Comparison of Coal Mining Reclamation Issues in the United States/Wyoming vs. Underground Coal Mining in Eastern China

Brenda K. Schladweiler
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Coal Mining in the United States

U.S. Coal Mining Areas

Coal Fired Power Plants Supplied by the Powder River Basin

Source: U.S. Energy Information Administration.
Coal mining is historical in Wyoming
  • Use of coal to fire steam engines on railroads, especially along the Union Pacific line in southern Wyoming

The oil embargo of the early 1970’s and need for low sulfur coal to meet environmental regulations led to a large increase of coal mining in the western U.S.

Coal mining is scattered throughout Wyoming but current mining is concentrated in the southwestern and northeastern corners
  • Much of the post-law coal mining in the south-central part of the state has been closed and reclaimed

Different challenges based on location within the state
  • Example is shrub establishment
Wyoming was ahead of federal regulations

- Open Cut Mining Law of 1969
- Environmental Quality Act of 1973
- Surface Coal Mining and Reclamation Act or SMCRA passed on the federal level in 1977.
  - SMCRA provided the overall framework for coal resource development, as well as environmental protection.
  - Wyoming obtained letter of conditional primacy in November 1980
- Wyoming’s regulations were divided into “coal” and “con-coal”.
- Abandoned Mine Land Program within WDEQ-LQD established in 1983.

SMCRA was 40 years old in 2017
Reclamation
40 Years Ago

- Was considered an “add-on”, not a field
- Much was agricultural based...just had to get something to grow to stabilize a site
  - Desired vegetation types vary based on geographic region
    - West – Rangeland/shrubland
    - Midwest – Prime Farmland
    - East - Forests
Surface Coal Mining in Wyoming...what has changed in 40 years since the passage of SMCRA?
LOTs!!!!

- Seed mixes
- Topography and topsoil replacement
- Shrub establishment
- Weed control
- Seeding equipment
- Wildlife considerations
- Grazing
- Use of GIS
- Reclamation amendments
What haven’t we learned yet under SMCRA?

- Regulations are written with broad brush implications but implemented on a site specific or region basis
  - Western vs. Eastern U.S. differences
  - Need to be flexible
- Wise use of a limited seed resource for shrubs and forbs
  - Strategic placement
- Stability vs. diversity – how can the two be balanced
China Industrial Development
Population Density of China
CHINA HAS WET AND ARID REGIONS

THREE MAIN RIVERS FLOW EAST TO WEST IN EASTERN CHINA
CHINA’S COAL RESOURCES
How has China’s coal consumption distribution changed over time?
Coal production in China

China’s coal production was 3.45 billion tons in 2017, 45.6% of global coal production.

85%-90% comes from underground mining, coal mining induced land subsidence increased 45,000 hectares/Year.

Coal yield and growth rate from 2003 to 2016 in China

W. Xiao, Z. Hu, J. Chen, ASMR 2019
The five eastern provinces are not only important grain bases in China, but also occupy an important role in China's coal mining and utilization.

W. Xiao, Z. Hu, J. Chen, ASMR 2019
General Issues
Multi-coal mining, superimposed settlement, large subsidence area
Ecosystem transition
Soil erosion, deterioration of water quality, surface water system disorder
Prominent conflict between man and land

W. Xiao, Z. Hu, J. Chen, ASMR 2019
The mining areas in the five eastern provinces of China (Henan, Hebei, Shandong, Anhui, Jiangsu) are mostly high ground-water level mining areas. Due to the high ground-water level, the damage of cultivated land caused by coal mining subsidence is particularly serious.
1. Ecological environment monitoring
2. Identify the extent of damage to cultivated land
Subsidence Occurs Relatively Rapidly

- 80-90% in the first 3 to 6 months after mining
- Remaining 10-20% over the next two years
According to China National Energy Administration's data on China's coal mine production capacity, by the end of December 2018, the state's new coal mine capacity was mainly concentrated in Shanxi, with an accumulated total of 180.02 million tons/year, of which opencast coal mine production is an important part.

Shu-fei Wang, Y. Cao, Z. Bai, ASMR 2019
Antaibao Opencast Coal Mine in Pingshuo, Shanxi Province, is the largest open-pit coal mine in China, which was constructed in 1984 by the cooperation between China and America. It is deeply imprinted with China's reform and opening, and is a milestone in the development history of China's coal industry.

Currently, Pingshuo coal mining area is the largest one that combined opencast mines with underground mines in China. The land and environment damage present the trend of point-line-area-net from 1984 to 2016.
New Era, New Requirements

In the new era, opencast coal mining has many new features, such as intelligent, large-scale, and rapid, so the intensity of mining continue to increase, bringing convenience and benefits, but also bringing a series of severe environmental issue. With the concept of “lucid waters and lush mountains are invaluable assets” and “Green Mine” put forward, more emphasis is placed on land reclamation and ecological reconstruction in the opencast coal mining area, and soil reconstruction is the core of land reclamation.

