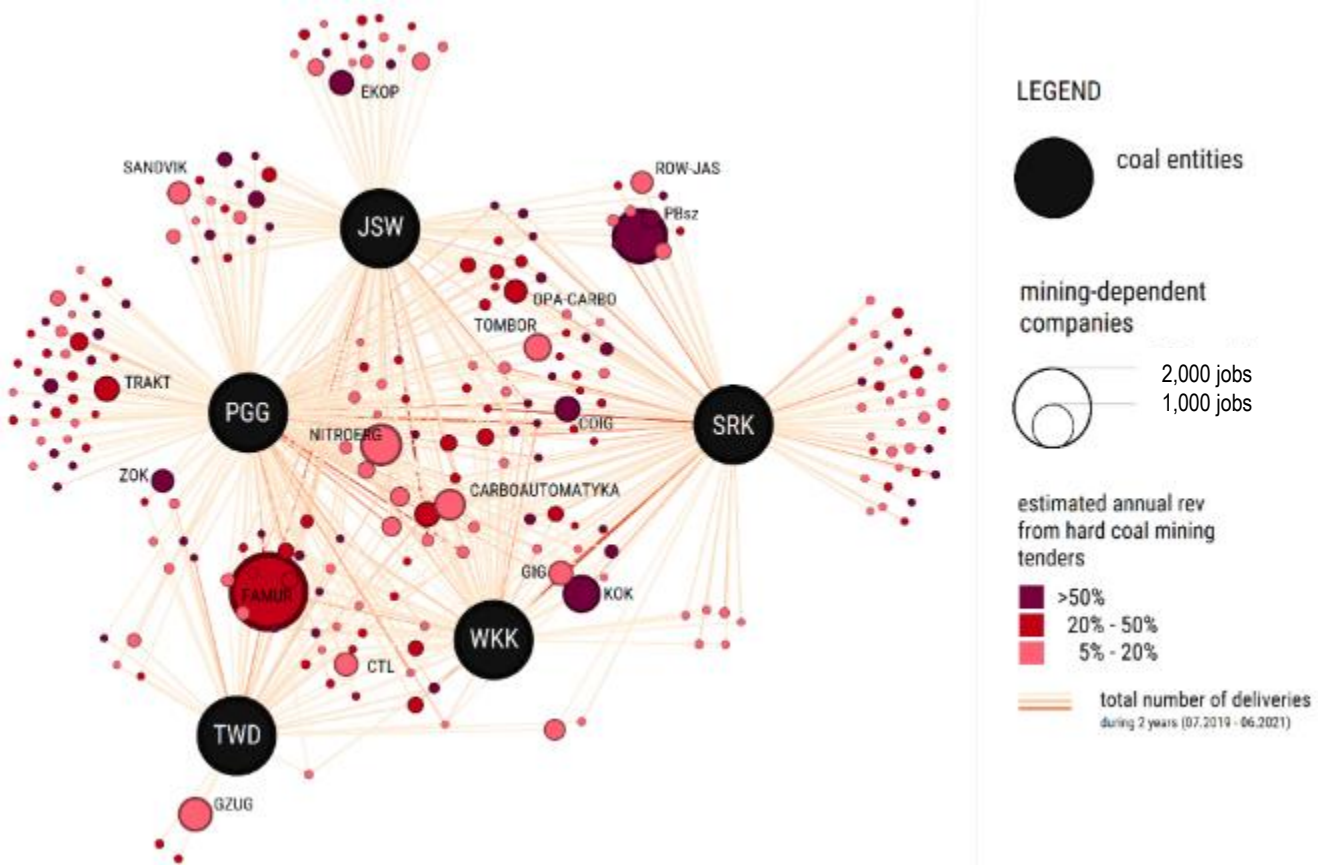
Job matching tool to assess viability of labor transitions and reskilling needs in current and future labor markets

A tool to match similar occupations was developed at the national level ;
The tool could be adapted to provide transition pathways specific to Ruda Ślaska with information on labor demand (labor market forecast, occupational barometer, local development strategies, etc.)

