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Region 9

ECOSYSTEM SERVICES PRIMER AND PILOT STUDY: IRON MOUNTAIN MINE, CA

Green Remediation

The practice of considering all environmental effects of remedy implementation and incorporating options to minimize the environmental footprints of cleanup actions

Iron Mountain Mine

Iron Mountain

Shasta Lake

Sacramento River

Spring Creek Reservoir
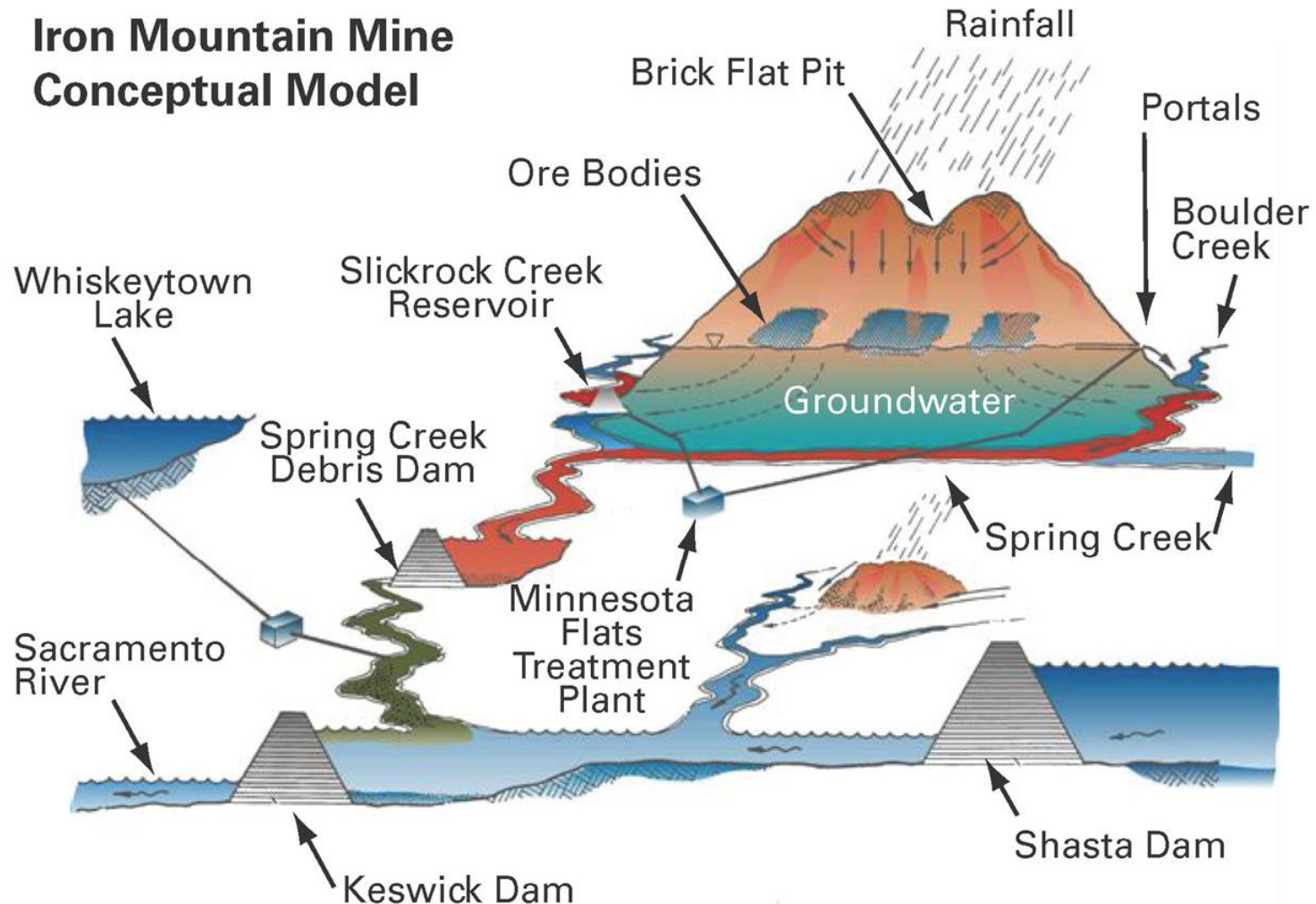
IMM Surface Water Drainage and Storage

