

Approach for environmental reclamation of Bor mining area under SATREPS project

Research on the Integration System of Spatial Environment Analysis and Advanced Metal Recovery to Ensure Sustainable Resources Development

April 2015 to March 2020



21 February, 2020

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Introduction

Background of research

Environmental-friendly

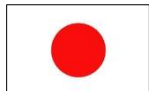
Establishment of new system for sustainable mining development

2006-2008: Master Plan for Promotion of the Mining Industry in the Republic of Serbia

2011-2013: Mining Waste Management in Bor Region

SATREPS

2015-2020: Research on the Integration System of Spatial Environment Analysis and Advanced Metal Recovery to Ensure Sustainable Resources Development



Representative organization :

- Akita Univ., Graduate School of International Resource Sciences
- Japan Space Systems (JSS)
- Mitsui Mineral Development Engineering Co., Ltd. (MINDECO)

Budget: 4.8 million US\$

JST: 1.8 million US\$, JICA: 3.0 million US\$

(Experimental equipment (1.5 million US\$ in total))

*Research resources:
Advanced technology &
Technical know-how*

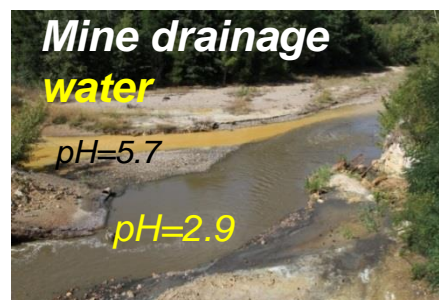
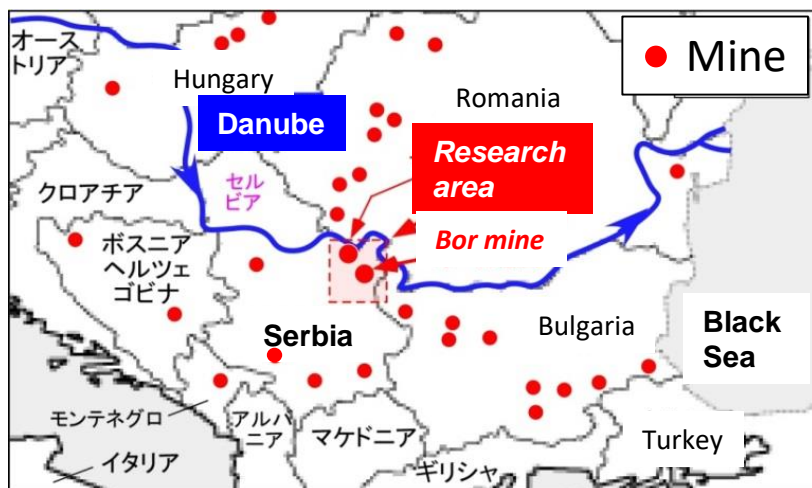
General organization:

- Ministry of Mining and Energy (MOME)
- Ministry of Environmental Protection (MOEP)
- Mining and Metallurgy Institute Bor (MMI-Bor)
- Technical Faculty Bor, Belgrade University (TF-Bor)

Budget: 0.8 million US\$

MNRE: 0.4 million US\$, IRM: 0.4 million US\$

*Research resources:
Research field &
Excellent researchers*



Aim of Research

Establishment of integrated environment reclamation system

3D large-scale environmental analysis & evaluation

1. Advanced satellite image analysis
2. Detailed field survey

Development of detoxification and resource recovery from mine wastes (flotation tailings, a waste water etc.)

