RECLAMATION OF TWO COAL MINES IN MONGOLIA: THE EREN MINE AND THE PLANNED TAVAN TOLGOI MINE

By
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ALL PHOTOGRAPHS ARE BY SEW EXCEPT WHERE NOTED.
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• Mongolia has been viewed in recent history as a low population, weak country subservient to neighbors.

• Now the view is this new democracy will determine much of what happens ecologically, hydrologically and economically in the region largely due to its location but also due to its reserves of minerals and hydrocarbons.
MONGOLIA’S CONUNDRUM: CONSERVATION VERSUS DEVELOPMENT.
OBJECTIVES

- GEOGRAPHY, HISTORY, POLITICS
- ECOLOGICAL MONGOLIA.
- OTHER ECOSYSTEM RESOURCES
- NON-RENEWABLE NATURAL RESOURCES
- MITIGATION OF ECOSYSTEM DISRUPTION ASSOCIATED WITH NATURAL RESOURCE DEVELOPMENT
GEOGRAPHY, HISTORY, POLITICS
ULAANBAATAR, CITY OF 1.5 MILLION IN A COUNTRY OF 3.5 MILLION. OTHER LARGE CITIES NEARBY IN RUSSIA INCLUDE ULAN-UDEN AND IRKUTSK.

MONGOLIA, EVEN WITH ULAANBAATAR, HAS THE LOWEST POPULATION DENSITY OF ANY COUNTRY IN THE WORLD!
MONGOLIA’S MOST IMPORTANT HISTORICAL POLITICAL BOUNDARY
THE GREAT WALL OF CHINA (GWC) NEAR BADALING.
ECOLOGICAL MONGOLIA
VEGETATIVE ASSOCIATIONS

Mongolia

- International boundary
- Province (aimag) boundary
- National capital
- Province (aimag) center
- Railroad
- Road

The cities of Darhan, Erdenet, and Ulaanbaatar are municipalities (hubs) with province-level status.

0 100 200 Kilometers
0 100 200 Miles

Lambert Conformal Conic Projection, SF AT NOD*
Steppe Desert
Ppt <100 mm/Yr

Desert Steppe
Ppt 170 mm/Yr

Typical Steppe
Ppt 270 mm/Yr

Meadow Steppe
Ppt 350 mm/Yr

Forest Steppe
Ppt > 400 mm/Yr
Dominant Grass Species and Moisture Gradient Across the Mongolian Steppe

Dry: Stipa gobica, S. breviflora, S. krylovii, S. Grandis, S. baicaulensis, Aneurlopedium chinense, Several Species the genus Caragana

Wet: Typical Steppe, Meadow Steppe
Tumenstogt, Mongolia

Average precipitation: 276 mm
C.V. greater than 50%

Typical Steppe

Growing Season

Month

Precipitation, mm

Average=276 mm
C.V. greater than 50%
SOILS

GOVI ON BASALT

MEADOW STEPPE
Soil Organic Matter (0-15 cm) as a function of Annual Precipitation

F=23.08
R=0.716***
R²=0.512

Williams, Dodd & Lockwood, 1994.
Typical Steppe Soil Characteristics

- **Taxonomy:** Melanic (NZ), Dark Chestnut (Russian), Mollisols (USA).
- **Texture:** 70% sand, 15% silt, 15% clay.
- **Deep mollic (organic) epipedon:** 50 to 200 cm
- **Organic Matter:** 2 to 4% in top 20 cm
- **pH:** 7.5
- **Electrical Conductivity:** 0.5 dS/cm
- **Nitrate:** 15 micrograms/g
- **Phosphorus:** 3 micrograms/g
- **Potassium:** 150 micrograms/g

Plant Available

Bataar and Williams, 1998.
HYDROLOGICAL MONGOLIA

Mongolia

- International boundary
- Province (aimag) boundary
- National capital
- Province (aimag) center
- Railroad
- Road

The cities of Darhan, Erdenet, and Ulaanbaatar are municipalities (hövsgöl) with province-level status.

0 100 200 Kilometers
0 100 200 Miles

Lambert Conformal Conic Projection, SF-1-NE-2N

Lake Baikal

Hovsgol Lake

Selenge Watershed
HOVSGOL NUUR (LAKE). 1645 M ELEVATION, 70% OF MONGOLIAS FRESH WATER
RIVER CROSSING

ERGIIN GOL, EXITS HOVSGOL LAKE.

SELENGE RIVER
LAKE BAIKAL,
- Maximum depth 1637 m
- Average depth of 773 m
- World’s largest volume of fresh water.
- 25 to 30 million years old
- Elevation at 445 m.

Considerable potential exists for contamination of Baikal posed by mercury placer in Mongolia (Tumenbayar, Batbayar & Grayson, 2000).

There is much pollution also entering the Selenge watershed from municipal and industrial wastes generated by developing cities such as Ulan Ude (Russia) and Ulaanbaatar (Mongolia).
TUUL RIVER UPSTREAM FROM ULAANBAATAR

THE TUUL AT ULAANBAATAR WHERE WATER FROM THE OVERTAXED SEWAGE TREATMENT PLANT ENTERS THE RIVER.
OTHER ECOSYSTEM RESOURCES
HOVSGOL NATIONAL PARK.