- **Three main creeks and tributaries impacted by AMD**

- **All three creeks discharge to Sacramento River**

- **River is most critical spawning habitat for salmon in CA**

- **River critical to the state's water supply**

- **Major source of hydroelectric power**
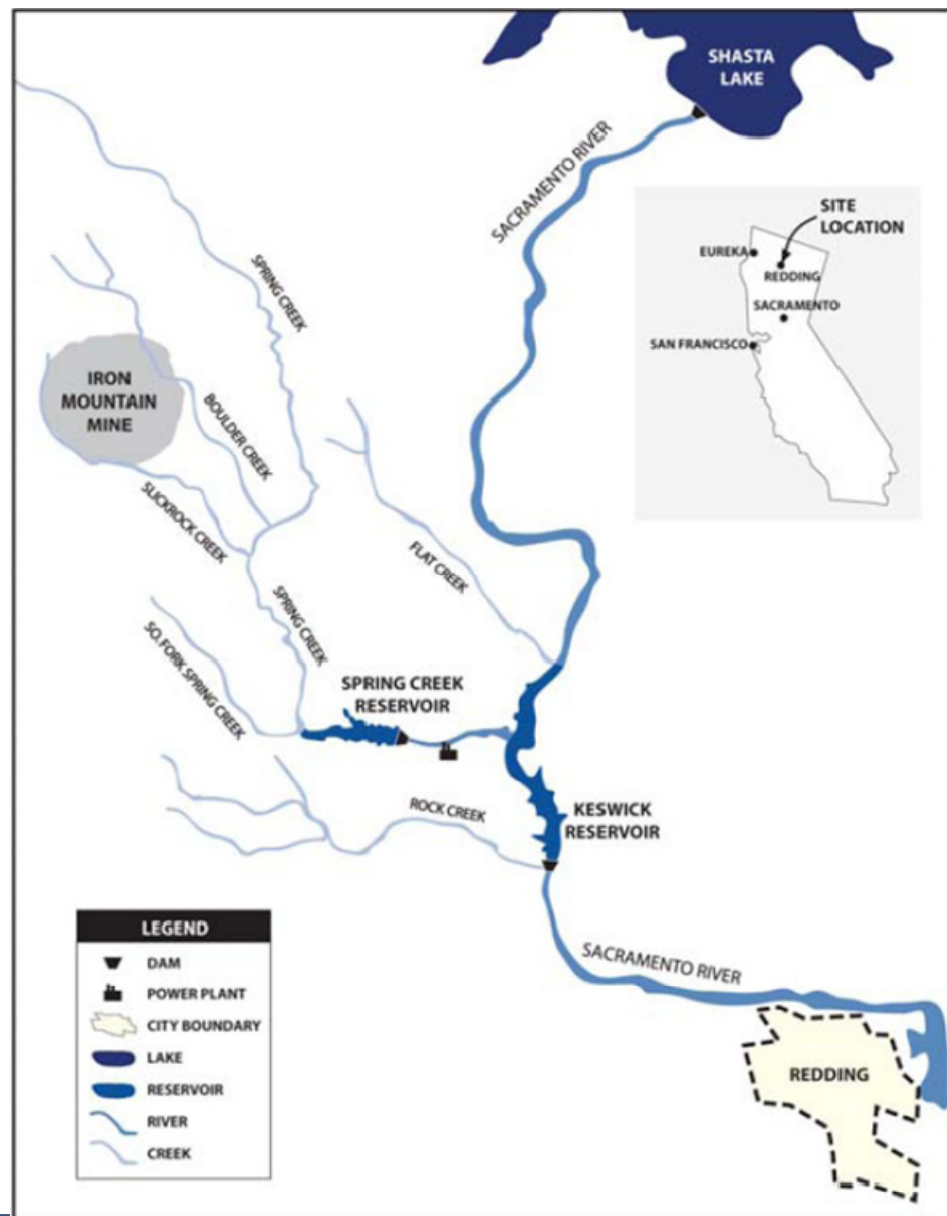
IMM Conceptual Site Model

Iron Mountain Mine Conceptual Model

Acid Mine Drainage (AMD)

Richmond Ore Body

**Impacts to Spring Creek
(pH = 3)**

Partial Remedial Action Status

◆ 5 RODs Signed

◆ Final RI/FS in progress

◆ Remedial actions performed to date:

- Clean water diversions
  - Slickrock Creek Retention Reservoir
- Lime neutralization treatment plant for AMD
  - Minnesota Flats Treatment Plant
- Waste pile and tailings consolidation, capping, and removals
- Spring Creek Arm of Keswick Reservoir
  - Contaminated sediment dredging and storage

Clean Water Diversion
Slickrock Creek Retention Reservoir

Lime Neutralization
Minnesota Flats Treatment Plant

Sediments Removal Project
Spring Creek Arm of Keswick

Understanding Ecosystem Services at Iron Mountain Mine

◆ Overall goals

   ▪ Incorporate consideration of ecosystem services during remedy selection

   ▪ Reduce impacts on ES or improve ES during remedial implementation

◆ Ecosystems Services Modeling Pilot Study

   ▪ IMM selected as basis for study

   ▪ InVEST modeling tool selected

InVEST Tools

Integrated **V**aluation of **E**cosystem **S**ervices and **T**radeoffs

Stakeholder Engagement

Scenarios

Biophysical Models → Maps / Tradeoff curves / Balance sheets

Economic Models → Dollar values / Maps / Tradeoff curves / Balance sheets

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InVEST Analysis: Models

◆ **Key Considerations**

- Results of models heavily dependent on accuracy of land use / land cover map input

- Can evaluate "future scenarios" of differing land use changes (i.e. remediation strategies) by altering the land use / land cover map and re-running the models

◆ **Assessment of Four Tools**

- Biodiversity: Habitat Quality and Rarity

- Carbon Storage and Sequestration

- Water Purification: Nutrient Retention

- Avoided Reservoir Sedimentation

LEGEND

Spring Creek Watershed		Deciduous Forest	
Open Water		Evergreen Forest	
Developed, Open Space		Mixed Forest	
Developed, Low Intensity		Shrub/Scrub	
Developed, Medium Intensity		Grassland/Herbaceous	
Developed, High Intensity		Woody Wetlands	
Barren Land (Rock/Sand/Clay)		Emergent Herbaceous Wetlands	

0   2,500   5,000
Feet

SOURCE: NATIONAL LAND COVER DATASET, 2001.