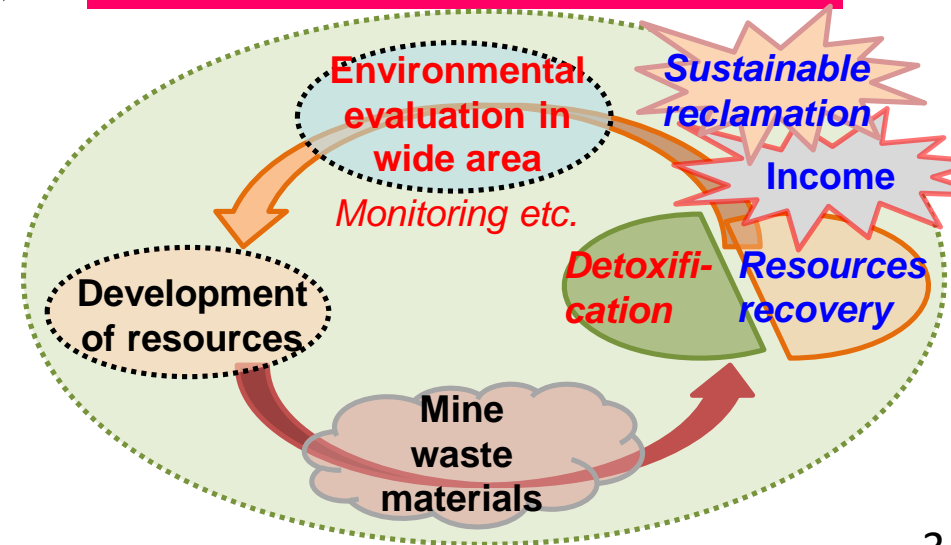
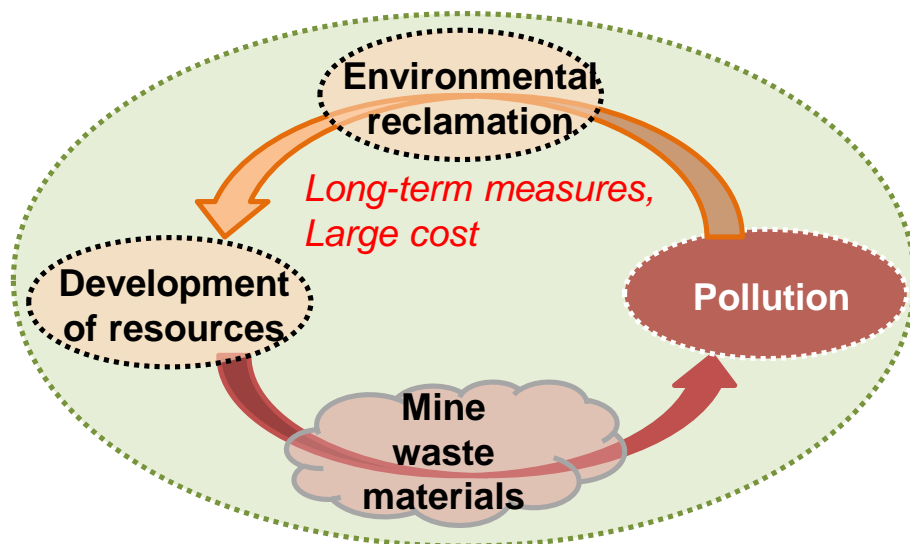
1. High pressure acid leaching method,
2. Neutralization method,
3. Adsorption method

systematization

Novelty of research

Global issues on environments in mining development activity

New system for environmental reclamation



Extraction of Environmental Load (Satellite Image Analysis)

Satellite Image Analysis

Low cost,
Swiftness,
Covering
wide area



Estimation of environmental impact of mine tailing by satellite image analysis

Tailing from marginal part of orebody,
Environmental load

Small

Tailing from central part of orebody,
Environmental load

Large

- Group 1
- Group 2
- Group 3
- Group 4

Distribution of mine tailings determined by Sentinel-2 satellite image

Mine tailing of the Majdanpek mine

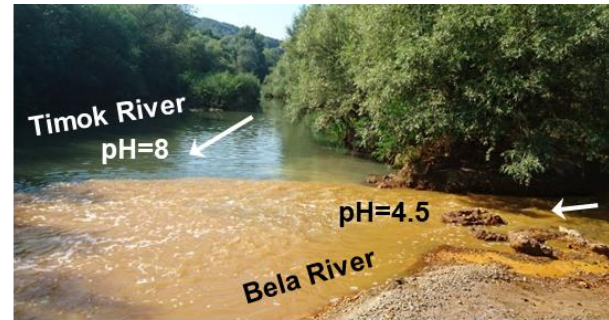
Mine tailing of the Bor mine

Effect by cloud

Mine tailing: Residue after extraction of ore minerals from ore

Extraction of Risk Area (Background Analysis)