GREATER THAN 9,000 SQ KM

WILDLIFE RESOURCES; IBEX, ARGALI, ELK, WOLF, WOLVERINE, MUSK DEER, BROWN BEAR, SIBERIAN MOOSE, SABLE.

FISH: EURASIAN PERCH, BURBOT, LENOK, HOVSGOL GRAYLING.
HOVSGOL, SOUTH SHORE.
BLUE CRANES
YAK
GORKHI-TERELJ NATIONAL PARK NEAR ULAANBAATAR.
SAND LANDS ON NORTH EAST BORDER OF GOVI.

PHOTOGRAPH BY ARIUNA JALSRAI.
PRECIPITOUS ZONE IN GOVI.

PHOTOGRAPH BY ARIUNA JALSRAI.
TAKI (PRESWALSKI’S HORSE) IN KHUSTAI NATIONAL PARK
THE RUB

• MONGOLIA HAS A LONG HISTORY OF CONNECTION TO AND DEPENDENCY ON ECOSYSTEM SERVICES.
• HER ECONOMY IS INCREASINGLY DRIVEN, HOWEVER, BY MINING AND EXTRACTION DEVELOPMENT.
• OUTSIDERS DESIRE TO PURCHASE THESE MINED PRODUCTS BUT BAULK AT ENVIRONMENTAL ACCOUNTABILITY.
NON-RENEWABLE NATURAL RESOURCES
GERS AT THE EDGE OF THE ERDENET COPPER MINE IN CENTRAL MONGOLIA.
BAGANUU COAL MINE. THIS MINE PROVIDES MOST OF THE COAL FOR HEATING IN ULAANBAATAR.
NINJA MINERS ON THE TUUL RIVER NEAR ZAAMAR PANNING FOR PLACER GOLD.
MITIGATION OF ECOSYSTEM DISRUPTION ASSOCIATED WITH NATURAL RESOURCE DEVELOPMENT
THE TAVAN TOLGOI AND THE EREEN MINE
THE TAVAN TOLGOI

- IN THE GOVI DESERT
- VERY LOW PRECIPITATION
- HIGHLY ERATIC PRECIPITATION
- PROBLEMATIC SOILS

A. Jalsrai Photograph
TYPICAL DEEP GOVI
SOIL SURFACE: GOVI
## SOME SOIL PROPERTIES AT TAVAN TOLGOI

<table>
<thead>
<tr>
<th>pH 1 to 1</th>
<th>pH 1 to 10</th>
<th>Texture</th>
<th>E. C. dS/m</th>
<th>Coarse Fragments</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.7</td>
<td>9.4</td>
<td>SCL</td>
<td>4 to 8</td>
<td>15%</td>
</tr>
<tr>
<td>9.1</td>
<td>9.9</td>
<td>SC</td>
<td>2 to 4</td>
<td>0</td>
</tr>
<tr>
<td>8.4</td>
<td>9.4</td>
<td>SC</td>
<td>4 to 8</td>
<td>15%</td>
</tr>
<tr>
<td>9</td>
<td>9.4</td>
<td>SC</td>
<td>&lt;2</td>
<td>25%</td>
</tr>
<tr>
<td>8.4</td>
<td>S</td>
<td>&gt;32</td>
<td>&lt;5%</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>SC</td>
<td>&gt;32</td>
<td>5%</td>
<td></td>
</tr>
<tr>
<td>8.8</td>
<td>9.2</td>
<td>CS</td>
<td>&lt;2</td>
<td>&lt;5%</td>
</tr>
<tr>
<td>8.7</td>
<td>9.1</td>
<td>SCL</td>
<td>&lt;2</td>
<td>&lt;5%</td>
</tr>
<tr>
<td>8.4</td>
<td>SiC</td>
<td>&lt;2</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>8.3</td>
<td>C</td>
<td>&lt;2</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>8.4</td>
<td>C</td>
<td>&lt;2</td>
<td>&lt;5%</td>
<td></td>
</tr>
<tr>
<td>8.2</td>
<td>C</td>
<td>8 to 16</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>7.8</td>
<td>SC</td>
<td>8 to 16</td>
<td>30%</td>
<td></td>
</tr>
<tr>
<td>7.8</td>
<td>SC</td>
<td>16 to 32</td>
<td>50%</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>S</td>
<td>4 to 8</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>
KEYSTONE SPECIES IN THE GOVI: SAXUL
(HALOXYLON AMMODOENDRON)
THE TAVAN TOLGOI OFFICIALLY HAS NO ACTIVE MINES
THE EREEN MINE

