Geochemical and Water Quality Modelling in Management of Acid Mine Drainage

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Background, Objectives and Scope of research

Background : One of important environmental issues in coal mines in Indonesia is **acid mine drainag**e. AMD problems are still exist in many coal mines, for example low pH water in **coal pit lake** in South Kalimantan (Rahmawati & Gautama, 2010; Saputri & Gautama, 2010) and **low pH in Ukud River** in Lati coal mine in East Kalimantan impacted by AMD (Abfertiawan, 2010).


Objective : Modeling the river's water quality from upstream to downstream that affected by acid mine drainage generation.

Scope of research :
- Ukud River at Lati Coal Mine (East Kalimantan) is used as study area
- The study was focused on the water quality impacted by acid mine drainage generated in mine pit as well as in overburden dumps
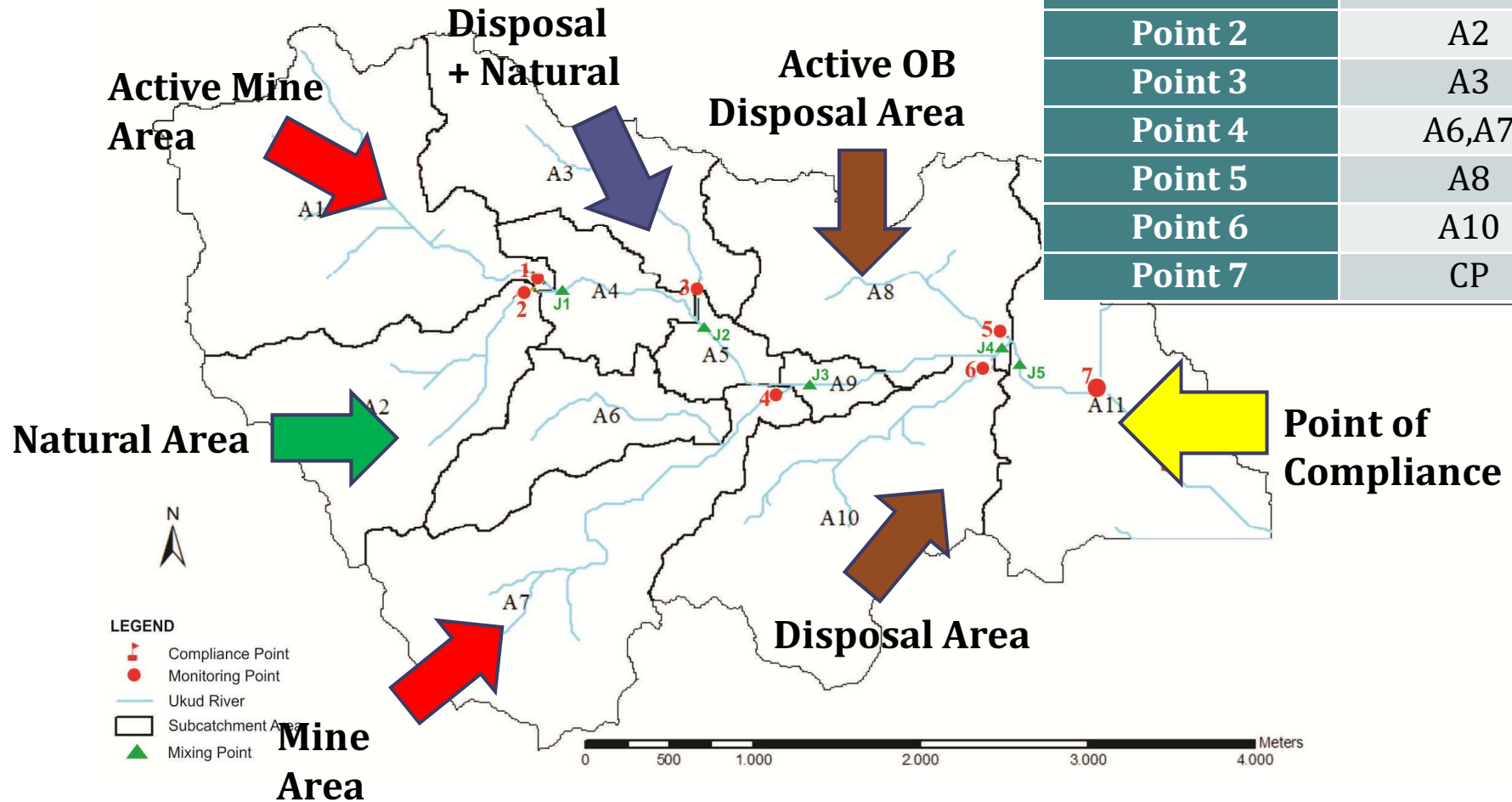
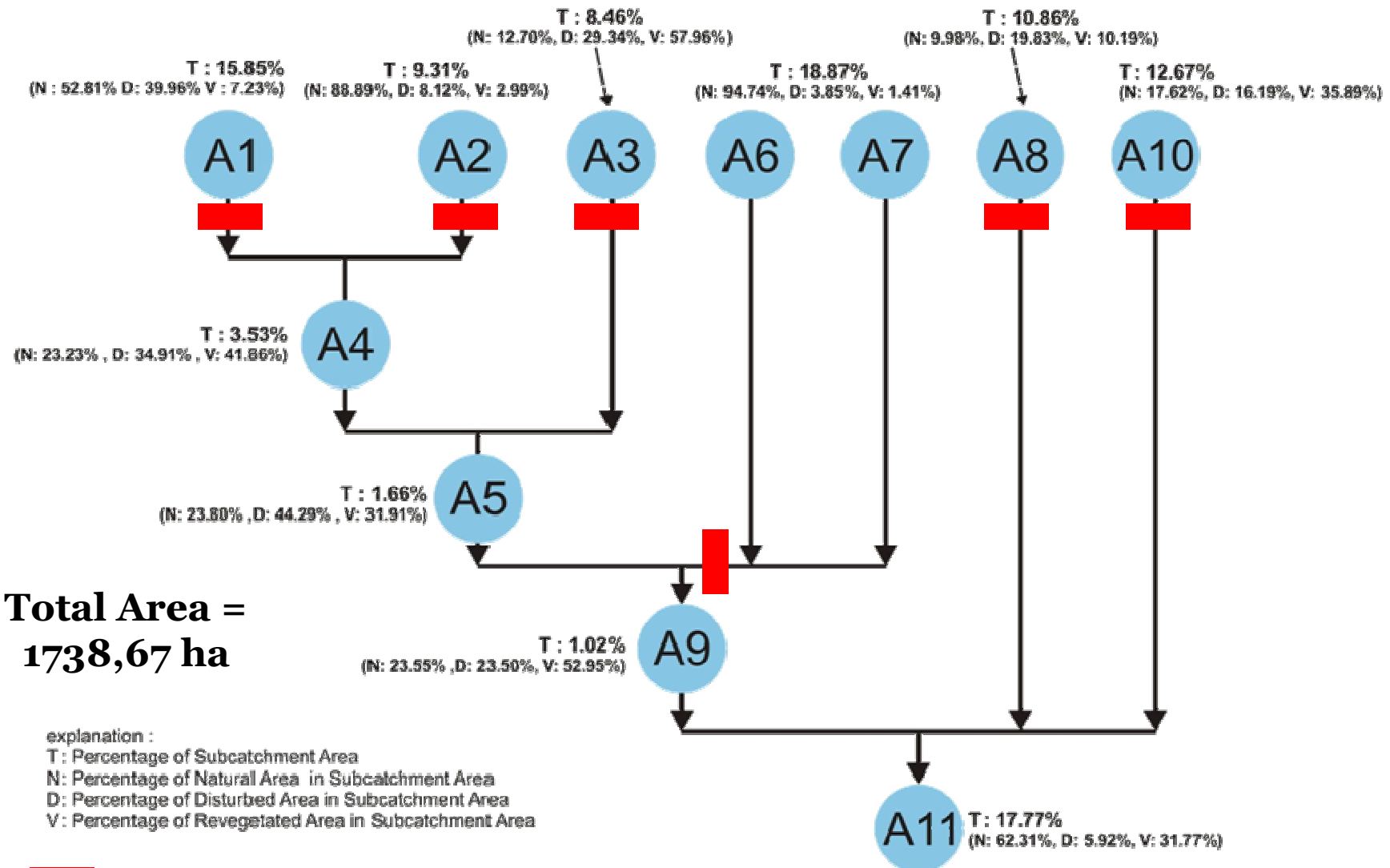## Case Study : Ukud River, Lati Mine Operation, Berau, East Kalimantan

