

IMWEBs Model and Ecosystem Services Market

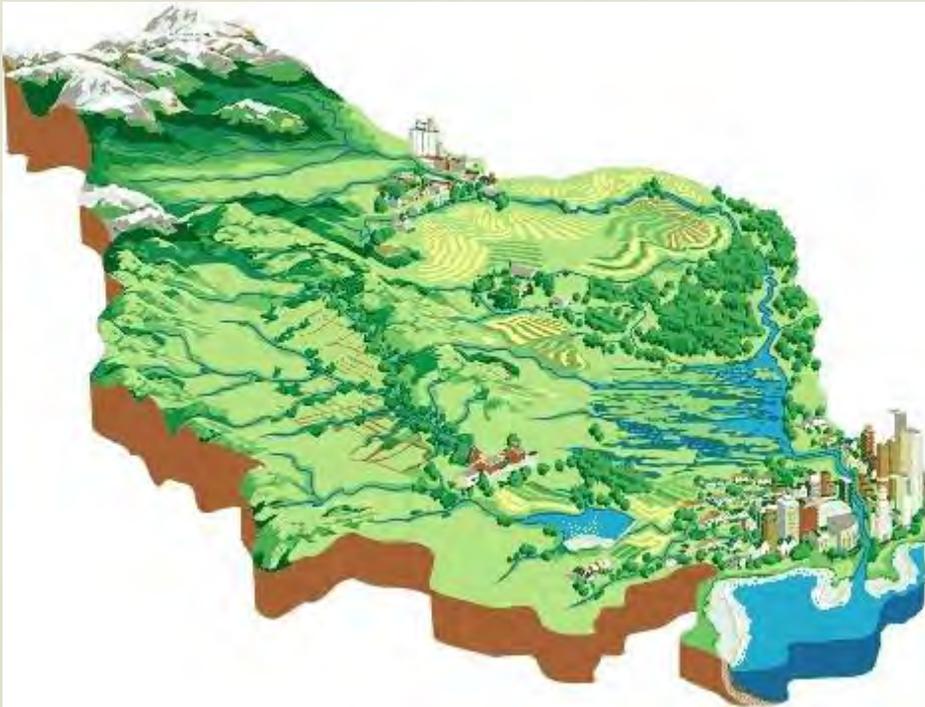
**Shawn Shao, Wanhong Yang, Yongbo Liu, and John Lindsay
Department of Geography**



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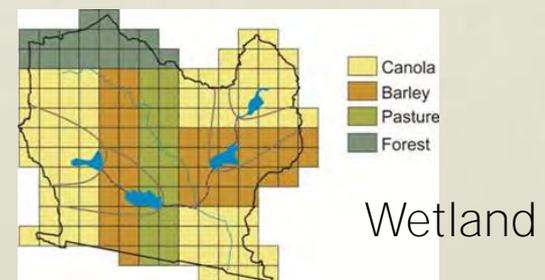
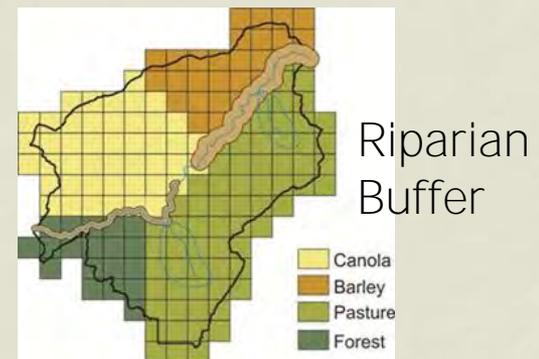
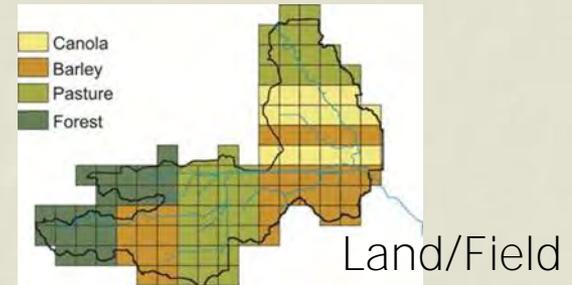
Agricultural Landscape