Detailed Field survey



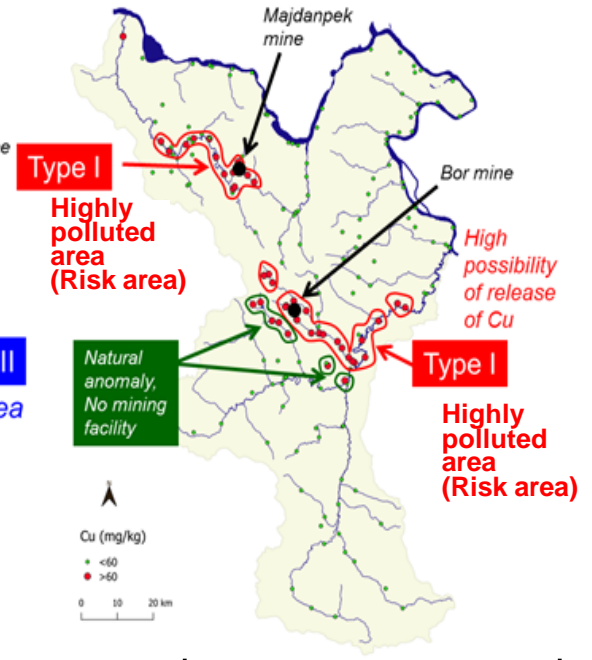
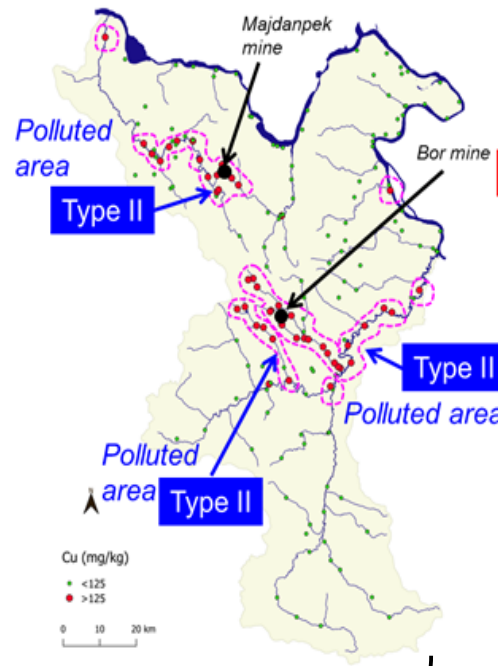
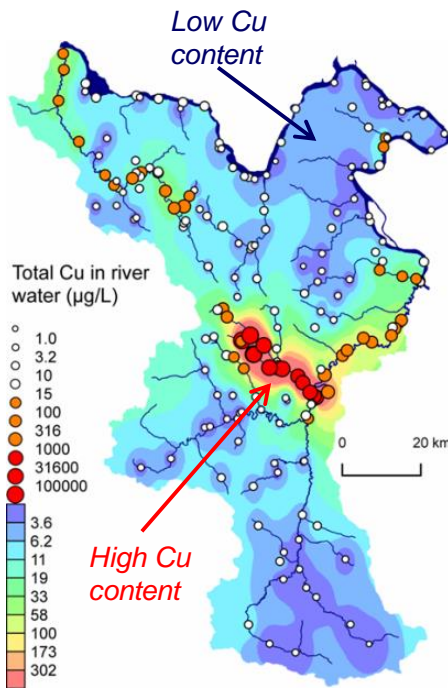
(a) Cu (River water)

(b) Cu (sediments)

(c) Cu content extracted from sediments by 0.5 M HCl

Distribution of Type I contaminated area

Distribution of Type II contaminated area



Extraction of high Cu content area

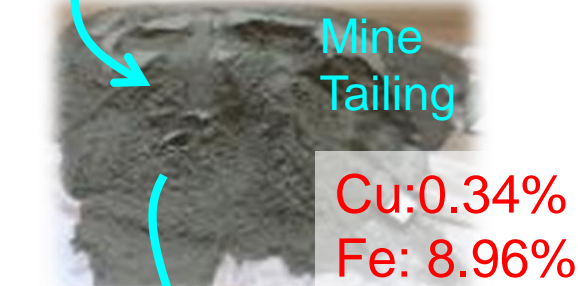
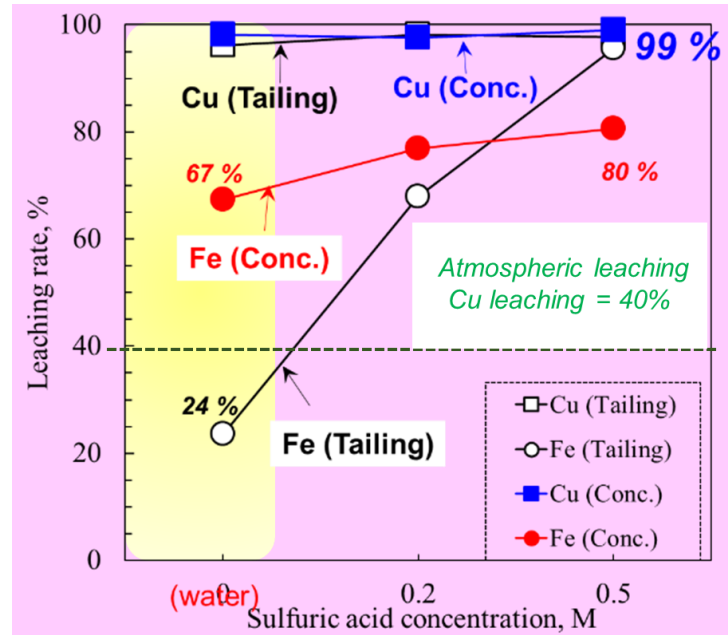
Extraction of High Cu elution area

Geochemical Map (200 sampling Points)

pH, Eh, Cl, SO₄²⁻, Al, Mn, Fe, Ni, Cu, Zn, As, Cd, Pb etc.