National Land Cover Dataset, 2001

InVEST Analysis: Study Area Selection

- ◆ Considered using one or more OUs for study area

- ◆ Used Spring Creek Watershed boundary
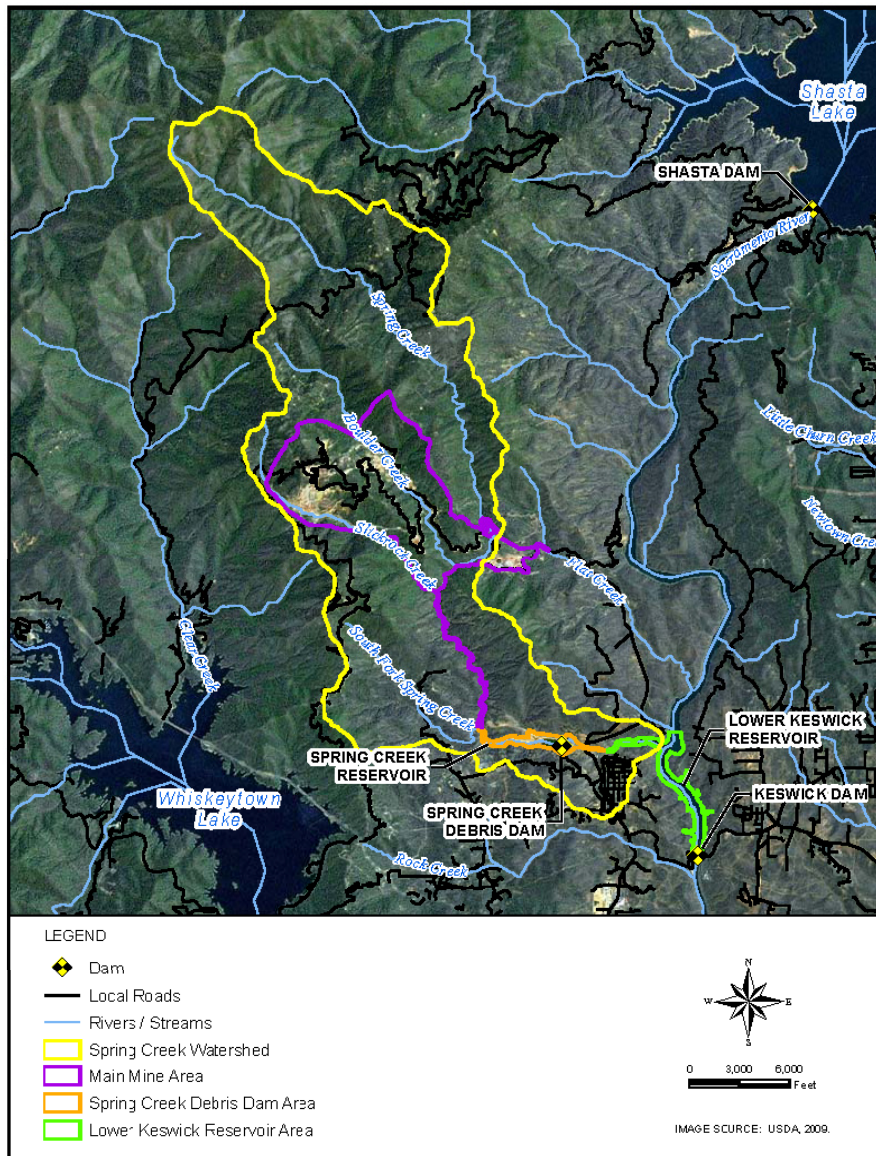
Data Requirements and Sources

Required Input	Source	BD	C	WP	S
Land Use / Land Cover Map	National Land Cover Dataset – 2001 www.mrlc.gov	√	√	√	√
Threat Data (i.e. Urban or Roads)	California Spatial Information Library http://atlas.ca.gov	√			
Carbon Pool Estimates	Field studies or general published tables		√		
Digital Elevation Model	National Elevation Dataset http://ned.usgs.gov			√	√
Watersheds & Sub-watersheds	Watershed Boundary Dataset OR Generate with ArcMap www.ncgc.nrcs.usda.gov/products/datasets/watershed			√	√
Precipitation	PRISM Climate Group www.prism.oregonstate.edu			√	