Looking at the wider economy of coal regions

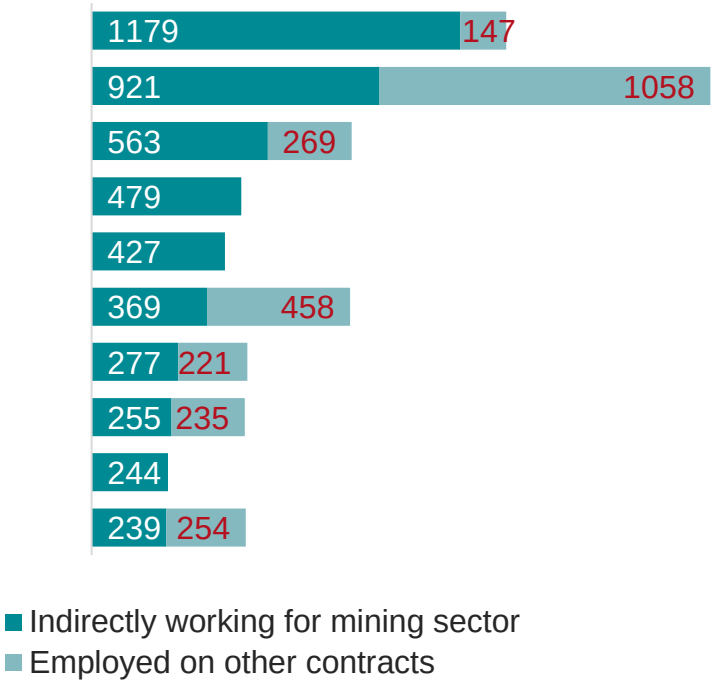
Subcontracting employment is concentrated among a few large firms, most of which will be highly affected

Employment is concentrated among a few large subcontractors...



Note: The figure represents subcontractors with headquarters in Upper Silesia with at least 5% of their annual revenues from hard coal mining tenders, which provided data about total employment (n=231).
Source: IBS (2021).