Detoxification and Metal Recovery from Tailing by High-Pressure Leaching

Over 95% of Cu was recovered by High-Pressure leaching

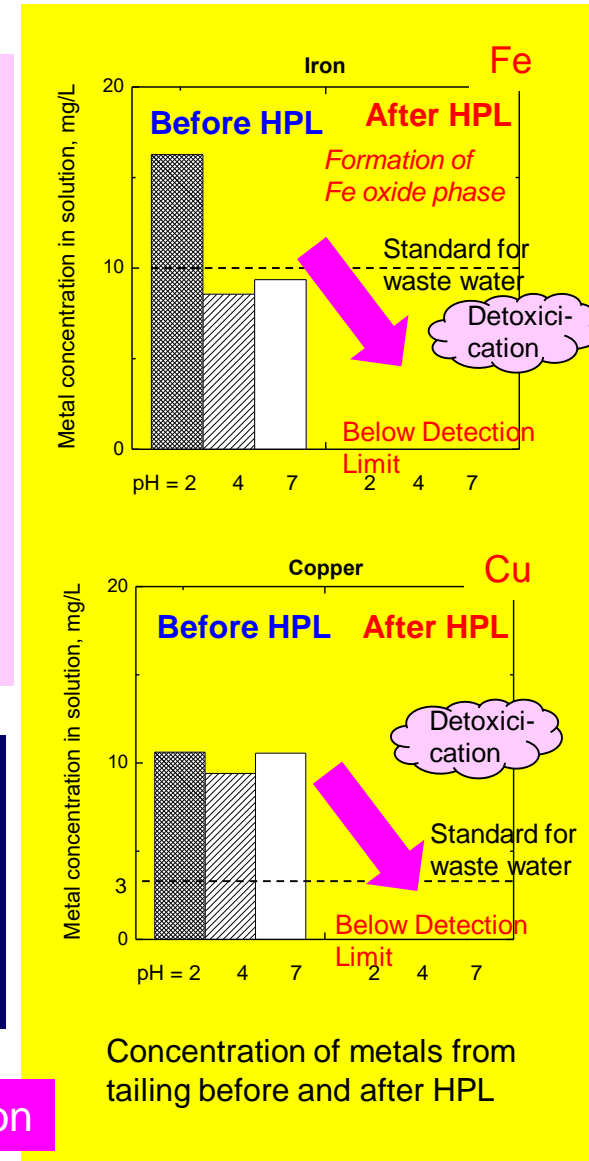


Merit of high-pressure leaching method

1. High extraction rate of metals
2. High efficiency for detoxification

HPL method → Good for detoxification

HPL

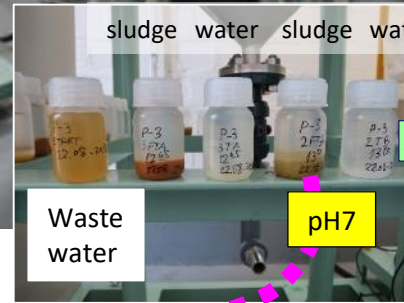
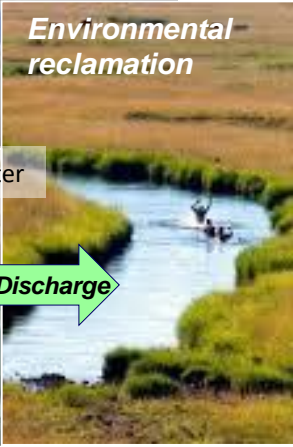


HPL

Detoxification of Mine Drainage Water (Neutralization Method)