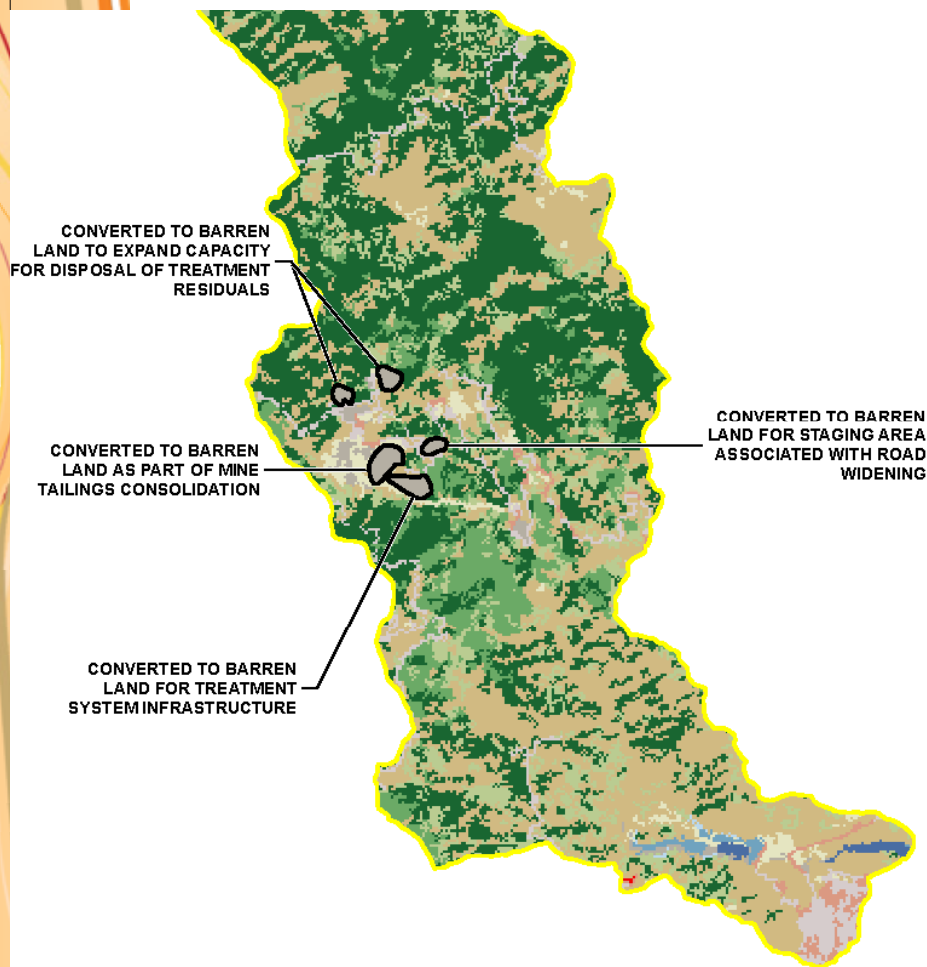Model Types: BD = Biodiversity / C = Carbon / WP = Water Purification / S = Avoided Sedimentation   (continued)

Data Requirements and Sources

Required Input	Source	BD	C	WP	S
Soil Depth	SSURGO Soil Data Viewer http://soils.usda.gov/survey/geography/ssurgo/			√	
Plant Available Water Content	SSURGO Soil Data Viewer http://soils.usda.gov/survey/geography/ssurgo/			√	
Potential Evapotranspiration	Food and Agriculture Organization of the U.N. www.fao.org/geonetwork/srv/en/metadata.show?id=7416&currTab=simple			√	
Rainfall Erosivity	InVEST Forum http://invest.ecoinformatics.org/shared/Erosivity-US.zip				√
Soil Erodibility	SSURGO Soil Data Viewer http://soils.usda.gov/survey/geography/ssurgo/				√
Model Coefficients Tables	User generated from peer-reviewed literature or general published tables			√	√

Model Types: BD = Biodiversity / C = Carbon / WP = Water Purification / S = Avoided Sedimentation

InVEST Analysis: Scenarios

CONVERTED TO BARREN LAND TO EXPAND CAPACITY FOR DISPOSAL OF TREATMENT RESIDUALS

CONVERTED TO BARREN LAND AS PART OF MINE TAILINGS CONSOLIDATION

CONVERTED TO BARREN LAND FOR STAGING AREA ASSOCIATED WITH ROAD WIDENING

CONVERTED TO BARREN LAND FOR TREATMENT SYSTEM INFRASTRUCTURE

'During Remediation' Scenario

◆ All models run for the 'Current' scenario

◆ All models run for the 'During Remediation' scenario

InVEST Analysis: Scenarios

CONVERTED TO GRASSLAND/ HERBACEOUS LAND AFTER RECLAMATION

CONVERTED TO EVERGREEN FOREST AFTER RECLAMATION

'After Remediation' Scenario

◆ Only Carbon Model run for the 'After Remediation' scenario

- Conversion of several areas from existing land use to either grassland or evergreen forest