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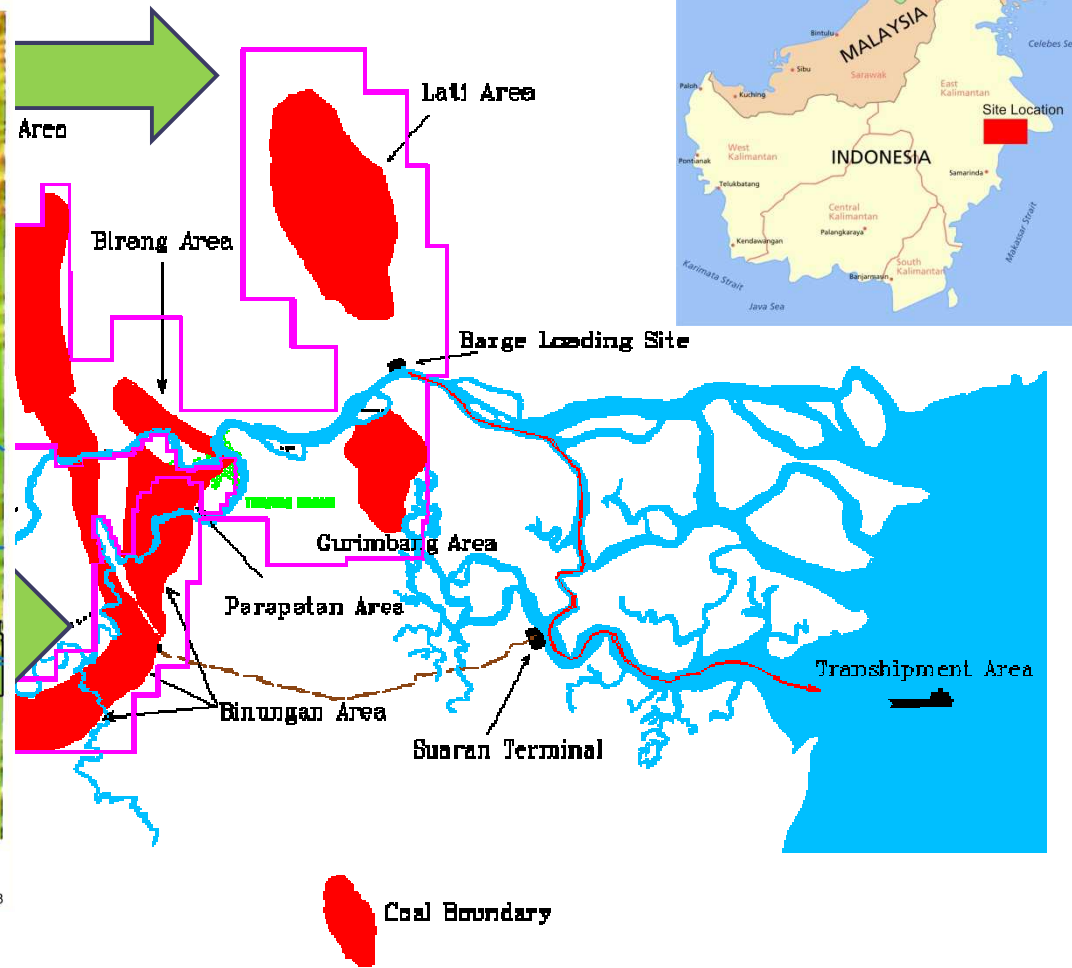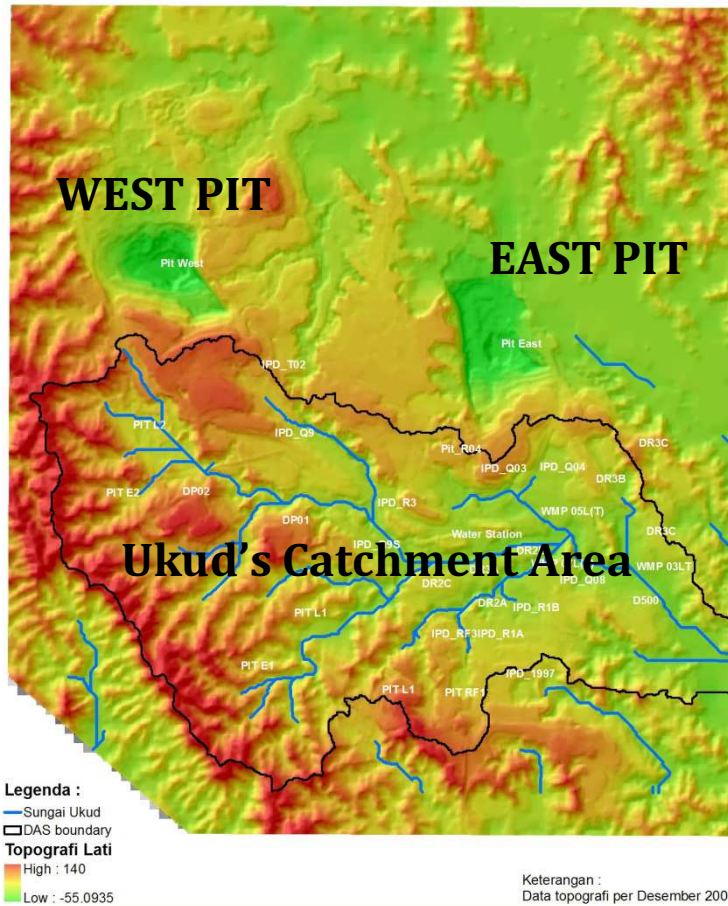
Ukud's Catchment Characteristics