- Agricultural beneficial management practices (BMPs)
- Water quantity and quality, carbon sequestration, and biodiversity benefits



Integrated Modelling for Watershed Evaluation of BMPs (**IMWEBs**)

- IMWEBs is a cell-based watershed hydrologic model
- IMWEBs is **the only model in Canada** that is designed for quantifying water quantity (drought and flooding) and quality (sediment and nutrients) of BMPs at **site, field, farm, watershed, and river basins scales.**
- IMWEBs is able to integrate economic costs, carbon sequestration and biodiversity benefits of BMPs



IMWEBs Supported BMP List

General BMPs

- Crop management
 - Tillage management
 - Fertilizer management
 - Grazing management
 - Irrigation management
 - Reservoir
-

Wetland restore BMPs

- Isolated wetland restoration
-

Livestock BMPs

Manure and nutrient management

- Manure incorporation
- Manure setback
- No application on snow
- Fall application
- Apply base on soil N level
- Apply base on soil P level
- Feedlot management
- Manure storage design
- Catch basin management
- Dugout

IMWEBs Supported BMP List

Livestock BMPs

Riparian and surface water management

- Riparian access management including fencing
- Vegetated filter strip
- Riparian buffer strip
- Grassed waterway

Wintering site management

- Changing location and area of wintering site
- Alternating wintering site annually
- Vegetation adjacent to wintering site

Pasture management

- Rotational grazing
- Timing and density of stocking
- Plant species in tame pasture
- Conservation and sustainable use of natural areas

Marginal crop land management

- Conservation to tame perennials
- Conservation to native perennials

IMWEBs Inputs and Outputs

- **IMWEBs inputs**

Climate (precipitation, temperature), topography, soil, landcover/landuse, land management practices (planting, harvesting, tillage, fertilizer and manure application), **BMPs** (manure management, riparian access management, rotational grazing, etc.)

- **IMWEBs outputs**

Time series (hourly, **daily**, monthly, and yearly) and spatial distribution of variables (water quantity and quality, sediment, nitrogen, and phosphorus) at site, field, farm, watershed, and river basin scales