- Represents landscape years after remedy implementation

Biodiversity Model: Habitat Quality & Degradation

Habitat Degradation
High : 111.937
Low : 0

Habitat Quality
High : 1
Low : 0

'Current' Scenario

Habitat Degradation
High : 111.937
Low : 0

Habitat Quality
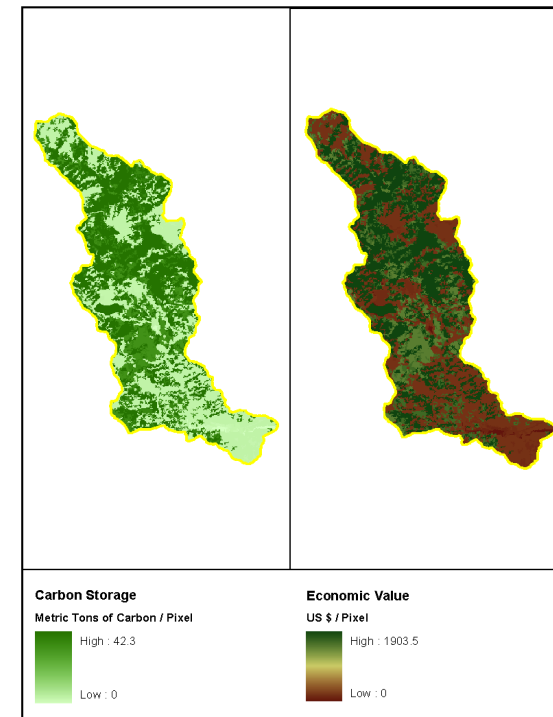High : 1
Low : 0
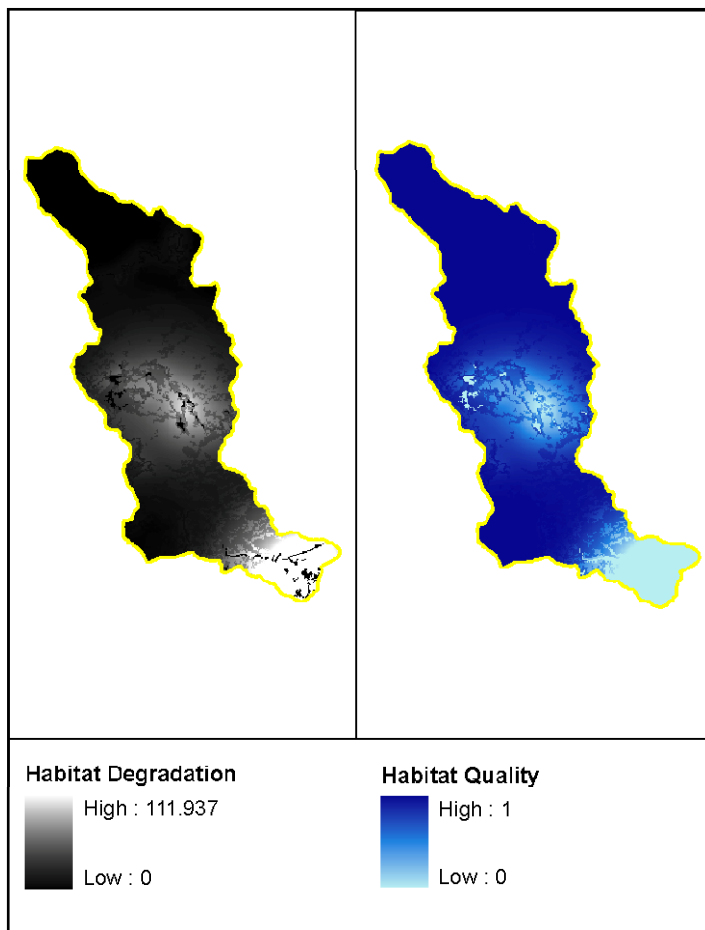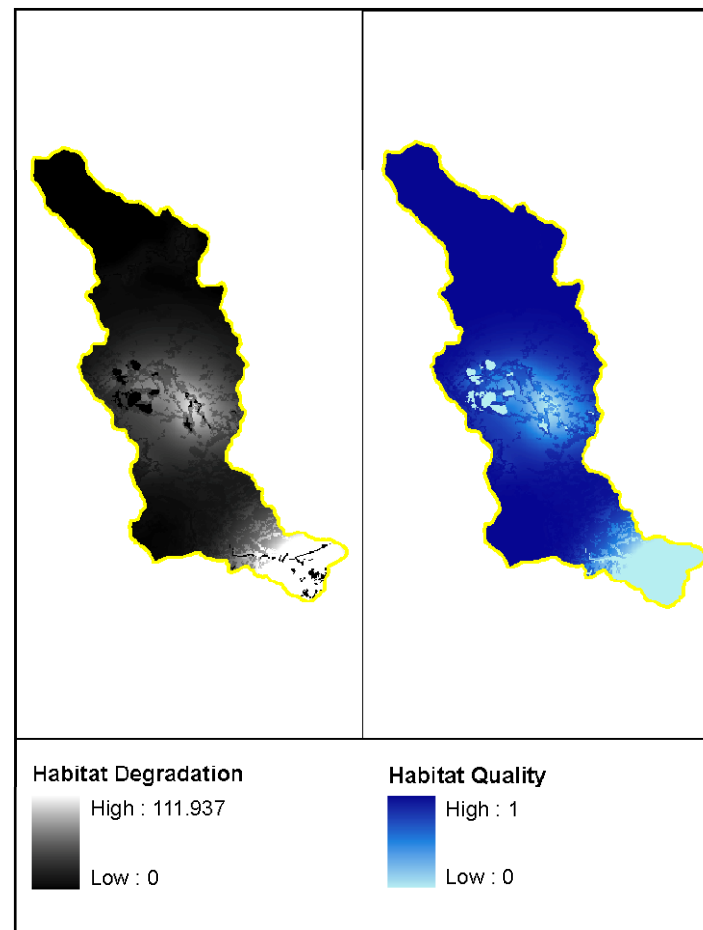
'During Remediation' Scenario