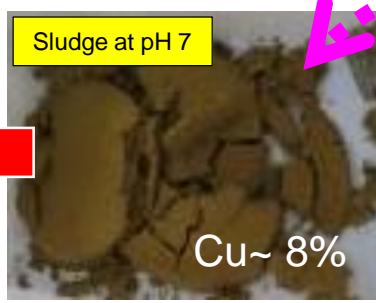


Two-step



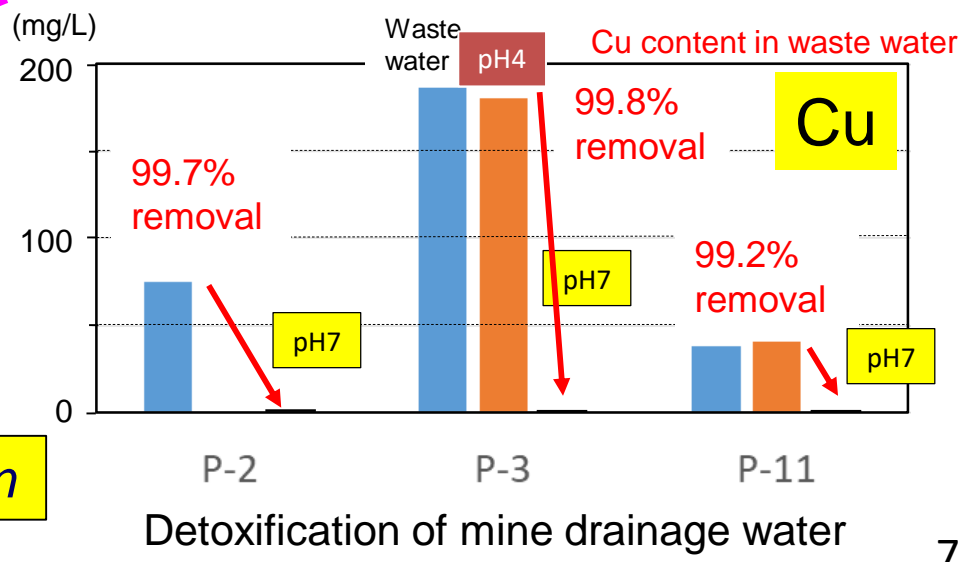
Copper Cathode for Industry

Recovery of copper



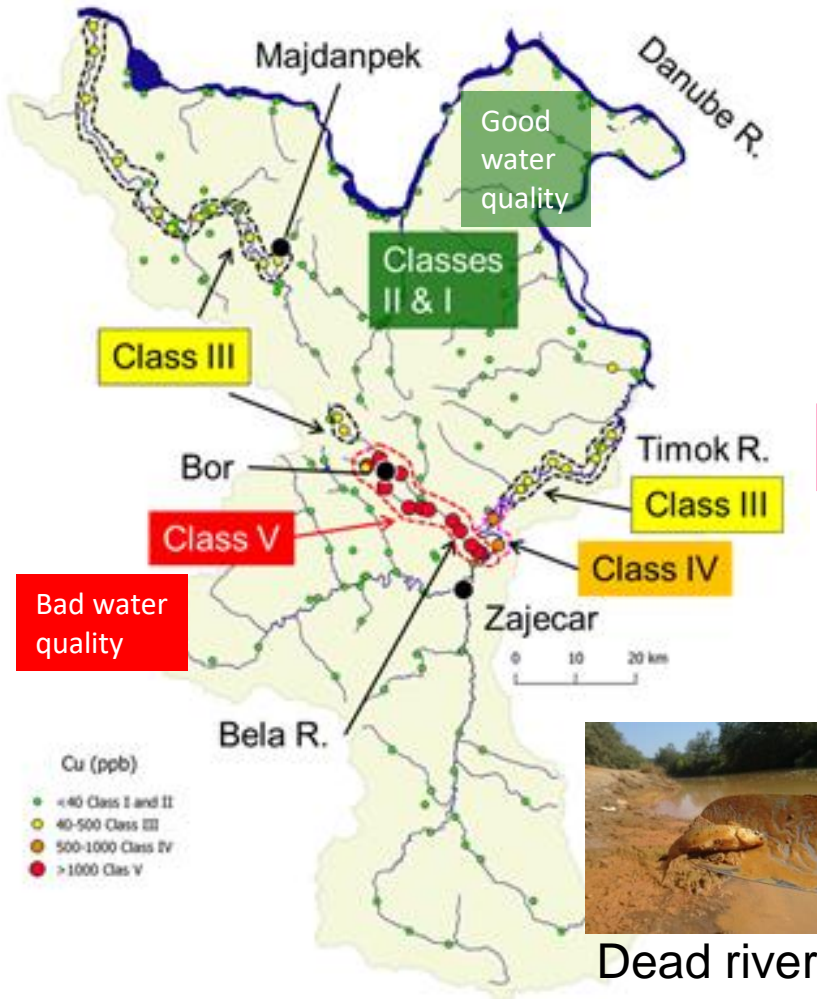
Copper income

Sustainable environmental reclamation

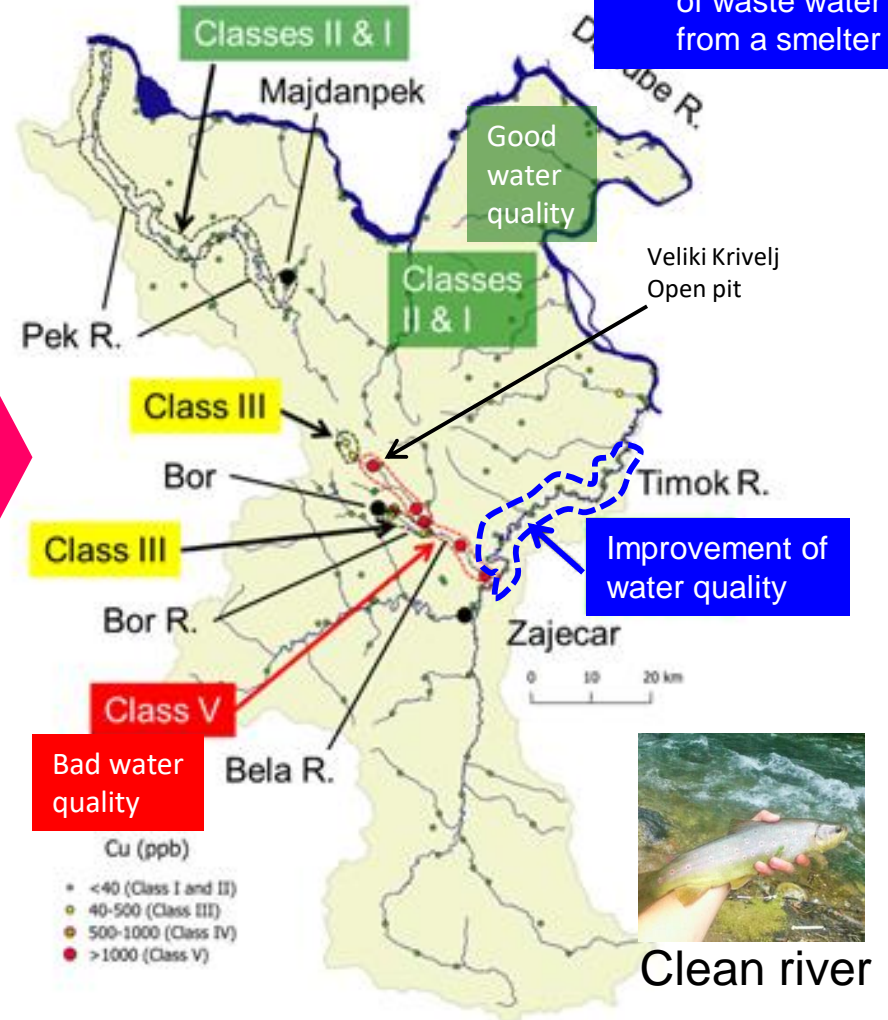


Prediction of Improvement of Water Quality after Neutralization

(A) Current condition



(B) After provision



- ✓ Neutralization (3 points)
- ✓ Countermeasure of waste water from a smelter

Environmental reclamation: Possible

Good for human health & EU accession

Approach for Social Implementation under SATREPS

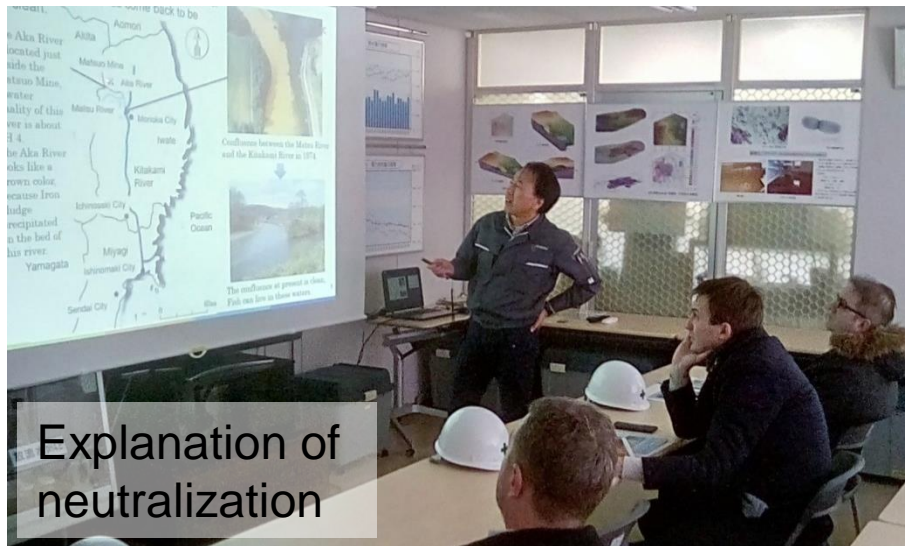
1. Explanation of research results obtained under SATREPS to the minister of Ministry of Mining and Energy (Oct, 2019) ➡ *Study plan over next two-year period was submitted by MMI-Bor.*
2. Establishment and implementation of Inter-Ministry Meeting between Ministry of Mining Energy and Ministry of Environmental Protection (2017, 2018, 2019, 2020)
3. Site visit and exchange of idea on environmental measure in Japan for vice minister of Serbian Government (5 persons, 2016, 2017, 2018, 2019)
4. Application of experimental equipment donated (1.5 million US\$), technique of chemical analysis and analysis technology by technology transfers for other environmental research projects (Serbia-German, Serbia-Romania)

From 2017 to 2020

From 2019 to 2021



Site Visit and Exchange of Idea on Environmental Measure in Japan for Vice Minister of Serbian Government



