THE MACAULAY LAND USE RESEARCH INSTITUTE

AFFORESTATION FOR PROVISION OF MULTIPLE ECOSYSTEM SERVICES:
economic implications for Ukraine

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The economics of planting trees on marginal lands in Ukraine with the purposes of timber production, erosion alleviation and climate change mitigation is analysed. Research is carried out across forestry zones, categories of land, tree species and management regimes. It employs an LP model for achieving max cumulative NPV of benefits from forest plantations over the examined period subject to the constraints.

LAND CONSIDERED FOR AFFORESTATION:

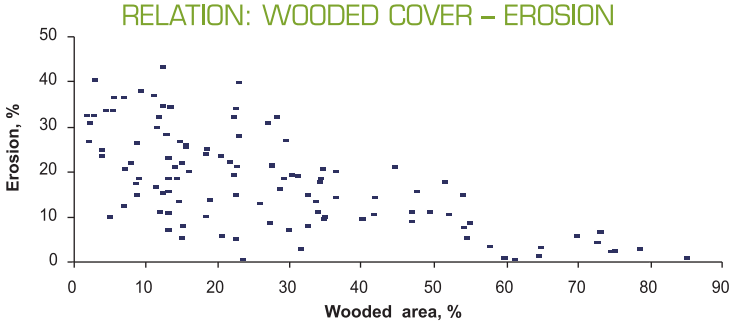
- previously productive land in Wooded Steppe and Polissja that has become marginal;
- some land not covered with forests in the Carpathian Mountains;
- eroded, contaminated, sandy and some land on slopes, along roads and rivers, and around water basins;
- land around industrial agglomerations and previously used in mining industry.

The **costs of afforestation comprise** direct costs of tree-planting and forest managment, and net returns associated with current land use for forage, pasture and wheat production.

A method of approximating a sum of monetary value for additional timber yield obtained from plantations and monetary estimates of soil protection benefits is used for computing the total **benefits of afforestation** to the LU sectors of economy. Carbon savings are approximated, as described in (Nijnik, 2002).

Regarding monetary value of additional timber, the traditional type model multiplies estimates of a physical crop change based on acreage in production by the price of timber. Evaluation of soil protection forest benefits is based on the "elasticities" of erosion with respect to forest cover.

RELATION: WOODED COVER – EROSION



The results of regression analysis provide evidence that erosion (*E, %*) depends on forest cover (*W, %*).

In the Carpathians for example:

$$log(E) = 4.3702 - 0.0523*W;\ or\ E = 79.059e^{-0.0523W},\ R^2 = 0.50$$
$$(5.46) \qquad (-3.99)$$

Annually, 1 ha of forest in Ukraine provides €1.6 to €58.2 of benefits to agriculture. They are the highest in the Steppe.

AN LP MODEL OF FOREST PLANTATIONS

$$Max \left\{ \sum_{zatm} X_{zatm} \cdot O_{zatm} \cdot P_{at} + \sum_{zatm} B_{zatm} \cdot X_{zatm} - \sum_{zatm} X_{zatm} \cdot C_{zatm} \right\}$$

z = 1, 2, 3, 4, 5 forestry zones;
a = 1, 2, 3 - land (1-bare, 2- forage/pasture, 3-weat);
t = 1, 2, 3, 4 tree species (1-pine; 2-oak; 3-beech; 4-fir);
m – forest management regimes (m_1, m_2, m_3);
X – ha of land; O_{zatm} - timber output, m^3/ha;
P_{at} - discounted stumpage price of timber, €/m^3;
B_{zatm} - discounted environmental benefits, €/ha;
C_{zatm} - discounted costs, €/ha. Major constraints are acreage.

ECONOMIC EVALUATION OF AFFORESTATION, PV, M€

Forestry zone	r %	Total benefits	Costs	NPV
Polissja (Woodland)	0	756.6	356.3	400.3
	2	128.1	162.7	-34.6
	4	33.3	99.5	-66.2
Wooded Steppe	0	3531.7	1084.3	2447.4
	2	834.7	486.0	348.7
	4	329.0	290.5	38.5
Steppe	0	4572.1	2173.3	2398.8
	2	1433.4	965.0	468.4
	4	696.6	570.2	126.4
Carpathians	0	1136.4	177.9	958.5
	2	204.9	80.9	124.0
	4	59.9	49.2	10.7
Crimea	0	707.3	345.0	362.3
	2	175.6	159.9	15.7
	4	74.2	99.4	-25.2

In the Polissja (see Map 1), the highest benefits would come from an increased timber production and carbon uptake. In the Steppe, they would occur due to the soil protection forest function. When only timber production and soil protection forest functions are considered at 2%-4% discount rates, the benefits from afforestation are high in some regions of the Steppe, Wooded Steppe and the Carpathians, where the tree-planting is economically justified on c.1.82 Mha. Incorporation of the effects through on climate mitigation increases social benefits. At a discount rate of 4%, afforestation is deemed to be limited to bare land in these forestry zones of c. 0.42 Mha.