Carbon Model: Carbon Storage & Economic Value
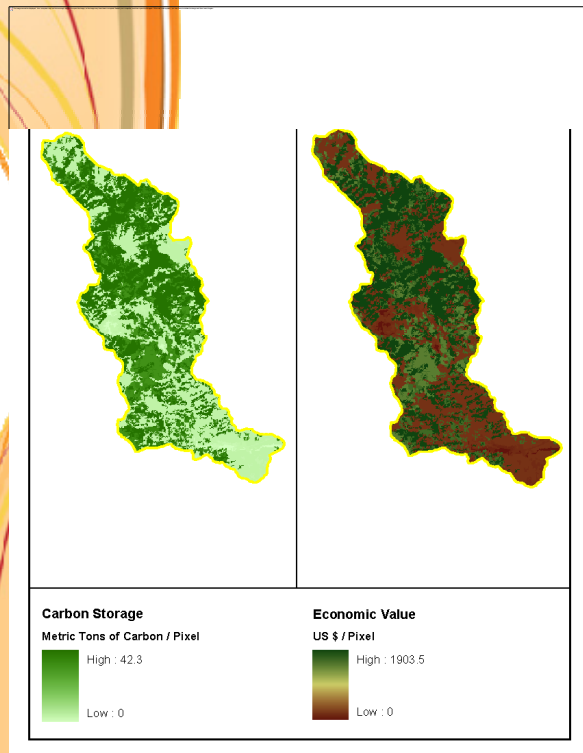
'Current' Scenario
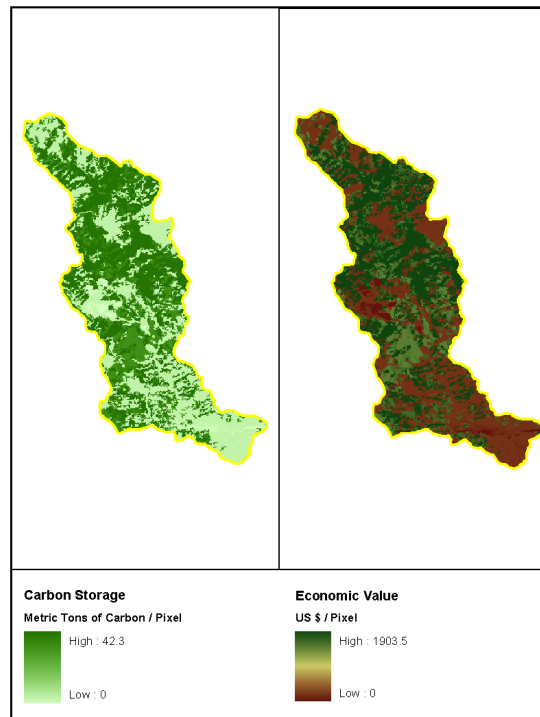
'During Remediation' Scenario