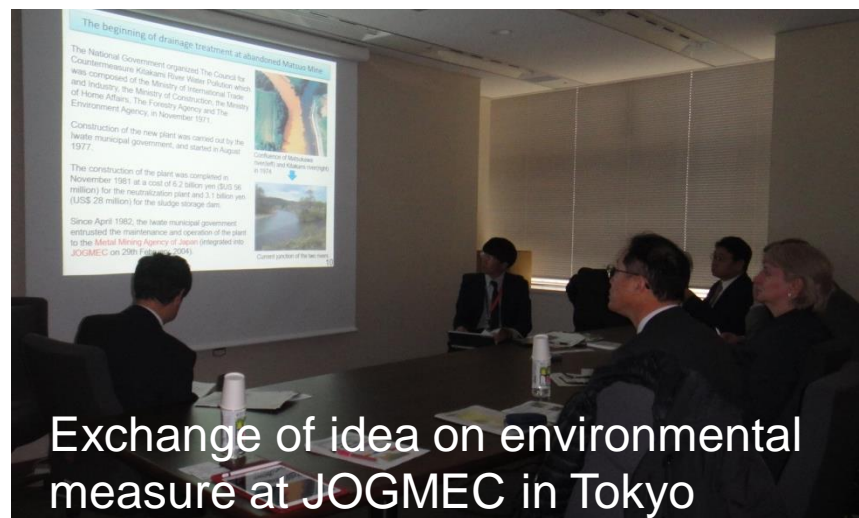
Explanation of neutralization



Observation of clean river water after provision
Kitakami R.

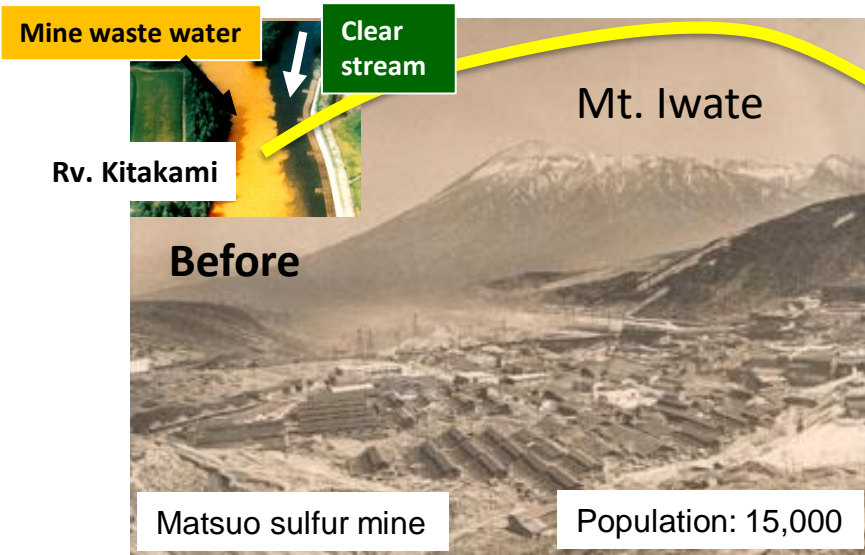
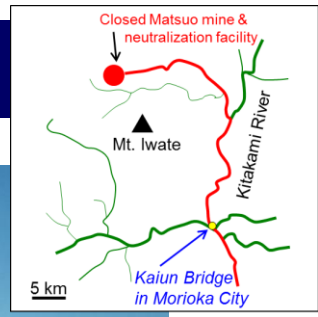