567,111.3 m

593,427.7 m

5,483,447 m

5,483,447 m

IMWEBs Simulation Results (2007-2010) - Surface Runoff



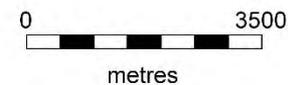
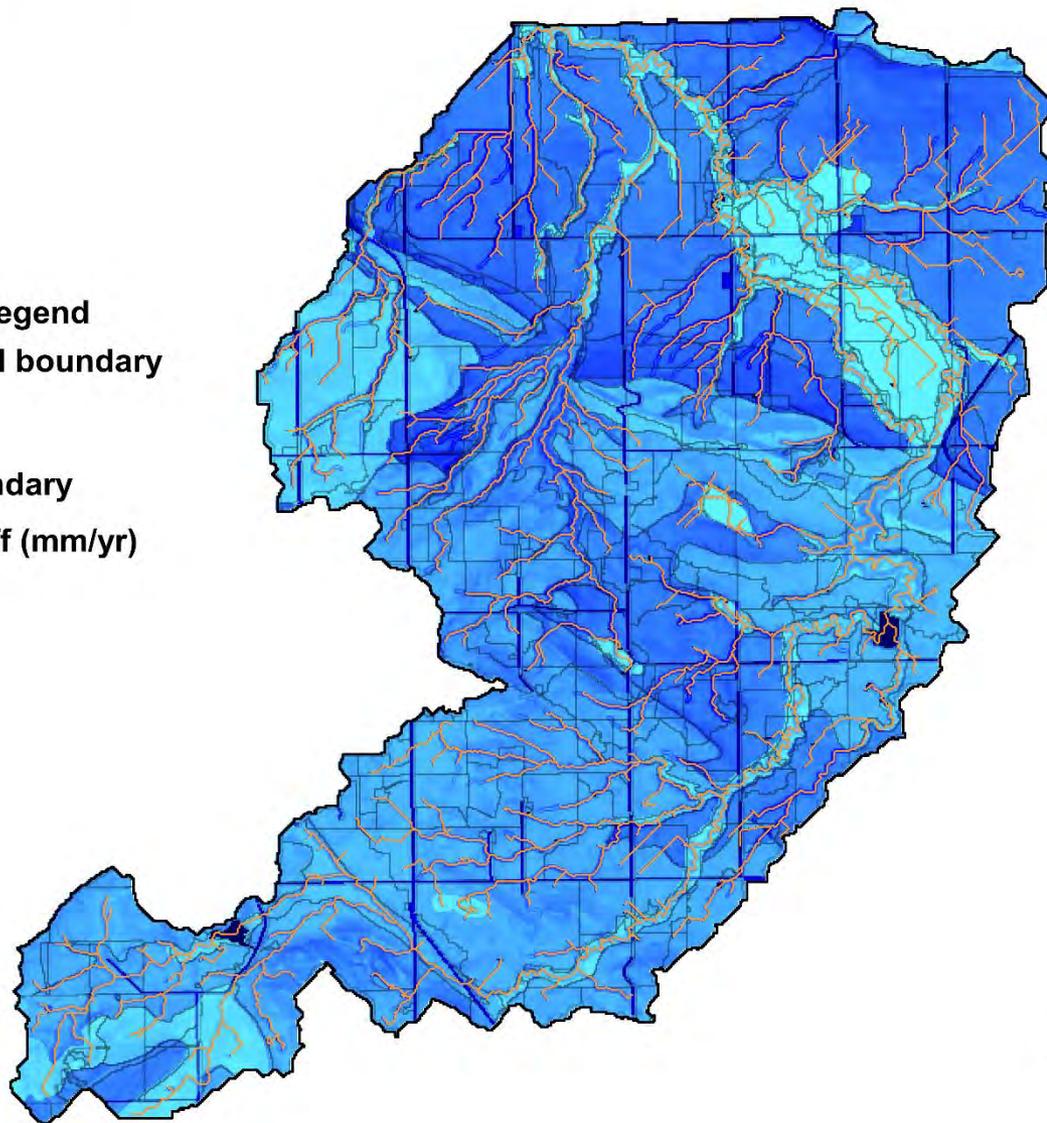
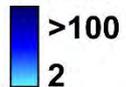
Legend

 Watershed boundary

 Stream

 Field boundary

Surface runoff (mm/yr)