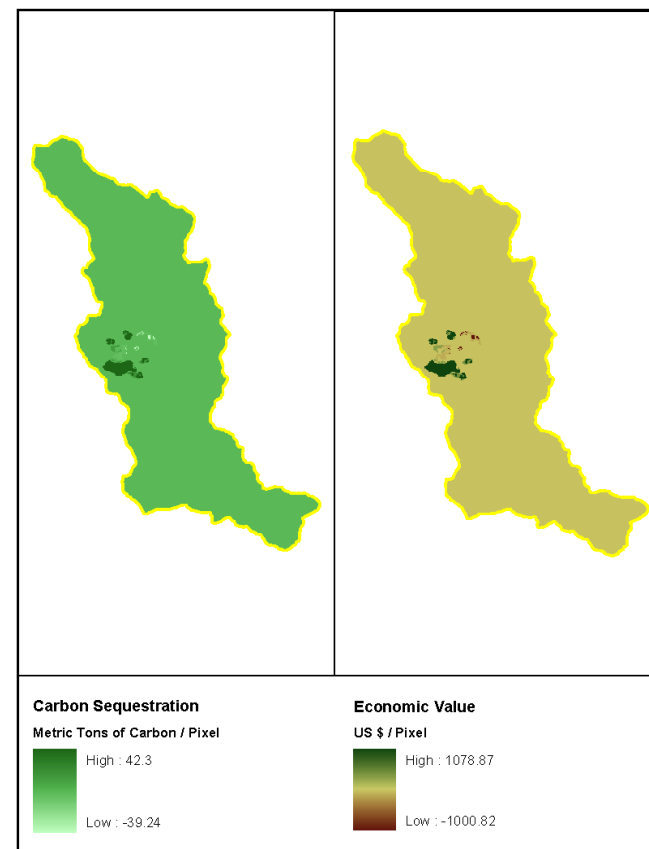**'After Remediation' Scenario**

Carbon Model: Carbon Sequestration & Economic Value

Carbon Sequestration
Metric Tons of Carbon / Pixel

High : 0

Low : -42.3

Economic Value
US $ / Pixel

High : 0

Low : -1272.31

Carbon Sequestration
Metric Tons of Carbon / Pixel

High : 42.3

Low : -39.24

Economic Value
US $ / Pixel

High : 1078.87

Low : -1000.82
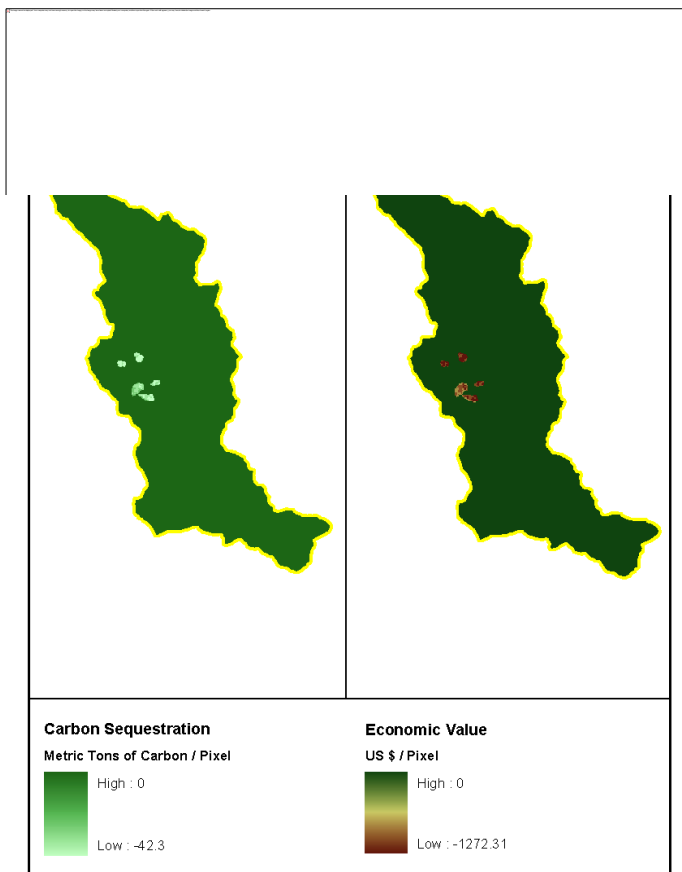
Between 'Current' and During Remediation' Scenario