There are 7 water quality & flow monitoring points have been installed .

Monitoring Point	Sub catchment
Point 1	A1
Point 2	A2
Point 3	A3
Point 4	A6,A7
Point 5	A8
Point 6	A10
Point 7	CP

Disposal + Natural

Active Mine Area

Active OB Disposal Area

Natural Area

Point of Compliance

Disposal Area

Mine Area

LEGEND

- Compliance Point
- Monitoring Point
- Ukud River
- Subcatchment Area
- Mixing Point

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Ukud's Catchment Characteristics

T : 8.46%
(N: 12.70%, D: 29.34%, V: 57.96%)

T : 10.86%
(N: 9.98%, D: 19.83%, V: 10.19%)

T : 15.85%
(N : 52.81% D: 39.96% V : 7.23%)

T : 9.31%
(N: 88.89%, D: 8.12%, V: 2.99%)

T : 18.87%
(N: 94.74%, D: 3.85%, V: 1.41%)

T : 12.67%
(N: 17.62%, D: 16.19%, V: 35.89%)

A1   A2   A3   A6   A7   A8   A10

T : 3.53%
(N: 23.23% , D: 34.91% , V: 41.86%)

A4

T : 1.66%
(N: 23.80% ,D: 44.29% , V: 31.91%)

A5

Total Area = 1738,67 ha

T : 1.02%
(N: 23.55% ,D: 23.50%, V: 52.95%)