5,463,347 m

5,463,347 m

567,111.3 m

593,427.7 m

**Practices affect multiple
ES / Issues around
baselines and stacking**

BMP Scenarios

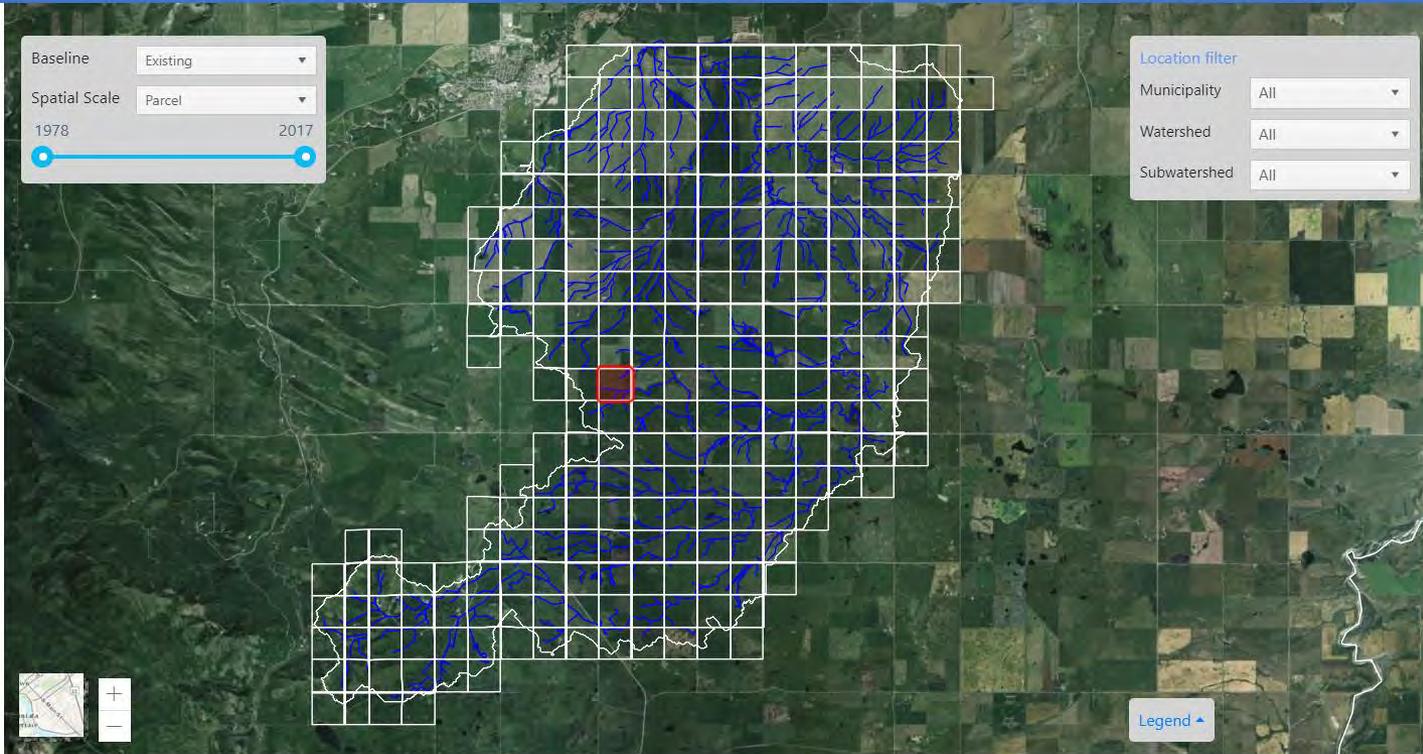
- **Conventional scenario** with no BMPs (Baseline 1)
Existing scenario with BMPs (Baseline 2)
Future/Additional BMP scenario
- Future/Additional BMP scenario – Existing scenario with BMPs (Baseline 2): **Benefits of additional BMPs**
- Existing scenario with BMPs (Baseline 2) – Conventional scenario with no BMPs (Baseline 1): **Benefits of existing BMPs**
- Future/Additional BMP scenario – Conventional scenario (Baseline 1): Additional BMP benefits with reference to historical baseline

Stacking

- One BMP vs. multiple BMPs at one location (interactions)
- One BMP vs. multiple BMPs at multiple locations (interactions)
- One benefit vs. multiple BMPs (water quantity and quality, carbon sequestration, and biodiversity benefits) at one or multiple locations
- On-site vs. off-site benefits
- Trade-offs among multiple benefits

Watershed Overview

- Overview
- Projects
 - AIIBMPs[LSD_Conv_1978_2017_WM
 - AIIBMPs[ESMode_TPOff02P]Parcel_Existing_1978_2017_WM
 - AIIBMPs[ESMode_TPOff05P][LSD_Existing_1978_2017_WM
 - AIIBMPs[ESMode_TPOff20P][LSD_Conv_1978_2017_WM
 - AIIBMPs[ESMode_TPOff20P][LSD_Conv_2001_2010_WM
 - AIIBMPs[ESMode_TPOff20P]Parcel_Conv_1978_2017_WM
 - Existing parcel 2008-2017 ES mode
 - Baseline information
 - BMP scope & intelligent recommendation
 - BMP selection & overview

