Landscape Characterization for Wetland Assessment

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Objective:

To estimate from land use data the **relative** magnitude of flows of nutrients and sediment into wetlands from their immediate watersheds.

The purpose is to **rank** wetlands based on the magnitude of the threats to their integrity.

It is not a way to estimate actual nutrient or sediment loadings to wetlands.

Rationale for this Approach:

The amount of water, nutrient, sediment and pesticide entering a wetland is largely a function of land use in its watershed.

The more the watershed has been altered or disturbed by human activities the more likely the wetland is being degraded by inputs of nutrients and sediments.

Only a limited amount of data is needed that can be obtained from existing maps and aerial photographs.

Approach:

Simple nutrient and sediment loading indices are calculated that reflect the potential relative magnitude of these inputs to a given wetland.

Two indices are being suggested:

(1) Nutrient Loading Index

(2) Sediment Risk Index

Nutrient Loading Index:

The **Nutrient Loading Index** (**NLI**) is a ratio of the potential current inputs from the watershed to what they were when the entire watershed was undisturbed, i.e., covered in natural vegetation.

NLI = Current Inputs/Natural Inputs

Where

$$\text{Current Inputs} = \acute{O}(LU_i \times NLRX_i)$$

LU_i = area of watershed in upland land use class i;

$NLRX_i$ = annual nutrient loss rate for land use class i for nutrient X.

$$\text{Natural Inputs} = TUWA \times NLRNVX$$

TUWA= total upland watershed area ($= \acute{O}LU_i$)

NLRNVX = loss rate of nutrient X for the natural vegetation type (NOTE: This is a constant.)

Characteristics of the Nutrient Loading Index:

(1) The higher the index value, the larger the potential relative nutrient loading into the wetland. **This index provides a measure of the relative threat to the wetland from nutrient inputs.**

(2) **The index does not give a realistic estimate of the actual annual loadings of nutrients to a wetland.** It only provides a crude way of ranking wetlands based on the likelihood that they are receiving nutrient loadings from the surrounding watershed.

(3) If there are point sources of nutrients within the watershed, the index needs to be adjusted appropriately.

Sediment Risk Index (SDI):

Sediment Risk Index =

Percent of watershed
(TUWA) classified as agricultural land or bare ground

+ Percent of wetland boundary adjacent to agricultural land or bare ground

+ Percent of agricultural land classified as HEL

Characteristics of the Sediment Risk Index:

(1) The Sediment Risk Index is a quick and dirty way to identify wetlands that have a greater risk of high sediment loadings.

(2) Human activities such as road construction, land clearing for housing developments, mining, lumbering, etc. can also cause significant short-term erosion problems. These activities should be noted during the assessment of the watershed and the sediment risk index adjusted by estimating the percentage of the watershed being disturbed by these activities and adding this percentage to the sediment risk index.

Case Study:

Table 1. Land use data (ha) for the watersheds of three wetlands in NW Iowa.

Land Use	Watershed W1	Watershed W2	Watershed W3
Natural vegetation	87	69	349
Mostly natural vegetation	88	0	44
Agriculture[1]	**132**	43	2,797
Mostly urban	0	67	0
Mixed	12	26	57
TUWA	319	206	3,247
Wetlands and lakes	80	87	276
Total Watershed Area	399	293	3,523

Nutrient Loss Rates for Nitrogen and Phosphorus:

Table 2. Potential annual nutrient loss rates (kg/ha/yr) for different upland land use classes (Adapted from Omernik (1977) and Marsh (1998)).

	Nutrient Loss Rate (NLR)	
Land Use (LU)	N	P
Natural vegetation	0.44	0.0085
Mostly natural vegetation	0.45	0.018
Agricultural land	**0.98**	0.031
Mostly agriculture	0.63	0.028
Mostly Urban	0.79	0.030
Mixed	0.55	0.019

S**ample Calculation:**

For agricultural land in the watershed of Wetland W1

Agricultural land = 132 ha (Table 1)

N nutrient loss rate for agricultural land = 0.98 kg/ha/yr (Table 2)

Current Input of P from agricultural land =

132 ha X 0.98 kg/ha/yr = **129 kg/yr**

Similar calculation done for each land use class in the watershed (Table 3).

Nutrient loading index for nitrogen and phosphorus for W1, W2, and W3:

Land Use	Nitrogen			Phosphorus		
	W1	W2	W3	W1	W2	W3
Natural vegetation	38	30	154	0.74	0.59	2.97
Mostly natural vegetation	40	0	20	1.6	0	0.8
Agricultural	**129**	42	2,741	4.1	1.3	86.7
Mostly urban	0	53	0	0.0	2.0	0.0
Mixed	7	14	31	0.2	0.5	1.1
Wetland and aquatic systems	0	0	0	0.0	0.0	0.0
Contemporary Inputs	214	140	2,946	6.6	4.4	91.6
Natural Inputs	140	91	1,429	2.7	1.8	27.6
Nutrient Loading Index	**1.5**	**1.5**	**2.1**	**2.4**	**2.4**	**3.3**

Sediment Risk Index:

Table 4. Percent of the watershed of each wetland classified as agricultural land, percent of wetland boundary adjacent to agricultural land, and percent of agricultural land classified as highly erodible (HEL).

Landscape Characteristics	W1	W2	W3
Percent agricultural land	41%	21%	86%
Percent of wetland boundary adjacent to agricultural land	25%	42%	29%
Percent of agricultural land that is HEL	9%	18%	22%
Sediment Risk Index	**75**	**81**	**137**

Conclusions

All three indicators of the potential risk of wetlands to nutrient and sediment inputs indicate that wetland W3 is at greater risk than W1 and W2.

Although W1 and W2 seem to at the same risk level, the source of this risk is different. In W1 runoff from agricultural land is the primary potential source of nutrients and sediments while for W2 it is runoff from urban areas.

Dickinson County, Iowa