... many of which rely heavily on mining contracts

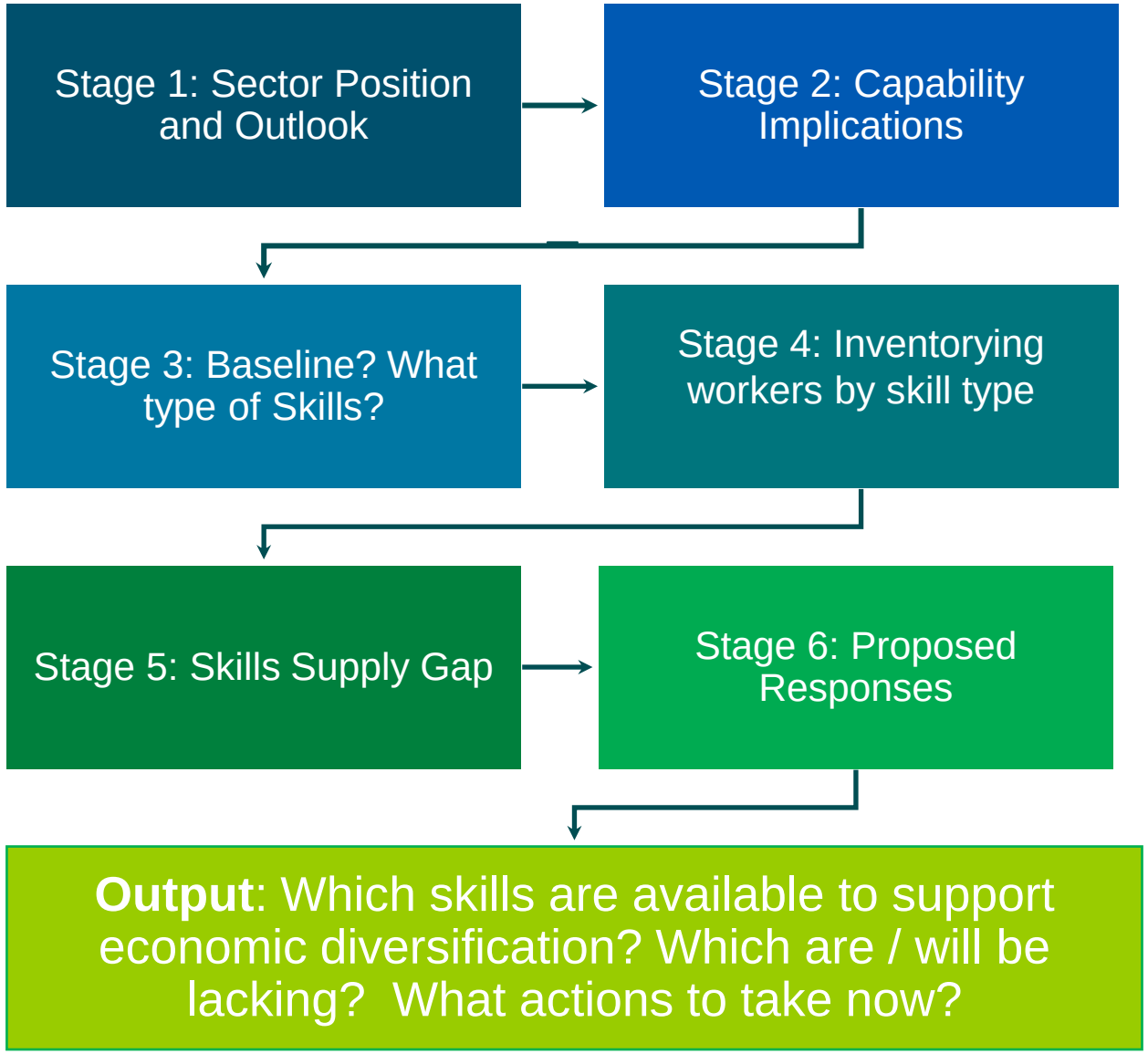


Note: Ten firms with largest number of employees working on mining contracts. The number of employees "working on mining contracts" is proportional to the share of revenues from mining tenders on total revenues.
Source: IBS (2021).

Skills are Essential for Fostering Economic Diversification

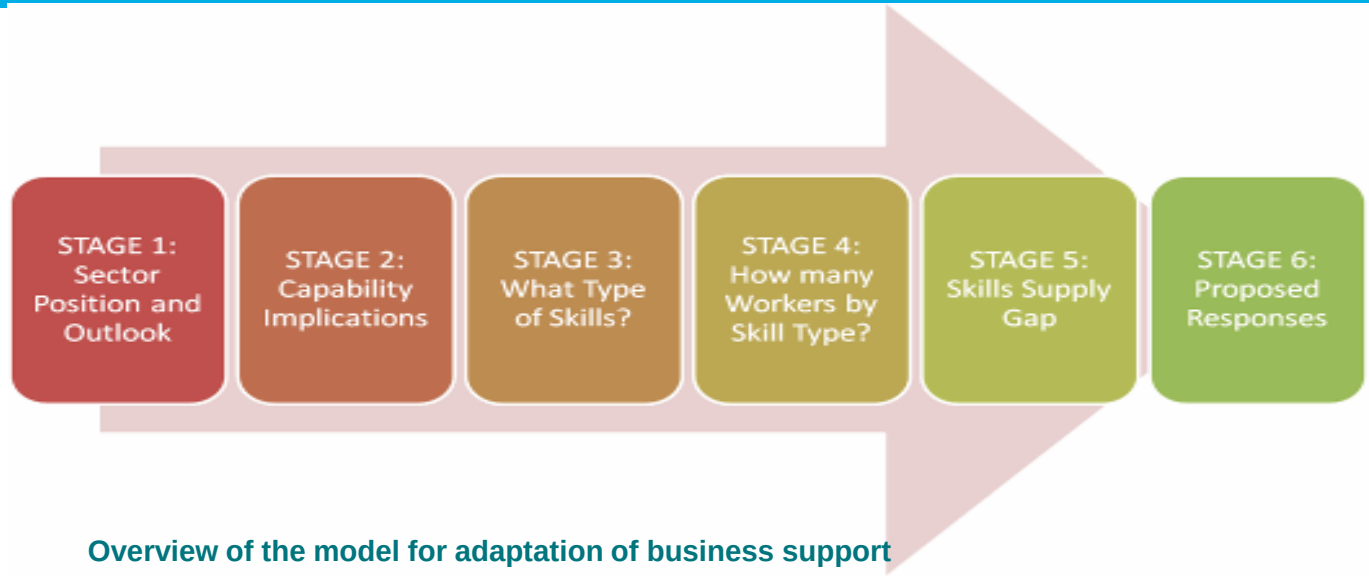
Approach / Methodology

- Review of existing literature/strategic documents
- Perform interviews with key stakeholders (Public administration, Private sector, Civil Society Organisations, Industry representatives, Trade Unions, Business Support Institutions)
- Review macroeconomic indicators
- Produce recommendations / action plan including list of priority investments and possible sources of financing