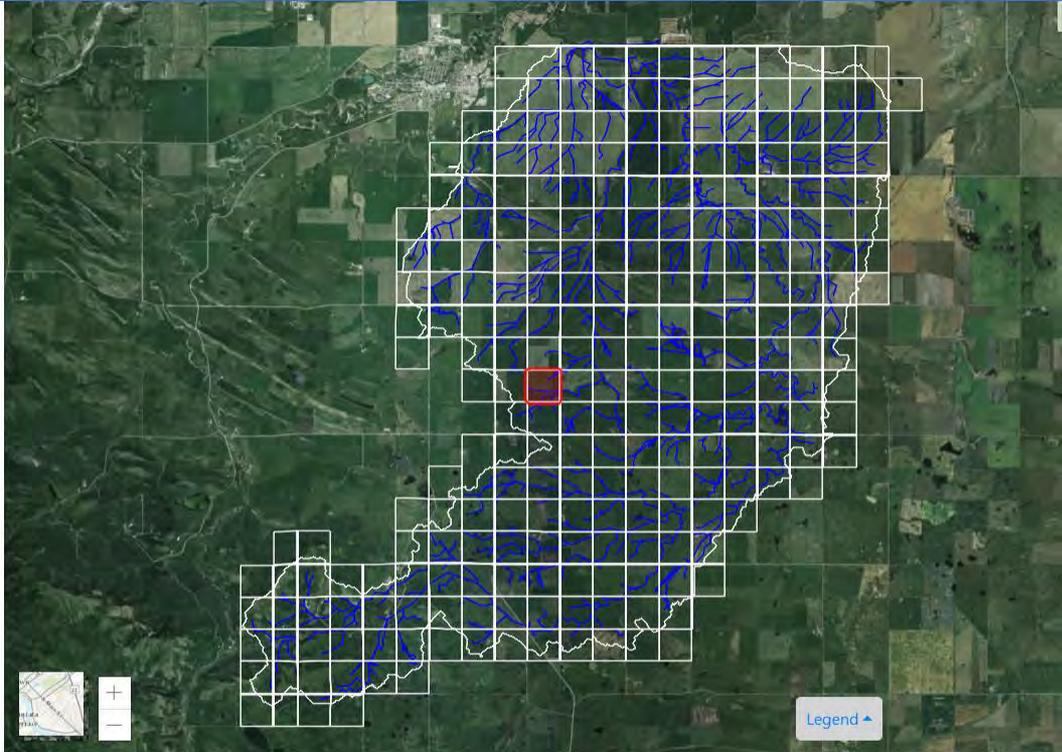


AB County, DigitalGlobe, GeoEye, Earthstar Geographics Powered by Earthstar

Parcel	Area (ha)	Elevation (m)	Slope (%)	Dominant Landuse	Dominant Soil Texture	Precipitation (mm)	Precipitation STD (mm)	Temperature (°C)	Temperature STD (°C)	Soil moisture (mm)	Soil moisture STD (mm)	ET (mm)	ET STD (mm)	Groundwater recharge (mm)	Groundw recharge (mm)
6	4.0204	1154	1.14	8	4	608.219	151.995	6.215	0.977	296.559	47.904	482.478	77.154	57.130	53.720
7	1.0745	1384	5.79	5	5	626.399	156.538	1.907	0.977	239.519	44.614	420.586	65.837	81.619	76.859
8	31.1333	1535	21.64	2	12	638.374	159.531	-0.879	0.977	238.870	38.539	349.044	44.666	71.960	68.812
9	64.6364	1285	4.63	8	5	619.022	154.695	3.643	0.977	238.411	41.427	446.777	66.567	77.872	72.852

