WISDOM: A Biophysical & Economic Systems Model for Short Rotation Coppice (SRC) Agroforestry Management

1. SHORT ROTATION COPPICE + WWP SYSTEMS ARE

Tools For Converting Wastes to Resources
- Manage treated domestic wastewater products (WWP) with short rotation coppice (SRC) agroforestry plantations
- Restore marginal agricultural land, and
- Produce sustainable wood fibre

Part of Complex Socio-Ecological Systems

2. “WISDOM” THE WILLOW SYSTEM DYNAMICS MODEL

Comprehensive Decision-Support Model for SRC Systems
- Uses system dynamics modelling approach to simulate inputs and crop growth
- Provides a method to identify and understand interactions and feedbacks between various system components including:
  - System Inputs: SRC cultivar, WWP characteristics & application rates, irrigation rates
  - Environmental Factors: Climate, soil characteristics (physical & chemical), SRC establishment and growth rates
  - Social Factors: Regulations, policies, economic scenarios, and carbon offset revenue opportunities
- Aids stakeholders and decision-makers in long-term planning for environmentally- and economically-sustainable SRC+WWP plantations

WISDOM Framework

- Model Inputs
  - Climate
  - Soil properties
  - Solute transport (optional)
  - Irrigation (optional)
  - Harvest & transportation
  - Economic input
  - Energy & Carbon mitigation input

- Model Parameters
  - Bio-chemo-physical components
    - Plant growth & yield
    - Soil water, solute transport
  - Managed/Economic Components
    - Harvest & transportation energy content, carbon mitigation, economics

- Model Outputs
  - Simulate biomass growth (oven dry tonnes/hectare (ODT/ha))
  - Monthly shoots, leaves, and root biomass
  - Mass of woodchips (ODT) produced
  - Simulate soil water balance
  - Calculate irrigation required (mm/month)
  - Simulate solute transport (1-D vertical)
  - Soil Electrical Conductivity/total dissolved solids (Cl)
  - Soil NO3-N/P/O3-1/Available Phosphorus
  - Support harvesting and transporting processes: economics
  - Estimate energy content and carbon mitigation: biofuels
  - Analyze SRC project economy: yearly cash flow, Internal Rate of Return, Net Present Value

3. WISDOM PERFORMANCE

WISDOM SRC System Parameters & Performance
- SRC + WWP plantation established in Alberta in 2006
- Two 3-year-rotation biomass harvest events (2008 and 2011)
- Eight years of data collection (2006-2013)
- Based on the Nash-Sutcliffe efficiency statistical test - close matches were observed between simulated and observed values for biomass production ($R^2 = 0.98$), tree height ($R^2 = 0.92$), and soil electrical conductivity ($R^2 = 0.90$)

Biomass Production Projections

Prediction of the overall project economy under the case of average yield using different:
- Harvesters: JF = JF-192, HS = Class HS-2, and BB = Bio-baler
- Operating speeds: Max = maximum, Avg = average, and Min = minimum

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