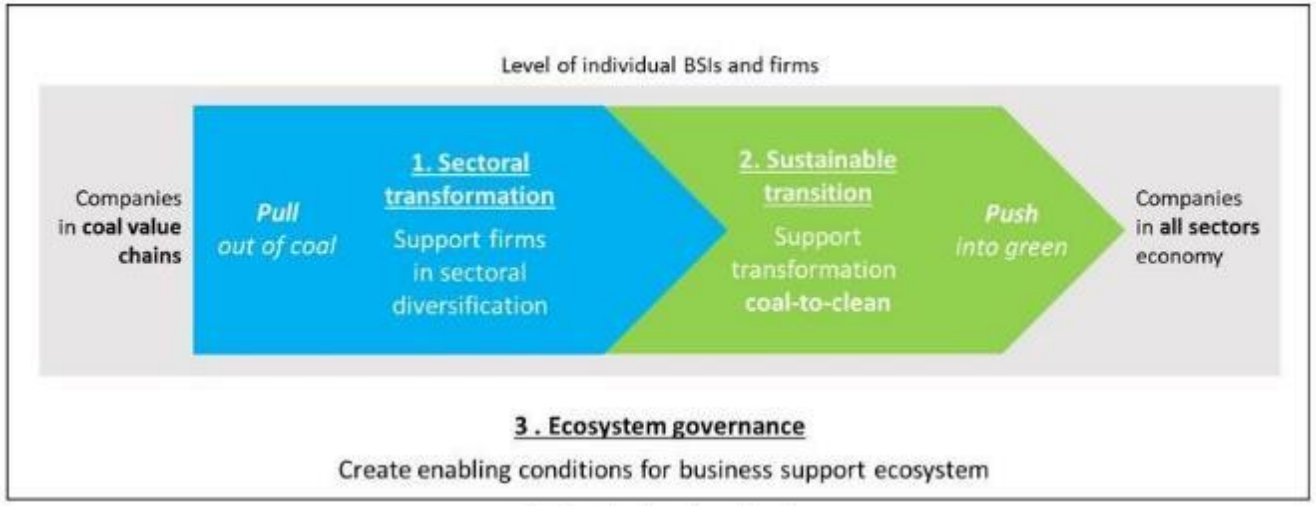


Economic diversification

- Review of existing literature/ strategic documents
- Performing interviews
  - Public administration
  - Private sector
  - Civil Society Organisations
  - Industry representatives
  - Trade Unions
  - **Business Support Institutions ⇒**
- Checking marco-economic indicators
- Recommendations and if requested – action plan that includes list of priority investments and possible sources of financing



Overview of the model for adaptation of business support ecosystem to needs of MSMEs in coal regions in transition



(unpublished report, The World Bank)

SPE (special purpose entities) address the multidisciplinary, multi-sectoral and multi-institutional challenges of just coal transition

Menu of typical SPE mandates

- Manage regulatory interface, obtain environmental and other required permits for turnkey opportunities for investors.

Regulatory and permitting

- Retirement, retrenchment, demobilization, reskilling and labor development, absorb and retain part of lost jobs, educational and training incentives, support to vulnerable groups, local value creation.

Social – Jobs and Community development:

- Receive and manage funds identification of financing instruments, public/private sector investment facilitation and ensuring long-term financial sustainability through self revenue generation.

Funding & Financing:

- Take ownership and control, spatial reorganization, decommissioning, remediation, repurposing, marketing and real estate redevelopment, managing long term social and environmental impacts.

Land and assets

- Monitoring, reporting, audits, accreditation and supervision of the agency through strong governance structure.

Checks and balances

- Liaison and engage stakeholders ranging from local community, municipalities, state, central, utilities (water, electricity, waste), transportation (railways, trucking) etc.

Liaison and stakeholder coordination

- Project life cycle coordination (identify, select, define, and implement), contract manager for civil works and projects.

Project management

- Strategic planning in early phases of a coal transition
- Spatial mapping, technical knowledge, analytics, communications-informatics, localized

Strategic planning and Knowledge

World Bank Just Transition:
https://www.worldbank.org/en/topic/extractiveindustries/justtransition

Lead for Land Repurposing and LURA application:
Dr. Wolfhart Pohl wpohl@worldbank.org

LURA Demo Version:
https://lurademo.geosysta.com/