A9

explanation :
T : Percentage of Subcatchment Area
N : Percentage of Natural Area in Subcatchment Area
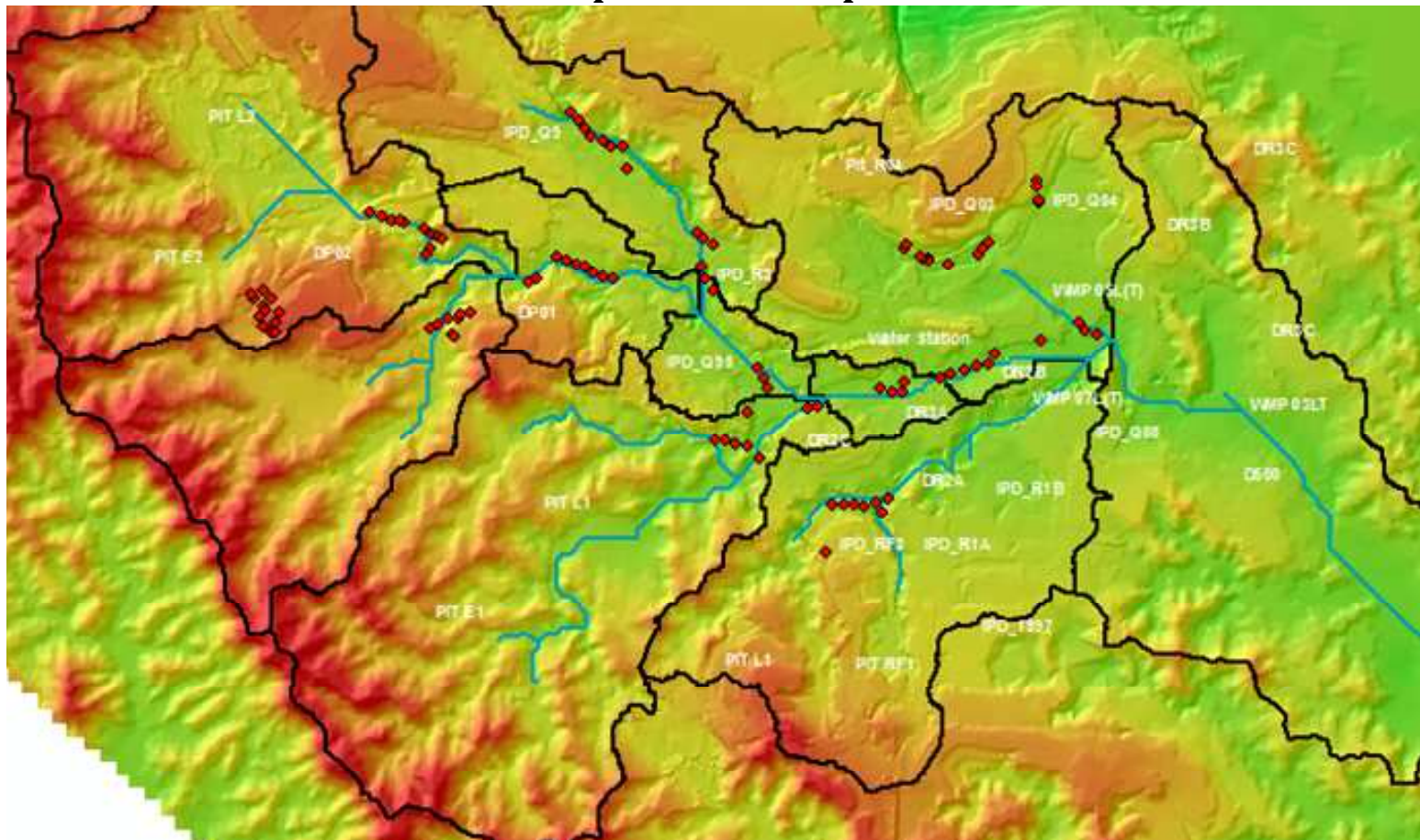D: Percentage of Disturbed Area in Subcatchment Area
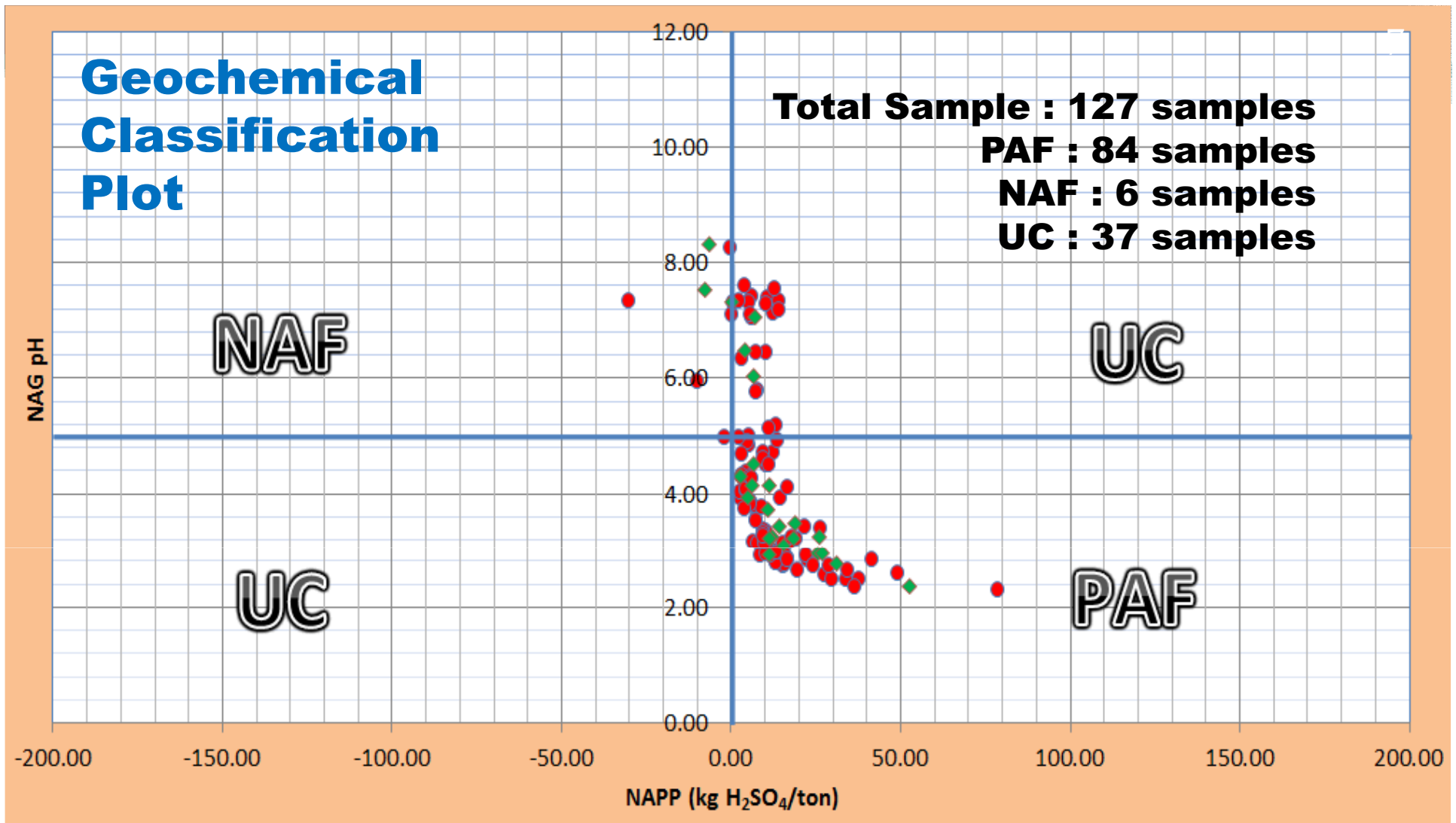V: Percentage of Revegetated Area in Subcatchment Area