Site visit of neutralization plant

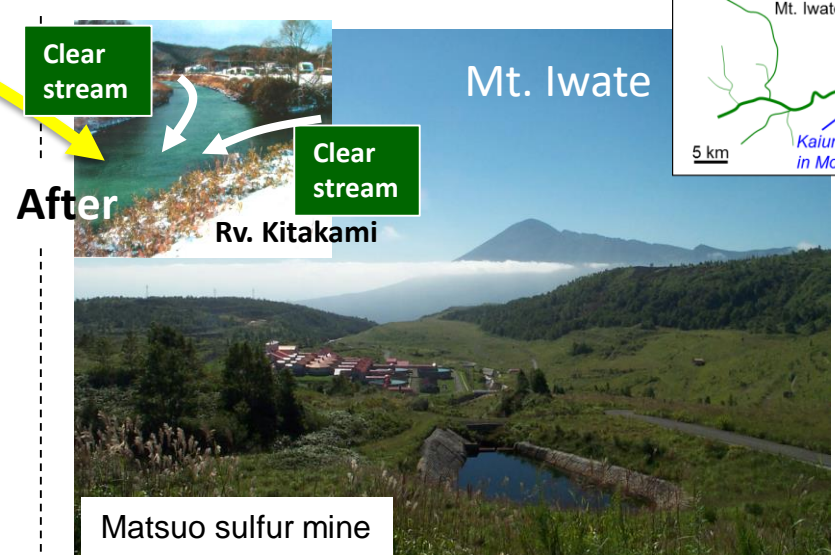


Exchange of idea on environmental measure at JOGMEC in Tokyo

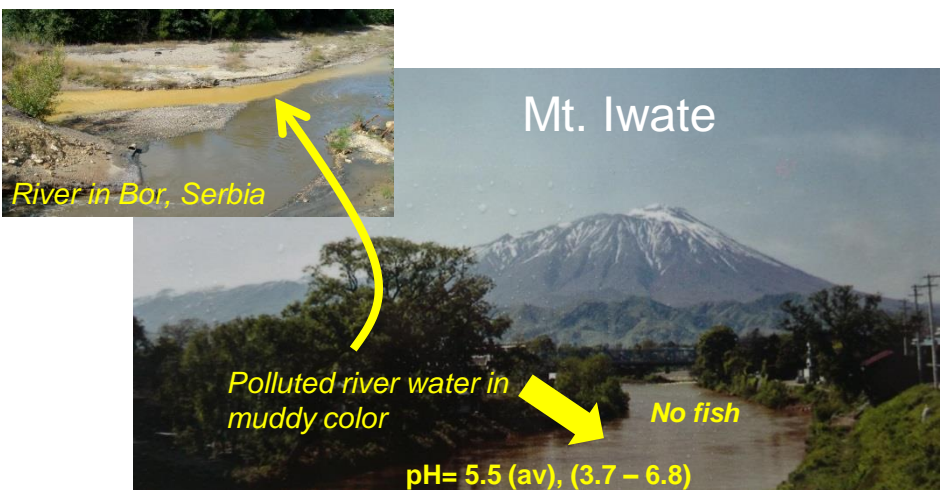
Example of Environmental Reclamation in Japan



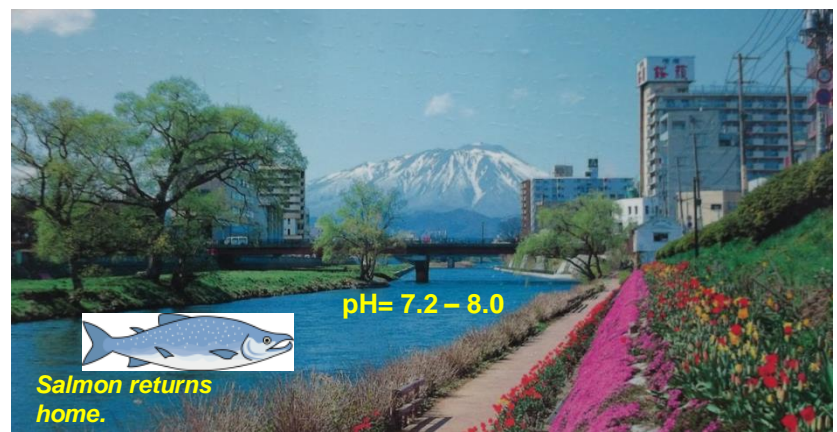
Before installation of the neutralization plant



After installation of the neutralization plant



Kitakami River in Morioka City in 1960s (50 km downstream from the Matsuo mine) The pollution reached downstream a further 100 km from Morioka.



Kitakami River seen from Kaiun Bridge in Morioka City in 2010s

Development of Human Resources

1. Short-term research study of counterpart in Japan (2015 - 2019)

Environmental evaluation: 8 persons, Satellite image analysis: 17 persons,
Detoxification of waste material: 14 persons (Total: 39 persons)

2. Implementation of educational program for environmental reclamation between Akita University and TF-Bor of Belgrade University (2016 - 2019 & continuation)

Two fields (Environmental evaluation and Detoxification, Three-week field work),
Collaboration between Serbian and Japanese students (in total 46 students)
17 students *29 students*

3. Advanced education in Ph.D. course in Akita University

2 persons (Ph.D. in engineering (Completion in 2018), Ph.D. candidate (D2))

4. Workshop for high school students in Bor City for fostering on environmental awareness

Participants: 16, Request from high school → Continuation of the work shop



Ph.D.
candidate
Research
on ground-
water



Research study in Japan



Bank of the Danube

Educational program for
environmental reclamation
between AU & TF-Bor



International Conference in Ph.D.
course
(Boston)

Dr. Stefan Đorđević in 2018



Workshop for high school
students in Bor

Short-term research study of counterpart in Japan

Visiting of Japan Science and Technology Agency



Experiment in mining site



Tour of treatment plant for municipal effluent



Experiment at Akita Univ.

Educational Program for Environmental Reclamation between Akita University and TF-Bor of Belgrade University



Workshop for High School Students in Bor for Fostering of Environmental Awareness

15

Explanation of outline of environmental activity under SATREPS project



Observation of waste water in the field



Experiment of waste water for detoxification in laboratory

We appreciate cooperation of Serbian
researchers and support by
Serbian Government.

Hvala vam puno na pažnji.

Thank you so much for your kind attention.