Baseline Information

- Overview
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 - AIIBMPs[LSD_Conv_1978_2017_WM]
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 - BMP scope & intelligent recommendation
 - BMP selection & overview



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Parcel	Area (ha)	Elevation (m)	Slope (%)	Dominant Landuse	Dominant Soil Texture	Precipitation (mm)	Precipitation STD (mm)	Temperature (°C)	Temperature STD (°C)	Soil moisture (mm)	Soil moisture STD (mm)
9	64.6364	1285	4.63	8	5	602.969	81.158	3.745	1.001	236.539	35.851
10	64.9101	1250	2.46	8	6	599.863	80.739	4.501	1.001	257.105	44.462
11	64.7365	1431	13.42	5	5	615.774	82.881	0.663	1.001	187.478	25.033
12	64.2513	1135	2.71	8	4	590.833	79.524	6.714	1.001	262.858	40.437

Spatial Scale

Parcel

Location filter

Municipality

Watershed

Subwatershed

Baseline BMP summary (?)

BMP	Count	Area (ha)	Cost (\$/ha)
ROGZ	2	123.103	0
SAMG	10	472.943	0
MASB	4	179.689	0
M148H	49	2324.666	0
NAOS	1	60.466	0
Total cost (\$/yr)			0

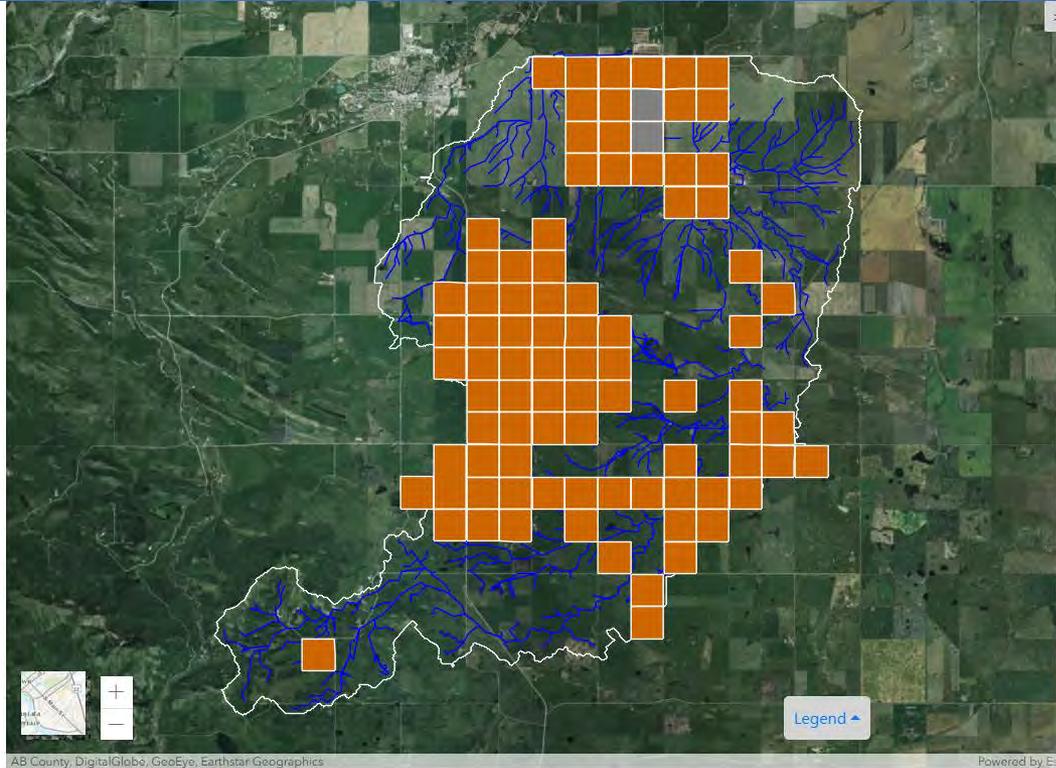
BMP effectiveness summary (?)