A11   T: 17.77%
(N: 62.31%, D: 5.92%, V: 31.77%)

Monitoring Point (Treatment)

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Ukud's Catchment Characteristics

As many as 102 rock samples were collected both in disposal area and along the stream .

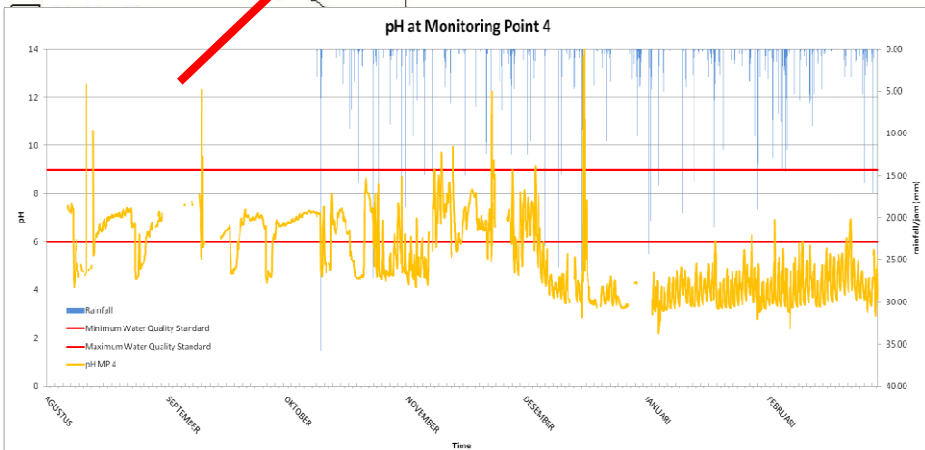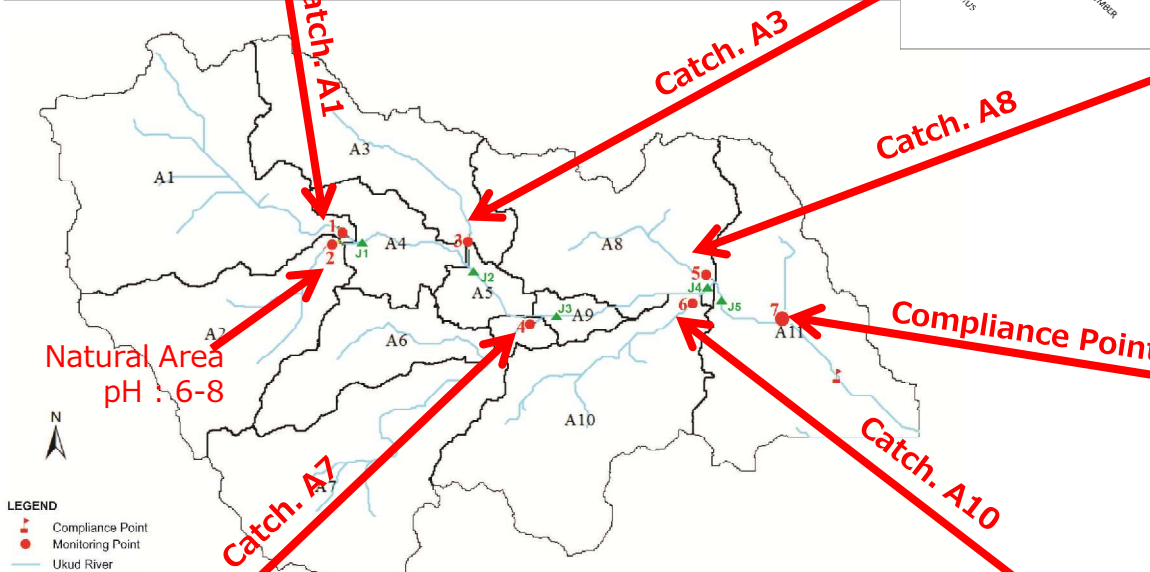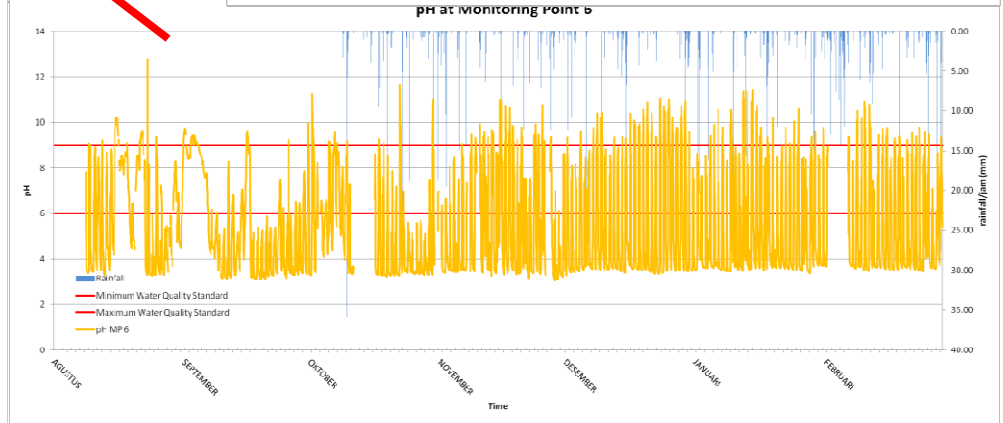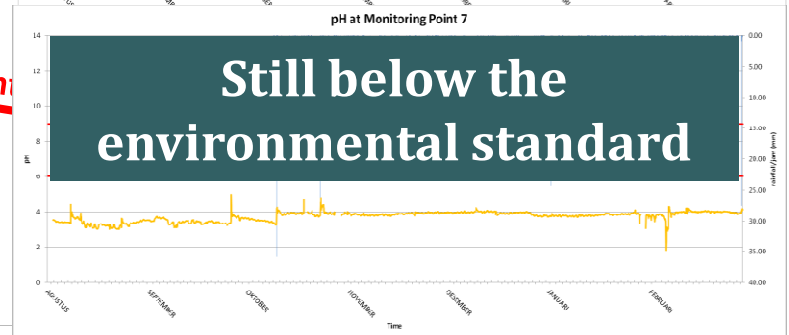**Rock sample collection points in Ukud's Cacthment Area**