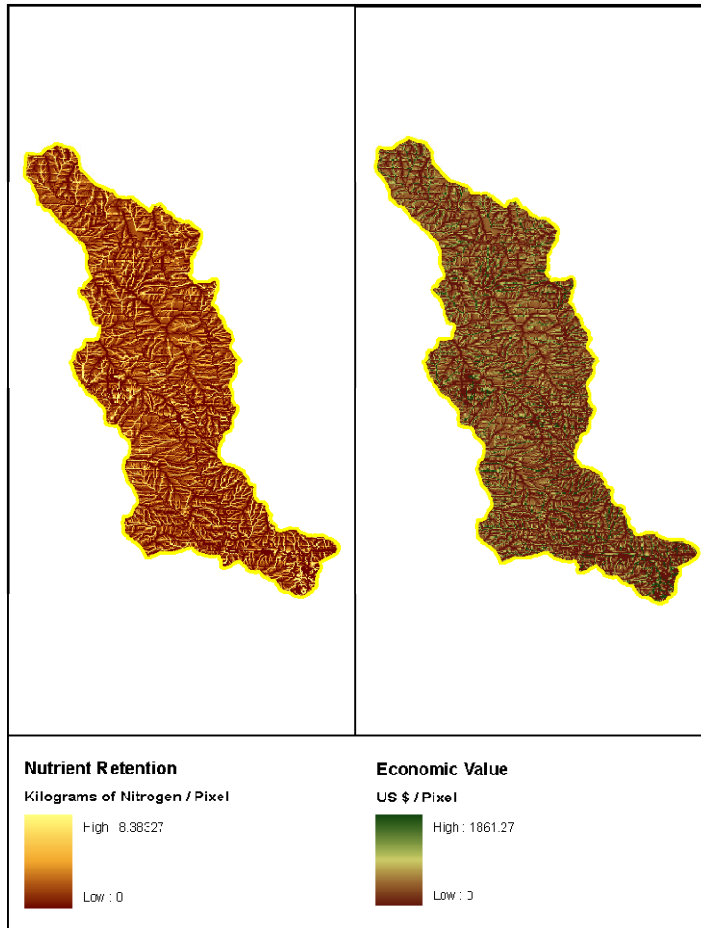**Between 'During Remediation' and 'After Remediation' Scenario**
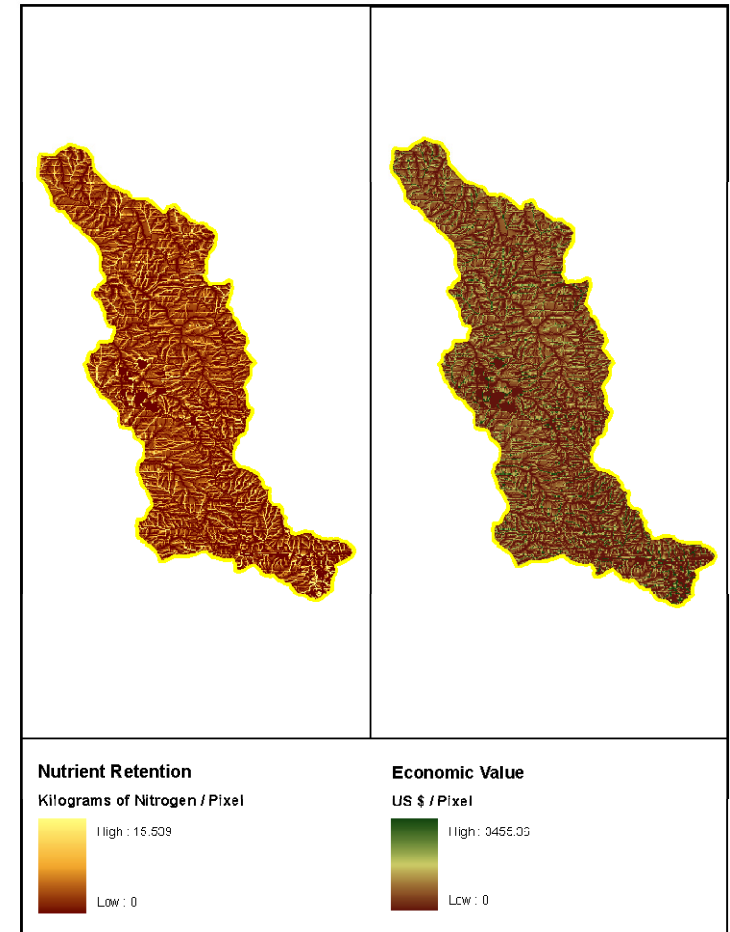
Water Purification Model: Nutrient Retention & Economic Value
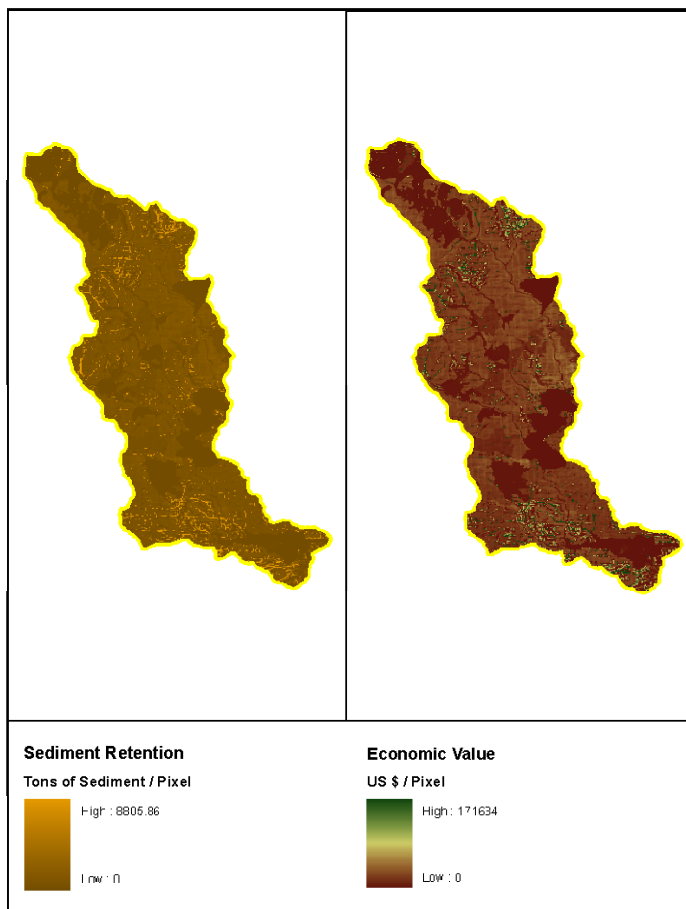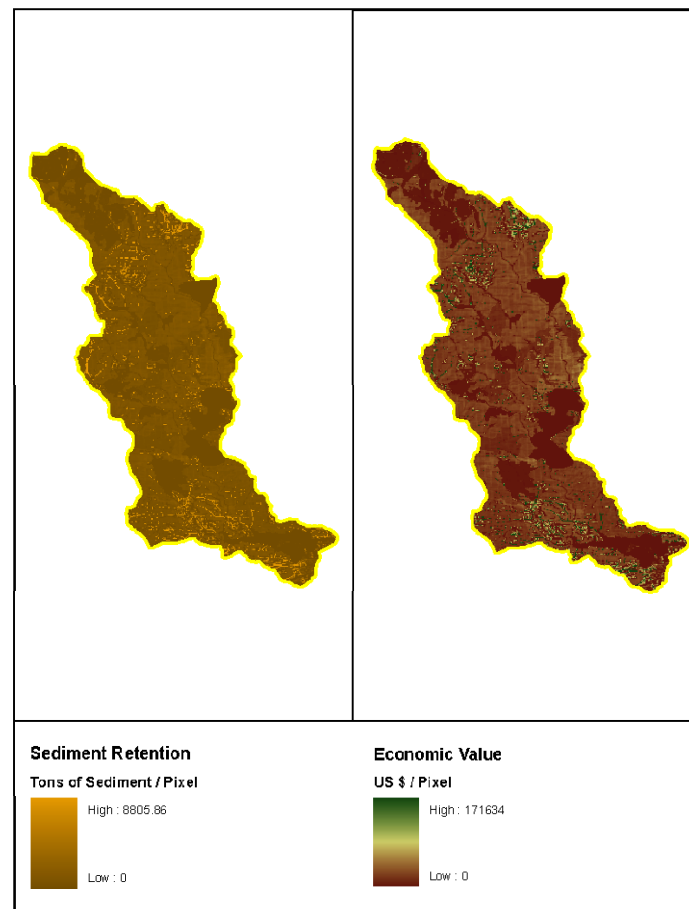

'Current' Scenario

'During Remediation' Scenario

Avoided Sedimentation Model: Sediment Retention & Economic Value

'Current' Scenario

'During Remediation' Scenario

Application

◆ Significant acreage in unproductive land currently present on Superfund sites

◆ Leads to types of reuse that will improve water and/or air quality

◆ USDA has an office to develop ecosystems markets

◆ EPA developing technical methods

Contact Information

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