Parameter	Value
Runoff offsite (m3/s)	-0.0092
TSS offsite (ton)	-1362.4896
DN offsite (kg)	-2557.1995
PN offsite (kg)	-1314.7809
TN offsite (kg)	-3827.9019
DP offsite (kg)	-131.1243
PP offsite (kg)	-452.8636
TP offsite (kg)	-601.6172

**Connect investments to
impacts**

Intelligent BMP Recommendation

- Overview
- Projects
 - AIIBMPs[LSD_Conv_1978_2017_WM]
 - AIIBMPs[ESMode_TPOff02P|Parcel_Existing_1978_2017_WM]
 - AIIBMPs[ESMode_TPOff05P|LSD_Existing_1978_2017_WM]
 - AIIBMPs[ESMode_TPOff20P|LSD_Conv_1978_2017_WM]
 - AIIBMPs[ESMode_TPOff20P|LSD_Conv_2001_2010_WM]
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 - ROGZ
 - SAMG
 - MASB
 - GWW
 - RIBUF
 - VFST
 - AOPANoMASB
 - BMP selection & overview



Quick Selection

Municipality: All

Watershed: All

Subwatershed: All

Select All Deselect All

Intelligent setting (?)

Eco-service

Add Constraint

#	Type	Value		
1...	Soil carbon onsite (ton)	5000		
1...	TP onsite (kg)	-500		



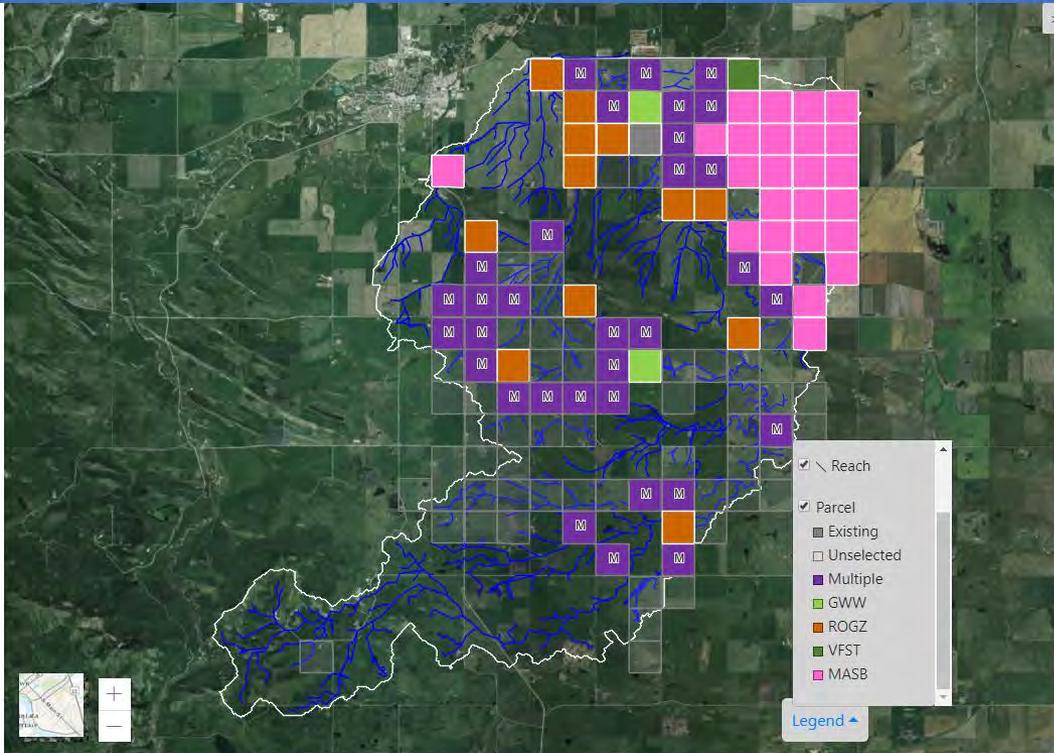
Run Intelligent Recommendation (?)