Geochemical Classification Plot

Total Sample : 127 samples
PAF : 84 samples
NAF : 6 samples
UC : 37 samples

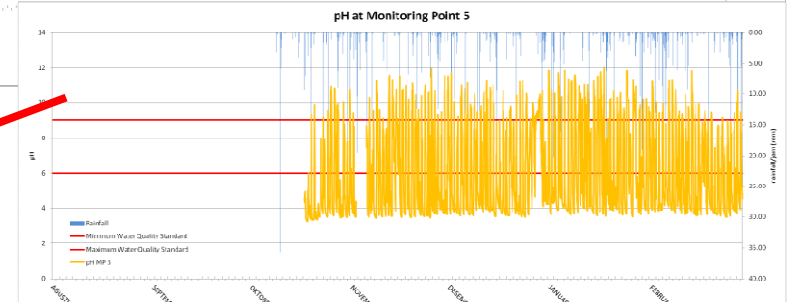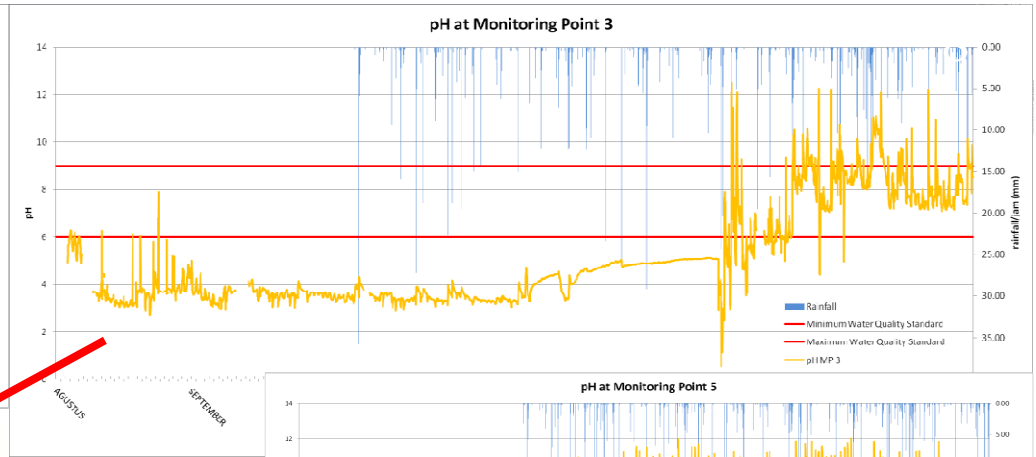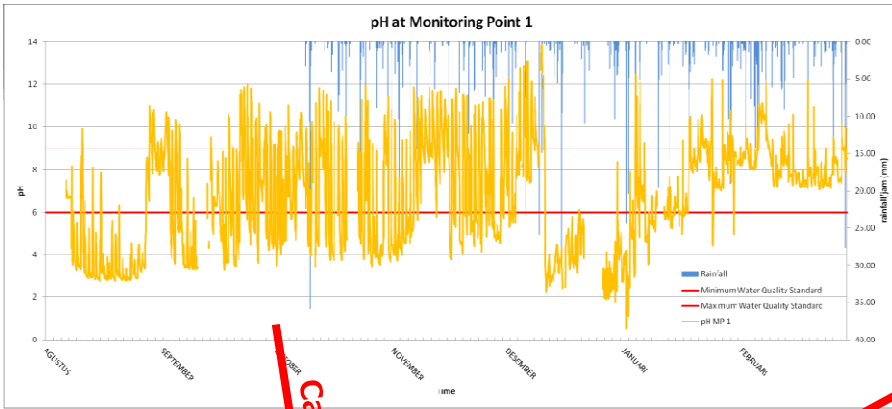NAG pH