Shu-fei Wang, Y. Cao, Z. Bai, ASMR 2019
Impacts of coal mining on eco-environment vary in different part of China

**Northwest 西北地区：**
Mining subsidence induced cracks and fissures; 开采沉陷引发的地表裂缝和裂纹;
Soil erosion; 水土流失;
Acid coal waste dumps spontaneous combustion; 酸性煤矸石山的自燃
Land occupation by surface mining露天开采的土地压占

**Southern 南部地区：**
mining subsidence induced landslide and mudslides; 开采沉陷引发的滑坡和泥石流
groundwater loses; 地下水流失

**Eastern 东部地区：**
Mining subsidence induced ponds area, 下沉积水
farmland lose, 耕地减少
Village movements 村庄搬迁
Potential future production
Potential Infrastructure Needs

Infrastructure Build Out Connects Xinjiang to Eastern Population Centers

- Capacity expected to increase from 20 MTPY in 2011 to ~200 MTPY in 2020
- Eight railway projects listed in Five-Year Plan to Eastern Generation & Transmission
  - Major transmission build to support "coal by wire" and nationwide power supply
    - 30+ GW of transmission planned by 2015 and 2020
  - Aggressive coal-fueled generation build out supports economic growth
  - Local Xinjiang coal demand expected to increase 90+ mmt by 2015

Plan in About 2020

Source: INRRC, Ministry of Railways, State Grid, Xinjiang local government, Fidelity Global Analysis.
Increased coal fired power plants to fuel industrial development and residential needs.
High Rise “mushrooms” on the landscape
Chinese transportation needs
New Cities and Universities, e.g., Anhui University of Science and Technology
China’s efforts to provide sustainable development given environmental impacts
Underground Coal Regions in China – Tour October 2017

Xi’an, Shaanxi
Xuzhou, Jiangsu
Huainan, Anhui
Jinan, Shandong
Yangquan, Shanxi
Beijing
Overview of October 2017 Activities

- Reclamation conference in Xi’an, Shaanxi Province
- Xi’an Canba National Wetland Park
- Xi’an to Xuzhou, Jiangsu Province, Pan’an Lake National Wetland Park
- Xuzhou to Huainan, Anhui Province
  - New university
  - Laolongyan reservoir – subsidence
  - Dongchen ecological park - subsidence/topsoil salvage ahead of subsidence
- Huainan to Jinan, Shandong Province
  - Yellow River sediment backfilling reclamation
- Jinan to Yangquan, Shanxi Province
  - Coal waste pile restoration
- Beijing, China University of Mining and Technology
Pan’an Lake Wetland Park
Mine Subsidence Areas
TOPSOIL SALVAGE STUDY AHEAD OF PLANNED SUBSIDENCE
Xi’an Chanba National Wetland Park
Yellow River Sediment Reclamation
Spoil Pile Restoration in Yangquan
Erosion Control in Building Boom
Other Cases: Tangshan South Lake Park 其他案例：唐山南湖公园
Other Cases: Huaibei National Mining Park

其他案例：淮北国家矿山公园
Jining City locates in Shandong province, close to Yellow river. 济宁位于山东省，黄河沿岸。

It is the one of biggest coal-bases in China, Yanzhou coal company is in this city. 中国最大的产煤基地之一，兖矿集团所在地。

Subsided land: 沉陷地面积 24575.79 hm² (2009)  
Predict: 预测塌陷面积  
2015: 47199.34 hm²  
2020: 68100.53 hm²
Comparison

China
- High population centers in the eastern 1/3 of the nation
- Underground mines primarily in the eastern 1/3
- High historical use of the land over 5000 years
- No overriding reclamation law
- Focus of reclamation is safety and productive food sources
- University systems are separated by discipline

United States
- High population centers in the eastern 1/3 of the nation
- Underground mines primarily in the eastern 1/3
- Higher use in the eastern half of the nation; less public land
- SMCRA is the overriding reclamation law
- Focus of reclamation is safety and reestablished land uses such as forestry, cropping, grazing and wildlife habitat
- University systems are inclusive
Recent Chinese Regulation Review

- 2018 trip to China to discuss U.S. federal and state mining regulations with Chinese government officials.
- Newly established Ministry of Natural Resources of the People’s Republic of China has combined various government agencies under the direction of the current Chinese President Xi Jinping.
- Sweeping changes to government structure announced in March 2018.
- Responsibilities of the new ministry include, in part, those previously divided amongst a host of other agencies.
- As best as can be described in agency terms found in the United States, this ministry would be a cross between the Department of Interior and the Department of Agriculture.
Random Take-away Thoughts from China

- Overriding mining rules and regulations limited
- Early stages of knowledge
- Working hand in hand with mining engineers is not as common
- University system limits collaborative
- Catch up vs. planning
- Drier parts of China tour to come
Questions

bschladweiler@bksenvironmental.com