-BULGAN GRASSLAND

-HIGH PRECIPITATION

-FAVORABLE SOILS
THE EREEN MINE IN 2008 PRIOR TO INITIATION OF RECLAMATION

Photograph Peabody
EREEN MINE SITE NEAR FINAL COMPLETION IN MAY 2010.
SALVAGING AND RESPREADING SUITABLE SOIL
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Average</th>
<th>Standard Deviation</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>7.96</td>
<td>0.65</td>
<td>7</td>
</tr>
<tr>
<td>Carbonate, %</td>
<td>2.24</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>EC, dS/m</td>
<td>0.108</td>
<td>0.029</td>
<td>7</td>
</tr>
<tr>
<td>%N</td>
<td>0.64</td>
<td>0.18</td>
<td>7</td>
</tr>
<tr>
<td>%OC</td>
<td>4.46</td>
<td>1.26</td>
<td>7</td>
</tr>
<tr>
<td>% Humus</td>
<td>7.69</td>
<td>2.17</td>
<td>7</td>
</tr>
<tr>
<td>NO₃, mg/100g</td>
<td>0.419</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>P₂O₅, mg/100g</td>
<td>1.77</td>
<td>0.94</td>
<td>7</td>
</tr>
<tr>
<td>K₂O, mg/100g</td>
<td>19.71</td>
<td>4.89</td>
<td>7</td>
</tr>
<tr>
<td>&lt;2.0, %</td>
<td>15.15</td>
<td>3.49</td>
<td>7</td>
</tr>
<tr>
<td>&lt;0.2, %</td>
<td>53.3</td>
<td>2.24</td>
<td>7</td>
</tr>
<tr>
<td>&lt;0.02, %</td>
<td>24.69</td>
<td>2.17</td>
<td>7</td>
</tr>
<tr>
<td>&lt;0.002, %</td>
<td>6.84</td>
<td>4.2</td>
<td>7</td>
</tr>
</tbody>
</table>
SEEDING USING A JOHN DEERE RANGELAND DRILL.
<table>
<thead>
<tr>
<th>Name of plants</th>
<th>Latin</th>
<th>Mongolia</th>
<th>Seed normative</th>
<th>1000 seed weight, gram</th>
<th>Seed planted in 1m², piece</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medicago varia</td>
<td>Эрлийз царгас</td>
<td>0,6</td>
<td>0.06</td>
<td>2.1</td>
<td>28</td>
</tr>
<tr>
<td>Bromis inermis</td>
<td>Соргуй согоовор</td>
<td>3,4</td>
<td>0.34</td>
<td>3.5</td>
<td>97</td>
</tr>
<tr>
<td>Agropyron cristatum</td>
<td>Саман ерхег</td>
<td>3,7</td>
<td>0.37</td>
<td>3.0</td>
<td>123</td>
</tr>
<tr>
<td>Stipa sibiricis</td>
<td>Сибирь хялганаб</td>
<td>2,3</td>
<td>0.23</td>
<td>3.3</td>
<td>70</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td></td>
<td><strong>10.0</strong></td>
<td><strong>1.0</strong></td>
<td></td>
<td><strong>318</strong></td>
</tr>
</tbody>
</table>
VEGETATIVE CHARACTERISTICS OF THE EREEN MINE SITE IN 2012.

- VEGETATIVE COVER ON RECLAIMED SITE IS VERY HIGH.

- MORE THAN 40 NATIVE SPECIES HAVE BEEN FOUND ON THE RECLAIMED SITE.

- ABOVE GROUND HARVESTABLE PLANT BIOMASS IS ABOUT FOUR TIMES THAT ON NATIVE AREAS.

THE EREEN MINE IS NOW A RESEARCH AND MONITORING SITE USED BY MONGOLIAN UNIVERSITIES AND A LOCATION FOR INSTRUCTION OF STUDENTS AND PROFESSIONALS.
MUCH MONITORING WORK AND EFFORTS TO COMPARE BIOTA ON THE EREEN MINE SITE WITH ADJACENT NATIVE SITES.

SOIL MICROORGANISMS (DILUTION PLATE COUNTS): FUNGI, BACTERIA, ACTINOMYCETES, N-FIXING ORGANISMS.

INSECTS: 42 SPECIES, 32 FAMILIES, 9 ORDERS: SOME DIFFERENCES BETWEEN RECLAIMED AND NATURAL AREAS

BIRDS: 31 SPECIES: RECLAIMED SITE COMPARABLE TO NATURAL AREAS.

MAMMALS: 5 REGISTERED IN THE RECLAIMED AREA. THESE ARE REPRESENTATIVE OF THE NATIVE SITES.
SUMMARY

- MINE LAND RECLAMATION IS POSSIBLE IN MONGOLIA
- SOME OF THE SITES IN MONGOLIA (E.G. TAVAN TOLGOI) WILL BE AMONG THE MOST CHALLENGING ON THE PLANET.
- MONGOLIA HAS A CHANCE TO BE A WORLD LEADER IN BALANCING DEVELOPMENT WITH CONSERVATION.
REFERENCES


Peabody Winsway Resources LLC. 2012. FAUNA MONITORING OF EREEN RECLAIMED SITE. Ch. Uuganbayar Biology Department, Mongolian State University of Agriculture, Mongolian Ornithological Society and others. Report, 59 pps.