NAPP (kg H$_2$SO$_4$/ton)

NAPP = Net Acid Producing Potential [kg H$_2$SO$_4$/ton rock] ;
NAG = Nett Acid Generating [kg H$_2$SO$_4$/ton rock] ;
PAF = Potentially Acid Forming
NAF   = Non Acid Forming
UC = Uncertain

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pH at Monitoring Point 1

pH at Monitoring Point 3

pH at Monitoring Point 5

pH at Monitoring Point 7

Still below the environmental standard

pH at Monitoring Point 4

pH at Monitoring Point 6

Catch. A1

Catch. A3

Catch. A8

Compliance Point

Natural Area pH : 6-8

Catch. A7

Catch. A10

LEGEND

Compliance Point
Monitoring Point
Ukud River

Water Quality Model

Determination of critical sub-catchment area

It is necessary to identify the most critical areas that gave significant influence on the water quality in the Ukud main stream.

Dilution is significant factor in controlling the ion concentration in the acid drainage (Lee & Kim, 2008).

| Mixing Point	Disch.	Concentration (mg/L)				Dilution Factor $[SO_4^=]$		Dilution $[H^+]$	Actual
	m³/s	$[SO_4^=]$	$[Fe^{2+}]$	$[Fe^{3+}]$	[Fe] Total	D_i	pH_i	pH_i	pH_i
J1	3.46	133,70	12,11	6,47	18,58	1,362	4,09	4,09	4,27
J2	5.47	84,63	7,91	4,35	12,26	5,216	4,81	4,17	n.d.
J3	7.44	78,69	5,81	3,2	9,01	1,772	5,06	4,22	4,24
J4	9.49	77,1	6,5	3,5	10	2,540	5,46	4,21	-
J5	11.56	76,7	8,8	4,6	13,4	1,218	5,55	4,22	4,37

Water Quality Model

Result of Simulation
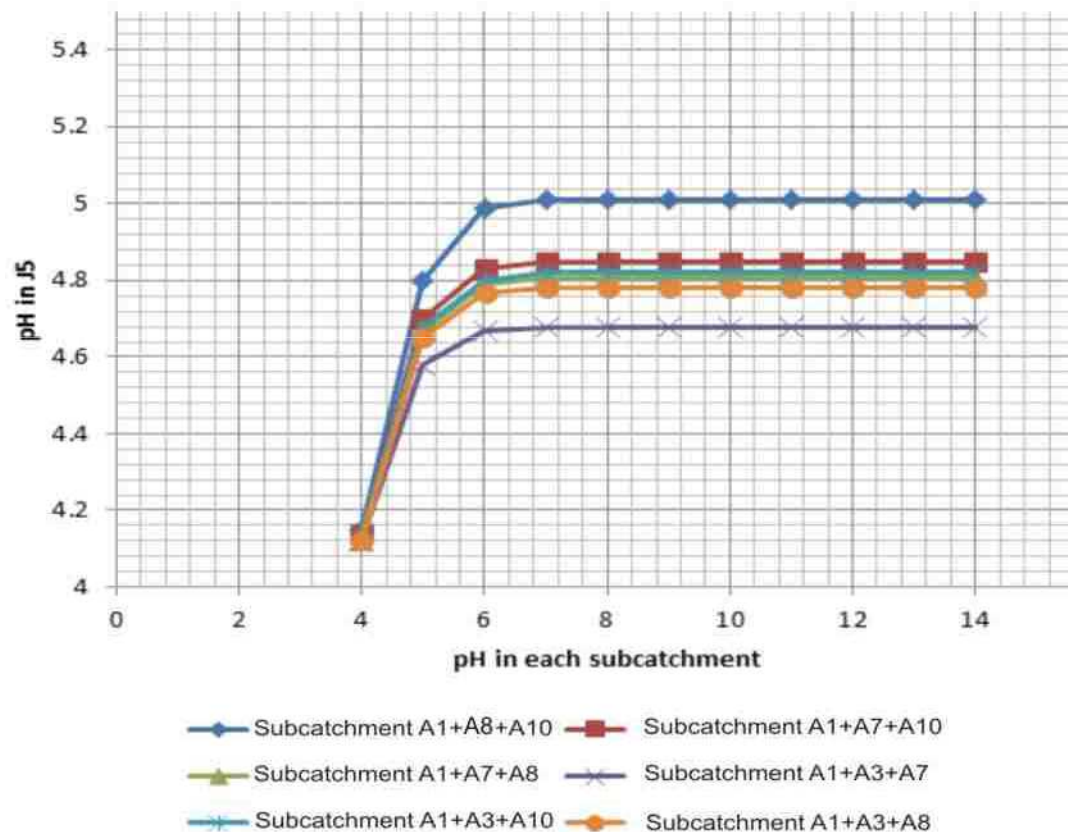
- Simulation has shown that efforts to improve the quality of run off water should be focused in **three sub-catchments, i.e. A1, A7 and A8**
- **Sub-catchment A1** : Others South mine pit.
- **Sub-catchment A7** : temporarily abandoned mine pit (L1)
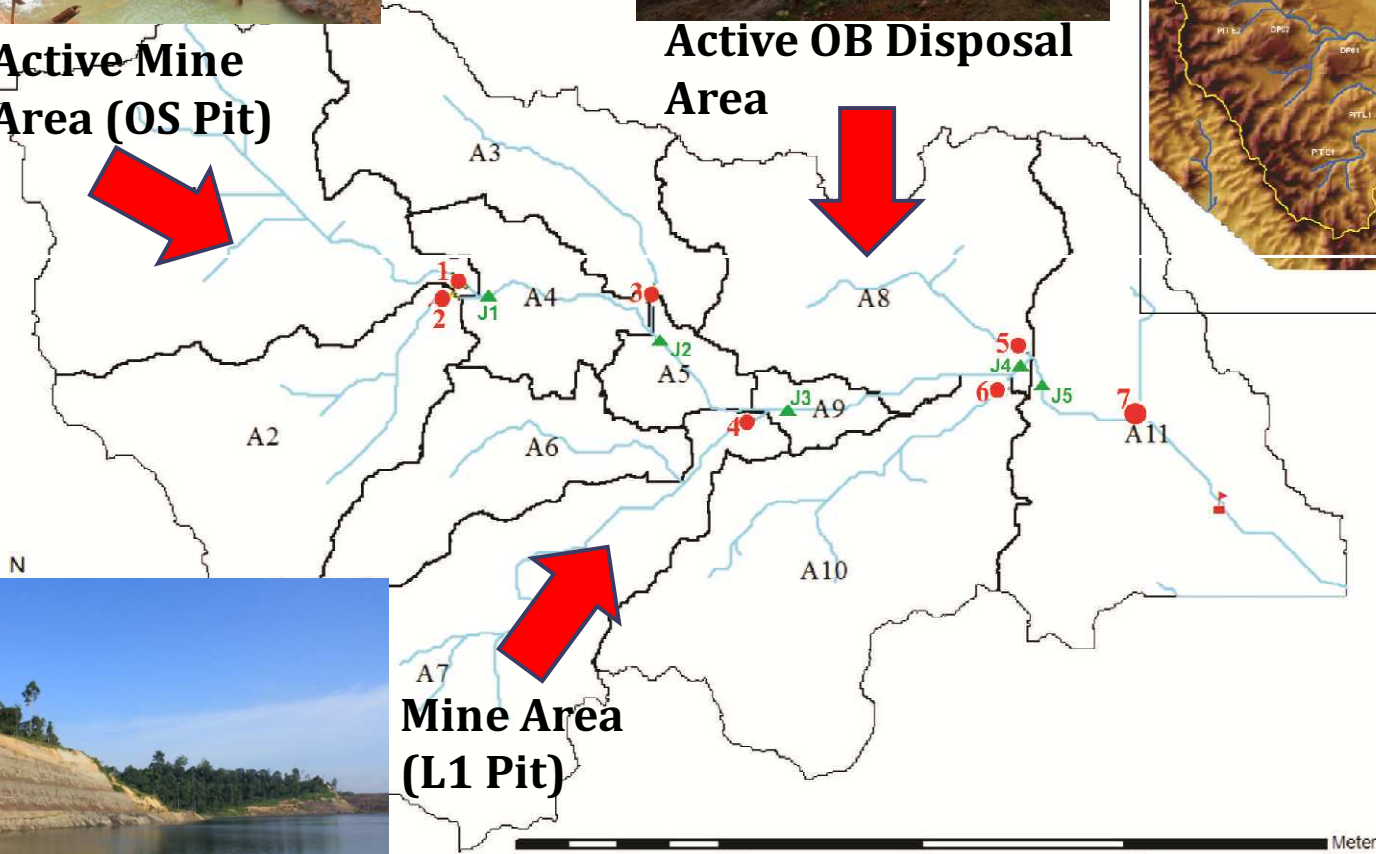- **Sub-catchment A8**: overburden disposal area.