BMP Selection and Overview

Overview

Projects

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 - ROGZ
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AB County, DigitalGlobe, GeoEye, Earthstar Geographics Powered by Esri

Parcel	Farm	Parcel BMP	Structural BMP	Cost(\$)
39	4	ROGZ, VFST (64.064 ha)	None	316.482429
140	43	ROGZ, VFST (64.575 ha)	None	132.413416
9	2	ROGZ, VFST (48.304 ha)	None	217.123437
76	22	ROGZ, VFST (58.895 ha), MI48H (14.725 ha, baseline)	None	158.63868

BMP summary (?)

BMP	Count	Area (ha)	Cost (\$/ha)
ROGZ_VFST	7	380.656	1487.93
VFST	8	415.512	658.24
ROGZ	12	743.777	3060.4
ROGZ_GWW	4	210.65	366.08
GWW	1	16.158	60.08
ROGZ_AOPANoMASB	4	211.549	1219.68
AOPANoMASB	1	63.289	180.46
VFST_AOPANoMASB	1	64.059	177.8
MASB_AOPANoMASB	2	128.127	239.82
MASB	29	1732...	761.79
ROGZ_VFST_AOPANoMASB	2	88.682	660.29

Total 9317.46

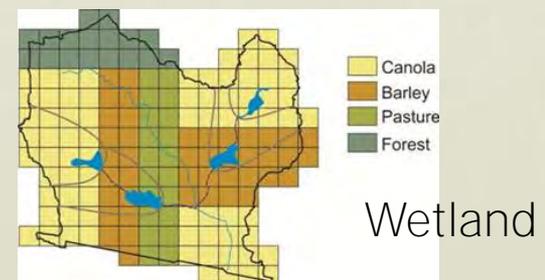
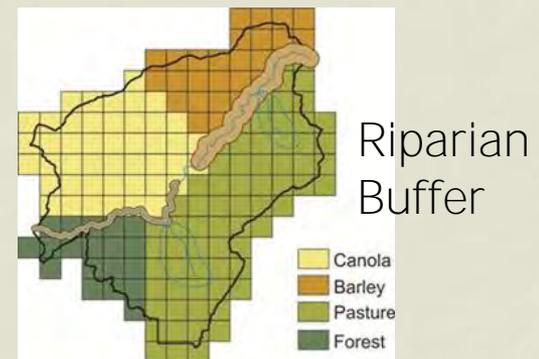
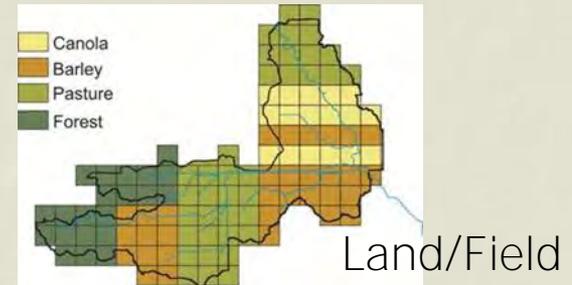
Effectiveness summary (?)

Effectiveness	Value
DN onsite (kg)	-1736.0086
PN onsite (kg)	-1434.2363
TN onsite (kg)	-3169.6544
DP onsite (kg)	-139.7856
PP onsite (kg)	-360.3397
TP onsite (kg)	-500.0472
Soil carbon onsite (ton)	5030.9492
Biodiversity onsite	0.8866
Runoff offsite (m3/s)	-0.0027
TSS offsite (ton)	-287.0046
DN offsite (kg)	-1736.0072

Report

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Acknowledgments

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