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Lati Coal Mine Area

... Model ...ation

Active Mine Area (OS Pit)
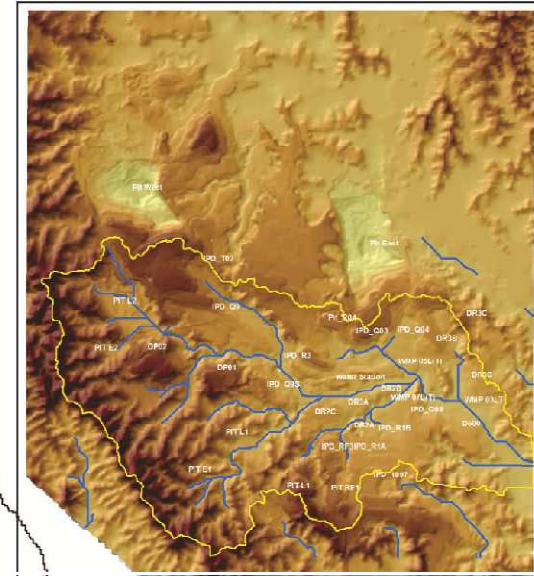
Active OB Disposal Area

Mine Area (L1 Pit)

Conclusion

a. The water quality in the point of compliance of Ukud river was influenced by the AMD load from all sub-catchments.

b. Simulation conducted for Ukud river had determined the critical sub-catchments that gave significant contribution of AMD into the Ukud river, namely sub-catchment A1, A7 and A8. It means that efforts to control the AMD and river water quality should be focused in those critical sub-catchments.

c. The main contribution to the water quality in Ukud River is sub-catchment A1, which is characterised by active mining operation in Other South (OS) Mine Pit and will be mined until 2015. The maximum measured discharge is 3 m^3/s with pH between 2-4.

Conclusion

d. The main AMD source in sub-catchment A7 is the overflow from temporarily abandoned L1 mine pit which is already filled up with acid water (pH value of 2-4).

e. The development of AMD Model still continue for a more complete, integrated and robust model.

Thank You…

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